Production Facility and Output Audit

For Puro.earth

CO_2 Removal Supplier	Eion Corp.
CO_2 Removal Method	Enhanced Rock Weathering
Production Facility Name	Twinterstellar 3021
Production Facility ID	387867
Location	122 sites in Mississippi and Louisiana, USA *See Appendix 5 for individual application sites*
Lead Auditor	Lily Schacht
Monitoring Period	May 10, 2023 – December 3, 2024
Crediting Period	May 10, 2023 – May 9, 2028
Number of CORCs	748.31
Report Date	September 18, 2025
Version	V1.3

350 SOLUTIONS

Contents

Acronym and Chemical Definitions

CDR	Carbon Dioxide Removal
CO_2	Carbon Dioxide
CORC	CO2 Removal Certificate
Cr	Chromium
ERW	Enhanced Rock Weathering
ESRS	European Sustainability Reporting Standards
f_w	Fraction Weathered
GRI	Global Reporting Initiative
HCl	Hydrochloric acid
HCO_3^-	Bicarbonate
HNO_3	Nitric Acid
LOI	Loss on ignition
Mg^{2+}	Magnesium
Mg_2SiO_4	Magnesium silicate
Ni	Nickel
PTE	Potentially toxic elements
SiO_2	Silica
TDS	Total Dissolved Solids

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Puro.earth Production Facility and Output Audit		
Company: Eion Corp	Company Contact: Chris Shrieves	Auditors: Lily Schacht Zoe Sandwith Tim Hansen
Removal Method: Enhanced Rock Weathering		
Document No: PU2505-PFAOA-VR		
Revision: V1.3		

**primary contact/lead author*

1. Introduction

Puro.earth contracted 350Solutions to validate and verify the eligibility of Eion Corp's Twinterstellar 3021 Production Facility and associated CO_2 Removal Certificate (CORC) claim. This Production Facility and Output Audit included observation of operations during a site visit, collection of files and evidence related to weathering material sourcing, application, and monitoring, review of data collection and handling procedures, and evaluation of adherence of the project to the relevant methodology. The crediting period for the Production Facility Audit is May 10, 2023 – May 9, 2028 and the monitoring period for this Output Audit is May 10, 2023 – December 3, 2024.

This audit involved a site visit to the application sites on July 22, 2025 and a desk review of documents provided by Eion. 350Solutions affirms that Eion has the appropriate equipment, procedures, and protocols in place to quantify CO_2 removal through the application of olivine to farmland in accordance with the requirements of Puro General Rules (Edition 4.1) and Puro's Enhanced Rock Weathering Methodology (Edition 2022 v.2)

Table 1. Production Facility and Output Audit Summary

CO_2 Removal Supplier	Eion Corp
Production Facility Name	Twinterstellar 3021
Facility ID	387867
Removal Method	Enhanced Rock Weathering
Crediting Period	May 10, 2023 – May 9, 2028
Monitoring Period	May 10, 2023 – December 3, 2024
Report Date	September 18, 2025
Number of CORCs	748.31
Site Visit Date	July 22, 2025
Production Facility Location	122 Fields in Mississippi and Louisiana, USA See Appendix 5 for individual application sites
Audit Type	Puro Production Facility and Output Audit, including on-site visit, in accordance with: - Puro General Rules (Edition 4.1) - Enhanced Rock Weathering Methodology (Edition 2022 v.2)

2. Technology Description

2.1 Process Overview

Eion spreads finely-ground olivine rock on farmland to remove carbon dioxide (CO_2) from the atmosphere in a process called Enhanced Rock Weathering (ERW). The olivine used for this project came from two quarries, Milbank Materials' Twin Sisters Olivine in Washington, USA (herein: TS) and Sibelco Olivine from Åheim, Norway (herein: 3021). The TS weathering material was sitting unused in a warehouse due to lack of demand while the 3021 weathering material may have been sold as a low-value filler for construction.

Olivine is primarily magnesium silicate (Mg_2SiO_4), which is weathered by carbonic acid to form dissolve magnesium (Mg^{2+}), bicarbonate (HCO_3^-), and silica (SiO_2). More information about the chemistry of enhanced rock weathering and the nuances in quantifying the resulting carbon dioxide removal (CDR) can be found in Cascade Climate's Foundations for CDR Quantification in ERW Deployments [1].

In the Spring of 2023, Eion spread approximately 15,000 tonnes of olivine on 3,640 ha of farmland. For this monitoring period, Eion is only claiming CORCs on the observed weathering on the fields where the TS material was spread, approximately 4,250 tonnes on 1,277 hectares.

2.2 Monitoring

Eion takes soil samples on a 2.5-acre grid before spreading olivine, soon after spreading, and again at the end of the monitoring period. Small field trials over one growing season involved sampling of biomass, soil, and porewater using lysimeters. The measurements taken and methods used are listed in Table 2.

Table 2. Measurements Taken at Application Sites and/or Field Trials

Sample Type	Analysis	Application Sites	Field Trials	Frequency
Soil	Aqua regia digestion for Mg, Ni, Cr	X	X	Before and after spreading, at the end of the monitoring period
	Mehlich 3 extraction for exchangeable base cation concentrations and CEC	X	X	
	Loss on ignition (LOI) for organic matter content	X	X	
	1:1 water pH	X	X	
Porewater	Nutrient concentrations (Nitrate, Phosphorus, Potassium, etc.)		X	Cumulative over measurement period (May 23 – August 18, 2023)
	Magnesium concentration		X	
	pH		X	
	Electrical conductivity		X	
	Total dissolved solids (TDS)		X	
	Bicarbonate and carbonate concentrations		X	
Plant Tissue	Mg, Ni, Cr concentrations		X	Peak biomass

An aqua regia digestion is used to quantify magnesium (Mg), nickel (Ni), and chromium (Cr) concentrations in the soil. This is an incomplete digestion because it does not dissolve all minerals, including some silicates, unlike the total digestions used in Reershemius et al., 2023 and Kantola et al., 2023 [2], [3]. Eion has demonstrated that the Mg in forsterite, which makes up ~90% of the olivine used, is completely digested in aqua regia, suggesting that the aqua regia digestion is suitable for measuring olivine dissolution. In Eion's studies, the recovery of Mg-bearing minerals in the clay and silt fractions was 25%, compared to 90% of the olivine. Exclusion of the preexisting Mg-bearing minerals could improve the signal-to-noise ratio in the data used to calculate CO_2 removal.

The Enhanced Rock Weathering Methodology (Edition 2022 v2) does not specify what method must be used to monitor the weathering reaction in soils, so the aqua regia digest is compliant. However, this data needs the following additional context to compare to existing studies using solid-phase mass balance methods to measure CO_2 removal.

1. The digest may not recover all the Ni present in the soil, which may lead to underestimating the olivine application rate. Eion has not studied the recovery of Ni to the same degree as the Mg recovery study. Ni can substitute for Mg in forsterite, suggesting that the Ni in the olivine is primarily in forsterite and is thus dissolved in aqua regia. Ultimately, underestimation of Ni in soil leads to a lower estimate of CO_2 removal.
2. The risk of potentially toxic element (PTE) contamination was assessed in the Environmental Risk Assessment (ERA) using a sodium peroxide fusion digestion, which is relatively complete compared to aqua regia digestions. Thus, the results of the ERA are acceptable and conservative (see Section 2.2.1). However, the concentrations of PTEs, particularly chromium (Cr), from aqua regia digests of post-weathering soil samples will be lower than the expected concentrations as calculated in the ERA. The chromium (Cr) in olivine is predominantly present in chromite, which is not readily dissolved in aqua regia. As a result, the mass balance on Cr in the soil can't be completed. The amount of Cr added to the soil is known, but it is impossible to know if the Cr is retained in the soil or has leached through. Eion does not maintain continuous lysimeters which would allow for measurements of Cr leaching. While we do not expect the Cr content to exceed legal limits in the soil or the groundwater based on the initial data presented, Eion cannot verify the exposure modeling in the ERA from the data currently collected.
3. Secondary Mg-bearing non-carbonate minerals (e.g., phyllosilicate clays) may form in the soil and prevent the bicarbonate ions from the weathering reaction from leaving the upper soil. When total digestion or porewater monitoring is used to calculate CO_2 removal, the base cations in these minerals are considered un-weathered and don't contribute to the estimated CO_2 removal. These minerals may not be fully dissolved in aqua regia and would count toward CO_2 removal. Eion has demonstrated that they can measure the loss of olivine from the soil but not distinguish between the potential fates of the Mg after weathering has occurred. It is possible that Mg-bearing secondary minerals form in the soil, which would lead to over-crediting CO_2 removal. That said, it is not currently feasible to quantify trace mineral contents in soils and the Puro

methodology do not explicitly discuss secondary mineral precipitation, so Eion does not need to monitor for secondary mineral precipitation separately. See Cascade Climate's Foundations for CDR Quantification in ERW Deployments: Section 8.6.1 for more information about measuring secondary mineral precipitation [1].

Again, aqua regia digests are compliant with the Puro ERW Methodology (Edition 2022 v2) but the data from Eion's project can't be directly compared to existing ERW studies that use total digestions. We recommend that Eion retains a subset of samples from future projects for total digestion analysis to provide a reference for comparisons.

2.2.1. Potentially Toxic Elements

Eion assesses the risk of PTE contamination due to olivine application on fields in the ERA, which was reviewed by both an external reviewer contracted by Eion and 350Solutions. Weathering material chemical composition was determined by sodium peroxide fusion, not aqua regia. The PTE contents of the weathering materials was compared to the United States Environmental Protection Agency's (US EPA) regulations for cumulative PTEs in land applied sewage sludge [4] (i.e., in kg/ha or kg/ha/yr) and the European Union (EU) Regulation 2019/1009 [5], which sets limits for PTEs in soil amendments and growth media. The concentrations of all regulated PTEs are below the more conservative limit, other than nickel (Ni), which meets the US EPA regulation, but not the EU regulation. However, as required by Puro's ERW methodology, the application of the higher regulatory limit is addressed in the ERA.

Chromium was included in the table of PTE limits in sewage sludge on the EPA website as of 2021 but has since been removed (current). However, Cr is not limited by the regulation (40 CFR § 503.13) and it is unclear why it was included in the earlier version of the EPA website. Still, the Cr limit from the EPA website were referenced in Eion's ERA and the weathering materials are compliant with this limit. The EU regulation does not set a limit on total Cr but sets a limit for hexavalent Cr (Cr(VI)), which is the more toxic form of Cr, of 2 ppm. Eion has analyzed their olivine sources for Cr(VI) content and all samples were below the method reporting limit of 0.40 ppm on a dry basis. Thus, the olivine sources are compliant with the referenced regulations.

2.3. CO_2 Removal Calculation

2.3.1. Initial CO_2 Removal

Initial CO_2 removal is determined by using soil samples collected on a 2.5-acre grid. Samples are digested in a 3:2 ratio of hydrochloric acid (HCl) and nitric acid (HNO_3), called aqua regia. First, the increase in nickel (Ni) before and soon after olivine application is compared to the concentration of Ni in the weathering material to determine the olivine application rate at that point. This application rate is then used to determine the mass of Mg added to the soil from olivine. Next, the amount of Mg leached is determined by subtracting the post-weathering Mg concentration from the calculated post-application Mg concentration. This is normalized to the amount of Mg added to determine the fraction of Mg weathered (f_w). Finally, f_w is multiplied by the potential CDR in olivine based on the Mg content to determine the observed gross CDR. The f_w results for each point are used in a Monte Carlo analysis to assess uncertainty in the method. Eion claims CORCs based on the 10^{th} percentile estimate of mean f_w.

2.3.2. Counterfactual Soil Weathering

Eion presented three methods for calculating the counterfactual weathering of soil based on control (no olivine application) data: porewater, soil, and a hybrid "flux" approach using both porewater data and agronomic soil data. Details on each of these methods are provided in Appendix 2.

Initially, Eion used the flux method to determine counterfactual soil weathering, which was approved by Puro. However, as clarified by Puro, the role of the auditor as described in Rule 6.4.1(c) of the ERW Methodology is to provide an opinion on the eligibility of the quantification method, which may or may not result in a change to the approved quantification method. It is 350Solutions' opinion that the flux approach is not eligible for the reasons described in Appendix 2. In this case, Puro deemed it appropriate to follow the auditor's opinion and requested that Eion revise their CORC claim using the soil approach. The soil method uses sample points where no olivine was applied in a method analogous to the method used to measure weathering in the treatment areas. The difference in Mg concentrations in the soil was simply calculated as the baseline Mg – Mg at the end of the monitoring period. This approach is the most conservative of the three approaches and is the most scientifically robust.

2.3.3. CO_2 Removal Losses

Discounts are taken for losses of CO_2 removal capacity including strong acid weathering (5.54%), plant uptake (default 5%), surface water losses (default 5%), and marine losses (default 10%). Strong acid weathering was calculated using the anion data from the lysimeter samples. The amount of Mg needed to charge balance the included acids (nitric, phosphoric, sulfuric, and hydrochloric acids) is determined from the concentrations of each acid in the lysimeter samples. This strong acid weathering is then extrapolated from the three-month measurement period (one growing season) to the full year. This results in a deduction of 5.54%. The remaining discount factors use the default values established by Puro in the ERW methodology.

2.4. Changes since Production Facility Audit and Previous Output Audit(s)

This is the initial audit for this Production Facility. The current state of the Production Facility is reflected in the reviewed audit package.

3. Production Facility and Output Audit Summary

3.1. Objectives

A planned series of audit activities (Table 4) was conducted by 350Solutions to independently verify the eligibility of the Twinterstellar 3021 following the guidelines of Puro General Rules (Edition 4.1) and Enhanced Rock Weathering Methodology (Edition 2022 v.2) and to validate the submitted CORC claim.

3.2. Responsibilities

The CO_2 Removal Supplier, Eion Corp, is responsible for the fair presentation of the Production Facility in the audit package. It is the responsibility of 350Solutions to express an opinion as to

whether the audit package supports Production Facility validation and CORC verification in accordance with the relevant Puro methodology.

3.3. Level of Assurance & Materiality

The Production Facility and output audit were completed with a reasonable level of assurance. The materiality threshold is guided by the Global Reporting Initiative (GRI) Universal Standards 3: Material Topics and European Sustainability Reporting Standards (ESRS) Implementation Guidance on Materiality Assessment [6], [7].

3.4. Validation and Verification Body Details

350Solutions Inc. declares that we are an impartial verifying body, free from any conflicts of interest, capable, and qualified to complete this validation and verification for the current operational period according to the Puro.earth General Rules.

350Solutions is an accredited inspection & verification body by ANAB under ISO 17020 for completion of ISO 14034 Technology Verifications and was the first accredited entity in North America for ISO 14034. 350Solutions is based out of Raleigh, North Carolina, USA. The Technical Lead for this audit is Lily Schacht. Quality assurance was provided by Zoe Sandwith. Complete auditor qualifications are attached as Appendix 5.

3.5. Methodology Applied & Eligibility

The audit was conducted following the specifications of the following Puro General Rules and Methodology:

- Puro.earth General Rules (Edition 4.1)
- Enhanced Rock Weathering Methodology (Edition 2022 v.2)

Production Facilities are eligible under these criteria if they meet the requirements described in Table 3.

Table 3. Requirements for Production Facility Eligibility

Requirement	Project Approach	Result
Activity is "capable of storing carbon dioxide in the form of carbonate and bicarbonate ions or solid carbonate minerals via the application of a weathering material to one or several application sites,"	The weathering of olivine rock results in the formation of carbonate and bicarbonate ions or solid carbonate minerals, depending on the soil conditions.	Eligible
The weathering material is applied to soil, and not in constant or nearly constant direct contact with a body of water	Eion applies olivine to farmland, not a body of water.	Eligible
All application sites comprising the Production Facility are subject to the same environmental and other relevant regulations	The only state-specific relevant regulations are regarding soil amendment labeling. The olivine was	Eligible

	registered as a soil amendment in both Louisiana and Mississippi.	
All application sites have broadly consistent:		Eligible
Geographic Location	All application sites are in the Lower Mississippi River Basin. See Appendix 5 for locations of individual sites.	Eligible
Climatic Conditions	All sites are in a humid subtropical climate region.	Eligible
Type of applied feedstock	All sites were spread with ground olivine rock.	Eligible
Soil type	All sites have a silt loam soil type	Eligible
Risk profile related to PTEs	As a result of similar properties for the previous four requirements, the risk profile related to PTEs is consistent between sites.	Eligible
The application sites correspond to the Production Facility of CO_2 Removal Certificates	The Production Facility is made up of several non-contiguous application sites.	Eligible
A Production Facility has undergone a process of third-party verification by a duly appointed auditor performing a Production Facility Audit.	This report contains the results of the Production Facility Audit. Additional requirements are discussed in the following sections of this report	Eligible
The Production Facility Auditor collected and checked the standing data of the CO_2 Removal Supplier and the Production Facility.	The Audit Package provided by Eion was reviewed and included the following requirements: 1. A certified trade registry extract 2. CO_2 Removal Supplier registration in the Puro Registry 3. Location of the application sites forming the Production Facility 4. Whether the Production Facility has benefited from public financial support 5. Date on which the Production Facility becomes eligible to issue CORCs	Eligible

3.6. Approach

The validation and verification process activities are described in Table 4. Appendix 1 contains the list of findings identified throughout the validation and verification process. Photographs of the facility, equipment, and operations are provided in Appendix 3. The list of files that were reviewed are listed in Appendix 4. Verifier qualifications are attached as Appendix 6.

Table 4. Validation and Verification Activities

Date(s)	Activity	Tasks	Documents Reviewed
June 18 – June 29, 2025	Initial Audit Package Review	- Review ERW Methodology Requirements - Compare audit package information to methodology requirements - Recalculate CORC claim	See Appendix 4
July 22, 2025	Site Visit	*See Appendix 3 for additional details*	N/A
July 1 – September 2, 2025	Additional Document Review	- Review additional supporting evidence for the items provided in the audit package	See Appendix 4
September 2 – 8, 2025	Report writing	- Write report describing all audit activities and outcomes	N/A
September 8 – 9, 2025	Quality assurance and revisions	- Independent review of audit result	N/A
September 10 – 17, 2025	External review and revisions	- Report review by Puro	N/A

3.7. Production Facility Boundary

The emission sources within the system boundary for this Production Facility are listed in Table 5. Emissions associated with project establishment (weathering material transport and application) are amortized over 2 years. This reporting period is 1.57 years.

Table 5. Emission Sources within the System Boundary

Category	Emission Source	Quantification Method
$E_{Sourcing}$	N/A – weathering material is a waste byproduct	N/A
$E_{Processing}$	N/A – weathering material is a waste byproduct	N/A
$E_{Transport}$	Quarry Transport	N/A – Weathering material was already at warehouse
	Loading for Rail Transport	Distance-based EPA emission factor used with the average distance from warehouse to rail loading station and number of trips from bills of lading
	Rail Transport	Distance and mass-based EPA emission factor with average distance and tonnes of feedstock used for deployments
	Distribution Facility to Farm Transport	Distance-based EPA emission factor with average distance to farm and number of truck loads

$E_{Application}$	Feedstock Bags – Production and Disposal	DEFRA Polypropylene emission factors for bag production and disposal. Number of bags estimated based on capacity and olivine delivered
	Spreader Application	EPA Diesel emission factor with estimated fuel use
$E_{Weathering}$	Sample Collection – Field Transport	EPA Gasoline emission factor with estimated fuel use
	Sample Collection – Lab Transport	Distance and mass-based EPA emission factor with mass of sample and distance from shipping facility to testing lab
	Lab Analysis	Cost-based EPA emission factor with actual sample cost
	Sample Collection Bags – Production and Disposal	DEFRA plastic film emission factor with number of samples and bag weight

4. Crediting Details

4.1. Crediting Period

The crediting period for this Production Facility is May 10, 2023 – May 9, 2028. This is the first crediting period for this Production Facility.

4.2. Monitoring Period

This is the first monitoring period for this Production Facility, spanning May 10, 2023 – December 3, 2024. Only sites where the Twin Sisters weathering material were used are included in this monitoring period.

5. Production Facility and Output Audit Results

5.1. Accuracy of the Statement

The values represented in the CORC Summary have been evaluated and cross-referenced with the presented evidence. Confirmation of CORC quantification and other requirements has been based on the following efforts:

- Recalculation of C_{stored} from soil data
- Recalculation of counterfactual weathering using the three approaches described in the Monitoring Plan: aqueous, solid-phase, and flux
- Review and recalculation of $E_{project}$ and supporting documents
- Recalculation of losses from strong acid weathering
- Confirmation of default loss terms for plant uptake, pedogenic carbonate precipitation, surface water losses, and marine losses

- Confirmation that the methods used for analysis are appropriate and required quality assurance procedures are in place

Issues identified during the audit process are listed in Appendix 1.

5.2. CORC Calculation

Each term in the CORC calculation was recalculated where possible, or the justification reviewed, where direct recalculation was not possible. The terms and corresponding values for this monitoring period are listed in Table 6.

Table 6. CORC Calculation for the Monitoring Period from May 10, 2023 – December 3, 2024

Parameter*	Initial Submission** (tonnes CO_2e)	Final Submission** (tonnes CO_2e)	Source
CORCs	**1315.99**	**748.31**	**ERW Methodology Rule 6.3.1**
C_{stored}	2255.10	1492.75	See Section 2.3
$C_{stored, gross}$	2836.64	2836.64	See Section 2.3.1
$C_{counterfactual\ weathering}$	581.54	1343.89	See Section 2.3.2
$E_{Project}$	345.24	363.27	See Section 3.7
$E_{leakage}$	0	0	Weathering material is a waste product and does not cause leakage. No other leakage risks were identified.
E_{loss}	575.84	381.17	25.5%***
Plant uptake	112.76	74.64	5%, default
Strong acid weathering	124.03	82.70	5.5%, See Section 2.3.3
Pedogenic carbonate precipitation	0	0	0%
Riverine losses	112.76	74.64	5%, default
Marine losses	225.51	149.28	10%, default

* Parameters as defined in Section 6.1 of the ERW Methodology

** Values have been rounded and may not add up without error.

*** Per ERW Methodology Rule 6.7.3, losses are calculated as an additive discount rather than multiplicative. A multiplicative discount would account for the decreased CO_2 flux as the weathering products travel from the soil to river to ocean and result in an overall lower deduction of 23.5%. Because the additive approach is required by the methodology and results in a more conservative estimate of CO_2 removal, it is used here.

5.3. Production Facility and Output Audit Opinion

350Solutions has reviewed the documentation of the technology, the instrumentation, the procedures, and performance and has found that the data presented in the Twinterstellar 3021 audit package and the site visit:

☒ ***Meets the requirements of Puro General Rules (Edition 4.1) and Enhanced Rock Weathering Methodology (Edition 2022 v.2)***

☐ ***Meets the requirements of the Puro General Rules (Edition 4.1) and Enhanced Rock Weathering Methodology (Edition 2022 v.2) with minor modifications***

☐ ***Does Not Meet the requirements of Puro General Rules (Edition 4.1) and Enhanced Rock Weathering Methodology (Edition 2022 v.2)***

Our opinion is provided with a reasonable level of assurance for Eion's activities in the Twinterstellar 3021 project area and weathering material sourcing.

Notice: 350Solutions, Inc. declares that we are an impartial auditor, free from any conflicts of interest, capable, and qualified to complete this audit according to the Puro.earth General Rules and related Validation and Verification Body Requirements. Verifications and audits conducted by 350Solutions are based on an evaluation of technology performance and CO_2 removal claims via site visit observations and review of data submitted by the audited company. Audits are completed in accordance with rules and methodologies specified by Puro.earth and utilizing the appropriate quality assurance procedures established under the 350Solutions accredited ISO 17020/14034 Quality Management Program, noting that this verification is not a fully compliant ISO 14034 verification. 350Solutions makes no expressed or implied warranties as to the performance of the technology and does not certify that a technology will always operate at the levels verified, nor that it meets all state, local, or federal legal requirements.

By adhering to the requirements of the Puro General Rules (Edition 4.1) and Enhanced Rock Weathering Methodology (Edition 2022 v.2), Eion's Twinterstellar 3021 Production Facility has been validated as eligible for CORC issuance.

Auditor Information		
VVB	**Lead Auditor**	**Audit ID No.**
350Solutions, Inc.	Lily Schacht	PU2505

Signed: Lily Schacht (Lead Auditor)

Lily Schacht
Digitally signed by Lily Schacht
Date: 2025.09.18 09:40:05 -04'00'

Zoe Sandwith (Quality Assurance)

Zoe Sandwith
Digitally signed by Zoe Sandwith
Date: 2025.09.18 06:41:59 -07'00'

5.4. Summary of Audit Findings

The final assessments of each of the major categories in the ERW Methodology are summarized in Table 7.

Table 7. Summary of Audit Findings

Category	Assessment
Baseline Characterization	Without the project, the weathering materials would have been used as a construction aggregate filler or landfilled, which would have prevented weathering. The baseline farm practices are applying aglime, as needed.
Stakeholder Consultation	Farmers are the primary group of stakeholders for this project. Potential farmers were invited to presentations where Eion described the enhanced rock weathering process and the

	impacts of olivine application on farmland. Eion's stakeholder engagement process is described in the Stakeholder Engagement Report.
Environmental and Social Safeguards	Eion meets all requirements for environmental and social safeguarding, as described in their Environmental and Social Safeguards Questionnaire and supporting evidence. The environmental risk assessment (ERA) was reviewed by a third party. The third party issued a list of corrections that Eion implemented before submitting the audit package to 350Solutions. The ERA did not take place before spreading, which Puro granted a deviation for by email on July 21, 2025.
Additionality	Eion satisfies requirements for environmental, regulatory, and financial additionality. The olivine would not be able to weather without Eion's project. The project is not required by any relevant regulatory body and is not financially viable without carbon finance.
Permanence and risk of reversal	Bicarbonate storage in the ocean, as is produced by ERW, is considered durable for >1000 years [1]. Once the weathering material is applied, it is extremely unlikely that CO_2 removal can be intentionally prevented or reversed. Known natural reversal mechanisms include plant uptake and losses due to CO_2 degassing and carbonate precipitation in water bodies (rivers and oceans). Estimates of these extent of these reversal mechanisms are described in Section 2.3.3.
No Double-Counting	Eion provided signed agreements from all partners (weathering material suppliers, growers, and agronomic consulting partner) stating that Eion has sole right to the removals generated by this project. The removals from this project will only be issued from Puro.
Leakage	The primary leakage (indirect emissions) risk for this project is additional quarrying of olivine due to the consumption of olivine rock powder by Eion. The weathering material suppliers have confirmed that the material is a waste product that would otherwise be stored in warehouses or used as a low-value filler in construction. The other major component of project emissions is the fuel use from transportation and spreading. Well-to-wheel emissions factors are used to ensure all emissions are accounted for. At this scale, no increase in fossil fuel extraction is expected due to the project.
Resolution of Findings from Previous Audit(s)	N/A – this is the first audit for this project.
Data Quality and Uncertainty	The data presented by Eion was complete and appropriate data quality checks were implemented. Uncertainty was quantified using Monte Carlo analysis for $C_{stored,\ gross}$ and $C_{counterfactual\ weathering}$.
CORC Calculation	See Section 5.2

6. Revision History

Version	Date Issued	Noted Changes
Draft Version 1.0 (v1.0)	September 8, 2025	N/A
Draft Version 1.1 (v1.1)	September 10, 2025	Edits following internal review
Draft Version 1.2 (v1.2)	September 17, 2025	Edits following review by Puro
Final Version 1.3 (v1.3)	September 18, 2025	Minor edit following review by Eion

7. References

[1] Cascade Climate, "Foundations for CDR Quantification in ERW Deployments." Oct. 2024. Accessed: Jan. 20, 2025. [Online]. Available: https://cascadeclimate.org/CC_Foundations%20for%20CDR%20Quantification%20in%20ERW%20Deployments.pdf

[2] T. Reershemius *et al.*, "Initial Validation of a Soil-Based Mass-Balance Approach for Empirical Monitoring of Enhanced Rock Weathering Rates," *Environ. Sci. Technol.*, vol. 57, no. 48, pp. 19497–19507, Dec. 2023, doi: 10.1021/acs.est.3c03609.

[3] I. B. Kantola *et al.*, "Improved net carbon budgets in the US Midwest through direct measured impacts of enhanced weathering," *Glob. Change Biol.*, vol. 29, no. 24, pp. 7012–7028, 2023, doi: 10.1111/gcb.16903.

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[5] "Regulation - 2019/1009 - EN - EUR-Lex." Accessed: Sep. 09, 2025. [Online]. Available: https://eur-lex.europa.eu/eli/reg/2019/1009/oj/eng

[6] Global Reporting Initiative, "Universal Standard 3: Material Topics 2021." Jan. 01, 2023.

[7] EFRAG, "ESRS 1 General Requirements." Accessed: Aug. 18, 2025. [Online]. Available: https://www.efrag.org/sites/default/files/media/document/2025-07/Amended_ESRS_Exposure_Draft_July_2025_ESRS_1.pdf

[8] A. Gransee and H. Führs, "Magnesium mobility in soils as a challenge for soil and plant analysis, magnesium fertilization and root uptake under adverse growth conditions," *Plant Soil*, vol. 368, no. 1, pp. 5–21, Jul. 2013, doi: 10.1007/s11104-012-1567-y.

Appendix 1: Log of Findings

All material clarifications, misstatements, and omissions have been resolved.

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
1	Clarification	25-Jun	Financial Additionality	How is the payment from farmers for CarbonBuilt accounted for in the finances?	Project Financials (pro forma)_Twinterstellar 3021	3.2.3	Farmers pay our partner, AGRIgate, Inc./Southern Ag (AGRIgate is the parent company of Southern Ag), for trucking and application, not us. We subsidize the cost for farmers.	Clarification provided	7-Jul-25
2	Clarification	25-Jun	Financial Additionality	How is the amount charged to the farmers determined? It seems like it ranges from $0-41 or more?	Statements of non-double counting nor claiming by associated parties_Twinterstellar 3021	3.2.3	Range is because costs are determined by total trucking distance (i.e., from the port/storage facility to the farm/fields). This customized approach helps to mirror growers' existing approach to operations for seamless integration (whereas something like a flat charge would create more or less benefit for different famers depending on their location).	Clarification provided	7-Jul-25

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
3	Clarification	25-Jun	Financial Additionality	Please describe financial agreement between Eion and AGRIgate. Does Eion pay for AGRIgate services?	Project Financials (pro forma)_Twinterstellar 3021	3.2.3	Yes, we pay AGRIgate for trucking, application, and soil sampling (those costs in the pro forma are paid to AGRigate). We retain ownership of the CarbonLock/olivine and any assoicated carbon removal claims. In the AGRIgate contract, CarbonLock/olivine is provided to the grower as an all-in service which includes trucking and application. Eion pays Southern Ag for the distribution of the product at the beginning of the season, and Southern Ag manages the entire process for both Eion and the grower. This includes soil sampling. Additional details in "AGRIgate - Eion Ag. Services Agreement with Exhibits_EXECUTED_20230331.pdf" in the Administrative documents folder.	Clarification provided	7-Jul-25
4	Misstatement	25-Jun	Project Details	Please provide the location of the Twin Sisters Quarry - 15540 N Lombard St, Portland, OR 97203 appears to be a distribution hub	Puro Project Description_Twinterstellar 3021_v1.4	5.2.1	Provided an updated version of the file with quarry location.	Update provided	7-Jul-25

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
5	Clarification	25-Jun	Project Details	Is the commitment date of the project January 4, 2023 or April 1, 2023? Generally, it is preferred to either use year-month-day format or spell out the month because Finland uses a different date format from the US	Puro Project Description_Twinterstellar 3021_v1.4	5.2.2	January 4, 2023 (format is year-month-day, consistent with Puro's requested formatting elsewhere in the doc).	Clarification provided	7-Jul-25

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
6	Clarification	26-Jun	Monitoring Plan; Stakeholder Engagement	Understanding that there has not been any documented evidence of decreased yield with olivine application, in the unlikely case that a grower observes a decrease in yield, what happens?	Puro Stakeholder Engagement Report_Eion_Twinterstellar 3021_v1.3	7.4.3	All available evidence indicates that the yield impact to olivine is neutral to positive and shows that in the range we operate (that is, between pH ~5.5 to pH ~7.5) the yield improvements are trivial relative to other sources of variance in yield. If a grower were to have a field where there was a negative yield after olivine addition, the available evidence suggests that this would most likely be an outcome of random chance or stressors unrelated to olivine application. If all treated fields showed a yield decline, we would need to investigate whether there is an agronomic explanation that is uniquely attributable to the added olivine, and not, for example, a widespread phenomenon like a weather event or pest/disease. Under most circumstances, our randomized control trials would have sufficient contextual data to interpret how the grower's field deviated from idealized conditions, but offhand we don't know what those would be. A one-time application (i.e., no plans to reapply to any fields) closely equivalent to typical lime application rates also decreases risk, but Eion would help growers investigate any affected fields and discuss next steps with them.	Clarification provided	7-Jul-25

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
7	Omission	26-Jun	Social Safeguards	How do you confirm that AGRIgate meets labor practices and rights requirements?	Puro Environmental and Social Safeguard_Twinterstellar 3021v1.1	General Rules 6.4.1.1, 6.4.3	AGRIgate/Southern Ag have been thoroughly vetted by our internal compliance team and external legal counsel to ensure adherence to labor practices, rights requirements, and "Know Your Customer" (KYC) legal considerations at the onset of the partnership. They maintain compliance through a robust operational framework aligned with the Fair Labor Standards Act (FLSA), Occupational Safety and Health Administration (OSHA) standards, and applicable state regulations. Their internal policies include regular monitoring of labor practices across their supply chain, periodic employee training to ensure awareness of labor rights and responsibilities, and contractual obligations requiring all partners to comply with jurisdictional laws. Additionally, AGRIgate's participation in U.S. Department of Agriculture (USDA) and other government programs mandates strict adherence to documented labor standards, subject to regular audits. Confidential grievance mechanisms are in place to address any concerns, ensuring a fair and ethical work environment.	Additional information provided	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
8	Clarification	26-Jun	Environmental Safeguards	How are growers asked to report Mg and Ni use? Provide exact wording used	Puro Environmental and Social Safeguard_Twinterstellar 3021v1.1	6.4.1	Eion and Southern Ag ask growers to notify us (preferably via email, describing the applicable field boundary, field name, application rate, chemical composition of material applied, and application date) if they plan to apply any product containing Ni or Mg as part of their regular operations (outside of olivine application). Southern Ag has working relationships with the growers, so usually privy to any other potential applications.	Clarification provided	7-Jul
9	Nonconformity	26-Jun	Monitoring Plan	There are several unanswered internal questions and unclear instructions in the Field Ops SOP. Please revise the SOP such that a new employee could follow the directions without needing to ask follow-up questions.	Eion_Field Ops SOP	7.4.3	This is an old file that should have been moved to the Archive folder, apologies. No longer needed/relevant since updated information is included in the Monitoring Plan.	SOP moved to archive folder	7-Jul
10	Omission	26-Jun	Monitoring Plan	What is included in Waters "Basic 2" analysis and Act's "UT-4M-Eion" Analysis? It is recommended that you spell this out in the SOP in case the labs change their analysis codes	Eion_Field Ops SOP	7.4.3	This is an old file that should have been moved to the Archive folder, apologies. No longer needed/relevant since updated information is included in the Monitoring Plan. Detailed information regarding material and soil analysis (and the relevant tests) included in sections E3 and E4 in the Monitoring Plan.	SOP moved to archive folder	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
11	Clarification	26-Jun	Monitoring Plan	What is the status of your internal software?	Eion_Field Ops SOP	7.4.3	Following the major.minor.patch format for softwarre versioning, will benchmark the present version of the codebase (that is reproducable) upon validation/verificaion of the initial batch of Twinterstellar 3021 credits. Stored in private GitHub in separate branches.	Clarification provided	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
12	Forward Action Request	26-Jun	Social Safeguards	Grievance mechanism should allow for anonymous feedback and invite feedback from community other than growers	Contact for grievances_Twinterstellar 3021	4.3.5, 4.5.3	In addition to a dedicated inbox for contacting Eion via our website (anonymously or not), one of the benefits of using an ag partner like AGRIgate/Southern Ag is that farmers and community members already have a relationship with the group and might use them for other services. Eion and AGRIgate also shared all contact information (websites, emails, and phone numbers) at the initial public meeting/stakeholder consultation and advocated for continuing communication, welcoming all and any feedback. Any stakeholders, whether they are participating in the project or not, may submit grievances directly to Eion or AGRIgate representatives (which can be shared with us anonymously). We also work closely with a contractor that lives and farms in the community and is able to collect feedback and provide advice on Eion's behalf. Thanks to this hands-on approach with stakeholders, Eion is able to make immediate changes if/when necessary to ensure a positive impact in the project and region.	Farmers are not the only relevant stakeholders for this project. The community surrounding the project area should also be included in stakeholder engagement. Neighbors may be concerned about dust migration and water quality from project activities and may not have the same relationship to AGRIgate	This does not need to be (and can't be) changed retroactively but a truly anonymous method for all community members to provide feedback is needed for future output audits

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
13	Clarification	26-Jun	Social and Environmental Safeguards	Slide 5 - How was the increase in bacteria involved in nitrogen cycling determined (i.e., what method was used to quantify this?) Were fungi measured? Please upload the raw data.	Eion - Agronomic Supplement	4.4.5	This slide/doc and data is not specific to the Twinterstellar project, but something conducted and used by Eion for more general/informational purposes. Genomics work was conducted by BiomeMakers; the methods overview and complete results were shared with us. There are no “raw” data per se, the raw data is retained by BiomeMakers and we get the summary report. The results say “preliminary” as we thought we would analyze more samples, but we did not. Uploaded files "Brochure Gheom 2021_ENG.pdf" and "Eion_Basil_T0-T1_Preliminary analysis" for additional details.	See item 34 - The statement "YES: Microbes in nitrogen cycling show enhanced activity" is not an accurate interpretation of the results provided by BiomeMakers. The increase in relative abundance of bacteria related to nitrogen cycling does **not** indicate that the **activity** of these microbes has increased. The slides provided by BiomeMakers specifically say "Treatment tends to increase mineralization and mobilization of nitrogen (**possibly significant** with more replication)" indicating that the potential trend is not statistically significant	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
14	Clarification	26-Jun	Social and Environmental Safeguards	For all plots with application rate on the x-axis, do the trends hold if only the actual application rate (2 or 8 t/ha) used at scale is considered? The only statistically significant increase in yield was in the 32 t/ha treatment.	Eion - Agronomic Supplement	4.4.5	We present no regressions, only averages for each treatment. One may see that in some cases the 2 t/ha treatment level exceeds the macro trend (e.g., plant N, Ca, K uptake, slides 6 and 7). One may see that in other cases, the response surface appears to be concave down (slide 4), and the 2 t/ha treatment shows an increase (over 0 t/ha) that the same or larger than (say) the 2=>8 t/ha or 8=>32 t/ha.	See item 34. It is misleading to claim impacts that are only statistically significant at application rates much higher than those used in practice, particularly if there was no observable impact at the lower application rates.	7-Jul
15	Omission	26-Jun	Social and Environmental Safeguards	Was CarbonLock registered with Mississippi and Louisiana in 2023? 2024 registrations were provided	Louisiana Approval; Mississippi Approval	4.4.2	The most current registrations at time of the first submission to Puro were included. Both were first/finally registered in 2024 (the processes started a year and years earlier). The material is registered as a soil and plant amendment in MS and liming agent in LA. Farmers paid Southern Ag for trucking and application (but not the material, Eion gave it to the growers and subsidized their additional costs, so it was not required to be registered in 2023 when applied).	Continued as finding 15a	Continued as finding 15a

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
15a	Clarification	3-Jul	Social and Environmental Safeguards	Your answer implies that the products were not registered in LA at the time of spreading. Is that correct?	Louisiana Approval; Mississippi Approval	4.4.2	Response was updated in the initial submission to better clarify details but does not appear to be captured in this log. Original submission was on July 2 and response was updated on July 3, before the new log was issued on July 9. I included the response and can add that while the original application was deemed "experimental" (due to no registration and no cost), Eion still acquired state registrations after application to assure growers/stakeholders that CarbonLock meets necessary requirements.	Clarification provided	17-Jul
16	Clarification	27-Jun	CORC Calculation	Are you only claiming CORCs for the Twin Sisters fields?	CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12 v1.5	6.4.1	Yes, for this initial submission. We will submit claims for fields that received the 3021 material later this year.	Clarification provided	7-Jul
17	Clarification	27-Jun	CORC Calculation	Which notebook was used for the CORC calculation - "Code-CDR quantification" or "CDR Quant_Code_All TS Fields_MP1"	N/A	6.4.1	CDR Quant_Code_All TS Fields_MP1 is used for CORC calculation. Code-CDR quantification functions describes the functions imported into the CDR calculation code.	Clarification provided	9-Jul
18	Clarification	27-Jun	CORC Calculation	What is the difference between Mapplied and AR?	Code-CDR quantification	6.4.1	Mapplied is total tonnes deployed = area * AR. AR = application rate of material.	Clarification provided	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
19	Clarification	27-Jun	CORC Calculation	How is mineral potential calculated?	Code-CDR quantification	6.4.1	Per page 26 in the Monitoring Plan: The mineral potential (MP) of our olivine mineral is determined using the following equation: MP [tCO2e/tOre] = MW_CO2 / 100 * (MgO%/MW_MgO) * V where MgO% is the mass fractions of magnesium oxide in the mineral. MW_CO2 is the molecular weight of CO2 (i.e., 44 g/mol), and V is the valence of the cation (+2 for Mg in this instance).	Clarification provided	7-Jul
20	Clarification	27-Jun	CORC Calculation	There are three notebooks/pdfs for natural background weathering. Please clarify which was used for the CORC calculation and provide the notebook with any functions and data required to run the code	07. Monitoring plan	6.4.1	Per the Monitoring Plan, the flux-based approach (after consultation with Puro) is utilized for our background deduction (i.e., file = Natural Background Weathering_Flux-based code_20250602). The file includes all functions and data to cacluate our final claim.	Clarification provided	7-Jul
21	Omission	27-Jun	CORC Calculation	Do you have a complete written description of the approach used to quantify the weathering process and the expected carbon removal? (See methodology requirement 6.2.4)	N/A	6.2.4	Yes, Section G in the Monitoring Plan.	Document provided	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
22	Clarification	27-Jun	CORC Calculation	How were points where the Ni decreased between the baseline and t1 samples handled?	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	We include the points to capture variability/noise in the fields/data (to better account for any uncertainty). Additionally, we expect some change since Ni is not fully immobile (the extent of the change can range so all points are still included). This approach captures results that can plausibly be attributed to random variability for conservativeness. AR is calculated per the change in Ni concentration from t0 vs. baseline.	Continued as finding 22a	Continued as finding 22a
22a	Clarification	17-Jul	CORC Calculation	From "Code-CDR quantification functions," it seems that dNi (and thus AR) is calculated from the change in Ni pre- and post-. dMg is also calculated from pre- and post-, implying that "post-" in this situation is t0 not t1. Can you please clarify?	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	When a first_post df is added as an argument to the run_prepost_permutation function, it uses the nickel from that column to calculate appliation rate. The line post['Ni'] = first_post['Ni'] assigns the nickel from first_post (i.e. post app) to nickel from post (i.e. t1) to calculate app-rate. But for magnesium the values from post are used. So first post = t0, post = t1. This is because we need Mg loss at t1, not at t0 (and therefore don't have Mg t0). So we use Ni at t0 (first post) to calculate Mg added. Then we use Mg t1 to see how much of the added Mg has weathered.	Clarification provided	5-Aug

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
23	Clarification	27-Jun	CORC Calculation	How were points where the Ni changed between t0 and t1 handled?	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	We include the points to capture variability/noise in the fields/data (to better account for any uncertainty). We expect some loss post application since Ni is not fully immobile (the extent of the change can range so all points are still included). This approach captures results that can plausibly be attributed to random variability for conservativeness.	Continued as finding 23a	Continued as finding 23a
23a	Clarification	17-Jul	CORC Calculation	According to "CDR Quant_Code_All TS Fields_MP1," these fields are filtered out. Please clarify.	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	The fields that are filtered out are the ones that have a lower avg nickel after receiving rock, that is where Ni_baseline > Ni_t0. If a field on average has a lower nickel concentration after receiving rock, it is conservatively discarded from analysis. Individual points are not considered in this filtering. Otherwise, Ni t1 is not used for any further calculations, but we capture/ include it to monitor how mobile nickel is.	Clarification provided	6-Aug
24	Clarification	27-Jun	CORC Calculation	Is fw calculated as an average across all fields or calculated separately for each field?	Code-CDR quantification	6.4.1	Average across all fields given the similar climatic conditions, soil type, and material applied.	Clarification provided	9-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
25	Clarification	27-Jun	CORC Calculation	How were points where Mg decreased between the baseline and t1 handled?	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	After consultation with Puro, it was agreed that we should continue to include the points to capture variability/noise in the fields/data (to better account for any uncertainty). Per Section G1 in the Monitoring Plan (p. 27): Eion relies on all field samples pulled and analyzed to calculate Cstored: none are omitted. This includes any scenarios from samples/fields where Mg_baseline > Mg_t1 or Mg_t1 >Mg_t0. This approach captures results that can plausibly be attributed to random variability for conservativeness	Continued as finding 25a	17-Jul
25a	Omission	17-Jul	CORC Calculation	Please provide Mg_t0 data (See item 40)	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	There is no Mg t0 data. Apologies for the confusion. Full response included for item 40.	Clarification provided	5-Aug
26	Clarification	27-Jun	CORC Calculation	How do application rates calculated from Ni compare to rates from as-applied maps?	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	Very, very close! Provided file "dNi-vs-AA-xcomparison.pdf."	Clarification provided. Note that upon further investigation, this is not a meaningful check as the bulk density used to calculated dNi is tuned from the as-applied maps. (Page 21 in monitoring plan)	7-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
27	Omission	27-Jun	CORC Calculation	Can you provide SOPs for the methods used by Waters? I only found the aqua regia digest.	N/A	6.4.1	Added file "SOP-01.107 - ICAP Mehlich 3 Extraction.pdf" from Waters that covers the other method used.	Continued as Finding 27a	Continued as Finding 27a
27a	Continued from Finding 27	17-Jul	CORC Calculation	Please provide SOPs for: wpH, CEC, SOC, OM	N/A	6.4.1	See files "Waters_SOP-01.104 Soil pH Soil-Water Ratio.pdf" and "Waters_OM_LOI_SOP.pdf." Waters noted that CEC is just a calculation from the cations. And we calculate SOC from OM.	SOPs provided	17-Jul
28	Clarification	27-Jun	Monitoring Plan	Were the feedstock samples from both sources analyzed individually for PSD, chemical composition, mineralogy, and trace elements? I see 1 sample from each source, but you took more than 1 sample from each	CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.5	7.4.4	Individual files for different analysis but they contain results from multiple stockpile samples for both the TS and 3021 materials.	Clarification provided	7-Jul
29	Nonconformity	3-Jul	ERA	Can you provide evidence that the ERA was completed before the decision to apply the feedstock was made? The first version of the ERA is dated July 31, 2024 and the Actlabs report is dated October 27, 2023, which was after all TS material had been applied	COA_TS Eion_ERA_Twinterstellar 3021_FINAL_v	4.5.8	The ERA was not completed prior to application for the Twinterstellar 3021 project. Eion started the project before identifying a registry/methodology to use for development. However, since this was/is one of Eion's first projects, Puro granted Eion an exception. See file "Puro ERA Exception.pdf."	Exception provided	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
30	Nonconformity	7-Jul	ERA	Exponent's review of the ERA does not consider the risks of radionuclides or asbestos in the weathering material	Exponent_Eion ERA Third Party Review_Edits_v1.1	4.5.10	The file is the final memo issued by Exponent after multiple rounds of back-and-forth and versions of the ERA. Questions they had regarding the characterization, evaluation, and organization of radionuclide and asbestos risks were answered during an earlier call, so no questions remained when the memo was issued.	Written exception from Puro provided	5-Aug
31	Nonconformity	7-Jul	ERA	Did Exponent review the ERA after the edits on pages 3-24 of their assessment were addressed by Eion?	Exponent_Eion ERA Third Party Review_Edits_v1.1	4.5.10	No, that was their final review and deliverable. Per Puro's request, we addressed and incorporated all comments/suggestions from Exponent's review and provided the file as evidence to document changes added to the latest version.	Written exception from Puro provided	5-Aug
32	Nonconformity	7-Jul	Monitoring Plan; ERA	Yield monitoring does not appear to be discussed	Twinterstellar 3021_Monitoring Plan_v1.5	7.4.3	Added additional language/clarity to Section E2 regarding yield monitoring and Section E1 mentions crop analysis under Field Trials/Control Plots. Uploaded file "Twinterstellar 3021_Monitoring Plan_v1.6.pdf."	Monitoring plan modified	17-Jul
33	Nonconformity	7-Jul	Monitoring Plan; ERA	Soil organic carbon monitoring does not appear to be discussed	Twinterstellar 3021_Monitoring Plan_v1.5	4.4.6	Added language to Section E4 regarding SOC. Uploaded files "Twinterstellar 3021_Monitoring Plan_v1.6.pdf" and "USDA_NRCS_SOM_SOC.pdf."	Monitoring plan modified	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
34	Clarification	7-Jul	Social and Environmental Safeguards	Were these slides presented to potential farmers? What is the purpose of this slide deck?	Eion - Agronomic Supplement	N/A	Slide deck was presented to growers at the initial stakeholder meeting/consultation conducted at the beginning of the project. It was included to share that a preliminary study showed that no harm to crops had occurred after application of CarbonLock. Regardless of any data or information on the slides, Eion stressed that our studies were limited at the time and did not advise growers that the product would increase yield (simply that combined with other literature available, we did not expect negative effects and it could be an effective option for neutralizing soil acidity). The slide deck was otherwise not distributed.	Clarification provided	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
35	Clarification	7-Jul	Social and Environmental Safeguards	How were the potential health risks communicated with stakeholders, including but not limited to farmer?	Eion - Agronomic Supplement Puro Stakeholder Engagement Report_Eion_Twinterstellar 3021_v1.2	4.3.3, 4.3.4	Labels and MSDS are supplied. And despite no risks actually identified (i.e., we take and evaluate measurements and also completed an ERA, obtained a third-party review by a team of experts, and the conclusion was there is a very low risk of adverse effects), Southern Ag helps/helped regularly communicate potential health concerns, how they are monitored, and test results with growers/the larger community throughout their everyday interactions (also gathering real-time feedback to share directly with Eion). Eion also has safety information publicly available on its website and acquired legal guidance regarding safety and requirements of using the material in agriculture. Further, Eion has spoken with elected representatives from the region several times regarding CarbonLock and our project, including U.S. Sen. Hyde-Smith, U.S. Sen. Wicker, U.S. Rep. Guest, and U.S. Rep. Graves.	Clarification provided	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
36	Clarification	7-Jul	ERW Simulation Model	What data was used to validate the model? What is the difference between the initial and validated model results? The description in"Eion's Model_Requirements for ERW Simulation Models" describes validation in the future tense but it seems that some model tuning has occured?	Kinetic model write-up Eion's Model_Requirements for ERW Simulation Models Model Validation Report Twinterstellar 3021_Initial simulation_Model export Twinterstellar 3021_Validated simulation_Model export	8.2.7	The model uses data from direct measurements and public datasets. Initial model was run with estimated values. The model was then calibrated with updated application site conditions: specifically temperature and soil pH (feedstock values remain unchanged per direct measurements pre-deployment). Validated using experimental data.	To discuss with Puro	5-Aug
37	Omission	7-Jul	CORC Calculation	Please provide the spreadsheets with soil chemical composition data from ActLabs	Twinterstellar 3021_Application Sites_TS Fields Data	6.4.1	Per the Monitoring Plan, Eion contracts Waters Agricultural Laboratories, Inc. (i.e., Waters Lab) for soil analysis (section E4.1). Activation Laboratories Ltd. (i.e., Actlabs) is used for material analysis (section E3.1). Soil data from Waters can be found in the Soil Samples_Raw Data Files folder and feedstock data from Actlabs can be found in the Weathering material characterization_Twinterstellar 3021 folder.	Files provided	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
38	Clarification	8-Jul	LCA	What happened with the 630 mt of feedstock applied on fields with field-level data?	LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.2	6.1	Per Sections D and G4 of the Monitoring Plan, we aren't including/claiming 630.20 mt of the total material due to issues with field-level data (i.e., missing samples and/or field issues). Thus, despite applying the material to fields, those tonnes/acres are unable to be used in CDR quantification and are simply a loss and conservatively excluded from any claims.	Clarification provided	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
39	Nonconformity	9-Jul	CORC Calculation	18 of 122 fields are outliers wrt. soil clay content (mean +/- 1.5IQR) and can't be grouped with the rest of the sites to calculate Cstored	Twinterstellar 3021_Application Sites_TS Fields Data	3.1.1	Per our conversation on 7/14/25, uploaded files "Soil clay % distribution.png" to show fields of focus and "Outliers_pH field comparisons.jpg" to demonstrate the considerable difference between measured pH and SSURGO pH for fields with higher claimed clay %. Field 56932f28-cbf5-4a35-a2bc-a504e8fe80ee is the exception. However, looking at pH and CEC values for all the fields (per http://extension.msstate.edu/content/interpreting-your-soil-test and https://extension.missouri.edu/publications/mg4), this largely suggests that the clay % from SSURGO for those fields is not representative of the few particular fields and it is, instead, highly likely that they are (closer to) silt loam soils like the rest of the project (also included file "Field 56932f28-cbf5-4a35-a2bc-a504e8fe80ee_CEC.png" to specifically show where the value lands comparatively). Therefore, all fields can/should arguably be grouped together.	Assessment is acceptable	17-Jul

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
40	Clarification	9-Jul	CORC Calculation	Was Mg analyzed at t0? If so, please provide that data	Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data	6.4.1	No, only Ni (to help calculate application rate). The response to finding 25 used some language from Puro (i.e., "scenarios from samples/fields where Mg_baseline > Mg_t1 or Mg_t1 >Mg_t0"). They mentioned this more generally, and since we don't have Mg t0, the latter scenario was/is irrelevant.	Clarification provided	17-Jul
41	Clarification	24-Jul	CORC Calculation	Do you have data on the recovery of Mg and Ni from aqua regia compared to a more complete digestion (HF or fusion)?	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	**Paraphrased from email communication:** Provided report from an internal study on Mg recovery showing high recovery of Mg from forsterite (>90%) and low recovery from some Mg-bearing clay minerals. Nickel recovery data is not reliable due to contamination from grinding equipment.	Clarification provided	2-Sep
42	Clarification	6-Aug	CORC Calculation	Can you run the CORC calculation using Cr as the tracer instead of Ni?	CDR Quant_Code_All TS Fields_MP1	6.4.1	**Paraphrased from email communication:** Cr is an "unreliable narrator" of application rate because the Cr in olivine is predominantly bound in chromite, which is not readily digested by aqua regia and is in a different mineral phase than the Mg, leading to greater variation in tracer: Mg ratios.	Clarification provided	2-Sep

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
43	Clarification	7-Aug	CORC Calculation	Why was an aqua regia digestion used rather than a total digestion?	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	**Paraphrased from email communication:** 1. Total digestions are prohibitively expensive 2. 4-acid digests did not reliably achieve complete digestion in previous work 3. Aqua regia decreases noise from background soil compared to total digestions 4. Aqua regia does digest olivine (See Finding 43)	Puro's ERW methodology does not explicitly state that total digestions must be used, so aqua regia digests are eligible.	15-Aug
44	Nonconformity	7-Aug	Environmental Safeguards	Aqua regia digestions result in underreporting Cr concentrations in soil, because Cr bound in chromite is not fully digested (See Finding 42)	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	**Paraphrased from email communication:** The standards for soil and fertilizer heavy metal limits are typically based on aqua regia digests, because it is more representative of the concentration that could be considered bioavailable.	Puro's ERW methodology does not explicitly state that total digestions must be used, so aqua regia digests are eligible.	15-Aug
45	Clarification	7-Aug	CORC Calculation	How do you ensure that you are not counting Mg-bearing non-carbonate secondary minerals as CDR?	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	**Paraphrased from email communication:** Olivine does not have Al, so Al-bearing clays formation is unlikely. Vermiculite, which doesn't contain Al, is highly soluble in aqua regia. "Expert geochemists we have consulted have examined this issue and concluded the potential for secondary silicate formation from olivine is unlikely to cause a concern from a CDR quantification perspective."	Puro's ERW methodology does not explicitly state that total digestions must be used, so aqua regia digests are eligible.	15-Aug

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
46	Nonconformity	9-Aug	CORC Calculation	All relevant loss pathways must be considered, which is not limited to the list of pathways specified in the methodology. Secondary silicate formation must be considered.	Twinterstellar 3021_Monitoring Plan_v1.6	6.7.2	**Excerpt from email communication:** The CDR removal supplier shall identify all **relevant** loss pathways (emphasis added). We have no reason to believe that non-carbonate secondary mineral precipitation is relevant.	On a call on August 15, 2025, Puro stated that secondary silicate precipitation does not need to be identified as a potential loss pathway.	15-Aug

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
47	Misstatement	7-Aug	CORC Calculation	The flux method for background weathering quantification is not scientifically robust. Background weathering must be calculated the same way as the treatment area (i.e., using the soil data).	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	**Paraphrased from email communication:** 1. Puro approved the flux method and did not approve the liquid-phase approach. The liquid-phase approach from a randomized control trial indicated no statistically significant difference between treatment and control. 2. The flux method is the liquid-phase approach normalized to the Mehlich 3 extractable pool to allow for extrapolation 3. The results of the flux method align with upper end of literature values Additionally, we disagree that the flux method is not scientifically robust and we have not received an explanation for why this method is not considered to be robust. Second, we disagree that the background weathering must be calculated in the same way as the treatment area. The methodology includes numerous instances where distinct pools are measured independently, including biomass to estimate plant uptake, leachate to estimate strong acid inefficiency, and feedstock to estimate elemental concentrations, although (as with background weathering) in all such cases in principle these fluxes should be manifest in the solid phase.	Continued as Finding 47a	Continued as Finding 47a

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
47a	Continued from Finding 47	11-Aug	CORC Calculation	Puro's approval of the flux method was based on comparison to literature values, not based on the underlying scientific principles. The solid-phase background weathering quantification method was assumed to be erroneously large due to feedstock transport to areas where feedstock was not supposed to have been applied. If this was the case, there would be a corresponding increase in Ni concentration in the control samples as Ni is the tracer used to determine olivine application.	Twinterstellar 3021_Monitoring Plan_v1.6	6.4.1	We have only conceded this point, the method used to estimate background weathering, because of how long the project has been in review. We have not conceded this point because we agree with the auditor's opinion of the technique, or even the registry on the applicability of using liquid phase data alone. However, we understand and respect that this will not be accepted at this time, so we have utilized an overly conservative claim using solid phase measurements.	Puro provided clarification on the intent of rule 6.4.1(c). The meaning of this rule is that the auditor must express an opinion on the eligibility of the method, which may result in changes to the CORC quantification approach. In this case, Puro deemed it appropriate to follow the auditor's opinion and requested that Eion change their method.	26-Aug
48	Omission	18-Aug	CORC Calculation	Data is missing from the flux and aqueous-phase approaches to quantifying background weathering	Natural Background Weathering_Flux-based-code_20250602 Natural Background Weathering_Mg Loss_Aqueous Phase_Code_TS Fields	6.4.1	Data provided	Data provided	18-Aug

ID No	Type	Date Issued	Category	Finding/Issue	Audit Evidence	Methodology Reference	Eion Response	350 Response	Date Resolved
49	Misstatement	2-Sep	CORC Calculation	The outlier in the background weathering dataset should be removed	Natural Background Weathering_Flux-based-code_20250602_v1.2 Natural Background Weathering_Mg Loss_Aqueous Phase_Code_TS Fields	6.4.1	Presumably you're identifying the point as an outlier by updating the z-score from 4 to 3? We originally used 4σ to try to best account for definite/extreme outlier situations and capture the possible natural variation that should realistically be included, especially considering that the dataset is the result of a first pass of anomaly removal already (hence, we want to avoid "overcleaning" the data). But you do raise a valid point that we didn't previously consider; we're using a different value compared to the deployment, so we updated the number to 3.64 for consistency. This gives us the same output (attached). We also haven't identified any distinct set of errors for the point, including compared to the others, so we think it seems reasonable to include it regardless. While we agree there are points that should be excluded (and have been removed with unexplainable extreme values of ~20k), the other point could be an expected value and representation of something happening in the project. The csv file that was shared with you is after removing those extremely high values.	Only one point had a value >20,000. Almost half of the points in the dataset were removed based on the number of samples for a field, but this cleaning is not justified because the points are averaged over the entire production facility, rather than by field. Keeping these points in the dataset and using the IQR method of outlier removal, which is less susceptible to extreme values than the z-score approach, both the point at ~5,500 ppm and the 20,000 ppm point should be removed.	5-Aug

Appendix 2: 350Solutions' Assessment of the Eligibility of the Counterfactual Soil Weathering Method

As discussed in Section 2.3.2, Eion presented three methods for quantification of counterfactual soil weathering. These methods are as follows:

1. The **porewater method** used lysimeter data from the field trial during a single growing season (May 23 and August 18, 2023). As reported by Eion, there was no statistically significant difference between Mg concentrations in the treatment and control plots, indicating that no additional weathering occurred during that time. Because this trial did not extend through the entire monitoring period, this is not taken as evidence that no olivine weathered during the ~1.5 year monitoring period, but rather the lysimeter data was not representative.
2. The **soil method** uses sample points where no olivine was applied in a method analogous to the method used to measure weathering in the treatment areas. The difference in Mg concentrations in the soil was simply calculated as the baseline Mg – Mg at the end of the monitoring period. This resulted in a counterfactual weathering estimate of 126 kg Mg/ha/yr reported by Eion. Puro.earth and 350Solutions independently calculated this value, removing an extreme outlier, and determined 148 kg Mg/ha/yr was more representative. Because the estimate of counterfactual weathering from the soil data was higher than the literature range (9.5-70 kg Mg/ha/yr), Eion attributes the high counterfactual weathering rate to unexpected olivine application on the control sites. If this was the case, it would be evident in elevated Ni concentrations in the soil samples from the end of the monitoring period. However, the Ni concentration data was requested by 350Solutions and was not provided by Eion (See Appendix 1).
3. The final approach used to calculate counterfactual weathering is called "the **flux approach**" because it accounts for the flux of Mg in the porewater relative to the pool of exchangeable Mg (Mehlich 3 extraction) initially in the soil (Figure 1). This results in a leaching rate of 80 kg Mg/ha/yr, which aligns with more closely with the literature references. Puro initially accepted the eligibility of this approach on the basis that the resulting weathering rate is plausible in the context of literature values. The conceptual basis for the approach was not considered when determining eligibility. As clarified by Puro, the role of the auditor as described in Rule 6.4.1(c) of the ERW Methodology is to provide an opinion on the eligibility of the quantification method, which may or may not result in a change to the approved quantification method. It is 350Solutions' opinion that the flux approach is not eligible for the reasons described below.

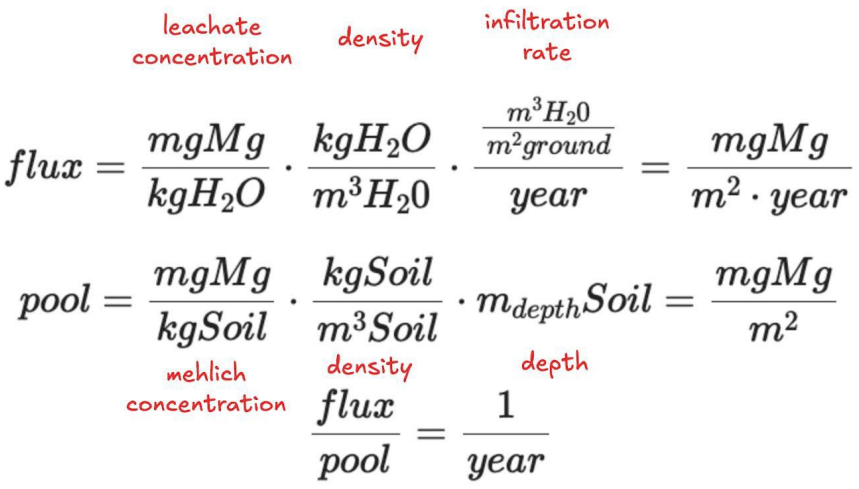

Figure 1. Flux approach for counterfactual weathering calculation. Source: Eion.

a. As mentioned in the porewater approach, there is no statistically significant difference in leachate Mg concentration between the treatment and control during the measurement period (three months). This result is inconsistent with the soil phase results where there is a statistically significant difference in the change in Mg over the entire monitoring period between the control and treatment areas (p-value = 0.01986). There are nine leachate samples for the control and treatment areas (18 samples total), compared to 1314 treatment and 205 control soil samples. We have more confidence in the soil results due to the length of monitoring and sample sizes. The leachate data may not be representative of the application sites and shouldn't be used in quantification of counterfactual weathering.
b. The leachate data from three months during the growing season is extrapolated to the full year. Leaching of Mg is highest in the fall and winter months when the soil is bare and the infiltration rate (precipitation – evapotranspiration) is high [8]. It is then unreasonable to assume that the concentration of Mg in the leachate will be constant over the year.
c. There are three pools of cations in the soil: non-labile, exchangeable (Mehlich-3), and dissolved in porewater. The assumption in the flux approach is that there is no movement of cations from the non-labile pool to the exchangeable pool (i.e., no soil weathering). We expect that cations will move from the non-labile pool to the exchangeable pool as the feedstock and soil weather. Thus, it is not possible to calculate counterfactual weathering if the assumption inherent to the calculation is that soil weathering doesn't occur.

For these reasons, Puro requested that Eion update their CORC claim using the soil method results. This ultimately reduced the CORC claim from 1316 to 748 tonnes.

Appendix 3: Site Visit Report

Site Visit Report		
Supplier: Eion Corp.	**Team Contacts:** Chris Shrieves	**Audit Team:** Lily Schacht
Pathway: Enhanced Rock Weathering		
Document ID: PU2505-SVR		
Revision: V1.0		

* primary contact/lead author

1. Site Visit Summary

Eion Corp is seeking validation of Production Facility Twinterstellar 3021 and verification of the CORC claim. Eion is removing CO_2 by enhanced rock weathering using olivine on farms in Mississippi and Louisiana, USA. As such, Puro's Enhanced Rock Weathering methodology is applicable. On July 22, 2025, 350Solutions attended a site visit to a subset of application sites that make up the Twinterstellar 3021 project, as well as the trial field sites.

Table 1. Site Visit Activities

Location	Topics Covered

[redacted] **MS,** [redacted]	- Confirm site location
	- Discussion with farmer regarding:
	  ○ Previous farming practices
	  ○ Historic and current fertilizer use
	  ○ Impression of Eion
	  ○ Impression of olivine performance

[redacted] **MS,** [redacted]	- Confirm site location
	- Discussion with farmer regarding:
	  ○ Previous farming practices
	  ○ Historic and current fertilizer use
	  ○ Impression of Eion
	  ○ Impression of olivine performance
	- Observe soil sampling process, including data collection and sample tracking

[redacted] **, MS** [redacted]	- Discussion of relationship between Southern Ag and Eion
[redacted] **MS** [redacted]	- Confirm site location - Discussion of trial design and implementation - Walkthrough of lysimeter use
[redacted] **MS** [redacted]	- Confirm site location - Discussion of trial design and implementation

2. Attendance

The site visit was attended by 350Solutions, Eion, and Southern Ag. [redacted]

Table 2. Site Visit Attendees

Organization	Name	Title/Purpose
350Solutions	Lily Schacht	Auditor
Eion	Chris Shrieves	Carbon Registry and Verification Lead
Southern Ag	Alanna Scholtes	Leads field trials
	Chloe Barton	Leads soil sampling and grower relationships
Independent Growers	[redacted]	Grower using CarbonLock (olivine)
	[redacted]	Grower using CarbonLock (olivine)

3. Observations

Both farmers described strong enthusiasm about Eion and CarbonLock (olivine). Both attested to increased yield and plant health in fields where CarbonLock had been applied compared to nearby farms without CarbonLock. They are both interested in increasing CarbonLock use, if it is available.

This growing season, all fields visited were in soybeans but typically follow standard row crop rotations. Despite heavy rain in the spring, all fields were planted and the only visible variation in plant health over the field was likely due to drainage (Figure 2).

Figure 2. Soybean field at [redacted]

Olivine was spread on the fields in 2023 and 2024 using a BBI MagnaSpread tractor-pulled spreader (Figure 3). The spreader is calibrated for CarbonLock to ensure even application. Spreading was not observed during the site visit but the growers walked through operation of the spreader.

Figure 3. BBI MagnaSpread spreader used for CarbonLock spreading. Left: control and hydraulic systems. Right: conveyer belt and spinning disks throw CarbonLock off the back of the spreader. This is fed by the large hopper on top.

Soil sampling is conducted using a standard soil probe. Sampling was demonstrated with a very rusty soil probe (Figure 4) but Chloe assured us that sampling usually occurs with a probe that is not rusty. The software used by Southern Ag creates “jobs” which contain a list of points for the sampling team to collect and submit for analysis to Waters Ag Lab (Figure 5).

Figure 4. Rusty soil probe used for sampling demonstration

Figure 5. Labeled soil sample collection bags

Appendix 4: Files Reviewed

Puro assessment report.docx
SBIR Selective Digest Report.pdf
SolidPhaseBackgroundWeathering_Histogram
Audit Document Index_EION_Twinterstellar 3021_v1.2_R4_Eion responses.xlsx
Contact information to auditor.xlsx
EION_Twinterstellar 3021_Review of Monitoring Plan_2025-05-16.pdf
Authorisation of representation of the activity and non-double claiming_Eion_Twinterstellar 3021.pdf
Trade registry extract_EION CORP_DE_Certificate of Incorporation_20221207.pdf
AGRIgate Agreement.PDF
Millbank Materials_Eion Corp_TS Release.pdf
Sibelco_Statement Eion assignment of rights for Carbon Capture.PDF

Estimated Project Removals_Twinterstellar 3021.pdf
Project Financials (pro forma)_Twinterstellar 3021.xlsx
Puro Additionality_Twinterstellar 3021_v1.4.pdf
BR_Calculating Background Weathering_Twinterstellar 3021.pdf
BR_Calculating Background Weathering_Twinterstellar 3021_v1.2.pdf
Estimated Total Project Removals _Twinterstellar 3021.pdf
Project Activity_Calculating Removals to Storage_Twinterstellar 3021_v1.1.pdf
Puro Additionality_Twinterstellar 3021.pdf
Puro Additionality_Twinterstellar 3021_v1.1.pdf
Puro Additionality_Twinterstellar 3021_v1.2.pdf

Puro Additionality_Twinterstellar 3021_v1.3.pdf
Eion_ERA_Twinterstellar 3021_FINAL_v4.pdf
Exponent_Eion ERA Third Party Review_Edits_v1.1.pdf
List of applicable regulations_Twinterstellar 3021.xlsx
Puro Environmental and Social Safeguard_Twinterstellar 3021v1.1.pdf
Puro Stakeholder Engagement Report_Eion_Twinterstellar 3021_v1.2.pdf
Eion_ERA_TS & 3021 Deployment_FINAL_v3_20240923.docx.pdf
Exponent_Eion ERA Third Party Review.pdf
Puro Environmental and Social Safeguard_Twinterstellar 3021.pdf
Puro Stakeholder Engagement Report_Eion_Twinterstellar 3021.pdf
Puro Stakeholder Engagement Report_Eion_Twinterstellar 3021_v1.1.pdf
Asbestos Report_TS & 3021 Samples.pdf
BET_3021.PDF
BET_TS.PDF
COA_3021.pdf
COA_TS & 3021_Full.pdf
COA_TS.pdf
Cr(VI)_ Summary of ALS Cr(VI) Results_Twinterstellar 3021.pdf
Cr(VI)_ALS_Chromium Hexavalent_TS & 3021.pdf
Final Results with Calcs.xlsx
PSD_3021.pdf
PSD_TS.pdf
Soil information_Baseline_Twinterstellar 3021.csv
2400487_BET_Physi-02_Run1.PDF
2400487_PSA-04_Run1.pdf
2400488_BET_Physi-02_Run1.PDF
2400488_PSA-04_Run1.pdf
A23-14828 Cert & Res_Sibelco 3021.pdf
A23-14829 Cert & Res_Twin Sisters Flour.pdf
A24-01460 Cert & Res_TS_3021 Full.pdf
A24-01460Final with Calcs.xlsx
AOP1073552-1 Final_asbestos.pdf
Sibelco_Olivine_SDS_29-06-2021_GB-IE (English) 083024.pdf
Twin Sisters Olivine SDS.pdf
Eion_Field Ops SOP.pdf
Contact for grievances_Twinterstellar 3021.jpg
Dispute Resolution_Twinterstellar 3021.jpg
CarbonLock Grower Meeting_202301_Twinterstellar 3021.xlsx
Eion - Agronomic Supplement.pdf
Louisiana Approval.pdf
Mississippi Approval.pdf
Sibelco Introduction Call - Oct 2021 - Final.pdf
Twinterstellar 3021_Application sites list.xlsx
Twinterstellar 3021_Application Sites_TS Fields Data.csv
Twinterstellar 3021_Application Sites_TS Fields Data.xlsx
Twinterstellar%203021_Application%20Sites_TS%20Fields%20Data(AutoRecovered).csv
Twinterstellar 3021_Application site locations_TS sites.xlsx
Application site locations_TS sites_Twinterstellar 3021.xlsx
Application site locations_Twinterstellar 3021.xlsx
Application site locations_Twinterstellar 30211.xlsx
Twinterstellar 3021_12 fields_20250203.xlsx
project-area-bounds.cpg
project-area-bounds.dbf

project-area-bounds.prj
project-area-bounds.shp
project-area-bounds.shx
project-samples.cpg
project-samples.dbf
project-samples.prj
project-samples.shp
project-samples.shx
project-areas.cpg
project-areas.dbf
project-areas.prj
project-areas.shp
project-areas.shx
Application Sites data_Twinterstellar 3021.xlsx
Application sites list_TS sites_Twinterstellar 3021.xlsx
Application sites list_Twinterstellar 3021.xlsx
Application Sites_TS Fields Data_Twinterstellar 3021.xlsx
Application Sites_TS Fields_Soil Data_Twinterstellar 3021.xlsx
Application sites_Twinterstellar 3021.xlsx
Application_sites_template.xlsx
production-facilities-bounds.cpg
production-facilities-bounds.dbf
production-facilities-bounds.prj
production-facilities-bounds.shp
production-facilities-bounds.shx
production-facilities.cpg
production-facilities.dbf
production-facilities.prj
production-facilities.shp
production-facilities.shx
WM Characterization_Twinterstellar 3021.xlsx
WM_characterization_template.xlsx
3021 Stockpile Sampling Protocol.pdf
Alternative fate_Twinterstellar 3021_v1.1.pdf
Millbank Materials_Twin Sisters_Core Values.pdf
Sibelco Environmental, Social and Governance -Aaheim.pdf
Sibelco sustainability priorities.pdf
Sibelco_Aheim Operational Permit.pdf
Twin Sisters_Permit_WAG503304.pdf
Jiajie Li et al._Integrated Mineral Carbonation of Ultramafic Mine Deposits—A Review.pdf
Liam A. Bullock et al._Global Carbon Dioxide Removal Potential of Waste Materials From Metal and Diamond Mining.pdf
Alternative fate_Twinterstellar 3021.pdf
Eion_Model Description_v1.1.pdf
Eion_Olivine_Forsterite Fayalite Discussion.pdf
Eion's Model_Requirements for ERW Simulation Models.pdf
Model demo.mov
Model Validation Report_ESIM-TS-001_v1.1.pdf
Twinterstellar 3021_Initial simulation_Model export.xlsx
Twinterstellar 3021_Initial simulation_Model result.png
Twinterstellar 3021_Validated simulation_Model export.xlsx
Twinterstellar 3021_Validated simulation_Model result.png
Eion_Model Description.pdf
Model simulation template - ERW.xlsx

Model validation & description_CarbonLock as Aglime Model_Whitepaper.pdf
Model Validation Report_ESIM-TS-001.pdf
Twinterstellar 3021_TS Material_Model.png
Twinterstellar 3021_TS Material_Model_Export.xlsx
3021 Feedstock_Weathering Curve.png
Results of model simulations.pdf
TS Feedstock_Weathering Curve.png
Background Weathering_Flux-based approach_Explanation.pdf
CDR Quant_Code_All TS Fields_MP1.pdf
Data system_Twinterstellar 3021_v1.1.pptx
GEE_output.csv
Natural Background Weathering_Flux-based code_20250602.pdf
Natural Background Weathering_Mg Loss_Aqueous Phase_Code_TS Fields.pdf
Natural Background Weathering_Mg Loss_Solid Phase_Code_TS Fields.pdf
Plant Uptake_Biomass Sample Results_Twinterstellar 3021.pdf
Plant Uptake_NDVI and_Biomass_Samples_Code_TS Fields.pdf
Strong Acid_Code.pdf
Twinterstellar 3021_Monitoring Plan_v1.5.pdf
CDR Quant_Code_All TS Fields.pdf
Data system_Twinterstellar 3021.pptx
EXAMPLE_Eion_Calculating CDR_Walk-through.xlsx
Monitoring plan checklist - ERW.xlsx
Monitoring Plan_Twinterstellar 3021.pdf
Twinterstellar 3021_Monitoring Plan.pdf
Twinterstellar 3021_Monitoring Plan_v1.1.pdf
Twinterstellar 3021_Monitoring Plan_v1.2.pdf
Twinterstellar 3021_Monitoring Plan_v1.3.pdf
Twinterstellar 3021_Monitoring Plan_v1.31.pdf
Twinterstellar 3021_Monitoring Plan_v1.4.pdf
ICP-OES AR Waters Lab SOP.pdf
ICP-OES Protocol.pdf
List of devices requiring calibration_Twinterstellar 3021_v1.1.xlsx
List of devices requiring calibration_Twinterstellar 3021.xlsx
Waters_SOP_CCE-Silicates_Titration_101923.pdf
LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.2.xlsm
LCA Report_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.2.pdf
LCA Result_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.2.xlsx
Transport Emission - Actuals.xlsx
Truck routes evidence.pdf
BOL-Rail-Portland-to-Vicksburg.pdf
Tristar-BOL-Vancouver.pdf
RailInc - Transport Rail.xlsx
Eion rock delivered.xlsx
Watco-BOL-Vicksburg-to-farm.pdf
Watco-BOL-Vicksburg.pdf
Summary_Transport Emission - Actuals_v1.1.xlsx
Summary_Transport Emission - Actuals_v1.2.xlsx
Eion LCA Report_Twinterstellar_v2025-01.pdf
Eion LCA Report_Twinterstellar_v2025-03.pdf
LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021.xlsm
LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.1.xlsm
LCA Report_Eion_Whitepaper.pdf
LCA Report_RAE-TS-001_WRE-TS-001_Twinterstellar 3021.pdf

LCA Report_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.1.pdf
LCA Result_RAE-TS-001_WRE-TS-001_Twinterstellar 3021.xlsx
LCA Result_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.1.xlsx
puro_LCA Model Eion-ERW-v2024-09.xlsm
puro_LCA Model Eion-Twinterstellar 3021_v1.1.xlsm
puro_LCA Model Eion-Twinterstellar 3021_v1.2.xlsm
puro_LCA Result-Eion-ERW-v2024-09.xlsx
puro_LCA Result-Eion-Twinterstellar 3021_v1.1.xlsx
puro_LCA Result-Eion-Twinterstellar 3021_v1.2.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.5.xlsx
_Monitoring data.txt
CORC Report Summary_ERW_Twinterstellar 3021.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.4.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-121.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-06 to 2024-08.xlsx
Carbon storage losses_River and ocean.pdf
CDR quantification_CORCs explanation.pdf
CDR quantification_CORCs explanation_v1.1.pdf
CDR quantification_Overview_v1.2.pdf
Code_BR_Background leachate volumes.pdf
Code_CDR Quant_12fields.pdf
Code_CDR Quant_All TS Fields.pdf
code-BR-inefficiencies-Background-leachate-volumes.pdf
code-CDR quantification.pdf
code-inefficiencies-PlantUptake.pdf
Code-inefficiencies-StrongAcid-volumes.pdf
Eion_Calculating CDR_Walk-through_Example.xlsx
Eion_Downstream_Whitepaper-1-1.pdf
Plant Uptake_Biomass Results_Twinterstellar 3021.pdf
Plant Uptake_NDVI_and_Biomass_Samples.pdf
TS Fields_Ni_Mg_Samples Data_Twinterstellar 3021.xlsx
TS__T0-T2 Samplesv1.1.xlsx
TS__T0-T2.csv
TS_All Fields Area and Tons.xlsx
3021_Commitment Date.pdf
Background Weathering Mg Loss_Solid Phase Control Points.csv
Background Weathering Mg Loss_Solid Phase Control Points.xlsx
Background Weathering Mg Loss_Solid Phase_WITH DUPLICATES.xlsx
Code-CDR quantification functions.pdf
Total Tonnes_Research Amendment.pdf
Trial Plots_Data_Twinterstellar 3021.csv
Trial Plots_Data_Twinterstellar 3021.xlsx
Trial Plots_Data_Twinterstellar 3021_2.csv
Trial Plots_Lysimeter Results.pdf
TS_Commitment Date.pdf
TS_Field 2 Sampling_Screenshot with Date.png
TS_Field 2 Sampling_Video.MOV
Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data.csv
Twinterstellar 3021_TS Fields_Ni_Mg_All Samples Data.xlsx
TS Fields_Ni_Mg_All Samples Data_Twinterstellar 3021.xlsx
Puro Project Description_Twinterstellar 3021_v1.4.docx
Puro Project Description_Twinterstellar 3021.pdf

Puro Project Description_Twinterstellar 3021_v1.1.pdf
Puro Project Description_Twinterstellar 3021_v1.2.pdf
Puro Project Description_Twinterstellar 3021_v1.3.docx
Audit Document Index_EION_Twinterstellar 3021_v1.2_R3.xlsx
Audit Document Index_EION_Twinterstellar 3021_v1.2_R3_Eion Responses.xlsx
Audit Document Index_EION_Twinterstellar 3021_v1.2_R4.xlsx
Audit Document Index_ERW_Twinterstellar 3021.xlsx
Audit Document Index_ERW_Twinterstellar 3021_submission 1.1.xlsx
Audit Document Index_ERW_Twinterstellar 3021_submission 1.xlsx
Audit Document Index_ERW_Twinterstellar 3021_v1.2_R2.xlsx
Audit Document Index_ERW_Twinterstellar 3021_v1.2_R2_Eion Responses.xlsx
EION_Twinterstellar 3021_Review of Monitoring Plan_2025-04-23.pdf
LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.4.xlsm
LCA Report_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.4.pdf
LCA Result_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.4.xlsx
Natural Background Weathering_Mg Loss_Solid Phase_Code_TS Fields_v1.2.pdf
Twinterstellar 3021_Monitoring Plan_v1.8.pdf
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.6.xlsx
LCA Model_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.3.xlsm
LCA Report_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.3.pdf
LCA Result_RAE-TS-001_WRE-TS-001_Twinterstellar 3021_v1.3.xlsx
Natural Background Weathering_Mg Loss_Solid Phase_Code_TS Fields_v1.1.pdf
Twinterstellar 3021_Monitoring Plan_v1.7.pdf
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.7.xlsx
ineff-108-background-Mg-loss-control-points_and_lab-nums.csv
ineff-108-background-Mg-loss-control-points_and_lab-nums.xlsx
CORC Report Summary_Twinterstellar 3021_Period 2023-05 to 2024-12_v1.8.xlsx
ineff-205-background-Mg-loss-control-points_and_lab-nums.csv
ineff-205-background-Mg-loss-control-points_and_lab-nums.xlsx
Comments from Adam Aug 7 2025.pdf
Eion Responses to Responses to Eion August 11.pdf
Field 56932f28-cbf5-4a35-a2bc-a504e8fe80ee _CEC.png
Outliers_pH field comparisons.jpg
PU2505- Eion Log of Findings_Eion Responses_Rd 2_20250716.xlsx
Puro ERA Exception.pdf
Soil clay % distribution.png
Twinterstellar 3021_Monitoring Plan_v1.6.pdf
USDA_NRCS_SOM_SOC.pdf
Waters_OM_LOI_SOP.pdf
Waters_SOP-01.104 Soil pH Soil-Water Ratio.pdf
Annual_Precip_ET_2022_Sites.csv
Annual_Precip_ET_2023_Sites.csv
Annual_Precip_ET_2024_Sites.csv
background_weathering.csv

Appendix 5: Application Site List

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Appendix 6: Verifier Qualifications

350Solutions, Inc. Corporate Experience

350Solutions serves as an independent expert in cleantech, low carbon, and environmental technologies. We provide an unbiased assessment of innovative technologies. 350Solutions is accredited through ANAB under ISO 17020 as an independent inspection body to provide independent technology evaluation services using the ISO 14034 ETV process. In addition, 350Solutions staff include a Certified Measurement and Verification Professional (CMVP for IPMVP) and a North Carolina Registered Professional Engineer (P.E.).

Lily Schacht
Senior Carbon Removal Verification Engineer, 350Solutions

EDUCATION:
MS, Environmental Engineering, University of Wisconsin – Madison, 2019
BS, Chemical, Energy, and Environmental Engineering, Washington University in St. Louis, 2017

EXPERIENCE SUMMARY:
Lily Schacht is an Environmental and Chemical Engineer with experience in process engineering, environmental chemistry, analytical methods, and life cycle analysis (LCA). At 350Solutions, Lily works on verifying carbon dioxide removal (CDR) technologies, with a focus on mineralization-based pathways, including enhanced weathering, direct air capture, and ocean alkalinity enhancement. Previously, Lily led agronomic research at an enhanced weathering CDR supplier where she organized field trials across multiple states to quantify carbon removal and crop yield changes after rock application. Before that, Lily developed rapid prototyping instrumentation to optimize a biomineralization process in concrete production and aided in scaling up the process to pilot-scale. Lily also built environmental impact models for process variable sensitivity analysis of demo-scale manufacturing processes. These models were used to drive the direction of research and development to minimize product life cycle impacts. Throughout her career, Lily has developed analytical chemistry methodologies for both liquid- and solid-phase analyses.

RESEARCH AND PROFESSIONAL EXPERIENCE:
March 2024 – Present: Carbon Removal Verification Engineer, 350Solutions
Verify CDR technologies on behalf of registries and the XPRIZE Carbon Removal challenge. Specializes in mineralization pathways, including mineralization kinetics, measurement methods, and open-system modeling.
Nov 2022 – Feb 2024: Researcher, Lithos Carbon
Quantified carbon removal rates and agronomic impacts of enhanced weathering on cropland across six US states; Evaluated chemical analysis methods for precision relative to cost.
Nov 2023 – Jan 2024: Independent Consultant, Keel Labs
Built an environmental impact model to evaluate potential material and process changes; Recommended areas for reducing material usage up to 80%
Dec 2020 – Oct 2022: Research Scientist II, Biomason
Guided experimentation and data analysis throughout all R&D teams to inform techno-economic analysis (TEA) and LCA; built and led the carbonate biomineralization prototyping workstream for rapid iteration; developed real-time measurement techniques for critical process parameters in solid state

SELECTED PUBLICATIONS & PRESENTATIONS:

- **Schacht, L.**, Baum, M., Liu, H., & Yap, M. (2023) Scaling Enhanced Rock Weathering: Agronomic Impacts at Field-Scale [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO.
- **Schacht, L.** and Ginder-Vogel, M. Arsenite Depletion by Manganese Oxides: A Case Study on the Limitations of Observed First Order Rate Constants. *Soil Syst.* 2018, 2(3), 39. https://doi.org/10.3390/soilsystems2030039

Zoe Sandwith
Research & Verification Associate, 350Solutions

EDUCATION:

BSc. Combined Biology & Earth Science, University of Victoria, 2011

EXPERIENCE SUMMARY:

Zoe Sandwith is an observational ocean scientist with expertise in ocean chemistry, biogeochemical cycles, oceanographic instrumentation, and field- and lab-based analytical methodologies. Zoe works on verifying carbon dioxide removal (CDR) technologies, with a focus on marine and open systems. Previously, Zoe conducted academic research on topics including: dissolved oxygen in dynamic coastal settings and constraining the error associated with different measurement techniques; the use of dissolved oxygen isotopes for understanding net community productivity and potential export efficiency; the analysis of the marine carbonate cycle and ocean acidification; and the development and testing of novel instrumentation. In addition to her research, Zoe has experience managing large, long-term observational research infrastructure at the marine interface.

SELECTED RESEARCH AND PROFESSIONAL EXPERIENCE:

Jun 2025 – Present: Research & Verification Associate, 350Solutions

Verify CDR technologies on behalf of registries and individual clients. Specializes in marine and open system pathways, instrumentation, carbonate system chemistry, and data quality

2021-2024: Scientist, Hakai Institute. Analyzed high-frequency, high resolution oceanographic data from field programs and autonomous platforms and synthesized in a regional context. Focused on dissolved oxygen dynamics, regional hypoxia, ocean acidification, and climatological linkages. Participated in field monitoring programs and developed and trialed low-cost autonomous sensors and sampling platforms.

2011-2020: Manager & Research Assistant III, Woods Hole Oceanographic Institution. Managed daily operations for the Martha's Vineyard Coastal Observatory and spearheaded infrastructure retrofit and upgrades and permitting review. Conducted research on biogeochemical cycles using gas tracers, specializing in dissolved oxygen isotopes and the dissolved oxygen to argon ratio for measuring Net Community Production, as well as high quality analysis of the isotopes of the nitrogen cycle and carbonate system. Operated in open and coastal ocean, estuarine, lacustrine and marsh systems. Managed multiple analytical laboratories.

SELECTED PUBLICATIONS:

Evans W, Campbell K, Weekes C, […] **Sandwith Z**, and Jackson J. 2025. Variability in Storm season intensity modulates ocean acidification conditions in the northern Strait of Georgia. *Nature Sci Reports 15(4505)*. https://doi.org/10.1038/s41598-025-88241-8

•Nicholson D, Michel APM, […] **Sandwith Z**, Monk S. 2018. Rapid mapping of methane and carbon dioxide in coastal ecosystems using the ChemYak, an autonomous surface vehicle. *Env Sci* Tech. https://doi.org/10.1021/acs.est.8b04190