Environmental
Product
Declaration

SOLID CARBON

BioLock Concrete Admixture

ASTM INTERNATIONAL

According to
ISO 21930
ISO 14025

1. General Information

Manufacturer Name:	BioForceTech – 938 Linden Avenue South San Francisco California USA
Program Operator:	ASTM International 100 Barr Harbor Drive West Conshohocken, PA 19428-2959, USA
Declaration Number:	EPD 507
Reference PCR:	ISO 21930: 2017
Date of Issuance:	July 15, 2023
End of Validity:	July 15, 2028
Product Name:	BioLock Admixture
EPD Owner:	Solid Carbon
Declared Unit:	1 Tonne of BioLock Admixture
EPD Scope:	Cradle-to-gate with options (A1, A2, A3, C4)
Verification:	ISO 21930 serves as the core PCR. Independent verification of the declaration according to ISO 14025 and ISO 21930. ☐ internal ☒ external
LCA Reviewer and EPD Verifier:	Timothy S. Brooke ASTM International

2. Product Information

2.1 Company Description

Solid Carbon develops and markets biobased concrete admixtures and binders that safely store waste carbon streams that would otherwise end up in the atmosphere in concrete. Depending on the application, product and dosage, Solid Carbon products can be used to enhance the strength, modify the performance or enrich the aethetics of concrete used in both cast-in-place and pre-cast applications.

2.2 Product Description

BioLock concrete admixture is a carbon rich material made through the pyrolysis of biosolids wastestreams. BioLock is incorporated into concrete for specific performance advantages such as the storage of biogenic carbon in concrete.

Figure 1: BioLock concrete admixture visual representation.

2.2 Technical Data

Table 1 shows physical property data for BioLock admixture

Table 1: Technical Data

Property	Value	Unit
Moisture Content	< 5	%
Carbon Content	30.47	%
Electrical Conductivity	1.35	dS/m
Bulk Density	795	kg/cubic meter
Fluid Temperature	2251	F
Elemental Ash Content	66	%

3. LCA Calculation Rules

3.1 Declared Unit

The declared unit is 1 Tonne of BioLock Admixture produced by the manufacturer.

3.2 System Boundary

The system boundary for this study is cradle-to-gate with options, including disposal at end of life. (see also Table 3):

- ***A1 Raw material supply***: Extraction, handling, and processing of input materials.
- ***A2 Transportation****:* Transportation of all input materials from the suppliers to the gate of the manufacturing facility.
- ***A3 Manufacturing*****:** The preparation processes of the manufacturing facility. This phase also includes the operations of the manufacturing facility and all process emissions that occur at the production facility.
- ***C4 Disposal:*** The disposal of BioLock admixture at end of life is included and exemplifies the non-reactivity of biochar that leads to permanent biogenic carbon over the product life cycle.

3.3 Estimates and Assumptions

All significant foreground data was gathered from the manufacturer based on measured values.

3.4 Cut-off Criteria

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.

No material or energy input or output was knowingly excluded from the system boundary.

3.5 Background Data and 3.6 Data Quality

Data was gathered for the primary material and energy inputs used in production for calendar year 2022. Table 2 describes each LCI data source for raw materials (A1), transportation (A2),

the core manufacture process (A3), and disposal (C4). Table 2 also includes a data quality assessment on the basis of the technological, temporal, and geographical representativeness.

Table 2: Secondary Data Sources and Data Quality Assessment

A1: Raw Material Inputs				
Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Biosolid	No burden: waste product	US	N/A	N/A
A2: Transportation				
Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Trucking	USLCI: Transport, single unit truck, short-haul, diesel powered, Northwest/tkm/RNA	Global	2014	**Technology:** very good **Time:** good Data is <10 years old **Geography:** very good
A3: Manufacturing				
Energy	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Electricity	Ecoinvent 3: Electricity, low voltage {WECC}| market for | Cut-off, U	Global	2018	**Technology:** very good **Time:** very good Data is <5 years old **Geography:** very good
C4: Disposal				
Process	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Landfill	ecoinvent 3.4: Inert waste {RoW}| treatment of, sanitary landfill | Alloc Rec, U (2018) [18] Modified foreground process with United States average electricity grid	Global/US	2018	**Technology:** very good **Time:** very good Data is <5 years old **Geography:** very good

3.7 Period under Review

Data was gathered for the primary material and energy inputs used in the production for calendar year 2022.

3.8 Allocation

Solid Carbon produces multiple products. Since the primary data for manufacturing was only available on a facility level, the environmental load among the products produced is allocated

according to its mass. For waste that is recycled, the 'recycled content approach' was chosen. The recycling of waste generated by the product system is cut off.

3.9 Comparability

This LCA was created using industry average data for upstream materials. Data variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel types used.

4. LCA Results

Life cycle impact assessment (LCIA) is the phase in which the set of results of the inventory analysis – the inventory flow table – is further processed and interpreter in terms of environmental impacts and resource use inventory metrics.Table 3 describes the system boundaries reported in this EPD. Tables 4 and 5 below summmarize the results for the cradle-to-gate (A1-A3) product system.

Table 3: Description of the System Boundary (x: included in LCA; mnd: module not declared; mnr: module not reported)

Product			Construction Installation		Use							End-of-Life				Benefits Beyond the System Boundary		
Raw Material Supply	Transport	Manufacturing	Transport	Construction / Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport	Waste Processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
x	x	x	mnd	mnd	mnd	mnd	mnr	mnr	mnr	mnd	mnd	mnd	mnd	mnd	x	mnd	mnd	mnd

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Table 4: LCIA Results for 1 Tonne BioLock Admixture								
Environmental Indicator	**Abbreviation**	**Units**	**A1-A3**	**A1-A3 +**	**A1**	**A2**	**A3**	**C4**
Core Mandatory Impact Indicator								
Global warming potential total	**GWPTOTAL**	kg CO_2-eq	-1.03E+03	-1.01E+03	-1.12E+03	0.00E+00	9.45E+01	1.06E+01
Global warming potential fossil	**GWPFOSSIL**	kg CO_2-eq	9.45E+01	1.05E+02	0.00E+00	0.00E+00	9.45E+01	1.06E+01
Global warming potential biogenic	**GWPBIO**	kg CO2-eq	-1.12E+03	-1.12E+03	-1.12E+03	0.00E+00	0.00E+00	0.00E+00
Depletion potential of the stratospheric ozone	**ODP**	kg CFC-	7.24E-06	8.86E-06	0.00E+00	0.00E+00	7.24E-06	1.62E-06
Acidification potential of land and water	**AP**	kg SO_2-eq	2.30E-01	2.67E-01	0.00E+00	0.00E+00	2.30E-01	3.72E-02
Eutrophication potential	**EP**	kg PO_4-eq	7.46E-01	7.61E-01	0.00E+00	0.00E+00	7.46E-01	1.51E-02
Formation of tropospheric ozone	**SFP**	kg O_3-eq	3.15E+00	4.02E+00	0.00E+00	0.00E+00	3.15E+00	8.66E-01
Abiotic depletion potential for fossil resources	**ADPf**	MJ	1.11E+03	1.22E+03	0.00E+00	0.00E+00	1.11E+03	1.13E+02
Use of Primary Resources								
Renewable primary energy carrier used as	**RPRE**	MJ	3.05E+02	3.08E+02	0.00E+00	0.00E+00	3.05E+02	3.46E+00
Renewable primary energy carrier used as	**RPRM**	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary energy used as energy	**NRPRE**	MJ	1.44E+03	1.56E+03	0.00E+00	0.00E+00	1.44E+03	1.23E+02
Non-renewable primary energy used as material	**NRPRM**	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary Material, Secondary Fuel and Recovered Energy								
Use of secondary materials	**SM**	kg	1.00E+03	1.00E+03	1.00E+03	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	**RSF**	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	**NRSF**	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	**RE**	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mandatory Inventory Parameters								
Use of freshwater resources	**FW**	m^3	4.13E-01	5.37E-01	0.00E+00	0.00E+00	4.13E-01	1.24E-01
Indicators Describing Waste								
Disposed of hazardous waste	**HWD**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Disposed of non-hazardous waste	**NHWD**	kg	0.00E+00	1.00E+03	0.00E+00	0.00E+00	0.00E+00	1.00E+03
Disposed of high-level radioactive waste	**HLRW**	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Disposed of low-level radioactive waste	**LLRW**	m^3	1.10E-06	1.10E-06	0.00E+00	0.00E+00	1.10E-06	0.00E+00
Components for reuse	**CRU**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	**MFR**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	**MER**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (waste to energy)	**EEE**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (waste to energy)	**ETE**	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

The biogenic carbon emissions across the declared modules negative due to the permanent carbon storage caused by the product. Based on ISO 21930 accounting rules, all carbon removed from the atmosphere (characterized in the LCIA as -1 kg CO2e/kg CO2) in module A1 is calculated as being emitted to the atmosphere in other modules (characterized in the LCIA as +1 kg CO2e/kg CO2). Total GWP_{BIO} includes biogenic carbon emissions and removals from the information modules A1-A3 and also reports values for modules C4 to account for the biogenic carbon that is not emitted in the declared modules to ensure a net neutral biogenic carbon balance. The A1-A3 column indicates the summation of A1-A3 and C4.

5. Interpretation

Figure 2 shows the relative contribution to the cumulative impacts of the A1 through A3 phases of the cradle-to-gate life cycle. There is no significant impacts know for A1 or A2 therefore for all the major impact categories (GWP, ODP, AP, EP, SFP, ADPf), the biggest contributor is A3 – Manufacturing.

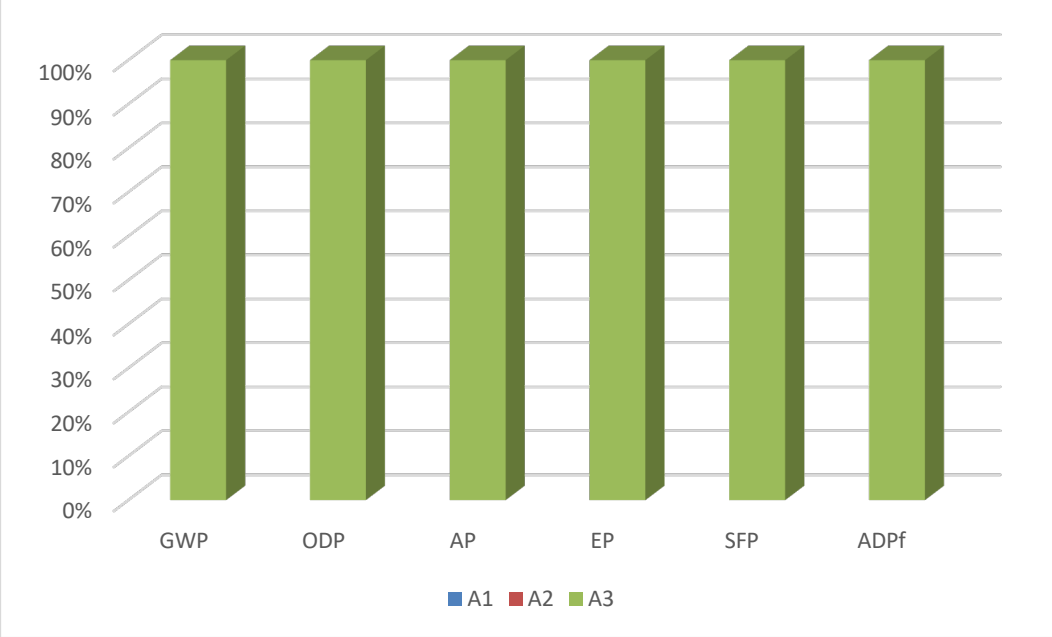

Figure 2. Contribution analysis for BioLock Admixture.

6. References

1. ASTM 2020 - ASTM Program Operator for Product Category Rules (PCR) and Environmental Product Declarations (EPDs) General Program Instructions v8, April 29th.

2. Athena Institute: 2021 - A Cradle-to-Gate Life Cycle Assessment of BioLock Admixture.

3. ISO 21930: 2017 Building construction – Sustainability in building construction – Environmental declaration of building products.

4. ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

5. ISO 14044:2006/AMD 1:2017/ AMD 2:2020 - Environmental management - Life cycle assessment - Requirements and guidelines.

6. 14040:2006/AMD 1:2020 - Environmental management - Life cycle assessment - Principles and framework.