

# Two Medicine Cut Bank Sand Unit (TMCBSU) Phase 4: OOIP Estimation

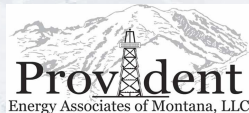
Arkanova Energy Corporation

Operator: Provident Energy Associates of Montana, LLC

*Kim Hemsley, Jennifer Zinn*

*G&G Team, DCS NGC*

*April 7, 2010*



# Outline:

OOIP Summary

Comparison of SLB 2010 Volumetrics to BLM 1996 Estimates

Primary and Secondary Recovery Estimates

Summary Points

Way Forward

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## OOIP Summary

- **130.3 MMSTB** - OOIP Recalculated by Schlumberger DCS in 2010 using Petrel model based on 228 field wells
- 105.4 MMSTB - OOIP Calculated by BLM in 1996 based on 114 field wells
- **24%** Volume Difference based on new OOIP estimation

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# OOIP Calculation

$$\text{OOIP} = \frac{(\text{Area} * \text{Th} * \text{Porosity} * (1 - S_w))}{\text{Formation Volume factor}}$$

$$\text{OOIP} = \frac{(230,097 \text{ acre-ft} * 0.114 * (1 - 0.3))}{1.1}$$

$$\text{OOIP} = 130.302 \text{ MMSTB}$$



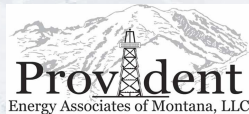
Two Medicine Cut Bank Sand Unit (TMCBSU)



# TMCBSU Lower Cut Bank OOIP Summary Table

	BLM 1996	DCS 2010	Percent Change
<b>OOIP</b>	105.39 MMSTB	<b>130.30 MMSTB</b>	<b>24%</b>
<b>Bulk Rock Volume</b>	168,092 acre-ft	<b>230,097 acre-ft</b>	<b>37%</b>
<b>Av. Porosity</b>	0.127	<b>0.114</b>	<b>-9.6%</b>
<b>Water Saturation</b>	0.3	0.3	-
<b>Formation Volume Factor (Bo)</b>	1.1 resbbl/STB	1.1 resbbl/STB	-
<b>LCB Av. Thickness</b>	18.3 ft	26 ft	42%
<b>OOIP/acre-ft</b>	627 bbl/acre-ft	566 bbl/acre-ft	-9.6%

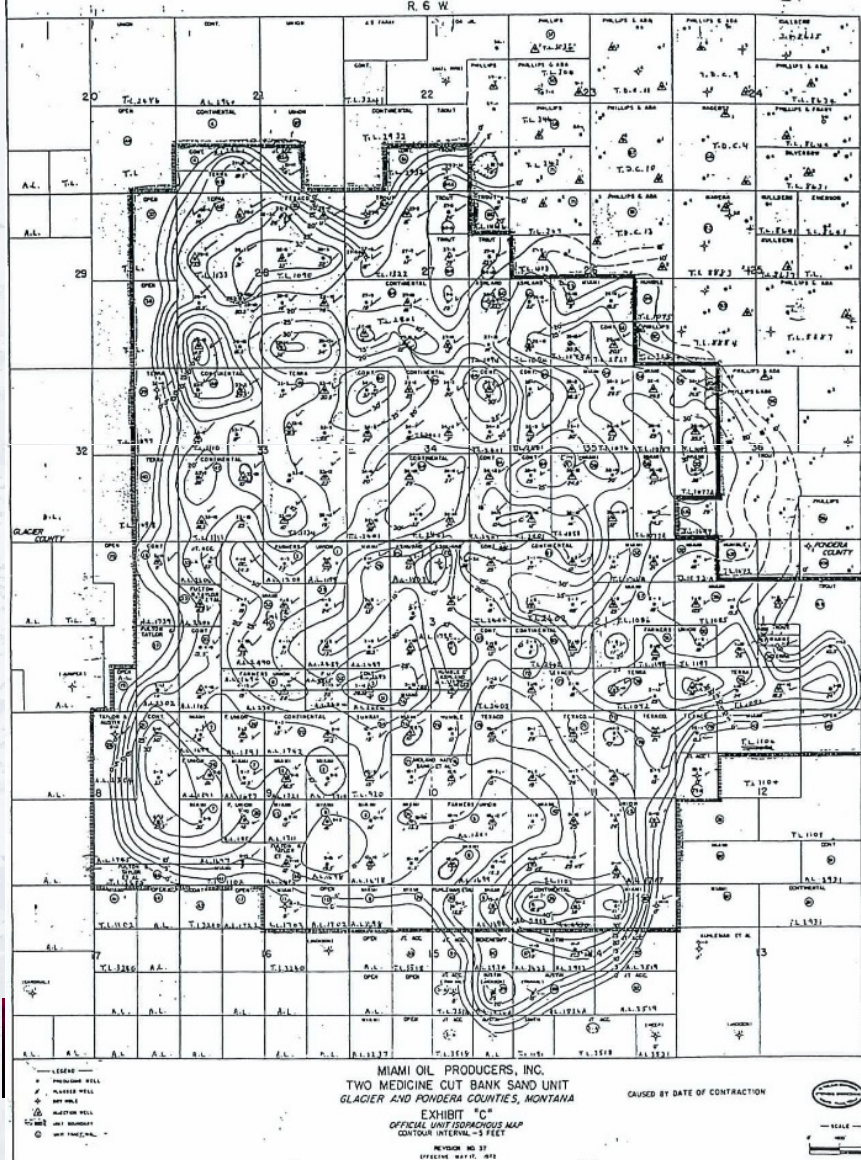
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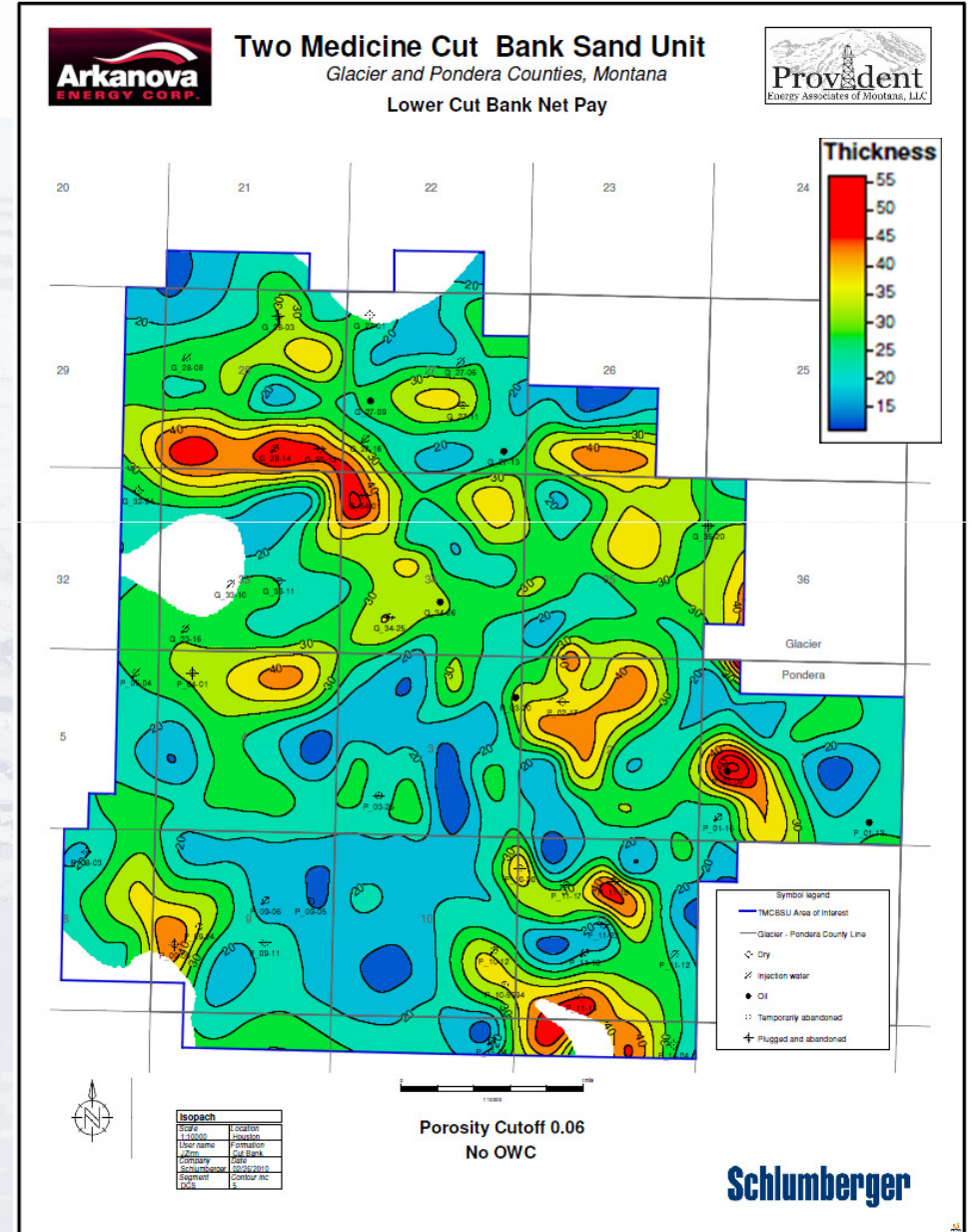


# Acreege Comparison

TMCBSU 9,191 acres



DCS 8,807 acres



# Area

- 8,807 acres - DCS 2010 acreage from 2010 LCB Net Pay Determination (6% porosity cutoff, no water contact)
- 9,191 acres –Acreage of the entire TMCBSU area of interest
- 4% Difference in area

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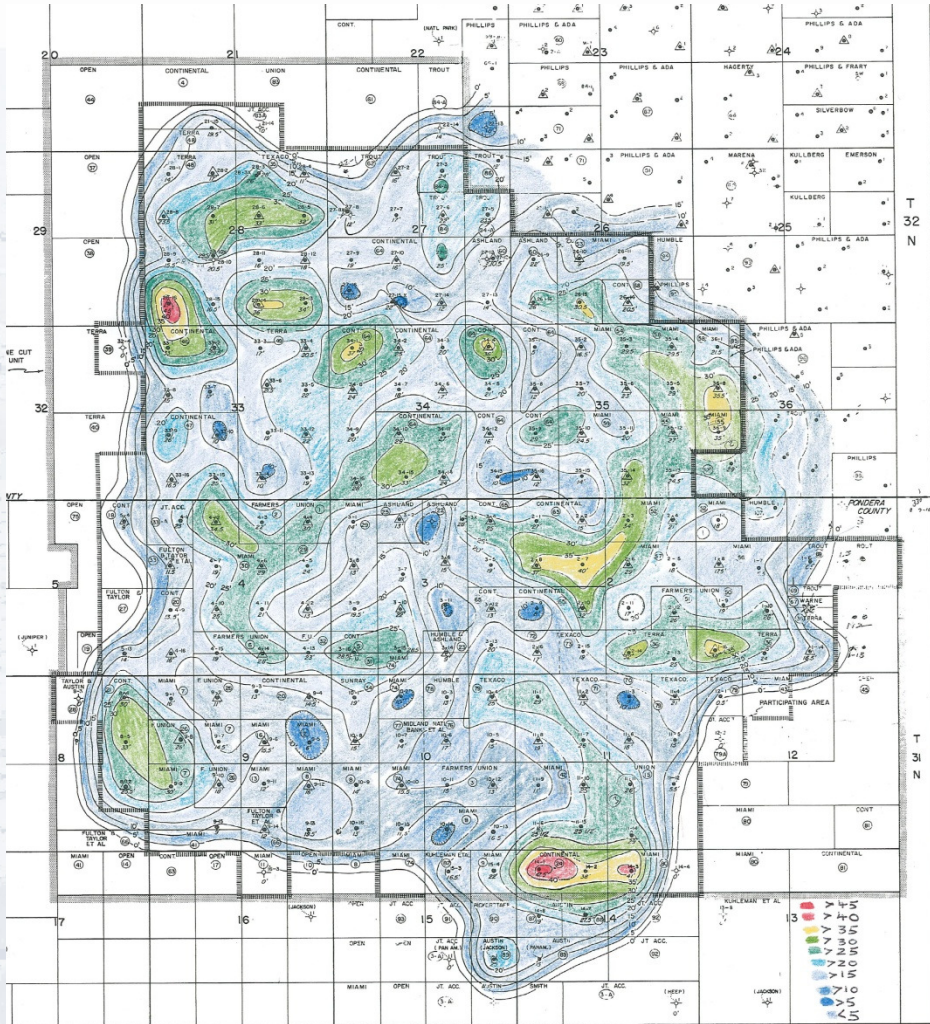




# Net Thickness Comparison

DCS 2010

BLM 1996



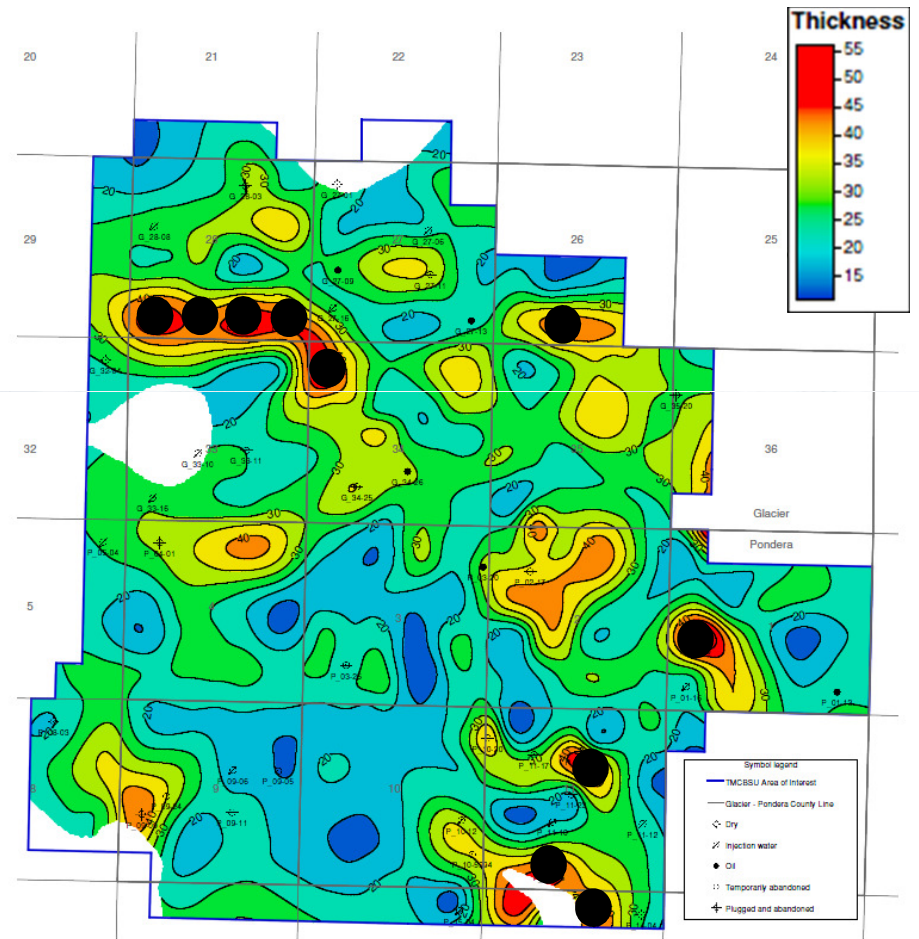
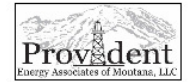
MIAMI OIL PRODUCERS, INC.  
TWO MEDICINE CUT BANK SAND UNIT  
GLACIER AND PONDERA COUNTIES, MONTANA  
EXHIBIT "C"  
OFFICIAL UNIT ISOPACHUS MAP  
REVISION NO. 33  
EFFECTIVE NOVEMBER 1, 1971

CAUSED BY THE DRILLING OF W.C.L.L. NO. 14-4 AND ALL OTHER ADDITIONAL INFORMATION TO DATE

SCALE 1" = 1000'



**Two Medicine Cut Bank Sand Unit**  
Glacier and Pondera Counties, Montana  
Lower Cut Bank Net Pay



Porosity Cutoff 0.06  
No OWC

ISOPACH	FOUNDRY
15	150000
20	200000
25	250000
30	300000
35	350000
40	400000
45	450000
50	500000
55	550000

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# LCB Thickness Comparison – Top 10 wells

Well	BLM LCB Sand Thickness	DCS LCB Net Sand Thickness	Percent Increase
P01-09	19	55.2	191
P11-06	16	43.8	174
G28-15	16.5	43.1	161
P11-15	25.5	45.2	77
G26-15	30.5	42.9	41
G28-14	36	48.8	36
G28-13	36	45.5	26
G34-01	37	45.3	22
P14-03	41	45.2	10
G28-16	45	47	5

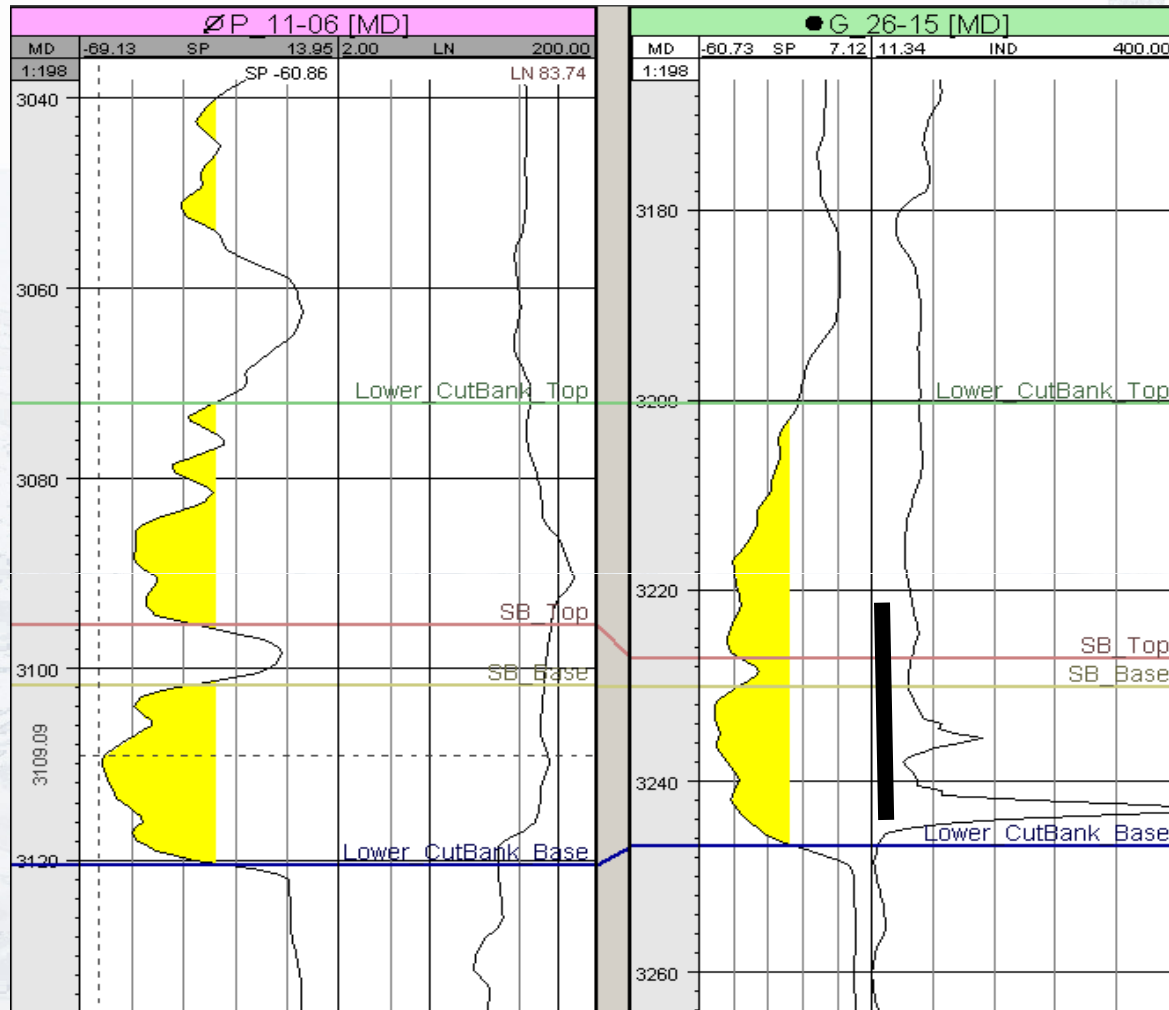
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Two Medicine Cut Bank Sand Unit (TMCBSU)

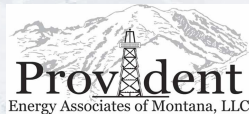


# DCS Sand Interpretation



Lower Cut Bank Fm.

Net Sand Th.	SLB 43.8 ft	SLB 42.9 ft
	BLM 16 ft	BLM 30.5 ft
Perf. Interval:	N/A	21 ft





## Reservoir Thickness

- 26 ft. – DCS 2010 Average Reservoir Thickness from LCB Net Sand Determination
- 18.3 ft. –Average Reservoir Thickness calculated from previous BLM 1996 report.
- 42% Difference in Average Reservoir Thickness
- Significant factor in Bulk Rock Volume calculation
- DCS Volumetrics based on net pay determination of 228 field wells and integrated geological model
- BLM Estimate based on 114 field wells and Miami Producers data and 1972 Isopachous map



# Porosity Comparison

- 11.4% - DCS 2010 Average Porosity calculated from 43 wells with Porosity logs in LCB reservoir model
- 12.7% - BLM 1996 Average Porosity calculated from 13 wells with core data

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# Other Reservoir Parameters

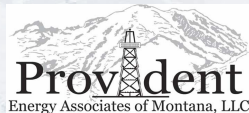
## BLM 1996 Report

Average water saturation  $S_w$  30%

Formation volume factor 1.1 resbbl/STB

## DCS 2010 Volumetric Estimation

Same values were used



# Recovery Factors

## BLM 1996 Report

Primary Recovery Factor 7.7%

Secondary Recovery Factor 26%

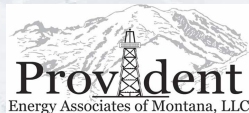
w/waterflood

## DCS 2010 Volumetric Estimation

Primary Recovery Factor 7.7%

Secondary Recovery Factor 24%

w/EOR



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# Engineering Opinion

## Formation Volume Factor

1.1 – Reasonable

Conversion factor of reservoir barrels to stock tank barrels. Range 1.05 – 1.2

## Primary Recovery

7.7% - Reasonable

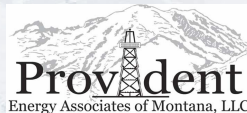
Dependent on many factors – pressure, oil type, reservoir quality, completions

## Secondary Recovery w/waterflood 20-26 % - Possible

>20% RF attainable with efficient waterflood design

Modeling recommended for reactivation of previous EOR operation

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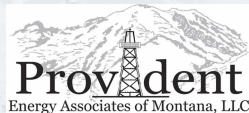
# Primary and Secondary Recovery

	<b>BLM 1996</b>	<b>DCS 2010</b>
<b>OOIP</b>	105.39 MMSTB	<b>130.3 MMSTB</b>
<b>OOIP/acre-ft</b>	627 bbl/acre-ft	<b>566 bbl/acre-ft</b>
<b>Primary Est. Ultimate Recovery</b>	48 bbl/acre-ft*	43.6 bbl/acre-ft
	8.12 MMSTB	<b>10.0 MMSTB</b>
<b>Total Estimated Ultimate Recovery**</b>	164 bbl/acre-ft	136.0 bbl/acre-ft
	27.5 MMSTB*	<b>31.27 MMSTB</b>
<b>Cumulative Oil Production</b>	10.6 MMSTB	<b>10.48 MMSTB*</b>
<b>Est. Remaining Recoverable Oil Volume***</b>	16 - 17 MMSTB	<b>20-21 MMSTB</b>

\* SLB 2009

\*\* Includes both initial Primary and Secondary Recovery with Waterflood

\*\*\* Assumes re-establishment of an optimized EOR program throughout TMCBSU





## OOIP Summary

- 130.3 MMSTB Lower Cut Bank OOIP Estimate
- 10.48 MMSTB Cumulative Oil Production (SLB 2009)
- 119.82 MMSTB Remaining OIP Estimate
- 24% increase over 1996 BLM OOIP estimate
- Volumetrics based on integrated geological model and 228 field wells
- ~20 MMSTB remaining recoverable oil volume – actual recovery contingent on re-establishment of an optimized EOR program throughout TMCBSU

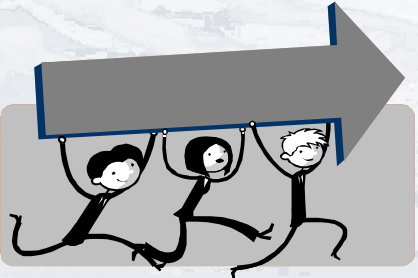
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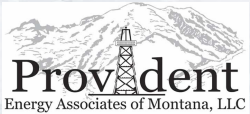
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# The Way Forward



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# Proposed Next Steps

## ➤ New Drill Locations

- Integrate geological, production, injection and field data for new well location selection for 2010 program

## ➤ Candidate Selection

- Identification of additional work-over/shut-in well candidates

## ➤ Reservoir Evaluation

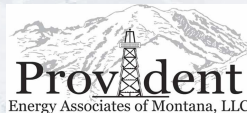
- Reservoir and Production Analysis of field engineering data, fracture analysis, recovery optimization, and EOR planning concurrent with field data acquisition program

## ➤ Field Development Planning

- Recommend drilling, logging and formation testing plans for both Cut Bank and Baaken in new wells
- Collaborate on field development strategies
  - Infill Drilling with Pressure Maintenance
  - Waterflood Reinstallation



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Thank You

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