

**STATE OF NEW MEXICO
NEW MEXICO OIL CONSERVATION DIVISION**

**APPLICATION OF OIL CONSERVATION DIVISION
TO ADOPT 19.15.41, 19.15.42, AND 19.15.43 NMAC**

No. 25875

**DIRECT TECHNICAL TESTIMONY OF DR. GREGORY SCHNAAR
ON BEHALF OF THE OIL CONSERVATION DIVISION**

JUNE 29, 2026

INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. Gregory Schnaar. 6501 Americas Parkway NE, Suite 200, Albuquerque, NM 87110

Q. ON WHOSE BEHALF ARE YOU SUBMITTING DIRECT TESTIMONY?

A. The Oil Conservation Division.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am employed by Daniel B. Stephens & Associates, Inc., a subsidiary of Geo-Logic Associates. My position is Principal Hydrogeologist.

Q. PLEASE DESCRIBE YOUR PAST EMPLOYMENT HISTORY.

A. My professional experience has focused on carbon capture and storage, Underground Injection Control Class VI permitting, groundwater investigations, environmental forensic evaluations, contaminant fate and transport, and regulatory support. I previously served as a post-doctoral fellow with the U.S. Environmental Protection Agency, where I was a member of the regulatory development team for the federal Class VI rulemaking. I have also supported U.S. EPA as a technical contractor in the development of Class VI technical guidance documents. In consulting roles, I have provided technical support for Class VI permit applications, Area of Review modeling, baseline monitoring, geochemical modeling, wellbore leakage analysis, and related regulatory submittals. My consulting experience has included work for federal and state agencies, including the U.S. EPA Office of Ground Water and Drinking Water, the U.S. Department of Justice, the New Mexico Environment Department and Oil Conservation Division (OCD), and the California State Water Resources Control Board and California Department of Justice.

Q. PLEASE SUMMARIZE YOUR EDUCATION EXPERIENCE.

A. I hold a Ph.D. in Soil, Water, and Environmental Science from the University of Arizona, which I received in 2006, and a B.S. in Environmental Science and Policy from the University of Maryland, which I received in 2002. I am also a Professional Geologist in Virginia, Wyoming, Nebraska and Arkansas.

Q. HAVE YOU PREVIOUSLY TESTIFIED IN STATE OR FEDERAL REGULATORY PROCEEDINGS?

A. I have not testified in formal regulatory hearings; however, I represented U.S. EPA in public hearings during the federal Class VI rulemaking. I have testified as an expert witness in state court.

Q. WHAT IS YOUR EXPERIENCE WITH THE FEDERAL CLASS VI INJECTION WELL PROCESS?

A. I have substantial experience with the federal Class VI injection well process. As a post-doctoral fellow at U.S. EPA headquarters, I was a member of the original Class VI rulemaking team and led portions of the rulemaking related to computational modeling. I also conducted outreach to Carbon Sequestration Partnerships, the U.S. Department of Energy, state Underground Injection Control regulators, and EPA Regional offices. After that work, I served as an expert technical contractor author for five U.S. EPA Underground Injection Control technical guidance documents related to geologic sequestration of carbon dioxide, including guidance addressing modeling, monitoring, operations, and site characterization. In my consulting practice, I have supported Class VI permit applications and related regulatory submissions in multiple states and U.S. EPA regions, including work involving Area of Review modeling, baseline soil gas and groundwater monitoring,

geochemical modeling, wellbore leakage analysis, dynamic modeling, permit drafting, fault leakage analysis, financial responsibility cost estimates, and monitoring, reporting and verification (MRV) planning. I have also assisted the State of New Mexico in connection with its Class VI primacy regulatory authority application.

PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to provide technical support for the Oil Conservation Division's proposed adoption of sections 19.15.41, 19.15.42, and 19.15.43 as part of New Mexico's application for Class VI Underground Injection Control primacy. My testimony addresses the technical and regulatory requirements applicable to Class VI wells, including permit application requirements, site characterization, Area of Review delineation, corrective action, well construction, operating requirements, testing and monitoring, reporting, post-injection site care, financial responsibility, and related safeguards intended to protect underground sources of drinking water (USDWs).

Q. WHAT ARE THE AREAS THAT YOU ARE GOING TO BE ADDRESSING?

A. I will address the technical structure of the Class VI program, the information an applicant must submit to support a Class VI permit application, the technical demonstrations required to show that a proposed project will protect underground sources of drinking water, and the manner in which the proposed New Mexico regulations reflect the federal Class VI requirements. I will also address New Mexico-specific provisions that supplement the federal framework, including requirements related to Area of Review reevaluation,

monitoring, emergency and remedial response planning, financial responsibility, Class II to Class VI conversion, and injection depth waivers.

Q. CAN YOU BRIEFLY EXPLAIN THE LANGUAGE UPDATES IN OCD EXHIBITS 1-3 AS IT COMPARES TO OCD'S AMENDED PETITION EXHIBITS 2A, 2B, AND 2C?

A. Yes. The updates were to conform the proposed rule language with the requirements of the New Mexico State Records Center and Archives (SRCA), such as the replacement of “§” with “Section”. Further, although the federal Class VI rules contain rule language that includes the use of “and/or”, the SRCA does not allow for the use of “and/or”. In most instances, the result was that “or both” was selected to provide flexibility and still satisfy the general rule language requirements. In a limited number of provisions, the OCD exercised its drafting discretion to use "or" or “and” rather than "or both." OCD determined that this language satisfies the substantive requirements and intent of the federal Class VI regulations and does not otherwise render the proposed rules less stringent than the corresponding federal Class VI requirements.

OVERVIEW OF THE CLASS VI PROGRAM

Q. WHAT IS A CLASS VI INJECTION WELL?

A. A Class VI injection well is a well that is used for the geologic sequestration of carbon dioxide, also referred to as carbon capture and storage (CCS). Under the federal and proposed New Mexico Class VI framework, Class VI wells include wells used to inject carbon dioxide for long-term containment in subsurface geologic formations beneath the lowermost formation containing an underground source of drinking water, wells operating

under an approved injection depth waiver, and wells associated with an approved expansion of an existing Class II aquifer exemption for the exclusive purpose of Class VI geologic sequestration.

Q. WHAT IS THE PURPOSE OF THE FEDERAL CLASS VI PROGRAM?

A. The purpose of the federal Class VI program is to regulate underground injection of carbon dioxide for geologic sequestration in a manner that protects underground sources of drinking water. The program establishes minimum standards for siting, permitting, construction, operation, mechanical integrity, monitoring, reporting, emergency response, post-injection site care, site closure, and financial responsibility. These requirements are intended to ensure that injected carbon dioxide, associated pressure effects, and displaced formation fluids do not endanger underground sources of drinking water.

Q. WHAT DOES “PRIMACY” MEAN UNDER THE SAFE DRINKING WATER ACT?

A. Under the Safe Drinking Water Act, primacy means that EPA has approved a state or tribe to administer and enforce an Underground Injection Control program in lieu of direct federal administration. To obtain primacy, the state or tribe must demonstrate that its program meets applicable federal requirements and that the state or tribe has adequate legal authority, regulations, procedures, staffing, technical capability, and enforcement mechanisms to implement the program in a manner that is at least as stringent as the federal program.

Q. WHY DO STATES AND TRIBES SEEK PRIMACY FOR CLASS VI WELLS?

A. States and tribes seek primacy so that Class VI permitting and oversight can be administered by the agency with direct knowledge of state geology, existing underground injection activities, state regulatory systems, local stakeholders, and project-specific conditions. In New Mexico, the Oil Conservation Division already administers the state's UIC programs for other well classes and has existing regulatory infrastructure, technical staff, inspection and compliance functions, and enforcement procedures. Class VI primacy would allow the Division to administer Class VI permitting and oversight as an integrated extension of that existing UIC framework.

Q. WHAT BENEFITS WOULD PRIMACY PROVIDE TO NEW MEXICO REGULATORS, OPERATORS, AND COMMUNITIES?

A. Primacy would provide New Mexico regulators with direct responsibility for reviewing permit applications, issuing Class VI permits, conducting compliance oversight, and enforcing permit and regulatory requirements. For operators, state administration can provide a clearer permitting path through the agency that already regulates underground injection and oil and gas operations in New Mexico. For communities, primacy can support locally informed review, public participation, coordination with state and local agencies, and ongoing oversight by the state agency responsible for underground injection activities.

CLASS VI PERMIT INFORMATION REQUIREMENTS

Q. ARE YOU FAMILIAR WITH THE FEDERAL CLASS VI PERMIT APPLICATION REQUIREMENTS CONTAINED IN 40 C.F.R. § 146.82? DID NEW

MEXICO INCORPORATE THE FEDERAL PERMIT INFORMATION REQUIREMENTS INTO ITS PROPOSED CLASS VI PROGRAM?

- A. Yes. I am familiar with the federal Class VI permit application requirements in 40 C.F.R. §146.82. Those requirements identify the technical and administrative information that must be considered before a Class VI permit may be issued. New Mexico incorporated those substantive permit information requirements into its proposed Class VI program through proposed section 19.15.43.9.C, which sets forth the information required prior to issuance of a permit to construct or convert a Class VI well and prior to approval to commence injection.

Q. WHAT DOES THE NEW MEXICO PROGRAM REQUIRE APPLICANTS TO SUBMIT AS PART OF A CLASS VI PERMIT APPLICATION?

- A. New Mexico requires a Class VI applicant to submit the technical and administrative information needed to determine whether the proposed project can be constructed and operated without endangering USDWs.¹ This includes general permit application information, maps showing the proposed injection well and Area of Review, information on the geologic structure and properties of the proposed storage site and overlying formations, tabulations of wells and other penetrations within the Area of Review, maps and cross sections showing USDWs and water wells, baseline geochemical data, proposed operating data, formation testing information, stimulation procedures, well construction information, an Area of Review and corrective action plan, financial responsibility demonstrations, a testing and monitoring plan, a plugging plan, a post-injection site care

¹ OCD Exhibit 3 at 19.15.43.9.C

and site closure plan, an emergency and remedial response plan, contact information for affected jurisdictions, and any other information requested by the Director.²

Q. WHAT IS THE PROCESS FOR THE STATE TO REVIEW THE INFORMATION SUBMITTED BY AN APPLICANT? WHAT IS THE MECHANISM IF ADDITIONAL INFORMATION IS REQUIRED FROM AN APPLICANT?

A. OCD will first conduct a completeness review to determine whether all required application components have been submitted. Permit processing will not proceed until the application is complete.³ Once the application is determined complete, OCD will conduct a technical review of the submitted information, including site characterization, modeling, well construction, monitoring, corrective action, financial responsibility, emergency response, and other permit elements.⁴ If the submitted information is incomplete or additional clarification is needed, OCD may request additional information from the applicant before proceeding with or completing the technical review.⁵

Q. WHAT DOES AN APPLICANT NEED TO PROVIDE REGARDING THE AREA OF REVIEW? WHAT DOES THE PROPOSED PROGRAM REQUIRE, PARTICULARLY TO ENSURE PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

² *Id.* at 19.15.43.9.C(1) NMAC

³ OCD Exhibit 1 at section 19.15.41.8.A(2)

⁴ OCD Exhibit 3 at section 19.15.43.9.C

⁵ OCD Exhibit 1 at section 19.15.41.8.A(2)

A. The applicant must submit a proposed Area of Review and corrective action plan.⁶ The Area of Review is the region surrounding the geologic sequestration project where underground sources of drinking water may be endangered by the injection activity. It must be delineated using computational modeling that accounts for the physical and chemical properties of the injected carbon dioxide stream and displaced fluids and is based on available site characterization, monitoring, and operational data.⁷ The applicant must also identify wells and other penetrations that may serve as conduits for fluid movement and evaluate whether corrective action is necessary to prevent movement of fluids into or between USDWs.⁸

Q. DOES THE PROGRAM REQUIRE APPLICANTS TO SUBMIT CORRECTIVE ACTION PLANS WHERE NECESSARY? WHAT IS THE PURPOSE OF CORRECTIVE ACTION IN THE CLASS VI PROGRAM?

A. Yes. The program requires applicants to submit corrective action plans where necessary.⁹ Corrective action in the Class VI program is intended to ensure that wells or other artificial penetrations within the Area of Review do not serve as conduits for the movement of carbon dioxide, displaced formation fluids, or other fluids into or between USDWs. Corrective action may include evaluation, repair, re-plugging, or other Director-approved measures designed to prevent endangerment of USDWs.¹⁰

⁶ OCD Exhibit 3 at section 19.15.43.9.C(1)(m)

⁷ *Id.* 19.15.43.9.B(1)

⁸ *Id.* 19.15.43.9.E(3)(b)

⁹ *Id.* 19.15.43.9.C(1)(m)

¹⁰ *Id.* 19.15.43.9.E(3)(b)

Q. WHAT GEOLOGIC INFORMATION REGARDING THE INJECTION ZONE AND CONFINEMENT ZONE DOES THE PROPOSED PROGRAM REQUIRE APPLICANTS TO SUBMIT? WHY IS THAT INFORMATION IMPORTANT IN EVALUATING A CLASS VI APPLICATION?

A. Applicants must submit information on the geologic structure and hydrogeologic properties of the proposed storage site and overlying formations.¹¹ This includes maps and cross sections of the Area of Review; the location, orientation, and properties of known or suspected faults and fractures that may transect the confining zone; data on the depth, areal extent, thickness, mineralogy, porosity, permeability, and capillary pressure of the injection and confining zones; geomechanical information; seismic history; and regional geologic and hydrogeologic maps and cross sections. This information is important because it allows the State to evaluate whether the injection zone has sufficient capacity and injectivity and whether the confining zone has sufficient integrity to contain the carbon dioxide stream and displaced fluids.

Q. WHAT INJECTION OPERATIONS INFORMATION ARE APPLICANTS REQUIRED TO SUBMIT? WHY IS THAT INFORMATION RELEVANT TO THE STATE'S REVIEW?

A. Applicants are required to submit proposed operating data for the geologic sequestration site, including the average and maximum daily injection rate, volume or mass, total anticipated volume or mass of the carbon dioxide stream, average and maximum injection pressure, the source or sources of the carbon dioxide stream, and an analysis of the

¹¹ *Id.* 19.15.43.9.C(1)(c)

chemical and physical characteristics of the carbon dioxide stream.¹² This information is relevant because injection pressure, rate, total volume, and fluid properties directly affect plume migration, pressure buildup, well design, monitoring needs, and the evaluation of whether injection can occur without initiating fractures or endangering USDWs.

Q. WHAT WELL CONSTRUCTION INFORMATION DOES THE PROPOSED CLASS VI PROGRAM REQUIRE APPLICANTS TO SUBMIT? HOW DOES THE PROPOSED PROGRAM USE THAT INFORMATION IN ITS PERMIT REVIEW?

A. Applicants must submit schematics or other appropriate drawings showing the surface and subsurface construction details of the well, proposed construction materials, and construction procedures that meet the Class VI requirements.¹³ The State reviews this information to determine whether casing, cement, tubing, packer materials, cementing methods, logging, testing, and related construction elements are sufficient to prevent movement of fluids into or between USDWs and to maintain mechanical integrity for the life of the project.

Q. WHAT EMERGENCY AND REMEDIAL RESPONSE PLANS DOES THE PROPOSED CLASS VI PROGRAM REQUIRE APPLICANTS TO SUBMIT? HOW DOES THAT SUPPORT PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

¹² *Id.* 19.15.43.9.C(1)(j)

¹³ *Id.* 19.15.43.9.C(1)(k); 19.15.43.9.C(1)(l)

A. The proposed Class VI program requires an emergency and remedial response plan as part of the Class VI application.¹⁴ The plan must describe the actions the owner or operator will take if the injected carbon dioxide stream, associated pressure front, or formation fluids may endanger a USDW. New Mexico's proposed program also requires community outreach during development of the plan, identification of notification procedures, training for local emergency responders, and continued outreach throughout the life of the project.¹⁵ These requirements support protection of USDWs by requiring advance planning for response actions before injection begins.

Q. DOES THE PROPOSED PROGRAM REQUIRE APPLICANTS TO PROVIDE POST-INJECTION SITE CARE INFORMATION? WHAT IS THE PURPOSE OF POST-INJECTION SITE CARE?

A. Yes. The proposed program requires applicants to submit a post-injection site care and site closure plan.¹⁶ Post-injection site care is the period after injection has ceased during which the operator must continue monitoring and other activities needed to demonstrate that the carbon dioxide plume and associated pressure front are behaving as predicted and that USDWs are not endangered. The plan must address monitoring locations, methods, frequency, reporting, the anticipated duration of post-injection site care, and the basis for any alternative timeframe.¹⁷

¹⁴ *Id.* 19.15.43.9.O(1)

¹⁵ *Id.* 19.15.43.9.O(2)

¹⁶ *Id.* 19.15.43.9.C(1)(q)

¹⁷ *Id.*

Q. DOES THE PROGRAM REQUIRE FINANCIAL RESPONSIBILITY DEMONSTRATIONS? WHY IS FINANCIAL RESPONSIBILITY IMPORTANT IN THE CLASS VI PROGRAM?

A. Yes. The program requires owners or operators to demonstrate and maintain financial responsibility sufficient to cover corrective action, injection well plugging, post-injection site care and site closure, and emergency and remedial response.¹⁸ Financial responsibility is important because these obligations may extend beyond the active injection period and must be funded even if the operator experiences financial distress or if additional work is needed to protect USDWs.

Q. DOES NEW MEXICO HAVE AUTHORITY TO REVIEW AND EVALUATE ALL INFORMATION SUBMITTED IN A CLASS VI PERMIT APPLICATION?

A. Yes. The proposed program gives OCD authority to review the information submitted in a Class VI permit application and to determine whether the application satisfies the technical and regulatory requirements of the Class VI program. OCD may use in-house expertise and contracted subject matter experts to review complex technical submittals, including modeling, geologic characterization, geochemistry, geomechanics, well construction, financial responsibility, and emergency and remedial response planning.

Q. CAN THE STATE REQUIRE MODIFICATIONS TO A PROPOSED PROJECT BASED ON ITS TECHNICAL REVIEW? CAN THE STATE DENY AN

¹⁸ OCD Exhibit 2 at section 19.15.42.12.B(2)(e)(e)(ii)-(iii); OCD Exhibit 3 at section 19.15.43.9.C(1)(n)

APPLICATION THAT FAILS TO SATISFY THE REQUIREMENTS OF THE PROGRAM?

- A. Yes. If OCD determines that a proposed project or submitted plan does not satisfy program requirements or does not adequately protect USDWs, OCD can require additional information, require revisions to the application or proposed permit conditions, impose conditions necessary to protect USDWs, or deny the application. That authority is essential because the permit review must be based on the site-specific technical record and must ensure that Class VI injection will not endanger USDWs.

Q. IN YOUR OPINION, DO NEW MEXICO'S PERMIT APPLICATION REQUIREMENTS REFLECT THE REQUIREMENTS OF 40 C.F.R. § 146.82? DO THESE REQUIREMENTS SUPPORT NEW MEXICO'S REQUEST FOR CLASS VI PRIMACY?

- A. In my opinion, New Mexico's permit application requirements reflect the substantive requirements of 40 C.F.R. § 146.82. The proposed New Mexico rules require applicants to provide the information needed to evaluate site suitability, Area of Review delineation, corrective action, well construction, operations, testing and monitoring, emergency response, financial responsibility, post-injection site care, and site closure. Those requirements support New Mexico's request for Class VI primacy because they provide the technical basis for OCD to evaluate whether a proposed Class VI project will protect underground sources of drinking water.

FEDERAL CLASS VI SITING AND SITE CHARACTERIZATION REQUIREMENTS

Q. ARE YOU FAMILIAR WITH THE FEDERAL CLASS VI REQUIREMENTS GOVERNING SITE SCREENING AND CHARACTERIZATION?

A. Yes. I am familiar with the federal Class VI requirements governing site screening and characterization, including the permit information requirements in 40 C.F.R. § 146.82 and the minimum siting criteria in 40 C.F.R. § 146.83. Those provisions require an applicant to develop and submit sufficient technical information to demonstrate that a proposed Class VI project is located in a suitable geologic system and can be constructed, operated, monitored, and closed without endangering underground sources of drinking water.

Q. WHAT IS THE PURPOSE OF THE FEDERAL SITE CHARACTERIZATION REQUIREMENTS FOR CLASS VI WELLS?

A. The purpose of the site characterization requirements is to require the applicant to develop a technical understanding of the proposed injection zone, confining zone, overlying formations, USDWs, faults and fractures, artificial penetrations, groundwater conditions, and other site-specific features that could affect containment. That information is used to evaluate whether the proposed project can safely receive the anticipated volume of carbon dioxide and whether the confining system can prevent movement of carbon dioxide or displaced fluids into USDWs.

Q. ARE THOSE REQUIREMENTS INTENDED TO ENSURE PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

A. Yes. The site characterization requirements are directly tied to protection of USDWs. They require the applicant to identify USDWs, evaluate their relationship to the proposed injection and confining zones, assess potential pathways for fluid movement, and demonstrate that the project will not allow injected carbon dioxide, displaced formation fluids, or associated pressure effects to endanger USDWs.

Q. DID NEW MEXICO RELY ON THE FEDERAL CLASS VI FRAMEWORK IN DEVELOPING ITS PROPOSED PRIMACY PROGRAM?

A. Yes. New Mexico relied on the federal Class VI framework in developing its proposed primacy program. The proposed New Mexico rules closely track the federal requirements in 40 C.F.R. Parts 144 and 146, while also adding certain New Mexico-specific provisions that are more detailed or more stringent in areas such as Area of Review reevaluation, monitoring, emergency response planning, seismicity monitoring, and community outreach.

Q. ARE THE FEDERAL SITING AND CHARACTERIZATION REQUIREMENTS REFLECTED IN NEW MEXICO'S PROPOSED CLASS VI REGULATIONS?

A. Yes. The proposed New Mexico Class VI regulations reflect the federal siting and characterization requirements. The New Mexico program requires applicants to submit detailed geologic, hydrogeologic, geochemical, geomechanical, seismic, mapping, well inventory, operating, and modeling information, and it requires the Director to evaluate

whether the proposed geologic system is suitable for Class VI injection and protective of USDWs.¹⁹

Q. DOES THE NEW MEXICO PROPOSED CLASS VI PROGRAM REQUIRE APPLICANTS TO DEMONSTRATE THAT A PROPOSED CLASS VI WELL IS LOCATED WITHIN A SUITABLE GEOLOGIC SYSTEM? WHY IS THAT DEMONSTRATION IMPORTANT BEFORE A PERMIT MAY BE ISSUED?

A. Yes. The proposed Class VI program requires applicants to demonstrate that a proposed Class VI well is located within a suitable geologic system.²⁰ That demonstration is important because Class VI permitting is fundamentally site-specific. Before a permit may be issued, the Director must be able to determine that the injection zone can receive and store the anticipated carbon dioxide stream and that the confining system can prevent movement of carbon dioxide and displaced fluids into underground sources of drinking water.

Q. UNDER THE FEDERAL FRAMEWORK, WHAT CHARACTERISTICS MUST A SUITABLE GEOLOGIC SYSTEM POSSESS?

A. Under the federal framework, a suitable geologic system must include an injection zone or zones of sufficient areal extent, thickness, porosity, and permeability to receive the total anticipated volume of the carbon dioxide stream. It must also include confining zone or zones that are free of transmissive faults or fractures and have sufficient areal extent and integrity to contain the injected carbon dioxide stream and displaced formation fluids at the

¹⁹ OCD Exhibit 3 at section 19.15.43.9.C

²⁰ *Id.*

proposed maximum pressures and volumes without initiating or propagating fractures in the confining zone.

Q. DOES THE NEW MEXICO PROPOSED CLASS VI PROGRAM REQUIRE EVALUATION OF THE INJECTION ZONE'S AREAL EXTENT? WHY IS AREAL EXTENT IMPORTANT IN EVALUATING A CLASS VI STORAGE RESERVOIR?

A. Yes. The proposed New Mexico program requires evaluation of the injection zone's areal extent.²¹ Areal extent is important because the storage reservoir must be large enough laterally, in combination with its thickness, porosity, permeability, and pressure conditions, to receive the anticipated volume of carbon dioxide without causing unacceptable pressure buildup, inducing fracturing, or causing the carbon dioxide plume or associated pressure front to migrate in a way that could endanger USDWs.

Q. WHAT OTHER FACTORS DOES THE PROPOSED NEW MEXICO PROGRAM REQUIRE TO DEMONSTRATE A SUITABLE GEOLOGIC SYSTEM? WHY IS THIS IMPORTANT?

A. In addition to areal extent, the proposed program requires evaluation of formation thickness, porosity, permeability, storage capacity, capillary pressure, mineralogy, geochemistry, geomechanical properties, fluid pressures, and the presence or absence of faults, fractures, and other potential conduits.²² These factors are important because they determine whether the injection zone can accept the injected carbon dioxide and whether

²¹ *Id.* 19.15.43.9.C(1)(c)

²² *Id.* See also 19.15.43.9.D(1)

the geologic system can contain the carbon dioxide stream and displaced formation fluids over the operational and post-injection periods.

Q. DOES THE PROPOSED CLASS VI PROGRAM REQUIRE APPLICANTS TO DEMONSTRATE THAT THE INJECTION ZONE CAN RECEIVE THE TOTAL ANTICIPATED VOLUME OF THE CARBON DIOXIDE STREAM? WHY IS THIS REQUIRMENT IMPORTANT FROM A RESERVOIR MANAGEMENT AND CONTAINMENT PERSPECTIVE?

A. Yes. The New Mexico proposed Class VI program requires applicants to demonstrate that the injection zone can receive the total anticipated volume of the carbon dioxide stream.²³ From a reservoir management perspective, this requirement ensures that the proposed injection rates, pressures, and total volumes are consistent with the capacity and injectivity of the formation.²⁴ From a containment perspective, it helps ensure that injection will not create excessive pressure, initiate or propagate fractures, or cause movement of carbon dioxide or displaced fluids into unauthorized zones or USDWs.

Q. IN ADDITION TO THE INJECTION ZONE, DOES THE PROPOSED CLASS VI PROGRAM REQUIRE EVALUATION OF CONFINING ZONES? WHAT IS THE PURPOSE OF A CONFINING ZONE IN A CLASS VI PROJECT?

A. Yes. In addition to evaluating the injection zone, the proposed Class VI program requires evaluation of the confining zone or zones, which is consistent with the federal framework.²⁵

²³ *Id.* 19.15.43.9.D(1)(a)

²⁴ *Id.* 19.15.43.9.C(1)(j)

²⁵ *Id.* 19.15.43.9.C(1)(c)

The purpose of a confining zone in a Class VI project is to act as a geologic barrier to vertical fluid movement. A suitable confining zone limits movement of the injected carbon dioxide stream and displaced formation fluids and helps ensure that injection does not endanger USDWs above or, where relevant, below the injection interval.

Q. WHAT DOES THE PERMIT REVIEWER EVALUATE IN DETERMINING WHETHER A CONFINING ZONE HAS SUFFICIENT INTEGRITY?

A. A permit reviewer evaluates whether the confining zone has sufficient thickness, lateral continuity, low permeability, high capillary entry pressure, geomechanical strength, and integrity to contain the injected carbon dioxide stream and displaced fluids.²⁶ The reviewer also evaluates whether faults, fractures, abandoned wells, or other artificial penetrations could compromise containment, and whether injection at the proposed pressures and volumes could initiate or propagate fractures in the confining zone.²⁷

Q. WHY IS CONTAINMENT A CENTRAL OBJECTIVE OF THE CLASS VI PROGRAM?

A. Containment is a central objective of the Class VI program because the program is designed to allow geologic sequestration of carbon dioxide while protecting USDWs. If the carbon dioxide plume, associated pressure front, or displaced formation fluids are not contained as predicted, they could migrate through geologic features or artificial penetrations and potentially affect USDWs. The Class VI requirements are therefore structured around demonstrating, monitoring, and maintaining containment throughout the project life cycle.

²⁶ *Id.* 19.15.43.9.C(1)(c)

²⁷ *Id.*

Q. DO THE FEDERAL REGULATIONS REQUIRE EVALUATION OF INJECTION PRESSURES AND VOLUMES? HAS NEW MEXICO INCORPORATED THOSE REQUIREMENTS INTO ITS PROPOSED PROGRAM?

A. Yes. The federal regulations require evaluation of proposed injection pressures, injection rates, and total injection volumes, and New Mexico has incorporated those requirements into its proposed Class VI program. The proposed rules require applicants to submit average and maximum injection pressures, average and maximum injection rates, total anticipated injection volumes or mass, and related operating information.²⁸ The Director uses that information to establish permit conditions and to ensure that injection will not initiate fractures in the confining zone or cause movement of fluids that endangers USDWs.

Q. WHY IS FRACTURE PREVENTION IMPORTANT TO PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

A. Fracture prevention is important because fractures can create or enlarge pathways for fluid movement. If injection pressure initiates new fractures or propagates existing fractures, carbon dioxide or displaced formation fluids could move out of the intended injection zone, potentially into or toward USDWs. Maintaining injection below appropriate pressure limits and evaluating the geomechanical behavior of the injection and confining zones are therefore critical components of USDW protection.

²⁸ *Id.* 19.15.43.9.C(1)(g)

Q. WHAT TYPES OF SITE CHARACTERIZATION DATA MUST AN APPLICANT PROVIDE TO SATISFY THE REQUIREMENTS FOR TECHNICAL DEMONSTRATIONS AND PERMIT REVIEW?

A. An applicant must provide site characterization data sufficient to support the technical demonstrations required for Class VI permitting.²⁹ That information includes geologic and topographic maps, cross sections, data on the injection and confining zones, fault and fracture information, geomechanical data, seismic history, baseline geochemical data, formation fluid information, well logs, cores or sidewall cores, formation testing data, operating data, well construction information, and a tabulation of wells and other penetrations within the Area of Review.³⁰ The purpose of these data is to allow the Director to evaluate whether the project is appropriately sited and whether the proposed injection activity can be conducted without endangering USDWs.

Q. ARE APPLICANTS REQUIRED TO PROVIDE SUFFICIENT INFORMATION TO DEMONSTRATE LONG-TERM CONTAINMENT CAPABILITY? HOW DOES THE AGENCY USE THIS INFORMATION IN DETERMINING WHETHER TO ISSUE A CLASS VI PERMIT?

A. Yes. Applicants must provide sufficient information to demonstrate long-term containment capability.³¹ The Director uses that information to evaluate whether the injection zone has adequate capacity and injectivity, whether the confining zone has sufficient integrity, whether faults, fractures, wells, or other penetrations could serve as migration pathways,

²⁹ *Id.* 19.15.43.9.C(1)

³⁰ *Id.*

³¹ *Id.*

and whether the predicted carbon dioxide plume and pressure front can be monitored and managed. If the technical record does not support long-term containment and protection of USDWs, the application should not be approved without additional information, revised plans, or permit conditions sufficient to address the identified concerns.

Q. CAN THE STATE DENY A PERMIT APPLICATION IF THE APPLICANT FAILS TO DEMONSTRATE A SUITABLE GEOLOGIC SYSTEM? WHY IS THAT AUTHORITY IMPORTANT TO IMPLEMENTATION OF THE PROGRAM?

A. Yes. The State can deny a permit application if the applicant fails to demonstrate that the proposed project is located in a suitable geologic system or otherwise fails to satisfy the Class VI requirements.³² That authority is important because Class VI permits are issued based on site-specific technical demonstrations. If the applicant cannot demonstrate that the injection and confining system will protect USDWs, the Director must be able to deny the application rather than authorize injection based on an inadequate technical showing.

Q. IN YOUR OPINION, DO NEW MEXICO'S PROPOSED SITING AND CHARACTERIZATION REQUIREMENTS REFLECT THE SUBSTANTIVE REQUIREMENTS CONTAINED IN 40 C.F.R. §§ 146.82 AND 146.83?

A. Yes. In my opinion, New Mexico's proposed siting and characterization requirements reflect the substantive requirements contained in 40 C.F.R. §§ 146.82 and 146.83. The proposed rules require the technical information needed to evaluate the injection zone, confining zone, geologic structure, hydrogeologic conditions, faults and fractures, artificial

³² OCD Exhibit 1 at section 19.15.41.8.C(1)

penetrations, baseline geochemistry, operating assumptions, and Area of Review modeling. Those requirements provide OCD with the technical basis to determine whether a proposed Class VI project is appropriately sited and protective of underground sources of drinking water.

CLASS VI PERMIT REPORTING REQUIREMENTS

Q. DOES THE NEW MEXICO PROPOSED PROGRAM REQUIRE OPERATORS TO SUBMIT REPORTS REGARDING CLASS VI OPERATIONS? WHAT TYPES OF OPERATIONAL INFORMATION MUST BE REPORTED?

A. Yes. The New Mexico proposed program requires operators to submit reports regarding Class VI operations.³³ Operational reporting includes, at a minimum, information on the physical, chemical, and other relevant characteristics of the carbon dioxide stream; monthly average, maximum, and minimum values for injection pressure, flow rate, injection volume, and annular pressure; events that exceed permitted operating parameters; events that trigger a shut-off device and the response taken; monthly and cumulative volumes or mass of carbon dioxide injected; annulus fluid volume added; and the results of monitoring required under the permit and approved testing and monitoring plan.

Q. WHAT TYPES OF MONITORING AND TESTING RESULTS MUST AN OPERATOR REPORT? WHY IS THAT IMPORTANT?

³³ *Id.* 19.15.43.9.L

A. Operators must report monitoring and testing results required by the permit and the approved testing and monitoring plan.³⁴ This includes results from carbon dioxide stream analysis, injection pressure, rate, volume, annular pressure, annulus fluid volume monitoring, corrosion monitoring, groundwater quality and geochemical monitoring, mechanical integrity testing, pressure fall-off testing, plume and pressure-front tracking, soil gas monitoring, seismicity monitoring where required, and any additional monitoring required by the Director. This reporting is important because it allows OCD to compare actual project performance against permit assumptions, identify deviations from expected behavior, and determine whether additional action is needed to protect USDWs.

Q. IN THE EVENT OF NONCOMPLIANCE, WHAT MUST AN OPERATOR REPORT?

A. In the event of noncompliance, the operator must report conditions that may endanger health or the environment, including evidence that the injected carbon dioxide stream or associated pressure front may cause endangerment to a USDW; noncompliance with permit conditions or malfunction of the injection system that may cause fluid migration into or between USDWs; triggering of a shut-off system; failure to maintain mechanical integrity; and, where applicable, releases of carbon dioxide detected through surface air, soil gas, or other monitoring technologies.³⁵ Information that may indicate endangerment must be reported within required timeframes, including 24-hour reporting for specified urgent conditions.

³⁴ *Id.* 19.15.43.9.L(1)(g)

³⁵ OCD Exhibit 2 at section 19.15.42.8.E

Q. DOES THE STATE HAVE AUTHORITY TO REQUIRE CORRECTIVE ACTION?

A. Yes. The State has authority to require corrective action in response to reported conditions.³⁶ If monitoring, testing, inspection, or other information indicates that injected carbon dioxide, displaced formation fluids, or associated pressure effects may endanger USDWs, OCD may require the operator to cease injection, investigate the condition, implement the approved emergency and remedial response plan, restore and demonstrate mechanical integrity, revise monitoring or corrective action plans, modify permit conditions, or take other actions necessary to prevent or address endangerment.³⁷

Q. CAN YOU EXPLAIN AREA OF REVIEW DELINEATION? HOW IS THAT APPLICABLE TO THE PROPOSED RULE?

A. Area of Review delineation refers to defining the lateral and vertical extent of the Area of Review for a proposed or operating Class VI geologic sequestration project. In the Class VI context, the Area of Review is delineated using computational modeling that predicts the movement of the carbon dioxide plume and the associated pressure front over time.³⁸ The proposed New Mexico rule requires applicants and permittees to delineate the Area of Review, periodically reevaluate it using monitoring and operational data, identify wells or other penetrations that may require corrective action, and update plans where the reevaluation shows that the modeled area or corrective action needs have changed.³⁹

³⁶ OCD Exhibit 3 at section 19.15.43.9.I(6)(d)

³⁷ OCD Exhibit 2 at section 19.15.42.12.A(16)(b)

³⁸ OCD Exhibit 3 at section 19.15.43.9.B(1)

³⁹ *Id.* 19.15.43.9.E(2)(b)

CLASS II TO CLASS VI CONVERSION REQUIREMENTS**Q. WHAT ARE CLASS II WELLS? WHY ARE THEY APPLICABLE TO CLASS VI WELLS?**

A. Class II wells are injection wells associated with oil and gas activities, including wells used for enhanced recovery, disposal of produced fluids, and hydrocarbon storage. They are applicable to the Class VI program because some Class II enhanced recovery operations inject carbon dioxide into oil and gas reservoirs. If carbon dioxide injection transitions from enhanced recovery to the primary purpose of long-term geologic sequestration, and the activity presents an increased risk to USDWs compared to Class II operations, the owner or operator must apply for and obtain a Class VI permit.⁴⁰

Q. DOES NEW MEXICO CURRENTLY HAVE PRIMACY OVER CLASS II WELLS?

A. Yes. New Mexico currently has primacy for Class II wells under the Safe Drinking Water Act. The State's Class II UIC program was approved under SDWA Section 1425 and is administered by the Oil Conservation Division. New Mexico also has primacy for Classes I, III, IV, and V under SDWA Section 1422, but the Class VI program requires separate approval before the State may administer Class VI permits.

Q. WHAT IS THE PROCESS TO CONVERT A CLASS II WELL TO A CLASS VI WELL?

⁴⁰ OCD Exhibit 2 at section 19.15.42.9.F(1).

A. A Class II well may not simply continue operating as a Class VI well without Class VI authorization. If an owner or operator is injecting carbon dioxide for the primary purpose of long-term storage into an oil and gas reservoir and the activity presents increased risk to USDWs compared with Class II operations, the owner or operator must apply for and obtain a Class VI geologic sequestration permit.⁴¹ The conversion process requires submittal of the Class VI permit information, including site characterization, Area of Review modeling, corrective action evaluation, well construction and integrity information, operating data, monitoring plans, financial responsibility, and post-injection site care and closure information. OCD then reviews the application under the Class VI standards before authorizing construction, conversion, or injection.⁴²

Q. WHAT FACTORS DOES THE STATE CONSIDER WHEN EVALUATING A CONVERSION?

A. In evaluating a conversion, the State considers whether the proposed injection activity is for geologic sequestration rather than Class II enhanced recovery, whether the existing well was constructed and operated in a manner compatible with Class VI requirements, whether the well has and can maintain mechanical integrity, whether the injection zone and confining system are suitable for Class VI storage, whether prior oil and gas operations or existing wells in the Area of Review could affect containment, whether corrective action is needed, whether the proposed operating pressures and volumes are appropriate, and

⁴¹ *Id.* 19.15.42.9.F(1)

⁴² OCD Exhibit 3 at section 19.15.43.9.A(2)

whether the applicant has provided adequate monitoring, emergency response, post-injection site care, site closure, and financial responsibility demonstrations.⁴³

Q. HOW DO THE CONVERSION REQUIREMENTS PROTECT UNDERGROUND SOURCES OF DRINKING WATER?

A. The conversion requirements protect USDWs by ensuring that a well originally permitted under the Class II program is not used for Class VI geologic sequestration unless it satisfies the more comprehensive Class VI technical requirements. Those requirements include site characterization, Area of Review delineation, corrective action, well construction review, mechanical integrity testing, operating limits, monitoring and reporting, emergency and remedial response planning, post-injection site care, site closure, and financial responsibility. This review ensures that conversion is allowed only where the well and geologic setting can support long-term containment and protection of USDWs.

INJECTION DEPTH WAIVER REQUIREMENTS

Q. IS THERE A PROCESS IF AN OWNER OR OPERATOR WANTS TO INJECT ABOVE THE LOWERMOST USDW?

A. Yes. The proposed Class VI program includes a process for an owner or operator to request an injection depth waiver when the owner or operator proposes to inject into a non-USDW formation above or between USDWs, rather than below the lowermost USDW. Because the standard Class VI siting framework generally requires injection beneath the lowermost formation containing a USDW, an injection depth waiver is a site-specific exception that

⁴³ OCD Exhibit 2 at section 19.15.42.9.F(2)

requires additional technical demonstrations and approval before injection may be authorized.⁴⁴

Q. HOW DOES THE STATE EVALUATE WHETHER INJECTION ABOVE THE LOWERMOST USDW CAN BE AUTHORIZED?

A. The State evaluates an injection depth waiver request using a site-specific technical record.⁴⁵ The owner or operator must demonstrate that injection at the proposed depth will not endanger USDWs, including any USDWs above or below the proposed injection zone.⁴⁶ That evaluation includes review of the geologic and hydrogeologic setting, the properties and continuity of the injection and confining zones, the location and characteristics of USDWs, faults, fractures, wells, and other potential pathways, the predicted carbon dioxide plume and pressure front, proposed operating pressures and volumes, monitoring and testing plans, corrective action, and any additional conditions needed to protect USDWs.⁴⁷

Q. HOW DOES THAT PROCESS ENSURE PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

A. The process protects USDWs by requiring the applicant to make an additional technical showing before deviating from the ordinary depth requirement. The waiver review focuses on whether the proposed injection interval, confining system, operating conditions, corrective action, and monitoring program are sufficient to prevent carbon dioxide,

⁴⁴ OCD Exhibit 3 at 19.15.43.9.P NMAC

⁴⁵ *Id.*

⁴⁶ *Id.*

⁴⁷ *Id.*

displaced formation fluids, or associated pressure effects from moving into or between USDWs. If the applicant cannot make that showing, the waiver should not be approved. If a waiver is approved, the State may impose permit conditions, monitoring requirements, reporting obligations, and corrective action requirements necessary to maintain USDW protection.

Q. WHAT IS THE PURPOSE OF GEOLOGIC CHARACTERIZATION IN THE CLASS VI CONTEXT?

A. The purpose of geologic characterization in the Class VI context is to develop a site-specific understanding of the injection zone, confining zone, overlying formations, USDWs, faults and fractures, artificial penetrations, and other features that could affect containment. That information provides the technical foundation for determining whether the proposed geologic system can receive the anticipated carbon dioxide stream and contain the carbon dioxide plume, pressure front, and displaced formation fluids without endangering USDWs.

Q. HOW DOES GEOLOGIC CHARACTERIZATION SUPPORT PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER?

A. Geologic characterization supports protection of USDWs by identifying the formations that contain USDWs, the proposed injection and confining intervals, and potential pathways for fluid movement. It allows the Director to evaluate whether faults, fractures, wells, or other penetrations could allow carbon dioxide or displaced formation fluids to migrate into

or between USDWs, and whether operating limits, monitoring, or corrective action are needed to prevent endangerment.

Q. WHAT ARE THE REQUIREMENTS FOR GEOLOGIC CHARACTERIZATION OF CLASS VI WELLS?

A. The geologic characterization requirements include maps and cross sections of the Area of Review; information on the depth, thickness, areal extent, lithology, mineralogy, porosity, permeability, capillary pressure, and geomechanical properties of the injection and confining zones; identification of USDWs and water wells; seismic history; faults and fractures; baseline geochemical information; formation fluid data; and information on wells and other artificial penetrations within the Area of Review.⁴⁸ Together, these data support evaluation of storage capacity, injectivity, confinement, plume and pressure-front migration, corrective action needs, and the adequacy of proposed monitoring.

Q. WHAT TYPES OF SAMPLES ARE REQUIRED AS PART OF SITE CHARACTERIZATION FOR A CLASS VI WELL?

A. Site characterization for a Class VI well typically requires samples and analytical data sufficient to characterize the injection zone, confining zone, formation fluids, and baseline environmental conditions.⁴⁹ Relevant samples may include cores or sidewall cores from the injection and confining formations, formation fluid samples from the injection zone and monitoring intervals, groundwater samples from identified USDWs or monitoring wells, and samples or analyses used to characterize the carbon dioxide stream. The purpose is to provide the geologic, geochemical, and hydrogeologic information needed to evaluate

⁴⁸ *Id.* 19.15.43.9.C(1)

⁴⁹ *Id.*

injectivity, containment, compatibility of injected fluids with formation materials and fluids, and baseline conditions before injection begins.

Q. HOW DOES SAMPLING HELP ESTABLISH BASELINE CONDITIONS?

A. Sampling establishes baseline conditions by documenting the chemical, physical, and hydrogeologic conditions that exist before injection begins. Baseline groundwater, formation fluid, and geochemical data provide a reference point for later monitoring results. That comparison allows the operator and OCD to determine whether observed changes are consistent with predicted project behavior or may indicate movement of carbon dioxide, displaced formation fluids, or pressure effects in a manner that requires investigation or response.

Q. WHY IS BASELINE SAMPLING IMPORTANT TO EVALUATING LONG-TERM CONTAINMENT?

A. Baseline sampling is important to long-term containment because it creates the data set against which future monitoring results are evaluated. Without reliable baseline information, it is more difficult to distinguish project-related changes from natural variability or preexisting conditions. Baseline sampling therefore supports detection of potential leakage, migration of displaced fluids, changes in groundwater chemistry, or other indicators that the carbon dioxide plume or pressure front is not behaving as predicted.

Q. HOW IS SAMPLING DATA USED IN THE CLASS VI CONTEXT?

A. Sampling data are used throughout the Class VI process. Before permitting, sampling supports site characterization, model development, assessment of geochemical compatibility, and design of the testing and monitoring plan. During injection, sampling results are compared to baseline conditions and model predictions to evaluate whether the project is operating as expected. After injection has ceased, continued sampling supports post-injection site care by helping demonstrate that the plume and pressure front have stabilized and that underground sources of drinking water remain protected.

Q. WHAT IS THE CONFINING ZONE?

A. The confining zone is the geologic formation, group of formations, or part of a formation that overlies or otherwise bounds the injection zone and has sufficiently low permeability and sufficient integrity to restrict vertical movement of injected carbon dioxide and displaced formation fluids.⁵⁰ In a Class VI project, the confining zone is a key component of the geologic containment system because it helps isolate the injection zone from USDWs.

Q. WHAT IS THE PURPOSE OF THE CONFINING ZONE IN A CLASS VI PROJECT?

A. The purpose of the confining zone is to provide a barrier that contains the carbon dioxide plume, associated pressure front, and displaced formation fluids within the intended geologic storage system. A competent confining zone reduces the potential for upward

⁵⁰ Id. 19.15.43.7.F

migration from the injection interval and helps ensure that injection operations do not allow carbon dioxide or displaced fluids to move into or between USDWs.

Q. WHY IS IT IMPORTANT TO DETERMINE WHETHER THE CONFINING ZONE HAS SUFFICIENT INTEGRITY TO CONTAIN THE CARBON DIOXIDE STREAM?

A. It is important to determine whether the confining zone has sufficient integrity because the confining zone is the primary geologic control on vertical containment. If the confining zone is of insufficient permeability, contains transmissive faults, fractures, improperly abandoned wells, or other pathways, or if injection pressures could initiate or propagate fractures, carbon dioxide or displaced formation fluids could migrate out of the intended storage interval. Evaluating confining-zone integrity therefore supports permit decisions, operating-pressure limits, monitoring design, corrective action requirements, and overall protection of USDWs.

Q. WHAT IS PLUME AND PRESSURE FRONT TRACKING? WHAT IS THE PURPOSE OF PLUME AND PRESSURE FRONT TRACKING IN THE CLASS VI PROGRAM?

A. Plume and pressure front tracking is the process of estimating, monitoring, and documenting the lateral and vertical extent of the injected carbon dioxide plume and the associated pressure front within the subsurface. In the Class VI program, plume mapping is used to evaluate whether the project is performing as predicted, whether the Area of Review remains appropriate, whether monitoring locations remain adequate, and whether

the carbon dioxide stream and displaced formation fluids are being contained within the intended geologic storage system.

Q. HOW OFTEN ARE OPERATORS REQUIRED TO UPDATE OR SUBMIT PLUME TRACKING INFORMATION?

A. Operators are required to submit plume and pressure-front information according to the schedule established in the permit and approved testing and monitoring plan, and as part of the periodic reporting and Area of Review reevaluation process.⁵¹ Plume maps should be updated as new monitoring, testing, and operational data become available, and they must be revised when the data indicate that the plume or pressure front is behaving differently than predicted or when the Area of Review must be reevaluated.

Q. HOW DOES THE STATE USE REPORTED PLUME DATA TO EVALUATE PROJECT PERFORMANCE?

A. The State uses reported plume data to compare observed project performance with the predictions made in the permit application, Area of Review model, and approved monitoring plan. If the plume or pressure front is larger, migrating in a different direction, moving more quickly, or affecting zones not predicted by the model, OCD can require additional investigation, monitoring, model updates, Area of Review reevaluation, corrective action, or permit modifications to ensure continued protection of USDWs.

⁵¹ *Id.* 19.15.43.9.L; 19.15.43.9.E(2)(b)(a)

Q. HOW DOES AN OPERATOR TRACK THE MOVEMENT OF THE CARBON DIOXIDE PLUME?

A. An operator tracks movement of the carbon dioxide plume through a combination of computational modeling, operational data, monitoring well data, geophysical surveys where appropriate, pressure monitoring, geochemical monitoring, and other permit-required monitoring technologies. The operator compares observed data to predicted plume and pressure-front behavior and updates the model and plume maps as needed to reflect actual project performance.

Tracking the carbon dioxide plume and pressure front is important because those features define the portion of the subsurface potentially affected by injection. Their location helps determine whether the Area of Review remains accurate, whether wells or other penetrations may require corrective action, whether monitoring locations are appropriate, and whether pressure changes could cause fluid movement into or between USDWs. Tracking also provides an early indication of whether the project is performing as predicted.

Q. WHAT TYPES OF DATA ARE USED TO DEVELOP AND UPDATE PLUME MAPS?

A. Plume maps are developed and updated using site characterization data, injection rate and volume data, pressure data, formation properties, geologic structure, well logs, monitoring well results, groundwater and formation fluid chemistry, mechanical integrity and pressure fall-off testing, geophysical data where available, and updated computational modeling.

These data allow the operator and the State to refine predictions of plume migration and pressure-front development over time.

Q. HOW DOES PLUME TRACKING HELP IDENTIFY POTENTIAL RISKS OF FLUID MIGRATION OR LOSS OF CONTAINMENT?

A. Plume tracking helps identify potential risks by showing whether the carbon dioxide plume or pressure front is approaching faults, fractures, abandoned wells, monitoring boundaries, USDWs, or other features that could serve as conduits for fluid migration. If mapped plume behavior differs from model predictions, that discrepancy can indicate the need for additional monitoring, model recalibration, Area of Review reevaluation, corrective action, or changes to injection operations.

Q. WHAT TYPES OF PLUME TRACKING INFORMATION MUST OPERATORS REPORT TO THE STATE?

A. Operators must report information sufficient to describe the current and predicted location of the carbon dioxide plume and associated pressure front, the data and methods used to update plume maps, comparison of observed conditions to model predictions, and any changes in the Area of Review or corrective action needs. Reported information may include updated maps, monitoring data, modeling results, injection volumes and pressures, pressure-front estimates, and discussion of any deviations from predicted performance.⁵²

⁵² *Id.* 19.15.43.9.E(5)

FINANCIAL ASSURANCE REQUIREMENTS

Q. WHAT IS FINANCIAL ASSURANCE?

A. Financial assurance is a demonstration by the owner or operator that adequate financial resources are available to perform required Class VI obligations if they become necessary. In the Class VI context, financial assurance helps ensure that funds will be available for activities such as corrective action, well plugging, emergency and remedial response, post-injection site care, and site closure, even if the operator is unable or unwilling to perform those activities at a later time.

Q. WHAT TYPES OF ACTIVITIES MUST FINANCIAL ASSURANCE COVER?

A. Financial assurance must cover the major obligations associated with a Class VI geologic sequestration project, including corrective action for wells and other artificial penetrations in the Area of Review, injection well plugging, post-injection site care, site closure, and emergency and remedial response.⁵³ These categories are important because they represent the activities most directly related to preventing or addressing potential endangerment of underground sources of drinking water during and after injection operations.

Q. HOW DO FINANCIAL ASSURANCE REQUIREMENTS SUPPORT WELL PLUGGING, CORRECTIVE ACTION, EMERGENCY RESPONSE, SITE CLOSURE, AND POST-INJECTION SITE CARE?

A. Financial assurance supports these activities by requiring the operator to establish a funding mechanism before injection begins and to maintain that mechanism for as long as

⁵³ *Id.* 19.15.43.9.F(3)

obligations remain. If corrective action, emergency response, plugging, site closure, or post-injection monitoring is required, the financial assurance instrument provides a source of funds to complete the work. This reduces the risk that necessary protective measures would be delayed or unfunded because of an operator's financial condition.

Q. HOW DO THESE REQUIREMENTS SUPPORT NEW MEXICO'S REQUEST FOR CLASS VI PRIMACY?

- A. These requirements support New Mexico's request for Class VI primacy because they demonstrate that the State's proposed program includes enforceable mechanisms to ensure that funds are available for the activities needed to protect USDWs throughout the project life cycle. Financial assurance complements the technical requirements for siting, construction, operation, monitoring, corrective action, post-injection site care, and closure by ensuring that those obligations can be implemented if needed.

POST-INJECTION SITE CARE ("PISC")

Q. WHAT IS THE PURPOSE OF POST-INJECTION SITE CARE?

- A. The purpose of post-injection site care is to ensure that, after injection has ceased, the carbon dioxide plume and associated pressure front are monitored until they no longer pose a potential endangerment to USDWs.⁵⁴ During the PISC period, the operator continues monitoring, reporting, and any necessary corrective or remedial activities to confirm that the plume and pressure front are behaving as predicted, that the Area of Review remains appropriate, and that the site can ultimately be closed safely.

⁵⁴ *Id.* 19.15.43.9.B(9)

Q. WHY IS POST-INJECTION MONITORING IMPORTANT TO LONG-TERM CONTAINMENT OF THE CARBON DIOXIDE STREAM?

A. Post-injection monitoring is important to long-term containment because project risks do not necessarily end when injection stops. Pressure dissipation, plume stabilization, geochemical changes, and potential migration pathways must continue to be evaluated after injection ceases. Monitoring during the PISC period allows the operator and OCD to verify that the carbon dioxide plume and pressure front are stabilizing or behaving as predicted, that USDWs remain protected, and that the technical basis for site closure has been satisfied.

CLASS VI PERMIT REPORTING REQUIREMENTS

Q. WHAT IS THE PURPOSE OF THE REPORTING REQUIREMENTS IN THE CLASS VI PROGRAM?

A. The purpose of the reporting requirements in the Class VI program is to ensure that the Director receives timely information needed to evaluate whether the well and geologic sequestration project are operating as permitted and whether underground sources of drinking water remain protected. Reporting allows the State to compare actual injection, monitoring, and testing results to the assumptions in the permit application and approved plans; identify deviations from expected performance; evaluate whether additional monitoring, corrective action, or permit modifications are needed; and maintain an administrative record of compliance throughout the operational and post-injection periods.

Q. WHAT TYPES OF OPERATIONAL INFORMATION ARE OPERATORS REQUIRED TO REPORT?

A. Operators are required to report operational information that describes how the well is being operated and whether those operations remain within approved permit limits.⁵⁵ That information includes injection pressure, injection rate, injection volume and mass, annular pressure, annulus fluid volume, the physical and chemical characteristics of the carbon dioxide stream, events that exceed permitted operating parameters, mechanical integrity-related information, results of required monitoring and testing, and any other information required by the permit or requested by the Director.⁵⁶

Q. HOW DOES THE PROPOSED CLASS VI PROGRAM REQUIRE REPORTING OF INJECTION PRESSURE, RATE, AND VOLUME? WHY IS THAT INFORMATION IMPORTANT TO SAFE CLASS VI OPERATIONS?

A. The proposed program requires operators to report injection pressure, injection rate, and injection volume and mass at the frequency and in the manner specified by the permit.⁵⁷ These data are important because pressure, rate, and volume directly affect plume migration, pressure-front development, injectivity, mechanical integrity, and the potential for fluid movement outside the intended injection zone. Regular reporting allows the State to confirm that the operator remains within approved operating limits and to identify conditions that may require operational changes or additional review.

⁵⁵ *Id.* 19.15.43.9.L NMAC

⁵⁶ *Id.*

⁵⁷ *Id.*

Q. HOW DOES THE PROPOSED PROGRAM REQUIRE REPORTING REGARDING THE CHARACTERISTICS OF THE CARBON DIOXIDE STREAM?

A. The proposed program requires reporting regarding the physical, chemical, and other relevant characteristics of the carbon dioxide stream.⁵⁸ This information is important because the composition of the carbon dioxide stream can affect corrosion potential, geochemical reactions, formation compatibility, injectivity, monitoring parameters, and the evaluation of whether the injected stream is consistent with the assumptions used in the permit application and approved operating plans.

Q. WHAT TYPES OF MONITORING AND TESTING RESULTS MUST BE REPORTED TO THE STATE? WHY IS THAT REPORTING IMPORTANT?

A. Operators must report the monitoring and testing results required by the permit and approved testing and monitoring plan.⁵⁹ Those results may include carbon dioxide stream analyses, injection pressure and rate data, annular pressure data, mechanical integrity test results, pressure fall-off testing, corrosion monitoring, groundwater or formation-fluid monitoring, geochemical monitoring, plume and pressure-front tracking, soil gas or surface monitoring where required, seismicity monitoring where required, and any additional monitoring required by the Director.⁶⁰ Reporting is important because it allows the State to evaluate whether the project is performing as predicted and whether USDWs remain protected.

⁵⁸ *Id.* 19.15.43.9.L(1); 19.15.43.9.K(1)

⁵⁹ *Id.* 19.15.43.9.L NMAC; 19.15.43.9.K

⁶⁰ *Id.*

Q. HOW DOES THE PROPOSED PROGRAM ADDRESS REPORTING OF NONCOMPLIANCE EVENTS OR OTHER CONDITIONS THAT MAY ENDANGER UNDERGROUND SOURCES OF DRINKING WATER?

A. The proposed program requires operators to report noncompliance events and other conditions that may endanger USDWs.⁶¹ Reportable conditions include failure to comply with permit conditions, evidence that the injected carbon dioxide stream or associated pressure front may endanger a USDW, loss of mechanical integrity, triggering of an automatic shut-off device, operating outside approved pressure or rate limits, malfunction of the injection system, or other information indicating that injected or displaced fluids may move into or between USDWs.

Q. WHY IS TIMELY REPORTING IMPORTANT IN THOSE CIRCUMSTANCES?

A. Timely reporting is important because conditions that may endanger USDWs require prompt evaluation and, where necessary, prompt response. If an operator reports a potential endangerment condition, loss of mechanical integrity, exceedance of permit limits, or other significant event quickly, the State can require immediate investigation, temporary suspension of injection, implementation of the emergency and remedial response plan, additional monitoring, corrective action, or permit modifications before the condition worsens.

⁶¹ *Id.* at 19.15.43.9.L(3); OCD Exhibit 2 at section 19.15.42.8.E

Q. HOW DOES THE PROGRAM REQUIRE REPORTING DURING THE POST-INJECTION SITE CARE PERIOD?

A. During the post-injection site care period, the program requires reporting of monitoring, testing, and other information needed to demonstrate that the carbon dioxide plume and associated pressure front are behaving as predicted and do not endanger USDWs.⁶² Reports may include updated monitoring results, pressure and geochemical data, plume and pressure-front evaluations, confirmation that the Area of Review remains appropriate, information supporting any request to modify the post-injection site care timeframe, and documentation needed to support eventual site closure.

Q. WHY IS REPORTING IMPORTANT AFTER INJECTION OPERATIONS HAVE CEASED?

A. Reporting remains important after injection operations have ceased because the carbon dioxide plume and pressure front may continue to migrate or equilibrate for some period of time. Post-injection reporting allows the State to confirm that pressure is dissipating, the plume is stabilizing or behaving as predicted, monitoring results do not indicate endangerment of USDWs, and the technical criteria for site closure are being met.

Q. WHAT TYPES OF RECORDS ARE OPERATORS REQUIRED TO MAINTAIN UNDER THE PROGRAM?

A. Operators are required to maintain records documenting compliance with the Class VI permit and approved plans.⁶³ These records typically include permit application materials,

⁶² OCD Exhibit 3 at 19.15.43.9.N(1)(b)(iv)

⁶³ *Id.* 19.15.43.9.L(6)

site characterization data, Area of Review modeling and reevaluations, corrective action records, well construction and plugging records, mechanical integrity testing, injection pressure, rate, and volume data, carbon dioxide stream analyses, monitoring and testing results, noncompliance reports, emergency and remedial response records, financial responsibility documentation, post-injection site care records, and site closure documentation.⁶⁴

CLASS VI WELL LOG REQUIREMENTS

Q. HOW DOES THE STATE REVIEW WELL LOG DATA SUBMITTED BY OPERATORS?

A. The State reviews well log data to evaluate whether the subsurface conditions encountered during drilling are consistent with the permit application and approved technical demonstrations. That review may include logs used to identify the injection zone, confining zone, USDWs, lithologic contacts, formation thickness, porosity, permeability indicators, fractures, casing and cement conditions, and other features relevant to well construction and containment. The State uses the log data to confirm that the well is constructed in the correct interval and that the geologic assumptions supporting the permit remain valid.

Q. HOW DO WELL LOGS SUPPORT THE STATE'S TECHNICAL REVIEW OF A CLASS VI APPLICATION?

A. Well logs support the State's technical review by providing direct or indirect evidence of the subsurface conditions encountered during drilling. They help verify the depth,

⁶⁴ *Id.*

thickness, and continuity of the injection and confining zones; identify USDWs and other relevant formations; evaluate lithology, porosity, permeability indicators, and potential fractures; and confirm casing and cement placement.⁶⁵ This information allows the State to compare actual well conditions with the application, refine the site characterization, and determine whether the well can be authorized for Class VI operation.

Q. HOW DOES SAMPLING SUPPORT LONG-TERM MONITORING AND OVERSIGHT OF THE PROJECT?

A. Sampling supports long-term monitoring and oversight by allowing the operator and the State to compare post-permit and post-injection data to baseline conditions and model predictions. Repeated sampling can identify changes in groundwater chemistry, formation fluid chemistry, pressure conditions, or other indicators that may suggest plume migration, displaced fluid movement, or loss of containment. Those data help determine whether monitoring plans should be revised, whether corrective action is needed, and whether the project remains protective of USDWs.

Q. IN YOUR OPINION, DO NEW MEXICO'S LOGGING, TESTING, AND SAMPLING REQUIREMENTS REFLECT THE FEDERAL CLASS VI FRAMEWORK? HOW DO THESE REQUIREMENTS SUPPORT NEW MEXICO'S REQUEST FOR CLASS VI PRIMACY?

A. Yes. In my opinion, New Mexico's logging, testing, and sampling requirements reflect the federal Class VI framework. Those requirements provide the information needed to verify

⁶⁵ *Id.* 19.15.43.9(H)

site characterization, confirm well construction, establish baseline conditions, monitor injection operations, evaluate mechanical integrity, track plume and pressure-front behavior, and detect conditions that could endanger USDWs. They support New Mexico's request for Class VI primacy by demonstrating that the State's program includes the technical data collection and oversight tools necessary to administer Class VI permits in a manner protective of underground sources of drinking water.

CLASS VI CORRECTIVE ACTION REQUIREMENTS

Q. HOW DOES THE PROPOSED NEW MEXICO CLASS VI PROGRAM IDENTIFY IMPROPERLY ABANDONED WELLS WITHIN THE AREA OF REVIEW?

A. The proposed program identifies improperly abandoned wells within the Area of Review through the applicant's well inventory, review of state oil and gas and UIC records, review of available well completion and plugging records, maps, drilling records, field investigations where appropriate, and information from other public or operator-provided sources.⁶⁶ The applicant must identify wells and other artificial penetrations that penetrate the injection zone or confining zone, or that otherwise may serve as conduits for fluid movement, and the State reviews that information as part of the Area of Review and corrective action evaluation.⁶⁷

Q. WHAT TYPES OF INFORMATION DOES THE STATE REVIEW IN EVALUATING IMPROPERLY ABANDONED WELLS?

⁶⁶ *Id.* 19.15.43.9.E

⁶⁷ *Id.* 19.15.43.9.E(3)(b)

A. In evaluating improperly abandoned wells, the State reviews information such as well location, depth, construction details, casing and cement records, plugging records, completion interval, stratigraphic intervals penetrated, proximity to the predicted carbon dioxide plume and pressure front, condition of the wellbore where known, and whether the well intersects the injection zone, confining zone, USDWs, or other relevant formations. The State may also consider historical drilling records, geophysical logs, operator records, field verification, and any uncertainty in the available records.

Q. HOW DOES THE STATE DETERMINE WHETHER AN ABANDONED WELL MAY POSE A RISK TO CONTAINMENT?

A. The State determines whether an abandoned well may pose a risk to containment by evaluating whether the well could provide a pathway for movement of carbon dioxide, displaced formation fluids, or pressure effects from the injection zone into the confining zone, overlying formations, or USDWs. That evaluation considers the well's location relative to the modeled carbon dioxide plume and pressure front, the formations penetrated, construction and plugging history, condition of casing and cement, whether the well intersects the injection or confining zones, and the level of uncertainty in the available records. Wells with incomplete records or inadequate plugging may require conservative evaluation and corrective action.

Q. WHAT TYPES OF CORRECTIVE ACTION MAY BE REQUIRED FOR IMPROPERLY ABANDONED WELLS?

A. Corrective action for improperly abandoned wells may include locating and verifying the well, evaluating existing plugging and construction records, conducting additional testing or investigation, repairing casing or cement where appropriate, re-entering and properly plugging the well, placing additional cement plugs, isolating penetrated intervals, or implementing other Director-approved measures to prevent the well from serving as a conduit for fluid movement.⁶⁸ The corrective action must be sufficient to prevent movement of carbon dioxide or displaced formation fluids into or between underground sources of drinking water.

Q. HOW DOES THE STATE REVIEW AND APPROVE CORRECTIVE ACTION PLANS FOR IMPROPERLY ABANDONED WELLS? CAN THE STATE REQUIRE ADDITIONAL CORRECTIVE ACTION IF CONDITIONS CHANGE?

A. The State reviews corrective action plans by evaluating the applicant's well inventory, the basis for identifying wells that require corrective action, the proposed corrective action methods, the timing of corrective action relative to injection, and whether the proposed work will prevent endangerment of USDWs. OCD may require additional information, revised corrective action procedures, verification testing, documentation of completed work, or additional corrective action if monitoring, Area of Review reevaluation, updated modeling, or newly discovered information indicates that a well or other penetration may pose a containment risk. Yes, the State can require additional corrective action if conditions change or if new information shows that the original plan is no longer adequate.

⁶⁸ *Id.* 19.15.43.9.E(4)

SEISMICITY—RISK EVALUATION AND MONITORING

Q. WHAT IS SEISMICITY? ARE YOU FAMILIAR WITH HOW SEISMICITY IS EVALUATED UNDER THE CLASS VI PROGRAM?

A. Seismicity refers to the occurrence, frequency, distribution, and magnitude of earthquakes or seismic events in a particular area. In the proposed New Mexico Class VI context, seismicity is evaluated because injection can increase subsurface pore pressure, and in some geologic settings pressure changes may affect existing faults or fractures. I am familiar with how seismicity is evaluated, including review of seismic history, faults and fractures, geomechanical conditions, injection pressures, monitoring data, and permit conditions designed to reduce the potential for induced seismicity and protect underground sources of drinking water.

Q. HOW DOES THE PROPOSED NEW MEXICO CLASS VI PROGRAM ADDRESS POTENTIAL INDUCED SEISMICITY RISKS ASSOCIATED WITH INJECTION?

A. The proposed program addresses potential induced seismicity risks by requiring site characterization and operating information sufficient to evaluate faults, fractures, seismic history, geomechanical conditions, formation pressures, proposed injection rates and pressures, and predicted pressure-front behavior. Those data are considered in establishing permit conditions, including operating pressure limits, monitoring requirements, reporting obligations, and response procedures.⁶⁹ New Mexico's proposed Class VI program requires

⁶⁹ *Id.* 19.15.43.9.I(1)

seismicity monitoring as part of the operational and post injection monitoring program for all Class VI injection projects.⁷⁰

Q. WHAT ROLE DOES SITE CHARACTERIZATION PLAY IN ASSESSING SEISMIC RISK?

A. Site characterization is central to assessing seismic risk because it identifies the geologic and geomechanical conditions that influence how the subsurface may respond to injection. Relevant information includes the location and orientation of known or suspected faults and fractures, regional and local seismic history, in situ stress conditions, fracture pressure, formation pressures, permeability, caprock integrity, and the predicted extent of the pressure front. This information helps determine whether proposed injection pressures and rates are appropriate and whether additional monitoring or operating controls are needed.

Q. HOW CAN INJECTION OPERATIONS BE MODIFIED IF SEISMICITY IS DETECTED OR SUSPECTED?

A. If seismicity is detected or suspected, injection operations can be modified through permit-required response procedures or Director-required actions. Depending on the circumstances, those actions may include reducing injection rate, reducing injection pressure, temporarily suspending injection, increasing monitoring frequency, evaluating pressure and seismic data, updating models, investigating whether the event is related to injection, revising operating limits, implementing the emergency and remedial response

⁷⁰ *Id.* 19.15.43.9.K(10)

plan where appropriate, or taking other measures necessary to protect USDWs and public safety.⁷¹

CLASS VI WELL CONSTRUCTION REQUIREMENTS

Q. HOW DOES THE STATE REVIEW WELL CONSTRUCTION PLANS BEFORE ISSUING A CLASS VI PERMIT?

A. Before issuing a Class VI permit, the State reviews the applicant's proposed well construction plans to determine whether the well can be constructed and operated in a manner that protects underground sources of drinking water. That review includes the proposed surface and subsurface construction details, casing and cementing program, tubing and packer configuration, corrosion-resistant materials, cement compatibility, proposed logging and testing, proposed injection interval, and procedures for demonstrating mechanical integrity. The State uses this information to determine whether the well design is appropriate for the anticipated injection pressures, carbon dioxide stream characteristics, geologic setting, and long-term containment objectives of the project.

Q. HOW DOES THE STATE ENSURE THAT CONSTRUCTION ACTIVITIES COMPLY WITH APPROVED PERMIT CONDITIONS?

A. The State ensures construction compliance through permit conditions, review of construction information, required notifications, inspections, and review of post-construction documentation. The operator must construct the well in accordance with the approved permit and any Director-approved construction procedures. During and after

⁷¹ *Id.*

construction, the State may review cementing records, logs, mechanical integrity test results, pressure tests, and other construction verification data to confirm that the well was built as approved and that it can maintain mechanical integrity before injection is authorized.

NEW MEXICO AMENDMENTS/STRINGENCY

Q. DO THE FEDERAL REQUIREMENTS FOR A STATE TO GAIN PRIMACY OF THE CLASS VI PROGRAM ALLOW A STATE TO DEVELOP MORE STRINGENT STANDARDS THAN THEIR FEDERAL COUNTERPARTS?

A. Yes. The federal requirements for Class VI primacy establish minimum standards that a state program must meet in order to be approved. A state may adopt requirements that are more stringent or broader in scope than the federal minimum requirements, provided the state has adequate legal authority to implement and enforce those requirements. For Class VI primacy, the key question is whether the state program is at least as stringent as the federal program and provides adequate authority, procedures, and technical safeguards to protect underground sources of drinking water.

Q. WHAT STANDARDS IN NEW MEXICO ARE ANTICIPATED TO BE MORE STRINGENT?

A. New Mexico's proposed Class VI rules are anticipated to be more stringent or more detailed than the federal counterpart requirements in several areas. Those areas include:

- Public participation and community outreach [OCD Exhibit 3 at proposed section 19.15.43.9.C(1)(u); 19.15.43.9.K];

- Alarms and automated shutdown systems to ensure immediate response to critical operating conditions [OCD Exhibit 3 at proposed section 19.15.43.9.I(5)(d)-(e)]
- Emergency and remedial response planning, including outreach and coordination with local emergency responders [OCD Exhibit 3 at proposed section 19.15.43.9.O(2)];
- Well logging [OCD Exhibit 3 at proposed section 19.15.43.9.H(1); 19.15.43.9.H(6)];
- Area of Review reevaluation and updating based on operational and monitoring data [OCD Exhibit 3 at proposed section 19.15.43.9.E(2)(b)(i); 19.15.43.9.E(5) NMAC];
- Groundwater monitoring frequency [OCD Exhibit 3 at proposed section 19.15.43.9.K(4)]
- Soil gas monitoring to detect movement of carbon dioxide that may endanger a USDW [OCD Exhibit 3 at proposed section 19.15.43.9.K(8)]
- Seismicity monitoring [OCD Exhibit 3 at proposed section 19.15.43.9.K(10)]
- Records retention [OCD Exhibit 3 at proposed section 19.15.43.9.L(6)]
- Injection well plugging and site closure [OCD Exhibit 3 at proposed section 19.15.43.9.M]

These provisions supplement the federal Class VI framework and are intended to ensure that OCD has sufficient information and enforceable authority to evaluate, permit, monitor, and regulate Class VI projects in a manner protective of USDWs.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

/s/Gregory Schnaar
Gregory Schnaar