ISOMETRIC

Ocean Alkalinity Enhancement from Coastal Outfalls 1.0.0 Protocol

Public Consultation Summary

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Context

Isometric held a public consultation on its Ocean Alkalinity Enhancement from Coastal Outfalls 1.0.0. Protocol to receive stakeholder input on this protocol and associated modules.

The public consultation was announced on the 28th of March, 2024. The period of consultation lasted 30 days, with the final day as the 5th of May, 2024.

After the initial public consultation, the feedback received was considered for incorporation into the Protocol and associated modules. All stakeholders have received responses to the submitted feedback.

This document summarizes the feedback received during the public consultation and the revisions included as a result of the comments. Content in italics and brackets are excerpts from the public consultation version of the protocol to give the reader necessary context behind the comment.

We thank all participants for their time.

Summary of feedback received

Section	Comment	Resolution
Ocean Alkalinity Enhancement from Coastal Outfalls 1.0.0		
1: Introduction	*A unique challenge of OAE is that once an OAE project releases alkalinity to the open environment, the alkaline plume mixes and moves with local hydrodynamics..* We are intentionally leveraging the vast surface area and mixing of the ocean. This choice necessitates a different type of MRV (as described in this protocol). There are also other CDR methods with large temporal and spatial scales (ex ERW has a large temporal scale as well)--we are not unique in this	Change Thank you for the suggestion and raising a good point. We have amended the language to reframe the introduction following this feedback.
3: Future Versions	What is the criteria and review process for an update? It will be critical for suppliers to understand the proposed changes and effect on ongoing and planned projects ahead of time	No Change The protocol versioning policy, as well as the review process and when projects will need to adopt updates are described in the latest version of the Isometric Standard, please see section 2.4.3 of the Standard.
4: Applicability	Does carbonate alkalinity here mean carbonate feedstocks? This may be confusing because bicarbonate and carbonate ions must be involved in CDR. (In other words, silicate minerals produce carbonate alkalinity upon weathering by carbonic acid.)	Change We amended this language to “carbonate feedstocks”. Feedstocks which directly add carbonates to the ocean, such as calcium carbonate or sodium carbonate, will increase ocean DIC but not through CO2 removal from the atmosphere. Thus, use of carbonate feedstocks will require some

		modification in the quantification step - namely characterizing and using a DIC forcing in addition to an alkalinity forcing.
4: Applicability	*This protocol assumes that carbonate alkalinity is not the primary source of alkalinity because of its reduced CDR potential per mol of alkalinity added.* Suggestion: Remove this statement altogether, as it is misleading.	Change We don't think this statement is misleading, but have decided to remove this bullet point cautioning about carbonate feedstocks requiring modifications to the quantification framework from this section, since it is confusing when placed with a list of other requirements.
4: Applicability	*The list of Mineral or solid feedstock OAE projects* Dissolved Carbonates are considered by authors referenced in this protocol (e.g., Gately et al. 2023; Renforth and Henderson 2017). Include dissolved carbonates to this list.	Change We amended the list to clarify that mineral or solid feedstocks could be added to the ocean as solid, slurry (partially dissolved), or liquid form (if pre-dissolved), while the electrochemical approaches in the list are all liquid forms of alkalinity. Carbonate feedstocks are already included in the list, so now it covers dissolved carbonates.
4: Applicability	Would remove "seawater" as a descriptor here. There can be non-seawater electrochem OAE projects, such as from waste brine	Change We removed "seawater."
4: Applicability	*As such, this Protocol is developed with initial small scale pilot deployments in mind.* Is this still relevant, given the previous restrictions on project size were removed?	Change We've deleted the sentence
4: Applicability	*Discharging Total Alkalinity* Is this the right use of this term?	Change We've changed it to "discharging CO2-reactive alkalinity"
4: Applicability	What is the definition of co-located? What proximity counts here? Projects may be located in similar sites but be operationally separate (ie both Captura and Equatic have pilots at Alta Sea but they are entirely separate systems and operations). I would remove this--each project should be required to do its own environmental monitoring and quantification and consider collaborating if operationally feasible.	Change Covered by comment on co-location below.
4: Applicability	*Projects making use of operational fossil fuel facilities*	Change We removed this applicability requirement,

	This statement is problematic. Host facilities marketing claims do not affect the quantification, sale, and retirement of the CDR credit unless these claims erroneously suggest the host facility is taking claim to the CDR credit. There are many fossil fuel related facilities that could host large electrochemical mCDR OAE systems. Examples include fossil gas power plants that may operate <10% of the hours of year. The infrastructure from those plants is otherwise idle and useful for scaling and reducing the cost of OAE CDR. Even if we operate when the fossil plant is operating, we can source our electricity from zero carbon sources. We should be able to reduce our costs by utilizing existing industrial infrastructure such as these facilities.	as it is possible to use cooling water from a power plant without the power plant operating, and we acknowledge that making use of existing infrastructure is a viable path to scaling CDR
4: Applicability	What is the definition of co-located? What proximity counts here? Projects may be located in similar sites but be operationally separate (ie both Captura and Equatic have pilots at Alta Sea but they are entirely separate systems and operations). I would remove this--each project should be required to do its own environmental monitoring and quantification and consider collaborating if operationally feasible.	Change The statement on collocated projects has been removed from the applicability section. Instead, we have added a description on collocation in the pre-deployment section which reads: “Projects which are co-located near other marine CDR activities must be disclosed in the PDD. Currently, there is minimal research on co-located marine CDR projects. Due to nonlinear interactions, attribution and prediction of air-sea CO2 uptake and environmental impacts for co-located projects is more challenging. Project co-location includes projects with overlapping mixing zones, spatially and temporally, and may extend to projects with overlapping regions of air-sea CO2 uptake. Collaboration on quantification and environmental monitoring efforts is recommended for co-located projects. The level of interaction between projects is expected to decrease as the alkalinity perturbation becomes more dilute away from the alkalinity dosing location. Guidance on robust quantification and responsible environmental safeguarding for multiple projects operating in the same area will be updated with the latest research. “

5.1 Project Design Document	Can you clarify what types of models this includes? Ocean models are reasonable--but there are many process control models that are IP for suppliers and that we would not want to share.	Change Here we only refer to the models that are discussed in the quantification section, and have added examples to the protocol text here (e.g. plume transport models, coastal dynamics models, and ocean biogeochemical models). We don't expect process control models to be relevant here for the net CO2 removal, but if they are, it is possible to have certain sensitive information redacted from the public version of the PDD.
5.2: Verification and Validation	*Verifiers should also verify the documentation of uncertainty of the GHG statement as required by Section 2.5.7 of the Isometric Standard* It seems that this should be moved to 5.2 above bullet list, as it is a critical deliverable of the supplier in the GHG statement that is required to be verified.	No change This is included in Section 7 (which features in the list), and this is consistent with where we list this across protocols at Isometric
5.2: Verification and Validation	Shouldn't the verification of the GHG Statement be listed here also for any deliveries?	No change Yes, this is included within Section 7, which features in this list.
5.2.2: Site visits	*Once every 2 years* Thank you for requiring this. I think this is especially critical for these pathways where the science is still developing	No change We agree this is really important!
5.2.2: Site visits	Can you clarify 'at each location'? For example, if a supplier eventually has 12 locations with identical operations up and down the northeast coast, does a verifier have to visit all locations? or is a visit to one or a representative sample adequate? I'd suggest the latter is the correct approach. (Note we understand that these are currently one-off single demo locations for existing suppliers).	Change This refers to each dosing location - we have added language to ensure this is clear.
5.2.3: Verifier Qualifications & Requirements	Accreditation logistics could make this challenging.	No change We have a working model for this in verification now, where VVBs must EITHER demonstrate they have this expertise on the team already (this can include naming a subcontractor who they identify and include on the team who will fulfil this role) OR, they can make a selection from one of our

		approved Science Network experts.
5.4	*Reduced rates for capital access* How does this affect additionality?	No Change This is standard language that is in all of our protocols at the moment for consistency. This is really only relevant for projects that have a non-CDR revenue stream, and this list is ticking through examples of ways people might be rewarding a project developer for CDR through an additional revenue stream.
5.5.1 Reporting of Uncertainty	• *emission factors utilized, as published in public and other databases* • *values of measured parameters from process instrumentation, such as truck or pallet weights from weigh scales, electricity usage from utility power meters and other similar equipment* • *laboratory analyses, including analysis of feedstocks* What types of uncertainties need to be accounted for here? Emissions factors come from databases and we use them as is once we identify the most applicable one. Variables like feedstock weight and electricity usage are presented via bills of lading and electricity bills that we accept as is. What kinds of uncertainties apply to these categories?	No Change We refer readers to a previous PDD on our registry to see an example of uncertainty reporting
5.6: Data Reporting and Availability	*such as through open data repositories* We think this is outstanding. It might be improved if you can list some specific critical data that is required? My concern is that a company can claim 'proprietary' for many things, so you may want to call out certain data sets that cannot be claimed as proprietary. (This may also be covered in the references - I did not dig in to those)	Change We agree this is really important for the wider community. This has been updated to guidance stating that data should be shared, to keep this more flexible for the supplier to allow for specific project data types.
6.2 Governance and Legal Framework	*Due to the novelty of marine CDR projects, the international, regional and local legal frameworks have yet to catch up with this new industry* Not true for the US. The EPA has issued guidance on mCDR permitting this year	Change We've added reference to the EPA guidance

6.2 Governance and Legal Framework	This is very water-focused. There are AHJ requirements around operational permitting (transportation, OSHA, material handling, etc) that aren't mentioned in this doc and should be included in Applicability	Change We changed the heading for this list to "Minimum requirements for coastal projects." We are working on streamlining and ensuring better consistency on the environmental and social safeguards across all our protocols right now, by creating a separate document for environmental and social safeguarding across all CDR projects. Thus, we won't include any major changes to the environmental and social safeguarding section in this protocol, but have noted your feedback for the work on the module. Thank you.
6.3.1: Environmental safeguards	Potential marine environmental risks associated with OAE are listed below	No Change Thank you for the feedback. We are keeping the list of risks for now as they are specific to OAE, but have noted this feedback for the environmental and social safeguarding module that is currency in the works (see above comment)
6.3.1: Environmental safeguards	There needs to be more discussion that environmental risks should be assessed relative to climate change impacts. Furthermore, there is no true ocean baseline in the midst of climate change and rapidly deteriorating and changing ocean conditions.	Change We've added additional context at the end of this section to expand upon the framing of environmental safeguards in this protocol. We explicitly state and explain why it is not realistic or expected for projects to prove "zero changes to the ocean ecosystem," but that the goal is to minimize as much as possible any potential large adverse impacts.
6.3.1: Environmental safeguards	*The list is not exhaustive* From a verification standpoint, this phrasing can be problematic. IF the list is not exhaustive or not fully defined, it is then potentially difficult for the verifier to check that an entity is in compliance. This should either be the minimum list, or indicate that this is a minimum to which Isometric and the sup[plier can add additional requirements on a case by case basis - which would be identified in the PDD and then are directly validatable.	Change We have removed the language suggesting that this list is not exhaustive, and clarified that risks should be identified against this list and added to on a case by case basis by the supplier and listed in the PDD.
6.3.1: Environmental	*Potential marine environmental risks associated with OAE are listed below. The*	No change

safeguards	*severity of these risks may vary based on site specificities, and the intensity and duration of alkalinity enhancement* We suggest that you require the OAE supplier to evaluate this list and provide aa list of those which apply to them and which do not in the PDD, along with evidence and justification for each and a monitoring plan associated with each that requires ongoing evaluation beyond, for example, a literature review.	We have space for this to be outlined against the risk assessment the supplier undertakes in the marine appendix of the PDD we have written. Suppliers are asked to identify risks facing their project, and then outline how these risks will be mitigated.
6.3.1: Environmental safeguards	*rapid or sudden changes in alkalinity dosing* Might there also be changes over slower time horizons due to this as well? (sort of captured ini some of the below items, perhaps?)	No change Yes, exactly - there would be some effects happening over slower time horizons as captured in this list.
6.5 Stakeholder Engagement	*It is important to holistically consider the risks above in relation to the risk of climate change. Changes to the ocean state due to climate change increasingly threaten aquatic life through warming temperatures, acidification, increased prevalence of marine viruses, mass mortalities and ecological regime shifts.* Because of this, is there a need to specify a frequency of evaluation of the environmental risks? It's not directly addressed here, and may be addressed in Monitoring Plan requirements, but it seems like it should be called out here. For example, the environmental risk assessment must be updated annually at a minimum or based on new data and science, etc.	No change Environmental risks would be assessed on a project by project basis, so in the short term, environmental risks would likely be assessed on a frequent enough basis to alleviate for this concern. This is something we will consider for future protocol versions though (updates happen at minimum every 2 years).
6.5 Stakeholder Engagement	*Environmental justice review* How is this defined? is this different than the social risk assessment o 3.7.2 mentioned above? The requirements of this review must be fully defined or it will be difficult to verify that it was done properly / is adequate	No change We have a section in an appendix for marine carbon removal in the PDD where dedicated information on the environmental justice review can be outlined, to build on the information required for the SIA. This can be assessed against the protocol requirements for what should be included in the environmental justice review.

6.5 Stakeholder Engagement	*The Stakeholder input process must adhere to requirements outlined in Section 3.5 of the Isometric Standard* There's a lot of process here that seems unnecessary to define so granularly (14 day notice of meetings, grievance acknowledgement timelines etc). It would be easier to simply define the objective (sufficient notice of meetings, timely acknowledgement of grievances). Many permit applications already require public input and have their own processes and timelines for doing so	No Change As this is defined in the Isometric Standard, no changes are made to this protocol but this comment has been noted for the Standard. The section of the Isometric Standard this is being referred to has been reviewed by environmental social scientists, who deemed that the specifications in Section 3.5 comply with best practices in this area and are adequately specific.
6.6: Adaptive Management	*For example, plans for pausing or stopping a deployment should be in place in instances where* This seems like it should be a must, and the 'for example' should be deleted	Change We have amended this in the protocol.
6.6: Adaptive management	*Project Proponents must include in the PDD a plan for information sharing, emergency response and conditions for stopping or pausing a deployment.* This is usually not covered in the PDD, the purpose of which is to explain how the supplier arrived at their Net CDR calcs.	No Change Thank you for the feedback. While we understand that this traditionally might not be usually covered in the PDD, Isometric's mission and approach is to raise the quality bar and to build trust in the durable CDR space, which means doing things differently than what's historically been done in the VCM. Our goal is to ensure projects credited by Isometric have rigorous risk management strategies in place to ensure responsible deployment and operations. There's an example of a successful verification of a project on our registry where you can see a PDD that includes descriptions of its environmental and social safeguards here.
6.6: Adaptive management	*danger to ecosystem health detected (such as by the local community or government agency)* This is already covered by regulatory non-compliance	Change We've combined this with the regulatory non-compliance bullet point
7.1 Reporting period	*Leakage emissions that occur outside of the project boundary as a result of induced market changes that are associated with the Reporting Period.*	Change We added a reference to section 7.4.4.4 here which discusses leakage emissions

	What does this refer to? How do we account for this?	
7.1: Reporting period	*Credits may be issued incrementally or all at once after full or near-complete equilibration.* Should make clear this is either credits issued incrementally (before full equilibration) or all at once after full equilibration. Full equilibration is not a pre-condition for issuing credits	Change We've amended the sentence so that it says "Credits may be issued (1) incrementally over time based on the incremental air-sea equilibration achieved over a reporting period, or (2) all at once after full or near-complete equilibration."
7.1 Reporting period	So only the extent of air-sea exchange (CDR) achieved in a reporting period can be credited in that reporting period. Projects may have to wait millenia to be fully credited?	No change Isometric's position is that any removal that occurs thousands of years in the future should not be credited and used to offset present day emissions. We expect in reality, most projects will select sites with fast equilibration timescales so that most of the credits will be issued within the first few years.
7.1 Reporting Period	What is the definition of near-complete? Suggestion: Setting a justified definition of near-complete equilibration (e.g., 80% and above).	Change Thanks for the question. We will clarify the language here--we don't have a particular required cutoff number in mind and are open to this being flexible (e.g. 70% vs 80%). This option is just presented as an alternative to incremental crediting, where instead of getting small batches of credits say every month, a project can pick a cutoff point (say e.g. 1 year) and get all the credits at a single time.
7.2: System boundary and GHG emissions scope	Are electrodialysis/membrane approaches in the scope of this protocol? If yes, the CO_2 stream should be considered too	No change Direct ocean removal is not considered under this protocol. The electrochemical methods included here only involve acid removal and returning the more alkaline stream to the ocean.
7.2: System boundary and GHG emissions scope	What is the standard for an intensive project? Operationally how would we get this emissions data?	No Change More information can be found in the energy accounting can be found in the Energy Use Accounting Module.
7.2: System	Acid is not a waste. It has a wide variety of	Change

boundary and GHG emissions scope	industrial uses	In this context "waste processing" is referring to waste from the perspective of the project i.e. any outputs as a result of the project process which are no longer needed/useful to the CDR process. We updated this to just say "acid" (instead of "waste acid") to avoid giving the impression that acid is generally a waste product though.
7.2: System boundary and GHG emissions scope	What is the definition of post-deployment? After the dosing and reporting periods end? After a system has been decommissioned?	Change Re-named to “pre-dosing, during dosing and post-dosing.” Post-dosing means any monitoring that might extend for some time after dosing ends. Anything that happens after the reporting period or after a system has been decommissioned would fall under End-of-life emissions.
7.2: System boundary and GHG emissions scope	*The separate facility must not consider the OAE process within their GHG accounting to avoid double counting of removals.* Unless they purchase the removal credits	No Change That is correct, the separate facility could purchase carbon removal credits to include in their separate GHG accounting and this would not be double counting.
7.2: System boundary and GHG emissions scope	*must be agreed upon with Isometric* And defined in the PDD?	Change We have updated this language to make this clearer on the inclusion in the PDD.
7.2: System boundary and GHG emissions scope	*The Project Proponent must consider all GHGs associated with SSRs, in alignment with the United States Environmental Protection Agency’s definition of GHGs* Or equivalent international standard	No Change We use this list of GHGs in the Isometric Standard, and want to stick with a single consistent definition of GHGs everywhere.
7.2: System boundary and GHG emissions scope	*Emissions associated with a project's impact on activities that fall outside of the system boundary of a project must also be considered.* How does this square with the project boundary? Isn't the goal of the boundary to define which emissions need to be accounted for?	No change Please see the Leakage section in 7.4.4.4
7.2.1:	*Furthermore, there may be potential for*	We'll be removing the omission of this being

Exclusion of Emissions from System Boundary	*additional CO_2 uptake from increased primary production and biological carbon export, or increased dimethylsulfide production due to increased pH. These potential secondary climate effects are uncertain at this time and are not included in the system boundary.* But OAE reduces the wastewater CO2 emissions that otherwise are within the system boundary. You are saying adding alkalinity to the wastewater (plume) once in the ocean to consume the plume's CO2 is CDR, but adding the same alkalinity to the same wastewater and consuming CO2 before entering the ocean isn't CDR. That is inconsistent/unfair since wastewater is within the system boundary and biogenic emissions are being consumed within the system boundary by the OAE. activity.	counted as CDR in the protocol and there will be future versions of Isometric protocols planned to account for this specific time of crediting, which could account for these upstream reductions in biogenic emissions happening in a wastewater pipe where alkalinity has been applied.
7.2.1: Exclusion of Emissions from System Boundary	*the amount of the waste product used by the carbon dioxide removal process was not already being utilized as a valuable by-product or co-product by another party for non-CDR uses*. This could change over the lifetime of a project and be fairly detrimental to the net removal of a project. The feedstock supplier will not inform the OAE supplier of this	No Change This clause prevents exclusion of waste input emissions if using the waste for the CDR project will cause an increase in emissions elsewhere associated with other parties not being able to utilize the waste product, and therefore causing knock on replacement emissions. We understand there may be difficulties in gathering this information and we are happy to work closely with Project Proponents to work out an appropriate solution.
7.2.1: Exclusion of Emissions from System Boundary	*counterfactual emissions from not using the waste product are properly taken into account*. What does this mean?	Change This now says "Market leakage emissions are fully considered." Leakage emissions are further discussed in 7.4.4.4”
7.2.1: Exclusion of Emissions from System Boundary	*the separate process has a pathway toward compliance with net-zero emissions*. What does this mean?	No Change This clause is in place to ensure that the CDR project is not reliant on the by-product of an industry which does not have a pathway compliant with net zero, for example fossil fuel extraction.
7.2.1: Exclusion of Emissions from System	How is activity defined here? Is this at the industry level or the plant/facility level?	Change This is in relation to the system boundary, which inherently means it would be facility

Boundary		level, rather than industry level. It has been rephrased to be more clear.
7.2.1: Exclusion of Emissions from System Boundary	*The separate facility must not consider the OAE process within their GHG accounting to avoid double counting of removals.* Unless they purchase the removal credits	No Change That is correct, the separate facility could purchase carbon removal credits to include in their separate GHG accounting. For the purposes of this protocol for first quantifying the credits, this statement still holds true.
7.3 Baseline	*The counterfactual for OAE projects considers the CO_2 that would have been removed from or outgassed to the atmosphere and stored in the ocean in the baseline scenario…* or prevented from outgassing (?)	Change Language updated to include outgassing. Another view of the baseline is the ocean DIC reservoir in the absence of the project, in which case there's no need to distinguish between uptake & outgassing.
7.4 Net CDR calculation	Why is the counterfactual term zero?	Change We've defined some new terms (Equations 2-4) and derived Equation 5 from Equation 1, so that the counterfactual term is explicitly used as part of delta CO2e_AirSeaFlux
7.4: Net CDR calculation	*Counterfactual presentation* This seems like a strange way to present this and is slightly confusing. I'm not sure why you would not have CO2estored and the counterfactual in the equation (without the delta) instead of having the counterfactual already accounted for in the delta and a 0 counterfactual term.	Change Same as above comment
7.4: Net CDR calculation	What about uncertainty discounting?	Change Quantification of uncertainty is required in line with Section 2.5.7 of the Isometric Standard. We have added language to refer readers to this section of the protocol for more guidance.
7.4: Net CDR calculation	Alkalinity can also be discharged near the surface.	Change Any discharge infrastructure which is stationary and located on the coast is eligible under this protocol. This includes cooling water outfalls which may be near the surface or above the surface. We have added language to clarify that the illustrated buoyant plume discharged a depth is an

		example of possible infrastructure.
7.4: Net CDR Calculation	What about surface discharge, such as from a power plant's cooling water outfall?	Change Same as above comment
7.4: Net CDR calculation	What about model validation?	No change All models that are used must be from a Reputable Source and/or shown to be reliable via peer-review, testing or correlation with empirical data. The source of models, any modifications, input parameters, data used and validation results must be clearly outlined in adherence with the Section 2.5.5 in the Isometric Standard. We have added some language referring to the Standard.
7.4.1 Calculation of CO2eStored, RP	*In the case of incremental Credit issuance, any previously issued removals must be subtracted from Equation 2 to ensure no double counting.* Recommend including this factor in Eq 2 for completeness and so it is not forgotten by suppliers/verifiers when referring to the protocol	No change As this is noted immediately below the equation, we have opted to keep the equation as is to keep this in line with how this equation/similar equations look in other protocols.
7.4.1 Calculation of CO2eStored, RP	*ΔCO2eStored* "Stored" is a confusing term as it is usually associated with sequestration--"removed" would be better	Change We reformatted the equations so now this term is called delta CO2e_AirSeaFlux
7.4.1 Calculation of CO2eStored, RP	Re: removal from the atmosphere What about reduced outgassing?	Change We made sure to consistently use "net removal from the atmosphere" throughout the protocol
7.4.1 Calculation of CO2eStored, RP	Is the quantification approach the same for carbonate feedstocks? Why not include carbonate alkalinity by saying that in this case the alkalinity is partially pre carbonated and this carbon must be subtracted from any CDR otherwise claimed?	Change Added "Note that the quantification framework for $\Delta CO_2e_{Stored, RP}(t)$ is written for projects that raise TA but not DIC. Projects whose primary alkalinity source is carbonate feedstocks, i.e. feedstocks that contain carbon and upon dissolution would increase the amount of DIC in the ocean (but not as a result of CO_2 removal from the atmosphere), will require some adjustments to the above quantification approach. The same general

		steps can be followed, but with alterations to account for the DIC that is added in addition to alkalinity. Adjustments to the quantification approach must be agreed upon with Isometric."
7.4.1: Calculation of CO2eStored, RP	Do I understand this term correctly that Delta CO2e_stored,RP is equivalent to Delta CO2_air-sea as given in the Air-sea CO2 uptake v1.0 protocol from Isometric under section 3.1.4? If so, I would suggest to: 1. Align the namings between the two protocols 2. Use the same formula (including the 44/12) conversion between carbon to CO2	Change Delta CO2e_stored,RP is equivalent to Delta CO2_AirSeaFlux. We have updated the equations to be consistent.
7.4.1: Calculation of CO2eStored, RP	Plume may not be buoyant	Change We have clarified this in the protocol now e.g. in the caption of figures, where relevant - to ensure it is not blanket assumed the plume would be buoyant.
7.4.1: Calculation of CO2eStored, RP	Statement: p.32/92 – "This Protocol requires total Credits are only issued after removal from the atmosphere." Comment: The air-sea gas exchange is the longest step (compared to mixing alkalinity in the near-field) and is ultimately modelled. Why wait for something that will be modelled in the end? Suggestion: If the risk of reversal is negligible and the alkalinity is dispersed, credits could be issued before the air-sea gas exchanges occur since this will only be confirmed by mathematical models. Again, there could be a provision for avoiding the retirement of such Removal Credits before the modelled/expected date of effective atmospheric removal.	No change We have considered the idea of issuing credits earlier on and setting restrictions around when they can be retired. This is not common practice however, so a result might be that buyers would not want to buy credits that have additional retirement restrictions on them (especially if other credits don't have these restrictions). Since we allow for incremental credit issuance based on the progression of air-sea equilibration, and the CO2 uptake happens most rapidly initially, we expect that most credits will be issued within the first few months/years of alkalinity addition. We're open to evolving this requirement as the community consensus evolves.
7.4.1.1: Step 1 Effluent Measurements	*Alkalinity dosing rate (e.g. umol/hour)* "This is an odd unit and not usually how we measure the dosing rate. It is orders of magnitude larger than this unit"	Change This was just provided as an example unit, but we have removed it as to not cause confusion and we understand that projects may use different units in this measurement.
7.4.1.1: Step 1	*Volumetric flow rate must be continuously*	Change

Effluent Measurements	*measured before being released into the ocean* This is a contentious term for engineers. Technically you cannot measure continuously--there is a defined frequency while being release, not before	We rephrased this sentence to "continuously monitored throughout the dosing period" (with the understanding that to continuously monitor something, you can take sufficiently high frequency measurements) In general throughout the rest of the protocol, we decided to keep the wording "continuous," since this language is generally understood to differentiate between sensors that measure at high frequency, compared to discrete bottle samples which might only occur once per hour or less. As an example, this language is also used in the EPA manual for "continuous pH monitoring":
7.4.1.1: Step 1 Effluent Measurements	Impacts to resident biota during pumping filtering, processing and electrolyzing seawater must be documented. [bury/sink the biomass thus killed/extracted and get extra CDR credits?]	Marine biota mortalities that result from the OAE process are not eligible for biomass-based CDR to prevent adverse incentives. Impacts to resident biota are required documentation, please refer to the environmental risks and monitoring requirements. We have revised language to make this more clear and included this in the monitoring table as well.
7.4.1.2: Alkalinity upscaling	*Sensitivity study* Are there any criteria for sensitivity in this context?	Change Added clarification that by sensitivity study, we mean quantifying the distribution of the net CO2 removal calculated from the model when the shape of the alkalinity forcing profile is varied. So a narrow distribution means the model is not sensitive, whereas a broad distribution means the model is very sensitive.
7.4.1.2: Alkalinity upscaling	*provided they are well-described and justified, and will be assessed by Isometric on a case-by-case basis* Verifiers will need documentation from Isometric clearly stating that the approach presented is acceptable and any specific criteria required to be implemented to effectively validate or monitor that approach are also clearly identified and approved	No change This can be part of the verification workflow for this approach. It is likely our team can support the subcontractor in subject matter expertise who works with a verifier with any queries and iteration on this process.
7.4.1.3:	*Moles carbon removed through air-sea gas*	Change

Air-Sea CO2 Uptake	*exchange should be less than the moles alkalinity added* Must?	
7.4.1.3: Air-Sea CO2 Uptake	*CDR efficiency defined by the molar ratio (mol carbon removed)/(mol alkalinity added) should agree with regional data if available.* Must?	Change
7.4.1.3: Air-Sea CO2 Uptake	*The air-sea CO2 equilibration can be quantified over the coastal domain, the open-ocean domain, or both* Must?	Change
7.4.2: Alkalinity losses	Because these loss terms are rightfully flexible in their definitions and requirements, this will become a difficult section for verification which will require significant expertise in each loss phenomenon to be utilized to verify, likely resulting in fairly significant costs for verification.	No change We agree, this is a non-trivial challenge for verification of mCDR, including OAE. This is where we envisage the subject matter expert dealing with this aspect of verification. This will likely require some iteration and learning to make sure we can make this as cost effective as possible, and make the process as smooth as possible.
7.4.2: Alkalinity losses	It's unclear that if losses were significant they would need to be subtracted in the overall equation for net CDR quantification	Change The losses are not directly subtracted from the overall net CDR quantification equation since the losses are alkalinity losses, and not CO_2 losses. Instead, the alkalinity losses need to be quantified in step 2 so that the proper quantity of alkalinity forcing is applied to the models in step 3. We've added additional language in the following places in the protocol to make this point clearer: - 7.4.1, included losses in Step 2 description - 7.4.1.2, specified that losses should be subtracted from alkalinity forcing function - 7.4.2, reminder that losses should be subtracted from alkalinity forcing function as part of step 2
7.4.4.1: Calculation of CO2eEstablishment, RP	*the Project Proponent should notify Isometric as early as possible* Must?	Change

7.4.4.1: Calculation of CO2eEstablishment, RP	*The anticipated lifetime of the project should be based on reasonable justification and should be included in the Project Design Document (PDD) to be assessed as part of project validation.* It might be prudent to define a maximum period for which allocation can be done to prevent overly long estimated lifetimes. other isometric protocols limit this to 10 yrs. It might be reasonable to set a max at 5 years, for example.	No change We are currently working on a cross-protocol project to think about how to potentially standardize project lifetimes across protocols, but right now, we don't have a standard lifetime defined, so to keep this consistent across protocols, there will be no change to this for now.
7.4.4.2: Calculation of CO2eOperations, RP	*GHG emissions associated with C O 2 e O p e r a t i o n s , R P C O 2 e Op er a t i o n s , RP should include all emissions associated with operational activities, including but not limited to the SSRs set out in Table 1.* Is there a reason for not including an equation here with all of the subcategories listed in Table 1 and the emissions sources (i.e. energy, transport, etc.)?	We tend not to include equations where all terms are already listed for ease somewhere else - for example, in the table where the SSRs are all listed above, in this instance.
7.4.4.2: Calculation of CO2eOperations, RP	*should include all emissions associated with operational activities, including but not limited to the SSRs set out in Table 1.* Must?	Change
7.4.4.2: Calculation of CO2eOperations, RP	"Statement: p.42/92 -- Section CO2e,operations,RP Comment: For electrochemical OAE approaches, acid waste management (neutralization and disposal) needs to occur during the reporting period. This is because contact between acid and carbonate minerals or mine-tailings in the open air would lead to detrimental effects (CO2 emissions). This is really important point for the integrity and exhaustivity of carbon accounting over the reporting period. Suggestion: Explicitly add that “Acid waste neutralization and disposal needs to occur over the Reporting Period for proper accounting.”"	Change Acid waste neutralization is included in operations (see Waste processing in Table 1). We have also explicitly called out acid waste neutralization in Calculation of CO2eOperations, RP.
7.4.4.4: Calculation of CO2eLeakage, RP	*As an example, creating a market for feedstocks may generate new revenue in the source sector that alters producer behavior in ways that result in additional*	No change An example from prior verifications that can illustrate what is required here is for example

	GHG emissions. Can you clarify the verifiers requirements for verifying the suppliers market assessment and impact on leakage? This potentially can go in quite a few different directions. For energy, i think Isometric has done a good job setting some specific requirements associated with the assessment. For other categories listed below (i.e. feedstock or consumables), there are no requirements listed, which will make this very difficult to verify - at least without engaging a panel of market dynamics experts in the specific potential leakage market.	for a mining waste feedstock, we currently would accept an affadavit from the producer of the waste essentially saying that it wouldn't have been used for anything. This approach can be used for other market leakage aspects too.
7.4.4.4: Calculation of CO2eLeakage, RP	• *energy use impact on the grid if the project is deemed an intensive facility (this may be particularly important for electrochemical OAE; more detail on intensive facilities is provided in the Isometric Energy Use Accounting Module)* • *feedstock replacement* • *consumables replacement* a) Aren't these all outside the system boundary and therefore not accounted for? b) How would this accounting work in practice? There are no existing standards for how to account for these potential effects. CarbonPlan says the same https://carbonplan.org/research/cdr-verification/ocean-alkalinity-enhancement-electrochemical	No Change a) Leakage is defined as emissions associated with a project's impact that fall outside the system boundary. Although more difficult to quantify, it is the responsibility of the project to ensure leakage emissions are considered so that the total impact of the project on GHG emissions can be understood. b) Methods vary from project to project, for example where feedstock may be diverted from an alternate use, emissions associated with replacing the function of the feedstock removed for use in the project must be accounted for. This may include accounting for emissions associated with additional transport, manufacturing, or energy use as a result of using a replacement feedstock.
7.4.4.5: Energy Use Accounting	May consider indicating that energy use accounting applies to establishment, operations, end of life, and leakage emissions terms	No change As this is covered by the Energy Accounting module, we have not made a change here.
7.4.4.6: Transportation Emissions Accounting	May consider indicating that transportation accounting may apply to establishment, operations, end of life terms	No change As this is covered by the Transportation module, we have not made a change here.
7.4.4.7: Embodied Emissions Accounting	may point out that embodied emissions may apply to all terms in Eq 1	Change We have added some language to outline this.

8.2: Buffer pools	Why is there a 2% buffer pool if the reversals are not able to be monitored?	Change Updated Section 2.5.9 of the Isometric Standard to clarify that CO2 storage open systems will have the lowest risk score from the Risk of Reversal questionnaire, but that still comes with a 2% buffer pool at this time as a precaution against unknowns. Also updated this section in the protocol to more clearly align with the Isometric Standard.
7.4.1.1: Effluent Measurements	This is not a precise definition of measurement point. It may not always be practical as the outflow may be (i) submerged, (ii) far offshore and/or deep, (iii) multiple – namely in the context of several and spread out dilution points. We suggest the possibility of measuring on-land before the last pipe connection to the ocean outfall. The aim is to make it coherent with the monitoring setup visually represented in section 10.2	Change "Step 1: Determination of alkalinity dosing rate is required via continuous measurement at the outflow, **or the input location of the ocean outfall when justified."**
10: Monitoring Requirements	*Determination of monitoring frequency and duration* Not sure how to determine what would be considered long enough- It would help to make this requirement more quantitative. Possibly determine residence time first then take at least 3 samples spaced 1 residence time apart?	Change It's hard to add more specificity on the monitoring frequency because there are many factors that influence it, such as the specific variable being monitored, the expected signal of that measurement compared to the noise of the ocean's natural variability, the measurement platform and what frequency is feasible (e.g. from a ship/mooring/autonomous vehicle, or water samples taken on land?). This is further complicated by the fact that the in-ocean monitoring plan encompasses environmental risk monitoring as well as quantifying alkalinity losses, both of which will require project-and-site-specific strategies. We have added more context and justification in the protocol for why this is open-ended, and some examples in Appendix 2. Ultimately we expect this to be something that will require judgment call/evaluation with subject matter experts.
10: Monitoring Requirements	TA is a seawater characteristic. For an effluent significantly different than seawater TA is ill defined	No Change Thank you for flagging this. We appreciate Total Alkalinity is ill defined, but

		measurement of alkalinity is still possible in non-seawater systems, which is what we're driving at here.
10: Monitoring Requirements	This actually is not assumed for regulatory purposes on the text “beyond the mixing zone, receiving waters are expected to be well-mixed, which can provide more representative measurements"	Change Language has been changed to "beyond the mixing zone, receiving waters will display less turbulent variability, which can provide more representative measurements"
10: Monitoring Requirements	How do you determine the validity of a new sensor technology? E.g. what would be required for you to accept a sensor as a valid method? A significant academic group adopting/using it, an intercomparison study in peer-reviewed literature, ...?	Change Per Appendix 2 (section 14.3.1), sensors must undergo calibration before deployment and routine recalibration. This is true for new sensors as well. We have added the following text to Appendix 2: “Adoption of innovative sensor technologies is encouraged. For novel sensors, additional information that would typically be available from a manufacturer would also have to be provided. These include detection range, resolution, accuracy, performance under different environmental conditions (ie. temperature ranges) and response time. The expected measurement conditions must be within the sensor’s range.
10: Monitoring Requirements	Does this mean measurements are not used for quantification and model validation at all? Or is this simply an additional section describing the purposes listed here?	Change This section is meant to be an overview of all ongoing measurements and Table 2 includes a summary of monitored parameters. Ongoing measurements are used for quantification in Section 7.4.1.1: Outflow measurements and Section 7.4.2 Alkalinity losses. We have updated and added the following language: "The aims of the monitoring plan are to demonstrate permit compliance, monitor environmental conditions, conduct ongoing measurement for quantification, and establish processes for adaptive management to ensure that projects stop if negative impacts are identified". We also added a subsection on measurement requirements for model validation and model inputs.

10: Monitoring Requirements	Defining pH < 9 as the "safety threshold" is extremely problematic. Permits can and do allow for pH > 9, if the local AHJ considers it safe. The pH limit should be set by the permit alone and not defined separately here.	Change We revised language to “Effluent must adhere to the pH safety threshold allowed under official permitting. In the absence of a permit, this protocol recommends a safety threshold of effluent pH < 9.”
10: Monitoring Requirements	What about other measurements that would be needed? There should be measurements of carbon flux.	Change We added language to clarify that the listed measurements represent the minimum common set of measurements needed across all projects. Additional measurements may be required based on specifics of the project and site. We have also included recommendations for measuring carbon flux.
10: Monitoring Requirements	Turbidity should be required since turbidity sensors exist, and can be a proxy for TSS.	Change Turbidity is now included as a required measurement in the mixing zone.
10: Monitoring Requirements	The mixing zone is too simplistic.	Change The mixing zone is indeed simplistic, however it is commonly used as a regulatory concept for compliance. We have added the following language to reflect the dynamic nature of the mixing zone, and some sampling recommendations for the mixing zone.
10: Monitoring Requirements	*Quantifying the impacts of seawater processing on resident biota* How about [biota concentration in seawater samples taken upstream of intake minus biota concentration in the discharge water (0?)] x volume pumped = biological impact/cost of process?	No change This could be an approach. Other approaches we have recommended include demographic mortality or conditional mortality studies, as they have a track record of being used to assess the impact of seawater intakes, such as for desalination.
10: Monitoring Requirements	*Removal activity from discharges that occur during time periods of safety threshold violations will not be eligible for crediting.* How does this work in practice? If we credit monthly but observe some problematic ecological change 6 mos after dosing alkalinity, which crediting period does this pertain to?	No Change Safety thresholds are imposed on the effluent characteristics and controlled prior to discharge, so those threshold violations will fall under a reporting period. Ecological changes 6 months later would fall under action threshold violations, which would trigger adaptive management plans.

Appendix 1: Analytical Methods	[no comment]	Change This Appendix has been moved into the Appendix: Guidance for High Quality Observational Data Collection under Specific Guidance for Bottle Samples