Market Evidence of Reserve Adjustment Factors and Risk Adjusted Discount Rates in a North American Unconventional Play

Theme: Resource Assessment

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Search and Discovery Article #11360 (2022)**
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[1]U.S. Department of the Interior, Appraisal and Valuation Services Office, Division of Minerals Evaluation

Abstract

There is a lack of information on how the U.S. oil and gas industry handles investment risk when valuing mineral rights. One of the more useful sources of information is the Annual Survey collected by the Society of Professional Evaluation Engineers' (SPEE) which asks industry experts to share their opinion concerning Reserve Adjustment Factors (RAF) and Risk Adjusted Discount Rates (RADR) for different reserve categories. But little has been done to observe direct market evidence of RAFs or RADRs. This research aims to address this shortfall.

This investigation gathered information on the sale of mineral rights in a region of Oklahoma and then conducted discounted cash flows to establish the un-risked fair market value (FMV) of the mineral rights at the date they were transacted. The un-risked FMV's are compared to the actual sale price. The difference between the two is indicative of the industries perspective on investment risk.

As would be expected, we observe progressive de-risking over the life cycle of mineral rights. Large risk adjustments are applied prior to initial drilling when reserves would be categorized as Possible or Probable. Then smaller risk adjustments are applied as exploratory wells are drilled and reserves become Proved-Undeveloped. Once a production unit is fully drilled-out there is almost no risk adjustment, and an industry standard 10% discount rate for Proved Developed Producing (PDP) reserves is applied.

Our findings serve to strengthen commonly accepted RAF and RADR with direct market evidence. It also serves as an example of how oil and gas evaluators can approach RAFs and RADRs in a way that is more consistent with the real-property appraisal. We encourage oil and gas evaluators to continue this type of research and seek market driven risk adjustments and discount rates when estimating FMVs.

Summary

Mineral rights values have a life-cycle –increase as they are drilled/proved/de-risked and decrease as they are depleted

Investment risk can be accounted for with a Reserve Adjustment Factor (RAF) or Reserve Adjusted Discount Rate (RADR), these change depending on the reserve category

The best data we have had available for what RAFs or RADRs industry participants apply is the annual SPEE survey

This study shows market-based evidence of RAFs and RADRs and provides an example which is more in line with real-property appraisal methods for Fair Market Valuations

Need more research! Additional efforts could focus on how RAF and RADR might change by play type, basin, operator, or interest type

United States Department of the Interior
OFFICE OF THE SECRETARY
Appraisal and Valuation Services Office
Division of Minerals Evaluation

Market Evidence of Reserve Adjustment Factors and Risk Adjusted Discount Rates in a North American Unconventional Play

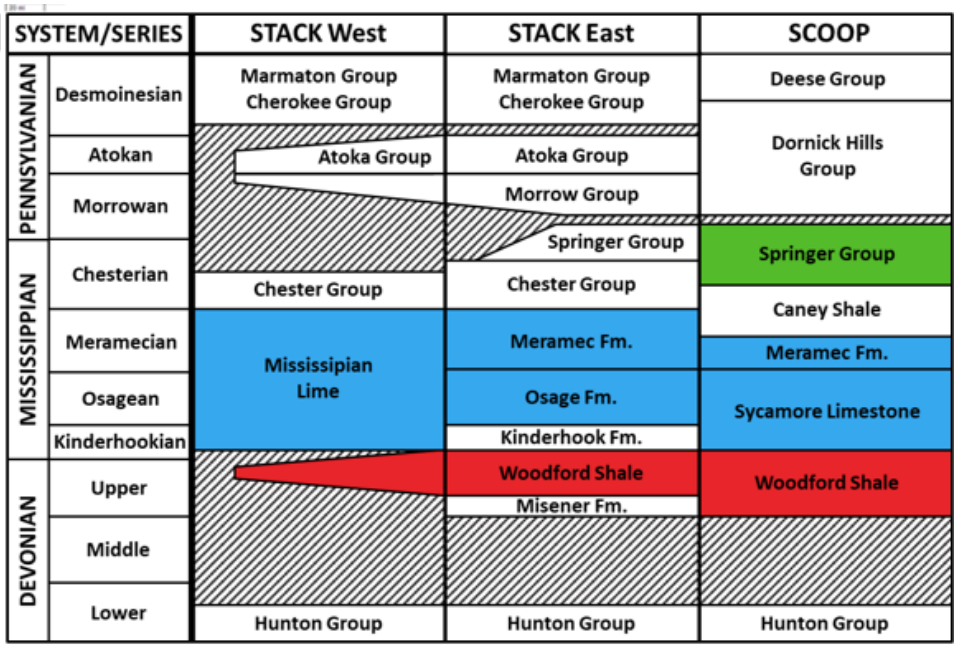
Nicholas Devereux Kernan, Geologist

Annual Conference - Rocky Mountain Section

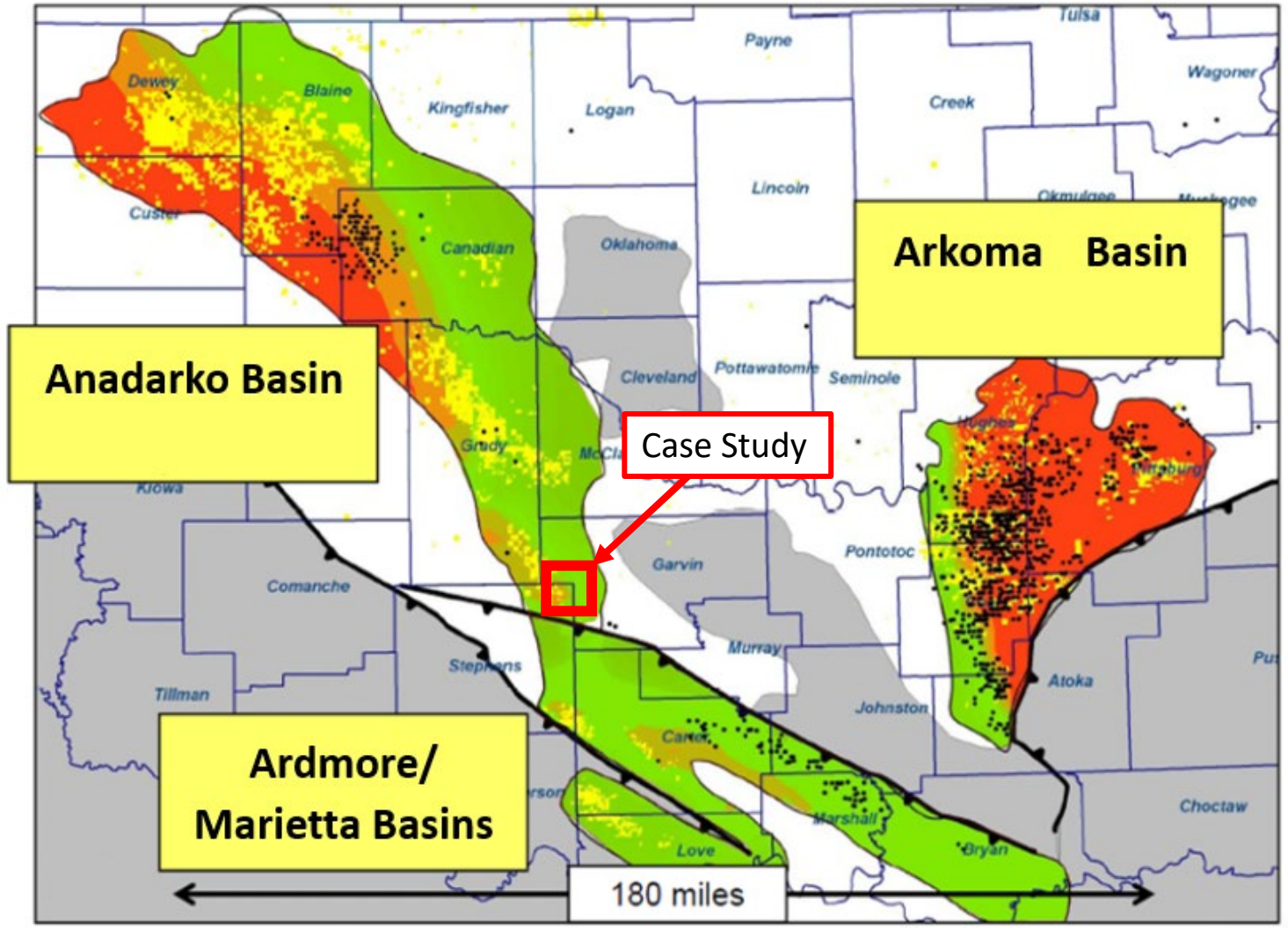
American Association of Petroleum Geologists

Denver -July 27, 2022

- Map (right) showing extent and maturity windows of the Woodford Formation
- Case study focused on the SCOOP play of the Anadarko Basin where the Woodford Formation is the primary target
- Region is optimal for this research due to the large number of mineral deeds transacted over a long period (10+ years) and at different stages of oil and gas development



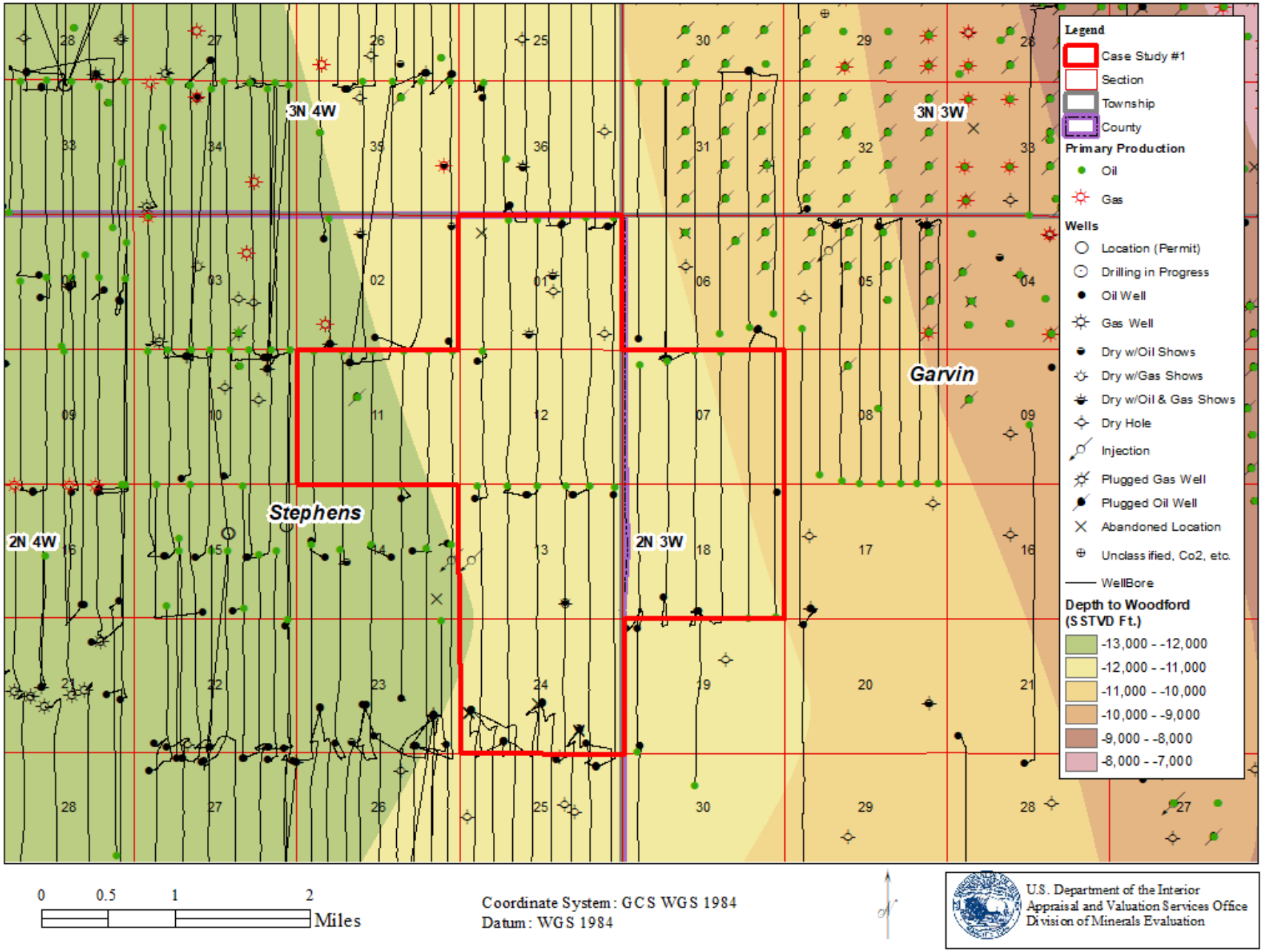
Symcox (2021)



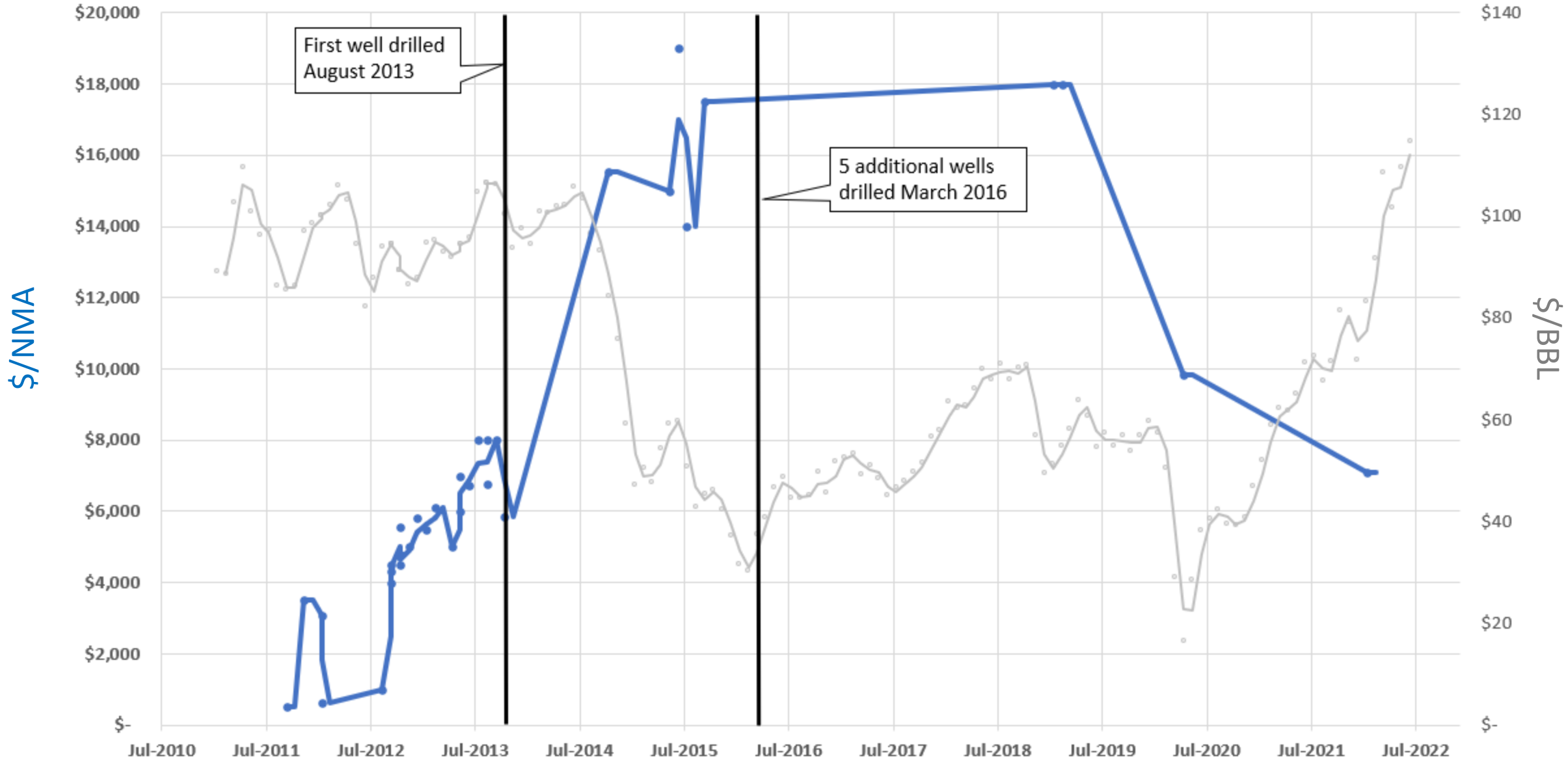
Continental (2010)

Case Study

- 7 sections with a relatively similar geology and development pattern
- Initial one-mile horizontal well drilled around August 2013
- Five additional two-mile horizontals wells drilled between November 2015 to March 2016



Mineral deed sales within the seven sections of the study area:



Mineral deed sales within the seven sections of the study area:

Key Take Away:

- There is a life-cycle to mineral rights values
- Go up in value as reserves are de-risked
- Go down in value as reserves are depleted

How is Investment Risk Applied?

- An investment is typically analyzed with a discounted cash flow (economic model that considers the time value of money)

- *Example: A five-year cash flow with an initial investment of $500,000 and a risk-free 10% discount rate:*

Year	NOI	PV 10
0	-500,000	-500,000
1	1,000,000	$909,091
2	800,000	$661,157
3	500,000	$375,657
4	300,000	$204,904
5	100,000	$62,092
Total	**2,200,000**	**1,712,902**

Risk-Free Net Present Value (NPV)

- To account for risk, we can apply a **Reserve Adjustment Factor (RAF)** or a **Risk Adjusted Discount Rate (RADR)** to our cash flow

How do we Apply Investment Risk?

- **Reserve Adjustment Factor (RAF) Method**
  - Applied to the NPV of discounted cashflows

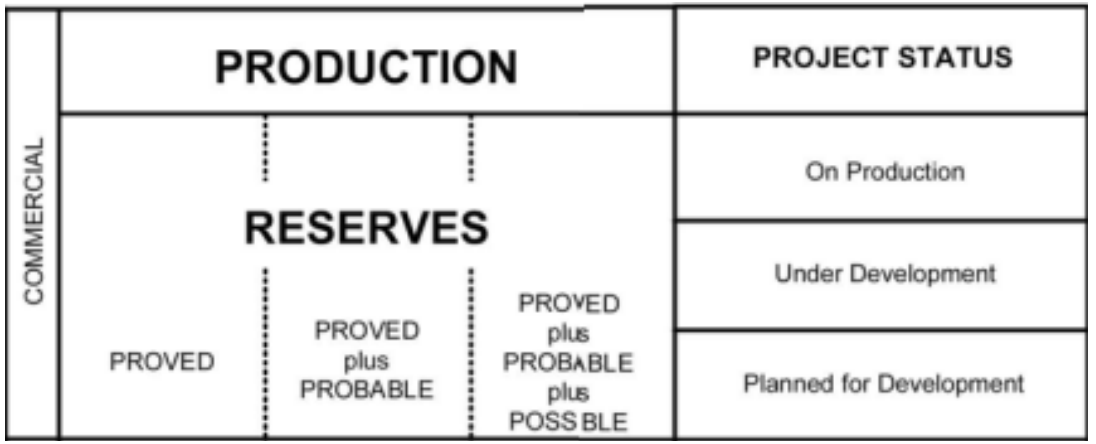
  - *Example: At a 10% risk-free discount rate a cash-flow has an NPV of $1,712,902*
    - *80% RAF = $1,712,902 x 0.80 = $1,370,322*
    - *50% RAF = $1,712,902 x 0.50 = $856,451*
    - *20% RAF = $1,712,902 x 0.20 = $342,581*

- **Risk Adjusted Discount Rate (RADR) Method**
  - The rate obtained by adding a risk premium to the risk-free rate
  - *Example:*

Year	NOI	PV 10	PV 20	PV 30
0	-500,000	-500,000	-500,000	-500,000
1	1,000,000	$909,091	$833,333	$769,231
2	800,000	$661,157	$555,556	$473,373
3	500,000	$375,657	$289,352	$227,583
4	300,000	$204,904	$144,676	$105,038
5	100,000	$62,092	$40,188	$26,933
Total	**2,200,000**	**1,712,902**	**1,363,104**	**1,102,158**

The Resources Classification System

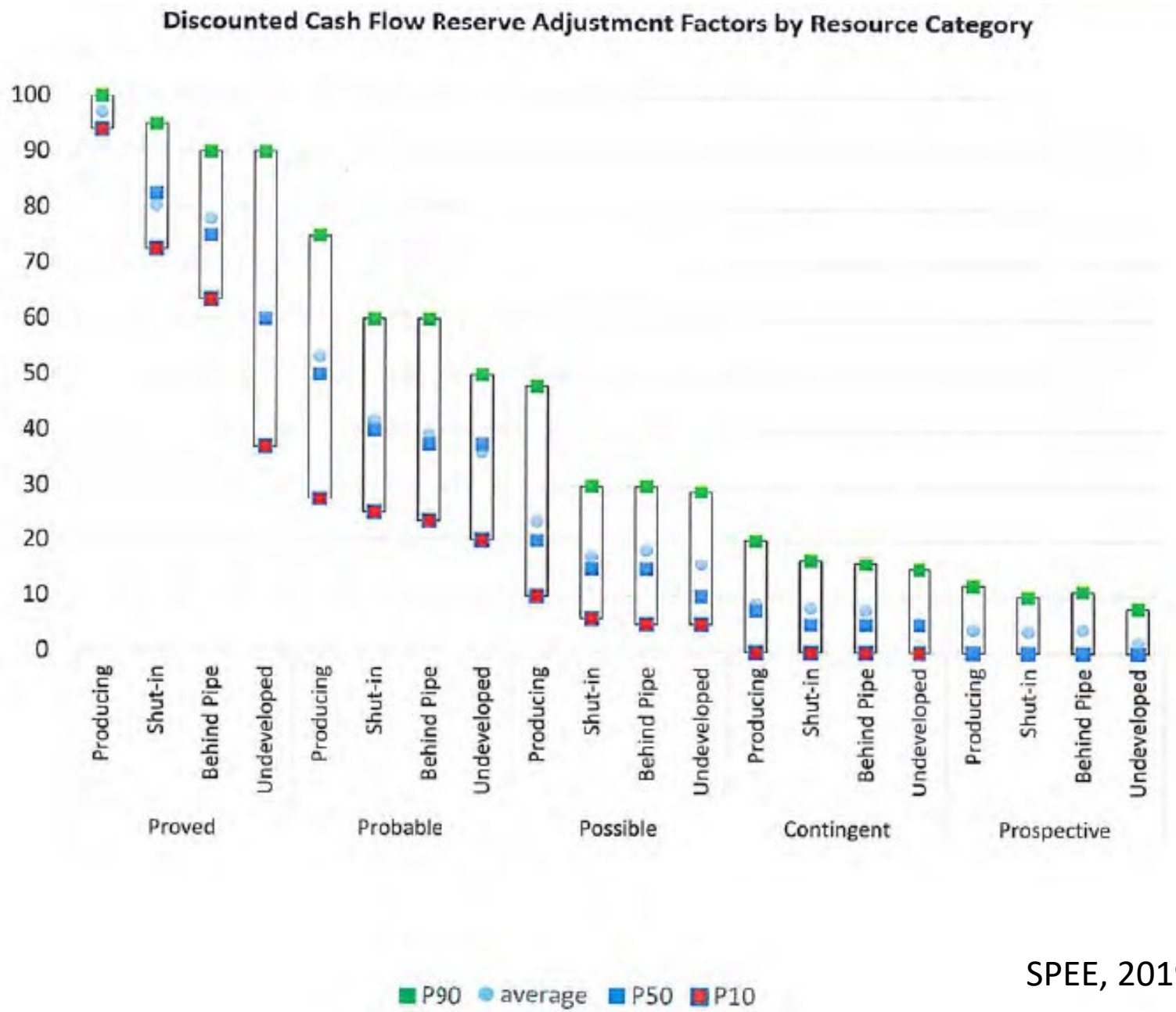
- Investment risk is best thought within the framework of the SPE resource classification system
- For continuous, unconventional reservoirs, there tends to be a relationship between distance from producing wells and the risk category
- For mineral buyers, a clear pathway to development is one of the largest risks



SPE, 2018

Existing Tools

- The Society of Professional Evaluation Engineers (SPEE) publishes annual surveys which ask professionals their opinion on handling risk
- At present, this is the primary indicator of how the market accounts for Risk
- **Graph to the right is for RAFs**. Number of responses varied by resource category from 39 for proved producing to 17 for prospective shut-in
- Higher risk categories have greater adjustments

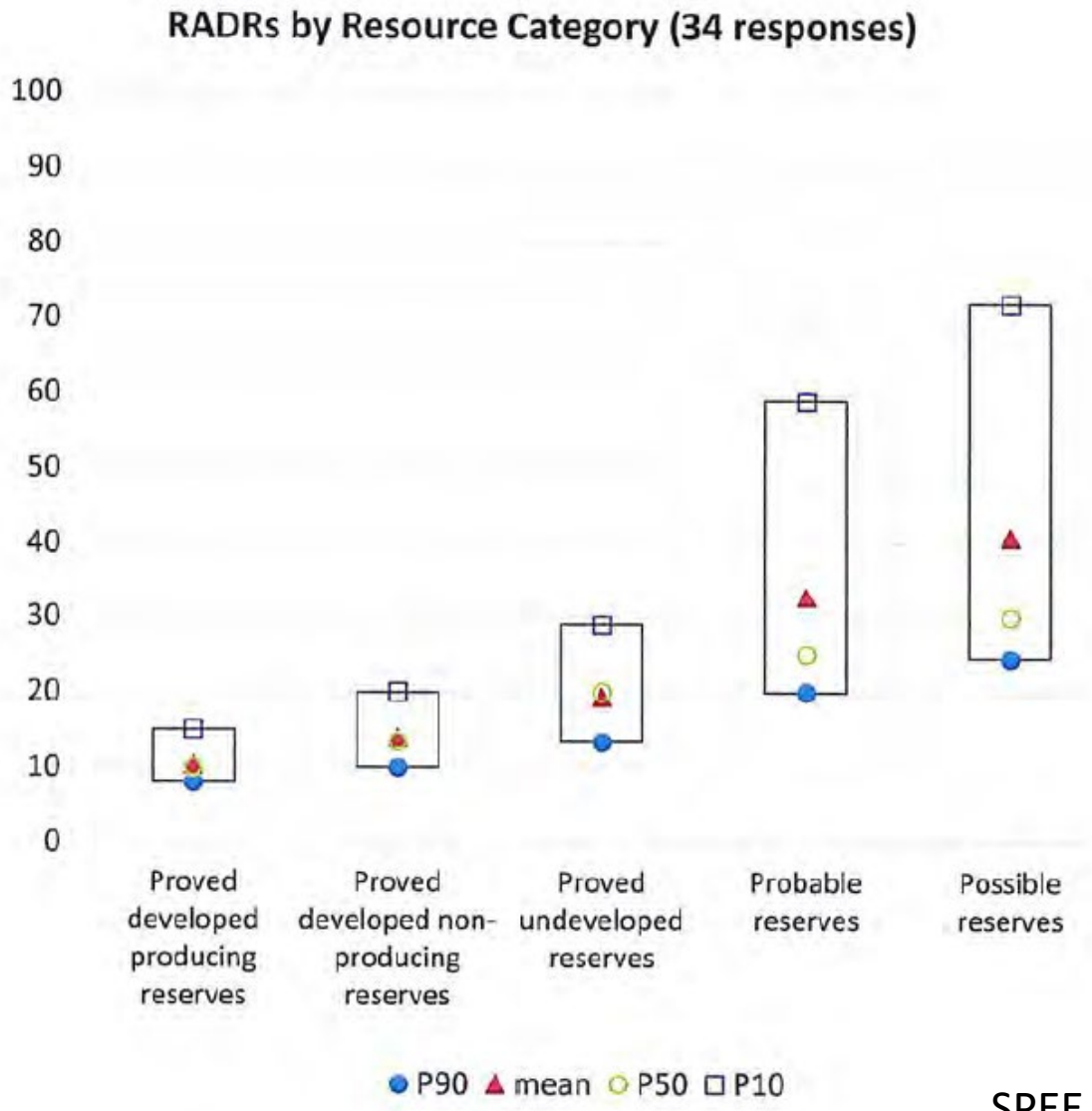


SPEE, 2019

Existing Tools

- **Graph to the right is for RADRs**. Number of responses was 34

- Higher risk categories have greater discounting



SPEE, 2019

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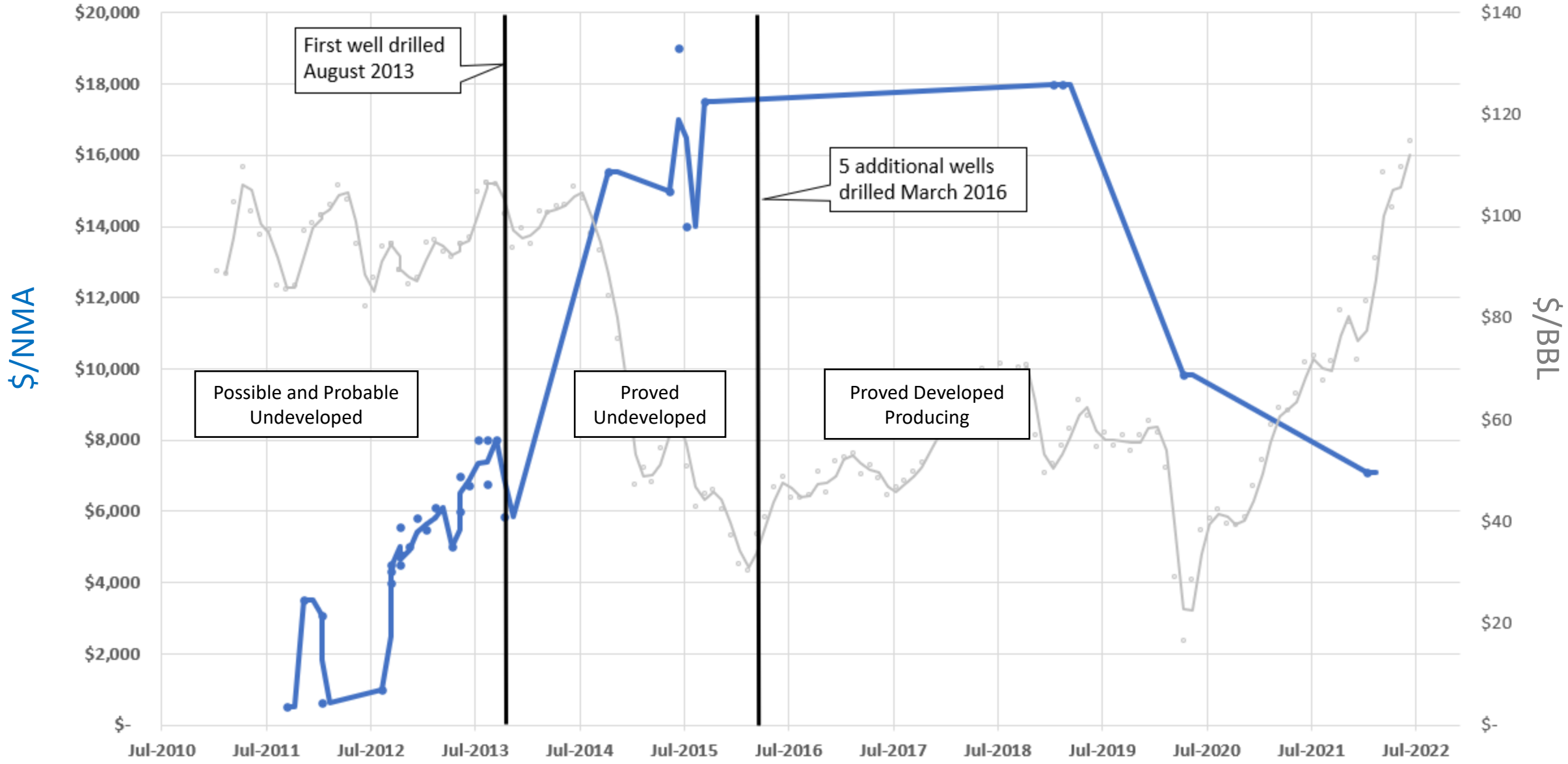


What About Market Indicators?

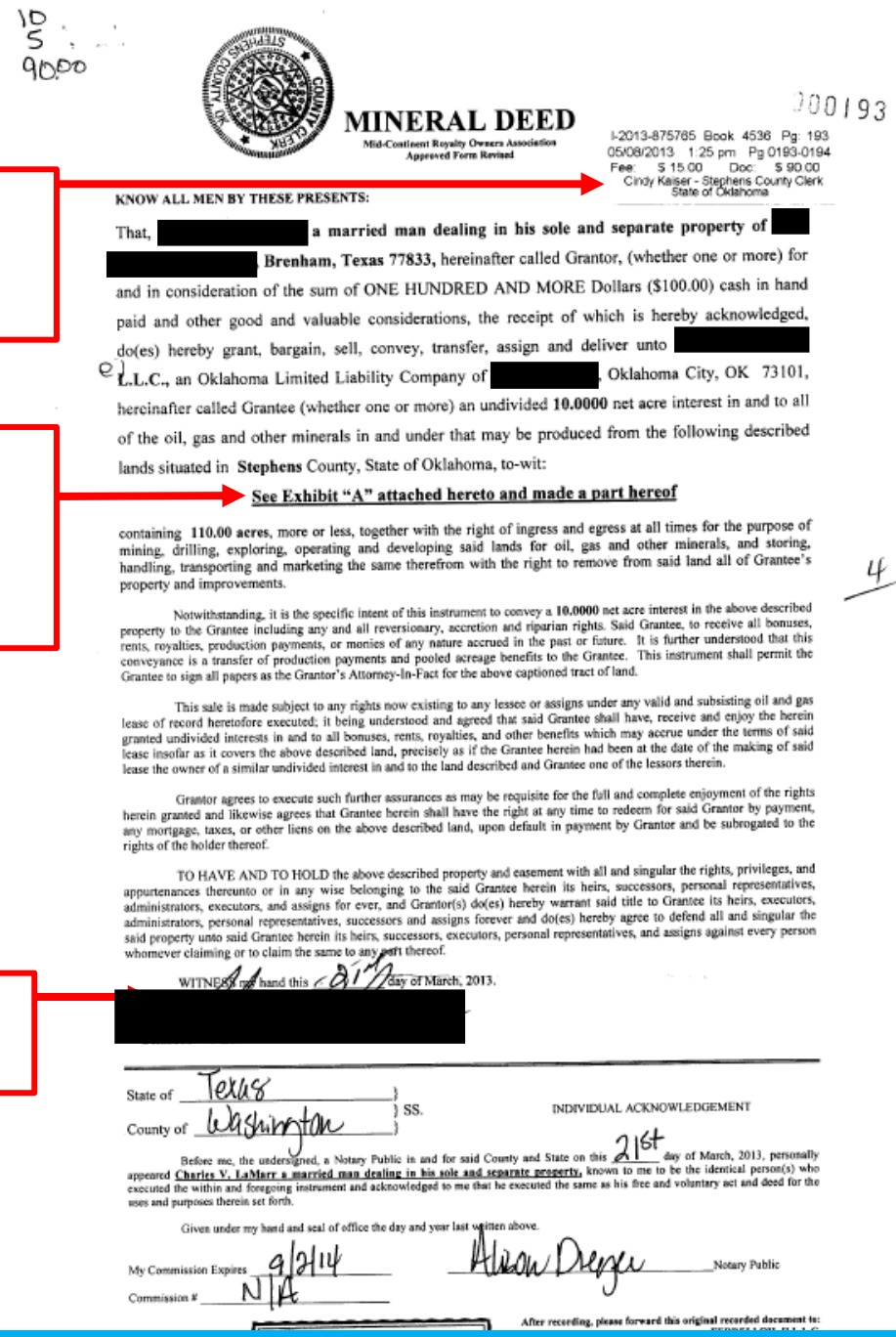
- For Fair Market Valuations(FMVs) interviews and surveys are great… but should be supported by market evidence (mineral deeds)

- Example to right is of a Mineral Deed that indicates a sale value of $6,000/NMA

Document stamping fee used to calculate sale price ($0.75/$500)
Ex: $90 fee = $60,000 sale

Property description and of net-mineral-acres (NMA).
Ex: 10 NMA in Section 24 2N 4W, Stephens County, OK

Date
Ex: May 2013



MINERAL DEED

Mid-Continent Royalty Owners Association Approved Form Revised

I-2013-875785 Book 4536 Pg 193
05/08/2013 1:25 pm Pg 0193-0194
Fee: $ 15.00 Doc: $ 90.00
Cindy Kaiser - Stephens County Clerk
State of Oklahoma

KNOW ALL MEN BY THESE PRESENTS:

That, [redacted] **a married man dealing in his sole and separate property of** [redacted] **Brenham, Texas 77833,** hereinafter called Grantor, (whether one or more) for and in consideration of the sum of ONE HUNDRED AND MORE Dollars ($100.00) cash in hand paid and other good and valuable considerations, the receipt of which is hereby acknowledged, do(es) hereby grant, bargain, sell, convey, transfer, assign and deliver unto [redacted] **L.L.C.,** an Oklahoma Limited Liability Company of [redacted] Oklahoma City, OK 73101, hereinafter called Grantee (whether one or more) an undivided **10.0000** net acre interest in and to all of the oil, gas and other minerals in and under that may be produced from the following described lands situated in **Stephens** County, State of Oklahoma, to-wit:

See Exhibit "A" attached hereto and made a part hereof

containing **110.00 acres**, more or less, together with the right of ingress and egress at all times for the purpose of mining, drilling, exploring, operating and developing said lands for oil, gas and other minerals, and storing, handling, transporting and marketing the same therefrom with the right to remove from said land all of Grantee's property and improvements.

Notwithstanding, it is the specific intent of this instrument to convey a **10.0000** net acre interest in the above described property to the Grantee including any and all reversionary, accretion and riparian rights. Said Grantee, to receive all bonuses, rents, royalties, production payments, or monies of any nature accrued in the past or future. It is further understood that this conveyance is a transfer of production payments and pooled acreage benefits to the Grantee. This instrument shall permit the Grantee to sign all papers as the Grantor's Attorney-In-Fact for the above captioned tract of land.

This sale is made subject to any rights now existing to any lessee or assigns under any valid and subsisting oil and gas lease of record heretofore executed; it being understood and agreed that said Grantee shall have, receive and enjoy the herein granted undivided interests in and to all bonuses, rents, royalties, and other benefits which may accrue under the terms of said lease insofar as it covers the above described land, precisely as if the Grantee herein had been at the date of the making of said lease the owner of a similar undivided interest in and to the land described and Grantee one of the lessors therein.

Grantor agrees to execute such further assurances as may be requisite for the full and complete enjoyment of the rights herein granted and likewise agrees that Grantee herein shall have the right at any time to redeem for said Grantor by payment, any mortgage, taxes, or other liens on the above described land, upon default in payment by Grantor and be subrogated to the rights of the holder thereof.

TO HAVE AND TO HOLD the above described property and easement with all and singular the rights, privileges, and appurtenances thereunto or in any wise belonging to the said Grantee herein its heirs, successors, personal representatives, administrators, executors, and assigns for ever, and Grantor(s) do(es) hereby warrant said title to Grantee its heirs, executors, administrators, personal representatives, successors and assigns forever and do(es) hereby agree to defend all and singular the said property unto said Grantee herein its heirs, successors, executors, personal representatives, and assigns against every person whomever claiming or to claim the same to any part thereof.

WITNESS my hand this 21st day of March, 2013.

[redacted]

State of Texas } SS.
County of Washington }

INDIVIDUAL ACKNOWLEDGEMENT

Before me, the undersigned, a Notary Public in and for said County and State on this 21st day of March, 2013, personally appeared **Charles V. LaMarr a married man dealing in his sole and separate property,** known to me to be the identical person(s) who executed the within and foregoing instrument and acknowledged to me that he executed the same as his free and voluntary act and deed for the uses and purposes therein set forth.

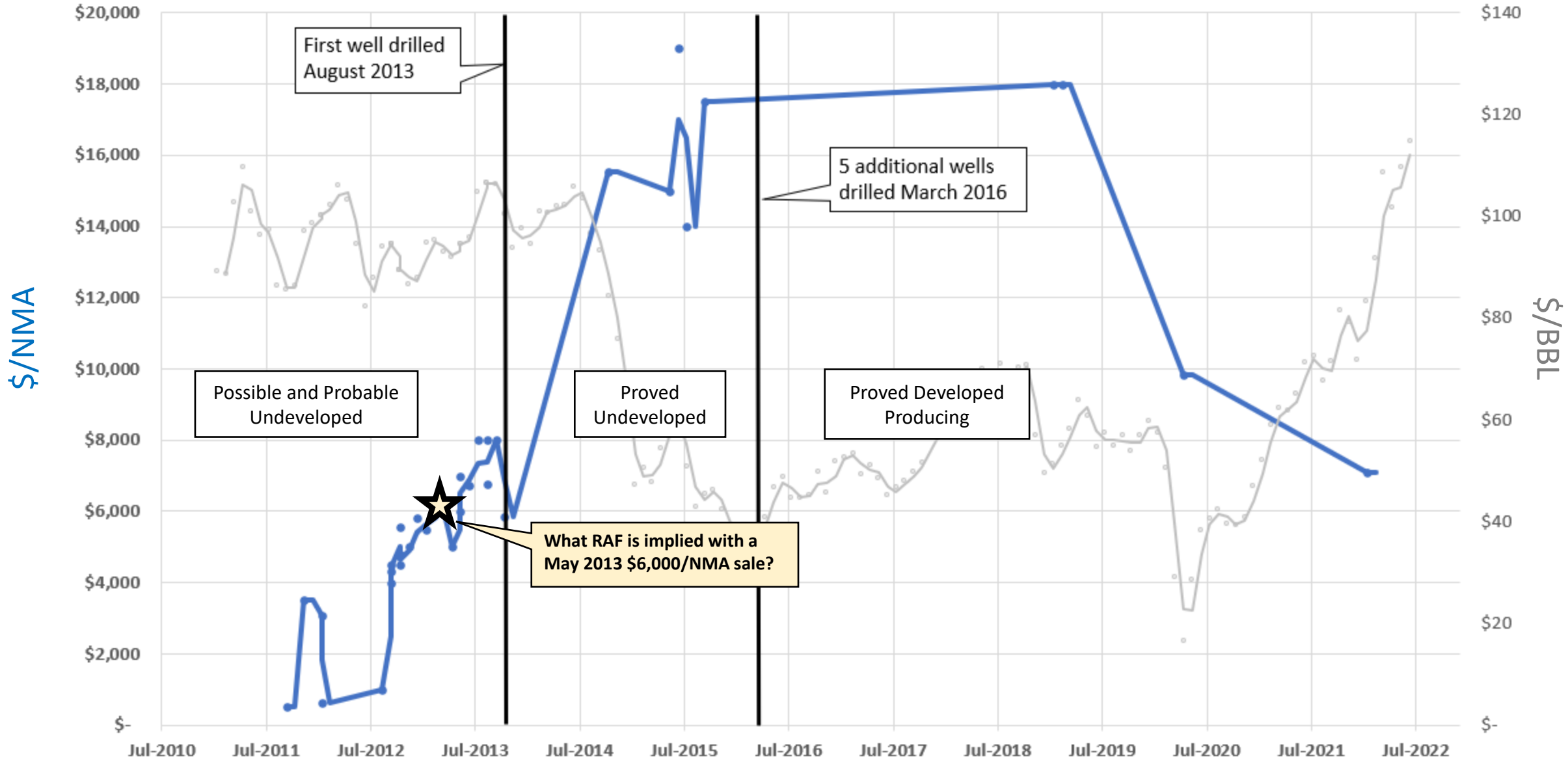
Given under my hand and seal of office the day and year last written above.

My Commission Expires 9/2/14
Commission # N/A

Notary Public

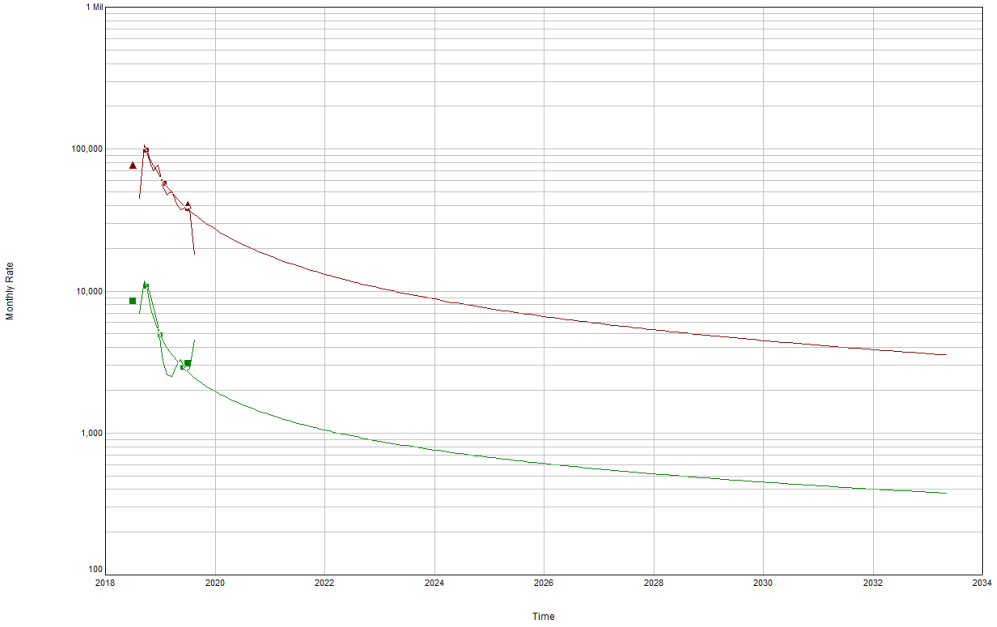
After recording, please forward this original recorded document to:

Mineral deed sales within the seven sections of the study area:

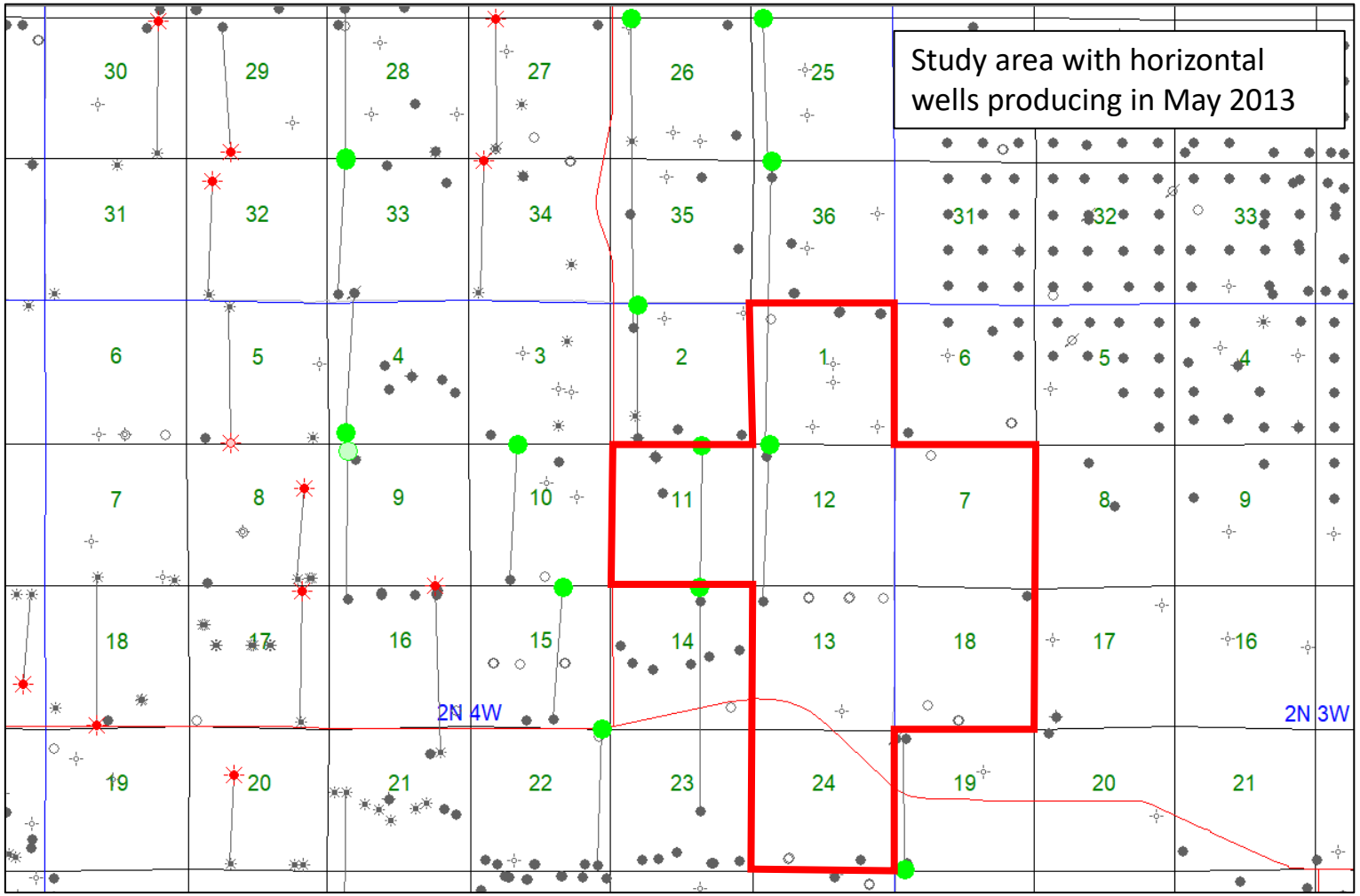


Assumptions for **May 2013** Discounted Cash Flow:

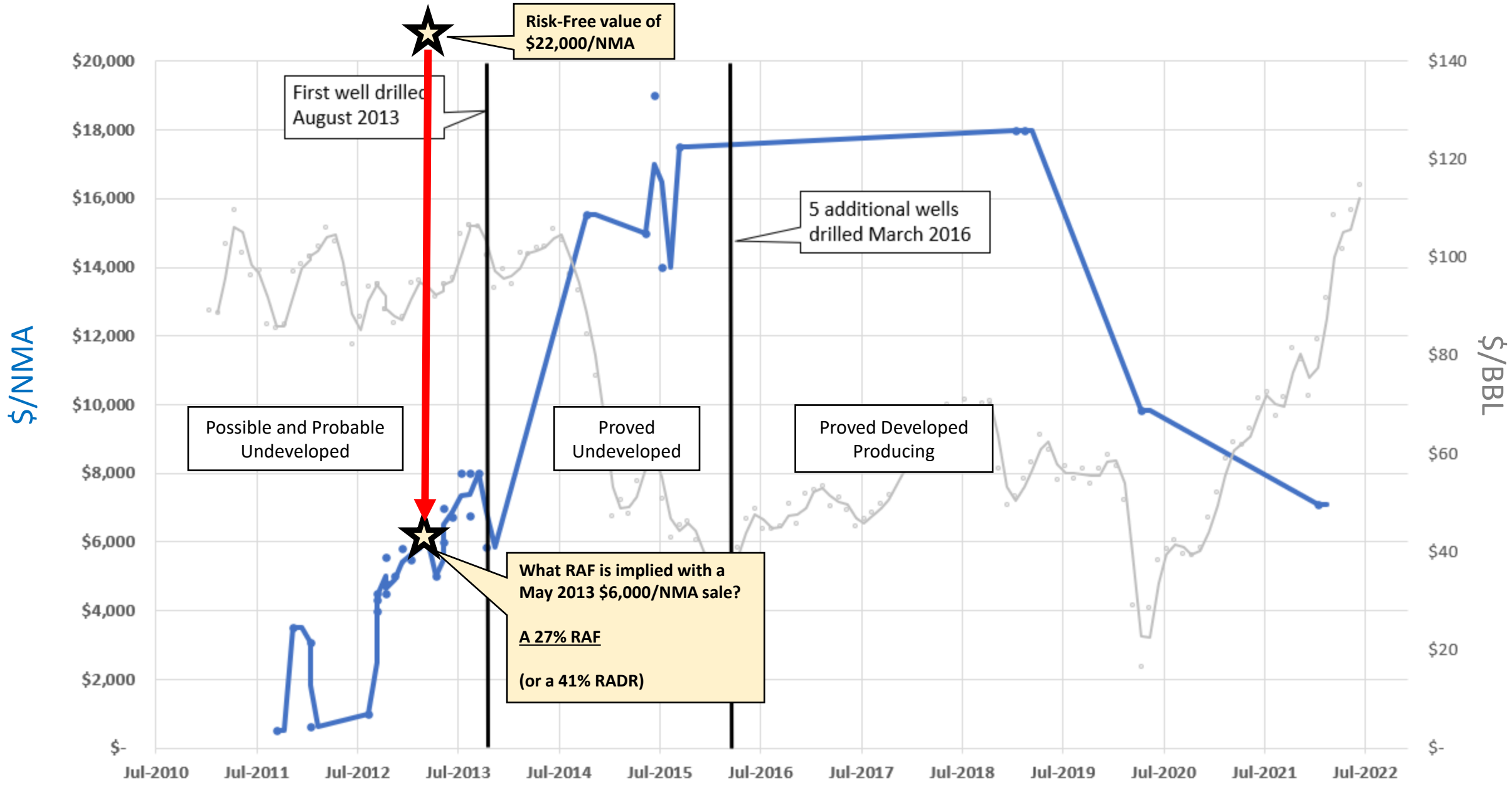
- Royalty: 3/16 (18.75%)
- Unit Size: 640 acres (1-section)
- Oil Price: $90/BBL (actual price averaged $115.42)
- Gas Price: $4/MCF (actual price averaged $4.02)
- State Severance Tax: 7%
- Development: Initial well drilled August 2013 and 5 additional wells drilled five years later
- Risk-Free Discount Rate: 10%
- July 2013 Woodford Type Curve:



In May 2013 there were several nearby sections producing from 1-mile horizontal Woodford wells. Development expectations were that each section would initially have one well to hold leases, then an additional five wells could be drilled in the future.



- **Results in an un-risked NPV of $22,000/NMA**
- **A sale of $6,000/NMA implies a 27% RAF or a 41% RADR**


Risk-Free value of $22,000/NMA
First well drilled August 2013
5 additional wells drilled March 2016
Possible and Probable Undeveloped
Proved Undeveloped
Proved Developed Producing
What RAF is implied with a May 2013 $6,000/NMA sale?
A 27% RAF
(or a 41% RADR)
$/NMA
$/BBL
$20,000
$18,000
$16,000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$-
$140
$120
$100
$80
$60
$40
$20
$-
Jul-2010
Jul-2011
Jul-2012
Jul-2013
Jul-2014
Jul-2015
Jul-2016
Jul-2017
Jul-2018
Jul-2019
Jul-2020
Jul-2021
Jul-2022

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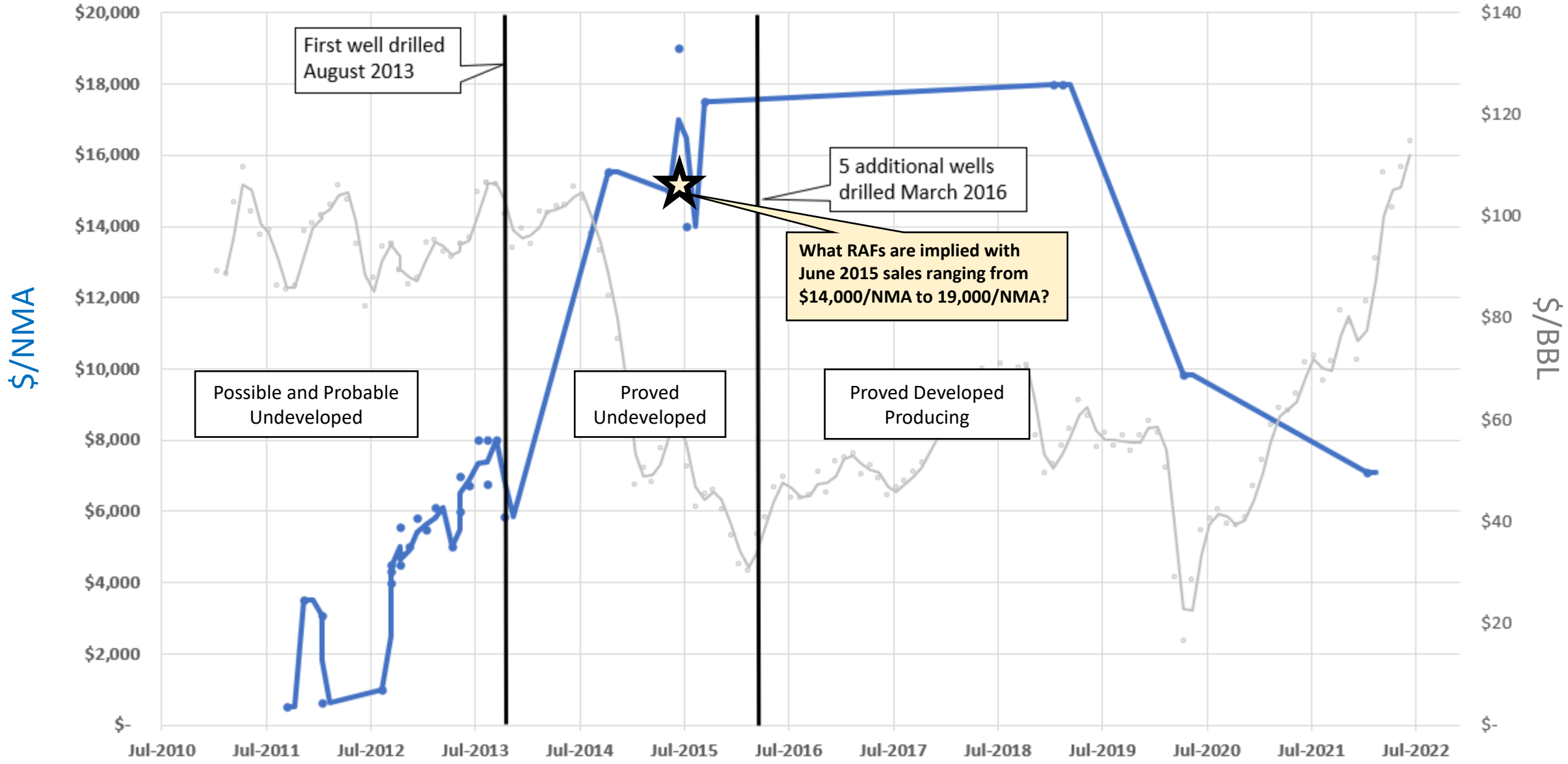
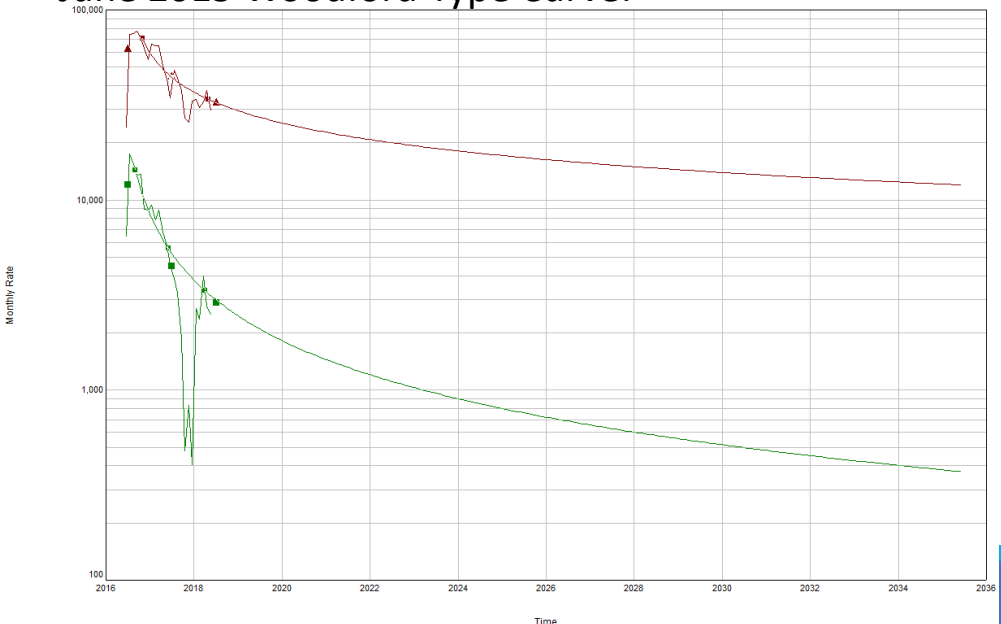
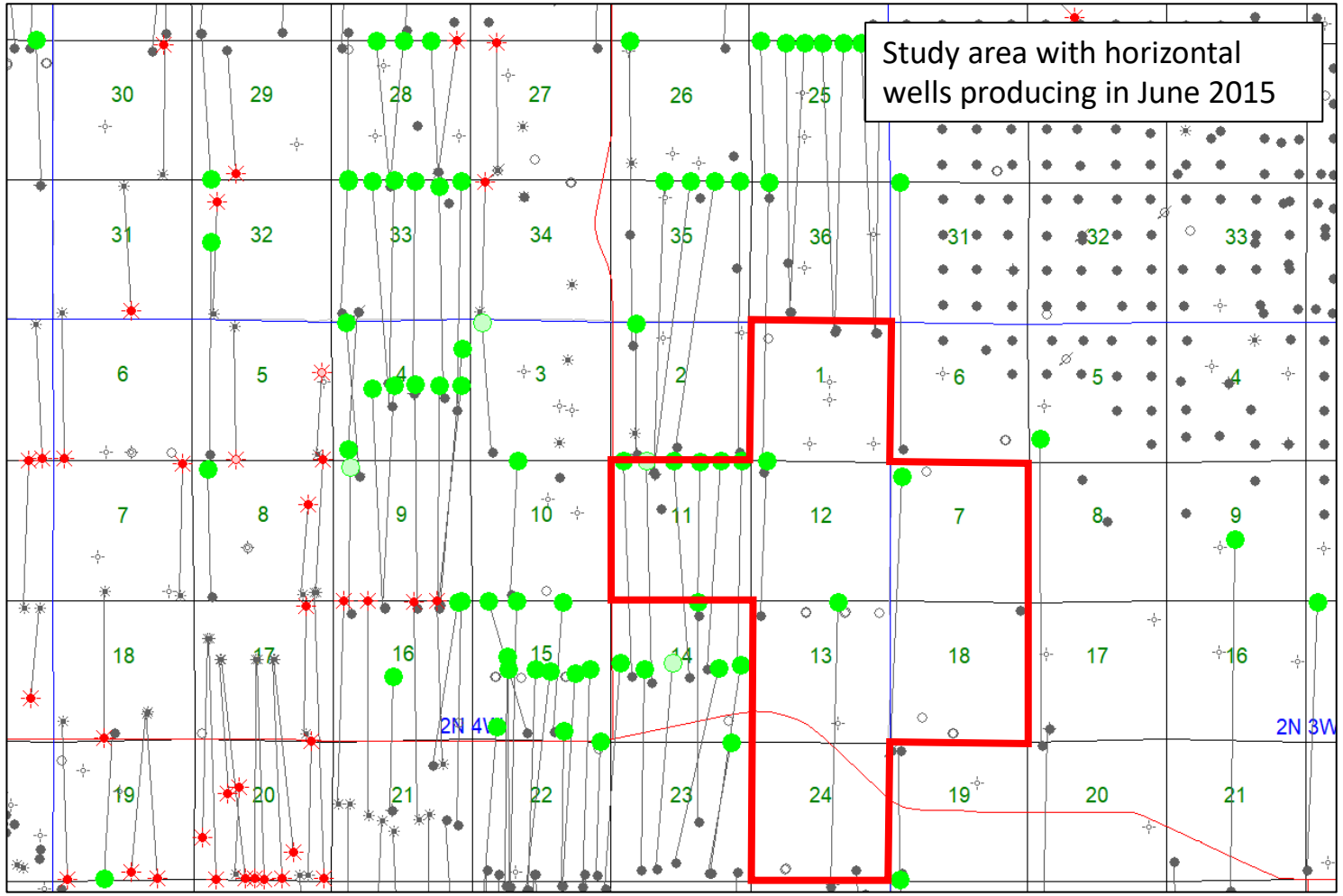


Assumptions for **June 2015** Discounted Cash Flow:

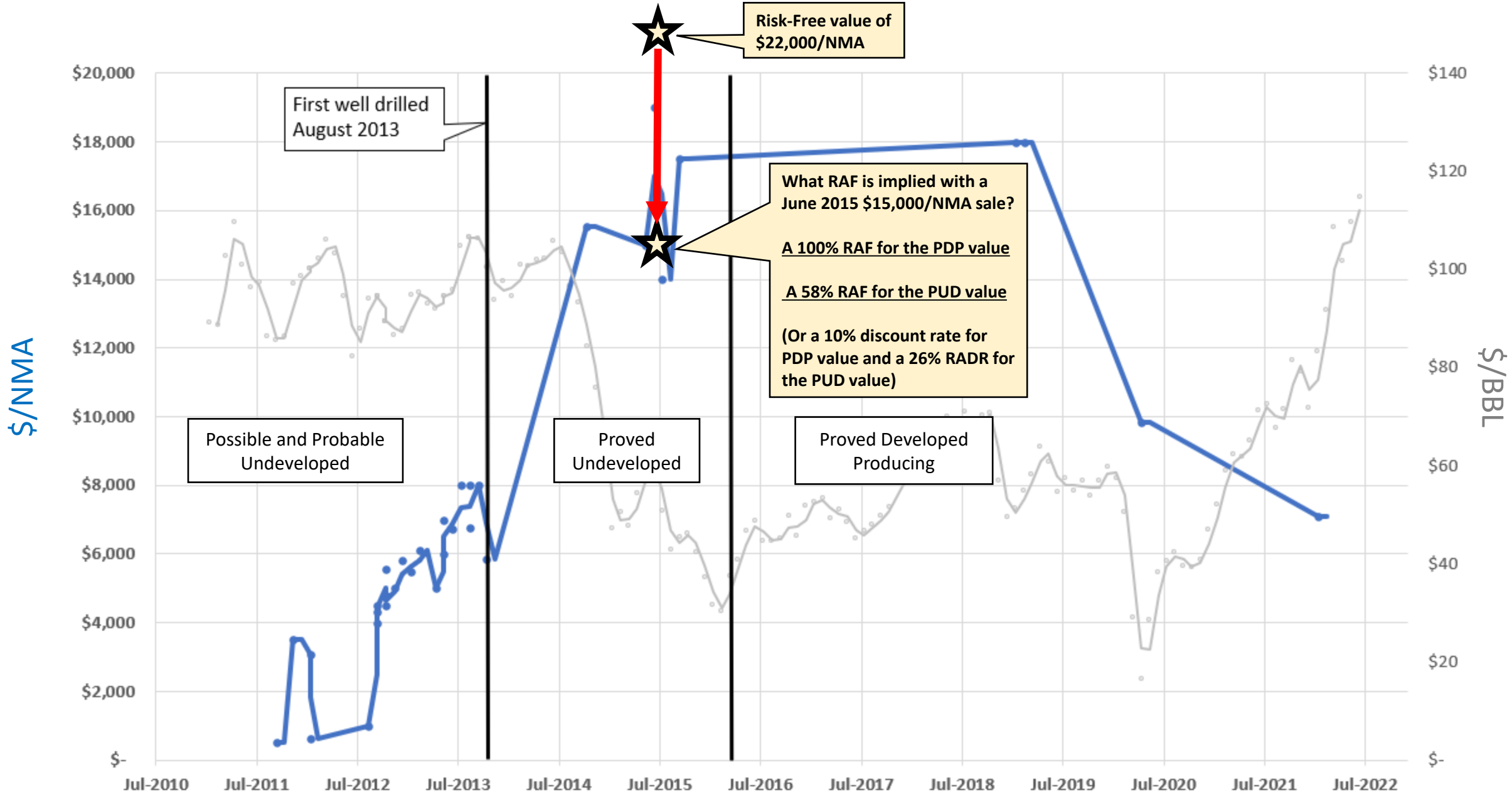
- Royalty: 3/16 (18.75%)
- Unit Size: 1,280 acres (2-sections) for subsequent wells
- Oil Price: $60/BBL (actual price averaged $59.47)
- Gas Price: $4/MCF (actual price averaged $3.43)
- State Severance Tax: 7%
- Development: PDP value from an existing 2013 well and PUD value from an additional five wells. Additional wells assumed to be two-mile horizontals cand completed in one year
- Risk-Free Discount Rate: 10%
- June 2015 Woodford Type Curve:



By June 2015 development had pivoted towards two-mile, horizontal wells and denser spacing. Commodity prices had significantly dropped.



- **Results in an un-risked NPV of $22,000/NMA**
- **$5,000/NMA associated with PDP value of an existing well**
- **Sales of $14,000/NMA to $19,000/NMA implies a 53% – 82% RAF or 15% to 30% RADR for the PUD value**


Risk-Free value of $22,000/NMA
First well drilled August 2013
What RAF is implied with a June 2015 $15,000/NMA sale?
A 100% RAF for the PDP value
A 58% RAF for the PUD value
(Or a 10% discount rate for PDP value and a 26% RADR for the PUD value)
Possible and Probable Undeveloped
Proved Undeveloped
Proved Developed Producing
$/NMA
$/BBL
$20,000
$18,000
$16,000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$-
$140
$120
$100
$80
$60
$40
$20
$-
Jul-2010
Jul-2011
Jul-2012
Jul-2013
Jul-2014
Jul-2015
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Jul-2020
Jul-2021
Jul-2022

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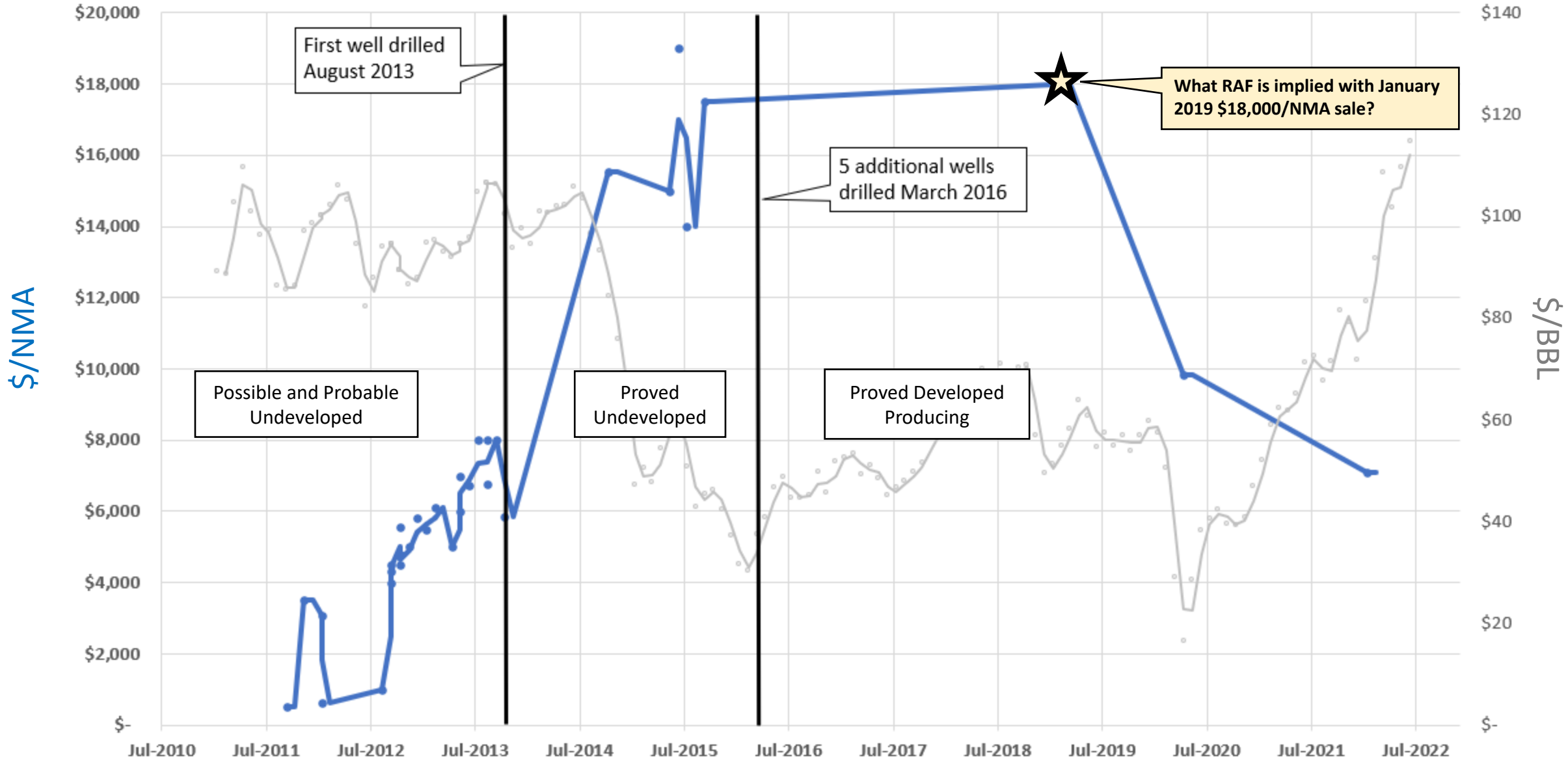
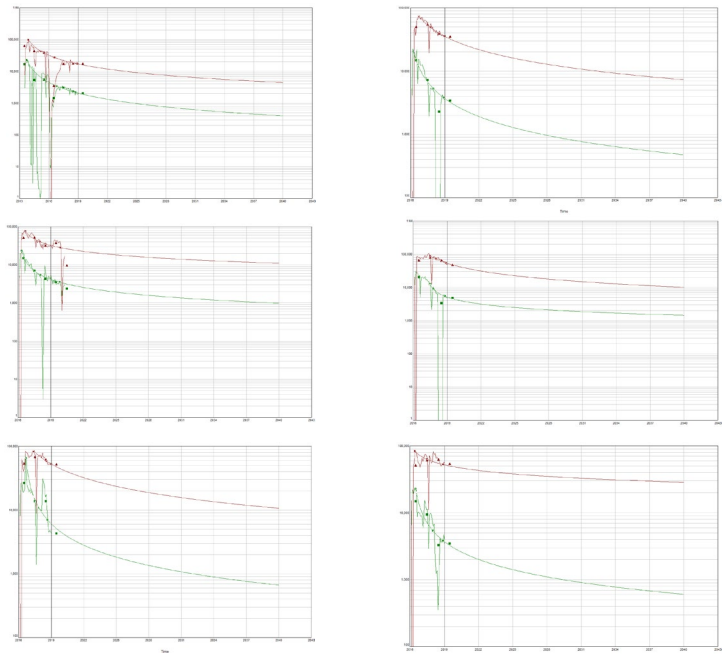
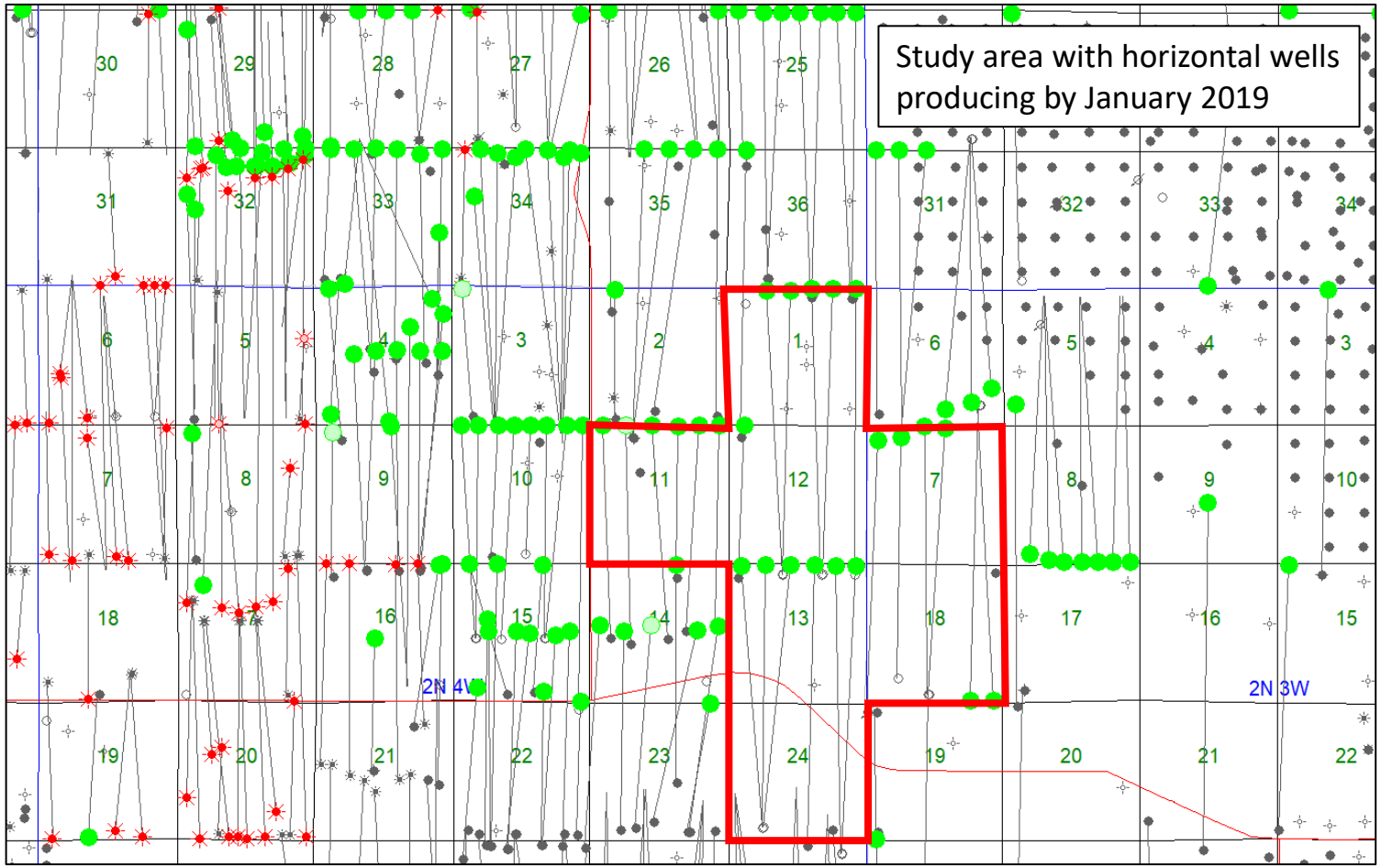


Assumptions for **January 2019** Discounted Cash Flow:

- Royalty: 3/16 (18.75%)
- Unit Size: 640 acres for initial well and 1,280 acres (for five subsequent wells
- Oil Price: $60/BBL (actual price averaged $62.45)
- Gas Price: $4/MCF (actual price averaged $3.27)
- State Severance Tax: 7%
- Risk-Free Discount Rate: 10%
- Forecasted production from existing wells:



By January 2019, units had been fully drilled out with six horizontal wells per section. Commodity prices had not changed very much.



- **Results in an un-risked NPV of $18,000/NMA**
- **A sale of $18,000/NMA implies a 100% RAF or a 10% discount rate**

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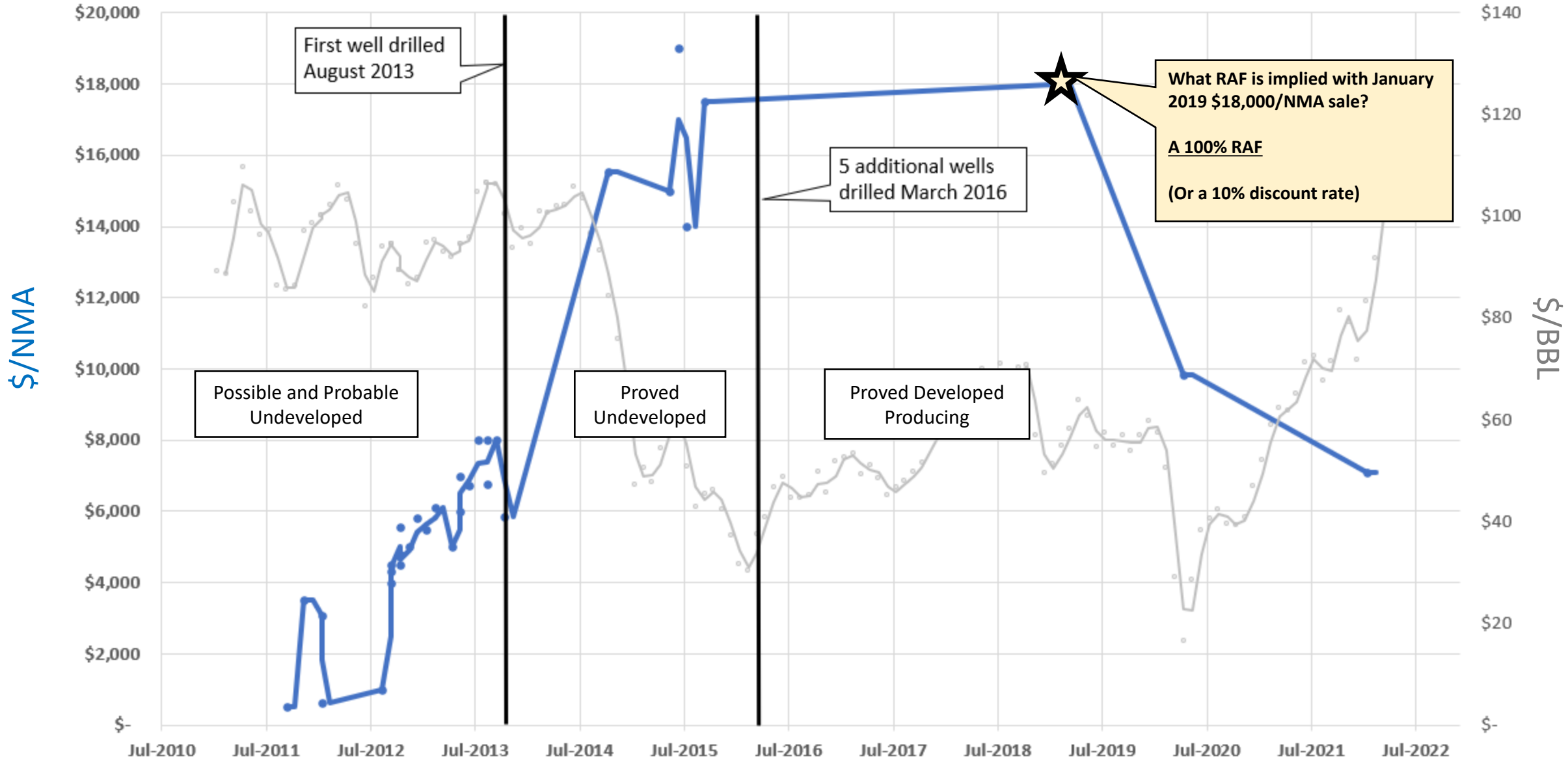
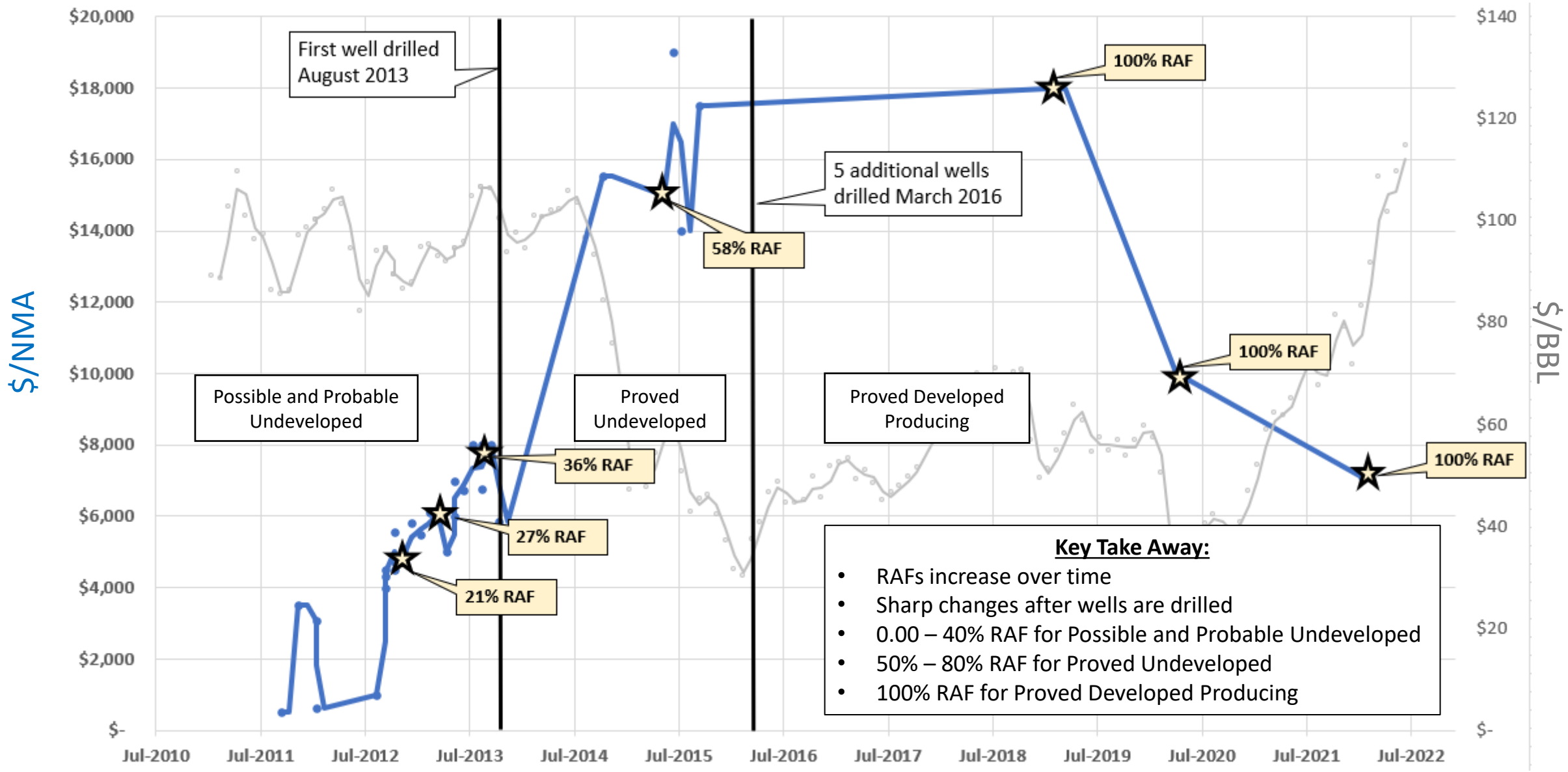
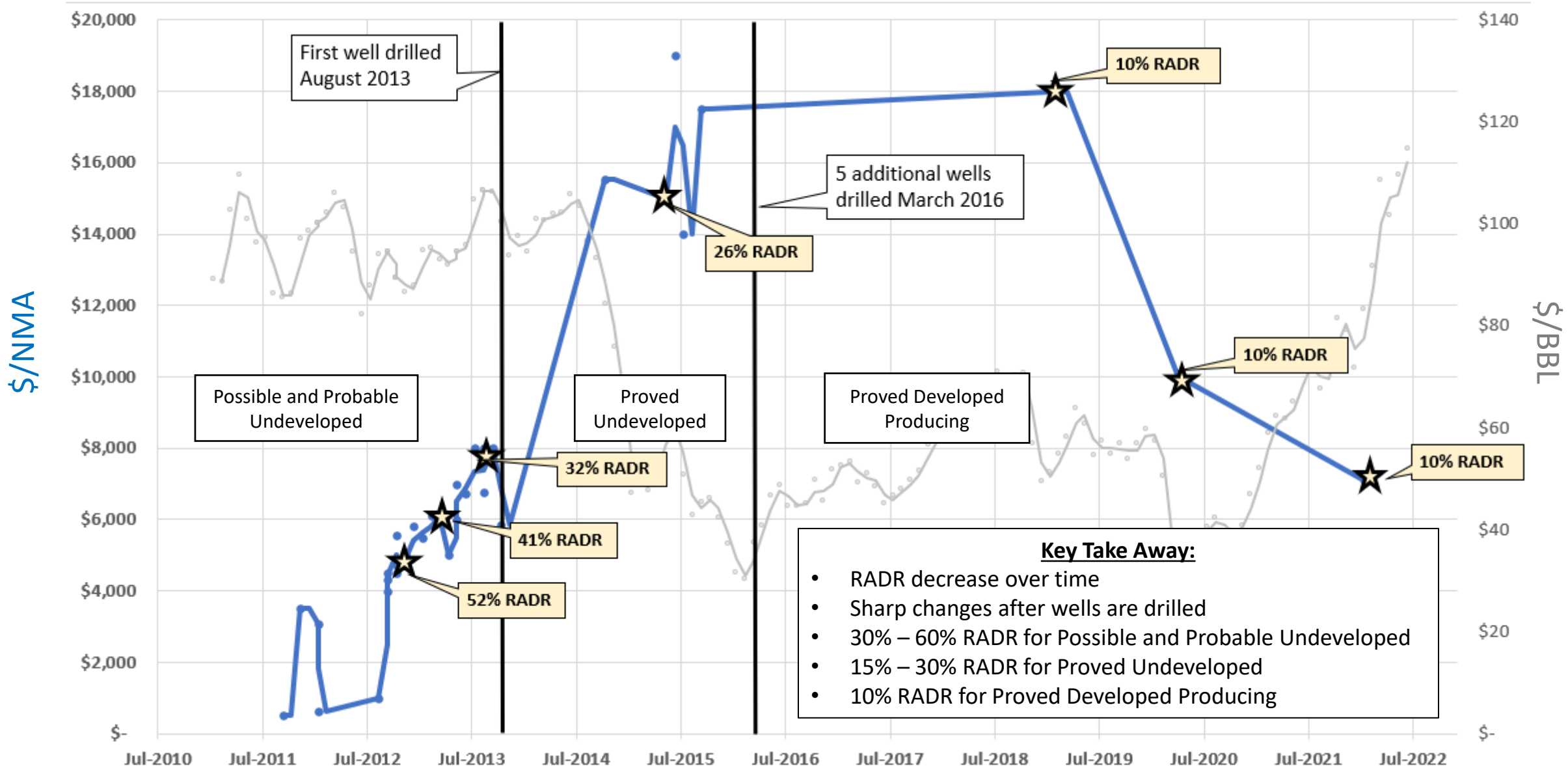


Conclusions: RAF



Conclusions: RADR



Summary

- Mineral rights values have a life-cycle – increase as they are drilled/proved/de-risked and decrease as they are depleted
- Investment risk can be accounted for with a Reserve Adjustment Factor (RAF) or Reserve Adjusted Discount Rate (RADR), these change depending on the reserve category
- The best data we have had available for what RAFs or RADRs industry participants apply is the annual SPEE survey
- This study shows market-based evidence of RAFs and RADRs and provides an example which is more in line with real-property appraisal methods for Fair Market Valuations
- Need more research! Additional efforts could focus on how RAF and RADR might change by play type, basin, operator, or interest type

Thank you!

- Tatiana Sazonova, Geologist - Program Lead for Indian Mineral Valuations
- Brett Brown, MAI - Regional Supervisory Appraiser for Oklahoma
- The Division of Minerals Evaluation Team

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