stripe

Carbon Neutral Initiative

Carbon Removal Purchase Application

Applicant Instructions

Please read the following information carefully and in full before beginning your application. If you have any questions as you work through, please book time with the Stripe team here and provide context on your questions in the booking request.

Hi there,

Thank you so much for your work on carbon removal, and thank you in advance for taking the time to apply for Stripe's purchase. This document serves as your application for Stripe's Spring 2022 Carbon Removal Purchase cycle. For your reference, all previously submitted applications are available here.

Timeline

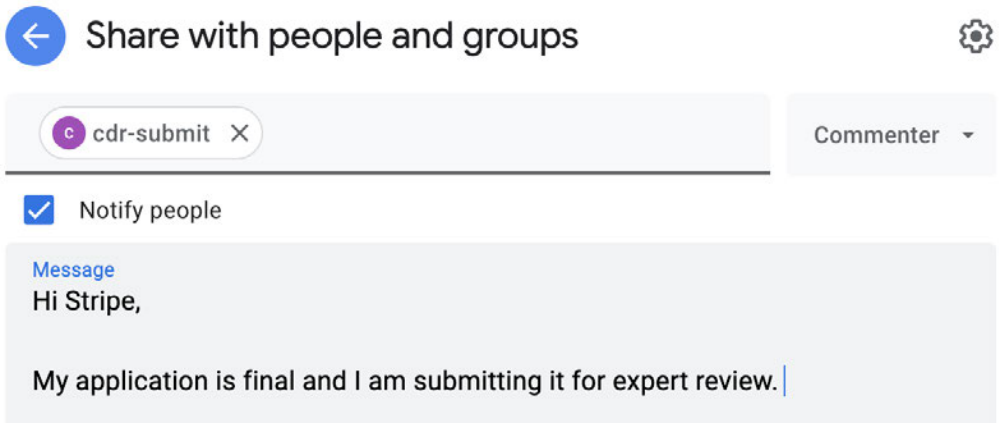
- **Friday, April 1st, 5pm PT:** This application is due. You are welcome and encouraged to submit early.
- **Mid April:** Stripe and Stripe's scientific expert reviewers will assess your application against our target criteria and hold a project interview with each team. We may also contact you during this period with clarifying questions or requests from our expert reviewers for more information regarding your application. Please respond promptly to these requests if you receive them to help enable a swift and fair review process.
- **Mid May:** Stripe notifies selected projects and jointly builds formal purchase contracts.
- **May/June:** Purchases announced, full content of all project applications made public.

How to apply

- **Step 1: Determine which category supplements apply to your project**
    - This document includes the General Application as well as all category supplements. All applicants should fill out the General Application, as well as whichever (typically 1 - 2) supplements that apply to their approach.

- You should fill out applicable supplements IN ADDITION to the General Application.
- Using examples from Stripe's existing portfolio:
  - Sustaera would fill out the DAC supplement AND the Geologic Injection supplement.
  - Eion Carbon would fill out the Surface Mineralization supplement
  - Running Tide would fill out the Biomass supplement AND the Ocean supplement.
  - CarbonBuilt would fill out the CO_2 Utilization supplement.
- It should be clear which supplements apply to your project, but if not, tag us in a comment or email cdr-apply@stripe.com and we can help clarify.

- **Step 2: Delete the supplements that don't apply to you.**
  - Resulting in a document with the General Application and your applicable supplements only.
- **Step 3: Fill out the application in the document itself!**
  - If you have any questions, or are confused by a question, tag cdr-apply@stripe.com inline and we'll do our best to assist. Please tag us as early in the application process as possible.
- **Step 5: TO SUBMIT YOUR APPLICATION, "Share" it in Google Docs with cdr-submit@stripe.com.**
  - Please delete this "Project Instructions" section prior to submitting.
  - Please give us "Commenter" permissions.
  - Please check the "Notify people" box.
  - Please enter a message making clear that your application is complete.



- **Your submission constitutes your consent for Stripe to make your full application and all of its content available publicly under a CC-0 "Public Domain" License, regardless of whether or not Stripe selects you for purchase.** For more details, see "Why we make applications public".

What we're looking for

Please refer to Stripe's carbon removal target criteria for a characterization of projects Stripe is excited to support. For clarity, we've slightly modified these criteria since our purchasing start in 2020, but their spirit remains the same. Our 2022 criteria are:

1. **Physical footprint**: Takes advantage of carbon sinks less constrained by arable land
2. **Capacity**: Has a path to being a meaningful part of the carbon removal solution portfolio (>0.5Gt CO_2/yr by 2040)
3. **Cost**: Has a path to being affordable at scale (<$100/ton by 2040)
4. **Durability**: Stores carbon permanently (>1,000 years)
5. **Verifiability**: Uses scientifically rigorous and transparent methods for monitoring and verification
6. **Additionality**: Results in net new carbon being removed rather than taking credit for removal that would have occurred regardless
7. **Public engagement and legal compliance**: Legally compliant, responsibly and actively engaging with the public to determine and mitigate possible risks and negative externalities
8. **Net-negative lifecycle**: Results in a net reduction in atmospheric CO_2

This application is meant to solicit high quality information such that we can evaluate you against the above criteria. There's no rubric that will give you points for specific answers. Instead, we are seeking to build a comprehensive understanding of your carbon removal solution. We value clear and accurate information over romanticization, and welcome citations and links to real data where appropriate.

Please be aware that your application and all content you provide here will be made public at the conclusion of Stripe's purchase cycle, to support transparency and knowledge-sharing in the field.

Why we make all applications public

Commercial-scale permanent carbon removal is a nascent field. We've developed this application and our overall purchase philosophy with the goal of advancing transparency and knowledge-sharing across the field, hopefully enabling impact beyond the dollar amount of any particular purchase we may make.

All applications to our earlier purchase cycles were made public, and can be accessed here. We're grateful to all our projects for providing this level of transparency. Making applications public enables derivative academic works and independent analysis from nonprofits like CarbonPlan (example here, here), and we've heard from a wide range of investors, engineers, and scientists that the corpus of applications is a valuable source of data on the current state of the field and opportunities for advancement.

For these reasons, we're again making applications from this purchase cycle public.

SPRING 2022 UPDATE: That said, we've heard feedback over the past year from the founder community that this level of transparency is tough, particularly for companies in stealth or in the process of patent filing. **We hear you and are making an adjustment this cycle.** The application should still serve as a comprehensive, standalone representation of the merits of what you're building, but we will allow for selective sharing of sensitive data directly with our expert review team through email exchange or the team interview outside of the public application. Please email the Stripe team at cdr-apply@stripe.com to identify and discuss any proposed public omissions.

We thank you not only for applying to our purchase, but for providing this valuable contribution to the field's collective knowledge via your public application.

Fine print

We intend to make the selection process as informal as possible. However, we do expect that (a) the content of your application is, to the best of your knowledge, complete and correct; (b) you do not include any content in your application that breaches any third party's rights, or discloses any third party's confidential information; (c) you understand that we will publicly publish your application, in full,

at the conclusion of the selection process. You also understand that Stripe is not obliged to explain how it decided to fund the projects that are ultimately funded, and - although extremely unlikely - it is possible that Stripe may decide to not proceed, or only partially proceed, with the carbon removal purchase project. Finally, if you are selected as a recipient for funding, Stripe will not be under any obligation to provide you with funding until such time as you and Stripe sign a formal written agreement containing the funding commitment.

General Application

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

Company or organization name

Carbon Neutral Initiative

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

Rotterdam, The Netherlands

Name of person filling out this application

Peter-Paul Laarhuis

Email address of person filling out this application

[redacted]

Brief company or organization description

Carbon Neutral Initiative removes CO_2 by means of enhanced weathering.

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 and system schematics.

In order to achieve the goals of the Paris Agreement, we do not only need to reduce CO_2 emissions, but also start now to remove CO_2 from the atmosphere. We will not achieve the targets by simply reducing emissions. According to the IPCC, by 2050 we must remove 10 gigatons of CO_2 from the atmosphere every year. An enormous task, but also one that has now been endorsed by the European Commission.

CO_2 removal with enhanced weathering

Enhanced weathering is one of the most promising solutions to permanently remove CO_2 from the atmosphere. It is a natural process that has been taking place for billions of years, in which minerals react with water and CO_2. For example, olivine is converted to magnesium carbonate and silica in solution. One ton of olivine potentially binds 1.25 tonnes of CO_2. Nature has been

removing CO_2 in this way for billions of years. Carbon Neutral Initiative (CNI) chooses to accelerate this weathering process ("enhanced weathering") by grinding minerals and spreading it in the right locations. This means that the entire process can be completed within 10 years.

Besides the removal of CO_2, an equally important goal is to conduct scientific research into enhanced weathering. Our scientific partner 'The Dutch Institute for Applied Scientific Research' (TNO) will conduct research into the weathering rate of olivine. In this way, in addition to the removal of CO_2, valuable knowledge is also gained that will help (CNI) and other initiatives in tackling climate change.

Project Guyana

As stated our project in Guyana is not only important for removing CO_2 from the atmosphere but also for research purposes, particularly into the weathering rate.

Prof. dr. Griffioen and Ir. Dijkstra (TNO) have extensive knowledge in this area. In consultation with them, we apply the olivine and basalt in an optimal way. They also conduct research into the speed of weathering. If we can improve the prediction of the weathering speed, we can finance these types of projects more easily – and cheaper. And that helps enormously to achieve the 10 gigatons removal!

We have been allocated 9 hectares of land on Canal #1, Georgetown, Guyana. This assigned land is part of a 100 hectare plot. After evaluation CNI may use the remaining 90 hectares of land as well.

Guyana basalt and gabbro

We source basalt from mines in Suriname and Guyana. Our preference goes to some mines in Guyana where basalt dust is qualified as waste, meaning that we do not have to emit additional CO_2 to mine, crush and grind the minerals. At this stage, it is not entirely clear whether this source is sufficient for our project. We might need to add some basalt that is not waste material. Both sources are within 200 km of our location, reducing emittance of CO_2 by as a result of transport as well.

How do we apply the minerals?

By grinding or milling basalt into small particles, we accelerate the weathering of the mineral. The milled basalt (between 20 and 30 microns) is mixed with the top 30 centimeters of the soil. By tractor the gabbro/basalt will be scattered on the field, and by plow it will be mixed with the top 30 centimeters. The appliance and mixing of the basalt with the soil will be done by local farmers. 6 Weeks later the landowners can re-use their land again.

To protect CNI's interests, we have drawn up a contract with the land owner.

This includes various conditions:

- *CNI may use the land for a period of 10 years by paying a one-time fee.*
- *The Carbon Neutral Initiative becomes the owner of the generated carbon credits.*
- *The land can be re-used after 6 weeks. Nevertheless, the top layer of soil with the*

applied minerals may not be removed nor be covered.

- Periodically, the adherence to the terms of the contract will be executed by Buro Cite.

How do we deal with risks?

Spreading basalt is generally beneficial to plant growth. However, the appliance of basalt cannot be unlimited. It contains small amounts of nickel. An excess of nickel in the soil can be detrimental to ecosystems. The Dutch National Institute for Public Health and the Environment (RIVM) has extensively investigated the effects of nickel in the soil on soil organisms (184 test results spread over 43 different types of organisms and soil processes) and determined risk values. We choose to stay within these values with a safety margin.

A soil analysis on actual nickel contents among other purposes will be conducted beforehand. Based on this analysis the amount of minerals that can be safely applied can be calculated.

Monitoring and research

TNO will monitor the weathering by means of lysimeters, where based on the change in pH-value of water, the change in magnesium bicarbonates and nickel the amount of carbon removal can be deducted. Moreover, risks (such as nickel precipitation) can be monitored.

Transport of the minerals

A local transport company will facilitate the transport from the mining site to Georgetown. This will be done in truckloads of 26 tons per truck. CNI has scheduled 20 working days to transport the total of 1731 MT.

In total an amount of 1.125 MT of carbon dioxide will be removed. Nevertheless, conducting the project will result in CO_2 emissions of 61 tonnes (Project and research travel and mining, crushing, grinding, applying and transporting the minerals). As a result, net carbon removal of the project amounts to 1.064 MT.

Co-benefits

CNI sources the minerals locally, pays landowners for the use of their land and use local entrepreneurs for, among other things, the appliance and transport of the minerals. 65% of the revenue from the Carbon Credits generated by the project remains within the local economy. Besides removing CO_2, our projects contribute to the local economy and deliver a huge contribution to the development of the CDR market.

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.)

- CNI, project owner and initiator

- TNO, scientific partner

- Marc Lucas, Paul Cheong chairman of the Private Sector Commission of Guyana

- Local transport company: to be determined

- Local workforce to apply the minerals

- Danley Major - Quarry Guyana

- Government in Guyana

- Puro, gateway to carbon credit buyers

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

Main risk: basalt contains small concentrations of nickel and chromium. Therefore, depending on the soil, there is a maximum of basalt you can scatter without harming the ecosystem.

Risk mitigation 1: we apply the minerals according to the recommendations of the RIVM, the Dutch National Institute for Public Health and the Environment. These will be applied in all countries, although there might not be any legislation in place.

Risk 2: After applying the minerals, the land can be reused for forestation, agriculture or solar panel use. However, it should not be covered, for instance by concrete. If it is, the weathering speed is slowed tremendously.

Risk mitigation 2: a contract is drawn up with the land owners to ensure an optimal weathering speed.

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

Not applicable

e. Who's the team working on this? What's your team's unfair advantage in building this solution? What skills do you not yet have on the team today that you are most urgently looking to recruit?

Founder Robert van der Luijt. Entrepreneur with a background in real estate and in the last three years as a commodity trader in low income countries. As a result he has ample

experience getting things done in Africa and Latin America.

Founder Peter-Paul Laarhuis. Entrepreneur with a background as an economist of low income countries. He has been working as a consultant and as an entrepreneur, the latter in innovative spaces such as Telecom and Health & ICT, two times resulting in the winning of the FD Awards.

Rana Vinita. Known for her publication on enhanced weathering "The potential and environmental impacts of enhanced olivine weathering as negative CO2 emission technology in Europe", she joined CNI in March.

Scientific partner TNO has been involved with CNI since the start providing information on the weathering speed, the best way of applying minerals considering the corresponding risks. They will contribute by monitoring the CO_2 removal of our projects.

TNO. Prof. dr. Jasper Griffioen is professor on water quality management at the University Utrecht. Furthermore, he is an expert researcher at TNO Geological Survey and has published on the weathering of olivine.

Dr. Joris Dijkstra is Environmental Geochemist at TNO Geological Survey. His expertise on soil chemistry and soil composition helps the initiative enormously. He is providing scientific support for the development of (inter-)national environment policies.

Martijn Schaap is project engineer. Martijn helps preparing projects in Suriname en Guyana, varying from sourcing land and minerals to preparing an enhanced weathering project.

Edwin Meijer is entrepreneur and feels obligated to combating climate change. Edwin advises us on the development of CNI and takes the lead at the Xprize.

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 2022 - Jun 2023. The end of this duration determines when Stripe will consider renewing our contract with you based on performance.*	*After approval 3 months to have applied the minerals on the land.*
When does carbon removal occur? *We recognize that some solutions deliver*	*After appliance of minerals, carbon removal starts almost immediately. It*

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 2022 - Jun 2023 OR 100 years.*	*takes 5 years to sequester 87% of the total potential of CO2, 9 years to sequester 100%. This is based on Rimstidt et al. (2012).*
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".*	*Net carbon removal:* *Year1: 243 MT* *Year2: 244 MT* *Year3: 190 MT* *Year4: 143 MT* *Year5: 102 MT* *Year6: 69 MT* *Year7: 42 MT* *Year8: 21 MT* *Year9: 8 MT* *Year10: 1 MT*
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.*	*Up to an order of thousands to millions of years.*

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

100% upper and lower bound

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.)*

Scientific studies show that mineralization is permanent by nature. The products of silicate weathering are thought to be sequestered for thousands to millions of years in the ocean as ocean alkalinity, or furthermore, as limestones (Schuiling & Krijgsman, 2006; Hartmann et al., 2013; Fuss et al., 2018). The uncertainty, however, will lie in determining the accurate or ideal weathering rate. The model used to determine the weathering rate is a regression model of experimental results by Rimstidt et al. (2012). Rather than using a steady-state weathering, we reflect the dissolution rate using a shrinking core model of Koornneef (working paper, n.d.) to include all sorts of factors that might affect the weathering rate on site. We will also have additional field experiments to validate the assumptions used on our model according to the site's condition.

Papers:
Schuiling, R. D., & Krijgsman, P. (2006). Enhanced weathering: An effective and cheap tool to sequester CO 2. Climatic Change, 74(1–3), 349–354.

Hartmann, J., West, A. J., Renforth, P., Köhler, P., De La Rocha, C. L., Wolf-Gladrow, D. A., Dürr, H. H., & Scheffran, J. (2013). Enhanced chemical weathering as a geoengineering strategy to reduce atmospheric carbon dioxide, supply nutrients, and mitigate ocean acidification. Reviews of Geophysics.

Fuss, S., Lamb, W. F., Callaghan, M. W., Hilaire, J., Creutzig, F., Amann, T., Beringer, T., De Oliveira Garcia, W., Hartmann, J., Khanna, T., Luderer, G., Nemet, G. F., Rogelj, J., Smith, P., Vicente, J. V., Wilcox, J., Del Mar Zamora Dominguez, M., & Minx, J. C. (2018). Negative emissions - Part 2: Costs, potentials and side effects. Environmental Research Letters, 13(6).

Rimstidt, J. D., Brantley, S. L., & Olsen, A. A. (2012). Systematic review of forsterite dissolution rate data. Geochimica et Cosmochimica Acta, 99, 159–178.

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?

The only possibility that CO2 is being released again is that the bicarbonates are exposed to an environment with an abnormal pH-value, that can only be created artificially. This is not the case under normal circumstances and not the case in our locations. As we are doing soil analysis, including pH-value, before starting a project, this risk cannot materialize.

Therefore, the only potential loss of carbon sequestration, due to the fundamental uncertainty of weathering rate, would be if there are environmental factors that limit the weathering rate.

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.)*

As there is still limited knowledge or large-scale application on this, we will rely on literature

and the theoretical stoichiometry of these silicate minerals which consumes CO2 to form carbonate and bicarbonate ions. As mentioned, we also have additional field experiments to validate the models used to determine the path of weathering rate.

From literature, it is known that the bicarbonate and carbonate ions are released to groundwater and are transported via rivers to the ocean after weathering (Hartmann et al., 2013). We see that this durability can also be estimated by measuring the products of olivine dissolution such as alkalinity, dissolved silicate, or dissolved inorganic carbon by sampling the soils from time to time.

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	*1125 tCO_2*
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	*Not applicable*

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)*

Based on the typical olivine content in basalt (~40%) and application rate of 100 ton/ha, to reach a complete dissolution within the 10 years of the project, we expect that the particles should be grinded to 20-30 μm. From the weathering rate model, the cumulative amount of olivine weathered is calculated and converted into tonnes of CO2 using the stoichiometry of a typical Mg-silicate found in basalt, which translates to 0.65 t CO2 / t basalt.

These estimated amounts depend on how the environmental factors affect the weathering process. As the soil pH is 5.5, initially the weathering is less efficient than in soils of higher pH. There would also be some interaction with microorganisms that shift the soil pH, and could either accelerate or even limit the weathering process. However, we have tried to best approximate the weathering rate by considering pH, temperature, surface area, and solubility in rainfall.

So, we have 9 hectare where we apply 192 tonnes per hectare, totalling 1.732 tonnes of basalt. So, gross carbon removal amounts to 1.125 tonnes. Total emissions amount to 61 tonnes, leaving 1.064 tonnes of carbon removed.

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).

Currently, when no rocks are sourced, it is negligible as carbon removal will happen almost immediately upon spreading the finely-grinded particles on the site. We will aim to source rocks that contain ~40% olivine and this could translate to ~0.65 ton CO2 / t basalt based on Mg-content of olivine in the basalt.

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.)*

To determine the particle size suited for a 10-year complete dissolution, a shrinking core model (Koornneef, working paper, n.d.; Renforth et al., 2012) and a dissolution regression equation (Rimstidt et al., 2012) in acidic soils were used.

As for the estimated olivine contents/type of rocks used, we use a geological/spatial map to determine where to source the rocks.

The potential carbon sequestration was also calculated according to the stoichiometric

reaction of Mg-olivine with CO2 to form carbonate and bicarbonate ions (Rimstidt et al., 2012).

To estimate a safe application rate, the possibility of Nickel release (as potentially harmful trace elements) can also be predicted by calculating the distribution coefficient of nickel over time in the soil (Sheppard et al., 2009) and compare it to the values allowable by RIVM.

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.

Letter of Intent TNO:

https://carbon-neutral-initiative.com/wp-content/uploads/2022/04/SV-036085-02me-LoI_CNI_ESW_okt2021_docx-1.pdf

Survey RIVM about maximum permissible risk levels of nickel:

https://carbon-neutral-initiative.com/wp-content/uploads/2022/04/RIVM-studie-2015-0137-1.pdf

Report about the potential of enhanced weathering by Rana Vinita:

https://carbon-neutral-initiative.com/wp-content/uploads/2022/04/R11948-MSc-Thesis-Rana-Vinita-TNO-format-2.pdf

Setup of measurement:

https://carbon-neutral-initiative.com/wp-content/uploads/2022/04/Lysimeters.pdf

Pitch deck:

https://carbon-neutral-initiative.com/wp-content/uploads/2022/04/Overview-Stripe-20220410-v1.pdf

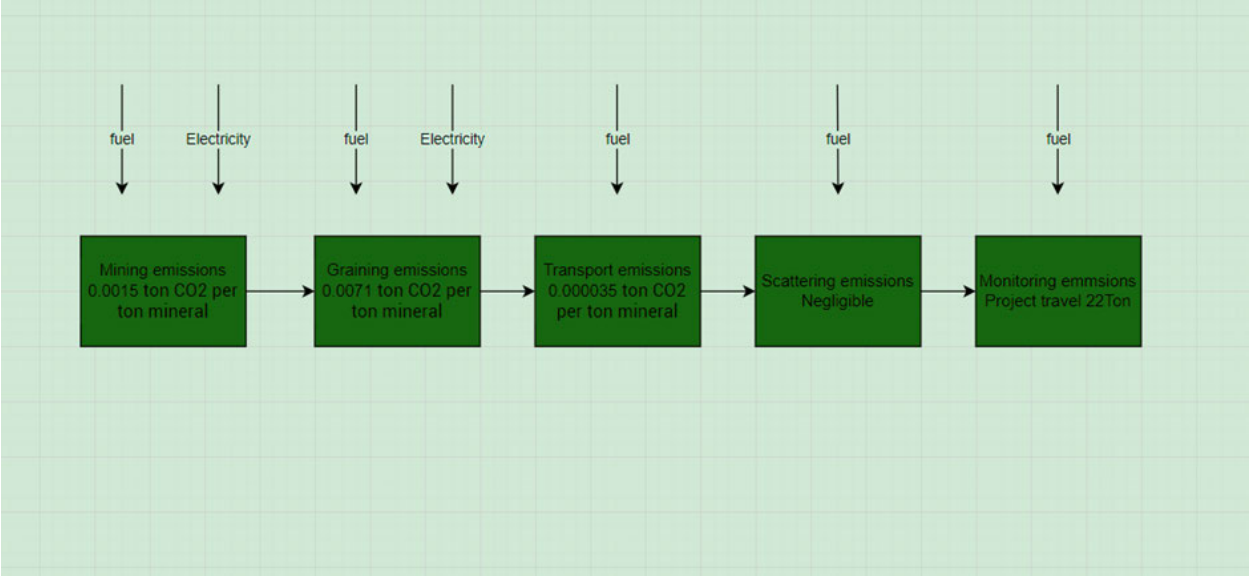
4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

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	*1125 tCO_2*

Gross project emissions	*61 tCO_2*
Emissions / removal ratio	*61/1125=5,4% emissions/removal rate for this project.*
Net carbon removal	*1064 tCO_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 2020 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.



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?

n.a.

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.

Mining: Scientific study Hangx, Spiers 2009
Crushing and grinding: Scientific study Hangx, Spiers 2009
Transport by truck: https://www.co2emissiefactoren.nl (Tank-To-Wheel values)
Flight costs research and project management: https://www.co2emissiefactoren.nl (Tank-To-Wheel values)
Applying minerals: negligible: TNO report 2020 R11948

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.

n.a.

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 progress.)

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

This will be the first unit of deployment. Therefore, Stripe's contribution enables us to show the potential of enhanced weathering in general and our method in particular.

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.

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2022	0			*<50 words*
2021	0			*<50 words*

2020	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.*)

There is no earlier deployment and therefore no earlier deployment costs. Nevertheless, the choice for countries such as Guyana and Suriname for our projects is due to their ideal circumstances, i.e. humid and warm conditions, that are beneficial for the weathering speed, reducing costs. Lower costs can be achieved as well by sourcing land with optimal enhanced weathering features and minerals with relative high carbon removal potential.

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)
0	*# tCO_2/unit*

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

We are open to purchasing high cost carbon removal today with the expectation the cost per ton will rapidly decline over time. We ask these questions to get a better understanding of your potential growth and the inflection points that shape your cost trajectory. There are no right or wrong answers, but we would prefer high and conservative estimates to low and optimistic. If we select you for purchase, we'll expect to work with you to understand your milestones and their verification in more depth. If you have any reservations sharing the information below in the public application format, please contact the Stripe team.

a. What is your cost per ton of CO_2 today?

$183/ton CO_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, non-levelized CAPEX costs, assumptions around energy costs, etc.

Cost components:

- *Minerals*
- *Transport of minerals*
- *Appliance of minerals*
- *Land lease*
- *Scientific support (TNO)*
- *Local research and support*
- *Project costs*

It would be great if we get the project funded by Stripe. Otherwise, we should include costs of finance. These might be considerable as the majority of costs of any enhanced weathering project is at the start. That is exactly why attach so much value to the research about the weathering speed. The faster the weathering rate, the lower the costs of finance, the better the prospects for enhanced weathering to fulfill a crucial role in the challenge of removing 10 Gigaton of CO_2 annually.

c. How do you expect your costs to decline over time? Specifically, what do you estimate your cost range will be as you reach megaton and then gigaton scale? We recognize that at this point, these are speculative and directional estimates, but we would like to understand the shape of your costs over time.

The project proposed for Stripe is a relatively small project utilising 9 hectares of land. At the current location, we have permittance to use an additional 90 hectares. Scaling up to this size brings costs down considerably ($78/ton CO_2 excluding, and $88/ton CO_2 including costs of finance). This is primarily a result of a better negotiating position and fixed project costs divided over more tCO_2.

When scaling up to Mtonnes and Gtonnes of tCO_2, costs come down more as the projects become more predictable. This will lower especially finance costs and we believe that costs of $ 50 per tCO_2 can be achieved in ideal circumstances, although new challenges arise, such as for instance land and minerals becoming scarcer on certain locations, resulting in upward price pressure.

d. Where are the primary areas you expect to be able to achieve cost declines? E.g., what are the primary assumptions and sensitivities driving your cost projection? What would need to be true for a long-term cost of <$100/ton to be achievable with your technology? (i.e., you are able to negotiate an x% reduction in CAPEX at scale and purchase renewable electricity at $y/kWh)

Our main components are minerals and the transport of minerals. We have received quotations for these costs. Furthermore, for our proposed project we have a relatively large share of project costs. Here again, we have received quotations. Furthermore, we have Martijn Schaap, representing us in Suriname and Guyana, assuring the project goes according to plan. Unexpected events may occur, but we have included a 10% post unforeseen in our project.

There is some uncertainty regarding the potential gross carbon removal potential of the minerals. Nevertheless, we can determine the theoretical potential based on a chemical analysis. However, there might be unknown circumstances on the site resulting in a lower gross carbon removal capacity which would cause a higher price per removed tCO_2.

Furthermore, monitoring the weathering rate will help us identify ideal circumstances for enhanced weathering.

When scaling to Mton and Gton scale, the main assumptions of our cost estimation are:

- *Getting access to minerals with higher carbon removal capacity*
- *Getting access to land with conditions ideal for the weathering process*
- *Results of our projects become predictable, resulting in lower costs of finance.*

In other words, we expect to be using less land, minerals and time for our projects, resulting in lower costs.

e. In a worst case scenario, what would your range of cost per ton be? We've been doing a lot of purchasing over the past few years and have started to see a few pieces that have tripped people up in achieving their projected cost reductions: owned vs leased land, renewable electricity cost, higher vendor equipment costs, deployment site adjustments, technical performance optimization, supporting plant infrastructure, construction overruns, etc. As a result, we'll likely push on the achievability of the cost declines you've identified to understand your assumptions and how you've considered ancillary costs. We would love to see your team kick the tires here, too.

<300 words

The main determinants of the costs for enhanced weathering are the minerals and the transport costs, especially when you scale up.

The higher the carbon removal capacity of minerals, the less minerals need to be purchased to remove 1 tCO_2. The lower the amount of minerals that need to be transported, which is a second significant cost item. Finally, the lower the distance between the mining site and the project site, the lower the transport costs are.

These key determinants can all be checked beforehand (carbon removal capacity by a chemical composition analysis). Based on these facts we can do a cost-benefits analysis for each project.

f. 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	Why is this milestone important to your ability to scale?	Target for achievement (eg Q4 2021)	How could we verify that you've achieved

		(200 words)		this milestone?
1	*<100 words* *Getting first project done*	*<200 words* *Demonstrating that our method is working. This will help financing our projects, selling our credits and sourcing land and minerals*	Q2 2022	*<100 words* *Invoices of mineral costs, transport costs. Pictures of the appliance of the minerals. CNI Report.*
2	*<100 words* *Getting first field results of the weathering rate*	*<200 words* *The more predictable the weathering rate is, the easier our projects can be financed, which is essential with our kind of business model.*	Q4 2022 Obviously, the measurements will continue after 2022.	*<100 words* *TNO Report*
3	*<100 words* *Getting first field results on soil organisms.*	*<200 words* *We work according to the maximum permissible risk as determined by the RIVM with a safety margin. This risk level is based on research on toxicity on soil organisms. It is good to have this confirmed in a field research showing that we can handle the risks of enhanced weathering appropriately.*	Q2 2023	*<100 words* *Report of ecologist.*

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	*1,064 tCO2*	*9,576 CO_2*	*After evaluation, we may have access to another 90 hectares*
2	*Difficult to quantify as the milestone helps us setting up new systems/sites.*		*n.a.*
3	*Difficult to quantify as the milestone helps us setting up new systems/sites.*		*n.a.*

g. 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	*$183/ton CO_2*	*$78/ton CO_2 excluding, and $88/ton CO_2 including costs of finance*	*This is primarily a result of a better negotiating position and fixed project costs divided over more tCO_2.*
2	*$183/ton CO_2*	*Lower costs of finance*	*When the weathering rate is better known, this will have a decreasing effect on costs of finance. Hard to quantify at this stage.*
3	*$183/ton CO_2*	*No direct effect*	*Access to finance, land and minerals might become easier, having a decreasing effect on costs.*

h. 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?

We would ask Jigar Shah how to shape our business. He has shown how to scale with a comparable business model (solar energy with high initial costs and a long payback period) by tapping into mainstream capital, enabling him to scale faster than competitors.

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

Although there is a wide awareness of the public to combat climate change, there is little awareness about the importance of carbon removal in general and enhanced weathering in particular and the huge challenge to be able to remove 10 Gton per year. So Stripe could help getting this message across. Furthermore, it would help us if Stripe is willing to be a reference for other potential buyers of our credits.

7. Public Engagement (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 mechanisms 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 and how your project is working to follow the White House Council on Environmental Quality's draft guidance on responsible CCU/S development. We recognize that, for early projects, this work may be quite nascent, but we are looking to understand your early approach.

a. Who have you identified as your external stakeholders, where are they located, and what process did you use to identify them? Please include discussion of the communities potentially engaging in or impacted by your project's deployment.

Stakeholders we have identified are the government, land owners, NGO's, local communities and local authorities.

The Carbon Neutral Initiative has had several discussions with these stakeholders (as well for other projects) in the last months, both online and in real life (Martijn Schaap). Main concerns raised by the stakeholders are the following:

- *Does the project result in a negative effect on land, animals and humans?*
- *Can land be reused after applying the minerals?*
- *Does the local population benefit from our project?*

More than 50% of our project costs are spent in the local economy. Sourcing of minerals is local, transport is local, land lease is local and the appliance of the minerals is done by a local workforce.

b. If applicable, how have you engaged with these stakeholders and communities? Has this work been performed in-house, with external consultants, or with independent advisors? If you do have any reports on public engagement that your team has prepared, please provide. *See Project Vesta's community engagement and governance approach as an example.*

Yes, we have engaged with several stakeholders and explained the details of the project. We have done this in-house and together with Martijn Schaap, our representative in Guyana.

We have had discussions with the Private Sector Commission (Guyana government), the Institute of Applied Science and Technology and the land owner.

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?

Stakeholders are positive about the goal of the project, but stress the importance of "bringing something rather than taking". They often had bad experiences for instance with mining companies, where the majority of the funds flee the country.

Having more than half of the costs of our costs being spent in the local economy is perceived as positive.

One of the modifications we have based on these discussions is that part of the research is done with local organizations.

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?

We don't have changes planned that are not implemented yet. For our projects in Guyana, the plots of land that we will be using are part of larger plots. In this way we can quickly anticipate any problems before scaling up.

8. Environmental Justice (Criteria #7)

a. What are the potential environmental justice considerations, if any, that you have identified associated with your project? Who are the key stakeholders?

The main risk of enhanced weathering are the small concentrations of nickel and chromium in olivine. Therefore, depending on the soil, there is a maximum of olivine you can scatter without harming the ecosystem.

With some minerals, there is a risk of dust aerosol hazards. Nevertheless, we are testing this before applying the minerals.

b. How do you intend to address any identified environmental justice concerns?

Risks related to nickel: we apply basalt and gabbro according to the recommendations of the RIVM, the Dutch National Institute for Public Health and the Environment. These will be applied in all countries, although there might not be any legislation in place. We already have done a soil analysis.

Risks related to dust aerosol hazards: We keep the spreading speed low and will mist the soil after application.

9. Legal and Regulatory Compliance (Criteria #7)

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

No legislation in Guyana is known related to our project. Nevertheless, we take the risk levels of the RIVM into account. We are bringing the recommendations of the Dutch National Institute for Public Health and the Environment (RIVM) for the maximum applicable amount into practice.

In Guyana we are in contact with the Environmental Protection Agency and Ministry of Natural Resources who have an interest in the correct implementation of our project.

b. What domestic permits or other forms of formal permission do you require, if any, to engage in the research or deployment of your project? 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.

We need permission from the land owners to apply the minerals on their land.

c. Is your solution potentially subject to regulation under any international legal regimes? If yes, please specify. Have you engaged with these regimes to date?

N.A.

d. 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.

N.A.

e. Has your CDR project received tax credits from any government compliance programs to-date? Do you intend to receive any tax credits during the proposed delivery window for Stripe's purchase? If so, which one(s)? (50 words)

N.A.

10. 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*	*1064*
Delivery window *at what point should Stripe consider your contract complete?*	*10 years, of which 77% after 4 years*
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*	*$ 235 per tCO_2.* *The difference in price is the result of the TNO research to be conducted about the weathering rate and an ecologist*

denominated in another currency, please convert that to USD and let us know here.	*monitoring the ecosystem.*

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?

We are using basalt, which we procure locally at mines in Guyana. The mines are located within 200 kms from the project site. This basalt consists for about 40% out of olivine.

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

Our preference material to use is obviously a waste product of another (mining) activity. This will save us ecological impacts, CO2-emittances and costs. We were able to source olivine as a waste product in Europe, but it makes no sense to transport these minerals to our project locations.

We have been (and will keep) looking for waste products in Suriname and Guyana. Unfortunately, the chemical composition of some of these waste products were not ideal or not suitable at all for our projects in Suriname and Guyana.

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.)

We do not process the mineral. The grinding has already been done by our supplier. For other projects, we might consider grinding the minerals ourselves.

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	*+- 6,8 km^2*	*Existing mine for basalt*
Source material processing	*+- 0,008 km^2*	*Existing mine for basalt*
Deployment	*0,09 km^2*	*Former agricultural land.*

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	*104,6 km^2*	*Mines of this size do exist*
Source material processing	*0,1 km^2*	
Deployment	*8,000 km^2*	*Land can be co-used for other purposes*

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.)*

Currently, we are not using waste material, although we prefer to. The material is being used primarily for roads.

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.

The model is based on current scientific literature and knowledge of environmental factors that affect silicate dissolution rates. This, however, can only be presented in range or upper estimate as it is based on laboratory results. We have diminished the use of steady-state weathering rate throughout the project so that the uncertainty could be reduced. Ultimately, we would want to determine the ideal weathering rate, however we are open to the uncertainty that could be caused by secondary precipitation, secondary coatings on dissolving surfaces due to weathering large amounts of silica, the release of trace metals, or the effect of biotic activity in the soil.

Another source of uncertainty would be that the shrinking core model assumed a perfect spherical grain shape, whereas most silicate rocks are irregularly shaped in reality. This could also become a rate-controlling factor for the weathering process.

Currently, we are in Puro's work group to develop a methodology for enhanced weathering. We have good hope that the methodology will be finalized by the summer. We will be working according to this methodology.

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

TNO will research the weathering rate of our project. The weathering rate can be deducted for instance from the change in pH-value of water, but as well in the changing presence of some substances, such as magnesium carbonate and nickel. Our challenge is to develop practical measurement devices. We are already testing monitoring devices in lysimeters (refer to enclosed documents about lysimeters).

The models we rely on require information such as: Mg content, size of reserve (if available), annual mean temperature, soil pH, annual mean precipitation, nickel distribution coefficient, particle size needed, and some other data relating to CO2 emission for mining, grinding, and transport.

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?

Basalt contains small concentrations of nickel and chromium, which will be released during the 9 years of weathering. Therefore, the amount of basalt to be applied is limited. Based on experimental research of the last 15 years on the nickel toxicity on soil organisms, the RIVM, the Dutch National Institute for Public Health and the Environment, has derived new maximum permissible risk (MPR) values for soil. Based on the metal amount in the soil (soil analysis) and

the chemical composition (XRD analysis), we can determine the maximum amount to apply (within a safety margin).

With some minerals, there is a risk of dust aerosol hazards. Nevertheless, we are testing this before applying the minerals.

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?

Not applicable, we do not apply on agricultural ground.

Nevertheless, basalt is known to increase the fertility of the soil as it is rich in iron, magnesium, and silica. Basalt weathers relatively quickly which means that it begins to release nutrients to plants as soon as the roots make contact. Over time, additional nutrients become available as rocks are pried apart by water, extreme temperatures, and microbes that work together to release minerals into the soil and make them available to plants.

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)

The effects of soil processes can be measured. Periodically, a soil sample with the will be taken to the GGMC (Guyana) laboratory. The activity of the organisms already present in the soil is determined in the laboratory under controlled conditions. The level of activity can then be monitored.

The amount of microorganisms is relevant as well for our research about the weathering rate. The degree of which microorganisms influence the dissolution rate in the field is still poorly understood. Biotic activity is also thought to exert influence on the weathering rate, as the presence of vegetation or biota matters when it comes to weathering according to some studies. Therefore, although basalt has a lower weathering efficiency, which could be partly compensated by increased plant biomass carbon, driven by nutrient release (Strefler et al., 2018). Irregular grain shapes, rather than the perfectly sphered grain shape as assumed in the model, also could accelerate weathering rates up to 40 times higher than in laboratory studies (Strefler et al., 2018).

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

We consider that the safety measures we have taken are appropriate to prevent any detrimental result. Nevertheless, in case of a negative impact of our project on the

environment, humans, plants or organisms, we would look at possibilities to mitigate these impacts. If this does not succeed we will abandon the project and excavate the site.