UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

January 12, 2017

Mr. Frederick Forthuber
Occidental Oil and Gas Corporation
5 Greenway Plaza, Suite 110
Houston, Texas 77046-0521

Re: Monitoring, Reporting and Verification (MRV) Plan for Hobbs Field

Dear Mr. Forthuber:

The United States Environmental Protection Agency (EPA) has reviewed the Monitoring, Reporting and Verification (MRV) Plan submitted for the Hobbs Field as required by 40 CFR Part 98, Subpart RR of the Greenhouse Gas Reporting Program. The EPA is approving the MRV Plan submitted by Occidental Permian Ltd. for the Hobbs Field as the final MRV plan. The MRV Plan Approval Number is 1009647-1. This decision is effective January 17, 2017 and appealable to EPA's Environmental Appeals Board under 40 CFR Part 78.

If you have any questions regarding this determination, please write to ghgreporting@epa.gov and a member of the Greenhouse Gas Reporting Program will respond.

Sincerely,

Julius Banks, Chief
Greenhouse Gas Reporting Branch

Technical Review of Subpart RR MRV Plan for the Hobbs Field

January 2017

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Appendices

This report summarizes the EPA's technical evaluation of the Greenhouse Gas Reporting Program (GHGRP) Subpart RR Monitoring, Reporting, and Verification (MRV) Plan submitted by Occidental Permian Ltd., hereafter referred to as Oxy, operator of the Hobbs Field.

1 Overview of Project

Occidental Permian Ltd. (OPL), Occidental Petroleum Corporation (OPC) and their affiliates (together, Oxy) submitted an MRV Plan related to enhanced oil recovery (EOR) operations within the North Hobbs Grayburg San Andres Unit (North Hobbs Unit) and the South Hobbs Project Area (South Hobbs Unit), (collectively referred to as the Hobbs Field) in the Permian Basin in New Mexico. The Hobbs Field was discovered in 1928. It is located in east-central Lea County, in southeastern New Mexico on the northwestern margin of the Central Basin Platform. The Field is approximately two miles west of the Texas state line and one hundred miles northwest of Midland, Texas. With more than 1,000 million barrels (MMB) of Original Oil in Place (OOIP), the Hobbs Basal Grayburg-San Andres field is one of the largest in North America.

The Basal Grayburg and San Andres formations lie beneath approximately 4,000 feet of overlying sediments. Multiple seals overlie the reservoir and serve as reliable barriers to prevent fluids from moving upwards towards the surface. The top seal is made up of anhydrite, shale, and impermeable silty dolomite rock layers that comprise the upper Grayburg. Above this lie several intervals of impermeable rock layers of various thicknesses: the Queen, Seven Rivers, Tansil, Yates, and Rustler formations. Both water and CO_2 have been successfully injected in the Hobbs Field since 1976.

The MRV Plan provides a comprehensive description of the project. Oxy receives CO_2 from the Permian pipeline delivery system through two custody transfer metering points. The CO_2 injected into the Hobbs Field is supplied by a number of different sources into the pipeline system. CO_2-EOR is done by water-alternating-gas (WAG) injection. Currently, Oxy has 10 injection manifolds and approximately 210 injection wells in the Hobbs Field. Each injection well is connected to a WAG header, which connects the CO_2 and water flowlines to the injection wellheads. This header has valves to control the flow of either CO_2 or water to each well. WAG headers are remotely operated and can inject either CO_2 or water at various rates and injection pressures. A WAG header control system is implemented at each satellite. It consists of a dual-purpose flow meter used to measure the injection rate of water or CO_2, depending on what is being injected.

As oil and gas are produced from the 235 active production wells, they are sent to one of 10 satellite batteries. Each satellite battery consists of a large vessel that performs gas-liquid separation. Each satellite battery also has well test equipment to measure production rates of oil, water and gas from individual production wells. After separation, the gas phase is transported by pipeline to a Recycle and Compression Facility (RCF) for processing. Once gas enters an RCF, it undergoes dehydration and compression. In the North Hobbs Unit (NHU), an additional process separates Natural Gas Liquids (NGLs) for sale. At the end of these processes, there is a CO_2 rich stream that is recycled through re-injection. Meters at each RCF outlet are used to determine the total volume of the CO_2 stream recycled back into the EOR operations. The liquid phase, which is a mixture of oil and water, is sent to one of four centralized tank batteries where oil is separated from water. The large size of the centralized tank batteries provides enough residence time for gravity to separate oil from water. The separated oil is metered through a Lease Automatic Custody Transfer (LACT) unit located at each centralized tank battery and sold. The water is removed from the bottom of the tanks at the central tank batteries and sent to water injection stations, where it is re-injected at the WAG headers. A table of all Hobbs Unit wells is provided in Appendix 5 of the MRV Plan.

The MRV Plan provides an explanation of the site setting, process, and operation. The plan states that the Hobbs Field could, potentially, hold an estimated maximum of about 7,949 billion standard cubic feet (Bscf) (430 million metric tons (MMT)) CO_2 in the reservoir space above the spill point. Oxy forecasts that at the end of EOR operations, stored CO_2 will fill approximately 27.6% of total calculated storage capacity. Oxy calculates the total CO_2 storage space based on the volume of rock and porosity and assumes an irreducible water saturation of 0.15, an irreducible oil saturation of 0.10 and a CO_2 formation volume factor of 0.45. Oxy notes that its operational experience at the Hobbs Field has created a strong understanding of the reservoir and its capacity. Figure 2 of the MRV Plan presents the cumulative annual forecasted volume of CO_2 stored over the modeling period (2003-2100), and Oxy anticipates storage of up to 2,197 Bscf (118.8 MMT).

The MRV Plan explains the monitoring timeframe of the project and the demonstration that would be made in order to discontinue reporting. The MRV Plan describes a "Specified Period" during which Oxy will have a subsidiary purpose of establishing the long-term containment of a measurable quantity of CO_2 in the Basal Grayburg - San Andres formation in the Hobbs Field. Oxy notes that the Specified Period will be shorter than the period of production from the Hobbs Field. This is in part because the purchase of new CO_2 for injection is projected to taper off significantly before production ceases at Hobbs Field, which is modeled through 2100. At the conclusion of the Specified Period, Oxy will submit a request for discontinuation of reporting when Oxy can provide a demonstration that the cumulative mass of CO_2 reported as sequestered during the Specified Period is not expected to migrate in the future in a manner likely to result in surface leakage. Oxy expects that it would be able to make this demonstration 2-3 years after injection for the Specified Period ceases based upon predictive modeling supported by monitoring data.

The description of the project is determined to be reasonable and provided information to comply with 40 CFR 98.448(a)(6). Under 40 CFR 98.448(a)(6), information regarding the Underground Injection Control (UIC) well permit class for each injection well and well identification numbers must be provided. The MRV Plan notes that the injection wells are permitted as UIC Class II and Oxy provided a table of well identification numbers in Appendix 5 of the Plan.

Under 40 CFR 98.448(a)(7), the proposed date to begin collecting data for calculating the total amount of CO_2 sequestered must be provided. In Section 8 of the MRV Plan, Oxy states that it "… is anticipated that this MRV Plan will be implemented by April 1, 2017 or within 90 days of EPA approval, whichever occurs later." As described later in this technical review, the strategy for detecting and quantifying surface leakage of CO_2 and for establishing expected baselines for monitoring would be established by this time.

The proposed time frame when the facility would cease reporting under Subpart RR is determined to comply with 40 CFR 98.441(b). 40 CFR 98.441(b)(1) states that "the owner or operator of a facility may submit a request to discontinue reporting any time after the well or group of wells is plugged and abandoned in accordance with applicable requirements". Because the word "may" is used in the regulation, Oxy is allowed to submit a request prior to the wells being plugged and abandoned. 40 CFR 98.441(b)(2)(ii) specifies the content of a request to discontinue reporting for UIC Class II wells. The request must contain "a demonstration that current monitoring and model(s) show that the injected CO_2 stream is not expected to migrate in the future in a manner likely to result in surface leakage". This is consistent with what Oxy is proposing to include in its cease reporting request in Section 8 of the MRV Plan.

2 Evaluation of the Delineation of the Maximum Monitoring Area (MMA) and Active Monitoring Area (AMA)

As part of the MRV Plan, the reporter must identify the maximum monitoring area (MMA) and active monitoring area (AMA), pursuant to 40 CFR 98.448(a)(1). Subpart RR defines MMA as "the area that must be monitored under this regulation and is defined as equal to or greater than the area expected to contain the free phase CO_2 plume until the CO_2 plume has stabilized plus an all-around buffer zone of at least one-half mile." Subpart RR defines AMA as "the area that will be monitored over a specific time interval from the first year of the period (n) to the last year in the period (t). The boundary of the AMA is established by superimposing two areas: (1) The area projected to contain the free phase CO_2 plume at the end of year t, plus an all-around buffer zone of one-half mile or greater if known leakage pathways extend laterally more than one-half mile; (2) The area projected to contain the free phase CO_2 plume at the end of year t + 5." See 40 CFR 98.449.

Oxy has defined the MMA as the boundary of the Hobbs Field plus a 0.5-mile-radius buffer and the AMA as the boundary of the Hobbs Field. As stated in the MRV Plan, factors considered included: the extent of free-phase CO_2 currently in the Hobbs Field; the operational strategies used for fluid and pressure management; and the geologic structure of the unit. The MRV Plan states that the experience of operating and adapting the Hobbs Field CO_2 flood over the past decade has created a strong understanding of the reservoir and its capacity to store CO_2, and it is reasonable to consider the entire unit as the AMA for the entire monitoring period. In addition, given the geology of the area and operational practices in the field, it is reasonable to conclude that CO_2 will not travel vertically or laterally outside the unit.

The MRV Plan includes a description of the pattern-level modeling conducted for reservoir management and planning at the site. In addition to monitoring described in the plan, simulation models representing either a multi-pattern segment of the field, or a portion of a single pattern, will be used to identify any leaks. The production and injection performance of each pattern will be monitored and compared to predicted or simulated behavior, and those patterns where performance deviates in a statistically significant manner from the predicted behavior will be identified. Predictions will also be constructed and validated from the actual performance data of analog projects that already have received significant CO_2 injection. The MRV Plan states that "If actual performance differs in a noticeable way from predictions, reservoir engineers will use professional judgment formed by an analysis of technical data to determine where further attention is needed." The use of simulation models coupled with actual performance data for purposes of reservoir characterization is determined to be reasonable.

The delineation of the MMA and AMA is determined to be in compliance with 40 CFR 98.448(a)(1). The MMA and AMA described in the MRV Plan are clearly and explicitly delineated and, respectively, cover the maximum monitoring area and active monitoring area that is defined in 98.449.

3 Identification of Potential Surface Leakage Pathways

As part of the MRV Plan, the reporter must identify potential surface leakage pathways for CO_2 in the maximum monitoring area and the likelihood, magnitude, and timing of surface leakage of CO_2 through these pathways pursuant to 40 CFR 98.448(a)(2). Oxy has identified the following possible leakage pathways in their MRV Plan:

- Existing wellbores;
- Previous operations;
- Drilling through the CO_2 area;
- Faults and fractures;
- Natural or induced seismic activity;
- Pipeline/surface equipment;
- Lateral migration outside of the Hobbs field; and
- Diffuse leakage through the seal.

Existing Wellbores, Previous Operations, and Drilling Through the CO_2 Area

The MRV Plan indicates that there are 701 completed wells, including active, shut-in, and temporarily and permanently abandoned wells completed in the Hobbs Field. As of August 2016, there are 445 active wells operated by Oxy in the Hobbs Field – with 210 injection wells and 235 production wells. In addition, there are approximately 256 wells not in use (i.e., shut-in, temporarily abandoned, or plugged and abandoned).

The MRV Plan provides tabulations of the wells based on their "age/completion" as follows: completed after 1980; drilled in 1946-1979 (with production casing that extent below the point of the producible oil/water contact); and drilled and completed in the 1930's (using heavy casing). Approximately 64% of the Hobbs Field wells are listed as active, approximately 3% are reported as shut-in, approximately 19% have been plugged and abandoned, and approximately 14% are temporarily abandoned.

The MRV Plan states that all wells, including both injection and production wells, are regulated by the New Mexico Oil Conservation Division (NMOCD) under New Mexico Administrative Code (NMAC) Title 9 Chapter 15 Parts 1-39. Oxy notes that The injection wells are subject to additional requirements promulgated by EPA – the UIC Class II program – implementation of which has been delegated to the NMOCD. The MRV Plan provides a summary of the regulations in Appendix 6 to the plan.

According to the MRV Plan, both water and CO_2 have been successfully injected in the Hobbs Field since 1976, with Oxy initiating CO_2 flooding in the Hobbs Field in 2003. The MRV Plan states that Oxy and the prior operators have kept detailed records and have completed numerous infill wells. The MRV Plan further states that Oxy's standard practice for drilling new wells includes a rigorous review of nearby wells to ensure that drilling will not cause damage to or interfere with existing wells. Oxy also follows AoR requirements under the UIC Class II program, which require identification of all active and abandoned wells in the AOR and implementation of procedures that ensure the integrity of those wells when applying for a permit for any new injection well. Oxy states that they have checked for the presence of old, unknown wells throughout the Hobbs Field over many years. These practices ensure that identified wells are sufficiently isolated and do not interfere with the CO_2 EOR operations and reservoir pressure management. Oxy indicated that their operational experience supports the conclusion that there are no unknown wells within the Hobbs Field and that it has sufficiently mitigated the risk of migration from older wells. Oxy has successfully optimized CO_2 flooding with infill wells because the confining zone has not been impaired by previous operations.

Faults and Fractures

The MRV Plan indicates a very low probability of leakage through subsurface features, such as faults and fractures, due to a lack of faults transecting the Basal Grayburg – San Andres reservoir in the project area. Oxy describes several methods it used to determine whether faults and fractures exist and the likelihood of their leading to leaks of CO_2 out of the injection zone. One piece of evidence cited in Section 2.2.1 describes how faults have been identified, using seismic surveys, in formations that are thousands of feet below the San Andres formation, but this faulting has been shown not to affect the San Andres or to have created potential leakage pathways. Another line of evidence is the accumulation of oil and gas in the Hobbs Field is consistent with the presence of a competent caprock and a lack of transmissive faults or fractures. A third line of evidence is the site operating history, which Oxy states shows no indication of interaction of water or CO_2 with existing or new faults or fractures. The weight of evidence, including north-south and west east seismic surveys, is consistent with a lack of faults and fractures that could compromise containment.

The accumulation of gas supports the concept of a competent caprock without pre-existing transmissive features under original reservoir conditions. Oxy has stated that reservoir pressure in the Hobbs Field is managed by maintaining an injection-to-withdrawal ratio (IWR) of 1.0. IWR is the ratio of the volume of fluids injected to the volume of fluids (oil, water, and CO_2) produced. Oxy plans to maintain the IWR by monitoring fluid injection and ensuring that the reservoir pressure does not reach a level that would fracture the reservoir seal. Oxy notes the use of shutoff controls if fracture pressures are exceeded. Oxy also states in Section 2.2.1 of the MRV Plan that there was no evidence of CO_2 and water interaction with existing or new faults or fractures, and if there was, it would lead to anomalies from expected performance which would lead to an investigation, such as injection profile surveys and pressure measurements to identify the cause.

Natural and Induced Seismic Activity

In Section 4.4 of the MRV Plan, Oxy indicates that the likelihood of leakage from either a natural or induced seismic event is small. Oxy notes that of the recorded earthquakes in the Permian Basin, none have occurred in the Hobbs Field; the closest was nearly 80 miles away. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity. Assuming that the future operating and pressure conditions in the Hobbs Field will be similar to what they have been over the last few decades, and Oxy's prior determination that there are no faults near the project site, leakage potential due to seismic activity would be expected to be minimal. Furthermore, if a seismic event were to cause subsurface leakage through the confining zone or at or around a well, Oxy's monitoring provisions (e.g., reservoir pressure, well pressure, and pattern monitoring) should detect this leak as well.

Pipeline/Surface Equipment

Oxy states that the current design and construction practices at the site, along with compliance with existing laws, will reduce the risk of unplanned leakage from surface facilities and therefore make the likelihood of a leak small. Frequent routine visual inspection of surface facilities by Field staff will provide an additional way to detect leaks and further support Oxy's efforts to detect and remedy any leaks in a timely manner. Should leakage be detected from pipeline or surface equipment, the volume of released CO_2 will be quantified following the requirements of 40 CFR Part 98, Subpart W.

Lateral Migration Outside of the Hobbs Field

Oxy indicates that the likelihood of lateral migration is small. In Section 4.7 of the MRV Plan, Oxy states that the Hobbs Field is situated above the highest elevation within the San Andres. This means that over long periods of time, injected CO_2 will tend to rise vertically towards the Upper San Andres and Basal Grayburg and continue towards the point in the Hobbs Field with the highest elevation. Second, the planned injection volumes and active fluid management during injection operations will prevent CO_2 from migrating laterally out of the structure. Finally, Oxy will not be increasing the total volume of fluids in the Hobbs Field. Based on site characterization and planned and projected operations Oxy estimates the total volume of stored CO_2 will be approximately 27.6% of calculated capacity.

Diffuse Leakage Through the Seal

Oxy discusses diffuse leakage through the seal, concluding it is highly unlikely based upon: (1) the trapping of a gas cap over millions of years; (2) the injection pattern monitoring program, which will ensure that no breach of the seal will be created; (3) the impermeability of the seal; (4) the fact that wells are cemented across this horizon; (5) that changes in injection pressure would trigger an investigation into the cause; and (6) the presence of secondary confining zones above the primary confining zone. Collectively, these general concepts support a demonstration of low risk of leakage through the confining zone.

Summary of Findings

The MRV Plan is determined to be in compliance with 40 CFR 98.448(a)(2). The regulation requires that potential surface leakage pathways for CO_2 be identified, as well as the likelihood, magnitude, and timing of surface leakage of CO_2 through these pathways. The MRV Plan identifies, describes and reviews potential pathways for surface leakage, including the likelihood, magnitude, and timing of potential leakage. For example, in examining existing well bores as a potential leakage pathway, Oxy identified active and inactive wells that are completed in or penetrate the Hobbs Field; summarizes regulatory requirements for the wells, and describes operational practices for mitigating potential risks. As another example, Oxy examined the probability of leakage through subsurface features, such as faults and fractures, and determined that there were no faults or fractures that transect the San Andres Formation interval in the project area and provided several lines of evidence supporting this conclusion. Oxy determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere.

4 Strategy for Detecting and Quantifying Surface Leakage of CO_2 and for Establishing Expected Baselines for Monitoring

Oxy's strategy for detecting and verifying potential subsurface leakage primarily includes pressure monitoring of injection wells, well maintenance, monitoring of production well performance, and field inspections (visual inspections and H_2S detection by Oxy staff). The MRV Plan describes Oxy's approach to these activities in Sections 4, 5 and 6 of the MRV Plan and summarizes them in Table 3 of the MRV Plan, reproduced below.

Risk	Monitoring Plan	Response Plan	Parallel Reporting (if any)
Loss of Well Control			
Tubing Leak	Monitor changes in annulus pressure; MIT for injectors	Workover crews respond within days	NMOCD
Casing Leak	Routine Field inspection; MIT for injectors; extra attention to high risk wells	Workover crews respond within days	NMOCD
Wellhead Leak	Routine Field inspection	Workover crews respond within days	NMOCD
Loss of Bottom-hole pressure control	Blowout during well operations	Maintain well kill procedures	NMOCD
Unplanned wells drilled through San Andres	Routine Field inspection to prevent unapproved drilling; compliance with NMOCD permitting for planned wells.	Assure compliance with NMOCD regulations	NMOCD Permitting
Loss of seal in abandoned wells	Reservoir pressure in WAG headers; high pressure found in new wells	Re-enter and reseal abandoned wells	NMOCD
Leaks in Surface Facilities			
Pumps, values, etc.	Routine Field inspection	Workover crews respond within days	Subpart W
Subsurface Leaks			
Leakage along faults	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near faults	-
Overfill beyond spill points	Reservoir pressure in WAG headers; high pressure found in new wells	Fluid management along lease lines	-
Leakage through induced fractures	Reservoir pressure in WAG headers; high pressure found in new wells	Comply with rules for keeping pressures below parting pressure	-
Leakage due to seismic event	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near seismic event	-

Based on this detection strategy, if results of the monitoring activities fall outside their normal predicted ranges, Oxy will initiate an investigation to determine if a leak has occurred. Triggers provided in the MRV Plan for leakage investigation include pressure deviation in injection wells, deviations in production levels, triggering of personal H_2S monitors, and visual siting of clouds of ice crystals surrounding a leak.

Pressure monitoring of injection wells, along with the historical operational and monitoring data determining the baseline, is an established way to detect leaks in the injection wells. It may also be able to detect leaks through producing or abandoned wells or faults by comparing the monitoring results to modeled predictions. Oxy monitors wells through continual, automated pressure monitoring in the injection zone, monitoring of the annular pressure in wellheads, and routine maintenance and inspection. Leaks from wellbores would be detected through the follow-up investigation of pressure anomalies, visual inspection, or the use of personal H_2S monitors. Anomalies in annular pressure or other issues detected during routine maintenance inspections would be treated in the same way. Field personnel would inspect the equipment in question and determine the nature of the problem. For simple matters the repair would be made at the time of inspection and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repairs were needed, a work order would be generated and Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting. Mechanical Integrity Tests (MITs) are also an established way to detect leaks along wellbores. Oxy states that all active injection wells undergo mechanical integrity testing every 2 years. Section 2.3.2 of the MRV Plan describes the test types and frequency for injection wells.

Visual sighting of clouds of ice crystals is a good way to detect leaks of pressurized supercritical CO_2 provided the observer is in place to notice the cloud when the leak occurs. Oxy notes that weekly field inspections take place. For visual inspections, the baseline would be normal visual conditions, namely the lack of clouds of ice crystals. Oxy's strategy to detect surface leakage also relies on the triggering of personal H_2S monitors worn by the staff. Hobbs Field oil is indicated to contain small amounts of H_2S, therefore, it is assumed that any leakage of CO_2 would co-exist with some amount of this gas. Oxy states that currently the average composition of this gas mixture as it enters the RCF is 82-88% CO_2 and 9,000-10,000 ppm H_2S.

In Section 7.4 of the MRV Plan, Oxy discusses how the mass of CO_2 emitted at the surface will be quantified, using a combination of measurements, engineering estimates, and emission factors. To the extent possible, Oxy will use published emission factors, such as those included in Subpart W of the GHG Reporting Program, to quantify CO_2 volumes. If a leakage event were to occur, Oxy notes the detected emissions will be quantified using acceptable emission factors such as those found in 40 CFR Part 98 Subpart W or engineering estimates of leak amounts based on measurements in the subsurface, Oxy's field experience, and other factors such as the frequency of inspection. Details on this estimation approach are indicated in Sections 5.1 and 7.4 of the MRV Plan, and leaks will be documented, evaluated and addressed in a timely manner.

The MRV Plan is determined to be in compliance with 40 CFR 98.448(a)(3) and 40 CFR 98.448(a)(4). 40 CFR 98.448(a)(3) requires that an MRV Plan contain a strategy for detecting and quantifying any surface leakage of CO_2 and 40 CFR 98.448(a)(4) requires that an MRV Plan include a strategy for establishing the expected baselines for monitoring CO_2 surface leakage. Oxy's MRV Plan describes a strategy for detecting and quantifying any surface leakage of CO_2 based on the identification of potential leakage risks. As described above, Oxy specifies monitoring methods and frequencies to detect potential leakage for various identified potential risks, describes how potential leakage would be quantified, and articulates baselines associated with the monitoring strategy. As noted above, Oxy has determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere.

5 Considerations Used to Calculate Site-Specific Variables for the Mass Balance Equation

A reporter who is actively producing oil or natural gas is required to calculate the amount of CO_2 sequestered using equation RR-11 per 40 CFR 98.443(f)(1). The equation is:

$$CO_2 = CO_{2I} - CO_{2P} - CO_{2E} - CO_{2FI} - CO_{2FP}$$

Where:

CO_2 is the total annual CO_2 mass sequestered in subsurface geologic formations (metric tons) at the facility in the reporting year.

CO_{2I} is the total annual CO_2 mass injected (metric tons) in the well or group of wells covered by this source category in the reporting year.

CO_{2P} is the total annual CO_2 mass produced (metric tons) net CO_2 entrained in oil in the reporting year.

CO_{2E} is the total annual CO_2 mass emitted (metric tons) by surface leakage in the reporting year.

CO_{2FI} is the total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead, for which a calculation procedure is provided in subpart W of this part.

CO_{2FP} is the total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity, for which a calculation procedure is provided in subpart W of this part.

Oxy explains its approach to calculating each of these variables in Sections 5 and 7 of the MRV Plan.

Calculation of Total Annual Mass Injected

The MRV Plan states that Oxy will use the equation for calculating the Mass of CO_2 Injected into the Subsurface at the Hobbs Field which is equal to the sum of the Mass of CO_2 Received as calculated in RR-3 of 98.443 (as described in Section 7.1) and the Mass of CO_2 Recycled as calculated using measurements taken from the flow meter located at the output of the RCF. Oxy explains in the MRV Plan that using data at each injection well would give an inaccurate estimate of total injection volume due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

Knowing the concentration of CO_2 in the injected stream is necessary to determine the mass of CO_2 injected, Oxy measures the volume of received CO_2 using commercial custody transfer meters at each the two off-take points from the Permian pipeline delivery system and at the point of transfer between the NHU and the SHU. Oxy notes that CO_2 composition is governed by the contract and the gas is routinely sampled to determine composition. Oxy also notes that injected CO_2 will be calculated using the flow meter volumes at the operations meter at the outlet of the RCFs and the custody transfer meter at the CO_2 off-take points from the Permian pipeline delivery system.

Calculation of Total Annual Mass Produced

Oxy states that the mass of CO_2 produced at the Hobbs Field will be calculated using the measurements from the flow meters at the inlet to RCF and the custody transfer meter for oil sales rather than the metered data from each production well. Oxy will use Equation RR-8 from 40 CFR 98.443 to calculate the total mass of CO_2 produced from the unit, and Equation RR-9 from 40 CFR 98.443 to calculate the mass of CO_2 produced, net of the mass of CO_2 entrained in oil leaving the Hobbs Field prior to treatment of the remaining gas fraction at the RCF. The concentration of CO_2 in produced oil or other fluid wells is measured at the flow meter directly downstream of each separator that sends a stream of gas into a recycle or end use system. The CO_2 flow rate for recycled CO_2 is measured at the flow meter located at the RCF outlet.

Consistent with Subpart RR requirements, Oxy will convert meter volumes from measured conditions to standard temperature and pressure using the Span and Wagner equation of state and the NIST database of thermodynamic properties. The volume of CO_2 in produced oil will be calculated by measuring the concentration of CO_2 in the oil and multiplying by the volume of oil measured at the custody meter for sales.

Oxy's standard production well test process assesses the composition of all produced fluids and production well performance is monitored using the production well test process conducted when produced fluids are gathered and sent to a satellite battery. Oxy implements a routine cycle for each satellite battery, with each well being tested approximately once every two months. During this cycle, each production well is diverted to the well test equipment for a period of time sufficient to measure and sample produced fluids (generally 8-12 hours). This test allows Oxy to allocate a portion of the produced fluids measured at the satellite battery to each production well, assess the composition of produced fluids by location, and assess the performance of each well. Oxy collects flow, pressure, and gas composition data from the Hobbs Field. Oxy states that metering protocols used by Oxy follow the prevailing industry standard(s) for custody transfer as currently promulgated by American Petroleum Institute (API), the American Gas Association (AGA), and the Gas Processors Association (GPA), as appropriate. This approach is consistent with EPA GHGRP's Subpart RR, section 98.444(e)(3).

Calculation of Total Annual Mass Emitted as Equipment Leakage or Vented Emissions

Subpart RR allows Subpart W methods to be used to calculate leaks from equipment between meters used to measure CO_2 injected and produced and the wellheads (i.e., equipment leaks that take place while the CO_2 is being measured, processed, or transported at the surface). Oxy's method for calculating total annual mass emitted from equipment and pipelines is consistent with the applicable requirements for equipment leakage under Subpart RR.

According to Oxy, there are approximately 701 wells in the unit. Of these, approximately 210 wells are injection wells. Currently, Oxy has 10 injection manifolds and each injection well is connected to a WAG header/manifold located at the satellite. Purchased CO_2 and recycled CO_2 from the CO_2 Recycle and Compression Facility (RCF) is sent through the main CO_2 distribution system to various CO_2 injectors throughout the Field. Produced fluids gathered from the production wells are sent to satellite batteries for separation into a gas/CO_2 mix and a produced fluids mix of water, oil, gas, and CO_2. The produced fluids mix is sent to centralized tank batteries where oil is separated for sale into a pipeline, water is recovered for reuse, and the remaining gas/CO_2 mix is merged with the output from the satellite batteries.

In Section 4.6 of the MRV Plan, Oxy notes that the current design and construction practices at the site, along with compliance with existing laws, will reduce the risk of unplanned leakage from surface facilities and therefore make likelihood of a leak small. Oxy also plans to conduct visual and areal inspections for indicators of leakage (white clouds and ice).

The strategy presented in the MRV Plan for detection and verification of any potential equipment leaks includes the use of Subpart W methods for determining equipment leaks, and also incident investigations triggered by visual inspections and/or use of H_2S meters by Oxy staff. Oxy also collects flow, pressure, and gas composition data from the Hobbs Field. Oxy uses reservoir simulation modeling, based on extensive history-matched data, to develop injection plans (fluid rate, pressure, volume) that are programmed into each WAG satellite. If injection pressure or rate measurements are beyond the specified set points determined as part of each pattern injection plan, a data flag is automatically triggered and field personnel will investigate and resolve the problem. Oxy will rely on Subpart W methods to determine leakage and vented emissions from surface equipment between the meter and the injection well.

Consistent with the Subpart RR requirements, Oxy will meet the requirement to account for leaks and vented emissions from equipment between the meters and wellheads using methods from Subpart W. Oxy plans on using the methods listed in Subpart W for QA/QC of equipment leaks and venting. The use of Subpart W methods is appropriate.

Calculation of Total Annual Mass Emitted by Surface Leakage

For reporting of the total annual CO_2 mass sequestered under Subpart RR, potential surface leaks must be accounted for in the mass balance equation. Pursuant to 40 CFR 98.448(a)(2), an MRV Plan must describe the likelihood, magnitude, and timing of surface leakage of CO_2 through potential pathways. Subpart RR also requires that the MRV Plan identify a strategy for establishing a baseline for monitoring CO_2 surface leakage, pursuant to 40 CFR 98.448(a)(4).

Oxy's strategy for calculating the total annual mass of CO_2 emitted by surface leakage was assessed and summarized in the previous section of this document and is determined to be in compliance with Subpart RR.

Summary of Findings

The MRV Plan is determined to be in compliance with 40 CFR 98.448(a)(5). 40 CFR 98.448(a)(5) requires that an MRV Plan include a summary of the considerations that the facility intends to use to calculate site-specific variables for the mass balance equation. This includes, but is not limited to, considerations for calculating CO_2 emissions from equipment leaks and vented emissions of CO_2 between the injection flow meter and injection well and/or the production flow meter and production well, and considerations for calculating CO_2 in produced fluids. The MRV Plan summarizes and describes considerations related to site-specific variables for the mass balance equation, including as related to calculation of total annual mass injected, calculation of total annual mass produced, and calculation of total annual mass emitted as equipment leakage or vented emissions. The MRV Plan also describes how total annual mass emitted by surface leakage would be calculated.

6 Summary of Findings

The Subpart RR MRV Plan for the Hobbs Field meets the requirements of 40 CFR 98.238. The regulatory provisions of 40 CFR 98.238(a), which specifies the requirements for MRV plans, are summarized below, along with a summary of relevant provisions in Oxy's MRV Plan.

Subpart RR MRV Plan Requirement	Oxy MRV Plan
40 CFR 98.448(a)(1): Delineation of the maximum monitoring area (MMA) and the active monitoring areas (AMA).	Section 3 of the MRV Plan describes the MMA and AMA. The MMA is delineated as the boundary of the Hobbs Field plus a 0.5-mile-radius buffer and the AMA is the boundary of the Hobbs Field. The monitoring area delineation takes into account site characterization and reservoir modeling along with pressure management considerations.

40 CFR 98.448(a)(2): Identification of potential surface leakage pathways for CO_2 in the MMA and the likelihood, magnitude, and timing, of surface leakage of CO_2 through these pathways.	Section 4 of the MRV Plan identifies and evaluates potential surface leakage pathways. The MRV Plan identifies the following potential pathways: existing wellbores, previous operations, and drilling through the CO_2 area; faults and fractures; natural or induced seismic activity; pipeline/surface equipment; lateral migration outside of the unit; and diffuse leakage through the seal. The MRV Plan analyzes the likelihood, magnitude, and timing of surface leakage through these pathways. Oxy determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere.
40 CFR 98.448(a)(3): A strategy for detecting and quantifying any surface leakage of CO_2.	Section 4 of the MRV Plan describes how the facility would detect CO_2 leakage to the surface, such as monitoring of existing wells, field inspections, and pressure modeling and monitoring. The monitoring strategy is summarized in Table 3 of the MRV Plan. Section 4 of the MRV Plan also describes how surface leakage would be quantified.
40 CFR 98.448(a)(4): A strategy for establishing the expected baselines for monitoring CO_2 surface leakage.	Section 6 of the MRV Plan describes the baselines against which monitoring results will be compared to assess potential surface leakage.
40 CFR 98.448(a)(5): A summary of the considerations you intend to use to calculate site-specific variables for the mass balance equation.	Section 7 of the MRV Plan describes Oxy's approach to determining the amount of CO_2 sequestered using the Subpart RR mass balance equation, including as related to calculation of total annual mass injected, calculation of total annual mass produced, and calculation of total annual mass emitted as equipment leakage or vented emissions.
40 CFR 98.448(a)(6): For each injection well, report the well identification number used for the UIC permit (or the permit application) and the UIC permit class.	Appendix 5 provides well identification numbers for each well. The MRV Plan specifies that injection wells are permitted as UIC Class II.
40 CFR 98.448(a)(7): Proposed date to begin collecting data for calculating total amount sequestered according to equation RR-11 or RR-12 of this subpart.	The MRV Plan states that the MRV Plan will be implemented April 1, 2017 or within 90 days of EPA approval. Oxy anticipates that the MRV program will be in effect during the Specified Period

Appendix A: Final MRV Plan

Oxy Hobbs Field CO_2 Subpart RR Monitoring, Reporting and Verification (MRV) Plan

January 2017

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Roadmap to the Monitoring, Reporting and Verification (MRV) Plan

Occidental Permian Ltd. (OPL) operates the North Hobbs Grayburg San Andres Unit (North Hobbs Unit) and the South Hobbs Project Area (South Hobbs Unit), (collectively referred to as the Hobbs Field) in the Permian Basin for the primary purpose of enhanced oil recovery (EOR) using carbon dioxide (CO_2) flooding. OPL intends to inject CO_2 with a subsidiary purpose of establishing long-term containment of a measureable quantity of CO_2 in subsurface geological formations at the Hobbs Field for a term referred to as the "Specified Period." During the Specified Period, OPL will inject CO_2 that is purchased (fresh CO_2) from affiliates of Occidental Petroleum Corporation (OPC) or third parties, as well as CO_2 that is recovered (recycled CO_2) from the Hobbs Field CO_2 Recycle and Compression Facilities (RCFs). OPL, OPC and their affiliates (together, Oxy) have developed this monitoring, reporting, and verification (MRV) plan in accordance with 40 CFR §98.440-449 (Subpart RR) to provide for the monitoring, reporting and verification of the quantity of CO_2 sequestered at the Hobbs Field during the Specified Period.

In accordance with Subpart RR, flow meters are used to quantify the volume of CO_2 received, injected, produced, contained in products, and recycled. If leakage is detected, the volume of leaked CO_2 will be quantified using two approaches. First, Oxy follows the requirements in 40 CFR §98.230-238 (Subpart W) to quantify fugitive emissions, planned releases of CO_2, and other surface releases from equipment. Second, Oxy's risk-based monitoring program uses surveillance techniques in the subsurface and above ground to detect CO_2 leaks from potential subsurface leakage pathways. If a leak is identified, the volume of the release will be estimated. The CO_2 volume data, including CO_2 volume at different points in the injection and production process, equipment leaks, and surface leaks, will be used in the mass balance equations included in 40 CFR §98.440-449 (Subpart RR) to calculate the volume of CO_2 stored on an annual and cumulative basis.

This MRV plan contains eleven sections:

- Section 1 contains general facility information.
- Section 2 presents the project description. This section describes the planned injection volumes, the environmental setting of the Hobbs Field, the injection process, and reservoir modeling. It also illustrates that the Hobbs Field is well suited for secure storage of injected CO_2.
- Section 3 describes the monitoring area: the Hobbs Field in New Mexico.
- Section 4 presents the evaluation of potential pathways for CO_2 leakage to the surface. The assessment finds that the potential for leakage through pathways other than the man-made well bores and surface equipment is minimal.
- Section 5 describes Oxy's risk-based monitoring process. The monitoring process utilizes Oxy's reservoir management system to identify potential CO_2 leakage indicators in the subsurface. The monitoring process also utilizes visual inspection of surface facilities, personal H_2S monitors, and Oxy's Specialized Field Risk

Management (SFRM) program as applied to Hobbs Field. Oxy's MRV efforts will be primarily directed towards managing potential leaks through well bores and surface facilities.

- Section 6 describes the baselines against which monitoring results will be compared to assess whether changes indicate potential leaks.
- Section 7 describes Oxy's approach to determining the volume of CO_2 sequestered using the mass balance equations in 40 CFR §98.440-449, Subpart RR of the Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP). This section also describes the site-specific factors considered in this approach.
- Section 8 presents the schedule for implementing the MRV plan.
- Section 9 describes the quality assurance program to ensure data integrity.
- Section 10 describes Oxy's record retention program.
- Section 11 includes several Appendices.

1. Facility Information

i) Reporter number – TBD

ii) The Oil Conservation Division (NMOCD) of the New Mexico Energy, Mineral and Natural Resources Department (EMNRD) regulates all oil, gas and geothermal activity in New Mexico. All wells in the Hobbs Field (including production, injection and monitoring wells) are permitted by NMOCD through New Mexico Administrative Code (NMAC) Title 19 Chapter 15. Additionally, NMOCD has primacy to implement the Underground Injection Control (UIC) Class II program in the state for injection wells. All injection wells in the Hobbs Field are currently classified as UIC Class II wells.

iii) Wells in the Hobbs Field are identified by name, API number, status, and type. The list of wells as of August 2016 is included in Appendix 5. Any new wells will be indicated in the annual report.

2. Project Description

The Hobbs Field is comprised of the North Hobbs Unit (NHU) and the South Hobbs Unit (SHU). The two units abut each other, produce oil and gas from the same geologic formations and structure, and are under the sole operatorship of Oxy. The geology, facilities/equipment, and operational procedures are similar for both units in the Hobbs Field. Because of these similarities, one MRV Plan is being prepared for the two units in the Hobbs Field and any important differences between the units will be noted in the MRV plan. This section describes the planned injection volumes, environmental setting of the Hobbs Field, injection process, and reservoir modeling conducted.

2.1 Project Characteristics

Oxy developed a long-term performance forecast for the Hobbs Field using the reservoir modeling approaches described in Section 2.4. This forecast is included here to provide a "big picture" overview of the total amounts of CO_2 anticipated to be injected, produced, and stored in the Hobbs Field as a result of its current and planned CO_2 EOR operations during the modeling period 2003-2100. This forecast is based on historic and predicted data. Figure 1 shows the actual (historic) CO_2 injection, production, and stored volumes in the Hobbs Field for the period 2003, when Oxy initiated CO_2 flooding, through 2016 (solid line) and the forecast for 2017 through 2100 (dotted line). The forecast is based on results from reservoir and recovery process modeling that Oxy uses to develop injection plans for each injection pattern, which is also described in Section 2.4. It is important to note that this is just a forecast; actual storage data will be collected, assessed, and reported as indicated in Sections 5, 6, and 7 in this MRV Plan. The forecast does illustrate, however, the large potential storage capacity at Hobbs field.

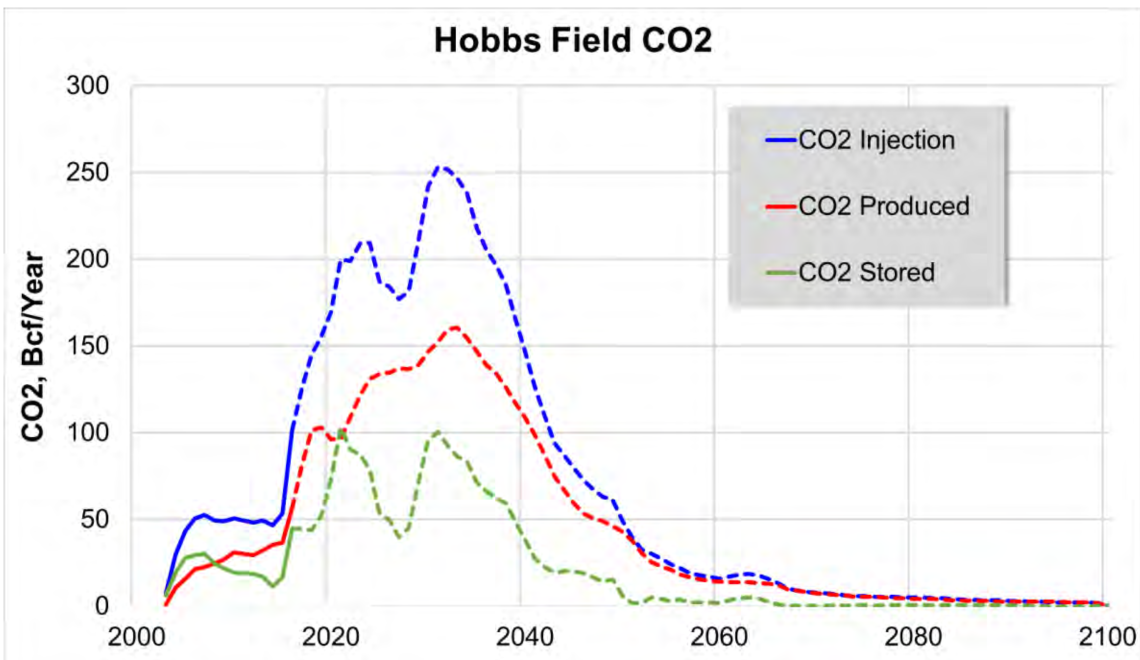


Figure 1 – Hobbs Field Historic and Forecast CO_2 Injection, Production, and Storage 2003-2100

Oxy adjusts the volume of CO_2 purchased to maintain reservoir pressure and to increase recovery of oil by extending or expanding the CO_2 flood. The volume of CO_2 purchased is the volume needed to balance the fluids removed from the reservoir and provide the solvency required to increase oil recovery. The model output shows CO_2 injection, production, and storage through 2100. However, this data is for planning purposes only and may not represent the actual operational life of the Hobbs Field. Oxy has injected

579 Bscf of CO_2 (31.3 million metric tonnes (MMMT)) into the Hobbs Field as of the end of 2015. Of that amount, 318 Bscf (17.2 MMMT) was produced and 261 Bscf (14.1 MMMT) was stored.

Although exact storage volumes will be calculated using the mass balance equations described in Section 7, Oxy forecasts that the total volume of CO_2 stored over the modeled injection period to be 2,197 Bscf (118.8 MMMT), which represents approximately 27.6% of the theoretical storage capacity of the Hobbs Field. For accounting purposes, the amount stored is the difference between the amount injected (including purchased and recycled CO_2) and the total of the amount produced less any CO_2 that: i) leaks to the surface, ii) is released through surface equipment leakage or malfunction, or iii) is entrained or dissolved in produced oil, as described in Section 7.

Figure 2 presents the cumulative annual forecasted volume of CO_2 stored by decade through 2100, the modeling period for the projection in Figure 1. The cumulative amount stored is equal to the sum of the annual storage volume for each year in the current decade plus the sum of the total of the annual storage volume for each year in the previous decade. The first decade reflects operations from 2003-2009, the second decade reflects the first decade plus estimated storage volume from 2010-2015 and projected storage for 2016-2019. The remaining decades reflect the prior storage plus projected cumulative storage for that decade. As is typical with CO_2 EOR operations, the rate of accumulation of stored CO_2 tapers over time as more recycled CO_2 is used for injection. Figure 2 illustrates the total cumulative storage over the modeling period, projected to be 2,197 Bscf (118.8 MMMT) of CO_2. This forecast illustrates the projected volume of subsidiary storage during the modeling period; the actual amounts stored during the Specified Period of reporting will be calculated as described in Section 7 of this MRV plan.

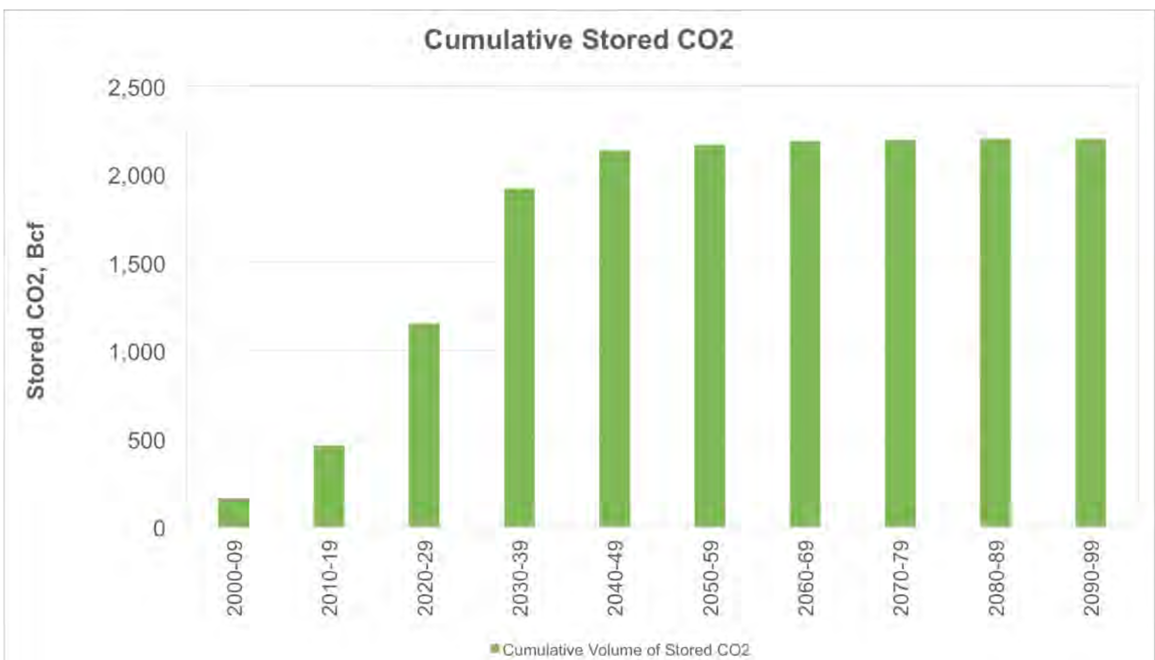


Figure 2 – Hobbs Field CO_2 Storage Forecasted by Decade During the Modeling Period 2003-2100

2.2 Environmental Setting

The project site for this MRV plan is the Hobbs Field, located in the Permian Basin in New Mexico.

2.2.1 Geology of the Hobbs Field

The Hobbs Field produces oil primarily from the San Andres formation. Some oil is also produced from the Basal Grayburg (lowest layer of the Grayburg formation), which lies directly above the San Andres (see Fig. 4). For convenience, the Basal Grayburg and San Andres formations will be referred to as "the reservoir" in this document. The productive interval, or reservoir, is composed of layers of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. This depository created a wide sedimentary basin, called the Permian Basin, which extends across the southeastern part of New Mexico and the western part of Texas. In the Permian Era, this part of the central United States was under water.

The Hobbs Field was discovered in 1928. It is located in east-central Lea County, in southeastern New Mexico (See Figure 3), on the northwestern margin of the Central Basin Platform. The Field is approximately two miles west of the Texas state line and one hundred miles northwest of Midland, as indicated by the red dot in Figure 3.

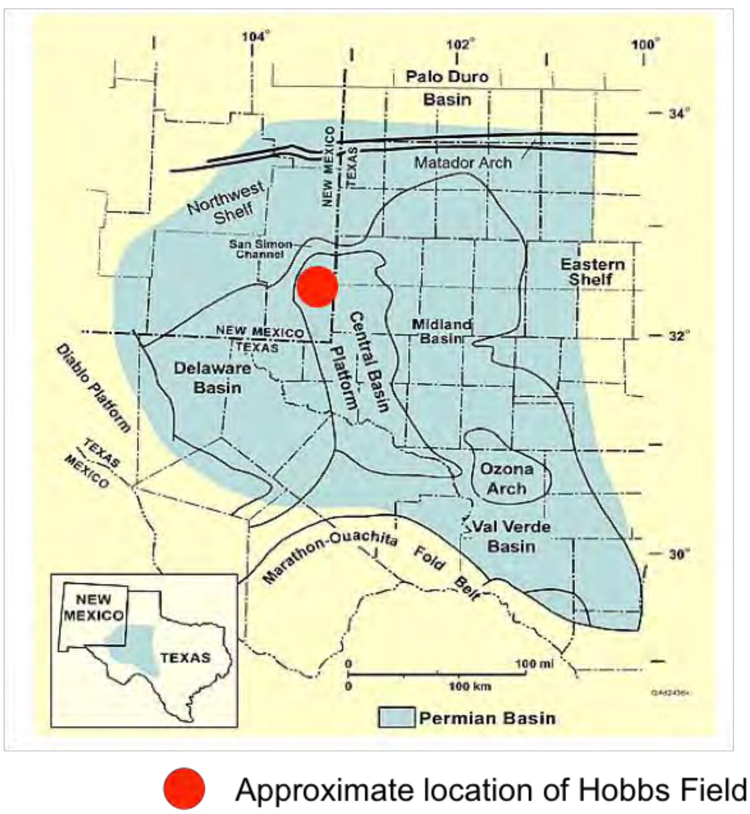


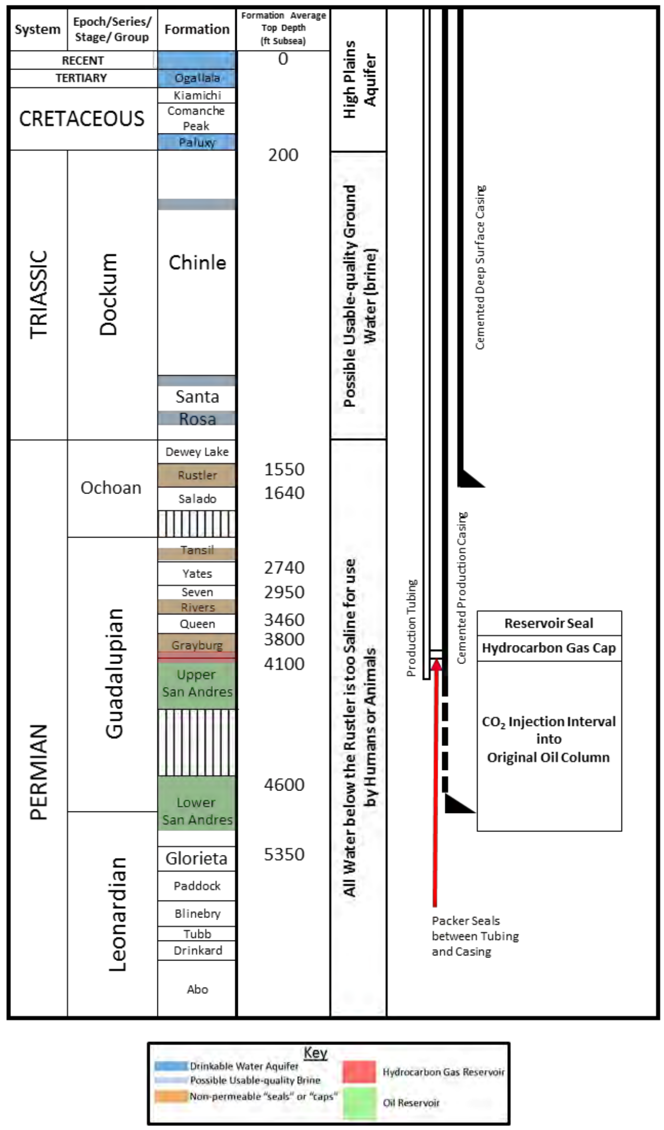
Figure 3 – Paleogeographic map of the Permian Basin showing approximate location of Hobbs Field.

With more than 1,000 million barrels (MMB) of Original Oil in Place (OOIP), the Hobbs Basal Grayburg-San Andres field is one of the largest in North America. During the millions of years following its deposition, the reservoir was buried under thick layers of impermeable rock, and finally uplifted to form the current landscape. The process of burial and uplifting produced some unevenness in the geologic layers. Originally flatlying, there are now some variations in elevation across the Permian Basin that form structural "highs," relatively higher subsurface elevations such as Hobbs Field, where oil and gas have accumulated over the ensuing millions of years.

As indicated in Figure 4, the Basal Grayburg and San Andres formations now lie beneath approximately 4,000 feet of overlying sediments. There are a number of sections above the reservoir that are impermeable and serve as reliable barriers to prevent fluids from moving upwards towards the surface. These barriers are referred to as seals because they effectively seal fluids into the formations beneath them. In the Hobbs Field, the top seal is made up of the anhydrite, shale, and impermeable silty dolomite rock layers that comprise the upper Grayburg. Above this, lie several intervals of impermeable rock layers of various thicknesses: the Queen, Seven Rivers, Tansil, Yates, and Rustler formations. These formations are highlighted orange on the stratigraphic column in Figure 4.

Between the surface and about 1,500 feet in depth there are intervals that contain underground sources of drinking water (USDW). These include the Ogallala and Paluxy aquifers, identified in blue in Figure 4. In addition, other potentially useful brine intervals (each having a higher dissolved solids content) are identified in light blue. NMOCD regulations require that all wells drilled through these intervals be cased and cemented to prevent the movement of formation or injected fluid from the injection zone into another zone or to the surface around the outside of a casing string (NMAC 19.15.26.9).

Figure 4 – Generalized Stratigraphic Section at Hobbs Field



Stratigraphic column has been adapted for Hobbs Field, and is modified from Katz *et al*, 1994 and Burke *et al*, 1960. Formation tops depths are observed field averages from Hobbs well log data.

There are no known faults or fractures affecting the Hobbs Field that provide a potential upward pathway for fluid flow. Oxy has confirmed this conclusion in multiple ways. First and foremost, the presence of oil, especially oil that has a gas cap, is indicative of a good quality natural seal. Oil and, to an even greater extent, gas, tend to migrate upward over time because both are less dense than the brine found in rock formations. Places where oil and gas remain trapped in the deep subsurface over millions of years, as is the case in the Hobbs Field, provide positive proof that faults or fractures do not provide a pathway for upward migration out of the CO_2-flooding interval. The existence of such faults or fractures in the Hobbs Field would have provided a pathway for oil and gas to escape, and they are not found there today.

Second, in the course of developing the Field, seismic surveys have been conducted to characterize the formations and provide information for the reservoir models used to design injection patterns. These surveys show the existence of faulting present well below the San Andres formation but none that penetrate the flooding interval. Figure 5 shows a seismic section oriented north-south through the Hobbs Field. Faulting can be identified deeper in the section, but not at the San Andres level. The same is true in west-east-oriented section (shown in Figure 6). This lack of faulting in the shallower formations is consistent with the presence of oil and gas in the San Andres formation at the time of discovery.

Figure 5 – North-South Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.

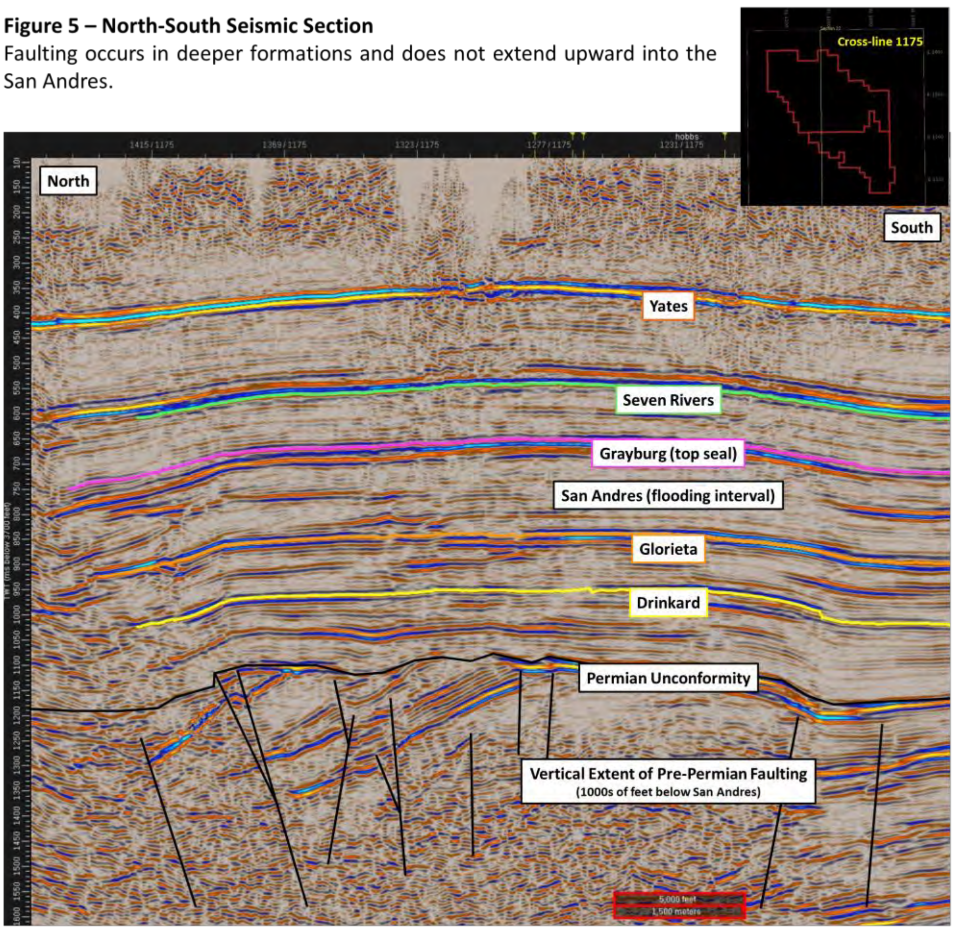
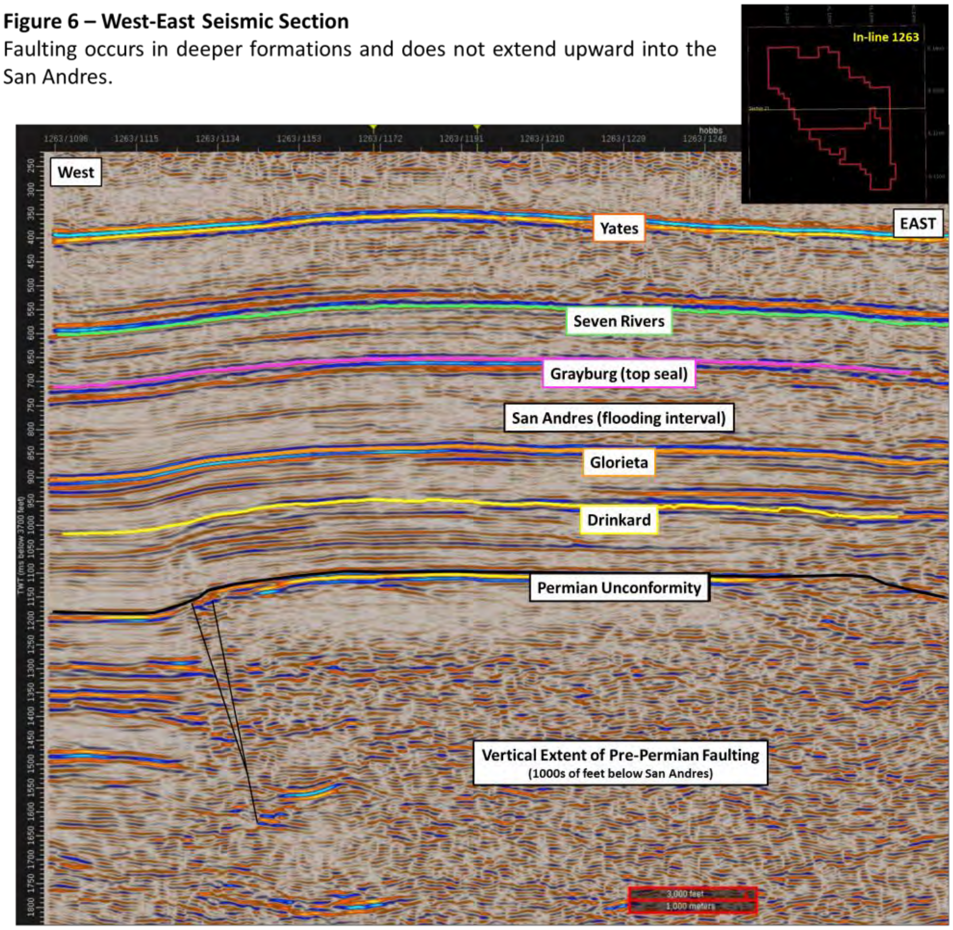


Figure 6 – West-East Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.



A west-to-east-oriented seismic section (Figure 6) shows the same relationship for faults that lie thousands of feet below the San Andres, and indicates that such faults do not provide pathways for fluids in the San Andres to migrate to the surface. This is discussed further in Section 4.3 in the review of potential leakage pathways for injected CO_2.

Lastly, the operating history at the Hobbs Field confirms that there are no faults or fractures penetrating the flood zone. Fluids, both water and CO_2, have been successfully injected in the Hobbs Field since 1976, and there is no evidence of any interaction with existing or new faults or fractures. In fact, it is the absence of faults and fractures in the Hobbs Field that make the reservoir such a strong candidate for CO_2 and water injection operations, and enable Field operators to maintain effective control over the injection and production processes.

Figure 4 shows a vertical snapshot of the geologic formations that lie beneath the Hobbs Field. Figure 7 provides an areal view of the four-way closure structure of the Field, showing the depth of the top of the San Andres formation. As indicated in the discussion of Figure 4, the upper portion of Grayburg formation is comprised of impermeable anhydrite and silty dolomite sections that serve as a seal. In effect, these sections form the hard ceiling of an upside down bowl or dome. Below this seal, the Basal Grayburg and San

Andres formations consists of permeable dolomites containing oil and gas. Figure 8 shows a two-dimensional picture of the structure of this formation.

The colors in the structure map in Figure 7 indicate changes in subsurface elevation, with red being higher, (i.e., the level closest to the surface) and magenta being lower (i.e., the level furthest below the surface). As indicated in Figure 7, both NHU and SHU are located at the highest elevation of a large, elongated domal structure that is comprised of the Grayburg and San Andres formations, within the Hobbs Field. The elevated area forms a natural trap for oil and gas that migrated from below over millions of years. Once trapped in these high points, the oil and gas has remained in place. In the case of the Hobbs Field, this oil and gas has been trapped in the reservoir for 50 to 100 million years. Over time, fluids, including CO_2, rise vertically until reaching the ceiling of the dome and then migrate to the highest elevation of the Hobbs Field structure. As a result, fluids injected into the Hobbs Field stay in the flooded reservoir and do not move to adjacent areas.

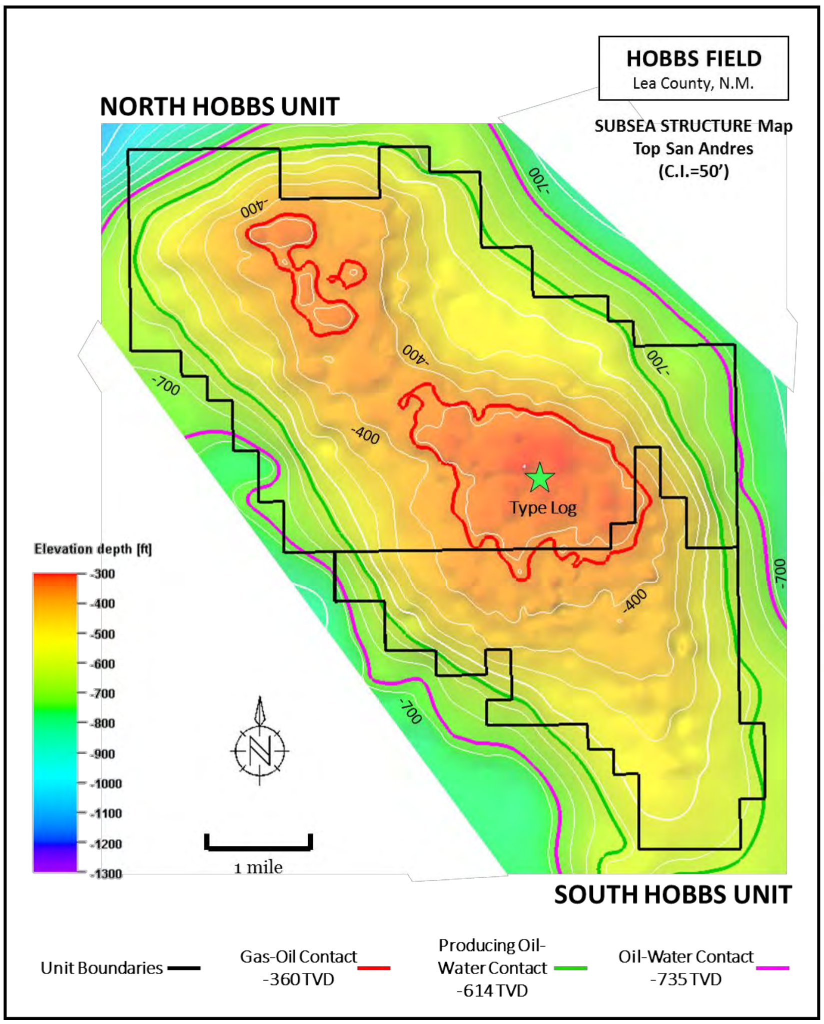


Figure 7 - Structure Map on the Top of San Andres Reservoir.

Buoyancy dominates where oil and gas are found in a reservoir. Gas, being lightest, rises to the top and water, being heavier, sinks to the bottom. Oil, being heavier than gas but lighter than water, lies in between. The cross section in Figure 8 shows saturation levels in the oil-bearing layers of the Hobbs Field and illustrates this principle.

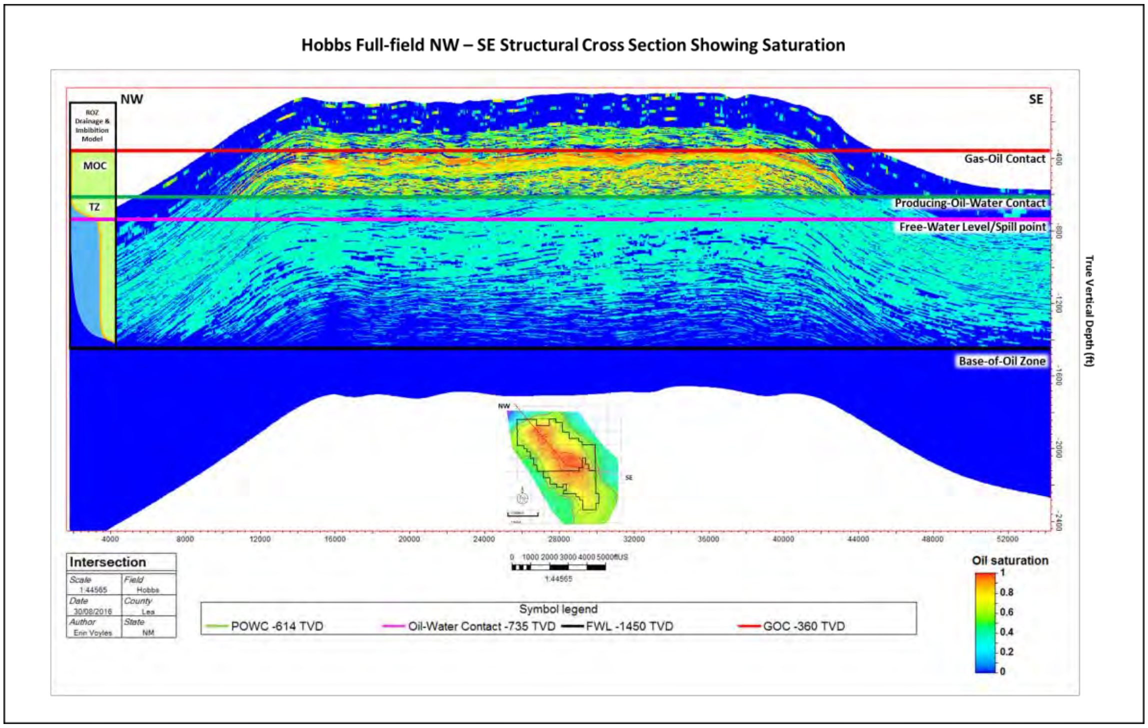


Figure 8 - Hobbs Field structural cross-section showing saturation distribution through Main Pay, Transition Zone, and Residual Oil Zone model.

At the time of its discovery, natural gas was trapped at the structural high points of the Hobbs Field, the area above the gas-oil contact (red line) in the cross section above. This interface is found approximately 4,000 feet below the surface (-360 ft subsea). Above the gas-oil interface is the volume known as the "gas cap." As discussed in Section 2.2.1, the presence of a gas cap is evidence of the effectiveness of the seal formed by the upper Grayburg. Gas is buoyant and highly mobile. If it could escape the Hobbs Field naturally, through faults or fractures, it would have done so over the millennia. Below the gas cap is an oil accumulation, which extends down to the Free-Water Level (FWL), (fuchsia line at -735 ft subsea), which is also the Hobbs structural spill point, or the maximum depth at which hydrocarbons will not leak out of the reservoir. The Base of Oil Zone is the point at which there are no distillable hydrocarbons – nothing moveable through primary, secondary, or tertiary recovery.

The Producing Oil-Water Contact (POWC), (green line at -614 ft subsea) was determined by early drilling to be the maximum depth where only oil, and no water, was produced. Below the POWC, wells produce a combination of oil and water. The uppermost region between the POWC and the free water level FWL/spillpoint is called the transition zone (TZ), and below that lies the residual oil zone (ROZ). The ROZ was water-flooded naturally millions of years ago, leaving behind a residual oil saturation[1] that is immobile

[1] "Residual oil saturation" is the fraction of oil remaining in the pore space, typically after water flooding.

without CO_2 flooding. This is approximately the same residual oil saturation remaining after water flooding in the water-swept areas of the main oil pay zone.

When supercritical CO_2 and water are injected into an oil reservoir, they are pushed from injection wells to production wells by the high pressure of the injected fluids. Once the CO_2 flood is complete and injection ceases, the remaining mobile CO_2 will rise slowly upward, driven by buoyancy forces. If the amount of CO_2 injected into the reservoir exceeds the secure storage capacity of the pore space, excess CO_2 could theoretically "spill" from the reservoir and migrate to other reservoirs on the Central Basin Platform. This risk is very low in the Hobbs Field, because there is more than enough pore space to retain the CO_2. Oxy has calculated the total pore space within the Hobbs Field, from the top of the reservoir down to the spill point, which is located at -735 ft subsea or roughly 4,350 – 4,400 feet below the surface, to be 4,769 MMB. Hobbs Field could hold an estimated maximum of about 7,949 Bscf (430 MMMT) CO_2 in the reservoir space above the spill point. Oxy forecasts that at the end of EOR operations stored CO_2 will fill approximately 27.6% of total calculated storage capacity. (See Section 2.1 for further explanation of the forecast.) The volume of CO_2 storage is based on the estimated total pore space within Hobbs Field from the top of the reservoir down to the spill point, or about 4,769 MMB. This is the volume of rock multiplied by porosity. CO_2 storage is calculated assuming an irreducible water saturation of 0.15, an irreducible oil saturation of 0.10, and a CO_2 formation volume factor of 0.45 (see chart below).

Top of Basal Grayburg down to -735 Total Vertical Depth (structural spill point)	
Variables	
Boundary	**Spill Point Contour**
Pore Volume [RB]	**4,769,117,630**
B_{CO2} [BBL/MCF]	**0.45**
S_{wirr}	**0.15**
Sor_{CO2}	**0.10**
Max CO_2 [MCF]	**7,948,529,383**
Max CO_2 [TCF]	**7.95**

$$CO_2(\text{max}) = \text{Volume (RB)} * (1 - S_{\text{wirr}} - S_{\text{orCO}_2}) / B_{\text{CO}_2}$$

Where:

CO_2(max) = the maximum amount of storage capacity

Volume (RB) = the volume in Reservoir Barrels of the rock formation

B_{CO2} = the formation volume factor for CO_2

S_{wirr} = the irreducible water saturation

Sor_{CO2} = the irreducible oil saturation

Given that the Hobbs Field is located at the highest subsurface elevations of the structure, that the confining zone has proved competent over both millions of years and throughout decades of EOR operations, and that the Hobbs Field has ample storage capacity, Oxy is confident that stored CO_2 will be contained securely within the Basal Grayburg-San Andres reservoir in the Hobbs Field.

2.2.2 Operational History of the Hobbs Field and Hobbs Field

The Hobbs Field was discovered in 1928 and intensive development began in 1930. It is located in the northwestern portion of the Central Basin Platform in the Permian Basin.

The Hobbs Field was originally developed with numerous leases held by individuals and companies. To improve efficiency, a number of smaller leases were combined (or unitized) into two larger legal entities (Units), which can be operated without the operational restrictions imposed by the former lease boundaries. In 1975, the South Hobbs Unit (SHU) was formed, followed by formation of the North Hobbs Unit (NHU) in 1980 (See Figure 9). Together, the NHU and SHU form the Hobbs Field.

The boundaries of the Hobbs Field are indicated in Figure 9. Under certain conditions, Oxy uses a Specialized Field Risk Management (SFRM) program to voluntarily apply additional design and operations specifications to further mitigate the potential risk from public exposure due to loss of containment. Due to the native concentration of H_2S in the Hobbs Field and its proximity to the City of Hobbs, a community with a population of roughly 40,000 according to the 2015 U.S. Census, Oxy screens Hobbs Field well locations and surface equipment to determine where the SFRM program is applied. The voluntary measures of the SFRM provide additional monitoring and will be further discussed in Sections 4 and 5.

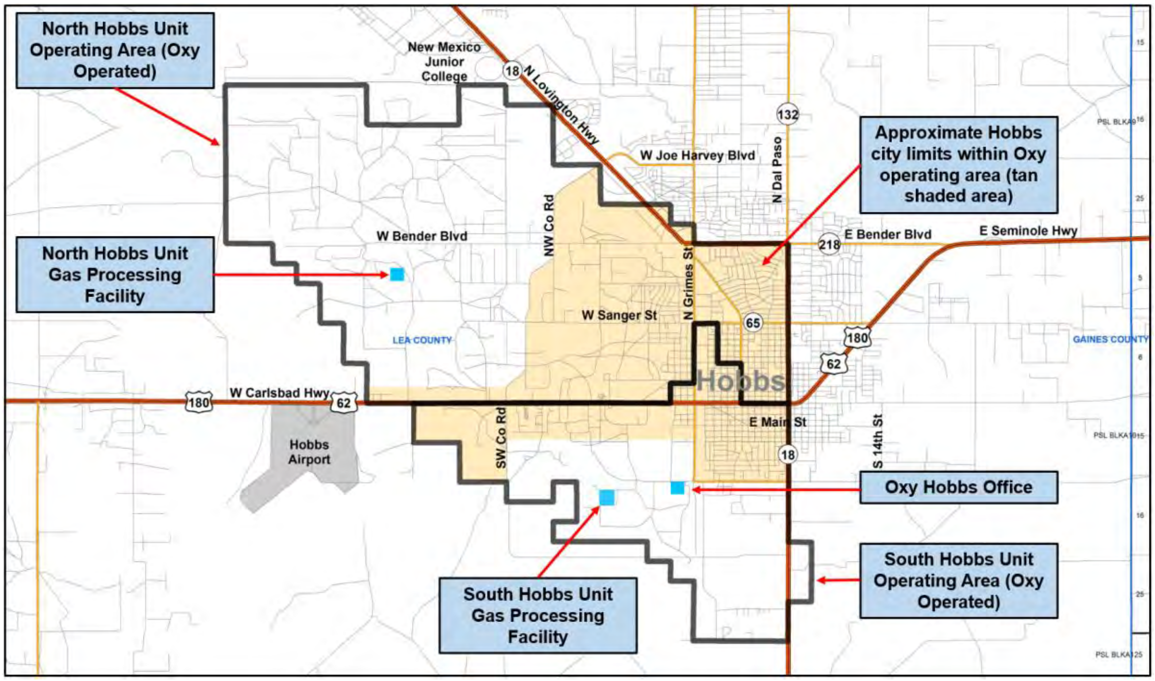


Figure 9 - Hobbs Field Map

Oxy began CO_2 flooding of the NHU of the Hobbs Field in 2003 and has continued and expanded it since that time. The SHU of the Hobbs Field began CO_2 flooding in 2015. The experience of operating and refining the Hobbs Field CO_2 floods over the past decade has created a strong understanding of the reservoir and its capacity to store CO_2.

2.3 Description of CO_2 EOR Project Facilities and the Injection Process

Figures 10 and 11 show a simplified flow diagram of the project facilities and equipment in the NHU and SHU, respectively. CO_2 is delivered to the Hobbs Field via the Permian pipeline delivery system. The CO_2 injected into the Hobbs Field is supplied by a number of different sources into the pipeline system. Specified amounts are drawn based on contractual arrangements among suppliers of CO_2, purchasers of CO_2, and the pipeline operator.

Once CO_2 enters the Hobbs Field there are four main processes involved in EOR operations. These processes are shown in Figures 10 and 11 and include:

1. **CO_2 Distribution and Injection**. Purchased CO_2 and recycled CO_2 from the CO_2 Recycle and Compression Facility (RCF) is sent through the main CO_2 distribution system to various CO_2 injectors throughout the Field.
2. **Produced Fluids Handling**. Produced fluids gathered from the production wells are sent to satellite batteries for separation into a gas/CO_2 mix and a produced fluids mix of water, oil, gas, and CO_2. The produced fluids mix is sent to centralized tank batteries where oil is separated for sale into a pipeline, water is recovered for reuse, and the remaining gas/CO_2 mix is merged with the output from the satellite

batteries. In the NHU, a portion of the gas/CO_2 mix is sent to the SHU and the rest is sent to a combined RCF and natural gas liquids (NGL) facility. In the SHU all of the gas/CO_2 mix from the satellite battery is sent to an RCF along with the gas/CO_2 mix received from the NHU. Produced oil is metered and sold; water is forwarded to the water injection stations for treatment and reinjection or disposal.

3. **Produced Gas Processing**. In the NHU, the gas/CO_2 mix separated at the satellite batteries goes to the RCF/NGL where the NGLs, and CO_2 streams are separated. The NGLs move to a commercial pipeline for sale. The majority of remaining CO_2 (e.g., the recycled CO_2) is returned to the CO_2 distribution system for reinjection. In the SHU, all of the gas/CO_2 mix is compressed for re-injection.
4. **Water Treatment and Injection**. Water separated in the tank batteries is processed at water injection stations to remove any remaining oil and then distributed throughout the Hobbs Field for reinjection along.

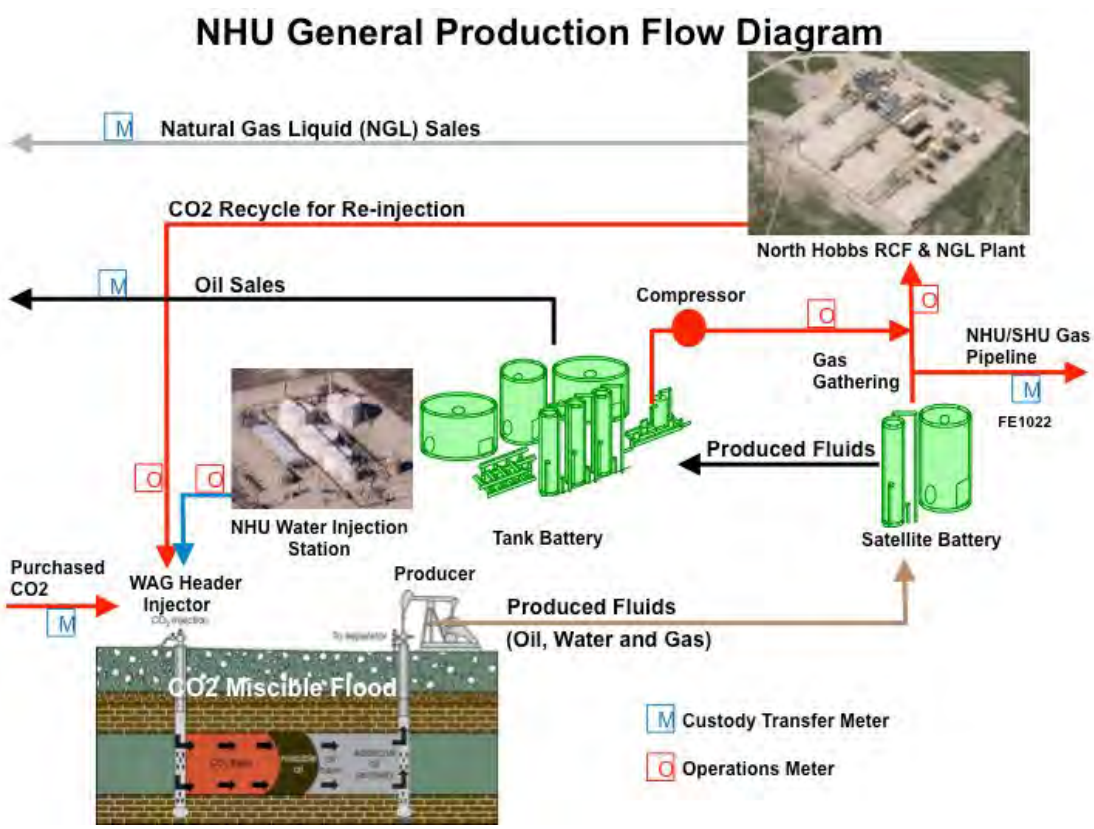


Figure 10 Hobbs Field – NHU Facilities General Production Flow Diagram

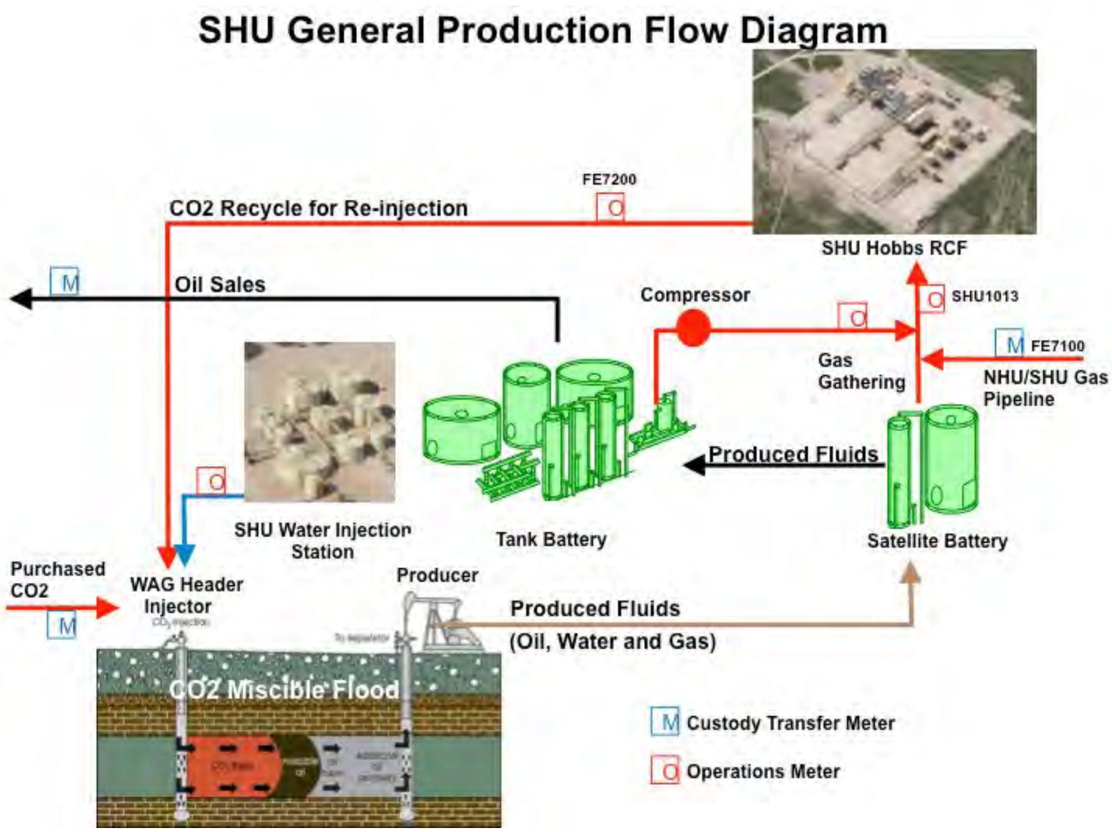


Figure 11 Hobbs Field – SHU Facilities General Production Flow Diagram

2.3.1 CO_2 Distribution and Injection.

Oxy purchases CO_2 from the Permian pipeline delivery system and receives it through two custody transfer metering points, as indicated in Figures 10 and 11. Purchased CO_2 and recycled CO_2 are sent through the CO_2 trunk lines to injection manifolds. At the manifolds, the CO_2 is sent through multiple distribution lines to individual injection wells. There are volume meters at the inlet and outlet of the RCF.

Currently, Oxy has 10 injection manifolds and approximately 210 injection wells in the Hobbs Field. Approximately 330 MMscf of CO_2 is injected each day, of which approximately 40% is purchased CO_2, and the balance (60%) is recycled from the RCFs. The ratio of purchased CO_2 to recycled CO_2 is expected to change over time, and eventually the percentage of recycled CO_2 will increase and purchases of fresh CO_2 will taper off as indicated in Section 2.1.

Each injection well is connected to a WAG header located at the satellite. WAG headers are remotely operated and can inject either CO_2 or water at various rates and injection pressures as specified in the injection plans. The length of time spent injecting each fluid is a matter of continual optimization that is designed to maximize oil recovery and minimize CO_2 utilization in each injection pattern. A WAG header control system is implemented at each satellite. It consists of a dual-purpose flow meter used to measure the injection rate of water or CO_2, depending on what is being injected. Data from these meters is sent to a central data monitoring station where it is compared to the injection plan for that satellite. As described in Sections 5 and 7, data from the WAG header control systems, visual inspections of the injection equipment, and use of the procedures contained in 40 CFR §98.230-238 (Subpart W), will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2.

2.3.2 Wells in the Hobbs Field

As of August 2016, there are 445 active wells that are completed in the Hobbs Field; roughly half of these are production wells (235 wells) and the others are injection wells (210 wells). In addition there about 256 wells that are not in use, bringing the total number of wells currently completed in the Hobbs Field to 701, as indicated in Figure 12.[2] Table 1 shows these well counts in the Hobbs Field by status.

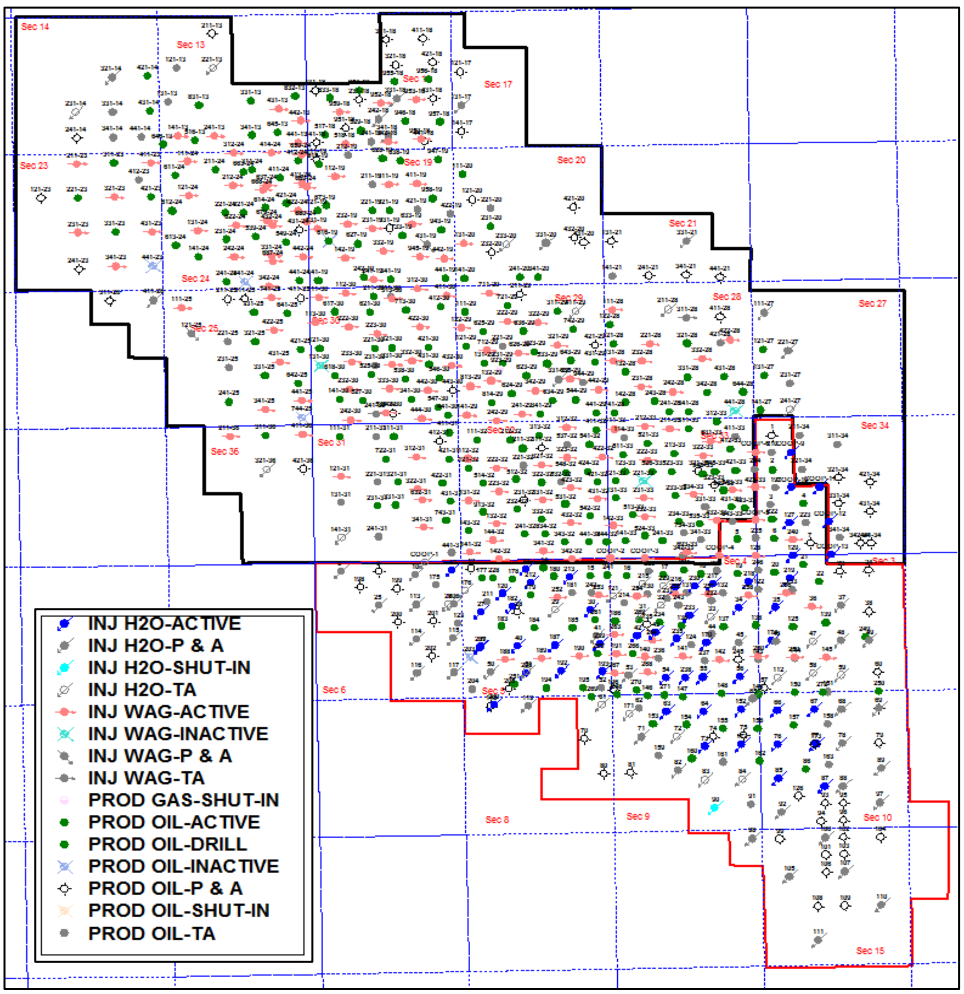


Figure 12 Hobbs Field Wells – As of August 2016

Table 1 - Hobbs Field Wells

[2] Wells that are not in use are deemed to be inactive, plugged and abandoned, temporarily abandoned, or shut in.

Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*
Drilled & Completed in the 1930's	105	4	26	33
Drilled 1946-1979	41	1	18	52
Completed after 1980	299	16	57	49
TOTAL	***445***	***21***	***101***	***134***

The wells in Table 1 are categorized in groups that relate to age and completion methods. Roughly 22% of these wells were drilled in the 1930's and were generally completed with three strings of casing (with surface and intermediate strings typically cemented to the surface). The production string was typically installed to the top of the producing interval, otherwise known as the main oil column (MOC), which extends to the producible oil/water contact (POWC). These wells were completed by stimulating the open hole (OH), and are not cased through the MOC. Normally within 20-30 years of initial completion, a full or partial liner would have been installed to allow for controlled production intervals and this liner would have been cemented to the top of the liner (TOL) that was installed. For example, if a full liner was installed, then Top of Cement (TOC) would be at the surface as the liner was installed to surface. More often, a partial liner would be installed from 3,800-4,300 ft, and the TOC would be at 3,800 ft. The casing weights used for 1930's vintage wells were heavy, with nothing lighter than 7" 24 #/ft. or 5 1/2" 15.5 #/ft. for the production string.

The wells in Table 1 drilled during the period 1946-1979 typically have two to three strings of high-grade casing cemented to a level where the top of the cement (TOC) extends above the previous casing depth. Cement bond logs (CBL) or temperature surveys (TS) have been used to determine that this depth is available on most wells. This group of wells rarely has liners installed because they were completed with production casing that extended below the point of the POWC.

The majority (roughly 66%) of wells in Table 1 were drilled after 1980. In the vast majority of these wellbores, the surface and production casings are cemented to the surface. Experience shows that these wells generally have not needed partial or full liners. Most of these wells have surface casing and production casing weights of 8 5/8" 24# and 5 1/2" 15.5 # respectively.

Oxy reviews these categories when planning well maintenance projects. Further, Oxy keeps well workover crews on call to maintain all active wells and to respond to any wellbore issues that arise. On average, in the Hobbs Field there are two to three incidents per year in which the well casing fails. Oxy detects these incidents by monitoring changes in the surface pressure of wells and by conducting Mechanical Integrity Tests (MITs), as explained later in this section and in the relevant regulations cited in Appendix 6. This rate of failure is less than 1% of wells per year and is considered extremely low.

Table 2 indicates non-Hobbs Field wells in the area by status. The Oxy-operated wells are completed below the Hobbs Field and provide minimal production of hydrocarbons. There are 17 active operated-by-others (OBO) wells, of which 3 are completed at depths shallower than the San Andres and 14 are completed at depths deeper than the San Andres. There are 32 inactive OBO wells, of which 27 have been properly plugged and abandoned (P&A'd) as required by the NMOCD (with 24 of these completed shallower than the San Andres and 3 deeper); the remaining 5 inactive OBO wells are temporarily abandoned (TA) in accordance with NMOCD rules and are completed deeper than the San Andres.

Table 2 – Non-Hobbs Field Wells

	Oxy Operated				Operated By Others	
Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*	*Active*	*Inactive*
Drilled & Completed in the 1930's	0	0	0		2	17
Drilled 1946-1979	1	0	0	8	5	11
Completed after 1980	7	4	15	15	10	4
TOTAL	***8***	***4***	***15***	***23***	***17***	***32***

All wells in oilfields, including both injection and production wells described in Tables 1 and 2, are regulated by the NMOCD under NMAC Title 9 Chapter 15 Parts 1-39.[3] A list of wells, with well identification numbers, is included in Appendix 5. The injection wells are subject to additional requirements promulgated by EPA – the UIC Class II program – implementation of which has been delegated to the NMOCD.

NMOCD rules govern well siting, construction, operation, maintenance, and closure for all wells in oilfields. Current rules require, among other provisions, that:

- Fluids be constrained in the strata in which they are encountered;
- Activities governed by the rule cannot result in the pollution of subsurface or surface water;
- Wells adhere to specified casing, cementing, drilling well control, and completion requirements designed to prevent fluids from moving from the strata they are encountered into strata with oil and gas, or into subsurface and surface waters;
- Wells file a completion report including basic electric log (e.g., a density, sonic, or resistivity (except dip meter) log run over the entire wellbore);
- Wells be equipped with a Bradenhead valve, measure the pressure between casing strings using the Bradenhead gauge, and follow procedures to report and address any instances where pressure on a Bradenhead is detected;
- Wells follow plugging procedures that require advance approval from the NMOCD and allow consideration of the suitability of the cement based on the use of the well, the location and setting of plugs.

In addition, Oxy implements a corrosion protection program to protect and maintain the steel used in injection and production wells from any CO_2-enriched fluids. Oxy currently employs methods to mitigate both internal and external corrosion of casing in wells in the

[3] See Appendix 6 for additional information.

Hobbs Field. These methods generally protect the downhole steel and the interior and exterior of well bores through the use of special materials (e.g. fiberglass tubing, corrosion resistant cements, nickel plated packers, corrosion resistant packer fluids) and procedures (e.g. packer placement, use of annular leakage detection devices, cement bond logs, pressure tests). These measures and procedures are typically included in the injection orders filed with the NMOCD. Corrosion protection methods and requirements may be enhanced over time in response to improvements in technology.

The NMOCD granted authority to inject CO_2 in the NHU and SHU after application, notice and hearing. As part of the application process, Oxy conducted an Area of Review (AOR) that included all wells within the NHU and SHU boundaries and extended ¼ mile around both units. According to EPA, the AOR refers to "the area around a deep injection well that must be checked for artificial penetrations, such as other wells, before a permit is issued. Well operators must identify all wells within the AOR that penetrate the injection or confining zone, and repair all wells that are improperly completed or plugged. The AOR is either a circle or a radius of at least ¼ mile around the well or an area determined by calculating the zone of endangering influence, where pressure due to injection may cause the migration of injected or formation fluid into a USDW."[4] Under these requirements Oxy has located and evaluated all wells in the AOR that penetrate the injection interval, including those operated by Oxy and those operated by other parties. Oxy will continue to comply with this regulation going forward.

Mechanical Integrity Testing (MIT)
Oxy complies with the MIT requirements implemented by NMOCD to periodically inspect wells and surface facilities to ensure that all wells and related surface equipment are in good repair and leak-free, and that all aspects of the site and equipment conform with Division rules and permit conditions. All active injection wells undergo an MIT at the following intervals:

- Before injection operations begin;
- Every 2 years as stated in the injection orders (NMOCD Order NO. R-4934-F / R-6199-F);
- After any workover that disturbs the seal between the tubing, packer, and casing;
- After any repair work on the casing; and
- When a request is made to suspend or reactivate the injection or disposal permit.

NMOCD requires that the operator notify the NMOCD district office prior to conducting an MIT. Operators are required to use a pressure recorder and pressure gauge for the tests. The operator's field representative must sign the pressure recorder chart and submit it with the MIT form. The casing-tubing annulus must be tested to a minimum of 300 psi for 30 minutes.

[4] USEPA, Underground Injection Control Program Glossary, http://water.epa.gov/type/groundwater/uic/glossary.cfm.

If a well fails an MIT, the operator must immediately shut the well in and provide notice to NMOCD. Casing leaks must be successfully repaired and retested or the well plugged and abandoned after submitting a formal notice and obtaining approval from the NMOCD.

Any well that fails an MIT cannot be returned to active status until it passes a new MIT.

2.3.3 Produced Fluids Handling

As injected CO_2 and water move through the reservoir, a mixture of oil, gas, and water (referred to as "produced fluids") flows to the production wells. Gathering lines bring the produced fluids from each production well to satellite batteries. Oxy has approximately 235 active production wells in the Hobbs Field and production from each is sent to one of ten satellite batteries. Each satellite battery consists of a large vessel that performs a gas-liquid separation. Each satellite battery also has well test equipment to measure production rates of oil, water and gas from individual production wells. Oxy has testing protocols for all wells connected to a satellite. Most wells are tested every two months. Some wells are prioritized for more frequent testing because they are new or located in an important part of the Field; some wells with mature, stable flow do not need to be tested as frequently; and finally some wells do not yield solid test results necessitating review or repeat testing.

After separation, the gas phase is transported by pipeline to an RCF for processing as described below. Currently the average composition of this gas mixture as it enters the RCF is 82-88% CO_2 and 9,000-10,000ppm H_2S; this composition will likely change over time as CO_2 EOR operations are implemented.

The liquid phase, which is a mixture of oil and water, is sent to one of four centralized tank batteries where oil is separated from water. The large size of the centralized tank batteries provides enough residence time for gravity to separate oil from water.

The separated oil is metered through the Lease Automatic Custody Transfer (LACT) unit located at each centralized tank battery and sold. The oil typically contains a small amount of dissolved or entrained CO_2. Analysis of representative samples of oil is conducted once a year to assess CO_2 content. Since 2012, the dissolved CO_2 content has averaged 0.18% by volume in the oil.

The water is removed from the bottom of the tanks at the central tank batteries and sent to water injection stations, where it is re-injected at the WAG headers.

Any gas that is released from the liquid phase rises to the top of the tanks and is collected by a Vapor Recovery Unit (VRU) that compresses the gas and sends it to an RCF for processing.

Hobbs oil is slightly sour, containing small amounts of hydrogen sulfide (H_2S), which is highly toxic. There are approximately 40 workers on the ground in the Hobbs Field at any given time, and all field personnel are required to wear H_2S monitors at all times. Although the primary purpose of H_2S detectors is protecting employees, monitoring will also supplement Oxy's CO_2 leak detection practices as discussed in Sections 5 and 7.

In addition, the procedures in 40 CFR §98.230-238 (Subpart W) and the two-part visual inspection process described in Section 5 are used to detect leakage from the produced fluids handling system. As described in Sections 5 and 7, the volume of leaks, if any, will be estimated to complete the mass balance equations to determine annual and cumulative volumes of stored CO_2.

2.3.4 Produced Gas Handling

Produced gas gathered from the satellite batteries and tank batteries is sent to an RCF. There is an operations meter at the RCF inlet.

Once gas enters an RCF, it undergoes dehydration and compression. In the NHU an additional process separates NGLs for sale. At the end of these processes there is a CO_2 rich stream that is recycled through re-injection. Meters at each RCF outlet are used to determine the total volume of the CO_2 stream recycled back into the EOR operations.

As described in Section 2.3.4, data from 40 CFR §98.230-238 (Subpart W), the two-part visual inspection process for production wells and areas described in Section 5, and information from the personal H_2S monitors are used to detect leakage from the produced gas handling system. This data will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2 as described in Sections 5 and 7.

2.3.5 Water Treatment and Injection

Produced water collected from the tank batteries is gathered through a pipeline system and moved to one of four water injection stations. Each facility consists of 10,000-barrel tanks where any remaining oil is skimmed from the water. Skimmed oil is returned to the centralized tank batteries. The water is sent to an injection pump where it is pressurized and distributed to the WAG headers for reinjection.

2.3.6 Facilities Locations

The current locations of the various facilities in the Hobbs Field are shown in Figure 13. As indicated above, there are four central tank batteries. There are ten active areas of operation that send fluids to one of ten satellite batteries. These active operations areas are highlighted and labeled with a number and letter, such as "24C" in the far west. The four centralized tank batteries are identified by the green squares. The four water treatment and injection stations are shown by the light blue squares. The two RCF facilities are indicated by red squares.

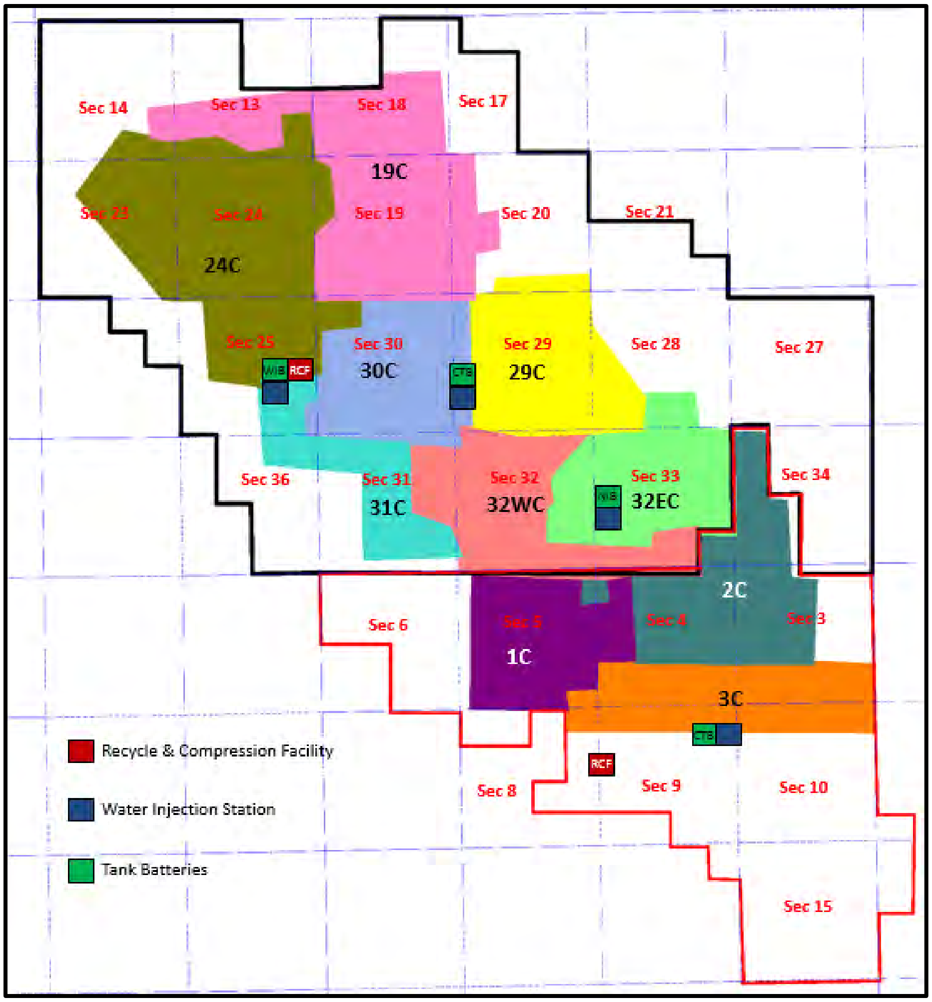


Figure 13 Location of Surface Facilities at Hobbs Field

NMOCD requires that injection pressures be limited to ensure injection fluids do not migrate outside the permitted injection interval. In the Hobbs Field, Oxy uses two methods to contain fluids: reservoir pressure management and the careful placement and operation of wells along the outer producing limits of the units.

Reservoir pressure in the Hobbs Field is managed by maintaining an injection to withdrawal ratio (IWR)[5] of approximately 1.0. To maintain the IWR, Oxy monitors fluid injection to ensure that reservoir pressure does not increase to a level that would fracture the reservoir seal or otherwise damage the oil field.

Oxy also prevents injected fluids from migrating out of the injection interval by keeping injection pressure below the formation fracture pressure, which is measured using step-rate

[5] Injection to withdrawal ratio (IWR) is the ratio of the volume of fluids injected to the volume of fluids produced (withdrawn). Volumes are measured under reservoir conditions for all fluids. Injected fluids are CO_2 and water; produced fluids are oil, water, and CO_2. By keeping IWR close to 1.0, reservoir pressure is held constant, neither increasing nor decreasing.

tests. In these tests, injection pressures are incrementally increased (e.g., in "steps") until injectivity increases abruptly, which indicates that an opening (fracture) has been created in the rock. Oxy manages its operations to ensure that injection pressures are kept below the formation fracture pressure so as to ensure that the valuable fluid hydrocarbons and CO_2 remain in the reservoir.

In addition, Oxy surrounds WAG operations with water injection wells to contain CO_2 within the patterns. There are a few small producer wells operated by third parties outside the boundary of Hobbs Field. The water injection wells also prevent any loss of CO_2 to these producer wells. There are currently no significant commercial operations surrounding the Hobbs Field to interfere with Oxy's operations.

2.4 Reservoir Modeling

Oxy uses reservoir simulation models to predict the behavior of fluids in a reservoir. These models provide a mathematical representation of the reservoir that incorporates all known information on the reservoir. In this way, future performance can be predicted in a manner consistent with available data, including logs and cores, as well as past production and injection history.

Mathematically, reservoir behavior is modeled by a set of differential equations that describe the fundamental principles of conservation of mass and energy, fluid flow, and phase behavior. These equations are complex and must be solved numerically using sophisticated computer modeling. The solution process involves sub-dividing the reservoir into a large number of blocks arranged on a grid. Each block is assigned specific rock properties (porosity, permeability, saturations, compositions and pressure). The blocks are small enough to adequately describe the reservoir, but large enough to keep their number manageable. The computer uses the differential equations to determine how various physical properties change with time in each grid block. Small time steps are used to progress from a known starting point through time. In this way the computer simulates reservoir performance, consistent with fundamental physics and actual reservoir geometry. The simulation represents the flow of each fluid phase (oil, water and gas), changes in fluid content (saturations), equilibrium between phases (compositional changes), and pressure changes over time.

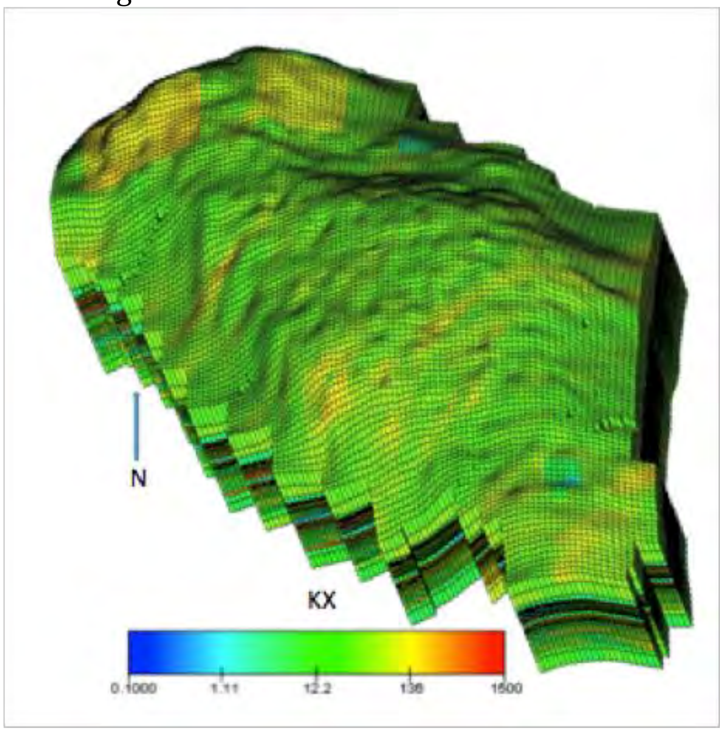
The reservoir simulator used by Oxy is a commercially available compositional simulator, called MORE, developed by Roxar. It is called "compositional" because it has the capability to keep track of the composition of each phase (oil, gas, and water) over time and throughout the volume of the reservoir. There are 16 components in the compositional model.

To build a simulation model, engineers and scientists input specific information on reservoir geometry, rock properties, and fluid flow properties. The input data includes:

- Reservoir geometry, including distance between wells, reservoir thickness and structural contours;

- Rock properties, such as permeability and porosity of individual layers, barriers to vertical flow, and layer continuity; and,
- Fluid flow properties including density and viscosity of each phase, relative permeability, capillary pressure, and phase behavior.

Figure 14 Hobbs Field Simulation Model



A simulation model for the Hobbs Field, illustrated in Figure 14, shows an aerial three-dimensional view of horizontal permeability in each layer. The color scale indicates range of permeability, with red being higher permeability and blue being lower permeability. The model covers the entire anticline structure and has been used to verify the use of actual and predicted dimensionless performance curves.

Layering

Within a flood, one of the most important properties to model is the effect of layering. Reservoir rocks were originally deposited over very long periods of time. Because the environment tended to be uniform at any one point in time, reservoir properties tend to be relatively uniform over large areas. Depositional environments change over time, however, and for this reason rock properties vary considerably with time or depth as they are deposited. Thus, rock properties are modeled as layers. Some layers have high permeability and some have lower permeability. Those with higher permeability take most of the injected fluids and are swept most readily. Those with lower permeability may be only partially contacted at the end of the flooding process. (The WAG process helps improve sweep efficiency.) As Figure 14 shows, the simulation is divided into 37 vertical grid blocks. These layers were consolidated in the simulation from a 169 layer geologic model. Each layer of simulation grid blocks is used to model the depositional layering as closely as practical. The seal rocks above the flood interval are not included in the simulation since they are impermeable and do not participate in fluid flow processes.

Figure 15 – Hobbs Simulation Cross-Section (Original Oil Saturation)

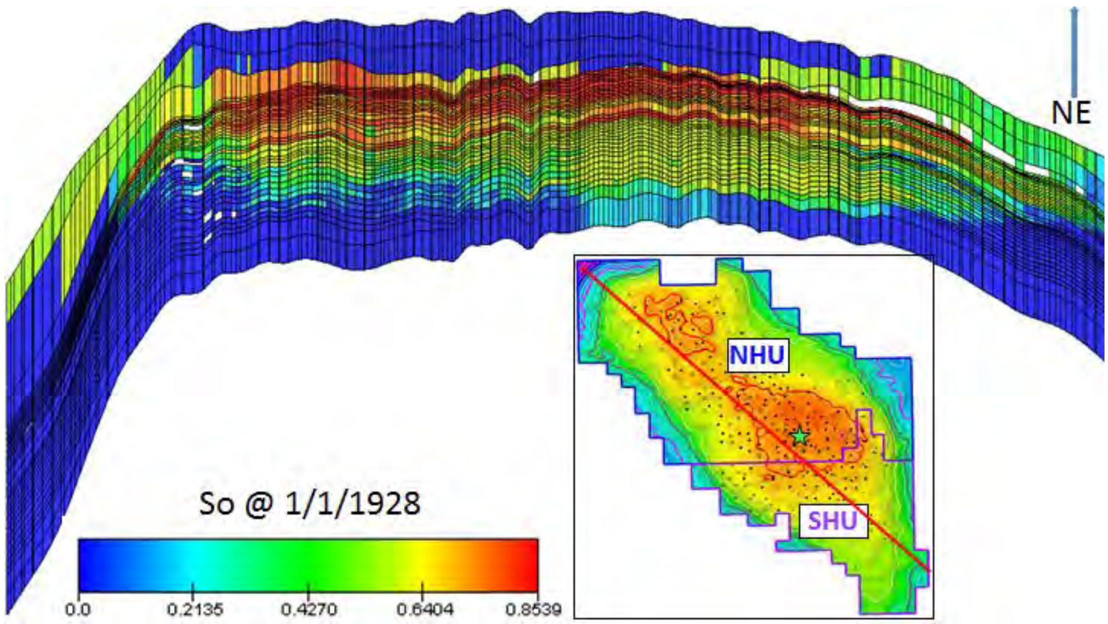


Figure 15 illustrates how initial oil saturation varied across the Hobbs Field in its original state. The original oil saturation shown in Figure 15 is derived from the geologic model shown in Figure 8.

Performance Prediction

Simulation models may represent either a multi-pattern segment of the field, or the entire field. Field-wide simulations are initially used to assess the viability of water and CO_2 flooding. Once a decision has been made to develop a CO_2 EOR project, Oxy uses modeling to plan the locations of and injection schedules for wells. In the case of the Hobbs Field, a geologic model that has evolved over the last several decades is used as a basis for the rock properties in the simulation model. The simulation model is tuned to match actual historical performance data collected during primary and waterflood field production. This provides Oxy with confidence that the model can adequately forecast oil, water and CO_2 production, along with CO_2 and water injection.

One objective of simulation is to develop an injection plan that maximizes oil recovery and minimizes the costs of the CO_2 flood. The injection plan includes such controllable items as:

- The cycle length and WAG ratio to inject water or CO_2 in the WAG process, and
- The best rate and pressure for each injection phase.

Simulations may also be used to:

- Evaluate infill or replacement wells,
- Determine the best completion intervals,
- Verify the need for well remediation or stimulation, and
- Determine anticipated rates and ultimate recovery.

Modeling allows Oxy to optimize the flood pattern and injection scheme, and provides assurance that the injected CO_2 will stay in-zone to contact and displace oil.

Simulation modeling is typically used for planning and not as a daily management tool because it is time-intensive and often does not provide sufficiently detailed information about the expected pressure, injection volumes, and production, at the level of an injection pattern. In order to analyze performance at the pattern level, Oxy uses dimensionless prototypes to manage CO_2 flood performance. The pattern-level prototypes can be constructed in one of two ways: from simulation or from actual performance of a more mature analog project. Where simulation is used to generate the predictions, the simulation results should be validated by comparison with analog project performance if possible.

If actual performance differs in a noticeable way from prediction, reservoir engineers use professional judgment formed by an analysis of technical data to determine where further attention is needed. The appropriate response could be to change injection rates, to alter the prediction model or to find and repair fluid leaks.

3. Delineation of Monitoring Area and Timeframes

3.1 Active Monitoring Area

Because CO_2 is present throughout the Hobbs Field and retained within it, the Active Monitoring Area (AMA) is defined by the boundary of the Hobbs Field. The following factors were considered in defining this boundary:

- Free phase CO_2 is present throughout the Hobbs Field: More than 579 Bscf (31.3 MMMT) tons of CO_2 have been injected throughout the Hobbs Field since 2003 and there has been significant infill drilling in the Hobbs Field, completing additional wells to further optimize production. Operational results thus far indicate that there is CO_2 throughout the Hobbs Field.
- CO_2 injected into the Hobbs Field remains contained within the field because of the fluid and pressure management approaches associated with CO_2 EOR. Namely, maintenance of an IWR of 1.0 assures a stable reservoir pressure; managed leaseline injection and production wells are used to retain fluids in the Hobbs Field

as indicated in Section 2.3.6; and operational results indicate that injected CO_2 is retained in the Hobbs Field.

- Furthermore, over geologic timeframes, stored CO_2 will remain in the Hobbs Field and will not migrate downdip as described in Section 2.2.3, because the Hobbs Field contains the area with the highest elevation.

3.2 Maximum Monitoring Area

The Maximum Monitoring Area (MMA) is defined in 40 CFR §98.440-449 (Subpart RR) as including the maximum extent of the injected CO_2 and a half-mile buffer bordering that area. As described in the AMA section (Section 3.1), the maximum extent of the injected CO_2 is anticipated to be bounded by the Hobbs Field. Therefore the MMA is the Hobbs Field plus the half-mile buffer as required by 40 CFR §98.440-449 (Subpart RR).

3.3 Monitoring Timeframes

Oxy's primary purpose for injecting CO_2 is to produce oil that would otherwise remain trapped in the reservoir and not, as in UIC Class VI, "specifically for the purpose of geologic storage."[6] During a Specified Period, Oxy will have a subsidiary purpose of establishing the long-term containment of a measurable quantity of CO_2 in the Basal Grayburg - San Andres formation in the Hobbs Field. The Specified Period will be shorter than the period of production from the Hobbs Field. This is in part because the purchase of new CO_2 for injection is projected to taper off significantly before production ceases at Hobbs Field, which is modeled through 2100. At the conclusion of the Specified Period, Oxy will submit a request for discontinuation of reporting. This request will be submitted when Oxy can provide a demonstration that current monitoring and model(s) show that the cumulative mass of CO_2 reported as sequestered during the Specified Period is not expected to migrate in the future in a manner likely to result in surface leakage. It is expected that it will be possible to make this demonstration within two to three years after injection for the Specified Period ceases based upon predictive modeling supported by monitoring data. The demonstration will rely on two principles: 1) that just as is the case for the monitoring plan, the continued process of fluid management during the years of CO_2 EOR operation after the Specified Period will contain injected fluids in the Hobbs Field, and 2) that the cumulative mass reported as sequestered during the Specified Period is a fraction of the theoretical storage capacity of the Hobbs Field *See* 40 C.F.R. § 98.441(b)(2)(ii).

4. Evaluation of Potential Pathways for Leakage to the Surface

4.1 Introduction

[6] EPA UIC Class VI rule, EPA 75 FR 77291, December 10, 2010, section 146.81(b).

In the roughly 40 years since the Hobbs Field was formed, the reservoir has been studied and documented extensively. Based on the knowledge gained from that experience, this section assesses the potential pathways for leakage of stored CO_2 to the surface. The following potential pathways are reviewed:

- Existing Well Bores
- Faults and Fractures
- Natural and Induced Seismic Activity
- Previous Operations
- Pipeline/Surface Equipment
- Lateral Migration Outside the Hobbs Field
- Drilling Through the CO_2 Area
- Diffuse Leakage Through the Seal

4.2 Existing Well Bores

As of August 2016, there are approximately 445 active Oxy operated wells in the Hobbs Field – split roughly evenly between production and injection wells. In addition, there are approximately 256 wells not in use and 22 OBO wells that penetrate the San Andres, as described in Section 2.3.2.

Leakage through existing well bores is a potential risk at the Hobbs Field that Oxy works to prevent by adhering to regulatory requirements for well drilling and testing; implementing best practices that Oxy has developed through its extensive operating experience; monitoring injection/production performance, wellbores, and the surface; and maintaining surface equipment.

As discussed in Section 2.3.2, regulations governing wells in the Hobbs Field require that wells be completed and operated so that fluids are contained in the strata in which they are encountered and that well operation does not pollute subsurface and surface waters. The regulations establish the requirements that all wells (injection, production, disposal) must comply with. Depending upon the purpose of a well, the requirements can include additional standards for AOR evaluation and MIT. In implementing these regulations, Oxy has developed operating procedures based on its experience as one of the world's leading operators of EOR floods. Oxy's best practices include developing detailed modeling at the pattern level to guide injection pressures and performance expectations; utilizing diverse teams of experts to develop EOR projects based on specific site characteristics; and creating a culture where all Field personnel are trained to look for and address issues promptly. Oxy's practices, which include corrosion prevention techniques to protect the wellbore as needed, as discussed in Section 2.3.2, ensures that well completion and operation procedures are designed not only to comply with regulations but also to ensure that all fluids (e.g., oil, gas, CO_2) remain in the Hobbs Field until they are produced through an Oxy well.

In addition, all Oxy facilities are internally screened to determine if the SFRM program should be applied. This determination is primarily based on proximity to the public. In the case of wells, SFRM guidelines call for using enhanced materials for well heads, installing sensors to detect H_2S, and using automatic shut-off valves triggered by the presence of detected gases.

As described in Section 5, continual and routine monitoring of Oxy's well bores and site operations will be used to detect leaks, including those from non-Oxy wells, or other potential well problems, as follows:

- Well pressure in injection wells is monitored on a continual basis. The injection plans for each pattern are programmed into the injection WAG satellite, as discussed in Section 2.3.1, to govern the rate, pressure, and duration of either water or CO_2 injection. Pressure monitors on the injection wells are programmed to flag pressures that significantly deviate from the plan. Leakage on the inside or outside of the injection wellbore would affect pressure and be detected through this approach. If such excursions occur, they are investigated and addressed. Over the years Oxy has managed the Hobbs Field, it is the company's experience that few excursions result in fluid migration out of the intended zone and that leakage to the surface is very rare.

- In addition to monitoring well pressure and injection performance, Oxy uses the experience gained over time to strategically approach well maintenance and updating. Oxy maintains well maintenance and workover crews onsite for this purpose. For example, the well classifications by age and construction method indicated in Table 1 inform Oxy's plan for monitoring and updating wells. Oxy uses all of the information at hand including pattern performance, and well characteristics to determine well maintenance schedules.

- Production well performance is monitored using the production well test process conducted when produced fluids are gathered and sent to a satellite battery. There is a routine cycle for each satellite battery, with each well being tested approximately once every two months. During this cycle, each production well is diverted to the well test equipment for a period of time sufficient to measure and sample produced fluids (generally 8-12 hours). This test allows Oxy to allocate a portion of the produced fluids measured at the satellite battery to each production well, assess the composition of produced fluids by location, and assess the performance of each well. Performance data are reviewed on a routine basis to ensure that CO_2 flooding is optimized. If production is off plan, it is investigated and any identified issues addressed. Leakage to the outside of production wells is not considered a major risk because of the reduced pressure in the casing. Further, the personal H_2S monitors are designed to detect leaked fluids around production wells.

- Finally, as indicated in Section 5, field inspections are conducted on a routine basis by field personnel. On any day, Oxy has approximately 40 personnel in the field.

Leaking CO_2 is very cold and leads to formation of bright white clouds and ice that are easily spotted. All field personnel are trained to identify leaking CO_2 and other potential problems at wellbores and in the field. Any CO_2 leakage detected will be documented and reported, quantified and addressed as described in Section 5.

Based on its ongoing monitoring activities and review of the potential leakage risks posed by well bores, Oxy concludes that it is mitigating the risk of CO_2 leakage through well bores by detecting problems as they arise and quantifying any leakage that does occur. Section 4.10 summarizes how Oxy will monitor CO_2 leakage from various pathways and describes how Oxy will respond to various leakage scenarios. In addition, Section 5 describes how Oxy will develop the inputs used in the Subpart RR mass-balance equation (Equation RR-11). Any incidents that result in CO_2 leakage up the wellbore and into the atmosphere will be quantified as described in Section 7.4.

4.3 Faults and Fractures

After reviewing geologic, seismic, operating, and other evidence, Oxy has concluded that there are no known faults or fractures that transect the Basal Grayburg – San Andres reservoir in the project area. As described in Section 2.2.1, faults have been identified in formations that are thousands of feet below the San Andres formation, but this faulting has been shown not to affect the San Andres or to have created potential leakage pathways.

Oxy has extensive experience in designing and implementing EOR projects to ensure injection pressures will not damage the oil reservoir by inducing new fractures or creating shear. As a safeguard, injection satellites are set with automatic shutoff controls if injection pressures exceed fracture pressures.

4.4 Natural or Induced Seismicity

After reviewing the literature and actual operating experience, Oxy concludes that there is no direct evidence that natural seismic activity poses a significant risk for loss of CO_2 to the surface in the Permian Basis, and specifically in the Hobbs Field.

Of the recorded earthquakes in the Permian Basin, none have occurred in the Hobbs Field; the closest was nearly 80 miles away. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity.

A few recent studies have suggested a possible relationship between CO_2 miscible flooding activities and seismic activity in certain areas. Determining whether the seismic activity is induced or triggered by human activity is difficult.

To evaluate this potential risk, Oxy has reviewed the nature and location of seismic events within the vicinity of the Hobbs Field. Some of the recorded earthquakes in southeastern New Mexico and West Texas are far removed from any injection operation. These are judged to be from natural causes. Others are near oil fields or water disposal wells and are placed in the category of “quakes in close association with human enterprise.” (See Frohlich, 2012) The concern about induced seismicity is that it could lead to fractures in the seal, providing a pathway for CO_2 leakage to the surface. Based on Oxy’s review of seismic data, none of the recorded “earthquakes” in the Permian Basin have occurred in the Hobbs Field. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity. Therefore, there is no direct evidence to suggest that natural seismic activity poses a significant risk for loss of CO_2 to the surface from the Hobbs Field. If induced seismicity resulted in a pathway for material amounts of CO_2 to migrate from the injection zone, other reservoir fluid monitoring provisions (e.g., reservoir pressure, well pressure, and pattern monitoring) would lead to further investigation.

4.5 Previous Operations

Oxy initiated CO_2 flooding in the Hobbs Field in 2003. Oxy and the prior operators have kept records of the site and have completed numerous infill wells. Oxy’s standard practice for drilling new wells includes a rigorous review of nearby wells to ensure that drilling will not cause damage to or interfere with existing wells. Oxy also follows AOR requirements under the UIC Class II program, which require identification of all active and abandoned wells in the AOR and implementation of procedures that ensure the integrity of those wells when applying for a permit for any new injection well.[7] As a result, Oxy has checked for the presence of old, unknown wells throughout the Hobbs Field over many years. These practices ensure that identified wells are sufficiently isolated and do not interfere with the CO_2 EOR operations and reservoir pressure management. Consequently, Oxy’s operational experience supports the conclusion that there are no unknown wells within the Hobbs Field and that it has sufficiently mitigated the risk of migration from older wells. Oxy has successfully optimized CO_2 flooding with infill wells because the confining zone has not been impaired by previous operations.

4.6 Pipeline / Surface Equipment

Damage to or failure of pipelines and surface equipment can result in unplanned losses of CO_2. Oxy reduces the risk of unplanned leakage from surface facilities, to the maximum extent practicable, by relying on the use of prevailing design and construction practices and maintaining compliance with applicable regulations. The facilities and pipelines currently utilize and will continue to utilize materials of construction and control processes that are standard for CO_2 EOR projects in the oil and gas industry. As described above, all facilities in the Hobbs Field are internally screened for the SFRM program. In the case of pipeline and surface equipment, the SRFM calls for more robust design and operating requirements to prevent and detect leakage. Operating and maintenance practices currently follow and will continue to follow demonstrated industry standards. CO_2 delivery via the Permian pipeline system will continue to comply with all applicable regulations. Finally,

[7] Current requirements are referenced in Appendix 6.

frequent routine visual inspection of surface facilities by Field staff will provide an additional way to detect leaks and further support Oxy's efforts to detect and remedy any leaks in a timely manner. Should leakage be detected from pipeline or surface equipment, the volume of released CO_2 will be quantified following the requirements of Subpart W of EPA's GHGRP.

4.7 Lateral Migration Outside the Hobbs Field

It is highly unlikely that injected CO_2 will migrate downdip and laterally outside the Hobbs Field because of the nature of the geology and the approach used for injection. First, as indicated in Section 2.2.1 "Geology of the Hobbs Field," the Hobbs Field is situated above the highest elevation within the San Andres. This means that over long periods of time, injected CO_2 will tend to rise vertically towards the Upper San Andres and Basal Grayburg and continue towards the point in the Hobbs Field with the highest elevation. Second, the planned injection volumes and active fluid management during injection operations will prevent CO_2 from migrating laterally out of the structure. Finally, Oxy will not be increasing the total volume of fluids in the Hobbs Field. Based on site characterization and planned and projected operations Oxy estimates the total volume of stored CO_2 will be approximately 27.6% of calculated capacity.

4.8 Drilling Through the CO_2 Area

It is possible that at some point in the future, drilling through the containment zone into the San Andres could occur and inadvertently create a leakage pathway. Oxy's review of this issue concludes that this risk is very low for three reasons. First, any wells drilled in the oil fields of New Mexico are regulated by NMOCD and are subject to requirements that fluids be contained in strata in which they are encountered.[8] Second, Oxy's visual inspection process, including routine site visits, is designed to identify unapproved drilling activity in the Hobbs Field. Third, Oxy plans to operate the CO_2 EOR flood in the Hobbs Field for several more decades, and will continue to be vigilant about protecting the integrity of its assets and maximizing the potential of resources (oil, gas, CO_2). In the unlikely event Oxy would sell the Field to a new operator, provisions would result in a change to the reporting program and would be addressed at that time.

4.9 Diffuse Leakage through the Seal

Diffuse leakage through the seal formed by the upper Grayburg is highly unlikely. The presence of a gas cap trapped over millions of years as discussed in Section 2.2.3 confirms that the seal has been secure for a very long time. Injection pattern monitoring program referenced in Section 2.3.1 and detailed in Section 5 assures that no breach of the seal will be created. The seal is highly impermeable where unperforated, cemented across the horizon where perforated by wells, and unexplained changes in injection pressure would trigger investigation as to the cause. Further, if CO_2 were to migrate through the Grayburg

[8] Current requirements are referenced in Appendix 6.

seal, it would migrate vertically until it encountered and was trapped by any of the additional shallower seals indicated in orange in Figure 4, Section 2.2.1.

4.10 Monitoring, Response, and Reporting Plan for CO_2 Loss

As discussed above, the potential sources of leakage include fairly routine issues, such as problems with surface equipment (pumps, valves, etc.) or subsurface equipment (well bores), and unique events such as induced fractures. Table 3 summarizes some of these potential leakage scenarios, the monitoring activities designed to detect those leaks, Oxy's standard response, and other applicable regulatory programs requiring similar reporting.

Sections 5.1.5 - 5.1.7 discuss the approaches envisioned for quantifying the volumes of leaked CO_2. Given the uncertainty concerning the nature and characteristics of leaks that will be encountered, the most appropriate methods for quantifying the volume of leaked CO_2 will be determined at the time. In the event leakage occurs, Oxy plans to determine the most appropriate methods for quantifying the volume leaked and will report it as required as part of the annual Subpart RR submission.

Any volume of CO_2 detected leaking to surface will be quantified using acceptable emission factors such as those found in 40 CFR Part 98 Subpart W or engineering estimates of leak amounts based on measurements in the subsurface, Oxy's field experience, and other factors such as the frequency of inspection. As indicated in Sections 5.1 and 7.4, leaks will be documented, evaluated and addressed in a timely manner. Records of leakage events will be retained in the electronic environmental documentation and reporting system. Repairs requiring a work order will be documented in the electronic equipment maintenance system.

Table 3 Response Plan for CO_2 Loss

Risk	Monitoring Plan	Response Plan	Parallel Reporting (if any)
Loss of Well Control			
Tubing Leak	Monitor changes in annulus pressure; MIT for injectors	Workover crews respond within days	NMOCD
Casing Leak	Routine Field inspection; MIT for injectors; extra attention to high risk wells	Workover crews respond within days	NMOCD
Wellhead Leak	Routine Field inspection	Workover crews respond within days	NMOCD
Loss of Bottom-hole pressure control	Blowout during well operations	Maintain well kill procedures	NMOCD

Unplanned wells drilled through San Andres	Routine Field inspection to prevent unapproved drilling; compliance with NMOCD permitting for planned wells.	Assure compliance with NMOCD regulations	NMOCD Permitting
Loss of seal in abandoned wells	Reservoir pressure in WAG headers; high pressure found in new wells	Re-enter and reseal abandoned wells	NMOCD
Leaks in Surface Facilities			
Pumps, values, etc.	Routine Field inspection	Workover crews respond within days	Subpart W
Subsurface Leaks			
Leakage along faults	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near faults	-
Overfill beyond spill points	Reservoir pressure in WAG headers; high pressure found in new wells	Fluid management along lease lines	-
Leakage through induced fractures	Reservoir pressure in WAG headers; high pressure found in new wells	Comply with rules for keeping pressures below parting pressure	-
Leakage due to seismic event	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near seismic event	-

Available studies of actual well leaks and natural analogs (e.g., naturally occurring CO_2 geysers) suggest that the amount released from routine leaks would be small as compared to the amount of CO_2 that would remain stored in the formation.[9]

4.11 Summary

The structure and stratigraphy of the San Andres reservoir in the Hobbs Field is ideally suited for the injection and storage of CO_2. The stratigraphy within the CO_2 injection zones is porous, permeable and very thick, providing ample capacity for long-term CO_2 storage. The San Andres formation is overlain by several intervals of impermeable geologic zones that form effective seals or "caps" to fluids in the San Andres formation (See Figure 4). After assessing potential risk of release from the subsurface and steps that have been taken to prevent leaks, Oxy has determined that the potential threat of leakage is extremely low.

In summary, based on a careful assessment of the potential risk of release of CO_2 from the subsurface, Oxy has determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere. Further, given the detailed knowledge of the Field and its operating protocols, Oxy concludes that it would be able to both detect and quantify any CO_2 leakage to the surface that could arise through either identified or unexpected leakage pathways.

[9] See references to following reports of measurements, assessments, and analogs in Appendix 4: IPCC Special Report on Carbon Dioxide Capture and Storage; Wright – Presentation to UNFCC SBSTA on CCS; Allis, R., et al, "Implications of results from CO2 flux surveys over known CO2 systems for long-term monitoring; McLing - Natural Analog CCS Site Characterization Soda Springs, Idaho Implications for the Long-term Fate of Carbon Dioxide Stored in Geologic Environments.

5. Monitoring and Considerations for Calculating Site Specific Variables

5.1 For the Mass Balance Equation

5.1.1 General Monitoring Procedures

As part of its ongoing operations, Oxy monitors and collects flow, pressure, and gas composition data from the Hobbs Field in centralized data management systems. These data are monitored continually by qualified technicians who follow Oxy response and reporting protocols when the systems deliver notifications that data exceed statistically acceptable boundaries.

As indicated in Figures 10 and 11, custody-transfer meters are used at the two points at which custody of the CO_2 from the Permian pipeline delivery system is transferred to Oxy, at the points at which custody of oil and NGLs are transferred to outside parties, and on both sides of the fluid transfer point between NHU and SHU. Meters measure flow rate continually. Fluid composition will be determined, at a minimum, quarterly, consistent with EPA GHGRP's Subpart RR, section 98.447(a). All meter and composition data are documented, and records will be retained for at least three years.

Metering protocols used by Oxy follow the prevailing industry standard(s) for custody transfer as currently promulgated by the API, the American Gas Association (AGA), and the Gas Processors Association (GPA), as appropriate. This approach is consistent with EPA GHGRP's Subpart RR, section 98.444(e)(3). These meters will be maintained routinely, operated continually, and will feed data directly to the centralized data collection systems. The meters meet the industry standard for custody transfer meter accuracy and calibration frequency. These custody meters provide the most accurate way to measure mass flows.

Historically, there is an immaterial difference between the NHU and SHU custody transfer meter measurements of fluids transferred from the NHU to the SHU that is attributed to calibration error. The fluids from the NHU move directly into the pipeline entering the SHU RCF and are co-mingled with other produced fluids from the SHU. Because this volume of gas is contained within the Hobbs Field it is part of the overall mass balance but is not calculated separately. This will be discussed further in this section and within Section 7.

Oxy maintains in-field process control meters to monitor and manage in-field activities on a real time basis. These are identified as operations meters in Figures 10 and 11. These meters provide information used to make operational decisions but are not intended to provide the same level of accuracy as the custody-transfer meters. The level of precision and accuracy for in-field meters currently satisfies the requirements for reporting in existing UIC permits. Although these meters are accurate for operational purposes, it is important to note that there is some variance between most commercial meters (on the order of 1-5%) which is additive across meters. This variance is due to differences in factory settings and meter calibration, as well as the operating conditions within a field. Meter elevation, changes in temperature (over the course of the day), fluid composition (especially in multi-component or multi-phase streams), or pressure can affect in-field meter readings. Unlike in a saline formation, where there are likely to be only a few injection wells and associated meters, at CO_2 EOR operations in the Hobbs Field there are currently 445 active injection and production wells and a comparable number of meters, each with an acceptable range of error. This is a site-specific factor that is considered in the mass balance calculations described in Section 7.

5.1.2 CO_2 Received

Oxy measures the volume of received CO_2 using commercial custody transfer meters at each of the two off-take points from the Permian pipeline delivery system and at the point of transfer between the NHU and the SHU. This transfer is a commercial transaction that is documented. CO_2 composition is governed by the contract and the gas is routinely sampled to determine composition. No CO_2 is received in containers.

5.1.3 CO_2 Injected into the Subsurface

Injected CO_2 will be calculated using the flow meter volumes at the operations meter at the outlet of the RCFs and the custody transfer meter at the CO_2 off-take points from the Permian pipeline delivery system

5.1.4 CO_2 Produced, Entrained in Products, and Recycled

The following measurements are used for the mass balance equations in Section 7:

CO_2 produced is calculated using the volumetric flow meters at the inlet to an RCF.

CO_2 is produced as entrained or dissolved CO_2 in produced oil, as indicated in Figures 10 and 11. The concentration of CO_2 in produced oil is measured at the custody transfer meter.

Recycled CO_2 is calculated using the volumetric flow meter at the outlet of the RCFs, which is an operations meter.

5.1.5 CO_2 Emitted by Surface Leakage

As discussed in Section 5.1.6 and 5.1.7 below, Oxy uses 40 CFR Part 98 Subpart W to estimate surface leaks from equipment at the Hobbs Field. Subpart W uses a factor-driven approach to estimate equipment leakage. In addition, Oxy uses an event-driven process to assess, address, track, and if applicable quantify potential CO_2 leakage to the surface. Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

The multi-layered, risk-based monitoring program for event-driven incidents has been designed to meet two objectives, in accordance with the leakage risk assessment in Section 4: 1) to detect problems before CO_2 leaks to the surface; and 2) to detect and quantify any leaks that do occur. This section discusses how this monitoring will be conducted and used to quantify the volumes of CO_2 leaked to the surface.

Monitoring for potential Leakage from the Injection/Production Zone:
Oxy will monitor both injection into and production from the reservoir as a means of early identification of potential anomalies that could indicate leakage from the subsurface.

Oxy uses reservoir simulation modeling, based on extensive history-matched data, to develop injection plans (fluid rate, pressure, volume) that are programmed into each WAG satellite. If injection pressure or rate measurements are beyond the specified set points determined as part of each pattern injection plan, a data flag is automatically triggered and field personnel will investigate and resolve the problem. These excursions will be reviewed by well-management personnel to determine if CO_2 leakage may be occurring. Excursions are not necessarily indicators of leaks; they simply indicate that injection rates and pressures are not conforming to the pattern injection plan. In many cases, problems are straightforward to fix (e.g., a meter needs to be recalibrated or some other minor action is required), and there is no threat of CO_2 leakage. In the case of issues that are not readily resolved, more detailed investigation and response would be initiated, and internal Oxy support staff would provide additional assistance and evaluation. Such issues would lead to the development of a work order in Oxy's work order management system. This record enables the company to track progress on investigating potential leaks and, if a leak has occurred, to quantify its magnitude.

Likewise, Oxy develops a forecast of the rate and composition of produced fluids. Each producer well is assigned to one satellite battery and is isolated once during each monthly cycle for a well production test. This data is reviewed on a periodic basis to confirm that production is at the level forecasted. If there is a significant deviation from the forecast, well management personnel investigate. If the issue cannot be resolved quickly, more detailed investigation and response would be initiated. As in the case of the injection pattern monitoring, if the investigation leads to a work order in the Oxy work order management system, this record will provide the basis for tracking the outcome of the investigation and if a leak has occurred, recording the quantity leaked to the surface. If leakage in the flood zone were detected, Oxy would use an appropriate method to quantify the involved volume of CO_2. This might include use of material balance equations based on known injected quantities and monitored pressures in the injection zone to estimate the volume of CO_2 involved.

A subsurface leak might not lead to a surface leak. In the event of a subsurface leak, Oxy would determine the appropriate approach for tracking subsurface leakage to determine and quantify leakage to the surface. To quantify leakage to the surface, Oxy would estimate the relevant parameters (e.g., the rate, concentration, and duration of leakage) to quantify the leak volume. Depending on specific circumstances, these determinations may rely on engineering estimates.

In the event leakage from the subsurface occurred diffusely through the seals, the leaked gas would include H_2S, which would trigger the alarm on the personal monitors worn by field personnel. Such a diffuse leak from the subsurface has not occurred in the Hobbs Field. In the event such a leak was detected, field personnel from across Oxy would determine how to address the problem. The team might use modeling, engineering estimates, and direct measurements to assess, address, and quantify the leakage.

Monitoring of Wellbores*:*

Oxy monitors wells through continual, automated pressure monitoring in the injection zone (as described in Section 4.2), monitoring of the annular pressure in wellheads, and routine maintenance and inspection.

Leaks from wellbores would be detected through the follow-up investigation of pressure anomalies, visual inspection, or the use of personal H_2S monitors.

Anomalies in injection zone pressure may not indicate a leak, as discussed above. However, if an investigation leads to a work order, field personnel would inspect the equipment in question and determine the nature of the problem. If it is a simple matter, the repair would be made and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repair were needed, Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Anomalies in annular pressure or other issues detected during routine maintenance inspections would be treated in the same way. Field personnel would inspect the equipment in question and determine the nature of the problem. For simple matters the repair would be made at the time of inspection and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repairs were needed, a work order would be generated and Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Because leaking CO_2 at the surface is very cold and leads to formation of bright white clouds and ice that are easily spotted, Oxy also employs a two-part visual inspection process in the general area of the Hobbs Field to detect unexpected releases from wellbores. First, field personnel visit the surface facilities on a routine basis. Inspections may include tank volumes, equipment status and reliability, lube oil levels, pressures and flow rates in the facility, and valve leaks. Field personnel inspections also check that injectors are on the proper WAG schedule and observe the facility for visible CO_2 or fluid line leaks.

Historically, Oxy has documented on average nine unexpected release events each year in the Hobbs Field. An identified need for repair or maintenance through visual inspections results in a work order being entered into Oxy's equipment and maintenance work order management system. The time to repair any leak is dependent on several factors, such as the severity of the leak, available manpower, location of the leak, and availability of materials required for the repair. Critical leaks are acted upon immediately.

Finally, Oxy uses the data collected by the H_2S monitors, which are worn by all field personnel at all times, as a last method to detect leakage from wellbores. The H_2S monitors detection limit is 10ppm; if an H_2S alarm is triggered, the first response is to protect the safety of the personnel, and the next step is to safely investigate the source of the alarm. As noted previously, Oxy considers H_2S a proxy for potential CO_2 leaks in the field. Thus, detected H_2S leaks will be investigated to determine and, if needed, quantify potential CO_2 leakage. If the incident results in a work order, this will serve as the basis for tracking the event for GHG reporting.

Additional Safeguards and Monitoring under SFRM Program:
As described above, because of the presence of H_2S and proximity to the City of Hobbs, Oxy screens all well locations and surface equipment to determine when to apply the SFRM program. Under the SFRM, Oxy voluntarily applies additional provisions for design and operation of facilities. The SFRM program is intended to further mitigate the risk of public exposure from the potential loss of well control, however, its provisions also enhance leak prevention and detection. All instances of triggered safeguards will be investigated to determine if there is CO_2 leakage.

Other Potential Leakage at the Surface:
Oxy will utilize the same visual inspection process and H_2S monitoring system to detect other potential leakage at the surface as it does for leakage from wellbores. Oxy utilizes routine visual inspections to detect significant loss of CO_2 to the surface. Field personnel routinely visit surface facilities to conduct a visual inspection. Inspections may include review of tank level, equipment status, lube oil levels, pressures and flow rates in the facility, valve leaks, ensuring that injectors are on the proper WAG schedule, and also conducting a general observation of the facility for visible CO_2 or fluid line leaks. If problems are detected, field personnel would investigate, and, if maintenance is required, generate a work order in the maintenance system, which is tracked through completion. In addition to these visual inspections, Oxy will use the results of the personal H_2S monitors worn by field personnel as a supplement for smaller leaks that may escape visual detection.

If CO_2 leakage to the surface is detected, it will be reported to surface operations personnel who will review the reports and conduct a site investigation. If maintenance is required, a work order will be generated in the work order management system. The work order will describe the appropriate corrective action and be used to track completion of the maintenance action. The work order will also serve as the basis for tracking the event for GHG reporting and quantifying any CO_2 emissions.

5.1.6 CO_2 emitted from equipment leaks and vented emissions of CO_2 from surface equipment located between the injection flow meter and the injection wellhead.

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.1.7 Mass of CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment located between the production flow meter and the production wellhead

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.2 To Demonstrate that Injected CO_2 is not Expected to Migrate to the Surface

At the end of the Specified Period, Oxy intends to cease injecting CO_2 for the subsidiary purpose of establishing the long-term storage of CO_2 in the Hobbs Field. After the end of the Specified Period, Oxy anticipates that it will submit a request to discontinue monitoring and reporting. The request will demonstrate that the amount of CO_2 reported under 40 CFR §98.440-449 (Subpart RR) is not expected to migrate in the future in a manner likely to result in surface leakage. At that time, Oxy will be able to support its request with years of data collected during the Specified Period as well as two to three (or more, if needed) years of data collected after the end of the Specified Period. This demonstration will provide the information necessary for the EPA Administrator to approve the request to discontinue monitoring and reporting and may include, but is not limited to:

i. Data comparing actual performance to predicted performance (purchase, injection, production) over the monitoring period;
ii. An assessment of the CO_2 leakage detected, including discussion of the estimated amount of CO_2 leaked and the distribution of emissions by leakage pathway;
iii. A demonstration that future operations will not release the volume of stored CO_2 to the surface;
iv. A demonstration that there has been no significant leakage of CO_2; and,
v. An evaluation of reservoir pressure in the Hobbs Field that demonstrates that injected fluids are not expected to migrate in a manner to create a potential leakage pathway.

6. Determination of Baselines

Oxy intends to utilize existing automatic data systems to identify and investigate excursions from expected performance that could indicate CO_2 leakage. Oxy's data systems are used primarily for operational control and monitoring and as such are set to capture more information than is necessary for reporting in the Annual Subpart RR Report. Oxy will develop the necessary system guidelines to capture the information that is relevant to identify possible CO_2 leakage. The following describes Oxy's approach to collecting this information.

Visual Inspections

As field personnel conduct routine inspections, work orders are generated in the electronic system for maintenance activities that cannot be addressed on the spot. Methods to capture work orders that involve activities that could potentially involve CO_2 leakage will be developed, if not currently in place. Examples include occurrences of well workover or repair, as well as visual identification of vapor clouds or ice formations. Each incident will be flagged for review by the person responsible for MRV documentation. (The responsible party will be provided in the monitoring plan, as required under Subpart A, 98.3(g).) The Annual Subpart RR Report will include an estimate of the amount of CO_2 leaked. Records of information used to calculate emissions will be maintained on file for a minimum of three years.

<u>Personal H_2S Monitors</u>

H_2S monitors are worn by all field personnel. Any monitor alarm triggers an immediate response to ensure personnel are not at risk and to verify the monitor is working properly. The person responsible for MRV documentation will receive notice of all incidents where H_2S is confirmed to be present. The Annual Subpart RR Report will provide an estimate the amount of CO_2 emitted from any such incidents. Records of information to calculate emissions will be maintained on file for a minimum of three years.

<u>Injection Rates, Pressures and Volumes</u>

Oxy develops target injection rate and pressure for each injector, based on the results of ongoing pattern modeling and within permitted limits. The injection targets are programmed into the WAG satellite controllers. High and low set points are also programmed into the controllers, and flags whenever statistically significant deviations from the targeted ranges are identified. The set points are designed to be conservative, because Oxy prefers to have too many flags rather than too few. As a result, flags can occur frequently and are often found to be insignificant. For purposes of Subpart RR reporting, flags (or excursions) will be screened to determine if they could also lead to CO_2 leakage to the surface. The person responsible for the MRV documentation will receive notice of excursions and related work orders that could potentially involve CO_2 leakage. The Annual Subpart RR Report will provide an estimate of CO_2 emissions. Records of information to calculate emissions will be maintained on file for a minimum of three years.

<u>Production Volumes and Compositions</u>

Oxy develops a general forecast of production volumes and composition which is used to periodically evaluate performance and refine current and projected injection plans and the forecast. This information is used to make operational decisions but is not recorded in an automated data system. Sometimes, this review may result in the generation of a work order in the maintenance system. The MRV plan implementation lead will review such work orders and identify those that could result in CO_2 leakage. Should such events occur, leakage volumes would be calculated following the approaches described in Sections 4 and 5. Impact to Subpart RR reporting will be addressed, if deemed necessary.

7. Determination of Sequestration Volumes Using Mass Balance Equations

To account for the site conditions and complexity of a large, active EOR operation, Oxy proposes to modify the locations for obtaining volume data for the equations in Subpart RR §98.443 as indicated below.

The first modification addresses the propagation of error that would result if volume data from meters at each injection and production well were utilized. This issue arises because while each meter has a small but acceptable margin of error, this error would become significant if data were taken from the approximately 445 meters within the Hobbs Field. As such, Oxy proposes to use the data from custody and operations meters on the main system pipelines to determine injection and production volumes used in the mass balance.

The second modification addresses the NGL sales from the NHU RCF. As indicated in Figure 10, NGL is separated from the fluid mix at the NHU RCF after it has been measured at the RCF inlet and before measurement at the RCF outlet. As a result the amount of CO_2 recycled already accounts for the amount entrained in NGL and therefore is not factored separately into the mass balance calculation.

The third modification addresses the transfer of fluids between the NHU and the SHU. For internal accounting purposes, NHU and SHU each use a custody transfer meter to track the volume transferred. Analyses of historic records show an immaterial difference between the two meter readings that is likely due to calibration differences. For accounting, one meter reading is used. The transfer takes place prior to the inlet of the RCFs and the NHU fluids are co-mingled with the other fluids going into the SHU RCF. On a net basis, the transfer does not have an impact on the material balance and there is not included in the mass balance calculation.

The following sections describe how each element of the mass-balance equation (Equation RR-11) will be calculated.

7.1. Mass of CO_2 Received

Oxy will use equation RR-2 as indicated in Subpart RR §98.443 to calculate the mass of CO_2 received from each delivery meter immediately upstream of the Permian pipeline delivery system on the Hobbs Field. The volumetric flow at standard conditions will be multiplied by the CO_2 concentration and the density of CO_2 at standard conditions to determine mass.

$$CO_{2T,r} = \sum_{p=1}^{4} (Q_{r,p} - S_{r,p}) * D * C_{CO_{2,p,r}} \qquad \text{(Eq. RR-2)}$$

where:

$CO_{2T,r}$ = Net annual mass of CO_2 received through flow meter r (metric tons).

$Q_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r in quarter p at standard conditions (standard cubic meters).

$S_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r that is redelivered to another facility without being injected into a site well in quarter p (standard cubic meters).
D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.
$C_{CO2,p,r}$ = Quarterly CO_2 concentration measurement in flow for flow meter r in quarter p (vol. percent CO_2, expressed as a decimal fraction).
p = Quarter of the year.
r = Receiving flow meters.

Given Oxy's method of receiving CO_2 and requirements at Subpart RR §98.444(a):

- All delivery to the Hobbs Field is used within each unit so quarterly flow redelivered, $S_{r,p}$, is zero ("0") and will not be included in the equation.
- Quarterly CO_2 concentration will be taken from the gas measurement database

Oxy will sum to total Mass of CO_2 Received using equation RR-3 in 98.443

$$CO_2 = \sum_{r=1}^{R} CO_{2T,r} \quad \text{(Eq. RR-3)}$$

where:

CO_2 = Total net annual mass of CO_2 received (metric tons).
$CO_{2T,r}$ = Net annual mass of CO_2 received (metric tons) as calculated in Equation RR-2 for flow meter r.
r = Receiving flow meter.

7.2 Mass of CO_2 Injected into the Subsurface

The equation for calculating the Mass of CO_2 Injected into the Subsurface at the Hobbs Field is equal to the sum of the Mass of CO_2 Received as calculated in RR-3 of 98.443 (as described in Section 7.1) and the Mass of CO_2 Recycled as calculated using measurements taken from the flow meter located at the output of the RCF. As previously explained, using data at each injection well would give an inaccurate estimate of total injection volume due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

The mass of CO_2 recycled will be determined using equations RR-5 as follows:

$$CO_{2,u} = \sum_{p=1}^{4} Q_{p,u} * D * C_{CO_{2,p,u}} \quad \text{(Eq. RR-5)}$$

where:

$CO_{2,u}$ = Annual CO_2 mass recycled (metric tons) as measured by flow meter u.
$Q_{p,u}$ = Quarterly volumetric flow rate measurement for flow meter u in quarter p at standard conditions (standard cubic meters per quarter).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,u}$ = CO_2 concentration measurement in flow for flow meter u in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

u = Flow meter.

The total Mass of CO_2 injected will be the sum of the Mass of CO_2 received (RR-3) and Mass of CO_2 recycled (modified RR-5).

$CO_{2I} = CO_2 + CO_{2,u}$

7.3 Mass of CO_2 Produced

The Mass of CO_2 Produced at the Hobbs Field will be calculated using the measurements from the flow meters at the inlet to RCF and the custody transfer meter for oil sales rather than the metered data from each production well. Again, using the data at each production well would give an inaccurate estimate of total injection due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

Equation RR-8 in 98.443 will be used to calculate the mass of CO_2 produced from all injection wells as follows:

$$CO_{2,w} = \sum_{p=1}^{4} Q_{p,w} * D * C_{CO_{2,p,w}} \quad \text{(Eq. RR-8)}$$

Where:

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) .

$Q_{p,w}$ = Volumetric gas flow rate measurement for meter w in quarter p at standard conditions (standard cubic meters).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,w}$ = CO_2 concentration measurement in flow for meter w in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

w = inlet meter to RCF.

Equation RR-9 in 98.443 will be used to aggregate the mass of CO_2 produced net of the mass of CO_2 entrained in oil leaving the Hobbs Field prior to treatment of the remaining gas fraction in RCF as follows:

$$CO_{2P} = \sum_{w=1}^{W} CO_{2,w} + X_{oil} \quad \text{(Eq. RR-9)}$$

Where:

CO_{2P} = Total annual CO_2 mass produced (metric tons) through all meters in the reporting year.

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) through meter w in the reporting year.

X_{oil} = Mass of entrained CO_2 in oil in the reporting year measured utilizing commercial meters and electronic flow-measurement devices at each point of custody transfer. The mass of CO_2 will be calculated by multiplying the total volumetric rate by the CO_2 concentration.

7.4 Mass of CO_2 emitted by Surface Leakage

Oxy will calculate and report the total annual Mass of CO_2 emitted by Surface Leakage using an approach that is tailored to specific leakage events and relies on 40 CFR Part 98 Subpart W reports of equipment leakage. As described in Sections 4 and 5.1.5-5.1.7, Oxy is prepared to address the potential for leakage in a variety of settings. Estimates of the amount of CO_2 leaked to the surface will likely depend on a number of site-specific factors including measurements, engineering estimates, and emission factors, depending on the source and nature of the leakage.

Oxy's process for quantifying leakage will entail using best engineering principles or emission factors. While it is not possible to predict in advance the types of leaks that will occur, Oxy describes some approaches for quantification in Section 5.1.5-5.1.7. In the event leakage to the surface occurs, Oxy would quantify and report leakage amounts, and retain records that describe the methods used to estimate or measure the volume leaked as reported in the Annual Subpart RR Report. Further, Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

Equation RR-10 in 48.433 will be used to calculate and report the Mass of CO_2 emitted by Surface Leakage:

$$CO_{2E} = \sum_{x=1}^{X} CO_{2,x} \quad \text{(Eq. RR-10)}$$

where:

CO_{2E} = Total annual CO_2 mass emitted by surface leakage (metric tons) in the reporting year.

$CO_{2,x}$ = Annual CO_2 mass emitted (metric tons) at leakage pathway x in the reporting year.

x = Leakage pathway.

7.5 Mass of CO_2 sequestered in subsurface geologic formations.

Oxy will use equation RR-11 in 98.443 to calculate the Mass of CO_2 Sequestered in Subsurface Geologic Formations in the Reporting Year as follows:

$$CO_2 = CO_{2I} - CO_{2P} - CO_{2E} - CO_{2FI} - CO_{2FP} \quad \text{(Eq. RR-11)}$$

where:

CO_2 = Total annual CO_2 mass sequestered in subsurface geologic formations (metric tons) at the facility in the reporting year.

CO_{2I} = Total annual CO_2 mass injected (metric tons) in the well or group of wells covered by this source category in the reporting year.

CO_{2P} = Total annual CO_2 mass produced (metric tons) net of CO_2 entrained in oil in the reporting year.

CO_{2E} = Total annual CO_2 mass emitted (metric tons) by surface leakage in the reporting year.

CO_{2FI} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead, for which a calculation procedure is provided in subpart W of this part.

CO_{2FP} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity, for which a calculation procedure is provided in subpart W of this part.

7.6 Cumulative mass of CO_2 reported as sequestered in subsurface geologic formations

Oxy will sum up the total annual volumes obtained using equation RR-11 in 98.443 to calculate the Cumulative Mass of CO_2 Sequestered in Subsurface Geologic Formations.

8. MRV Plan Implementation Schedule

It is anticipated that this MRV plan will be implemented by April 1, 2017 or within 90 days of EPA approval, whichever occurs later. Other GHG reports are filed on March 31 of the year after the reporting year and it is anticipated that the Annual Subpart RR Report will be filed at the same time. As described in Section 3.3 above, Oxy anticipates that the MRV program will be in effect during the Specified Period, during which time Oxy will operate the Hobbs Units with the subsidiary purpose of establishing long-term containment of a measurable quantity of CO_2 in subsurface geological formations at the Hobbs Field. Oxy anticipates establishing that a measurable amount of CO_2 injected during the Specified Period will be stored in a manner not expected to migrate resulting in future surface leakage. At such time, Oxy will prepare a demonstration supporting the long-term containment determination and submit a request to discontinue reporting under this MRV plan. *See* 40 C.F.R. § 98.441(b)(2)(ii).

9. Quality Assurance Program

9.1 Monitoring QA/QC

As indicated in Section 7, Oxy has incorporated the requirements of §98.444 (a) – (d) in the discussion of mass balance equations. These include the following provisions.

CO_2 Received and Injected

- The quarterly flow rate of CO_2 received by pipeline is measured at the receiving custody transfer meters.
- The quarterly CO_2 flow rate for recycled CO_2 is measured at the flow meter located at the RCF outlet.

CO_2 Produced

- The point of measurement for the quantity of CO_2 produced from oil or other fluid production wells is a flow meter directly downstream of each separator that sends a stream of gas into a recycle or end use system.
- The produced gas stream is sampled at least once per quarter immediately downstream of the flow meter used to measure flow rate of that gas stream and measure the CO_2 concentration of the sample.
- The quarterly flow rate of the produced gas is measured at the flow meters located at the RCF inlet.

CO_2 emissions from equipment leaks and vented emissions of CO_2

These volumes are measured in conformance with the monitoring and QA/QC requirements specified in subpart W of 40 CFR Part 98.

Flow meter provisions

The flow meters used to generate date for the mass balance equations in Section 7 are:

- Operated continuously except as necessary for maintenance and calibration.
- Operated using the calibration and accuracy requirements in 40 CFR §98.3(i).
- Operated in conformance with American Petroleum Institute (API) standards.
- National Institute of Standards and Technology (NIST) traceable.

Concentration of CO_2

As indicated in Appendix 1, CO_2 concentration is measured using an appropriate standard method. Further, all measured volumes of CO_2 have been converted to standard cubic meters at a temperature of 60 degrees Fahrenheit and at an absolute pressure of 1 atmosphere, including those used in Equations RR-2, RR-5 and RR-8 in Section 7.

9.2 Missing Data Procedures

In the event Oxy is unable to collect data needed for the mass balance calculations, procedures for estimating missing data in §98.445 will be used as follows:

- A quarterly flow rate of CO_2 received that is missing would be estimated using invoices or using a representative flow rate value from the nearest previous time period.
- A quarterly CO_2 concentration of a CO_2 stream received that is missing would be estimated using invoices or using a representative concentration value from the nearest previous time period.
- A quarterly quantity of CO_2 injected that is missing would be estimated using a representative quantity of CO_2injected from the nearest previous period of time at a similar injection pressure.
- For any values associated with CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment at the facility that are reported in this subpart, missing data estimation procedures specified in subpart W of 40 CFR Part 98 would be followed.
- The quarterly quantity of CO_2 produced from subsurface geologic formations that is missing would be estimated using a representative quantity of CO_2 produced from the nearest previous period of time.

9.3 MRV Plan Revisions

In the event there is a material change to the monitoring and/or operational parameters of the Oxy CO_2 EOR operations in the Hobbs Field that is not anticipated in this MRV plan, the MRV plan will be revised and submitted to the EPA Administrator within 180 days as required in §98.448(d).

10. Records Retention

Oxy will follow the record retention requirements specified by §98.3(g). In addition, it will follow the requirements in Subpart RR §98.447 by maintaining the following records for at least three years:

- Quarterly records of CO_2 received at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of produced CO_2, including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of injected CO_2 including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Annual records of information used to calculate the CO_2 emitted by surface leakage from leakage pathways.

- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead.
- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity.

These data will be collected as generated and aggregated as required for reporting purposes.

11. Appendices

Appendix 1. Conversion Factors

Oxy reports CO_2 volumes at standard conditions of temperature and pressure as defined in the State of New Mexico – 60 ^oF and 15.025 psi.

To convert these volumes into metric tonnes, a density is calculated using the Span and Wagner equation of state as recommended by the EPA. Density was calculated using the database of thermodynamic properties developed by the National Institute of Standards and Technology (NIST), available at http://webbook.nist.gov/chemistry/fluid/.

At State of New Mexico standard conditions, the Span and Wagner equation of state gives a density of 0.0027097 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.40921 x 10^{-2} MT/Mcf or 0.0019102 MT/m^3.

Note at EPA standard conditions of 60 ^oF and one atmosphere, the Span and Wagner equation of state gives a density of 0.0026500 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.29003×10^{-5} MT/ft^3 or 0.0018682 MT/m^3.

The conversion factor 5.40921×10^{-2} MT/Mcf has been used throughout to convert Oxy volumes to metric tons.

Appendix 2. Acronyms

AGA – American Gas Association
AMA – Active Monitoring Area
AoR – Area of Review
API – American Petroleum Institute
Bscf – billion standard cubic feet
B/D – barrels per day
bopd – barrels of oil per day
cf – cubic feet
CH_4 – Methane
CO_2 – Carbon Dioxide
CRP – CO_2 Removal Plant
CTB – Central Tank Battery
DOT – US Department of Transportation
EOR – Enhanced Oil Recovery
EPA – US Environmental Protection Agency
EMNRD – New Mexico Energy, Minerals, and Natural Resources Department
ESD – Emergency Shutdown Device
GHG – Greenhouse Gas
GHGRP – Greenhouse Gas Reporting Program
HC – Hydrocarbon
H_2S – Hydrogen Sulfide
IWR -- Injection to Withdrawal Ratio
LACT – Lease Automatic Custody Transfer meter
LEL – Lower Explosive Limit
MIT – Mechanical Integrity Test
MMA – Maximum Monitoring Area
MMB – Million barrels
Mscf – Thousand standard cubic feet
MMscf – Million standard cubic feet
MMMT – Million metric tonnes
MMT – Thousand metric tonnes
MRV – Monitoring, Reporting, and Verification
MT -- Metric Tonne
NG—Natural Gas
NGLs – Natural Gas Liquids
OOIP – Original Oil-In-Place
OPC – Occidental Petroleum Corporation
OPL – Occidental Petroleum Ltd.
OPS – Office of Pipeline Safety
PHMSA – Pipeline and Hazardous Materials Safety Administration
PPM – Parts Per Million
RCF – Hobbs Field CO_2 Recycling and Compression Facility
ROZ – Residual Oil Zone
SACROC – Scurry Area Canyon Reef Operators Committee

ST – Short Ton
TSD – Technical Support Document
TVDSS – True Vertical Depth Subsea
TZ – Transition Zone
UIC – Underground Injection Control
USEPA – U.S. Environmental Protection Agency
USDW – Underground Source of Drinking Water
VRU -- Vapor Recovery Unit
WAG – Water Alternating Gas

Appendix 3. References

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Appendix 4. Glossary of Terms

This glossary describes some of the technical terms as they are used in this MRV plan. For additional glossaries please see the U.S. EPA Glossary of UIC Terms (http://water.epa.gov/type/groundwater/uic/glossary.cfm) and the Schlumberger Oilfield Glossary (http://www.glossary.oilfield.slb.com/).

Anhydrite -- Anhydrite is a mineral—anhydrous calcium sulfate, $CaSO_4$.

Bradenhead -- a casing head in an oil well having a stuffing box packed (as with rubber) to make a gastight connection
Contain / Containment – having the effect of keeping fluids located within in a specified portion of a geologic formation.

Dip -- Very few, if any, geologic features are perfectly horizontal. They are almost always tilted. The direction of tilt is called "dip." Dip is the angle of steepest descent measured from the horizontal plane. Moving higher up structure is moving "updip." Moving lower is "downdip." Perpendicular to dip is "strike." Moving perpendicular along a constant depth is moving along strike.

Dolomite -- Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate $CaMg(CO_3)_2$.

Downdip -- See "dip."

Formation -- A body of rock that is sufficiently distinctive and continuous that it can be mapped. At Wasson, for example, San Andres formation is a layer of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. The San Andres can be mapped over much of the Permian Basin.

Igneous Rocks -- Igneous rocks crystallize from molten rock, or magma, with interlocking mineral crystals.

Infill Drilling -- The drilling of additional wells within existing patterns. These additional wells decrease average well spacing. This practice both accelerates expected recovery and increases estimated ultimate recovery in heterogeneous reservoirs by improving the continuity between injectors and producers. As well spacing is decreased, the shifting flow paths lead to increased sweep to areas where greater hydrocarbon saturations remain.

Metamorphic Rocks -- Metamorphic rocks form from the alteration of preexisting rocks by changes in ambient temperature, pressure, volatile content, or all of these. Such changes can occur through the activity of fluids in the Earth and movement of igneous bodies or regional tectonic activity.

Permeability -- Permeability is the measure of a rock's ability to transmit fluids. Rocks that transmit fluids readily, such as sandstones, are described as permeable and tend to have many large, well-connected pores. Impermeable formations, such as shales and siltstones, tend to be finer grained or of a mixed grain size, with smaller, fewer, or less interconnected pores.

Phase -- Phase is a region of space throughout which all physical properties of a material are essentially uniform. Fluids that don't mix together segregate themselves into phases. Oil, for example, does not mix with water and forms a separate phase.

Pore Space -- See porosity.

Porosity -- Porosity is the fraction of a rock that is not occupied by solid grains or minerals. Almost all rocks have spaces between rock crystals or grains that is available to be filled with a fluid, such as water, oil or gas. This space is called "pore space."

Primary recovery -- The first stage of hydrocarbon production, in which natural reservoir energy, such as gas drive, water drive or gravity drainage, displaces hydrocarbons from the reservoir, into the wellbore and up to surface. Initially, the reservoir pressure is considerably higher than the bottomhole pressure inside the wellbore. This high natural differential pressure drives hydrocarbons toward the well and up to surface. However, as the reservoir pressure declines because of production, so does the differential pressure. To reduce the bottomhole pressure or increase the differential pressure to increase hydrocarbon production, it is necessary to implement an artificial lift system, such as a rod pump, an electrical submersible pump or a gas-lift installation. Production using artificial lift is considered primary recovery. The primary recovery stage reaches its limit either when the reservoir pressure is so low that the production rates are not economical, or when the proportions of gas or water in the production stream are too high. During primary recovery, only a small percentage of the initial hydrocarbons in place are produced, typically around 10% for oil reservoirs. Primary recovery is also called primary production.

Saturation -- The fraction of pore space occupied by a given fluid. Oil saturation, for example, is the fraction of pore space occupied by oil.

Seal – A geologic layer (or multiple layers) of impermeable rock that serve as a barrier to prevent fluids from moving upwards to the surface.

Secondary recovery -- The second stage of hydrocarbon production during which an external fluid such as water or gas is injected into the reservoir through injection wells located in rock that has fluid communication with production wells. The purpose of secondary recovery is to maintain reservoir pressure and to displace hydrocarbons toward the wellbore. The most common secondary recovery techniques are gas injection and waterflooding.

Sedimentary Rocks -- Sedimentary rocks are formed at the Earth's surface through deposition of sediments derived from weathered rocks, biogenic activity or precipitation from solution. There are three main types of rocks – igneous, metamorphic and sedimentary.

Stratigraphic section -- A stratigraphic section is a sequence of layers of rocks in the order they were deposited.

Strike -- See “dip.”

Updip -- See “dip.”

Appendix 5. Well Identification Numbers

The following table presents the well name, API number, status and type for the wells in the Hobbs Units as of August 2016. The table is subject to change over time as new wells are drilled, existing wells change status, or existing wells are repurposed. The following terms are used:

- Well Status
  - ACTIVE refers to active wells
  - DRILL refers to wells under construction
  - P&A refers to wells that have been closed (plugged and abandoned) per NMOCD regulations
  - TA refers to wells that have been temporarily abandoned
  - SHUT_IN refers to wells that have been temporarily idled or shut-in
  - INACTIVE refers to wells that have been completed but are not in use
- Well Type
  - INJ_WAG refers to wells that inject water and CO_2 Gas
  - INJ_H2O refers to wells that inject water
  - PROD_GAS refers to wells that produce natural gas
  - PROD_OIL refers to wells that produce oil

Well Name	API Number	Well Type	Well Status
NHSAU 111-19	30025073560000	PROD_OIL	P & A
NHSAU 111-20	30025073750000	PROD_OIL	ACTIVE
NHSAU 111-24	30025054770000	INJ_WAG	ACTIVE
NHSAU 111-25	30025054910000	INJ_WAG	ACTIVE
NHSAU 111-27	30025233750000	INJ_H2O	P & A
NHSAU 111-28	30025074220000	INJ_WAG	ACTIVE
NHSAU 111-29	30025239190000	PROD_OIL	ACTIVE
NHSAU 111-30	30025070770000	INJ_WAG	ACTIVE
NHSAU 111-31	30025075110000	PROD_OIL	ACTIVE
NHSAU 111-32	30025075280000	PROD_OIL	ACTIVE
NHSAU 111-33	30025125050000	INJ_WAG	ACTIVE
NHSAU 112-19	30025073580000	INJ_WAG	ACTIVE
NHSAU 112-30	30025290630000	INJ_WAG	ACTIVE
NHSAU 112-32	30025075260000	INJ_WAG	ACTIVE
NHSAU 113-30	30025290640000	INJ_WAG	ACTIVE
NHSAU 114-33	30025232070000	PROD_OIL	TA
NHSAU 121-13	30025054400000	PROD_OIL	TA
NHSAU 121-17	30025073330000	PROD_OIL	P & A
NHSAU 121-19	30025073570000	PROD_OIL	ACTIVE

NHSAU 121-20	30025073780000	PROD_OIL	P & A
NHSAU 121-23	30025054620000	PROD_OIL	P & A
NHSAU 121-24	30025054760000	INJ_WAG	ACTIVE
NHSAU 121-25	30025055020000	INJ_WAG	P & A
NHSAU 121-27	30025124940000	PROD_OIL	ACTIVE
NHSAU 121-28	30025074200000	PROD_OIL	ACTIVE
NHSAU 121-29	30025074490000	PROD_OIL	ACTIVE
NHSAU 121-30	30025074640000	PROD_OIL	ACTIVE
NHSAU 121-31	30025075140000	INJ_WAG	ACTIVE
NHSAU 121-32	30025230070000	PROD_OIL	ACTIVE
NHSAU 121-33	30025075590000	PROD_OIL	ACTIVE
NHSAU 122-28	30025289640000	PROD_OIL	ACTIVE
NHSAU 122-29	30025289530000	INJ_WAG	ACTIVE
NHSAU 123-33	30025232630000	PROD_OIL	ACTIVE
NHSAU 131-13	30025054480000	PROD_OIL	TA
NHSAU 131-17	30025073360000	INJ_H2O	P & A
NHSAU 131-18	30025073390000	PROD_OIL	P & A
NHSAU 131-19	30025073610000	INJ_WAG	ACTIVE
NHSAU 131-20	30025232060000	INJ_WAG	ACTIVE
NHSAU 131-21	30025073930000	PROD_OIL	P & A
NHSAU 131-24	30025054840000	INJ_WAG	ACTIVE
NHSAU 131-27	30025074100000	PROD_OIL	ACTIVE
NHSAU 131-28	30025124970000	INJ_WAG	ACTIVE
NHSAU 131-29	30025074470000	PROD_OIL	ACTIVE
NHSAU 131-30	30025074810000	INJ_WAG	INACTIVE
NHSAU 131-31	30025075090000	PROD_OIL	TA
NHSAU 131-32	30025075270000	INJ_WAG	ACTIVE
NHSAU 131-33	30025075440000	PROD_OIL	ACTIVE
NHSAU 132-28	30025232770000	PROD_OIL	ACTIVE
NHSAU 132-29	30025269170000	INJ_WAG	ACTIVE
NHSAU 132-32	30025271390000	INJ_WAG	ACTIVE
NHSAU 141-13	30025054370000	INJ_WAG	ACTIVE
NHSAU 141-17	30025073350000	PROD_OIL	P & A
NHSAU 141-18	30025073370000	PROD_OIL	P & A
NHSAU 141-19	30025073650000	PROD_OIL	ACTIVE
NHSAU 141-20	30025073830000	PROD_OIL	ACTIVE
NHSAU 141-21	30025073900000	PROD_OIL	TA
NHSAU 141-24	30025054850000	PROD_OIL	ACTIVE

NHSAU 141-27	30025074080000	PROD_OIL	ACTIVE
NHSAU 141-28	30025124960000	PROD_OIL	ACTIVE
NHSAU 141-29	30025074480000	INJ_WAG	ACTIVE
NHSAU 141-30	30025074870000	PROD_OIL	ACTIVE
NHSAU 141-31	30025075100000	INJ_H2O	TA
NHSAU 141-32	30025075230000	INJ_WAG	ACTIVE
NHSAU 141-33	30025075430000	PROD_OIL	ACTIVE
NHSAU 142-19	30025271380000	INJ_WAG	ACTIVE
NHSAU 142-28	30025232460000	PROD_OIL	ACTIVE
NHSAU 142-32	30025282650000	INJ_WAG	ACTIVE
NHSAU 142-33	30025284110000	INJ_WAG	ACTIVE
NHSAU 143-32	30025289430000	PROD_OIL	ACTIVE
NHSAU 144-32	30025316620000	INJ_WAG	ACTIVE
NHSAU 19-616	30025371540001	PROD_OIL	INACTIVE
NHSAU 211-13	30025054410000	PROD_OIL	P & A
NHSAU 211-19	30025073590000	PROD_OIL	TA
NHSAU 211-23	30025054690000	INJ_WAG	ACTIVE
NHSAU 211-24	30025070470000	PROD_OIL	ACTIVE
NHSAU 211-25	30025054890000	PROD_OIL	P & A
NHSAU 211-28	30025074250000	INJ_H2O	TA
NHSAU 211-29	30025074330000	PROD_OIL	P & A
NHSAU 211-30	30025074630000	PROD_OIL	ACTIVE
NHSAU 211-31	30025075030000	PROD_OIL	TA
NHSAU 211-32	30025075250000	PROD_OIL	ACTIVE
NHSAU 211-33	30025075640000	INJ_WAG	ACTIVE
NHSAU 211-34	30025075790000	PROD_OIL	TA
NHSAU 211-36	30025055420000	INJ_WAG	ACTIVE
NHSAU 212-19	30025288800000	PROD_OIL	TA
NHSAU 212-24	30025291290000	INJ_WAG	ACTIVE
NHSAU 212-32	30025302580000	PROD_OIL	ACTIVE
NHSAU 212-33	30025290260000	INJ_WAG	ACTIVE
NHSAU 213-33	30025290650000	PROD_OIL	ACTIVE
NHSAU 221-13	30025054390000	INJ_H2O	TA
NHSAU 221-19	30025073550000	PROD_OIL	ACTIVE
NHSAU 221-20	30025073770000	PROD_OIL	TA
NHSAU 221-23	30025054700000	PROD_OIL	ACTIVE
NHSAU 221-24	30025098760000	PROD_OIL	ACTIVE
NHSAU 221-25	30025054960000	PROD_OIL	TA

NHSAU 221-27	30025309100000	INJ_H2O	P & A
NHSAU 221-28	30025074290000	INJ_WAG	ACTIVE
NHSAU 221-29	30025074300000	PROD_OIL	TA
NHSAU 221-30	30025074620000	PROD_OIL	ACTIVE
NHSAU 221-31	30025075040000	PROD_OIL	TA
NHSAU 221-32	30025075200000	PROD_OIL	TA
NHSAU 221-33	30025075600000	INJ_WAG	INACTIVE
NHSAU 221-34	30025075780000	PROD_OIL	TA
NHSAU 222-29	30025269340000	INJ_WAG	ACTIVE
NHSAU 222-30	30025268330000	INJ_WAG	ACTIVE
NHSAU 222-32	30025271400000	INJ_WAG	ACTIVE
NHSAU 222-33	30025269750000	INJ_WAG	ACTIVE
NHSAU 223-30	30025285550000	INJ_WAG	ACTIVE
NHSAU 223-32	30025289440000	INJ_WAG	ACTIVE
NHSAU 231-14	30025054510000	INJ_H2O	TA
NHSAU 231-18	30025073410000	PROD_OIL	P & A
NHSAU 231-19	30025073620000	INJ_WAG	ACTIVE
NHSAU 231-20	30025073820000	PROD_OIL	ACTIVE
NHSAU 231-23	30025054710000	INJ_WAG	ACTIVE
NHSAU 231-24	30025054830000	PROD_OIL	ACTIVE
NHSAU 231-25	30025054980000	PROD_OIL	TA
NHSAU 231-27	30025124950000	PROD_OIL	TA
NHSAU 231-28	30025074210000	INJ_WAG	ACTIVE
NHSAU 231-29	30025074380000	PROD_OIL	ACTIVE
NHSAU 231-30	30025074790000	PROD_OIL	TA
NHSAU 231-31	30025075070000	PROD_OIL	ACTIVE
NHSAU 231-32	30025075210000	PROD_OIL	P & A
NHSAU 231-33	30025075450000	INJ_WAG	ACTIVE
NHSAU 232-19	30025291720000	INJ_WAG	ACTIVE
NHSAU 232-20	30025073840000	PROD_OIL	P & A
NHSAU 232-28	30025288820000	INJ_WAG	ACTIVE
NHSAU 232-30	30025269350000	INJ_WAG	ACTIVE
NHSAU 232-32	30025230350000	PROD_OIL	ACTIVE
NHSAU 232-33	30025268340000	INJ_WAG	ACTIVE
NHSAU 233-20	30025272140000	INJ_H2O	TA
NHSAU 233-30	30025289420000	INJ_WAG	ACTIVE
NHSAU 233-33	30025284100000	PROD_OIL	ACTIVE
NHSAU 234-33	30025292750000	PROD_OIL	ACTIVE

NHSAU 241-13	30025054360000	INJ_WAG	ACTIVE
NHSAU 241-14	30025054530000	PROD_OIL	P & A
NHSAU 241-18	30025073380000	PROD_OIL	TA
NHSAU 241-19	30025073640000	INJ_WAG	ACTIVE
NHSAU 241-20	30025124930000	PROD_OIL	ACTIVE
NHSAU 241-21	30025073910000	PROD_OIL	P & A
NHSAU 241-23	30025054720000	PROD_OIL	P & A
NHSAU 241-24	30025054820000	PROD_OIL	ACTIVE
NHSAU 241-25	30025055010000	PROD_OIL	ACTIVE
NHSAU 241-27	30025074090000	INJ_H2O	TA
NHSAU 241-28	30025124980000	PROD_OIL	ACTIVE
NHSAU 241-29	30025074370000	INJ_WAG	ACTIVE
NHSAU 241-30	30025074800000	INJ_WAG	TA
NHSAU 241-31	30025075080000	PROD_OIL	TA
NHSAU 241-32	30025075330000	PROD_OIL	ACTIVE
NHSAU 241-33	30025075470000	PROD_OIL	ACTIVE
NHSAU 242-18	30025271980000	INJ_H2O	P & A
NHSAU 242-19	30025234810000	PROD_OIL	ACTIVE
NHSAU 242-24	30025268320000	INJ_WAG	ACTIVE
NHSAU 242-28	30025292760000	INJ_WAG	ACTIVE
NHSAU 242-29	30025284130000	INJ_WAG	ACTIVE
NHSAU 242-30	30025288860000	INJ_WAG	ACTIVE
NHSAU 243-28	30025233040000	PROD_OIL	ACTIVE
NHSAU 311-18	30025073480000	PROD_OIL	P & A
NHSAU 311-19	30025073690000	INJ_WAG	ACTIVE
NHSAU 311-23	30025054640000	PROD_OIL	ACTIVE
NHSAU 311-24	30025054810000	PROD_OIL	ACTIVE
NHSAU 311-25	30025055060000	PROD_OIL	P & A
NHSAU 311-26	30025251160000	PROD_OIL	P & A
NHSAU 311-28	30025074170000	INJ_WAG	TA
NHSAU 311-29	30025074320000	PROD_OIL	ACTIVE
NHSAU 311-30	30025074690000	PROD_OIL	TA
NHSAU 311-31	30025074910000	PROD_OIL	ACTIVE
NHSAU 311-32	30025075150000	PROD_OIL	P & A
NHSAU 311-33	30025075550000	PROD_OIL	ACTIVE
NHSAU 311-34	30025125090000	PROD_OIL	TA
NHSAU 311-36	30025055410000	PROD_OIL	ACTIVE
NHSAU 312-24	30025291300000	INJ_WAG	ACTIVE

NHSAU 312-30	30025291970000	INJ_WAG	ACTIVE
NHSAU 312-31	30025270600000	INJ_WAG	ACTIVE
NHSAU 312-32	30025290170000	INJ_WAG	ACTIVE
NHSAU 312-33	30025291990000	PROD_OIL	ACTIVE
NHSAU 313-30	30025232700000	INJ_WAG	ACTIVE
NHSAU 313-32	30025302630000	PROD_OIL	ACTIVE
NHSAU 321-14	30025054570000	INJ_H2O	P & A
NHSAU 321-18	30025073450000	PROD_OIL	P & A
NHSAU 321-19	30025073600000	PROD_OIL	ACTIVE
NHSAU 321-23	30025054630000	INJ_WAG	ACTIVE
NHSAU 321-24	30025054800000	PROD_OIL	ACTIVE
NHSAU 321-25	30025055050000	PROD_OIL	ACTIVE
NHSAU 321-28	30025074160000	PROD_OIL	ACTIVE
NHSAU 321-29	30025074310000	INJ_WAG	ACTIVE
NHSAU 321-30	30025074670000	PROD_OIL	ACTIVE
NHSAU 321-31	30025074920000	PROD_OIL	ACTIVE
NHSAU 321-32	30025125060000	INJ_WAG	ACTIVE
NHSAU 321-33	30025075480000	PROD_OIL	P & A
NHSAU 321-34	30025125100000	PROD_OIL	P & A
NHSAU 321-36	30025055400000	INJ_H2O	TA
NHSAU 322-29	30025288830000	INJ_WAG	ACTIVE
NHSAU 322-31	30025302040000	INJ_WAG	ACTIVE
NHSAU 322-32	30025075180000	PROD_OIL	ACTIVE
NHSAU 322-33	30025271690000	INJ_WAG	ACTIVE
NHSAU 323-29	30025289410000	PROD_OIL	ACTIVE
NHSAU 323-32	30025269730000	INJ_WAG	ACTIVE
NHSAU 323-33	30025289510000	PROD_OIL	P & A
NHSAU 331-13	30025054470000	PROD_OIL	ACTIVE
NHSAU 331-14	30025054550000	PROD_OIL	TA
NHSAU 331-18	30025073460000	INJ_H2O	P & A
NHSAU 331-19	30025073630000	PROD_OIL	P & A
NHSAU 331-20	30025073810000	INJ_H2O	P & A
NHSAU 331-21	30025206960000	INJ_H2O	P & A
NHSAU 331-23	30025054740000	PROD_OIL	ACTIVE
NHSAU 331-24	30025054880000	INJ_WAG	ACTIVE
NHSAU 331-25	30025055000000	PROD_OIL	ACTIVE
NHSAU 331-28	30025074120000	PROD_OIL	ACTIVE
NHSAU 331-29	30025074360000	INJ_H2O	P & A

NHSAU 331-30	30025074720000	INJ_WAG	ACTIVE
NHSAU 331-31	30025074990000	PROD_OIL	ACTIVE
NHSAU 331-32	30025075380000	INJ_WAG	ACTIVE
NHSAU 331-33	30025075460000	PROD_OIL	TA
NHSAU 331-34	30025075660000	PROD_OIL	P & A
NHSAU 332-19	30025291950000	INJ_WAG	ACTIVE
NHSAU 332-28	30025316550000	INJ_WAG	ACTIVE
NHSAU 332-30	30025289540000	INJ_WAG	ACTIVE
NHSAU 332-32	30025291730000	PROD_OIL	ACTIVE
NHSAU 333-30	30025289550000	INJ_WAG	ACTIVE
NHSAU 341-13	30025054460000	PROD_OIL	ACTIVE
NHSAU 341-14	30025054500000	PROD_OIL	TA
NHSAU 341-18	30025237650000	INJ_H2O	P & A
NHSAU 341-19	30025124910000	PROD_OIL	ACTIVE
NHSAU 341-20	30025073710000	PROD_OIL	ACTIVE
NHSAU 341-21	30025073960000	PROD_OIL	P & A
NHSAU 341-23	30025054750000	INJ_WAG	ACTIVE
NHSAU 341-24	30025054900000	PROD_OIL	INACTIVE
NHSAU 341-25	30025054970000	INJ_WAG	ACTIVE
NHSAU 341-28	30025124890000	PROD_OIL	ACTIVE
NHSAU 341-29	30025074450000	PROD_OIL	ACTIVE
NHSAU 341-30	30025246650000	PROD_OIL	ACTIVE
NHSAU 341-31	30025075000000	INJ_WAG	ACTIVE
NHSAU 341-32	30025075390000	INJ_WAG	ACTIVE
NHSAU 341-33	30025127570000	PROD_OIL	TA
NHSAU 341-34	30025075670000	PROD_OIL	TA
NHSAU 342-18	30025073420000	INJ_WAG	ACTIVE
NHSAU 342-24	30025290620000	INJ_WAG	ACTIVE
NHSAU 342-28	30025299310000	PROD_OIL	ACTIVE
NHSAU 342-29	30025288840000	INJ_WAG	ACTIVE
NHSAU 342-30	30025125010000	PROD_OIL	P & A
NHSAU 342-32	30025282660000	INJ_WAG	ACTIVE
NHSAU 342-33	30025282670000	INJ_WAG	TA
NHSAU 342-34	30025281990000	PROD_OIL	P & A
NHSAU 343-32	30025299060000	PROD_OIL	ACTIVE
NHSAU 411-18	30025073490000	PROD_OIL	P & A
NHSAU 411-19	30025073700000	INJ_WAG	ACTIVE
NHSAU 411-23	30025127830000	INJ_WAG	ACTIVE

NHSAU 411-24	30025235220000	PROD_OIL	ACTIVE
NHSAU 411-25	30025055030000	PROD_OIL	P & A
NHSAU 411-26	30025055090000	INJ_H2O	P & A
NHSAU 411-28	30025074190000	PROD_OIL	P & A
NHSAU 411-29	30025074540000	INJ_H2O	TA
NHSAU 411-30	30025074700000	INJ_WAG	ACTIVE
NHSAU 411-31	30025074900000	PROD_OIL	ACTIVE
NHSAU 411-32	30025075160000	PROD_OIL	ACTIVE
NHSAU 411-33	30025075560000	PROD_OIL	TA
NHSAU 411-36	30025055390000	INJ_WAG	ACTIVE
NHSAU 412-23	30025054680000	PROD_OIL	TA
NHSAU 412-24	30025054790000	PROD_OIL	ACTIVE
NHSAU 412-30	30025233840000	PROD_OIL	ACTIVE
NHSAU 412-31	30025232040000	PROD_OIL	P & A
NHSAU 412-33	30025299320000	PROD_OIL	ACTIVE
NHSAU 413-24	30025284140000	INJ_WAG	ACTIVE
NHSAU 414-24	30025288790000	INJ_WAG	ACTIVE
NHSAU 421-14	30025054560000	PROD_OIL	ACTIVE
NHSAU 421-18	30025073470000	PROD_OIL	P & A
NHSAU 421-19	30025073680000	PROD_OIL	TA
NHSAU 421-20	30025073880000	PROD_OIL	P & A
NHSAU 421-23	30025054660000	PROD_OIL	ACTIVE
NHSAU 421-24	30025230810000	PROD_OIL	ACTIVE
NHSAU 421-25	30025055040000	PROD_OIL	ACTIVE
NHSAU 421-28	30025074180000	PROD_OIL	TA
NHSAU 421-29	30025074590000	PROD_OIL	P & A
NHSAU 421-30	30025074680000	PROD_OIL	ACTIVE
NHSAU 421-31	30025074930000	PROD_OIL	ACTIVE
NHSAU 421-32	30025125070000	PROD_OIL	ACTIVE
NHSAU 421-33	30025075540000	PROD_OIL	ACTIVE
NHSAU 421-34	30025075730000	PROD_OIL	P & A
NHSAU 421-36	30025099260000	PROD_OIL	P & A
NHSAU 422-19	30025291960000	PROD_OIL	TA
NHSAU 422-24	30025054780000	INJ_WAG	ACTIVE
NHSAU 422-25	30025269330000	INJ_WAG	ACTIVE
NHSAU 422-28	30025272430000	INJ_WAG	ACTIVE
NHSAU 422-30	30025270590000	INJ_WAG	ACTIVE
NHSAU 422-31	30025288870000	PROD_OIL	ACTIVE

NHSAU 422-32	30025290740000	INJ_WAG	ACTIVE
NHSAU 422-33	30025282680000	INJ_WAG	ACTIVE
NHSAU 423-32	30025291980000	INJ_WAG	ACTIVE
NHSAU 424-32	30025231300000	PROD_OIL	ACTIVE
NHSAU 431-13	30025054450000	INJ_WAG	ACTIVE
NHSAU 431-14	30025054540000	PROD_OIL	ACTIVE
NHSAU 431-18	30025073440000	PROD_OIL	P & A
NHSAU 431-19	30025226010000	INJ_WAG	P & A
NHSAU 431-20	30025073860000	PROD_OIL	P & A
NHSAU 431-23	30025054670000	INJ_WAG	ACTIVE
NHSAU 431-24	30025054870000	PROD_OIL	P & A
NHSAU 431-25	30025054920000	INJ_WAG	ACTIVE
NHSAU 431-28	30025074130000	PROD_OIL	ACTIVE
NHSAU 431-29	30025074580000	PROD_OIL	ACTIVE
NHSAU 431-30	30025074740000	PROD_OIL	ACTIVE
NHSAU 431-31	30025127580000	PROD_OIL	ACTIVE
NHSAU 431-32	30025075370000	INJ_WAG	ACTIVE
NHSAU 431-33	30025075530000	PROD_OIL	ACTIVE
NHSAU 431-34	30025075680000	PROD_OIL	P & A
NHSAU 432-20	30025073870000	PROD_OIL	P & A
NHSAU 432-24	30025290730000	INJ_WAG	ACTIVE
NHSAU 432-30	30025289570000	INJ_WAG	ACTIVE
NHSAU 432-32	30025269740000	INJ_WAG	ACTIVE
NHSAU 432-33	30025282690000	INJ_WAG	ACTIVE
NHSAU 433-33	30025303080000	PROD_OIL	ACTIVE
NHSAU 441-13	30025127320000	INJ_WAG	ACTIVE
NHSAU 441-14	30025250200000	PROD_OIL	TA
NHSAU 441-18	30025073430000	PROD_OIL	P & A
NHSAU 441-19	30025073660000	PROD_OIL	ACTIVE
NHSAU 441-21	30025073970000	PROD_OIL	P & A
NHSAU 441-23	30025054730000	PROD_OIL	INACTIVE
NHSAU 441-24	30025054860000	PROD_OIL	INACTIVE
NHSAU 441-25	30025054990000	INJ_WAG	ACTIVE
NHSAU 441-28	30025074110000	INJ_WAG	INACTIVE
NHSAU 441-29	30025074440000	PROD_OIL	ACTIVE
NHSAU 441-30	30025074730000	PROD_OIL	ACTIVE
NHSAU 441-31	30025074980000	PROD_OIL	TA
NHSAU 441-32	30025075360000	PROD_OIL	ACTIVE

NHSAU 441-34	30025075800000	PROD_OIL	P & A
NHSAU 442-13	30025288780000	INJ_WAG	ACTIVE
NHSAU 442-19	30025288810000	INJ_WAG	ACTIVE
NHSAU 442-24	30025290980000	INJ_WAG	ACTIVE
NHSAU 442-29	30025288850000	INJ_WAG	ACTIVE
NHSAU 442-30	30025270010000	INJ_WAG	ACTIVE
NHSAU 443-30	30025289580000	PROD_OIL	P & A
NHSAU 444-30	30025289590000	INJ_WAG	ACTIVE
NHSAU 511-33	30025349060000	PROD_OIL	ACTIVE
NHSAU 512-32	30025349070000	PROD_OIL	ACTIVE
NHSAU 513-33	30025349800000	PROD_OIL	ACTIVE
NHSAU 514-32	30025362450000	PROD_OIL	ACTIVE
NHSAU 516-13	30025380230000	PROD_OIL	ACTIVE
NHSAU 517-18	30025380870000	PROD_OIL	ACTIVE
NHSAU 518-18	30025381140000	INJ_WAG	ACTIVE
NHSAU 521-33	30025346430000	PROD_OIL	ACTIVE
NHSAU 523-33	30025343720000	PROD_OIL	ACTIVE
NHSAU 524-33	30025349930000	PROD_OIL	ACTIVE
NHSAU 525-30	30025362160000	PROD_OIL	ACTIVE
NHSAU 526-33	30025233340006	PROD_OIL	ACTIVE
NHSAU 527-30	30025362470000	PROD_OIL	ACTIVE
NHSAU 529-18	30025381100000	PROD_OIL	ACTIVE
NHSAU 531-32	30025343740000	PROD_OIL	ACTIVE
NHSAU 532-32	30025125040101	PROD_OIL	TA
NHSAU 533-29	30025355410000	PROD_OIL	ACTIVE
NHSAU 534-33	30025343730000	INJ_WAG	ACTIVE
NHSAU 535-33	30025357580000	PROD_OIL	ACTIVE
NHSAU 536-30	30025362860000	INJ_WAG	ACTIVE
NHSAU 537-32	30025361490000	PROD_OIL	TA
NHSAU 538-30	30025362810000	PROD_OIL	ACTIVE
NHSAU 539-24	30025362130000	PROD_OIL	ACTIVE
NHSAU 541-32	30025349640000	PROD_OIL	ACTIVE
NHSAU 542-32	30025343750000	PROD_OIL	ACTIVE
NHSAU 543-33	30025349970000	INJ_WAG	ACTIVE
NHSAU 544-29	30025346440000	PROD_OIL	ACTIVE
NHSAU 545-33	30025344160000	PROD_OIL	ACTIVE
NHSAU 546-30	30025362800000	PROD_OIL	ACTIVE
NHSAU 547-30	30025362420000	PROD_OIL	ACTIVE

NHSAU 548-32	30025361500000	PROD_OIL	ACTIVE
NHSAU 549-24	30025361930000	PROD_OIL	ACTIVE
NHSAU 611-24	30025354670000	PROD_OIL	ACTIVE
NHSAU 612-24	30025354500000	PROD_OIL	ACTIVE
NHSAU 613-24	30025353700000	PROD_OIL	ACTIVE
NHSAU 614-24	30025355550000	PROD_OIL	ACTIVE
NHSAU 615-19	30025371270000	PROD_OIL	ACTIVE
NHSAU 616-19	30025374100000	PROD_OIL	ACTIVE
NHSAU 617-30	30025371020000	PROD_OIL	ACTIVE
NHSAU 618-30	30025371200000	PROD_OIL	ACTIVE
NHSAU 621-30	30025353320000	PROD_OIL	ACTIVE
NHSAU 622-24	30025371520000	INJ_WAG	ACTIVE
NHSAU 623-29	30025348690000	PROD_OIL	ACTIVE
NHSAU 624-29	30025348700000	PROD_OIL	ACTIVE
NHSAU 625-29	30025372130000	PROD_OIL	ACTIVE
NHSAU 626-29	30025372500000	INJ_WAG	ACTIVE
NHSAU 627-19	30025372350000	PROD_OIL	ACTIVE
NHSAU 628-19	30025385240000	PROD_OIL	ACTIVE
NHSAU 631-33	30025349940000	INJ_WAG	ACTIVE
NHSAU 632-31	30025372140000	INJ_WAG	ACTIVE
NHSAU 633-19	30025374460000	INJ_WAG	ACTIVE
NHSAU 634-29	30025353840000	PROD_OIL	ACTIVE
NHSAU 635-29	30025374090000	INJ_WAG	ACTIVE
NHSAU 636-29	30025371280000	PROD_OIL	ACTIVE
NHSAU 637-24	30025371010000	INJ_WAG	ACTIVE
NHSAU 638-19	30025381250000	PROD_OIL	ACTIVE
NHSAU 641-25	30025371180000	PROD_OIL	ACTIVE
NHSAU 642-25	30025371050000	PROD_OIL	ACTIVE
NHSAU 643-29	30025353760000	PROD_OIL	ACTIVE
NHSAU 644-28	30025353490000	PROD_OIL	ACTIVE
NHSAU 645-13	30025385180000	PROD_OIL	ACTIVE
NHSAU 646-13	30025380710000	PROD_OIL	ACTIVE
NHSAU 659-24	30025430780000	INJ_WAG	ACTIVE
NHSAU 663-24	30025430260000	PROD_OIL	ACTIVE
NHSAU 668-24	30025430740000	INJ_WAG	ACTIVE
NHSAU 669-24	30025430390000	INJ_WAG	ACTIVE
NHSAU 673-19	30025430580000	PROD_OIL	ACTIVE
NHSAU 679-24	30025430400000	INJ_WAG	ACTIVE

NHSAU 680-24	30025430730000	INJ_WAG	ACTIVE
NHSAU 687-24	30025430380000	INJ_WAG	ACTIVE
NHSAU 693-33	30025432820000	INJ_WAG	ACTIVE
NHSAU 711-29	30025374510000	INJ_WAG	ACTIVE
NHSAU 712-29	30025375580000	INJ_WAG	ACTIVE
NHSAU 713-30	30025349830000	PROD_OIL	ACTIVE
NHSAU 721-29	30025374740000	PROD_OIL	ACTIVE
NHSAU 722-31	30025374280000	PROD_OIL	ACTIVE
NHSAU 731-25	30025374810000	PROD_OIL	ACTIVE
NHSAU 733-19	30025374450000	PROD_OIL	ACTIVE
NHSAU 734-33	30025350110000	PROD_OIL	TA
NHSAU 741-25	30025374800000	INJ_WAG	ACTIVE
NHSAU 742-29	30025374750000	PROD_OIL	ACTIVE
NHSAU 743-31	30025354510000	PROD_OIL	ACTIVE
NHSAU 744-25	30025054930000	PROD_OIL	INACTIVE
NHSAU 813-29	30025348710000	INJ_WAG	ACTIVE
NHSAU 814-29	30025355270000	PROD_OIL	ACTIVE
NHSAU 831-13	30025408160000	PROD_OIL	ACTIVE
NHSAU 832-13	30025408220000	PROD_OIL	ACTIVE
NHSAU 833-18	30025408340000	PROD_OIL	ACTIVE
NHSAU 834-32	30025354520000	PROD_OIL	ACTIVE
NHSAU 843-33	30025357430000	PROD_OIL	TA
NHSAU 844-32	30025355340000	PROD_OIL	ACTIVE
NHSAU 913-32	30025353850000	PROD_OIL	ACTIVE
NHSAU 923-29	30025360110000	PROD_GAS	SHUT-IN
NHSAU 943-19	30025374350000	PROD_OIL	ACTIVE
NHSAU 944-29	30025359990000	PROD_OIL	TA
NHSAU 945-19	30025408590000	INJ_WAG	ACTIVE
NHSAU 946-18	30025415500000	PROD_OIL	ACTIVE
NHSAU 947-19	30025415510000	PROD_OIL	ACTIVE
NHSAU 948-33	30025415780000	PROD_OIL	ACTIVE
NHSAU 949-33	30025416430000	PROD_OIL	ACTIVE
NHSAU 950-18	30025424560000	INJ_WAG	ACTIVE
NHSAU 951-18	30025424840000	PROD_OIL	P & A
NHSAU 952-18	30025424780000	INJ_WAG	ACTIVE
NHSAU 953-18	30025424690000	INJ_WAG	ACTIVE
NHSAU 954-18	30025424900000	PROD_OIL	ACTIVE
NHSAU 955-18	30025424850000	PROD_OIL	ACTIVE

NHSAU 956-18	30025424700000	PROD_OIL	ACTIVE
NHSAU 957-18	30025424710000	PROD_OIL	ACTIVE
NHSAU 958-19	30025424540000	PROD_OIL	ACTIVE
NHSAU 959-18	30025427760000	INJ_WAG	ACTIVE
SHOU-100C15	30025076940000	INJ_H2O	P & A
SHOU-101C15	30025076880000	PROD_OIL	P & A
SHOU-102B15	30025076890000	PROD_OIL	P & A
SHOU-103B15	30025076910000	PROD_OIL	P & A
SHOU-104A15	30025224820000	PROD_OIL	P & A
SHOU-105E15	30025200280000	INJ_H2O	P & A
SHOU-106F15	30025076930000	PROD_OIL	P & A
SHOU-107G15	30025076920000	INJ_H2O	P & A
SHOU-108K15	30025076900000	PROD_OIL	P & A
SHOU-109J15	30025076990000	PROD_OIL	P & A
SHOU-10B06	30025076400000	INJ_H2O	P & A
SHOU-110I15	30025076980000	INJ_H2O	P & A
SHOU-111N15	30025076960000	INJ_H2O	P & A
SHOU-112M03	30025251270000	INJ_H2O	TA
SHOU-113G06	30025076390000	INJ_H2O	P & A
SHOU-114J06	30025076440000	INJ_H2O	P & A
SHOU-115I06	30025076420000	INJ_H2O	P & A
SHOU-116O06	30025076450000	INJ_H2O	P & A
SHOU-117P06	30025076430000	INJ_H2O	P & A
SHOU-118D08	30025076540000	PROD_OIL	P & A
SHOU-119C08	30025076530000	INJ_H2O	P & A
SHOU-11A06	30025076350000	INJ_H2O	ACTIVE
SHOU-120C05	30025261150000	INJ_H2O	ACTIVE
SHOU-121E04	30025261160000	INJ_H2O	TA
SHOU-122E04	30025261170000	PROD_OIL	TA
SHOU-123H06	30025261180000	PROD_OIL	TA
SHOU-124J04	30025261190000	PROD_OIL	TA
SHOU-125L03	30025261200000	PROD_OIL	ACTIVE
SHOU-126N10	30025261210000	PROD_OIL	P & A
SHOU-127M34	30025283310000	INJ_H2O	ACTIVE
SHOU-128P03	30025283320000	INJ_WAG	ACTIVE
SHOU-129N34	30025283330000	INJ_H2O	ACTIVE
SHOU-12D05	30025076250000	PROD_OIL	P & A
SHOU-130F04	30025283340000	PROD_OIL	TA
SHOU-131G04	30025283350000	PROD_OIL	TA
SHOU-132H04	30025283360000	PROD_OIL	TA
SHOU-133E03	30025283370000	PROD_OIL	TA
SHOU-135F04	30025283380000	PROD_OIL	P & A
SHOU-136F04	30025283390000	PROD_OIL	ACTIVE
SHOU-137I04	30025283400000	PROD_OIL	ACTIVE
SHOU-138I04	30025283410000	PROD_OIL	ACTIVE
SHOU-139F03	30025283420000	PROD_OIL	ACTIVE
SHOU-13C05	30025076240000	INJ_H2O	ACTIVE

SHOU-140L04	30025283430000	INJ_WAG	ACTIVE
SHOU-141K04	30025283440000	INJ_WAG	ACTIVE
SHOU-142O04	30025283450000	INJ_WAG	ACTIVE
SHOU-143P04	30025283460000	PROD_OIL	TA
SHOU-144N03	30025283470000	PROD_OIL	TA
SHOU-145K03	30025283480000	INJ_WAG	ACTIVE
SHOU-146D09	30025283490000	PROD_OIL	ACTIVE
SHOU-147C09	30025283500000	PROD_OIL	ACTIVE
SHOU-148A09	30025283510000	PROD_OIL	ACTIVE
SHOU-149A09	30025283520000	PROD_OIL	ACTIVE
SHOU-14B05	30025076140000	PROD_OIL	ACTIVE
SHOU-150M03	30025283530000	PROD_OIL	ACTIVE
SHOU-151N03	30025283540000	PROD_OIL	TA
SHOU-152A09	30025283550000	INJ_H2O	ACTIVE
SHOU-153C09	30025283560000	PROD_OIL	ACTIVE
SHOU-154B09	30025283570000	PROD_OIL	ACTIVE
SHOU-155H09	30025283580000	PROD_OIL	ACTIVE
SHOU-156H09	30025283590000	PROD_OIL	ACTIVE
SHOU-157D10	30025283600000	PROD_OIL	ACTIVE
SHOU-158C10	30025283610000	PROD_OIL	TA
SHOU-159F09	30025283620000	PROD_OIL	TA
SHOU-15A05	30025076190000	PROD_OIL	ACTIVE
SHOU-160G09	30025283630000	PROD_OIL	ACTIVE
SHOU-161G09	30025283640000	PROD_OIL	TA
SHOU-162H09	30025283650000	PROD_OIL	ACTIVE
SHOU-163K10	30025283660000	PROD_OIL	TA
SHOU-16D04	30025076050000	PROD_OIL	ACTIVE
SHOU-170J04A	30025266230000	INJ_H2O	ACTIVE
SHOU-171D09	30025285440000	INJ_H2O	TA
SHOU-172H09	30025285430000	INJ_H2O	ACTIVE
SHOU-173E10	30025287330000	INJ_H2O	ACTIVE
SHOU-174L03A	30025266220000	INJ_H2O	ACTIVE
SHOU-175A06	30025289730000	PROD_OIL	TA
SHOU-176D05	30025289740000	INJ_H2O	TA
SHOU-177D05	30025289750000	PROD_OIL	ACTIVE
SHOU-178C05	30025289760000	PROD_OIL	ACTIVE
SHOU-179F05	30025289770000	PROD_OIL	ACTIVE
SHOU-17C04	30025127680000	PROD_OIL	ACTIVE
SHOU-180B05	30025289780000	PROD_OIL	ACTIVE
SHOU-181B05	30025289790000	PROD_OIL	TA
SHOU-182F05B	30025276280002	INJ_H2O	ACTIVE
SHOU-183E05	30025289800000	PROD_OIL	ACTIVE
SHOU-184F05	30025290830000	PROD_OIL	ACTIVE
SHOU-185I05	30025290840000	PROD_OIL	ACTIVE
SHOU-186E04	30025289810000	PROD_OIL	ACTIVE
SHOU-187J05	30025076210000	INJ_H2O	ACTIVE
SHOU-188K05	30025289820000	INJ_WAG	ACTIVE
SHOU-189J05	30025290850000	INJ_WAG	ACTIVE

SHOU-18B04	30025076290000	PROD_OIL	ACTIVE
SHOU-190I05	30025290820000	INJ_WAG	ACTIVE
SHOU-191L04	30025289830000	INJ_WAG	ACTIVE
SHOU-192O05	30025244470000	INJ_H2O	ACTIVE
SHOU-193P05	30025289840000	INJ_H2O	ACTIVE
SHOU-194O05	30025290540000	PROD_OIL	ACTIVE
SHOU-195P05	30025289850000	PROD_OIL	ACTIVE
SHOU-196M04	30025289860000	PROD_OIL	P & A
SHOU-197L34	30025294440000	PROD_OIL	TA
SHOU-198C06	30025294420000	PROD_OIL	P & A
SHOU-199B06	30025294580000	PROD_OIL	P & A
SHOU-19A04	30025075980000	PROD_OIL	ACTIVE
SHOU-1D34	30025075750000	PROD_OIL	P & A
SHOU-200G06	30025294100000	PROD_OIL	P & A
SHOU-201H06	30025294590000	PROD_OIL	P & A
SHOU-202I06	30025294430000	PROD_OIL	P & A
SHOU-203L05	30025294600000	PROD_OIL	INACTIVE
SHOU-204M05	30025294110000	PROD_OIL	TA
SHOU-205N05	30025294120000	PROD_OIL	P & A
SHOU-206H06	30025295190000	INJ_H2O	P & A
SHOU-207L05	30025295200000	INJ_H2O	ACTIVE
SHOU-208N05	30025295210000	INJ_H2O	ACTIVE
SHOU-209D08	30025295220000	INJ_H2O	ACTIVE
SHOU-20D03	30025076030000	PROD_OIL	ACTIVE
SHOU-210D34	30025296770000	PROD_OIL	TA
SHOU-211E05	30025297500000	PROD_OIL	TA
SHOU-212F05	30025297510000	INJ_H2O	ACTIVE
SHOU-213A05	30025297520000	INJ_H2O	ACTIVE
SHOU-214E04	30025297300000	PROD_OIL	TA
SHOU-215E04	30025297530000	INJ_H2O	TA
SHOU-216C04	30025297540000	INJ_H2O	ACTIVE
SHOU-217B04	30025297550000	INJ_H2O	ACTIVE
SHOU-218A04	30025297560000	INJ_H2O	ACTIVE
SHOU-219D03	30025297570000	INJ_H2O	ACTIVE
SHOU-21C03	30025235300000	PROD_OIL	ACTIVE
SHOU-220C04	30025298910000	PROD_OIL	TA
SHOU-221B04	30025298920000	PROD_OIL	ACTIVE
SHOU-222L34	30025298930000	PROD_OIL	ACTIVE
SHOU-223N34	30025304860000	PROD_OIL	TA
SHOU-224B04	30025304870000	PROD_OIL	TA
SHOU-225M34	30025312110000	PROD_OIL	TA
SHOU-228D05	30025312120000	PROD_OIL	ACTIVE
SHOU-229C04	30025314200000	INJ_H2O	TA
SHOU-22C03	30025075870000	PROD_OIL	ACTIVE
SHOU-230B04	30025314210000	INJ_H2O	ACTIVE
SHOU-231F04	30025314270000	PROD_OIL	TA
SHOU-232G04	30025314190000	PROD_OIL	TA
SHOU-233G04	30025314220000	INJ_H2O	ACTIVE

SHOU-234F04	30025314280000	PROD_OIL	ACTIVE
SHOU-235K04	30025314230000	INJ_H2O	ACTIVE
SHOU-236K04	30025314290000	PROD_OIL	TA
SHOU-237O04	30025314300000	PROD_OIL	TA
SHOU-238O04	30025314240000	INJ_H2O	ACTIVE
SHOU-239	30025349460000	INJ_H2O	ACTIVE
SHOU-23B03	30025075820000	PROD_OIL	P & A
SHOU-240	30025353420000	INJ_WAG	ACTIVE
SHOU-241	30025353180000	PROD_OIL	ACTIVE
SHOU-242	30025353050000	PROD_OIL	TA
SHOU-243	30025372660000	PROD_OIL	TA
SHOU-244	30025357420000	PROD_OIL	TA
SHOU-245	30025355540000	PROD_OIL	P & A
SHOU-246	30025372710000	PROD_OIL	TA
SHOU-248	30025399550000	PROD_OIL	ACTIVE
SHOU-249	30025425400000	PROD_OIL	ACTIVE
SHOU-24A03	30025075850000	PROD_OIL	P & A
SHOU-250	30025425410000	PROD_OIL	ACTIVE
SHOU-251	30025425920000	PROD_OIL	ACTIVE
SHOU-252	30025425930000	INJ_WAG	ACTIVE
SHOU-253	30025425940000	INJ_WAG	ACTIVE
SHOU-254	30025425950000	INJ_WAG	ACTIVE
SHOU-255	30025425960000	INJ_WAG	ACTIVE
SHOU-256	30025426470000	INJ_WAG	ACTIVE
SHOU-257	30025426460000	INJ_WAG	ACTIVE
SHOU-258	30025426480000	INJ_WAG	ACTIVE
SHOU-259	30025426970000	INJ_WAG	ACTIVE
SHOU-25F06	30025076480000	INJ_H2O	P & A
SHOU-260	30025426960000	INJ_WAG	ACTIVE
SHOU-261	30025431020000	PROD_OIL	DRILL
SHOU-262	30025430990000	PROD_OIL	ACTIVE
SHOU-263	30025431030000	INJ_WAG	ACTIVE
SHOU-264	30025430960000	INJ_WAG	ACTIVE
SHOU-265	30025430970000	PROD_OIL	DRILL
SHOU-266	30025430980000	PROD_OIL	DRILL
SHOU-267	30025431040000	INJ_WAG	ACTIVE
SHOU-268	30025431000000	INJ_WAG	ACTIVE
SHOU-269	30025431060000	PROD_OIL	DRILL
SHOU-26H06	30025076410000	INJ_H2O	TA
SHOU-270	30025431050000	PROD_OIL	DRILL
SHOU-271	30025431010000	PROD_OIL	DRILL
SHOU-272	30025431070000	PROD_OIL	ACTIVE
SHOU-28F05	30025076300000	PROD_OIL	P & A
SHOU-29G05	30025076200000	INJ_H2O	TA
SHOU-2E34	30025075710000	PROD_OIL	ACTIVE
SHOU-30H05	30025076130000	INJ_H2O	ACTIVE
SHOU-31E04	30025075970000	INJ_H2O	TA
SHOU-32F04	30025076100000	INJ_H2O	TA

SHOU-33G04	30025076000000	INJ_H2O	TA
SHOU-34H04	30025075990000	INJ_H2O	ACTIVE
SHOU-35E03	30025075890000	INJ_H2O	ACTIVE
SHOU-36F03	30025075880000	INJ_WAG	ACTIVE
SHOU-37G03	30025075840000	INJ_H2O	P & A
SHOU-38H03	30025075860000	PROD_OIL	P & A
SHOU-39L05	30025076340000	INJ_H2O	ACTIVE
SHOU-3L34	30025075690000	PROD_OIL	TA
SHOU-40K05	30025076230000	INJ_H2O	ACTIVE
SHOU-41I03	30025209330000	INJ_H2O	P & A
SHOU-42L04	30025125140000	INJ_H2O	ACTIVE
SHOU-43K04	30025076010000	INJ_H2O	ACTIVE
SHOU-44J04	30025076020000	PROD_OIL	TA
SHOU-45I04	30025076070000	INJ_H2O	P & A
SHOU-46L03	30025075910000	PROD_OIL	TA
SHOU-47K03	30025075930000	INJ_H2O	TA
SHOU-48J03	30025075900000	INJ_H2O	P & A
SHOU-49I03	30025075920000	INJ_H2O	P & A
SHOU-4K34	30025075700000	PROD_OIL	ACTIVE
SHOU-50M05	30025076320000	INJ_H2O	P & A
SHOU-51N05	30025076330000	INJ_H2O	TA
SHOU-52P05	30025076180000	PROD_OIL	TA
SHOU-53M04	30025076120000	INJ_H2O	P & A
SHOU-54N04	30025076080000	INJ_H2O	ACTIVE
SHOU-55O04	30025076110000	INJ_H2O	ACTIVE
SHOU-56P04	30025076090000	INJ_H2O	ACTIVE
SHOU-57M03	30025075830000	PROD_OIL	P & A
SHOU-58N03	30025075940000	INJ_H2O	TA
SHOU-59O03	30025075960000	INJ_H2O	TA
SHOU-5P33	30025075650000	PROD_OIL	ACTIVE
SHOU-60P03	30025075950000	PROD_OIL	P & A
SHOU-61A08	30025076520000	INJ_H2O	TA
SHOU-62D09	30025076580000	PROD_OIL	TA
SHOU-63C09	30025076620000	INJ_H2O	ACTIVE
SHOU-64B09	30025076690000	INJ_H2O	ACTIVE
SHOU-65A09	30025076600000	INJ_H2O	P & A
SHOU-66D10	30025076720000	INJ_H2O	ACTIVE
SHOU-67C10	30025076760000	INJ_H2O	ACTIVE
SHOU-68B10	30025076790000	INJ_H2O	P & A
SHOU-69-A10	30025076770001	INJ_H2O	P & A
SHOU-6M34	30025075720000	PROD_OIL	ACTIVE
SHOU-70H08	30025076560000	PROD_OIL	P & A
SHOU-71E09	30025076700000	INJ_H2O	P & A
SHOU-72F09	30025076670000	INJ_H2O	TA
SHOU-73G09	30025076710000	INJ_H2O	ACTIVE
SHOU-74G09	30025234160001	PROD_OIL	P & A
SHOU-75H09	30025076630000	PROD_OIL	P & A
SHOU-76E10	30025076780000	INJ_H2O	ACTIVE

SHOU-77F10	30025076800000	PROD_OIL	P & A
SHOU-78G10	30025076810000	INJ_H2O	P & A
SHOU-79H10	30025201130000	PROD_OIL	P & A
SHOU-7N34	30025075760000	PROD_OIL	P & A
SHOU-80I08	30025076510000	PROD_OIL	P & A
SHOU-81L09	30025076660000	PROD_OIL	P & A
SHOU-82K09	30025076640000	INJ_H2O	P & A
SHOU-83J09	30025076680000	INJ_H2O	TA
SHOU-84I09	30025076590000	INJ_H2O	TA
SHOU-85L10	30025076750000	INJ_H2O	ACTIVE
SHOU-86K10	30025234150000	PROD_OIL	ACTIVE
SHOU-87K10	30025127650000	INJ_H2O	ACTIVE
SHOU-88J10	30025127240000	INJ_H2O	P & A
SHOU-89I10	30025213410000	INJ_H2O	P & A
SHOU-8D06	30025076490000	INJ_H2O	P & A
SHOU-90O09	30025201670000	INJ_H2O	SHUT-IN
SHOU-91P09	30025200470000	PROD_OIL	TA
SHOU-92M10	30025076730000	INJ_H2O	P & A
SHOU-93N10	30025127270000	PROD_OIL	P & A
SHOU-94N10	30025076740000	PROD_OIL	P & A
SHOU-95O10	30025127260000	PROD_OIL	P & A
SHOU-96O10	30025076820000	PROD_OIL	P & A
SHOU-97P10	30025220060000	INJ_H2O	P & A
SHOU-98A16	30025077000000	INJ_H2O	P & A
SHOU-99D15	30025205390000	PROD_OIL	P & A
SHOU-9C06	30025076470000	PROD_OIL	P & A
SHOU-W27E05	30025076310000	INJ_H2O	ACTIVE
SHUCOOP-1	30025283040000	INJ_H2O	TA
SHUCOOP-10	30025289690000	INJ_H2O	ACTIVE
SHUCOOP-11	30025289700000	INJ_H2O	ACTIVE
SHUCOOP-12	30025289710000	INJ_H2O	ACTIVE
SHUCOOP-13	30025289720000	INJ_H2O	ACTIVE
SHUCOOP-2	30025283050000	INJ_WAG	ACTIVE
SHUCOOP-3	30025283060000	INJ_WAG	ACTIVE
SHUCOOP-4	30025283070000	INJ_WAG	ACTIVE
SHUCOOP-5	30025283080000	INJ_WAG	ACTIVE
SHUCOOP-6	30025283090000	INJ_WAG	ACTIVE
SHUCOOP-9	30025289680000	INJ_H2O	ACTIVE

Appendix 6. Summary of Key Regulations Referenced in MRV Plan

There are four primary regulations cited in this plan:

1. See New Mexico Administrative Code 19.15.16.9 "Sealing Off Strata" found online at: http://www.emnrd.state.nm.us/OCD/documents/SearchablePDFofOCDTitle19Chapter15-Revised12-15-15.pdf.

2. 40 CFR Parts 144, 145, 146, 147

3. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-6199-F found online at: http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/256181/R-6199-F_1_HO.pdf

4. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-4934-F found online at http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/253379/R-4934-F_1_HO.pdf

Appendix B: Submissions and Responses to Requests for Additional Information

Oxy Hobbs Field CO_2 Subpart RR Monitoring, Reporting and Verification (MRV) Plan

January 2017

Table of Contents

Roadmap to the Monitoring, Reporting and Verification (MRV) Plan

Occidental Permian Ltd. (OPL) operates the North Hobbs Grayburg San Andres Unit (North Hobbs Unit) and the South Hobbs Project Area (South Hobbs Unit), (collectively referred to as the Hobbs Field) in the Permian Basin for the primary purpose of enhanced oil recovery (EOR) using carbon dioxide (CO_2) flooding. OPL intends to inject CO_2 with a subsidiary purpose of establishing long-term containment of a measureable quantity of CO_2 in subsurface geological formations at the Hobbs Field for a term referred to as the "Specified Period." During the Specified Period, OPL will inject CO_2 that is purchased (fresh CO_2) from affiliates of Occidental Petroleum Corporation (OPC) or third parties, as well as CO_2 that is recovered (recycled CO_2) from the Hobbs Field CO_2 Recycle and Compression Facilities (RCFs). OPL, OPC and their affiliates (together, Oxy) have developed this monitoring, reporting, and verification (MRV) plan in accordance with 40 CFR §98.440-449 (Subpart RR) to provide for the monitoring, reporting and verification of the quantity of CO_2 sequestered at the Hobbs Field during the Specified Period.

In accordance with Subpart RR, flow meters are used to quantify the volume of CO_2 received, injected, produced, contained in products, and recycled. If leakage is detected, the volume of leaked CO_2 will be quantified using two approaches. First, Oxy follows the requirements in 40 CFR §98.230-238 (Subpart W) to quantify fugitive emissions, planned releases of CO_2, and other surface releases from equipment. Second, Oxy's risk-based monitoring program uses surveillance techniques in the subsurface and above ground to detect CO_2 leaks from potential subsurface leakage pathways. If a leak is identified, the volume of the release will be estimated. The CO_2 volume data, including CO_2 volume at different points in the injection and production process, equipment leaks, and surface leaks, will be used in the mass balance equations included in 40 CFR §98.440-449 (Subpart RR) to calculate the volume of CO_2 stored on an annual and cumulative basis.

This MRV plan contains eleven sections:

- Section 1 contains general facility information.
- Section 2 presents the project description. This section describes the planned injection volumes, the environmental setting of the Hobbs Field, the injection process, and reservoir modeling. It also illustrates that the Hobbs Field is well suited for secure storage of injected CO_2.
- Section 3 describes the monitoring area: the Hobbs Field in New Mexico.
- Section 4 presents the evaluation of potential pathways for CO_2 leakage to the surface. The assessment finds that the potential for leakage through pathways other than the man-made well bores and surface equipment is minimal.
- Section 5 describes Oxy's risk-based monitoring process. The monitoring process utilizes Oxy's reservoir management system to identify potential CO_2 leakage indicators in the subsurface. The monitoring process also utilizes visual inspection of surface facilities, personal H_2S monitors, and Oxy's Specialized Field Risk

Management (SFRM) program as applied to Hobbs Field. Oxy's MRV efforts will be primarily directed towards managing potential leaks through well bores and surface facilities.

- Section 6 describes the baselines against which monitoring results will be compared to assess whether changes indicate potential leaks.
- Section 7 describes Oxy's approach to determining the volume of CO_2 sequestered using the mass balance equations in 40 CFR §98.440-449, Subpart RR of the Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP). This section also describes the site-specific factors considered in this approach.
- Section 8 presents the schedule for implementing the MRV plan.
- Section 9 describes the quality assurance program to ensure data integrity.
- Section 10 describes Oxy's record retention program.
- Section 11 includes several Appendices.

1. Facility Information

i) Reporter number – TBD

ii) The Oil Conservation Division (NMOCD) of the New Mexico Energy, Mineral and Natural Resources Department (EMNRD) regulates all oil, gas and geothermal activity in New Mexico. All wells in the Hobbs Field (including production, injection and monitoring wells) are permitted by NMOCD through New Mexico Administrative Code (NMAC) Title 19 Chapter 15. Additionally, NMOCD has primacy to implement the Underground Injection Control (UIC) Class II program in the state for injection wells. All injection wells in the Hobbs Field are currently classified as UIC Class II wells.

iii) Wells in the Hobbs Field are identified by name, API number, status, and type. The list of wells as of August 2016 is included in Appendix 5. Any new wells will be indicated in the annual report.

2. Project Description

The Hobbs Field is comprised of the North Hobbs Unit (NHU) and the South Hobbs Unit (SHU). The two units abut each other, produce oil and gas from the same geologic formations and structure, and are under the sole operatorship of Oxy. The geology, facilities/equipment, and operational procedures are similar for both units in the Hobbs Field. Because of these similarities, one MRV Plan is being prepared for the two units in the Hobbs Field and any important differences between the units will be noted in the MRV plan. This section describes the planned injection volumes, environmental setting of the Hobbs Field, injection process, and reservoir modeling conducted.

2.1 Project Characteristics

Oxy developed a long-term performance forecast for the Hobbs Field using the reservoir modeling approaches described in Section 2.4. This forecast is included here to provide a "big picture" overview of the total amounts of CO_2 anticipated to be injected, produced, and stored in the Hobbs Field as a result of its current and planned CO_2 EOR operations during the modeling period 2003-2100. This forecast is based on historic and predicted data. Figure 1 shows the actual (historic) CO_2 injection, production, and stored volumes in the Hobbs Field for the period 2003, when Oxy initiated CO_2 flooding, through 2016 (solid line) and the forecast for 2017 through 2100 (dotted line). The forecast is based on results from reservoir and recovery process modeling that Oxy uses to develop injection plans for each injection pattern, which is also described in Section 2.4. It is important to note that this is just a forecast; actual storage data will be collected, assessed, and reported as indicated in Sections 5, 6, and 7 in this MRV Plan. The forecast does illustrate, however, the large potential storage capacity at Hobbs field.

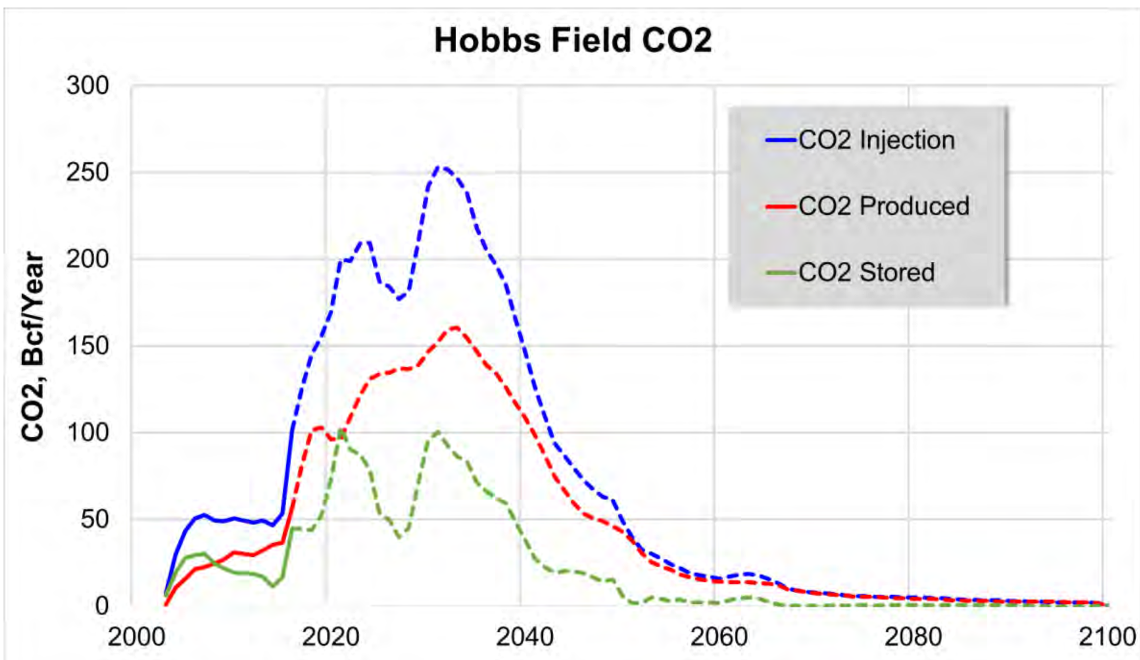


Figure 1 – Hobbs Field Historic and Forecast CO_2 Injection, Production, and Storage 2003-2100

Oxy adjusts the volume of CO_2 purchased to maintain reservoir pressure and to increase recovery of oil by extending or expanding the CO_2 flood. The volume of CO_2 purchased is the volume needed to balance the fluids removed from the reservoir and provide the solvency required to increase oil recovery. The model output shows CO_2 injection, production, and storage through 2100. However, this data is for planning purposes only and may not represent the actual operational life of the Hobbs Field. Oxy has injected

579 Bscf of CO_2 (31.3 million metric tonnes (MMMT)) into the Hobbs Field as of the end of 2015. Of that amount, 318 Bscf (17.2 MMMT) was produced and 261 Bscf (14.1 MMMT) was stored.

Although exact storage volumes will be calculated using the mass balance equations described in Section 7, Oxy forecasts that the total volume of CO_2 stored over the modeled injection period to be 2,197 Bscf (118.8 MMMT), which represents approximately 27.6% of the theoretical storage capacity of the Hobbs Field. For accounting purposes, the amount stored is the difference between the amount injected (including purchased and recycled CO_2) and the total of the amount produced less any CO_2 that: i) leaks to the surface, ii) is released through surface equipment leakage or malfunction, or iii) is entrained or dissolved in produced oil, as described in Section 7.

Figure 2 presents the cumulative annual forecasted volume of CO_2 stored by decade through 2100, the modeling period for the projection in Figure 1. The cumulative amount stored is equal to the sum of the annual storage volume for each year in the current decade plus the sum of the total of the annual storage volume for each year in the previous decade. The first decade reflects operations from 2003-2009, the second decade reflects the first decade plus estimated storage volume from 2010-2015 and projected storage for 2016-2019. The remaining decades reflect the prior storage plus projected cumulative storage for that decade. As is typical with CO_2 EOR operations, the rate of accumulation of stored CO_2 tapers over time as more recycled CO_2 is used for injection. Figure 2 illustrates the total cumulative storage over the modeling period, projected to be 2,197 Bscf (118.8 MMMT) of CO_2. This forecast illustrates the projected volume of subsidiary storage during the modeling period; the actual amounts stored during the Specified Period of reporting will be calculated as described in Section 7 of this MRV plan.

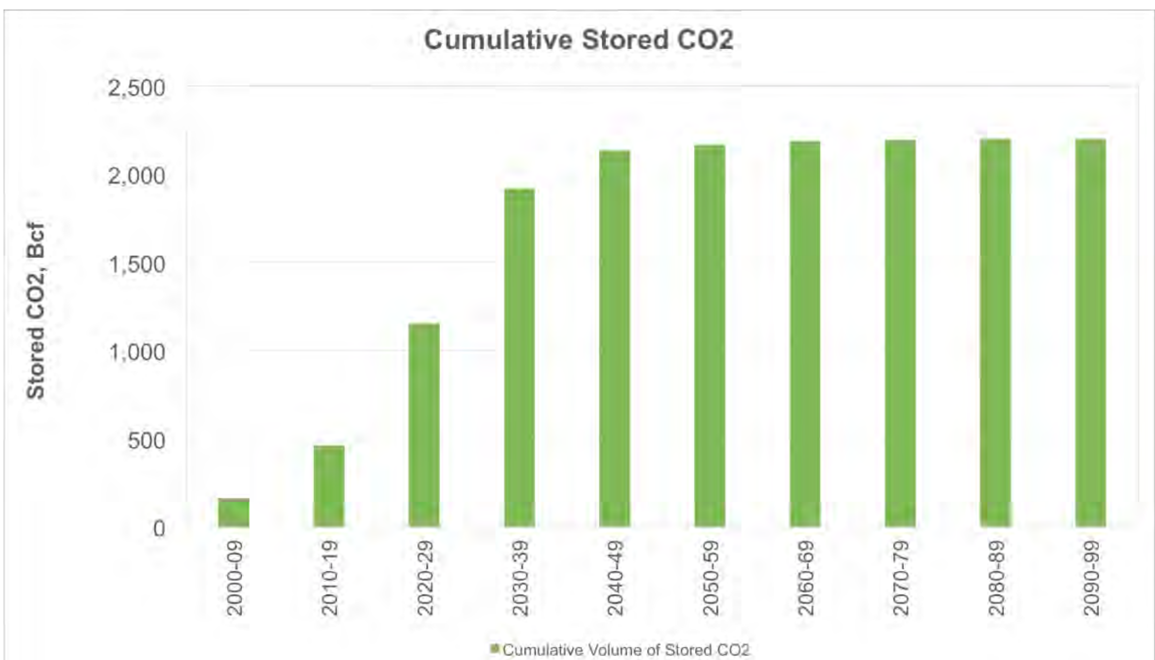


Figure 2 – Hobbs Field CO_2 Storage Forecasted by Decade During the Modeling Period 2003-2100

2.2 Environmental Setting

The project site for this MRV plan is the Hobbs Field, located in the Permian Basin in New Mexico.

2.2.1 Geology of the Hobbs Field

The Hobbs Field produces oil primarily from the San Andres formation. Some oil is also produced from the Basal Grayburg (lowest layer of the Grayburg formation), which lies directly above the San Andres (see Fig. 4). For convenience, the Basal Grayburg and San Andres formations will be referred to as “the reservoir” in this document. The productive interval, or reservoir, is composed of layers of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. This depository created a wide sedimentary basin, called the Permian Basin, which extends across the southeastern part of New Mexico and the western part of Texas. In the Permian Era, this part of the central United States was under water.

The Hobbs Field was discovered in 1928. It is located in east-central Lea County, in southeastern New Mexico (See Figure 3), on the northwestern margin of the Central Basin Platform. The Field is approximately two miles west of the Texas state line and one hundred miles northwest of Midland, as indicated by the red dot in Figure 3.

Approximate location of Hobbs Field

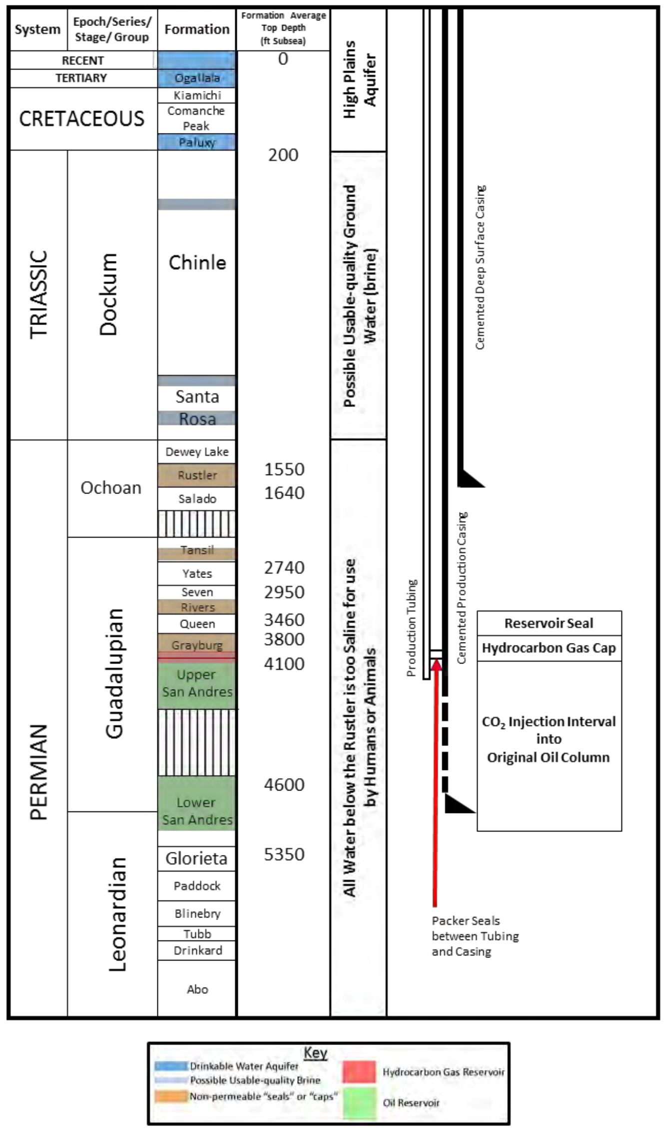
Figure 3 – Paleogeographic map of the Permian Basin showing approximate location of Hobbs Field.

With more than 1,000 million barrels (MMB) of Original Oil in Place (OOIP), the Hobbs Basal Grayburg-San Andres field is one of the largest in North America. During the millions of years following its deposition, the reservoir was buried under thick layers of impermeable rock, and finally uplifted to form the current landscape. The process of burial and uplifting produced some unevenness in the geologic layers. Originally flatlying, there are now some variations in elevation across the Permian Basin that form structural "highs," relatively higher subsurface elevations such as Hobbs Field, where oil and gas have accumulated over the ensuing millions of years.

As indicated in Figure 4, the Basal Grayburg and San Andres formations now lie beneath approximately 4,000 feet of overlying sediments. There are a number of sections above the reservoir that are impermeable and serve as reliable barriers to prevent fluids from moving upwards towards the surface. These barriers are referred to as seals because they effectively seal fluids into the formations beneath them. In the Hobbs Field, the top seal is made up of the anhydrite, shale, and impermeable silty dolomite rock layers that comprise the upper Grayburg. Above this, lie several intervals of impermeable rock layers of various thicknesses: the Queen, Seven Rivers, Tansil, Yates, and Rustler formations. These formations are highlighted orange on the stratigraphic column in Figure 4.

Between the surface and about 1,500 feet in depth there are intervals that contain underground sources of drinking water (USDW). These include the Ogallala and Paluxy aquifers, identified in blue in Figure 4. In addition, other potentially useful brine intervals (each having a higher dissolved solids content) are identified in light blue. NMOCD regulations require that all wells drilled through these intervals be cased and cemented to prevent the movement of formation or injected fluid from the injection zone into another zone or to the surface around the outside of a casing string (NMAC 19.15.26.9).

Figure 4 – Generalized Stratigraphic Section at Hobbs Field



Stratigraphic column has been adapted for Hobbs Field, and is modified from Katz *et al*, 1994 and Burke *et al*, 1960. Formation tops depths are observed field averages from Hobbs well log data.

There are no known faults or fractures affecting the Hobbs Field that provide a potential upward pathway for fluid flow. Oxy has confirmed this conclusion in multiple ways. First and foremost, the presence of oil, especially oil that has a gas cap, is indicative of a good quality natural seal. Oil and, to an even greater extent, gas, tend to migrate upward over time because both are less dense than the brine found in rock formations. Places where oil and gas remain trapped in the deep subsurface over millions of years, as is the case in the Hobbs Field, provide positive proof that faults or fractures do not provide a pathway for upward migration out of the CO_2-flooding interval. The existence of such faults or fractures in the Hobbs Field would have provided a pathway for oil and gas to escape, and they are not found there today.

Second, in the course of developing the Field, seismic surveys have been conducted to characterize the formations and provide information for the reservoir models used to design injection patterns. These surveys show the existence of faulting present well below the San Andres formation but none that penetrate the flooding interval. Figure 5 shows a seismic section oriented north-south through the Hobbs Field. Faulting can be identified deeper in the section, but not at the San Andres level. The same is true in west-east-oriented section (shown in Figure 6). This lack of faulting in the shallower formations is consistent with the presence of oil and gas in the San Andres formation at the time of discovery.

Figure 5 – North-South Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.

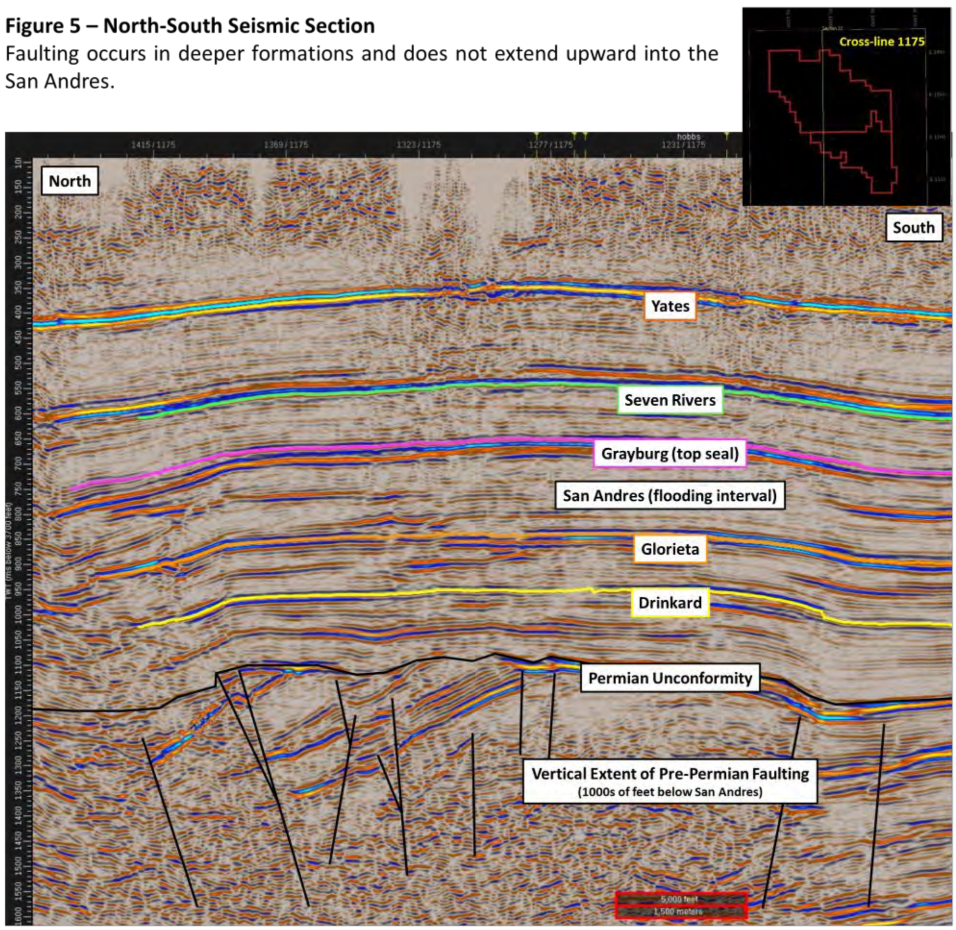
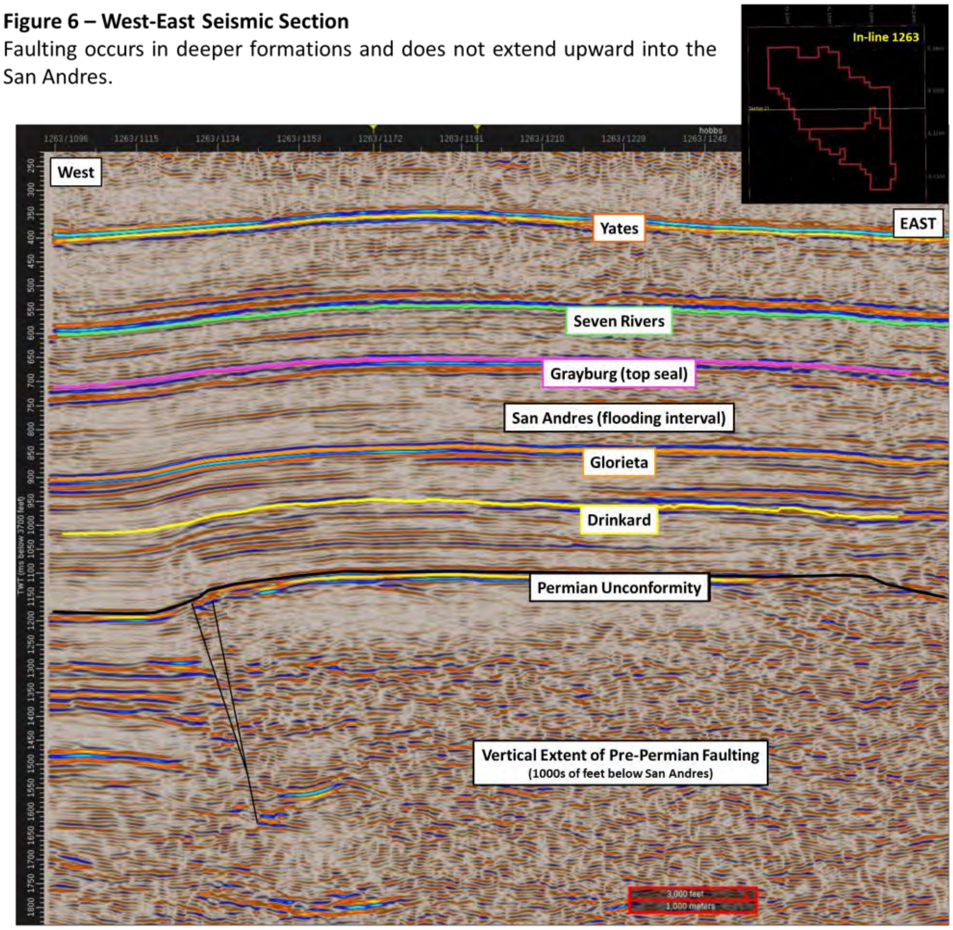


Figure 6 – West-East Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.



A west-to-east-oriented seismic section (Figure 6) shows the same relationship for faults that lie thousands of feet below the San Andres, and indicates that such faults do not provide pathways for fluids in the San Andres to migrate to the surface. This is discussed further in Section 4.3 in the review of potential leakage pathways for injected CO_2.

Lastly, the operating history at the Hobbs Field confirms that there are no faults or fractures penetrating the flood zone. Fluids, both water and CO_2, have been successfully injected in the Hobbs Field since 1976, and there is no evidence of any interaction with existing or new faults or fractures. In fact, it is the absence of faults and fractures in the Hobbs Field that make the reservoir such a strong candidate for CO_2 and water injection operations, and enable Field operators to maintain effective control over the injection and production processes.

Figure 4 shows a vertical snapshot of the geologic formations that lie beneath the Hobbs Field. Figure 7 provides an areal view of the four-way closure structure of the Field, showing the depth of the top of the San Andres formation. As indicated in the discussion of Figure 4, the upper portion of Grayburg formation is comprised of impermeable anhydrite and silty dolomite sections that serve as a seal. In effect, these sections form the hard ceiling of an upside down bowl or dome. Below this seal, the Basal Grayburg and San

Andres formations consists of permeable dolomites containing oil and gas. Figure 8 shows a two-dimensional picture of the structure of this formation.

The colors in the structure map in Figure 7 indicate changes in subsurface elevation, with red being higher, (i.e., the level closest to the surface) and magenta being lower (i.e., the level furthest below the surface). As indicated in Figure 7, both NHU and SHU are located at the highest elevation of a large, elongated domal structure that is comprised of the Grayburg and San Andres formations, within the Hobbs Field. The elevated area forms a natural trap for oil and gas that migrated from below over millions of years. Once trapped in these high points, the oil and gas has remained in place. In the case of the Hobbs Field, this oil and gas has been trapped in the reservoir for 50 to 100 million years. Over time, fluids, including CO_2, rise vertically until reaching the ceiling of the dome and then migrate to the highest elevation of the Hobbs Field structure. As a result, fluids injected into the Hobbs Field stay in the flooded reservoir and do not move to adjacent areas.

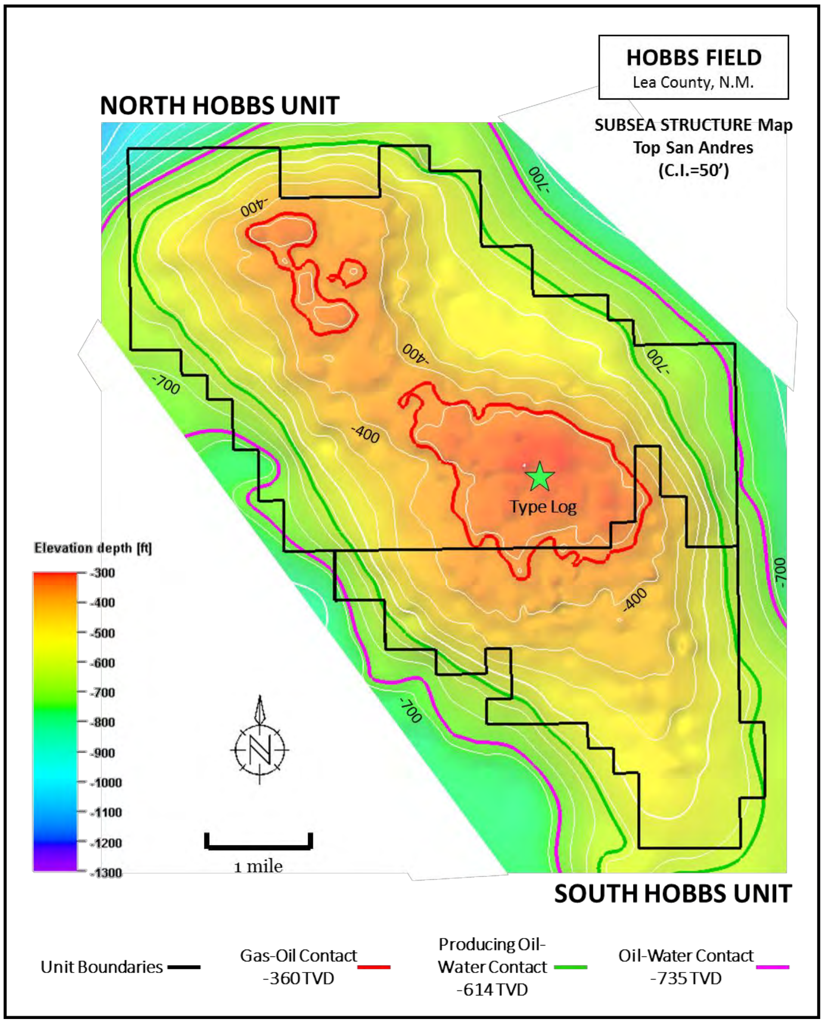


Figure 7 - Structure Map on the Top of San Andres Reservoir.

Buoyancy dominates where oil and gas are found in a reservoir. Gas, being lightest, rises to the top and water, being heavier, sinks to the bottom. Oil, being heavier than gas but lighter than water, lies in between. The cross section in Figure 8 shows saturation levels in the oil-bearing layers of the Hobbs Field and illustrates this principle.

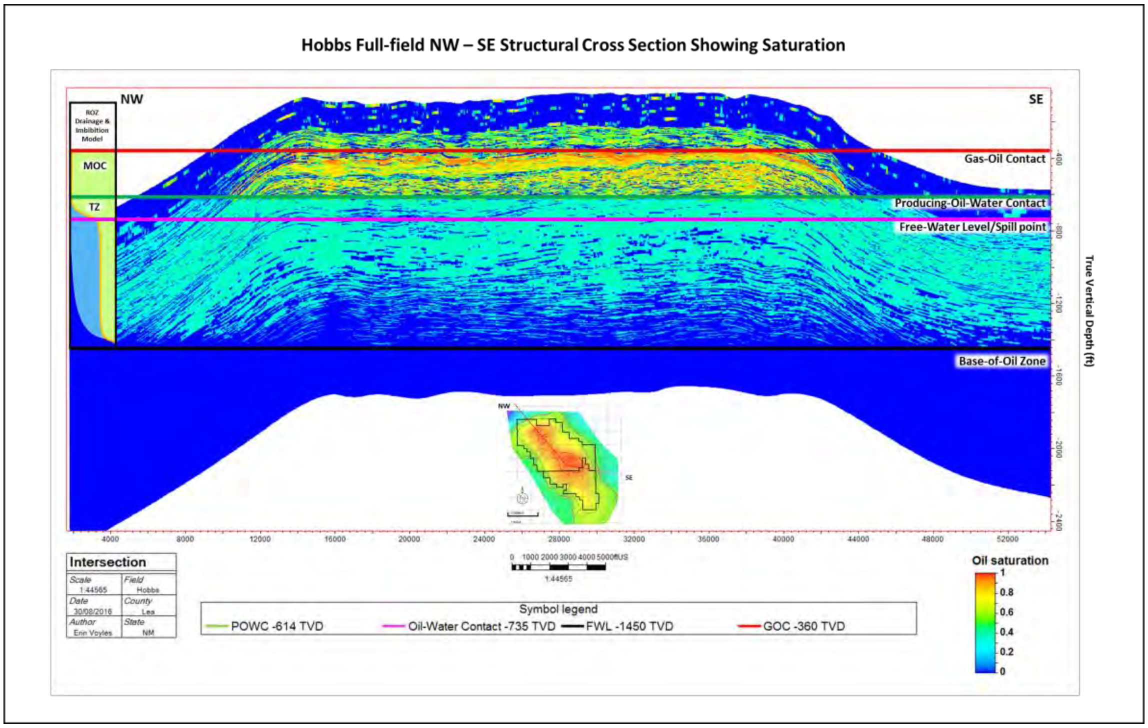


Figure 8 - Hobbs Field structural cross-section showing saturation distribution through Main Pay, Transition Zone, and Residual Oil Zone model.

At the time of its discovery, natural gas was trapped at the structural high points of the Hobbs Field, the area above the gas-oil contact (red line) in the cross section above. This interface is found approximately 4,000 feet below the surface (-360 ft subsea). Above the gas-oil interface is the volume known as the "gas cap." As discussed in Section 2.2.1, the presence of a gas cap is evidence of the effectiveness of the seal formed by the upper Grayburg. Gas is buoyant and highly mobile. If it could escape the Hobbs Field naturally, through faults or fractures, it would have done so over the millennia. Below the gas cap is an oil accumulation, which extends down to the Free-Water Level (FWL), (fuchsia line at -735 ft subsea), which is also the Hobbs structural spill point, or the maximum depth at which hydrocarbons will not leak out of the reservoir. The Base of Oil Zone is the point at which there are no distillable hydrocarbons – nothing moveable through primary, secondary, or tertiary recovery.

The Producing Oil-Water Contact (POWC), (green line at -614 ft subsea) was determined by early drilling to be the maximum depth where only oil, and no water, was produced. Below the POWC, wells produce a combination of oil and water. The uppermost region between the POWC and the free water level FWL/spillpoint is called the transition zone (TZ), and below that lies the residual oil zone (ROZ). The ROZ was water-flooded naturally millions of years ago, leaving behind a residual oil saturation[1] that is immobile

[1] "Residual oil saturation" is the fraction of oil remaining in the pore space, typically after water flooding.

without CO_2 flooding. This is approximately the same residual oil saturation remaining after water flooding in the water-swept areas of the main oil pay zone.

When supercritical CO_2 and water are injected into an oil reservoir, they are pushed from injection wells to production wells by the high pressure of the injected fluids. Once the CO_2 flood is complete and injection ceases, the remaining mobile CO_2 will rise slowly upward, driven by buoyancy forces. If the amount of CO_2 injected into the reservoir exceeds the secure storage capacity of the pore space, excess CO_2 could theoretically "spill" from the reservoir and migrate to other reservoirs on the Central Basin Platform. This risk is very low in the Hobbs Field, because there is more than enough pore space to retain the CO_2. Oxy has calculated the total pore space within the Hobbs Field, from the top of the reservoir down to the spill point, which is located at -735 ft subsea or roughly 4,350 – 4,400 feet below the surface, to be 4,769 MMB. Hobbs Field could hold an estimated maximum of about 7,949 Bscf (430 MMMT) CO_2 in the reservoir space above the spill point. Oxy forecasts that at the end of EOR operations stored CO_2 will fill approximately 27.6% of total calculated storage capacity. (See Section 2.1 for further explanation of the forecast.) The volume of CO_2 storage is based on the estimated total pore space within Hobbs Field from the top of the reservoir down to the spill point, or about 4,769 MMB. This is the volume of rock multiplied by porosity. CO_2 storage is calculated assuming an irreducible water saturation of 0.15, an irreducible oil saturation of 0.10, and a CO_2 formation volume factor of 0.45 (see chart below).

Top of Basal Grayburg down to -735 Total Vertical Depth (structural spill point)	
Variables	
Boundary	Spill Point Contour
Pore Volume [RB]	4,769,117,630
B_{CO2} [BBL/MCF]	0.45
S_{wirr}	0.15
Sor_{CO2}	0.10
Max CO_2 [MCF]	7,948,529,383
Max CO_2 [TCF]	7.95

$$CO_2(\max) = \text{Volume (RB)} * (1 - S_{wirr} - S_{orCO_2}) / B_{CO_2}$$

Where:
CO_2(max) = the maximum amount of storage capacity
Volume (RB) = the volume in Reservoir Barrels of the rock formation
B_{CO2} = the formation volume factor for CO_2
S_{wirr} = the irreducible water saturation

Sor_{CO2} = the irreducible oil saturation

Given that the Hobbs Field is located at the highest subsurface elevations of the structure, that the confining zone has proved competent over both millions of years and throughout decades of EOR operations, and that the Hobbs Field has ample storage capacity, Oxy is confident that stored CO_2 will be contained securely within the Basal Grayburg-San Andres reservoir in the Hobbs Field.

2.2.2 Operational History of the Hobbs Field and Hobbs Field

The Hobbs Field was discovered in 1928 and intensive development began in 1930. It is located in the northwestern portion of the Central Basin Platform in the Permian Basin.

The Hobbs Field was originally developed with numerous leases held by individuals and companies. To improve efficiency, a number of smaller leases were combined (or unitized) into two larger legal entities (Units), which can be operated without the operational restrictions imposed by the former lease boundaries. In 1975, the South Hobbs Unit (SHU) was formed, followed by formation of the North Hobbs Unit (NHU) in 1980 (See Figure 9). Together, the NHU and SHU form the Hobbs Field.

The boundaries of the Hobbs Field are indicated in Figure 9. Under certain conditions, Oxy uses a Specialized Field Risk Management (SFRM) program to voluntarily apply additional design and operations specifications to further mitigate the potential risk from public exposure due to loss of containment. Due to the native concentration of H_2S in the Hobbs Field and its proximity to the City of Hobbs, a community with a population of roughly 40,000 according to the 2015 U.S. Census, Oxy screens Hobbs Field well locations and surface equipment to determine where the SFRM program is applied. The voluntary measures of the SFRM provide additional monitoring and will be further discussed in Sections 4 and 5.

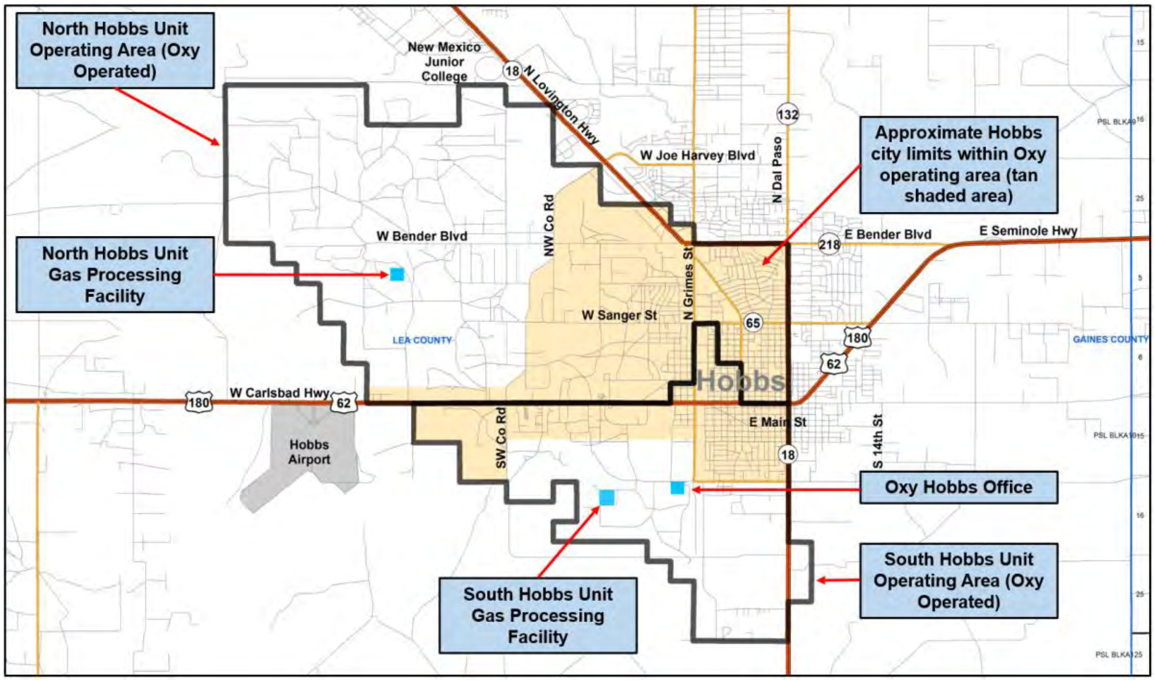


Figure 9 - Hobbs Field Map

Oxy began CO_2 flooding of the NHU of the Hobbs Field in 2003 and has continued and expanded it since that time. The SHU of the Hobbs Field began CO_2 flooding in 2015. The experience of operating and refining the Hobbs Field CO_2 floods over the past decade has created a strong understanding of the reservoir and its capacity to store CO_2.

2.3 Description of CO_2 EOR Project Facilities and the Injection Process

Figures 10 and 11 show a simplified flow diagram of the project facilities and equipment in the NHU and SHU, respectively. CO_2 is delivered to the Hobbs Field via the Permian pipeline delivery system. The CO_2 injected into the Hobbs Field is supplied by a number of different sources into the pipeline system. Specified amounts are drawn based on contractual arrangements among suppliers of CO_2, purchasers of CO_2, and the pipeline operator.

Once CO_2 enters the Hobbs Field there are four main processes involved in EOR operations. These processes are shown in Figures 10 and 11 and include:

1. **CO_2 Distribution and Injection**. Purchased CO_2 and recycled CO_2 from the CO_2 Recycle and Compression Facility (RCF) is sent through the main CO_2 distribution system to various CO_2 injectors throughout the Field.
2. **Produced Fluids Handling**. Produced fluids gathered from the production wells are sent to satellite batteries for separation into a gas/CO_2 mix and a produced fluids mix of water, oil, gas, and CO_2. The produced fluids mix is sent to centralized tank batteries where oil is separated for sale into a pipeline, water is recovered for reuse, and the remaining gas/CO_2 mix is merged with the output from the satellite

batteries. In the NHU, a portion of the gas/CO_2 mix is sent to the SHU and the rest is sent to a combined RCF and natural gas liquids (NGL) facility. In the SHU all of the gas/CO_2 mix from the satellite battery is sent to an RCF along with the gas/CO_2 mix received from the NHU. Produced oil is metered and sold; water is forwarded to the water injection stations for treatment and reinjection or disposal.

3. **Produced Gas Processing**. In the NHU, the gas/CO_2 mix separated at the satellite batteries goes to the RCF/NGL where the NGLs, and CO_2 streams are separated. The NGLs move to a commercial pipeline for sale. The majority of remaining CO_2 (e.g., the recycled CO_2) is returned to the CO_2 distribution system for reinjection. In the SHU, all of the gas/CO_2 mix is compressed for re-injection.
4. **Water Treatment and Injection**. Water separated in the tank batteries is processed at water injection stations to remove any remaining oil and then distributed throughout the Hobbs Field for reinjection along.

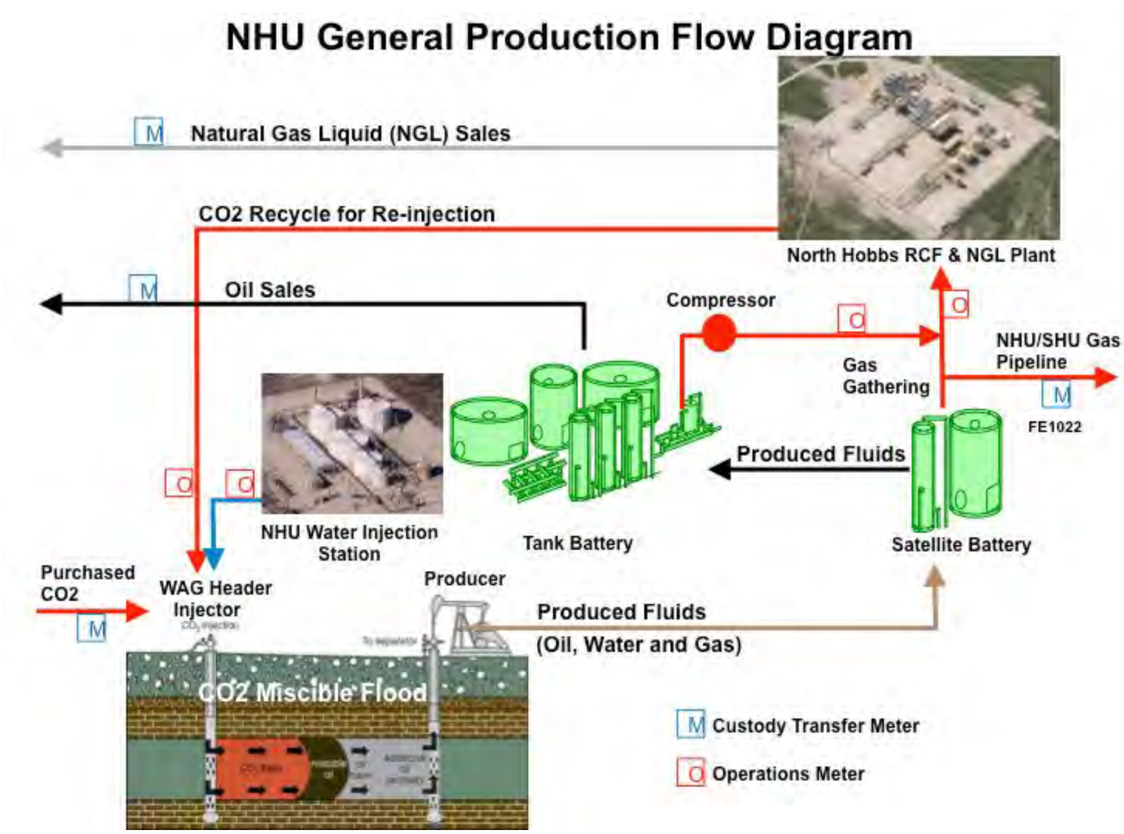


Figure 10 Hobbs Field – NHU Facilities General Production Flow Diagram

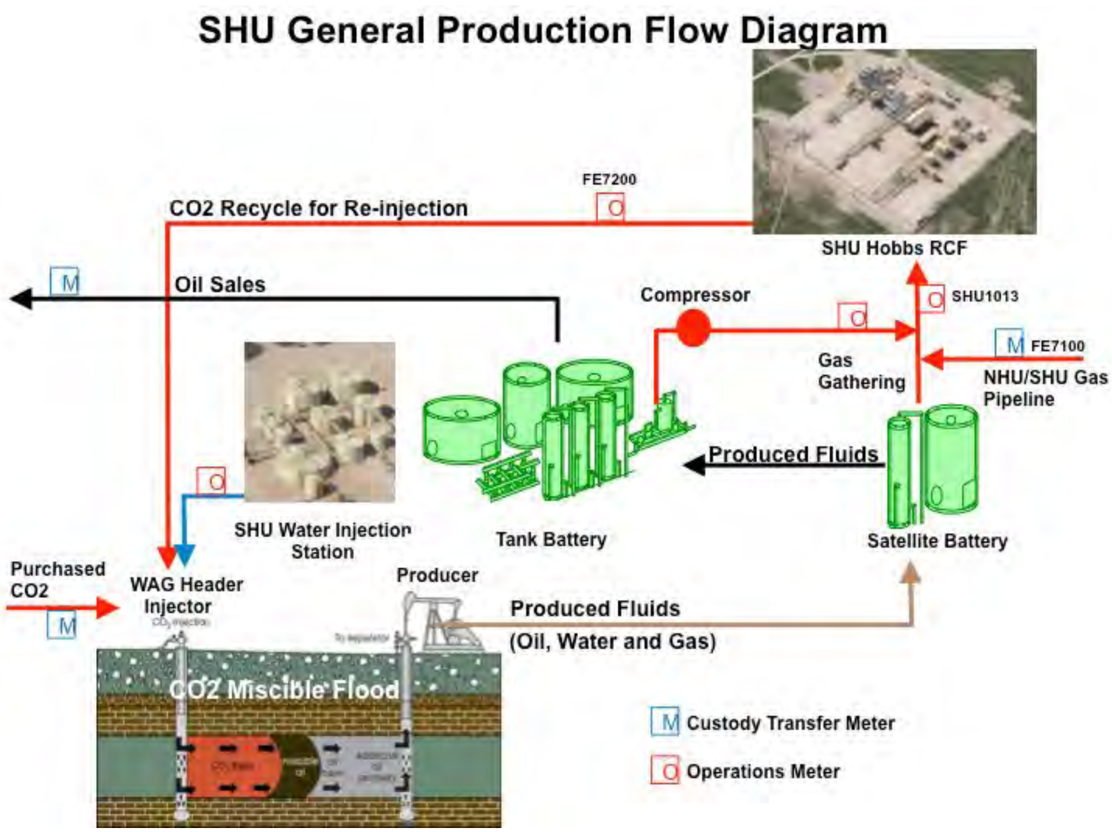


Figure 11 Hobbs Field – SHU Facilities General Production Flow Diagram

2.3.1 CO_2 Distribution and Injection.

Oxy purchases CO_2 from the Permian pipeline delivery system and receives it through two custody transfer metering points, as indicated in Figures 10 and 11. Purchased CO_2 and recycled CO_2 are sent through the CO_2 trunk lines to injection manifolds. At the manifolds, the CO_2 is sent through multiple distribution lines to individual injection wells. There are volume meters at the inlet and outlet of the RCF.

Currently, Oxy has 10 injection manifolds and approximately 210 injection wells in the Hobbs Field. Approximately 330 MMscf of CO_2 is injected each day, of which approximately 40% is purchased CO_2, and the balance (60%) is recycled from the RCFs. The ratio of purchased CO_2 to recycled CO_2 is expected to change over time, and eventually the percentage of recycled CO_2 will increase and purchases of fresh CO_2 will taper off as indicated in Section 2.1.

Each injection well is connected to a WAG header located at the satellite. WAG headers are remotely operated and can inject either CO_2 or water at various rates and injection pressures as specified in the injection plans. The length of time spent injecting each fluid is a matter of continual optimization that is designed to maximize oil recovery and minimize CO_2 utilization in each injection pattern. A WAG header control system is implemented at each satellite. It consists of a dual-purpose flow meter used to measure the injection rate of water or CO_2, depending on what is being injected. Data from these meters is sent to a central data monitoring station where it is compared to the injection plan for that satellite. As described in Sections 5 and 7, data from the WAG header control systems, visual inspections of the injection equipment, and use of the procedures contained in 40 CFR §98.230-238 (Subpart W), will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2.

2.3.2 Wells in the Hobbs Field

As of August 2016, there are 445 active wells that are completed in the Hobbs Field; roughly half of these are production wells (235 wells) and the others are injection wells (210 wells). In addition there about 256 wells that are not in use, bringing the total number of wells currently completed in the Hobbs Field to 701, as indicated in Figure 12.[2] Table 1 shows these well counts in the Hobbs Field by status.

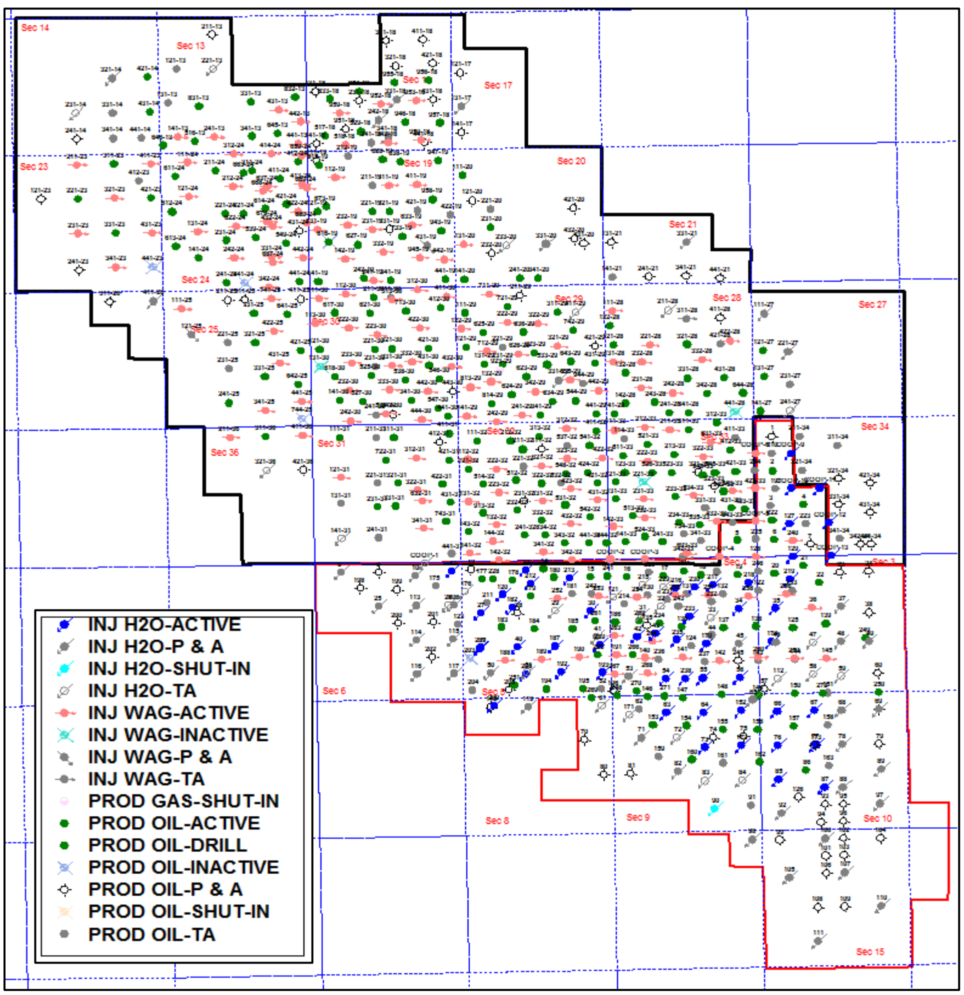


Figure 12 Hobbs Field Wells – As of August 2016

Table 1 - Hobbs Field Wells

[2] Wells that are not in use are deemed to be inactive, plugged and abandoned, temporarily abandoned, or shut in.

Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*
Drilled & Completed in the 1930's	105	4	26	33
Drilled 1946-1979	41	1	18	52
Completed after 1980	299	16	57	49
TOTAL	***445***	***21***	***101***	***134***

The wells in Table 1 are categorized in groups that relate to age and completion methods. Roughly 22% of these wells were drilled in the 1930's and were generally completed with three strings of casing (with surface and intermediate strings typically cemented to the surface). The production string was typically installed to the top of the producing interval, otherwise known as the main oil column (MOC), which extends to the producible oil/water contact (POWC). These wells were completed by stimulating the open hole (OH), and are not cased through the MOC. Normally within 20-30 years of initial completion, a full or partial liner would have been installed to allow for controlled production intervals and this liner would have been cemented to the top of the liner (TOL) that was installed. For example, if a full liner was installed, then Top of Cement (TOC) would be at the surface as the liner was installed to surface. More often, a partial liner would be installed from 3,800-4,300 ft, and the TOC would be at 3,800 ft. The casing weights used for 1930's vintage wells were heavy, with nothing lighter than 7" 24 #/ft. or 5 1/2" 15.5 #/ft. for the production string.

The wells in Table 1 drilled during the period 1946-1979 typically have two to three strings of high-grade casing cemented to a level where the top of the cement (TOC) extends above the previous casing depth. Cement bond logs (CBL) or temperature surveys (TS) have been used to determine that this depth is available on most wells. This group of wells rarely has liners installed because they were completed with production casing that extended below the point of the POWC.

The majority (roughly 66%) of wells in Table 1 were drilled after 1980. In the vast majority of these wellbores, the surface and production casings are cemented to the surface. Experience shows that these wells generally have not needed partial or full liners. Most of these wells have surface casing and production casing weights of 8 5/8" 24# and 5 1/2" 15.5 # respectively.

Oxy reviews these categories when planning well maintenance projects. Further, Oxy keeps well workover crews on call to maintain all active wells and to respond to any wellbore issues that arise. On average, in the Hobbs Field there are two to three incidents per year in which the well casing fails. Oxy detects these incidents by monitoring changes in the surface pressure of wells and by conducting Mechanical Integrity Tests (MITs), as explained later in this section and in the relevant regulations cited in Appendix 6. This rate of failure is less than 1% of wells per year and is considered extremely low.

Table 2 indicates non-Hobbs Field wells in the area by status. The Oxy-operated wells are completed below the Hobbs Field and provide minimal production of hydrocarbons. There are 17 active operated-by-others (OBO) wells, of which 3 are completed at depths shallower than the San Andres and 14 are completed at depths deeper than the San Andres. There are 32 inactive OBO wells, of which 27 have been properly plugged and abandoned (P&A'd) as required by the NMOCD (with 24 of these completed shallower than the San Andres and 3 deeper); the remaining 5 inactive OBO wells are temporarily abandoned (TA) in accordance with NMOCD rules and are completed deeper than the San Andres.

Table 2 – Non-Hobbs Field Wells

	Oxy Operated				Operated By Others	
Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*	*Active*	*Inactive*
Drilled & Completed in the 1930's	0	0	0		2	17
Drilled 1946-1979	1	0	0	8	5	11
Completed after 1980	7	4	15	15	10	4
TOTAL	***8***	***4***	***15***	***23***	***17***	***32***

All wells in oilfields, including both injection and production wells described in Tables 1 and 2, are regulated by the NMOCD under NMAC Title 9 Chapter 15 Parts 1-39.[3] A list of wells, with well identification numbers, is included in Appendix 5. The injection wells are subject to additional requirements promulgated by EPA – the UIC Class II program – implementation of which has been delegated to the NMOCD.

NMOCD rules govern well siting, construction, operation, maintenance, and closure for all wells in oilfields. Current rules require, among other provisions, that:

- Fluids be constrained in the strata in which they are encountered;
- Activities governed by the rule cannot result in the pollution of subsurface or surface water;
- Wells adhere to specified casing, cementing, drilling well control, and completion requirements designed to prevent fluids from moving from the strata they are encountered into strata with oil and gas, or into subsurface and surface waters;
- Wells file a completion report including basic electric log (e.g., a density, sonic, or resistivity (except dip meter) log run over the entire wellbore);
- Wells be equipped with a Bradenhead valve, measure the pressure between casing strings using the Bradenhead gauge, and follow procedures to report and address any instances where pressure on a Bradenhead is detected;
- Wells follow plugging procedures that require advance approval from the NMOCD and allow consideration of the suitability of the cement based on the use of the well, the location and setting of plugs.

In addition, Oxy implements a corrosion protection program to protect and maintain the steel used in injection and production wells from any CO_2-enriched fluids. Oxy currently employs methods to mitigate both internal and external corrosion of casing in wells in the

[3] See Appendix 6 for additional information.

Hobbs Field. These methods generally protect the downhole steel and the interior and exterior of well bores through the use of special materials (e.g. fiberglass tubing, corrosion resistant cements, nickel plated packers, corrosion resistant packer fluids) and procedures (e.g. packer placement, use of annular leakage detection devices, cement bond logs, pressure tests). These measures and procedures are typically included in the injection orders filed with the NMOCD. Corrosion protection methods and requirements may be enhanced over time in response to improvements in technology.

The NMOCD granted authority to inject CO_2 in the NHU and SHU after application, notice and hearing. As part of the application process, Oxy conducted an Area of Review (AOR) that included all wells within the NHU and SHU boundaries and extended ¼ mile around both units. According to EPA, the AOR refers to "the area around a deep injection well that must be checked for artificial penetrations, such as other wells, before a permit is issued. Well operators must identify all wells within the AOR that penetrate the injection or confining zone, and repair all wells that are improperly completed or plugged. The AOR is either a circle or a radius of at least ¼ mile around the well or an area determined by calculating the zone of endangering influence, where pressure due to injection may cause the migration of injected or formation fluid into a USDW."[4] Under these requirements Oxy has located and evaluated all wells in the AOR that penetrate the injection interval, including those operated by Oxy and those operated by other parties. Oxy will continue to comply with this regulation going forward.

Mechanical Integrity Testing (MIT)

Oxy complies with the MIT requirements implemented by NMOCD to periodically inspect wells and surface facilities to ensure that all wells and related surface equipment are in good repair and leak-free, and that all aspects of the site and equipment conform with Division rules and permit conditions. All active injection wells undergo an MIT at the following intervals:

- Before injection operations begin;
- Every 2 years as stated in the injection orders (NMOCD Order NO. R-4934-F / R-6199-F);
- After any workover that disturbs the seal between the tubing, packer, and casing;
- After any repair work on the casing; and
- When a request is made to suspend or reactivate the injection or disposal permit.

NMOCD requires that the operator notify the NMOCD district office prior to conducting an MIT. Operators are required to use a pressure recorder and pressure gauge for the tests. The operator's field representative must sign the pressure recorder chart and submit it with the MIT form. The casing-tubing annulus must be tested to a minimum of 300 psi for 30 minutes.

[4] USEPA, Underground Injection Control Program Glossary, http://water.epa.gov/type/groundwater/uic/glossary.cfm.

If a well fails an MIT, the operator must immediately shut the well in and provide notice to NMOCD. Casing leaks must be successfully repaired and retested or the well plugged and abandoned after submitting a formal notice and obtaining approval from the NMOCD.

Any well that fails an MIT cannot be returned to active status until it passes a new MIT.

2.3.3 Produced Fluids Handling

As injected CO_2 and water move through the reservoir, a mixture of oil, gas, and water (referred to as "produced fluids") flows to the production wells. Gathering lines bring the produced fluids from each production well to satellite batteries. Oxy has approximately 235 active production wells in the Hobbs Field and production from each is sent to one of ten satellite batteries. Each satellite battery consists of a large vessel that performs a gas-liquid separation. Each satellite battery also has well test equipment to measure production rates of oil, water and gas from individual production wells. Oxy has testing protocols for all wells connected to a satellite. Most wells are tested every two months. Some wells are prioritized for more frequent testing because they are new or located in an important part of the Field; some wells with mature, stable flow do not need to be tested as frequently; and finally some wells do not yield solid test results necessitating review or repeat testing.

After separation, the gas phase is transported by pipeline to an RCF for processing as described below. Currently the average composition of this gas mixture as it enters the RCF is 82-88% CO_2 and 9,000-10,000ppm H_2S; this composition will likely change over time as CO_2 EOR operations are implemented.

The liquid phase, which is a mixture of oil and water, is sent to one of four centralized tank batteries where oil is separated from water. The large size of the centralized tank batteries provides enough residence time for gravity to separate oil from water.

The separated oil is metered through the Lease Automatic Custody Transfer (LACT) unit located at each centralized tank battery and sold. The oil typically contains a small amount of dissolved or entrained CO_2. Analysis of representative samples of oil is conducted once a year to assess CO_2 content. Since 2012, the dissolved CO_2 content has averaged 0.18% by volume in the oil.

The water is removed from the bottom of the tanks at the central tank batteries and sent to water injection stations, where it is re-injected at the WAG headers.

Any gas that is released from the liquid phase rises to the top of the tanks and is collected by a Vapor Recovery Unit (VRU) that compresses the gas and sends it to an RCF for processing.

Hobbs oil is slightly sour, containing small amounts of hydrogen sulfide (H_2S), which is highly toxic. There are approximately 40 workers on the ground in the Hobbs Field at any given time, and all field personnel are required to wear H_2S monitors at all times. Although the primary purpose of H_2S detectors is protecting employees, monitoring will also supplement Oxy's CO_2 leak detection practices as discussed in Sections 5 and 7.

In addition, the procedures in 40 CFR §98.230-238 (Subpart W) and the two-part visual inspection process described in Section 5 are used to detect leakage from the produced fluids handling system. As described in Sections 5 and 7, the volume of leaks, if any, will be estimated to complete the mass balance equations to determine annual and cumulative volumes of stored CO_2.

2.3.4 Produced Gas Handling

Produced gas gathered from the satellite batteries and tank batteries is sent to an RCF. There is an operations meter at the RCF inlet.

Once gas enters an RCF, it undergoes dehydration and compression. In the NHU an additional process separates NGLs for sale. At the end of these processes there is a CO_2 rich stream that is recycled through re-injection. Meters at each RCF outlet are used to determine the total volume of the CO_2 stream recycled back into the EOR operations.

As described in Section 2.3.4, data from 40 CFR §98.230-238 (Subpart W), the two-part visual inspection process for production wells and areas described in Section 5, and information from the personal H_2S monitors are used to detect leakage from the produced gas handling system. This data will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2 as described in Sections 5 and 7.

2.3.5 Water Treatment and Injection

Produced water collected from the tank batteries is gathered through a pipeline system and moved to one of four water injection stations. Each facility consists of 10,000-barrel tanks where any remaining oil is skimmed from the water. Skimmed oil is returned to the centralized tank batteries. The water is sent to an injection pump where it is pressurized and distributed to the WAG headers for reinjection.

2.3.6 Facilities Locations

The current locations of the various facilities in the Hobbs Field are shown in Figure 13. As indicated above, there are four central tank batteries. There are ten active areas of operation that send fluids to one of ten satellite batteries. These active operations areas are highlighted and labeled with a number and letter, such as “24C” in the far west. The four centralized tank batteries are identified by the green squares. The four water treatment and injection stations are shown by the light blue squares. The two RCF facilities are indicated by red squares.

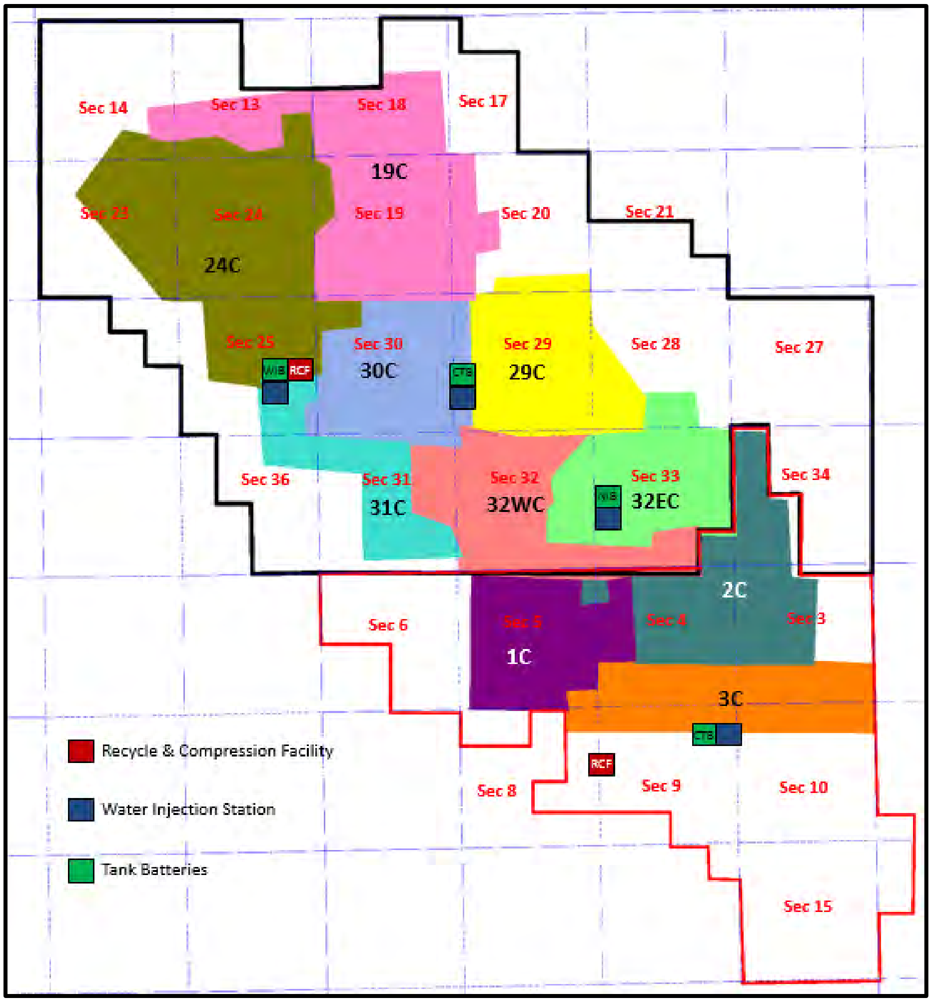


Figure 13 Location of Surface Facilities at Hobbs Field

NMOCD requires that injection pressures be limited to ensure injection fluids do not migrate outside the permitted injection interval. In the Hobbs Field, Oxy uses two methods to contain fluids: reservoir pressure management and the careful placement and operation of wells along the outer producing limits of the units.

Reservoir pressure in the Hobbs Field is managed by maintaining an injection to withdrawal ratio (IWR)[5] of approximately 1.0. To maintain the IWR, Oxy monitors fluid injection to ensure that reservoir pressure does not increase to a level that would fracture the reservoir seal or otherwise damage the oil field.

Oxy also prevents injected fluids from migrating out of the injection interval by keeping injection pressure below the formation fracture pressure, which is measured using step-rate

[5] Injection to withdrawal ratio (IWR) is the ratio of the volume of fluids injected to the volume of fluids produced (withdrawn). Volumes are measured under reservoir conditions for all fluids. Injected fluids are CO_2 and water; produced fluids are oil, water, and CO_2. By keeping IWR close to 1.0, reservoir pressure is held constant, neither increasing nor decreasing.

tests. In these tests, injection pressures are incrementally increased (e.g., in "steps") until injectivity increases abruptly, which indicates that an opening (fracture) has been created in the rock. Oxy manages its operations to ensure that injection pressures are kept below the formation fracture pressure so as to ensure that the valuable fluid hydrocarbons and CO_2 remain in the reservoir.

In addition, Oxy surrounds WAG operations with water injection wells to contain CO_2 within the patterns. There are a few small producer wells operated by third parties outside the boundary of Hobbs Field. The water injection wells also prevent any loss of CO_2 to these producer wells. There are currently no significant commercial operations surrounding the Hobbs Field to interfere with Oxy's operations.

2.4 Reservoir Modeling

Oxy uses reservoir simulation models to predict the behavior of fluids in a reservoir. These models provide a mathematical representation of the reservoir that incorporates all known information on the reservoir. In this way, future performance can be predicted in a manner consistent with available data, including logs and cores, as well as past production and injection history.

Mathematically, reservoir behavior is modeled by a set of differential equations that describe the fundamental principles of conservation of mass and energy, fluid flow, and phase behavior. These equations are complex and must be solved numerically using sophisticated computer modeling. The solution process involves sub-dividing the reservoir into a large number of blocks arranged on a grid. Each block is assigned specific rock properties (porosity, permeability, saturations, compositions and pressure). The blocks are small enough to adequately describe the reservoir, but large enough to keep their number manageable. The computer uses the differential equations to determine how various physical properties change with time in each grid block. Small time steps are used to progress from a known starting point through time. In this way the computer simulates reservoir performance, consistent with fundamental physics and actual reservoir geometry. The simulation represents the flow of each fluid phase (oil, water and gas), changes in fluid content (saturations), equilibrium between phases (compositional changes), and pressure changes over time.

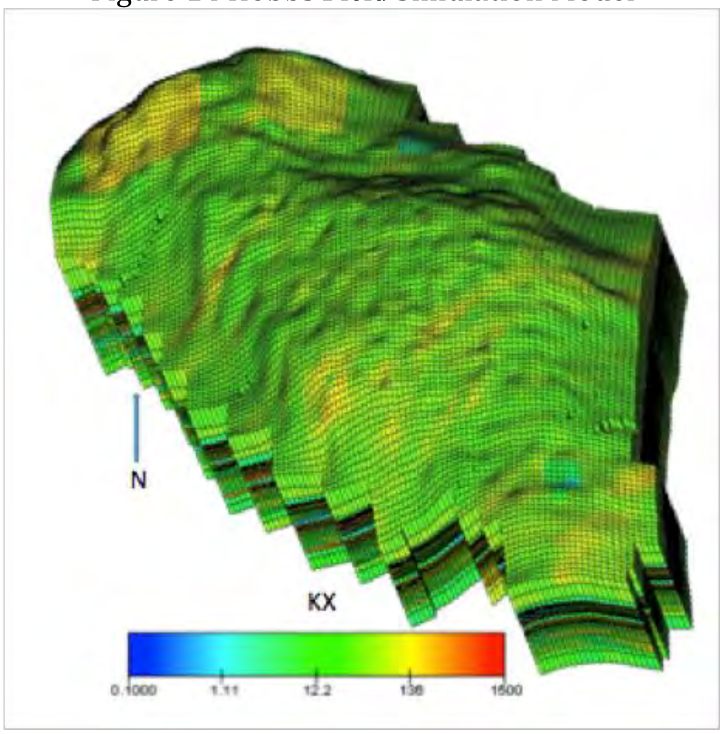
The reservoir simulator used by Oxy is a commercially available compositional simulator, called MORE, developed by Roxar. It is called "compositional" because it has the capability to keep track of the composition of each phase (oil, gas, and water) over time and throughout the volume of the reservoir. There are 16 components in the compositional model.

To build a simulation model, engineers and scientists input specific information on reservoir geometry, rock properties, and fluid flow properties. The input data includes:

- Reservoir geometry, including distance between wells, reservoir thickness and structural contours;

- Rock properties, such as permeability and porosity of individual layers, barriers to vertical flow, and layer continuity; and,
- Fluid flow properties including density and viscosity of each phase, relative permeability, capillary pressure, and phase behavior.

Figure 14 Hobbs Field Simulation Model



A simulation model for the Hobbs Field, illustrated in Figure 14, shows an aerial three-dimensional view of horizontal permeability in each layer. The color scale indicates range of permeability, with red being higher permeability and blue being lower permeability. The model covers the entire anticline structure and has been used to verify the use of actual and predicted dimensionless performance curves.

Layering

Within a flood, one of the most important properties to model is the effect of layering. Reservoir rocks were originally deposited over very long periods of time. Because the environment tended to be uniform at any one point in time, reservoir properties tend to be relatively uniform over large areas. Depositional environments change over time, however, and for this reason rock properties vary considerably with time or depth as they are deposited. Thus, rock properties are modeled as layers. Some layers have high permeability and some have lower permeability. Those with higher permeability take most of the injected fluids and are swept most readily. Those with lower permeability may be only partially contacted at the end of the flooding process. (The WAG process helps improve sweep efficiency.) As Figure 14 shows, the simulation is divided into 37 vertical grid blocks. These layers were consolidated in the simulation from a 169 layer geologic model. Each layer of simulation grid blocks is used to model the depositional layering as closely as practical. The seal rocks above the flood interval are not included in the simulation since they are impermeable and do not participate in fluid flow processes.

Figure 15 – Hobbs Simulation Cross-Section (Original Oil Saturation)

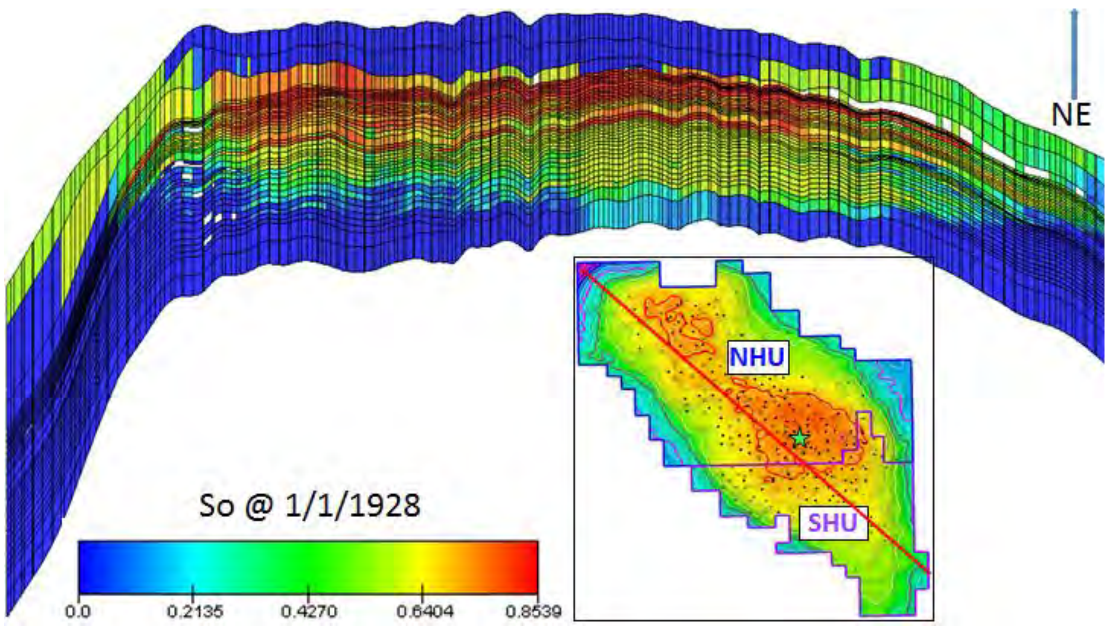


Figure 15 illustrates how initial oil saturation varied across the Hobbs Field in its original state. The original oil saturation shown in Figure 15 is derived from the geologic model shown in Figure 8.

Performance Prediction

Simulation models may represent either a multi-pattern segment of the field, or the entire field. Field-wide simulations are initially used to assess the viability of water and CO_2 flooding. Once a decision has been made to develop a CO_2 EOR project, Oxy uses modeling to plan the locations of and injection schedules for wells. In the case of the Hobbs Field, a geologic model that has evolved over the last several decades is used as a basis for the rock properties in the simulation model. The simulation model is tuned to match actual historical performance data collected during primary and waterflood field production. This provides Oxy with confidence that the model can adequately forecast oil, water and CO_2 production, along with CO_2 and water injection.

One objective of simulation is to develop an injection plan that maximizes oil recovery and minimizes the costs of the CO_2 flood. The injection plan includes such controllable items as:

- The cycle length and WAG ratio to inject water or CO_2 in the WAG process, and
- The best rate and pressure for each injection phase.

Simulations may also be used to:

- Evaluate infill or replacement wells,
- Determine the best completion intervals,
- Verify the need for well remediation or stimulation, and
- Determine anticipated rates and ultimate recovery.

Modeling allows Oxy to optimize the flood pattern and injection scheme, and provides assurance that the injected CO_2 will stay in-zone to contact and displace oil.

Simulation modeling is typically used for planning and not as a daily management tool because it is time-intensive and often does not provide sufficiently detailed information about the expected pressure, injection volumes, and production, at the level of an injection pattern. In order to analyze performance at the pattern level, Oxy uses dimensionless prototypes to manage CO_2 flood performance. The pattern-level prototypes can be constructed in one of two ways: from simulation or from actual performance of a more mature analog project. Where simulation is used to generate the predictions, the simulation results should be validated by comparison with analog project performance if possible.

If actual performance differs in a noticeable way from prediction, reservoir engineers use professional judgment formed by an analysis of technical data to determine where further attention is needed. The appropriate response could be to change injection rates, to alter the prediction model or to find and repair fluid leaks.

3. Delineation of Monitoring Area and Timeframes

3.1 Active Monitoring Area

Because CO_2 is present throughout the Hobbs Field and retained within it, the Active Monitoring Area (AMA) is defined by the boundary of the Hobbs Field. The following factors were considered in defining this boundary:

- Free phase CO_2 is present throughout the Hobbs Field: More than 579 Bscf (31.3 MMMT) tons of CO_2 have been injected throughout the Hobbs Field since 2003 and there has been significant infill drilling in the Hobbs Field, completing additional wells to further optimize production. Operational results thus far indicate that there is CO_2 throughout the Hobbs Field.
- CO_2 injected into the Hobbs Field remains contained within the field because of the fluid and pressure management approaches associated with CO_2 EOR. Namely, maintenance of an IWR of 1.0 assures a stable reservoir pressure; managed leaseline injection and production wells are used to retain fluids in the Hobbs Field

as indicated in Section 2.3.6; and operational results indicate that injected CO_2 is retained in the Hobbs Field.

- Furthermore, over geologic timeframes, stored CO_2 will remain in the Hobbs Field and will not migrate downdip as described in Section 2.2.3, because the Hobbs Field contains the area with the highest elevation.

3.2 Maximum Monitoring Area

The Maximum Monitoring Area (MMA) is defined in 40 CFR §98.440-449 (Subpart RR) as including the maximum extent of the injected CO_2 and a half-mile buffer bordering that area. As described in the AMA section (Section 3.1), the maximum extent of the injected CO_2 is anticipated to be bounded by the Hobbs Field. Therefore the MMA is the Hobbs Field plus the half-mile buffer as required by 40 CFR §98.440-449 (Subpart RR).

3.3 Monitoring Timeframes

Oxy's primary purpose for injecting CO_2 is to produce oil that would otherwise remain trapped in the reservoir and not, as in UIC Class VI, "specifically for the purpose of geologic storage."[6] During a Specified Period, Oxy will have a subsidiary purpose of establishing the long-term containment of a measurable quantity of CO_2 in the Basal Grayburg - San Andres formation in the Hobbs Field. The Specified Period will be shorter than the period of production from the Hobbs Field. This is in part because the purchase of new CO_2 for injection is projected to taper off significantly before production ceases at Hobbs Field, which is modeled through 2100. At the conclusion of the Specified Period, Oxy will submit a request for discontinuation of reporting. This request will be submitted when Oxy can provide a demonstration that current monitoring and model(s) show that the cumulative mass of CO_2 reported as sequestered during the Specified Period is not expected to migrate in the future in a manner likely to result in surface leakage. It is expected that it will be possible to make this demonstration within two to three years after injection for the Specified Period ceases based upon predictive modeling supported by monitoring data. The demonstration will rely on two principles: 1) that just as is the case for the monitoring plan, the continued process of fluid management during the years of CO_2 EOR operation after the Specified Period will contain injected fluids in the Hobbs Field, and 2) that the cumulative mass reported as sequestered during the Specified Period is a fraction of the theoretical storage capacity of the Hobbs Field *See* 40 C.F.R. § 98.441(b)(2)(ii).

4. Evaluation of Potential Pathways for Leakage to the Surface

4.1 Introduction

[6] EPA UIC Class VI rule, EPA 75 FR 77291, December 10, 2010, section 146.81(b).

In the roughly 40 years since the Hobbs Field was formed, the reservoir has been studied and documented extensively. Based on the knowledge gained from that experience, this section assesses the potential pathways for leakage of stored CO_2 to the surface. The following potential pathways are reviewed:

- Existing Well Bores
- Faults and Fractures
- Natural and Induced Seismic Activity
- Previous Operations
- Pipeline/Surface Equipment
- Lateral Migration Outside the Hobbs Field
- Drilling Through the CO_2 Area
- Diffuse Leakage Through the Seal

4.2 Existing Well Bores

As of August 2016, there are approximately 445 active Oxy operated wells in the Hobbs Field – split roughly evenly between production and injection wells. In addition, there are approximately 256 wells not in use and 22 OBO wells that penetrate the San Andres, as described in Section 2.3.2.

Leakage through existing well bores is a potential risk at the Hobbs Field that Oxy works to prevent by adhering to regulatory requirements for well drilling and testing; implementing best practices that Oxy has developed through its extensive operating experience; monitoring injection/production performance, wellbores, and the surface; and maintaining surface equipment.

As discussed in Section 2.3.2, regulations governing wells in the Hobbs Field require that wells be completed and operated so that fluids are contained in the strata in which they are encountered and that well operation does not pollute subsurface and surface waters. The regulations establish the requirements that all wells (injection, production, disposal) must comply with. Depending upon the purpose of a well, the requirements can include additional standards for AOR evaluation and MIT. In implementing these regulations, Oxy has developed operating procedures based on its experience as one of the world's leading operators of EOR floods. Oxy's best practices include developing detailed modeling at the pattern level to guide injection pressures and performance expectations; utilizing diverse teams of experts to develop EOR projects based on specific site characteristics; and creating a culture where all Field personnel are trained to look for and address issues promptly. Oxy's practices, which include corrosion prevention techniques to protect the wellbore as needed, as discussed in Section 2.3.2, ensures that well completion and operation procedures are designed not only to comply with regulations but also to ensure that all fluids (e.g., oil, gas, CO_2) remain in the Hobbs Field until they are produced through an Oxy well.

In addition, all Oxy facilities are internally screened to determine if the SFRM program should be applied. This determination is primarily based on proximity to the public. In the case of wells, SFRM guidelines call for using enhanced materials for well heads, installing sensors to detect H_2S, and using automatic shut-off valves triggered by the presence of detected gases.

As described in Section 5, continual and routine monitoring of Oxy's well bores and site operations will be used to detect leaks, including those from non-Oxy wells, or other potential well problems, as follows:

- Well pressure in injection wells is monitored on a continual basis. The injection plans for each pattern are programmed into the injection WAG satellite, as discussed in Section 2.3.1, to govern the rate, pressure, and duration of either water or CO_2 injection. Pressure monitors on the injection wells are programmed to flag pressures that significantly deviate from the plan. Leakage on the inside or outside of the injection wellbore would affect pressure and be detected through this approach. If such excursions occur, they are investigated and addressed. Over the years Oxy has managed the Hobbs Field, it is the company's experience that few excursions result in fluid migration out of the intended zone and that leakage to the surface is very rare.

- In addition to monitoring well pressure and injection performance, Oxy uses the experience gained over time to strategically approach well maintenance and updating. Oxy maintains well maintenance and workover crews onsite for this purpose. For example, the well classifications by age and construction method indicated in Table 1 inform Oxy's plan for monitoring and updating wells. Oxy uses all of the information at hand including pattern performance, and well characteristics to determine well maintenance schedules.

- Production well performance is monitored using the production well test process conducted when produced fluids are gathered and sent to a satellite battery. There is a routine cycle for each satellite battery, with each well being tested approximately once every two months. During this cycle, each production well is diverted to the well test equipment for a period of time sufficient to measure and sample produced fluids (generally 8-12 hours). This test allows Oxy to allocate a portion of the produced fluids measured at the satellite battery to each production well, assess the composition of produced fluids by location, and assess the performance of each well. Performance data are reviewed on a routine basis to ensure that CO_2 flooding is optimized. If production is off plan, it is investigated and any identified issues addressed. Leakage to the outside of production wells is not considered a major risk because of the reduced pressure in the casing. Further, the personal H_2S monitors are designed to detect leaked fluids around production wells.

- Finally, as indicated in Section 5, field inspections are conducted on a routine basis by field personnel. On any day, Oxy has approximately 40 personnel in the field.

> Leaking CO_2 is very cold and leads to formation of bright white clouds and ice that are easily spotted. All field personnel are trained to identify leaking CO_2 and other potential problems at wellbores and in the field. Any CO_2 leakage detected will be documented and reported, quantified and addressed as described in Section 5.

Based on its ongoing monitoring activities and review of the potential leakage risks posed by well bores, Oxy concludes that it is mitigating the risk of CO_2 leakage through well bores by detecting problems as they arise and quantifying any leakage that does occur. Section 4.10 summarizes how Oxy will monitor CO_2 leakage from various pathways and describes how Oxy will respond to various leakage scenarios. In addition, Section 5 describes how Oxy will develop the inputs used in the Subpart RR mass-balance equation (Equation RR-11). Any incidents that result in CO_2 leakage up the wellbore and into the atmosphere will be quantified as described in Section 7.4.

4.3 Faults and Fractures

After reviewing geologic, seismic, operating, and other evidence, Oxy has concluded that there are no known faults or fractures that transect the Basal Grayburg – San Andres reservoir in the project area. As described in Section 2.2.1, faults have been identified in formations that are thousands of feet below the San Andres formation, but this faulting has been shown not to affect the San Andres or to have created potential leakage pathways.

Oxy has extensive experience in designing and implementing EOR projects to ensure injection pressures will not damage the oil reservoir by inducing new fractures or creating shear. As a safeguard, injection satellites are set with automatic shutoff controls if injection pressures exceed fracture pressures.

4.4 Natural or Induced Seismicity

After reviewing the literature and actual operating experience, Oxy concludes that there is no direct evidence that natural seismic activity poses a significant risk for loss of CO_2 to the surface in the Permian Basis, and specifically in the Hobbs Field.

Of the recorded earthquakes in the Permian Basin, none have occurred in the Hobbs Field; the closest was nearly 80 miles away. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity.

A few recent studies have suggested a possible relationship between CO_2 miscible flooding activities and seismic activity in certain areas. Determining whether the seismic activity is induced or triggered by human activity is difficult.

To evaluate this potential risk, Oxy has reviewed the nature and location of seismic events within the vicinity of the Hobbs Field. Some of the recorded earthquakes in southeastern New Mexico and West Texas are far removed from any injection operation. These are judged to be from natural causes. Others are near oil fields or water disposal wells and are placed in the category of "quakes in close association with human enterprise." (See Frohlich, 2012) The concern about induced seismicity is that it could lead to fractures in the seal, providing a pathway for CO_2 leakage to the surface. Based on Oxy's review of seismic data, none of the recorded "earthquakes" in the Permian Basin have occurred in the Hobbs Field. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity. Therefore, there is no direct evidence to suggest that natural seismic activity poses a significant risk for loss of CO_2 to the surface from the Hobbs Field. If induced seismicity resulted in a pathway for material amounts of CO_2 to migrate from the injection zone, other reservoir fluid monitoring provisions (e.g., reservoir pressure, well pressure, and pattern monitoring) would lead to further investigation.

4.5 Previous Operations

Oxy initiated CO_2 flooding in the Hobbs Field in 2003. Oxy and the prior operators have kept records of the site and have completed numerous infill wells. Oxy's standard practice for drilling new wells includes a rigorous review of nearby wells to ensure that drilling will not cause damage to or interfere with existing wells. Oxy also follows AOR requirements under the UIC Class II program, which require identification of all active and abandoned wells in the AOR and implementation of procedures that ensure the integrity of those wells when applying for a permit for any new injection well.[7] As a result, Oxy has checked for the presence of old, unknown wells throughout the Hobbs Field over many years. These practices ensure that identified wells are sufficiently isolated and do not interfere with the CO_2 EOR operations and reservoir pressure management. Consequently, Oxy's operational experience supports the conclusion that there are no unknown wells within the Hobbs Field and that it has sufficiently mitigated the risk of migration from older wells. Oxy has successfully optimized CO_2 flooding with infill wells because the confining zone has not been impaired by previous operations.

4.6 Pipeline / Surface Equipment

Damage to or failure of pipelines and surface equipment can result in unplanned losses of CO_2. Oxy reduces the risk of unplanned leakage from surface facilities, to the maximum extent practicable, by relying on the use of prevailing design and construction practices and maintaining compliance with applicable regulations. The facilities and pipelines currently utilize and will continue to utilize materials of construction and control processes that are standard for CO_2 EOR projects in the oil and gas industry. As described above, all facilities in the Hobbs Field are internally screened for the SFRM program. In the case of pipeline and surface equipment, the SRFM calls for more robust design and operating requirements to prevent and detect leakage. Operating and maintenance practices currently follow and will continue to follow demonstrated industry standards. CO_2 delivery via the Permian pipeline system will continue to comply with all applicable regulations. Finally,

[7] Current requirements are referenced in Appendix 6.

frequent routine visual inspection of surface facilities by Field staff will provide an additional way to detect leaks and further support Oxy's efforts to detect and remedy any leaks in a timely manner. Should leakage be detected from pipeline or surface equipment, the volume of released CO_2 will be quantified following the requirements of Subpart W of EPA's GHGRP.

4.7 Lateral Migration Outside the Hobbs Field

It is highly unlikely that injected CO_2 will migrate downdip and laterally outside the Hobbs Field because of the nature of the geology and the approach used for injection. First, as indicated in Section 2.2.1 "Geology of the Hobbs Field," the Hobbs Field is situated above the highest elevation within the San Andres. This means that over long periods of time, injected CO_2 will tend to rise vertically towards the Upper San Andres and Basal Grayburg and continue towards the point in the Hobbs Field with the highest elevation. Second, the planned injection volumes and active fluid management during injection operations will prevent CO_2 from migrating laterally out of the structure. Finally, Oxy will not be increasing the total volume of fluids in the Hobbs Field. Based on site characterization and planned and projected operations Oxy estimates the total volume of stored CO_2 will be approximately 27.6% of calculated capacity.

4.8 Drilling Through the CO_2 Area

It is possible that at some point in the future, drilling through the containment zone into the San Andres could occur and inadvertently create a leakage pathway. Oxy's review of this issue concludes that this risk is very low for three reasons. First, any wells drilled in the oil fields of New Mexico are regulated by NMOCD and are subject to requirements that fluids be contained in strata in which they are encountered.[8] Second, Oxy's visual inspection process, including routine site visits, is designed to identify unapproved drilling activity in the Hobbs Field. Third, Oxy plans to operate the CO_2 EOR flood in the Hobbs Field for several more decades, and will continue to be vigilant about protecting the integrity of its assets and maximizing the potential of resources (oil, gas, CO_2). In the unlikely event Oxy would sell the Field to a new operator, provisions would result in a change to the reporting program and would be addressed at that time.

4.9 Diffuse Leakage through the Seal

Diffuse leakage through the seal formed by the upper Grayburg is highly unlikely. The presence of a gas cap trapped over millions of years as discussed in Section 2.2.3 confirms that the seal has been secure for a very long time. Injection pattern monitoring program referenced in Section 2.3.1 and detailed in Section 5 assures that no breach of the seal will be created. The seal is highly impermeable where unperforated, cemented across the horizon where perforated by wells, and unexplained changes in injection pressure would trigger investigation as to the cause. Further, if CO_2 were to migrate through the Grayburg

[8] Current requirements are referenced in Appendix 6.

seal, it would migrate vertically until it encountered and was trapped by any of the additional shallower seals indicated in orange in Figure 4, Section 2.2.1.

4.10 Monitoring, Response, and Reporting Plan for CO_2 Loss

As discussed above, the potential sources of leakage include fairly routine issues, such as problems with surface equipment (pumps, valves, etc.) or subsurface equipment (well bores), and unique events such as induced fractures. Table 3 summarizes some of these potential leakage scenarios, the monitoring activities designed to detect those leaks, Oxy's standard response, and other applicable regulatory programs requiring similar reporting.

Sections 5.1.5 - 5.1.7 discuss the approaches envisioned for quantifying the volumes of leaked CO_2. Given the uncertainty concerning the nature and characteristics of leaks that will be encountered, the most appropriate methods for quantifying the volume of leaked CO_2 will be determined at the time. In the event leakage occurs, Oxy plans to determine the most appropriate methods for quantifying the volume leaked and will report it as required as part of the annual Subpart RR submission.

Any volume of CO_2 detected leaking to surface will be quantified using acceptable emission factors such as those found in 40 CFR Part 98 Subpart W or engineering estimates of leak amounts based on measurements in the subsurface, Oxy's field experience, and other factors such as the frequency of inspection. As indicated in Sections 5.1 and 7.4, leaks will be documented, evaluated and addressed in a timely manner. Records of leakage events will be retained in the electronic environmental documentation and reporting system. Repairs requiring a work order will be documented in the electronic equipment maintenance system.

Table 3 Response Plan for CO_2 Loss

Risk	Monitoring Plan	Response Plan	Parallel Reporting (if any)
Loss of Well Control			
Tubing Leak	Monitor changes in annulus pressure; MIT for injectors	Workover crews respond within days	NMOCD
Casing Leak	Routine Field inspection; MIT for injectors; extra attention to high risk wells	Workover crews respond within days	NMOCD
Wellhead Leak	Routine Field inspection	Workover crews respond within days	NMOCD
Loss of Bottom-hole pressure control	Blowout during well operations	Maintain well kill procedures	NMOCD

Unplanned wells drilled through San Andres	Routine Field inspection to prevent unapproved drilling; compliance with NMOCD permitting for planned wells.	Assure compliance with NMOCD regulations	NMOCD Permitting
Loss of seal in abandoned wells	Reservoir pressure in WAG headers; high pressure found in new wells	Re-enter and reseal abandoned wells	NMOCD
Leaks in Surface Facilities			
Pumps, values, etc.	Routine Field inspection	Workover crews respond within days	Subpart W
Subsurface Leaks			
Leakage along faults	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near faults	-
Overfill beyond spill points	Reservoir pressure in WAG headers; high pressure found in new wells	Fluid management along lease lines	-
Leakage through induced fractures	Reservoir pressure in WAG headers; high pressure found in new wells	Comply with rules for keeping pressures below parting pressure	-
Leakage due to seismic event	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near seismic event	-

Available studies of actual well leaks and natural analogs (e.g., naturally occurring CO_2 geysers) suggest that the amount released from routine leaks would be small as compared to the amount of CO_2 that would remain stored in the formation.[9]

4.11 Summary

The structure and stratigraphy of the San Andres reservoir in the Hobbs Field is ideally suited for the injection and storage of CO_2. The stratigraphy within the CO_2 injection zones is porous, permeable and very thick, providing ample capacity for long-term CO_2 storage. The San Andres formation is overlain by several intervals of impermeable geologic zones that form effective seals or "caps" to fluids in the San Andres formation (See Figure 4). After assessing potential risk of release from the subsurface and steps that have been taken to prevent leaks, Oxy has determined that the potential threat of leakage is extremely low.

In summary, based on a careful assessment of the potential risk of release of CO_2 from the subsurface, Oxy has determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere. Further, given the detailed knowledge of the Field and its operating protocols, Oxy concludes that it would be able to both detect and quantify any CO_2 leakage to the surface that could arise through either identified or unexpected leakage pathways.

[9] See references to following reports of measurements, assessments, and analogs in Appendix 4: IPCC Special Report on Carbon Dioxide Capture and Storage; Wright – Presentation to UNFCC SBSTA on CCS; Allis, R., et al, "Implications of results from CO2 flux surveys over known CO2 systems for long-term monitoring; McLing - Natural Analog CCS Site Characterization Soda Springs, Idaho Implications for the Long-term Fate of Carbon Dioxide Stored in Geologic Environments.

5. Monitoring and Considerations for Calculating Site Specific Variables

5.1 For the Mass Balance Equation

5.1.1 General Monitoring Procedures

As part of its ongoing operations, Oxy monitors and collects flow, pressure, and gas composition data from the Hobbs Field in centralized data management systems. These data are monitored continually by qualified technicians who follow Oxy response and reporting protocols when the systems deliver notifications that data exceed statistically acceptable boundaries.

As indicated in Figures 10 and 11, custody-transfer meters are used at the two points at which custody of the CO_2 from the Permian pipeline delivery system is transferred to Oxy, at the points at which custody of oil and NGLs are transferred to outside parties, and on both sides of the fluid transfer point between NHU and SHU. Meters measure flow rate continually. Fluid composition will be determined, at a minimum, quarterly, consistent with EPA GHGRP's Subpart RR, section 98.447(a). All meter and composition data are documented, and records will be retained for at least three years.

Metering protocols used by Oxy follow the prevailing industry standard(s) for custody transfer as currently promulgated by the API, the American Gas Association (AGA), and the Gas Processors Association (GPA), as appropriate. This approach is consistent with EPA GHGRP's Subpart RR, section 98.444(e)(3). These meters will be maintained routinely, operated continually, and will feed data directly to the centralized data collection systems. The meters meet the industry standard for custody transfer meter accuracy and calibration frequency. These custody meters provide the most accurate way to measure mass flows.

Historically, there is an immaterial difference between the NHU and SHU custody transfer meter measurements of fluids transferred from the NHU to the SHU that is attributed to calibration error. The fluids from the NHU move directly into the pipeline entering the SHU RCF and are co-mingled with other produced fluids from the SHU. Because this volume of gas is contained within the Hobbs Field it is part of the overall mass balance but is not calculated separately. This will be discussed further in this section and within Section 7.

Oxy maintains in-field process control meters to monitor and manage in-field activities on a real time basis. These are identified as operations meters in Figures 10 and 11. These meters provide information used to make operational decisions but are not intended to provide the same level of accuracy as the custody-transfer meters. The level of precision and accuracy for in-field meters currently satisfies the requirements for reporting in existing UIC permits. Although these meters are accurate for operational purposes, it is important to note that there is some variance between most commercial meters (on the order of 1-5%) which is additive across meters. This variance is due to differences in factory settings and meter calibration, as well as the operating conditions within a field. Meter elevation, changes in temperature (over the course of the day), fluid composition (especially in multi-component or multi-phase streams), or pressure can affect in-field meter readings. Unlike in a saline formation, where there are likely to be only a few injection wells and associated meters, at CO_2 EOR operations in the Hobbs Field there are currently 445 active injection and production wells and a comparable number of meters, each with an acceptable range of error. This is a site-specific factor that is considered in the mass balance calculations described in Section 7.

5.1.2 CO_2 Received

Oxy measures the volume of received CO_2 using commercial custody transfer meters at each of the two off-take points from the Permian pipeline delivery system and at the point of transfer between the NHU and the SHU. This transfer is a commercial transaction that is documented. CO_2 composition is governed by the contract and the gas is routinely sampled to determine composition. No CO_2 is received in containers.

5.1.3 CO_2 Injected into the Subsurface

Injected CO_2 will be calculated using the flow meter volumes at the operations meter at the outlet of the RCFs and the custody transfer meter at the CO_2 off-take points from the Permian pipeline delivery system

5.1.4 CO_2 Produced, Entrained in Products, and Recycled

The following measurements are used for the mass balance equations in Section 7:

CO_2 produced is calculated using the volumetric flow meters at the inlet to an RCF.

CO_2 is produced as entrained or dissolved CO_2 in produced oil, as indicated in Figures 10 and 11. The concentration of CO_2 in produced oil is measured at the custody transfer meter.

Recycled CO_2 is calculated using the volumetric flow meter at the outlet of the RCFs, which is an operations meter.

5.1.5 CO_2 Emitted by Surface Leakage

As discussed in Section 5.1.6 and 5.1.7 below, Oxy uses 40 CFR Part 98 Subpart W to estimate surface leaks from equipment at the Hobbs Field. Subpart W uses a factor-driven approach to estimate equipment leakage. In addition, Oxy uses an event-driven process to assess, address, track, and if applicable quantify potential CO_2 leakage to the surface. Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

The multi-layered, risk-based monitoring program for event-driven incidents has been designed to meet two objectives, in accordance with the leakage risk assessment in Section 4: 1) to detect problems before CO_2 leaks to the surface; and 2) to detect and quantify any leaks that do occur. This section discusses how this monitoring will be conducted and used to quantify the volumes of CO_2 leaked to the surface.

Monitoring for potential Leakage from the Injection/Production Zone:
Oxy will monitor both injection into and production from the reservoir as a means of early identification of potential anomalies that could indicate leakage from the subsurface.

Oxy uses reservoir simulation modeling, based on extensive history-matched data, to develop injection plans (fluid rate, pressure, volume) that are programmed into each WAG satellite. If injection pressure or rate measurements are beyond the specified set points determined as part of each pattern injection plan, a data flag is automatically triggered and field personnel will investigate and resolve the problem. These excursions will be reviewed by well-management personnel to determine if CO_2 leakage may be occurring. Excursions are not necessarily indicators of leaks; they simply indicate that injection rates and pressures are not conforming to the pattern injection plan. In many cases, problems are straightforward to fix (e.g., a meter needs to be recalibrated or some other minor action is required), and there is no threat of CO_2 leakage. In the case of issues that are not readily resolved, more detailed investigation and response would be initiated, and internal Oxy support staff would provide additional assistance and evaluation. Such issues would lead to the development of a work order in Oxy's work order management system. This record enables the company to track progress on investigating potential leaks and, if a leak has occurred, to quantify its magnitude.

Likewise, Oxy develops a forecast of the rate and composition of produced fluids. Each producer well is assigned to one satellite battery and is isolated once during each monthly cycle for a well production test. This data is reviewed on a periodic basis to confirm that production is at the level forecasted. If there is a significant deviation from the forecast, well management personnel investigate. If the issue cannot be resolved quickly, more detailed investigation and response would be initiated. As in the case of the injection pattern monitoring, if the investigation leads to a work order in the Oxy work order management system, this record will provide the basis for tracking the outcome of the investigation and if a leak has occurred, recording the quantity leaked to the surface. If leakage in the flood zone were detected, Oxy would use an appropriate method to quantify the involved volume of CO_2. This might include use of material balance equations based on known injected quantities and monitored pressures in the injection zone to estimate the volume of CO_2 involved.

A subsurface leak might not lead to a surface leak. In the event of a subsurface leak, Oxy would determine the appropriate approach for tracking subsurface leakage to determine and quantify leakage to the surface. To quantify leakage to the surface, Oxy would estimate the relevant parameters (e.g., the rate, concentration, and duration of leakage) to quantify the leak volume. Depending on specific circumstances, these determinations may rely on engineering estimates.

In the event leakage from the subsurface occurred diffusely through the seals, the leaked gas would include H_2S, which would trigger the alarm on the personal monitors worn by field personnel. Such a diffuse leak from the subsurface has not occurred in the Hobbs Field. In the event such a leak was detected, field personnel from across Oxy would determine how to address the problem. The team might use modeling, engineering estimates, and direct measurements to assess, address, and quantify the leakage.

<u>Monitoring of Wellbores</u>*:*
Oxy monitors wells through continual, automated pressure monitoring in the injection zone (as described in Section 4.2), monitoring of the annular pressure in wellheads, and routine maintenance and inspection.

Leaks from wellbores would be detected through the follow-up investigation of pressure anomalies, visual inspection, or the use of personal H_2S monitors.

Anomalies in injection zone pressure may not indicate a leak, as discussed above. However, if an investigation leads to a work order, field personnel would inspect the equipment in question and determine the nature of the problem. If it is a simple matter, the repair would be made and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repair were needed, Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Anomalies in annular pressure or other issues detected during routine maintenance inspections would be treated in the same way. Field personnel would inspect the equipment in question and determine the nature of the problem. For simple matters the repair would be made at the time of inspection and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repairs were needed, a work order would be generated and Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Because leaking CO_2 at the surface is very cold and leads to formation of bright white clouds and ice that are easily spotted, Oxy also employs a two-part visual inspection process in the general area of the Hobbs Field to detect unexpected releases from wellbores. First, field personnel visit the surface facilities on a routine basis. Inspections may include tank volumes, equipment status and reliability, lube oil levels, pressures and flow rates in the facility, and valve leaks. Field personnel inspections also check that injectors are on the proper WAG schedule and observe the facility for visible CO_2 or fluid line leaks.

Historically, Oxy has documented on average nine unexpected release events each year in the Hobbs Field. An identified need for repair or maintenance through visual inspections results in a work order being entered into Oxy's equipment and maintenance work order management system. The time to repair any leak is dependent on several factors, such as the severity of the leak, available manpower, location of the leak, and availability of materials required for the repair. Critical leaks are acted upon immediately.

Finally, Oxy uses the data collected by the H_2S monitors, which are worn by all field personnel at all times, as a last method to detect leakage from wellbores. The H_2S monitors detection limit is 10ppm; if an H_2S alarm is triggered, the first response is to protect the safety of the personnel, and the next step is to safely investigate the source of the alarm. As noted previously, Oxy considers H_2S a proxy for potential CO_2 leaks in the field. Thus, detected H_2S leaks will be investigated to determine and, if needed, quantify potential CO_2 leakage. If the incident results in a work order, this will serve as the basis for tracking the event for GHG reporting.

Additional Safeguards and Monitoring under SFRM Program:
As described above, because of the presence of H_2S and proximity to the City of Hobbs, Oxy screens all well locations and surface equipment to determine when to apply the SFRM program. Under the SFRM, Oxy voluntarily applies additional provisions for design and operation of facilities. The SFRM program is intended to further mitigate the risk of public exposure from the potential loss of well control, however, its provisions also enhance leak prevention and detection. All instances of triggered safeguards will be investigated to determine if there is CO_2 leakage.

Other Potential Leakage at the Surface:
Oxy will utilize the same visual inspection process and H_2S monitoring system to detect other potential leakage at the surface as it does for leakage from wellbores. Oxy utilizes routine visual inspections to detect significant loss of CO_2 to the surface. Field personnel routinely visit surface facilities to conduct a visual inspection. Inspections may include review of tank level, equipment status, lube oil levels, pressures and flow rates in the facility, valve leaks, ensuring that injectors are on the proper WAG schedule, and also conducting a general observation of the facility for visible CO_2 or fluid line leaks. If problems are detected, field personnel would investigate, and, if maintenance is required, generate a work order in the maintenance system, which is tracked through completion. In addition to these visual inspections, Oxy will use the results of the personal H_2S monitors worn by field personnel as a supplement for smaller leaks that may escape visual detection.

If CO_2 leakage to the surface is detected, it will be reported to surface operations personnel who will review the reports and conduct a site investigation. If maintenance is required, a work order will be generated in the work order management system. The work order will describe the appropriate corrective action and be used to track completion of the maintenance action. The work order will also serve as the basis for tracking the event for GHG reporting and quantifying any CO_2 emissions.

5.1.6 CO_2 emitted from equipment leaks and vented emissions of CO_2 from surface equipment located between the injection flow meter and the injection wellhead.

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.1.7 Mass of CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment located between the production flow meter and the production wellhead

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.2 To Demonstrate that Injected CO_2 is not Expected to Migrate to the Surface

At the end of the Specified Period, Oxy intends to cease injecting CO_2 for the subsidiary purpose of establishing the long-term storage of CO_2 in the Hobbs Field. After the end of the Specified Period, Oxy anticipates that it will submit a request to discontinue monitoring and reporting. The request will demonstrate that the amount of CO_2 reported under 40 CFR §98.440-449 (Subpart RR) is not expected to migrate in the future in a manner likely to result in surface leakage. At that time, Oxy will be able to support its request with years of data collected during the Specified Period as well as two to three (or more, if needed) years of data collected after the end of the Specified Period. This demonstration will provide the information necessary for the EPA Administrator to approve the request to discontinue monitoring and reporting and may include, but is not limited to:

i. Data comparing actual performance to predicted performance (purchase, injection, production) over the monitoring period;
ii. An assessment of the CO_2 leakage detected, including discussion of the estimated amount of CO_2 leaked and the distribution of emissions by leakage pathway;
iii. A demonstration that future operations will not release the volume of stored CO_2 to the surface;
iv. A demonstration that there has been no significant leakage of CO_2; and,
v. An evaluation of reservoir pressure in the Hobbs Field that demonstrates that injected fluids are not expected to migrate in a manner to create a potential leakage pathway.

6. Determination of Baselines

Oxy intends to utilize existing automatic data systems to identify and investigate excursions from expected performance that could indicate CO_2 leakage. Oxy's data systems are used primarily for operational control and monitoring and as such are set to capture more information than is necessary for reporting in the Annual Subpart RR Report. Oxy will develop the necessary system guidelines to capture the information that is relevant to identify possible CO_2 leakage. The following describes Oxy's approach to collecting this information.

<u>Visual Inspections</u>
As field personnel conduct routine inspections, work orders are generated in the electronic system for maintenance activities that cannot be addressed on the spot. Methods to capture work orders that involve activities that could potentially involve CO_2 leakage will be

developed, if not currently in place. Examples include occurrences of well workover or repair, as well as visual identification of vapor clouds or ice formations. Each incident will be flagged for review by the person responsible for MRV documentation. (The responsible party will be provided in the monitoring plan, as required under Subpart A, 98.3(g).) The Annual Subpart RR Report will include an estimate of the amount of CO_2 leaked. Records of information used to calculate emissions will be maintained on file for a minimum of three years.

Personal H_2S Monitors

H_2S monitors are worn by all field personnel. Any monitor alarm triggers an immediate response to ensure personnel are not at risk and to verify the monitor is working properly. The person responsible for MRV documentation will receive notice of all incidents where H_2S is confirmed to be present. The Annual Subpart RR Report will provide an estimate the amount of CO_2 emitted from any such incidents. Records of information to calculate emissions will be maintained on file for a minimum of three years.

Injection Rates, Pressures and Volumes

Oxy develops target injection rate and pressure for each injector, based on the results of ongoing pattern modeling and within permitted limits. The injection targets are programmed into the WAG satellite controllers. High and low set points are also programmed into the controllers, and flags whenever statistically significant deviations from the targeted ranges are identified. The set points are designed to be conservative, because Oxy prefers to have too many flags rather than too few. As a result, flags can occur frequently and are often found to be insignificant. For purposes of Subpart RR reporting, flags (or excursions) will be screened to determine if they could also lead to CO_2 leakage to the surface. The person responsible for the MRV documentation will receive notice of excursions and related work orders that could potentially involve CO_2 leakage. The Annual Subpart RR Report will provide an estimate of CO_2 emissions. Records of information to calculate emissions will be maintained on file for a minimum of three years.

Production Volumes and Compositions

Oxy develops a general forecast of production volumes and composition which is used to periodically evaluate performance and refine current and projected injection plans and the forecast. This information is used to make operational decisions but is not recorded in an automated data system. Sometimes, this review may result in the generation of a work order in the maintenance system. The MRV plan implementation lead will review such work orders and identify those that could result in CO_2 leakage. Should such events occur, leakage volumes would be calculated following the approaches described in Sections 4 and 5. Impact to Subpart RR reporting will be addressed, if deemed necessary.

7. Determination of Sequestration Volumes Using Mass Balance Equations

To account for the site conditions and complexity of a large, active EOR operation, Oxy proposes to modify the locations for obtaining volume data for the equations in Subpart RR §98.443 as indicated below.

The first modification addresses the propagation of error that would result if volume data from meters at each injection and production well were utilized. This issue arises because while each meter has a small but acceptable margin of error, this error would become significant if data were taken from the approximately 445 meters within the Hobbs Field. As such, Oxy proposes to use the data from custody and operations meters on the main system pipelines to determine injection and production volumes used in the mass balance.

The second modification addresses the NGL sales from the NHU RCF. As indicated in Figure 10, NGL is separated from the fluid mix at the NHU RCF after it has been measured at the RCF inlet and before measurement at the RCF outlet. As a result the amount of CO_2 recycled already accounts for the amount entrained in NGL and therefore is not factored separately into the mass balance calculation.

The third modification addresses the transfer of fluids between the NHU and the SHU. For internal accounting purposes, NHU and SHU each use a custody transfer meter to track the volume transferred. Analyses of historic records show an immaterial difference between the two meter readings that is likely due to calibration differences. For accounting, one meter reading is used. The transfer takes place prior to the inlet of the RCFs and the NHU fluids are co-mingled with the other fluids going into the SHU RCF. On a net basis, the transfer does not have an impact on the material balance and there is not included in the mass balance calculation.

The following sections describe how each element of the mass-balance equation (Equation RR-11) will be calculated.

7.1. Mass of CO_2 Received

Oxy will use equation RR-2 as indicated in Subpart RR §98.443 to calculate the mass of CO_2 received from each delivery meter immediately upstream of the Permian pipeline delivery system on the Hobbs Field. The volumetric flow at standard conditions will be multiplied by the CO_2 concentration and the density of CO_2 at standard conditions to determine mass.

$$CO_{2T,r} = \sum_{p=1}^{4} (Q_{r,p} - S_{r,p}) * D * C_{CO_{2,p,r}} \qquad \text{(Eq. RR-2)}$$

where:

$CO_{2T,r}$ = Net annual mass of CO_2 received through flow meter r (metric tons).

$Q_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r in quarter p at standard conditions (standard cubic meters).

$S_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r that is redelivered to another facility without being injected into a site well in quarter p (standard cubic meters).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,r}$ = Quarterly CO_2 concentration measurement in flow for flow meter r in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

r = Receiving flow meters.

Given Oxy's method of receiving CO_2 and requirements at Subpart RR §98.444(a):

- All delivery to the Hobbs Field is used within each unit so quarterly flow redelivered, $S_{r,p}$, is zero ("0") and will not be included in the equation.
- Quarterly CO_2 concentration will be taken from the gas measurement database

Oxy will sum to total Mass of CO_2 Received using equation RR-3 in 98.443

$$CO_2 = \sum_{r=1}^{R} CO_{2T,r} \quad \text{(Eq. RR-3)}$$

where:

CO_2 = Total net annual mass of CO_2 received (metric tons).

$CO_{2T,r}$ = Net annual mass of CO_2 received (metric tons) as calculated in Equation RR-2 for flow meter r.

r = Receiving flow meter.

7.2 Mass of CO_2 Injected into the Subsurface

The equation for calculating the Mass of CO_2 Injected into the Subsurface at the Hobbs Field is equal to the sum of the Mass of CO_2 Received as calculated in RR-3 of 98.443 (as described in Section 7.1) and the Mass of CO_2 Recycled as calculated using measurements taken from the flow meter located at the output of the RCF. As previously explained, using data at each injection well would give an inaccurate estimate of total injection volume due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

The mass of CO_2 recycled will be determined using equations RR-5 as follows:

$$CO_{2,u} = \sum_{p=1}^{4} Q_{p,u} * D * C_{CO_{2,p,u}} \quad \text{(Eq. RR-5)}$$

where:

$CO_{2,u}$ = Annual CO_2 mass recycled (metric tons) as measured by flow meter u.

$Q_{p,u}$ = Quarterly volumetric flow rate measurement for flow meter u in quarter p at standard conditions (standard cubic meters per quarter).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,u}$ = CO_2 concentration measurement in flow for flow meter u in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

u = Flow meter.

The total Mass of CO_2 injected will be the sum of the Mass of CO_2 received (RR-3) and Mass of CO_2 recycled (modified RR-5).

$$CO_{2I} = CO_2 + CO_{2,u}$$

7.3 Mass of CO_2 Produced

The Mass of CO_2 Produced at the Hobbs Field will be calculated using the measurements from the flow meters at the inlet to RCF and the custody transfer meter for oil sales rather than the metered data from each production well. Again, using the data at each production well would give an inaccurate estimate of total injection due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

Equation RR-8 in 98.443 will be used to calculate the mass of CO_2 produced from all injection wells as follows:

$$CO_{2,w} = \sum_{p=1}^{4} Q_{p,w} * D * C_{CO_{2,p,w}} \quad \text{(Eq. RR-8)}$$

Where:

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) .

$Q_{p,w}$ = Volumetric gas flow rate measurement for meter w in quarter p at standard conditions (standard cubic meters).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,w}$ = CO_2 concentration measurement in flow for meter w in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

w = inlet meter to RCF.

Equation RR-9 in 98.443 will be used to aggregate the mass of CO_2 produced net of the mass of CO_2 entrained in oil leaving the Hobbs Field prior to treatment of the remaining gas fraction in RCF as follows:

$$CO_{2P} = \sum_{w=1}^{W} CO_{2,w} + X_{oil} \quad \text{(Eq. RR-9)}$$

Where:

CO_{2P} = Total annual CO_2 mass produced (metric tons) through all meters in the reporting year.

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) through meter w in the reporting year.

X_{oil} = Mass of entrained CO_2 in oil in the reporting year measured utilizing commercial meters and electronic flow-measurement devices at each point of custody transfer. The mass of CO_2 will be calculated by multiplying the total volumetric rate by the CO_2 concentration.

7.4 Mass of CO_2 emitted by Surface Leakage

Oxy will calculate and report the total annual Mass of CO_2 emitted by Surface Leakage using an approach that is tailored to specific leakage events and relies on 40 CFR Part 98 Subpart W reports of equipment leakage. As described in Sections 4 and 5.1.5-5.1.7, Oxy is prepared to address the potential for leakage in a variety of settings. Estimates of the amount of CO_2 leaked to the surface will likely depend on a number of site-specific factors including measurements, engineering estimates, and emission factors, depending on the source and nature of the leakage.

Oxy's process for quantifying leakage will entail using best engineering principles or emission factors. While it is not possible to predict in advance the types of leaks that will occur, Oxy describes some approaches for quantification in Section 5.1.5-5.1.7. In the event leakage to the surface occurs, Oxy would quantify and report leakage amounts, and retain records that describe the methods used to estimate or measure the volume leaked as reported in the Annual Subpart RR Report. Further, Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

Equation RR-10 in 48.433 will be used to calculate and report the Mass of CO_2 emitted by Surface Leakage:

$$CO_{2E} = \sum_{x=1}^{X} CO_{2,x} \quad \text{(Eq. RR-10)}$$

where:

CO_{2E} = Total annual CO_2 mass emitted by surface leakage (metric tons) in the reporting year.

$CO_{2,x}$ = Annual CO_2 mass emitted (metric tons) at leakage pathway x in the reporting year.

x = Leakage pathway.

7.5 Mass of CO_2 sequestered in subsurface geologic formations.

Oxy will use equation RR-11 in 98.443 to calculate the Mass of CO_2 Sequestered in Subsurface Geologic Formations in the Reporting Year as follows:

$$CO_2 = CO_{2I} - CO_{2P} - CO_{2E} - CO_{2FI} - CO_{2FP} \quad \text{(Eq. RR-11)}$$

where:

CO_2 = Total annual CO_2 mass sequestered in subsurface geologic formations (metric tons) at the facility in the reporting year.

CO_{2I} = Total annual CO_2 mass injected (metric tons) in the well or group of wells covered by this source category in the reporting year.

CO_{2P} = Total annual CO_2 mass produced (metric tons) net of CO_2 entrained in oil in the reporting year.

CO_{2E} = Total annual CO_2 mass emitted (metric tons) by surface leakage in the reporting year.

CO_{2FI} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead, for which a calculation procedure is provided in subpart W of this part.

CO_{2FP} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity, for which a calculation procedure is provided in subpart W of this part.

7.6 Cumulative mass of CO_2 reported as sequestered in subsurface geologic formations

Oxy will sum up the total annual volumes obtained using equation RR-11 in 98.443 to calculate the Cumulative Mass of CO_2 Sequestered in Subsurface Geologic Formations.

8. MRV Plan Implementation Schedule

It is anticipated that this MRV plan will be implemented by April 1, 2017 or within 90 days of EPA approval, whichever occurs later. Other GHG reports are filed on March 31 of the year after the reporting year and it is anticipated that the Annual Subpart RR Report will be filed at the same time. As described in Section 3.3 above, Oxy anticipates that the MRV program will be in effect during the Specified Period, during which time Oxy will operate the Hobbs Units with the subsidiary purpose of establishing long-term containment of a measurable quantity of CO_2 in subsurface geological formations at the Hobbs Field. Oxy anticipates establishing that a measurable amount of CO_2 injected during the Specified Period will be stored in a manner not expected to migrate resulting in future surface leakage. At such time, Oxy will prepare a demonstration supporting the long-term containment determination and submit a request to discontinue reporting under this MRV plan. *See* 40 C.F.R. § 98.441(b)(2)(ii).

9. Quality Assurance Program

9.1 Monitoring QA/QC

As indicated in Section 7, Oxy has incorporated the requirements of §98.444 (a) – (d) in the discussion of mass balance equations. These include the following provisions.

CO_2 Received and Injected

- The quarterly flow rate of CO_2 received by pipeline is measured at the receiving custody transfer meters.
- The quarterly CO_2 flow rate for recycled CO_2 is measured at the flow meter located at the RCF outlet.

CO_2 Produced

- The point of measurement for the quantity of CO_2 produced from oil or other fluid production wells is a flow meter directly downstream of each separator that sends a stream of gas into a recycle or end use system.
- The produced gas stream is sampled at least once per quarter immediately downstream of the flow meter used to measure flow rate of that gas stream and measure the CO_2 concentration of the sample.
- The quarterly flow rate of the produced gas is measured at the flow meters located at the RCF inlet.

CO_2 emissions from equipment leaks and vented emissions of CO_2

These volumes are measured in conformance with the monitoring and QA/QC requirements specified in subpart W of 40 CFR Part 98.

Flow meter provisions

The flow meters used to generate date for the mass balance equations in Section 7 are:

- Operated continuously except as necessary for maintenance and calibration.
- Operated using the calibration and accuracy requirements in 40 CFR §98.3(i).
- Operated in conformance with American Petroleum Institute (API) standards.
- National Institute of Standards and Technology (NIST) traceable.

Concentration of CO_2

As indicated in Appendix 1, CO_2 concentration is measured using an appropriate standard method. Further, all measured volumes of CO_2 have been converted to standard cubic meters at a temperature of 60 degrees Fahrenheit and at an absolute pressure of 1 atmosphere, including those used in Equations RR-2, RR-5 and RR-8 in Section 7.

9.2 Missing Data Procedures

In the event Oxy is unable to collect data needed for the mass balance calculations, procedures for estimating missing data in §98.445 will be used as follows:

- A quarterly flow rate of CO_2 received that is missing would be estimated using invoices or using a representative flow rate value from the nearest previous time period.
- A quarterly CO_2 concentration of a CO_2 stream received that is missing would be estimated using invoices or using a representative concentration value from the nearest previous time period.
- A quarterly quantity of CO_2 injected that is missing would be estimated using a representative quantity of CO_2injected from the nearest previous period of time at a similar injection pressure.
- For any values associated with CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment at the facility that are reported in this subpart, missing data estimation procedures specified in subpart W of 40 CFR Part 98 would be followed.
- The quarterly quantity of CO_2 produced from subsurface geologic formations that is missing would be estimated using a representative quantity of CO_2 produced from the nearest previous period of time.

9.3 MRV Plan Revisions

In the event there is a material change to the monitoring and/or operational parameters of the Oxy CO_2 EOR operations in the Hobbs Field that is not anticipated in this MRV plan, the MRV plan will be revised and submitted to the EPA Administrator within 180 days as required in §98.448(d).

10. Records Retention

Oxy will follow the record retention requirements specified by §98.3(g). In addition, it will follow the requirements in Subpart RR §98.447 by maintaining the following records for at least three years:

- Quarterly records of CO_2 received at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of produced CO_2, including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of injected CO_2 including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Annual records of information used to calculate the CO_2 emitted by surface leakage from leakage pathways.

- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead.
- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity.

These data will be collected as generated and aggregated as required for reporting purposes.

11. Appendices

Appendix 1. Conversion Factors

Oxy reports CO_2 volumes at standard conditions of temperature and pressure as defined in the State of New Mexico – 60 °F and 15.025 psi.

To convert these volumes into metric tonnes, a density is calculated using the Span and Wagner equation of state as recommended by the EPA. Density was calculated using the database of thermodynamic properties developed by the National Institute of Standards and Technology (NIST), available at http://webbook.nist.gov/chemistry/fluid/.

At State of New Mexico standard conditions, the Span and Wagner equation of state gives a density of 0.0027097 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.40921×10^{-2} MT/Mcf or 0.0019102 MT/m^3.

Note at EPA standard conditions of 60 ^{o}F and one atmosphere, the Span and Wagner equation of state gives a density of 0.0026500 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.29003 x 10^{-5} MT/ft^3 or 0.0018682 MT/m^3.

The conversion factor 5.40921 x 10^{-2} MT/Mcf has been used throughout to convert Oxy volumes to metric tons.

Appendix 2. Acronyms

AGA – American Gas Association
AMA – Active Monitoring Area
AoR – Area of Review
API – American Petroleum Institute
Bscf – billion standard cubic feet
B/D – barrels per day
bopd – barrels of oil per day
cf – cubic feet
CH_4 – Methane
CO_2 – Carbon Dioxide
CRP – CO_2 Removal Plant
CTB – Central Tank Battery
DOT – US Department of Transportation
EOR – Enhanced Oil Recovery
EPA – US Environmental Protection Agency
EMNRD – New Mexico Energy, Minerals, and Natural Resources Department
ESD – Emergency Shutdown Device
GHG – Greenhouse Gas
GHGRP – Greenhouse Gas Reporting Program
HC – Hydrocarbon
H_2S – Hydrogen Sulfide
IWR -- Injection to Withdrawal Ratio
LACT – Lease Automatic Custody Transfer meter
LEL – Lower Explosive Limit
MIT – Mechanical Integrity Test
MMA – Maximum Monitoring Area
MMB – Million barrels
Mscf – Thousand standard cubic feet
MMscf – Million standard cubic feet
MMMT – Million metric tonnes
MMT – Thousand metric tonnes
MRV – Monitoring, Reporting, and Verification
MT -- Metric Tonne
NG—Natural Gas
NGLs – Natural Gas Liquids
OOIP – Original Oil-In-Place
OPC – Occidental Petroleum Corporation
OPL – Occidental Petroleum Ltd.
OPS – Office of Pipeline Safety
PHMSA – Pipeline and Hazardous Materials Safety Administration
PPM – Parts Per Million
RCF – Hobbs Field CO_2 Recycling and Compression Facility
ROZ – Residual Oil Zone
SACROC – Scurry Area Canyon Reef Operators Committee

ST – Short Ton
TSD – Technical Support Document
TVDSS – True Vertical Depth Subsea
TZ – Transition Zone
UIC – Underground Injection Control
USEPA – U.S. Environmental Protection Agency
USDW – Underground Source of Drinking Water
VRU -- Vapor Recovery Unit
WAG – Water Alternating Gas

Appendix 3. References

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Appendix 4. Glossary of Terms

This glossary describes some of the technical terms as they are used in this MRV plan. For additional glossaries please see the U.S. EPA Glossary of UIC Terms (http://water.epa.gov/type/groundwater/uic/glossary.cfm) and the Schlumberger Oilfield Glossary (http://www.glossary.oilfield.slb.com/).

Anhydrite -- Anhydrite is a mineral—anhydrous calcium sulfate, $CaSO_4$.

Bradenhead -- a casing head in an oil well having a stuffing box packed (as with rubber) to make a gastight connection
Contain / Containment – having the effect of keeping fluids located within in a specified portion of a geologic formation.

Dip -- Very few, if any, geologic features are perfectly horizontal. They are almost always tilted. The direction of tilt is called "dip." Dip is the angle of steepest descent measured from the horizontal plane. Moving higher up structure is moving "updip." Moving lower is "downdip." Perpendicular to dip is "strike." Moving perpendicular along a constant depth is moving along strike.

Dolomite -- Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate $CaMg(CO_3)_2$.

Downdip -- See "dip."

Formation -- A body of rock that is sufficiently distinctive and continuous that it can be mapped. At Wasson, for example, San Andres formation is a layer of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. The San Andres can be mapped over much of the Permian Basin.

Igneous Rocks -- Igneous rocks crystallize from molten rock, or magma, with interlocking mineral crystals.

Infill Drilling -- The drilling of additional wells within existing patterns. These additional wells decrease average well spacing. This practice both accelerates expected recovery and increases estimated ultimate recovery in heterogeneous reservoirs by improving the continuity between injectors and producers. As well spacing is decreased, the shifting flow paths lead to increased sweep to areas where greater hydrocarbon saturations remain.

Metamorphic Rocks -- Metamorphic rocks form from the alteration of preexisting rocks by changes in ambient temperature, pressure, volatile content, or all of these. Such changes can occur through the activity of fluids in the Earth and movement of igneous bodies or regional tectonic activity.

Permeability -- Permeability is the measure of a rock's ability to transmit fluids. Rocks that transmit fluids readily, such as sandstones, are described as permeable and tend to have many large, well-connected pores. Impermeable formations, such as shales and siltstones, tend to be finer grained or of a mixed grain size, with smaller, fewer, or less interconnected pores.

Phase -- Phase is a region of space throughout which all physical properties of a material are essentially uniform. Fluids that don't mix together segregate themselves into phases. Oil, for example, does not mix with water and forms a separate phase.

Pore Space -- See porosity.

Porosity -- Porosity is the fraction of a rock that is not occupied by solid grains or minerals. Almost all rocks have spaces between rock crystals or grains that is available to be filled with a fluid, such as water, oil or gas. This space is called "pore space."

Primary recovery -- The first stage of hydrocarbon production, in which natural reservoir energy, such as gas drive, water drive or gravity drainage, displaces hydrocarbons from the reservoir, into the wellbore and up to surface. Initially, the reservoir pressure is considerably higher than the bottomhole pressure inside the wellbore. This high natural differential pressure drives hydrocarbons toward the well and up to surface. However, as the reservoir pressure declines because of production, so does the differential pressure. To reduce the bottomhole pressure or increase the differential pressure to increase hydrocarbon production, it is necessary to implement an artificial lift system, such as a rod pump, an electrical submersible pump or a gas-lift installation. Production using artificial lift is considered primary recovery. The primary recovery stage reaches its limit either when the reservoir pressure is so low that the production rates are not economical, or when the proportions of gas or water in the production stream are too high. During primary recovery, only a small percentage of the initial hydrocarbons in place are produced, typically around 10% for oil reservoirs. Primary recovery is also called primary production.

Saturation -- The fraction of pore space occupied by a given fluid. Oil saturation, for example, is the fraction of pore space occupied by oil.

Seal – A geologic layer (or multiple layers) of impermeable rock that serve as a barrier to prevent fluids from moving upwards to the surface.

Secondary recovery -- The second stage of hydrocarbon production during which an external fluid such as water or gas is injected into the reservoir through injection wells located in rock that has fluid communication with production wells. The purpose of secondary recovery is to maintain reservoir pressure and to displace hydrocarbons toward the wellbore. The most common secondary recovery techniques are gas injection and waterflooding.

Sedimentary Rocks -- Sedimentary rocks are formed at the Earth's surface through deposition of sediments derived from weathered rocks, biogenic activity or precipitation from solution. There are three main types of rocks – igneous, metamorphic and sedimentary.

Stratigraphic section -- A stratigraphic section is a sequence of layers of rocks in the order they were deposited.

Strike -- See “dip.”

Updip -- See “dip.”

Appendix 5. Well Identification Numbers

The following table presents the well name, API number, status and type for the wells in the Hobbs Units as of August 2016. The table is subject to change over time as new wells are drilled, existing wells change status, or existing wells are repurposed. The following terms are used:

- Well Status
  - ACTIVE refers to active wells
  - DRILL refers to wells under construction
  - P&A refers to wells that have been closed (plugged and abandoned) per NMOCD regulations
  - TA refers to wells that have been temporarily abandoned
  - SHUT_IN refers to wells that have been temporarily idled or shut-in
  - INACTIVE refers to wells that have been completed but are not in use
- Well Type
  - INJ_WAG refers to wells that inject water and CO_2 Gas
  - INJ_H2O refers to wells that inject water
  - PROD_GAS refers to wells that produce natural gas
  - PROD_OIL refers to wells that produce oil

Well Name	API Number	Well Type	Well Status
NHSAU 111-19	30025073560000	PROD_OIL	P & A
NHSAU 111-20	30025073750000	PROD_OIL	ACTIVE
NHSAU 111-24	30025054770000	INJ_WAG	ACTIVE
NHSAU 111-25	30025054910000	INJ_WAG	ACTIVE
NHSAU 111-27	30025233750000	INJ_H2O	P & A
NHSAU 111-28	30025074220000	INJ_WAG	ACTIVE
NHSAU 111-29	30025239190000	PROD_OIL	ACTIVE
NHSAU 111-30	30025070770000	INJ_WAG	ACTIVE
NHSAU 111-31	30025075110000	PROD_OIL	ACTIVE
NHSAU 111-32	30025075280000	PROD_OIL	ACTIVE
NHSAU 111-33	30025125050000	INJ_WAG	ACTIVE
NHSAU 112-19	30025073580000	INJ_WAG	ACTIVE
NHSAU 112-30	30025290630000	INJ_WAG	ACTIVE
NHSAU 112-32	30025075260000	INJ_WAG	ACTIVE
NHSAU 113-30	30025290640000	INJ_WAG	ACTIVE
NHSAU 114-33	30025232070000	PROD_OIL	TA
NHSAU 121-13	30025054400000	PROD_OIL	TA
NHSAU 121-17	30025073330000	PROD_OIL	P & A
NHSAU 121-19	30025073570000	PROD_OIL	ACTIVE

NHSAU 121-20	30025073780000	PROD_OIL	P & A
NHSAU 121-23	30025054620000	PROD_OIL	P & A
NHSAU 121-24	30025054760000	INJ_WAG	ACTIVE
NHSAU 121-25	30025055020000	INJ_WAG	P & A
NHSAU 121-27	30025124940000	PROD_OIL	ACTIVE
NHSAU 121-28	30025074200000	PROD_OIL	ACTIVE
NHSAU 121-29	30025074490000	PROD_OIL	ACTIVE
NHSAU 121-30	30025074640000	PROD_OIL	ACTIVE
NHSAU 121-31	30025075140000	INJ_WAG	ACTIVE
NHSAU 121-32	30025230070000	PROD_OIL	ACTIVE
NHSAU 121-33	30025075590000	PROD_OIL	ACTIVE
NHSAU 122-28	30025289640000	PROD_OIL	ACTIVE
NHSAU 122-29	30025289530000	INJ_WAG	ACTIVE
NHSAU 123-33	30025232630000	PROD_OIL	ACTIVE
NHSAU 131-13	30025054480000	PROD_OIL	TA
NHSAU 131-17	30025073360000	INJ_H2O	P & A
NHSAU 131-18	30025073390000	PROD_OIL	P & A
NHSAU 131-19	30025073610000	INJ_WAG	ACTIVE
NHSAU 131-20	30025232060000	INJ_WAG	ACTIVE
NHSAU 131-21	30025073930000	PROD_OIL	P & A
NHSAU 131-24	30025054840000	INJ_WAG	ACTIVE
NHSAU 131-27	30025074100000	PROD_OIL	ACTIVE
NHSAU 131-28	30025124970000	INJ_WAG	ACTIVE
NHSAU 131-29	30025074470000	PROD_OIL	ACTIVE
NHSAU 131-30	30025074810000	INJ_WAG	INACTIVE
NHSAU 131-31	30025075090000	PROD_OIL	TA
NHSAU 131-32	30025075270000	INJ_WAG	ACTIVE
NHSAU 131-33	30025075440000	PROD_OIL	ACTIVE
NHSAU 132-28	30025232770000	PROD_OIL	ACTIVE
NHSAU 132-29	30025269170000	INJ_WAG	ACTIVE
NHSAU 132-32	30025271390000	INJ_WAG	ACTIVE
NHSAU 141-13	30025054370000	INJ_WAG	ACTIVE
NHSAU 141-17	30025073350000	PROD_OIL	P & A
NHSAU 141-18	30025073370000	PROD_OIL	P & A
NHSAU 141-19	30025073650000	PROD_OIL	ACTIVE
NHSAU 141-20	30025073830000	PROD_OIL	ACTIVE
NHSAU 141-21	30025073900000	PROD_OIL	TA
NHSAU 141-24	30025054850000	PROD_OIL	ACTIVE

NHSAU 141-27	30025074080000	PROD_OIL	ACTIVE
NHSAU 141-28	30025124960000	PROD_OIL	ACTIVE
NHSAU 141-29	30025074480000	INJ_WAG	ACTIVE
NHSAU 141-30	30025074870000	PROD_OIL	ACTIVE
NHSAU 141-31	30025075100000	INJ_H2O	TA
NHSAU 141-32	30025075230000	INJ_WAG	ACTIVE
NHSAU 141-33	30025075430000	PROD_OIL	ACTIVE
NHSAU 142-19	30025271380000	INJ_WAG	ACTIVE
NHSAU 142-28	30025232460000	PROD_OIL	ACTIVE
NHSAU 142-32	30025282650000	INJ_WAG	ACTIVE
NHSAU 142-33	30025284110000	INJ_WAG	ACTIVE
NHSAU 143-32	30025289430000	PROD_OIL	ACTIVE
NHSAU 144-32	30025316620000	INJ_WAG	ACTIVE
NHSAU 19-616	30025371540001	PROD_OIL	INACTIVE
NHSAU 211-13	30025054410000	PROD_OIL	P & A
NHSAU 211-19	30025073590000	PROD_OIL	TA
NHSAU 211-23	30025054690000	INJ_WAG	ACTIVE
NHSAU 211-24	30025070470000	PROD_OIL	ACTIVE
NHSAU 211-25	30025054890000	PROD_OIL	P & A
NHSAU 211-28	30025074250000	INJ_H2O	TA
NHSAU 211-29	30025074330000	PROD_OIL	P & A
NHSAU 211-30	30025074630000	PROD_OIL	ACTIVE
NHSAU 211-31	30025075030000	PROD_OIL	TA
NHSAU 211-32	30025075250000	PROD_OIL	ACTIVE
NHSAU 211-33	30025075640000	INJ_WAG	ACTIVE
NHSAU 211-34	30025075790000	PROD_OIL	TA
NHSAU 211-36	30025055420000	INJ_WAG	ACTIVE
NHSAU 212-19	30025288800000	PROD_OIL	TA
NHSAU 212-24	30025291290000	INJ_WAG	ACTIVE
NHSAU 212-32	30025302580000	PROD_OIL	ACTIVE
NHSAU 212-33	30025290260000	INJ_WAG	ACTIVE
NHSAU 213-33	30025290650000	PROD_OIL	ACTIVE
NHSAU 221-13	30025054390000	INJ_H2O	TA
NHSAU 221-19	30025073550000	PROD_OIL	ACTIVE
NHSAU 221-20	30025073770000	PROD_OIL	TA
NHSAU 221-23	30025054700000	PROD_OIL	ACTIVE
NHSAU 221-24	30025098760000	PROD_OIL	ACTIVE
NHSAU 221-25	30025054960000	PROD_OIL	TA

NHSAU 221-27	30025309100000	INJ_H2O	P & A
NHSAU 221-28	30025074290000	INJ_WAG	ACTIVE
NHSAU 221-29	30025074300000	PROD_OIL	TA
NHSAU 221-30	30025074620000	PROD_OIL	ACTIVE
NHSAU 221-31	30025075040000	PROD_OIL	TA
NHSAU 221-32	30025075200000	PROD_OIL	TA
NHSAU 221-33	30025075600000	INJ_WAG	INACTIVE
NHSAU 221-34	30025075780000	PROD_OIL	TA
NHSAU 222-29	30025269340000	INJ_WAG	ACTIVE
NHSAU 222-30	30025268330000	INJ_WAG	ACTIVE
NHSAU 222-32	30025271400000	INJ_WAG	ACTIVE
NHSAU 222-33	30025269750000	INJ_WAG	ACTIVE
NHSAU 223-30	30025285550000	INJ_WAG	ACTIVE
NHSAU 223-32	30025289440000	INJ_WAG	ACTIVE
NHSAU 231-14	30025054510000	INJ_H2O	TA
NHSAU 231-18	30025073410000	PROD_OIL	P & A
NHSAU 231-19	30025073620000	INJ_WAG	ACTIVE
NHSAU 231-20	30025073820000	PROD_OIL	ACTIVE
NHSAU 231-23	30025054710000	INJ_WAG	ACTIVE
NHSAU 231-24	30025054830000	PROD_OIL	ACTIVE
NHSAU 231-25	30025054980000	PROD_OIL	TA
NHSAU 231-27	30025124950000	PROD_OIL	TA
NHSAU 231-28	30025074210000	INJ_WAG	ACTIVE
NHSAU 231-29	30025074380000	PROD_OIL	ACTIVE
NHSAU 231-30	30025074790000	PROD_OIL	TA
NHSAU 231-31	30025075070000	PROD_OIL	ACTIVE
NHSAU 231-32	30025075210000	PROD_OIL	P & A
NHSAU 231-33	30025075450000	INJ_WAG	ACTIVE
NHSAU 232-19	30025291720000	INJ_WAG	ACTIVE
NHSAU 232-20	30025073840000	PROD_OIL	P & A
NHSAU 232-28	30025288820000	INJ_WAG	ACTIVE
NHSAU 232-30	30025269350000	INJ_WAG	ACTIVE
NHSAU 232-32	30025230350000	PROD_OIL	ACTIVE
NHSAU 232-33	30025268340000	INJ_WAG	ACTIVE
NHSAU 233-20	30025272140000	INJ_H2O	TA
NHSAU 233-30	30025289420000	INJ_WAG	ACTIVE
NHSAU 233-33	30025284100000	PROD_OIL	ACTIVE
NHSAU 234-33	30025292750000	PROD_OIL	ACTIVE

NHSAU 241-13	30025054360000	INJ_WAG	ACTIVE
NHSAU 241-14	30025054530000	PROD_OIL	P & A
NHSAU 241-18	30025073380000	PROD_OIL	TA
NHSAU 241-19	30025073640000	INJ_WAG	ACTIVE
NHSAU 241-20	30025124930000	PROD_OIL	ACTIVE
NHSAU 241-21	30025073910000	PROD_OIL	P & A
NHSAU 241-23	30025054720000	PROD_OIL	P & A
NHSAU 241-24	30025054820000	PROD_OIL	ACTIVE
NHSAU 241-25	30025055010000	PROD_OIL	ACTIVE
NHSAU 241-27	30025074090000	INJ_H2O	TA
NHSAU 241-28	30025124980000	PROD_OIL	ACTIVE
NHSAU 241-29	30025074370000	INJ_WAG	ACTIVE
NHSAU 241-30	30025074800000	INJ_WAG	TA
NHSAU 241-31	30025075080000	PROD_OIL	TA
NHSAU 241-32	30025075330000	PROD_OIL	ACTIVE
NHSAU 241-33	30025075470000	PROD_OIL	ACTIVE
NHSAU 242-18	30025271980000	INJ_H2O	P & A
NHSAU 242-19	30025234810000	PROD_OIL	ACTIVE
NHSAU 242-24	30025268320000	INJ_WAG	ACTIVE
NHSAU 242-28	30025292760000	INJ_WAG	ACTIVE
NHSAU 242-29	30025284130000	INJ_WAG	ACTIVE
NHSAU 242-30	30025288860000	INJ_WAG	ACTIVE
NHSAU 243-28	30025233040000	PROD_OIL	ACTIVE
NHSAU 311-18	30025073480000	PROD_OIL	P & A
NHSAU 311-19	30025073690000	INJ_WAG	ACTIVE
NHSAU 311-23	30025054640000	PROD_OIL	ACTIVE
NHSAU 311-24	30025054810000	PROD_OIL	ACTIVE
NHSAU 311-25	30025055060000	PROD_OIL	P & A
NHSAU 311-26	30025251160000	PROD_OIL	P & A
NHSAU 311-28	30025074170000	INJ_WAG	TA
NHSAU 311-29	30025074320000	PROD_OIL	ACTIVE
NHSAU 311-30	30025074690000	PROD_OIL	TA
NHSAU 311-31	30025074910000	PROD_OIL	ACTIVE
NHSAU 311-32	30025075150000	PROD_OIL	P & A
NHSAU 311-33	30025075550000	PROD_OIL	ACTIVE
NHSAU 311-34	30025125090000	PROD_OIL	TA
NHSAU 311-36	30025055410000	PROD_OIL	ACTIVE
NHSAU 312-24	30025291300000	INJ_WAG	ACTIVE

NHSAU 312-30	30025291970000	INJ_WAG	ACTIVE
NHSAU 312-31	30025270600000	INJ_WAG	ACTIVE
NHSAU 312-32	30025290170000	INJ_WAG	ACTIVE
NHSAU 312-33	30025291990000	PROD_OIL	ACTIVE
NHSAU 313-30	30025232700000	INJ_WAG	ACTIVE
NHSAU 313-32	30025302630000	PROD_OIL	ACTIVE
NHSAU 321-14	30025054570000	INJ_H2O	P & A
NHSAU 321-18	30025073450000	PROD_OIL	P & A
NHSAU 321-19	30025073600000	PROD_OIL	ACTIVE
NHSAU 321-23	30025054630000	INJ_WAG	ACTIVE
NHSAU 321-24	30025054800000	PROD_OIL	ACTIVE
NHSAU 321-25	30025055050000	PROD_OIL	ACTIVE
NHSAU 321-28	30025074160000	PROD_OIL	ACTIVE
NHSAU 321-29	30025074310000	INJ_WAG	ACTIVE
NHSAU 321-30	30025074670000	PROD_OIL	ACTIVE
NHSAU 321-31	30025074920000	PROD_OIL	ACTIVE
NHSAU 321-32	30025125060000	INJ_WAG	ACTIVE
NHSAU 321-33	30025075480000	PROD_OIL	P & A
NHSAU 321-34	30025125100000	PROD_OIL	P & A
NHSAU 321-36	30025055400000	INJ_H2O	TA
NHSAU 322-29	30025288830000	INJ_WAG	ACTIVE
NHSAU 322-31	30025302040000	INJ_WAG	ACTIVE
NHSAU 322-32	30025075180000	PROD_OIL	ACTIVE
NHSAU 322-33	30025271690000	INJ_WAG	ACTIVE
NHSAU 323-29	30025289410000	PROD_OIL	ACTIVE
NHSAU 323-32	30025269730000	INJ_WAG	ACTIVE
NHSAU 323-33	30025289510000	PROD_OIL	P & A
NHSAU 331-13	30025054470000	PROD_OIL	ACTIVE
NHSAU 331-14	30025054550000	PROD_OIL	TA
NHSAU 331-18	30025073460000	INJ_H2O	P & A
NHSAU 331-19	30025073630000	PROD_OIL	P & A
NHSAU 331-20	30025073810000	INJ_H2O	P & A
NHSAU 331-21	30025206960000	INJ_H2O	P & A
NHSAU 331-23	30025054740000	PROD_OIL	ACTIVE
NHSAU 331-24	30025054880000	INJ_WAG	ACTIVE
NHSAU 331-25	30025055000000	PROD_OIL	ACTIVE
NHSAU 331-28	30025074120000	PROD_OIL	ACTIVE
NHSAU 331-29	30025074360000	INJ_H2O	P & A

NHSAU 331-30	30025074720000	INJ_WAG	ACTIVE
NHSAU 331-31	30025074990000	PROD_OIL	ACTIVE
NHSAU 331-32	30025075380000	INJ_WAG	ACTIVE
NHSAU 331-33	30025075460000	PROD_OIL	TA
NHSAU 331-34	30025075660000	PROD_OIL	P & A
NHSAU 332-19	30025291950000	INJ_WAG	ACTIVE
NHSAU 332-28	30025316550000	INJ_WAG	ACTIVE
NHSAU 332-30	30025289540000	INJ_WAG	ACTIVE
NHSAU 332-32	30025291730000	PROD_OIL	ACTIVE
NHSAU 333-30	30025289550000	INJ_WAG	ACTIVE
NHSAU 341-13	30025054460000	PROD_OIL	ACTIVE
NHSAU 341-14	30025054500000	PROD_OIL	TA
NHSAU 341-18	30025237650000	INJ_H2O	P & A
NHSAU 341-19	30025124910000	PROD_OIL	ACTIVE
NHSAU 341-20	30025073710000	PROD_OIL	ACTIVE
NHSAU 341-21	30025073960000	PROD_OIL	P & A
NHSAU 341-23	30025054750000	INJ_WAG	ACTIVE
NHSAU 341-24	30025054900000	PROD_OIL	INACTIVE
NHSAU 341-25	30025054970000	INJ_WAG	ACTIVE
NHSAU 341-28	30025124890000	PROD_OIL	ACTIVE
NHSAU 341-29	30025074450000	PROD_OIL	ACTIVE
NHSAU 341-30	30025246650000	PROD_OIL	ACTIVE
NHSAU 341-31	30025075000000	INJ_WAG	ACTIVE
NHSAU 341-32	30025075390000	INJ_WAG	ACTIVE
NHSAU 341-33	30025127570000	PROD_OIL	TA
NHSAU 341-34	30025075670000	PROD_OIL	TA
NHSAU 342-18	30025073420000	INJ_WAG	ACTIVE
NHSAU 342-24	30025290620000	INJ_WAG	ACTIVE
NHSAU 342-28	30025299310000	PROD_OIL	ACTIVE
NHSAU 342-29	30025288840000	INJ_WAG	ACTIVE
NHSAU 342-30	30025125010000	PROD_OIL	P & A
NHSAU 342-32	30025282660000	INJ_WAG	ACTIVE
NHSAU 342-33	30025282670000	INJ_WAG	TA
NHSAU 342-34	30025281990000	PROD_OIL	P & A
NHSAU 343-32	30025299060000	PROD_OIL	ACTIVE
NHSAU 411-18	30025073490000	PROD_OIL	P & A
NHSAU 411-19	30025073700000	INJ_WAG	ACTIVE
NHSAU 411-23	30025127830000	INJ_WAG	ACTIVE

NHSAU 411-24	30025235220000	PROD_OIL	ACTIVE
NHSAU 411-25	30025055030000	PROD_OIL	P & A
NHSAU 411-26	30025055090000	INJ_H2O	P & A
NHSAU 411-28	30025074190000	PROD_OIL	P & A
NHSAU 411-29	30025074540000	INJ_H2O	TA
NHSAU 411-30	30025074700000	INJ_WAG	ACTIVE
NHSAU 411-31	30025074900000	PROD_OIL	ACTIVE
NHSAU 411-32	30025075160000	PROD_OIL	ACTIVE
NHSAU 411-33	30025075560000	PROD_OIL	TA
NHSAU 411-36	30025055390000	INJ_WAG	ACTIVE
NHSAU 412-23	30025054680000	PROD_OIL	TA
NHSAU 412-24	30025054790000	PROD_OIL	ACTIVE
NHSAU 412-30	30025233840000	PROD_OIL	ACTIVE
NHSAU 412-31	30025232040000	PROD_OIL	P & A
NHSAU 412-33	30025299320000	PROD_OIL	ACTIVE
NHSAU 413-24	30025284140000	INJ_WAG	ACTIVE
NHSAU 414-24	30025288790000	INJ_WAG	ACTIVE
NHSAU 421-14	30025054560000	PROD_OIL	ACTIVE
NHSAU 421-18	30025073470000	PROD_OIL	P & A
NHSAU 421-19	30025073680000	PROD_OIL	TA
NHSAU 421-20	30025073880000	PROD_OIL	P & A
NHSAU 421-23	30025054660000	PROD_OIL	ACTIVE
NHSAU 421-24	30025230810000	PROD_OIL	ACTIVE
NHSAU 421-25	30025055040000	PROD_OIL	ACTIVE
NHSAU 421-28	30025074180000	PROD_OIL	TA
NHSAU 421-29	30025074590000	PROD_OIL	P & A
NHSAU 421-30	30025074680000	PROD_OIL	ACTIVE
NHSAU 421-31	30025074930000	PROD_OIL	ACTIVE
NHSAU 421-32	30025125070000	PROD_OIL	ACTIVE
NHSAU 421-33	30025075540000	PROD_OIL	ACTIVE
NHSAU 421-34	30025075730000	PROD_OIL	P & A
NHSAU 421-36	30025099260000	PROD_OIL	P & A
NHSAU 422-19	30025291960000	PROD_OIL	TA
NHSAU 422-24	30025054780000	INJ_WAG	ACTIVE
NHSAU 422-25	30025269330000	INJ_WAG	ACTIVE
NHSAU 422-28	30025272430000	INJ_WAG	ACTIVE
NHSAU 422-30	30025270590000	INJ_WAG	ACTIVE
NHSAU 422-31	30025288870000	PROD_OIL	ACTIVE

NHSAU 422-32	30025290740000	INJ_WAG	ACTIVE
NHSAU 422-33	30025282680000	INJ_WAG	ACTIVE
NHSAU 423-32	30025291980000	INJ_WAG	ACTIVE
NHSAU 424-32	30025231300000	PROD_OIL	ACTIVE
NHSAU 431-13	30025054450000	INJ_WAG	ACTIVE
NHSAU 431-14	30025054540000	PROD_OIL	ACTIVE
NHSAU 431-18	30025073440000	PROD_OIL	P & A
NHSAU 431-19	30025226010000	INJ_WAG	P & A
NHSAU 431-20	30025073860000	PROD_OIL	P & A
NHSAU 431-23	30025054670000	INJ_WAG	ACTIVE
NHSAU 431-24	30025054870000	PROD_OIL	P & A
NHSAU 431-25	30025054920000	INJ_WAG	ACTIVE
NHSAU 431-28	30025074130000	PROD_OIL	ACTIVE
NHSAU 431-29	30025074580000	PROD_OIL	ACTIVE
NHSAU 431-30	30025074740000	PROD_OIL	ACTIVE
NHSAU 431-31	30025127580000	PROD_OIL	ACTIVE
NHSAU 431-32	30025075370000	INJ_WAG	ACTIVE
NHSAU 431-33	30025075530000	PROD_OIL	ACTIVE
NHSAU 431-34	30025075680000	PROD_OIL	P & A
NHSAU 432-20	30025073870000	PROD_OIL	P & A
NHSAU 432-24	30025290730000	INJ_WAG	ACTIVE
NHSAU 432-30	30025289570000	INJ_WAG	ACTIVE
NHSAU 432-32	30025269740000	INJ_WAG	ACTIVE
NHSAU 432-33	30025282690000	INJ_WAG	ACTIVE
NHSAU 433-33	30025303080000	PROD_OIL	ACTIVE
NHSAU 441-13	30025127320000	INJ_WAG	ACTIVE
NHSAU 441-14	30025250200000	PROD_OIL	TA
NHSAU 441-18	30025073430000	PROD_OIL	P & A
NHSAU 441-19	30025073660000	PROD_OIL	ACTIVE
NHSAU 441-21	30025073970000	PROD_OIL	P & A
NHSAU 441-23	30025054730000	PROD_OIL	INACTIVE
NHSAU 441-24	30025054860000	PROD_OIL	INACTIVE
NHSAU 441-25	30025054990000	INJ_WAG	ACTIVE
NHSAU 441-28	30025074110000	INJ_WAG	INACTIVE
NHSAU 441-29	30025074440000	PROD_OIL	ACTIVE
NHSAU 441-30	30025074730000	PROD_OIL	ACTIVE
NHSAU 441-31	30025074980000	PROD_OIL	TA
NHSAU 441-32	30025075360000	PROD_OIL	ACTIVE

NHSAU 441-34	30025075800000	PROD_OIL	P & A
NHSAU 442-13	30025288780000	INJ_WAG	ACTIVE
NHSAU 442-19	30025288810000	INJ_WAG	ACTIVE
NHSAU 442-24	30025290980000	INJ_WAG	ACTIVE
NHSAU 442-29	30025288850000	INJ_WAG	ACTIVE
NHSAU 442-30	30025270010000	INJ_WAG	ACTIVE
NHSAU 443-30	30025289580000	PROD_OIL	P & A
NHSAU 444-30	30025289590000	INJ_WAG	ACTIVE
NHSAU 511-33	30025349060000	PROD_OIL	ACTIVE
NHSAU 512-32	30025349070000	PROD_OIL	ACTIVE
NHSAU 513-33	30025349800000	PROD_OIL	ACTIVE
NHSAU 514-32	30025362450000	PROD_OIL	ACTIVE
NHSAU 516-13	30025380230000	PROD_OIL	ACTIVE
NHSAU 517-18	30025380870000	PROD_OIL	ACTIVE
NHSAU 518-18	30025381140000	INJ_WAG	ACTIVE
NHSAU 521-33	30025346430000	PROD_OIL	ACTIVE
NHSAU 523-33	30025343720000	PROD_OIL	ACTIVE
NHSAU 524-33	30025349930000	PROD_OIL	ACTIVE
NHSAU 525-30	30025362160000	PROD_OIL	ACTIVE
NHSAU 526-33	30025233340006	PROD_OIL	ACTIVE
NHSAU 527-30	30025362470000	PROD_OIL	ACTIVE
NHSAU 529-18	30025381100000	PROD_OIL	ACTIVE
NHSAU 531-32	30025343740000	PROD_OIL	ACTIVE
NHSAU 532-32	30025125040101	PROD_OIL	TA
NHSAU 533-29	30025355410000	PROD_OIL	ACTIVE
NHSAU 534-33	30025343730000	INJ_WAG	ACTIVE
NHSAU 535-33	30025357580000	PROD_OIL	ACTIVE
NHSAU 536-30	30025362860000	INJ_WAG	ACTIVE
NHSAU 537-32	30025361490000	PROD_OIL	TA
NHSAU 538-30	30025362810000	PROD_OIL	ACTIVE
NHSAU 539-24	30025362130000	PROD_OIL	ACTIVE
NHSAU 541-32	30025349640000	PROD_OIL	ACTIVE
NHSAU 542-32	30025343750000	PROD_OIL	ACTIVE
NHSAU 543-33	30025349970000	INJ_WAG	ACTIVE
NHSAU 544-29	30025346440000	PROD_OIL	ACTIVE
NHSAU 545-33	30025344160000	PROD_OIL	ACTIVE
NHSAU 546-30	30025362800000	PROD_OIL	ACTIVE
NHSAU 547-30	30025362420000	PROD_OIL	ACTIVE

NHSAU 548-32	30025361500000	PROD_OIL	ACTIVE
NHSAU 549-24	30025361930000	PROD_OIL	ACTIVE
NHSAU 611-24	30025354670000	PROD_OIL	ACTIVE
NHSAU 612-24	30025354500000	PROD_OIL	ACTIVE
NHSAU 613-24	30025353700000	PROD_OIL	ACTIVE
NHSAU 614-24	30025355550000	PROD_OIL	ACTIVE
NHSAU 615-19	30025371270000	PROD_OIL	ACTIVE
NHSAU 616-19	30025374100000	PROD_OIL	ACTIVE
NHSAU 617-30	30025371020000	PROD_OIL	ACTIVE
NHSAU 618-30	30025371200000	PROD_OIL	ACTIVE
NHSAU 621-30	30025353320000	PROD_OIL	ACTIVE
NHSAU 622-24	30025371520000	INJ_WAG	ACTIVE
NHSAU 623-29	30025348690000	PROD_OIL	ACTIVE
NHSAU 624-29	30025348700000	PROD_OIL	ACTIVE
NHSAU 625-29	30025372130000	PROD_OIL	ACTIVE
NHSAU 626-29	30025372500000	INJ_WAG	ACTIVE
NHSAU 627-19	30025372350000	PROD_OIL	ACTIVE
NHSAU 628-19	30025385240000	PROD_OIL	ACTIVE
NHSAU 631-33	30025349940000	INJ_WAG	ACTIVE
NHSAU 632-31	30025372140000	INJ_WAG	ACTIVE
NHSAU 633-19	30025374460000	INJ_WAG	ACTIVE
NHSAU 634-29	30025353840000	PROD_OIL	ACTIVE
NHSAU 635-29	30025374090000	INJ_WAG	ACTIVE
NHSAU 636-29	30025371280000	PROD_OIL	ACTIVE
NHSAU 637-24	30025371010000	INJ_WAG	ACTIVE
NHSAU 638-19	30025381250000	PROD_OIL	ACTIVE
NHSAU 641-25	30025371180000	PROD_OIL	ACTIVE
NHSAU 642-25	30025371050000	PROD_OIL	ACTIVE
NHSAU 643-29	30025353760000	PROD_OIL	ACTIVE
NHSAU 644-28	30025353490000	PROD_OIL	ACTIVE
NHSAU 645-13	30025385180000	PROD_OIL	ACTIVE
NHSAU 646-13	30025380710000	PROD_OIL	ACTIVE
NHSAU 659-24	30025430780000	INJ_WAG	ACTIVE
NHSAU 663-24	30025430260000	PROD_OIL	ACTIVE
NHSAU 668-24	30025430740000	INJ_WAG	ACTIVE
NHSAU 669-24	30025430390000	INJ_WAG	ACTIVE
NHSAU 673-19	30025430580000	PROD_OIL	ACTIVE
NHSAU 679-24	30025430400000	INJ_WAG	ACTIVE

NHSAU 680-24	30025430730000	INJ_WAG	ACTIVE
NHSAU 687-24	30025430380000	INJ_WAG	ACTIVE
NHSAU 693-33	30025432820000	INJ_WAG	ACTIVE
NHSAU 711-29	30025374510000	INJ_WAG	ACTIVE
NHSAU 712-29	30025375580000	INJ_WAG	ACTIVE
NHSAU 713-30	30025349830000	PROD_OIL	ACTIVE
NHSAU 721-29	30025374740000	PROD_OIL	ACTIVE
NHSAU 722-31	30025374280000	PROD_OIL	ACTIVE
NHSAU 731-25	30025374810000	PROD_OIL	ACTIVE
NHSAU 733-19	30025374450000	PROD_OIL	ACTIVE
NHSAU 734-33	30025350110000	PROD_OIL	TA
NHSAU 741-25	30025374800000	INJ_WAG	ACTIVE
NHSAU 742-29	30025374750000	PROD_OIL	ACTIVE
NHSAU 743-31	30025354510000	PROD_OIL	ACTIVE
NHSAU 744-25	30025054930000	PROD_OIL	INACTIVE
NHSAU 813-29	30025348710000	INJ_WAG	ACTIVE
NHSAU 814-29	30025355270000	PROD_OIL	ACTIVE
NHSAU 831-13	30025408160000	PROD_OIL	ACTIVE
NHSAU 832-13	30025408220000	PROD_OIL	ACTIVE
NHSAU 833-18	30025408340000	PROD_OIL	ACTIVE
NHSAU 834-32	30025354520000	PROD_OIL	ACTIVE
NHSAU 843-33	30025357430000	PROD_OIL	TA
NHSAU 844-32	30025355340000	PROD_OIL	ACTIVE
NHSAU 913-32	30025353850000	PROD_OIL	ACTIVE
NHSAU 923-29	30025360110000	PROD_GAS	SHUT-IN
NHSAU 943-19	30025374350000	PROD_OIL	ACTIVE
NHSAU 944-29	30025359990000	PROD_OIL	TA
NHSAU 945-19	30025408590000	INJ_WAG	ACTIVE
NHSAU 946-18	30025415500000	PROD_OIL	ACTIVE
NHSAU 947-19	30025415510000	PROD_OIL	ACTIVE
NHSAU 948-33	30025415780000	PROD_OIL	ACTIVE
NHSAU 949-33	30025416430000	PROD_OIL	ACTIVE
NHSAU 950-18	30025424560000	INJ_WAG	ACTIVE
NHSAU 951-18	30025424840000	PROD_OIL	P & A
NHSAU 952-18	30025424780000	INJ_WAG	ACTIVE
NHSAU 953-18	30025424690000	INJ_WAG	ACTIVE
NHSAU 954-18	30025424900000	PROD_OIL	ACTIVE
NHSAU 955-18	30025424850000	PROD_OIL	ACTIVE

NHSAU 956-18	30025424700000	PROD_OIL	ACTIVE
NHSAU 957-18	30025424710000	PROD_OIL	ACTIVE
NHSAU 958-19	30025424540000	PROD_OIL	ACTIVE
NHSAU 959-18	30025427760000	INJ_WAG	ACTIVE
SHOU-100C15	30025076940000	INJ_H2O	P & A
SHOU-101C15	30025076880000	PROD_OIL	P & A
SHOU-102B15	30025076890000	PROD_OIL	P & A
SHOU-103B15	30025076910000	PROD_OIL	P & A
SHOU-104A15	30025224820000	PROD_OIL	P & A
SHOU-105E15	30025200280000	INJ_H2O	P & A
SHOU-106F15	30025076930000	PROD_OIL	P & A
SHOU-107G15	30025076920000	INJ_H2O	P & A
SHOU-108K15	30025076900000	PROD_OIL	P & A
SHOU-109J15	30025076990000	PROD_OIL	P & A
SHOU-10B06	30025076400000	INJ_H2O	P & A
SHOU-110I15	30025076980000	INJ_H2O	P & A
SHOU-111N15	30025076960000	INJ_H2O	P & A
SHOU-112M03	30025251270000	INJ_H2O	TA
SHOU-113G06	30025076390000	INJ_H2O	P & A
SHOU-114J06	30025076440000	INJ_H2O	P & A
SHOU-115I06	30025076420000	INJ_H2O	P & A
SHOU-116O06	30025076450000	INJ_H2O	P & A
SHOU-117P06	30025076430000	INJ_H2O	P & A
SHOU-118D08	30025076540000	PROD_OIL	P & A
SHOU-119C08	30025076530000	INJ_H2O	P & A
SHOU-11A06	30025076350000	INJ_H2O	ACTIVE
SHOU-120C05	30025261150000	INJ_H2O	ACTIVE
SHOU-121E04	30025261160000	INJ_H2O	TA
SHOU-122E04	30025261170000	PROD_OIL	TA
SHOU-123H06	30025261180000	PROD_OIL	TA
SHOU-124J04	30025261190000	PROD_OIL	TA
SHOU-125L03	30025261200000	PROD_OIL	ACTIVE
SHOU-126N10	30025261210000	PROD_OIL	P & A
SHOU-127M34	30025283310000	INJ_H2O	ACTIVE
SHOU-128P03	30025283320000	INJ_WAG	ACTIVE
SHOU-129N34	30025283330000	INJ_H2O	ACTIVE
SHOU-12D05	30025076250000	PROD_OIL	P & A
SHOU-130F04	30025283340000	PROD_OIL	TA
SHOU-131G04	30025283350000	PROD_OIL	TA
SHOU-132H04	30025283360000	PROD_OIL	TA
SHOU-133E03	30025283370000	PROD_OIL	TA
SHOU-135F04	30025283380000	PROD_OIL	P & A
SHOU-136F04	30025283390000	PROD_OIL	ACTIVE
SHOU-137I04	30025283400000	PROD_OIL	ACTIVE
SHOU-138I04	30025283410000	PROD_OIL	ACTIVE
SHOU-139F03	30025283420000	PROD_OIL	ACTIVE
SHOU-13C05	30025076240000	INJ_H2O	ACTIVE

SHOU-140L04	30025283430000	INJ_WAG	ACTIVE
SHOU-141K04	30025283440000	INJ_WAG	ACTIVE
SHOU-142O04	30025283450000	INJ_WAG	ACTIVE
SHOU-143P04	30025283460000	PROD_OIL	TA
SHOU-144N03	30025283470000	PROD_OIL	TA
SHOU-145K03	30025283480000	INJ_WAG	ACTIVE
SHOU-146D09	30025283490000	PROD_OIL	ACTIVE
SHOU-147C09	30025283500000	PROD_OIL	ACTIVE
SHOU-148A09	30025283510000	PROD_OIL	ACTIVE
SHOU-149A09	30025283520000	PROD_OIL	ACTIVE
SHOU-14B05	30025076140000	PROD_OIL	ACTIVE
SHOU-150M03	30025283530000	PROD_OIL	ACTIVE
SHOU-151N03	30025283540000	PROD_OIL	TA
SHOU-152A09	30025283550000	INJ_H2O	ACTIVE
SHOU-153C09	30025283560000	PROD_OIL	ACTIVE
SHOU-154B09	30025283570000	PROD_OIL	ACTIVE
SHOU-155H09	30025283580000	PROD_OIL	ACTIVE
SHOU-156H09	30025283590000	PROD_OIL	ACTIVE
SHOU-157D10	30025283600000	PROD_OIL	ACTIVE
SHOU-158C10	30025283610000	PROD_OIL	TA
SHOU-159F09	30025283620000	PROD_OIL	TA
SHOU-15A05	30025076190000	PROD_OIL	ACTIVE
SHOU-160G09	30025283630000	PROD_OIL	ACTIVE
SHOU-161G09	30025283640000	PROD_OIL	TA
SHOU-162H09	30025283650000	PROD_OIL	ACTIVE
SHOU-163K10	30025283660000	PROD_OIL	TA
SHOU-16D04	30025076050000	PROD_OIL	ACTIVE
SHOU-170J04A	30025266230000	INJ_H2O	ACTIVE
SHOU-171D09	30025285440000	INJ_H2O	TA
SHOU-172H09	30025285430000	INJ_H2O	ACTIVE
SHOU-173E10	30025287330000	INJ_H2O	ACTIVE
SHOU-174L03A	30025266220000	INJ_H2O	ACTIVE
SHOU-175A06	30025289730000	PROD_OIL	TA
SHOU-176D05	30025289740000	INJ_H2O	TA
SHOU-177D05	30025289750000	PROD_OIL	ACTIVE
SHOU-178C05	30025289760000	PROD_OIL	ACTIVE
SHOU-179F05	30025289770000	PROD_OIL	ACTIVE
SHOU-17C04	30025127680000	PROD_OIL	ACTIVE
SHOU-180B05	30025289780000	PROD_OIL	ACTIVE
SHOU-181B05	30025289790000	PROD_OIL	TA
SHOU-182F05B	30025276280002	INJ_H2O	ACTIVE
SHOU-183E05	30025289800000	PROD_OIL	ACTIVE
SHOU-184F05	30025290830000	PROD_OIL	ACTIVE
SHOU-185I05	30025290840000	PROD_OIL	ACTIVE
SHOU-186E04	30025289810000	PROD_OIL	ACTIVE
SHOU-187J05	30025076210000	INJ_H2O	ACTIVE
SHOU-188K05	30025289820000	INJ_WAG	ACTIVE
SHOU-189J05	30025290850000	INJ_WAG	ACTIVE

SHOU-18B04	30025076290000	PROD_OIL	ACTIVE
SHOU-190I05	30025290820000	INJ_WAG	ACTIVE
SHOU-191L04	30025289830000	INJ_WAG	ACTIVE
SHOU-192O05	30025244470000	INJ_H2O	ACTIVE
SHOU-193P05	30025289840000	INJ_H2O	ACTIVE
SHOU-194O05	30025290540000	PROD_OIL	ACTIVE
SHOU-195P05	30025289850000	PROD_OIL	ACTIVE
SHOU-196M04	30025289860000	PROD_OIL	P & A
SHOU-197L34	30025294440000	PROD_OIL	TA
SHOU-198C06	30025294420000	PROD_OIL	P & A
SHOU-199B06	30025294580000	PROD_OIL	P & A
SHOU-19A04	30025075980000	PROD_OIL	ACTIVE
SHOU-1D34	30025075750000	PROD_OIL	P & A
SHOU-200G06	30025294100000	PROD_OIL	P & A
SHOU-201H06	30025294590000	PROD_OIL	P & A
SHOU-202I06	30025294430000	PROD_OIL	P & A
SHOU-203L05	30025294600000	PROD_OIL	INACTIVE
SHOU-204M05	30025294110000	PROD_OIL	TA
SHOU-205N05	30025294120000	PROD_OIL	P & A
SHOU-206H06	30025295190000	INJ_H2O	P & A
SHOU-207L05	30025295200000	INJ_H2O	ACTIVE
SHOU-208N05	30025295210000	INJ_H2O	ACTIVE
SHOU-209D08	30025295220000	INJ_H2O	ACTIVE
SHOU-20D03	30025076030000	PROD_OIL	ACTIVE
SHOU-210D34	30025296770000	PROD_OIL	TA
SHOU-211E05	30025297500000	PROD_OIL	TA
SHOU-212F05	30025297510000	INJ_H2O	ACTIVE
SHOU-213A05	30025297520000	INJ_H2O	ACTIVE
SHOU-214E04	30025297300000	PROD_OIL	TA
SHOU-215E04	30025297530000	INJ_H2O	TA
SHOU-216C04	30025297540000	INJ_H2O	ACTIVE
SHOU-217B04	30025297550000	INJ_H2O	ACTIVE
SHOU-218A04	30025297560000	INJ_H2O	ACTIVE
SHOU-219D03	30025297570000	INJ_H2O	ACTIVE
SHOU-21C03	30025235300000	PROD_OIL	ACTIVE
SHOU-220C04	30025298910000	PROD_OIL	TA
SHOU-221B04	30025298920000	PROD_OIL	ACTIVE
SHOU-222L34	30025298930000	PROD_OIL	ACTIVE
SHOU-223N34	30025304860000	PROD_OIL	TA
SHOU-224B04	30025304870000	PROD_OIL	TA
SHOU-225M34	30025312110000	PROD_OIL	TA
SHOU-228D05	30025312120000	PROD_OIL	ACTIVE
SHOU-229C04	30025314200000	INJ_H2O	TA
SHOU-22C03	30025075870000	PROD_OIL	ACTIVE
SHOU-230B04	30025314210000	INJ_H2O	ACTIVE
SHOU-231F04	30025314270000	PROD_OIL	TA
SHOU-232G04	30025314190000	PROD_OIL	TA
SHOU-233G04	30025314220000	INJ_H2O	ACTIVE

SHOU-234F04	30025314280000	PROD_OIL	ACTIVE
SHOU-235K04	30025314230000	INJ_H2O	ACTIVE
SHOU-236K04	30025314290000	PROD_OIL	TA
SHOU-237O04	30025314300000	PROD_OIL	TA
SHOU-238O04	30025314240000	INJ_H2O	ACTIVE
SHOU-239	30025349460000	INJ_H2O	ACTIVE
SHOU-23B03	30025075820000	PROD_OIL	P & A
SHOU-240	30025353420000	INJ_WAG	ACTIVE
SHOU-241	30025353180000	PROD_OIL	ACTIVE
SHOU-242	30025353050000	PROD_OIL	TA
SHOU-243	30025372660000	PROD_OIL	TA
SHOU-244	30025357420000	PROD_OIL	TA
SHOU-245	30025355540000	PROD_OIL	P & A
SHOU-246	30025372710000	PROD_OIL	TA
SHOU-248	30025399550000	PROD_OIL	ACTIVE
SHOU-249	30025425400000	PROD_OIL	ACTIVE
SHOU-24A03	30025075850000	PROD_OIL	P & A
SHOU-250	30025425410000	PROD_OIL	ACTIVE
SHOU-251	30025425920000	PROD_OIL	ACTIVE
SHOU-252	30025425930000	INJ_WAG	ACTIVE
SHOU-253	30025425940000	INJ_WAG	ACTIVE
SHOU-254	30025425950000	INJ_WAG	ACTIVE
SHOU-255	30025425960000	INJ_WAG	ACTIVE
SHOU-256	30025426470000	INJ_WAG	ACTIVE
SHOU-257	30025426460000	INJ_WAG	ACTIVE
SHOU-258	30025426480000	INJ_WAG	ACTIVE
SHOU-259	30025426970000	INJ_WAG	ACTIVE
SHOU-25F06	30025076480000	INJ_H2O	P & A
SHOU-260	30025426960000	INJ_WAG	ACTIVE
SHOU-261	30025431020000	PROD_OIL	DRILL
SHOU-262	30025430990000	PROD_OIL	ACTIVE
SHOU-263	30025431030000	INJ_WAG	ACTIVE
SHOU-264	30025430960000	INJ_WAG	ACTIVE
SHOU-265	30025430970000	PROD_OIL	DRILL
SHOU-266	30025430980000	PROD_OIL	DRILL
SHOU-267	30025431040000	INJ_WAG	ACTIVE
SHOU-268	30025431000000	INJ_WAG	ACTIVE
SHOU-269	30025431060000	PROD_OIL	DRILL
SHOU-26H06	30025076410000	INJ_H2O	TA
SHOU-270	30025431050000	PROD_OIL	DRILL
SHOU-271	30025431010000	PROD_OIL	DRILL
SHOU-272	30025431070000	PROD_OIL	ACTIVE
SHOU-28F05	30025076300000	PROD_OIL	P & A
SHOU-29G05	30025076200000	INJ_H2O	TA
SHOU-2E34	30025075710000	PROD_OIL	ACTIVE
SHOU-30H05	30025076130000	INJ_H2O	ACTIVE
SHOU-31E04	30025075970000	INJ_H2O	TA
SHOU-32F04	30025076100000	INJ_H2O	TA

SHOU-33G04	30025076000000	INJ_H2O	TA
SHOU-34H04	30025075990000	INJ_H2O	ACTIVE
SHOU-35E03	30025075890000	INJ_H2O	ACTIVE
SHOU-36F03	30025075880000	INJ_WAG	ACTIVE
SHOU-37G03	30025075840000	INJ_H2O	P & A
SHOU-38H03	30025075860000	PROD_OIL	P & A
SHOU-39L05	30025076340000	INJ_H2O	ACTIVE
SHOU-3L34	30025075690000	PROD_OIL	TA
SHOU-40K05	30025076230000	INJ_H2O	ACTIVE
SHOU-41I03	30025209330000	INJ_H2O	P & A
SHOU-42L04	30025125140000	INJ_H2O	ACTIVE
SHOU-43K04	30025076010000	INJ_H2O	ACTIVE
SHOU-44J04	30025076020000	PROD_OIL	TA
SHOU-45I04	30025076070000	INJ_H2O	P & A
SHOU-46L03	30025075910000	PROD_OIL	TA
SHOU-47K03	30025075930000	INJ_H2O	TA
SHOU-48J03	30025075900000	INJ_H2O	P & A
SHOU-49I03	30025075920000	INJ_H2O	P & A
SHOU-4K34	30025075700000	PROD_OIL	ACTIVE
SHOU-50M05	30025076320000	INJ_H2O	P & A
SHOU-51N05	30025076330000	INJ_H2O	TA
SHOU-52P05	30025076180000	PROD_OIL	TA
SHOU-53M04	30025076120000	INJ_H2O	P & A
SHOU-54N04	30025076080000	INJ_H2O	ACTIVE
SHOU-55O04	30025076110000	INJ_H2O	ACTIVE
SHOU-56P04	30025076090000	INJ_H2O	ACTIVE
SHOU-57M03	30025075830000	PROD_OIL	P & A
SHOU-58N03	30025075940000	INJ_H2O	TA
SHOU-59O03	30025075960000	INJ_H2O	TA
SHOU-5P33	30025075650000	PROD_OIL	ACTIVE
SHOU-60P03	30025075950000	PROD_OIL	P & A
SHOU-61A08	30025076520000	INJ_H2O	TA
SHOU-62D09	30025076580000	PROD_OIL	TA
SHOU-63C09	30025076620000	INJ_H2O	ACTIVE
SHOU-64B09	30025076690000	INJ_H2O	ACTIVE
SHOU-65A09	30025076600000	INJ_H2O	P & A
SHOU-66D10	30025076720000	INJ_H2O	ACTIVE
SHOU-67C10	30025076760000	INJ_H2O	ACTIVE
SHOU-68B10	30025076790000	INJ_H2O	P & A
SHOU-69-A10	30025076770001	INJ_H2O	P & A
SHOU-6M34	30025075720000	PROD_OIL	ACTIVE
SHOU-70H08	30025076560000	PROD_OIL	P & A
SHOU-71E09	30025076700000	INJ_H2O	P & A
SHOU-72F09	30025076670000	INJ_H2O	TA
SHOU-73G09	30025076710000	INJ_H2O	ACTIVE
SHOU-74G09	30025234160001	PROD_OIL	P & A
SHOU-75H09	30025076630000	PROD_OIL	P & A
SHOU-76E10	30025076780000	INJ_H2O	ACTIVE

SHOU-77F10	30025076800000	PROD_OIL	P & A
SHOU-78G10	30025076810000	INJ_H2O	P & A
SHOU-79H10	30025201130000	PROD_OIL	P & A
SHOU-7N34	30025075760000	PROD_OIL	P & A
SHOU-80I08	30025076510000	PROD_OIL	P & A
SHOU-81L09	30025076660000	PROD_OIL	P & A
SHOU-82K09	30025076640000	INJ_H2O	P & A
SHOU-83J09	30025076680000	INJ_H2O	TA
SHOU-84I09	30025076590000	INJ_H2O	TA
SHOU-85L10	30025076750000	INJ_H2O	ACTIVE
SHOU-86K10	30025234150000	PROD_OIL	ACTIVE
SHOU-87K10	30025127650000	INJ_H2O	ACTIVE
SHOU-88J10	30025127240000	INJ_H2O	P & A
SHOU-89I10	30025213410000	INJ_H2O	P & A
SHOU-8D06	30025076490000	INJ_H2O	P & A
SHOU-90O09	30025201670000	INJ_H2O	SHUT-IN
SHOU-91P09	30025200470000	PROD_OIL	TA
SHOU-92M10	30025076730000	INJ_H2O	P & A
SHOU-93N10	30025127270000	PROD_OIL	P & A
SHOU-94N10	30025076740000	PROD_OIL	P & A
SHOU-95O10	30025127260000	PROD_OIL	P & A
SHOU-96O10	30025076820000	PROD_OIL	P & A
SHOU-97P10	30025220060000	INJ_H2O	P & A
SHOU-98A16	30025077000000	INJ_H2O	P & A
SHOU-99D15	30025205390000	PROD_OIL	P & A
SHOU-9C06	30025076470000	PROD_OIL	P & A
SHOU-W27E05	30025076310000	INJ_H2O	ACTIVE
SHUCOOP-1	30025283040000	INJ_H2O	TA
SHUCOOP-10	30025289690000	INJ_H2O	ACTIVE
SHUCOOP-11	30025289700000	INJ_H2O	ACTIVE
SHUCOOP-12	30025289710000	INJ_H2O	ACTIVE
SHUCOOP-13	30025289720000	INJ_H2O	ACTIVE
SHUCOOP-2	30025283050000	INJ_WAG	ACTIVE
SHUCOOP-3	30025283060000	INJ_WAG	ACTIVE
SHUCOOP-4	30025283070000	INJ_WAG	ACTIVE
SHUCOOP-5	30025283080000	INJ_WAG	ACTIVE
SHUCOOP-6	30025283090000	INJ_WAG	ACTIVE
SHUCOOP-9	30025289680000	INJ_H2O	ACTIVE

Appendix 6. Summary of Key Regulations Referenced in MRV Plan

There are four primary regulations cited in this plan:

1. See New Mexico Administrative Code 19.15.16.9 "Sealing Off Strata" found online at: http://www.emnrd.state.nm.us/OCD/documents/SearchablePDFofOCDTitle19Chapter15-Revised12-15-15.pdf.

2. 40 CFR Parts 144, 145, 146, 147

3. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-6199-F found online at: http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/256181/R-6199-F_1_HO.pdf

4. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-4934-F found online at http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/253379/R-4934-F_1_HO.pdf

Request for Additional Information: Hobbs Subpart RR MRV Plan
December 22, 2016

Oxy Response – January 3, 2017

Instructions: Please enter responses into this table. Any long responses, references, or supplemental information may be attached to the end of the table as an appendix. Supplemental information may also be provided in a resubmitted MRV plan.

No.	MRV Plan Section	MRV Plan Page	EPA Questions	Responses
1.	2. Project Description	13	MRV Plan: "In the case of the Hobbs Field, this oil and gas has been trapped in the reservoir for 50 to100 million years." There is a type-o – "to100" should read "to 100".	Corrected typo
2.	2. Project Description	18	MRV Plan: "Water separated in the tank batteries is processed at water injection stations to remove any remaining oil and then distributed throughout the Hobbs Field either for reinjection along with CO_2 (the WAG or "water alternating gas" process) or sent to "swing" wells." Please provide a description or definition for "swing" well.	"Swing well" is a term used by Oxy to indicate a well in the injection interval that is currently involved in water injection but that may switch to WAG injection in the future. The term added unnecessary confusion because injection into such wells is contained in the Hobbs Field. The sentence was modified to read: Water separated in the tank batteries is processed at water injection stations to remove any remaining oil and then distributed throughout the Hobbs Field for reinjection."
3.	2. Project Description	20	Table 1 - Hobbs Field Wells The table title is not on the same page as the table.	Corrected

No.	MRV Plan		EPA Questions	Responses
	Section	Page		
4.	2. Project Description	21	MRV Plan: "On average, in the Hobbs Field there are two to three incidents per year in which the well casing fails. Oxy detects these incidents by monitoring changes in the surface pressure of wells and by conducting Mechanical Integrity Tests (MITs), as explained later in this section." Please provide further explanation (or cross reference to other section(s) of the MRV Plan) on the regulatory requirement in place and/or the procedures Oxy plans to use to address well casing failures.	The citation for the relevant regulations is contained in Appendix 6. This appendix was mislabeled in the main text and was corrected in the text at page 21 and is in footnotes # 3, 7 and 8.
5.	2. Project Description	21	MRV Plan: "More often, al partial liner would be installed from 3,800-4,300 ft, and the TOC would be at 3,800 ft." There is a type-o – "al partial liner" should read "a partial liner".	Corrected
6.	2. Project Description	21	MRV Plan: "The majority (roughly 66%) of wells in in Table 1 were drilled after 1980." There is a type-o – "in in Table 1" should read "in Table 1".	Corrected

No.	MRV Plan		EPA Questions	Responses
	Section	Page		
7.	2. Project Description	22/33	MRV Plan (p. 22): None of the wells operated by other entities are completed within the San Andres. 85% of the "inactive" wells have been properly plugged and abandoned (P&A'd) as required by the NMOCD, the remaining four are temporarily abandoned (TA)." Please provide further explanation, if information is available, regarding the completion status of the non-Oxy wells. For example, are they drilled shallower than the San Andres formation?	Review of Oxy records indicated an error in the reported number of inactive wells operated by others (OBO); it should be 32 instead of 28 and has been corrected. We have also added information about these wells. The new text reads: "There are 17 active operated-by-others (OBO) wells, of which 3 are completed at depths shallower than the San Andres and 14 are completed at depths deeper than the San Andres. There are 32 inactive OBO wells, of which 27 have been properly plugged and abandoned (P&A'd) as required by the NMOCD (with 24 of these completed shallower than the San Andres and 3 deeper); the remaining 5 inactive OBO wells are temporarily abandoned (TA) in accordance with NMOCD rules and are completed deeper than the San Andres." In addition, the OBO wells that are shallower than the San Andres are not considered a potential pathway for leakage since they do not penetrate the confining layer. The 22 wells that are completed deeper than the San Andres have been evaluated as part of the AOR process completed by Oxy for drilling new wells. Further, problems in the integrity of these OBO wells resulting in leakage pathways would be detected through Oxy's operational monitoring of injection pressures and production volumes. Unexpected performance would lead to further investigation and problems with existing wellbores would be result in action by Oxy and/or by the other operators. This is referenced in Section 4.2.

No.	MRV Plan		EPA Questions	Responses
	Section	Page		
8.	2. Project Description	27	MRV Plan: "In addition, Oxy contains formation fluids within the Hobbs Field by operating offsetting injection and production wells drilled along the lease lines that are designed to balance fluids and thereby avoid losses to adjacent units. There are currently no significant operations surrounding the remaining boundary of the Hobbs Field to interfere with these operations." Please provide further explanation regarding the wells drilled along the lease lines. What does it mean to have offsetting wells when there are no significant operations surrounding the boundary?	This was modified to clarify Oxy's use of water curtains to contain CO_2 within WAG patterns. It now reads: "In addition, Oxy surrounds WAG operations with water injection wells to contain CO_2 within the patterns. There are a few small producer wells operated by third parties outside the boundary of Hobbs Field. The water injection wells also prevent any loss of CO_2 to these producer wells. There are currently no significant commercial operations surrounding the Hobbs Field to interfere with Oxy's operations."
9.	4. Evaluation of Potential Pathways for Leakage to the Surface	36	MRV Plan: "It is possible that at some point in the future, drilling through the containment zone into the San Andres could occur and inadvertently create a leakage pathway. Oxy's review of this issue concludes that this risk is very low for three reasons. First, any wells drilled in the oil fields of New Mexico are regulated by NMOCD and are subject to requirements that fluids be contained in strata in which they are encountered.[8] Second, Oxy's visual inspection process, including routine site visits, is designed to identify unapproved drilling activity in the Hobbs Field. Third, Oxy plans to operate the CO_2 EOR flood in the Hobbs Field for several more decades, and will continue to be vigilant about protecting the integrity of its assets and maximizing the potential of resources (oil, gas, CO_2). In the unlikely event Oxy would sell the Field to a new operator, provisions would result in a change to the reporting program and would be addressed at that time." Please provide further explanation regarding the last sentence. For example, does this refer to requirements of 40 CFR 98.4(h) for updating the certificate of representation?	Footnote 8 incorrectly referenced Appendix 7 and has been changed to indicate Appendix 6, which includes the relevant federal and state regulations.

<table>
<tr><th rowspan="2">No.</th><th colspan="2">MRV Plan</th><th rowspan="2">EPA Questions</th><th rowspan="2">Responses</th></tr>
<tr><th>Section</th><th>Page</th></tr>
<tr><td>10.</td><td>4. Evaluation of Potential Pathways for Leakage to the Surface</td><td>36</td><td>MRV Plan: “It is highly unlikely that injected CO_2 will migrate downdip and laterally outside the Hobbs Field because of the nature of the geology and the approach use for injection.”

There is a type-o – “approach use for injection” should read “approach used for injection”.</td><td>Corrected</td></tr>
<tr><td>11.</td><td>5. Monitoring and Considerations for Calculating Site Specific

Variables</td><td>40</td><td>MRV Plan: “Oxy measures the volume of received CO_2 using commercial custody transfer meters at each the two off-take points from the Permian pipeline delivery system and at the point of transfer between the NHU and the SHU.”

There is a type-o – “at each the two” should read “at each of the two”.</td><td>Corrected</td></tr>
<tr><td>12.</td><td>5. Monitoring and Considerations for Calculating Site Specific Variables</td><td>43</td><td>MRV Plan: Finally, Oxy uses the data collected by the H_2S monitors, which are worn by all field personnel at all times, as a last method to detect leakage from wellbores. If an H_2S alarm is triggered, the first response is to protect the safety of the personnel, and the next step is to safely investigate the source of the alarm. As noted previously, Oxy considers H_2S a proxy for potential CO_2 leaks in the field. Thus, detected H_2S leaks will be investigated to determine and, if needed, quantify potential CO_2 leakage. If the incident results in a work order, this will serve as the basis for tracking the event for GHG reporting.”

What is the limit of detection on the H_2S monitors that are deployed?</td><td>The detection limit for the H_2S monitors is 10 ppm. This has been reflected in the text.</td></tr>
</table>

No.	MRV Plan		EPA Questions	Responses
	Section	Page		
13.	7. Determination of Sequestration Volumes Using Mass Balance Equations	46	MRV Plan: The amount of CO_2 in the NGL does not impact the mass balance and is therefore not included in the mass balance calculation. Only the volume of CO_2 recycled from the RCF impacts the mass balance equation and it is the volume measured at the RCF outlet." Please provide further explanation on why CO_2 in the NGL does not impact the mass balance.	Replaced relevant paragraph with following: "The second modification addresses the NGL sales from the NHU RCF. As indicated in Figure 10, NGL is separated from the fluid mix at the NHU RCF after it has been measured at the RCF inlet and before measurement at the RCF outlet. As a result the amount of CO_2 recycled already accounts for the amount entrained in NGL and therefore is not factored separately into the mass balance calculation."
14.	7. Determination of Sequestration Volumes Using Mass Balance Equations	46	MRV Plan: "Analyses of historic records show an immaterial difference between the twometer readings that is likely due to calibration differences." There is a type-o – "twometer" should read "two meter"	Corrected

Oxy Hobbs Field CO_2 Subpart RR Monitoring, Reporting and Verification (MRV) Plan

December 2016

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Roadmap to the Monitoring, Reporting and Verification (MRV) Plan

Occidental Permian Ltd. (OPL) operates the North Hobbs Grayburg San Andres Unit (North Hobbs Unit) and the South Hobbs Project Area (South Hobbs Unit), (collectively referred to as the Hobbs Field) in the Permian Basin for the primary purpose of enhanced oil recovery (EOR) using carbon dioxide (CO_2) flooding. OPL intends to inject CO_2 with a subsidiary purpose of establishing long-term containment of a measureable quantity of CO_2 in subsurface geological formations at the Hobbs Field for a term referred to as the "Specified Period." During the Specified Period, OPL will inject CO_2 that is purchased (fresh CO_2) from affiliates of Occidental Petroleum Corporation (OPC) or third parties, as well as CO_2 that is recovered (recycled CO_2) from the Hobbs Field CO_2 Recycle and Compression Facilities (RCFs). OPL, OPC and their affiliates (together, Oxy) have developed this monitoring, reporting, and verification (MRV) plan in accordance with 40 CFR §98.440-449 (Subpart RR) to provide for the monitoring, reporting and verification of the quantity of CO_2 sequestered at the Hobbs Field during the Specified Period.

In accordance with Subpart RR, flow meters are used to quantify the volume of CO_2 received, injected, produced, contained in products, and recycled. If leakage is detected, the volume of leaked CO_2 will be quantified using two approaches. First, Oxy follows the requirements in 40 CFR §98.230-238 (Subpart W) to quantify fugitive emissions, planned releases of CO_2, and other surface releases from equipment. Second, Oxy's risk-based monitoring program uses surveillance techniques in the subsurface and above ground to detect CO_2 leaks from potential subsurface leakage pathways. If a leak is identified, the volume of the release will be estimated. The CO_2 volume data, including CO_2 volume at different points in the injection and production process, equipment leaks, and surface leaks, will be used in the mass balance equations included in 40 CFR §98.440-449 (Subpart RR) to calculate the volume of CO_2 stored on an annual and cumulative basis.

This MRV plan contains eleven sections:

- Section 1 contains general facility information.
- Section 2 presents the project description. This section describes the planned injection volumes, the environmental setting of the Hobbs Field, the injection process, and reservoir modeling. It also illustrates that the Hobbs Field is well suited for secure storage of injected CO_2.
- Section 3 describes the monitoring area: the Hobbs Field in New Mexico.
- Section 4 presents the evaluation of potential pathways for CO_2 leakage to the surface. The assessment finds that the potential for leakage through pathways other than the man-made well bores and surface equipment is minimal.
- Section 5 describes Oxy's risk-based monitoring process. The monitoring process utilizes Oxy's reservoir management system to identify potential CO_2 leakage indicators in the subsurface. The monitoring process also utilizes visual inspection

of surface facilities, personal H_2S monitors, and Oxy's Specialized Field Risk Management (SFRM) program as applied to Hobbs Field. Oxy's MRV efforts will be primarily directed towards managing potential leaks through well bores and surface facilities.

- Section 6 describes the baselines against which monitoring results will be compared to assess whether changes indicate potential leaks.
- Section 7 describes Oxy's approach to determining the volume of CO_2 sequestered using the mass balance equations in 40 CFR §98.440-449, Subpart RR of the Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP). This section also describes the site-specific factors considered in this approach.
- Section 8 presents the schedule for implementing the MRV plan.
- Section 9 describes the quality assurance program to ensure data integrity.
- Section 10 describes Oxy's record retention program.
- Section 11 includes several Appendices.

1. Facility Information

i) Reporter number – TBD

ii) The Oil Conservation Division (NMOCD) of the New Mexico Energy, Mineral and Natural Resources Department (EMNRD) regulates all oil, gas and geothermal activity in New Mexico. All wells in the Hobbs Field (including production, injection and monitoring wells) are permitted by NMOCD through New Mexico Administrative Code (NMAC) Title 19 Chapter 15. Additionally, NMOCD has primacy to implement the Underground Injection Control (UIC) Class II program in the state for injection wells. All injection wells in the Hobbs Field are currently classified as UIC Class II wells.

iii) Wells in the Hobbs Field are identified by name, API number, status, and type. The list of wells as of August 2016 is included in Appendix 5. Any new wells will be indicated in the annual report.

2. Project Description

The Hobbs Field is comprised of the North Hobbs Unit (NHU) and the South Hobbs Unit (SHU). The two units abut each other, produce oil and gas from the same geologic formations and structure, and are under the sole operatorship of Oxy. The geology, facilities/equipment, and operational procedures are similar for both units in the Hobbs Field. Because of these similarities, one MRV Plan is being prepared for the two units in the Hobbs Field and any important differences between the units will be noted in the

MRV plan. This section describes the planned injection volumes, environmental setting of the Hobbs Field, injection process, and reservoir modeling conducted.

2.1 Project Characteristics

Oxy developed a long-term performance forecast for the Hobbs Field using the reservoir modeling approaches described in Section 2.4. This forecast is included here to provide a "big picture" overview of the total amounts of CO_2 anticipated to be injected, produced, and stored in the Hobbs Field as a result of its current and planned CO_2 EOR operations during the modeling period 2003-2100. This forecast is based on historic and predicted data. Figure 1 shows the actual (historic) CO_2 injection, production, and stored volumes in the Hobbs Field for the period 2003, when Oxy initiated CO_2 flooding, through 2016 (solid line) and the forecast for 2017 through 2100 (dotted line). The forecast is based on results from reservoir and recovery process modeling that Oxy uses to develop injection plans for each injection pattern, which is also described in Section 2.4. It is important to note that this is just a forecast; actual storage data will be collected, assessed, and reported as indicated in Sections 5, 6, and 7 in this MRV Plan. The forecast does illustrate, however, the large potential storage capacity at Hobbs field.

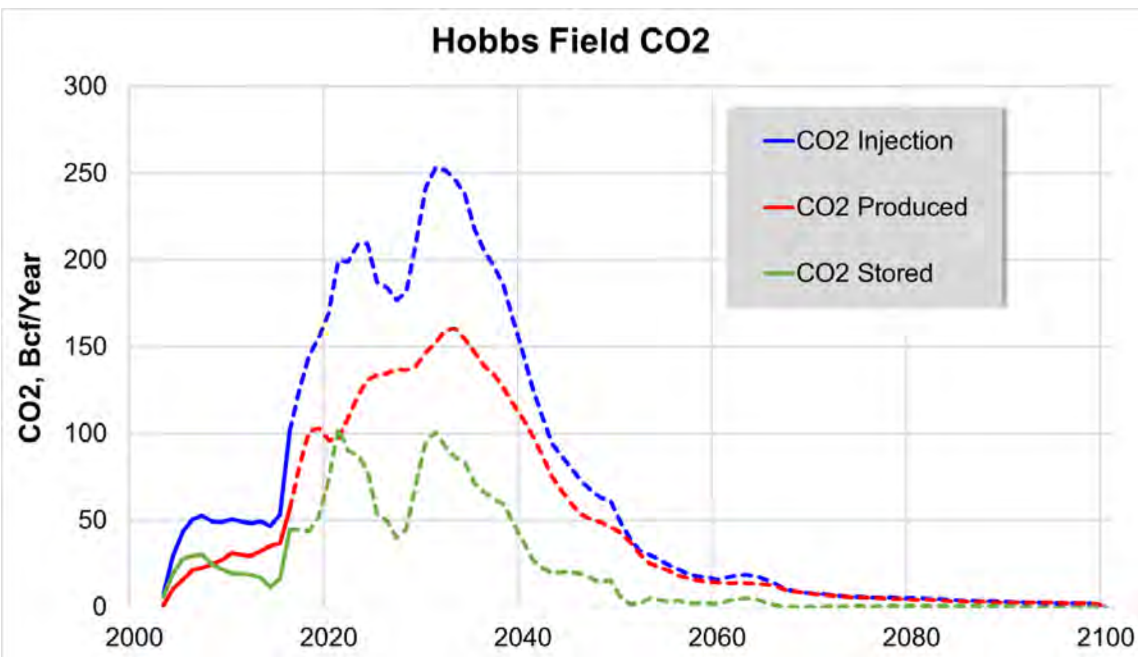


Figure 1 – Hobbs Field Historic and Forecast CO_2 Injection, Production, and Storage 2003-2100

Oxy adjusts the volume of CO_2 purchased to maintain reservoir pressure and to increase recovery of oil by extending or expanding the CO_2 flood. The volume of CO_2 purchased is the volume needed to balance the fluids removed from the reservoir and provide the solvency required to increase oil recovery. The model output shows CO_2 injection, production, and storage through 2100. However, this data is for planning purposes only and may not represent the actual operational life of the Hobbs Field. Oxy has injected 579 Bscf of CO_2 (31.3 million metric tonnes (MMMT)) into the Hobbs Field as of the end of 2015. Of that amount, 318 Bscf (17.2 MMMT) was produced and 261 Bscf (14.1 MMMT) was stored.

Although exact storage volumes will be calculated using the mass balance equations described in Section 7, Oxy forecasts that the total volume of CO_2 stored over the modeled injection period to be 2,197 Bscf (118.8 MMMT), which represents approximately 27.6% of the theoretical storage capacity of the Hobbs Field. For accounting purposes, the amount stored is the difference between the amount injected (including purchased and recycled CO_2) and the total of the amount produced less any CO_2 that: i) leaks to the surface, ii) is released through surface equipment leakage or malfunction, or iii) is entrained or dissolved in produced oil, as described in Section 7.

Figure 2 presents the cumulative annual forecasted volume of CO_2 stored by decade through 2100, the modeling period for the projection in Figure 1. The cumulative amount stored is equal to the sum of the annual storage volume for each year in the current decade plus the sum of the total of the annual storage volume for each year in the previous decade. The first decade reflects operations from 2003-2009, the second decade reflects the first decade plus estimated storage volume from 2010-2015 and projected storage for 2016-2019. The remaining decades reflect the prior storage plus projected cumulative storage for that decade. As is typical with CO_2 EOR operations, the rate of accumulation of stored CO_2 tapers over time as more recycled CO_2 is used for injection. Figure 2 illustrates the total cumulative storage over the modeling period, projected to be 2,197 Bscf (118.8 MMMT) of CO_2. This forecast illustrates the projected volume of subsidiary storage during the modeling period; the actual amounts stored during the Specified Period of reporting will be calculated as described in Section 7 of this MRV plan.

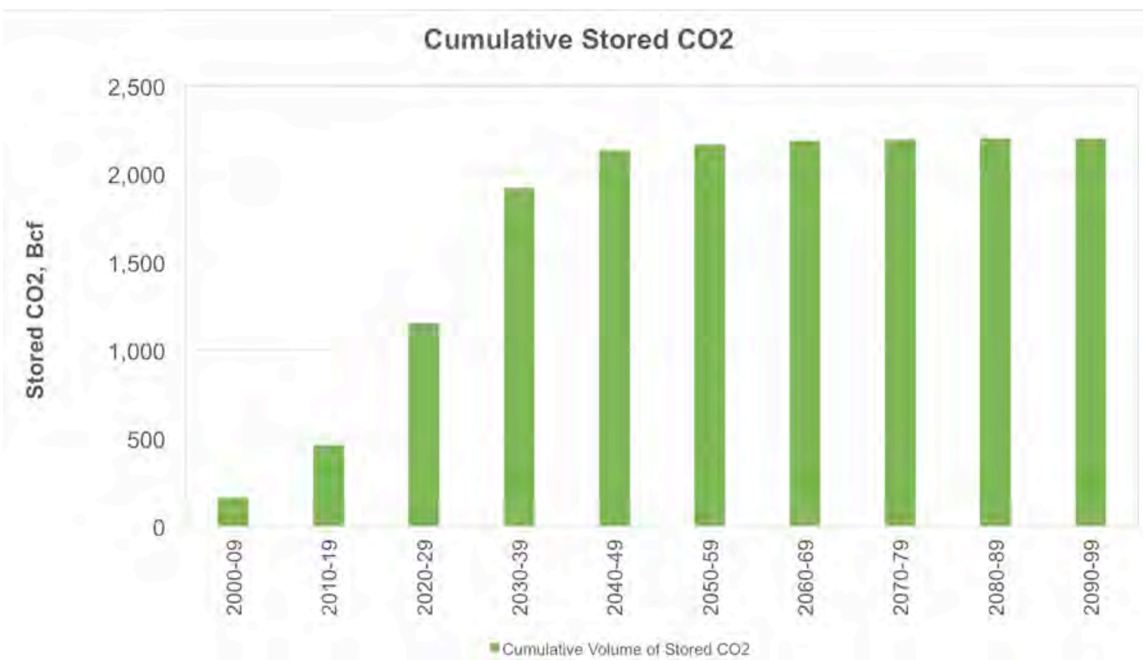


Figure 2 – Hobbs Field CO_2 Storage Forecasted by Decade During the Modeling Period 2003-2100

2.2 Environmental Setting

The project site for this MRV plan is the Hobbs Field, located in the Permian Basin in New Mexico.

2.2.1 Geology of the Hobbs Field

The Hobbs Field produces oil primarily from the San Andres formation. Some oil is also produced from the Basal Grayburg (lowest layer of the Grayburg formation), which lies directly above the San Andres (see Fig. 4). For convenience, the Basal Grayburg and San Andres formations will be referred to as "the reservoir" in this document. The productive interval, or reservoir, is composed of layers of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. This depository created a wide sedimentary basin, called the Permian Basin, which extends across the southeastern part of New Mexico and the western part of Texas. In the Permian Era, this part of the central United States was under water.

The Hobbs Field was discovered in 1928. It is located in east-central Lea County, in southeastern New Mexico (See Figure 3), on the northwestern margin of the Central Basin Platform. The Field is approximately two miles west of the Texas state line and one hundred miles northwest of Midland, as indicated by the red dot in Figure 3.

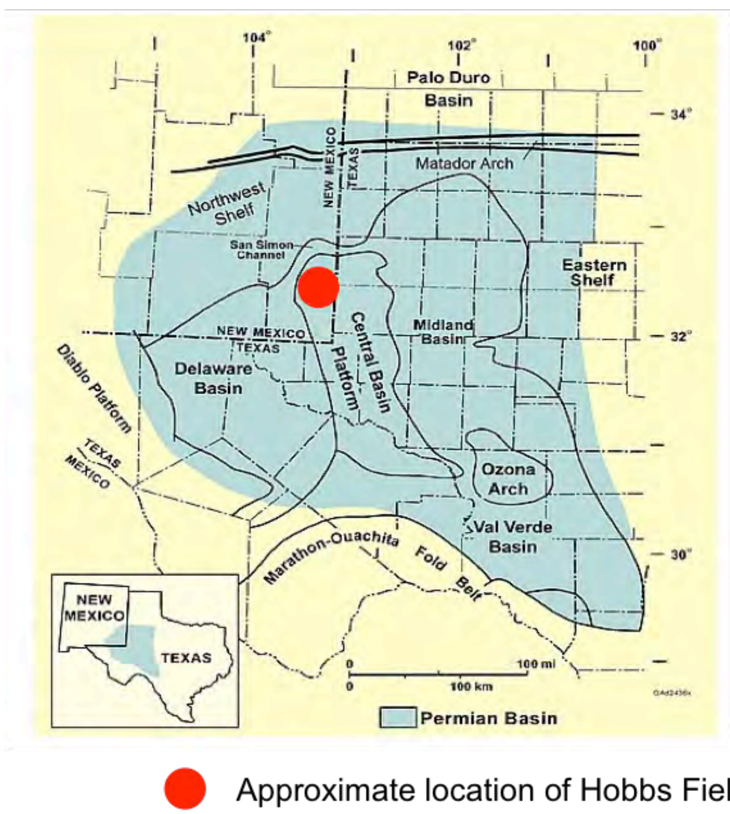


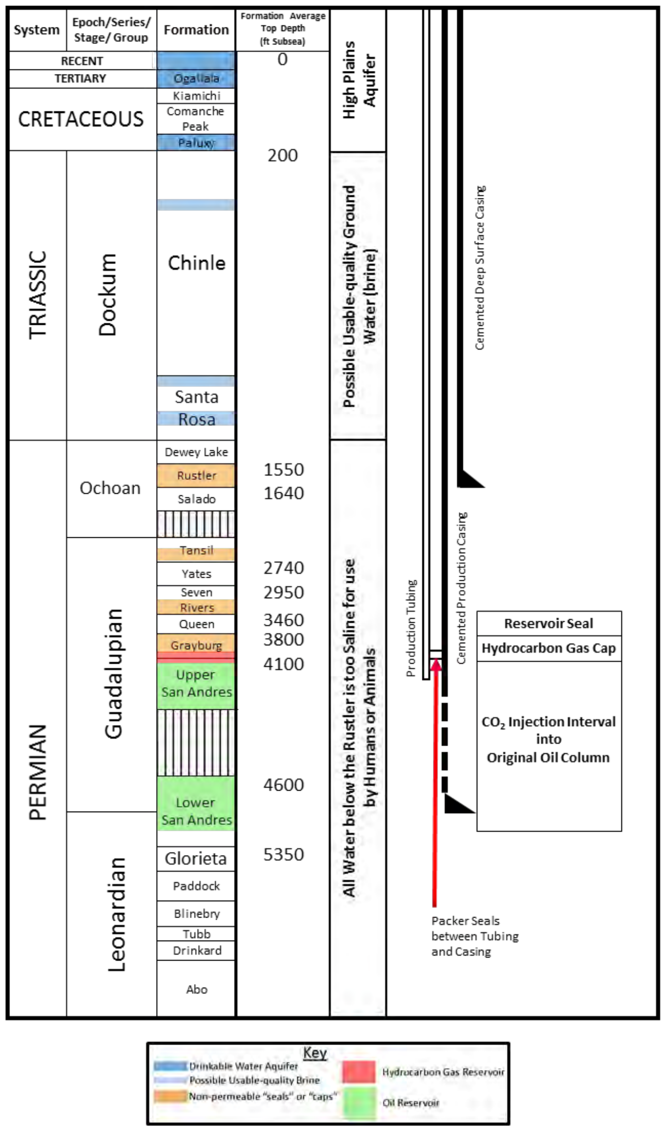
Figure 3 – Paleogeographic map of the Permian Basin showing approximate location of Hobbs Field.

With more than 1,000 million barrels (MMB) of Original Oil in Place (OOIP), the Hobbs Basal Grayburg-San Andres field is one of the largest in North America. During the millions of years following its deposition, the reservoir was buried under thick layers of impermeable rock, and finally uplifted to form the current landscape. The process of burial and uplifting produced some unevenness in the geologic layers. Originally flatlying, there are now some variations in elevation across the Permian Basin that form structural "highs," relatively higher subsurface elevations such as Hobbs Field, where oil and gas have accumulated over the ensuing millions of years.

As indicated in Figure 4, the Basal Grayburg and San Andres formations now lie beneath approximately 4,000 feet of overlying sediments. There are a number of sections above the reservoir that are impermeable and serve as reliable barriers to prevent fluids from moving upwards towards the surface. These barriers are referred to as seals because they effectively seal fluids into the formations beneath them. In the Hobbs Field, the top seal is made up of the anhydrite, shale, and impermeable silty dolomite rock layers that comprise the upper Grayburg. Above this, lie several intervals of impermeable rock layers of various thicknesses: the Queen, Seven Rivers, Tansil, Yates, and Rustler formations. These formations are highlighted orange on the stratigraphic column in Figure 4.

Between the surface and about 1,500 feet in depth there are intervals that contain underground sources of drinking water (USDW). These include the Ogallala and Paluxy aquifers, identified in blue in Figure 4. In addition, other potentially useful brine intervals (each having a higher dissolved solids content) are identified in light blue. NMOCD regulations require that all wells drilled through these intervals be cased and cemented to prevent the movement of formation or injected fluid from the injection zone into another zone or to the surface around the outside of a casing string (NMAC 19.15.26.9).

Figure 4 – Generalized Stratigraphic Section at Hobbs Field



Stratigraphic column has been adapted for Hobbs Field, and is modified from Katz *et al*, 1994 and Burke *et al*, 1960. Formation tops depths are observed field averages from Hobbs well log data.

There are no known faults or fractures affecting the Hobbs Field that provide a potential upward pathway for fluid flow. Oxy has confirmed this conclusion in multiple ways. First and foremost, the presence of oil, especially oil that has a gas cap, is indicative of a good quality natural seal. Oil and, to an even greater extent, gas, tend to migrate upward over time because both are less dense than the brine found in rock formations. Places where oil and gas remain trapped in the deep subsurface over millions of years, as is the case in the Hobbs Field, provide positive proof that faults or fractures do not provide a pathway for upward migration out of the CO_2-flooding interval. The existence of such faults or fractures in the Hobbs Field would have provided a pathway for oil and gas to escape, and they are not found there today.

Second, in the course of developing the Field, seismic surveys have been conducted to characterize the formations and provide information for the reservoir models used to design injection patterns. These surveys show the existence of faulting present well below the San Andres formation but none that penetrate the flooding interval. Figure 5 shows a seismic section oriented north-south through the Hobbs Field. Faulting can be identified deeper in the section, but not at the San Andres level. The same is true in west-east-oriented section (shown in Figure 6). This lack of faulting in the shallower formations is consistent with the presence of oil and gas in the San Andres formation at the time of discovery.

Figure 5 – North-South Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.

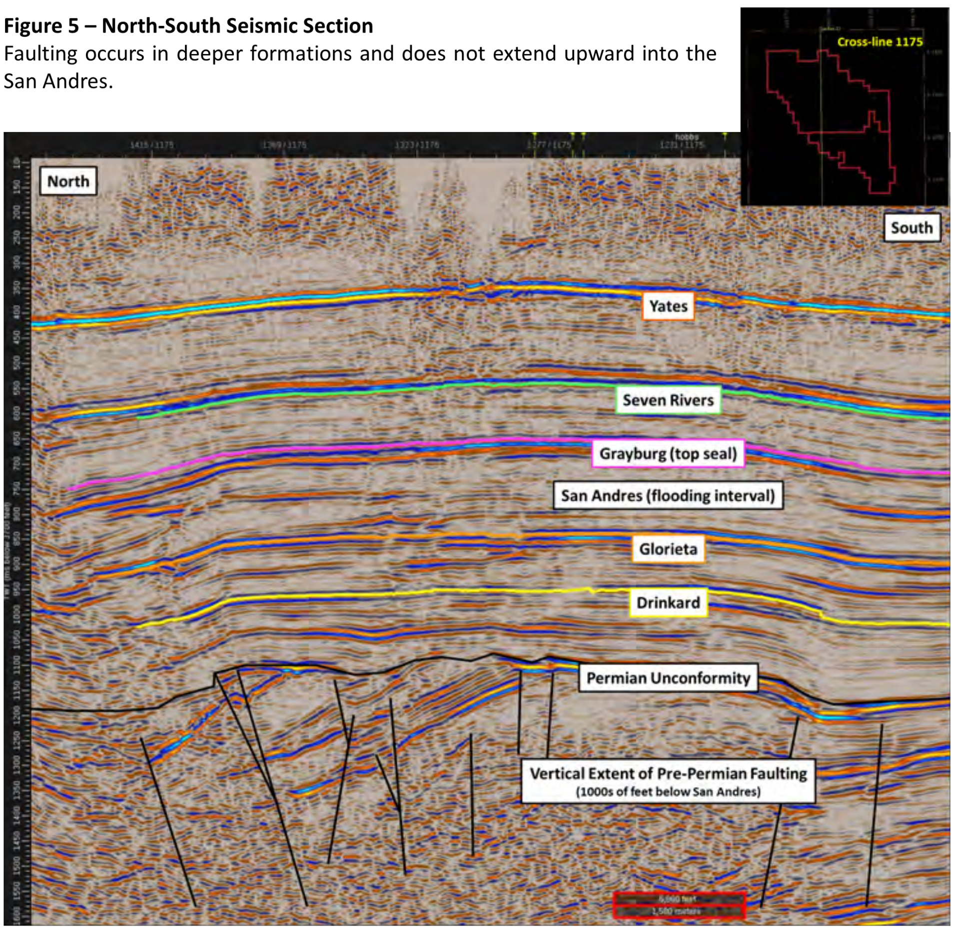
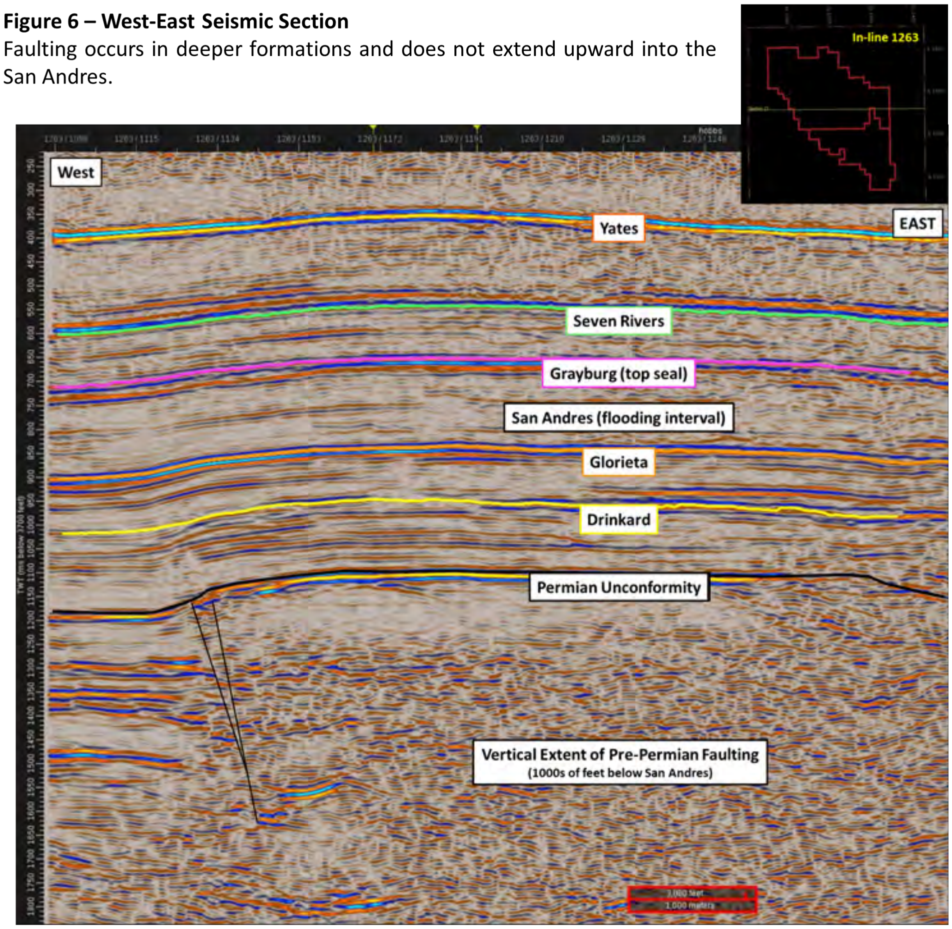


Figure 6 – West-East Seismic Section
Faulting occurs in deeper formations and does not extend upward into the San Andres.



A west-to-east-oriented seismic section (Figure 6) shows the same relationship for faults that lie thousands of feet below the San Andres, and indicates that such faults do not provide pathways for fluids in the San Andres to migrate to the surface. This is discussed further in Section 4.3 in the review of potential leakage pathways for injected CO_2.

Lastly, the operating history at the Hobbs Field confirms that there are no faults or fractures penetrating the flood zone. Fluids, both water and CO_2, have been successfully injected in the Hobbs Field since 1976, and there is no evidence of any interaction with existing or new faults or fractures. In fact, it is the absence of faults and fractures in the Hobbs Field that make the reservoir such a strong candidate for CO_2 and water injection operations, and enable Field operators to maintain effective control over the injection and production processes.

Figure 4 shows a vertical snapshot of the geologic formations that lie beneath the Hobbs Field. Figure 7 provides an areal view of the four-way closure structure of the Field, showing the depth of the top of the San Andres formation. As indicated in the discussion of Figure 4, the upper portion of Grayburg formation is comprised of impermeable anhydrite and silty dolomite sections that serve as a seal. In effect, these sections form the hard ceiling of an upside down bowl or dome. Below this seal, the Basal Grayburg and

San Andres formations consists of permeable dolomites containing oil and gas. Figure 8 shows a two-dimensional picture of the structure of this formation.

The colors in the structure map in Figure 7 indicate changes in subsurface elevation, with red being higher, (i.e., the level closest to the surface) and magenta being lower (i.e., the level furthest below the surface). As indicated in Figure 7, both NHU and SHU are located at the highest elevation of a large, elongated domal structure that is comprised of the Grayburg and San Andres formations, within the Hobbs Field. The elevated area forms a natural trap for oil and gas that migrated from below over millions of years. Once trapped in these high points, the oil and gas has remained in place. In the case of the Hobbs Field, this oil and gas has been trapped in the reservoir for 50 to100 million years. Over time, fluids, including CO_2, rise vertically until reaching the ceiling of the dome and then migrate to the highest elevation of the Hobbs Field structure. As a result, fluids injected into the Hobbs Field stay in the flooded reservoir and do not move to adjacent areas.

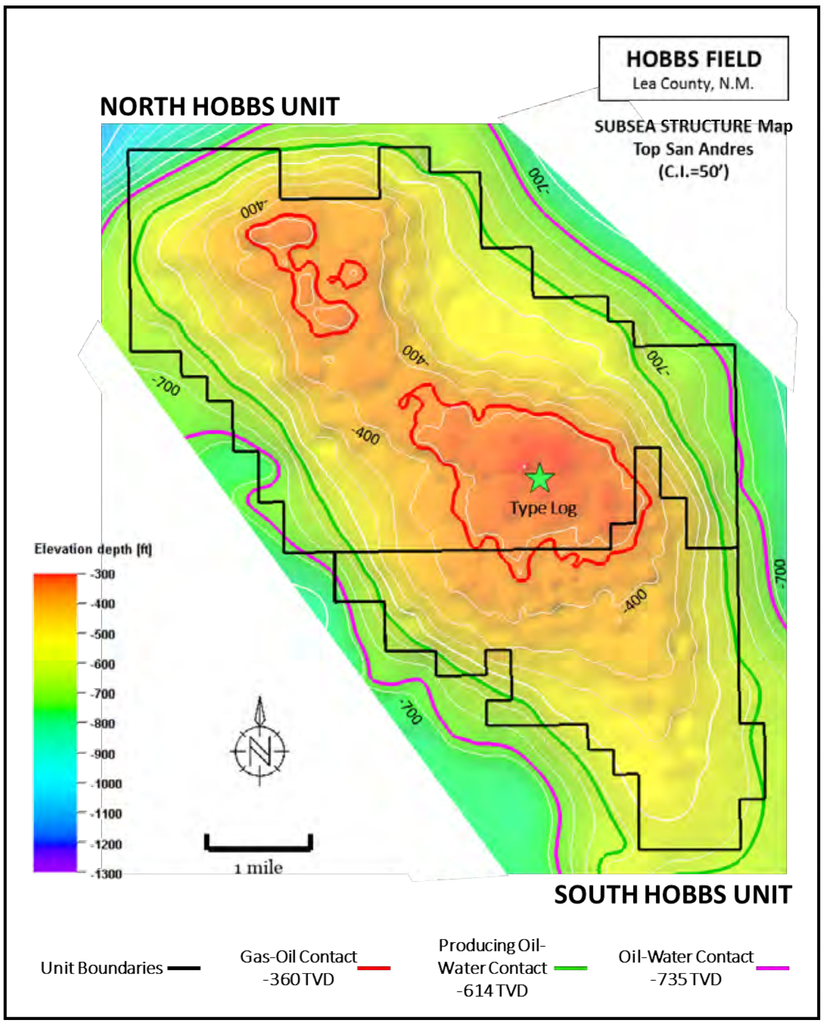


Figure 7 - Structure Map on the Top of San Andres Reservoir.

Buoyancy dominates where oil and gas are found in a reservoir. Gas, being lightest, rises to the top and water, being heavier, sinks to the bottom. Oil, being heavier than gas but lighter than water, lies in between. The cross section in Figure 8 shows saturation levels in the oil-bearing layers of the Hobbs Field and illustrates this principle.

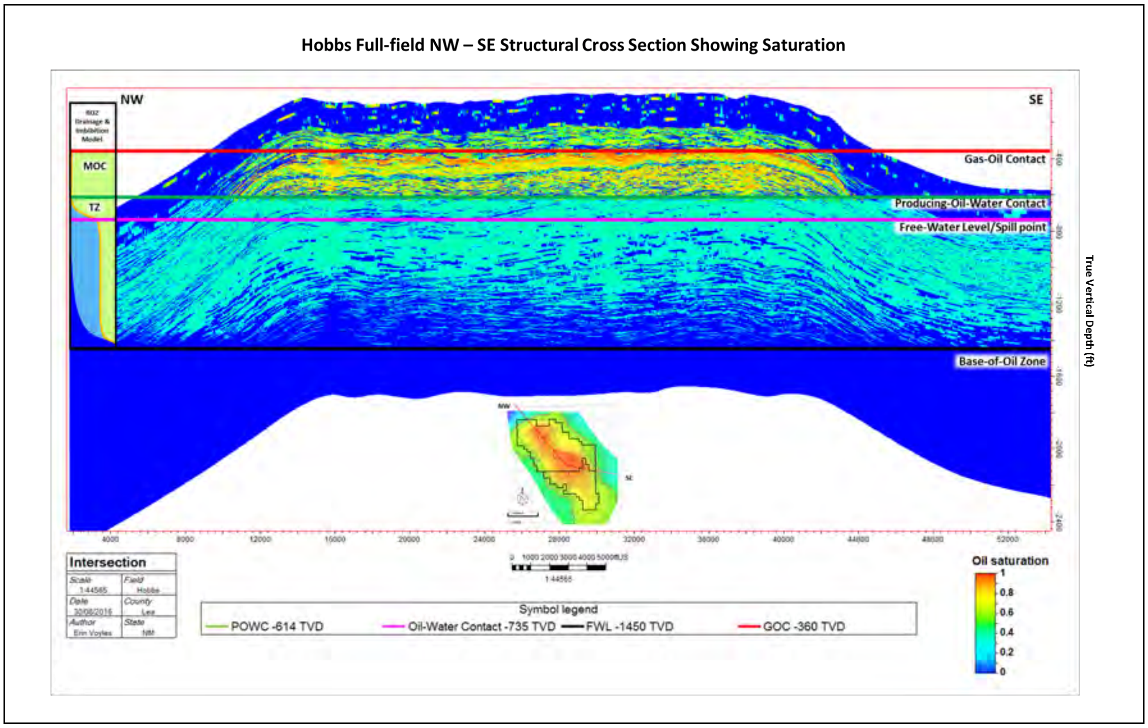


Figure 8 - Hobbs Field structural cross-section showing saturation distribution through Main Pay, Transition Zone, and Residual Oil Zone model.

At the time of its discovery, natural gas was trapped at the structural high points of the Hobbs Field, the area above the gas-oil contact (red line) in the cross section above. This interface is found approximately 4,000 feet below the surface (-360 ft subsea). Above the gas-oil interface is the volume known as the "gas cap." As discussed in Section 2.2.1, the presence of a gas cap is evidence of the effectiveness of the seal formed by the upper Grayburg. Gas is buoyant and highly mobile. If it could escape the Hobbs Field naturally, through faults or fractures, it would have done so over the millennia. Below the gas cap is an oil accumulation, which extends down to the Free-Water Level (FWL), (fuchsia line at -735 ft subsea), which is also the Hobbs structural spill point, or the maximum depth at which hydrocarbons will not leak out of the reservoir. The Base of Oil Zone is the point at which there are no distillable hydrocarbons – nothing moveable through primary, secondary, or tertiary recovery.

The Producing Oil-Water Contact (POWC), (green line at -614 ft subsea) was determined by early drilling to be the maximum depth where only oil, and no water, was produced. Below the POWC, wells produce a combination of oil and water. The uppermost region between the POWC and the free water level FWL/spillpoint is called the transition zone

(TZ), and below that lies the residual oil zone (ROZ). The ROZ was water-flooded naturally millions of years ago, leaving behind a residual oil saturation[1] that is immobile without CO_2 flooding. This is approximately the same residual oil saturation remaining after water flooding in the water-swept areas of the main oil pay zone.

When supercritical CO_2 and water are injected into an oil reservoir, they are pushed from injection wells to production wells by the high pressure of the injected fluids. Once the CO_2 flood is complete and injection ceases, the remaining mobile CO_2 will rise slowly upward, driven by buoyancy forces. If the amount of CO_2 injected into the reservoir exceeds the secure storage capacity of the pore space, excess CO_2 could theoretically "spill" from the reservoir and migrate to other reservoirs on the Central Basin Platform. This risk is very low in the Hobbs Field, because there is more than enough pore space to retain the CO_2. Oxy has calculated the total pore space within the Hobbs Field, from the top of the reservoir down to the spill point, which is located at -735 ft subsea or roughly 4,350 – 4,400 feet below the surface, to be 4,769 MMB. Hobbs Field could hold an estimated maximum of about 7,949 Bscf (430 MMMT) CO_2 in the reservoir space above the spill point. Oxy forecasts that at the end of EOR operations stored CO_2 will fill approximately 27.6% of total calculated storage capacity. (See Section 2.1 for further explanation of the forecast.) The volume of CO_2 storage is based on the estimated total pore space within Hobbs Field from the top of the reservoir down to the spill point, or about 4,769 MMB. This is the volume of rock multiplied by porosity. CO_2 storage is calculated assuming an irreducible water saturation of 0.15, an irreducible oil saturation of 0.10, and a CO_2 formation volume factor of 0.45 (see chart below).

Top of Basal Grayburg down to -735 Total Vertical Depth (structural spill point)	
Variables	
Boundary	**Spill Point Contour**
Pore Volume [RB]	**4,769,117,630**
B_{CO2} [BBL/MCF]	**0.45**
S_{wirr}	**0.15**
Sor_{CO2}	**0.10**
Max CO_2 [MCF]	**7,948,529,383**
Max CO_2 [TCF]	**7.95**

$$CO_2(max) = Volume\ (RB) * (1 - S_{wirr} - S_{orCO_2}) / B_{CO_2}$$

[1] "Residual oil saturation" is the fraction of oil remaining in the pore space, typically after water flooding.

Where:
$CO_2(max)$ = the maximum amount of storage capacity
Volume (RB) = the volume in Reservoir Barrels of the rock formation
B_{CO2} = the formation volume factor for CO_2
S_{wirr} = the irreducible water saturation
Sor_{CO2} = the irreducible oil saturation

Given that the Hobbs Field is located at the highest subsurface elevations of the structure, that the confining zone has proved competent over both millions of years and throughout decades of EOR operations, and that the Hobbs Field has ample storage capacity, Oxy is confident that stored CO_2 will be contained securely within the Basal Grayburg-San Andres reservoir in the Hobbs Field.

2.2.2 Operational History of the Hobbs Field and Hobbs Field

The Hobbs Field was discovered in 1928 and intensive development began in 1930. It is located in the northwestern portion of the Central Basin Platform in the Permian Basin.

The Hobbs Field was originally developed with numerous leases held by individuals and companies. To improve efficiency, a number of smaller leases were combined (or unitized) into two larger legal entities (Units), which can be operated without the operational restrictions imposed by the former lease boundaries. In 1975, the South Hobbs Unit (SHU) was formed, followed by formation of the North Hobbs Unit (NHU) in 1980 (See Figure 9). Together, the NHU and SHU form the Hobbs Field.

The boundaries of the Hobbs Field are indicated in Figure 9. Under certain conditions, Oxy uses a Specialized Field Risk Management (SFRM) program to voluntarily apply additional design and operations specifications to further mitigate the potential risk from public exposure due to loss of containment. Due to the native concentration of H_2S in the Hobbs Field and its proximity to the City of Hobbs, a community with a population of roughly 40,000 according to the 2015 U.S. Census, Oxy screens Hobbs Field well locations and surface equipment to determine where the SFRM program is applied. The voluntary measures of the SFRM provide additional monitoring and will be further discussed in Sections 4 and 5.

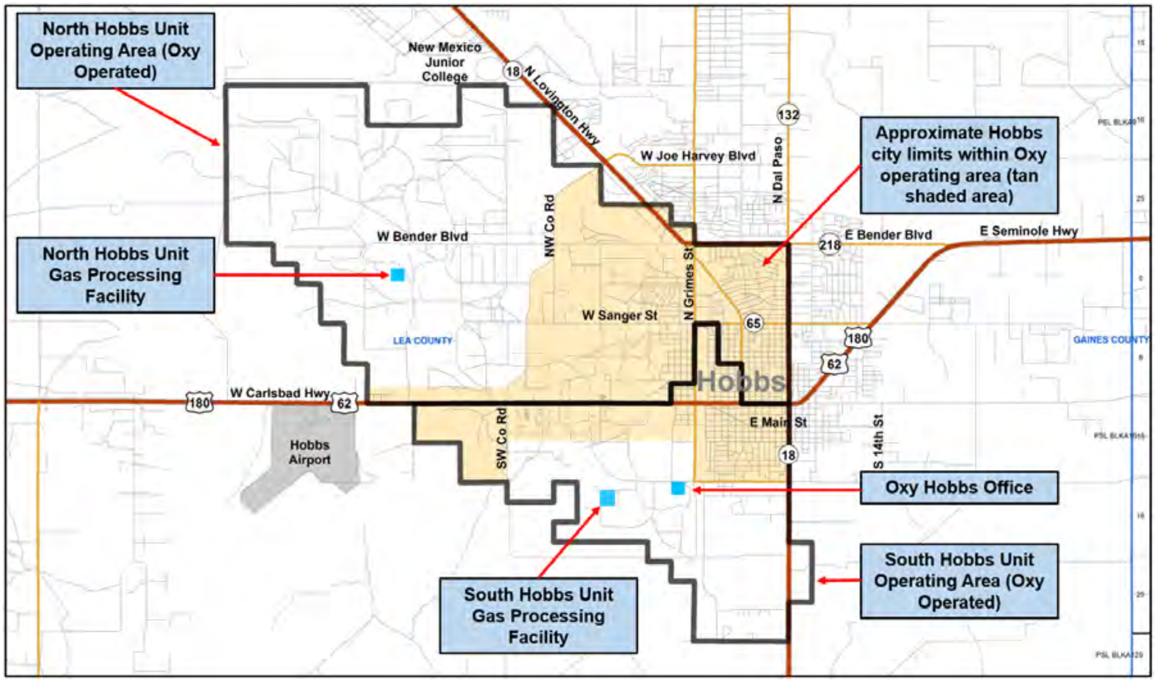


Figure 9 - Hobbs Field Map

Oxy began CO_2 flooding of the NHU of the Hobbs Field in 2003 and has continued and expanded it since that time. The SHU of the Hobbs Field began CO_2 flooding in 2015. The experience of operating and refining the Hobbs Field CO_2 floods over the past decade has created a strong understanding of the reservoir and its capacity to store CO_2.

2.3 Description of CO_2 EOR Project Facilities and the Injection Process

Figures 10 and 11 show a simplified flow diagram of the project facilities and equipment in the NHU and SHU, respectively. CO_2 is delivered to the Hobbs Field via the Permian pipeline delivery system. The CO_2 injected into the Hobbs Field is supplied by a number of different sources into the pipeline system. Specified amounts are drawn based on contractual arrangements among suppliers of CO_2, purchasers of CO_2, and the pipeline operator.

Once CO_2 enters the Hobbs Field there are four main processes involved in EOR operations. These processes are shown in Figures 10 and 11 and include:

1. **CO_2 Distribution and Injection**. Purchased CO_2 and recycled CO_2 from the CO_2 Recycle and Compression Facility (RCF) is sent through the main CO_2 distribution system to various CO_2 injectors throughout the Field.
2. **Produced Fluids Handling**. Produced fluids gathered from the production wells are sent to satellite batteries for separation into a gas/CO_2 mix and a produced fluids mix of water, oil, gas, and CO_2. The produced fluids mix is sent to centralized tank batteries where oil is separated for sale into a pipeline, water is recovered for reuse, and the remaining gas/CO_2 mix is merged with the output

from the satellite batteries. In the NHU, a portion of the gas/CO_2 mix is sent to the SHU and the rest is sent to a combined RCF and natural gas liquids (NGL) facility. In the SHU all of the gas/CO_2 mix from the satellite battery is sent to an RCF along with the gas/CO_2 mix received from the NHU. Produced oil is metered and sold; water is forwarded to the water injection stations for treatment and reinjection or disposal.

3. **Produced Gas Processing**. In the NHU, the gas/CO_2 mix separated at the satellite batteries goes to the RCF/NGL where the NGLs, and CO_2 streams are separated. The NGLs move to a commercial pipeline for sale. The majority of remaining CO_2 (e.g., the recycled CO_2) is returned to the CO_2 distribution system for reinjection. In the SHU, all of the gas/CO_2 mix is compressed for re-injection.
4. **Water Treatment and Injection**. Water separated in the tank batteries is processed at water injection stations to remove any remaining oil and then distributed throughout the Hobbs Field either for reinjection along with CO_2 (the WAG or "water alternating gas" process) or sent to "swing" wells.

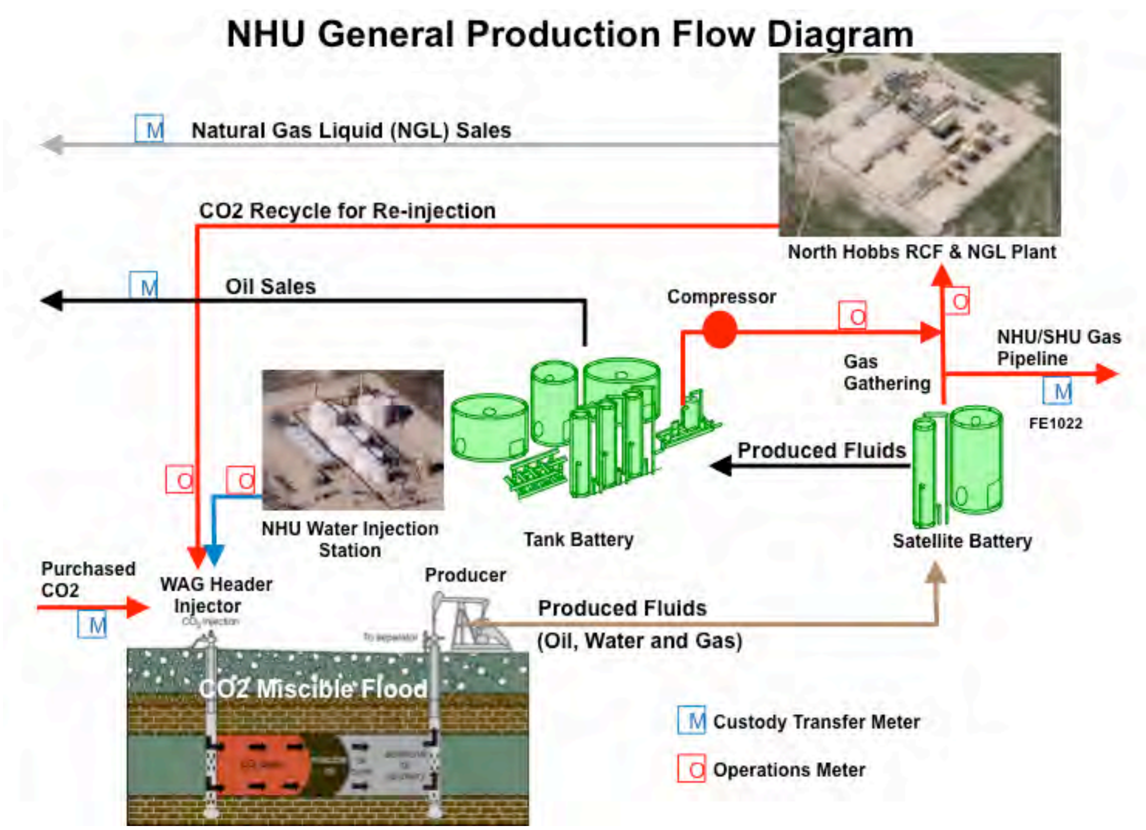


Figure 10 Hobbs Field – NHU Facilities General Production Flow Diagram

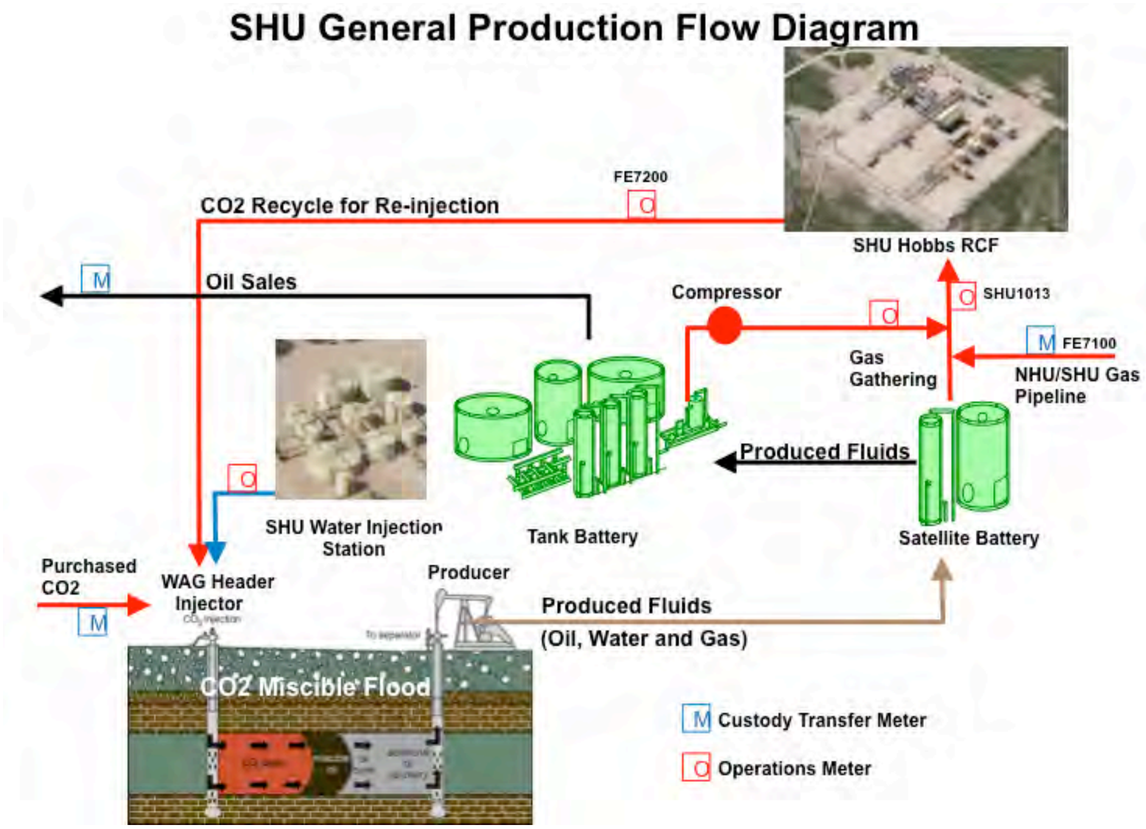


Figure 11 Hobbs Field – SHU Facilities General Production Flow Diagram

2.3.1 CO_2 Distribution and Injection.

Oxy purchases CO_2 from the Permian pipeline delivery system and receives it through two custody transfer metering points, as indicated in Figures 10 and 11. Purchased CO_2 and recycled CO_2 are sent through the CO_2 trunk lines to injection manifolds. At the manifolds, the CO_2 is sent through multiple distribution lines to individual injection wells. There are volume meters at the inlet and outlet of the RCF.

Currently, Oxy has 10 injection manifolds and approximately 210 injection wells in the Hobbs Field. Approximately 330 MMscf of CO_2 is injected each day, of which approximately 40% is purchased CO_2, and the balance (60%) is recycled from the RCFs. The ratio of purchased CO_2 to recycled CO_2 is expected to change over time, and eventually the percentage of recycled CO_2 will increase and purchases of fresh CO_2 will taper off as indicated in Section 2.1.

Each injection well is connected to a WAG header located at the satellite. WAG headers are remotely operated and can inject either CO_2 or water at various rates and injection pressures as specified in the injection plans. The length of time spent injecting each fluid is a matter of continual optimization that is designed to maximize oil recovery and minimize CO_2 utilization in each injection pattern. A WAG header control system is implemented at each satellite. It consists of a dual-purpose flow meter used to measure the injection rate of water or CO_2, depending on what is being injected. Data from these meters is sent to a central data monitoring station where it is compared to the injection plan for that satellite. As described in Sections 5 and 7, data from the WAG header control systems, visual inspections of the injection equipment, and use of the procedures contained in 40 CFR §98.230-238 (Subpart W), will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2.

2.3.2 Wells in the Hobbs Field

As of August 2016, there are 445 active wells that are completed in the Hobbs Field; roughly half of these are production wells (235 wells) and the others are injection wells (210 wells). In addition there about 256 wells that are not in use, bringing the total number of wells currently completed in the Hobbs Field to 701, as indicated in Figure 12.[2] Table 1 shows these well counts in the Hobbs Field by status.

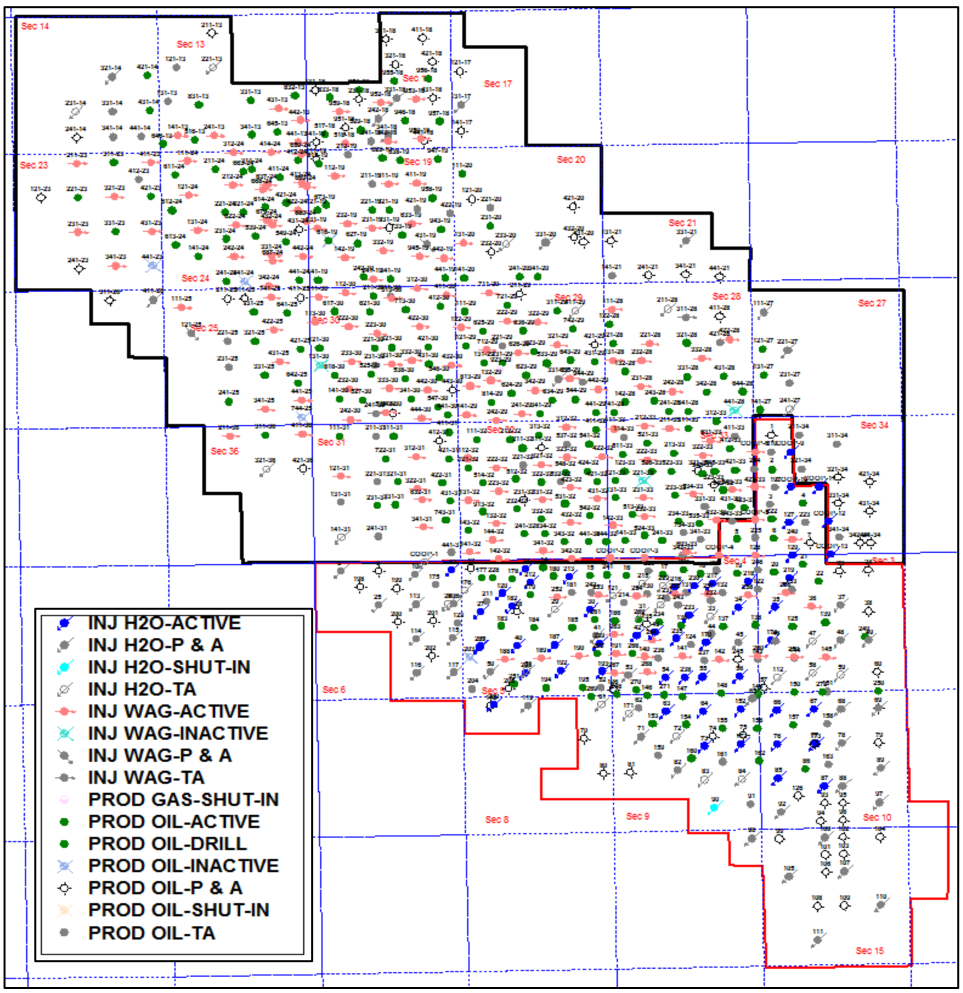


Figure 12 Hobbs Field Wells – As of August 2016

Table 1 - Hobbs Field Wells

[2] Wells that are not in use are deemed to be inactive, plugged and abandoned, temporarily abandoned, or shut in.

Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*
Drilled & Completed in the 1930's	105	4	26	33
Drilled 1946-1979	41	1	18	52
Completed after 1980	299	16	57	49
TOTAL	***445***	***21***	***101***	***134***

The wells in Table 1 are categorized in groups that relate to age and completion methods. Roughly 22% of these wells were drilled in the 1930's and were generally completed with three strings of casing (with surface and intermediate strings typically cemented to the surface). The production string was typically installed to the top of the producing interval, otherwise known as the main oil column (MOC), which extends to the producible oil/water contact (POWC). These wells were completed by stimulating the open hole (OH), and are not cased through the MOC. Normally within 20-30 years of initial completion, a full or partial liner would have been installed to allow for controlled production intervals and this liner would have been cemented to the top of the liner (TOL) that was installed. For example, if a full liner was installed, then Top of Cement (TOC) would be at the surface as the liner was installed to surface. More often, al partial liner would be installed from 3,800-4,300 ft, and the TOC would be at 3,800 ft. The casing weights used for 1930's vintage wells were heavy, with nothing lighter than 7" 24 #/ft. or 5 1/2" 15.5 #/ft. for the production string.

The wells in Table 1 drilled during the period 1946-1979 typically have two to three strings of high-grade casing cemented to a level where the top of the cement (TOC) extends above the previous casing depth. Cement bond logs (CBL) or temperature surveys (TS) have been used to determine that this depth is available on most wells. This group of wells rarely has liners installed because they were completed with production casing that extended below the point of the POWC.

The majority (roughly 66%) of wells in in Table 1 were drilled after 1980. In the vast majority of these wellbores, the surface and production casings are cemented to the surface. Experience shows that these wells generally have not needed partial or full liners. Most of these wells have surface casing and production casing weights of 8 5/8" 24# and 5 1/2" 15.5 # respectively.

Oxy reviews these categories when planning well maintenance projects. Further, Oxy keeps well workover crews on call to maintain all active wells and to respond to any wellbore issues that arise. On average, in the Hobbs Field there are two to three incidents per year in which the well casing fails. Oxy detects these incidents by monitoring changes in the surface pressure of wells and by conducting Mechanical Integrity Tests (MITs), as explained later in this section. This rate of failure is less than 1% of wells per year and is considered extremely low.

Table 2 indicates non-Hobbs Field wells in the area by status. The Oxy-operated wells are completed below the Hobbs Field and provide minimal production of hydrocarbons. None of the wells operated by other entities are completed within the San Andres. 85% of the “inactive” wells have been properly plugged and abandoned (P&A’d) as required by the NMOCD, the remaining four are temporarily abandoned (TA).

Table 2 – Non-Hobbs Field Wells

	Oxy Operated				Operated By Others	
Age/Completion of Well	*Active*	*Shut-in*	*Temporarily Abandoned*	*Plugged and Abandoned*	*Active*	*Inactive*
Drilled & Completed in the 1930's	0	0	0		2	14
Drilled 1946-1979	1	0	0	8	5	11
Completed after 1980	7	4	15	15	10	3
TOTAL	***8***	***4***	***15***	***23***	***17***	***28***

All wells in oilfields, including both injection and production wells described in Tables 1 and 2, are regulated by the NMOCD under NMAC Title 9 Chapter 15 Parts 1-39.[3] A list of wells, with well identification numbers, is included in Appendix 5. The injection wells are subject to additional requirements promulgated by EPA – the UIC Class II program – implementation of which has been delegated to the NMOCD.

NMOCD rules govern well siting, construction, operation, maintenance, and closure for all wells in oilfields. Current rules require, among other provisions, that:

- Fluids be constrained in the strata in which they are encountered;
- Activities governed by the rule cannot result in the pollution of subsurface or surface water;
- Wells adhere to specified casing, cementing, drilling well control, and completion requirements designed to prevent fluids from moving from the strata they are encountered into strata with oil and gas, or into subsurface and surface waters;
- Wells file a completion report including basic electric log (e.g., a density, sonic, or resistivity (except dip meter) log run over the entire wellbore);
- Wells be equipped with a Bradenhead valve, measure the pressure between casing strings using the Bradenhead gauge, and follow procedures to report and address any instances where pressure on a Bradenhead is detected;
- Wells follow plugging procedures that require advance approval from the NMOCD and allow consideration of the suitability of the cement based on the use of the well, the location and setting of plugs.

In addition, Oxy implements a corrosion protection program to protect and maintain the steel used in injection and production wells from any CO_2-enriched fluids. Oxy currently

[3] See Appendix 7 for additional information.

employs methods to mitigate both internal and external corrosion of casing in wells in the Hobbs Field. These methods generally protect the downhole steel and the interior and exterior of well bores through the use of special materials (e.g. fiberglass tubing, corrosion resistant cements, nickel plated packers, corrosion resistant packer fluids) and procedures (e.g. packer placement, use of annular leakage detection devices, cement bond logs, pressure tests). These measures and procedures are typically included in the injection orders filed with the NMOCD. Corrosion protection methods and requirements may be enhanced over time in response to improvements in technology.

The NMOCD granted authority to inject CO_2 in the NHU and SHU after application, notice and hearing. As part of the application process, Oxy conducted an Area of Review (AOR) that included all wells within the NHU and SHU boundaries and extended ¼ mile around both units. According to EPA, the AOR refers to "the area around a deep injection well that must be checked for artificial penetrations, such as other wells, before a permit is issued. Well operators must identify all wells within the AOR that penetrate the injection or confining zone, and repair all wells that are improperly completed or plugged. The AOR is either a circle or a radius of at least ¼ mile around the well or an area determined by calculating the zone of endangering influence, where pressure due to injection may cause the migration of injected or formation fluid into a USDW."[4] Under these requirements Oxy has located and evaluated all wells in the AOR that penetrate the injection interval, including those operated by Oxy and those operated by other parties. Oxy will continue to comply with this regulation going forward.

Mechanical Integrity Testing (MIT)
Oxy complies with the MIT requirements implemented by NMOCD to periodically inspect wells and surface facilities to ensure that all wells and related surface equipment are in good repair and leak-free, and that all aspects of the site and equipment conform with Division rules and permit conditions. All active injection wells undergo an MIT at the following intervals:

- Before injection operations begin;
- Every 2 years as stated in the injection orders (NMOCD Order NO. R-4934-F / R-6199-F);
- After any workover that disturbs the seal between the tubing, packer, and casing;
- After any repair work on the casing; and
- When a request is made to suspend or reactivate the injection or disposal permit.

NMOCD requires that the operator notify the NMOCD district office prior to conducting an MIT. Operators are required to use a pressure recorder and pressure gauge for the tests. The operator's field representative must sign the pressure recorder chart and submit it with the MIT form. The casing-tubing annulus must be tested to a minimum of 300 psi for 30 minutes.

[4] USEPA, Underground Injection Control Program Glossary, http://water.epa.gov/type/groundwater/uic/glossary.cfm.

If a well fails an MIT, the operator must immediately shut the well in and provide notice to NMOCD. Casing leaks must be successfully repaired and retested or the well plugged and abandoned after submitting a formal notice and obtaining approval from the NMOCD.

Any well that fails an MIT cannot be returned to active status until it passes a new MIT.

2.3.3 Produced Fluids Handling

As injected CO_2 and water move through the reservoir, a mixture of oil, gas, and water (referred to as "produced fluids") flows to the production wells. Gathering lines bring the produced fluids from each production well to satellite batteries. Oxy has approximately 235 active production wells in the Hobbs Field and production from each is sent to one of ten satellite batteries. Each satellite battery consists of a large vessel that performs a gas-liquid separation. Each satellite battery also has well test equipment to measure production rates of oil, water and gas from individual production wells. Oxy has testing protocols for all wells connected to a satellite. Most wells are tested every two months. Some wells are prioritized for more frequent testing because they are new or located in an important part of the Field; some wells with mature, stable flow do not need to be tested as frequently; and finally some wells do not yield solid test results necessitating review or repeat testing.

After separation, the gas phase is transported by pipeline to an RCF for processing as described below. Currently the average composition of this gas mixture as it enters the RCF is 82-88% CO_2 and 9,000-10,000ppm H_2S; this composition will likely change over time as CO_2 EOR operations are implemented.

The liquid phase, which is a mixture of oil and water, is sent to one of four centralized tank batteries where oil is separated from water. The large size of the centralized tank batteries provides enough residence time for gravity to separate oil from water.

The separated oil is metered through the Lease Automatic Custody Transfer (LACT) unit located at each centralized tank battery and sold. The oil typically contains a small amount of dissolved or entrained CO_2. Analysis of representative samples of oil is conducted once a year to assess CO_2 content. Since 2012, the dissolved CO_2 content has averaged 0.18% by volume in the oil.

The water is removed from the bottom of the tanks at the central tank batteries and sent to water injection stations, where it is re-injected at the WAG headers.

Any gas that is released from the liquid phase rises to the top of the tanks and is collected by a Vapor Recovery Unit (VRU) that compresses the gas and sends it to an RCF for processing.

Hobbs oil is slightly sour, containing small amounts of hydrogen sulfide (H_2S), which is highly toxic. There are approximately 40 workers on the ground in the Hobbs Field at any given time, and all field personnel are required to wear H_2S monitors at all times. Although the primary purpose of H_2S detectors is protecting employees, monitoring will also supplement Oxy's CO_2 leak detection practices as discussed in Sections 5 and 7.

In addition, the procedures in 40 CFR §98.230-238 (Subpart W) and the two-part visual inspection process described in Section 5 are used to detect leakage from the produced fluids handling system. As described in Sections 5 and 7, the volume of leaks, if any, will be estimated to complete the mass balance equations to determine annual and cumulative volumes of stored CO_2.

2.3.4 Produced Gas Handling

Produced gas gathered from the satellite batteries and tank batteries is sent to an RCF. There is an operations meter at the RCF inlet.

Once gas enters an RCF, it undergoes dehydration and compression. In the NHU an additional process separates NGLs for sale. At the end of these processes there is a CO_2 rich stream that is recycled through re-injection. Meters at each RCF outlet are used to determine the total volume of the CO_2 stream recycled back into the EOR operations.

As described in Section 2.3.4, data from 40 CFR §98.230-238 (Subpart W), the two-part visual inspection process for production wells and areas described in Section 5, and information from the personal H_2S monitors are used to detect leakage from the produced gas handling system. This data will be gathered to complete the mass balance equations necessary to determine annual and cumulative volumes of stored CO_2 as described in Sections 5 and 7.

2.3.5 Water Treatment and Injection

Produced water collected from the tank batteries is gathered through a pipeline system and moved to one of four water injection stations. Each facility consists of 10,000-barrel tanks where any remaining oil is skimmed from the water. Skimmed oil is returned to the centralized tank batteries. The water is sent to an injection pump where it is pressurized and distributed to the WAG headers for reinjection.

2.3.6 Facilities Locations

The current locations of the various facilities in the Hobbs Field are shown in Figure 13. As indicated above, there are four central tank batteries. There are ten active areas of operation that send fluids to one of ten satellite batteries. These active operations areas are highlighted and labeled with a number and letter, such as "24C" in the far west. The four centralized tank batteries are identified by the green squares. The four water treatment and injection stations are shown by the light blue squares. The two RCF facilities are indicated by red squares.

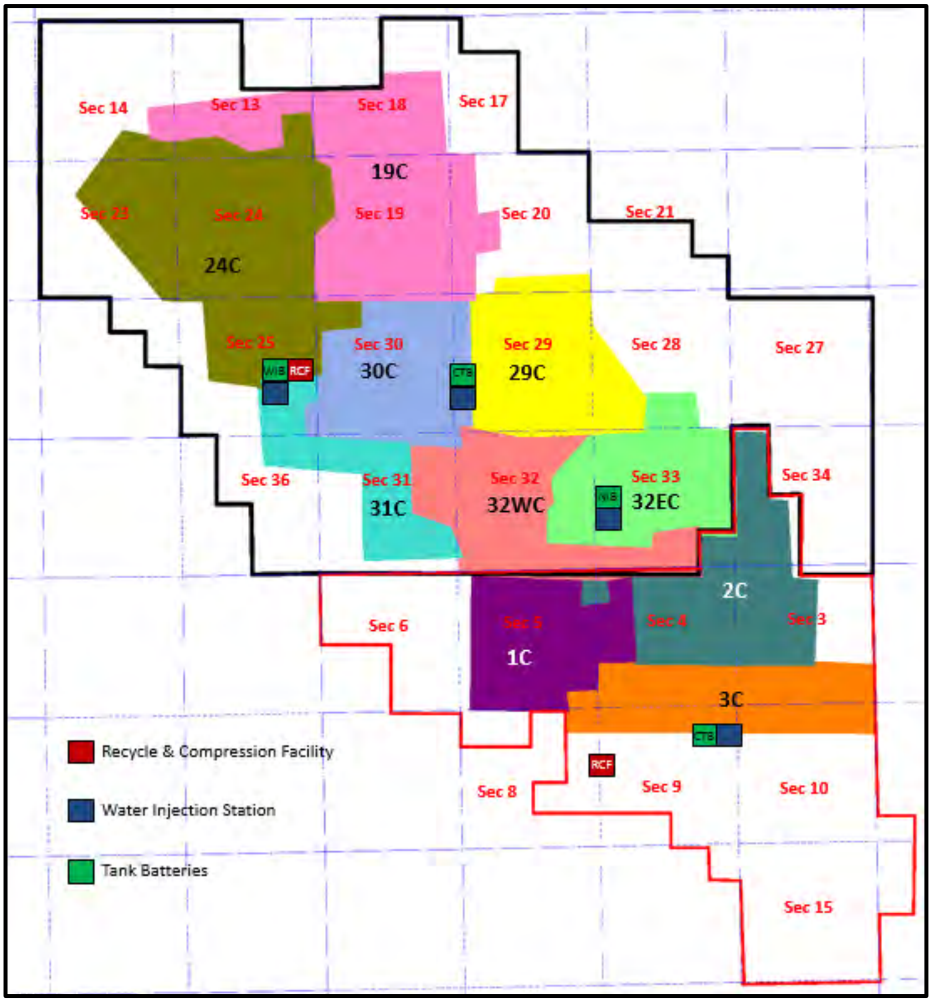


Figure 13 Location of Surface Facilities at Hobbs Field

NMOCD requires that injection pressures be limited to ensure injection fluids do not migrate outside the permitted injection interval. In the Hobbs Field, Oxy uses two methods to contain fluids: reservoir pressure management and the careful placement and operation of wells along the outer producing limits of the units.

Reservoir pressure in the Hobbs Field is managed by maintaining an injection to withdrawal ratio (IWR)[5] of approximately 1.0. To maintain the IWR, Oxy monitors fluid injection to ensure that reservoir pressure does not increase to a level that would fracture the reservoir seal or otherwise damage the oil field.

[5] Injection to withdrawal ratio (IWR) is the ratio of the volume of fluids injected to the volume of fluids produced (withdrawn). Volumes are measured under reservoir conditions for all fluids. Injected fluids are CO_2 and water; produced fluids are oil, water, and CO_2. By keeping IWR close to 1.0, reservoir pressure is held constant, neither increasing nor decreasing.

Oxy also prevents injected fluids from migrating out of the injection interval by keeping injection pressure below the formation fracture pressure, which is measured using step-rate tests. In these tests, injection pressures are incrementally increased (e.g., in "steps") until injectivity increases abruptly, which indicates that an opening (fracture) has been created in the rock. Oxy manages its operations to ensure that injection pressures are kept below the formation fracture pressure so as to ensure that the valuable fluid hydrocarbons and CO_2 remain in the reservoir.

In addition, Oxy contains formation fluids within the Hobbs Field by operating offsetting injection and production wells drilled along the lease lines that are designed to balance fluids and thereby avoid losses to adjacent units. There are currently no significant operations surrounding the remaining boundary of the Hobbs Field to interfere with these operations.

2.4 Reservoir Modeling

Oxy uses reservoir simulation models to predict the behavior of fluids in a reservoir. These models provide a mathematical representation of the reservoir that incorporates all known information on the reservoir. In this way, future performance can be predicted in a manner consistent with available data, including logs and cores, as well as past production and injection history.

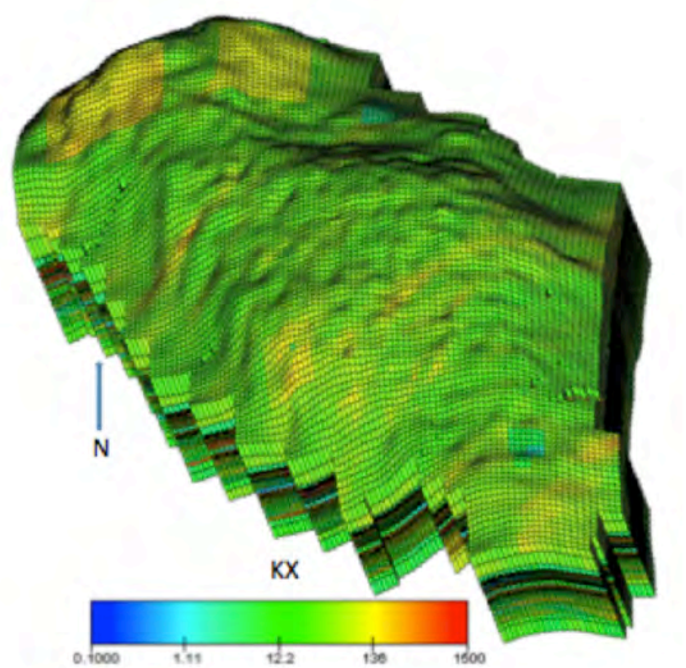
Mathematically, reservoir behavior is modeled by a set of differential equations that describe the fundamental principles of conservation of mass and energy, fluid flow, and phase behavior. These equations are complex and must be solved numerically using sophisticated computer modeling. The solution process involves sub-dividing the reservoir into a large number of blocks arranged on a grid. Each block is assigned specific rock properties (porosity, permeability, saturations, compositions and pressure). The blocks are small enough to adequately describe the reservoir, but large enough to keep their number manageable. The computer uses the differential equations to determine how various physical properties change with time in each grid block. Small time steps are used to progress from a known starting point through time. In this way the computer simulates reservoir performance, consistent with fundamental physics and actual reservoir geometry. The simulation represents the flow of each fluid phase (oil, water and gas), changes in fluid content (saturations), equilibrium between phases (compositional changes), and pressure changes over time.

The reservoir simulator used by Oxy is a commercially available compositional simulator, called MORE, developed by Roxar. It is called "compositional" because it has the capability to keep track of the composition of each phase (oil, gas, and water) over time and throughout the volume of the reservoir. There are 16 components in the compositional model.

To build a simulation model, engineers and scientists input specific information on reservoir geometry, rock properties, and fluid flow properties. The input data includes:

- Reservoir geometry, including distance between wells, reservoir thickness and structural contours;
- Rock properties, such as permeability and porosity of individual layers, barriers to vertical flow, and layer continuity; and,
- Fluid flow properties including density and viscosity of each phase, relative permeability, capillary pressure, and phase behavior.

Figure 14 Hobbs Field Simulation Model



A simulation model for the Hobbs Field, illustrated in Figure 14, shows an aerial three-dimensional view of horizontal permeability in each layer. The color scale indicates range of permeability, with red being higher permeability and blue being lower permeability. The model covers the entire anticline structure and has been used to verify the use of actual and predicted dimensionless performance curves.

Layering

Within a flood, one of the most important properties to model is the effect of layering. Reservoir rocks were originally deposited over very long periods of time. Because the environment tended to be uniform at any one point in time, reservoir properties tend to be relatively uniform over large areas. Depositional environments change over time, however, and for this reason rock properties vary considerably with time or depth as they are deposited. Thus, rock properties are modeled as layers. Some layers have high permeability and some have lower permeability. Those with higher permeability take most of the injected fluids and are swept most readily. Those with lower permeability may be only partially contacted at the end of the flooding process. (The WAG process helps improve sweep efficiency.) As Figure 14 shows, the simulation is divided into 37 vertical grid blocks. These layers were consolidated in the simulation from a 169 layer geologic model. Each layer of simulation grid blocks is used to model the depositional layering as closely as practical. The seal rocks above the flood interval are not included in the simulation since they are impermeable and do not participate in fluid flow processes.

Figure 15 – Hobbs Simulation Cross-Section (Original Oil Saturation)

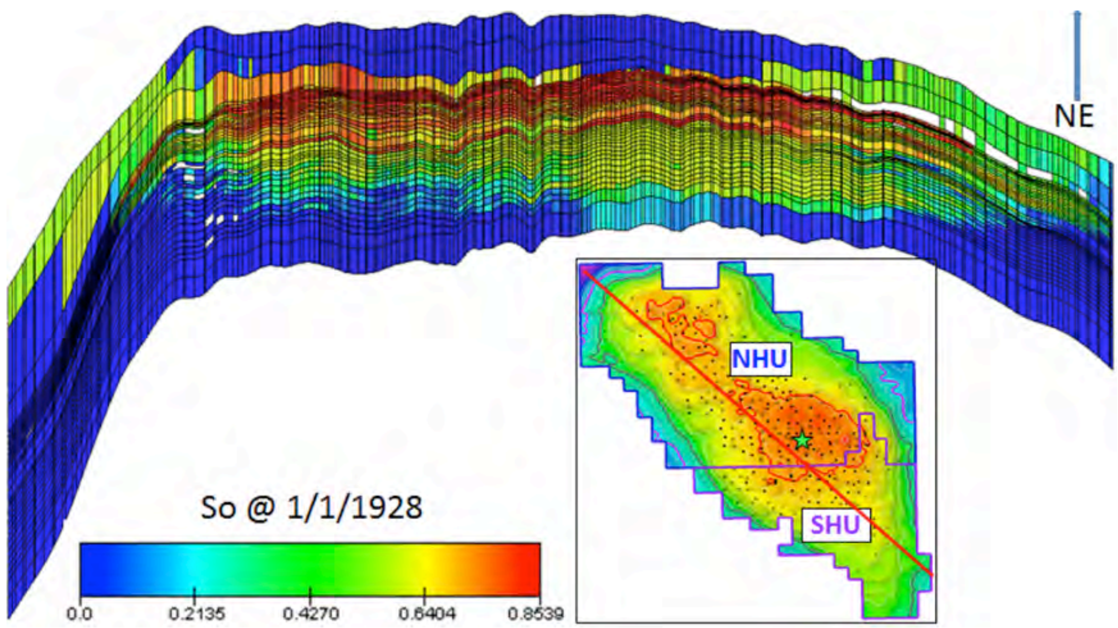


Figure 15 illustrates how initial oil saturation varied across the Hobbs Field in its original state. The original oil saturation shown in Figure 15 is derived from the geologic model shown in Figure 8.

Performance Prediction

Simulation models may represent either a multi-pattern segment of the field, or the entire field. Field-wide simulations are initially used to assess the viability of water and CO_2 flooding. Once a decision has been made to develop a CO_2 EOR project, Oxy uses modeling to plan the locations of and injection schedules for wells. In the case of the Hobbs Field, a geologic model that has evolved over the last several decades is used as a basis for the rock properties in the simulation model. The simulation model is tuned to match actual historical performance data collected during primary and waterflood field production. This provides Oxy with confidence that the model can adequately forecast oil, water and CO_2 production, along with CO_2 and water injection.

One objective of simulation is to develop an injection plan that maximizes oil recovery and minimizes the costs of the CO_2 flood. The injection plan includes such controllable items as:

- The cycle length and WAG ratio to inject water or CO_2 in the WAG process, and
- The best rate and pressure for each injection phase.

Simulations may also be used to:

- Evaluate infill or replacement wells,
- Determine the best completion intervals,
- Verify the need for well remediation or stimulation, and
- Determine anticipated rates and ultimate recovery.

Modeling allows Oxy to optimize the flood pattern and injection scheme, and provides assurance that the injected CO_2 will stay in-zone to contact and displace oil.

Simulation modeling is typically used for planning and not as a daily management tool because it is time-intensive and often does not provide sufficiently detailed information about the expected pressure, injection volumes, and production, at the level of an injection pattern. In order to analyze performance at the pattern level, Oxy uses dimensionless prototypes to manage CO_2 flood performance. The pattern-level prototypes can be constructed in one of two ways: from simulation or from actual performance of a more mature analog project. Where simulation is used to generate the predictions, the simulation results should be validated by comparison with analog project performance if possible.

If actual performance differs in a noticeable way from prediction, reservoir engineers use professional judgment formed by an analysis of technical data to determine where further attention is needed. The appropriate response could be to change injection rates, to alter the prediction model or to find and repair fluid leaks.

3. Delineation of Monitoring Area and Timeframes

3.1 Active Monitoring Area

Because CO_2 is present throughout the Hobbs Field and retained within it, the Active Monitoring Area (AMA) is defined by the boundary of the Hobbs Field. The following factors were considered in defining this boundary:

- Free phase CO_2 is present throughout the Hobbs Field: More than 579 Bscf (31.3 MMMT) tons of CO_2 have been injected throughout the Hobbs Field since 2003 and there has been significant infill drilling in the Hobbs Field, completing additional wells to further optimize production. Operational results thus far indicate that there is CO_2 throughout the Hobbs Field.

- CO_2 injected into the Hobbs Field remains contained within the field because of the fluid and pressure management approaches associated with CO_2 EOR. Namely, maintenance of an IWR of 1.0 assures a stable reservoir pressure; managed leaseline injection and production wells are used to retain fluids in the Hobbs Field as indicated in Section 2.3.6; and operational results indicate that injected CO_2 is retained in the Hobbs Field.
- Furthermore, over geologic timeframes, stored CO_2 will remain in the Hobbs Field and will not migrate downdip as described in Section 2.2.3, because the Hobbs Field contains the area with the highest elevation.

3.2 Maximum Monitoring Area

The Maximum Monitoring Area (MMA) is defined in 40 CFR §98.440-449 (Subpart RR) as including the maximum extent of the injected CO_2 and a half-mile buffer bordering that area. As described in the AMA section (Section 3.1), the maximum extent of the injected CO_2 is anticipated to be bounded by the Hobbs Field. Therefore the MMA is the Hobbs Field plus the half-mile buffer as required by 40 CFR §98.440-449 (Subpart RR).

3.3 Monitoring Timeframes

Oxy's primary purpose for injecting CO_2 is to produce oil that would otherwise remain trapped in the reservoir and not, as in UIC Class VI, "specifically for the purpose of geologic storage."[6] During a Specified Period, Oxy will have a subsidiary purpose of establishing the long-term containment of a measurable quantity of CO_2 in the Basal Grayburg - San Andres formation in the Hobbs Field. The Specified Period will be shorter than the period of production from the Hobbs Field. This is in part because the purchase of new CO_2 for injection is projected to taper off significantly before production ceases at Hobbs Field, which is modeled through 2100. At the conclusion of the Specified Period, Oxy will submit a request for discontinuation of reporting. This request will be submitted when Oxy can provide a demonstration that current monitoring and model(s) show that the cumulative mass of CO_2 reported as sequestered during the Specified Period is not expected to migrate in the future in a manner likely to result in surface leakage. It is expected that it will be possible to make this demonstration within two to three years after injection for the Specified Period ceases based upon predictive modeling supported by monitoring data. The demonstration will rely on two principles: 1) that just as is the case for the monitoring plan, the continued process of fluid management during the years of CO_2 EOR operation after the Specified Period will contain injected fluids in the Hobbs Field, and 2) that the cumulative mass reported as sequestered during the Specified Period is a fraction of the theoretical storage capacity of the Hobbs Field *See* 40 C.F.R. § 98.441(b)(2)(ii).

[6] EPA UIC Class VI rule, EPA 75 FR 77291, December 10, 2010, section 146.81(b).

4. Evaluation of Potential Pathways for Leakage to the Surface

4.1 Introduction

In the roughly 40 years since the Hobbs Field was formed, the reservoir has been studied and documented extensively. Based on the knowledge gained from that experience, this section assesses the potential pathways for leakage of stored CO_2 to the surface. The following potential pathways are reviewed:

- Existing Well Bores
- Faults and Fractures
- Natural and Induced Seismic Activity
- Previous Operations
- Pipeline/Surface Equipment
- Lateral Migration Outside the Hobbs Field
- Drilling Through the CO_2 Area
- Diffuse Leakage Through the Seal

4.2 Existing Well Bores

As of August 2016, there are approximately 445 active Oxy operated wells in the Hobbs Field – split roughly evenly between production and injection wells. In addition, there are approximately 256 wells not in use, as described in Section 2.3.2.

Leakage through existing well bores is a potential risk at the Hobbs Field that Oxy works to prevent by adhering to regulatory requirements for well drilling and testing; implementing best practices that Oxy has developed through its extensive operating experience; monitoring injection/production performance, wellbores, and the surface; and maintaining surface equipment.

As discussed in Section 2.3.2, regulations governing wells in the Hobbs Field require that wells be completed and operated so that fluids are contained in the strata in which they are encountered and that well operation does not pollute subsurface and surface waters. The regulations establish the requirements that all wells (injection, production, disposal) must comply with. Depending upon the purpose of a well, the requirements can include additional standards for AOR evaluation and MIT. In implementing these regulations, Oxy has developed operating procedures based on its experience as one of the world's leading operators of EOR floods. Oxy's best practices include developing detailed modeling at the pattern level to guide injection pressures and performance expectations; utilizing diverse teams of experts to develop EOR projects based on specific site characteristics; and creating a culture where all Field personnel are trained to look for and address issues promptly. Oxy's practices, which include corrosion prevention techniques to protect the wellbore as needed, as discussed in Section 2.3.2, ensures that well completion and operation procedures are designed not only to comply with regulations but also to ensure that all fluids (e.g., oil, gas, CO_2) remain in the Hobbs Field until they are produced through an Oxy well.

In addition, all Oxy facilities are internally screened to determine if the SFRM program should be applied. This determination is primarily based on proximity to the public. In the case of wells, SFRM guidelines call for using enhanced materials for well heads, installing sensors to detect H_2S, and using automatic shut-off valves triggered by the presence of detected gases.

As described in Section 5, continual and routine monitoring of Oxy's well bores and site operations will be used to detect leaks, including those from non-Oxy wells, or other potential well problems, as follows:

- Well pressure in injection wells is monitored on a continual basis. The injection plans for each pattern are programmed into the injection WAG satellite, as discussed in Section 2.3.1, to govern the rate, pressure, and duration of either water or CO_2 injection. Pressure monitors on the injection wells are programmed to flag pressures that significantly deviate from the plan. Leakage on the inside or outside of the injection wellbore would affect pressure and be detected through this approach. If such excursions occur, they are investigated and addressed. Over the years Oxy has managed the Hobbs Field, it is the company's experience that few excursions result in fluid migration out of the intended zone and that leakage to the surface is very rare.

- In addition to monitoring well pressure and injection performance, Oxy uses the experience gained over time to strategically approach well maintenance and updating. Oxy maintains well maintenance and workover crews onsite for this purpose. For example, the well classifications by age and construction method indicated in Table 1 inform Oxy's plan for monitoring and updating wells. Oxy uses all of the information at hand including pattern performance, and well characteristics to determine well maintenance schedules.

- Production well performance is monitored using the production well test process conducted when produced fluids are gathered and sent to a satellite battery. There is a routine cycle for each satellite battery, with each well being tested approximately once every two months. During this cycle, each production well is diverted to the well test equipment for a period of time sufficient to measure and sample produced fluids (generally 8-12 hours). This test allows Oxy to allocate a portion of the produced fluids measured at the satellite battery to each production well, assess the composition of produced fluids by location, and assess the performance of each well. Performance data are reviewed on a routine basis to ensure that CO_2 flooding is optimized. If production is off plan, it is investigated and any identified issues addressed. Leakage to the outside of production wells is not considered a major risk because of the reduced pressure in the casing. Further, the personal H_2S monitors are designed to detect leaked fluids around production wells.

- Finally, as indicated in Section 5, field inspections are conducted on a routine basis by field personnel. On any day, Oxy has approximately 40 personnel in the field. Leaking CO_2 is very cold and leads to formation of bright white clouds and ice that are easily spotted. All field personnel are trained to identify leaking CO_2 and other potential problems at wellbores and in the field. Any CO_2 leakage detected will be documented and reported, quantified and addressed as described in Section 5.

Based on its ongoing monitoring activities and review of the potential leakage risks posed by well bores, Oxy concludes that it is mitigating the risk of CO_2 leakage through well bores by detecting problems as they arise and quantifying any leakage that does occur. Section 4.10 summarizes how Oxy will monitor CO_2 leakage from various pathways and describes how Oxy will respond to various leakage scenarios. In addition, Section 5 describes how Oxy will develop the inputs used in the Subpart RR mass-balance equation (Equation RR-11). Any incidents that result in CO_2 leakage up the wellbore and into the atmosphere will be quantified as described in Section 7.4.

4.3 Faults and Fractures

After reviewing geologic, seismic, operating, and other evidence, Oxy has concluded that there are no known faults or fractures that transect the Basal Grayburg – San Andres reservoir in the project area. As described in Section 2.2.1, faults have been identified in formations that are thousands of feet below the San Andres formation, but this faulting has been shown not to affect the San Andres or to have created potential leakage pathways.

Oxy has extensive experience in designing and implementing EOR projects to ensure injection pressures will not damage the oil reservoir by inducing new fractures or creating shear. As a safeguard, injection satellites are set with automatic shutoff controls if injection pressures exceed fracture pressures.

4.4 Natural or Induced Seismicity

After reviewing the literature and actual operating experience, Oxy concludes that there is no direct evidence that natural seismic activity poses a significant risk for loss of CO_2 to the surface in the Permian Basis, and specifically in the Hobbs Field.

Of the recorded earthquakes in the Permian Basin, none have occurred in the Hobbs Field; the closest was nearly 80 miles away. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity.

A few recent studies have suggested a possible relationship between CO_2 miscible flooding activities and seismic activity in certain areas. Determining whether the seismic activity is induced or triggered by human activity is difficult.

To evaluate this potential risk, Oxy has reviewed the nature and location of seismic events within the vicinity of the Hobbs Field. Some of the recorded earthquakes in southeastern New Mexico and West Texas are far removed from any injection operation. These are judged to be from natural causes. Others are near oil fields or water disposal wells and are placed in the category of "quakes in close association with human enterprise." (See Frohlich, 2012) The concern about induced seismicity is that it could lead to fractures in the seal, providing a pathway for CO_2 leakage to the surface. Based on Oxy's review of seismic data, none of the recorded "earthquakes" in the Permian Basin have occurred in the Hobbs Field. Moreover, Oxy is not aware of any reported loss of injectant (waste water or CO_2) to the surface associated with any seismic activity. Therefore, there is no direct evidence to suggest that natural seismic activity poses a significant risk for loss of CO_2 to the surface from the Hobbs Field. If induced seismicity resulted in a pathway for material amounts of CO_2 to migrate from the injection zone, other reservoir fluid monitoring provisions (e.g., reservoir pressure, well pressure, and pattern monitoring) would lead to further investigation.

4.5 Previous Operations

Oxy initiated CO_2 flooding in the Hobbs Field in 2003. Oxy and the prior operators have kept records of the site and have completed numerous infill wells. Oxy's standard practice for drilling new wells includes a rigorous review of nearby wells to ensure that drilling will not cause damage to or interfere with existing wells. Oxy also follows AOR requirements under the UIC Class II program, which require identification of all active and abandoned wells in the AOR and implementation of procedures that ensure the integrity of those wells when applying for a permit for any new injection well.[7] As a result, Oxy has checked for the presence of old, unknown wells throughout the Hobbs Field over many years. These practices ensure that identified wells are sufficiently isolated and do not interfere with the CO_2 EOR operations and reservoir pressure management. Consequently, Oxy's operational experience supports the conclusion that there are no unknown wells within the Hobbs Field and that it has sufficiently mitigated the risk of migration from older wells. Oxy has successfully optimized CO_2 flooding with infill wells because the confining zone has not been impaired by previous operations.

4.6 Pipeline / Surface Equipment

Damage to or failure of pipelines and surface equipment can result in unplanned losses of CO_2. Oxy reduces the risk of unplanned leakage from surface facilities, to the maximum extent practicable, by relying on the use of prevailing design and construction practices

[7] Current requirements are referenced in Appendix 7.

and maintaining compliance with applicable regulations. The facilities and pipelines currently utilize and will continue to utilize materials of construction and control processes that are standard for CO_2 EOR projects in the oil and gas industry. As described above, all facilities in the Hobbs Field are internally screened for the SFRM program. In the case of pipeline and surface equipment, the SRFM calls for more robust design and operating requirements to prevent and detect leakage. Operating and maintenance practices currently follow and will continue to follow demonstrated industry standards. CO_2 delivery via the Permian pipeline system will continue to comply with all applicable regulations. Finally, frequent routine visual inspection of surface facilities by Field staff will provide an additional way to detect leaks and further support Oxy's efforts to detect and remedy any leaks in a timely manner. Should leakage be detected from pipeline or surface equipment, the volume of released CO_2 will be quantified following the requirements of Subpart W of EPA's GHGRP.

4.7 Lateral Migration Outside the Hobbs Field

It is highly unlikely that injected CO_2 will migrate downdip and laterally outside the Hobbs Field because of the nature of the geology and the approach use for injection. First, as indicated in Section 2.2.1 "Geology of the Hobbs Field," the Hobbs Field is situated above the highest elevation within the San Andres. This means that over long periods of time, injected CO_2 will tend to rise vertically towards the Upper San Andres and Basal Grayburg and continue towards the point in the Hobbs Field with the highest elevation. Second, the planned injection volumes and active fluid management during injection operations will prevent CO_2 from migrating laterally out of the structure. Finally, Oxy will not be increasing the total volume of fluids in the Hobbs Field. Based on site characterization and planned and projected operations Oxy estimates the total volume of stored CO_2 will be approximately 27.6% of calculated capacity.

4.8 Drilling Through the CO_2 Area

It is possible that at some point in the future, drilling through the containment zone into the San Andres could occur and inadvertently create a leakage pathway. Oxy's review of this issue concludes that this risk is very low for three reasons. First, any wells drilled in the oil fields of New Mexico are regulated by NMOCD and are subject to requirements that fluids be contained in strata in which they are encountered.[8] Second, Oxy's visual inspection process, including routine site visits, is designed to identify unapproved drilling activity in the Hobbs Field. Third, Oxy plans to operate the CO_2 EOR flood in the Hobbs Field for several more decades, and will continue to be vigilant about protecting the integrity of its assets and maximizing the potential of resources (oil, gas, CO_2). In the unlikely event Oxy would sell the Field to a new operator, provisions would result in a change to the reporting program and would be addressed at that time.

[8] Current requirements are referenced in Appendix 7.

4.9 Diffuse Leakage through the Seal

Diffuse leakage through the seal formed by the upper Grayburg is highly unlikely. The presence of a gas cap trapped over millions of years as discussed in Section 2.2.3 confirms that the seal has been secure for a very long time. Injection pattern monitoring program referenced in Section 2.3.1 and detailed in Section 5 assures that no breach of the seal will be created. The seal is highly impermeable where unperforated, cemented across the horizon where perforated by wells, and unexplained changes in injection pressure would trigger investigation as to the cause. Further, if CO_2 were to migrate through the Grayburg seal, it would migrate vertically until it encountered and was trapped by any of the additional shallower seals indicated in orange in Figure 4, Section 2.2.1.

4.10 Monitoring, Response, and Reporting Plan for CO_2 Loss

As discussed above, the potential sources of leakage include fairly routine issues, such as problems with surface equipment (pumps, valves, etc.) or subsurface equipment (well bores), and unique events such as induced fractures. Table 3 summarizes some of these potential leakage scenarios, the monitoring activities designed to detect those leaks, Oxy's standard response, and other applicable regulatory programs requiring similar reporting.

Sections 5.1.5 - 5.1.7 discuss the approaches envisioned for quantifying the volumes of leaked CO_2. Given the uncertainty concerning the nature and characteristics of leaks that will be encountered, the most appropriate methods for quantifying the volume of leaked CO_2 will be determined at the time. In the event leakage occurs, Oxy plans to determine the most appropriate methods for quantifying the volume leaked and will report it as required as part of the annual Subpart RR submission.

Any volume of CO_2 detected leaking to surface will be quantified using acceptable emission factors such as those found in 40 CFR Part 98 Subpart W or engineering estimates of leak amounts based on measurements in the subsurface, Oxy's field experience, and other factors such as the frequency of inspection. As indicated in Sections 5.1 and 7.4, leaks will be documented, evaluated and addressed in a timely manner. Records of leakage events will be retained in the electronic environmental documentation and reporting system. Repairs requiring a work order will be documented in the electronic equipment maintenance system.

Table 3 Response Plan for CO_2 Loss

Risk	Monitoring Plan	Response Plan	Parallel Reporting (if any)
Loss of Well Control			
Tubing Leak	Monitor changes in annulus pressure; MIT for injectors	Workover crews respond within days	NMOCD
Casing Leak	Routine Field inspection; MIT for injectors; extra attention to high risk wells	Workover crews respond within days	NMOCD
Wellhead Leak	Routine Field inspection	Workover crews respond within days	NMOCD
Loss of Bottom-hole pressure control	Blowout during well operations	Maintain well kill procedures	NMOCD
Unplanned wells drilled through San Andres	Routine Field inspection to prevent unapproved drilling; compliance with NMOCD permitting for planned wells.	Assure compliance with NMOCD regulations	NMOCD Permitting
Loss of seal in abandoned wells	Reservoir pressure in WAG headers; high pressure found in new wells	Re-enter and reseal abandoned wells	NMOCD
Leaks in Surface Facilities			
Pumps, values, etc.	Routine Field inspection	Workover crews respond within days	Subpart W
Subsurface Leaks			
Leakage along faults	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near faults	-
Overfill beyond spill points	Reservoir pressure in WAG headers; high pressure found in new wells	Fluid management along lease lines	-
Leakage through induced fractures	Reservoir pressure in WAG headers; high pressure found in new wells	Comply with rules for keeping pressures below parting pressure	-
Leakage due to seismic event	Reservoir pressure in WAG headers; high pressure found in new wells	Shut in injectors near seismic event	-

Available studies of actual well leaks and natural analogs (e.g., naturally occurring CO_2 geysers) suggest that the amount released from routine leaks would be small as compared to the amount of CO_2 that would remain stored in the formation.[9]

4.11 Summary

The structure and stratigraphy of the San Andres reservoir in the Hobbs Field is ideally suited for the injection and storage of CO_2. The stratigraphy within the CO_2 injection zones is porous, permeable and very thick, providing ample capacity for long-term CO_2 storage. The San Andres formation is overlain by several intervals of impermeable geologic zones that form effective seals or "caps" to fluids in the San Andres formation (See Figure 4). After assessing potential risk of release from the subsurface and steps

[9] See references to following reports of measurements, assessments, and analogs in Appendix 4: IPCC Special Report on Carbon Dioxide Capture and Storage; Wright – Presentation to UNFCC SBSTA on CCS; Allis, R., et al, "Implications of results from CO2 flux surveys over known CO2 systems for long-term monitoring; McLing - Natural Analog CCS Site Characterization Soda Springs, Idaho Implications for the Long-term Fate of Carbon Dioxide Stored in Geologic Environments.

that have been taken to prevent leaks, Oxy has determined that the potential threat of leakage is extremely low.

In summary, based on a careful assessment of the potential risk of release of CO_2 from the subsurface, Oxy has determined that there are no leakage pathways at the Hobbs Field that are likely to result in significant loss of CO_2 to the atmosphere. Further, given the detailed knowledge of the Field and its operating protocols, Oxy concludes that it would be able to both detect and quantify any CO_2 leakage to the surface that could arise through either identified or unexpected leakage pathways.

5. Monitoring and Considerations for Calculating Site Specific Variables

5.1 For the Mass Balance Equation

5.1.1 General Monitoring Procedures

As part of its ongoing operations, Oxy monitors and collects flow, pressure, and gas composition data from the Hobbs Field in centralized data management systems. These data are monitored continually by qualified technicians who follow Oxy response and reporting protocols when the systems deliver notifications that data exceed statistically acceptable boundaries.

As indicated in Figures 10 and 11, custody-transfer meters are used at the two points at which custody of the CO_2 from the Permian pipeline delivery system is transferred to Oxy, at the points at which custody of oil and NGLs are transferred to outside parties, and on both sides of the fluid transfer point between NHU and SHU. Meters measure flow rate continually. Fluid composition will be determined, at a minimum, quarterly, consistent with EPA GHGRP's Subpart RR, section 98.447(a). All meter and composition data are documented, and records will be retained for at least three years.

Metering protocols used by Oxy follow the prevailing industry standard(s) for custody transfer as currently promulgated by the API, the American Gas Association (AGA), and the Gas Processors Association (GPA), as appropriate. This approach is consistent with EPA GHGRP's Subpart RR, section 98.444(e)(3). These meters will be maintained routinely, operated continually, and will feed data directly to the centralized data collection systems. The meters meet the industry standard for custody transfer meter accuracy and calibration frequency. These custody meters provide the most accurate way to measure mass flows.

Historically, there is an immaterial difference between the NHU and SHU custody transfer meter measurements of fluids transferred from the NHU to the SHU that is attributed to calibration error. The fluids from the NHU move directly into the pipeline entering the SHU RCF and are co-mingled with other produced fluids from the SHU. Because this volume of gas is contained within the Hobbs Field it is part of the overall mass balance but is not calculated separately. This will be discussed further in this section and within Section 7.

Oxy maintains in-field process control meters to monitor and manage in-field activities on a real time basis. These are identified as operations meters in Figures 10 and 11. These meters provide information used to make operational decisions but are not intended to provide the same level of accuracy as the custody-transfer meters. The level of precision and accuracy for in-field meters currently satisfies the requirements for reporting in existing UIC permits. Although these meters are accurate for operational purposes, it is important to note that there is some variance between most commercial meters (on the order of 1-5%) which is additive across meters. This variance is due to differences in factory settings and meter calibration, as well as the operating conditions within a field. Meter elevation, changes in temperature (over the course of the day), fluid composition (especially in multi-component or multi-phase streams), or pressure can affect in-field meter readings. Unlike in a saline formation, where there are likely to be only a few injection wells and associated meters, at CO_2 EOR operations in the Hobbs Field there are currently 445 active injection and production wells and a comparable number of meters, each with an acceptable range of error. This is a site-specific factor that is considered in the mass balance calculations described in Section 7.

5.1.2 CO_2 Received

Oxy measures the volume of received CO_2 using commercial custody transfer meters at each the two off-take points from the Permian pipeline delivery system and at the point of transfer between the NHU and the SHU. This transfer is a commercial transaction that is documented. CO_2 composition is governed by the contract and the gas is routinely sampled to determine composition. No CO_2 is received in containers.

5.1.3 CO_2 Injected into the Subsurface

Injected CO_2 will be calculated using the flow meter volumes at the operations meter at the outlet of the RCFs and the custody transfer meter at the CO_2 off-take points from the Permian pipeline delivery system

5.1.4 CO_2 Produced, Entrained in Products, and Recycled

The following measurements are used for the mass balance equations in Section 7:

CO_2 produced is calculated using the volumetric flow meters at the inlet to an RCF.

CO_2 is produced as entrained or dissolved CO_2 in produced oil, as indicated in Figures 10 and 11. The concentration of CO_2 in produced oil is measured at the custody transfer meter.

Recycled CO_2 is calculated using the volumetric flow meter at the outlet of the RCFs, which is an operations meter.

5.1.5 CO_2 Emitted by Surface Leakage

As discussed in Section 5.1.6 and 5.1.7 below, Oxy uses 40 CFR Part 98 Subpart W to estimate surface leaks from equipment at the Hobbs Field. Subpart W uses a factor-driven approach to estimate equipment leakage. In addition, Oxy uses an event-driven process to assess, address, track, and if applicable quantify potential CO_2 leakage to the surface. Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

The multi-layered, risk-based monitoring program for event-driven incidents has been designed to meet two objectives, in accordance with the leakage risk assessment in Section 4: 1) to detect problems before CO_2 leaks to the surface; and 2) to detect and quantify any leaks that do occur. This section discusses how this monitoring will be conducted and used to quantify the volumes of CO_2 leaked to the surface.

<u>Monitoring for potential Leakage from the Injection/Production Zone:</u>

Oxy will monitor both injection into and production from the reservoir as a means of early identification of potential anomalies that could indicate leakage from the subsurface.

Oxy uses reservoir simulation modeling, based on extensive history-matched data, to develop injection plans (fluid rate, pressure, volume) that are programmed into each WAG satellite. If injection pressure or rate measurements are beyond the specified set points determined as part of each pattern injection plan, a data flag is automatically triggered and field personnel will investigate and resolve the problem. These excursions will be reviewed by well-management personnel to determine if CO_2 leakage may be occurring. Excursions are not necessarily indicators of leaks; they simply indicate that injection rates and pressures are not conforming to the pattern injection plan. In many cases, problems are straightforward to fix (e.g., a meter needs to be recalibrated or some other minor action is required), and there is no threat of CO_2 leakage. In the case of issues that are not readily resolved, more detailed investigation and response would be initiated, and internal Oxy support staff would provide additional assistance and evaluation. Such issues would lead to the development of a work order in Oxy's work order management system. This record enables the company to track progress on investigating potential leaks and, if a leak has occurred, to quantify its magnitude.

Likewise, Oxy develops a forecast of the rate and composition of produced fluids. Each producer well is assigned to one satellite battery and is isolated once during each monthly cycle for a well production test. This data is reviewed on a periodic basis to confirm that production is at the level forecasted. If there is a significant deviation from the forecast, well management personnel investigate. If the issue cannot be resolved quickly, more detailed investigation and response would be initiated. As in the case of the injection pattern monitoring, if the investigation leads to a work order in the Oxy work order management system, this record will provide the basis for tracking the outcome of the investigation and if a leak has occurred, recording the quantity leaked to the surface. If leakage in the flood zone were detected, Oxy would use an appropriate method to quantify the involved volume of CO_2. This might include use of material balance equations based on known injected quantities and monitored pressures in the injection zone to estimate the volume of CO_2 involved.

A subsurface leak might not lead to a surface leak. In the event of a subsurface leak, Oxy would determine the appropriate approach for tracking subsurface leakage to determine and quantify leakage to the surface. To quantify leakage to the surface, Oxy would estimate the relevant parameters (e.g., the rate, concentration, and duration of leakage) to quantify the leak volume. Depending on specific circumstances, these determinations may rely on engineering estimates.

In the event leakage from the subsurface occurred diffusely through the seals, the leaked gas would include H_2S, which would trigger the alarm on the personal monitors worn by field personnel. Such a diffuse leak from the subsurface has not occurred in the Hobbs Field. In the event such a leak was detected, field personnel from across Oxy would determine how to address the problem. The team might use modeling, engineering estimates, and direct measurements to assess, address, and quantify the leakage.

Monitoring of Wellbores*:*
Oxy monitors wells through continual, automated pressure monitoring in the injection zone (as described in Section 4.2), monitoring of the annular pressure in wellheads, and routine maintenance and inspection.

Leaks from wellbores would be detected through the follow-up investigation of pressure anomalies, visual inspection, or the use of personal H_2S monitors.

Anomalies in injection zone pressure may not indicate a leak, as discussed above. However, if an investigation leads to a work order, field personnel would inspect the equipment in question and determine the nature of the problem. If it is a simple matter, the repair would be made and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repair were needed, Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Anomalies in annular pressure or other issues detected during routine maintenance inspections would be treated in the same way. Field personnel would inspect the equipment in question and determine the nature of the problem. For simple matters the repair would be made at the time of inspection and the volume of leaked CO_2 would be included in the 40 CFR Part 98 Subpart W report for the Hobbs Field. If more extensive repairs were needed, a work order would be generated and Oxy would determine the appropriate approach for quantifying leaked CO_2 using the relevant parameters (e.g., the rate, concentration, and duration of leakage). The work order would serve as the basis for tracking the event for GHG reporting.

Because leaking CO_2 at the surface is very cold and leads to formation of bright white clouds and ice that are easily spotted, Oxy also employs a two-part visual inspection process in the general area of the Hobbs Field to detect unexpected releases from wellbores. First, field personnel visit the surface facilities on a routine basis. Inspections may include tank volumes, equipment status and reliability, lube oil levels, pressures and flow rates in the facility, and valve leaks. Field personnel inspections also check that injectors are on the proper WAG schedule and observe the facility for visible CO_2 or fluid line leaks.

Historically, Oxy has documented on average nine unexpected release events each year in the Hobbs Field. An identified need for repair or maintenance through visual inspections results in a work order being entered into Oxy's equipment and maintenance work order management system. The time to repair any leak is dependent on several factors, such as the severity of the leak, available manpower, location of the leak, and availability of materials required for the repair. Critical leaks are acted upon immediately.

Finally, Oxy uses the data collected by the H_2S monitors, which are worn by all field personnel at all times, as a last method to detect leakage from wellbores. If an H_2S alarm is triggered, the first response is to protect the safety of the personnel, and the next step is to safely investigate the source of the alarm. As noted previously, Oxy considers H_2S a proxy for potential CO_2 leaks in the field. Thus, detected H_2S leaks will be investigated to determine and, if needed, quantify potential CO_2 leakage. If the incident results in a work order, this will serve as the basis for tracking the event for GHG reporting.

Additional Safeguards and Monitoring under SFRM Program:
As described above, because of the presence of H_2S and proximity to the City of Hobbs, Oxy screens all well locations and surface equipment to determine when to apply the SFRM program. Under the SFRM, Oxy voluntarily applies additional provisions for design and operation of facilities. The SFRM program is intended to further mitigate the risk of public exposure from the potential loss of well control, however, its provisions also enhance leak prevention and detection. All instances of triggered safeguards will be investigated to determine if there is CO_2 leakage.

Other Potential Leakage at the Surface:
Oxy will utilize the same visual inspection process and H_2S monitoring system to detect other potential leakage at the surface as it does for leakage from wellbores. Oxy utilizes routine visual inspections to detect significant loss of CO_2 to the surface. Field personnel routinely visit surface facilities to conduct a visual inspection. Inspections may include review of tank level, equipment status, lube oil levels, pressures and flow rates in the facility, valve leaks, ensuring that injectors are on the proper WAG schedule, and also conducting a general observation of the facility for visible CO_2 or fluid line leaks. If problems are detected, field personnel would investigate, and, if maintenance is required, generate a work order in the maintenance system, which is tracked through completion. In addition to these visual inspections, Oxy will use the results of the personal H_2S monitors worn by field personnel as a supplement for smaller leaks that may escape visual detection.

If CO_2 leakage to the surface is detected, it will be reported to surface operations personnel who will review the reports and conduct a site investigation. If maintenance is required, a work order will be generated in the work order management system. The work order will describe the appropriate corrective action and be used to track completion of the maintenance action. The work order will also serve as the basis for tracking the event for GHG reporting and quantifying any CO_2 emissions.

5.1.6 CO_2 emitted from equipment leaks and vented emissions of CO_2 from surface equipment located between the injection flow meter and the injection wellhead.

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.1.7 Mass of CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment located between the production flow meter and the production wellhead

Oxy evaluates and estimates leaks from equipment, the CO_2 content of produced oil, and vented CO_2, as required under 40 CFR Part 98 Subpart W.

5.2 To Demonstrate that Injected CO_2 is not Expected to Migrate to the Surface

At the end of the Specified Period, Oxy intends to cease injecting CO_2 for the subsidiary purpose of establishing the long-term storage of CO_2 in the Hobbs Field. After the end of the Specified Period, Oxy anticipates that it will submit a request to discontinue monitoring and reporting. The request will demonstrate that the amount of CO_2 reported under 40 CFR §98.440-449 (Subpart RR) is not expected to migrate in the future in a manner likely to result in surface leakage. At that time, Oxy will be able to support its request with years of data collected during the Specified Period as well as two to three (or more, if needed) years of data collected after the end of the Specified Period. This demonstration will provide the information necessary for the EPA Administrator to approve the request to discontinue monitoring and reporting and may include, but is not limited to:

i. Data comparing actual performance to predicted performance (purchase, injection, production) over the monitoring period;
ii. An assessment of the CO_2 leakage detected, including discussion of the estimated amount of CO_2 leaked and the distribution of emissions by leakage pathway;
iii. A demonstration that future operations will not release the volume of stored CO_2 to the surface;
iv. A demonstration that there has been no significant leakage of CO_2; and,
v. An evaluation of reservoir pressure in the Hobbs Field that demonstrates that injected fluids are not expected to migrate in a manner to create a potential leakage pathway.

6. Determination of Baselines

Oxy intends to utilize existing automatic data systems to identify and investigate excursions from expected performance that could indicate CO_2 leakage. Oxy's data systems are used primarily for operational control and monitoring and as such are set to capture more information than is necessary for reporting in the Annual Subpart RR Report. Oxy will develop the necessary system guidelines to capture the information that is relevant to identify possible CO_2 leakage. The following describes Oxy's approach to collecting this information.

Visual Inspections
As field personnel conduct routine inspections, work orders are generated in the electronic system for maintenance activities that cannot be addressed on the spot. Methods to capture work orders that involve activities that could potentially involve CO_2 leakage will be developed, if not currently in place. Examples include occurrences of well workover or repair, as well as visual identification of vapor clouds or ice formations. Each incident will be flagged for review by the person responsible for MRV documentation. (The responsible party will be provided in the monitoring plan, as required under Subpart A, 98.3(g).) The Annual Subpart RR Report will include an estimate of the amount of CO_2 leaked. Records of information used to calculate emissions will be maintained on file for a minimum of three years.

Personal H_2S Monitors
H_2S monitors are worn by all field personnel. Any monitor alarm triggers an immediate response to ensure personnel are not at risk and to verify the monitor is working properly. The person responsible for MRV documentation will receive notice of all incidents where H_2S is confirmed to be present. The Annual Subpart RR Report will provide an estimate the amount of CO_2 emitted from any such incidents. Records of information to calculate emissions will be maintained on file for a minimum of three years.

Injection Rates, Pressures and Volumes
Oxy develops target injection rate and pressure for each injector, based on the results of ongoing pattern modeling and within permitted limits. The injection targets are programmed into the WAG satellite controllers. High and low set points are also programmed into the controllers, and flags whenever statistically significant deviations from the targeted ranges are identified. The set points are designed to be conservative, because Oxy prefers to have too many flags rather than too few. As a result, flags can occur frequently and are often found to be insignificant. For purposes of Subpart RR reporting, flags (or excursions) will be screened to determine if they could also lead to CO_2 leakage to the surface. The person responsible for the MRV documentation will receive notice of excursions and related work orders that could potentially involve CO_2 leakage. The Annual Subpart RR Report will provide an estimate of CO_2 emissions. Records of information to calculate emissions will be maintained on file for a minimum of three years.

Production Volumes and Compositions

Oxy develops a general forecast of production volumes and composition which is used to periodically evaluate performance and refine current and projected injection plans and the forecast. This information is used to make operational decisions but is not recorded in an automated data system. Sometimes, this review may result in the generation of a work order in the maintenance system. The MRV plan implementation lead will review such work orders and identify those that could result in CO_2 leakage. Should such events occur, leakage volumes would be calculated following the approaches described in Sections 4 and 5. Impact to Subpart RR reporting will be addressed, if deemed necessary.

7. Determination of Sequestration Volumes Using Mass Balance Equations

To account for the site conditions and complexity of a large, active EOR operation, Oxy proposes to modify the locations for obtaining volume data for the equations in Subpart RR §98.443 as indicated below.

The first modification addresses the propagation of error that would result if volume data from meters at each injection and production well were utilized. This issue arises because while each meter has a small but acceptable margin of error, this error would become significant if data were taken from the approximately 445 meters within the Hobbs Field. As such, Oxy proposes to use the data from custody and operations meters on the main system pipelines to determine injection and production volumes used in the mass balance.

The second modification addresses the NGL sales from the NHU RCF. As indicated in Figure 10, NGL is separated from the fluid mix at the NHU RCF and sold off site. The amount of CO_2 in the NGL does not impact the mass balance and is therefore not included in the mass balance calculation. Only the volume of CO_2 recycled from the RCF impacts the mass balance equation and it is the volume measured at the RCF outlet. The remainder of the CO_2 -- that is, the difference between the inlet measurement and the outlet measurement occurring at RCF – does not have an impact on the mass balance of the Hobbs Field and therefore is not included in the mass balance equations. This is because the purpose of the MRV plan under Subpart RR is to determine the amount of CO_2 stored at the project site, as well as the amount of CO_2 emitted from the project site. Subpart RR of the GHGRP is not intended to account for CO_2 emissions throughout the CO_2 supply chain; those emissions are reported under other GHGRP subparts.

The third modification addresses the transfer of fluids between the NHU and the SHU. For internal accounting purposes, NHU and SHU each use a custody transfer meter to track the volume transferred. Analyses of historic records show an immaterial difference between the twometer readings that is likely due to calibration differences. For accounting, one meter reading is used. The transfer takes place prior to the inlet of the RCFs and the NHU fluids are co-mingled with the other fluids going into the SHU RCF. On a net basis, the transfer does not have an impact on the material balance and there is not included in the mass balance calculation.

The following sections describe how each element of the mass-balance equation (Equation RR-11) will be calculated.

7.1. Mass of CO_2 Received

Oxy will use equation RR-2 as indicated in Subpart RR §98.443 to calculate the mass of CO_2 received from each delivery meter immediately upstream of the Permian pipeline delivery system on the Hobbs Field. The volumetric flow at standard conditions will be multiplied by the CO_2 concentration and the density of CO_2 at standard conditions to determine mass.

$$CO_{2T,r} = \sum_{p=1}^{4} (Q_{r,p} - S_{r,p}) * D * C_{CO_{2,p,r}} \qquad \text{(Eq. RR-2)}$$

where:

$CO_{2T,r}$ = Net annual mass of CO_2 received through flow meter r (metric tons).

$Q_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r in quarter p at standard conditions (standard cubic meters).

$S_{r,p}$ = Quarterly volumetric flow through a receiving flow meter r that is redelivered to another facility without being injected into a site well in quarter p (standard cubic meters).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,r}$ = Quarterly CO_2 concentration measurement in flow for flow meter r in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

r = Receiving flow meters.

Given Oxy's method of receiving CO_2 and requirements at Subpart RR §98.444(a):

- All delivery to the Hobbs Field is used within each unit so quarterly flow redelivered, $S_{r,p}$, is zero ("0") and will not be included in the equation.
- Quarterly CO_2 concentration will be taken from the gas measurement database

Oxy will sum to total Mass of CO_2 Received using equation RR-3 in 98.443

$$CO_2 = \sum_{r=1}^{R} CO_{2T,r} \qquad \text{(Eq. RR-3)}$$

where:

CO_2 = Total net annual mass of CO_2 received (metric tons).

$CO_{2T,r}$ = Net annual mass of CO_2 received (metric tons) as calculated in Equation RR-2 for flow meter r.

r = Receiving flow meter.

7.2 Mass of CO_2 Injected into the Subsurface

The equation for calculating the Mass of CO_2 Injected into the Subsurface at the Hobbs Field is equal to the sum of the Mass of CO_2 Received as calculated in RR-3 of 98.443 (as described in Section 7.1) and the Mass of CO_2 Recycled as calculated using measurements taken from the flow meter located at the output of the RCF. As previously explained, using data at each injection well would give an inaccurate estimate of total injection volume due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

The mass of CO_2 recycled will be determined using equations RR-5 as follows:

$$CO_{2,u} = \sum_{p=1}^{4} Q_{p,u} * D * C_{CO_{2,p,u}} \quad \text{(Eq. RR-5)}$$

where:

$CO_{2,u}$ = Annual CO_2 mass recycled (metric tons) as measured by flow meter u.

$Q_{p,u}$ = Quarterly volumetric flow rate measurement for flow meter u in quarter p at standard conditions (standard cubic meters per quarter).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,u}$ = CO_2 concentration measurement in flow for flow meter u in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

u = Flow meter.

The total Mass of CO_2 injected will be the sum of the Mass of CO_2 received (RR-3) and Mass of CO_2 recycled (modified RR-5).

$CO_{2I} = CO_2 + CO_{2,u}$

7.3 Mass of CO_2 Produced

The Mass of CO_2 Produced at the Hobbs Field will be calculated using the measurements from the flow meters at the inlet to RCF and the custody transfer meter for oil sales rather than the metered data from each production well. Again, using the data at each production well would give an inaccurate estimate of total injection due to the large number of wells and the potential for propagation of error due to allowable calibration ranges for each meter.

Equation RR-8 in 98.443 will be used to calculate the mass of CO_2 produced from all injection wells as follows:

$$CO_{2,w} = \sum_{p=1}^{4} Q_{p,w} * D * C_{CO_{2,p,w}} \quad \text{(Eq. RR-8)}$$

Where:

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) .

$Q_{p,w}$ = Volumetric gas flow rate measurement for meter w in quarter p at standard conditions (standard cubic meters).

D = Density of CO_2 at standard conditions (metric tons per standard cubic meter): 0.0018682.

$C_{CO2,p,w}$ = CO_2 concentration measurement in flow for meter w in quarter p (vol. percent CO_2, expressed as a decimal fraction).

p = Quarter of the year.

w = inlet meter to RCF.

Equation RR-9 in 98.443 will be used to aggregate the mass of CO_2 produced net of the mass of CO_2 entrained in oil leaving the Hobbs Field prior to treatment of the remaining gas fraction in RCF as follows:

$$CO_{2P} = \sum_{w=1}^{W} CO_{2,w} + X_{oil} \qquad \text{(Eq. RR-9)}$$

Where:

CO_{2P} = Total annual CO_2 mass produced (metric tons) through all meters in the reporting year.

$CO_{2,w}$ = Annual CO_2 mass produced (metric tons) through meter w in the reporting year.

X_{oil} = Mass of entrained CO_2 in oil in the reporting year measured utilizing commercial meters and electronic flow-measurement devices at each point of custody transfer. The mass of CO_2 will be calculated by multiplying the total volumetric rate by the CO_2 concentration.

7.4 Mass of CO_2 emitted by Surface Leakage

Oxy will calculate and report the total annual Mass of CO_2 emitted by Surface Leakage using an approach that is tailored to specific leakage events and relies on 40 CFR Part 98 Subpart W reports of equipment leakage. As described in Sections 4 and 5.1.5-5.1.7, Oxy is prepared to address the potential for leakage in a variety of settings. Estimates of the amount of CO_2 leaked to the surface will likely depend on a number of site-specific factors including measurements, engineering estimates, and emission factors, depending on the source and nature of the leakage.

Oxy's process for quantifying leakage will entail using best engineering principles or emission factors. While it is not possible to predict in advance the types of leaks that will occur, Oxy describes some approaches for quantification in Section 5.1.5-5.1.7. In the event leakage to the surface occurs, Oxy would quantify and report leakage amounts, and retain records that describe the methods used to estimate or measure the volume leaked as reported in the Annual Subpart RR Report. Further, Oxy will reconcile the Subpart W report and results from any event-driven quantification to assure that surface leaks are not double counted.

Equation RR-10 in 48.433 will be used to calculate and report the Mass of CO_2 emitted by Surface Leakage:

$$CO_{2E} = \sum_{x=1}^{X} CO_{2,x} \quad \text{(Eq. RR-10)}$$

where:

CO_{2E} = Total annual CO_2 mass emitted by surface leakage (metric tons) in the reporting year.

$CO_{2,x}$ = Annual CO_2 mass emitted (metric tons) at leakage pathway x in the reporting year.

x = Leakage pathway.

7.5 Mass of CO_2 sequestered in subsurface geologic formations.

Oxy will use equation RR-11 in 98.443 to calculate the Mass of CO_2 Sequestered in Subsurface Geologic Formations in the Reporting Year as follows:

$$CO_2 = CO_{2I} - CO_{2P} - CO_{2E} - CO_{2FI} - CO_{2FP} \quad \text{(Eq. RR-11)}$$

where:

CO_2 = Total annual CO_2 mass sequestered in subsurface geologic formations (metric tons) at the facility in the reporting year.

CO_{2I} = Total annual CO_2 mass injected (metric tons) in the well or group of wells covered by this source category in the reporting year.

CO_{2P} = Total annual CO_2 mass produced (metric tons) net CO_2 entrained in oil in the reporting year.

CO_{2E} = Total annual CO_2 mass emitted (metric tons) by surface leakage in the reporting year.

CO_{2FI} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead, for which a calculation procedure is provided in subpart W of this part.

CO_{2FP} = Total annual CO_2 mass emitted (metric tons) from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity, for which a calculation procedure is provided in subpart W of this part.

7.6 Cumulative mass of CO_2 reported as sequestered in subsurface geologic formations

Oxy will sum up the total annual volumes obtained using equation RR-11 in 98.443 to calculate the Cumulative Mass of CO_2 Sequestered in Subsurface Geologic Formations.

8. MRV Plan Implementation Schedule

It is anticipated that this MRV plan will be implemented by April 1, 2017 or within 90 days of EPA approval, whichever occurs later. Other GHG reports are filed on March 31 of the year after the reporting year and it is anticipated that the Annual Subpart RR Report will be filed at the same time. As described in Section 3.3 above, Oxy anticipates that the MRV program will be in effect during the Specified Period, during which time Oxy will operate the Hobbs Units with the subsidiary purpose of establishing long-term containment of a measurable quantity of CO_2 in subsurface geological formations at the Hobbs Field. Oxy anticipates establishing that a measurable amount of CO_2 injected during the Specified Period will be stored in a manner not expected to migrate resulting in future surface leakage. At such time, Oxy will prepare a demonstration supporting the long-term containment determination and submit a request to discontinue reporting under this MRV plan. *See* 40 C.F.R. § 98.441(b)(2)(ii).

9. Quality Assurance Program

9.1 Monitoring QA/QC

As indicated in Section 7, Oxy has incorporated the requirements of §98.444 (a) – (d) in the discussion of mass balance equations. These include the following provisions.

CO_2 Received and Injected

- The quarterly flow rate of CO_2 received by pipeline is measured at the receiving custody transfer meters.
- The quarterly CO_2 flow rate for recycled CO_2 is measured at the flow meter located at the RCF outlet.

CO_2 Produced

- The point of measurement for the quantity of CO_2 produced from oil or other fluid production wells is a flow meter directly downstream of each separator that sends a stream of gas into a recycle or end use system.
- The produced gas stream is sampled at least once per quarter immediately downstream of the flow meter used to measure flow rate of that gas stream and measure the CO_2 concentration of the sample.
- The quarterly flow rate of the produced gas is measured at the flow meters located at the RCF inlet.

CO_2 emissions from equipment leaks and vented emissions of CO_2

These volumes are measured in conformance with the monitoring and QA/QC requirements specified in subpart W of 40 CFR Part 98.

Flow meter provisions

The flow meters used to generate date for the mass balance equations in Section 7 are:

- Operated continuously except as necessary for maintenance and calibration.

- Operated using the calibration and accuracy requirements in 40 CFR §98.3(i).
- Operated in conformance with American Petroleum Institute (API) standards.
- National Institute of Standards and Technology (NIST) traceable.

Concentration of CO_2
As indicated in Appendix 1, CO_2 concentration is measured using an appropriate standard method. Further, all measured volumes of CO_2 have been converted to standard cubic meters at a temperature of 60 degrees Fahrenheit and at an absolute pressure of 1 atmosphere, including those used in Equations RR-2, RR-5 and RR-8 in Section 7.

9.2 Missing Data Procedures

In the event Oxy is unable to collect data needed for the mass balance calculations, procedures for estimating missing data in §98.445 will be used as follows:

- A quarterly flow rate of CO_2 received that is missing would be estimated using invoices or using a representative flow rate value from the nearest previous time period.
- A quarterly CO_2 concentration of a CO_2 stream received that is missing would be estimated using invoices or using a representative concentration value from the nearest previous time period.
- A quarterly quantity of CO_2 injected that is missing would be estimated using a representative quantity of CO_2injected from the nearest previous period of time at a similar injection pressure.
- For any values associated with CO_2 emissions from equipment leaks and vented emissions of CO_2 from surface equipment at the facility that are reported in this subpart, missing data estimation procedures specified in subpart W of 40 CFR Part 98 would be followed.
- The quarterly quantity of CO_2 produced from subsurface geologic formations that is missing would be estimated using a representative quantity of CO_2 produced from the nearest previous period of time.

9.3 MRV Plan Revisions

In the event there is a material change to the monitoring and/or operational parameters of the Oxy CO_2 EOR operations in the Hobbs Field that is not anticipated in this MRV plan, the MRV plan will be revised and submitted to the EPA Administrator within 180 days as required in §98.448(d).

10. Records Retention

Oxy will follow the record retention requirements specified by §98.3(g). In addition, it will follow the requirements in Subpart RR §98.447 by maintaining the following records for at least three years:

- Quarterly records of CO_2 received at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of produced CO_2, including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Quarterly records of injected CO_2 including volumetric flow at standard conditions and operating conditions, operating temperature and pressure, and concentration of these streams.
- Annual records of information used to calculate the CO_2 emitted by surface leakage from leakage pathways.
- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the flow meter used to measure injection quantity and the injection wellhead.
- Annual records of information used to calculate the CO_2 emitted from equipment leaks and vented emissions of CO_2 from equipment located on the surface between the production wellhead and the flow meter used to measure production quantity.

These data will be collected as generated and aggregated as required for reporting purposes.

11. Appendices

Appendix 1. Conversion Factors

Oxy reports CO_2 volumes at standard conditions of temperature and pressure as defined in the State of New Mexico – 60 ^{o}F and 15.025 psi.

To convert these volumes into metric tonnes, a density is calculated using the Span and Wagner equation of state as recommended by the EPA. Density was calculated using the database of thermodynamic properties developed by the National Institute of Standards and Technology (NIST), available at http://webbook.nist.gov/chemistry/fluid/.

At State of New Mexico standard conditions, the Span and Wagner equation of state gives a density of 0.0027097 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.40921 x 10^{-2} MT/Mcf or 0.0019102 MT/m^3.

Note at EPA standard conditions of 60 ^{o}F and one atmosphere, the Span and Wagner equation of state gives a density of 0.0026500 lb-moles per cubic foot. Using a molecular weight for CO_2 of 44.0095, 2204.62 lbs/metric ton and 35.314667 ft^3/m^3, gives a CO_2 density of 5.29003 x 10^{-5} MT/ft^3 or 0.0018682 MT/m^3.

The conversion factor 5.40921 x 10^{-2} MT/Mcf has been used throughout to convert Oxy volumes to metric tons.

Appendix 2. Acronyms

AGA – American Gas Association
AMA – Active Monitoring Area
AoR – Area of Review
API – American Petroleum Institute
Bscf – billion standard cubic feet
B/D – barrels per day
bopd – barrels of oil per day
cf – cubic feet
CH_4 – Methane
CO_2 – Carbon Dioxide
CRP – CO_2 Removal Plant
CTB – Central Tank Battery
DOT – US Department of Transportation
EOR – Enhanced Oil Recovery
EPA – US Environmental Protection Agency
EMNRD – New Mexico Energy, Minerals, and Natural Resources Department
ESD – Emergency Shutdown Device
GHG – Greenhouse Gas
GHGRP – Greenhouse Gas Reporting Program
HC – Hydrocarbon
H_2S – Hydrogen Sulfide
IWR -- Injection to Withdrawal Ratio
LACT – Lease Automatic Custody Transfer meter
LEL – Lower Explosive Limit
MIT – Mechanical Integrity Test
MMA – Maximum Monitoring Area
MMB – Million barrels
Mscf – Thousand standard cubic feet
MMscf – Million standard cubic feet
MMMT – Million metric tonnes
MMT – Thousand metric tonnes
MRV – Monitoring, Reporting, and Verification
MT -- Metric Tonne
NG—Natural Gas
NGLs – Natural Gas Liquids
OOIP – Original Oil-In-Place
OPC – Occidental Petroleum Corporation
OPL – Occidental Petroleum Ltd.
OPS – Office of Pipeline Safety
PHMSA – Pipeline and Hazardous Materials Safety Administration
PPM – Parts Per Million
RCF – Hobbs Field CO_2 Recycling and Compression Facility
ROZ – Residual Oil Zone
SACROC – Scurry Area Canyon Reef Operators Committee

ST – Short Ton
TSD – Technical Support Document
TVDSS – True Vertical Depth Subsea
TZ – Transition Zone
UIC – Underground Injection Control
USEPA – U.S. Environmental Protection Agency
USDW – Underground Source of Drinking Water
VRU -- Vapor Recovery Unit
WAG – Water Alternating Gas

Appendix 3. References

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Appendix 4. Glossary of Terms

This glossary describes some of the technical terms as they are used in this MRV plan. For additional glossaries please see the U.S. EPA Glossary of UIC Terms (http://water.epa.gov/type/groundwater/uic/glossary.cfm) and the Schlumberger Oilfield Glossary (http://www.glossary.oilfield.slb.com/).

Anhydrite -- Anhydrite is a mineral—anhydrous calcium sulfate, $CaSO_4$.

Bradenhead -- a casing head in an oil well having a stuffing box packed (as with rubber) to make a gastight connection
Contain / Containment – having the effect of keeping fluids located within in a specified portion of a geologic formation.

Dip -- Very few, if any, geologic features are perfectly horizontal. They are almost always tilted. The direction of tilt is called "dip." Dip is the angle of steepest descent measured from the horizontal plane. Moving higher up structure is moving "updip." Moving lower is "downdip." Perpendicular to dip is "strike." Moving perpendicular along a constant depth is moving along strike.

Dolomite -- Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate $CaMg(CO_3)_2$.

Downdip -- See "dip."

Formation -- A body of rock that is sufficiently distinctive and continuous that it can be mapped. At Wasson, for example, San Andres formation is a layer of permeable dolomites that were deposited in a shallow marine environment during the Permian Era, some 250 to 300 million years ago. The San Andres can be mapped over much of the Permian Basin.

Igneous Rocks -- Igneous rocks crystallize from molten rock, or magma, with interlocking mineral crystals.

Infill Drilling -- The drilling of additional wells within existing patterns. These additional wells decrease average well spacing. This practice both accelerates expected recovery and increases estimated ultimate recovery in heterogeneous reservoirs by improving the continuity between injectors and producers. As well spacing is decreased, the shifting flow paths lead to increased sweep to areas where greater hydrocarbon saturations remain.

Metamorphic Rocks -- Metamorphic rocks form from the alteration of preexisting rocks by changes in ambient temperature, pressure, volatile content, or all of these. Such changes can occur through the activity of fluids in the Earth and movement of igneous bodies or regional tectonic activity.

Permeability -- Permeability is the measure of a rock's ability to transmit fluids. Rocks that transmit fluids readily, such as sandstones, are described as permeable and tend to have many large, well-connected pores. Impermeable formations, such as shales and siltstones, tend to be finer grained or of a mixed grain size, with smaller, fewer, or less interconnected pores.

Phase -- Phase is a region of space throughout which all physical properties of a material are essentially uniform. Fluids that don't mix together segregate themselves into phases. Oil, for example, does not mix with water and forms a separate phase.

Pore Space -- See porosity.

Porosity -- Porosity is the fraction of a rock that is not occupied by solid grains or minerals. Almost all rocks have spaces between rock crystals or grains that is available to be filled with a fluid, such as water, oil or gas. This space is called "pore space."

Primary recovery -- The first stage of hydrocarbon production, in which natural reservoir energy, such as gas drive, water drive or gravity drainage, displaces hydrocarbons from the reservoir, into the wellbore and up to surface. Initially, the reservoir pressure is considerably higher than the bottomhole pressure inside the wellbore. This high natural differential pressure drives hydrocarbons toward the well and up to surface. However, as the reservoir pressure declines because of production, so does the differential pressure. To reduce the bottomhole pressure or increase the differential pressure to increase hydrocarbon production, it is necessary to implement an artificial lift system, such as a rod pump, an electrical submersible pump or a gas-lift installation. Production using artificial lift is considered primary recovery. The primary recovery stage reaches its limit either when the reservoir pressure is so low that the production rates are not economical, or when the proportions of gas or water in the production stream are too high. During primary recovery, only a small percentage of the initial hydrocarbons in place are produced, typically around 10% for oil reservoirs. Primary recovery is also called primary production.

Saturation -- The fraction of pore space occupied by a given fluid. Oil saturation, for example, is the fraction of pore space occupied by oil.

Seal – A geologic layer (or multiple layers) of impermeable rock that serve as a barrier to prevent fluids from moving upwards to the surface.

Secondary recovery -- The second stage of hydrocarbon production during which an external fluid such as water or gas is injected into the reservoir through injection wells located in rock that has fluid communication with production wells. The purpose of secondary recovery is to maintain reservoir pressure and to displace hydrocarbons toward the wellbore. The most common secondary recovery techniques are gas injection and waterflooding.

Sedimentary Rocks -- Sedimentary rocks are formed at the Earth's surface through deposition of sediments derived from weathered rocks, biogenic activity or precipitation from solution. There are three main types of rocks – igneous, metamorphic and sedimentary.

Stratigraphic section -- A stratigraphic section is a sequence of layers of rocks in the order they were deposited.

Strike -- See “dip.”

Updip -- See “dip.”

Appendix 5. Well Identification Numbers

The following table presents the well name, API number, status and type for the wells in the Hobbs Units as of August 2016. The table is subject to change over time as new wells are drilled, existing wells change status, or existing wells are repurposed. The following terms are used:

- Well Status
  - ACTIVE refers to active wells
  - DRILL refers to wells under construction
  - P&A refers to wells that have been closed (plugged and abandoned) per NMOCD regulations
  - TA refers to wells that have been temporarily abandoned
  - SHUT_IN refers to wells that have been temporarily idled or shut-in
  - INACTIVE refers to wells that have been completed but are not in use
- Well Type
  - INJ_WAG refers to wells that inject water and CO_2 Gas
  - INJ_H2O refers to wells that inject water
  - PROD_GAS refers to wells that produce natural gas
  - PROD_OIL refers to wells that produce oil

Well Name	API Number	Well Type	Well Status
NHSAU 111-19	30025073560000	PROD_OIL	P & A
NHSAU 111-20	30025073750000	PROD_OIL	ACTIVE
NHSAU 111-24	30025054770000	INJ_WAG	ACTIVE
NHSAU 111-25	30025054910000	INJ_WAG	ACTIVE
NHSAU 111-27	30025233750000	INJ_H2O	P & A
NHSAU 111-28	30025074220000	INJ_WAG	ACTIVE
NHSAU 111-29	30025239190000	PROD_OIL	ACTIVE
NHSAU 111-30	30025070770000	INJ_WAG	ACTIVE
NHSAU 111-31	30025075110000	PROD_OIL	ACTIVE
NHSAU 111-32	30025075280000	PROD_OIL	ACTIVE
NHSAU 111-33	30025125050000	INJ_WAG	ACTIVE
NHSAU 112-19	30025073580000	INJ_WAG	ACTIVE
NHSAU 112-30	30025290630000	INJ_WAG	ACTIVE
NHSAU 112-32	30025075260000	INJ_WAG	ACTIVE
NHSAU 113-30	30025290640000	INJ_WAG	ACTIVE
NHSAU 114-33	30025232070000	PROD_OIL	TA
NHSAU 121-13	30025054400000	PROD_OIL	TA
NHSAU 121-17	30025073330000	PROD_OIL	P & A
NHSAU 121-19	30025073570000	PROD_OIL	ACTIVE

NHSAU 121-20	30025073780000	PROD_OIL	P & A
NHSAU 121-23	30025054620000	PROD_OIL	P & A
NHSAU 121-24	30025054760000	INJ_WAG	ACTIVE
NHSAU 121-25	30025055020000	INJ_WAG	P & A
NHSAU 121-27	30025124940000	PROD_OIL	ACTIVE
NHSAU 121-28	30025074200000	PROD_OIL	ACTIVE
NHSAU 121-29	30025074490000	PROD_OIL	ACTIVE
NHSAU 121-30	30025074640000	PROD_OIL	ACTIVE
NHSAU 121-31	30025075140000	INJ_WAG	ACTIVE
NHSAU 121-32	30025230070000	PROD_OIL	ACTIVE
NHSAU 121-33	30025075590000	PROD_OIL	ACTIVE
NHSAU 122-28	30025289640000	PROD_OIL	ACTIVE
NHSAU 122-29	30025289530000	INJ_WAG	ACTIVE
NHSAU 123-33	30025232630000	PROD_OIL	ACTIVE
NHSAU 131-13	30025054480000	PROD_OIL	TA
NHSAU 131-17	30025073360000	INJ_H2O	P & A
NHSAU 131-18	30025073390000	PROD_OIL	P & A
NHSAU 131-19	30025073610000	INJ_WAG	ACTIVE
NHSAU 131-20	30025232060000	INJ_WAG	ACTIVE
NHSAU 131-21	30025073930000	PROD_OIL	P & A
NHSAU 131-24	30025054840000	INJ_WAG	ACTIVE
NHSAU 131-27	30025074100000	PROD_OIL	ACTIVE
NHSAU 131-28	30025124970000	INJ_WAG	ACTIVE
NHSAU 131-29	30025074470000	PROD_OIL	ACTIVE
NHSAU 131-30	30025074810000	INJ_WAG	INACTIVE
NHSAU 131-31	30025075090000	PROD_OIL	TA
NHSAU 131-32	30025075270000	INJ_WAG	ACTIVE
NHSAU 131-33	30025075440000	PROD_OIL	ACTIVE
NHSAU 132-28	30025232770000	PROD_OIL	ACTIVE
NHSAU 132-29	30025269170000	INJ_WAG	ACTIVE
NHSAU 132-32	30025271390000	INJ_WAG	ACTIVE
NHSAU 141-13	30025054370000	INJ_WAG	ACTIVE
NHSAU 141-17	30025073350000	PROD_OIL	P & A
NHSAU 141-18	30025073370000	PROD_OIL	P & A
NHSAU 141-19	30025073650000	PROD_OIL	ACTIVE
NHSAU 141-20	30025073830000	PROD_OIL	ACTIVE
NHSAU 141-21	30025073900000	PROD_OIL	TA
NHSAU 141-24	30025054850000	PROD_OIL	ACTIVE

NHSAU 141-27	30025074080000	PROD_OIL	ACTIVE
NHSAU 141-28	30025124960000	PROD_OIL	ACTIVE
NHSAU 141-29	30025074480000	INJ_WAG	ACTIVE
NHSAU 141-30	30025074870000	PROD_OIL	ACTIVE
NHSAU 141-31	30025075100000	INJ_H2O	TA
NHSAU 141-32	30025075230000	INJ_WAG	ACTIVE
NHSAU 141-33	30025075430000	PROD_OIL	ACTIVE
NHSAU 142-19	30025271380000	INJ_WAG	ACTIVE
NHSAU 142-28	30025232460000	PROD_OIL	ACTIVE
NHSAU 142-32	30025282650000	INJ_WAG	ACTIVE
NHSAU 142-33	30025284110000	INJ_WAG	ACTIVE
NHSAU 143-32	30025289430000	PROD_OIL	ACTIVE
NHSAU 144-32	30025316620000	INJ_WAG	ACTIVE
NHSAU 19-616	30025371540001	PROD_OIL	INACTIVE
NHSAU 211-13	30025054410000	PROD_OIL	P & A
NHSAU 211-19	30025073590000	PROD_OIL	TA
NHSAU 211-23	30025054690000	INJ_WAG	ACTIVE
NHSAU 211-24	30025070470000	PROD_OIL	ACTIVE
NHSAU 211-25	30025054890000	PROD_OIL	P & A
NHSAU 211-28	30025074250000	INJ_H2O	TA
NHSAU 211-29	30025074330000	PROD_OIL	P & A
NHSAU 211-30	30025074630000	PROD_OIL	ACTIVE
NHSAU 211-31	30025075030000	PROD_OIL	TA
NHSAU 211-32	30025075250000	PROD_OIL	ACTIVE
NHSAU 211-33	30025075640000	INJ_WAG	ACTIVE
NHSAU 211-34	30025075790000	PROD_OIL	TA
NHSAU 211-36	30025055420000	INJ_WAG	ACTIVE
NHSAU 212-19	30025288800000	PROD_OIL	TA
NHSAU 212-24	30025291290000	INJ_WAG	ACTIVE
NHSAU 212-32	30025302580000	PROD_OIL	ACTIVE
NHSAU 212-33	30025290260000	INJ_WAG	ACTIVE
NHSAU 213-33	30025290650000	PROD_OIL	ACTIVE
NHSAU 221-13	30025054390000	INJ_H2O	TA
NHSAU 221-19	30025073550000	PROD_OIL	ACTIVE
NHSAU 221-20	30025073770000	PROD_OIL	TA
NHSAU 221-23	30025054700000	PROD_OIL	ACTIVE
NHSAU 221-24	30025098760000	PROD_OIL	ACTIVE
NHSAU 221-25	30025054960000	PROD_OIL	TA

NHSAU 221-27	30025309100000	INJ_H2O	P & A
NHSAU 221-28	30025074290000	INJ_WAG	ACTIVE
NHSAU 221-29	30025074300000	PROD_OIL	TA
NHSAU 221-30	30025074620000	PROD_OIL	ACTIVE
NHSAU 221-31	30025075040000	PROD_OIL	TA
NHSAU 221-32	30025075200000	PROD_OIL	TA
NHSAU 221-33	30025075600000	INJ_WAG	INACTIVE
NHSAU 221-34	30025075780000	PROD_OIL	TA
NHSAU 222-29	30025269340000	INJ_WAG	ACTIVE
NHSAU 222-30	30025268330000	INJ_WAG	ACTIVE
NHSAU 222-32	30025271400000	INJ_WAG	ACTIVE
NHSAU 222-33	30025269750000	INJ_WAG	ACTIVE
NHSAU 223-30	30025285550000	INJ_WAG	ACTIVE
NHSAU 223-32	30025289440000	INJ_WAG	ACTIVE
NHSAU 231-14	30025054510000	INJ_H2O	TA
NHSAU 231-18	30025073410000	PROD_OIL	P & A
NHSAU 231-19	30025073620000	INJ_WAG	ACTIVE
NHSAU 231-20	30025073820000	PROD_OIL	ACTIVE
NHSAU 231-23	30025054710000	INJ_WAG	ACTIVE
NHSAU 231-24	30025054830000	PROD_OIL	ACTIVE
NHSAU 231-25	30025054980000	PROD_OIL	TA
NHSAU 231-27	30025124950000	PROD_OIL	TA
NHSAU 231-28	30025074210000	INJ_WAG	ACTIVE
NHSAU 231-29	30025074380000	PROD_OIL	ACTIVE
NHSAU 231-30	30025074790000	PROD_OIL	TA
NHSAU 231-31	30025075070000	PROD_OIL	ACTIVE
NHSAU 231-32	30025075210000	PROD_OIL	P & A
NHSAU 231-33	30025075450000	INJ_WAG	ACTIVE
NHSAU 232-19	30025291720000	INJ_WAG	ACTIVE
NHSAU 232-20	30025073840000	PROD_OIL	P & A
NHSAU 232-28	30025288820000	INJ_WAG	ACTIVE
NHSAU 232-30	30025269350000	INJ_WAG	ACTIVE
NHSAU 232-32	30025230350000	PROD_OIL	ACTIVE
NHSAU 232-33	30025268340000	INJ_WAG	ACTIVE
NHSAU 233-20	30025272140000	INJ_H2O	TA
NHSAU 233-30	30025289420000	INJ_WAG	ACTIVE
NHSAU 233-33	30025284100000	PROD_OIL	ACTIVE
NHSAU 234-33	30025292750000	PROD_OIL	ACTIVE

NHSAU 241-13	30025054360000	INJ_WAG	ACTIVE
NHSAU 241-14	30025054530000	PROD_OIL	P & A
NHSAU 241-18	30025073380000	PROD_OIL	TA
NHSAU 241-19	30025073640000	INJ_WAG	ACTIVE
NHSAU 241-20	30025124930000	PROD_OIL	ACTIVE
NHSAU 241-21	30025073910000	PROD_OIL	P & A
NHSAU 241-23	30025054720000	PROD_OIL	P & A
NHSAU 241-24	30025054820000	PROD_OIL	ACTIVE
NHSAU 241-25	30025055010000	PROD_OIL	ACTIVE
NHSAU 241-27	30025074090000	INJ_H2O	TA
NHSAU 241-28	30025124980000	PROD_OIL	ACTIVE
NHSAU 241-29	30025074370000	INJ_WAG	ACTIVE
NHSAU 241-30	30025074800000	INJ_WAG	TA
NHSAU 241-31	30025075080000	PROD_OIL	TA
NHSAU 241-32	30025075330000	PROD_OIL	ACTIVE
NHSAU 241-33	30025075470000	PROD_OIL	ACTIVE
NHSAU 242-18	30025271980000	INJ_H2O	P & A
NHSAU 242-19	30025234810000	PROD_OIL	ACTIVE
NHSAU 242-24	30025268320000	INJ_WAG	ACTIVE
NHSAU 242-28	30025292760000	INJ_WAG	ACTIVE
NHSAU 242-29	30025284130000	INJ_WAG	ACTIVE
NHSAU 242-30	30025288860000	INJ_WAG	ACTIVE
NHSAU 243-28	30025233040000	PROD_OIL	ACTIVE
NHSAU 311-18	30025073480000	PROD_OIL	P & A
NHSAU 311-19	30025073690000	INJ_WAG	ACTIVE
NHSAU 311-23	30025054640000	PROD_OIL	ACTIVE
NHSAU 311-24	30025054810000	PROD_OIL	ACTIVE
NHSAU 311-25	30025055060000	PROD_OIL	P & A
NHSAU 311-26	30025251160000	PROD_OIL	P & A
NHSAU 311-28	30025074170000	INJ_WAG	TA
NHSAU 311-29	30025074320000	PROD_OIL	ACTIVE
NHSAU 311-30	30025074690000	PROD_OIL	TA
NHSAU 311-31	30025074910000	PROD_OIL	ACTIVE
NHSAU 311-32	30025075150000	PROD_OIL	P & A
NHSAU 311-33	30025075550000	PROD_OIL	ACTIVE
NHSAU 311-34	30025125090000	PROD_OIL	TA
NHSAU 311-36	30025055410000	PROD_OIL	ACTIVE
NHSAU 312-24	30025291300000	INJ_WAG	ACTIVE

NHSAU 312-30	30025291970000	INJ_WAG	ACTIVE
NHSAU 312-31	30025270600000	INJ_WAG	ACTIVE
NHSAU 312-32	30025290170000	INJ_WAG	ACTIVE
NHSAU 312-33	30025291990000	PROD_OIL	ACTIVE
NHSAU 313-30	30025232700000	INJ_WAG	ACTIVE
NHSAU 313-32	30025302630000	PROD_OIL	ACTIVE
NHSAU 321-14	30025054570000	INJ_H2O	P & A
NHSAU 321-18	30025073450000	PROD_OIL	P & A
NHSAU 321-19	30025073600000	PROD_OIL	ACTIVE
NHSAU 321-23	30025054630000	INJ_WAG	ACTIVE
NHSAU 321-24	30025054800000	PROD_OIL	ACTIVE
NHSAU 321-25	30025055050000	PROD_OIL	ACTIVE
NHSAU 321-28	30025074160000	PROD_OIL	ACTIVE
NHSAU 321-29	30025074310000	INJ_WAG	ACTIVE
NHSAU 321-30	30025074670000	PROD_OIL	ACTIVE
NHSAU 321-31	30025074920000	PROD_OIL	ACTIVE
NHSAU 321-32	30025125060000	INJ_WAG	ACTIVE
NHSAU 321-33	30025075480000	PROD_OIL	P & A
NHSAU 321-34	30025125100000	PROD_OIL	P & A
NHSAU 321-36	30025055400000	INJ_H2O	TA
NHSAU 322-29	30025288830000	INJ_WAG	ACTIVE
NHSAU 322-31	30025302040000	INJ_WAG	ACTIVE
NHSAU 322-32	30025075180000	PROD_OIL	ACTIVE
NHSAU 322-33	30025271690000	INJ_WAG	ACTIVE
NHSAU 323-29	30025289410000	PROD_OIL	ACTIVE
NHSAU 323-32	30025269730000	INJ_WAG	ACTIVE
NHSAU 323-33	30025289510000	PROD_OIL	P & A
NHSAU 331-13	30025054470000	PROD_OIL	ACTIVE
NHSAU 331-14	30025054550000	PROD_OIL	TA
NHSAU 331-18	30025073460000	INJ_H2O	P & A
NHSAU 331-19	30025073630000	PROD_OIL	P & A
NHSAU 331-20	30025073810000	INJ_H2O	P & A
NHSAU 331-21	30025206960000	INJ_H2O	P & A
NHSAU 331-23	30025054740000	PROD_OIL	ACTIVE
NHSAU 331-24	30025054880000	INJ_WAG	ACTIVE
NHSAU 331-25	30025055000000	PROD_OIL	ACTIVE
NHSAU 331-28	30025074120000	PROD_OIL	ACTIVE
NHSAU 331-29	30025074360000	INJ_H2O	P & A

NHSAU 331-30	30025074720000	INJ_WAG	ACTIVE
NHSAU 331-31	30025074990000	PROD_OIL	ACTIVE
NHSAU 331-32	30025075380000	INJ_WAG	ACTIVE
NHSAU 331-33	30025075460000	PROD_OIL	TA
NHSAU 331-34	30025075660000	PROD_OIL	P & A
NHSAU 332-19	30025291950000	INJ_WAG	ACTIVE
NHSAU 332-28	30025316550000	INJ_WAG	ACTIVE
NHSAU 332-30	30025289540000	INJ_WAG	ACTIVE
NHSAU 332-32	30025291730000	PROD_OIL	ACTIVE
NHSAU 333-30	30025289550000	INJ_WAG	ACTIVE
NHSAU 341-13	30025054460000	PROD_OIL	ACTIVE
NHSAU 341-14	30025054500000	PROD_OIL	TA
NHSAU 341-18	30025237650000	INJ_H2O	P & A
NHSAU 341-19	30025124910000	PROD_OIL	ACTIVE
NHSAU 341-20	30025073710000	PROD_OIL	ACTIVE
NHSAU 341-21	30025073960000	PROD_OIL	P & A
NHSAU 341-23	30025054750000	INJ_WAG	ACTIVE
NHSAU 341-24	30025054900000	PROD_OIL	INACTIVE
NHSAU 341-25	30025054970000	INJ_WAG	ACTIVE
NHSAU 341-28	30025124890000	PROD_OIL	ACTIVE
NHSAU 341-29	30025074450000	PROD_OIL	ACTIVE
NHSAU 341-30	30025246650000	PROD_OIL	ACTIVE
NHSAU 341-31	30025075000000	INJ_WAG	ACTIVE
NHSAU 341-32	30025075390000	INJ_WAG	ACTIVE
NHSAU 341-33	30025127570000	PROD_OIL	TA
NHSAU 341-34	30025075670000	PROD_OIL	TA
NHSAU 342-18	30025073420000	INJ_WAG	ACTIVE
NHSAU 342-24	30025290620000	INJ_WAG	ACTIVE
NHSAU 342-28	30025299310000	PROD_OIL	ACTIVE
NHSAU 342-29	30025288840000	INJ_WAG	ACTIVE
NHSAU 342-30	30025125010000	PROD_OIL	P & A
NHSAU 342-32	30025282660000	INJ_WAG	ACTIVE
NHSAU 342-33	30025282670000	INJ_WAG	TA
NHSAU 342-34	30025281990000	PROD_OIL	P & A
NHSAU 343-32	30025299060000	PROD_OIL	ACTIVE
NHSAU 411-18	30025073490000	PROD_OIL	P & A
NHSAU 411-19	30025073700000	INJ_WAG	ACTIVE
NHSAU 411-23	30025127830000	INJ_WAG	ACTIVE

NHSAU 411-24	30025235220000	PROD_OIL	ACTIVE
NHSAU 411-25	30025055030000	PROD_OIL	P & A
NHSAU 411-26	30025055090000	INJ_H2O	P & A
NHSAU 411-28	30025074190000	PROD_OIL	P & A
NHSAU 411-29	30025074540000	INJ_H2O	TA
NHSAU 411-30	30025074700000	INJ_WAG	ACTIVE
NHSAU 411-31	30025074900000	PROD_OIL	ACTIVE
NHSAU 411-32	30025075160000	PROD_OIL	ACTIVE
NHSAU 411-33	30025075560000	PROD_OIL	TA
NHSAU 411-36	30025055390000	INJ_WAG	ACTIVE
NHSAU 412-23	30025054680000	PROD_OIL	TA
NHSAU 412-24	30025054790000	PROD_OIL	ACTIVE
NHSAU 412-30	30025233840000	PROD_OIL	ACTIVE
NHSAU 412-31	30025232040000	PROD_OIL	P & A
NHSAU 412-33	30025299320000	PROD_OIL	ACTIVE
NHSAU 413-24	30025284140000	INJ_WAG	ACTIVE
NHSAU 414-24	30025288790000	INJ_WAG	ACTIVE
NHSAU 421-14	30025054560000	PROD_OIL	ACTIVE
NHSAU 421-18	30025073470000	PROD_OIL	P & A
NHSAU 421-19	30025073680000	PROD_OIL	TA
NHSAU 421-20	30025073880000	PROD_OIL	P & A
NHSAU 421-23	30025054660000	PROD_OIL	ACTIVE
NHSAU 421-24	30025230810000	PROD_OIL	ACTIVE
NHSAU 421-25	30025055040000	PROD_OIL	ACTIVE
NHSAU 421-28	30025074180000	PROD_OIL	TA
NHSAU 421-29	30025074590000	PROD_OIL	P & A
NHSAU 421-30	30025074680000	PROD_OIL	ACTIVE
NHSAU 421-31	30025074930000	PROD_OIL	ACTIVE
NHSAU 421-32	30025125070000	PROD_OIL	ACTIVE
NHSAU 421-33	30025075540000	PROD_OIL	ACTIVE
NHSAU 421-34	30025075730000	PROD_OIL	P & A
NHSAU 421-36	30025099260000	PROD_OIL	P & A
NHSAU 422-19	30025291960000	PROD_OIL	TA
NHSAU 422-24	30025054780000	INJ_WAG	ACTIVE
NHSAU 422-25	30025269330000	INJ_WAG	ACTIVE
NHSAU 422-28	30025272430000	INJ_WAG	ACTIVE
NHSAU 422-30	30025270590000	INJ_WAG	ACTIVE
NHSAU 422-31	30025288870000	PROD_OIL	ACTIVE

NHSAU 422-32	30025290740000	INJ_WAG	ACTIVE
NHSAU 422-33	30025282680000	INJ_WAG	ACTIVE
NHSAU 423-32	30025291980000	INJ_WAG	ACTIVE
NHSAU 424-32	30025231300000	PROD_OIL	ACTIVE
NHSAU 431-13	30025054450000	INJ_WAG	ACTIVE
NHSAU 431-14	30025054540000	PROD_OIL	ACTIVE
NHSAU 431-18	30025073440000	PROD_OIL	P & A
NHSAU 431-19	30025226010000	INJ_WAG	P & A
NHSAU 431-20	30025073860000	PROD_OIL	P & A
NHSAU 431-23	30025054670000	INJ_WAG	ACTIVE
NHSAU 431-24	30025054870000	PROD_OIL	P & A
NHSAU 431-25	30025054920000	INJ_WAG	ACTIVE
NHSAU 431-28	30025074130000	PROD_OIL	ACTIVE
NHSAU 431-29	30025074580000	PROD_OIL	ACTIVE
NHSAU 431-30	30025074740000	PROD_OIL	ACTIVE
NHSAU 431-31	30025127580000	PROD_OIL	ACTIVE
NHSAU 431-32	30025075370000	INJ_WAG	ACTIVE
NHSAU 431-33	30025075530000	PROD_OIL	ACTIVE
NHSAU 431-34	30025075680000	PROD_OIL	P & A
NHSAU 432-20	30025073870000	PROD_OIL	P & A
NHSAU 432-24	30025290730000	INJ_WAG	ACTIVE
NHSAU 432-30	30025289570000	INJ_WAG	ACTIVE
NHSAU 432-32	30025269740000	INJ_WAG	ACTIVE
NHSAU 432-33	30025282690000	INJ_WAG	ACTIVE
NHSAU 433-33	30025303080000	PROD_OIL	ACTIVE
NHSAU 441-13	30025127320000	INJ_WAG	ACTIVE
NHSAU 441-14	30025250200000	PROD_OIL	TA
NHSAU 441-18	30025073430000	PROD_OIL	P & A
NHSAU 441-19	30025073660000	PROD_OIL	ACTIVE
NHSAU 441-21	30025073970000	PROD_OIL	P & A
NHSAU 441-23	30025054730000	PROD_OIL	INACTIVE
NHSAU 441-24	30025054860000	PROD_OIL	INACTIVE
NHSAU 441-25	30025054990000	INJ_WAG	ACTIVE
NHSAU 441-28	30025074110000	INJ_WAG	INACTIVE
NHSAU 441-29	30025074440000	PROD_OIL	ACTIVE
NHSAU 441-30	30025074730000	PROD_OIL	ACTIVE
NHSAU 441-31	30025074980000	PROD_OIL	TA
NHSAU 441-32	30025075360000	PROD_OIL	ACTIVE

NHSAU 441-34	30025075800000	PROD_OIL	P & A
NHSAU 442-13	30025288780000	INJ_WAG	ACTIVE
NHSAU 442-19	30025288810000	INJ_WAG	ACTIVE
NHSAU 442-24	30025290980000	INJ_WAG	ACTIVE
NHSAU 442-29	30025288850000	INJ_WAG	ACTIVE
NHSAU 442-30	30025270010000	INJ_WAG	ACTIVE
NHSAU 443-30	30025289580000	PROD_OIL	P & A
NHSAU 444-30	30025289590000	INJ_WAG	ACTIVE
NHSAU 511-33	30025349060000	PROD_OIL	ACTIVE
NHSAU 512-32	30025349070000	PROD_OIL	ACTIVE
NHSAU 513-33	30025349800000	PROD_OIL	ACTIVE
NHSAU 514-32	30025362450000	PROD_OIL	ACTIVE
NHSAU 516-13	30025380230000	PROD_OIL	ACTIVE
NHSAU 517-18	30025380870000	PROD_OIL	ACTIVE
NHSAU 518-18	30025381140000	INJ_WAG	ACTIVE
NHSAU 521-33	30025346430000	PROD_OIL	ACTIVE
NHSAU 523-33	30025343720000	PROD_OIL	ACTIVE
NHSAU 524-33	30025349930000	PROD_OIL	ACTIVE
NHSAU 525-30	30025362160000	PROD_OIL	ACTIVE
NHSAU 526-33	30025233340006	PROD_OIL	ACTIVE
NHSAU 527-30	30025362470000	PROD_OIL	ACTIVE
NHSAU 529-18	30025381100000	PROD_OIL	ACTIVE
NHSAU 531-32	30025343740000	PROD_OIL	ACTIVE
NHSAU 532-32	30025125040101	PROD_OIL	TA
NHSAU 533-29	30025355410000	PROD_OIL	ACTIVE
NHSAU 534-33	30025343730000	INJ_WAG	ACTIVE
NHSAU 535-33	30025357580000	PROD_OIL	ACTIVE
NHSAU 536-30	30025362860000	INJ_WAG	ACTIVE
NHSAU 537-32	30025361490000	PROD_OIL	TA
NHSAU 538-30	30025362810000	PROD_OIL	ACTIVE
NHSAU 539-24	30025362130000	PROD_OIL	ACTIVE
NHSAU 541-32	30025349640000	PROD_OIL	ACTIVE
NHSAU 542-32	30025343750000	PROD_OIL	ACTIVE
NHSAU 543-33	30025349970000	INJ_WAG	ACTIVE
NHSAU 544-29	30025346440000	PROD_OIL	ACTIVE
NHSAU 545-33	30025344160000	PROD_OIL	ACTIVE
NHSAU 546-30	30025362800000	PROD_OIL	ACTIVE
NHSAU 547-30	30025362420000	PROD_OIL	ACTIVE

NHSAU 548-32	30025361500000	PROD_OIL	ACTIVE
NHSAU 549-24	30025361930000	PROD_OIL	ACTIVE
NHSAU 611-24	30025354670000	PROD_OIL	ACTIVE
NHSAU 612-24	30025354500000	PROD_OIL	ACTIVE
NHSAU 613-24	30025353700000	PROD_OIL	ACTIVE
NHSAU 614-24	30025355550000	PROD_OIL	ACTIVE
NHSAU 615-19	30025371270000	PROD_OIL	ACTIVE
NHSAU 616-19	30025374100000	PROD_OIL	ACTIVE
NHSAU 617-30	30025371020000	PROD_OIL	ACTIVE
NHSAU 618-30	30025371200000	PROD_OIL	ACTIVE
NHSAU 621-30	30025353320000	PROD_OIL	ACTIVE
NHSAU 622-24	30025371520000	INJ_WAG	ACTIVE
NHSAU 623-29	30025348690000	PROD_OIL	ACTIVE
NHSAU 624-29	30025348700000	PROD_OIL	ACTIVE
NHSAU 625-29	30025372130000	PROD_OIL	ACTIVE
NHSAU 626-29	30025372500000	INJ_WAG	ACTIVE
NHSAU 627-19	30025372350000	PROD_OIL	ACTIVE
NHSAU 628-19	30025385240000	PROD_OIL	ACTIVE
NHSAU 631-33	30025349940000	INJ_WAG	ACTIVE
NHSAU 632-31	30025372140000	INJ_WAG	ACTIVE
NHSAU 633-19	30025374460000	INJ_WAG	ACTIVE
NHSAU 634-29	30025353840000	PROD_OIL	ACTIVE
NHSAU 635-29	30025374090000	INJ_WAG	ACTIVE
NHSAU 636-29	30025371280000	PROD_OIL	ACTIVE
NHSAU 637-24	30025371010000	INJ_WAG	ACTIVE
NHSAU 638-19	30025381250000	PROD_OIL	ACTIVE
NHSAU 641-25	30025371180000	PROD_OIL	ACTIVE
NHSAU 642-25	30025371050000	PROD_OIL	ACTIVE
NHSAU 643-29	30025353760000	PROD_OIL	ACTIVE
NHSAU 644-28	30025353490000	PROD_OIL	ACTIVE
NHSAU 645-13	30025385180000	PROD_OIL	ACTIVE
NHSAU 646-13	30025380710000	PROD_OIL	ACTIVE
NHSAU 659-24	30025430780000	INJ_WAG	ACTIVE
NHSAU 663-24	30025430260000	PROD_OIL	ACTIVE
NHSAU 668-24	30025430740000	INJ_WAG	ACTIVE
NHSAU 669-24	30025430390000	INJ_WAG	ACTIVE
NHSAU 673-19	30025430580000	PROD_OIL	ACTIVE
NHSAU 679-24	30025430400000	INJ_WAG	ACTIVE

NHSAU 680-24	30025430730000	INJ_WAG	ACTIVE
NHSAU 687-24	30025430380000	INJ_WAG	ACTIVE
NHSAU 693-33	30025432820000	INJ_WAG	ACTIVE
NHSAU 711-29	30025374510000	INJ_WAG	ACTIVE
NHSAU 712-29	30025375580000	INJ_WAG	ACTIVE
NHSAU 713-30	30025349830000	PROD_OIL	ACTIVE
NHSAU 721-29	30025374740000	PROD_OIL	ACTIVE
NHSAU 722-31	30025374280000	PROD_OIL	ACTIVE
NHSAU 731-25	30025374810000	PROD_OIL	ACTIVE
NHSAU 733-19	30025374450000	PROD_OIL	ACTIVE
NHSAU 734-33	30025350110000	PROD_OIL	TA
NHSAU 741-25	30025374800000	INJ_WAG	ACTIVE
NHSAU 742-29	30025374750000	PROD_OIL	ACTIVE
NHSAU 743-31	30025354510000	PROD_OIL	ACTIVE
NHSAU 744-25	30025054930000	PROD_OIL	INACTIVE
NHSAU 813-29	30025348710000	INJ_WAG	ACTIVE
NHSAU 814-29	30025355270000	PROD_OIL	ACTIVE
NHSAU 831-13	30025408160000	PROD_OIL	ACTIVE
NHSAU 832-13	30025408220000	PROD_OIL	ACTIVE
NHSAU 833-18	30025408340000	PROD_OIL	ACTIVE
NHSAU 834-32	30025354520000	PROD_OIL	ACTIVE
NHSAU 843-33	30025357430000	PROD_OIL	TA
NHSAU 844-32	30025355340000	PROD_OIL	ACTIVE
NHSAU 913-32	30025353850000	PROD_OIL	ACTIVE
NHSAU 923-29	30025360110000	PROD_GAS	SHUT-IN
NHSAU 943-19	30025374350000	PROD_OIL	ACTIVE
NHSAU 944-29	30025359990000	PROD_OIL	TA
NHSAU 945-19	30025408590000	INJ_WAG	ACTIVE
NHSAU 946-18	30025415500000	PROD_OIL	ACTIVE
NHSAU 947-19	30025415510000	PROD_OIL	ACTIVE
NHSAU 948-33	30025415780000	PROD_OIL	ACTIVE
NHSAU 949-33	30025416430000	PROD_OIL	ACTIVE
NHSAU 950-18	30025424560000	INJ_WAG	ACTIVE
NHSAU 951-18	30025424840000	PROD_OIL	P & A
NHSAU 952-18	30025424780000	INJ_WAG	ACTIVE
NHSAU 953-18	30025424690000	INJ_WAG	ACTIVE
NHSAU 954-18	30025424900000	PROD_OIL	ACTIVE
NHSAU 955-18	30025424850000	PROD_OIL	ACTIVE

NHSAU 956-18	30025424700000	PROD_OIL	ACTIVE
NHSAU 957-18	30025424710000	PROD_OIL	ACTIVE
NHSAU 958-19	30025424540000	PROD_OIL	ACTIVE
NHSAU 959-18	30025427760000	INJ_WAG	ACTIVE
SHOU-100C15	30025076940000	INJ_H2O	P & A
SHOU-101C15	30025076880000	PROD_OIL	P & A
SHOU-102B15	30025076890000	PROD_OIL	P & A
SHOU-103B15	30025076910000	PROD_OIL	P & A
SHOU-104A15	30025224820000	PROD_OIL	P & A
SHOU-105E15	30025200280000	INJ_H2O	P & A
SHOU-106F15	30025076930000	PROD_OIL	P & A
SHOU-107G15	30025076920000	INJ_H2O	P & A
SHOU-108K15	30025076900000	PROD_OIL	P & A
SHOU-109J15	30025076990000	PROD_OIL	P & A
SHOU-10B06	30025076400000	INJ_H2O	P & A
SHOU-110I15	30025076980000	INJ_H2O	P & A
SHOU-111N15	30025076960000	INJ_H2O	P & A
SHOU-112M03	30025251270000	INJ_H2O	TA
SHOU-113G06	30025076390000	INJ_H2O	P & A
SHOU-114J06	30025076440000	INJ_H2O	P & A
SHOU-115I06	30025076420000	INJ_H2O	P & A
SHOU-116O06	30025076450000	INJ_H2O	P & A
SHOU-117P06	30025076430000	INJ_H2O	P & A
SHOU-118D08	30025076540000	PROD_OIL	P & A
SHOU-119C08	30025076530000	INJ_H2O	P & A
SHOU-11A06	30025076350000	INJ_H2O	ACTIVE
SHOU-120C05	30025261150000	INJ_H2O	ACTIVE
SHOU-121E04	30025261160000	INJ_H2O	TA
SHOU-122E04	30025261170000	PROD_OIL	TA
SHOU-123H06	30025261180000	PROD_OIL	TA
SHOU-124J04	30025261190000	PROD_OIL	TA
SHOU-125L03	30025261200000	PROD_OIL	ACTIVE
SHOU-126N10	30025261210000	PROD_OIL	P & A
SHOU-127M34	30025283310000	INJ_H2O	ACTIVE
SHOU-128P03	30025283320000	INJ_WAG	ACTIVE
SHOU-129N34	30025283330000	INJ_H2O	ACTIVE
SHOU-12D05	30025076250000	PROD_OIL	P & A
SHOU-130F04	30025283340000	PROD_OIL	TA
SHOU-131G04	30025283350000	PROD_OIL	TA
SHOU-132H04	30025283360000	PROD_OIL	TA
SHOU-133E03	30025283370000	PROD_OIL	TA
SHOU-135F04	30025283380000	PROD_OIL	P & A
SHOU-136F04	30025283390000	PROD_OIL	ACTIVE
SHOU-137I04	30025283400000	PROD_OIL	ACTIVE
SHOU-138I04	30025283410000	PROD_OIL	ACTIVE
SHOU-139F03	30025283420000	PROD_OIL	ACTIVE
SHOU-13C05	30025076240000	INJ_H2O	ACTIVE

SHOU-140L04	30025283430000	INJ_WAG	ACTIVE
SHOU-141K04	30025283440000	INJ_WAG	ACTIVE
SHOU-142O04	30025283450000	INJ_WAG	ACTIVE
SHOU-143P04	30025283460000	PROD_OIL	TA
SHOU-144N03	30025283470000	PROD_OIL	TA
SHOU-145K03	30025283480000	INJ_WAG	ACTIVE
SHOU-146D09	30025283490000	PROD_OIL	ACTIVE
SHOU-147C09	30025283500000	PROD_OIL	ACTIVE
SHOU-148A09	30025283510000	PROD_OIL	ACTIVE
SHOU-149A09	30025283520000	PROD_OIL	ACTIVE
SHOU-14B05	30025076140000	PROD_OIL	ACTIVE
SHOU-150M03	30025283530000	PROD_OIL	ACTIVE
SHOU-151N03	30025283540000	PROD_OIL	TA
SHOU-152A09	30025283550000	INJ_H2O	ACTIVE
SHOU-153C09	30025283560000	PROD_OIL	ACTIVE
SHOU-154B09	30025283570000	PROD_OIL	ACTIVE
SHOU-155H09	30025283580000	PROD_OIL	ACTIVE
SHOU-156H09	30025283590000	PROD_OIL	ACTIVE
SHOU-157D10	30025283600000	PROD_OIL	ACTIVE
SHOU-158C10	30025283610000	PROD_OIL	TA
SHOU-159F09	30025283620000	PROD_OIL	TA
SHOU-15A05	30025076190000	PROD_OIL	ACTIVE
SHOU-160G09	30025283630000	PROD_OIL	ACTIVE
SHOU-161G09	30025283640000	PROD_OIL	TA
SHOU-162H09	30025283650000	PROD_OIL	ACTIVE
SHOU-163K10	30025283660000	PROD_OIL	TA
SHOU-16D04	30025076050000	PROD_OIL	ACTIVE
SHOU-170J04A	30025266230000	INJ_H2O	ACTIVE
SHOU-171D09	30025285440000	INJ_H2O	TA
SHOU-172H09	30025285430000	INJ_H2O	ACTIVE
SHOU-173E10	30025287330000	INJ_H2O	ACTIVE
SHOU-174L03A	30025266220000	INJ_H2O	ACTIVE
SHOU-175A06	30025289730000	PROD_OIL	TA
SHOU-176D05	30025289740000	INJ_H2O	TA
SHOU-177D05	30025289750000	PROD_OIL	ACTIVE
SHOU-178C05	30025289760000	PROD_OIL	ACTIVE
SHOU-179F05	30025289770000	PROD_OIL	ACTIVE
SHOU-17C04	30025127680000	PROD_OIL	ACTIVE
SHOU-180B05	30025289780000	PROD_OIL	ACTIVE
SHOU-181B05	30025289790000	PROD_OIL	TA
SHOU-182F05B	30025276280002	INJ_H2O	ACTIVE
SHOU-183E05	30025289800000	PROD_OIL	ACTIVE
SHOU-184F05	30025290830000	PROD_OIL	ACTIVE
SHOU-185I05	30025290840000	PROD_OIL	ACTIVE
SHOU-186E04	30025289810000	PROD_OIL	ACTIVE
SHOU-187J05	30025076210000	INJ_H2O	ACTIVE
SHOU-188K05	30025289820000	INJ_WAG	ACTIVE
SHOU-189J05	30025290850000	INJ_WAG	ACTIVE

SHOU-18B04	30025076290000	PROD_OIL	ACTIVE
SHOU-190I05	30025290820000	INJ_WAG	ACTIVE
SHOU-191L04	30025289830000	INJ_WAG	ACTIVE
SHOU-192O05	30025244470000	INJ_H2O	ACTIVE
SHOU-193P05	30025289840000	INJ_H2O	ACTIVE
SHOU-194O05	30025290540000	PROD_OIL	ACTIVE
SHOU-195P05	30025289850000	PROD_OIL	ACTIVE
SHOU-196M04	30025289860000	PROD_OIL	P & A
SHOU-197L34	30025294440000	PROD_OIL	TA
SHOU-198C06	30025294420000	PROD_OIL	P & A
SHOU-199B06	30025294580000	PROD_OIL	P & A
SHOU-19A04	30025075980000	PROD_OIL	ACTIVE
SHOU-1D34	30025075750000	PROD_OIL	P & A
SHOU-200G06	30025294100000	PROD_OIL	P & A
SHOU-201H06	30025294590000	PROD_OIL	P & A
SHOU-202I06	30025294430000	PROD_OIL	P & A
SHOU-203L05	30025294600000	PROD_OIL	INACTIVE
SHOU-204M05	30025294110000	PROD_OIL	TA
SHOU-205N05	30025294120000	PROD_OIL	P & A
SHOU-206H06	30025295190000	INJ_H2O	P & A
SHOU-207L05	30025295200000	INJ_H2O	ACTIVE
SHOU-208N05	30025295210000	INJ_H2O	ACTIVE
SHOU-209D08	30025295220000	INJ_H2O	ACTIVE
SHOU-20D03	30025076030000	PROD_OIL	ACTIVE
SHOU-210D34	30025296770000	PROD_OIL	TA
SHOU-211E05	30025297500000	PROD_OIL	TA
SHOU-212F05	30025297510000	INJ_H2O	ACTIVE
SHOU-213A05	30025297520000	INJ_H2O	ACTIVE
SHOU-214E04	30025297300000	PROD_OIL	TA
SHOU-215E04	30025297530000	INJ_H2O	TA
SHOU-216C04	30025297540000	INJ_H2O	ACTIVE
SHOU-217B04	30025297550000	INJ_H2O	ACTIVE
SHOU-218A04	30025297560000	INJ_H2O	ACTIVE
SHOU-219D03	30025297570000	INJ_H2O	ACTIVE
SHOU-21C03	30025235300000	PROD_OIL	ACTIVE
SHOU-220C04	30025298910000	PROD_OIL	TA
SHOU-221B04	30025298920000	PROD_OIL	ACTIVE
SHOU-222L34	30025298930000	PROD_OIL	ACTIVE
SHOU-223N34	30025304860000	PROD_OIL	TA
SHOU-224B04	30025304870000	PROD_OIL	TA
SHOU-225M34	30025312110000	PROD_OIL	TA
SHOU-228D05	30025312120000	PROD_OIL	ACTIVE
SHOU-229C04	30025314200000	INJ_H2O	TA
SHOU-22C03	30025075870000	PROD_OIL	ACTIVE
SHOU-230B04	30025314210000	INJ_H2O	ACTIVE
SHOU-231F04	30025314270000	PROD_OIL	TA
SHOU-232G04	30025314190000	PROD_OIL	TA
SHOU-233G04	30025314220000	INJ_H2O	ACTIVE

SHOU-234F04	30025314280000	PROD_OIL	ACTIVE
SHOU-235K04	30025314230000	INJ_H2O	ACTIVE
SHOU-236K04	30025314290000	PROD_OIL	TA
SHOU-237O04	30025314300000	PROD_OIL	TA
SHOU-238O04	30025314240000	INJ_H2O	ACTIVE
SHOU-239	30025349460000	INJ_H2O	ACTIVE
SHOU-23B03	30025075820000	PROD_OIL	P & A
SHOU-240	30025353420000	INJ_WAG	ACTIVE
SHOU-241	30025353180000	PROD_OIL	ACTIVE
SHOU-242	30025353050000	PROD_OIL	TA
SHOU-243	30025372660000	PROD_OIL	TA
SHOU-244	30025357420000	PROD_OIL	TA
SHOU-245	30025355540000	PROD_OIL	P & A
SHOU-246	30025372710000	PROD_OIL	TA
SHOU-248	30025399550000	PROD_OIL	ACTIVE
SHOU-249	30025425400000	PROD_OIL	ACTIVE
SHOU-24A03	30025075850000	PROD_OIL	P & A
SHOU-250	30025425410000	PROD_OIL	ACTIVE
SHOU-251	30025425920000	PROD_OIL	ACTIVE
SHOU-252	30025425930000	INJ_WAG	ACTIVE
SHOU-253	30025425940000	INJ_WAG	ACTIVE
SHOU-254	30025425950000	INJ_WAG	ACTIVE
SHOU-255	30025425960000	INJ_WAG	ACTIVE
SHOU-256	30025426470000	INJ_WAG	ACTIVE
SHOU-257	30025426460000	INJ_WAG	ACTIVE
SHOU-258	30025426480000	INJ_WAG	ACTIVE
SHOU-259	30025426970000	INJ_WAG	ACTIVE
SHOU-25F06	30025076480000	INJ_H2O	P & A
SHOU-260	30025426960000	INJ_WAG	ACTIVE
SHOU-261	30025431020000	PROD_OIL	DRILL
SHOU-262	30025430990000	PROD_OIL	ACTIVE
SHOU-263	30025431030000	INJ_WAG	ACTIVE
SHOU-264	30025430960000	INJ_WAG	ACTIVE
SHOU-265	30025430970000	PROD_OIL	DRILL
SHOU-266	30025430980000	PROD_OIL	DRILL
SHOU-267	30025431040000	INJ_WAG	ACTIVE
SHOU-268	30025431000000	INJ_WAG	ACTIVE
SHOU-269	30025431060000	PROD_OIL	DRILL
SHOU-26H06	30025076410000	INJ_H2O	TA
SHOU-270	30025431050000	PROD_OIL	DRILL
SHOU-271	30025431010000	PROD_OIL	DRILL
SHOU-272	30025431070000	PROD_OIL	ACTIVE
SHOU-28F05	30025076300000	PROD_OIL	P & A
SHOU-29G05	30025076200000	INJ_H2O	TA
SHOU-2E34	30025075710000	PROD_OIL	ACTIVE
SHOU-30H05	30025076130000	INJ_H2O	ACTIVE
SHOU-31E04	30025075970000	INJ_H2O	TA
SHOU-32F04	30025076100000	INJ_H2O	TA

SHOU-33G04	30025076000000	INJ_H2O	TA
SHOU-34H04	30025075990000	INJ_H2O	ACTIVE
SHOU-35E03	30025075890000	INJ_H2O	ACTIVE
SHOU-36F03	30025075880000	INJ_WAG	ACTIVE
SHOU-37G03	30025075840000	INJ_H2O	P & A
SHOU-38H03	30025075860000	PROD_OIL	P & A
SHOU-39L05	30025076340000	INJ_H2O	ACTIVE
SHOU-3L34	30025075690000	PROD_OIL	TA
SHOU-40K05	30025076230000	INJ_H2O	ACTIVE
SHOU-41I03	30025209330000	INJ_H2O	P & A
SHOU-42L04	30025125140000	INJ_H2O	ACTIVE
SHOU-43K04	30025076010000	INJ_H2O	ACTIVE
SHOU-44J04	30025076020000	PROD_OIL	TA
SHOU-45I04	30025076070000	INJ_H2O	P & A
SHOU-46L03	30025075910000	PROD_OIL	TA
SHOU-47K03	30025075930000	INJ_H2O	TA
SHOU-48J03	30025075900000	INJ_H2O	P & A
SHOU-49I03	30025075920000	INJ_H2O	P & A
SHOU-4K34	30025075700000	PROD_OIL	ACTIVE
SHOU-50M05	30025076320000	INJ_H2O	P & A
SHOU-51N05	30025076330000	INJ_H2O	TA
SHOU-52P05	30025076180000	PROD_OIL	TA
SHOU-53M04	30025076120000	INJ_H2O	P & A
SHOU-54N04	30025076080000	INJ_H2O	ACTIVE
SHOU-55O04	30025076110000	INJ_H2O	ACTIVE
SHOU-56P04	30025076090000	INJ_H2O	ACTIVE
SHOU-57M03	30025075830000	PROD_OIL	P & A
SHOU-58N03	30025075940000	INJ_H2O	TA
SHOU-59O03	30025075960000	INJ_H2O	TA
SHOU-5P33	30025075650000	PROD_OIL	ACTIVE
SHOU-60P03	30025075950000	PROD_OIL	P & A
SHOU-61A08	30025076520000	INJ_H2O	TA
SHOU-62D09	30025076580000	PROD_OIL	TA
SHOU-63C09	30025076620000	INJ_H2O	ACTIVE
SHOU-64B09	30025076690000	INJ_H2O	ACTIVE
SHOU-65A09	30025076600000	INJ_H2O	P & A
SHOU-66D10	30025076720000	INJ_H2O	ACTIVE
SHOU-67C10	30025076760000	INJ_H2O	ACTIVE
SHOU-68B10	30025076790000	INJ_H2O	P & A
SHOU-69-A10	30025076770001	INJ_H2O	P & A
SHOU-6M34	30025075720000	PROD_OIL	ACTIVE
SHOU-70H08	30025076560000	PROD_OIL	P & A
SHOU-71E09	30025076700000	INJ_H2O	P & A
SHOU-72F09	30025076670000	INJ_H2O	TA
SHOU-73G09	30025076710000	INJ_H2O	ACTIVE
SHOU-74G09	30025234160001	PROD_OIL	P & A
SHOU-75H09	30025076630000	PROD_OIL	P & A
SHOU-76E10	30025076780000	INJ_H2O	ACTIVE

SHOU-77F10	30025076800000	PROD_OIL	P & A
SHOU-78G10	30025076810000	INJ_H2O	P & A
SHOU-79H10	30025201130000	PROD_OIL	P & A
SHOU-7N34	30025075760000	PROD_OIL	P & A
SHOU-80I08	30025076510000	PROD_OIL	P & A
SHOU-81L09	30025076660000	PROD_OIL	P & A
SHOU-82K09	30025076640000	INJ_H2O	P & A
SHOU-83J09	30025076680000	INJ_H2O	TA
SHOU-84I09	30025076590000	INJ_H2O	TA
SHOU-85L10	30025076750000	INJ_H2O	ACTIVE
SHOU-86K10	30025234150000	PROD_OIL	ACTIVE
SHOU-87K10	30025127650000	INJ_H2O	ACTIVE
SHOU-88J10	30025127240000	INJ_H2O	P & A
SHOU-89I10	30025213410000	INJ_H2O	P & A
SHOU-8D06	30025076490000	INJ_H2O	P & A
SHOU-90O09	30025201670000	INJ_H2O	SHUT-IN
SHOU-91P09	30025200470000	PROD_OIL	TA
SHOU-92M10	30025076730000	INJ_H2O	P & A
SHOU-93N10	30025127270000	PROD_OIL	P & A
SHOU-94N10	30025076740000	PROD_OIL	P & A
SHOU-95O10	30025127260000	PROD_OIL	P & A
SHOU-96O10	30025076820000	PROD_OIL	P & A
SHOU-97P10	30025220060000	INJ_H2O	P & A
SHOU-98A16	30025077000000	INJ_H2O	P & A
SHOU-99D15	30025205390000	PROD_OIL	P & A
SHOU-9C06	30025076470000	PROD_OIL	P & A
SHOU-W27E05	30025076310000	INJ_H2O	ACTIVE
SHUCOOP-1	30025283040000	INJ_H2O	TA
SHUCOOP-10	30025289690000	INJ_H2O	ACTIVE
SHUCOOP-11	30025289700000	INJ_H2O	ACTIVE
SHUCOOP-12	30025289710000	INJ_H2O	ACTIVE
SHUCOOP-13	30025289720000	INJ_H2O	ACTIVE
SHUCOOP-2	30025283050000	INJ_WAG	ACTIVE
SHUCOOP-3	30025283060000	INJ_WAG	ACTIVE
SHUCOOP-4	30025283070000	INJ_WAG	ACTIVE
SHUCOOP-5	30025283080000	INJ_WAG	ACTIVE
SHUCOOP-6	30025283090000	INJ_WAG	ACTIVE
SHUCOOP-9	30025289680000	INJ_H2O	ACTIVE

Appendix 6. Summary of Key Regulations Referenced in MRV Plan

There are four primary regulations cited in this plan:

1. See New Mexico Administrative Code 19.15.16.9 “Sealing Off Strata” found online at: http://www.emnrd.state.nm.us/OCD/documents/SearchablePDFofOCDTitle19Chapter15-Revised12-15-15.pdf.

2. 40 CFR Parts 144, 145, 146, 147

3. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-6199-F found online at: http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/256181/R-6199-F_1_HO.pdf

4. See State of New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Commission Order NO. R-4934-F found online at http://ocdimage.emnrd.state.nm.us/imaging/filestore/SantaFeAdmin/HO/253379/R-4934-F_1_HO.pdf