[Eion Corp] Carbon Removal Purchase Application

General Application

(The General Application applies to everyone, all applicants should complete this)

Company or organization name

Eion Corp

Company or organization location (we welcome applicants from anywhere in the world)

Princeton, New Jersey

Berkeley, California

Name of person filling out this application

Adam Wolf

Elliot Chang

Email address of person filling out this application

x

x

Brief company or organization description (<10 words)

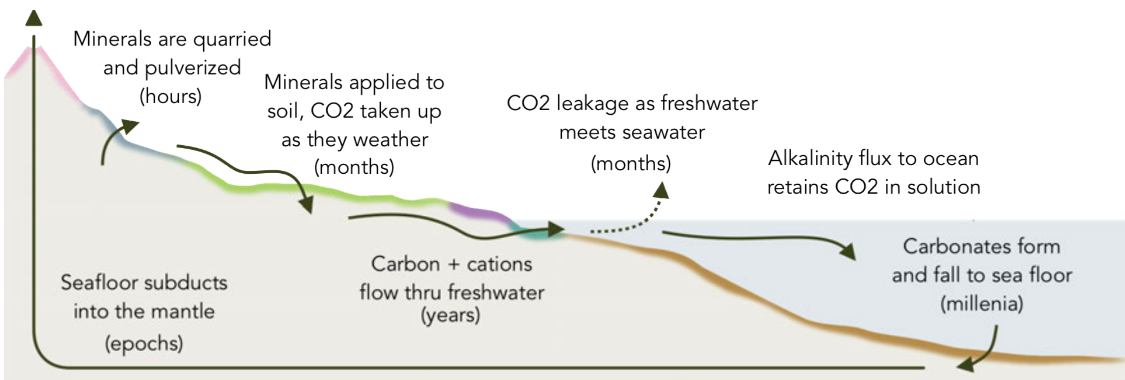
Eion's mission is to remove carbon permanently and at scale, with rigorous scientific verification, while providing economic and environmental benefits in rural areas.

stripe

1. Overall CDR solution (All criteria)

a. Provide a technical explanation of the proposed project, including as much specificity regarding location(s), scale, timeline, and participants as possible. Feel free to include figures.

<1500 words Eion is a carbon dioxide removal (CDR) business using ex-situ terrestrial enhanced rock weathering, or ERW. The basic premise of this approach is that when mineral breakdown occurs, cations (chiefly Mg^{2+} and Ca^{2+}) become available in soil solution, which, by the principle of charge balance, are accompanied by increases in dissolved inorganic carbon (DIC; chiefly HCO3). This DIC ultimately reaches the ocean, where this carbon has a residence time on the order of 50,000 years.



We focus the deployment of this CDR strategy in agricultural and managed forestry settings, with particular attention to the agronomic considerations of the engineered materials amended into the soil, and the post-application verification of the CDR. Because the net CDR offering is dependent on rock, soil, and marine chemistry, as well as emissions associated with extraction, processing, and transportation activities, we have developed a detailed lifecycle analysis (LCA) that is geographically specific in its parameters, and can be run in a prognostic (planned) or retrospective (actual) mode. We do not own land or capital equipment, but coordinate with other actors in the supply chain to process and move material according to our specifications, and collect data from these activities to aggregate into a CDR offering.

Because our business depends on a) the basic availability of resources (source material, logistics, land), b) the impact of these resources on the net CDR offering, and c) potential economic/social co-benefits of application, we have designed the enterprise to be flexible in terms of the localities where the CDR will take place (e.g. in the Southern Great Plains, Pacific Northwest, and/or East Coast). Our priorities are agricultural regions growing commodity crops or plantation forests in acid-affected soils with high precipitation and warm mean annual temperatures. These environmental conditions favor faster mineral dissolution, and application of ERW will directly ameliorate soil acidity. Further, our chosen locations minimize environmental costs and externalities, as they are in close proximity to either feedstock sources or ports; payment from ecosystem services will have higher impact to farm livelihoods; and learnings from supply chain development can be replicated elsewhere.

We envision several scenarios for the proposed project, anticipated to coincide with the 2022 North American growing season:

Scenario 1:
Olivine is sourced as fine powder from a quarry in Norway, transported by container ship to Morehead City NC, processed in proximity to the port, loaded into rail cars to be transported to Guilford County NC (near Greensboro) where we have a cooperator with agricultural land.

Scenario 2:
Olivine is sourced from Birmingham AL (having previously been imported from Norway to Mobile AL), processed in Birmingham AL, and transported by truck to central AL (Montgomery County), eastern AL (Cherokee County), or eastern MS (Noxubee County), where we have relationships to cooperators.

Scenario 3:
Olivine is sourced from Whatcom County WA, processed in Bellingham WA, and transported into rural Whatcom County WA, where we have relationships to cooperators with agricultural land.

Scenario 4:
As with Scenario 2 but using Blast Furnace Slag from a local Birmingham AL power plant in lieu of Olivine.

One of the main differences between scenarios is the transport costs (both cash and carbon):

Scenarios

Scenario 1	Segment	Leg	Mode	Distance (km)
Quarry Norway	Q2M	1	Boat	8000
Port Morehead City	Q2M	2	Rail	10
Mill near port	M2F	1	Rail	300
Field Greensboro	M2F	2	Road	20

Scenario 2	Segment	Leg	Mode	Distance (km)
Quarry Norway	Q2M	1	Boat	10500
Port Mobile AL	Q2M	2	Rail	10
Mill Birmingham AL	M2F	1	Rail	350
Field Montgomery Cc	M2F	2	Road	20

Scenario 3	Segment	Leg	Mode	Distance (km)
Quarry Washington	Q2M	1	Road	50
Mill Bellngham	M2F	1	Road	20
Field Whatcom Co				

Scenario 4	Segment	Leg	Mode	Distance (km)
Blast Fnc Birmingham	Q2M	1	Road	25
Mill Birmingham AL	M2F	2	Road	50
Field Montgomery Co				

The Norway source (Scenario 1) has the largest production volume of olivine in the world (ca. 2M tpa), but there are severe container shipping bottlenecks that impact the timeliness and cost of this solution for deployment in the US in Spring 2022. US stock exists now (Scenario 2), but this is a finite supply (amount currently unknown) designed to meet existing US demand for industrial minerals with relatively high monetary cost. Scenario 3 uses an active quarry in the Pacific Northwest, with existing expertise and infrastructure for mineral processing, and close proximity to potential land application regions; nonetheless the current capacity of this quarry is quite small (<5K tpa) and would therefore require investment to bring to significant scale in the future. Scenario 4 makes use of blast furnace slag (BFS) as a low-cost byproduct of the steel industry. The chemical attributes of this material are favorable for carbon removal and agronomic application, as well as the proximity to application sites, but this feedstock has some limitations that disfavor it (possible metal contamination, variable chemistry, limited potential supply).

The extraction step makes use of a surface quarry to produce a stream of ores with the target composition. Our company is focused on olivine as a mineral that has a high composition of Mg, and is more reactive with acidity than other minerals. As a consequence the mineral potential (tons CO_2e per ton ore, calculated below in section 3b) is high. Because most if not all of the cost drivers are experienced on a per-ton-ore basis, while revenue is on a per-ton-carbon basis, we see the high mineral potential as essential for early stage commercialization efforts. In addition to the high mineral potential, the ore bodies we have examined have a relatively consistent chemical and mineralogical composition, allowing for quality control in the products derived, both in their agronomic performance and mineral potential. We have additionally put considerable effort into characterizing the trace element composition of various ore bodies for chemical fingerprinting in verification activities.

A surface quarry does not produce a waste stream, which means that there is not a separation step, nor is there a need for a storage locality for the waste (i.e. a tailings pile) for subsequent reclamation. The lack of a separation stage avoids the need for water and post-separation treatment and reclamation. All of these phenomena dramatically reduce the environmental impact, and simplify permitting requirements.

Our current proposal does not include a milling step, because there is sufficient current production of product ground to the target size; the materials we have sourced have 0.55 m^2/g (BET method) with a modal particle size of 185uM (laser diffraction method). This value is at the higher end of observed surface areas for this particle size, but within the 95th percentile reported by Strefler *et al.* (2018). We do however include a pelletizing step for facilitating transport and application using conventional vessels and equipment.

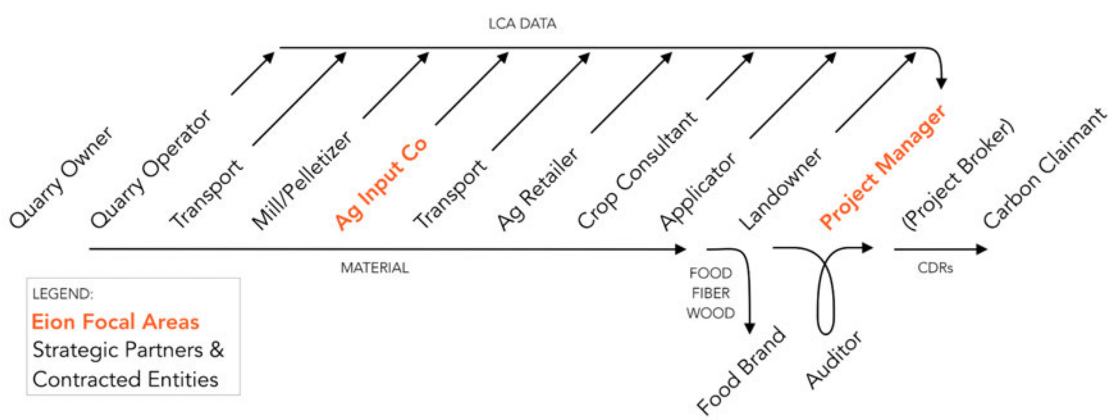
Our focal geography is in the southeast, owing to the soil acidity, and we have a cooperator who is a farmer and a consulting agronomist with land to pilot. Soil tests at this site show a pH of 5.6 with a buffer pH of 6.85 suggesting a $CaCO_3$ equivalent lime application rate of ~7 tons ore per ha to bring to pH 6.5. Under a carbon offering of 1000 tons carbon, and a net CDR rate of 0.923 t CO2/t Ore, this application rate demands 155 acres, just under a quarter section. We are currently conducting greenhouse studies with this identical soil at Rutgers University (supported by a grant from the NJ Council on Science Technology and Innovation, collaboration with Prof Jim Simon) at rates of 0, 2, 8, 32 t/ha, under two different crop types, with soil and plant chemistry, soil genomics, crop disease, and yield information being gathered to refine the potential application rate. In a parallel effort, we are conducting soil column studies, likewise with the identical soil, at UC Berkeley (collaboration with Prof Celine Pallud) to validate the verification methodology using trace elements. To the extent we need a fallback plan from this Scenario 1 owing to supply constraints, we have initiated engagements with landowners in proximity to other feedstock sources to meet the contracted CDR.

At the time of application, and periodically thereafter, soils at the site will be monitored for the loss of reaction products, i.e. Mg, in reference to a conserved set of trace elements (e.g. rare earth elements) that are contained in the rock but remain bound to the soil exchange complex. At the surface area we have measured in our feedstock, and the chemistry of our target soil, we anticipate the reaction will proceed mostly within a single growing season, but this is an area of considerable uncertainty in the literature and we will monitor carefully.

The core team includes Adam Wolf (founder/CEO of Eion; PhD Stanford under Chris Field and Joe Berry, postdoc Princeton under Steve Pacala; founder/Chief Scientist Arable Labs), Elliot Chang (founder/Chief Scientist, PhD UC Berkeley; postdoc LBL/LLNL); Alison Marklein (PhD UC Davis under Ben Houlton; LBL); Rog Hardy, an exploration geologist with significant industry experience; Bill O'Connor, former head of the DOE mineralization efforts at Albany Research Center spearheaded by Klaus Lackner (1995-2005), and Bob Hatcher (distinguished prof emeritus of Geology at U Tennessee). Outside consulting by Pilio Ltd (lifecycle analysis), Samuel Engineering (quarry/mill engineering and costing). Our science advisory board includes Steve Pacala (Princeton, NAS), Anna Michalak (Carnegie, Stanford, US CCSP), David Lobell (Stanford), Celine Pallud (UCB), Eve Hinckley (CU), Jim Simon (Rutgers), and Jane Zelikova (CSU).

b. What is your role in this project, and who are the other actors that make this a full carbon removal solution? *(E.g. I am a broker. I sell carbon removal that is generated from a partnership between DAC Company and Injection Company. DAC Company owns the plant and produces compressed CO_2. DAC Company pays Injection Company for storage and long-term monitoring.)*

<50 words



Our two roles:
Ag Input Company: We formulate a product (CarbonLock$_{TM}$) that processes industrial minerals into a formulated and pelletized agricultural input for ERW.

Project Manager: We coordinate strategic partners and contractors to deliver CarbonLock to the field; quantify carbon removal; and compute the LCA as evidence of net CDR.

c. What are the three most important risks your project faces?

<300 words

1. The ideal application rate is uncertain, with only a few studies to guide agronomic recommendations. Some studies suggest application rates up to 40-50t/ha, but it is not always clear how application rates are influenced by the particle size of the material (determining rate of cation availability) or the resident soil chemistry. The risk associated with application rate can be borne by the landowner, as high rates may impact yield by competing with nutrient uptake; or the risk can be borne by Eion as low rates require applications across more acres to meet the contracted CDR.
2. Supply and transport uncertainty plays a critical role, as described above, on the geography of our project, with a potential consequence that shifts our partners (contractors and landowners) from the East Coast of the United States to the West. The sooner we can lock in a supply, the earlier these partnerships can be developed and the project can proceed at a sensible pace.
3. Supply and transport uncertainty also impose risks to direct costs and timeline (which manifests in cost). For example, the high density of the material under consideration favors boat or rail transport, but as the timeline is compressed, then road transport must be considered, which results in higher costs (both cash and carbon).

We are addressing the first risk by conducting off-season rate trials in the greenhouse and in the field in anticipation of first commercial-scale deployment.

We are addressing the second risk by developing partnerships with a wider group of potential stakeholders than we will necessarily be able to serve immediately.

We are addressing the final risk by pursuing multiple supply options simultaneously until our preferred scenario is secured.

d. If any, please link to your patents, pending or granted, that are available publicly.

Not public:

U.S. Provisional Patent Application No.: 63/213,398
Filed: June 22, 2021
VERIFICATION METHODS AND AGRONOMIC ENHANCEMENTS FOR CARBON REMOVAL BASED ON ENHANCED ROCK WEATHERING

2. Timeline and Durability (Criteria #4 and Criteria #5)

a. Please fill out the table below.

	Timeline for Offer to Stripe
Project duration *Over what duration will you be actively running your DAC plant, spreading olivine, growing and sinking kelp, etc. to deliver on your offer to Stripe? E.g. Jun 2021 - Jun 2022. The end of this duration determines when Stripe will consider renewing our contract with you based on performance.*	*<10 words* Q3-4 2021 sourcing supply Q2 2022 applying material Q3 2022, ongoing verification of performance
When does carbon removal occur? *We recognize that some solutions deliver carbon removal during the project duration (e.g. DAC + injection), while others deliver carbon removal gradually after the project duration (e.g. spreading olivine for long-term mineralization). Over what timeframe will carbon removal occur?* *E.g. Jun 2021 - Jun 2022 OR 500 years.*	*<10 words* To a first approximation, the carbon removal begins immediately following application, and progresses over 1-3 years.
Distribution of that carbon removal over time *For the time frame described above, please detail how you anticipate your carbon removal capacity will be distributed. E.g. "50% in year one, 25% each year thereafter" or "Evenly distributed over the whole time frame". We're asking here specifically about the physical carbon removal process here, NOT the "Project duration". Indicate any uncertainties, eg "We anticipate a steady decline in annualized carbon removal from year one into the out-years, but this depends on unknowns re our mineralization kinetics".*	*<50 words* Based on the 0.56 m^2/g surface area of our proposed feedstock, we present the following time scales of dissolution and subsequent carbon removal: Soil pH 4: ~20 days Soil pH 5: ~2 months Soil pH 6: ~6 months Soil pH 7: ~1 year, 4 months Soil pH 8: ~ 3 years, 10 months

Durability *Over what duration you can assure durable carbon storage for this offer (e.g, these rocks, this kelp, this injection site)? E.g. 1000 years.*	*<10 words* ~85% remains in the ocean for ~40,000 years; ~15% lost in estuaries within decades.

b. What are the upper and lower bounds on your durability claimed above in table 2(a)?

Number/range The durability of DIC in ocean water ranges from 4,500 years to 125,000 years.

c. Have you measured this durability directly, if so, how? Otherwise, if you're relying on the literature, please cite data that justifies your claim. *(E.g. We rely on findings from Paper_1 and Paper_2 to estimate permanence of mineralization, and here are the reasons why these findings apply to our system. OR We have evidence from this pilot project we ran that biomass sinks to D ocean depth. If biomass reaches these depths, here's what we assume happens based on Paper_1 and Paper_2.)*

<200 words This topic has been the focus of considerable investigation, because the ocean is a significant sink for anthropogenic CO2 emissions. One way to estimate the timescale is to divide the pool of DIC in water (in Gt) by the net sedimentation rate of $CaCO_3$. Each mole of net $CaCO_3$ loss results in a mole of CO_2 loss. To take Renforth's recent 2021 summary, the upper ocean is 920 Gt and the upper estimate for net sedimentation rate to coastal shelf is 0.2 Gt/year; 920/1.5 = 4,600 years lifetime. Alternatively, the budget could be estimated assuming DIC mixes in the entire ocean, which has a size of 38,120 Gt, and a net loss of 0.2 (from the coast) and 0.1 (in the deep ocean). (Note that $CaCO_3$ that falls in the deep ocean is largely dissolved as it falls below the calcite and aragonite saturation lysoclines.) Considering the entire ocean, the lifetime of DIC is 38,120/0.3 = 127,000 years. The difference between the upper and lower values is determined by the combined dynamics of transport, chemistry, and biology. David Archer conducted a number of pulse-release simulations in the 1990s, and concluded a lifetime of ~40,000 years; this work is used in textbooks (e.g. Ocean Biogeochemical Dynamics by Sarmiento and Gruber 2006)

d. What durability risks does your project face? Are there physical risks (e.g. leakage, decomposition and decay, damage, etc.)? Are there socioeconomic risks (e.g. mismanagement of storage, decision to consume or combust derived products, etc.)? What fundamental uncertainties exist about the underlying technological or biological process?

<200 words

ERW makes use of a thermodynamically favorable reaction that is irreversible under the range of conditions in natural ecosystems. The durability of ERW is defined by the carbonate system equations and the conserved cation budget of waters. The principal loss of weathered DIC occurs when fresh water (acidic to neutral pH) mixes with ocean waters (alkaline pH and saline) This estuarine leakage (reported in the literature by Hartmann, Raymond, and others) represents approximately 15% of the DIC that is initially removed at the site of application. We account for this leakage explicitly.

A secondary potential loss occurs when cations are taken up by plants as essential nutrients, and cations precipitate from the soil/groundwater/freshwater system. We examined plant stoichiometric composition to estimate that the cations we propose to apply exceed plant demand by many orders of magnitude, and thus plant uptake is insignificant to the overall CDR. Finally, the pH of surface waters we have examined are not in the range that would favor precipitation of Mg or Ca compounds. Both of these are testable hypotheses.

e. How will you quantify the actual permanence/durability of the carbon sequestered by your project? If direct measurement is difficult or impossible, how will you rely on models or assumptions, and how will you validate those assumptions? *(E.g. monitoring of injection sites, tracking biomass state and location, estimating decay rates, etc.)*

<200 words

We see two paths to evaluating our assumptions.

One path is to model the hydrological paths from the site of application, through river networks, to the ocean, making use of data collected by the USGS. We have an NSF proposal currently under review to support this effort; the chief concern is that water could pass through a transient high pH flow path that forces out CO_2, and then returns to a lower pH when it ultimately reaches the ocean.

A second path is to conduct detailed cation budgets within the root zone (where weathering takes place) and below the root zone (where the carbon is considered "sequestered") using zero-tension lysimeters and ion-exchange resins. Similarly, we have a USGS-NRCS-CIG proposal currently under review to support this effort.

Regardless of the success of these grant proposals, we will take every effort to falsify our assumptions on the functioning of the biochemical system and modify the CDR offering accordingly.

3. Gross Capacity (Criteria #2)

a. Please fill out the table below. **All tonnage should be described in metric tonnes here and throughout the application.**

	Offer to Stripe (metric tonnes CO_2) over the timeline detailed in the table in 2(a)
Gross carbon removal Do not subtract for embodied/lifecycle emissions or permanence, we will ask you to subtract this later	*E.g. XXX tCO_2* 1000 t CO_2 embodied in 1083 t Ore
If applicable, additional avoided emissions e.g. for carbon mineralization in concrete production, removal would be the CO_2 utilized in concrete production and avoided emissions would be the emissions reductions associated with traditional concrete production	*E.g. XXX tCO_2* West and McBride (Ag For Met 2005) conclude 59 kg C or 216 kg CO_2 are released to the atmosphere per ton of limestone ($CaCO_3$) applied as aglime. This number is the net flow of bicarbonate that accompanies Ca export to the sea. To the extent the landowner is currently using aglime, we would avoid 1083 * 216 = 233 t CO_2. However, we are not including this in our offer as it involves a counterfactual assumption.

b. Show your work for 3(a). How did you calculate these numbers? If you have significant uncertainties in your capacity, what drives those? *(E.g. This specific species sequesters X tCO_2/t biomass. Each deployment of our solution grows on average Y t biomass. We assume Z% of the biomass is sequestered permanently. We are offering two deployments to Stripe. X*Y*Z*2 = 350 tCO_2 = Gross removal. OR Each tower of our mineralization reactor captures between X and Y tons CO_2/yr, all of which we have the capacity to inject. However, the range between X and Y is large, because we have significant uncertainty in how our reactors will perform under various environmental conditions)*

<150 words

Beerling (2020), citing Renforth (2012), citing O'Connor (2004) provides a mineral potential for CO_2 removal based on feedstock chemical composition (MgO% and CaO%):

$$MP \equiv \frac{tCO_2e}{tOre} = \frac{MW_{CO_2}}{100\%} \cdot \left(\frac{MgO\%}{MW_{MgO}} + \frac{CaO\%}{MW_{CaO}} \right) * V$$

Where V is the ionic valence (i.e., 2 for Mg and Ca).

Defining dissolved inorganic carbon (DIC) and total alkalinity (TA) as follows (other parameters defined in Zeebe and Wolf-Gladrow 2001):

$$DIC = s \cdot \left[1 + \frac{K_1}{h} + \frac{K_1 K_2}{h^2}\right]$$

$$TA = s \cdot \frac{K_1}{h} + s \cdot 2 \cdot \frac{K_1 K_2}{h^2} + \frac{K_w}{h} - h$$

then, the derivative of each equation with respect to h is:

$$\frac{dDIC}{dh} = -s \cdot \left(\frac{K_1}{h^2} + 2 \cdot \frac{K_1 K_2}{h^3}\right)$$

$$\frac{dTA}{dh} = -s \cdot \left(\frac{K_1}{h^2} + 4 \cdot \frac{K_1 K_2}{h^3}\right) - \frac{K_w}{h^2} - 1$$

and the derivative of DIC (i.e. carbon uptake) with respect to TA (i.e. additional cation):

$$\frac{dDIC}{dTA} = \frac{dDIC}{dh} \cdot \frac{dh}{dTA}$$

At acidic to neutral pH of land, dDIC/dTA is essentially 1. At the mean ocean conditions of pH=8.08, T=16.1 and S=35, dDIC/dTA is 0.856. We use these two values to estimate leakage:

$$Leakage = -MP \cdot f_{Leakage}$$ where $$f_{Leakage} = \left.\frac{dDIC}{dTA}\right|_{land} - \left.\frac{dDIC}{dTA}\right|_{sea}$$

The CDR above is computed as CDRgross (the mineral potential) minus leakage. NB: our CDR net here and LCA in Supplementary Material is what Stripe defines as CDR gross above.

$$CDR_{net} = CDR_{gross} - Leakage$$

For Scenario 1, MgO% = 48.87, CaO%=0.13, MP = 1.077, dDIC/dTA land = 0.99974, dDIC/dTA sea = 0.856, and CDRnet is 0.923 tCO2e/tOre. 1000 tons of CO_2 offered requires 1083 tons Ore applied.

c. What is your total overall capacity to sequester carbon at this time, e.g. gross tonnes / year / (deployment / plant / acre / etc.)? Here we are talking about your project / technology as a whole, so this number may be larger than the specific capacity offered to Stripe and described above in 3(b). We ask this to understand where your technology currently stands, and to give context for the values you provided in 3(b).

 # metric tonnes CO_2/yr

We currently have 1 ton ore for R&D purposes, and are sourcing an additional volume for this offering. We're developing the capacity for 5,000t Ore in 2022, 50,000 t Ore in 2023 and 500,000 t Ore in 2024. To the extent we can offer more CDR in 2022 to Stripe at low marginal cost, we will.

d. We are curious about the foundational assumptions or models you use to make projections about your solution's capacity. Please explain how you make these estimates, and whether you have ground-truthed your methods with direct measurement of a real system (e.g. a proof of concept experiment, pilot project, prior deployment, etc.). We welcome citations, numbers, and links to real data! *(E.g. We assume our sorbent has X absorption rate and Y desorption rate. This aligns with [Sorbent_Paper_Citation]. Our pilot plant performance over [Time_Range] confirmed this assumption achieving Z tCO_2 capture with T tons of sorbent.)*

<200 words

A diverse body of evidence supports our feasibility assessment

<u>Lab Analyses</u> (see Supplementary material for original analyses)

- Hazen labs conducted SW846 analysis (EPA standard RCRA metals leachate test) and found no detectable hazardous metals including Cr, Ni, and Cd.
- ActLabs analyzed a wide variety of feedstocks, particularly for high precision rare earth element analyses.
- Waypoint analyzed a number of prospective soils for chemistry, texture, pH, CEC
- Union Process analyzed particle size distribution and surface area analysis
- Mineralogical analyses conducted by Professor Bob Hatcher (U of Tennessee).

<u>Biogeochemical Models</u>

- Carbonate system parameters were drawn from Zeebe and Wolf-Gladrow (2001), CO2sys (Lewis 97), and Sarmiento and Gruber (2006)
- Phreeqc geochemical modeling was parameterized using the lab results above; we made use of a version of the driver file provided by David Beerling to Elliot Chang and have continued to extend the use of this model to incorporate rare earth elements.

<u>Techno-Economic Models</u>

- Geologic maps were used to estimate reserves and spatial extent of known ore bodies.
- Quarry modeling reflecting these boundary conditions, as well as typical production attributes (volume per day, etc) was performed using Sherpa, an industry-standard model commonly used by the DOE. This model in turn was inspected by outside engineers for realism, and subsequently refined.

e. Documentation: If you have them, please provide links to any other information that may help us understand your project in detail. This could include a project website, third-party documentation, project specific research, data sets, etc.

- *Up to 5 links*

  [Eion-Stripe 2021 Procurement Supplementary Material]

  [Elliot Chang's Dissertation on REE tracers in soils]

4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

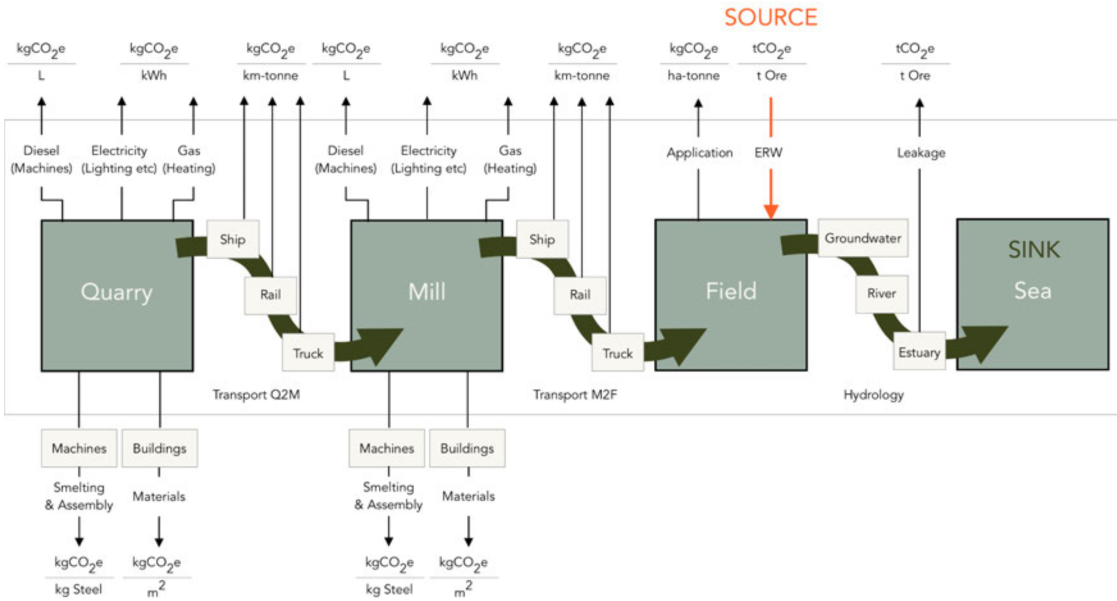
a. Please fill out the table below to help us understand your system's efficiency, and how much your lifecycle deducts from your gross carbon removal capacity.

	Offer to Stripe (metric tonnes CO_2)
Gross carbon removal	1000 tons CO_2
Gross project emissions	51 kg CO_2 emissions per ton CO_2 removed, or 51 tons CO_2 emissions total.
Emissions / removal ratio	1000/51 = 19.608x
Net carbon removal	1000 - 51 = 949 tons CO_2

b. Provide a carbon balance or "process flow" diagram for your carbon removal solution, visualizing the numbers above in table 4(a). Please include all carbon flows and sources of energy, feedstocks, and emissions, with numbers wherever possible *(E.g. see the generic diagram below from the CDR Primer,Charm's application from last year for a simple example, or CarbonCure's for a more complex example).* If you've had a third-party LCA performed, please link to it.

Our lifecycle analysis considers several stages in the LCA, which we summarize as (1) the quarry that extracts the material, (2) transport from quarry to mill, (3) the mill that processes the material, (4) transport from the mill to the field, (5) application on the field, and (6) biogeochemistry in the soil and hydrology downstream. A professional mining engineering firm has examined the design of the quarry and the mill (which itself is derived from an industry standard software package) and a professional LCA firm has examined the emissions factors used and benchmarked against comparables. Both of these organizations provided refinements to the model that are included here.

1. The quarry includes operational carbon (chiefly diesel energy to run the machines) as well as capital carbon (chiefly the energy to produce steel and assemble the machines). In Scenario 1, the grid energy to power the station is Norwegian.
2. Transportation to North Carolina is assumed to be by bulk carrier (8000 km). If this transportation step is container ship, then project emissions will ~ triple (but will still be relatively small).
3. Like the quarry, the mill includes both operational carbon and capital carbon; the operational carbon is however grid power not diesel. The mill is assumed to be Norwegian here, but could be in North Carolina with little impact on the final project emissions.
4. Transport from port to near the field is assumed to be by rail (300 km). If this turns out to be by truck, project emissions would ~ double.
5. Application in the field is larger than either the quarry or the mill, but nonetheless represents only 0.2% of CDRgross.



The summary costs for these various stages are summarized below for Scenario 1:

Carbon Costs, kgCO2e		per tCO2e	per t Ore
Capital	Development	0.0	0.0
	Quarry Capex	0.0	0.0
	Mill Capex	0.0	0.0
Operational	Quarry Opex	0.5	0.4
	Transport Quarry to Mill	31.0	28.6
	Mill Opex	0.2	0.2
	Transport Mill to Field	12.3	11.3
	Land Application	1.8	1.6
	Total Carbon Cost	45.7	42.1
	As percentage of net CDR	4.9%	

Scenario 2 and 4 are similar to Scenario 1; Scenario 3 has very low emissions (<20 $kgCO_2/tCO_2e$). Transportation has the dominant impact on lifecycle emissions.

c. Please articulate and justify the boundary conditions you assumed above: why do your calculations and diagram include or exclude different components of your system?

<100 words

We included everything we could collect data on; because ERW is not currently an established agricultural practice, nearly all aspects are additional from a CDR perspective. We excluded the costs of equipment and infrastructure when ample capacity already exists, but included new requirements. Quarrying and milling equipment in Norway has already been purchased, but significant additional production necessitates new equipment. We excluded capital costs of transport, including rail, because excess capacity exists. Additionally, we excluded tree

removal because on ~century timescales, reforestation would occur. Other phenomena are excluded (e.g. winter heating of buildings) as requirements are uncertain and presumed small.

d. Please justify all numbers used in your diagram above. Are they solely modeled or have you measured them directly? Have they been independently measured? Your answers can include references to peer-reviewed publications, e.g. Climeworks LCA paper.

<200 words

The fuel usage for individual pieces of equipment come from Sherpa (https://www.costmine.com/), and these in turn come from the equipment manufacturers. Emissions factor for fuel comes from EPA. Electricity in different regions from CarbonFootprint (https://www.carbonfootprint.com/), which aggregates different country emissions factors. Vehicular emissions comes from DEFRA (https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021) which are assumed to apply globally. Sherpa (Stebbins and Leinart, 2011, SME Handbook) was used to model the quarry production itself; this model has been used by the DOE for modeling energy in the limestone and aggregate industries (https://www.energy.gov/sites/default/files/2013/11/f4/stone.pdf).

The emissions factors, and the benchmarking of the operation against comparables were reviewed by Pilio Ltd. The quarry and mill designs, including equipment sizing that influences emissions, were reviewed by Samuel Engineering.

e. If you can't provide sufficient detail above in 4(d), please point us to a third-party independent verification, or tell us what an independent verifier would measure about your process to validate the numbers you've provided. (We may request such an audit be performed.)

<100 words

Chiefly, the emissions are directly measurable by fuel and electricity consumption of the constituent activities. Failing this, equipment use can be assessed by time (hours per ton ore) and an emissions factor (kg CO_2 per hour) can be applied based on fractional usage (total hours) to compute project emissions (kg CO_2 per ton).

5. Learning Curve and Costs (Backward-looking) (Criteria #2 and #3)

We are interested in understanding the learning curve of different carbon removal technologies (i.e. the relationship between accumulated experience producing or deploying a technology, and technology costs). To this end, we are curious to know how much additional deployment Stripe's procurement of your solution would result in. (There are no right or wrong answers here. If your project is selected we may ask for more information related to this topic so we can better evaluate your progress.)

a. Please define and explain your unit of deployment. (*E.g.* # of plants, # of modules) *(50 words)*

<50 words Tons of ore is the basic unit driving production planning, unit economics, communications, and freight logistics. The ore's chemistry can be characterized by a conversion factor (units ore per unit CDR); because the value is near 1, a ton of ore is nearly a ton of CO2e for our feedstocks.

b. How many units have you deployed from the origin of your project up until today? Please fill out the table below, adding rows as needed. Ranges are acceptable if necessary.

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2021	1	$385 materials + $800 transport	0.923 tons CO_2	*<50 words* For R&D
2020	0			*<50 words*
2019	0			*<50 words*

c. Qualitatively, how and why have your deployment costs changed thus far? (*E.g. Our costs have been stable because we're still in the first cycle of deployment, our costs have increased due to an unexpected engineering challenge, our costs are falling because we're innovating next stage designs, or our costs are falling because with larger scale deployment the procurement cost of third party equipment is declining.*)

<50 wordsl Initial sourcing was low volume, and although transportation was freight class, it was considerable distance from the source that was initially quoted by the vendor. Future sourcing will be optimized around deployment locations to minimize transport. Regardless, we would expect order-of-magnitude increases in procurement volume to lower unit costs, even when sourced from the same vendor.

d. How many additional units would be deployed if Stripe bought your offer? The two numbers below should multiply to equal the first row in table 3(a).

# of units	Unit gross capacity (tCO_2/unit)
1083	0.923

6. Cost and Milestones (Forward-looking) (Criteria #2 and #3)

We ask these questions to get a better understanding of your growth trajectory and inflection points, there are no right or wrong answers. If we select you for purchase, we'll expect to work with you to understand your milestones and their verification in more depth.

a. What is your cost per ton CO_2 today?

\$/ton CO_2 \$1185/t Ore / 0.923 = \$1283/tCO_2

b. Help us understand, in broad strokes, what's included vs excluded in the cost in 6(a) above. We don't need a breakdown of each, but rather an understanding of what's "in" versus "out." Consider describing your CAPEX/OPEX blend, assumptions around energy costs, etc.

>100 words The cost in 6(a) includes the cost of the raw material (milled to a fine powder) and transported near to its destination. It does not include pelletization; transportation to the field site; custom land application; or verification (labor or analytical costs). Forward looking, the costs will closely echo the LCA above from a CAPEX and OPEX perspective, particularly as we seek to scale by ramping up production.

c. List and describe **up to three** key upcoming milestones, with the latest no further than Q2 2023, that you'll need to achieve in order to scale up the capacity of your approach.

Milestone #	Milestone description (100 words)	Why is this milestone important to your ability to scale? (200 words)	Target for achievement (eg Q4 2021)	How could we verify that you've achieved this milestone?
1	A product that works, with evidence. We define our products as CarbonLock, a	All strategic partnerships and investment will be contingent on having a product that is demonstrated to	Lab: Q4 2021 Greenhouse: Q1 2022 Field: Q1 2022	For CarbonLock, we anticipate a physical product that could be tested by a 3rd party; as well as

	physical product that is applied to agricultural fields to permanently remove CO_2, and CarbonBond, a service for verifying carbon removal from treated lands.	solve our customer's pain point 10x better than any alternative. This includes empirical demonstration of carbon removal and agronomic benefits in lab, greenhouse, and field settings; formulation and production process validation as an agricultural input; and rigorous verification using our patent-pending methodology.	Plus additional field trials in Q2-3 2022.	publication of quality data from experiments. For CarbonBond, we anticipate 3rd party validation of our verification service, an approved patent, and publications.
2	A validated financial model, showing profitability.	Investment will be contingent on a rigorous financial model, with all key assumptions validated and uncertainties quantified modeling the unit costs of the entire enterprise (including channel margins) and showing the potential returns to an equity or debt financing (or both).	Q1 2022	We would have a spreadsheet with citations for data sources, with a letter from an engineering firm outlining the results of their examination of the work.
3	Strategic partnerships and channel development.	The key benefit of this approach to CDR is to make use of existing agricultural infrastructure, which is optimized to bring 100s of millions of tons of materials to and from each farmed acre every year. For Eion to succeed, we will need to leverage	Q3 2022	We would have a letter of intent, a memorandum of understanding, or similar documentation with partners to commercialize the technology, including both production and distribution.

		that existing infrastructure by developing commercial relationships with existing entities in our target geographies.		

i. How do these milestones impact the total gross capacity of your system, if at all?

Milestone #	Anticipated total gross capacity prior to achieving milestone (ranges are acceptable)	Anticipated total gross capacity after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	1 t Ore	1 t Ore	We don't anticipate a capacity change from the R&D work.
2	1 t Ore	1 t Ore	We don't anticipate a capacity change from the financial modeling work, but we anticipate a capacity change following financing events.
3	1 t Ore	1000 - 100,000 t Ore	With strategic partnerships in place, we would dramatically increase our access to production facilities and raw materials, our capacity to transport materials, and relationships with landowners for field applications.

d. How do these milestones impact your costs, if at all?

Milestone #	Anticipated cost/ton prior to achieving milestone (ranges are acceptable)	Anticipated cost/ton after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	$1283/tCO_2$	$1283/tCO_2$	We don't anticipate a cost change from the R&D work

2	$1283/t$CO_2$	$1283/t$CO_2$	We don't anticipate a capacity change from the financial modeling work, but we anticipate volume discounted unit costs following a financing event.
3	$1283/t$CO_2$	$50-$100/tCO_2	At the anticipated production volume, unit costs should approach that of the crushed rock industry.

e. If you could ask one person in the world to do one thing to most enable your project to achieve its ultimate potential, who would you ask and what would you ask them to do?

I would ask Janet Yellen to provide guidance to the Treasury Department that ERW falls within the scope of 45Q.

f. Other than purchasing, what could Stripe do to help your project?

Guidance on a go-to-market approach in Europe, with its distinct set of policies, regulations, financial incentives, and corporate insetting opportunities.

7. Public Engagement and Environmental Justice (Criteria #7)

In alignment with Criteria 7, Stripe requires projects to consider and address potential social, political, and ecosystem risks associated with their deployments. Projects with effective public engagement tend to do the following:

- Identify key stakeholders in the area they'll be deploying
- Have some mechanism to engage and gather opinions from those stakeholders and take those opinions seriously, iterating the project as necessary.

The following questions are for us to help us gain an understanding of your public engagement strategy. There are no right or wrong answers, and we recognize that, for early projects, this work may not yet exist or may be quite nascent.

a. Who are your external stakeholders, where are they, and how did you identify them?

<100 words

Our stakeholders help us understand who benefits from carbon market revenue and address potential criticisms to the continually-refined growth strategy. At this initial stage, the quarry and mill are remote, and the anticipated offering can be fulfilled by deployment in one quarter section (<160ac) by one landowner, an informed crop-consultant. As we scale up, opportunities for workforce development and land loans could positively impact key issues in rural areas, including lack of access to land and job loss owing to automation. Other stakeholders include government entities (eg USDA NRCS), ag service providers, and local communities near future brownfield quarry development.

b. If applicable, how have you engaged with these stakeholders? Has this work been performed in-house, with external consultants, or with independent advisors?

<100 words

We have engaged with stakeholders extensively in-house, visiting potential areas in person and meeting landowners. We also use our large network of agricultural practitioners, business leaders, and academics to reach out to people where we don't have prior contacts. In particular, we engage with HBCUs, rural cultural institutions, community development finance institutions, and workforce development organizations in the communities where we are working. We collaborate directly with local communities to ensure our efforts improve local conditions and are socially just.

c. If applicable, what have you learned from these engagements? What modifications have you already made to your project based on this feedback, if any?

<100 words

The biggest lesson that we have learned is that a carbon market that only transfers money from entity A to entity B is a lost opportunity to direct the revenue stream in ways that simultaneously accomplish other pressing social and environmental issues. Rural areas face severe economic distress (including job loss, automation, lack of finance) that carbon markets can help alleviate. While our business is focused on carbon sequestration and verification, we actively look for scalable means of achieving social and environmental impact simultaneously with delivery of our core product.

d. Going forward, do you have changes planned that you have not yet implemented? How do you anticipate that your processes for (a) and (b) will change as you execute on the work described in this application?

<100 words

We have an immense backlog of potential environmental justice avenues to follow up on, translating ideas into concrete collaborations and programs. Executing on the present application would focus us geographically, which will reinforce and deepen our geographic focus, and allow us to make longer-term commitments to potential community partners.

e. What environmental justice concerns apply to your project, if any? How do you intend to consider or address them?

<100 words

ERW has two primary environmental justice concerns, which principally affect people in proximity to the project: heavy metal contamination and the growing footprint of mineral extraction. We meticulously quantified measured concentrations of heavy metals and potential application rates, and see little potential for harm presently. Many environmental justice concerns of consumer products, such as those related to mineral extraction, are displaced overseas (c.f. cobalt, lithium, nickel) where they impact poorer people and are less regulated. We are interested in increasing domestic production, to ensure that we bear the costs ourselves, to create good jobs domestically, and to recognize that aggregate quarrying is commonplace and relatively low impact.

11. Legal and Regulatory Compliance (Criteria #7)

a. What legal opinions, if any, have you received regarding deployment of your solution?

<100 words

We've not engaged counsel, nor received formal opinions. Nonetheless, we have discussed the potential 45Q application (both allowability and potential deal structure) with two law firms specializing in tax issues; discussed with permitting experts the risks a potential brownfield quarry development might face; and discussed with a law professor the environmental justice considerations of the project. We conclude that the procedures for applying under 45Q is not well established; the permitting requirements are particularly low for our potential project parameters; and that the environmental justice considerations are relatively benign, as they do not differ from other aggregate quarry considerations.

b. What permits or other forms of formal permission do you require, if any? Please clearly differentiate between what you have already obtained, what you are currently in the process of obtaining, and what you know you'll need to obtain in the future but have not yet begun the process to do so.

<100 words

We anticipate at some point we would need a permit for CarbonLock as a soil amendment, particularly in the EU, but at present ground natural mineral amendments are considered *de facto* OMRI approved. Some quarry development may have permitting requirements, but other quarries are already permitted for expansion and don't require additional permits. We've not begun seeking any particular permits as no current activities require any.

c. In what areas are you uncertain about the legal or regulatory frameworks you'll need to comply with? This could include anything from local governance to international treaties. For some types of projects, we recognize that clear regulatory guidance may not yet exist.

<100 words

We have adequate counsel for any potential regulations we'd need to comply with.

d. Does the project from which you are offering carbon removal receive credits from any government compliance programs? If so, which one(s)? (50 words)

<50 words No

12. Offer to Stripe

This table constitutes your offer to Stripe, and will form the basis of our expectations for contract discussions if you are selected for purchase.

	Offer to Stripe
Net carbon removal (metric tonnes CO_2)	1000 t CO_2
Delivery window (at what point should Stripe consider your contract complete?)	*Should match the first row in table 2(a), "Project duration"* Q4 2023
Price ($/metric tonne CO_2) ***Note on currencies:*** *while we welcome applicants from anywhere in the world, our purchases will be executed exclusively in USD ($). If your prices are typically denominated in another currency, please convert that to USD and let us know here.*	*This is the price per ton of your offer to us for the tonnage described above. Please quote us a price and describe any difference between this and the costs described in (6).* $500/t CO_2. This is approximately half the cost we presently face, and we hope to fit within this budget based on volume transactions with our vendors. In the event that a larger volume can be delivered to Stripe within the budget (e.g. if FCL delivery of material allows for a larger amount to be delivered for a set cost) then we could over-deliver on the contracted amount, lowering the effective price per ton.

Application Supplement: Surface Mineralization

(Only fill out this supplement if it applies to you)

Source Material and Physical Footprint (Criteria #1 and #8)

1. What source material are you using, and how do you procure it?

<100 words

We use olivine, based on its high mineral potential. 80% of the global olivine production originates from the Gusdal quarry in Norway. The quarry operator has an exclusive arrangement with an industrial mineral vendor serving the steel industry in the US. We obtain olivine from this vendor.

There is a small quarry in Whatcom County, WA that produces on-demand for a single customer. With prior arrangement, we can also source from this site.

We have done extensive chemical, physical, and mineralogical analyses of these sources and other sources at defunct brownfield sites that could be developed in the future.

2. Describe the ecological impacts of obtaining your source material. Is there an existing industry that co-produces the minerals required?

<100 words

Olivine is used by the steel industry as a refractory mineral for high temperature castings and blast furnace insulation. Blast furnace slag comes from smelting iron ore. Magnesium silicates also exist in tailings piles from nickel and cobalt production, but because these pose high risk for heavy metal contamination to agricultural land we avoid this feedstock.

The ecological impacts of olivine extraction are low; people even build homes on retired production pits. Olivine pits are alkaline, require no water, and generally sit above the water table. The carbon per unit ore is 4x greater than basalt and traprock, and thus the cash costs and lifecycle emissions are 25%. Olivine dust does not cause silicosis, unlike quartz dust, an alternative refractory material. Olivine quarries may release sediment into streams, but this is avoidable.

3. Do you process that source mineral in any way (e.g grinding to increase surface area)? What inputs does this processing require (e.g. water, energy)? You should have already included their associated carbon intensities in your LCA in Section 6.)

<200 words

Current raw olivine product offerings available include a product with modal particle size of 1865uM and 0.55m2/g surface area, and a more scarce product with modal particle size of 9um and 6.5 m2/g surface area. We base our work on the more abundant, coarser product, based on several factors: slower reactivity that is less likely to impact crop cation uptake; lower grinding energy requirements; higher commercial availability; and less human health risk (i.e. OSHA PM10/PM2.5 concerns). While we don't grind these materials ourselves, we view dust concerns seriously: dust collection at the mill is essential, as is direct flow of the material from the grinder to the pelletizer. Pelletizing is common in soil amendment production, as it facilitates transport and reduces potential dust and drift. We have an active R&D effort with one pelletizer, and are beginning work with two other potential vendors. Wet milling is another option, which reduces energy in the grinding stage, but it introduces a process water requirement and an energy-expensive dehydration step. On balance we prefer the dry processes.

4. Please fill out the table below regarding your project's physical footprint. If you don't know (e.g. you procure your source material from a mining company who doesn't communicate their physical footprint), indicate that in the square.

	Land area (km^2) in 2021	**Competing/existing project area use (if applicable)**
Source material mining	The quarry in Norway is 65 ha; the quarry in WA is 5 ha. The footprint for this project would be on the order of 300 cubic meters, or 0.01ha (3m x 1m x 100m)	Generally olivine mines are in montane areas surrounded by forest; horizontal expansion would cut into the forest.
Source material processing	A mill and pelletizer at this scale might have a footprint of 1 ha.	Most likely any additional footprint we would have would be within the footprint of an existing crushed rock facility.
Deployment	We estimate above ~160ha (calculation above)	This land would remain agricultural.

1. Imagine, hypothetically, that you've scaled up and are sequestering 100Mt of CO_2/yr. Please project your footprint at that scale (we recognize this has significant uncertainty, feel free to provide ranges and a brief description).

	Projected # of km^2 enabling 100Mt/yr	**Projected competing project area use (if applicable)**

Source material mining	*Current global production of 2 Mt of olivine has a footprint of approx 65 ha; 50 times this amount is 650ha. Note that not all expansion is horizontal, much expansion is vertical.*	Generally olivine mines are in montane areas surrounded by forest; horizontal expansion would cut into the forest.
Source material processing	This would have a footprint that resembled a large number of cement plants in the US.	Competing use depends on location. It could be an urban brownfield.
Deployment	*100Mt / 8t/ha = 12.5M ha or 30M ac. For reference, US corn production is on 90M ac.*	This land would remain agricultural.

5. If you weren't proceeding with this project, what's the alternative use(s) of your source material? What factors would determine this outcome? *(E.g. Alternative uses for olivine include X & Y. It's not clear how X & Y would compete for the olivine we use. OR Olivine would not have been mined but for our project.)*

<50 words Olivine is used as refractory materials and steel castings, but the projected market for olivine is shrinking. If we were not to use it, it would remain in situ. If we scaled dramatically and became a major olivine consumer, then this would necessarily entail proportionate extraction.

Measurement and Verification (Criteria #4 and #5)

6. We are aware that the current state of the field may include unknowns about the kinetics of your material. Describe how these unknowns create uncertainties regarding your carbon removal and material, and what you wish you knew.

<200 words The current literature (e.g. Oelkers et al. 2018) reports a consensus of ~100 days' weathering rate at our target soil pH of 5.5 and observed feedstock surface area, with higher rates at lower pH values. We intend to accelerate the process by dropping the pH to ~3.5-4.0 at the local chemical lattice sites of the rock material via mixed incorporations of protonated, dried bio-polymers in the ground rock pellets. When exposed to soil pore water moisture and rainfall, the pre-protonated alginate, cellulose, and fungi binders used in our pelletized rock can induce local proton attack on the rock particle lattice, which would accelerate the weathering process below 100 days, while not significantly altering the bulk soil pH. Although current experimentation is underway to determine the exact kinetic enhancement, in this report, we present the literature-supported reference of ~100 days' weathering rate when

applying our 100 micron-sized rock material to the acidic North Carolina agricultural soil. *References:* Eric H. Oelkers, Julien Declercq, Giuseppe D. Saldi, Sigurdur R. Gislason, Jacques Schott, Olivine dissolution rates: A critical review, Chemical Geology, Volume 500, 2018, Pages 1-19, ISSN 0009-2541, https://doi.org/10.1016/j.chemgeo.2018.10.008)

7. If your materials are deployed extensively, what measurement approaches will be used to monitor weathering rates across different environments? What modelling approaches will be used, and what data do these models require?

<100 words Eion has developed a patent-pending monitoring, reporting, and verification strategy ("CarbonBond") to accompany the pelletized soil amendment ("CarbonLock"). We use rare earth elements and mineralogical compositions of aluminosilicates and iron oxides as unique tracers in our source materials rock for fraud prevention, which third-party verifiers can implement to ensure the applied rock is the claimed source material. Next, we implement a rare earth element-based measurement scheme whereby a soil sample is collected and used to estimate Mg and HCO_3 leaching below the vadose zone. We supplement our analyses with one-dimensional reactive transport models that build upon Beerling et al. 2021, with the novel addition of calibrated rare earth exchange coefficients.

Human and Ecosystem Impacts, Toxicity Risk (Criteria #7)

8. What are the estimated environmental release rates of heavy metals (e.g. Cr, Ni, Pb, Hg)? Dust aerosol hazards? P loading to streams? How will this be monitored?

<100 words

Consider an experiment where 1cm depth of our proposed feedstock is added, over time, to a soil. The proposed feedstock has 1650ppm Cr, and a bulk density of 3.5g/cm^3. This 1cm depth addition has a mass of 35,000g/m^2 (~350t/ha, an extreme case). At the measured concentration, 57g Cr has been added to 1m^2. Consider a root volume of 1m depth, and a soil bulk density of 1.1 Mg/m^3. The Cr has a concentration in this volume of 51g/Mg or 51ug/g. Cr is considered toxic in the range of 5-100 mg Cr/g soil. The added rock is 0.051mg/5g, or 1/100 the toxicity threshold. Note that while basalt has ~¼ the Cr concentration, it also has ¼ the CDR removal potential, so the potential toxicity is the same, but at the cost of considerably larger process carbon costs. Dust is addressed by pelletization; P in our feedstock is trivial. The same chemistry to verify carbon removal would safeguard metal buildup in soils.

9. If minerals are deployed in farmland, what are the estimated effects on crop yields, what's this estimation based on, and how will actual effects be monitored?

<100 words

The UIUC Energy Farm has a basalt experiment from 2017 onwards that shows yield improvements of 10% in soy and 15% in maize, which are not readily explained based on P and K in the feedstock. Because positive yield impacts are central to introducing this amendment at scale, we have a number of research trials being established to develop this body of evidence further. Currently we have a greenhouse trial at Rutgers using acidic soils from our target application site, investigating the impact on silicic acid on disease resistance in multiple crops. We also have southern winter field trials and upper midwest summer trials planned as well.

10. How will you monitor potential impacts on organisms in your deployment environment? (E.g. Health of humans working in agricultural contexts, health of intertidal species, etc. depending on the context of deployment)

<100 words

We have a soil genomics study underway at Rutgers to monitor impacts on soil biota; such work has never been conducted so far as we know. As far as human health concerns, similar precautions would apply to any soil amendment, such as aglime. Historically, industry has favored olivine over quartz as an industrial mineral because it does not cause silicosis.

11. If you detect negative impacts, at what point would you choose to abort the project and how?

<100 words

Eion's mission is to remove carbon permanently and at scale, with rigorous scientific verification, while providing economic and environmental benefits in rural areas. Such a mission is made possible only through planning for potential hazards, safe practices and proper execution. The detection of negative impacts -- ranging from environmental to human-health harm -- will be addressed immediately and the operation at the source of negative impact will be placed on hold until the problem can be addressed. If a negative impact cannot be mitigated while continuing the project, we will notify Stripe and abort the project.