Biochar Product Definition and Standard DRAFT VERSION

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Leading Carbon Ltd.

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Disclaimer

This document has been prepared with the intent of providing the public with a standardized method for classifying Biochars with relevant, reliable and measurable characteristics. In no way shall the IBI or its associates be responsible for the use or misuse of information and guidance provided in this document.

The benefits of a given Biochar vary widely with the combination of crop, soil and climate. This standards makes no claims towards the potential benefits of any given Biochar in any particular application. Caution and careful investigation is warranted when selecting Biochar for an application.

This document is subject to continuous updates and modification as the science and body of knowledge surrounding Biochars continues to evolve.

Forward

This Biochar Product Standard has been developed through the International Biochar Initiative with the collaboration of a wide variety of industry experts on an international level.

This Biochar Product Standard has been developed with the intent to further the Biochar industry through achieving more consistent levels of product quality and making standard information more consistently accessible, as well as to further the use, understanding and benefits of Biochar.

The Biochar Product Standard project approach is designed to support an IBI certification program. The standard can also then be leveraged into the various national and regional product standards bodies, as may be appropriate. By starting with an internal IBI process, the discussion can be focused among experts in the field, ensuring an efficient path from concept to final product.

The proposed standard development process will rely on the following principles:

- Build from congruence in best practice guidance for standards development (ISO, ASTM, IEEE);
- Strict adherence to process required to ensure that the process yields appropriate results efficiently.
- Engage the knowledgeable and diverse stakeholder group active in Biochar industry;
- Organize an independent review committee with broad stakeholder representation (project developers, ENGOs, Researchers, etc.).
- Rely on existing infrastructure and capacity within IBI for leadership and administration of initiative;
- Provide oversight to standards development process.
- Formalize and validate standard development and review process.

The participants charged with the development of the standardization of Biochar have been divided into two working groups.

The working groups have been organized as follows:

Working Group #1:
North America/South America/Africa

Jim Amonette, United States
Jason Aramburu, United States
Louis de Lange, South Africa
Mariam Ekebafe, Nigeria
Johannes Lehmann, United States
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Working Group #2:
Asia/Europe/Australia/New Zealand

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Thomas Harttung, Denmark
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1 Scope

This standard establishes measuring, reporting methods, instructions and markings for the product characteristics of concern for Biochar as a soil improvement agent, remediation of soil pollution or protection against soil pollution and as an avenue for carbon sequestration.

Different applications and hence differentiated testing requirements of Biochar are defined in this standard as means for subjugation and classification of Biochar products.

This standard does not provide limits or terms for defining the sustainability of a Biochar product on a life cycle analysis basis, be it for a certification scheme or otherwise.

2 Effective Date

The effective date of this standard is targeted to be *[August 1 2011].* The trail and comment period is tentatively scheduled for early summer 2011.

3 References

- [identify here all reference documents or standards identified as part of or support to this document]
- ISO 17512-1:2008 – Soil quality -- Avoidance test for determining the quality of soils and effects of chemicals on behaviour -- Part 1: Test with earthworms (Eisenia fetida and Eisenia andrei)
- ISO 17512-2 (under development) - Soil quality -- Avoidance test for determining the quality of soils and effects of chemicals on behaviour -- Part 2: Test with collembolans (Folsomia candida)
- Iodine Method; ASTM 1510-09 Compares the relative surface area of biochar (Mianowski et al., 2007)
- Dumas combustion
- McShields Method
- Method 4B2 of Rayment and Higginson (1992) using 0.01 M CaCl2 (1:5)
- Method R&H 3A1 (Rayment and Higginson 1992) Indicates soluble cations and anions
- Method 19A1 (Rayment and Higginson 1992) testing carbonate equivalent -Expressed as a percentage of CaCO3
- Acid Extractable Elements and Metals by microwave and ICP USEPA 3050B and USEPA 6010
- Colwell, Olsen or Mehlich etc Colwell method (generally performs well in both acidic and alkaline conditions, the hydroxyls and carbonate in the NaHCO3 decreases the activity of Ca and Al, and therefore resulting in release of P. Other methods may also be appropriate.)
- Toxicity testing conducted using the Organisation for Economic Co-operation and Development (OECD) earthworm avoidance method (OECD, 1984) as described in Van

Zwieten et al., 2004. Biochar is applied into OECD standard soil at a rate of 1% w/w, with 10 replicates.

- Germination inhibition is tested against three test species using OECD standard soil (OECD 2004). Method description in Van Zwieten et al., 2009.
- NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A and B
- Dumas combustion with removal of carbonate C

4 Terms and Definitions

[identify here all technical terms that may not be clear or may have subjective definitions]

Anthropogenic Carbon – Carbon which has not participated in the biosphere, or has been sequestered for a long period, including fossilized carbon (petroleum, natural gas, etc.). Anthropogenic carbon is released by human activity and has an associated CO_2 equivalence which can be assigned based on the molecular form in which the carbon is released.

Ash – The solid mineral fraction of biomass or organic matter which is not combustible. Ash may remain as a fixed solid after combustion of an organic substance, or it may be entrained as solid particulate matter in the exhaust gases from combustion.

Biochar – A solid carbonaceous material obtained from thermally degrading organic material following good carbonisation practices that is added to soils following good agricultural practices to improve soil functions and to reduce emissions from organic material that would otherwise naturally degrade to greenhouse gases. These properties are measureable and verifiable in a characterisation scheme.

Biogenic Carbon – Carbon which participates in the biosphere in the atmosphere, oceans, soils or biomass matter. Biogenic carbon has a CO_2 equivalence of zero.

Biomass –Biological material derived from, or produced by living organisms. Biomass does not include petroleum related resources from ancient or fossilized biological material. Biomass carbon is considered biogenic as opposed to anthropogenic carbon.

Contaminants – An undesirable material in a Biochar or Biochar feedstock which degrades the quality or usefulness of the final Biochar product. Contaminants may or may not be toxic.

Diluents / Dilutant – A material derived from either organic fossil sources (e.g., plastics) or inorganic sources (e.g. clays) that are mixed with the 'organic material' before processing or with the biochar after processing.

Municipal Solid Waste (MSW) – Domestic or small commercial non-hazardous wastes. MSW includes garbage (e.g., milk cartons and coffee grounds), refuse (e.g., metal scrap, wall board, and empty containers), sludge from a waste treatment plant, a water supply treatment plant, or an air pollution control facility (e.g., scrubber sludge). Other discarded material, including solid,

semi-solid, liquid, or contained gaseous material resulting from community activities. This standard is only concerned with non-hazardous fractions of MSW.

Organic material – Biological material derived from, or produced by living, or recently living organisms. This material can be 'unprocessed' or 'processed'. 'Unprocessed material' is living material, or recently living material, that has not gone through an anthropic chemical modification (e.g., wood chips). 'Processed material' is recently living material that has been chemically modified by anthropic processes (e.g., paper sludge).

Feedstock material – the organic material used for undergoing the pyrolysis or carbonization process to create Biochar. Typically for Biochar, the feedstock material consists of biomass, but may also contain dilutants.

Good carbonisation practices **-** good carbonisation practices ensure the Biochar production process is optimised to minimise GHG emissions. In addition, the process should comply with local emission and OHS standards.

Good agricultural practices[1] – a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economical, social and environmental sustainability". Those related to soils are "(i) reducing erosion by wind and water through hedging and ditching, (ii) application of fertilisers at appropriate moments and in adequate doses (i.e., when the plant needs the fertilizer), to avoid run-off (see nitrogen balance method), (iii) maintaining or restoring soil organic content, by manure application, use of grazing, crop rotation, (iv) reduce soil compaction issues (by avoiding using heavy mechanical devices), (v) Maintain soil structure, by limiting heavy tillage practices, and (vi) i*n situ* green manuring by growing pulse crops like cowpea, horse gram, sunhemp".

Holding Time – The time a char is held within the pyrolitic temperature range during its pyrolysis. This time is a characteristic parameter of pyrolysis process.

Heating Rate – The rate at which a feed stock is heated to the pyrolitic temperature range when it is undergoing pyrolysis. This rate is a characterisitic parameter of the pyrolysis process.

Manufacturer – The party or parties who take responsibility for processing the feedstock materials into Biochar, acquiring appropriate labelling, and testing of the Biochar.

Pyrolysis –A thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen.

Labile Carbon – the portion of carbon retained in a Biochar after pyrolysis which is likely to be released to the environment in under 100 years. It is likely that once the labile carbon is released to the environment, it will partake in chemical or biological reactions in the environment so as to be ultimately converted to carbon dioxide in the atmosphere.

[1] UN FAO definition

Recalcitrant Carbon – the portion of carbon which will likely remain in the Biochar for more than 100 years after incorporation into soil or a final storage. This carbon is not likely to be converted to carbon dioxide in the atmosphere.

Char – any solid product of pyrolysis or combustion, including that from natural fires, gasifier operations, coal burning facilities, etc.

Pyrochar – Biochars that do not meet minimum agricultural standards

Agrichar—a registered trademark held by BEST Energies for Biochar produced by a proprietary slow pyrolysis process.

Soil functions – Soil functions are defined by the proposal for a European Soil Framework Directive COM(2006)232, as follows: "(i) biomass production, including in agriculture and forestry; (ii) storing, filtering and transforming nutrients, substances and water; (iii) biodiversity pool, such as habitats, species and genes; (iv) physical and cultural environment for humans and human activities; (v) source of raw materials; (vi) acting as carbon pool; and (vii) archive of geological and archeological heritage.". In this document, we will focus on environmental and production functions of biochar in soils.

Torrefaction—a process whereby dry biomass is heated to temperatures in the range of 200-325°C to release any remaining moisture, to increase its density and to increase its energy density.

Hydrothermal Conversion —a process in which wet biomass is heated for several hours between about 180°C and250°C and autogenous pressure.

Flash Pyrolysis—a type of slow-pyrolysis process conducted at 10 atmospheres pressure that is complete in about 30 minutes (developed by Dr. Michael Antal at the University of Hawaii)

Highest Treatment Temperature (HTT) – The maximum temperature to which the feedstock and Biochar are subject during the pyrolysis or carbonization process.

[DRAFT NOTES TO WGs: PLEASE FEEL FREE TO PROVIDE MORE TERMS AND THEIR DEFINITIONS OR REVISE THE EXSITING DEFINTIONS PROVIDED]

5 Feedstock material and Biochar production

5.1 General feedstock material requirements

The material used as feedstock to Biochar processes have direct impacts on the nature and quality of the resulting Biochar and shall have the following properties:

- Be of a cellulosic biomass origin with very little chemical or physical changes imposed.

Examples include but are not limited to: wood chips, corn stover, rice and peanut hulls, tree bark, paper mill sludge, animal manure, forestry residues, natural rubbers, organic

fractions of municipal and agricultural wastes. Non-biotic fractions of waste (i.e. plastics) are considered dilutents to a Biochar.

- OR be a waste material or by-product of other value generation processes and not resulting from the direct destruction of biomass systems or conversion of land use type specifically for the generation of Biochar feedstock material.

Examples include but are not limited to wood chips from unsuitable lumber or forest residues from a logging operation , paper mill sludge from a paper mill

- Be of suitable physical and chemical characteristics for the Biochar process through which it is intended to undergo.

Examples include but are not limited to particle or grain size, moisture content, flammability, sulphur content

- Be free of any significant quantities of contaminant substances known to degrade the quality and usefulness of the final Biochar product

Examples include but are not limited to wood preservatives or leaded paint on waste wood

- Have no more than *[20%]* diluents

Examples include but are not limited to petroleum products, rubber, PVC, etc.

5.2 Feedstock material reporting

The feedstock material(s) used to generate a Biochar shall be declared by the manufacturer as discussed in Section 7.2.

5.3 General Biochar process requirements

The processes used to generate a Biochar from the feedstock material shall:

- Provide a means to control the rate and extent to which the carbonization process proceeds and therefore the residence time of feedstock in the process.
- Provide for a means of escape *[and destruction]* for volatile gases and derivatives from the feedstock / Biochar material in a safe, effective and reliable fashion. The syngas or offgas should be captured and at the minimum flared but optimally used as a source of energy to offset fossil fuels. The plant itself should comply with local emission and OHS standards.
- Provide a mechanism to safely arrest the pyrolysis process effectively. The method to safely arrest the process must b e an active form of suppression, such that it is capable to stop pyrolysis of feedstock already undergoing pyrolysis. Discontinuing the supply of feedstock is not considered an active method for stopping the pyrolysis process.
- Maintain a desired level of consistency of the Biochar production to the extent possible by limiting variations in the process conditions relative to variations in the operating environment and feedstock variability and report significant variations in consistency as described in Section 8.

Further requirements include:

- Biochar production shall follow all applicable laws of the country in which it occurs, and shall endeavour to follow all international treaties relevant to thermal processes to which the relevant country is a party.
- Biochar production shall comply with local regulatory requirements that govern utilisation of the source material.
- Biochar production and utilisation shall contribute to climate change mitigation by reducing GHG emissions (compared to fossil fuels) and converting labile carbon into more stable forms of carbon.
- Biochar production and application shall avoid negative impacts on biodiversity, ecosystems, and areas of High Conservation Value.
- Biochar production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights.
- Air pollution from biochar production and processing shall be minimized along the supply chain.
- Biochar production shall not violate land rights.

6 Product Classification

As per the descriptions given in this section, Biochar products shall be classified and labelled such that the relevant parameters can be made known to users of Biochar.

The classification scheme does not provide any insight towards the applications of any Biochar product, as the onus is on the user to determine if a Biochar is suitable given the soil conditions, climate, etc. to which he/she intends to apply the Biochar. The classification scheme works to:

- Provide a uniform information presentation scheme in which a Biochar user would be able to fairly compare and assess the properties of different Biochars and determine if any particular Biochar is suitable for their intended application.

- Incrementally heighten the requirements of general quality, so that a higher class provides more comprehensive understanding of the contents included in the product as well as a lower probability of adverse effects on soil functions when used properly.

Higher class ratings do not mean any one product is more suitable than others for any particular application.

The proposed definitions of the classes are given in the following subsections. Class requirements are cumulative meaning Class IV has the least requirements, and each subsequent class has incremental requirements in addition to the previous requirements. Figure 1 shows the relationship of requirements for each class.

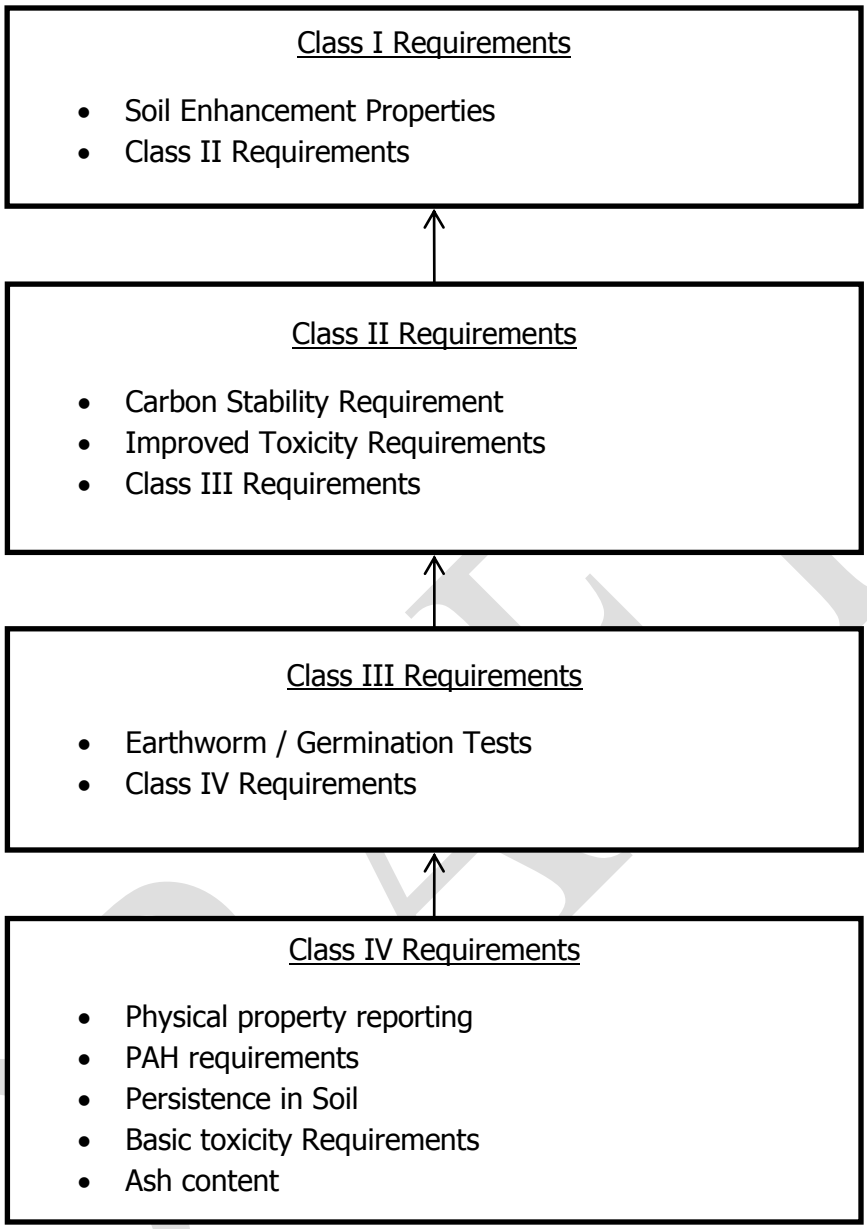

Figure 1 - Class requirements flow diagram

Each product shall be tested once for each feedstock and process. When a new feedstock material is added to a process, the classification testing for a Biochar shall need to be repeated. When a new process is implemented on a feedstock, the classification testing for a Biochar shall be repeated.

6.1 Class I

Class I Biochars shall conform to the requirements presented in the table below.

Requirement	**Limit**	**Test**
Acid neutralising capacity	*Declare*	?
Rate of oxidation / surface changes	*Declare*	*?*
Electrical Conductivity	*Declare*	*?*
Cation Exchange Capacity	*Declare*	*?*
Soprtion Activity	*Optional Declaration*	*Butane Adsorption Activity Test?*
NPK	*Optional Declaration*	*?*
Liming Value	*Optional Declaration*	*?*

In addition, Class I Biochars must meet all requirements of Class II Biochars.

6.2 Class II

Class II Biochars shall conform to the requirements presented in the table below:

Requirement	Limit*	Unit	Test
Cadmium	3	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Chromium (total)	100	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Copper	100	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Mercury	1	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Nickel	60	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Selenium	5	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Zinc	200	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade A
Furans	0.5	ng/kg I TEQ OMS	*Surrogate test?*
Dioxins	0.5	ng/kg I TEQ OMS	*Chlorine surrogate test?*
Stable Carbon Content	*>50*	*% C*	*[Dumas combustion with removal of carbonate C] OR [McShields Method]*

* Limits are expressed as 'less than' unless specified otherwise

In addition, Class II Biochars must meet all requirements of Class III Biochars.

6.3 Class III

Class III Biochars shall conform to the requirements presented in the table below

Contaminant	Limit*	Unit	Test
Polychorinated Biphenyls	0.2	mg/kg TM	*[Compost Ordinance?] or [feedstock precursor?]*
Moisture Retention / porosity	*?*	*?*	*?*
Earthworm avoidance test	*[pass?]*	Toxicity testing conducted using the OECD earthworm avoidance method (OECD, 1984) as described in Van Zwieten et al., 2004.	
Germination Inhibition Assay	*[pass?]*	Germination inhibition is tested against three test species using OECD standard soil (OECD 2004). Method description in Van Zwieten et al., 2009.	

* Limits are expressed as 'less than' unless specified otherwise

In addition, Class III Biochars must meet all requirements of Class IV Biochars.

6.4 Class IV

Class IV Biochars shall conform to the requirements presented in the tables below:

Requirement	Limit*	Unit	Test Method
Particle size distribution	Declare	Ø m	*[?]*
Moisture content	Declare		*[?]*
Carbon sequestration value	Declare	g CO_2 / kg	*[?]*
Total Carbon	>60	%	*[Dumas combustion with removal of carbonate C] OR [McShields Method]*
Bulk Density	Declare	kg / m3	*[?]*
Polycyclic aromatic hydrocarbons	16	mg EPA PAH/kg TM	*[Compost Ordinance?]*
Total Ash content	50	%	*[?]*
Arsenic	20	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Cadmium	5	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Chromium (total)	250	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Cobalt	150	mg/kg	An Update of Ontario's Compost Guideline and Regulatory Framework (EBR Registry Number 010-6658).
Copper	375	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Lead	150	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Molybdenum	20	mg/kg	An Update of Ontario's Compost Guideline and Regulatory Framework (EBR Registry Number 010-6658).
Mercury	4	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Nickel	125	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Selenium	8	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B
Zinc	700	mg/kg	NSW EPA230800d (EPA Compost Guidelines Public Consultation (2009) for Grade B

* Limits are expressed as 'less than' unless specified otherwise

7 Product Marking and Instructions

7.1 IBI Marking General Requirements

The IBI label shall be attached or included in transactional documents, packaging, advertisement or other commercial documentation associated with a Biochar product if and only if all the requirements of this standard are adhered to in their entirety.

The IBI label shall be not be larger than *[3%]* of the surface on which it is included and shall not give the impression that the product has direct providence from the IBI or any of its associates. The label shall be placed in a fashion that is visible and clear, however not mistaken as the entity responsible for the production, sale or use of the Biochar product.

An example of the IBI product standard label is included in Appendix 1

7.2 Product information requirements

Included with the IBI label, the manufacturer shall make available to the user, information pertaining to:

- The feedstock material(s)
- The relevant information required by class
- Suitable application methods (tillage, burial only, spreading method under specified weather conditions, etc.)
- Other relevant safety concerns regarding transportation and application methods or constraints
- Other materials combined or otherwise mixed with the Biochar (soils, fertilizers, etc.)

7.3 Special instruction

The manufacturer shall make available to the user, instructions for suitable storage and transportation methods with respect to maintaining:

- The safety of the users and foreseeable non-users whose presence is anticipatable in the intended or normal use of the product.
- The quality of the product in terms of soil safety, carbon stability, soil fertilization properties and other general properties as described in this standard (see Section 5)

8 Conformity and Record Keeping

Documentation and reporting are required by producers seeking to gain the IBI's confidence in product standardization. Being a product of potentially variable feedstock, the reporting of Biochar feedstock contents, pyrolysis process and end-product quality are all necessary to provide adequate assurance in end-product uniformity. As such, record keeping will be mandatory, not only for the purpose of proof-of-adequate sample testing, but also for proof of product authorization though time.

Chain of custody and product traceability will require an assurance that adequate care and transparency is being exercised to enable trace-back of end products to producers and feedstock suppliers from end-users across the Biochar market. All levels in the Biochar production and supply chain will be required to participate in record keeping in order to maintain quality assurance. For the sake of feedstock supplier and pyrolysis producer, files may be amalgamated on site if this enables more accurate and longer-term full-circle accounting. Producers and vendors will be required to maintain records in order to enable backtracking between finished product on the shelf and the pyrolysis project operators.

Appendix 1 – Marking and Labeling Examples

An example IBI product marking is given below with the necessary product information as described in this standard:

IBI APPROVED BIOCHAR PRODUCT		
International Biochar Initiative www.biochar-international.com	PRODUCT TYPE:	CLASS II
	FEEDSTOCK TYPE:	WOODY RESIDUES, SAW DUST, BARK
	DENSITY:	700KG /M3
	CARBON SEQ. VALUE	30% BY MASS
	PARTICLE SIZE:	5mm
	APPLICATION METHOD:	DIRECT
	INGREDIENTS:	50% - BIOCHAR 45% - COMPOSTED SOIL MIXTURE 5% - WATER
	APPROVAL DATE:	NOV 2010
	APPROVAL INDEX:	123456789