Proposed Australian Standard Biochar for Soils:

ANZBI – DRAFT FOR COMMENT

REV C September 2019

PREFACE

This Draft Standard was prepared by the task force of the Australian and New Zealand Biochar Initiative (ANZBI). The committee included Professor Stephen Joseph, Dr Adrian Morphett, Dr Mohammad Reza Ghaffariyan, Dr Graham Lancaster, Peter Burgess, Craig Bagnall, Richard Upperton, Don Coyne, Euan Beamont, Kathy Dawson, Samuel Robb, Karen Siepen, Jon Brough, Terri Sun, and Dennis Enright. It is intended to constitute the first draft to be presented to the members of ANZBI for comment before being presented to Standards Australia as the basis for a potential Australian standard on biochar use in soils. It is based on the Australian Compost Standard AS4454-2012, European Biochar Certificate Guidelines (2019) and the IBI Standardized Product Definition and Product Testing Guidelines for Biochar That Is Used in Soil (2015).

Relevant local, territory, state and federal government regulations not referenced in this standard, may detail additional requirements. In particular, prior to establishing a manufacturing facility, investigations may be required to ensure approval for location.

The terms “normative” and “informative” have been used in this document to denote the intended application of Annexes: a normative annex is an integral part of a standard that constitutes requirements of the standard, whereas an informative annex is only for information and guidance.

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SECTION 1 - SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for biochar and biochar-based products that are used to amend the physical and chemical properties of natural and artificial soils and growing media.

It specifies physical, chemical, biological and labelling requirements for lump, powdered, granular, pelleted and liquid products whose carbon content is greater than 30% on a dry weight basis. This limit applies to biochars before they are mixed with other chemicals, biomass or minerals. It covers products marketed or distributed both in bags and bulk in all market sectors including domestic use, urban landscaping, agriculture, land and rehabilitation. It also applies to water remediation where the nutrient rich biochar after filtration is added back to the soil.

The standard applies to the biochar that is mixed with compost, manure and sludges, minerals, chemicals and nutrient rich liquids before adding to soils.

Some biochars have a fertiliser value, and a purpose of the Standard is to enable the consumer to understand the fertiliser value of the material.

This standard only covers the properties of biochar's before they are added to the soil. It recognises that the effect on soil properties, seed germination, toxicity, plant resistance to disease, yield and quality is a function of the method, frequency and application rate.

The standard also applies to biochar that is used to filter water and air of nutrients and then applied to land. This standard does not apply to biochar that is added to animal feed, construction materials, metal reductant, road base, an ingredient in food, an activated carbon or used as a fuel. Animal feed standard will be produced after ongoing research has been completed under an MLA funded UWA/CSIRO/UNSW program has been completed

This standard includes all high mineral biomass feedstocks including paper sludge, rice husks, straws and manures. All feedstocks that are used should meet state regulations related to land clearing and logging.

The carbon composition of the following biochars provides the rationale for the above limit of carbon in biochar that has not been blended with other amendments or fertilisers as 30%. These data are taken from Enders et al 2012, where C is measured using ASTM D1762-84.

Table 1.1 *Typical Carbon and Ash contents of Biochar*

Sample name and biochar production temperature	%C	%Ash
Pine chips 400 C	74.1	3.7
Switchgrass 400 C	73.7	2.9
Eucalyptus wood 400 C	70.4	5.6
Wheat straw 550 C	69.5	20.5
Switchgrass 550 C	81.7	5.3
Pine chips 550 C	76.8	4.9
Rice husk 550 C	38.7	48.4
Municipal greenwaste 550 C	73.4	8.5
Miscanthus straw 550 C	67.8	11.6
Eucalyptus wood 550 C	75.6	5.3
Greenhouse (tomato) waste 550 C	30.8	13.1
Poultry litter 550 C	36.7	42.8
Digestate biochar 700 C	50.6	32.7
Wheat straw 700 C	69.0	21.3
Rice husk 700 C	42.5	11.8
Miscanthus straw 700 C	72.4	1.6
Mixed softwood 700 C	86.6	6.1
Coffee husk 450 C	61.3	16.1

1.2 APPLICATION

This Standard is intended for use by all levels of government, those who manufacture or supply biochar and biochar-based products.

1.3 OBJECTIVE

The objective of this standard is to provide manufacturers, suppliers, customers and government bodies with the requirements for the physical and chemical properties, toxicity testing, Occupational Health and Safety (OHS) properties related to storage, transportation, application, labelling and marking of biochar and biochar based products. A further objective of the standard is to provide a classification of biochars to assist purchasers to determine if the biochar or biochar products are fit for purpose. It is recommended that biochar compost products be tested using AS 4454.

1.4 REFERENCED DOCUMENTS

- Australian Standard AS4454 (2012), Composts, Soil Conditioners and Mulches
- International Biochar Initiative (IBI)- Biochar Standards V2.1 (2015)
- European Biochar Certificate V 8.2E
- Environmental Guidelines: Use and Disposal of Biosolids Products (2000), NSW EPA
- Waste Classification Guidelines Part 1: Classifying Waste (2014), NSW EPA
- Addendum to the Waste Classification Guidelines (2014) Part 1: Classifying Waste (2016), NSW EPA
- Perspective on Baseline Biochar Metrics – Past, Present & Future (2016), Hugh McLaughlin, NextChar
- Biochar Standards and Classification Schemes (2018), Hugh McLaughlin, NextChar
- F Thompson, W.H. (Ed). Test Methods for the Examination of Composting and Compost (TMECC), The US Composting Council Research and Education Foundation, and The United States Department of Agriculture, 2001.
- Canadian Council of Ministers for the Environment (CCME) (2005) Guidelines for Compost 29 Quality. PN 1340 Winnipeg Manitoba, Canada. ISBN 1-896997-60-0.
- US Geological Service. Polynuclear Aromatic Hydrocarbons (PAHs)/Polycyclic Aromatic 24 Hydrocarbons (PAHs) http://toxics.usgs.gov/definitions/pah.html (Accessed March 25 2012) Van Loo, S., & Koppejan, J. (Eds.). (2007). The handbook of biomass combustion 26 and co-firing. Earthscan.
- Milne, T.A.; Brennan, A.H.; Glenn, B.H. Sourcebook of Methods of Analysis for Biomass 5 Conversion and Biomass Conversion Processes. SERI/SP-220-3548. Golden, CO: Solar 6 Energy

Research Institute, February 1990.Oregon Department of Environmental Quality. 7 Fact Sheet: Management of Wood Ash Generated from Biomass Combustion Facilities. 8 Updated 5/5/2011.

1.5 DEFINITIONS

(a) **Activated Carbon** also called activated charcoal is produced from low ash biomass (usually coconut shells and hardwood) at high temperatures to produce a high Carbon material with a high surface area of greater than 600 square meters per gram. Activation can be either be achieved, but not limited too, using steam of carbon dioxide at temperatures greater than 700^{o}C or through treatment with some salts or acids.

(b) **Ash:** The inorganic matter, or mineral residue of total solids, that remains when a sample is combusted in the presence of excess air. (Adapted from US Composting Council and US Department of Agriculture, 2001)

(c) **Biochar:** A solid product from heating biomass in an oxygen-starved environment. The resulting product will have an organic carbon content greater than 30% and a molar H/C ratio below 0.7. The molar H:Corg ratio is a material property that is correlated with the degree of thermochemical alteration that produces fused aromatic ring structures in the material. The presence of these structures is an intrinsic measure of the stability of the material.

(d) **Biosolids:** Solid, semi-solid or slurry material produced by the treatment of sewage

(e) **Condensate:** The liquid that either is captured from the flue gas from the pyrolysis process as it is cooled or from directly quenching of the biochar with water.

(f) **Compost:** An organic product that has undergone controlled aerobic and thermophilic biological transformation through the composting process to achieve pasteurization and reduce phytotoxic compounds which achieves a specified level of maturity required for compost (definition as per AS4544).

(g) **Contaminant:** An undesirable material in a biochar material or biochar feedstock that compromises the quality or usefulness of the biochar or through its presence or concentration causes an adverse effect on the natural environment or impairs human use of the environment (adapted from Canadian Council of Ministers of the Environment, 2005). These can include heavy metals and compounds formed in the pyrolysis process including polyaromatic hydrocarbons, dioxins and furans.

(h) **Diluent/Dilutant:** Inorganic material that is deliberately mixed or inadvertently comingled with biomass feedstock prior to processing. These materials include soils and common constituents of natural soils such as clays and gravel that may be gathered with biomass or intermixed through prior use of the feedstock biomass (such as for animal bedding). Diluents/dilutants may be found in a diverse range of feedstocks, such as agricultural residues, manures, and municipal solid wastes. It should be noted that

they could have other negative plant effects on growth or on the concentration of the heavy metals of the food that is grown with the biochar. Some soil diluents may be beneficial and add extra nutrients and organic matter. Testing is required to confirm any negative or positive effects.

(i) **Organic Carbon (Corg)**: Carbon in the organic matter of biochar feedstocks. Biochar feedstocks can contain such compounds as sugars, starches, proteins, fats, cellulose, and lignocellulose, which are thermochemically degradable.

Other organic carbon forms can include petroleum and petroleum by-products such as plastics and contaminated oils, which are, for the purposes of these standards, included within the definition of contaminants. (Adapted from US Composting Council and US Department of Agriculture, 2001)

(j) **Inorganic Carbon (Cinorg)**: The carbon associated with inorganic C compounds typically calcium and magnesium carbonates (lime, dolomite)

(k) **Feedstock**: The material undergoing the thermochemical process to create biochar. Feedstock material for biochar consists of biological material but may also contain diluents. (IBI, 2015)

(l) **Fixed Carbon**: The carbon that remains after heating the biomass or biochar in a covered crucible to approximately 600C. It should be noted that this test was developed for thermal coals and does not necessarily give an accurate measure of the stability of biochar in the soil.

(m) **Labile or mineralizable carbon [in biochar]**: The carbon that can be either extracted by washing with water or is available as a source of food for microbes.

(n) **Hydrogen (H)**: Hydrogen content of the biomass or biochar.

(o) **Minerals**: Inorganic compounds that are either derived from the biomass or diluents. These inorganic compounds can either be amorphous or crystalline.

(p) **Municipal Waste/Municipal Solid Waste (MSW)**: Solid non-hazardous refuse that originates from residential, industrial, commercial, institutional, demolition, land clearing, or construction sources (adapted from Canadian Council of Ministers of the Environment 2005).

(q) **Polycyclic Aromatic Hydrocarbons (PAHs)**: PAHs refer to a family of compounds built from two or more benzene rings. Sources of PAHs include fossil fuels and incomplete combustion of organic matter, in auto engines, incinerators, forest fires, charcoal grilling, or other biomass burning. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. Out of hundreds of different PAH compounds, only a few are considered to be highly toxic and of regulatory concern. (Adapted from USGS, 2012). APPENDIX A has a detailed description of type and toxicity of PAH.

(r) **Torrefaction (also referred to as conditioning)**: Torrefaction is a thermal pretreatment of biomass that increases energy density, HHV (higher heating value), grindability and hydrophobicity. Temperatures

range from 220°C to 350°C, and time for torrefaction can vary from less than 1 minute to greater than 12 hours.

(s) **Volatile Matter**: Those products, exclusive of moisture, given off by a material as a gas or vapor, determined by prescribed methods that vary according to the nature of the material. (Adapted from Milne et al, 1990).

(t) **Wood Vinegar**: A red brown liquid formed in the distillation/pyrolysis of wood which principally contains acetic acid, methanol, acetone and wood oils. It consists of over 200 compounds and is used as a biopesticide and a stimulant for seed germination and plant growth.

SECTION 2 – SPECIFIC REQUIREMENTS

2.1 PRODUCT CLASSIFICATION

This product classification is based on extensive analysis of the literature on the properties and use of the biochar. The principal defining feature is the total carbon and ash content. It should be noted that this is not a hierarchical classification as each type of biochar will have specific applications for which it is fit for purpose. The H/Corg ratio is an indicator for the stability of biochar in soil (refer **APPENDIX B**). The lower the ratio the greater is the percentage of the biochar remaining after 100 years in the soil.

Product classification criteria are specified in **Table 2.1**, with additional requirements given in **Table 2.2**.

Table 2.1: *Classification Criteria for Biochars*

Biochar Classification Type	**Carbon Content (%Corg)**	**Ash Content (% ash)**	**Produced from (examples)**	**H/Corg ratio**	**Notes**
HCB - High Carbon low ash biochars	>70	<10	wood, bamboo, switch grass and nut shells	0.3 – 0.7	Typically low nutrient content
MCB - Medium Carbon medium ash biochars	55 - 70	5 - 25	straw/stalks, grasses, kernels and cobs, some poultry litter and manures	0.3 – 0.7	Relatively high nutrient content and pH value and may be used as a liming agent.
LCB - Low Carbon high ash	30 - 55	>25	sludge, rice husk, some poultry litter and manures, and greenhouse waste	> and/or <0.7	
Partially Combusted Organic Material (**Not biochar**	<30	NA	NA	NA	NA

Note: All biochars are made at pyrolysis temperatures of between 350 – 750˚C. Biomass thermally treated below 350 ˚C will be considered as being torrefied.

Test methods are taken from AS4454, IBI classification publication and from McLaughlin[1] on the issues related to measuring moisture content and ash composition. Methods of sampling are given in **APPENDIX E**.

Most biochars are very difficult to ignite unless they are bone dry, however it is recommenced for both OHS and flammability issues that the biochar has a moisture content greater than 10%. For long term storage the biochar should have a moisture content of less than 15% to ensures little chance of the growth of pathogens or self-ignition.

Table 2.2: *Chemical, Physical and Basic Agronomic Testing of Biochars*

For high carbon low ash biochars there is very little available N and P and thus to reduce testing costs no measurements are required. It should be noted that deviation from AS4454 where research has shown that specific analytical techniques are more appropriate to give accurate measurements. Specific tests methods from AS4454 are given in ***APPENDIX F****.*

Characteristic and unit of measurement	**Units**	**HCB**	**MCB**	**LCB**	**Test Method**
Moisture	% of total mass, dry basis	>10%	>10%	>10%	Dry at 150°C as per ASTM D2867 standard test for moisture for activated carbon[2] . This is more appropriate than the moisture test method in the compost standard (AS4454).
Total Carbon and Hydrogen	%	declare	declare	declare	Total C and H analysis by dry combustion-elemental analyser.
Organic Carbon (Corg)	%	declare	declare	declare	Total C and H analysis by dry combustion-elemental analyser. Inorganic C analysis by determination of CO_2-C content with 1N HCl, as outlined in ASTM D4373 Standard Test Method for Rapid Determination of Carbonate Content of Soils. Organic C calculated as Total C – Inorganic C

[1] https://www.nextchar.com/wp-content/uploads/2016/12/Baseline-Biochar-Metrics-Ver-X.pdf

[2] Note AS4454 specifies drying at 105°C however recent research by Mclaughlin shows that not all water is removed at this temperature. The drying and ashing procedure is given in pdf file at https://www.nextchar.com/wp-content/uploads/2016/12/Baseline-Biochar-Metrics-Ver-X.pdf

H:Corg		<0.7	<0.7	>or <0.7	Refer Appendix B of the IBI Biochar Standards
Total Ash	%	<10%	<25%	>25%	dry at 150°C as per ASTM D2867 then open crucible and ash at 550°C[2]
pH		declare	declare	declare	As per AS4454
Total $CaCO_3$ equivalent % dry matter	%	declare	declare	declare	ISO 10693 (1995): Soil Quality - Determination of carbonate content
Electrical Conductivity dS/m	dS/m	declare	declare	declare	As per AS4454
Available Phosphorous (p)	mg/kg	optional All wood biochars have very little available P	declare	declare	2% formic acid followed by spectrophotometry (Wang et al. 2012)[3] Bray P Extraction (Bray No1 Extract Test)(Rayment and Lyons 2011)
Total P	mg/kg	optional	declare	declare	Modified dry ashing (Enders and Lehmann 2012)[4]. Elements in the digest determined by common analytical techniques
Total Nitrogen (N)	mg/kg	optional	declare	declare	Dry combustion-elemental analyzer following the same procedure for total C and H above.
Available N as nitrate	mg/kg	optional	declare	declare	2M KCl extraction followed by spectrophotometry (Rayment and Lyons 2011)[5]
Available N as ammonium	mg/kg	optional	declare	declare	2M KCl extraction followed by spectrophotometry (Rayment and Lyons 2011)[5]

[3] Wang, T., Camps-Arbestain, M., Hedley, M., & Bishop, P. (2012). Predicting phosphorus 35 bioavailability from high-ash biochars. Plant and soil, 357(1-2), 173-187.

[4] Enders, A. and Lehmann, J. (2012) Comparison of wet digestion and dry ashing methods for 31 total elemental analysis of biochar. Communications in Soil Science and Plant Analysis. 32 43:1042–1052. _._ _

[5] Rayment, G.E., and Lyons, D.J. (2011) Soil Chemical Methods – Australasia. CSIRO Publishing, 26 Collingwood, Victoria, Australia.

Total potassium	mg/kg	optional	declare	declare	Modified dry ashing (Enders and Lehmann 2012)[4]. Elements in the digest determined by common analytical techniques or total elements by ICP-MS
Silica	mg/kg	optional	optional Unless being sold as a high Si amendment	optional Unless being sold as a high Si amendment	NaOH 550°C fusion followed by ICPOES analysis[6]
Total Calcium Magnesium, Iron and Sulphate-S	mg/kg	optional	declare	declare	1M HCl extraction (Camps Arbestain et al. 2015)[7]. Elements in the digest determined by common analytical techniques.
Particle size distribution	%	declare	declare	declare	Progressive dry sieving with 50 mm, 25 mm, 16 mm, 8mm, 4mm, 2 mm, 1 mm, and 0.5 mm sieves.
Surface area	m^2/g	optional	optional	optional	BET CO2 adsorption or NMR cryoporosimetry,
Germination Inhibition Assay Worm avoidance test and germination tests	Pass/fail	Pass/fail	Pass/fail	Pass/fail	OECD methodology (1984) using three test species, as described by Van Zwieten et al. (2010).[8] See **Appendix C** for further information.

[6] Hallmark and Wilding (1982) Silicon. In Miller and Keeney Chemical and Microbiological Properties (1982) Soil Science Society of America Madison USA

[7] Camps Arbestain M, et al. 2015. A Biochar 19 Classification System and Associated Test Methods. In: Biochar for Environmental 20 Management - Science and Technology, 2nd edition. J. Lehmann and S. Joseph (eds.). 21 Routledge.

[8] Van Zwieten, L., Kimber, S., Morris, S., Chan, K.Y., Downie, A., Rust, J., Joseph, S., and Cowie, 28 A. (2010) Effects of biochar from slow pyrolysis of papermill waste on agronomic 29 performance and soil fertility. Plant and Soil 327:235-246

Table 2.3: *Measurement of potential heavy metal toxic elements in biochars using limits and test method in AS4454*

If the heavy metal concentration is higher than recommended standard in AS4454 then undertake the Toxicity Characteristic Leaching Procedure (TCLP) (USEPA method 1311, (1992), USEPA, SW-846) (APPENDIX D). If this is undertaken it is recommended that all parameters required for TCLP are also analysed for Total Concentration to facilitate analysis (proponents should check to ensure such). See further comments in Appendix D regarding potential limitations of TCLP testing and additional beneficial test options available to biochar producers which can be further considered where appropriate.

Parameter	Maximum Allowed Limit (Total Concentration) (mg/kg dry wt)	Test Method
Arsenic	20	AS 4454-2012
Cadmium	1	AS 4454-2012
Chromium	100	AS 4454-2012
Boron	100	AS 4454-2012
Copper	150	AS 4454-2012
Lead	150	AS 4454-2012
Mercury	1	AS 4454-2012
Selenium	5	AS 4454-2012
Zinc	100	AS 4454-2012
Boron	Declaration	TMECC (2001)

Table 2.4: *Measurement of potential toxic organic compounds in biochars. Testing to be carried out if required by state EPA. Some EPA's may want other organics tested as phalates*

Parameter	Requirement	Units	Test Method/Requirement
Polycyclic Aromatic Hydrocarbons (PAHs), total (sum of 16 US EPA PAHs)	As per state EPA regulations applied for specific biomass amendments applied to soil	mg/kg (dry wt)	As per state EPA regulations applied for specific biomass amendments
Dioxins/Furans (PCDD/Fs)	As above	**ng/kg** WHO-TEQ (dry wt)	A As above
Polychlorinated Biphenyls (PCBs)	As above	mg/kg (dry wt)	As above

2.2 PROCESS CRITERIA

2.2.1 Biochar Heating and Cooling Temperature

(a) For biochars that are produced in batch kilns, the temperature throughout the feedstock/biochar should not vary by more than 100°C during the heating and cooling cycle to avoid condensation of liquids on the biochar that may contain polyaromatic hydrocarbons.

(b) Biochar must be cooled to less than 120°C before being exposed to air to prevent any possibility of chemisorption of air and spontaneous combustion.

(c) Carbonaceous materials (coals compost and charcoal) left at specific temperatures have been known to spontaneously combust (https://en.wikipedia.org/wiki/Spontaneous_combustion). Although research Pagni et al (2002)[9] has indicated that biochar and charcoal, that is either wet or dry, will not spontaneously combust at temperatures below 80°C it is recommended that solid biochar, that is to be stored in large volumes (>500 m³.), is dry (approximately 15% m.c.) before leaving the pyrolysis kiln. This will minimize the risk of spontaneous combustion. It should also be noted that fungi and bacteria can form on wet biochar that has been exposed to air and alter the properties of the biochar, especially those produced from manures and sludges which can potentially be a health hazard. There are no known hazards associated with storing biochar that is completely immersed in water.

2.3 PHYSICAL AND CHEMICAL REQUIREMENTS

Products shall comply with the physical and chemical requirements for the classification as set out in Table 2.2 and

Table **2.3**. Note for high carbon biochars produced from woody biomass it is optional to give NPK concentrations as they are usually very small. It is recommended that concentrations of Mg, Ca, Si and Fe are given as these can be important for liming effect and for improving strength and nutrient availability of plants. Surface area and pore volume is an important aspect of high carbon biochars and for high carbon woody biochars can be carried out using CO_2 BET method (See IBI characterisation guidelines). For medium and high ash content biochars, the surface area and pore volume measurements may not reflect the true value unless more expensive NMR measurements (Rawal et al. 2016)[10] are carried out.

[9] Pagni, P.J., Cuzzillo, B.R., Wolters, F.C., and Frost, T.R., "Size Constraints on Self Ignition of Charcoal Briquets," 7th International Symposium on Fire Safety Science, 16-21 June, 2002, Worcester Polytechnic Institute, Worcester, Massachusetts, USA

[10] Rawal, A., Joseph, S.D., et al.., 2016. Mineral-biochar composites: molecular structure and porosity. *Environ. Sci. Technol*. 50, 7706-7714

2.3.1 Toxicity Tests

All biochars should be tested using worm avoidance and germination tests as specified in Van Zwieten et al 2010. In addition, other plant tests are recommended to be carried out as specified in AS4454 and as per section 3.3.2 (these tests are optional).

Many papers have been prepared on the impact of biochar on the availability of heavy metals and adsorption of PAH. If required by EPA or other authorities it is recommended to use USEPA 1311 Toxicity Characteristic Leaching Procedure (TCLP) test. NATA certified laboratories can undertake this test.

2.3.2 Additional Plant Tests (Optional)

Previous research has shown that the efficacy of biochar is a function of how much and how often biochar is added to the soil. In particular too much biochar can cause growth inhibition usually due to either locking up of nitrogen and phosphorus (especially in high carbon high temperature biochar) or a salting effect from a high nutrient content biochar where too high a concentration of salts has been transported to the roots of a plant. AS4454 provides a test for composts to determine a maximum application rate based on the EC value (see Appendix F(i)). To allow consumers to understand the effects of too high an application rate it is recommended that suppliers carry out rate trials similar to that carried out by Yin Chan et al. (2008)[11].

For biochar that is added to the raw material (whether or not they are dried) for composting and vermicomposting, tests should be carried out as per AS4544.

SECTION 3 - VERIFICATION OF REQUIREMENTS AND TESTING

3.1 PRODUCT TESTING

3.1.1 Storage before testing

Products should be tested as soon as possible after reaching a lab. Samples should be stored in fridge at 4°C. Samples should be dried to 0% moisture content at 40°C over 2 days and the moisture content recorded then kept in sealed containers in the fridge at 4°C until tests carried out.

3.1.2 Physical and Chemical Testing

Products shall be tested prior to distribution at least once a year or if major process conditions are changed.

[11] K. Y. Chan, L. Van Zwieten, I. Meszaros, A. Downie, and S. Joseph (2008) Agronomic values of greenwaste biochar as a soil amendment. *Australian Journal of Soil Research*, 2007, **45**, 629–634

3.1.3 Test Methods

Test methods for the analysis of the properties of the biochars specified in Table 2.1 and elsewhere in this standard shall be in accordance with relevant aspects of Appendices A-F.

NOTE: Methods for sampling and preparation of samples prior to analysis are given in APPENDIX E. APPENDIX F gives guidance on test methods for assessing the nutrient value of biochar. APPENDIX G gives guidance on the determination of compliance with this Standard.

3.2 CLAIMING COMPLIANCE

Documentation shall be retained to demonstrate the product complies with the requirements in Table 3.1, 3.2 and 3.3.

1. Manufacturers making a statement of compliance with this Australian Standard on a product, its packaging, or promotional material related to that product, are advised to ensure that such compliance is capable of being verified.
2. Acceptable evidence of compliance with this Standard should include (but is not limited to) the following:
   (a) Three test reports on samples representative of products produced under normal production conditions.
   (a) Certification license numbers and certificates.
   (b) Independent evidence of conformance with the processing, testing and record keeping activities associated with the production of the products claimed to be compliant with this standard.

SECTION 4 – PACKAGING MARKING AND DOCUMENTATION

4.1 PACKAGING

4.1.1 Volume—Packaged materials

All products shall be packaged in multiples of a litre and the volume shall be measured in accordance with the method in Appendix F(vi) to this standard, which is consistent with Appendix J of AS4454.

When measured in accordance with this method, the actual volume of packaged product shall not be less than the volume stated on the primary package.

NOTE: Attention is drawn to relevant state or territory and federal regulations governing size and weight requirements that are not within the scope of this Standard.

4.1.2 Volume—Bulk materials

Details on the determination of volume of bulk product are subject to agreement between the supplier and the purchaser, e.g. loose or settled volume, or weight at a specified moisture content.

The method for determining volume and bulk density of bulk materials using a small sample (minimum 10 L) is described in Appendix F(vi). Using the bulk density determined as in Appendix F(vi), the mass of a load of product, and the volume of product dispatched can be determined.

NOTE: Parties need to be aware that settling will occur during transport.

4.1.3 Protection

Both packaged and bulk products should be protected so that, under normal conditions of handling, storage and transport, the contents do not become contaminated by extraneous matter (e.g. plant propagules, pathogens and pests) and the contents of packages are not released unintentionally. Packaging shall contain perforations to allow for pressure equalization, and ease and safety of handling.

4.2 REQUIRED MARKING OR DOCUMENTATION

Any product supplied in accordance with this Standard shall be accompanied by information supplied either on the primary packaging or, where unavailable, a separate information sheet that is permanently and legibly marked with the information listed below.

NOTE: In this Standard, the term *'information sheet'* can mean an invoice or other document that provides the information in a location where the consumer is most likely to read it.

On packages, the letters shall be no less than 9 point in size and in a prominent position.

This information shall accompany the product in order to verify compliance with this Standard and include the following:

(a) Name or registered trademark and full street address of the manufacturer, packer or distributor.

(b) Volume of contents, in litres (to the nearest litre), printed in letters a minimum of 18 point in size. The only statement of volume shall be the volume determined according to the method for the determination of volume in Appendix J.

NOTE: Packages should **not** be marked with codes such as *'No. 1 pack'*, or similar, as a substitute for stating the actual number of litres of contents in the package. Mass of contents should not be marked as a substitute for stating the actual volume in litres, although a mass may be provided in addition to volume.

(c) If the product contains fine particles that could cause respiratory problems or pathogenic micro-organisms then a health warning label and hazardous information label for customers on the handling

of the products on the package for bagged product or the information sheet/invoice in the case of bulk products shall be provided. The label must be permanently and legibly marked as follows:

(i) *Appearance* - The warning specified in Item (c)(ii) shall be printed in a contrasting colour to other non-warning printing, have a border in bold and shall appear in accordance with Items (A), (B) or (C) as appropriate:

(A) On 15 L or larger packages: in 16 point Arial bold or other Sans Serif font.

(B) On packages of less than 15 L: in 12 point Arial bold or other Sans Serif font.

(C) On the information sheet/invoice: in 10 point Arial bold or other Sans Serif font.

(ii) *Health warning label* - The following warning* shall be printed in a prominent position on the front of the package for bagged product or bulk product on the information sheet/invoice.

Example:

Health Warning

- This product contains dust particles
- Keep Product moist when handling to avoid dust
- Avoid breathing dust- wear particulate mask if dusty
- Wear appropriate gloves and footwear as a precautionary measure
- Wash hands immediately after use
- Read detailed warning label on this bag and refer to manufacturers Material Safety Data Sheet (MSDS)

4.3 REQUIRED MARKING-CONDITIONAL UPON PRODUCT CLAIMS OR TEST RESULTS

The information sheet or primary package shall be permanently and legibly marked with the following information, depending on the conditional statement for that particular component, written in a prominent position, in letters no less than 9 point in size, set out as follows:

(a) Instructions on the maximum application rate for a given soil and plant

(b) If the manufacturer intends that the product is to be used as a nutrient supplement then details of the total and available P and N and total K

(c) If the product total heavy metal content (total concentration) exceeds the relevant state EPA requirements and those listed in table 3.3 of the draft standard but the leachable heavy metal contents are below the EPA requirements this needs to be noted.

4.3.1 Maximum application rate of product with different salinities

Table 4.1 sets out maximum application rates of product with different salinities for plants of different sensitivities to salinity.

Table 4.1: *Maximum Application Rate of Biochar Product with Different Salinities for Plants of Different Sensitivities to Salinity*

EC range *(see Appendix F(i))* **dS/m**	**Sensitive plants** **L/m^2**	**Tolerant plants** **L/m^2**
0-1	Unlimited	Unlimited
1-2	<15	<60
2-4	<8	<32
4-8	<4	<16
8-12	<2.5	<10
>12	<2	<8

NOTES:

1. These rates are for mulches or for incorporation into soil to a depth of 5 cm. When incorporated into the soil to a depth of at least 10 cm these amounts can be doubled.
2. The maximum rate of application of product is to be stated on the primary package or information sheet (as per Clause 5.3(a)), based on the electrical conductivity (EC) result, as in the following example:

The concentration of soluble plant nutrients in this product is such that the maximum rate of application on one occasion should be no more than 4 L per square meter for sensitive plants and no more than 16 L per square meter for tolerant plants. Repeat applications may be made after several weeks.

APPENDICES

APPENDIX A: PAH, PCDD/F and PCB Compounds to be Tested

APPENDIX B: The Use of H:Corg to Indicate C Stability

APPENDIX C: Toxicity and Germination Inhibition tests

APPENDIX D: TCLP Test

APPENDIX E: METHOD FOR SAMPLING, SAMPLING HANDLING AND PREPARATION PRIOR TO ANALYSIS

APPENDIX F: ANALYTICAL METHODS FROM AS4454:

- *Appendix F(i): METHOD FOR DETERMINATION OF PH, ELECTRICAL CONDUCTIVITY, AMMONIUM, NITRATE AND SOLUBLE PHOSPHORUS CONTENT (AS4454 App B)*
- *Appendix F ii: METHOD FOR DETERMINATION OF TOTAL CARBON AND NITROGEN CONTENT (AS4454 App C)*
- *Appendix F(iii): METHOD FOR DETERMINATION OF TOTAL CONTENT OF NUTRIENTS, CONTAMINANT METALS AND OTHER ELEMENTS (AS4454 App D)*
- *Appendix F(iv): METHOD FOR DETERMINATION OF PARTICLE SIZE GRADING (AS4454 App G)*
- *Appendix F(v): METHOD FOR DETERMINATION OF TOTAL CARBONATE CONTENT (AS4454 App H)*
- *Appendix F(vi): METHOD FOR THE MEASUREMENT OF A VOLUME OF PACKAGED PRODUCT AND OF THE VOLUME AND BULK DENSITY OF BULK PRODUCT (AS4454 App J)*

APPENDIX G: MEANS OF DEMONSTRATING COMPLIANCE WITH THIS STANDARD (Informative) (AS4454 App. Q)