



**Verified Carbon
Standard**

A VERRA STANDARD

Geologic Carbon Storage (GCS) Requirements

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1 INTRODUCTION

This document provides project-level requirements for geologic carbon storage (GCS) project activities. GCS is an umbrella term and broadly refers to carbon capture and storage activities, geologic carbon mineralization, and carbon capture, utilization, and storage in geologic reservoirs. In its current version, this document provides requirements for CCS projects only. Subsequent versions may have additional sections to provide requirements for more GCS activity types and may evolve as methodologies are developed under this scope.

In addition to the requirements set out in this document, GCS projects must conform with all applicable VCS Program rules to be eligible for registration, VCU issuance, and release of buffer credits from the GCS pooled buffer account.

The material in this document has been inspired by and adapted from the following sources:

- 1) US EPA. (2002). Part 146- Underground Injection Control Program Class VI Requirements (40 CFR § 146.86) – Injection Well Construction Requirements. <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-146/subpart-H/section-146.86>
- 2) US EPA Office of Water. (201). Underground Injection Control (UIC) Program Class VI Well Site Characterization Guidance. <https://www.epa.gov/sites/default/files/2015-07/documents/epa816r13004.pdf>
- 3) European Union. (2009). European Parliament and the Council of the European Union (2009) Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC. <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF>
- 4) California Air Resources Board. (2018). Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard. https://ww2.arb.ca.gov/sites/default/files/2020-03/CCS_Protocol_Under_LCFS_8-13-18_ada.pdf
- 5) International Organization for Standardization. (2017). ISO 27914-2017 – Carbon dioxide capture, transportation and geological storage – Geological storage. <https://www.iso.org/standard/64148.html>

Although not required, these sources can be used as guidance for project proponents and storage site operators.

2 GENERAL GCS REQUIREMENTS

Each GCS project type (CCS, GCM, or CCUS) will have unique requirements. This section sets out the rules and requirements applicable to all GCS projects under the VCS Program and is in addition to requirements set out in the VCS Program document *VCS Standard*. CCS-specific requirements are set out in Section 3 below.

Appendix 2 illustrates the timelines and milestones relevant to GCS projects.

2.1 Expansion of GCS Projects

Concept

GCS projects may expand over time by adding capture, transport, or storage sites/zones and sharing existing infrastructure.

The expanded element of a project does not represent the full value chain of capture, transport, and storage themselves, as such they are not a standalone project. They are not another instance of a project activity and are not a grouped project. A project expansion is not a unison of multiple projects but rather is restricted to the addition of project activities (capture, transport and/or storage sites/zones).

A project expansion can occur at any time and may not have been planned during the initial project design. Note that the initial project before an expansion may include multiple transport facilities and capture and/or storage sites. Therefore, the initial project may have either a cooperative hub or vertically integrated operating model, and both operating models can have project expansions.

The expansion of GCS Projects is managed on a case-by-case basis through the existing project description deviation requirements, with specific considerations for GCS project types.

Requirements

Eligibility Criteria

2.1.1 Expanded projects shall have a dedicated connection of CO₂ flowing to or from the expansion and the initial project, or other previous project expansions.

Project Description for Expanding GCS Projects

2.1.2 The project expansion shall be documented as a project description deviation in accordance with the requirements set out in the VCS Program Document *VCS Standard*.

2.1.3 Both the original and expanded project description documents shall be made available at all subsequent verifications.

2.1.4 Regardless of whether or not the project expansion impacts the applicability of the GCS methodology (or modules), additionality or appropriateness of the baseline, the project

description shall be revised to include the following:

- 1) A description of the project expansion.
- 2) A description for the use of any additional GCS methodologies or module(s) (if applicable).
- 3) The location of project expansion areas and connection points as specified in Section 2.3.
- 4) Details of any new project proponents or other entities involved in the expanded project.
- 5) Determinations that the expanded project conforms with the applicability criteria of the methodology.
- 6) A description of how the expansion impacts additionality or the appropriateness of baseline scenario.

2.2 Ownership

Concept

Project proponents must demonstrate that they have the legal right to control and operate project activities. Given that GCS projects may be developed as vertically integrated or cooperative hubs, and because the risk of reversal at GCS storage sites persists beyond the crediting period, there are distinct considerations for ownership.

Requirements

- 2.2.1 The project description shall be accompanied by evidence establishing project ownership accorded to the project proponent(s) for the plant, equipment, and processes at all capture facility site(s), transportation system(s), and storage sites(s). The *VCS Standard* gives types of evidence.
- 2.2.2 For each storage site, evidence shall establish that each of the following either is the project proponent(s) or vests project ownership to the project proponent(s) through an enforceable and irrevocable agreement:
 - 1) the pore space tenure holder(s).
 - 2) the storage site operator(s).
- 2.2.3 Pore space tenure holders shall establish tenure for the target injection zone which spans the anticipated CO₂ storage area by having:
 - 1) Title(s) or lease(s) to the pore space.
 - 2) A legal opinion from a qualified, independent lawyer, licensed to practice within the jurisdiction where the storage site is located, that endorses that the tenure has been transferred, granted, or leased by the person(s) with the authority or ownership rights to the relevant pore space.

- 2.2.4 Storage site operators shall establish operatorship for a storage site by having:
- 1) Valid licenses, permits, or other such authorizations issued by the regulating jurisdiction to:
 - a. Drill injection and monitoring wells.
 - b. Operate the storage site(s).
 - 2) Access rights to all onshore surface and offshore locations with injection and monitoring wells.
 - 3) A legal opinion from a qualified, independent lawyer, licensed to practice within the jurisdiction where the storage site is located, that endorses that access rights have been granted by the person(s) with the authority or ownership rights to the relevant locations.
- 2.2.5 When an agreement evidences that a storage site operator vests project ownership to the project proponent:
- 1) The agreements shall include clauses that assign responsibility for each of the following at the storage site(s):
 - a) Storage site closure and/or post-closure requirements, including the effort and cost of site remediation (remedial liability), as well as redress for the release of injected CO₂ (climate liability).
 - b) Funding for post-injection site care (PISC) costs as per the Non-Permanence Risk Tool for Geologic Carbon Storage.
 - 2) The project proponent(s) shall have a legal opinion from a qualified, independent lawyer, licensed to practice within the jurisdiction where the project is located, that endorses that the agreements or laws of that jurisdiction assign all the responsibilities described in Section 2.2.5(1).
- 2.2.6 Where project ownership changes or the parties to the agreements referenced in Section 2.2.5 change, the project proponent shall have:
- 1) An executed assignment and novation agreement, or equivalent, such that the new owners and contractual parties assume all the rights and obligations in the original agreements and pore space tenure instruments.
 - 2) A legal opinion from an appropriately qualified, independent lawyer, licensed to practice within the jurisdiction where the project is located, that endorses that the assignment and novation agreement or equivalent, serves to transfer to the new owners and contractual parties all the rights and obligations in the original agreements and pore space tenure instruments.

2.3 Project Location

- 2.3.1 The project location shall be specified in the project description, with the following information

provided:

- 1) The GHG emissions source location(s) at the capture site(s), specified by a geodetic coordinate.
- 2) The planned transportation network specified by a geodetic polygon, modes of transportation to be used, and their respective anticipated transport distances (if applicable).
- 3) The geographic area(s) of any expansion of project activities, specified by geodetic polygons.
- 4) The flowing CO₂ connection point(s) between the added project activities and the original or previously added project areas, with each connection point specified by a geodetic coordinate.
- 5) The injection and monitoring wellhead surface location(s) and bottom hole location(s) from deviated and/or horizontal wellbores when applicable, specified by a geodetic coordinate(s), along with the bottom hole depth.
- 6) A vertical surface projection of the storage reservoir area of review delineated with geodetic polygons provided in a KML file.
- 7) The total area of the storage reservoir surface footprint.

2.4 Non-Permanence Risk

Concept

To safeguard against the risk of CO₂ loss (a reversal) from a GCS project, the Verra Registry maintains a GCS pooled buffer account that holds a percentage of all GCS project credits. Buffer credits are cancelled to cover carbon known, or believed, to be lost. As such, the VCUs already issued to projects that subsequently fail are not cancelled and do not have to be “paid back”. All VCUs issued to GCS projects (as with all projects) are permanent. Processes related to the GCS buffer credits and the buffer pool shall be advanced in accordance with the VCS Program document *Registration and Issuance Process* which is subject to forthcoming changes.

Requirements

- 2.4.1 Projects shall prepare a non-permanence risk report in accordance with the VCS Program document *GCS Non-Permanence Risk Tool* at validation and each verification. The report shall be prepared using the *VCS Non-Permanence Risk Report Template*.
- 2.4.2 The project may use multiple geologic storage zones. A risk analysis shall be carried out by the project proponent for each respective storage site and storage zone in accordance with the VCS Program document *GCS Non-Permanence Risk Tool*. The highest risk rating obtained for an individual storage site or zone shall be applied across the entirety of the project.

- 2.4.3 Buffer credits shall be deposited in the GCS pooled buffer account based on the non-permanence risk report assessed by the validation/verification body. Buffer credits are not VCUs and cannot be traded. The full rules and procedures for the deposit of buffer credits are set out in the VCS Program document *Registration and Issuance Process*.
- 2.4.4 Validation of non-permanence risk analyses may be conducted by the same validation/verification body that is conducting the validation or verification of the project and at the same time as the validation or verification of the project, as applicable.
- 2.4.5 Where an event occurs that is likely to qualify as a loss event, the project proponent shall follow the loss event reporting requirements set out in the VCS Program document *Registration and Issuance Process*.
- 2.4.6 At the verification event after the loss event, the monitoring report shall restate the loss from the loss event and calculate the net GHG benefit for the monitoring period, including the loss event, in accordance with the requirements set out in the methodology applied and the VCS Program document *Registration and Issuance Process*.
- 2.4.7 At a verification event where a reversal has occurred, the project proponent shall follow the buffer account reconciliation requirements set out in the VCS Program document *Registration and Issuance Process*, and no further VCUs shall be issued to the project or any other project with the same project proponent, or combination of project proponents, until the deficit is remedied. The deficit is equivalent to the full amount of the reversal, including GHG emissions from losses to project and baseline carbon stocks.
- 2.4.8 As set out in the VCS Program document *Registration and Issuance Process*, where projects fail to submit a verification report within the prescribed period from the previous verification event, a percentage of buffer credits is put on hold under the conservative assumption that the carbon benefits represented by buffer credits held in the GCS pooled buffer account may have been reversed or lost in the field.

3 CCS REQUIREMENTS

3.1 CCS Specific Matters

Regulatory Oversight

- 3.1.1 The project shall be located in a jurisdiction where regulatory oversight is provided by the government or a government agency (i.e., a statutory regulator).
- 3.1.2 Where the regulatory program meets the minimum criteria set out in Section 3.1.3 below, regulatory oversight may be demonstrated through receipt and continued validity of a permit, license, or other such authorization to construct and operate injection wells and store CO₂ in geological reservoirs. Regulatory oversight may exist at various combinations of supra-national

(e.g., the European Union), national, and sub-national levels.

3.1.3 Regulatory oversight means the following characteristics of a project are regulated:

- 1) Storage site(s) selection and reservoir characterization – Regulators have evaluated, and found adequate for the project activity, at least all the following:
 - a) Reservoir capacity, including the geometry and extent of storage, and the spatial distribution of relevant geologic properties (e.g., porosity, permeability, pressure, temperature and/or fluid saturation).
 - b) Injectivity of the storage reservoir, including a geological and hydrogeological characterization of the storage reservoir.
 - c) Trapping mechanism(s), including characterization of the primary seal, secondary seals, any other confining strata, faults, and fractures.
 - d) The integrity of both pre-existing and new wells, including their design and future ability to confine fluids.
 - e) Proximity to and potential impacts to/from other subsurface activities and/or resources including hydrocarbons, mineral resources, geothermal energy sources, dissolved minerals, waste disposal and other CCS projects.
 - f) Geochemical properties of the caprock/storage reservoir rock and/or fluid interaction.
 - g) Geo-mechanical properties including natural seismicity, tectonic activity, faults, in-situ stress properties, and rock mechanical properties of both the storage reservoir and seals.
 - h) Characterization and protection of aquifers used for potable water or other water resources.
- 2) Well design, construction, and operating limits – Regulators have evaluated, and found adequate for the project activity, all the following:
 - a) Well designs meet the injection depth and injection rate for the project while maintaining wellbore integrity for the anticipated lifetime of the project until storage site closure, protecting groundwater sources, and withstanding anticipated conditions during the project.
 - b) Well casing, tubing, strings, and liners are of appropriate strength, material, and geometry to withstand the anticipated project conditions for the lifetime of the project until storage site closure, including pressure, corrosivity, temperature, and stress.
 - c) Cementing procedures and materials structurally support the well and casings, provides annulus seals below the base of protected groundwater, isolation at different reservoir intervals, and are appropriate to withstand the anticipated project conditions and post-injection conditions.

- 3) Monitoring requirements – Regulators require a monitoring program for the project activity that includes all the following:
 - a) The CO₂ storage reservoir is monitored during the injection and closure period.
 - b) The monitoring results support the identification of CO₂ loss in the storage reservoir.
 - c) Responsibility for monitoring is unambiguously assigned.
- 4) Storage site closure requirements – Regulators have a documented and enforced process for the closure of storage sites that includes all the following:
 - a) Storage sites are closed at their end-of-life following specified timelines or conditional timelines driven by specified criteria.
 - b) Conditions, or qualifying criteria to be evaluated, are defined and met for successful site closure.
 - c) Responsibility for storage site closure, post-injection site care funding and post-closure liabilities are unambiguously defined. Post-closure liabilities include the effort and cost of site remediation (remedial liability), as well as redress for the release of injected CO₂ to the atmosphere or other zones (climate liability).

Reservoir Management

- 3.1.4 The storage site operator shall operate the storage site(s) such that the reservoir pressure does not reactivate faults or fracture the caprock at any point in time, and:
- 1) For depleted oil and gas reservoirs, the reservoir pressure shall not exceed the original pressure of the reservoir except locally around injectors during injection and well stimulation where it must remain below the caprock fracture pressure.
 - 2) For all other reservoirs, the reservoir pressure must remain below the caprock fracture pressure except locally around injectors during injection and well stimulation.

3.2 Project Design

- 3.2.1 The storage reservoir(s) shall be at a depth no shallower than 800 m from the surface, such that the temperature and pressure of the storage reservoir are sufficient to maintain the CO₂ in a liquid, supercritical, or dense phase.
- 3.2.2 A project may have multiple storage sites only where all the following criteria are met:
- 1) All storage sites have a common storage site operator.
 - 2) All storage sites have interconnecting infrastructure.
 - 3) All storage sites are located within the same jurisdictional boundary.

- 4) All storage sites are overseen by the same regulatory authorities and operate under the same regulatory approval.

3.3 Project Crediting Period

- 3.3.1 The project crediting period shall be seven years, five times renewable for a total of up to 42 years.

3.4 Monitoring

Concept

Monitoring CCS projects consists of modeling activities using a reservoir model, geologic evaluations, a CCS monitoring program, and storage site closure activities. These monitoring activities seek to detect CO₂ leak precursors at a storage site to prevent and detect CO₂ leaks and quantify GHG emissions from a reversal should it occur.

A monitoring program used to satisfy jurisdictional regulatory requirements can be used to fulfill VCS monitoring requirements if it meets the requirements in this section.

Requirements

Reservoir Model

- 3.4.1 The storage site operator shall create the following:
 - 1) A reservoir model based on numerical modeling simulation tools.
 - 2) A geologic evaluation that is supplemental to the reservoir model where dynamic data limitations and uncertainties exist.
- 3.4.2 The reservoir model and geological evaluation shall incorporate geological data obtained from storage site selection activities, reservoir characterization activities, and ongoing results from the monitoring program. This may include petrophysical data, core data, test data, geophysical analysis (seismic data), pressure data, and any other data or analyses to build and make effective use of a representative model and geologic evaluation.
- 3.4.3 The reservoir model shall include at least the following two elements:
 - 1) Geostatic model – A representation of the storage complex that allows evaluation of potential behaviors.
 - 2) Flow model – A representation of the flow of CO₂ and other fluids through the storage complex. This shall build from the geostatic model, using pressure- and saturation-dependent properties, well locations, and geometries to calculate the pressure/saturation distribution in the reservoir, and the injection profiles over time.

- 3.4.4 The geologic evaluation shall include a geo-chemical evaluation and geo-mechanical evaluation that is based on the estimated pressure and CO₂ migration in the reservoir model. The evaluations shall predict stress changes, deformations, risks of induced seismicity, and CO₂ interactions with minerals and fluids in the geological complex.
- 3.4.5 The storage site operator shall apply the reservoir model and geologic evaluation to:
- 1) Replicate the actual past behavior of the injected CO₂ over time.
 - 2) Assess the risk of stored CO₂ loss (i.e., leaks) and characterize the distributions and uncertainty of the outputs.
 - 3) Estimate the pressure differential between pre-injection and post-injection pressures in the injection zone(s).
 - 4) Evaluate the conformance of plume behavior against expectations.
 - 5) Predict the CO₂ extent and associated pressure front at the expected time of site closure and throughout the post-injection assessment period (PIAP).
- 3.4.6 Any reservoir model or geologic evaluation indicating potential non-negligible CO₂ containment loss shall be:
- 1) Identified and discussed in an update to the monitoring program as a concern and vulnerability being investigated through a specifically designed study.
 - 2) Investigated within nine months of the indication through a specifically designed study that seeks a CO₂ leak signal using techniques that have a reasonable likelihood of detecting the type and quantity of CO₂ loss if it were to occur.

CCS Monitoring Program

CCS Monitoring Program Document

- 3.4.7 The project description shall be accompanied by a CCS monitoring program document with, at a minimum, the following elements:
- 1) Project-specific monitoring objectives and performance metrics based on systematic risk analysis and identification of potential leakage pathways, including the use of monitoring data for history matching and otherwise addressing uncertainties.
 - 2) Monitoring techniques for the near-surface (including around any existing or abandoned wellbores) and sub-surface, during pre-injection, injection, closure, and post-closure. For each monitoring technique, the locations, parameters, tools, detection thresholds, detection frequencies, spatial resolutions, and a description of how these contribute to the project-specific monitoring objectives and performance metrics are established in Section 3.4.7(1) above.
 - 3) A discussion of concerns and vulnerabilities based on previous monitoring program results and reservoir model results, including a description of any specifically designed studies to investigate non-negligible CO₂ containment loss per Section 3.4.6.

- 4) Methods used to assess the movement or change in saturation of the injected CO₂ plume, characterize the conformance of CO₂ behavior to expectations, and confirm the containment.
- 5) Urgent response and remedial plans in the event of a leak.
- 6) Conditions and a frequency for updating the monitoring program.

Operations and Monitoring

3.4.8 The storage site operator shall execute the activities described by the elements in the monitoring program for the duration of the project injection period and the post-injection period until storage site closure. The project proponent shall execute post-closure monitoring where this is defined in the monitoring program.

3.4.9 The combined duration of monitoring post-injection until storage site closure and post-closure shall be no less than ten years. This does not preclude longer monitoring durations where required by the regulator and/or desired by the project proponent(s). Where regulators allow storage site closure before ten years, post-closure monitoring is required.

3.4.10 The monitoring program shall be updated as follows:

- 1) At least once during each project crediting period.
- 2) According to any conditions or frequency specified in the monitoring program as defined in Section 3.4.7(6).
- 3) Upon prediction of a non-negligible CO₂ containment loss in the reservoir model as set out in Section 3.4.6.
- 4) Upon identification of CO₂ loss by the monitoring program.
- 5) At the discretion of the storage site operator.

CCS Monitoring Program Results

3.4.11 The project proponent shall document monitoring program results for each monitoring period in the monitoring report and shall include the following elements:

- 1) Results of monitoring program activities, performance metrics, and confirmation of containment or declaration of leak volume.
- 2) Uncertainties in measured data/calculated performance metrics, and the extent to which monitoring has changed containment uncertainties.
- 3) Descriptions of monitoring techniques used, including locations, parameters, tools and equipment, detection thresholds, detection frequencies, spatial resolutions, analytical methods, and a description of deviations or departures from the monitoring program techniques defined in the monitoring program document.
- 4) Responsibilities of personnel involved in the execution of the monitoring program, including their names, and roles for the reporting period.

- 5) Updated results and commentary of subsurface behavior from the reservoir model and geologic evaluations as per each task in Section 3.4.5 using the latest monitoring program results.
- 6) Updates and commentary on concerns and vulnerabilities identified in the monitoring program or from the reservoir model and geologic evaluations.
- 7) Modifications to the monitoring program going forward, including justification.
- 8) Storage site closure conditions that have been met for monitoring program results reports that cover closure events.

3.4.12 The project proponent shall document CCS monitoring program results at least annually after the entire project crediting period has ended for post-injection monitoring (including closure and post-closure) and shall include each of the elements in Section 3.4.11 and if applicable 3.4.15. Post-injection monitoring program results shall be accompanied by an opinion from a third-party verifier affirming the confirmation of containment or declaration of leak volume.

Storage Site Closure

Closure Plan

The closure plan describes the storage site closure activities, sets conditions for progression through the steps to close the storage site(s), and ensures that no CO₂ will leak after the storage site closure.

3.4.13 The storage site operator shall create and maintain a closure plan document. The closure plan shall include the following elements:

- 1) The duration of the post-injection site care period and a schedule of the processes, events, and site activities used to close the storage site(s).
- 2) Closure conditions required by regulators as set out in Section 3.1.3(4).
- 3) Closure conditions specified by the project proponent, pore space tenure holder(s), and storage site operator(s).
- 4) A description of each of the post-injection site care period activities, such as monitoring, abandonment of wells and facilities, corrective actions, remediation of the site(s), and other storage site closure and post-closure activities.
- 5) Post-injection site care period cost estimates put forward when the closure plan is developed, discounted to present value. PISC costs include the monitoring program costs (from the end of injection to site closure), site closure costs, remediation costs, any corrective action costs, and post-closure monitoring costs. The discount rate shall be the

most recently available headline consumer price index inflation for the country in which the storage site(s) is/are located, as defined by the World Bank Global Database of Inflation.¹

3.4.14 The closure plan shall be updated:

- 1) Upon identification of CO₂ loss by the monitoring program.
- 2) Upon project crediting period renewal.

Storage Site Closure Conditions

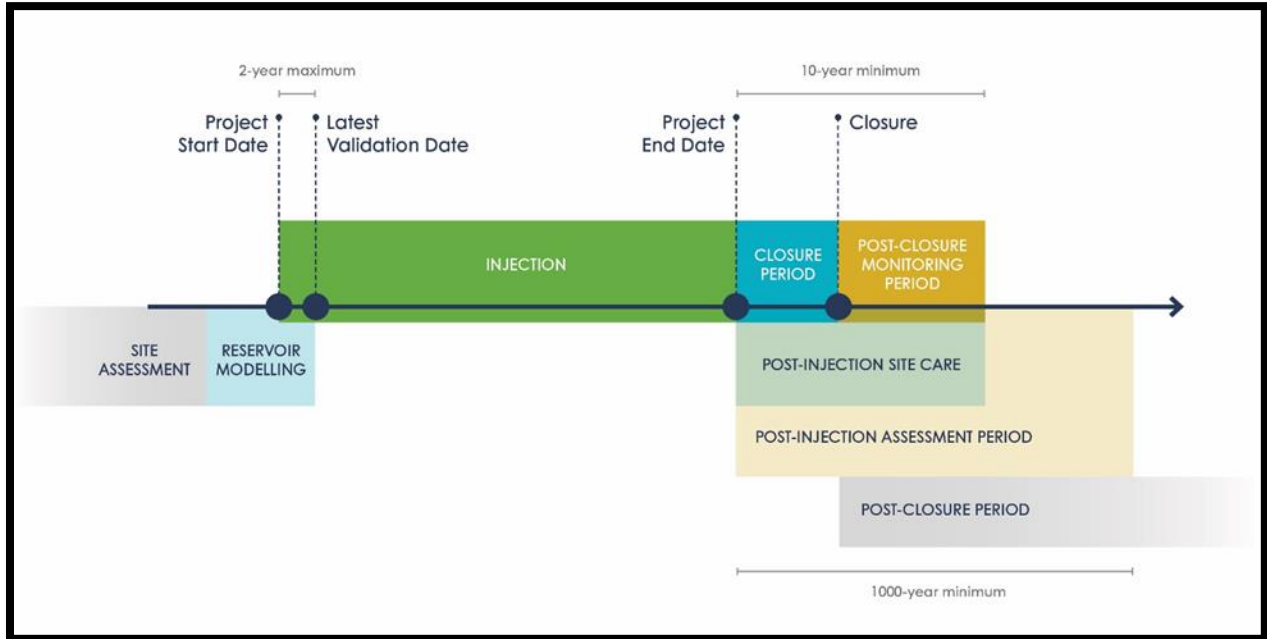
3.4.15 The following conditions shall be met prior to storage site closure, and shall be documented in the CCS monitoring program results for the post-injection reporting period prior to closure:

- 1) There is containment at the storage site(s).
- 2) There is no significant risk that injected CO₂ will have a significant adverse impact on the environment or human health.
- 3) The behavior of the CO₂ has trended towards increased conformance with the reservoir model and geologic evaluations, per Section 3.4.5. Specifically:
 - a) The extent of the CO₂ plume conforms to expectations, and
 - b) The pressure differential between pre-injection and post-injection pressures in the injection zone(s) conforms to expectations,
- 4) The future CO₂ plume migration through the PIAP is understood.

¹ Ha, J., Kose, M.A., & Ohnsorge, F. (2021). *One-Stop Source: A Global Database of Inflation*. Policy Research Working Paper 9737. World Bank. Dataset available at: <https://www.worldbank.org/en/research/brief/inflation-database>

APPENDIX 1: GCS PROJECT TIMELINES

An overview of the milestones, phases, and timelines associated with a GCS project is set out in the figure below.



APPENDIX 2: DOCUMENT HISTORY

Version	Date	Comment
v4.0	21 Dec 2022	Initial version released under VCS Version 4.
v4.0	17 Jan 2023	Minor formatting errors were corrected.



Standards for a Sustainable Future



**Verified Carbon
Standard**



**Jurisdictional
& Nested REDD+**



**Climate, Community
& Biodiversity Standards**



**Sustainable Development
Verified Impact Standard**



**Plastic Waste
Reduction Standard**