

**CARIBBEAN COMMUNITY CLIMATE CHANGE CENTRE**



**Caribbean Community  
Climate Change Centre**

**Environment and Risk  
Management Plan  
for  
Piloting the Cultivation  
of  
*Arundo donax* in Northern Belize**

**Belmopan, Belize  
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## 1. PURPOSE OF THE ENVIRONMENT AND RISK MANAGEMENT PLAN

The purpose of this *Environment and Risk Management Plan* is to provide a framework to guide mitigation and management of potential risks that may arise from a proposed biomass pilot project (*Biomass Pilot*) to confirm the feasibility of managed/controlled cultivation of *Arundo donax* (*Ad*) for utilization as an energy crop in Belize.

The Government of Belize (GoB) through its Ministry of Finance, Public Service, Energy, and Public Utilities (MFPSEPU) has led an initiative to expand the utilization of biomass to meet some of its energy needs with the aim of adapting to climate impacts as well as to reduce the country's carbon footprint. The GoB has requested the Caribbean Community Climate Change Centre<sup>1</sup> ("5Cs"), a regional organization headquartered in Belize to coordinate the regions response to climate change, to undertake an effort to research, analyze and determine a suitable and sustainable way forward.

The *Biomass Pilot* designed by the 5Cs is one of several key activities proposed for World Bank support as a part of the Energy Resilience for Climate Adaptation Project ("ERCAP"), which is expected to be funded by a grant from the Global Environmental Facility's (GEF's) through the Special Climate Change Fund (SCCF) that has the mandate to support climate adaptation.

The *Environment and Risk Management Plan*, which is based on guidelines prepared in the United States by the North Carolina Department of Agriculture and Consumer Services<sup>2</sup>, seeks to identify potential risks or unintended consequences that could arise at each phase of the production cycle, and describes measures that will be taken in the *Biomass Pilot* project to manage and mitigate those risks in order to ensure that the *Biomass Pilot* is environmentally sustainable and socially acceptable in Belize.

### 1.1. Background

- Changes in the global climate patterns pose considerable risks for the Caribbean region. Belize, located adjacent to Mexico and Guatemala in the southeastern part of the Yucatan Peninsula, is exposed to the Caribbean Sea, making the country prone to extreme weather patterns including hurricanes and tropical storms. Climate change is likely to exacerbate these impacts including wide fluctuations in rainfall and weather patterns.<sup>3</sup>

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<sup>1</sup> The Caribbean Community Climate Change Centre ("5Cs") coordinates the Caribbean region's response to climate change. Officially opened in August 2005, 5Cs provides climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States and execute projects in the region with various development partners, including the World Bank.

<sup>2</sup> Voluntary Best Management Practices for Energy Crops: Minimizing the Risk of Invasiveness. North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, Biofuels Center of North Carolina, 2011

<sup>3</sup> Gonguez, D. (2008). Analyses of trends in averages and projections of temperature and precipitation. Belize City: National Meteorological and Hydrological Service. Belize.

- One of the major climate-related risks that Belize faces is the unpredictability and shortfalls in hydro availability due to fluctuations in rainfall. This is significant because 59% of the total installed power generation capacity of 111MW in the country is from climate friendly hydropower<sup>4</sup>. However, the availability of this capacity increasingly fluctuates due to variations in rainfall patterns. For example, BECOL Hydro, which has a total installed capacity of 52.5 MW from three cascading hydropower operations, reached slightly more than 50% of its requirements in 2010, and dropped some 25% by 2012 because of insufficient rainfall. Similar impact was seen with the smaller Hydro Maya operation, which had a fall in availability of 30% in 2012.
- When hydropower is not sufficiently available, the national power company, BEL, has the option of utilizing its back-up generation capacity, which comprises of the Westlake and BAPCOL power plants (22.8 MW and 23.5 MW respectively) that operate with diesel or heavy fuel oil – a more costly and environmentally unfriendly solution. Alternately, Belize can look to increasing its imports from Mexico, which can either be costly<sup>5</sup> or produced from less clean energy resources. In 2012, for example, the hydro shortage contributed to the cost of power increasing to 35.5 US cents per kWh<sup>6</sup>, 17% higher than the previous year.
- Moreover, the 111 MW of installed capacity is insufficient to meet the existing domestic power needs in Belize and keep up with the 5% growth in power demand. Therefore, an agreement to access up to 50 MW of additional capacity from Mexico’s Comisión Federal de Electricidad (CFE), while providing reliability, undermines the country’s energy independence. Therefore, cheaper and cleaner sources of domestic generation capacity from domestic sources would be beneficial.
- The climate risks affecting hydro availability are likely to worsen going forward. Studies for Belize have uncovered an alarming find in that the temperature in Belize is rising faster than the global average. They predict a 3.5°C increase in average temperatures over 2010-2100.<sup>7</sup> Studies suggest that the intensity of El Niño and La Niña will increase as a result and will probably occur more frequently<sup>8</sup>, which will further deteriorate the availability of hydropower and its predictability. The overall rainfall patterns forecasted for Belize show variability as well as a long-term downward trend.

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<sup>4</sup> Belize Electricity Limited (BEL) Annual Report 2013

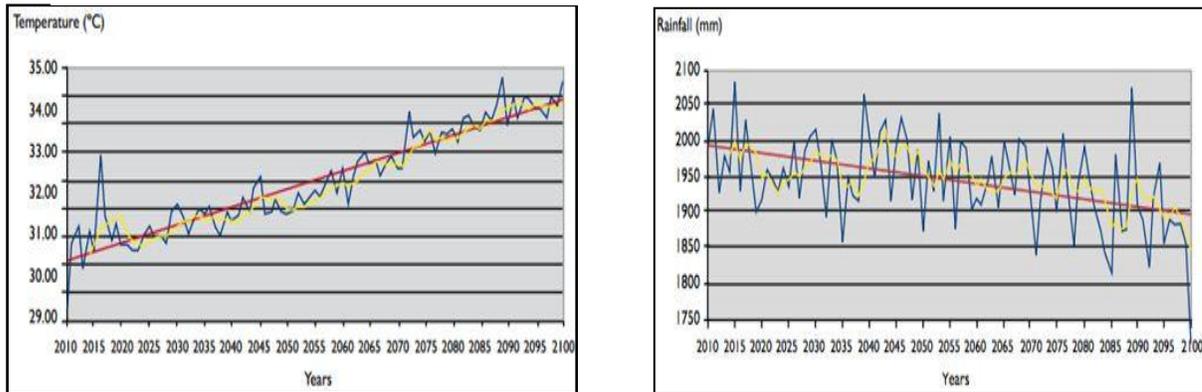
<sup>5</sup> Mexico also experienced similar weather patterns as Belize, and therefore due to this correlation, during low rainfall years, the spot prices for electricity exported to Belize tend to be high.

<sup>6</sup> BEL Annual Report, 2012

<sup>7</sup> Gonguez, D. (2008). Analyses of Trends in averages and projections of temperature and precipitation. Belize City: National Meteorological and Hydrological Services.

<sup>8</sup> Climate Change in Latin America. EuropeAid 2009

**Figure 2: Projection of average rainfall for Belize 2010 - 2100**



Blue line = Annual average; Yellow line = 5 year moving average; Red line = the linear trend

*Source: Gonguez (2008), Analyses of Trends in averages and projections of temperature and precipitation. Belize City: National Meteorological and Hydrological Services.*

- A good option for Belize to offset the shortage of domestic power supply, particular hydro resources, is to utilize domestic biomass resources, which will also enhance the energy security of the country<sup>9</sup>. In fact, the utilization of biomass has already proven effective since the introduction of the 13.2 MW co-generation power plant (BELCOGEN) operated by the Belize Sugar Industries (BSI) utilizing bagasse<sup>10</sup> - a fibrous biomass residue from the sugar refining process. After meeting its own operational energy needs, BELCOGEN sells the excess electricity to the national grid in Belize. The harvesting and processing of sugarcane begins at the end of the rainy season and continues into the dry season, the resulting bagasse is available during the dry season when hydro levels are at its lowest. Depending on the size of the sugarcane crop, enough bagasse may be produced to allow electricity generation for the national grid for up to three months after the close of the grinding season. Since it began operating, BELCOGEN has supplied between 9-14 % of Belize's electricity demand<sup>11</sup>, providing considerable relief from the fluctuations in hydro availability that the country has faced. And there is considerable scope to further support climate adaptation as more biomass generated electricity can be absorbed into the power system in Belize.
- However, the sugar cane operations do not produce sufficient bagasse to supply the BELCOGEN power plant throughout the year. At present sugar production levels, the supply of bagasse is sufficient to operate the power plant for 6-7 months each year. The sugar industry in the country is not expected to expand in the near to medium term as it faces greater competition and less favorable access to the European market. The shortage of biomass results in the BELCOGEN power plant remaining idle for 4-5 months during the year after the available bagasse supply runs out. According to BEL, during the off-crop

<sup>9</sup> Other renewable resources options such as wind and solar are not suitable substitutes to offset lack of hydro availability since they are not always dispatchable due to its intermittent nature.

<sup>10</sup> The fibrous residue that remains after sugarcane is processed and refined

<sup>11</sup> BEL Annual Shareholders Report, 2014

season, BELCOGEN only produce 5MW compared with the 13.2 MW capacity of the power plant. It is not able to fulfill its obligation under the power purchase agreement to supply BEL with 100 GWh per year. BEL is concerned that *“Without full generation from BELCOGEN, in times when the CFE supply is unavailable, BEL would barely be able to meet the country’s peak power demand.”*<sup>12</sup>

- The Government of Belize is taking steps to adapt to the unpredictable availability of hydropower that will be exacerbated by a changing climate, with greater utilization of biomass. It has proven to be an effective energy solution that offsets the seasonality of hydro, is dispatchable to respond to variations in electricity demand, and enhances the country’s energy security in a cost effective way. It enables Belize to take advantage of its relatively large, abundant, unutilized land area that is an opportunity resulting from its low population density of 15 people per square kilometre<sup>13</sup>, one of the lowest in Central America. While the primary focus is adaptation, biomass also provides a clean energy solution to the alternate of more diesel or heavy fuel oil based generation, which will contribute as a mitigation measure in the face of the climate change challenge. It is estimated that an additional supply of biomass during the out-of-crop period would replace at least 21.7 GWh from alternate sources, which would save BEL over US\$ 500,000 per year and avoid about 20,000 tonnes of CO<sub>2</sub> emissions annually. The GoB requested the 5Cs, in its role as the agency established to coordinate the region’s response to climate change, to identify alternate sources of biomass for supplying the countries energy needs. The 5Cs enlisted the support of the Clinton Climate Initiative (CCI), and coordinated efforts with BSI to identify a viable source of biomass that could serve as a supplement to bagasse in the BELCOGEN facility.

## **1.2. Identification of a supplemental biomass crop for supplying BELCOGEN**

- The 5Cs and CCI carried out a technical study<sup>14</sup> that included significant research to identify suitable crops that could be utilized as a supplement to the existing supply of bagasse. As a part of the research for the study, the 5Cs and CCI explored a variety of options that could potentially be a source of biomass. Some of the key criteria applied for identifying, screening, and selecting potentially suitable biomass crops were:
  - ✓ Crops that already exists in Belize with particular emphasis on the degree of resistance to fires which occur during the dry season.
  - ✓ Crops that have potential for high energy yields that would be suitable for power generation in existing power generation equipment in the country.
  - ✓ Ability of crop to grow resiliently on the relatively abundant marginal land in areas of the country that is not adequate for agriculture
  - ✓ Can be grown in practical proximity initially to the existing BELCOGEN biomass co-generation power plant since transporting biomass over long distances is costly and often impractical

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<sup>12</sup> BEL Annual Report, 2011

<sup>13</sup> World Bank Data

<sup>14</sup> “Belize Biomass Project Opportunity: *Arundo donax* for Co-generation at BELCOGEN” prepared by Caribbean Community Climate Change Centre (5Cs) and Clinton Climate Initiative (CCI), October 2013

- ✓ Crops that are sufficiently hardy and naturally resistant to natural disasters and weather impacts such as flooding, droughts, fire<sup>15</sup>, pests etc.
- During the initial research, a number of crops that were present in Belize were identified and screened as follows: These species with potential for biomass fuel include Caribbean pine, Cohune, *Acacia mangium*, and *Arundo donax*. Pine, cohune, and *Arundo donax* have all been in existence in Belize for an extended number of years (in some cases at least over 100 years), but *Acacia* has been introduced more recently (estimated about 7 to 10 years).
  - a) Caribbean pine (*Pinus caribaea* var. *hondurensis*) is comparable to the yellow pines of the southeastern United States and grows all over Belize. However, the single largest natural habitat is the Mountain Pine Ridge Forest Reserve in the western part of the country. This reserve has always shown evidence of the bark beetle, *Dendroctonus frontalis*, but a combination of circumstances resulted in a massive infestation which eventually destroyed an estimated 80% of the pine forest between 1999 and 2001.<sup>16</sup> These circumstances include prolonged drought in the three preceding years placing the forest under stress, and lack of silvicultural treatments, such as thinning, intended to improve the forest health. Literature reveals that the southeastern United States and the Central American pine forests were all seriously devastated by the same pests, bark beetle and *Ipps*. around that same time. While pine grows in Belize, it has proven vulnerable to insects under certain environmental conditions, throwing into doubt its hardiness. Caribbean pine has greater value for lumber than for biomass, and matures in 30 to 35 years, with a high resin content, which has been evaluated as too slow and unfeasible for BELCOGEN generation.
  - b) Cohune Palm (*Attalea cohune*), a traditional source of cooking oil across the country and already growing in 1.9 million acres, is commonly found growing on soil of good and moderate agricultural quality. The tree has multiple uses ranging from the leaves for thatch, to heart of palm for food. This crop is considered not feasible for energy production because of its other uses, and needs for high-yield agricultural lands.
  - c) *Acacia mangium* is a broadleaf legume species that can tolerate a wide range of soil types, including low fertility as well as high fertility soils. *Acacia mangium* grows in well drained acidic soils (pH <4.0) of low to moderate fertility. Within its range, Asia and the Pacific (Indonesia, Malaysia, Australia, and Papua New Guinea), this species grows in the coastal tropical lowlands on the rainforest margins, and is found growing on sandy or loamy alluvium in the coastal plains. It grows rapidly and colonizes disturbed areas, but is not fire resilient, a factor which also contributed to its elimination as a commercially cultivatable biomass crop on marginal lands. However, *Acacia mangium* displays other commercial values which make it useful for purposes other than biomass fuel. Its wood properties make it suitable for paper pulp and conversion to lumber, which is suitable for furniture, particle board, molding, veneer, and construction. The non-timber benefits of the species include honey and adhesive production, all together which make *Acacia*

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<sup>15</sup> *Arundo donax* crop is resistant to fire when the crop is alive, which is why, it is chopped, dried and then shredded, which will render the biomass material combustible in power plant boilers.

<sup>16</sup> Forest Department, Belize

*mangium* more valuable than for biomass fuel alone. In addition, *Acacia mangium* is considered as an invasive species in Belize.

- d) *Arundo donax* is a large robust weed of up to 6 meter high, naturally already established in a number of locations across Belize. It has the resilient and rapid growth characteristics making it the most suitable biomass crop identified.
- The preliminary research led the 5Cs and CCI to exclude from consideration a number of crops due to inability to meet some of the important criteria, and narrow further consideration to *Arundo donax*. *Arundo donax* L. var. *Versicolor* (Mill.) is a grass in the Family **Poaceae**. Wild cane, as it is called in Belize, is a large robust plant that is 2-6 meter high, and can be found naturally growing in a number of locations across Belize.<sup>17</sup> It can grow unbranched or branched above, spreading from horizontal rootstocks. Leaves are pale green to bluish-green, 45-60 cm long and 4-6 cm wide with large, basal ear lobes compared to those of *Phragmites australis* which are much smaller, leaf tips soft or firm not rigid and penetrating as in *P. mauritianus*. Inflorescences are cream or brown, compact, spear-shaped, 40-70 cm long.<sup>18</sup> It is native to Tropical Asia and the Mediterranean region.<sup>19</sup> It has been introduced to many countries worldwide and has become naturalized in warm temperate to tropical areas. The 5Cs has identified large plots of *Arundo donax* growing along the banks of Belize's Monkey and Sittee Rivers as well as in some areas in Orange Walk, the district where the existing BELCOGEN power plant is located.

**Figure 3: Example of *Arundo donax***



<sup>17</sup> The existence of *Arundo* in Belize has been recorded as early as 1883. D. Morris, then Director of Public Gardens and Plantations, Jamaica, recorded *Arundo* in current Belize's Sittee River area in his book, *The Colony of British Honduras, Its Resources and Prospects; with Particular Reference to Its Indigenous Plants and Economic Production* (Harrison and Sons, London, 1883), 30: "In most situations the wild cane (*Arundo*) and aquatic grasses exist as dense, tall-growing thickets, close to the water's edge."

<sup>18</sup> Henderson, 2001; Wagner et al., 1999 *Biofuels as Invasive Species*. CABI Expert White Paper Series in Biofuels.

<sup>19</sup> US Department of Agriculture (USDA) Forest Service – Fire Effects Information System. PIER, 2010d *Arundo donax*.

- *Arundo donax* is known for its fast growth and resilience. It may be harvested up to 3 times per year. The seeds of *Arundo donax* are sterile; therefore propagation is through the planting of the rhizomes in soil with high moisture availability, or by preparing land in a manner similar to that for the planting of sugar cane (i.e. land is plowed and seed beds prepared) and the *Arundo* stalks laid end to end and then covered with soil. It will self-propagate only in unobstructed wet areas, when the rhizome and or stalk are covered.
- The 5Cs and CCI research also provided evidence that *Arundo donax* could be a very good biofuel substitute, as it surpassed bagasse in terms of potential crop yields and calorific value.<sup>20</sup> *Arundo donax* had lower ash content than bagasse, which could make its combustion even cleaner than bagasse, while its higher moisture content makes it hardy in terms of its resistivity to fires during cultivation. Its ability to grow in marginal lands not adequate for agriculture provides an opportunity to utilize some of the significant amount of land in Belize that is currently not utilized for any purpose, with minimal biodiversity impact. A technical analysis contracted by BELCOGEN from Norconsult, a Norwegian consulting company, has reviewed the characteristics of *Arundo donax* and confirmed its suitability for combustion in facilities similar to BELCOGEN.<sup>21</sup>

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**Table 1: Comparison of *Arundo donax* and Bagasse**

<i>Arundo Donax</i> and Bagasse Characteristics			
Item	Unit	<i>Arundo Donax</i>	Bagasse
Crop Yields	(dry tonnes/acre)	15-20	8-10
Gross Calorific Value	(BTU/dry lb)	8,147	7,772
Net Calorific Value	(BTU/dry lb)	7,641	7,291
Moisture Content (wet basis)	(%)	64.5	50.3
Ash Content	(%)	5.7	8.6

**Source:** Elektrowatt-Ekono Oy (2005); North Carolina Biofuels Center; CCI literature review

- Based on the results of the technical analysis, the GoB made a decision to take the appropriate steps to confirm the feasibility of commercial production through the managed/controlled cultivation and processing of the crop, in order to supply BELCOGEN during the dry, off-crop season when they typically run out of the bagasse supply. The GoB requested the 5Cs to design a *Biomass Pilot* to test the production and harvesting of the crop in a limited and controlled capacity in marginal lands that are not suitable for agriculture, to evaluate the feasibility of a potential commercial operation. The 5Cs has prepared a proposal for a *Biomass Pilot* that will be able to confirm the technical, financial, commercial, and environmental and social viability of such an endeavor. The MFPSEPU has included the *Biomass Pilot* as a key activity in the Energy Resilience for Climate Adaptation Project (ERCAP), which is being prepared by the GoB to enhance the resilience of the energy sector

<sup>20</sup> Elektrowatt-Ekono Oy (former Ekono Energy Ltd) is Finland's largest independent consulting and engineering company in the energy field. In 2005, Elektrowatt-Ekono Oy conducted a study on potential fuel sources to compliment the use of bagasse in BELCOGEN.

<sup>21</sup> Report prepared by Norconsult for BSI/ASR, a group operating the BELCOGEN biomass co-generation power plant in Belize.

in order to adapt to climate change. ERCAP is being supported by the World Bank through a grant from the GEF's Special Climate Change Fund (SCCF). On May 27, 2015, the Government Cabinet endorsed the *Biomass Pilot* proposed by the 5Cs.

## 2. Project Description

### 2.1. Purpose of the *Biomass Pilot*

- The purpose of the *Biomass Pilot* is to demonstrate the feasibility of the managed cultivation of an alternate source of bioenergy production in Belize utilizing marginal land that is not suitable for agriculture, as a supplemental fuel for operating the existing BELCOGEN power plant on a year-round basis<sup>22</sup>. The *Biomass Pilot* will test the feasibility of the managed cultivation in a small scale of an already existing, fast-growing C3 perennial rhizomatous grass - *Arundo donax*, throughout the year, particularly during the dry season when hydro resources are scarce as an alternate source for power generation. It will also test the application of industry-standard risk management practices for cultivation of the crop under the specific circumstances in Belize.
- If the Biomass Pilot is proven technically, financially viable as well as environmentally and socially sustainable, then commercial cultivation of the crop will be evaluated through an industry standard feasibility study (FS) and an environmental and social impact assessment (ESIA) for the expanded use that would enable about 4-5 months of additional of supply to the existing BELCOGEN power plant for year-around operation. If the results indicate that further cultivation of *Arundo donax* is not feasible, the *Biomass Pilot* would be terminated in an environmentally appropriate manner for eradicating the crop in order to ensure that there is no continued growth in the *Biomass Pilot* project area thereafter.

### 2.2. Project Location

- The location of the *Biomass Pilot* is in the Orange Walk district in Northern Belize less than 20 miles from the BELCOGEN facility. In this district the Government of Belize identified an area of approximately 1,800 acres of publicly owned, uninhabited, marginal land that is not suitable for agriculture but could be utilized for biomass cultivation. From this larger area, a land area totalling 400 acres has been selected for piloting the managed/controlled cultivation of *Arundo donax* through the proposed *Biomass Pilot*. The identified land areas are located at a minimum 830 metres from the nearest water source at the Blue Creek, a small waterway, of between 4 to 6 metres width, flowing into the Rio Hondo. The *Biomass Pilot* Location is about 2,800 metres (1.7 miles) away from the international border between Mexico and Belize. Following a Government Cabinet decision taken on May 27, 2015 endorsing the *Biomass Pilot* proposed by the 5Cs, the Ministry of Natural Resources and

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<sup>22</sup> As previously noted, current availability of bagasse is insufficient to operate the BELCOGEN power plant throughout the year.



**Figure 5: Biomass Pilot Location and surrounds**



Figure 5 provides a closer look at the surrounding area from the 1800 acres of marginal land (marked in red) for biomass cultivation identified by the GoB. The dark green area in the map (in Figure 5) including the 1800 acres comprises natural vegetation. There are no residents in the proposed *Biomass Pilot* or the larger 1,800 acre area. The yellow concentration is the village of San Lazaro of fewer than two thousand residents, which is located 7 miles east of the *Biomass Pilot* site. Orange Walk Town (not shown on the map) which is the nearest significant population center, is located further 10 miles east from San Lazaro. The solid white line in the upper left corner of the picture is a portion of the Rio Hondo, which is the international border between Belize and Mexico. At its nearest point, the Rio Hondo is about 1.7 miles away from the project site.

## 2.3. Project Components

The *Biomass Pilot* proposed as a part of ERCAP under consideration by the World Bank for funding support from GEF's SCCF includes two key sub-components: 1) a research phase, and 2) a cultivation phase.

### 2.3.1. First Sub-Component (“Research/Test Phase”)

Under the first sub-component, the 5Cs will carry out research to test biomass yields from *Arundo donax* under different agronomic parameters and different systems for cultivation of the plant. These cultivation systems will take place on small plot areas no more than an acre in size (all within the 400 acre area designated for the *Biomass Pilot*) that in some plots will be subsoiled, i.e. a bulldozer is used to draw a specially designed equipment which can go as deep as 18 inches into the soil to break up structures that prevent proper drainage. After subsoiling the plots will be plowed prior to preparation for planting. Other plots will not be subsoiled, but only plowed and prepared for planting. Some plot areas will be limed and fertilized with different levels based on the results of the soils test. Other areas will be drained (within the 400 acre area designated by a buffer zone) and some others not drained. One or two plots will be selected to pilot and refine eradication techniques throughout the Research/Test Phase, which will help further inform the implementation of the subsequent phase. The various plot areas laid out over the 400 acres will provide the data that give key information for the feasibility assessment such as rate of growth, annual yields, nutrient uptake, water balance, fuel quality, and the proposed eradication approach. The lands on which the plots are to be located have high degrees of variability in terms of soil thickness, organic matter, particle density, nutrient and water holding capacity, and poor infiltration. Soil analysis and geospatial analysis will be used as a principal guide for the laying out and monitoring of research<sup>23</sup>. The Research Phase is expected to last about three years in duration.

**Soil Tests:** The soil tests that will be carried out for each research plot include:

- (a) pH of soils;
- (b) Fertility of soils (Ca, Mg, N, P, K);
- (c) Levels of Aluminum and Manganese in soils; and
- (d) Particle and bulk density of the soil to a depth of 3 feet.

**Research/Test Plots:** A total of 50 plots not exceeding an acre each in area will be utilized from the total 400 acre area designated for the *Biomass Pilot* to carry out yield and production trials, by planting the crop under different techniques and conditions in order to evaluate the results. It will help inform the approach and techniques to be utilized in the subsequent cultivation phase,

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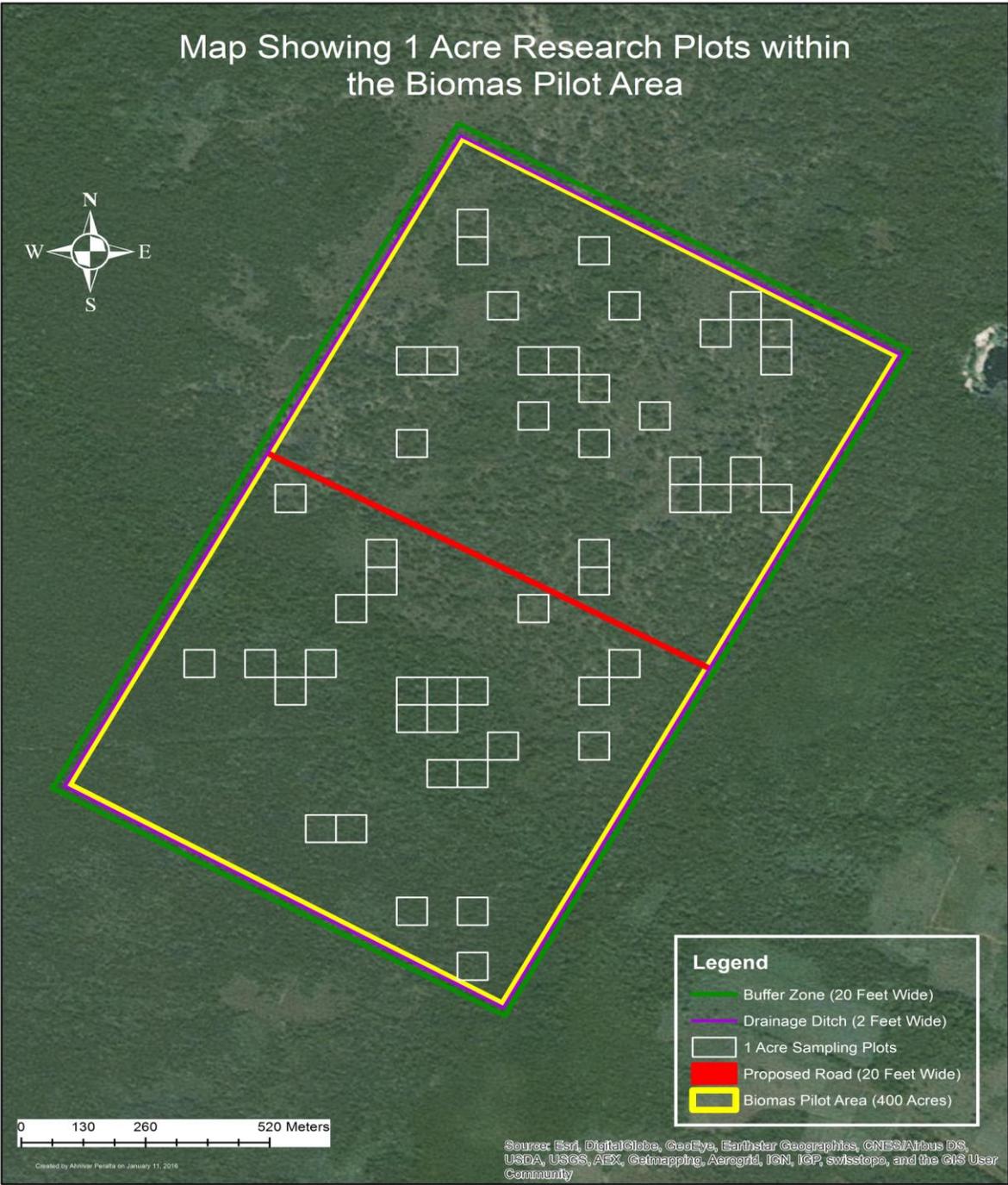
<sup>23</sup> The technical information summarized in this document is extracted from the detailed technical proposal prepared by the 5Cs for the *Biomass Pilot*: Pilot Project for the Production of *Arundo donax* as a Renewable Biomass Fuel for Belize

should the results be as anticipated. These research/test plots will also help establish baselines that can be monitored throughout the *Biomass Pilot*. One or two plots will be selected to pilot and refine eradication techniques throughout the Research/Test Phase, which will help further inform the implementation of the subsequent phase.

Using mathematical models, the 400 acre parcel will be subdivided into 400 plots using a simple grid template. The 50 individual plots of each being up to one acre in size to be planted will then be selected using the systematic sampling method, as it is a common methodology applied in the sector. A site map of the results will be prepared and used to record treatments, for monitoring, identification, and management (recording of outputs). Since the purpose of these research plots is to determine yields, they will be established at different densities to allow for comparison.

- **Land Clearing:** The initial clearing will take place on the areas covering the statistically selected fifty test/research plots. An experienced and licensed contractor will be hired to clear the vegetation using a bulldozer equipped with a root and brush rake. This type of equipment will reduce soil loss and compacting caused by using heavy equipment repeatedly on the same site. The cleared vegetation will be shredded and returned to the land as smaller pieces of biomass –some of which will be incorporated into the soil. Each plot will then be located be identified by a GPS location, half of the total number of research plots will be sub-soiled using a bulldozer trailing a subsoiler to a depth of approximately 18 inches, based on the soil tests, to break up the underlying hardpan.
- **Plowing and land preparation –** Upon completion of land clearing and subsoiling activities a portion of the 50 plots will now be plowed by a tractor drawn plow. Subsequent to plowing, the area will be limed followed by application of natural fertilizer produced in Belize. Liming reduces or neutralizes soil acidity. After plowing, liming and fertilizer application the tractor will then create four-inch deep furrows spaced at one and two feet apart in the different plots into which the *Arundo donax* stalks will be manually planted and the covered over with soil and then left to germinate. Please see the illustration in Figure 6.

Figure 6: Illustration of Research Plots within the Biomass Pilot Area (400 acres)



- Construction of Buffer Zone/Access Roads – Simultaneously with the land clearing and preparation activities, the project would establish at least 20 foot wide built-up access

road around the periphery of the 400 acre land area designated for the *Biomass Pilot*. This road, which will be elevated 12-18 inches, will serve multiple purposes including enabling access into the field, as well as serve as a mechanism/barrier to contain the crop and plant material as intended within the designated pilot area. In addition, the construction will include drainage to ensure adequate water flow within the 400 acres but will also ensure that water utilized for cultivation and other purposes will not be drained outside the Buffer Zone and is retained within the *Biomass Pilot* project area. The Buffer Zone will also serve to minimize potential flooding of the fields during the rainy season and as a fire break to prevent any external wild fires to impact the *Biomass Pilot* project area. The Buffer Zone/Access Roads will be constructed to support the entire *Biomass Pilot* project including the research phase (sub-component 1) as well as the managed production and cultivation phase (sub-component 2). *The risk management aspects of the Buffer Zone are further described later in the paper in the Risk Management section 4.4.*

- Planting – For the initial planting in the 50 test plots, *Arundo donax* will be harvested from where it is already growing in Belize, specifically the Monkey and Sittee Rivers area, for which the 5Cs have already obtained a permit (Appendix 5) from the Forest Department. The freshly harvested stems (only, without the rhizomes) of the *Arundo donax* will be cut on site where it is collected, and loaded immediately into closed metal container trucks (similar to Figure 7 that shown below) which are equipped with lockable doors in the rear. Each load will be locked for transportation in order to ensure that no spillage occurs between the collection site and the planting (*Biomass Pilot* project) site. The vehicle will be inspected including tires by project personnel prior to transportation to ensure that there is no crop material outside the container truck. Once the stalks are transported to the *Biomass Pilot* project site, the doors of the container truck will be further inspected before reopening. *The risk management practices that will be implemented during planting and transportation are further described later in the paper*

Figure 7: Type of container trucks for transportation of *Arundo donax* cuttings



*in the Risk Management section 4.4.*

- The live stalks of freshly harvested stems cut 18 to 36 inches in length will be laid end-to-end in the furrows, covered with soil, and monitored for germination. The research plots will be monitored for over a period of one year while increases in height will be measured and recorded. Canopy closure will be observed. Soil tests will also be conducted to monitor soil moisture during the period of the trials. Records will be maintained of all data collected. The 5Cs will keep the World Bank informed of the results during the Research Phase.

### **2.3.2. Second Sub-Component (“Managed Production and Cultivation Phase”)**

- Based on the yield results and the success of various agricultural systems employed for the research as illustrated in the GRDI – for the relationship between factors the results would tell us about the impacts of subsoiling on total biomass yield and under what soil conditions subsoiling should be done prior to planting. These will be similar results for liming and fertilizer application, for example what rate of liming (tons/acre) gives the best yields, how the yield is affected by the level of fertilizers application, and whether the area was subsoiled or not for planting. The results from the various test plots in sub-component 1 will provide the data to identify the best set of soil conditions for the establishing high yielding *Arundo donax* farms. This information derived from the *Biomass Pilot* will be the agronomic basis for deciding whether to expand cultivation to 400 acres within the 500 acre area that was approved by the GoB or end the activity by removal of all *Arundo donax* material from the site. The goal is to pilot and test whether *Arundo donax* can be cultivated in a sustainable manner that is commercially feasible to supply the operations in the existing power plant at BELCOGEN as a supplement to bagasse. If the decision is to proceed with the cultivation of 400 acres, the 5Cs will discuss with the World Bank the results of the Research Phase, and seek its no-objection to proceed following after reaching formal agreement with BELCOGEN. Upon receiving the World Bank’s no-objection, the 5Cs will proceed with establishing the 400 acres cultivation area for the *Biomass Pilot* as described in the following sections. *Please see Section 4.4 for the details of the risk management plan for the expansion of the managed/controlled cultivation of the crop to the 400 acres, and the eradication approach for the 50 acres of test/research plots or the 400 acre cultivation, in the event of the Biomass Pilot is terminated following either stage based on results.*
- The first step in expanding cultivation to the entire 400 acres would be removing the remaining vegetation from the area. The next step would be decided by the results of the impacts of subsoiling on yield liming, fertilizer, distance between furrows, and drainage. This data from the research plots which would provide the following information – the degree of subsoiling required, the amount of lime to be added if any and similarly the level of natural fertilizer to be applied across the entire 400 acres. As with the research plots the *Arundo donax* will be planted in furrows. The planting material will come from the research plots by

cutting existing *Arundo donax* stalks growing in the research plots, it is estimated that yields of approximately 15 tons per acre will provide all the planting material need for the 400 acres. To establish the 400 acre the entire area will be adequately prepared for the planting of the *Arundo donax* crop. This includes the plowing of the plot areas and the preparation of beds. The steps outlined in First Sub-Component (section 2.3.1) above will essentially be replicated guided by the results from the research plots. Establishment of the 400 acres will be done as follows:

- Removal of the natural vegetation from the area as was done for the research plots using bulldozer equipped with rake for removal of biomass above and below ground. The site will be sub-soiled and prepared for planting using tractor.
- Planting of *Arundo donax* – Tractor drawn plows will prepare the land for liming. Four inch deep furrows spaced one and two feet apart will again be made to receive the cuttings.
- Freshly cut *Arundo donax* stems will be cut to lengths between 18 and 36 inches as determined by the analysis of the research plots, laid end-to-end in the furrows, and covered with soil. As previously noted, no rhizomes will be removed or transported.
- Buffer Zone – The existing Buffer Zone, of at least 20 feet width, which was established at the inception of the *Biomass Pilot*, is designed to support the entire 400 acre project; and will continue to serve as: a) access road, b) barrier to contain crop and prevent unintended propagation outside project area, c) maintain water within project area and prevent drainage beyond the 400 acres, and d) a fire break in the event wild fires outside the project attempts to encroach the cultivation area.
- Water-Drainage - The water that will be utilized for cultivating the crop will be natural rain water that will be retained within the project area and prevented from drainage outside by the Buffer Zone/Access Road barrier. No water will be utilized for the *Biomass Pilot* from the nearby Blue Creek, nor will any water from the project be drained into the creek. However, drainage will be constructed within the cultivate plots (i.e. within the 400 acre *Biomass Pilot*) to adequately distribute water and also clear used water from washing machinery and equipment. The water will drain and remain within the 400 acre project area contained by the Buffer Zone. The project will dig a single small well for supplying water for washing machinery and equipment as well as other project uses.
- For the initial planting in the expanded 400 acre area, *Arundo donax* will be harvested from the existing test plots that were planted during the Research Phase (sub-component1). The freshly harvested stems (without the rhizomes) of the *Arundo donax* will be cut and (re) planted within the larger 400 acre area, with the stalks also placed end-to end in the furrows before covering with soil.

- The risk management aspects during each of the steps of establishing the expanded plots and planting the crop is further detailed later in the paper in the Risk Management section 4.4.

**Harvesting:** Once the *Arundo donax* is ready to be harvested, typically two times a year, this will be carried out mechanically utilizing a harvester with brush cutters, as shown in Figure 8 that will be rented locally with project funds. The chipped material of approximately half inch sized pieces will be discharged directly into tractor drawn trailers for transportation to the on-site storage area. The rhizomes of the plant will not be removed and will remain in the soil. The processed crop, which is chipped, does not contain rhizomes, and is therefore not capable of further propagation. Additionally, since the seeds of *Arundo donax* are sterile, the crop does not propagate through them via airborne or other means either. The machinery that is used for harvesting and processing will be cleaned and washed prior to leaving the project premises until recalled for the next harvesting operation.

**Figure 8: Picture of Mechanized Harvesting System for *Arundo***



*Source: 5Cs*

**Storage:** The harvested (cropped and chipped) *Arundo donax* will be immediately moved to a custom constructed storage area of about 19,000 square feet within the pilot premises, where the material will be dried over a period of 2-3 weeks. During this period, depending on climate conditions the typical water content of the plant of about 60% will reduce to about 15%-20%. The chipped and dried biomass material will be stored at the custom constructed storage area with hardened concrete flooring until it is ready to be transported as demanded by BELCOGEN. Immediately before transportation, the chipped/dried and stored biomass material will be further shredded using a mechanical plant shredder so that the ½ inch material will be transformed into fibers that are similar to bagasse, ready to be utilized in the boilers of the existing BELCOGEN biomass co-generation power plant.

*The risk management aspects during harvesting, processing, and storage will be further detailed later in the paper in the Risk Management section 4.4.*

- **Transportation:** The stored *Arundo donax* material, which is now ready for utilization in the existing BELCOGEN boilers will be transported upon request to the BSI facilities, located less than 20 miles from the site of the *Biomass Pilot*. The fibers, which are comparable to processed bagasse at this point, will be transported in locked container trucks (Figure 7) as shown earlier in Section 2.3.1 that will use mostly secondary roads without crossing any sensitive areas or natural habitats within Orange Walk on its way to the existing BELCOGEN power plant. The container trucks will be washed and inspected prior to departure. The route from the location of the *Biomass Pilot* to the existing BELCOGEN power plant will be periodically inspected to ensure that the fibrous biomass materials do not fall from the locked container trucks for unanticipated reasons. Once the fibrous biomass materials reach the existing BELCOGEN facility, it will be stored along with bagasse in the existing storage facilities, which operate in compliance with domestic regulations in Belize.

*The risk management aspects of the transportation of harvested, chipped, and shredded biomass material will be further detailed later in the paper in the Risk Management section 4.4.*

- **Evaluating Results:** The *Biomass Pilot* will be implemented for three years during which time the *Arundo donax* crop will be harvested one to two times per year. The results from the *Biomass Pilot* will be carefully monitored and evaluated during this time.
  - At the conclusion of the three (3) year Research/Test Phase (sub-component 1), an evaluation will be carried out to determine the best approach for proceeding with the expanded cultivation of the full 400 acres in sub-component 2. For example, the evaluation will consider whether the research plots which have been subsoiled, limed and fertilized displaying better growth and yields than the plots that were not prepared in that manner for planting of the *Arundo donax*. The research results from subcomponent 1 will provide the information as to the cultivation systems that would generate the highest biomass yield per acre. These research results will be shared with the World Bank, for its no-objection to proceed with the next sub-component.
  - Sub-component 2 – the managed production and cultivation phase, when the *Biomass Pilot* will be expanded, following the World Bank’s no-objection, to cover up to the entire 400 acre area, will be based on the cultivation approaches and techniques identified as being most suitable from the research/test phase (sub-component 1). At the conclusion of the Managed Production and Cultivation phase (sub-component 2), an industry compliant Feasibility Study (FS) and an Environmental and Social Impact Assessment (ESIA) in-line with international standards will be carried out. The Terms of Reference (TORs) for the FS and ESIA will be submitted for the World Bank’s no-objection prior to proceeding with sub-component 2 – the managed production and cultivation phase. The primary purpose of the FS and the ESIA is to

evaluate and determine whether the Biomass Pilot provided successful evidence to confirm whether *Arundo donax* could be commercially cultivated on marginal land in Belize in a technically sound, financially feasible, and environmentally sustainable manner. In this regard, the pilot will provide valuable information and lessons that will inform the FS and the ESIA, so that any further development will be prudently undertaken and meet the highest standards of quality and safeguards. The FS and the ESIA will be prepared in consultation with and the results publicly disclosed.<sup>24</sup> Any follow-on activity may be pursued by the 5Cs following the *Biomass Pilot*, as a separate project.

- In the event that the FS and/or the ESIA from the *Biomass Pilot* identify technical, commercial, financial, or safeguard related issues that cannot be mitigated or managed, in a cost-effective manner then the effort would wind down with the eradication and disposal of the remaining *Arundo donax* from the existing plots within the piloted 400 acres. *Further details regarding the steps for eradication is provided later in the paper in the Risk Management section 4.4*

### 3. BIODIVERSITY IMPACT

*Arundo donax*, commonly referred to as wild cane, is a plant that has been documented at least since 1883<sup>25</sup> as part of the Belize ecosystem/landscape. *Arundo donax* can be found across present day Belize. Subsequent to collection of data from the field, collaborative work between the 5Cs, the Land Information Centre of the Belize Ministry of Natural Resources and Agriculture, and CATHALAC of Panama, enabled the development of baseline data about the distribution of *Arundo* in Belize. The spectrum analysis exercise undertaken by CATHALAC<sup>26</sup> in October 2012 using satellite imaging estimated that, some 354 square kilometres of land area is under *Arundo donax* on a national scale, which converts to about 1.5 percent of the country's territory (see Appendix 8).

The areas within the country where *Arundo donax* is in existence includes the Orange Walk District in Northern Belize where the proposed *Biomass Pilot* will be established. Please see Figure 9 which identifies the *Arundo donax* distribution in Orange Walk District based on enlarged satellite images of the Orange Walk district applying spectrum analyses. Some locations of the naturally growing *Arundo donax* within the Orange Walk District are circled in white on the map.

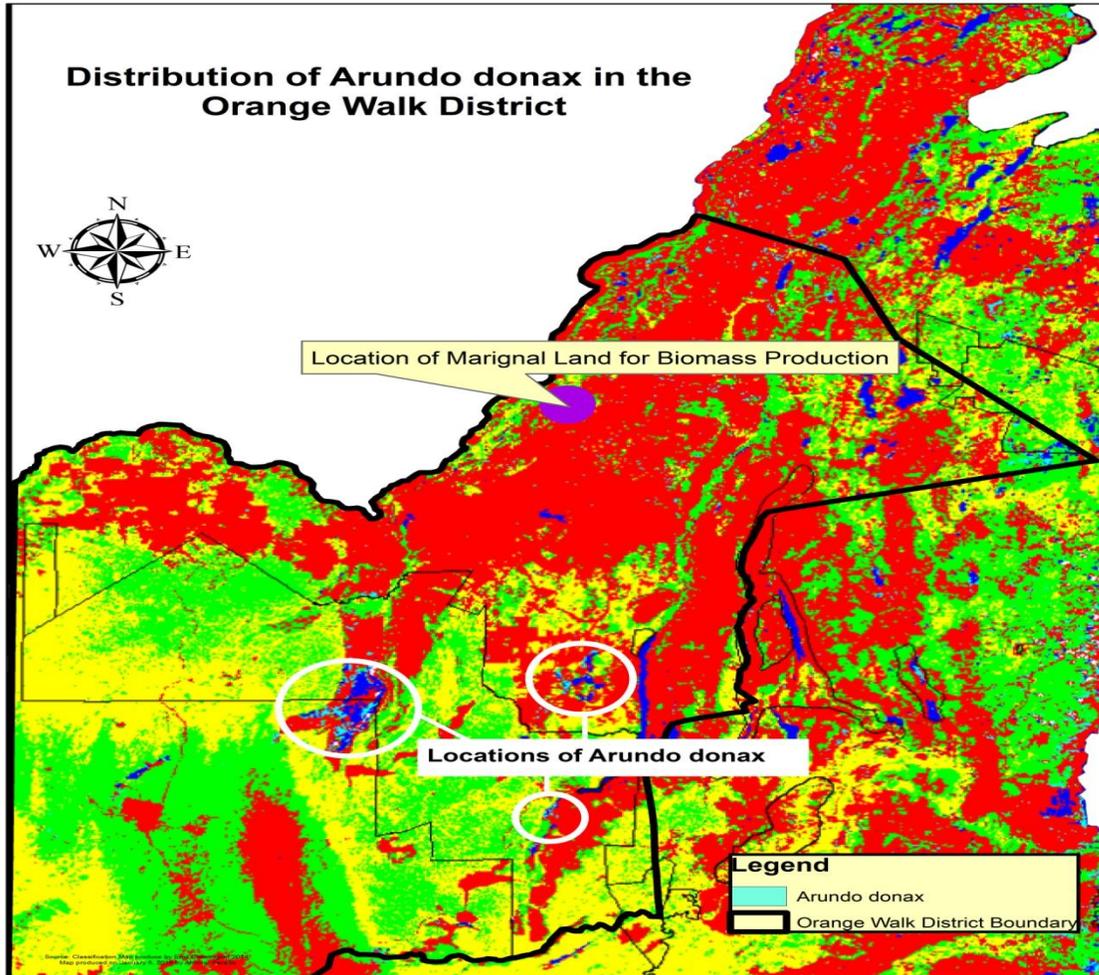
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<sup>24</sup> Since the FS and the ESIA will be prepared during the implementation of the ERCAP project, it will be subject to World Bank and GoB review and approval for standards.

<sup>25</sup> D. Morris, then Director of Public Gardens and Plantations, Jamaica, recorded *Arundo* in current Belize's Sittee River area in his book, *The Colony of British Honduras, Its Resources and Prospects; with Particular Reference to Its Indigenous Plants and Economic Production* (Harrison and Sons, London, 1883), 30: "In most situations the wild cane (*Arundo*) and aquatic grasses exist as dense, tall-growing thickets, close to the water's edge."

<sup>26</sup> Emil Cherrington, The Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC in Spanish - Centro del Agua del Trópico Húmedo para America Latina y el Caribe)

Figure 9: *Arundo donax* distribution in Orange Walk District.



Map: A. Peralta, 2015

The aggressive growth of *Arundo donax*, which is one reason it is attractive as a biomass crop, can also raise concerns that it can spread laterally by rhizomes into agricultural land resulting in the replacement of native species of vegetation. Riparian areas are particularly sensitive. However, as the spectrum analysis from the 2012 satellite imaging confirms (Appendix 8), that there is already considerable growth of *Arundo donax* along the banks of the Monkey and Sittee Rivers in the south of the country, as well as in the Orange Walk District in the north of the country (see Figure 9) where the proposed *Biomass Pilot* is located. However, unlike many other species with aggressive growth, *Arundo donax*'s seeds are sterile, making it far less likely to spread unintentionally since it does not propagate through airborne means. For *Arundo donax* to propagate, it requires either a rhizome or a stalk that is planted manually and covered with

soil. In Belize, unlike some other plants, *Arundo donax* is not classified as an invasive species, and therefore, its cultivation is not restricted.

The 5Cs carried out a comparative evaluation applying spectrum analysis to satellite images from March, 2000 and October, 2012; to identify the growth of *Arundo donax* in Belize (see Appendix 8). The results of the analysis indicates that the coverage of *Arundo donax* in the year 2000 was 457 square kilometres (about 2 percent) and in 2012 its coverage was 354 square kilometres (about 1.5 percent). The satellite imaging confirms that, on a national basis, there has not been any significant propagation of *Arundo donax*; where its coverage nationally has remained largely unchanged, relegated primarily to riparian areas<sup>27</sup>. The satellite imaging confirms that in over 100 years of existence, *Arundo donax* in Belize has been primarily limited to riparian areas, and even without specific human management, has not spread extensively.

In fact, when Belize submitted its Fourth National Report to the United Nations Convention on Biological Diversity in 2010; it listed species considered to be “Invasive” in the country which excluded *Arundo donax*. It is on the basis that there is no evidence of invasiveness of the crop in Belize that Belize Department of Environment had no objection<sup>28</sup> to the *Biomass Pilot* utilizing *Arundo donax*. *Arundo donax* is classified differently in various jurisdictions. For example, while the United States Environmental Protection Agency (EPA) approved *Arundo donax* as a biofuel, and it is presently being cultivated in the states of North Carolina and Oregon, while the crop is banned in California<sup>27</sup>.

In the specific case of the proposed *Biomass Pilot* in Belize, the biodiversity impact of *Arundo donax* spreading to replace native species and vegetation is minimal. This is primarily because the *Biomass Pilot* will only utilize the relatively abundant land in Belize that is classified as “marginal” and not suitable for agriculture. The land classification in Belize is separated into five categories for land potential and agricultural value, as illustrated in table 4 below. The classification, conventionally categorized, is based on agricultural potential and soil attributes, including fertility and drainage. The 2003 National Food and Agriculture Policy<sup>29</sup>, based on the results of a number of studies, declared that 64% of all land in Belize is unsuitable for agriculture. Of the land that is unsuitable for agriculture in Belize, a sizable 4,600 square kilometers (over 20% of total land area) are marginal (Land Value category 4). The 500 acre land area that was approved by the Ministry of Natural Resources and Agriculture (including the 400 acre area that will be utilized) for the *Biomass Pilot* (and even the larger surrounding 1,800 acre area identified by the 5Cs) has been confirmed as being “marginal” by the Department of Environment of the Ministry of Forestry, Fisheries, and Sustainable Development following an inspection by its officials prior to the agency providing a no-objection to 5Cs to proceed with the

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<sup>27</sup> The satellite imaging shows that the natural coverage of *Arundo donax* in the country actually declined from 2000 to 2012 reducing from 457 square kilometres to 354 square kilometres, although the reduction is not very significant (coverage went from 2 percent to 1.5 percent). While it is not possible to confirm the exact reasons for the decline, closer observations of the satellite images to isolate the areas where the crop coverage declined suggests that it may have been eradicated for the likely expansion of agriculture, primarily banana cultivation in the mid-south.

<sup>28</sup> Letter dated May 26, 2015 by the Department of Environment.

<sup>27</sup> University of California Agriculture and Natural Resources, 2007. How to Manage Pests in Gardens and Landscapes. Integrated Pest Management.

<sup>29</sup> Issued by the Ministry of Agriculture and Fisheries.

*Biomass Pilot (Please see Appendix 2 for No-Objection Letter)*. These lands have low quality soil and poor drainage, making them unsuitable for agriculture even with skilled management and the use of high value chemical inputs (fertilizers). Despite the poor agricultural potential for conventional crop production, the 5Cs analysis suggests that these lands, which would otherwise be unutilized, can be well suited for growing a resilient biomass crop such as *Arundo donax*.

**Table 4: Summary of Land Potential (Agricultural Value)**

Agricultural Value	Area (km <sup>2</sup> )	%	Characteristics	Economic Potential
1	990	4.3	Includes floodplain soils, generally acid but respond well to fertilizers.	High to very high income potential. Suitable for most crops.
2	2,790	12.1	Includes the undulating to flat well drained limestone land. Generally high fertility, but citrus should be avoided because of risk of lime chlorosis and droughtiness.	Good chance of financial success. Suitable for arable, pasture and sugar-cane.
3	4,480	19.5	On limestone but imperfectly drained, although some may suffer from moisture deficiency. Some soils are compacted or shallow.	Moderate chance of financial success with good management, unlikely to provide economic return under poor management.
<b>4</b>	<b>4,670</b>	<b>20.3</b>	<b>These soils are really poorly drained, shallow, and droughty.</b>	<b>Marginal, even with skilled management and high inputs.</b>
5	10,040	43.7	Mostly steep slopes of the Maya mountains and limestone karst.	Extremely small chance of financial success.

SOURCE: King, R.B., Pratt, J.H., Warner, M.P. and Zisman, S.A. (1993). *Agricultural Development Prospects in Belize (NRI Bulletin 48)* – a study prepared for the benefit of the ministries of Agriculture and Fisheries, Natural Resources and Tourism and Environment.

The biodiversity concerns about fast growing species such as *Arundo donax* stem primarily from the unintended growth into land where existing native species and vegetation will be replaced. In the case of the proposed *Biomass Pilot*, it is intended and by design that controlled cultivation will be undertaken in otherwise unutilized land with limited biodiversity value for the specific purpose of producing biofuel to capture economic and environmental benefits for the country by generating cheaper and cleaner energy. The specific land area acquired for the *Biomass Pilot* is modest in scale, uninhabited by people and not utilized for any agricultural purposes. Therefore, in the absence of the *Biomass Pilot* these lands would remain unutilized. Another biodiversity concern is the introduction of new crops that may overrun native species and existing vegetation. However, cultivating *Arundo donax* will not introduce a new plant as the species already exists in Belize in general and more specifically in the Orange Walk area (as previously illustrated in Figure 9). Most importantly, for the purposes of safeguarding biodiversity, the proposed *Biomass Pilot* will not lead to any significant habitat lost or destroyed since the specific land area acquired has limited vegetation and tree cover (and partly as a result) not a habitat for fauna. As importantly, this document includes a risk management plan following good-practice guidelines to ensure that the proposed *Biomass Pilot* does not result in unintended expansion of the crop beyond the 400 acre area designated for the project.

The 400 acre area designated for the *Biomass Pilot* is characterized by leached soils over white clays and white sandy soils which support lowland broadleaf forests comprising species such as Palmetto (*Acoelorrhaphe wrightii*), scrub oak (*Quercus spp*), Bullet tree (*Bucida bucera*), and calabash (*Crescentia alata*). None of the tree specimens found in the 400 acre *Biomass Pilot* area is of commercial quality. The Palmetto palm is abundant across the entire country in much more readily accessed locations. The stems are occasionally harvested and used for locally produced lobster traps. Much better specimens of Bullet Tree are found in wetland areas and along all the waterways throughout the country. The Bullet Tree specimens observed in the 400 acre *Biomass Pilot* are stunted and malformed. The other species are considered shrubs and have no commercial value. The type of vegetation and the incidence of wildfires might attract white-tailed deer (*Odocoileus virginianus*) and Gibnut (*Agouti paca*) - species where their conservation status is stable<sup>30</sup>. While the area may be considered as habitat for such animal species, no evidence of wildlife, including fauna and avifauna, was observed during an inspection by the Department of Environment, Forest Department, and Land and Surveys Department; prior to granting the letter of Environmental Clearance (Please see letter at Appendix 2). This type of ecosystem is common in Belize and can be found in over 20 percent of the land area across the country. Figure 10 below provides an illustration of typical vegetation cover on the 400 acres of land on which the *Biomass Pilot* is expected to take place.

A 2006 study<sup>31</sup> identified areas within the country that had significant biodiversity value and designated them as Key Biodiversity Areas (KBAs). This study subsequently served as the basis for the GEF funded Management of Key Biodiversity Areas Project. According to this study, the area designated for the *Biomass Pilot* is not in proximity to any designated KBA.

Conservation in Belize is mostly ‘in situ conservation’, so the national protected areas system is the nucleus in conserving biological resources. This means that species are maintained and preserved in their natural habitats. The vegetation found in the study area is plagio-climax and therefore there is limited biodiversity. At the same time the soils are low fertility therefore the plants that grow there are those that are very efficient in extracting nutrients. The area is of shallow soils above a hardpan layer which inhibits the infiltration of water and root growth to the lower levels of the soil, again limiting the variety of plant species. This type of soils exists in about 20 % of the lands in Belize so there is no potential loss of valuable biodiversity species, biodiversity and/or ecosystem functions. This study was undertaken under the GEF funded Strengthening National Capacities for the Operationalization, Consolidation, and Sustainability of Belize’s Protected Areas project.

**Figure 10: Vegetation on the Project site.**

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<sup>30</sup> According to the International Union for Conservation of Nature and Natural Resources (IUCN)

<sup>31</sup> Jan Meerman and Jenny Hewson, “Establishing a Baseline to Monitor Species and Key Biodiversity Areas in Belize”, Critical Ecosystem Partnership Fund (CEPF), 2006.



The use of the proposed 400 acre *Biomass Pilot* area for research will therefore have minimal impact on biodiversity. It is not located near a KBA, utilizes marginal land that would otherwise not be utilized as it is not suitable for agriculture, consists of an ecosystem that is abundantly available in Belize, and identified as an area of limited biodiversity value. While the biodiversity impacts are small, the proposed *Biomass Pilot* will lead to a positive impact in addressing climate change as it will contribute to the reduction of Greenhouse Gases (as well as reduce local pollution by offsetting the potential need to utilize diesel based generation); and help Belize adapt to climatic changes that affect the country. Therefore, the proposed *Biomass Pilot* has significant economic and environmental benefits while having minimal negative biodiversity impact due to the limited existing biodiversity value of the area. It is on the basis of this determination on balance that the proposed *Biomass Pilot* was endorsed by the Government Cabinet, and received permission to proceed by a number of responsible Government agencies including the Forest Department in the Ministry of Forestry, Fisheries, and Sustainable Development, the Department of Environment, and the Ministry of Energy, Science and Technology, and Public Utilities.

#### **4. RISK MANAGEMENT PLAN FOR PILOTING CULTIVATION OF ARUNDO DONAX**

##### **4.1 Potential Risks associated with Managed Cultivation of *Arundo donax***

It is feasible to prudently carry out the managed/controlled cultivation of *Arundo donax* for specific focused applications, as is the case with the proposed *Biomass Pilot*, which is specifically designed to evaluate the feasibility of cultivating the crop as a source of biomass for energy production. A similar controlled and managed cultivation of *Arundo donax* has been ongoing successfully in North Carolina in the United States for over six years<sup>32</sup>. In the case of Belize, managed/controlled cultivation of *Arundo Donax* provides an opportunity to utilize relatively abundant, uninhabited marginal land that would otherwise be unused, with minimal biodiversity impact. Therefore, the key safeguard consideration is to ensure that the implementation of the proposed *Biomass Pilot* is managed and controlled according to its design. More specifically, that the *Arundo donax* is cultivated within the designated boundaries; and that the likelihood of it leading to unintended propagation beyond the *Biomass Pilot* area is

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<sup>32</sup> Undertaken by the North Carolina Department of Agriculture, the United States.

minimized. As importantly, there should be a plan to safely and prudently eradicate any remaining *Arundo donax* should the cultivation not be continued beyond the proposed *Biomass Pilot*. Thus, the primary objective of the remaining sections of the *Environment and Risk Management Plan for the Biomass Pilot* is to identify key risks that could potentially lead to the unintended propagation from the *Biomass Pilot* and introduce measures and steps that will be taken by the 5Cs during its implementation to minimize such risks.

The basis for the following risk management framework detailed in Section 4.3 developed for the *Biomass Pilot* is the Voluntary Best Management Practices for Energy Crops: Minimizing the Risk of Invasiveness, produced by the North Carolina Department of Agriculture in the United States, in association with the Biofuels Center of North Carolina<sup>33</sup>. It provides guidance as to the best-practices for managing risks and containing a crop that can grow aggressively such as *Arundo donax*; so that the design and goals of the proposed *Biomass Pilot* can be maintained and unintended propagation avoided. The guiding principles of the Risk Guidelines are adapted and applied to the specific circumstances of the proposed *Arundo donax Biomass Pilot* in Belize. In addition to putting into practice best management practices for minimizing the risk of invasiveness, the *Biomass Pilot* is also expected to provide valuable information on the managed/controlled cultivation of *Arundo Donax*, which will serve as input into the preparation of an Environmental and Social Impact Assessment (ESIA) at the conclusion of a *Biomass Pilot* to guide potential further cultivation of the crop in the future. The preparation of the risk management framework will also meet the requirements of the World Bank, which is expected to provide funding support for the *Biomass Pilot* through the Energy Resilience for Climate Adaptation Project. The Environmental and Risk Management Plan was subsequently reviewed by a specialist from the North Carolina Department of Agriculture, and was confirmed to be consistent with their guidelines Voluntary Best Management Practices for Energy Crops: Minimizing the Risk of Invasiveness. The North Carolina Department of Agriculture has also agreed in principle to provide guidance to the 5Cs in the implementation of the *Biomass Pilot*.

#### **4.2 Principles for the Risk Management Plan to Mitigate Risks**

The Risk Management Guidelines proposes the methodology summarized in the table below, in order to identify various potential risks throughout the production chain for cultivating and supplying a biomass crop for energy use. For more information and the complete document, please refer to Appendix 6: Voluntary Best Management Practices for Energy Crops: Minimizing the Risk of Invasiveness prepared by the North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, and the Biofuels Center of North Carolina in 2012.

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<sup>33</sup> Voluntary Best Management Practices for Energy Crops: Minimizing the Risk of Invasiveness, North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, and the Biofuels Center of North Carolina, 2012.

 <p>Information Gathering</p>	<p>The first step is to explore risks of the crop prior to its selection, which the 5Cs have already carried out, and is described in detail in the previous sections of this document. The goal is to ensure that the crop is not prohibited or restricted; and ensure that the cultivation is appropriate to the circumstances and potential risks are identified.</p>
 <p>Planting and Management in the Field</p>	<p>Identify ways in which propagates escape from the production field, which could result in intended propagation beyond the design of the <i>Biomass Pilot</i>; and for the risks identified, specify measures and steps that will be taken to reduce the likelihood of propagates dispersal and establishment.</p>
 <p>Harvesting</p>	<p>The harvesting methods that are utilized should eliminate or reduce viable propagules in order to minimize the likelihood of unintended propagation beyond the design of the <i>Biomass Pilot</i>.</p>
 <p>Storage</p>	<p>Storage sites are analogous to production fields in serving as a stationary source of propagules; and therefore, should be designed, constructed, and managed in a manner that minimizes the likelihood of unintended propagation beyond the design of the <i>Biomass Pilot</i></p>
 <p>Transportation</p>	<p>Land along the route from harvested fields to the bioenergy facility could also be susceptible to inadvertent escapes. As such, the transporting of feedstock material should be done in a manner that reduces unintentional propagates loss in order to minimize the likelihood of unintended propagation beyond the design of the <i>Biomass Pilot</i>.</p>

It is important to note that the above are guidance principles only, and that each project should be screened against these principles to determine the risks that are specific to the said project; and implement mitigation measures only to those that apply. In this spirit, the following sections screen the proposed *Biomass Pilot* against the guidance principles to, first, determine the risks that are applicable in this instance, and then indicate the measures and steps that the 5Cs will take during implementation to eliminate or minimize the likelihood of unintended propagation. The measures that will be taken by the 5Cs to manage these risks during the implementation of the *Biomass Pilot* are detailed in the remainder of Sections 4.3 and 4.4 below; and summarized in a table in Appendix 1.

### 4.3 Approaches to Risk Mitigation for the *Biomass Pilot*

- The identification and selection of *Arundo donax* as a potentially promising biomass crop that can grow on uninhabited, marginal land that is not suitable for agriculture in Belize was determined on the basis of the research and analysis that was carried out by the 5Cs with the assistance of CCI. The research was also validated by BSI, the owners of the BELCOGEN power plant and the recipient of the processed biomass from the *Biomass Pilot*; and permits were granted by the Ministry of Natural Resources and Agriculture,

and the Department of Environment complying with the policy and regulatory framework in Belize; which provided the basis for the decision to move forward with a pilot to demonstrate the feasibility of cultivating *Arundo donax* and testing it in the existing BELCOGEN power plant during its idle months.

- The *Biomass Pilot*, which will be carried out in a total of 400 acres of land designated as marginal and not suitable for agriculture, will be guided by the risk management framework detailed in this document; in order to ensure that it follows good environmental practices commensurate with the risks. At the conclusion of the pilot, on the basis of its results, observations and lessons learned, an industry-standard Environmental and Social Impact Assessment (ESIA) will be prepared and submitted to the World Bank for its approval. This ESIA will be for any follow-on activity that may result post *Biomass Pilot*.
- Should the *Biomass Pilot* prove that *Arundo donax* can be cultivated in a technically and commercially viable manner; and also confirm by the ESIA that the crop can be sustainably cultivated successfully and risks adequately managed, then it is likely that cultivation would expand to part of the larger 1,800 acre area for commercial operation. The post-*Biomass Pilot* commercial operation, which would provide processed biomass to the existing power plant at BELCOGEN on an ongoing basis, will comply with the Environmental and Social Management Plan in the ESIA to continue to manage potential safeguard related risks that could arise with the cultivation of *Arundo donax*.
- Should the results of the *Biomass Pilot* lead to the conclusion that further cultivation should not proceed, either for technical, commercial, or environmental and social related reasons, then the existing 400 acres cultivated through the proposed *Biomass Pilot* will be orderly wound down according to accepted industry practice as described in the following sections of this document. Once the *Biomass Pilot* is successfully concluded, then there will be no additional risk of unintended propagation of the crop.

#### **4.4 Characteristics of *Arundo donax* and the Risk of Propagation**

As previously noted, *Arundo donax* also known as Wild Cane in Belize, is a large, robust plant known for its fast growth and resilience. As a result, it can be harvested about three times a year, which is one of the reasons as to why it was selected for the proposed *Biomass Pilot*. However, this fast growing nature can also present an environmental challenge should the plant propagate beyond its intended design. It is important to clarify that *Arundo donax* does not propagate through seeds as these are sterile in the plant. Therefore, there is no risk of propagation through airborne and other means where the *Arundo donax* seeds could be dispersed beyond intended areas. *Arundo donax* propagates only through rhizomes and cuttings of the stem/stalk. Typically, stalks of the plant are planted manually and then covered with soil in order to cultivate *Arundo donax*. Therefore, propagation is only feasible through the transplanting and transfers of live

rhizomes and stem cuttings. The method chosen for the initial planting in the *Biomass Pilot* will be through the freshly harvested pieces of the stem. The primary environmental concern posed by *Arundo donax* is its aggressive annual growth and ability to spread laterally by rhizomes in the event it is not properly managed. The practices that will be put in place by the 5Cs, at each of the stages of producing the biomass, to manage this risk and to eliminate or substantially reduce the likelihood of unintended propagation through the spread of rhizomes are further detailed in the sections below.

#### **4.4.1 Planting and Management of the Field**

**Land Preparation.** The land area where the 5Cs obtained permission from the Government's Ministry of Natural Resources and Immigration is located in an uninhabited area within the Orange Walk District within about a 20 mile distance from the existing BELCOGEN power plant. The permit grants the 5Cs a lease for 500 acres within a larger area of 1800 acres of marginal land not suitable for agriculture, of which 400 acres will be utilized for the *Biomass Pilot*. The area was selected specifically because the land is publicly owned and not occupied by any private citizens, and has limited use or biodiversity value since it is not suitable for agriculture or other uses. The land area is flat preventing the runoff of water, which makes it suitable for cultivating *Arundo donax*, the exact extent which will be determined based on the results of the Research Phase (sub-component 1) of cultivating the test plots. The lack of drainage (as well as the elevated Buffer Zone, described later) also prevents rhizomes from potentially escaping into nearby waterways – preventing a key risk from being realized. The closest waterway, which is a small waterway named Blue Creek, is also at an adequate distance (at least 830 meters) from the nearest point of the 400 acre land area approved by GoB for the *Biomass Pilot*.

- The first step in preparation for the cultivation of the crop would be to prepare for the fifty (50) acres of research plots within the 400 acre land area designated for the *Biomass Pilot*. Initial preparation would be the clearing of vegetation from the area covering the 50 test plots that can be up to an acre each in area. Following the research phase (sub-component 1), site preparation will require clearing the remainder of the 400 acre parcel for carrying out the managed cultivation phase (sub-component 2) of the *Biomass pilot*. The land clearing and site preparation process for each phase (sub-component) will be similar as summarized earlier in Section 2.3.2. A contractor will be hired to clear the vegetation using a bulldozer equipped with a root and brush rake, which reduces soil loss and compacting caused by using heavy equipment repeatedly on the same site. Tractor drawn plows will be then used to prepare the land for liming in-line with industry practice to reduce or neutralize the acidity of the soil. The tractor will next be used to create the four- inch deep furrows spaced at one and

two feet apart in the different plots required for planting of the plant cuttings (stalks/stems without rhizomes).

During site visits to the area, no commercial timber species were identified, which was confirmed by the Department of Environment staff following their inspection visit to the area on 22<sup>nd</sup> May 2015<sup>34</sup>. However, should any such timber be found during land clearing, then the following contingency steps will be taken for proper extraction.

- Prior to any land clearing the 5Cs will apply to the Forest Department for a Salvage Permit. This type of permit allows recovery of commercially useful timber and non-timber forest products.
- The Supervisor and 5Cs Project Manager will inspect the entire site to determine if there are any commercially valuable trees to be recovered.
- If such trees are located, the 5Cs will contract an experienced timber harvesting company (based on the Forest Department's recommendation) for the salvage.
- The identified trees will be marked with paint and the contractor directed to remove them for transportation to a sawmill before any land clearing begins.
- Prior to removal from the site, the timber material will be inspected and measured on site for estimation of royalties.
- The site will be inspected after the salvage operation to ensure all commercially valuable trees have been removed.
- Land preparation will then be allowed to proceed.

Illegal removal of forest products from the site will not be allowed. The full-time presence of the security personnel on site and the patrols they conduct will serve as adequate control and to discourage any intruders.

The area proposed for the *Biomass Pilot* is not designated as an archeological or historical area of significance, and no artifacts of similar items of value have been found in the area. Nor is it a burial site that contains graves. However, during the land clearing work, if a contractor discovers items of such significance during excavation or construction, then the contractor shall take the following steps, which will be included in their contract:

- Stop the development activities in the area of the chance find immediately;
- Notify the Supervisor who in turn will notify the 5Cs Project Managers.
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, constant guarding of the site shall be arranged until the responsible authorities take over

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<sup>34</sup> Please see DOE letter dated 26<sup>th</sup> May 2015 at Appendix 2.

- Delineate the discovered site or area; (to be done by Institute of Archeology (DOA) /National Institute of Culture and Heritage.
- The IOA will conduct an assessment and advise project staff about subsequent procedures.
- If the cultural sites and/or relics are of high value and site preservation is recommended by the IOA, the 5Cs will make necessary design changes to accommodate the request and preserve the site;
- Decisions concerning the management of the finding shall be communicated in writing by relevant authorities;
- Construction works could resume only after written permission is granted from the Institute of Archeology concerning safeguard of the heritage.

Any worker removing such artifacts for personal use or gain shall be dismissed and subjected to legal action.

BUDGET: The total budget for land preparation is US\$ 315,675, and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

**Constructing Buffer Zone around Planting Areas.** The land area, once cleared, will be set-up into the plots where the *Arundo donax* will be planted and cultivated. These designated cultivation areas will be completely surrounded and protected by at least 20 feet wide access road that will function as a buffer zone. A two foot wide ditch will be dug and maintained clean along the entire inner perimeter of the buffer zone/access road. This access road will be built by experienced contractors. The road alignment will be demarcated and gravel material will be trucked in to cover the existing base material. Imported material will be dumped up, and graded to produce a camber on both sides, which allows water to run off the carriage way but remain within the larger 400 acre area<sup>35</sup>.

When finished, the carriage way will be elevated to a minimum of 12 inches (but up to 18 inches if needed) above the land on both sides. The road surface will be leveled and elevated to maintain that level in order to ensure there are no low spots that might allow spills. While the North Carolina Guidelines recommend a buffer zone with perennial cover, the proposed elevated compacted road offers better protection given the circumstances of this specific *Biomass Pilot*. The inner ditch will function as a physical barrier if there is lateral movement of the rhizomes. Perennial vegetative cover poses more of a fire risk in Belize because it will dry out and could serve as a fuel if encountered by wildfires emanating from outside the 400 acre *Biomass Pilot* area. Perennial cover on the buffer road would also impede free movement of patrol and transport vehicles. Additional access will be built within the 400 acre *Biomass Pilot* area, except

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<sup>35</sup> The water will be maintained within the 400 acre area to facilitate the cultivation of *Arundo donax*, and it will not be released outside the *Biomass Pilot* project area.

<sup>32</sup> Pilu, R., Bucci, A., Badone, F.C., and Landroni, M., (2012). Giant Reed (*Arundo donax*): A weed Plant or a promising energy species. Plant Production department, Universita Studi degli de Milano, Milan, Italy.

that these will be up to twenty-four feet wide for personnel, machinery and equipment to gain access to the crop. In effect a shallow 400 acre area enclosed by a 12 to 18 inch high dyke will be created inside which the *Arundo donax* will be cultivated. The access road, functioning as a dyke, will also be high enough to prevent any flood water from entering the plantation. Signs identifying the site as a research project will be prepared and erected at strategic spots along the access road/buffer zone. The at least 20 foot wide buffer zone that will be constructed will have multiple important purposes:

- Additional barrier to prevent unintended propagation. As previously noted, the *Arundo donax* plant propagates through the underground rhizome since its seeds that are above-ground are sterile. The *Biomass Pilot*, during its implementation, will only harvest the above ground material of the plant and will not extract the rhizome. However, as an added barrier following Environment and Risk Management guidelines, the buffer zone will further prevent any unintended shift of rhizomes laterally underground that could lead to the risk of propagation beyond the planned plot areas of the *Biomass Pilot*. The rhizomes reach up to 50 cm in length<sup>32</sup> and need prepared land (as described above) for germination. The elevated road/Buffer Zone (12-18 inches in height) will be of compacted material and at least twenty feet wide, and not subject to scouring by floodwater since it will be elevated above flood water levels, therefore functioning as an effective barrier to the movement of rhizomes by water.
- As a road providing access to the plantation area. The buffer zone will also serve as a road that will provide access into the plantation area for planting equipment and harvesting machinery to be transported as well as for security personnel from the project who will closely monitor the project area.
- As a means of preventing water run-off. The buffer zones, which are elevated to 12 to 18 inches above the plantation area, will also contain water utilized for cultivating the *Arundo donax* during the *Biomass Pilot*, and prevent any runoff outside the 400 acre project area. This is ideal for the cultivation of the crop, but equally important, since it will further reduce any opportunity for movement of rhizomes as a result of any drainage into nearby land or water resources<sup>36</sup>. As previously noted, the nearest water source, the creek known as the Blue Creek, is at least 830 metres away from the proposed location of the *Biomass Pilot*. Given that the proposed land area is flat and not tilted/sloped more than 5% and there is little opportunity for rhizomes to escape, additional barriers such as silt-fences or berms are not deemed to be necessary for the proposed *Biomass Pilot*. In addition, the type of natural vegetation that currently exists along the banks of the Blue Creek will also not enable *Arundo donax* to take root. This is because the land beneath

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<sup>36</sup> It is important to note that the proposed *Biomass Pilot* will not plant any new rhizomes in the project area, only freshly cut stalks at the inception of the project when establishing the research plots. Thereafter, it is the stalks that will be cut and replanted. Therefore, any rhizomes that naturally occur in the project area will be underground and will not be extracted due to any project activities. As such, it is very unlikely that there would be rhizomes at the surface that could get moved due to drainage. Nevertheless, the elevated buffer zone that prevents drainage adds another barrier to prevent potential propagation and further reduced such risk.

the riparian forest on the banks of the Blue Creek, is completely covered with vegetation, and is not disturbed, which means that there are no furrows in which the rhizomes can settle and become covered with soil. Therefore, the conditions for the rhizomes to germinate do not exist since *Arundo donax* requires disturbed, cleared or prepared land for the rhizomes to germinate.

During preparation, the 5Cs also reviewed whether *Arundo donax* exists near the project site along the Blue Creek or the Rio Hondo. Utilizing satellite imagery from CATHALAC and follow-up visual inspections, no evidence of *Arundo donax* growing along these segments of the waterways was observed. It has helped establish a baseline against which the area will be closely monitored (see Inspections/Monitoring section later in 4.4.1) during the implementation of the *Biomass Pilot* to ensure that the various risk mitigation measures/features – (i.e. distance from waterways, buffer zone, no rhizome removal) will prevent the crop from propagating beyond the designated *Biomass Pilot* area of 400 acres, and does not encroach any of the areas near the waterways. The same technology will be applied with future satellite imaging to monitor and confirm (along with visual inspections) that the *Arundo donax* remains contained within project area.

**Figure 11: Natural vegetation on the banks of the Blue Creek**



Photo: E. Green, 2015

It is important to note that, the various safeguards that follow good-practice guidelines will provide a number of barriers against the unintended propagation of *Arundo Donax* during the implementation of the *Biomass Pilot*. Even in the very unlikely circumstance where each of these barriers is breached, then the additional propagation will also be within the larger 1,800 acres of marginal land that is not suitable for agriculture. Should such encroachment occur, for which there would be regular monitoring to identify (as detailed in the section on Inspection/Monitoring Plan in following page); quick action would be taken to eradicate and prevent the further propagation beyond the design area. Any such potential eradication will be carried out in-line with the eradication procedures/process also described later in this section 4.4.

BUDGET: The total budget for construction of the buffer zone/access road is US\$ 223,500, and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

**Human Access to the Field.** Human access to the field will be limited by its location and nature of design. The proposed location for the 400 acres for the *Biomass Pilot* is at a minimum five miles from the nearest households, and not within proximity to large population centers (nearest town of San Lazaro is 7 miles away and has a population of less than 2,000). In addition, the crop itself, once planted, will serve as a barrier providing limited space that would not enable easy encroachment without machinery. Finally, the *Biomass Pilot* area will also be regularly monitored by project personnel, in line with the Inspection/Monitoring Plan detailed below in this document. Project personnel would disperse any people if they were to encroach into the *Biomass Pilot* area.

**Inspection/Monitoring Plan.** The *Biomass Pilot* area including buffer zones and area surrounding the 400 acre zones will be regularly monitored by project personnel. This will include a supervisor plus two field workers, equipped with an All-Terrain Vehicle (ATV) for mobility:

- A security company will be contracted to provide security of the area, and at least one person will be on duty in the *Biomass Pilot* project area at all times.
- The security personnel's main duties will be to patrol the perimeter and interior access roads of the *Biomass Pilot* project area at regular intervals using ATV to enable complete coverage of the entire area on each circuit, and will have the following general qualifications: - be a non-resident of the immediate area; have at least five years of service with the security company; and have a history of duty in remote locations under difficult conditions. Personnel will conduct inspection at eight-hour intervals each day, inspecting the plantation areas of the *Biomass Pilot* for signs of entrance into the fields on foot or vehicle. The 5Cs Project Manager will familiarize the security personnel with the Environment and Risk Management Plan and train them inspection and monitoring (including reporting forms). These personnel will report any findings during each day of duty to the Supervisor. Anything out of the ordinary will be followed-up by the Supervisor. The Supervisor will report any unusual observation to the 5Cs Project Manager who will determine what action to take. If there is human encroachment into area, then the security officer will notify the Supervisor. The Supervisor reports to 5Cs Project Staff, who will conduct a site inspection. The next action depends on the nature of the encroachment. A simple trail may be sign of a curious visitor who wanted to see the interior. An open road might be sign of someone removing material. After the site visit, the 5Cs personnel will collaborate with the Land and Surveys Department to determine whether they have any knowledge of activity in the area. If the inspections lead to the

identification of escapes (i.e. plant material), then the following immediate actions will be taken.

- Specific inspections will be conducted near the Blue Creek waterway following heavy rains or after a flood event in order to ensure that there has been no resultant escapes from the project site.
- Any escaped plant material will be collected or dug up if rooting has occurred, and taken into the interior of the parcel for replanting or disposal.

Please see Annex 9 for an inspection and monitoring form as well as a notification schedule for significant events (e.g. spills during transportation, observation of the crop's spread beyond the buffer zone, floods on site). Simple reporting sheets, similar to a checklist, will be provided for preparation and submission of inspection report. These forms will be completed daily by the security personnel on site.

**BUDGET:** The total budget for inspection and monitoring is US\$ 51,000 (Two watchmen (US\$ 10,000) & Purchase & Maintenance of Essential Equipment (US\$ 41,000)<sup>37</sup>) and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

**Handling of Excess Plant Material.** The cultivated *Arundo donax* plant material will be handled as follows:

- The excess leaves of the crop are not promulgates, and therefore, will biodegrade.
- The stalks of the crop are the *primary source* of biomass once it is processed. Therefore, it will be harvested and processed, as per steps described in the next section of this document to maximize the quantity and quality of fuel produced.
- The rhizomes through which *Arundo donax* naturally propagates, will remain underground throughout the *Biomass Pilot*, and will not be extracted, as per procedures described in the next section. The rhizomes will only be extracted when it is being eradicated, as per the procedures described later in this section.

**Water Usage.** The *Arundo donax* will be cultivated utilizing rain water, which given the poor drainage in the selected 400 acres of marginal land as well as the elevated buffer zone, will contain the water within the *Biomass Pilot* project area, making it ideal for the cultivation of the crop. The ability of *Arundo donax* to grow in such an environment is its attractive quality, which will be further tested and confirmed through the *Biomass Pilot*. The *Biomass Pilot* will not utilize any other regional water sources except for the digging of a single well primarily to provide water for washing the machinery and equipment and for the use of project personnel. A water storage tank will also be installed to capture rain water, and to minimize the use of well water for washing the machinery and equipment and for the use of project personnel. Should the tank or the well run out of water during the dry season, water will be transported from the nearest

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<sup>37</sup> The same equipment will be also used for handling of excess plant material described in the following section.

village, San Lazaro, about 7 miles away from the *Biomass Pilot* project area. In addition, the *Biomass Pilot* project will contain water within the buffer zone and will not release any water to the nearby waterways including the Blue Creek.

**Fire Prevention.** In Belize, especially during the dry season, there is a risk of wild fires that can often ignite in areas such as sugar plantations where crops begin to dry. Hot embers from such external fires can potentially be blown for various distances, and if it were to reach the location of the proposed *Biomass Pilot*, it could pose a problem due to surrounding vegetation. However, *Arundo donax* itself, while the crop is planted, has a natural resilience to fires due to its high moisture content (about 60%). Typically, the crop is not combustible before it has been dried. Therefore, a potential wild fire that may arise from other sources is unlikely to impact the *Biomass Pilot* due to this natural protection. Furthermore, the 20 foot wide buffers/access road infrastructure will also serve as a fire break since there is no living or dried biomass in the buffer zone that would fuel wildfires to cross over to the *Biomass Pilot* project area. Forest or wildfires in the north of the country are generally ground fires because the forest structure and composition will not support crown fires (forest fires which burn in the canopy or leafy part of the trees). The fire which does ignite or is set will run on the ground consuming fuel as it spreads. However, should such fires impact any areas designated for the *Biomass Pilot*, then the following steps are in place to minimize adverse impacts:

- The security and monitoring that will be maintained 24/7 as a part of project oversight will constantly monitor project area and identify potential fire risks.
- If they identify potential for it to impact the *Biomass Pilot* area, the staff will notify the nearest fire station about fifteen miles away in Orange Walk Town and secure their own safety, by moving to a site upwind and away from the fire. Security personnel will be equipped with two-way radios, so will be able to call their headquarters to pass on the message. The Headquarters staff of the security company will be expected to call 5Cs personnel.
- 5Cs project personnel will call the Fire Service as backup.
- Forest Department staff and employees also have extensive training and experience to deal with fires, and could be called on to assist in the case of a fire. They are also supplied with some appropriate equipment.
- If professional help (member of the National Fire Service or Forest Department) reaches the site quickly, the personnel on site may provide assistance as necessary. .

BUDGET: The total budget for handling of excess plant material, water uses, and fire prevention is US\$ 78,500 (Purchase and Maintenance of Essential Equipment (US\$ 41,000)<sup>38</sup> & Fire prevention under Safety and Security (US\$ 37,500), and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

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<sup>38</sup> The same equipment will be also used for inspection and monitoring described in the previous section.

**Eradication Plan.** The eradication plan is designed to address two particular risks: 1) to eliminate unintended propagation should any lateral shifts in rhizomes occur, and 2) to wind down the *Biomass Pilot* and clear the land area should the decision arise not to continue at either the conclusion of the research phase (end of or during first three years) or the managed cultivation phase post-pilot (end of fourth year).

During the implementation of the *Biomass Pilot*, the following steps will be taken:

- The constant monitoring of the designated and surrounding area of the *Biomass Pilot* and other ad-hoc supervision visits by Project Personnel will identify if, despite the various barriers that are already in-place, any rhizomes have shifted/are shifting laterally, which would be confirmed by young shoots emerging in the buffer zone through the road material. It is important to note that this likelihood is very limited given the project sale, design, and preventive risk management measures that are taken. If any lateral shifting does occur unintentionally, it would only be on the edges of the outer perimeter of the plots (the density and the compacted nature of the planted plots will provide little room for rhizomes from the plants in the middle of the plots to shift; and will be shaded by existing plants limiting sunlight that is necessary to sprout/grow). Moreover, if the rhizomes in the perimeter were to shift, given that their length is about 50 centimeters, it would be slow and unlikely to traverse a long distance as the rhizome would need to sprout within a distance of about 60 centimetres. Therefore, such movement, if it were to occur, can be easily and quickly detected before it would extend beyond the buffer zone.
- If any movement of the rhizomes is detected that could be a potential risk for unintended propagation (i.e. likely to extend outside the designated plots), then these rhizomes will be immediately dug-up using a back-hoe to excavate the areas, identify where the rhizomes are growing from, and removing it from whatever channel it used to cross over. As previously noted, the nature of the plant, cultivation design, and size of rhizome it is unlikely to cross any distance even within the buffer zone, much less outside the *Biomass Pilot* area. However, the monitoring for unintended propagation will include areas that include the buffer zone as well as outside its perimeter. If any unintended propagation is detected, it will be traced by digging into the soils with spades and rakes to uncover the rhizomes so that it could be physically removed completely. During the implementation of the *Biomass Pilot*, such rhizomes will be replanted within the plots designated for cultivation (i.e. the 400 acre area designated for the *Biomass Pilot*) following the same procedures used for originally planting the crop.

At the conclusion of each of the phases - the Research Phase and the Cultivation Phase - of the proposed *Biomass Pilot*, there will be an evaluation of results from that phase to determine whether to proceed further. In the case of the Research Phase, the 5Cs will discuss with the World Bank the results of the testing including outcome of the pilot eradication of one or two plots. At the same time, the 5Cs, should they wish to proceed to the next

Managed Cultivation Phase of up to 400 acres, will also submit for the World Bank's no-objection, TORs for a feasibility study (FS) and environmental and social impact assessment (ESIA) to be carried out at the conclusion of the Managed Cultivation Phase. If the decision following the Research Phase is not to proceed further, then the 50 one acre plots would be eradicated and the *Biomass Pilot* would be wound down earlier than anticipated, following the approach described below. If the 5Cs proceed with the managed cultivation of up to 400 acres based on the World Bank's no-objection, then at its conclusion, a comprehensive decision will be made on the basis of the completed FS and the ESIA regarding the prospects of continuing the operation on a commercial basis beyond the *Biomass Pilot*. This decision will be made from the results and the lessons learned from the *Biomass Pilot* on the basis of the technical, financial, environmental and social viability of the activity. It is feasible that the results of the *Biomass Pilot* lead to the conclusion that further cultivation of *Arundo donax* is not viable, and therefore, the activity should not be pursued further. In such a circumstance, the *Biomass Pilot* would be wound down in an orderly manner, which will include the eradication of the areas of up to 400 acres where *Arundo donax* is planted. The 5Cs have researched the protocols of Best Management Practices and determined that the most appropriate means of eradication in such a circumstance is through a combination of mechanical and manual methods. The process through which it would lead to the permanent eradication of the research plots or the cultivated crop from the *Biomass Pilot* would include the following steps:

- The 5Cs, on the basis of the results following the Research Phase or the final feasibility study and ESIA prepared by industry specialists following the Managed Cultivation Phase, will make a determination whether the crops cultivated up to that point (either up to 50 acres or 400 acres) in the *Biomass Pilot* should be permanently eradicated.
- In the case following the Research Phase, this decision will be based on the results from the three years of testing for yields, cultivation techniques, and eradication approaches. The eradication approach described below would be adjusted based on test results, if necessary, and will be applied for up to 50 acres of one acre plots, as indicated below.
- In the case of the managed cultivation of the 400 acres, the consultants preparing the ESIA document will be requested to further review the proposed eradication plan and provide input into further improving the eradication approach, which will be incorporated in the steps ultimately taken. This will have the benefit of the results from the one or two test plots that were eradicated and monitored during the three-year Research Phase, which would ensure that the eradication method that is implemented will be effective.
- Whether the eradication takes place following the first three year Research Phase or at the end of the fourth year following the Managed Cultivation Phase, the overall approach proposed for eradication would be as follows:

- The first step in eradication would be to dig-up all of the rhizomes in the area where the *Arundo donax* is cultivated. This will be done through the raking of the field using the same equipment used for site preparation. This will be followed by field crews using regular rakes and spades to dig up the rhizomes for extraction and disposal. The uprooted rhizomes will then be processed through a biomass chipper which will chop the biomass into small pieces of a size less than half an inch shown below in Figure 14. The material will then be left to dry subsequent to destruction by burning under controlled conditions.
- Once the rhizomes are cropped, and collected, they will be placed on the drying slab, dried, and then set on fire under controlled conditions prescribed by the Forest or Agriculture Department.
- The above ground stalks and sterile seeds of the crop, which are not promulgates, will biodegrade once the field is plowed. This process will take about one week.
- The inspections to ensure that the rhizomes and stems of the plant are completely eradicated will be conducted 1 to 3 times per year for two years following eradication activities.

As previously noted, the *Biomass Pilot* will not only test the agronomics of the project, but will also evaluate and refine the environmental aspects through the eradication of one or two plots on a trial basis. Although there is existing experience in Belize for eradicating *Arundo donax* since it is an existing crop in the country, which is the basis for the proposed eradication plan, further testing will help refine as well as re-confirm the effectiveness of the proposed approach. Therefore, during the Research Phase, one or two of the fifty research plots will be selected designated as a control plot to be used to test the results of eradication practices. These plots will be developed and cultivated along with the others, but at the end of the first year, the select plots will be eradicated to remove all traces of the *Arundo* plants; i.e. plowing, raking and physical removal. This plot will then be monitored throughout the duration of the Research Phase to ensure that there is no regrowth. This will provide information that can help confirm the applicability of the eradication approach or provide insights as to the necessary adjustments. Similar, to the other research plots, the results of the eradication test plots will also be recorded as part of the Biomass pilot study.

The requirement to eradicate the crop at any time the *Biomass Pilot* is brought to closure is a requirement of the government of Belize as well as the World Bank. The Chief Environment Officer of the DOE confirmed that, while eradication is a requirement imposed by the GoB, the Eradication Plan does not have to be formally submitted to them for prior approval; and also burning the residual crop is an acceptable method of disposal for biomass. Although not required, the 5Cs have shared with the DOE a previous draft version of the Environmental and Risk Management Plan. Upon completion, a copy of the final version of the Environment and

Risk Management Plan, which includes the Eradication Plan, will be submitted to the DOE, as a way of keeping them informed.

**BUDGET:** The total budget for eradication of up to 50 test plots following the Research Phase is estimated at US\$35,100 or if the eradication is carried out following the larger 400 acre area at the end of the *Biomass Pilot*, including follow-up inspections, the estimated cost is US\$ 280,800, including contingencies for both cases. The 5Cs will cover these costs of eradication which will take place either at the end of the Research Phase or at the conclusion of the Managed Cultivation Phase, if at all. Please see Appendix 7 for more details regarding the budget.

#### **4.4.2 Harvesting and Processing**

It is noted that during harvesting the crop for *Arundo donax* for utilization as a biomass fuel, the rhizomes, which are the promulgates in *Arundo donax*, will not be extracted, and will remain in the ground. Additionally, as previously noted, the *Arundo donax* seeds are sterile and therefore, will not propagate either. And, as will be further detailed in this section, the *Arundo Donax* stalks, which will be utilized for biomass energy use, will be cropped, chipped, dried and shredded in a manner such that it will be converted to a fibrous material similar to bagasse; which is also not capable of propagation in such a form. In other words, the design of the harvesting approach is such that the extracted and processed material is incapable of further propagation.

**Harvesting.** The managed/controlled cultivation of *Arundo donax* in the *Biomass Pilot* will be mechanically harvested as shown previously in Figure 8. The harvesting will be done with motorized brush cutters. At no time will harvesting within the *Biomass Pilot* area (400 acres) result in the rhizome of the plant being extracted from the soil. The stalks, while being cut in the field will also be simultaneously chipped into ½ inch pieces. This will have the triple benefit of a) the material immediately being processed as being ready for utilization as biomass, b) the material being more suitable for storage unlike full stalks, and c) the material not being capable of propagation even in the accidental event that some rhizome materials is extracted with the stalks as it will be chipped (and eventually shredded) to a non-promulgate form; further minimizing the risk of unintended spread of the crop<sup>39</sup>.

Once the harvesting is completed, all of the equipment, which will be locally rented, will be thoroughly washed to ensure that any plant materials is removed prior to the equipment leaving the 400 acre location of the Biomass Pilot. Washing will be done within the location of the *Biomass Pilot* at the central work location where the dedicated storage facility will be located along with temporary structure to house project personnel and equipment. The central work location will also have a water supply in the form of a well that will be dug up for the purposes of the project. Hand pumped water from the well will be used to wash equipment. The water used to wash equipment will run into the drains that are located between the inner side of the

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<sup>39</sup> During the Research Phase, the cropped and chipped biomass material will be tested to reconfirm that they do not have promulgate capabilities (i.e. see if it regrows, if the chipped ½ inch biomass material is buried under soil). This will provide even greater assurance that there is minimal risk for promulgation once the crop is harvested.

access road/buffer zone and the planting; and will not drain beyond the project area. Once the equipment is washed, there will be a visual inspection carried out by 5Cs project staff that will be documented and logged for record keeping. It is only following the inspection being successfully completed that the equipment will leave the premises of the *Biomass Pilot* to be returned to the equipment rental company.

**BUDGET:** The budget for harvesting the *Arundo donax* is estimated as US\$ 73,125 and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

### 4.4.3 Storage

**Construction of Storage Area.** A storage area of about 19,000 square meters will be specially constructed to hold the cropped and chipped *Arundo donax*. The storage area, which will be located within the 400 acre area designated for the *Biomass Pilot*, will be a combination of elevated area covered by marl and stone and concrete flooring. The area with marl and flooring will be for parking and washing of equipment entering and leaving, and location of the temporary building for housing project personnel and supplies. The open concreted flooring storage area will serve multiple purposes: a) area for storing the harvested and processed biomass material eliminating contact with ground so that the processed biomass does not get contaminated with dirt making it less suitable for use in the existing BELCOGEN biomass co-generation power plant, b) area for air-drying the biomass in order to reduce its moisture content to about 15-20 percent, c) area for temporarily holding the processed biomass until it is shipped on demand to the power plant. The concrete floored storage area's principal function is to prevent the biomass material from contact with the ground in order to have it as clean fuel, but also represent another measure in reducing the prospects for further propagation in the highly unlikely event that a fully intact rhizome eluded the harvesting, and initial processing of the biomass material. The storage area will be without cover, as is common industry practice in such operations, and the manner in which the chipped biomass material is stacked in a cone shaped wide base, gives the pile stability against the wind, provides proper drainage in case of rainfall, and provides good aeration to facilitate quick drying. The North Carolina Best Management Practices suggest that the storage of viable biomass material should be covered; this is because it is plant material that is being stored instead of inert biomass that is no longer viable. However the material being stored in Belize is already being converted to inert (unviable) biomass as it has already been chipped into small pieces, rather than the larger pieces of plant material that is typically stored in the US. The small pieces also allow water to run through to the bottom of the pile, while only allowing the outer layers to get wet since rain water will run off the cone shaped pile easily. Therefore, an uncovered storage area is appropriate for the *Biomass Pilot*. Moreover, the open-air storage further facilitates through air-drying that transforms the cropped and chipped *Arundo donax* where its water content is reduced to 15-20 percent. Furthermore, the cone shape pile structure will not be subject to movement due to winds and other weather elements, as shown in the example in Figure 12 below, which illustrates open air storage of the sugarcane bagasse at the existing BELCOGEN power plant in the Orange Walk District in Belize. It is worth noting that this processed material is not capable of propagation. The situation would be similar in the case of *Arundo donax*.

**Figure 12: Storage of bagasse at the existing ASR-BSI (BELCOGEN) Plant, Orange Walk, Belize,**



Photo: E. Green

**Drying the Processed Biomass.** One of the primary purposes of the storage area within the premises of the *Biomass Pilot* is for drying the harvested and processed plant material that is chipped to ½ to 1 inch in size. Drying of the harvested and processed material is necessary for the following reasons: 1) to further ensure that no viable plant material leaves the *Biomass Pilot* area (once dried, the chipped material is inert -- virtually “dead”), 2) to reduce the amount of moisture that can increase the weight of material that has to be transported increasing costs, and 3) to ensure that the chipped *Arundo donax* is transformed to a form that is suitable for combustion in the power plant given its naturally high water content (as previously noted, the natural state of *Arundo donax* is not very combustible). The chopped and processed biomass, once delivered to the storage area by the container trucks, will be laid flat for period to allow additional drying if needed, this will be followed by piling of the dried material in a similar cone structure as shown in Figure 12 until ready for use. The pile will be aerated occasionally by mechanical means through the use of a tractor with a front end bucket, during which samples will be taken and tested for moisture content. The overall drying process will take about 2-3 weeks, depending on weather conditions, at which point the biomass crop’s water content will reduce to about 15-20%. As the water content is removed, the processed and dried biomass material continues to be further rendered incapable of promulgation. It will continue to further reduce the risks of unwanted promulgation of *Arundo donax*.

**Shredding/Final Processing.** The biomass material, which at this point is chopped and processed into ½ inch sized pieces and dried to a level where its water content is 15-20%, will be further processed while at the storage facilities. The final processing step is to shred the biomass material from the ½ inch pieces to fibers similar in size and texture to the bagasse

material, as illustrated in Figure 13 and 14 below. As can be seen in Figure 14, there are no surviving propagates in the biomass material at this point.

The shredding process will be carried out on the premises of the *Biomass Pilot* project premises close to or immediately before transporting the biomass material to the existing power plant facilities at BELCOGEN, upon their request. The shredding process consists of removing the dried pieces from storage, which are then fed into a chipper/shredder machine that reduces the material into fibers similar in size and texture to bagasse, as well as simultaneously load the material directly into lockable container trucks on the *Biomass Pilot premises* for delivery to the BELCOGEN facility. The result of the shredding process is that the biomass material is transformed into a fibrous substance comparable to bagasse. This process will prepare the biomass materials to a format that can be easily blended with sugarcane bagasse and utilized as a fuel in the existing BELCOGEN power plant. This step of final processing will also have the benefit of making it virtually impossible for any of the biomass crop to be capable of propagating leaving the *Biomass Pilot Area*.

**Figure 13: Sample of dried bagasse that was discharged by the sugar factory crushing and extraction mills**



**Figure 14: Sample of chipped and dried *Arundo donax***

(This sample includes chips that are manually crushed, whereas the *Biomass Pilot* will use machines to shred the chipped *Arundo donax* to a more fibrous texture similar to that of bagasse, as in Figure 13)



Figure 13 above is a picture of a sample of the bagasse obtained from the sugar factory. This is the material that comes out of the factory after processing of sugar cane is complete. It is stored in the open until the factory operator is ready to introduce it as fuel. The second photograph, Figure 14 shows a sample of the *Arundo donax* that has been manually chipped and dried. The actual *Arundo donax* in the *Biomass Pilot* would be shredded by a machine, which would render it in a more fibrous form similar to sugarcane bagasse. Therefore, the texture and the size of the biomass material would be smaller than the sample shown.

It is worth noting that, often in biomass projects, live and unprocessed plant material is transported across distances before it is stored and processed as a fuel for energy sector needs. In such instances, the movement of live and unprocessed biomass material can get dislodged along the way increasing the risk of unintended propagation. In the case of the proposed *Biomass Pilot*, the plant rhizome is left underground by design; the plant itself is simultaneously cropped and chipped at the time of harvesting, and then dried at on-premises storage before being further shredding prior to any movement of the material outside the premises of the project. At this point, the plant material is virtually “dead” and does not have properties where it could propagate intentionally or unintentionally.

**Fire Prevention and Control.** Threats of fire will come from the following sources:

- Preparation of meal -- any cooking will utilize bottled gas stoves so precautions will be necessary to avoid household fire through use of smoke detectors and having fire extinguishers readily available.
- Fuel spillage fire – there will be significant use of diesel and gasoline to power heavy equipment and hand operated equipment such as bush cutters. Workers will receive training of how to safely handle fuels as well as safety requirement.

- Wildfires – ignited by smokers, farmers, weather -- principal threat here is the fire coming onto the *Biomass Pilot* area. As mentioned earlier the establishment of a Buffer zone around the 400 acre *Biomass Pilot* area would act as major fire break to protect the research. There is very little possibility that a ground fire could make it across the buffer zone even in the presence of very high winds and dried biomass fuel on the ground, in such a case the fire prevention protocols described previously (section 4.4.1) in this Environmental and Risk Management Plan will be initiated. Additionally as shown in Figure 6 the buffer zone consist not only of the elevated and surfaced roadway but also an interior drainage ditch which represents yet another barrier to fires getting into or going out from the *Biomass Pilot Area*.
- Ignition of the harvested biomass – the harvested biomass in ½ inch sizes stored in the cone shape will only ignite if fire at high temperature is introduced, an ember from a farmer burning sugarcane field will not have enough energy to ignite the storage piles. If ignition does occur the smoke alarms located at the site would alert staff to take the necessary measures of fire extinguisher, water or call the fire department (following fire prevention protocols described in section 4.4.1). This material does not ignite spontaneously as would be the case with wood residue in sawdust piles.

**BUDGET:** The budget for constructing the storage area including the fire prevention measures is estimated as US\$ 95,000, and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget.

#### **4.4.4 Transportation**

Since the processing (chipping, drying, and shredding) and storage of the biomass crop is carried out on the premises of the *Biomass Pilot*, the transportation of the material is the final step of the production chain of the proposed project. Unlike in many biomass cultivations that transport live biomass material, the proposed *Biomass Pilot* will only transport inert (unviable) biomass material that is not capable of propagation.

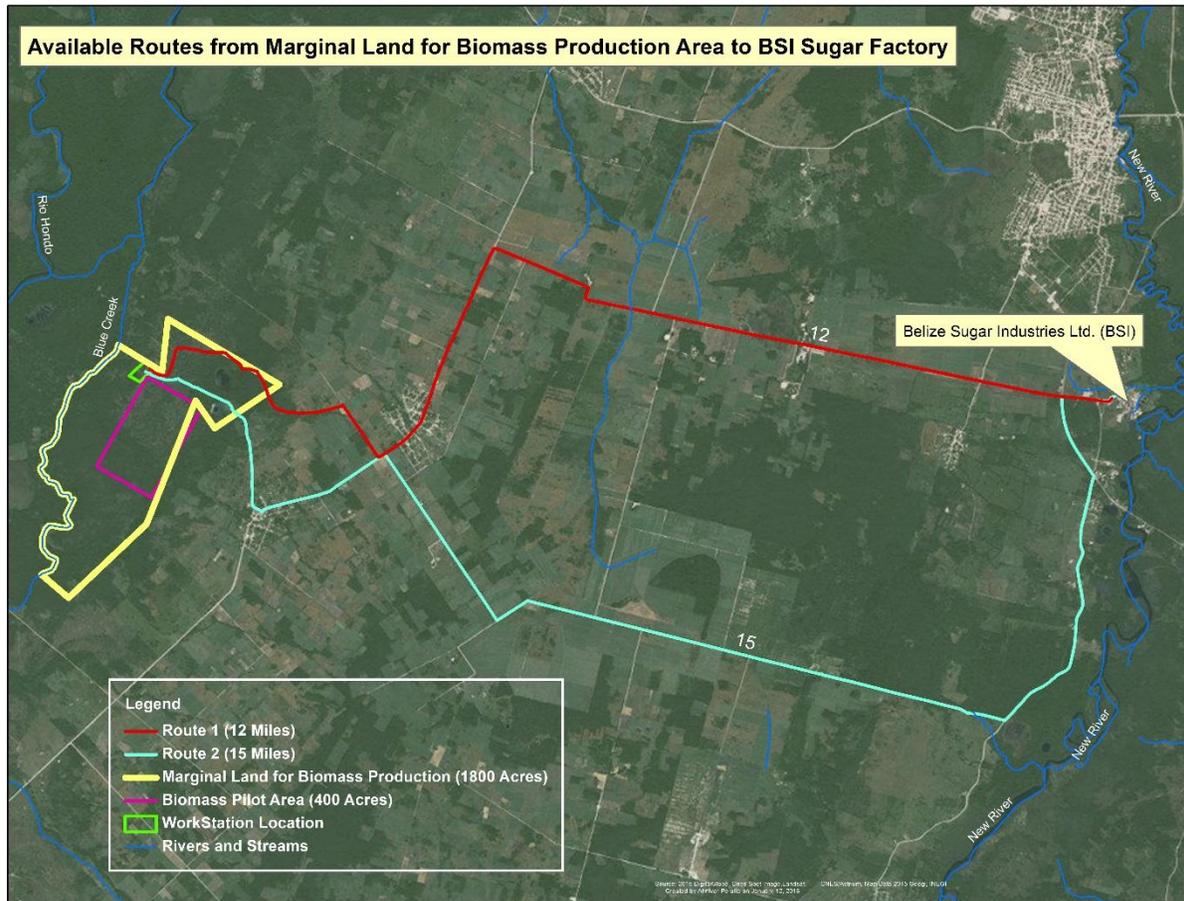
The transportation of the cropped, chipped, dried and shredded biomass material to the existing BELCOGEN power plant facility premises will be carried out by a number of locked container trucks. The first activity would be to prepare the container trucks, shown in Figure 7 for transportation, which would include the following steps:

- Communication between management of the BELCOGEN facility and the 5Cs will determine the volume and timing for the transportation of the biofuel to the existing BELCOGEN power plant facilities.
- Once the “order” has been placed, the 5Cs will determine the number of container trucks that would be requirement, and make arrangement for the rental of the vehicles.
- The container trucks would be loaded as outlined above, directly from the discharge of the chipper shredder machine. Any required labour for managing the load in the

container truck will be a requirement of and the responsibility of the transportation contractor. It is anticipated that the transportation contractors will come primarily from the sugar cane areas and are well accustomed to this type of activity. Sugarcane is mechanically harvested and loaded

- The container trucks would then be fully locked to prevent accidental spillage during transportation. While the material that is being transported will not be capable of propagation, the locked container trucks will serve as an additional barrier that mitigates the risk of spillage of biomass material on the way to the BELCOGEN power plant facility further preventing possible unintended germination of the crop outside the designated premises of the *Biomass Pilot*.
- The container trucks would traverse a distance of less than 20 miles from the *Biomass Pilot* location to the BELCOGEN power plant premises. The two routes that the container trucks will utilize are existing feeder (access) roads, other than the public roads, that do not include any large population centers or sensitive areas in particular of biodiversity consequence. Feeder roads in Belize are unpaved roads built to enable farmers to travel shorter distances between the fields and the sugar factory thus minimizing the use of the paved roads and residential areas. San Lazaro a village located about 7 miles away from the *Biomass Pilot* site is home to fewer than 2000 residents. Orange Walk Town with a population of 46,133 is the largest population centre located about 15 miles away. Please see Figure 15 below which shows the transfer routes for the container trucks carrying the chipped, dried, and shredded biomass material from the *Biomass Pilot* site to the existing BELCOGEN biomass co-generation power plant.

**Figure 15: Transportation Routes Map for *Arundo donax***



Map: A. Peralta, 2015

The red and the pale green lines are the alternate transfer routes to be used to transport the processed and shredded *Arundo donax* biomass material from the project site to the existing BELCOGEN power plant, less than 20 miles from the project site. It is estimated that 6-7 container truckload per day will be transferred for a period of about 20 days at the end of the Managed Cultivation of the *Biomass Pilot*. The yellow line is the identified 1800 acres of marginal land available for biomass cultivation by the GoB; and the purple line outlines the 400 acres that are designated for the *Biomass Pilot* by the 5Cs, which are within the 500 acres that were approved by the GoB. The broken white line indicates an additional 100 acres, which will not be cultivated. At least 20 foot wide access road/buffer zone will completely encircle the purple rectangle (400 acres) and the small green rectangle (Work Station and Storage) on the northwest corner.

As the processed and shredded biomass material is transported, the following actions will be taken to monitor and oversee the operations:

- The transportation route between the *Biomass Pilot* location and the existing BELCOGEN power plant facilities will be inspected daily depending on the number of container trucks, at midday and at end of day after the final container truck has been dispatched. The inspector contractor will be equipped with portable vacuum and broom and trash bags to immediately clean-up if any spillage from the container trucks are detected. Contractor will be asked to report on any sign of spills after each trip. If necessary, motorized street sweepers will be utilized to clear debris from road if there is processed and shredded biomass material that is encountered. The collected debris will be brought back to the *Biomass Pilot* area and returned to the fields. The daily route inspection planned for risk management will ensure that any fallen material will not lie on the ground long enough to allow any potential for germination<sup>40</sup>. Again, it should be stressed that, while even such spillage will be rare due to the locked container trucks, the processed and shredded biomass material, if it were to spill, does not have any properties that can propagate.
- Once the container trucks reaches the BELCOGEN power plant site facility, the shredded biomass material will be transferred to the storage facility on-site, which has been in operation since the commissioning of the power plant in October 2009 and in compliance with the regulations of Belize. Since the final shredded biomass material leaving the *Biomass Pilot* area will be physically similar in form to the sugarcane bagasse, it is appropriate that it is handled in-line with the procedures and processes at the BELCOGEN facility until it is combusted in the boilers of the existing power plant to produce electricity.
- Once the transportation rounds are completed, then the container trucks will be thoroughly cleaned and washed back at the premises of the *Biomass Pilot* before they are returned to the rental company. As stated earlier the wash waste will be drained, but as with all water utilized for the *Biomass Pilot*, it will remain within the 400 acre project area, as per the design of the drainage system. During the transportation period the container trucks will be stationed at the *Biomass Pilot* area. The cleaning and washing of the container trucks will be carried out by cleaned with the appropriate equipment contracted for the purpose.

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<sup>40</sup> The biomass material that is shredded to a fibrous substance at this point is not considered viable plant material; and therefore, will not propagate. In tests carried out by the 5Cs during the technical studies, even full stalks that were left lying in the sun and rain for several weeks did not display the growth of any buds or sprouts, since there is no rhizome promulgate. The biomass material that is being transported is further chipped, dried and shredded making it virtually impossible to propagate. Although the cropped and chipped material cannot propagate based on its agronomical and physical nature, this will be re-confirmed in the Research Phase during the implementation of the *Biomass Pilot*.

BUDGET: The budget for transportation and associated risk mitigation activities is estimated as US\$ 11,250, and will be covered by ERCAP funds. Please see Appendix 7 for more details regarding the budget ct.

## **5. STAFFING FOR OVERSEEING IMPLEMENTATION OF ENVIRONMENT AND RISK MANAGEMENT PRACTICES FOR BIOMASS PILOT**

The 5Cs, with funding support from ERCAP and its own funds will ensure that the risk management actions following good practice guidelines will be successfully implemented during the *Biomass Pilot* in order to specifically safeguard against the unintended propagation of the crop in non-designated areas. The original proposal for staffing which consisted of a project manager and a research assistant has been increased to ensure that the required level of human resources is available to implement the risk management activities.

The additional staffing includes an assistant project manager whose responsibility will be primarily to ensure the risk management practices are successfully implemented. Also added to the human resources are security and safety personnel who will be responsible for the Project site as well as monitoring transfers of any *Arundo donax* plant material from the *Biomass Pilot* area.

All Staff will be recruited from current 5Cs staff or recruited by the 5Cs, Security and safety personnel will be retained via contracts. The anticipated personnel for implementing the proposed risk management actions include the following:

- The overall safeguards aspects will be supervised by a designated **Project Manager** from the 5Cs, who will be assisted by an **Assistant Project Manager** who will specifically focus on implementation of the risk management plan.
- Internal monitoring of the agronomic research/experiments will be overseen by the **Project Manager** with guidance from an **Energy Advisor** specializing in agronomy, as well as support from a **Research Assistant**.
- The 5Cs will also enlist the assistance of an experienced professional with prior experience cultivating biomass in general, and *Arundo donax* in particular, to provide advisory assistance during the key phases of the *Biomass Pilot* including land clearance and set-up, establishment of test plots, and planting and harvesting the crop during cultivation. The advisory support will be provided through visits to Belize during specific stages of the *Biomass Pilot* where the 5Cs would benefit from experienced, independent input; as well as through remote guidance on an on-call, as-needed basis. The North Carolina Department of Agriculture has agreed in principle to provide this support to the 5Cs through its specialists who are cultivating *Arundo donax* in the United States. In addition, the 5Cs may also seek the support of other experienced professionals such as from Costa Rica and the state of Oregon in the United States.

- **Security Personnel** will be procured under contract negotiated with an established Security Company. A presence (minimum of two persons) will be maintained for the duration of the pilot. They will provide on-site management for daily activities required. They would also receive basic training for fire alert and fire control. Their presence would also improve the security of the site. They are also utilized during cleaning of equipment, and collecting samples.

Please see Table 11 for budget for personnel.

**Table 11: Personnel Budget**

Personnel Budget (Unit: USD)		Funding Source	
Titles (number)	Total Costs	WB/GEF	5Cs
Project Manager (1)	<b>118,800</b>	68,800	50,000
Energy Advisor (1)	<b>108,000</b>		108,000
Assistant Project Manager (1)	<b>60,000</b>	60,000	
Research Assistant (1)	<b>44,000</b>		44,000
Watchman (2)	<b>10,000</b>	10,000	
Expert Consultants	<b>31,000</b>	31,000	
Local Transportation Expenses	<b>56,000</b>	23,750	32,250
Total Costs	<b>427,800</b>	193,550	234,250

## 6. POST PILOT ACTIONS

Following the completion of the *Biomass Pilot* managed cultivation activities, the 5Cs will commission the preparation of a full feasibility study to review the technical and financial viability of producing *Arundo donax* on a larger scale on revenue generating basis within the identified 1,800 acre land area in which the 400 acre area for the *Biomass Pilot* is located. An independent Environmental and Social Impact Assessment (ESIA) that meets World Bank requirements and international standards will also be carried out based on the results of the *Biomass Pilot* and the lessons learned. The TOR for the ESIA will be prepared with the benefit of the results of the three year Research Phase (sub-component 1), and will be submitted to the World Bank for its no-objection (along with the TOR for the feasibility study) at the conclusion of the Research Phase, prior to proceeding with the managed cultivation phase (subcomponent 2). The ESIA itself will be prepared at the conclusion of the cultivation phase (sub-component 2) at the end of the *Biomass Pilot*. The GoB also requires an Environmental Impact Assessment (EIA) for cultivations larger than 500 acres. Therefore, the ESIA prepared at the end of the *Biomass Pilot*, for any post-*Biomass Pilot* activities, will address the safeguards requirements of the World Bank as well as the GoB.

The ESIA will be prepared by consultants selected on the basis of the World Bank's procurement guidelines. The ESIA will use the data and other information generated by the 5Cs from the *Biomass Pilot*, as well as assist them in obtaining additional information necessary for the completing the evaluation. Qualification requirement for the study team would require

agronomics, biodiversity expert, environmental and social specialists, and geospatial expert. The exercise is expected to take 90 days and will begin upon the completion of the activities in the managed cultivation component of the *Biomass Pilot*. Stakeholder consultation will be conducted for the ESIA before it is finalized.

The results from the *Biomass Pilot*, feasibility study and the ESIA will help inform the decision whether to proceed with the commercial cultivation of biomass, likely in some part of the larger 1,800 acres of marginal land (that also includes the 400 acre *Biomass Pilot*) that was identified for this purpose by the GoB, to provide year-round supply of biomass fuel to the existing BELCOGEN biomass co-generation power plant. Should it proceed, then any future project will be in designed in-line with the informed recommendations of the ESIA and in compliance with the domestic policies and regulations of the Government of Belize. Since the post *Biomass Pilot* continued cultivation of *Arundo donax* in the 400 acre or the larger 1,800 acre areas would be a revenue generating project, the cost of implementing the ESIA including the monitoring will be covered by these cash flows. The ESIA would be available to the public on the 5Cs website.

In the event that the decision is not to proceed with further managed cultivation of biomass, then the existing cultivation from the *Biomass Pilot* will be eradicated according to the procedures described previously in this document.

## 7. REGULATIONS AND PERMITTING

The summary table lists the various permits that have been processed for undertaking the proposed *Biomass Pilot* project.

**Table 12: List of Permits required and their status**

No.	Permit required	Source	Status	Documentation
1	Cabinet's approval of land lease	Ministry of Natural Resources and Agriculture	Provided	CLS Letter dated 27 <sup>th</sup> May 2015
2	Land Acquisition	Ministry of Natural Resources and Agriculture	Letter advising of lease of 500 acres of land for a five-year period provided.	CLS Letter dated 27 <sup>th</sup> May 2015
3	Permission to Survey (to formalize lease )	Ministry of Natural Resources and Agriculture	Permission to Survey granted by CLS, Survey underway.	CLS Letter dated 27 <sup>th</sup> May 2015
4	Environmental Clearance for proposed Cultivation (plantation) site	Department of the Environment, Ministry of Forestry, Fisheries and Sustainable Development.	Provided	Chief Environmental Officer letter dated 26 <sup>th</sup> May 2015
5	DOE on clearance for <i>Biomass Pilot</i> utilizing	Department of the Environment,	Conditions attached to Environmental	Chief Environmental

	<i>Arundo donax</i>	Ministry of Forestry, Fisheries and Sustainable Development	Clearance	Officer letter dated 26 <sup>th</sup> May 2015
6	Scientific Collection/Research Permit	Forest Department, Ministry of Forestry, Fisheries and Sustainable Development	Provided	Chief Forest Officer Permit dated 22 <sup>nd</sup> May 2015
7	Salvage Permit	Forest Department, Ministry of Forestry, Fisheries and Sustainable Development	Prepared but held by Forest Department	Permit prepared, but held until salvage operator is identified.
8	Environment and Risk Management Plan	Caribbean Community Climate Change Centre	Underway	Draft being reviewed by World Bank

**Notes:**

No.1: Land Lease - Government of Belize approves the Centre’s proposal of a pilot development project.

No.2: GOB’s formal issue of a 5-year lease, through the Lands and Survey Department, of the 500 acre parcel gives the 5Cs the permission to use the land according to approved development plans, in this case the *Arundo donax* pilot project.

No. 3: The Lands and Surveys Department has to provide a letter allowing the Centre to contract a registered surveyor to demarcate the parcel on the ground, develop a plan of the site, and submit this plan to the department for authentication. The plan is then registered with a unique description (schedule).

No: 4, 5, & 6. Provisional conditions provided by the department for different stages of the pilot project. The 5Cs proposes to utilize all tools to ensure compliance with all relevant national laws.

No. 7: Scientific Collection Permit allows collection of plant material, *Arundo donax* stems and rhizomes from naturally growing sites for research purposes.

No. 8: Salvage Permit – If there is any commercially valuable timber or non-timber forest product found on the area under preparation, the permit holder is allowed to recover such material for utilization.

## 8. IMPACT MONITORING

The implementation of the *Biomass Pilot* will be monitored throughout all phases. This includes monitoring by 5Cs project staff as well as by Forest Department, and Department of Environment Staff monitoring during implementation is a routine practice by DOE staff for new projects), as appropriate. Monitoring does not apply only to spills, or potentially negative environmental impact, but for observations of any unforeseen social impacts that might arise during project implementation.

Monitoring will be carried out

- To observe the results of the research phase which will become key information (rate of growth, annual yields, nutrient uptake, water balance, and fertilizer quality) for the feasibility assessment. These will be carried out in-line with the technical proposal of project.
- To ensure good practice during construction to address any concerns regarding aspects such as noise, dust pollution, excessive traffic, and water pollution that the community may have. Notification boards shall be erected at the *Biomass Pilot* construction site to provide information about the project, as well as contact information about the Project Manager and Assistant Project Manager including telephone numbers and other contact information so that any affected people can have the channel to voice their concerns and suggestions.
- To take actions specific to the Environment and Risk Management Plan, including regular inspections of the *Biomass Pilot* area for excessive plant material, human encroachment, for potential rhizome escape); inspections of container trucks before they leave the *Biomass Pilot* premises; inspection of the transportation route following each trip by container truck; and, inspection of all machinery and equipment before it is returned to rental agencies.

Please see table 13 for summary of below for a presentation of the impacts that will be monitored, with some details regarding the nature of aspect monitored, about when, when and by whom they will be monitored.

The monitoring and inspection information related to potential unintended promulgates will be compiled by the 5Cs on a quarterly basis and reported to the DOE and copied to the World Bank for its information. This includes potential rhizome escapes, spills of shredded (unviable) crop during transportation, inspection of equipment and transportation vehicles prior to departing project area, and if there is any human encroachment from non-project personnel. The report will summarize the date and nature of any documented issues, the remedial actions taken, and any additional information that confirms closure on the matter. The source information will be from the daily logs that are maintained by the 5Cs for documenting the monitoring for promulgates as well as other safety features. Should the 5Cs confront an issue that they find difficult to adequately address in a reasonable manner, then it will notify DOE immediately and initiate the necessary remedial action in coordination with the GoB.

A Third Party Reviewer from the United States or Costa Rica, with prior experience cultivating biomass in general, and *Arundo donax* in particular including the application of risk management practices, will be contracted to assist the 5Cs team periodically as needed with the implementation including monitoring and evaluation of the *Biomass Pilot*. This would include visits specifically during the first planting of research plots following construction of buffer zone, after planting of all 50 acres of research (i.e. 50 plots), and when the full 400 acres will be planted. They may be called upon to visit at other times depending on the progress of the research and needs; and will remain available throughout project to provide guidance remotely.

5Cs held a public consultation on the *Biomass Pilot* on 24<sup>th</sup> February, 2016 to present the project concept to the stakeholders and to incorporate any recommended actions into this document (see Appendix 10 for the public consultation meeting report). During the public consultation, the

project concept and approach were discussed, and no issues of concern, which would require additional revision of this document, were raised. However, the 5Cs will collaborate with the Department of Environment and the nearest Village Council to establish a Grievance Committee to provide means through which concerns related to the *Biomass Pilot* can be conveniently channeled and quickly addressed. This would include:

- **The Grievance Committee:** It will be comprised of three members, a representative of the Department of Environment, one from the Village Council, and one from the 5Cs. The Project Manager will serve as the ex-officio member of the Grievance Committee.
- **Notification to Community:** Notices will be placed at prominent locations in the village including the Community Centre, and the Primary Schools. The notice will be in English and Spanish, and will inform where, to whom and how to submit complaints.
- **Addressing Concerns:** A meeting will be convened within one week of receipt of the complaint by the Project Manager, during which the complaints will be aired and discussed. The 5Cs will then take remedial action as necessary.
- **Confirming Resolution of Concerns:** Following remedial action, the 5Cs will communicate to the grieved party through appropriate means to confirm the satisfactory resolution of the matter; and also inform the Grievance Committee

**Table 13: Summary of Impacts Monitoring**

*(The impact monitoring will cover the entire four year duration of the Biomass Pilot)*

<b>Category</b>	<b>What</b>	<b>Where</b>	<b>Frequency</b>	<b>Method</b>	<b>By Whom</b>	<b>Costs</b>
Environmental	Waste	<i>Biomass Pilot</i> area	After research plots and plantation establishment, as decided by DOE.	Observations	DOE, 5Cs	DOE
Social/ (aesthetics) Environmental	Spill of <i>Arundo donax</i> (shredded)	Residential areas, feeder roads, and highways	After every trip of the container truck transporting material	Road inspections	Project personnel	Project
Environmental	Water pollution	Blue Creek	Monthly for the first two years, then at quarterly intervals.	Water quality testing <sup>41</sup>	DOE staff, 5Cs	DOE, Project <sup>42</sup>
Environmental	Excess plant material	<i>Biomass Pilot</i> area	Nursery and plantation preparation, eradication	Inspection	Project personnel, 5Cs	Project
Environmental	Pollution	<i>Biomass Pilot</i> area	Cleaning equipment	Inspection	5Cs /project personnel	Project
Environmental	Inspection of Container Trucks	<i>Biomass Pilot</i> area	Before and after loading	Visual inspection	5Cs / project personnel	Project
Environmental	Potential rhizome escape	Research plots, and biomass plots, Buffer Zone	Weekly during cultivation	Visual inspection of ditch & buffer zone	5Cs / project personnel	Project
Social	Human encroachment	<i>Biomass Pilot</i> area	Daily	Visual inspection	5Cs / project personnel	Project
Environmental	Inspection of equipment	<i>Biomass Pilot</i> area	Following washing and before leaving site to return to owners.	Visual	5Cs / project personnel	Project
Environmental, Compliance Monitoring	All categories, Site monitoring	Research plots, <i>Biomass Pilot</i> , storage area, transfer routes, ASR-BSI factory storage	Quarterly	Visual	Independent Consultant	Project

<sup>41</sup> The 5Cs is required by DOE to conduct water quality testing at monthly intervals during the first two years of the project. After the first two years, the frequency of the tests is reduced to quarterly. The ERCAP funds will cover the costs of these tests, which are included in the budget. The tests conducted on site included those for Dissolved Oxygen, temperature and pH.

<sup>42</sup> The DOE will do its own periodic verification tests, the cost of which are partially defrayed by the Monitoring Fee which that will be covered by ERCAP funds. Based on DOE guidance, this monitoring fee is estimated to \$1000 per year or less for the project.

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## Appendix 1: Summary of Risk Management Plan

The following is a summary of key actions described in this document, which are to be taken during the implementation of the pilot in order to ensure that the risks, primarily of invasiveness, is minimized and managed.



<p><b>Objective of Biomass Pilot:</b> The proposal is for the <u>managed/controlled cultivation</u> of Arundo donax (AD) in specifically identified and contained areas, for testing its suitability as a biomass fuel.</p>	<p><b>Land for Biomass Pilot:</b> Land area for pilot is a total of 500 acres within a larger area of 1,800 acres identified by the Government of Belize for the activity. It is identified by the Ministry of Natural Resources and Agriculture as marginal, non-agricultural land. The testing of the AD will take place on <b>400</b> of the 500 acres designated by the Government.</p>	<p><b>Viability of Seeds:</b> No viable seeds will be produced as a part of the Biomass Pilot, since seeds for AD are sterile. The plant will not propagate through its seeds, eliminating any prospect for unwanted propagation through airborne or other similar means.</p>	<p><b>Storage:</b> The pilot will construct 19,000 square feet storage with concrete flooring at the pilot area, where the harvested AD material will be transported immediately following harvesting (i.e. cropping and chipping).</p>	<p><b>Transportation:</b> Container trucks used for transportation of dried and shredded AD will be locked during transportation. The primary reason for the use of lockable container trucks is to prevent spillage that may cause disruption en-route and loss, rather than any risks since the dried and shredded biomass material can no longer propagate. Nevertheless, it is an additional barrier that will eliminate any risk of unwanted propagation.</p>
<p><b>Biomass Pilot Results:</b> The approach to The Biomass Pilot operation is designed to help test/confirm whether it is feasible to cultivate and utilize the crop as a biomass feedstock from technical, commercial, financial, and environmental and social perspectives</p>	<p><b>Buffer Zone:</b> The 400 acre designated Biomass Pilot area that will be used for AD growing will be surrounded by a buffer area of at least 20 foot width that is elevated 12-18 inches, which will have multiple purposes:</p> <ul style="list-style-type: none"> <li>• It will primarily provide containment against the lateral shift of rhizomes, minimizing the likelihood of unintended propagation beyond the designed cultivation area.</li> <li>• Prevent drainage beyond the 400 acre cultivation area keeping all water within Biomass Pilot area. This will prevent any plant material from being drained beyond the Biomass Pilot area.</li> <li>• Serve as an access road to the area where crop is cultivated</li> <li>• Act as a fire break should outside fires threaten the pilot project area</li> </ul>	<p><b>Harvesting:</b> The AD will be mechanically harvested using rotary head cutters, where the machinery will also simultaneously chip the material to approximately ½ inch sized pieces. The chipped material will be discharged directly into a tractor drawn trailer before it is transported to a specially constructed storage area on the premises of the Biomass Pilot. According to several agronomist specialists, the ½ inch chipped material does not have the capability to propagate, and never leave the pilot area as freshly cut plant material, further reducing any chance of propagation outside the pilot area.</p>	<p><b>Drying:</b> The cropped and chipped biomass material will be air-dried in the on-premise storage facility, which reduces the water content of the biomass material to about 15-20 percent in about 2-3 weeks. The biomass material, at this point, can no longer propagate even if planted beneath the soil, according to a number of agronomist specialists.</p>	<p><b>Transport Route:</b> The transport route, which is less than 20 miles, does not traverse through any major population centres or sensitive areas; in particular of biodiversity consequence or any surface water sources. It will pass by some sugar cane fields.</p>

<p><b>Utilization of Land:</b> The pilot will only utilize a land area that is publicly owned and identified as marginal by the Ministry of Natural Resources and Agriculture. Marginal land is non-agricultural land where the soils are poorly drained, shallow and droughty and cannot be utilized even with skilled management and high inputs. A number of failed attempts at commercial agriculture on these marginal lands. The crop will not be introduced to any areas outside of the designated land area. Therefore, the pilot will not utilize land that will have any alternate agricultural use</p>	<p><b>Planting AD:</b> The initial 50 acres of test plots (within the 400 acres designated for the Biomass Pilot) will be established from fresh cut stalks from AD growing in the South of the country. The AD stalks collected will be transported in fully enclosed, locked, and inspected container trucks to the Biomass Pilot area. No rhizomes will be removed, uprooted, or transported during the proposed Biomass Pilot.</p> <p>The AD stalks for planting the additional 350 acres (i.e. the remaining 400 acres designated for the Biomass Pilot) during the managed cultivation sub-component, will be supplied from AD stalks cut from the 50 acres of research plots within the Biomass Pilot area. There will be no transport of any live plant material outside the Biomass Pilot area or the removal of any rhizomes within the project area. The rhizomes from the AD will remain underground in the Biomass Pilot area and not being removed at any stage of the Biomass Pilot activity will greatly limit the risk of unwanted propagation.</p>	<p><b>Cleaning Machinery and Equipment:</b> All machinery that is utilized for harvesting will be washed before they leave pilot facilities. Washing will be done within the location of the Biomass Pilot at a designated central work location, which will also have a water supply in the form of a well. The water used to wash equipment will be drained within the premises as per the design of plots and Buffer Zone; and will not drain beyond the project area as it will be contained by the Buffer Zone.</p>	<p><b>Shredding:</b> Prior to delivering the stored biomass material to the existing BELCOGEN biomass co-generation power plant, it will be further shredded and directly loaded into container trucks for transport. The shredding, converts the biomass material to a fibrous content that is ready for utilization in the power plant boilers. The dried and shredded biomass material cannot propagate, since it does not have any properties of a live plant material.</p>	<p><b>Transport Route Inspection:</b></p> <p>The route will be inspected daily during the transfer of the biomass, even if a spillage of the processed and shredded AD will be rare due to the locked container trucks, if it were to spill, the biomass material does not have any properties that can propagate.</p> <p>The inspector contractor will be equipped with portable vacuum and broom and trash bags to immediately clean-up if any spillage from the container trucks are detected. Contractor will be asked to report on any sign of spills after each trip.</p> <p>If necessary, motorized street sweepers will be utilized to clear debris from road if there is processed and shredded biomass material that is encountered.</p> <p>The collected debris will be brought back to the biomass pilot site and returned to the cultivation areas.</p> <p>The daily route inspection planned for risk management will ensure that any fallen material will not remain on the ground for any extended period of time.</p>
<p>The seeds of crop are sterile so it cannot propagate through airborne and other means via the seeds. The only means of natural propagation of crop is through the spread of rhizomes that are underground. Managed propagation requires the harvesting and planting of AD stalks in a manner similar to any sugarcane.</p>	<p><b>Water Resources:</b> The area 400 acre designated for cultivation of AD in the Biomass Pilot is sufficiently far from the nearest water source (at least 830 meter distance from nearest stream), preventing any AD plant material from being introduced to water sources. It will prevent waterborne transportation and propagation of the crop due to the proposed Biomass Pilot.</p> <p>The designated land area/fields are flat lands and do not naturally drain water. While this aspect makes the area suitable for cultivating the crop, it also limits run off of water reducing the likelihood of any plant material spreading.</p>			<p><b>Cleaning Transport Equipment:</b> All transportation equipment will be washed before, moving off site. Washing will be done within the premises of the 400 acre Biomass Pilot at the designated central work location, which will be supplied with water from a well on the premises.</p> <p>The used wash water will drain but will be contained within the 400 acre Biomass Pilot premises due to the elevated buffer zone and drainage design./</p>

	<p>The road/buffer zone established around the Biomass Pilot area, which will be elevated 12-18 inches, is also a barrier designed to prevent drainage and water runoff as well as contain all plant material within the designated 400 acre Biomass Pilot area.</p> <p>The above characteristics, measures and project design features help ensure that no water sources will be contaminated and lead to unwanted propagation of AD as a result of the Biomass Pilot.</p>			
<p><b>Risk Management Framework to Prevent Unwanted Propagation:</b> Since the risk of propagation of the crop is only if the cultivation is not adequately managed, it is good practice to prepare a framework for managing any residual risks. This document represents such a Risk Management Framework that will further minimize any residual risk of uncontrolled propagation.</p>	<p><b>Handling/Utilization of Plant Material:</b> Plant material will be handled/utilized as follows:</p> <ul style="list-style-type: none"> <li>• The excess leaves are biodegradable and do not propagate</li> <li>• The stalks are cropped, processed (chipped, dried, and shredded) as biomass feedstock. This biomass material cannot propagate.</li> <li>• The rhizomes through which AD propagates remain underground throughout project and are not extracted; and further protected by a buffer zone. This will prevent propagation outside the 400 acre Biomass Pilot area through the spread of rhizomes.</li> </ul>			
<p><b>Post-Pilot Assessment:</b> At the conclusion of the pilot, a complete environmental and social impact assessment (ESIA) will be commissioned to ascertain potential impacts and mitigation measures that may be required for expansion of AD cultivation beyond pilot. The Biomass Pilot itself will provide valuable information on refining the practices for the managed cultivation of AD, which can be incorporated into the ESIA. The post-Biomass Pilot ESIA will comply with World Bank and Government of Belize environmental and social safeguard requirements</p>	<p><b>Access to Biomass Pilot Area:</b> There are no residents living in the proposed project area, and it is all publicly owned land. The nearest household is at least 5 miles from the Biomass Pilot area, and even then, it is a limited population that resides in these distant communities. These factors make it unlikely that there would be unauthorized/unprepared access by outsiders to the Biomass pilot area. In addition, the nature of the plants will make unplanned access difficult. Moreover, there will be posted signs restricting access as well as regular monitoring by project security to ensure that there is no unauthorized access to</p>			

	<p>the Biomass pilot area by outsiders/non-project personnel. Only authorized project personnel will be provided access to the 400 acre Biomass Pilot area</p>			
	<p><b>Monitoring and Inspection:</b>  There will be an inspection plan under implementation with regular monitoring for propagules in the cultivated fields and buffer zones, including sight inspection of the plots and surrounding buffer and surrounding areas to determine if there is any unwanted growth. If any such cases are observed outside the cultivated area, it will be immediately removed and replanted within the 400 acre area designated for the Biomass Pilot that is surrounded by the buffer zone.</p> <p>Monitoring will also be undertaken to ensure that there is no unwanted encroachment into the Biomass Pilot area by unauthorized personnel.</p>			
	<p><b>Eradication Plan:</b> In the event that the pilot is unsuccessful or termination of the project is necessary, then the field will be ploughed repeatedly to uproot the rhizomes, and raked to remove rhizomes. This industry practice is being applied instead of chemical eradication of the crop. As the AD rhizomes do not grow to more than 50 centimetres in length, to cross an area of 20 feet would require that plant to have shoots about every two feet.</p>			

## Appendix 2: DOE Letter of Environmental Clearance



### DEPARTMENT OF THE ENVIRONMENT

Market Square

Belmopan, Belize

Tel: 501-822-2548 / 2819 | Fax: 501-822-2860

Email: [envirodepf@btl.net](mailto:envirodepf@btl.net) or [envirodepf@ffsd.gov.bz](mailto:envirodepf@ffsd.gov.bz) | Website: [www.doe.gov.bz](http://www.doe.gov.bz)

Please Quote: DOE/C/135/15 (6)



May 26, 2015

Dr. Kenrick Leslie  
Executive Director  
Caribbean Community Climate Change Centre  
Lawrence Nicholas Building, Ring Road  
P.O. Box 563  
Belmopan City

Dear Mr. Leslie,

Subsequent to a review of the project document for the proposed Pilot Project for the Production of *Arundo donax* as a Renewable Biomass Fuel for Belize, personnel from the Department of the Environment (DOE), Forest Department and the Land and Surveys Department conducted a joint site inspection of the proposed project area for the cultivation of approximately 500 acres of the said plant in the Orange Walk District.

The inspection revealed that the proposed cultivation area is a low land savannah with sparse tropical evergreen, being poorly drained and in its natural state. Notwithstanding, the DOE foresees no significant negative environmental impacts from the proposed pilot project, thus hereby grants environmental clearance to the Caribbean Community Climate Change Center (5Cs) for the cultivation of 500 acres of *Arundo donax* within the below described plots:

- Plot I

All that area consisting of approximately 110 acres, situate West of Trinidad Village, Tower Hill Registration Section, Block No. 4, Orange Walk District, more specifically being within the boundaries of the following coordinates:

Eastings	Northings
319138	1996140
319465	1996715
320196	1996285
319746	1995834

- Plot II

All that area consisting of approximately 394 acres, situate West of Trinidad Village, Tower Hill Registration Section, Block No. 4, Orange Walk District, more specifically being within the boundaries of the following coordinates:

Eastings	Northings
319822	1995944
320683	1995459
319886	1994052
319027	1994539

This clearance is being granted contingent upon 5Cs compliance with the following:

1. The use of agrochemicals (whether as pest control or fertilizer) is prohibited, unless otherwise approved by the Pesticides Control Board and the DOE.
2. Prior to undertaking any vegetation clearance, 5Cs must consult with and obtain the required permits from the Forest Department. 5Cs is required to comply with a conditions of the permit, including the payment of royalties, where applicable.
3. No vegetation clearance shall be conducted within the 66 feet buffer of the existing creek bordering Plot I to the west.
4. Adequate measures will put in place to control against the *Arundo donax* colonizing area outside the above described plots. Such measures must take into consideration conditions I above.
5. Should any find be made of any important habitat niche (mammals, birds, reptiles), every effort shall be made for their protection and possible transfer to another natural environment.
6. Cleared vegetation shall be mulched and used as an organic soil conditioner. Should the burning of vegetation be required, these will be stockpiled in windrows away from the perimeter boundaries of the plots and will be monitored until the fire is completely burnt out or extinguished.
7. 5Cs must consult with and obtain input from the Institute of Archaeology regarding the potential archaeological significance of the area. Notwithstanding, during the clearance of vegetation, should there be a discovery of any feature of archaeological or historical significance 5Cs shall cease work in the immediate area and contact the IoA. Work in the area shall only resume on approval from the IoA.
8. Mechanical preparation of the land, if deemed necessary, must take into consideration the natural sheet flow of the area.
9. If the *Arundo donax* compatibility test in the BELCOGEN facility is unsuccessful, this clearance becomes null and void and the plots shall be cleared and re-vegetated with plants native to the area.
10. Should the compatibility test be successful and 5Cs intend to maintain the plots, they are required to control the *Arundo donax* to ensure it does not colonize areas outside the plot boundaries.
11. 5Cs shall provide the DOE with a copy of its findings, including biomass production under the various agronomic parameters tested.
12. No further development shall be undertaken within the described plots or other areas associated with the cultivation of *Arundo donax* without prior written approval from the DOE.

Thank you for your kind consideration and cooperation.

Regards,

  
Martin Alegria  
Chief Environmental Officer  
Department of the Environment

### Appendix 3: Notification of Lease



*Ministry of Natural Resources and Agriculture  
H.M. Queen Elizabeth II Boulevard, Belmopan, Belize, C.A.  
Ph: (501) 802-2630 Fax: (501) 822-2333  
Email: [minister@mnr.gov.bz](mailto:minister@mnr.gov.bz), [ceo@mnr.gov.bz](mailto:ceo@mnr.gov.bz), [info@mnr.gov.bz](mailto:info@mnr.gov.bz)*

*Ref. No: CLS065/09/15(56)*

*27 May 2015*

Dr. Kenrick Leslie  
Executive Director  
Caribbean Community Climate Change Centre  
Belmopan

Re: Approved lease for 500 Acres of land

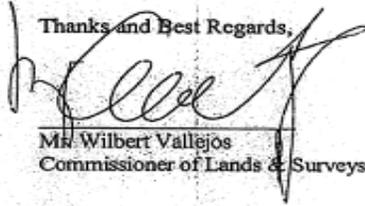
Dear Dr. Leslie:

The Ministry of Natural Resources and Agriculture is pleased to inform you that Cabinet has approved a short term lease of 500 acres of marginal land to the Caribbean Community Climate Change Center. The lease agreement would be for the duration of the project or for a period not exceeding five (5) years beginning September 2015 at a rental of \$1 per acre in accordance with the terms and conditions of the Energy Resilience for Climate Change Project being implemented by the Ministry of Energy, Science and Technology and Public Utilities and standard lease conditions as per the National Lands Act.

Through this medium, we are kindly requesting you to visit the Ministry of Natural Resources and Agriculture office in Belmopan for assistance with the lease application process for Caribbean Community Climate Change Center.

We look forward to further collaboration and should there be any questions or concerns, please do not hesitate to contact us.

Thanks and Best Regards,



Mr. Wilbert Vallejos  
Commissioner of Lands & Surveys Department

CC: Hon. Joy Gravit  
Minister of Energy, Science & Technology and Public Utilities

Dr. Colin Young  
Chief Executive Officer,  
Ministry of Energy, Science & Technology and Public Utilities

## Appendix 4: Permission to Survey Land

**BELIZE**

**MINISTRY OF NATURAL RESOURCES  
AND AGRICULTURE**

**PLEASE QUOTE**

**NO: CLS 67/015/15 (7)**

**DATE: 27<sup>th</sup> MAY, 2015**

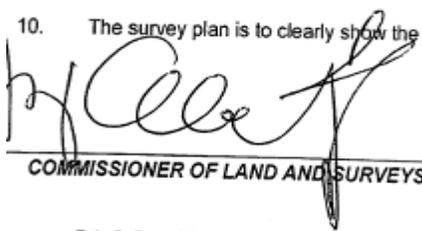
CARIBBEAN COMMUNITY CLIMATE CHANGE CENTRE  
2<sup>nd</sup> FLOOR, LAWRENCE NICHOLAS BUILDING  
CITY OF BELMOPAN  
BELIZE

Dear Sir/Madam

**RE: PERMISSION IS BEING GRANTED TO SURVEY +/- 500 ACRES OF NATIONAL LAND SITUATED IN TRINIDAD VILLAGE, TOWER HILL REGISTRATION SECTION, ORANGE WALK DISTRICT.**

**Permission is being granted by the Commissioner of Lands and Surveys subject to the following conditions: -**

1. Before the commencement of surveys the Licensed Surveyor must contact the National Estate Officer for the relevant information concerning the lease and liaise with the District Land and Surveys Officer.
2. In the event of cancellation due to non-fulfillment of the Lease conditions, no refund will be given for survey cost.
3. The surveying of the land by the Lessee does not constitute a right of TITLE, but must fulfill the Location Ticket conditions or the Lease Purchase conditions.
4. The Surveying of the land by the Lessee should be contracted to a Licensed Surveyor only.
5. "Permission granted by the Commissioner of Land and Surveys" and reference is printed on the Surveyed Plan.
6. The Surveyor must submit a copy of this permission, bearing the seal and signature of the District Lands and Surveys Officer, when the plan is submitted for authentication.
7. Hydro Line for the Belize Electricity Limited must be shown on the Plan with a right of way of 50 feet on both sides of its centerline.
8. This permission is valid for one (1) year in the case of new leases being processed.
9. Where there is evidence of any existing Survey of the parcel for which permission to survey is granted the Surveyor is required to bring it to the attention of the Principal Surveyor.
10. The survey plan is to clearly show the 66ft sea reserve.

  
\_\_\_\_\_  
COMMISSIONER OF LAND AND SURVEYS

cc: D.L.S.O. – ORANGE WALK DISTRICT  
NATIONAL ESTATE OFFICER



## Appendix 5: Scientific Collection Permit

### FOREST DEPARTMENT

Ministry of Forestry, Fisheries and Sustainable Development  
Forest Drive, Belmopan, Belize  
Tel: (501) 822-1524 • Fax: (501) 822-1523  
Email: secretary.fd@ffsd.gov.bz



*Please Quote*

Ref. No. CD/60/3/15(31)

Caribbean Community Climate Change Centre  
Second Floor, Lawrence Nicholas Building  
Ring Road, Belmopan  
Belize C.A.

May 22<sup>nd</sup>, 2015

#### SCIENTIFIC COLLECTION/RESEARCH PERMIT WILDLIFE PROTECTION ACT NO. 4/1981

Permission is hereby granted to the above-named and address to do **Research/Collection** in the Country of Belize subject to the following conditions:

1. The permit is:
  - a.) Valid for Caribbean Community Climate Change Centre and 10 companions only.
  - b.) Valid until May 21<sup>st</sup>, 2016.
2. This permit provides research/collection to be done at: Public land of naturally growing Arundo donax in the Stann Creek and Toledo district, beyond the 66 foot wide reserve along permanent waterways. This will include the Monkey and the Sittee Rivers only.
3. This permit allows permit holder to do research/collection entitled: Pilot project for the production of Arundo donax as a renewable energy biomass for Belize.
4. The objective of the research is: To demonstrate the long-term feasibility of bioenergy production in Belize, based on an indigenous fast growing C3 perennial rhizomatous grass- Arundo donax- cultivated on widely available agricultural lands as the priority feedstock.

5. This permit provides for the following: Collection of 400 tons of Arundo donax only.
6. The permit holder must supply the Forest Department with both digital and hard copy of progress Report at the end of each year of the project and a final report at the end of the Project.
7. This permit may be cancelled at anytime not withstanding condition 1(b) above at the discretion of the Minister of Forestry, Fisheries and Sustainable Development.
8. The permit holder shall make provision to accommodate Forest Department staff on field trips as convenient to both parties.
9. Research fee has been paid vide treasury receipt no: 1392392 dated 28.5.15.



Cc: CFO  
File  
O.I.C. Savannah, Toledo

## Appendix 6: Voluntary Best Management Practices for Energy Crops



### Voluntary Best Management Practices for Energy Crops *Minimizing the Risk of Invasiveness*

September 2011

*The North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, and the Biofuels Center of North Carolina have developed the following guidelines or best management practices to help bioenergy feedstock growers and processors reduce the risk of unintentional escape and spread of potentially invasive species. The following document is not intended to be utilized as a regulatory document and, as such, the recommended best management practices outlined below are completely voluntary.*

#### **OVERVIEW AND PURPOSE**

North Carolina is engaged in two significant initiatives that have the potential to transform how the state's energy needs for both electricity and transportation are met. One of the initiatives establishes new mandates for the generation of renewable electricity and the other sets a state policy goal for the production of liquid biofuels. Both of these new initiatives will require substantial amounts of biomass, including the production of energy crops.

North Carolina's bioenergy initiatives have the potential to increase jobs, strengthen our agricultural sector, and enhance our environment. The best management practices outlined in this document should serve to develop the industry in a responsible manner. The practices were developed in a collaborative process and embody the idea that addressing concerns about potential invasiveness from the outset will lead to a greater understanding and awareness that these new energy crops will one day be a significant piece of North Carolina's agricultural sector.

Successful development of the bioenergy industry in North Carolina will require cost-effective and environmentally responsible production of new energy crops. Some energy crops or feedstocks may have some of the same traits (e.g., drought tolerance, rapid growth rates, etc.) which are found in invasive plants. Invasive plants are generally considered those species that are non-native whose introduction does, or is likely to, cause economic or environmental harm.

It is imperative that the introduction of new energy crops does not cause economic or environmental harm through unintended consequences. As such, it is important that the bioenergy industries in North Carolina take a strategic approach to these issues by utilization of responsible practices.

**The best management practices outlined in this document serve as a first iteration and will be continually updated and modified as new information from research and experience is gathered.**

## BEST MANAGEMENT PRACTICES TO MITIGATE THE INVASION RISK

The task of minimizing the risk of escapes by potentially invasive feedstocks can be managed at several steps in a process that ends with production at the manufacturing facility. The guidelines following *Figure 1* suggest reasonable actions at each of these steps.



*Figure 1.* Flow chart showing progression of energy crop production from the point where species are selected to the point where the crop is utilized at the bioenergy manufacturing facility.

Any private or public enterprise cultivating crops for the purpose of bioenergy production (e.g., liquid fuels such as ethanol or power from combustion) should adhere to the following practices to reduce the unintended propagation of energy crops.

### 1 Information Gathering

#### Prohibited or Restricted Plant Check

The first step taken by growers and landowners before the planting of any energy crop is to identify whether any prohibitions or regulatory restrictions exist for the species in question. Those species subject to regulation are identified by listing and designation at the state and federal level. For more information about the regulations governing noxious weeds in North Carolina, please contact the N.C. Department of Agriculture and Consumer Services Plant Industry Division (NCDA):

<http://www.ncagr.gov/plantindustry/plant/index.htm>

#### Right Plant, Right Place

It is important to note that even when a plant is not prohibited or restricted by law or regulation, the plant may still be identified as having some level of risk for invasiveness. Consequently, growers and landowners should educate themselves about the energy crop in question and make a determination as to whether the risks of potential unintended spread can be managed through the implementation of safeguards or best management practices. Growers and landowners can learn more about the plant in question through the N.C. Department of Agriculture and Consumer Services or North Carolina Cooperative Extension. After checking on the plant in question, the grower can then make an informed decision as to whether that particular plant is well suited to be planted in the region in question.

### 2 Planting and Management in the Field

One of the main sources for propagule escape is the production field. In horticulture, a propagule is any plant material used for the purpose of plant propagation. The following practices are recommended to reduce propagule dispersal and establishment:

- Production fields should not be located directly adjacent to major dispersal corridors, such as streams, irrigation canals, major roads, or utility right-of-ways;
- If viable seeds are produced, measures should be taken to minimize their dispersal, such as choosing late-flowering cultivars or harvesting prior to seed maturation;
- Human access to the fields should be controlled;
- Establish a buffer area surrounding the production field of 20 feet, which should be maintained with a perennial cover (e.g., legumes, bermudagrass, tall fescue);
- Field boundaries, buffer areas, and adjacent areas should be inspected regularly for propagules/seedlings;
- Excess planting material should be killed by drying out on an impermeable surface or by burning;
- Barriers (e.g., silt fences or berms) should be installed down slope of production fields to intercept crop fragments (inflorescences, stems, etc.) if the field is sloped  $\geq 5\%$ ; and
- An eradication plan should be prepared prior to planting that provides treatment recommendations and procedures that are followed after confirmation of escapes or abandonment of the field.

### 3 Harvesting

Harvesting methods should eliminate or reduce viable propagules.

- All planting, harvesting, and transport vehicles and equipment should be cleaned (e.g., air gun, water) of all plant material prior to moving off site;
- If viable seeds are produced, harvesting/baling methods should be used to reduce propagule spread (e.g., wrapping bales); and
- If stem fragments are known propagule sources, harvest practices should reduce/eliminate propagule viability (e.g., shredding above-ground material to kill stem buds).

#### 4 Transportation

Land along the route from harvested fields to the bioenergy facility could also be susceptible to inadvertent escapes. The susceptibility of the areas will range from a high likelihood of energy crop propagule surviving and establishing to an area very unlikely to support an introduced propagule. As such, the transporting of feedstock material should be done in a manner that reduces unintentional propagule loss.

- Trucks and trailers should be covered;
- Routes that minimize crossing of highly sensitive habitats (e.g., riparian areas) should be utilized; and
- Right of way along transport routes should be visually inspected to ensure no escapes.

#### 5 Storage

Storage sites are analogous to production fields in serving as a stationary source of propagules.

- Storage sites should be placed in locations not adjacent to sensitive habitats;
- Storage sites should be inspected on a regular schedule for seedlings; and
- Stored plant material should be covered.

#### CURRENT AND FUTURE CONSIDERATIONS

As noted above, invasive plant species are generally considered those species that are non-native whose introduction is likely to cause economic or environmental harm. Although a federal Executive Order is in place that provides some framework for guidance on management and risk mitigation, much of the

regulatory structure governing invasive species is found at the state level.

In North Carolina the primary state agency with jurisdiction over invasive species issues is the N.C. Department of Agriculture and Consumer Services. This agency administers the State Noxious Weed Regulations under the Authority of the Plant Pest Law (N.C.G.S. 106-419 et seq.). The implementation of these regulations is the primary mechanism for addressing the threat of invasive species in North Carolina. A portion of that regulatory structure is the agency's responsibility to maintain the state's noxious weed list. Designation on the state's noxious weed list may prohibit the movement into or within the state of that species.

Although none of the energy grasses being trial grown in North Carolina for biofuels purposes is listed on the state's noxious weed list, some of these grasses have been designated as invasive in certain regions of the United States. Consequently, the practices outlined in this document are a safeguard to limit any unintended consequences from the development of the bioenergy sectors.

At the federal level, both the U.S. Environmental Protection Agency and the U.S. Department of Agriculture (USDA) are focusing increased attention on issues related to energy crops and potential invasiveness concerns. For example, the USDA recently released a technical guide to growing and managing Giant Miscanthus. Included in the document are a number of recommendations to minimize the risk of invasiveness. For more information on the USDA technical guide, see:

<http://plant-materials.nrcs.usda.gov/pubs/NPMtechnotes/npmptn4.pdf>





The North Carolina Department of Agriculture and Consumer Services, North Carolina Cooperative Extension, and the Biofuels Center of North Carolina would like to acknowledge the assistance and contribution of a number of interested parties in the development of this document. In particular, Dr. Jacob Barney, Assistant Professor at Virginia Tech, was instrumental in the creation of the document.

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Staff with the Biofuels Center of North Carolina were responsible for the layout and graphics in the document. Printed copies of this document were paid for by the Biofuels Center of North Carolina. To obtain copies, please contact Wil Glenn, Director of Communications and Public Affairs.

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v2: Aug 15, 2012

## Appendix 7: Budget

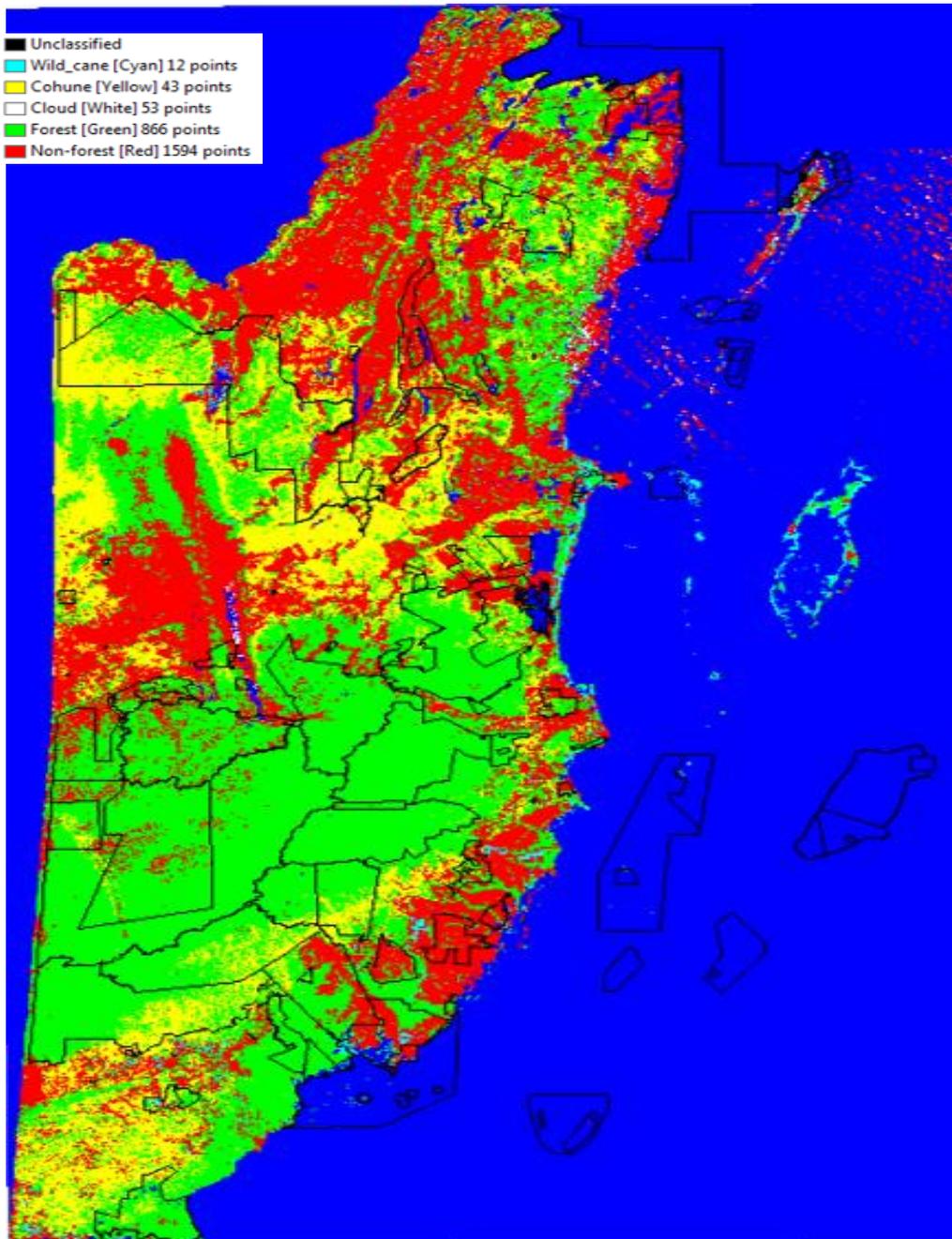
Budget Items (Unit: USD)	1st Sub- Component (50 acres)	2nd Sub- Component (400 acres)	Total	Funding Source	
				WB/GEF	5Cs
<b>Land Identification and surveys</b>	5,000	40,000	<b>45,000</b>	45,000	-
<b>Land Preparation &amp; Fertilizing</b>	35,075	280,600	<b>315,675</b>	315,675	-
<b>Planting</b>	41,250	60,000	<b>101,250</b>	101,250	-
<b>Harvesting</b>	18,750	54,375	<b>73,125</b>	73,125	-
<b>Buffer Zone/Access Road Construction</b>	223,500		<b>223,500</b>	223,500	-
<b>Project Office, PV system, radio, furnishings and equipment</b>			<b>126,500</b>	126,500	-
Project Office, PV system, radio, furnishings and equipment	37,250				
Monitoring, Safety and Security	48,250				
Purchase & Maintenance of Essential Equipment	41,000				
<b>Storage Area Construction</b>			<b>95,000</b>	95,000	-
<b>Transportation of biomass</b>			<b>11,250</b>	11,250	-
<b>Personnel</b>			<b>427,800</b>	193,550	234,250
Project Manager (1)	118,800				
Energy Advisor (1)	108,000				
Assistant Project Manager (1)	60,000				
Research Assistant (1)	44,000				
Watchman (2)	10,000				
Expert Consultants	31,000				
Local Transportation	56,000				
<b>Feasibility Study &amp; Environmental and Social Impact Assessment</b>			<b>96,803</b>	96,803	-
<b>Eradication of Biomass (including inspection costs and contingencies)<sup>43</sup></b>			<b>280,800</b>	-	280,800
<b>Total</b>			<b>1,796,703</b>	1,281,652	515,050

<sup>43</sup> This budget for eradication covers the cost of either the eradication required at the end of the Research Phase (US\$35,100) or the requirements at the end of the Managed Cultivation Phase (US\$280,800), if at all. Only one of the eradication options will be needed. The 5Cs commitment to provide the necessary contingent funds for eradication will be formalized and made binding through the legal agreement with the World Bank.

## Appendix 8: Spectrum Analyses of Satellite Imaging to Identify *Arundo donax* Coverage in Belize

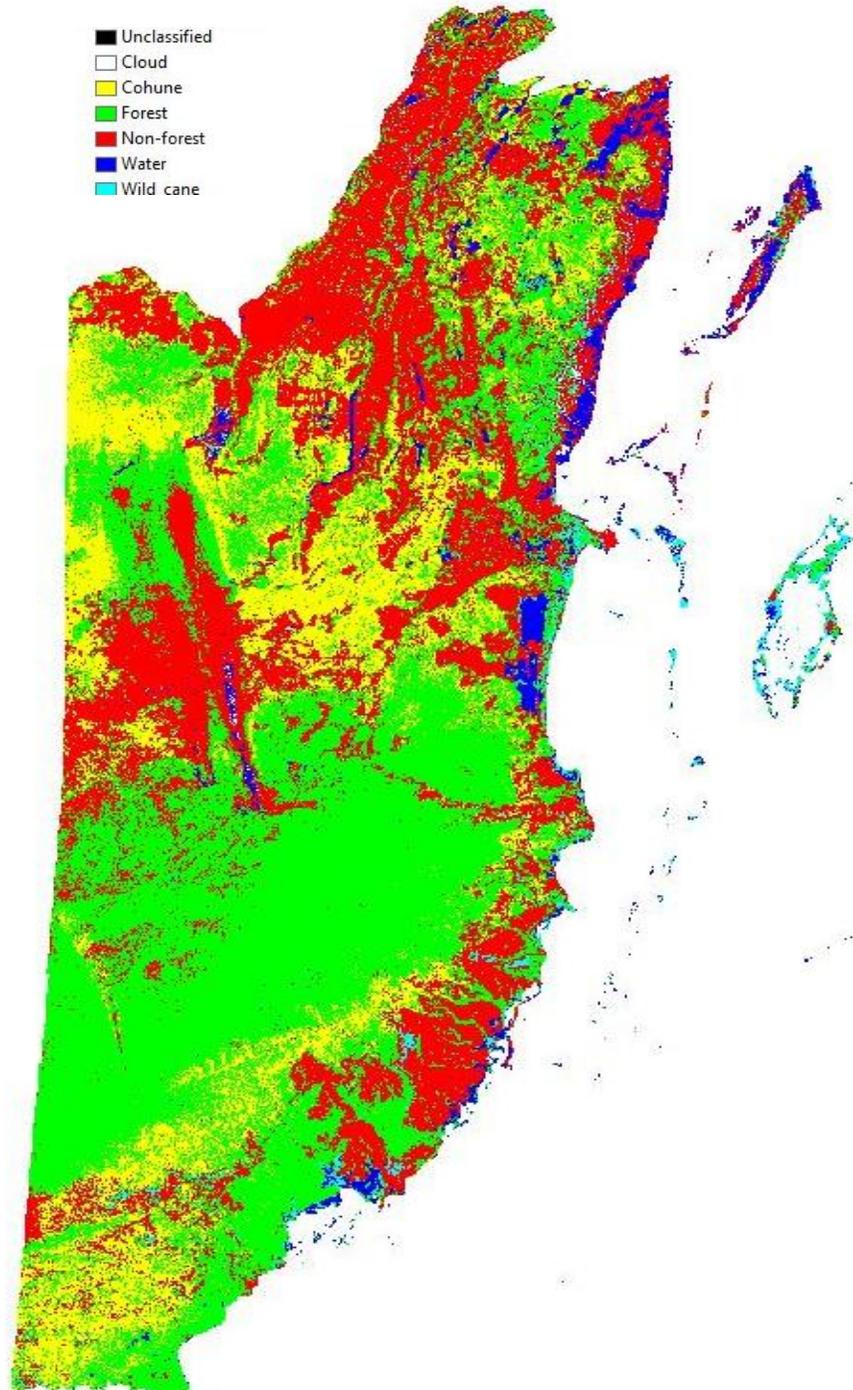
A. A spectrum analysis map of Belize from **October 2012**

Land area in Belize under <i>Arundo donax</i> , as identified through satellite imaging	354 km <sup>2</sup>
Total estimated land area of Belize	22,965 km <sup>2</sup>
<i>Estimated area in Belize with existing Arundo donax (area with Arundo donax/ Total land area of Belize)</i>	1.54%



B. A spectrum analysis map of Belize from **March 2000**

Land area in Belize under <i>Arundo donax</i> , as identified through satellite imaging	457 km <sup>2</sup>
Total estimated land area of Belize	22,965 km <sup>2</sup>
<i>Estimated area in Belize with existing Arundo donax (area with Arundo donax/ Total land area of Belize)</i>	1.99%



## Appendix 9: Sample Inspection/Monitoring Report Forms



**CARIBBEAN COMMUNITY CLIMATE CHANGE CENTRE**

**ARUNDO DONAX BIOMASS PILOT PROJECT**

*Orange Walk District, Belize*

### MONITORING & INSPECTION REPORT

1. Name of Monitor/Inspector: \_\_\_\_\_
2. Number of Persons on Inspection: \_\_\_\_\_
3. Date of Inspection: \_\_\_\_\_ Time of Inspection: \_\_\_\_\_
4. Method on Inspection: Vehicle: \_\_\_\_\_ Foot: \_\_\_\_\_ Other: \_\_\_\_\_
5. Supervisor's name: \_\_\_\_\_
6. Supervisor's #: \_\_\_\_\_
7. Weather : Sunny \_\_\_\_\_, Cloudy \_\_\_\_\_, Rainy \_\_\_\_\_, Dry \_\_\_\_\_

#### 8. Inspection Table

#	Site /Location Inspected	Risk	Evidence	Yes	No or N/A
1	Buffer Zone Road	Escape of Plants	Shoots on road		
		Human intrusion	Footprints, wheel tracks		
		Fire	Smoke and/or ashes		
2	Inner Drainage Ditch	Escape of plants	New rhizomes in ditch		
			Roots across the ditch		
3	Research Plots (50 one acre plots)	Human intrusion	Cut plants		
			Trails among the plants		
			Hunters' remains		
		Excess Plant Material (during planting)	Plants outside plots		
		Potential rhizome escape			
4	Plantation (400 one acre plots)	Human intrusion	Cut plants		
			Trails among the plants		
			Hunters' remains		
		Excess Plant Material (during planting)	Plants outside plots		
		Potential rhizome escape			
5	Office Quarters	Spills	Shredded material		
6	Periphery of the Storage Area	Plant material	Plant pieces		
		Spills	Shredded material		
7	Container Trucks	Spills	Shredded material		

Appendix 9 (Continued)

#	Site /Location Inspected	Risk	Evidence	Yes	No or N/A
	(Before leaving the Pilot Area)				
8	Transfer Route (after each trip of container truck transporting)	Spills	Shredded material		
9	Blue Creek (after floods)	Escape	Shoots on banks		
10	Rio Hondo (after floods)	Escape	Shoots on banks		
11	Equipment (When returning at the end of the Pilot)	Spills	Shredded material		

9: Action Taken

- |  |     |    |
|--|-----|----|
| (a) Immediate telephone call to supervisor | YES | NO |
| (b) Telephone report sent later            | YES | NO |
| (c) Written report sent later              | YES | NO |
| (d) Other                                  | YES | NO |
| (e) None                                   | YES | NO |

10: Date of last visit of Supervisor: \_\_\_\_\_

11: Outstanding issues from last report:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

12: Comments

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

13: Signatures

Supervisor: \_\_\_\_\_

Project Manager: \_\_\_\_\_

## Appendix 10: Public Consultation Meeting Report

<b>MEETING REPORT</b>	
<b><u>Date of Report:</u></b> 25 <sup>th</sup> February 2016	<b><u>Prepared by:</u></b> E. D. Green
<b><u>Cleared for distribution by:</u></b> CCCCC	
<b><u>Title/Subject:</u></b> Public Consultation Meeting on “ <b>Piloting the Cultivation of Wild cane (<i>Arundo donax</i>) in Belize</b> ”.	
<b><u>Date of Meeting:</u></b> 24 <sup>th</sup> February 2015  between 7.00 to 9.00 pm.	<b><u>Venue:</u></b>  Ignacia Moguel Health Post  San Lazaro Village,  Orange Walk district,  Belize.
<b><u>List of Participants:</u></b> Please see Attachment A	
<b><u>Agenda/Purpose</u></b>  To present the project concept and steps to be taken to mitigate risks to the national stakeholders, including residents of the area in the vicinity of the Project Site, in order to obtain feedback, and incorporate any recommended actions in the Environment and Risk Management Plan (ERMP) that had been prepared by the 5Cs.	
<b><u>Methodology</u></b>  The meeting was arranged by the Caribbean Community Climate Change Centre (5Cs) with the collaboration of the San Lazaro Village Council through the Chair, Mr. Noel Carrillo. Mr. Carrillo also teaches at primary school about 35 miles away from his residence, but in his capacity as Village Council Chair, he approved the use of the venue for the consultation meeting, the Ignacia Moguel Health Post, since the village did not have a Community Centre. The ERMP had been posted on the websites of the 5Cs and the Department of the Environment. It was also attached to the e-mail messages that extended the invitation to the consultation meeting to specific agencies, institutions and individuals. Prior to the beginning of the consultation meeting in the evening, the venue was opened at 2.30 pm, and hard copies of the ERMP were available for perusal.  The San Lazaro Village Council Chair had to seek medical assistance at the hospital in Belize City that same day of the consultation, so the Opening Prayer was delivered by a member of staff of the 5Cs.  Mr. Ryan Cobb, the Energy Officer of the Ministry of Finance, Public Service, Energy and Public	

Utilities then made a power point presentation on the topic". One participant pointed out that although all the local stakeholders in attendance were Hispanic, most understood English very well. However, he requested translation for a couple whom he indicated might not be completely understand the presentation in English. In deference, Mr Cobb made the entire presentation in Spanish. The presentation is attached to this report. The introductory presentation set the context of the main presentation to be made by the 5Cs' Executive Director. Mr. Cobb continued to provide translator services for the entire consultation, since he also translated the next presentation made by Dr. Kenrick Leslie, the Executive Director of the Climate Change Centre. The introductory presentation was repeated later in the evening for those stakeholders who arrived late.

Indicating that he wanted the stakeholders to understand the project and its impact on the area and country, he also explained that he wanted their feedback to improve the project if anything had been overlooked. He then described how the research project would be implemented in phases. The activities that would be undertaken during the project were described. The potential risks associated with the cultivation of the plant were described to the stakeholders in detail, with examples in other countries cited. The measures taken to address the risks were similarly described. One of the oldest residents of the village shared his knowledge about a small patch of the caña brava (Spanish name for Wild Cane) growing in a small swampy area near another village called Caledonia in the same district. He knew of the patch of wild cane as a child and observed that the patch has never grown any bigger during his lifetime.

The consultation was highly interactive as everyone present made their contribution to the discussions. No new issue or concern was raised, hence no additional new input was provided for incorporation within the Environment and Risk Management Plan.

#### **Main Points on Introductory Presentation - Belize's Energy Sector**

The presentation described how the Chalillo reservoir reached a very low level in 2012 due to the long dry year, and the amount of electricity could not be generated. He related that climate change would make the situation worse for Belize therefore the Ministry was interested in other sources of energy. One villager described that he lost part of his papaya crops at that same time. He also mentioned that some farmers were planting other crops to reduce losses caused by uncertain weather conditions on their traditional crops.

#### **Points of the Main Presentation:**

- *Development of local energy* - other neighbouring countries have cheaper energy making Belize less competitive in production and manufacturing.
- *Replacement of energy imports from Mexico* - Replacing imported energy with locally produced energy would mean savings that could be redirected to other development sectors in Belize such as agriculture. *Arundo donax* can be a substitute for diesel, etc.
- *Arundo donax would not compete with sugar cane* because it grows on lands that are otherwise useless for anything else
- *Arundo donax cultivation would provide work* – cultivation of this crop could grow into a new industry for the Corozal, Orange Walk and parts of Belize Districts.
- *Market for the product.* – International markets exist in Europe and in the Caribbean. Cultivation of the crop could produce revenue for Belize on the international market

through the sale of carbon credits because the plant stores carbon. Locally, there was a business aspect to the project since the harvest would be to the BELCOGEN plant for fuel.

- *The presence of the 5Cs in San Lazaro that night* – The area for the experiment was ideal because it satisfied all the needs; close to the factory, national poor quality lands that was not being used, government had approved a lease of 500 acres behind San Lazaro for the experiment, the most important consideration was that the 5Cs wanted the input (opinion and advice) of the local stakeholders on the project.
- *Wild cane being invasive* – It was emphasized to the stakeholders that the plant was considered invasive (a pest and spreading outside its original range) in other parts of the world. However, it was explained that it had been brought to Belize over 100 years earlier. The experiment would also demonstrate that it would not get out of control.
- *Lessons to be learnt* – This experiment in Belize was a test case. There was interest in the results of the experiment, to determine if such cultivation could be promoted in other parts of the world.

The Main presentation concluded that experimental cultivation of the plant would enable the 5Cs to confirm some information already available or to provide answers to a few questions that remain. Examples of questions that would be answered include:-

- i) What is the length of the growing time for the plant?
  - ii) How will the plant respond to different applications of lime?
- Participants had the opportunity to ask questions during the presentations and afterwards.

### **Questions and Answers**

Question: Is there any specific month for harvesting the *Arundo donax*?

Answer: *No. It is not seasons. It also recovers from fires after three months.*

Question: What is its maturity in months or size?

Answer: *This needs to be established through the experiment.*

Question: Is it growing in Belize?

Answer: *Yes, all across the country in small patches. Here the Farmer, Mr. Carrillo shared his story about where he saw it growing (on a swampy area between Caledonia and Buena Vista Villages) in the Orange Walk District since he was a child.*

Question: What is the yield of the crop?

Answer: *At present only estimates of the yield was available. During the experiment, the exact yields of tons of biomass per acre would be measured.*

Question: Will the cultivation of *Arundo donax* create a problem for the sugar industry?

Answer: *No, since it does not compete with sugar cane for the same lands to grow on, it does not yield the same products.*

Question: Does harvesting of *Arundo* require burning?

Answer: *Apparently not, but the experiment will verify this or show otherwise.*

Question: What will *Arundo donax* be used for?

Answer: *If the experiment is successful, the wild cane will be planted as a fuel for the BELCOGEN plant, so it will meet the shortfall produced when bagasse runs out. It has more energy than bagasse in the same unit volume. It can be converted to biodiesel for use in BEL diesel generators. It can be made into pellets for use as charcoal (for export to Europe and the Caribbean).*

Question: What is the cost to plant a crop?

Answer: *Some estimates of costs of establishing plantations are available, but this will be refined during the experiment. However, it is presently estimated that it is about half the cost of planting the same acreage of sugarcane. It requires no fertilizer, and no replanting of the fields each year once established because of the way it regenerates. It does not need good quality land to grow.*

Question: What other benefits come with this crop?

Answer: *At the local level it can become a new industry which means work for the stakeholders in the area. At the national level, it can reduce imports of Mexican produced electricity, thereby reducing dependency on that country. It would make Belize's Energy supply more reliable and resilient.*

Question: Will there be problems with the access /feeder roads?

Answer: *The project made provisions to upgrade and maintain the existing access/feeder roads that would be used to transport the material to the factory.*

Question (ASR-BSI representative): How is cutting, and shredding dealt with? What about moisture content of the material delivered to the factory? What were the emissions? What about impact on water quality in the area? Will there be an Environmental Impact Assessment?

Answer: *Cutting (harvesting) and shredding will be done using mechanical means. (The stakeholders were later shown samples of the shredded Arundo). The moisture content falls quickly once it is harvested and shredded, and this will be measured during the experiment. The emissions produced during the combustion of the Arundo will be monitored by the 5Cs in collaboration with the Department of Environment. Water quality testing will be conducted periodically throughout the experiment. An EIA will be conducted following the cultivation of the larger 400 acres area and conclusion of the biomass pilot before any further development. In fact, a comprehensive Environment and Risk Management Plan has been prepared by the 5Cs in collaboration with the World Bank that seeks to address for all the risks associated with a project of this nature. The purpose of this consultation is to obtain feedback to finalize that plan.*

### **Outputs**

- At the end of the discussions, when all questions were answered, a self-appointed spokesman, spoke on behalf of the local (San Lazaro) stakeholders and stated that they welcomed the project in their part of the country. He also described that the project presented an opportunity for the stakeholders to do something for their future generations in that part of the country. The teacher of the Agriculture High School also welcomed the project to the area.

### **Follow-up Actions by the Centre**

- The Environment and Risk Management Plan would be translated into Spanish, printed and distributed to local stakeholders.

- On the request of the teacher of the Belize Agriculture High School , the 5Cs would establish a partnership with that institution to disseminate climate change information to parents and other residents through the children.
- The site where the wild cane was described to be growing would be visited and mapped for future reference.

**Recommendations/Expectations & Conclusion.**

- The Executive Director promised that the local stakeholders would be kept informed continuously throughout the implementation of the project.
- Since not everyone had internet, any information or reports coming out of the project would be provided in hard copy through the Village Council and the Teacher and the Belize Agriculture High School located in the nearby village, Trinidad. The documents would be produced in English and Spanish.
- The local stakeholders recommended that Saturday night after 6.00 pm or Sunday afternoon would be good for other meetings. The majority of the residents are Adventists.

**Closing of the Meeting**

At the close of the public consultation meeting, the Deputy Director of the 5Cs advised the stakeholders that they should be partners with the 5Cs. Information will be shared with them at all times, and they were always welcome to ask questions and share their thoughts.

The project has potential since it can bring jobs to the area and country; it can result in the production of cheaper energy; it reduces the risk of electrical power outages. He stated that the success of the project depended on stakeholder involvement, and buy-in of the residents. He felt that this meeting had established a partnership between San Lazaro and the 5Cs.

**Attachments**

- ✓ Agenda- Public Consultation Meeting
- ✓ Environment and Risk Management Plan - CCCCC

**Distribution**

CCCCC, World Bank, BSI-ASR, DOE, MNRA, MFSEPU, Forest Department, San Lazaro Village Council

**Attachment A: Agenda - Public Consultation Meeting**

Piloting the Cultivation of Wild cane (*Arundo donax*) in Belize

Consultation Meeting

24<sup>th</sup> March 2016

Ignacia Moguel Health Post

San Lazaro, Orange Walk District, Belize

AGENDA

- 6.30 p.m. Registration
- 7.00 to 7.05 p.m. Blessings: Mr. Noel Carrillo – Chairman – San Lazaro Village Council
- 7.05 to 7.20 p.m. Reason for the Project: Representative – Ministry of Finance, Public Service, Energy, and Public Utilities
- 7.20 to 7.50 p.m. Presentation: Piloting the Cultivation of *Arundo donax* in Belize – Dr. Kenrick Leslie – Executive Director – Caribbean Community Climate Change Centre (CCCCC)
- 8.00 to 9:00 pm. Questions and Answers
- 9.00 p.m. Closing Remarks: Dr. Ulric Trotz – Deputy Director and Science Advisor - Caribbean Community Climate Change Centre (CCCCC)

**Attachment B: Participants in the Public Consultation Meeting**

EVENT: *Arundo donax* Public Consultation – San Lazaro, O. W.

Date: 24<sup>th</sup> February 2016

No.	NAME	INSTITUTION	TEL./FAX.	E-MAIL
1	Daniel Cowo <sup>(4-20 pm)</sup>	Carpenter, San Lazaro		
2	Angel Dubon	MPSEPU	627-4209	eamanager@estp.gov.bz
3	Jose A. Sanchez	SC	671-1010	jsanchez@caribbeanliante.bz
4	Arvic Trotz	SC	676-0701	atrotz2@gmail.com
5	John Moody	CCCCC	610-0274	john.moody47@yahoo.com
6	Helconito Costenada	Farmer	660-9412	
7	Elisberla Carrillo	Farmer	665-8535	
8	Azerin Carrillo	Farmer	665-8862	
9	Justin Guy	MPSEPU	666-6795	
10	Earl Green	CCCCC	600-3054	egreen@contbandminite.bz
11	Anis Ramirez	Farmer	661-6113	

EVENT: *Arundo donax* Public Consultation – San Lazaro, O. W.

Date: 24<sup>th</sup> February 2016

No.	NAME	INSTITUTION	TEL./FAX.	E-MAIL
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16	Luis Maaz	Land Consultant	607-0099	MaazLuis@yahoo.com
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18	Hector Cante	Farmer	668-4737	
19	Juan Maguel	Teacher	667-7684	jddm2@hotmail.com
20	Carlo Cal	Cane Farmer	651-4816	ShamCal23@hotmail.com
21	Ryan Cobbs	MPSEPU	822-0160/0162	energy@estpu.gov.bz