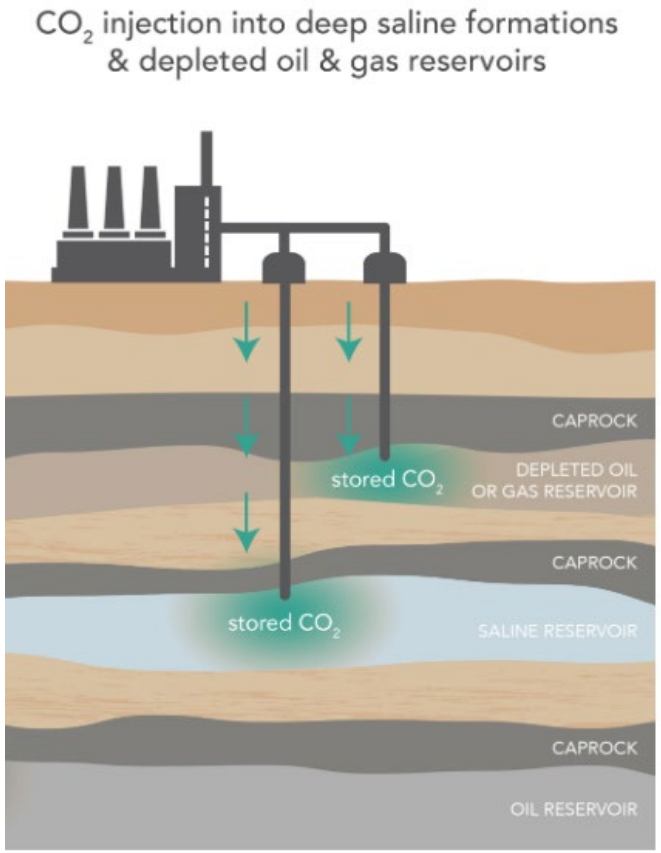
Overview of CARB's Carbon Capture and Sequestration Protocol Under the Low Carbon Fuel Standard

For the Environmental Justice Advisory Committee
June 27, 2022

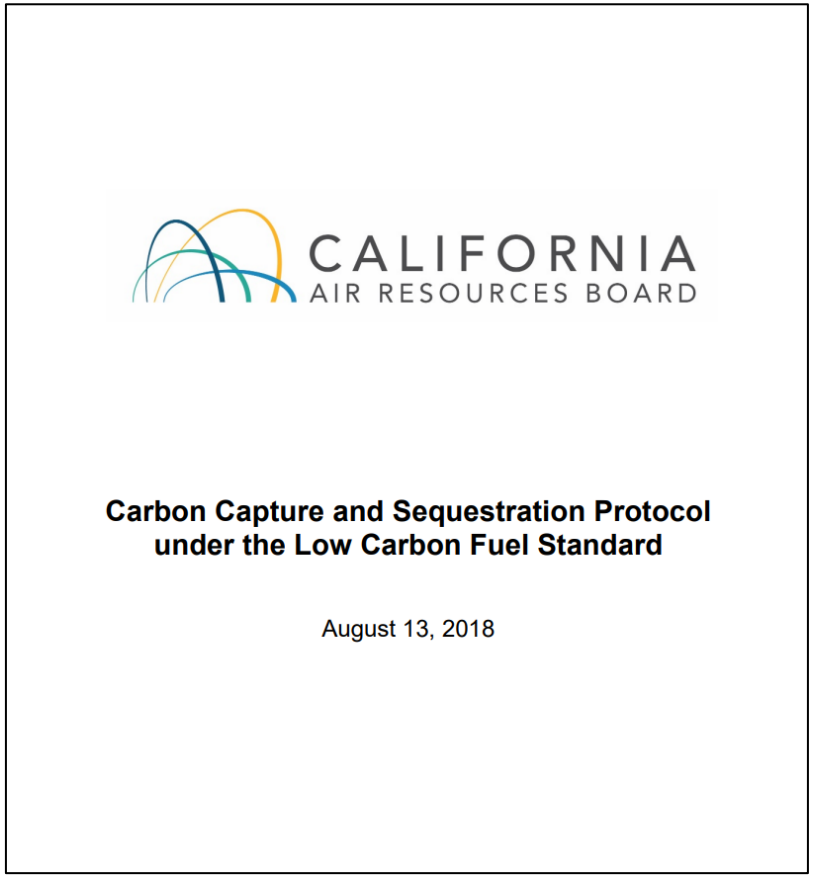
Carbon Capture and Sequestration: Overview

- CCS involves capture, transport, and sequestration of carbon dioxide (CO2)
  - CARB's CCS Protocol focuses on sequestration
  - Includes requirement for CCS Project Operator to submit list of permits and construction approvals required by other regulatory entities and jurisdictions and their status



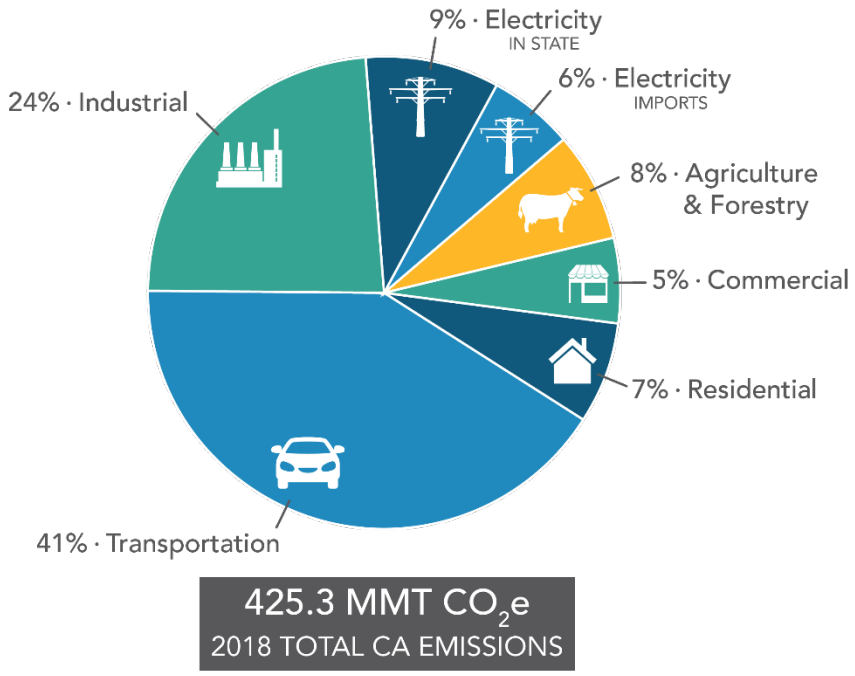
Carbon Capture and Sequestration Protocol: Main Elements

- Main sections of CARB's CCS Protocol
  - Section A: Applicability - eligible reservoirs
  - Section B: Accounting methodology for CCS projects under LCFS - how GHG reductions are estimated
  - Section C: Permanence requirements – ensure safe, permanent sequestration of injected CO2



Carbon Capture and Sequestration Project Eligibility

- Types of CCS projects that may be certified for LCFS credit generation:
  - Low carbon fuel pathways (e.g. ethanol or biogas)
  - Refinery investment (e.g., steam reforming)
  - Innovative crude (e.g., co-gen at oilfield)
  - Direct air capture projects
- Eligible reservoirs (all on-shore)
  - Saline formations
  - Depleted oil and gas reservoirs
  - CO2-Enhanced oil recovery

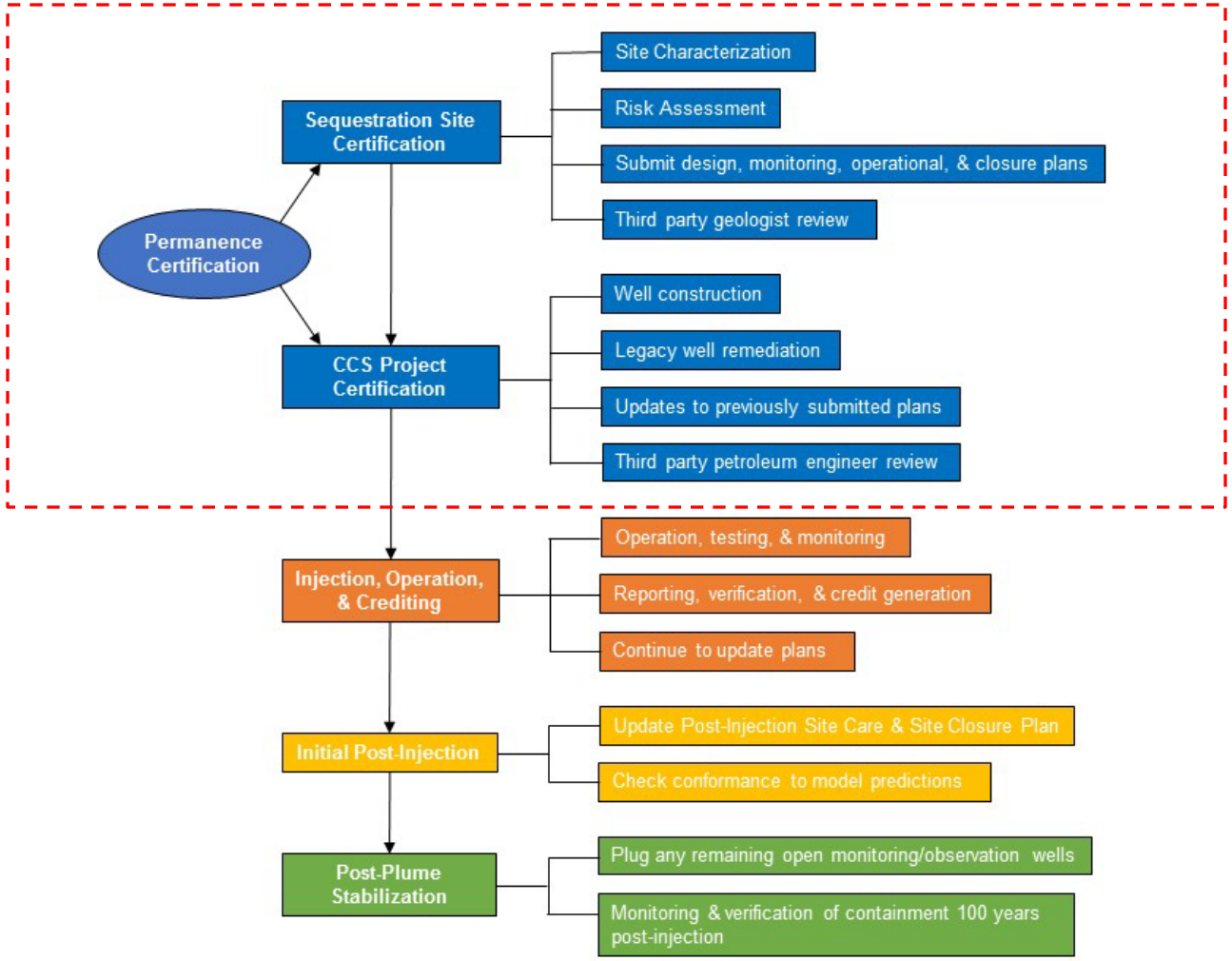


Source: 2020 Edition, California Greenhouse Gas Emission Inventory: 2000-2018

Eligible CCS Project Types

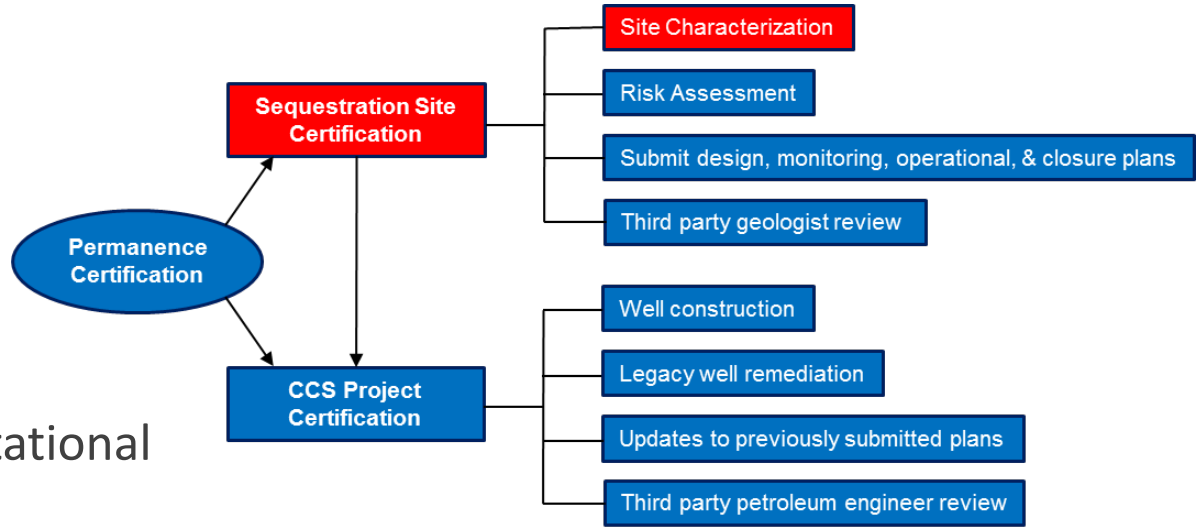
Project Type (these entities receive the LCFS credits)	Examples (where the CO_2 is captured from)
Direct air capture (credits generated by the capturer)	• Chemical separation (e.g. absorption, membrane separation) of CO_2 directly from ambient (atmospheric) air
Tier 2 pathway (credits generated by the alternative fuel producer)	• CO_2 from fermentation during ethanol production • CO_2 streams from production of renewable diesel, renewable gasoline, and alternative jet fuel • CO_2 produced as part of biogas from anaerobic digestion • CO_2 from power plants that produce low-CI electricity supplied for eligible transportation applications such as electric vehicle charging, etc. • CO_2 from hydrogen production using steam methane reforming • CO_2 from production of any other alternative transportation fuel listed in sections 95482(a) of the LCFS regulation
Refinery Investment (credits generated by the refinery)	• CO_2 from steam methane reforming at or supplying hydrogen to a refinery • CO_2 from steam generators and/or combined heat and power plants at a refinery
Innovative Crude (credits generated by the crude producer[1])	• CO_2 from steam methane reforming at a bitumen upgrader • CO_2 from steam generators or combined heat and power plants that supply steam, heat, or power demand at an oil field • CO_2 from processing of associated gas from crude oil production at an oil field. Associated gas must be consumed at the oil field as part of oil recovery operations.

CCS Project Stages & Protocol Provisions



Sequestration Site Certification: Site Characterization

- Geologic Evaluation
  - Formation Testing
  - Well Logging
- Characterize confining layers
- Identify faults and determine whether they are transmissive
- Delineate Storage Complex and provide Computational Modeling Results
  - Must show 90% chance of more than 99% containment over project life (including post-injection site care period)
- Submit Corrective Action Plan
- Submit Baseline Testing and Monitoring Plan
- Identify whether need for dissipation interval



Sequestration Site Certification: Site-Based Risk Assessment

- Characterize potential risks of adverse impacts to:
  - Environment
  - Health & Safety
- Minimum Evaluation:
  - Leakage risk
  - Risk scenarios identified in the Emergency and Remedial Response Plan
- Risk Management Plan:
  - Identify risks and how risks are ranked
  - Steps to manage, monitor, avoid, and minimize risk

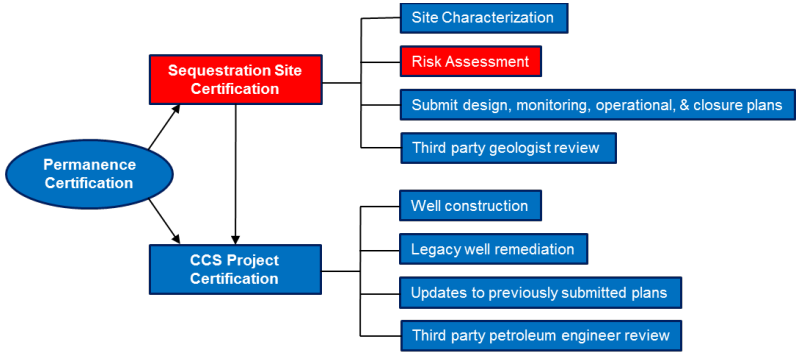


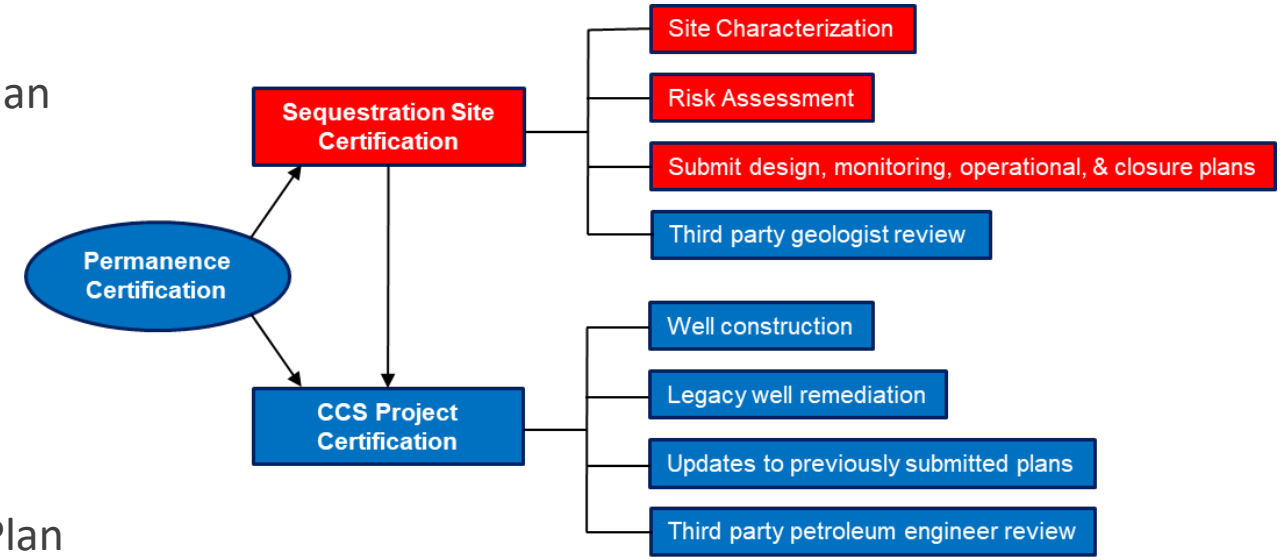
Table 1. Risk scenario classification

	Insubstantial[2]	Substantial[2]	Catastrophic[2]
> 5%[1]	Medium risk	High risk	High risk
1-5%[1]	Low risk	Medium risk	High risk
< 1%[1]	Low risk	Medium risk	Medium risk

[1] Probability of occurrence over 100 years
[2] Severity of potential consequences

Sequestration Site Certification: Summary of Required Information & Plans

- Site Evaluation
- Risk Assessment and Risk Management Plan
- Corrective Action Plan
- Baseline Testing and Monitoring Plan
- Well Construction Plan
- Testing and Monitoring Plan
- Well Plugging and Abandonment Plan
- Post-Injection Site Care and Site Closure Plan
- Emergency and Remedial Response Plan
- Financial Responsibility Demonstration
  - Initial Buffer contribution calculation
- Legal Understanding Demonstration



Sequestration Site Certification: Financial Responsibility Demonstration

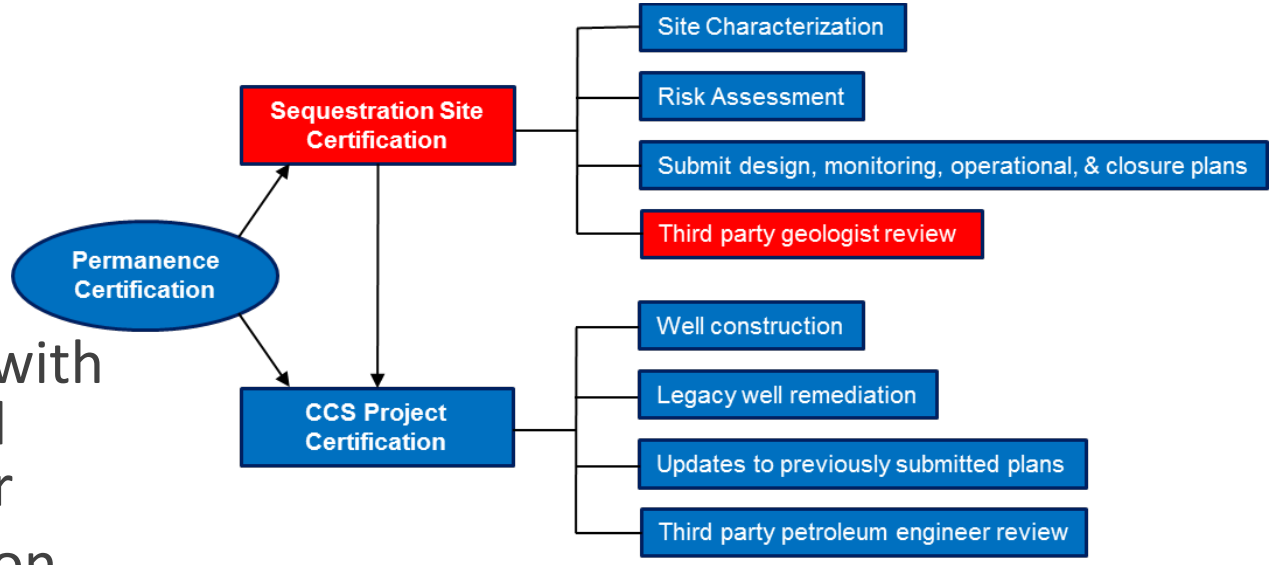
- CCS Project Operator must use qualifying instruments, approved by Executive Officer
- Qualifying instruments must cover the cost of:
  - Corrective action
  - Well plugging and abandonment
  - Post-injection site care and site closure
  - Emergency and remedial response
  - Public health and environmental impacts associated with leakage
- Financial responsibility must be maintained until site closure approved by Executive Officer

Sequestration Site Certification: Buffer Account

- Addresses potential market impacts of leakage
- Percentage of CCS project credits must be contributed to LCFS buffer account based on project risk rating
- Project risk rating determined by evaluation of risk types:
  - Financial – based on CCS Operator's Moody's rating or Standard & Poor's rating
  - Social – based on World Justice Project Rule of Law Index
  - Management – based on surface facility access control
  - Site – based on site geology
  - Well integrity – USEPA Class VI wells?
- Buffer account contributions range between 8% and 16.4%.

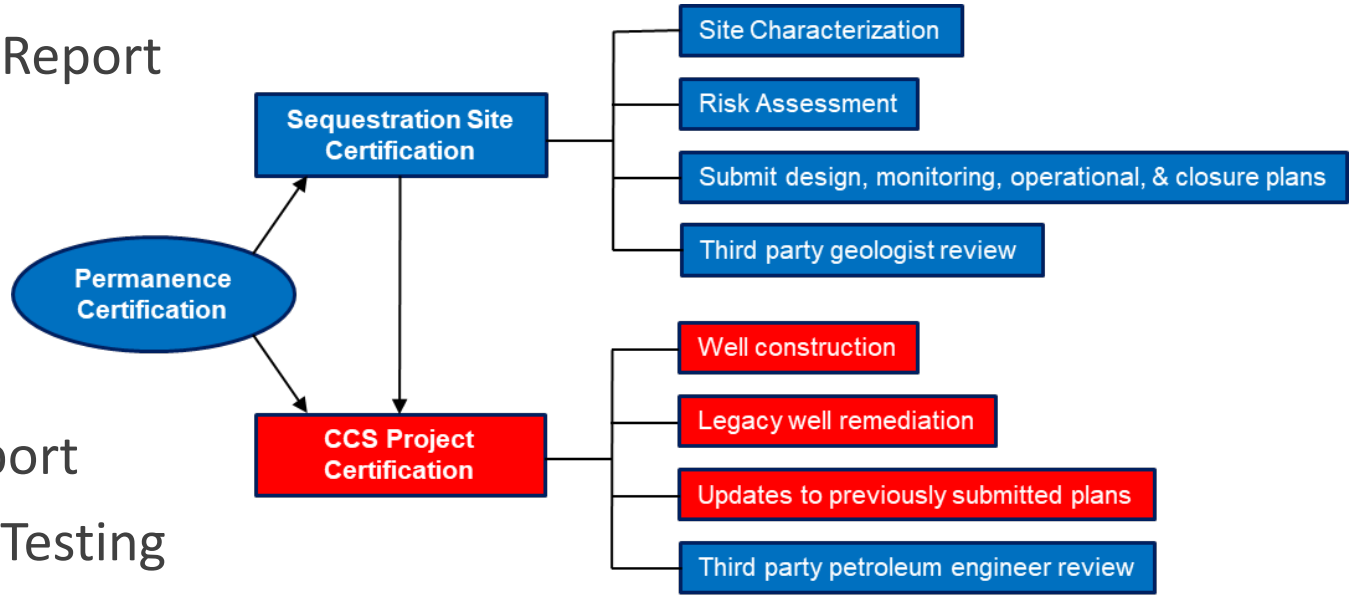
Sequestration Site Certification: Third-Party Review

- Application for Sequestration Site Certification must be reviewed and certified by a professional geologist (PG) prior to submittal to CARB Executive Officer
- PG credentials and history of work with applicant must be submitted to and approved by CARB Executive Officer
- PG review report should comment on each section of the application and provide findings related to whether the section meets the requirements of the CCS Protocol



CCS Project Certification: Summary of Required Information & Plans

- Formation Testing and Well Logging Report
- Updated Storage Complex Delineation and Computational Modeling Results
- Corrective Action Report
- Baseline Testing and Monitoring Report
- Well Construction and Pre-injection Testing Report
- Updates to information or plans required in Sequestration Site Certification application



CCS Project Certification: Third-Party Review

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- PE credentials and history of work with applicant must be submitted to and approved by CARB Executive Officer
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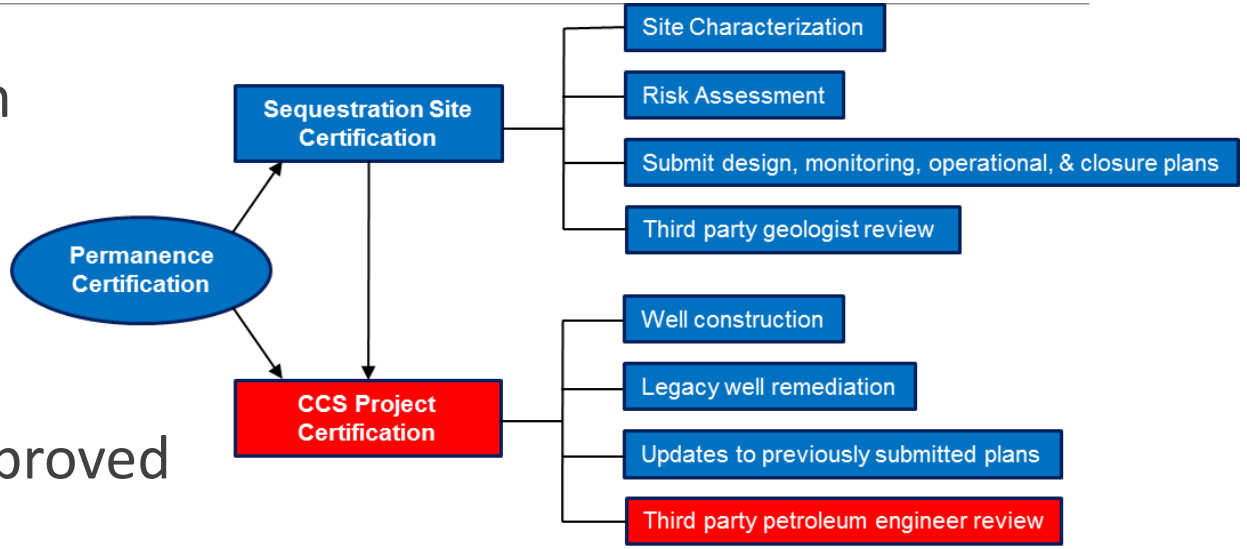

Resources

- CARB, 2018: Carbon Capture and Sequestration Protocol
- CARB, 2018: Low Carbon Fuel Standard regulation (CCS provisions are in section 95490 beginning on page 186