STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN, LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS LEA COUNTY, NEW MEXICO

CASE NOS. 23614-23617

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO.

CASE NO. 23775

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO

CASE NOS. 24018-24020, 24025

APPLICATION OF GOODNIGHT PERMIAN MIDSTREAM, LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO.

DIVISION CASE NO. 24123
ORDER NO. R-22869-A

GOODNIGHT MIDSTREAM PERMIAN, LLC's, NOTICE OF ERRATA AND OF FILING REVISED SUR-REBUTTAL OF WILLIAM J. KNIGHTS, P.G.

Goodnight Midstream Permian, LLC ("Goodnight") respectfully provides notice of filing the attached Revised Sur-Rebuttal of William J. Knights, P.G., in order to correct a typographical error in Figure 13 of the Sur-Rebuttal of William J. Knights, P.G., previously filed in the above-captioned matters. During preparation for the second section of the hearing in this matter, Mr.

Knights identified an error in Figure 13, which stated 16,000 BO, but should have stated 19,000 BO. The attached Revised Sur-Rebuttal corrects that typographical error.

DATED: April 4, 2025

Respectfully submitted,

HOLLAND & HART LLP

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EXHIBIT A

STATE OF NEW MEXICO
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OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM
PERMIAN, LLC FOR APPROVAL OF
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CASE NO. 23775

APPLICATIONS OF EMPIRE NEW MEXICO LLC
TO REVOKE INJECTION AUTHORITY,
LEA COUNTY, NEW MEXICO

CASE NOS. 24018-24027

Revised Rebuttal Report of: William J. Knights, P.G.
April 1, 2025

NETHERLAND, SEWELL & ASSOCIATES, INC.

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INTRODUCTION

My name is William J. Knights. I work for Netherland, Sewell & Associates, Inc. (NSAI) as Vice President and Senior Technical Advisor. I have been with NSAI since 1991.

I provided direct written testimony in these cases that were filed with the Commission on August 26, 2024, on behalf of Goodnight Midstream Permian, LLC (Goodnight). I have been asked to prepare rebuttal testimony in response to Ops Geologic, LLC (OPS) witness testimony of Empire Petroleum Corporation (Empire) that (I) Loco Hills Field has relevant type log, that the chronostratigraphy is an effective correlation technique, and that there is not a permeability barrier between the potential residual oil zones (ROZ) and the Goodnight injection interval; (II) that 4.0 percent total porosity is a reasonable net pay cutoff to use in estimation of oil-in-place (OIP) and that 1.5 percent effective porosity is a reasonable definition for a vertical permeability barrier (baffle); (III) oil saturation uplift above core measurements of greater than 100 percent is reasonable; and (IV) OPS's San Andres top structure and well penetrations indicate communication between the Grayburg Reservoir and San Andres Aquifer, that the OIP estimated in the San Andres Formation is an ROZ, and that the volumes presented are a realistic and viable target for economic recovery.

SUMMARY OF REFUTATIONS

The following is a summary of my opinions, all of which are rendered within a reasonable degree of professional certainty:

I. Type Log Relevance and Grayburg Formation and San Andres Aquifer Separation

Loco Hills Field, from where the OPS type log was taken, is 50 miles from the Eunice Monument South Unit (EMSU), with many closer San Andres Formation penetrations between the two locations. This is significant because lithostratigraphic classification is more effective than chronostratigraphic picks in defining reservoirs because of depositional variability. NSAI evaluated rock characteristics for hydrocarbon recovery independent of stratigraphic nomenclatures. Mr. Bailey and Dr. Lindsey identify the presence of a regional unconformity at the top of the San Andres Formation, defined by stylolite and anhydrite layers, which are known to form efficient permeability barriers in carbonate environments.

II. Baffles, Permeability, and Net Pay

Mr. Birkhead's use of a 1.5 percent effective porosity (PHIE) threshold for vertical reservoir boundaries and a 4.0 percent total porosity (PHIT) cutoff for net oil pay is inconsistent with industry-standard minimum permeability for oil flow of 1 millidarcy (mD) thresholds. At EMSU, the 1mD threshold for oil to flow corresponds to 7.0 and 10.0 percent PHIE cutoffs. His 1.5 PHIE cutoff for a vertical baffle and 0.5 percent PHIT vertical baffle cutoff, corresponding to a 0.00008 mD, is an unreasonably low threshold for a vertical permeability barrier. His interpreted permeability barriers appear more influenced by lithologic interpretation rather than consistent reservoir characteristics, and his OIP estimates are overly optimistic because of the use of a low PHIE cutoff. Additionally, carbon dioxide (CO_2) flooding efficiency is impacted by permeability distribution, with less than 30 percent of OPS's estimated net pay having PHIE above 10.0 percent and greater than 1.0 mD permeability, limiting effective CO_2 contact for enhanced oil recovery into lower porosity original oil-in-place (OOIP).

III. Oil Saturation Estimation and Comparison to Core Data

Mr. Birkhead's assumption that core oil saturation (S_o) significantly underpredicts actual S_o contradicts ROZ process theory, which suggests natural water flushing removes lighter oil, thus reducing the oil formation volume factor (B_o).

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OPS's models estimate significantly higher S_o than core measurements. The EMSU 746 well tested 100 percent water production, despite OPS predicting high oil saturation, well above common industry standard, and irreducible oil saturations, indicating that OPS's S_o estimates are overly optimistic and inconsistent with core and reservoir data.

IV. Structure and OOIP

The interpretation of the San Andres Formation top and oil column in the EMSU remains highly debated, with Mr. Bailey asserting communication between the Grayburg and San Andres Formations through fractures, though pressures and depletion variability support their separation. OPS's estimates of OOIP are criticized as overly optimistic because of high S_o assumptions and unrealistic porosity/permeability net pay cutoffs, leading to inflated projections that lack economic viability. The definition of an ROZ, the contradiction of irreducible oil saturations, and the comparison to the S_o characteristics in Tall Cotton Field highlight less favorable EMSU reservoir characteristics. This suggests significantly lower recovery factors and casts significant doubt on the economic feasibility of OPS's OOIP estimates, particularly in the lower San Andres Aquifer.

GEOLOGIC REFUTATIONS

I. Type Log Relevance and Grayburg and San Andres Aquifer Separation

Loco Hills Field, from where the OPS type log was taken, is located 50 miles away from the EMSU, with more than 50,000 San Andres Formation penetrations closer to the EMSU, as shown in Figure 1. Loco Hills Field is located on the Northwestern Shelf, a different geologic province than the Central Basin Platform. The dolomite described at the top of the San Andres Formation and Lovington Sand at Loco Hills Field are found locally and do not necessarily extend 50 miles away to the EMSU, which is in a different geologic setting on the western margin of the Central Basin Platform.

The subunit nomenclature and top of the San Andres reservoir vary widely depending on the interpreter. For example, the top of the San Andres reservoir differs across NuTech Energy Alliance Ltd's first and second analyses, the later OPS tops, and earlier versions interpreted by Goodnight, Chevron Corporation, XTO Energy Inc., Occidental Petroleum Corporation, and others, including Empire.

In Mr. Bailey's rebuttal, he stated that he used a chronostratigraphic pick to define the top of the San Andres reservoir. However, a chronostratigraphic pick is not a functional reservoir pick because multiple different depositional environments co-exist laterally at any one time depositing a range of lithologies. A better approach for defining reservoirs is to use a lithostratigraphic framework that categorizes specific lithologies and rock characteristics. In shallow-water carbonate environments such as the EMSU, the lateral extent of a given lithology or rock type cross time boundaries as sea levels rise and fall and can vary dramatically over short distances. In cases like this, a simpler classification model—such as distinguishing between reservoir and non-reservoir—is more functional.

The NSAI interpretations are independent of each group's stratigraphic nomenclature. Instead, NSAI evaluates the rocks based on their characteristics related to hydrocarbon storage and recovery. Regardless of its nomenclature, the rock remains at the same depth and spatial coordinates, with specific petrophysical characteristics. This approach provides a more accurate assessment of oil volume relative to potential economic recovery.

Mr. Bailey states on page 6 of his rebuttal, "I agree that the Grayburg and San Andres are separate geologic intervals. We define the top of the San Andres as the tight dolomite sequence approximately 130-150' above the Lovington Sand and thinning to the east onto the Eunice Monument anticline, where it is approximately 100' below the top of the San Andres in the R.R. Bell 4. The top of the San Andres is correlated by a tight dolostone/anhydrite sequence identified using gamma ray (GR), density (RHOB), density/neutron porosity (DPHI/NPHI), sonic (DT), and photoelectric (PE) log curves." Dr. Lindsey states, "The San Andres top is a regional unconformity. Core tied back to well logs is the surest way to identify the top of the San Andres." These statements suggest that a regional unconformity exists at the top of the San Andres reservoir, which Mr. Bailey defines as a tight dolomite and dolostone/anhydrite sequence that he has mapped across the EMSU. Honarpour et al. (2010) comments on how anhydrite can affect vertical permeability "One to two orders of magnitude reduction in vertical permeability are measured when stylolite and anhydride layers appear." These are reasonable stratigraphic permeability barriers as defined by Mr. Bailey, vertically isolating the Grayburg Producing Interval and ROZ from the deeper Goodnight San Andres Aquifer.

II. Baffles, Permeability, and Net Pay

Mr. Birkhead's rebuttal states: "Looking at the EMSU 746 as an example in Exhibit L-7 shows a baffle flag created by OPS Geologic to show where effective porosity drops below 1.5%. The rarity of this flag on the plot suggests more continuity of pathways than extensive baffling." However, his assessment conflicts with the literature he has relied upon for his rebuttal testimony. Honarpour et al. (2010) writes: "The vertical permeability, measured on full-diameter cores was mostly between 0.1 and 100% of horizontal permeability, occasionally showing much lower vertical to horizontal permeability, attributed to local discontinuous baffles. Discontinuous stylolites and anhydrites at bedding-scale create a more tortuous path for fluid flow in the vertical direction. The impact of these stylolite and anhydrite baffles can be seen in vertical permeability measured on full-diameter cores. One to two orders of magnitude reduction in vertical permeability are measured when stylolite and anhydride layers appear." This suggests that vertical permeability would be dramatically lower Mr. Birkhead's 1.5 percent PHIE cutoff.

Mr. Birkhead's 4.0 percent PHIT is used to determine his net oil pay, but he uses the 1.5 percent PHIE threshold for determining a baffle. Industry-standard conventional permeability cutoffs for oil net pay are 1.0 mD for oil and 0.1 mD for gas. The concept of using a 1.5 percent PHIE to define a baffle, versus a 4.0 percent PHIT as a net pay cutoff, is inconsistent with the permeability models Mr. Birkhead employs.

The relationship of Mr. Birkhead's PHIE to the three Lucia permeability models he used in his rebuttal is shown in Figure 2. The 1.5 percent PHIE Mr. Birkhead suggests for baffles corresponds to a maximum permeability of 0.00008 mD, far below the industry standard of 1.0 mD. In fact, his graph indicates a 7.0 or 10.0 percent PHIE porosity would more closely align with the conventional oil net pay cutoff of 1.0 mD and more commonly be used to define a baffle. Permeability distributions play a crucial role in determining recovery factors, as oil mobility is limited by low-permeability rocks.

High-permeability layers can cycle fluid through the reservoir, bypassing oil in lower-permeability intervals, as observed in the EMSU Grayburg waterflood. Similarly, the CO_2 flood will preferentially move through high-porosity and high-permeability layers identified in the ROZ in both the Grayburg and the San Andres Formations, leading to early CO_2 breakthrough and poor conformance, ultimately reducing recoveries compared to reservoirs with more homogeneous porosity and permeability properties.

Vertical permeability is typically lower—and often significantly lower—than horizontal permeability, thus applying horizontal permeability values to define vertical permeability barriers may dramatically overestimate vertical flow barriers. My estimates of vertical permeability barriers across the crest of the structure, represented by the EMSU 457 and EMSU 746 wells, based on Birkhead's log analysis, are shown in Figure 3. The black boxes adjacent to the stratigraphic column indicate zones where porosity falls below 7.0 percent PHIE, corresponding to approximately 0.05 to 1.00 mD based on the Lucia permeability model Mr. Birkhead used. Mr. Birkhead's baffle flags, represented by thin colored bars directly to the right of the stratigraphic column, are more prominent in the EMSU 457 well but almost nonexistent in the EMSU 746 well. In many places where the permeability curves fall below the 0.20 mD scale on the lefthand side of Figure 3, Mr. Birkhead does not show his baffle flags. His sand estimation for these two wells is also highly inconsistent with the development of vertical barriers, with the

EMSU 746 well being nearly devoid of sand, while the EMSU 457 well is relatively dominated by sand throughout. This is a good indicator that Mr. Birkhead's permeability barriers are more related to his lithologic interpretation.

Multiple permeability barriers exist below the Grayburg Formation producing oil-water contact (POWC) at -350 feet (ft) true vertical depth subsea (TVDSS), based on a 7.0 percent PHIE threshold for vertical permeability barriers rather than Mr. Birkhead's 1.5 percent. The evidence supports the conclusion that across the EMSU the Grayburg Reservoir is separated from the underlying San Andres Aquifer. Mr. Birkhead's claim that the rarity of baffle flags suggests continuity of fluid pathways is inconsistent with industry-standard definitions for vertical permeability barriers.

Another key permeability-related issue is the amount of net oil pay thickness used in volumetric OIP estimates. Mr. Birkhead states, "Oil saturation of the ROZ should be viewed as a spectrum, not an absolute value." While industry standards also consider net oil pay as a spectrum, his sensitivity analysis only varied oil saturation (S_o) for the low- and high-case scenarios. A more reasonable approach would be to use a series of porosity cutoffs and an OPS low-side S_o of 20 percent, rather than relying solely on two OPS S_o values for sensitivity analysis.

A comparison of net oil pay thickness based on OPS's 4 percent PHIE and 20 percent S_o cutoffs with a more conventional analysis of movable oil (1mD rock) using 7 percent and a more conservative 10 percent PHIE cutoff is shown in Figure 4. Applying a 7 percent PHIE cutoff reduces the feet of net oil pay to 68 percent of OPS's estimates – while a 10 percent PHIE cutoff (where most rocks had permeabilities above 1 mD) – further reduces the feet of net oil pay to 31 percent of OPS's estimates. Assuming the models accurately estimated S_o, OPS's use of a 4 percent PHIE cutoff for both high and low cases presents an overly optimistic view of net oil pay thickness compared to industry standards.

The net oil pays ft in Figure 4 are color-coded to represent the various TVDSS intervals. The Grayburg Reservoir's production interval ranges from -100 to -350 ft TVDSS, terminating at the POWC. Below the POWC, the next 150 ft, down to -500 ft TVDSS, is considered the potential ROZ. Beneath the ROZ, a transition zone extends to -700 ft TVDSS, followed by the deepest interval, the aquifer, below -700 ft TVDSS.

A comparison of OPS's and NSAI's S_o across four distinct depth intervals in the EMSU is shown in Figure 5. Most OPS net oil pay is concentrated in the producing interval and the potential ROZ, with significantly less pay calculated in the deeper transition and aquifer intervals. OPS identified the San Andres top above the POWC, extending into the oil-producing interval. While some oil is present in shallower, separate, and isolated intervals above -500 ft TVDSS, these volumes are insignificant to economic recovery. The same can be seen in the R.R. Bell #4 well shown in Figure 6.

The EMSU 746 well, which tested 100 percent water in the San Andres Formation, highlights in Figure 7 how the OPS unique saturation algorithm consistently assigns high oil saturations to lower porosity rocks, while higher porosity, high-permeability rocks exhibit very low oil saturations. A key factor in CO_2 flooding is the ability to contact the net oil pay with CO_2. Lower permeability reduces the likelihood of CO_2 reaching the oil. As shown in Figure 4, less than 30 percent of the total OPS net pay has a PHIE greater than 10 percent, making it the most likely to interact with injected CO_2. An additional 37 percent of OPS net oil pay has a PHIE above 7 percent, suggesting some potential for CO_2 contact. The remaining 32 percent of OPS net pay, with lower permeability, is less likely to be contacted by CO_2, limiting its effectiveness in enhanced oil recovery.

III. <u>Oil Saturation Estimation and Comparison to Core Data</u>

Mr. Birkhead states, "The wireline data established very high resistivities parallel with porosity development denoting hydrocarbon, along with comparative zones of porosity with low resistivity denoting water. Core residual oil saturations are lower than the in-situ value due to degassing and flushing by water-based mud." He sites Egbogah: "Most authors conclude that the oil saturation in the reservoir is at least as great as, and probably appreciably greater than, the saturation measured on the core samples." (Egbogah et al., 1997; Wisenbaker, 1973, Tu et al., 2017). However, the concept of core S_o being appreciably higher is inconsistent with the ROZ process theory. The concept of a ROZ is that the rocks have already had a natural power washing from water flow which would eliminate the lighter, more mobile oil, leaving behind less volatile oil. The B_o post flush would be lower than the initial oil formation volume factor (B_{oi}) due to this flushing. The amount of increase in the S_o above core measurements would be very dependent on the pre-flush B_{oi} and post-flush B_o in the ROZ. OPS's use of the same B_o for the producing Grayburg Formation and the ROZ is inappropriate.

Using flushing in a conventional producing zone as an analogy for adjusting core S_o would be inappropriate without carefully considering the reservoir and fluid properties. As demonstrated in Figures 5 and 6, OPS models estimate significantly higher S_o than what is measured in the cores from the EMSU 679 and RR Bell wells. Specific intervals show substantial deviations from core S_o in OPS's Low and High Case scenarios. Reservoir fluids at high oil saturations and normal reservoir conditions usually become mobile during testing. This effect is amplified with the extra pressure drawdown created by using an electric submersible pump (ESP). The mudlog for the EMSU 746 well (Figure 7) shows perforations in the deeper zone at -1,500 TVDSS that yielded no fluorescence, no oil cut, and no gas beyond background levels. This zone was perforated and tested with an ESP and produced 100 percent water. OPS calculates 80 percent oil in the High Case and over 60 percent oil in the Low Case. Apart from the OPS log analysis, all other metrics suggest that there is no oil saturation in this interval. The test results on this interval, combined with deviations from core S_o and the lack of any mudlog shows, indicate that the OPS S_o estimates are unreasonably high and not an indicator of recoverable oil.

A comparison of S_o versus the PHIE distribution for the OPS Low Case and core data from the EMSU 679 well is shown in Figure 9. As shown in Figure 8, the OPS model assigns high S_o to low-porosity intervals, contradicting the EMSU 679 well core data that shows that lower-porosity rocks do not exhibit higher oil saturations. Additionally, core data does show lower S_o in the deeper aquifer intervals, consistent with a non-ROZ saturation profile of less than 20 percent S_o. This trend of decreasing S_o below the depth levels that define an ROZ is not observed in the OPS log analysis. OPS log's S_o inconsistency with core measurements is further evidence that OPS log analysis is overly optimistic in estimating moveable oil saturations.

IV. Structure and OOIP

There has been significant debate regarding the location of the San Andres Formation top across the EMSU. In the latest Empire expert interpretation of the San Andres Formation structure top, a substantial number of wells have penetrated below this interpreted top and the POWC at -350 ft TVDSS. The structural crest is concentrated in a small portion of the EMSU (Figure 10). The inset map shown on the right side of Figure 10 identifies wells that have been drilled through the OPS-defined San Andres oil column and into the San Andres water column in this area. Mr. Bailey also identifies the EMSU 658, EMSU 628, and EMSU 713 as wells that have penetrated the San Andres Formation. He strongly asserts that communication exists between the Grayburg and San Andres Formations based on the Lindsey fracture study, which identified fractures up to three ft in height. These small fractures could reasonably connect the uppermost portion of the OPS-defined water-wet San Andres Formation below -350 TVDSS (POWC) to wells drilled close to this depth. To maintain internal consistency, this would be an obvious source of San Andres Formation water that is unrelated to Goodnight's disposal injection without requiring large, undocumented fractures penetrating multiple vertical permeability barriers into the deeper San Andres Aquifer, hundreds of ft below.

The available data overwhelmingly supports the separation and isolation of the shallower oil columns in both the producing Grayburg reservoir and the ROZ above the transition zone from the deeper Goodnight water injection interval. Mr. Bailey states, "The cross sections I've provided (Exhibits K-10 through K-14) clearly show that oil saturations are above 20 percent and potentially above 40 percent throughout the Upper San Andres." This, along with the OPS structural and stratigraphic interpretation, and the OPS San Andres OOIP maps, indicates that San Andres OOIP is concentrated in the small area at the crest of the structure. However, this area has been drilled through by many historical wells and has likely been partially drained because of these completions or through communication via the small fractures described by Dr. Lindsey that are not related to the San Andres Aquifer.

The interpretation of OOIP from Mr. Birkhead's petrophysical analysis in the lower San Andres is strongly disputed by contradictory data, which suggests no economically significant OOIP is present in this interval. This further supports the conclusion that any viable OOIP is located at significantly shallower depths and remains separated and isolated from any lower San Andres water injection.

The two OOIP sensitivities presented by OPS are based on highly optimistic S_o estimates that exceed measured core data, as well as overly optimistic porosity and permeability cutoffs derived from the data provided by Mr. Birkhead. The extrapolation of these petrophysical estimates across the EMSU leads to significantly inflated OOIP estimates. Mr. Bailey states "That brings the OOIP volumes for the total San Andres to 630 millions of barrels (MMBLS) for the low case and 1,049 MMBLS for the high case (Exhibit K-55)" but does not address the economic analysis of a project. OOIP should be evaluated at the individual economic unit level, taking into account well counts and recovery efficiency. Estimating large OOIP numbers by extrapolating across an area and thickness does not have any relevance to an economic development analysis. Industry-standard evaluation models developed for the unconventional space use a section as a practical economic unit, allowing for a manageable analysis of the reservoir's economic viability. Mr. Metzer and Mr. Trentham present Tall Cotton Field as the only single isolated ROZ development that could give some indication of recovery efficiency or recovery factor relative to an ROZ target. Our analysis of Tall Cotton Field estimated ultimate oil recovery and recovery efficiency is shown in Figures 11 and 12.

Public data from the Texas Railroad Commission hearing provides the initial field rules used to develop this CO_2 project. For the Tall Cotton ROZ, the average porosity is 12 percent, while the EMSU has an average PHIE of 8 percent. The average core S_o for Tall Cotton is 25.0 percent, whereas the EMSU 679 well has a core S_o of 14.5 percent. The average uplift for Tall Cotton log analysis S_o was 100 percent, resulting in an average field S_o of 50 percent, which aligns with Mr. Birkhead's uplift in his low case. Another key distinction from the EMSU OPS interpretation is that in the Tall Cotton ROZ field, the higher oil saturations are found in the higher porosity rocks, whereas in the OPS interpretation, higher S_o is observed in lower porosity rocks. This difference impacts the potential for CO_2 to contact the oil, positively for Tall Cotton, as CO_2 is more likely to contact oil in higher porosity rocks, and negatively for the EMSU, where CO_2 may have less efficient contact with oil in lower porosity rocks.

The three porosity cutoffs used in my sensitivity analysis for the OPS EMSU are marked on the graph on the right-hand side of Figure 12. One striking difference between the two analyses is that 95 percent of the Tall Cotton interval is above 7 percent porosity, with most above 10 percent, compared to 68 percent and 31 percent net oil pay respectively for the EMSU. The graph also shows that, using Mr. Birkhead's 4 percent cutoff, Tall Cotton Field is essentially 100 percent net oil pay.

I evaluated the recovery factor analysis for Tall Cotton Field using the petrophysical analysis parameters presented to the Texas Railroad Commission, which reasonably compare with Mr. Birkhead's uplift in oil saturations above core measurements. The results, based on an estimated ultimate recovery of 8 millions of barrels of oil (MMBO) in Tall Cotton Field, show a 6 percent recovery factor for a 70-well development across one 640-acre section (about 10-acre spacing). Given the less favorable characteristics of the EMSU, 6 percent would be a high-side case, and a reasonable recovery range for the EMSU would be from 1 percent to 6 percent, based on the assumptions that Mr. Birkhead's oil net pay using 4 percent cutoffs, Mr. Bailey's mapping of OIP, and Empire's B_{oi} estimate of 1.3 are accurate.

The Mr. Bailey and Mr. Birkhead OOIP mapping, shown in Figure 13, highlights the highest OOIP concentration over a small portion of the EMSU. Using these estimates in the best OOIP areas, the potential range of recoverable oil from the Tall Cotton review results in oil-per-well values ranging from approximately 2,000 barrels of oil (BO) to as high as 19,000 BO per well. These estimates are based on 10-acre spacing, or 64 wells per section, whereas

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the EMSU is on 40-acre spacing, which is approximately 16 wells per section. If the reasonable net oil pay scenarios were applied to this analysis, these estimates would be reduced by 32 percent and 69 percent, respectively. Noticeably, Mr. Bailey's maps use OOIP per section or MMBO per section, which, along with the development spacing and recovery efficiency from Tall Cotton Field, respectively, can be used as a reasonable range of potential oil recoveries.

Given the OPS OOIP estimates presented and the supporting evidence, I believe that the OPS petrophysical analysis in the lower San Andres Formation is, at best, speculative and not supported by evidence or data regarding the OOIP volume. Additionally, while the upper San Andres Formation interval is less speculative, it has insignificant OOIP to suggest any economically recoverable volumes of oil.

DISCLAIMER

This report summarizes my analysis and opinions to date. I reserve the right to amend or supplement this report, if necessary, should additional information become available to me, and to rebut any related opinions reached by experts related to these cases. All the opinions and conclusions herein are rendered to a reasonable degree of professional certainty.

I affirm under penalty of perjury under the laws of the State of New Mexico that the foregoing statements are true and correct. I understand that this self-affirmed statement will be used as written testimony in this case. This statement is made on the date next to my signature below.

Sincerely,

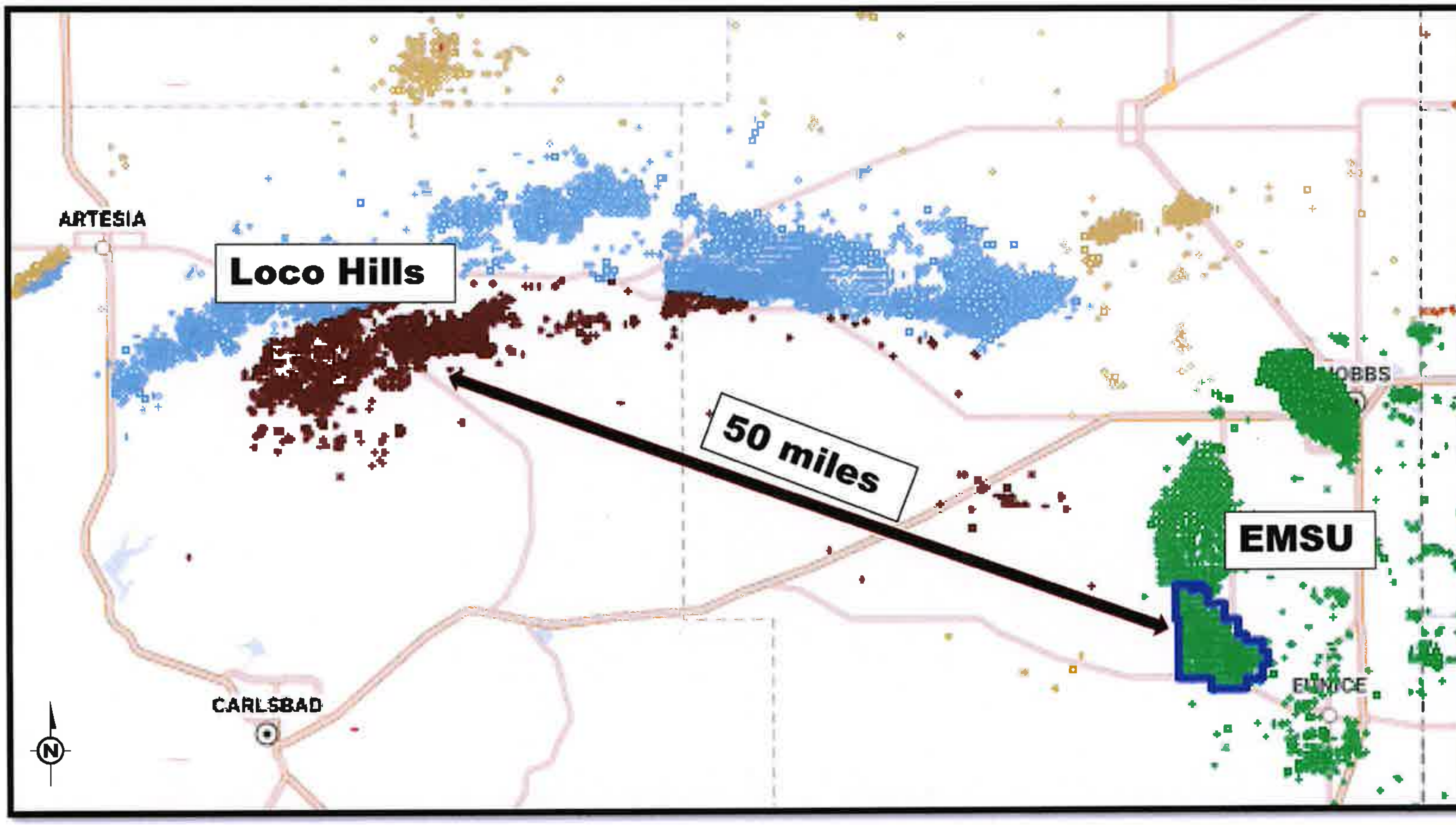
William J. Knights, P.G. 1532
Vice President

Date Signed: April 1, 2025

STATE OF TEXAS
W. J. KNIGHTS
GEOLOGY
1532
LICENSED
PROFESSIONAL GEOSCIENTIST

WJK:LMS

NETHERLAND, SEWELL & ASSOCIATES, INC.



Permian Basin
New Mexico

OPS Type Log Location Map

SCALE IN MILES
0 5 10 15 20

All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 1

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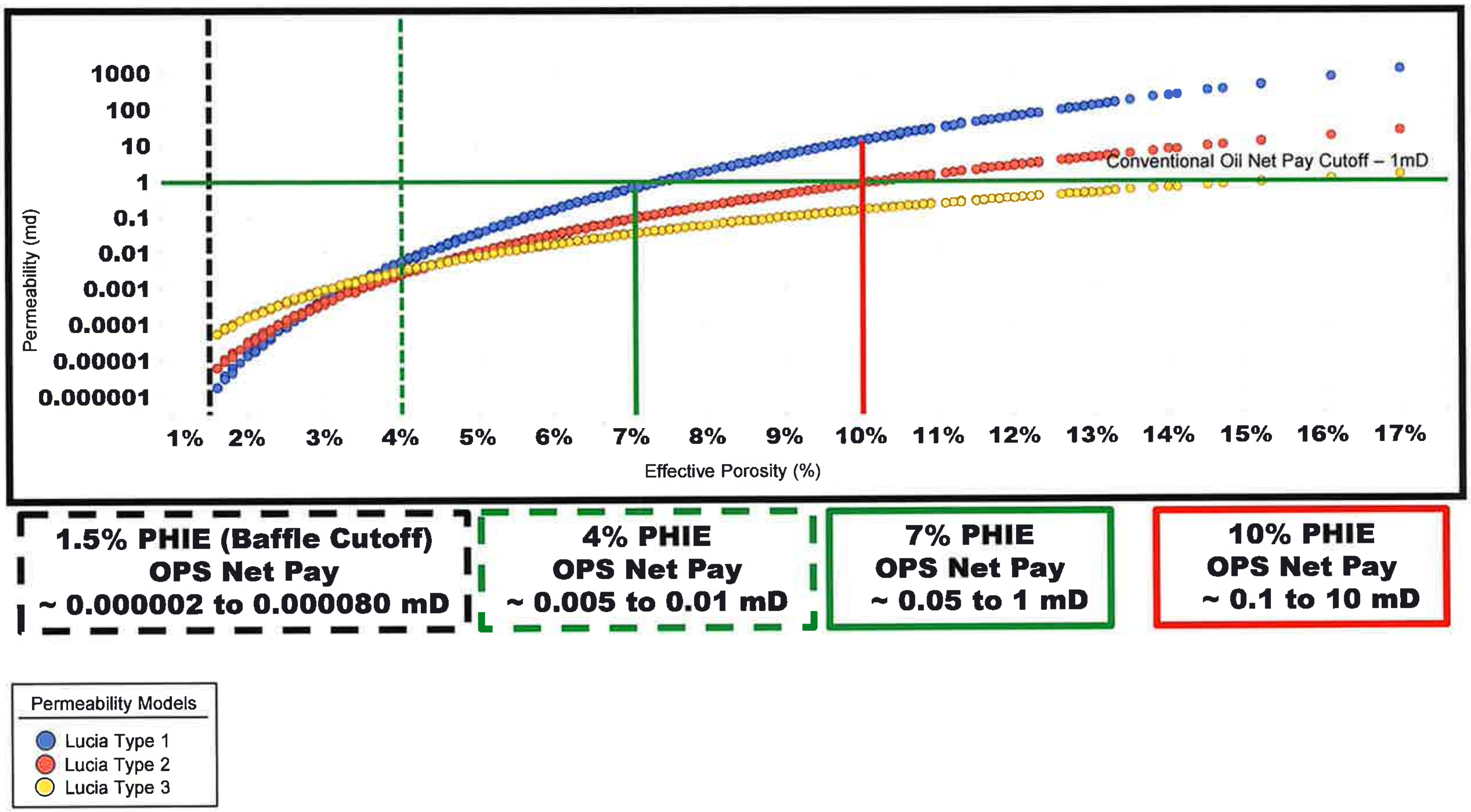
OPS Porosity versus Permeability
Eunice Monument South Unit Area
Lea County, New Mexico



All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 2

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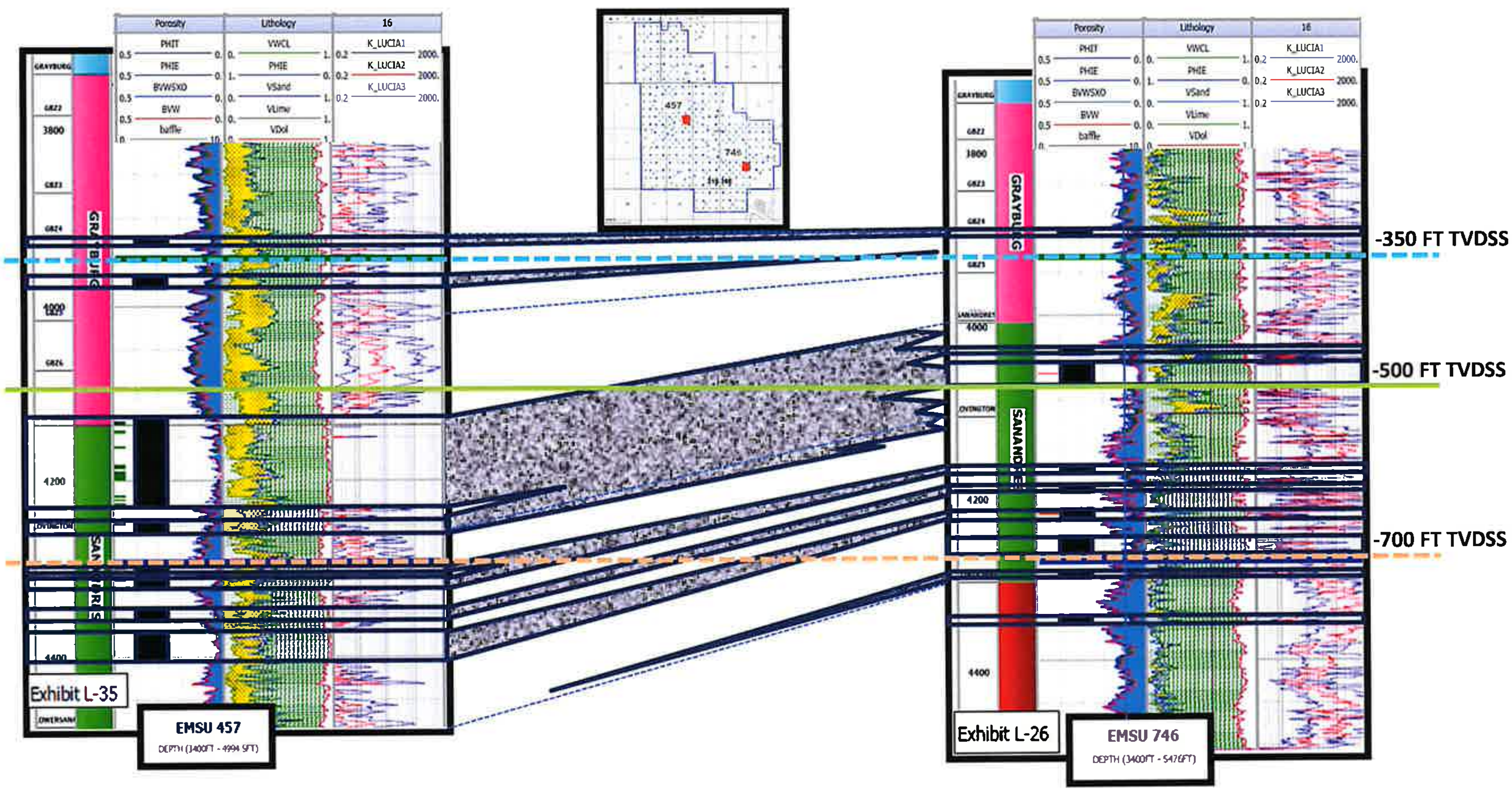
Vertical Permeability Barriers
Grayburg Reservoir and San Andres Aquifer
Lea County, New Mexico



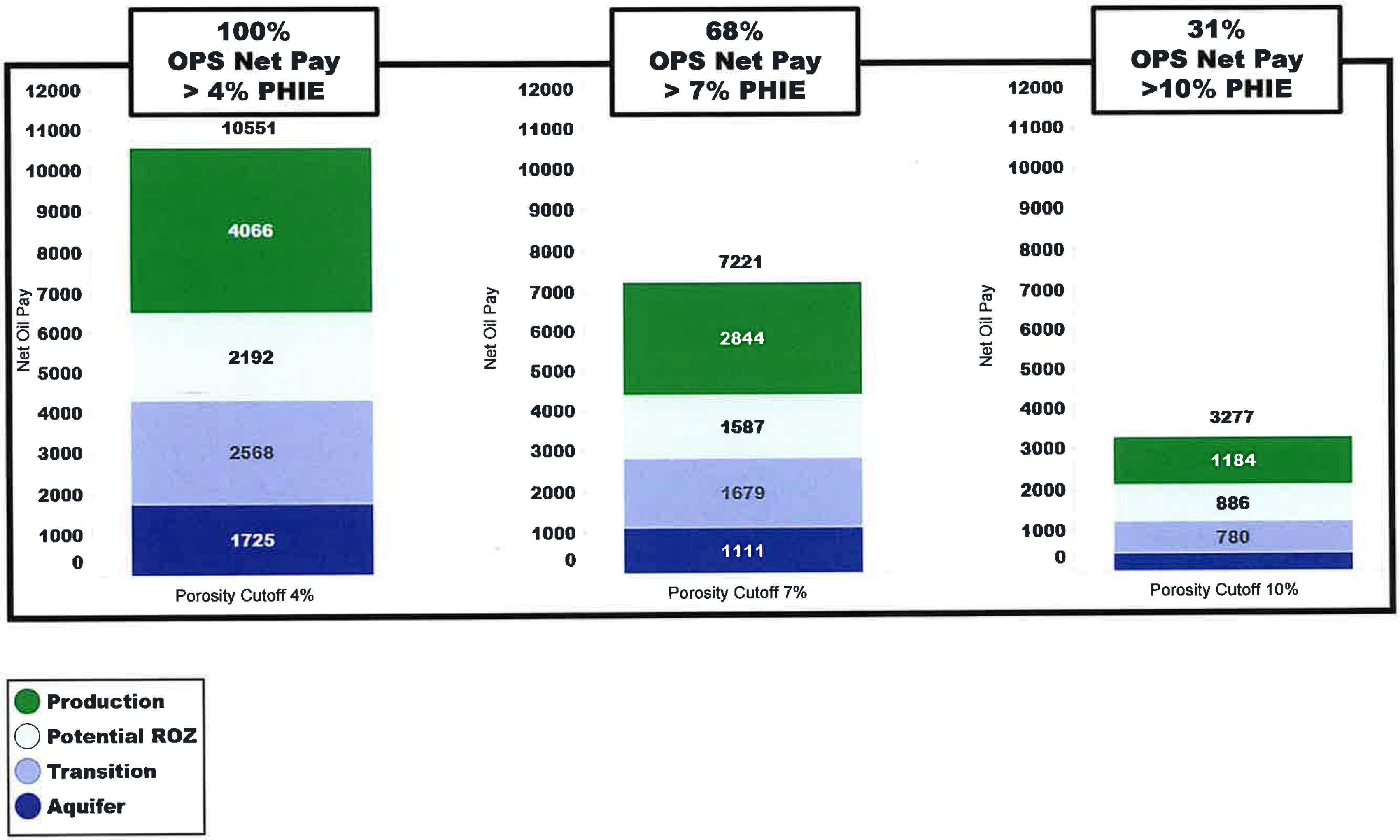
Vertical permeability barriers ~Hz 0.05 to 1.00 mD (~ 7% Effective Porosity)

All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 3

NETHERLAND, SEWELL & ASSOCIATES, INC.

Porosity Sensitivity Cases
Eunice Monument South Unit Area
Lea County, New Mexico



All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 4

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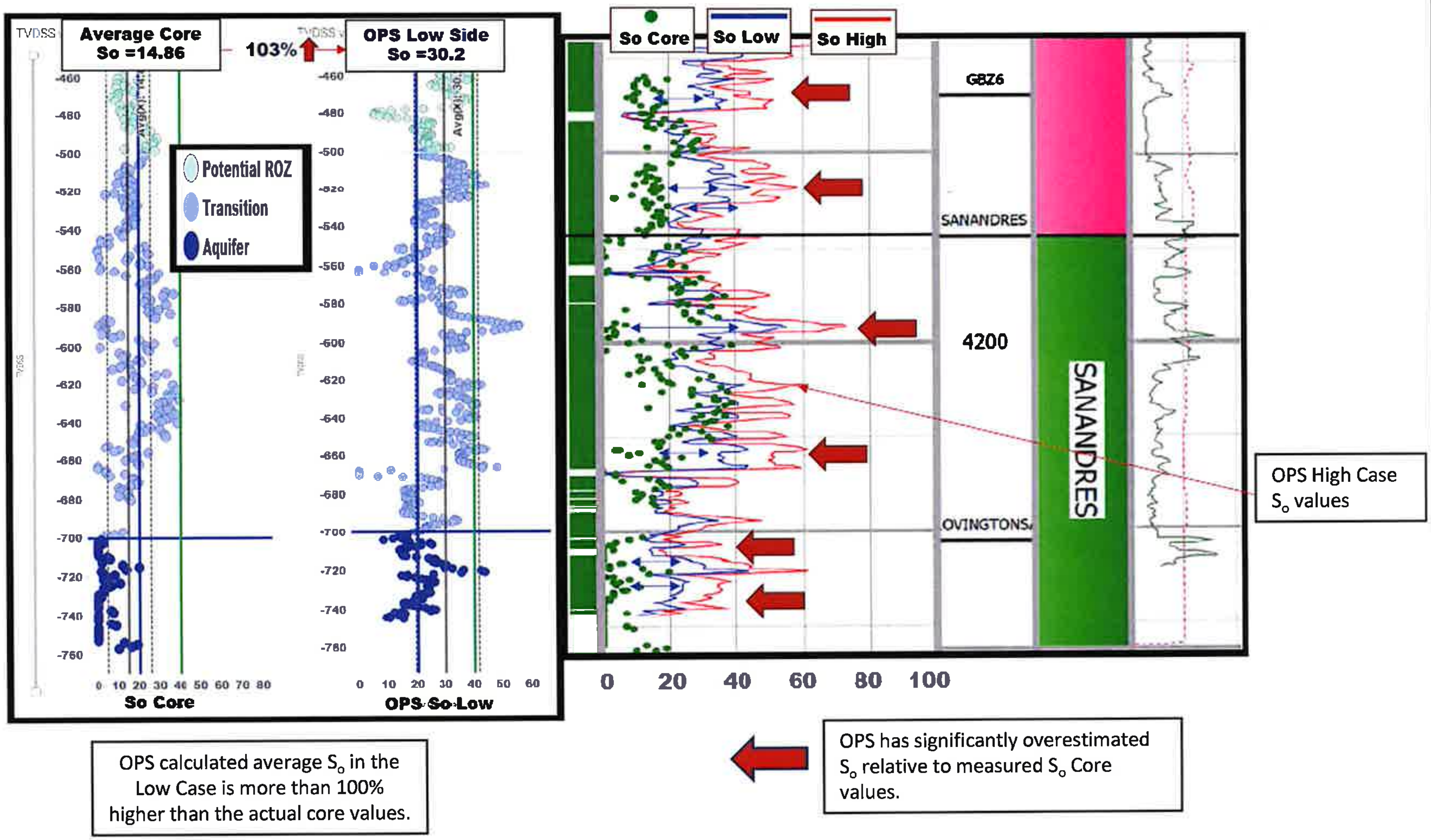
EMSU 679 Core and OPS Modeled Oil Saturation Comparison
Eunice Monument South Unit Area
Lea County, New Mexico

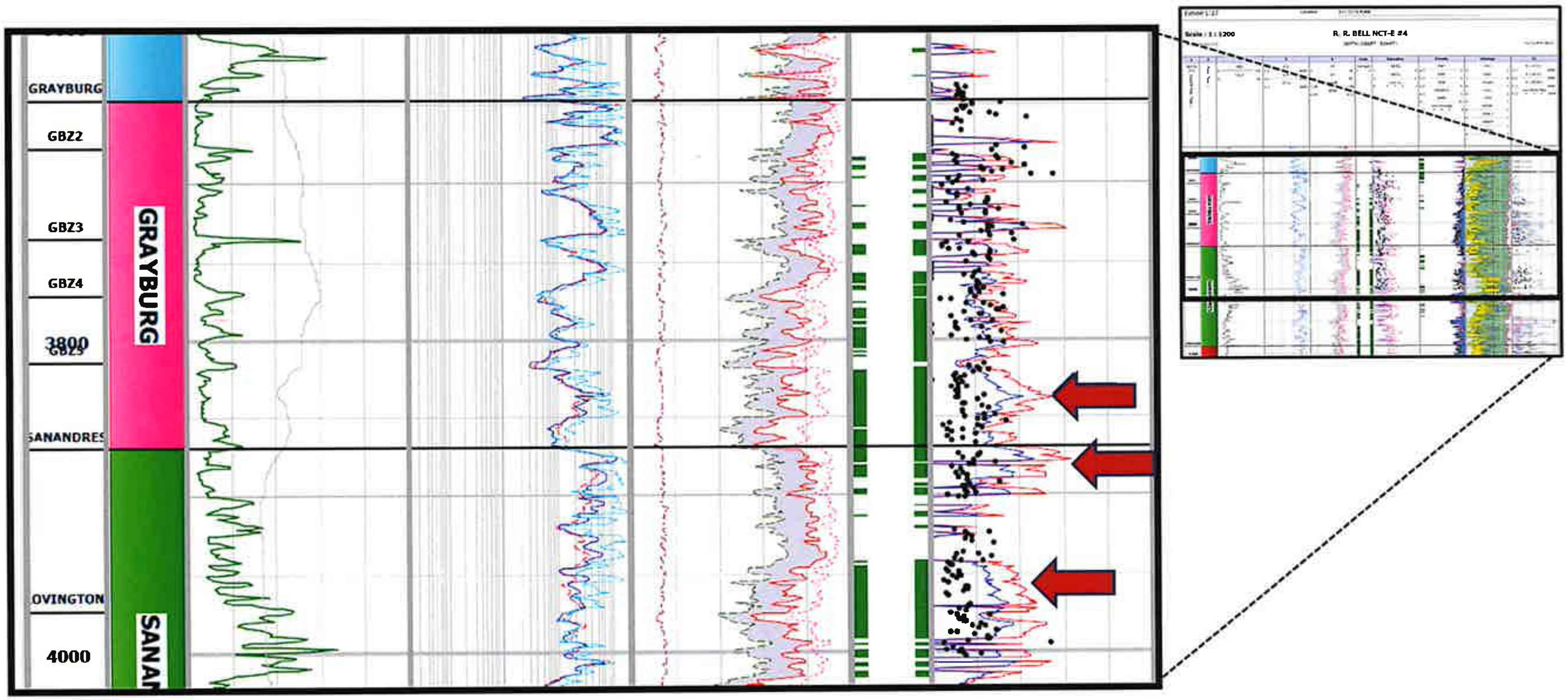


All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 5

NSAI NETHERLAND, SEWELL & ASSOCIATES, INC.

NCT-E #4 Core and OPS Modeled Oil Saturation Comparison
Eunice Monument South Unit Area
Lea County, New Mexico



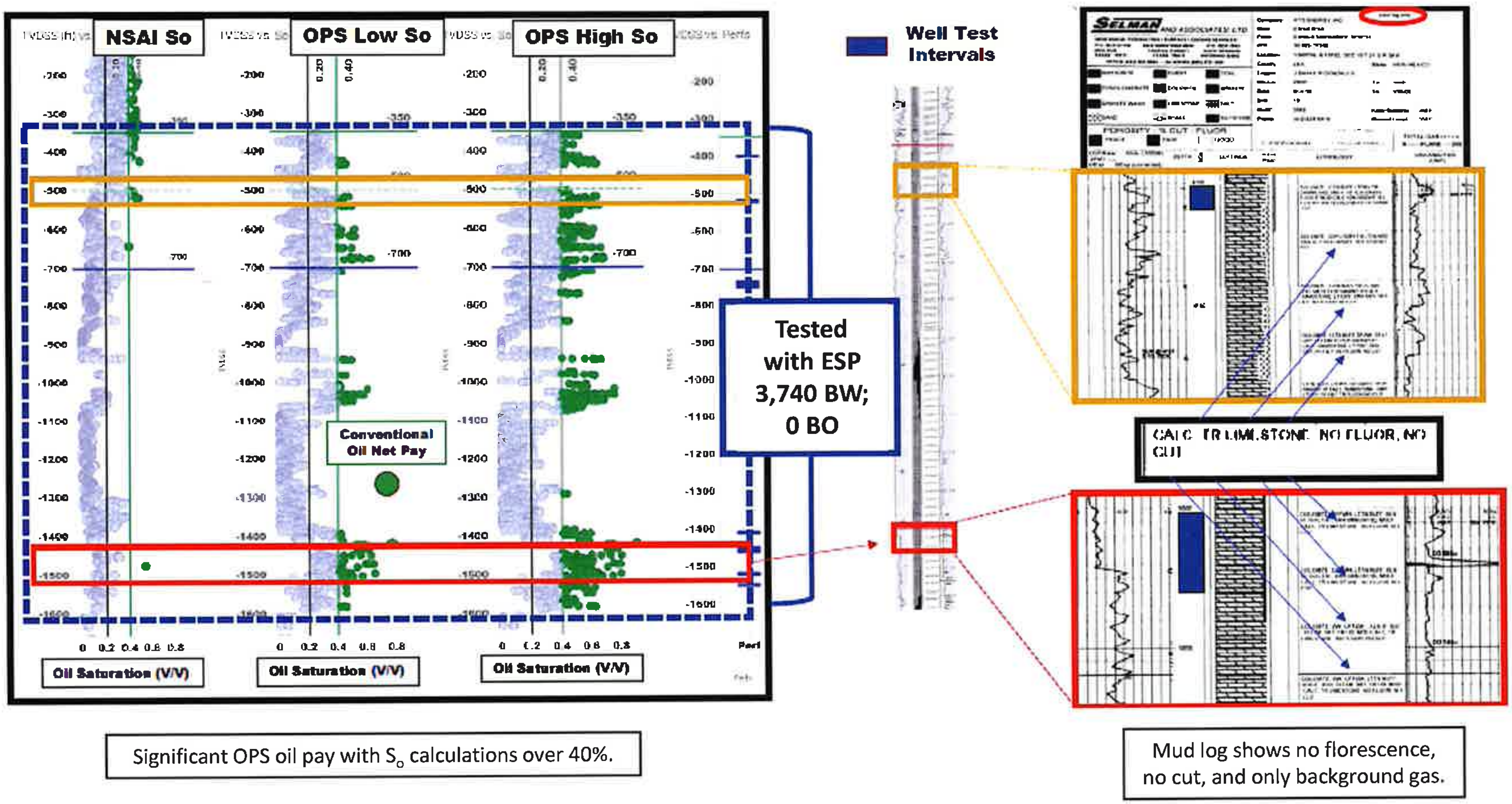
Both OPS Low and High Cases significantly overestimate S_o relative to measured S_o Core values. This overestimation increases with depth.

All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 6

NETHERLAND, SEWELL & ASSOCIATES, INC.

EMSU 746 Oil Saturation Analysis
Eunice Monument South Unit Area
Lea County, New Mexico



Test results and mud log contradict OPS S_o interpretation and irreducible oil saturations used by various Empire witnesses (Meltzer and Buchwalter).

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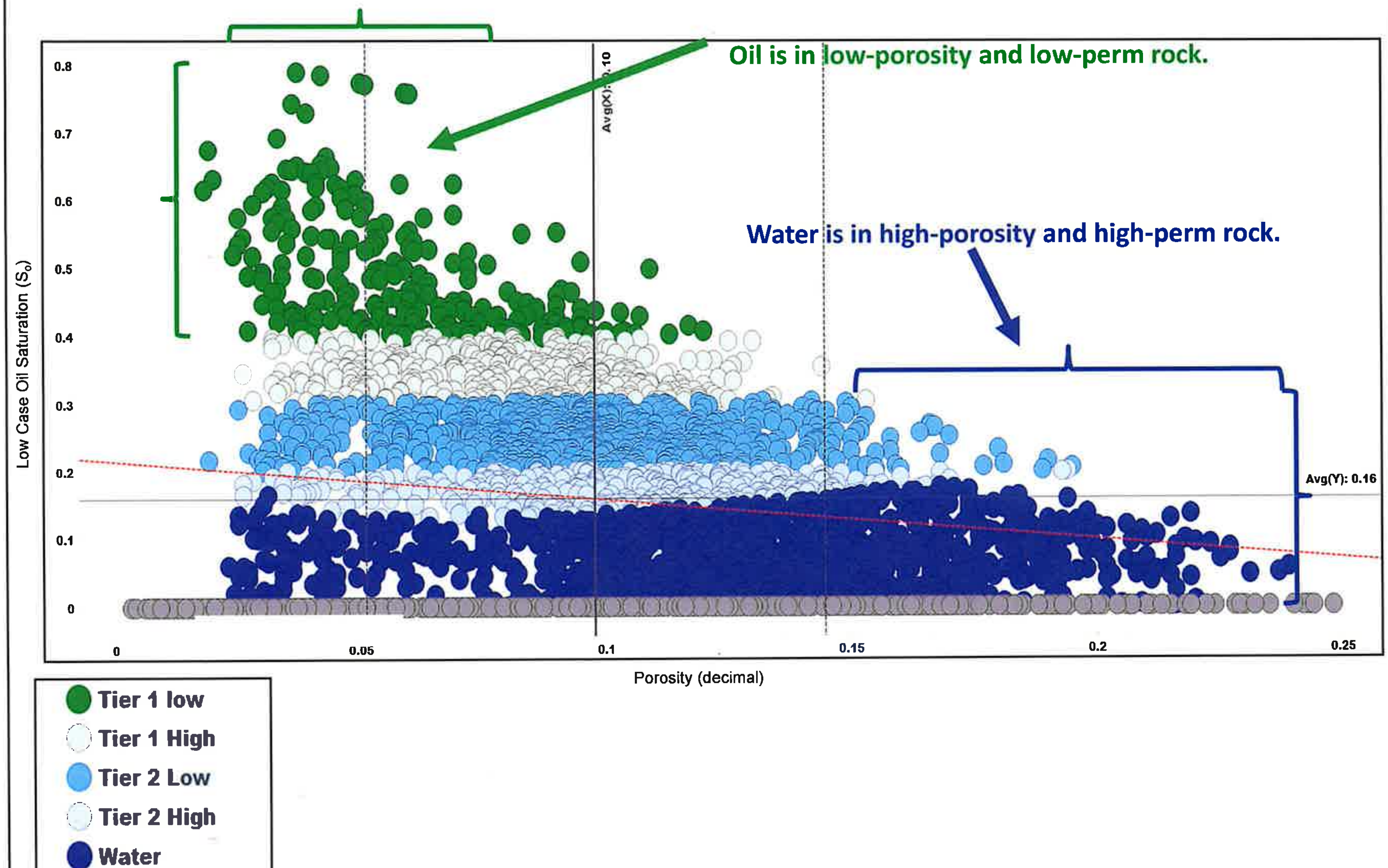
Figure 7

NETHERLAND, SEWELL & ASSOCIATES, INC.

EMSU 746 OPS Oil Saturation Distribution
Eunice Monument South Unit Area
Lea County, New Mexico



All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 8

NETHERLAND, SEWELL & ASSOCIATES, INC.

EMSU 679 Core and OPS Modeled Porosity and Oil Saturation Comparison
Eunice Monument South Unit Area
Lea County, New Mexico

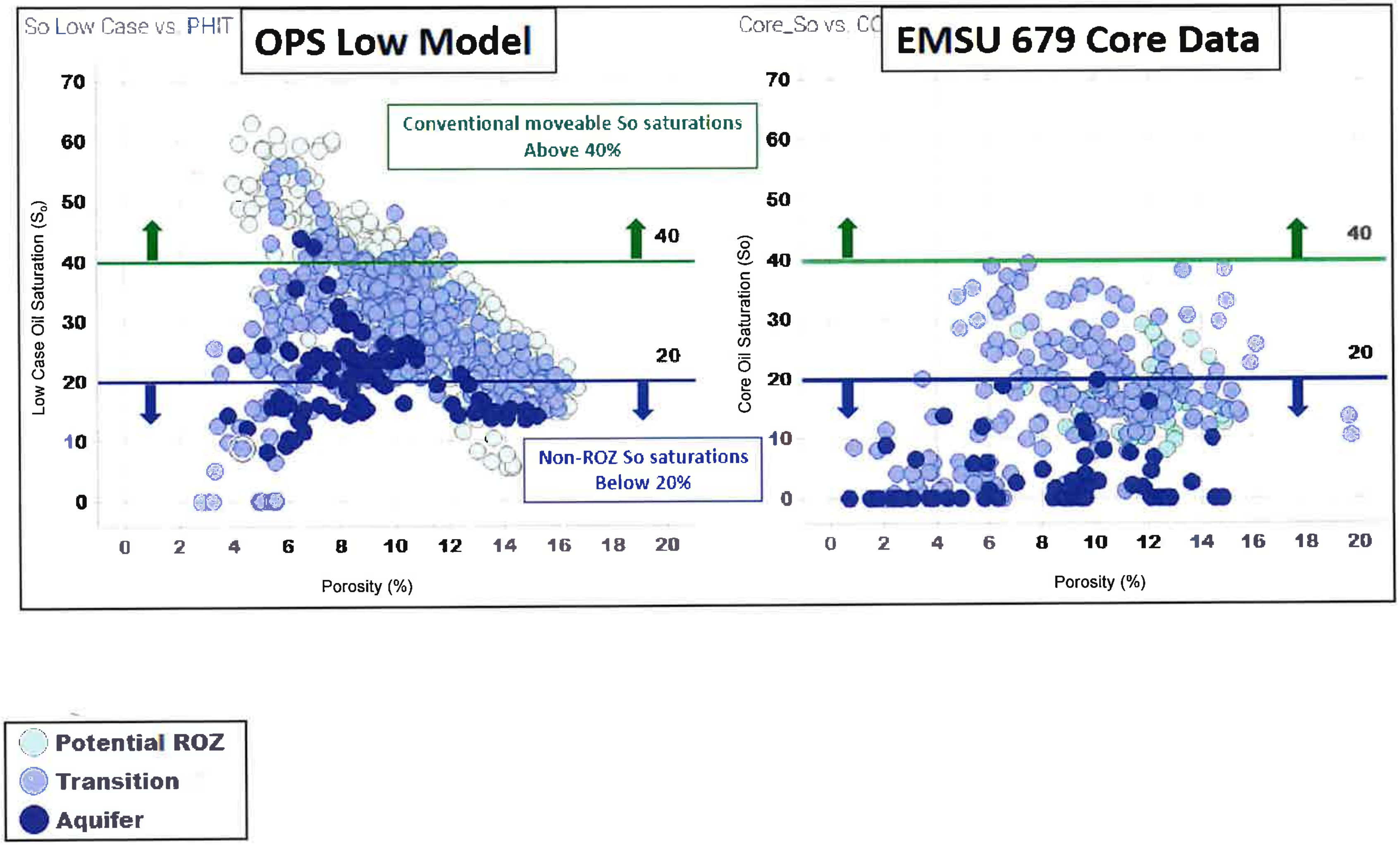


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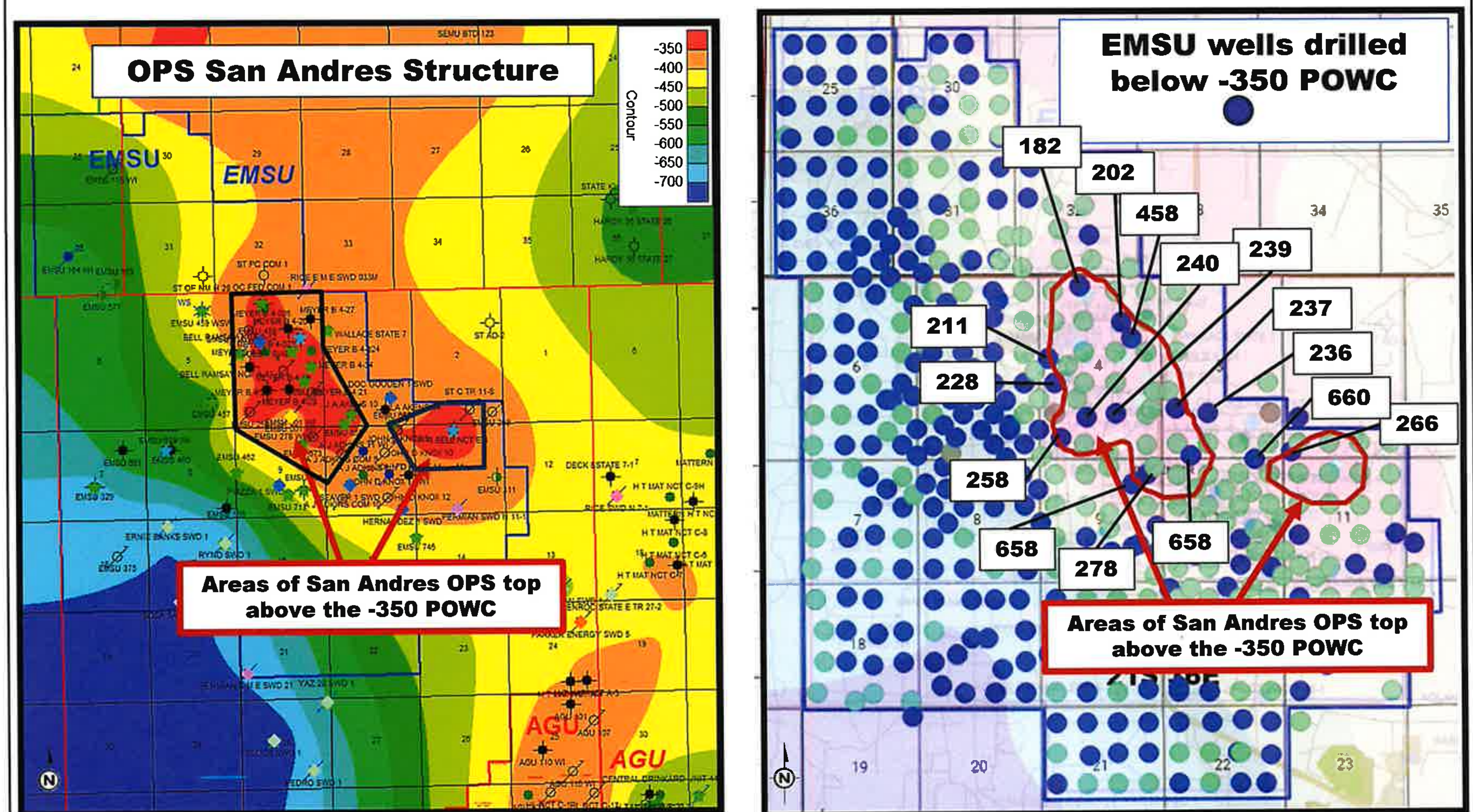
Figure 9

NSAI NETHERLAND, SEWELL & ASSOCIATES, INC.

OPS San Andres Well Penetrations
Eunice Monument South Unit Area
Lea County, New Mexico

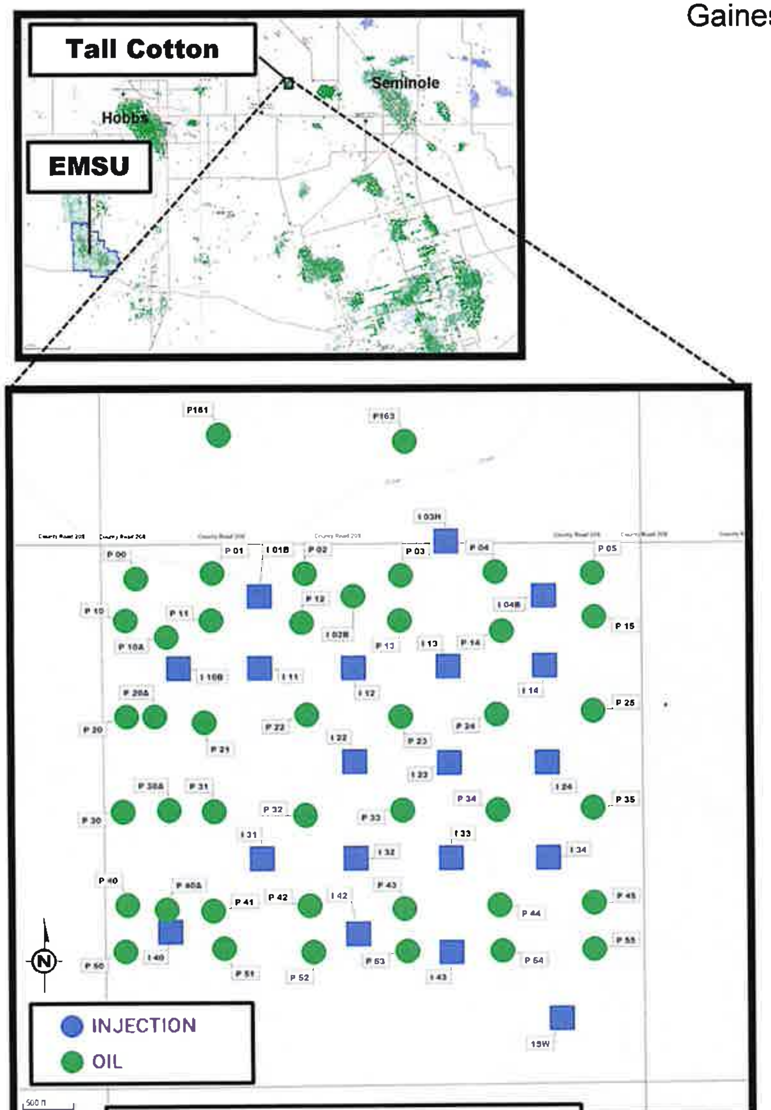


All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 10

NETHERLAND, SEWELL & ASSOCIATES, INC.

Tall Cotton CO_2 Field Production
Tall Cotton Unit Area
Gaines County, Texas



Tall Cotton CO_2 Injection Unit

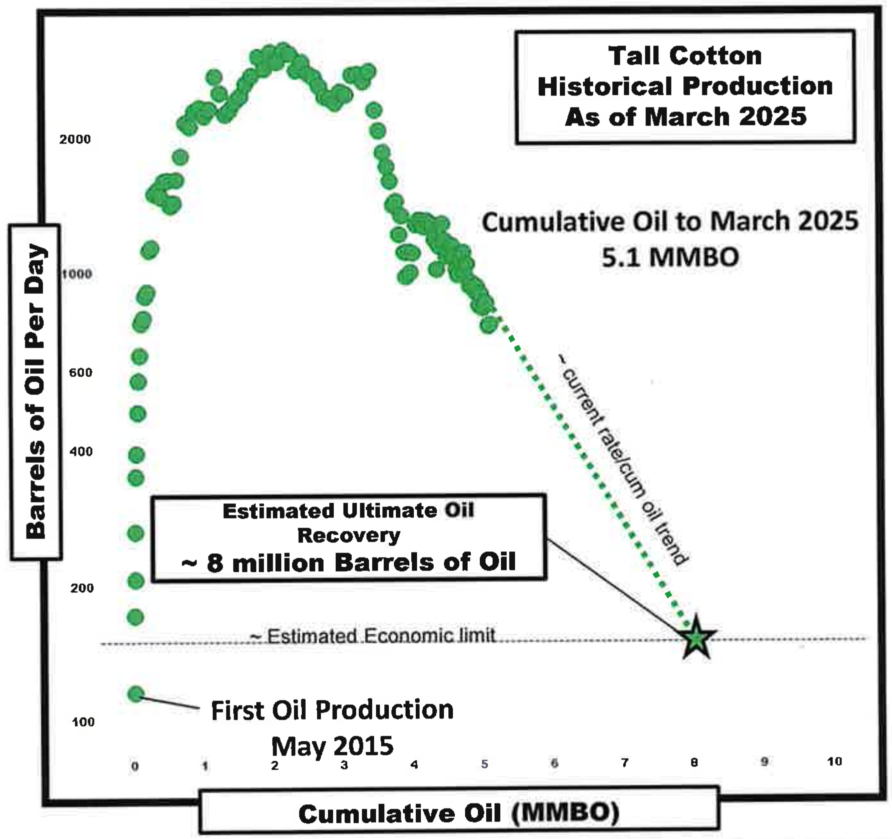


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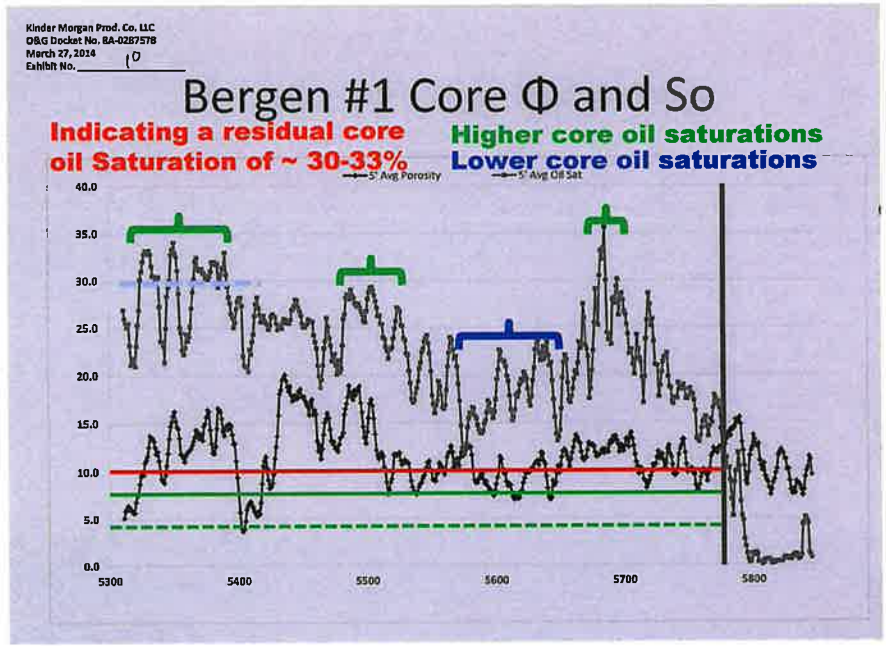
Figure 11

NETHERLAND, SEWELL & ASSOCIATES, INC.

Tall Cotton Recovery Efficiency Analysis
Tall Cotton Unit Area
Gaines County, Texas

The "discovery" well for the proposed Tall Cotton (San Andres) field is Kinder Morgan's Bergen Lease, Well No. 1 (API No. 42-165-37662). The Bergen No. 1 well was drilled in October and November 2012. Kinder Morgan collected 9 continuous San Andres Formation core samples over a gross interval of 540 feet. This testing indicated the well to have 450 feet of net pay with an average porosity of greater than 12 percent. All zones tested water at very good rates, and zone 1 (upper) produced at a 1 percent oil cut. Core sample oil saturations were measured in the laboratory to average about 25 percent. Adjusting this laboratory oil saturation estimate of core samples to gross in situ interval conditions indicate oil saturations of about 50 percent. The adjusted values generally agree with estimates based on downhole wireline tools. Based on this information, a field correlative interval was proposed from a depth of 5,250 feet to 5,800 feet.



Porosity x S_o x BO/AF x H x AC/SEC / B_{oi}
12% x 50% x 7758 x 550 x 640 / 1.3 =

126 MMBO/Section
EUR (10-acre spacing) ~ 8 MMBO
Tall Cotton Recovery Factor ~ 6%

OPS EMSU Log Analysis
Lower porosity
Lower core S_o
Lower Net/Gross

Four Key Characteristics of Tall Cotton Development:
- **Higher S_o in Higher Porosity intervals**
- **95% of the Core S_o is greater 20% and > 7% porosity**
- **Average porosity 12%**
- **Average core S_o 25%**
- **10-acre full CO_2 development in one section**

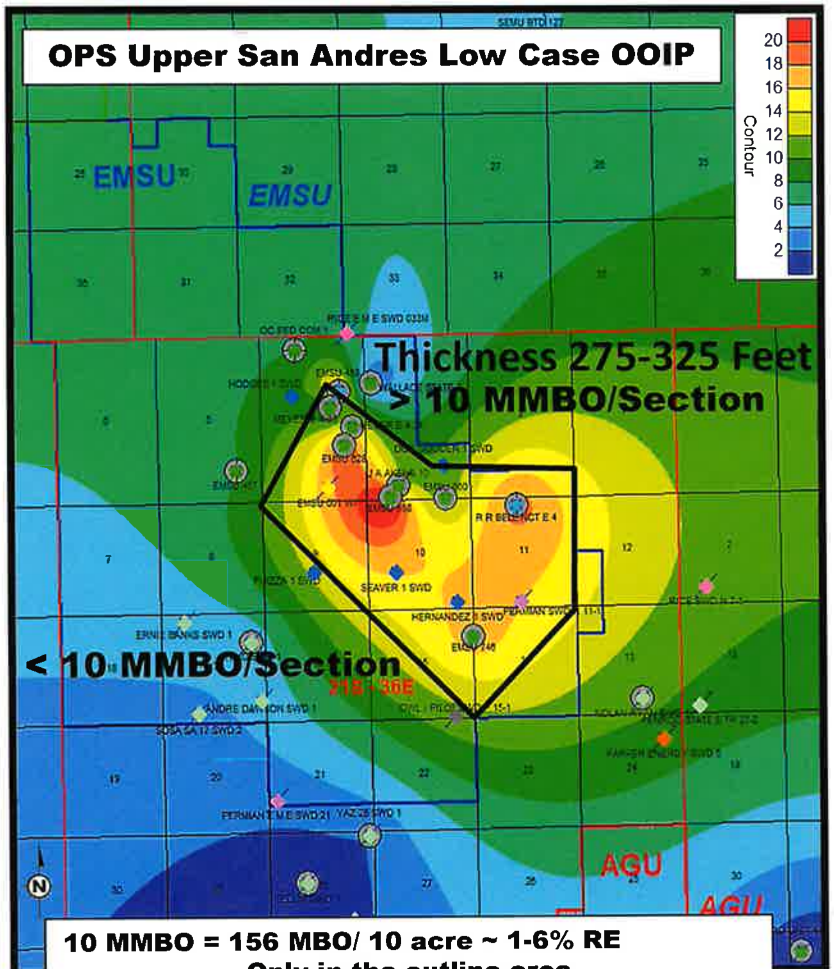
Based on Tall Cotton RE
Est ~ EMSU ROZ RE 1-6%

All estimates and exhibits herein are part of this NSAI report and are subject to its parameters and conditions.

Figure 12

NSAI NETHERLAND, SEWELL & ASSOCIATES, INC.

OPS San Andres OOIP and Estimated Oil Recovery
Eunice Monument South Unit Area
Lea County, New Mexico



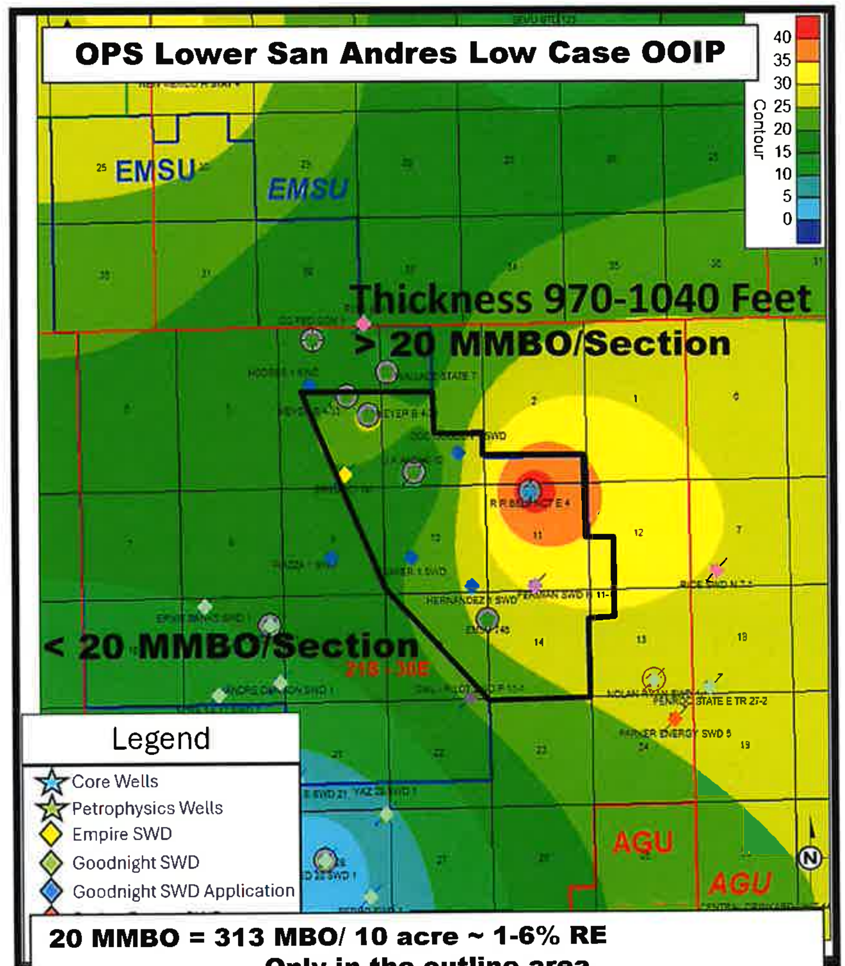


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Figure 13

APPENDIX A - BIBLIOGRAPHY

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APPENDIX B - ABBREVIATIONS

%	percent
Baffles	vertical reservoir boundaries
B_o	oil formation volume factor
B_{oi}	initial oil formation volume factor
BO	barrels of oil
CO_2	carbon dioxide
Empire	Empire Petroleum Corporation
EMSU	Eunice Monument South Unit
ESP	electrical submersible pump
ft	feet
Goodnight	Goodnight Midstream Permian, LLC
MMBLS	millions of barrels
MMBO	millions of barrels of oil
mD	millidarcy
NSAI	Netherland, Sewell & Associates, Inc.
OIP	oil-in-place
OOIP	original oil-in-place
PHIE	percent effective porosity
PHIT	percent total porosity
POWC	producing oil-water contact
ROZ	residual oil zones
S_o	oil saturation
TVDSS	true vertical depth subsea