General Application

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

Company or organization name

greenSand Stock

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

Enkhuizen, Netherlands

Name of person filling out this application

Liselotte ten Bosch

Email address of person filling out this application

liselotte@greensand.nl

Brief company or organization description

greenSand removes CO2 with surface mineralization of Olivine

1. Overall CDR solution (All criteria)

greenSand applies Olivine for surface mineralisation by replacing “conventional sand, pebbles, and stones” whenever technically possible. The smaller the particle size, the faster the sequestration of CO2.

The stone that removes CO2

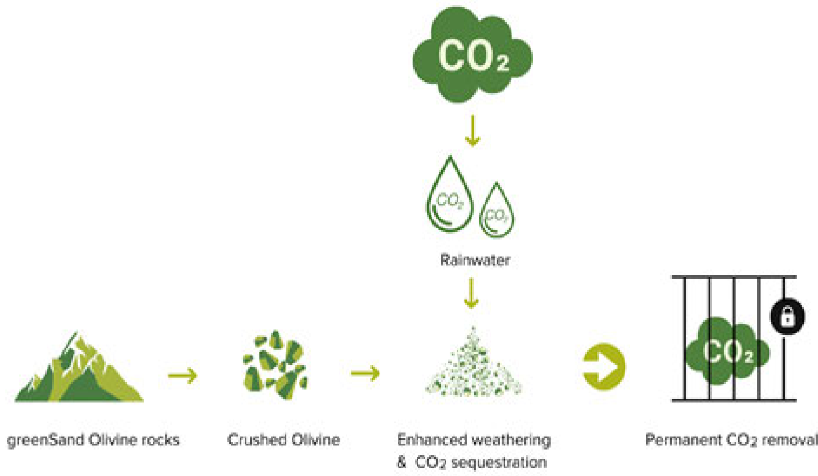
The unique attribute of greenSand is that it permanently removes CO2 from the air, in a way that nature has been doing it for billions of years: with the mineral Olivine. But what is so special about this rock? Olivine is a volcanic rock that makes up more than 50% of the Earth’s upper mantle, meaning that it is one of Earth’s most common and abundant minerals. Large Olivine deposits can be found all over the globe. The best and most important thing about it is that Olivine is a CO2-absorbing mineral. CO2 removal through rock weathering is an effective and natural approach to fight and reverse climate change.

Olivine mineralization

The carbon removal process starts when the CO2 in the atmosphere reacts with rainwater, making it more acidic. This can be compared to sparkling water, in which the carbon dioxide adds sparkling bubbles to the water. Next, this acidic rainwater falls onto the greenSand Olivine rock, where a natural reaction is initiated between CO2, water, and the mineral Olivine. This process is called weathering. During the weathering process the CO2 is being mineralized. In other words: CO2 dissolves into a different material. The result is an ionic liquid (Magnesium and bicarbonate ions). Only when this liquid is dried solid Magnesium-Carbonate is formed (and half of the sequestered CO2 will be released again). As there is sufficient rainfall this is not likely.

Its chemical formula is:

greenSand + CO_2 + water => Magnesium + Bicarbonate + Silica
$Mg_2SiO_4 + 4CO_2 + 4H_2O \Rightarrow 2Mg^{2+} + 4HCO_3^- + Si(OH)_4$



The model

Together with Deltares (a Dutch knowledge institute) a model developed is to calculate the CO2 uptake over time.

The base of the model is the PhD thesis of Amanda Olsen (FORSTERITE DISSOLUTION KINETICS: APPLICATIONS AND IMPLICATIONS FOR CHEMICAL WEATHERING, 2007)

With a pH and temperature dependency as described by her:

Forsterite dissolution rate data from previously published studies were combined with results from my experiments and regressed to produce rate laws at low and high pH. For pH < 5.05

$$r_{BET} = 1.00\times10^{5}\left(e^{\frac{-68550}{RT}}\right)a_{H^+}^{0.48} \quad \text{or} \quad r_{geo} = 1.10\times10^{6}\left(e^{\frac{-69715}{RT}}\right)a_{H^+}^{0.50}$$

and for pH > 5.05

$$r_{BET} = 32.36\left(e^{\frac{-55084}{RT}}\right)a_{H^+}^{0.22} \quad \text{or} \quad r_{geo} = 759\left(e^{\frac{-58924}{RT}}\right)a_{H^+}^{0.24}$$

I then developed a diagram that shows the effect rate-determining variables on the lifetime of olivine grains in weathering environments using these rate laws.

A shrinking core model is developed, taking into consideration the particle size distribution of the used olivine.

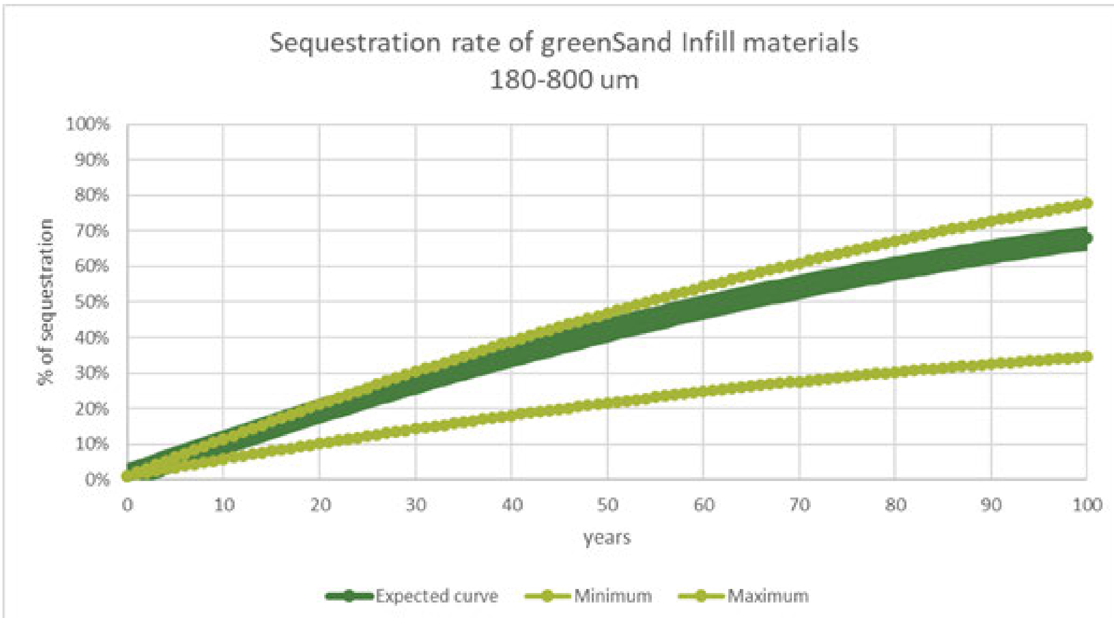
Input parameters are:

- Purity of the olivine
- k-factor (from literature)
- Temperature (for the project location)
- pH (either soil or rainwater)
- Particle Size Distribution (as measured)
- time steps

The output of the modeo

- CO_2 sequestered (over time)
- Magnesium (& Nickel) release
- Alkalinity

The output is the CO_2 uptake over time as described below (for the specific solutions that we are offering in this document)



Life Cycle Assessment

The material 180-800 um is a residual material from the production of foundry sand. While 0producing foundry sand this fine fraction is sieved out of the product as a residual product a0nd was currently not used. So conform the usual allocation method is the "CO_2 impact" only to be accounted for towards the main product.

But being aware of these allocations both the nett, gross and avoided CO_2 emissions are calculated.

			Amount	**5.000**	**ton**					
				Olivine				**Conventional sand**		
Mining				2,8	kg/ton				1,4	kg/ton
Milling				0,7	kg/ton				-	kg/ton
Crushing and grinding				3	kg/ton					
Transportatior	Ship	15	gr/ton km							
		1.526	km	22,9	kg/ton				-	
	Truck	138	gr/ton km							
		50	km	6,9	kg/ton		150	km	20,7	kg/ton
Total CO2 emissions				**36,3**	**kg/ton**				**22,1**	**kg/ton**
CO2 removed		68%							-	kg/ton
CO2 uptake per kg (max)				**1,1**	**kg CO2/kg olivine (Iron ratio)**					
				748	**kg CO2/ton**				**0**	**kg/ton**
Gross CO2 removed				**3.740**	ton CO2/total					
Efficiency				=(CO2 removed - CO2 emitted)/ CO2 removed						
				95%						
Nett CO2 removed				3.559	ton CO2/total					
Gross emissions				**181**	ton CO2/total					
Emission/removal ratio				**5%**						
Net carbon removal				**3.559**	ton CO2					

The Project

greenSand is launching a new scalable solution: sand infill. For this project we will collaborate with the Antea group, which is located in the Netherlands. There is a declaration of intent between the Antea group and greenSand, meaning that Antea is willing to replace regular sand infill on sport fields with greenSand Olivine for 5,000 metric tons per year. The gross CO2 (lifetime Olivine) potential for the Netherlands is, therefore, 3.400 tons CO2 per year for sport applications. This is excluding the potential for landscaping.

When Olivine is grinded, the sequestration rate increases. It means that when, for example, children are running on sport fields, Olivine removes CO2 even faster! Although it is still unknown today by how much exactly the rate is accelerated, it is anyway amazing to realize that your own kid can contribute to CO2 removal just by playing sports.

The olivine sequesters 68% based on the model, however, this application is likely to present faster sequestration rates due to the fact that these sport fields are actively being used. Meaning the olivine will move and be surrounded in more moisture conditions and therefore sequestration rates are highly likely to increase.

The locations of the project

greenSand always sources Olivine closest to its location to reduce the footprint of the projects. However, each Olivine source has different characteristics and therefore, the applications of it are also different. greenSand has gained insight knowledge over the last 12 years about the right use of Olivine. The current markets of greenSand are the Netherlands, Belgium, UK, Germany, Denmark, and Scandinavia. The first project will be realised in the

Netherlands and Scandinavia simultaneously.

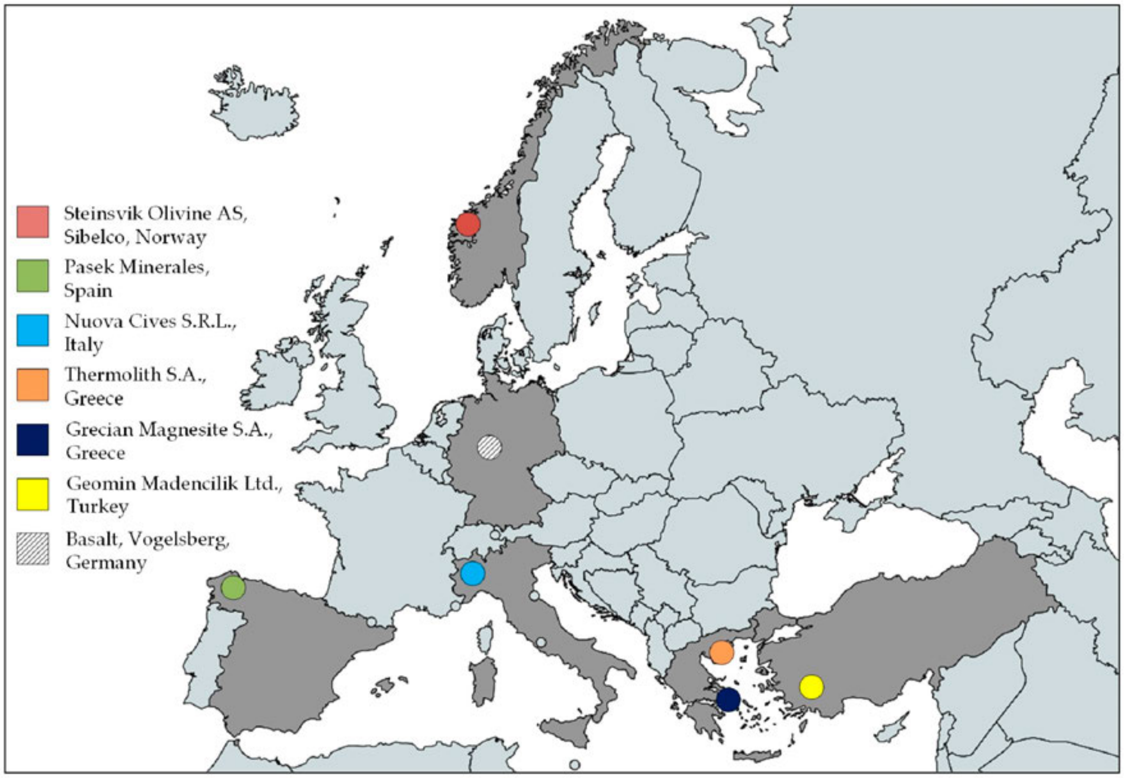


Figure 1 - (Kremer & Wotruba, 2020)

Phases, scalability, and timeline

The size of the global sand infill market is approximately 6,5 Megatons per year. However, sand infill is only a small part of greenSand's portfolio and only represents the market that can use this particular particle size. Markets that can be added to these solutions are sand for sandpits/sandboxes, paving sand, and when more research will be available, Olivine can also be used as a lime substitute and as part of a stone mixture fertilizer.

The entire scalability of surface mineralisation is limitless. Some applications to mention here are ballast for train roads, walking paths, inspection paths, foundation layers, granulate, paving sand, etc. For greenSand it is important to find an application that does not generate additional material need but rather replaces other stones and pebbles worldwide that do not have the CO2-removing feature. All together, it has the potential to remove >0.5 gigatons of CO2 per year within the next 20 years. Especially as the price difference between these traditional materials and olivine will become smaller in the future (due to the scaling up of the olivine logistics). So the "green premium" (price difference between olivine and traditional sand) becomes smaller.

Price

Project owners, contractors, architects, landscapers, gardeners, and households, in general, need sand and stone. Especially here in the Netherlands, with rising sea water levels, we are in the need of more sand and stones in the upcoming year. Replacing those with Olivine is an incredibly simple solution. Since greenSand and Olivine are not at the same scale as granite, porfier or other sand and stone types, we are currently not able to price the Olivine at the same levels. Where we sell around 10.000 tons a year, granite sells it at about 100.000 tons a week. Until Olivine is at the same scale, it is not possible to price it competitively in the market without a "green premium". Therefore, greenSand uses the CDR structure in the following way:

1. Contractor usually pays between 60-80€ (71-94.66 $)* per ton of the sand infill delivered at location. greenSand costs around 195 euro (230.58 $)* per ton at current scale.
2. greenSand will offer sand infill for about 5-10% extra compared to the regular materials. The rest will be paid for by CDRs
3. This is how we deal with the green Premium, but this will truly help scale the project to similar price levels.

2021	Turnover	Material	CDR
Sand infill	€60 / ton		
greenSand Infill	€195 /ton =	€60 +	€135

2040	Turnover	Material	CDR
Sand infill	€70 / ton		
greenSand Infill	€90 /ton =	€70 +	€20

Below is a price estimation of the CDR prices and the sand infill prices when scaling from 5,000 tons to 0.5 gigatons.

*Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

a. 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.)*

greenSand's role is to distribute Olivine to businesses and individuals. For this project we will collaborate with Antea sport and provide them with the necessary amount of greenSand sand infill to replace all their sport fields with CO2-removing Olivine sand infill to start the scaling process. Next to the distributor, we also sell CDRs and are busy with the validation of the CDRs within the next year. Read how CDR pricing works under price of point 1.

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

There are different risks to different facets of Olivine: risk related to the application and risk related to CDR validation.

1. Application: The customer needs to buy the olivine for the infill application. But by using the CDR credits and a cooperation with the major organisation making these artificial grasses, this is covered.
2. CDR validation: The olivine used is rather small (< 1mm) so the CO2 uptake is not in a millenium time-scale. But rather decades. It sequestered +-68% in 100 years. But how much will this increase as the sport fields are actively used, keeping the sand in motion.

3. Olivine contains different types of minerals, and can contain asbestos. To ensure that the materials are free of asbestos SGS performs batch tests for each shipment arriving to make sure the olivine meets the regulations.

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

-N.a.

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.*	May 2021 - June 2022
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.*	Gradual carbon removal starts immediately and lasts for about 200 years. At least 68% sequestration within 100 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*	68% in the first 100 years

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".	
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.*	Permanent, i.e. >1000 years

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

Permanent, geological sequestration, The long-term carbon cycle.

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.)*

Mineralisation is permanent due to its nature. The main question is how fast the reaction is proceeding.

Scientific studies that show weathering rates that we relied on (amongst others): https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042098 & https://pubs.acs.org/doi/abs/10.1021/acs.est.6b05942. Together with PlanBCO2 and Deltares, a model was made to estimate the weathering rates for practical purposes. This applies to our application as both are about surface mineralisation and that is what we are doing. Currently, field experiments are being conducted by Deltares in Delft, to conform the model in the field. 12 plots with different Olivine sources are being tested.

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?

Mineralisation is by its nature permanent, so there is no risk of leakage, decomposition etc.

Other potential risks are described here It is known that Olivine can contain asbestos. So by the selection of the mine this needs to be taken into consideration. Pol Knops is involved in another project (www.asbeter.nl) to destroy asbestos, so he is very well-aware of the risk of this hazardous material. greenSand performs tests on each shipment. Another point is that Olivine contains smaller amounts of Nickel and Chromium. The features of these elements need to be monitored. The partner Deltares (and especially Jos Vink) is very well known for his expertise in this field. https://www.deltares.nl/nl/experts/jos-vink/ For most applications it is the chemical reaction towards ionic Magnesium and bi-carbonate ions. This implies that about 1.25 kg CO2 is sequestered per 1 kg of Olivine. As Olivine also contains iron (which is not binding CO2) we usually calculate with 1 kg CO2 per kg of olivine. The reaction proceeds towards an Ionic Magnesium-bi-carbonate solution. This sequesters 4 CO2 molecules for each olivine molecule. When solid Magnesium-Carbonate is being produced the CO2 uptake is 2 molecules of CO2. But given the nature of the ambient weathering and the availability of water the reaction is toward the ionic solutions (and therefore to 4 Molecules and 1 kg CO2 /kg olivine)

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.)*

For the quantification we divide the projects into bigger and smaller ones. For bigger projects typically a comprehensive LCA./CO2 report and calculation is made. This takes into account the location, reference material, particle size, and application. Thus, the CO2 impact is calculated. And if required, a CO2 certificate is issued. For smaller projects this is too cumbersome. Therefore, a slightly different approach is used. All of the sales are recorded. Of these sales the date, amount and particle size are noted. We established a model (based on particle size) to calculate the CO2 uptake over time. This is implemented in our database and uploaded to our heatmap on the greenSand website. It visualizes for each project the CO2 sequestration over time (see the example of Hoekse Lijn). For the forthcoming years the certification will require more attention, so that we will be in a better position to quantify and explain the CO2 uptake. For the future, we aim at performing an LCA. But for the Dutch requirements a CO2 balance is sufficient. In general, we use an average LCA, where an example project is used for LCA calculations based on average distance as logistics is one of the biggest influences in CO2 efficiency. We rely on the model for sequestration because it is impossible to measure at project sites, however, we are working on validating the model by doing additional field experience. These outcomes will validate the assumptions of the model. The validation of this model will likely confirm the assumptions of which the CDRs are currently being issued at. It is impossible to meet at various locations as the test locations costs are estimated at €200.000 (236.658 $)* for a 2-year period.

*Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

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	*5,500 ton CO2*
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	*111 ton CO2*

b. Show your work for 2(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)*

				Olivine				**Conventional sand**		
Mining				2,8	kg/ton				1,4	kg/ton
Milling				0,7	kg/ton				-	kg/ton
Crushing and grinding				3	kg/ton					
Transportatior	Ship	15	gr/ton km							
		1.526	km	22,9	kg/ton				-	
	Truck	138	gr/ton km							
		50	km	6,9	kg/ton		150	km	20,7	kg/ton
Total CO2 emissions				**36,3**	**kg/ton**				**22,1**	**kg/ton**
CO2 removed		68%							-	kg/ton
CO2 uptake per kg (max)				**1,1**	**kg CO2/kg olivine (Iron ratio)**					
				748	**kg CO2/ton**				**0**	**kg/ton**
Gross CO2 removed				**3.740**	ton CO2/total					
Efficiency				=(CO2 removed - CO2 emitted)/ CO2 removed						
				95%						
Nett CO2 removed				3.559	ton CO2/total					
Gross emissions				**181**	ton CO2/total				110,5	
Emission/removal ratio				**5%**						
Net carbon removal				**3.559**	ton CO2					

This is how the calculations were made. Mining CO2 emissions information was retrieved here:

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).

GreenSand develops various projects. All of them are mentioned on the website.

The reason for using the infill for this application is due to a combination of very finely grinded olivine, a letter of intent from a big customer, and the CO2 potential within this market. Also having children play on permanent CO2 removing sports fields is an amazing way to educate about these existing and natural solutions.

We have an interactive map called greenSand world where below you can see how much CO2 has been removed already, how much olivine was spread. Below the map is a slider that you can move to see the future CO2 removal that will still happen.

https://www.greensand.nl/en/world

Today 03/24/2021 45.496 tons of olivine have been spread with 3.288 tons of CO2 removed.

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.)*

GreenSand and Pol Knops are involved in mineralisation since 2010. In 2012 the first version of the model was created (at that time for the publication of Wageningen University https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042098).

The base was a PhD thesis of Dr. Amanda Olsen (https://vtechworks.lib.vt.edu/handle/10919/28213)

And this was expanded with taking into account a particle distribution (instead of mono disperse particles) and including multiple time steps.

This model was regularly updated, validated (i.e. the paper of NIOZ https://pubs.acs.org/doi/abs/10.1021/acs.est.6b05942).

And the last couple of years coupling the CO2 uptake with the behaviour of the heavy metals (together with Deltares see i.e. this poster https://www.slideshare.net/PolKnops/poster-agu-lenferink)

The latest is a validation with the most recent work of Deltares field plots. But that work is still in progress (see, but only in Dutch https://www.deltares.nl/nl/projecten/olivijn-validatie-rekenmodel-met-veldproef-op-campus-van-deltares/)

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.

In close cooperation with Antea are the sites selected. As usual for greenSand are all finalised projects mentioned on the site.

Antea develops these artificial grass playing fields, and here is the olivine to be used for infill sand.

Displaying all realiszed locations

https://www.greensand.nl/nieuws/greensand-op-de-kaart

Some specific projects here:

https://www.greensand.nl/en/civil/applications/railways

https://www.greensand.nl/en/civil/applications/olivine-paths

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	*5100 ton CO2*
Gross project emissions	*181 ton CO2*
Emissions / removal ratio	*5%*
Net carbon removal	*3.559 ton CO2 (offer is 68% within 100 years)*

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.

				Olivine				**Conventional sand**		
Mining				2,8	kg/ton				1,4	kg/ton
Milling				0,7	kg/ton				-	kg/ton
Crushing and grinding				3	kg/ton					
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Emission/removal ratio				**5%**						
Net carbon removal				**3.559**	ton CO2					

Data from: Hangx/Spiers Coastal spreading of olivine to control atmospheric CO2 concentrations: A critical analysis of viability

https://www.sciencedirect.com/science/article/abs/pii/S1750583609000656

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?

The approach takes into consideration from mine to the application. And also the conventional reference material.

The weathering rate of Olivine is partially measured and partially modelled.

The outcome of the modelling is a weathering rate as a function of time. For this call we submit the CO2 uptake for the next 100 years (68%).

The olivine needs to be mined, milled, crushed and transported to the Netherlands, which *emits CO_2. If no olivine is used, a conventional material would be used.*

See the table. The data are originating from Hangs/Spiers "Coastal spreading of olivine to control atmospheric CO_2 concentrations: A critical analysis of viability" Table 2.

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.

See the table. The data is originating from Hangs/Spiers "Coastal spreading of olivine to control atmospheric CO_2 concentrations: A critical analysis of viability" Table 2.

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.)

Deltares (Dutch knowledge institute) verifies CO_2 sequestration together with PlanBCO2

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)*

The units of deployment are the tons of olivine that we have distributed for CO_2 sequestration purposes by replacing regular sand and pebbles.

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 ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2021	4000 ton 0-4mm 125 ton 180-800mu (new product)	€35 / ton (41.42$/ton)* €150 /ton (177.49 $/ton)*		*4000 tons today of the 0-4 mm gradation. We are launching the new product and sold 125 tons of infill material at unit cost €150*
2020	4000 ton	€45 /ton (53.25$/ton)*	4000	*Corona pussed most projects and therefore to 2021*
2019	4200 ton	€45 / ton (53.25$/ton)*	4200	*Due to economies of scale the cost price is dropping*
2008	800kg	€220 /ton (260.32$/ton)*	1200	*The first big bag costs were 220€ per 800 kg back in 2008-2009.*

*Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

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.)*

Our costs are highly dependent on economies of scale, the bigger the projects and market the more the cost price will drop. Also, because the sale of CDRs are increasing we are able to price the product competitively in the market.

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)
+- 5000 tons of olivine	*5100 tons*

stripe

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?

€144/ton CO_2 (170.39 $/ton)*

*Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

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."

The costs include the purchasing and distribution costs of the olivine, and the expenses related to setting up an additional supply chain and getting the right certification (KIWA and/or SGS test reports). Also, it includes costs related to a first pilot Project in Breda, and official LCA calculations.

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	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	*Get the right certification / verification and LCA calculations* *E.g. a standard for olivine sequestration (ONCRA)*	*greenSand received the first approval of KIWA to start applying olivine to sport fields. The grain size meets the curve, as well as other regulations. The first pilot will be installed in Q2 2021*	Q2 first pilot, Q4 results 2021	*Outcome of the results of the pilot by both Antea and KIWA.*
2	*First sales of CO2*	*The CO2 rights*	Q2 2021	*The certificates*

	certificates for sand infill	*belong to the certificate holders, therefore in order to supply the sand infill at a competitive price the gap will be paid by certificate holders*		*designs and availability on the market. First purchase has been made, second one stripe.*
3	*Sprinkling the first 5000 tons of sand infill*	*This will create enough reference projects to expand to other parts in europe and beyond and start sharing our knowledge to make it more accessible.*	Between Q4 2021 and Q4 2022	*All dots are connected to the greenSand world map [here](). And we can provide a copy of sales of the product*

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	*1000 tons mostly to landscaping rather than sport field applications.*	*5000 tons sport applications per year in the Netherlands. 1000 tons for landscaping*	*The pilot field is of crucial importance to get a higher certification of KIWA than the one we currently have.*
2	*Same as previous*	*Same as previous*	*Same as previous, allowing to offer the olivine at the same price as regular sand infill by selling the CO2 certificates separately of the physical product*
3	*5000 tons 2022*	*10.000 tons in 2023*	*Having Antea, a big player in the Dutch market, intending to replace all sand infills with olivine infills, will provide reference projects, which will help to convince other EU countries to start using olivine*

			infill.

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	*144€* *(170.39 $)**	*144€* *(170.39 $)**	*The KIWA certification will directly impact demand, including possibility to be pre-registered in big tender projects*
2	*144€* *(170.39 $)**	*134€* *(158.56 $)**	*After the first initial purchase of 5000 tons we are able to drop the price due to faster inventory rotations.*
3	*€134* *(158.56 $)**	*€118* *(139.63 $)**	*Economies of scale are driving the costs down, faster and more efficient supply chain.*

*Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

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?

We would need someone in Brussel that changes the legislation to make it compulsory for building projects/tenders to use the most sustainable solution if the technical specifications allow for it, e.g. using olivine gravel/powder/split (minerals that can sequester CO_2) in all cases instead of common alternative materials in order to add the CO_2-removing benefit.

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

We have been trying to get STRIPE connected to exact online, but no right API does exist yet. Write a review on olivine that can help other companies assisting in making their purchasing decision. Awareness through an interview with Stripe.

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?

Citizens, the olivine mines, governments, policy makers, news papers e.g. news about geo-engineering, nature surroundings of both the projects and mines, universities and knowledge institutes, contractors, civil engineers, landscapers, among others. The stakeholders were identified during a stakeholder analysis for the business model in 2020.

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

Most has been dealt with internally, Pol Knops helps a lot with the connection between the different stakeholders, and we have volunteers helping on some of these issues. These stakeholders even include competing entries to the Stripe contest. Pol Knops and the model was also used for Project Vesta at the previous round of Stripe.

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?

That CO2 removal requires explanation. Reducing CO2 is quite obviously the first priority. But CDR is for the general public difficult to explain. And even NGO's are not in favour (as it could distract the attention towards drastic reductions of CO2 emissions). That replacing conventional civil products (as in fill sand) with a more sustainable alternative is on the hand appealing (no geo-engineering discussions). But quite some people are hesitant to change. And the legislation, certification can also hinder this substitution. One of the remarks on olivine is Asbestos. As olivine can contain asbestos we have had quite some discussions around this topic. We do not want to harm anyone, and therefore we always let SGS perform additional batch testing when shiploads of olivine arrive, to prove that

greenSand is not dangerous in it’s applications. So far we have always dealt with these situations through testing and proofing product safety.

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 are currently looking into how to raise awareness about carbon removal solutions among citizens, for example combining tree planting with olivine substrates. Also, there must be more public education about why CO2 removal (and not only CO2 reduction) is necessary. We have had 3 citizens initiatives this year to replace regular pebbles with olivine in neighbourhoods. We have an additional member to our team who will help to enhance these community projects.

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

One of our major concerns is that we do not want to send the wrong message to businesses with the sale of carbon removal certificates. Companies should not consider purchasing CO2-removal certificates as a solution to continue with their traditional polluting business practices. We want to avoid companies to think they don’t need to switch to sustainable business practices because they can ‘green-wash’ their image with carbon removal certificates. The goal is not to keep polluting and compensate for it, which would result in not moving forward towards a greener future but standing still. Instead the goal is to remove excessive CO2 that has accumulated over the past decades, i.e. clean up the mess that humanity has caused, AND switching to sustainable business practices. This means CO2 reduction in combination with CO2 removal. greenSand is working on informing and educating about this issue on its website and social media accounts and is committed to sending the right message.

11. Legal and Regulatory Compliance (Criteria #7)

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

Olivine is legally an allowed construction material. We test each shipment for these criteria (including the risk of asbestos). We know that our sourced olivine doesn't contain asbestos, but if there are questions arising we want to refer to an official certificate.

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.

For replacing civil products it fulfills the criteria of construction material. In due time we want to penetrate the market of fertilisers (as a lime replacement with even more CO2 avoidance (as Lime is a CO2 source), but this takes time (and investment).

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.

Greensand is already selling olivine for 12 years, so we know we are meeting the legal requirements for civil uses. In due time we want fertiliser applications. And putting Olivine on beaches (see i.e. Project Vesta) is an interesting market, but that is quite challenging (i.e. London protocol).

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)	3.559 ton CO2
Delivery window (at what point should Stripe consider your contract complete?)	May 2021 - June 2022
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.*	€144 (170.39 $)* prices dependent on current exchange rates at time of purchase. *Based on March 24th 2021 exchange rate: EUR€1 = USD$1.18 (NASDAQ)

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?

Olivine/Dunite. From our regular suppliers. For this market we use the Norwegean olivine due to its technical and chemical composition.

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

Yes, Olivine is already mined and sold. The sale is for other markets (steel industry, foundry, Abrasive blasting. CO2 removal is for these mines a novel application.

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.)

Depending on the application is the material grinded, sieved etc. For this application is the material a residual material from the foundry industry. For this application the olivine grinded and miled. This material is sieved into a coarser fraction for use as foundry sand. And a finer residual material.

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	< 0,1 km2	Regular sand < 0,1 km2

Source material processing	<< 0,1 km2	E.g. Gravel production facility << 0,1 km2
Deployment	200,000 m2 (is about 30 football fields)	Same dosage, surface area.

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	*1 km2* *(100 Megaton = 28 M m3 olivine. Depth of mine 40 meter = 700.000 m2 = less 1 km2 . Maybe with smaller depth 2-5 km2* *Spain, Italy and Norway have got these feedstocks available.*	
Source material processing	< 1km2	
Deployment	*Obviously not infill sand, as this market is not at this scale.* *5 cm thickness = 555 km2.* *But this as a replacement for conventional sand/pebbles/granite* *As i.e. next to a railway. In Europe there is about 218.000 km railway track, so this amount could be applied in Europe next to these railways*	

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.)

The olivine wouldn't be mined. And the infill sand would be sourced from regular sand.

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 the current knowledge (and validated by Deltares) and expanded to include heavy metals.
There is always a range in the kinetics which is unsure. We are constant in contact with researchers to validate the model for other applications, so this uncertainty can be reduced.
In an ultimate goal local field measurements would indicate the weathering rate, but this is quite challenging (based on our decade expertise).

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?

The actual weathering rates are very difficult (and expensive) to measure.
That is the very reason for using a model. As far as we know this is currently still the only validated and used model for Olivine / CO2 application. And as Greensand cooperates with Project Vesta, is delivering material to other test sites we are very confident about this.
The model is validated with actual measurements. And now includes a Nickel risk module.
The CO2 model requires: Olivine purity (Mg content), particle size distribution, Temperature, Dissolved Organic Carbon, pH
The Nickel module is described at http://www.pnec-pro.com
(open access and free to download)

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?

Olivine contains Nickel and Chromium (and none Pb or Hg). The release rate of Ni and Cr can be calculated beforehand. And the absorption to the
There are no Dust aerosols hazards (as Olivine is used for abrasive blasting for which conventional sand is banned).

Olivine doesn't contain P.
For agricultural applications the release of Alkalinity and Magnesium could (depending on the soil and plant type) be a concern. That is one of the reasons why this application is not pursued at this moment.

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?

This is partially described in my paper of 2012 (open access)_
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042098

This is described on:
https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/344827
Basically an assessment based on modelling the Co2 uptake, Nickel release, Nickel absorption by soil and split over the plant. And finally a comparison with the Accepted Daily Intake.

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)

Beforehand risk assessment (for civil applications according to the certification for construction material). For other applications with a risk assessment (done by Deltares).

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

If it is not fulfilling the legal requirements (these are more restrictive than eco-toxicological concerns.