



**Enhanced Oil Potential
at the Grieve Field,
Natrona County,
Wyoming**

SEPTEMBER 2010

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Grieve Field: Location Map

Wind River Basin; Infrastructure

- Extensive oil, gas, some CO₂ pipeline network

Grieve-CO₂ Flood EOR

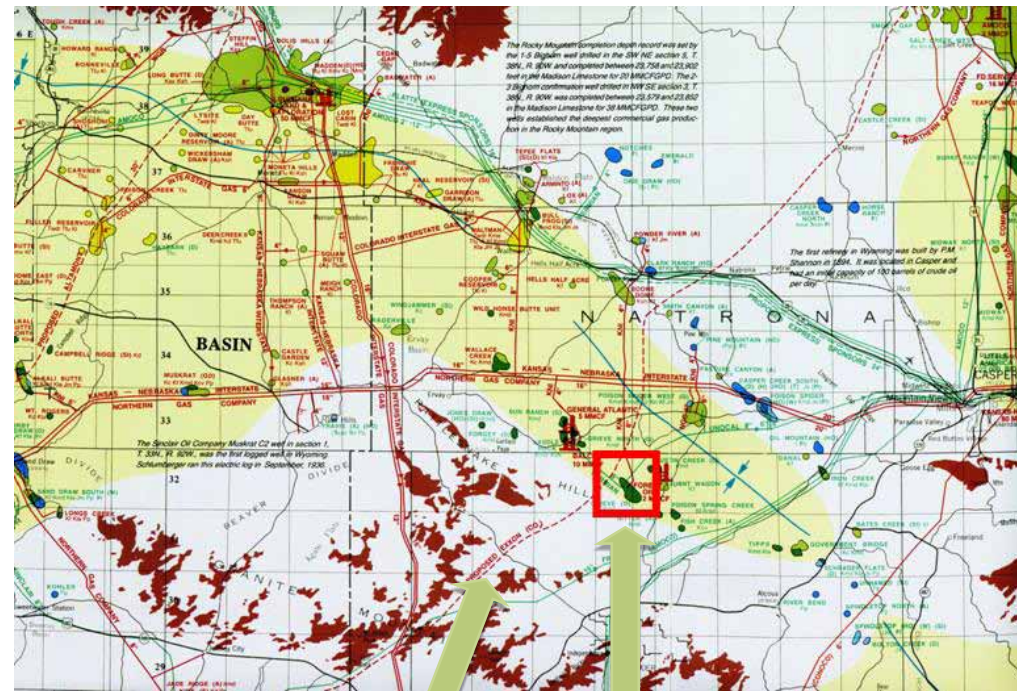
- Ryder Scott confirmed 3P reserves of 18.6 million barrels in April 2008
- Extensive negotiations (2006-2008) with parties who currently emit, sell or use CO₂
- Attempts to secure suitable CO₂ contracts were unsuccessful

Grieve-Chemical Flood (ASP) EOR

- Preliminary results encouraging for Grieve rocks and fluids
- Started extensive program of laboratory testing and field development planning with Surtek Inc. started in December 2008
- Ryder Scott confirmed 2.39 MMBO P2 reserves and 2.43 MMBO P3 reserves, in July 2010.

Infrastructure Map

Wind River Basin, Wyoming



CO₂ pipeline

Grieve Field

Grieve Field: History and Production

n Cumulative Production:

- ≈ 30 Million Barrels Oil,
- ≈73.5 BCF Gas, and
- ≈34 Million Barrels Water
- Peak production in 1960: over 12,000 BOPD

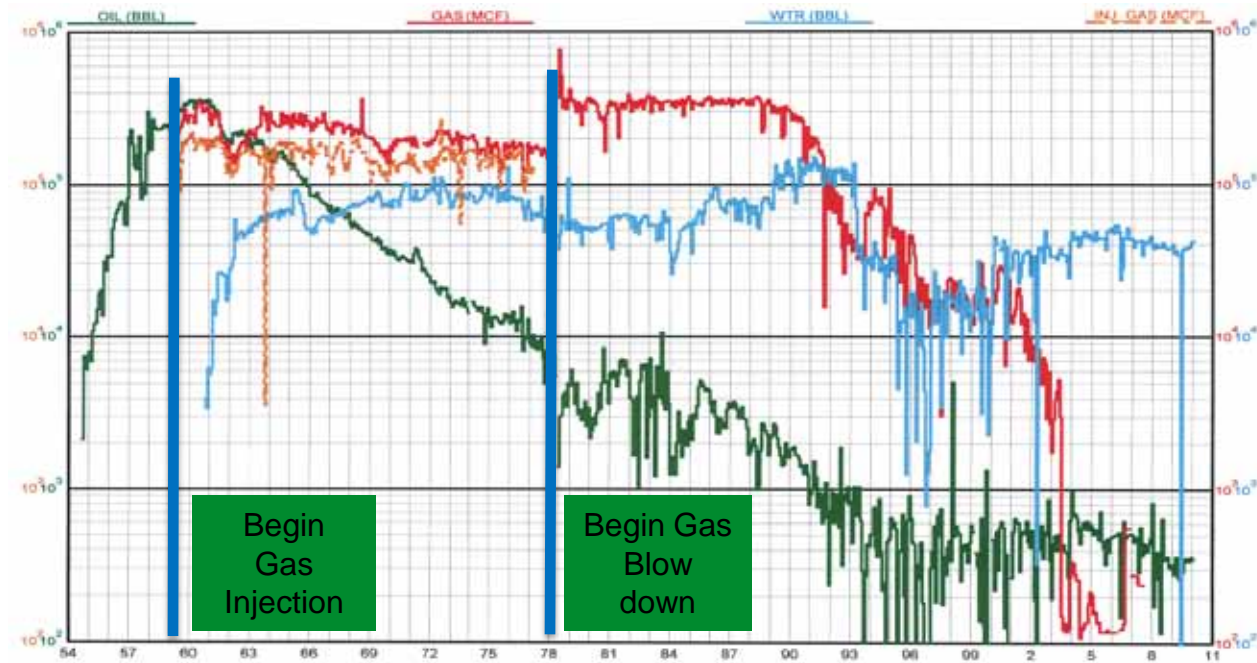
n OOIP

≈ 75 Million Barrels (Nitec history match number).

n Therefore only ≈40% oil recovery to end 2009.

n Never water flooded

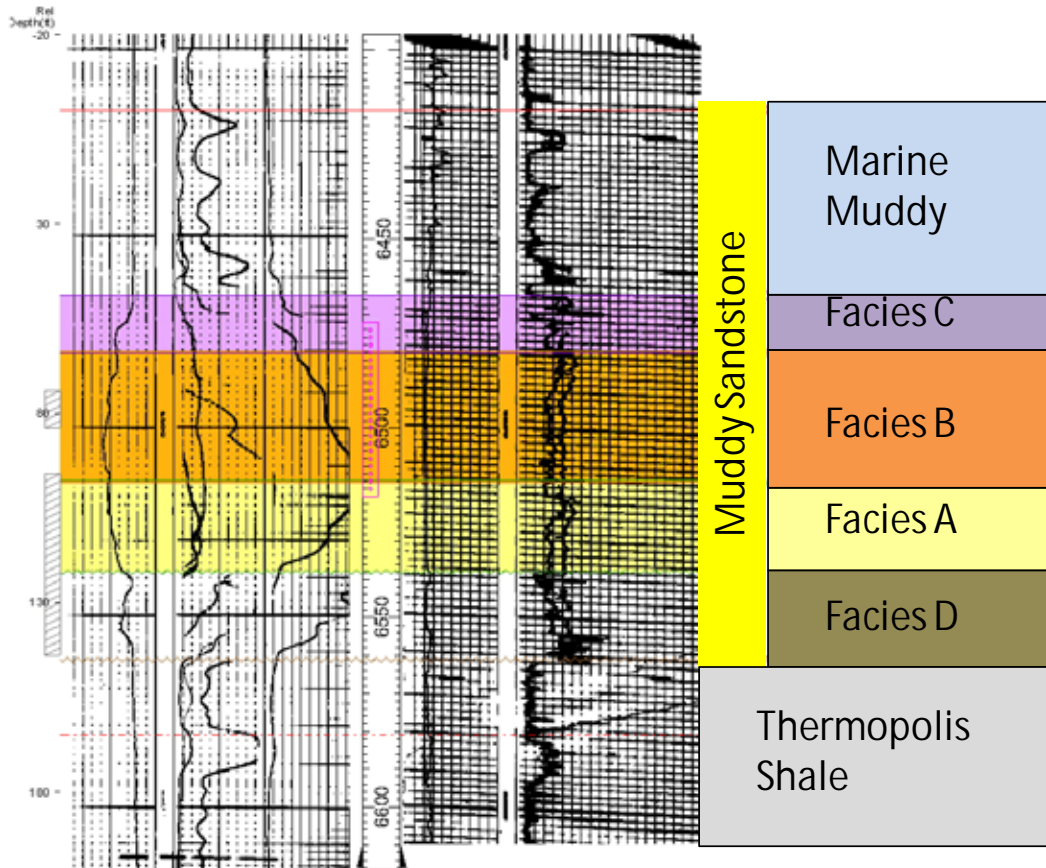
n One well currently producing (around 10 BOPD)



Monthly Data 1954 – 2009

Grieve Field: Type Log

9
T32N R85W S21



- n Stratigraphic trap in the Lower Cretaceous Muddy Sandstone
- n 6,800 feet average reservoir depth
- n Reservoir thickness ranges from 0 to 90 feet
- n 30 wells have core data.
- n Large data set available to build reservoir model and provide high confidence level in projections

Muddy Sandstone: Outcrop Northwest of Grieve



Muddy Facies B

Planar Laminate
Sandstone, Fine
Grained

Muddy Facies A

Cross-Bedded
Sandstone, Massive
appearance, Fine
grained

Muddy Sandstone: Section is Completely Oil Saturated



Wyoming Stratigraphy: Second to None



Very few places in the world can you produce from a reservoir and within 20 miles explore the stratigraphic relationships at the outcrop scale.



Grieve Field: Reservoir Properties & Geometry

Stratigraphic Trap

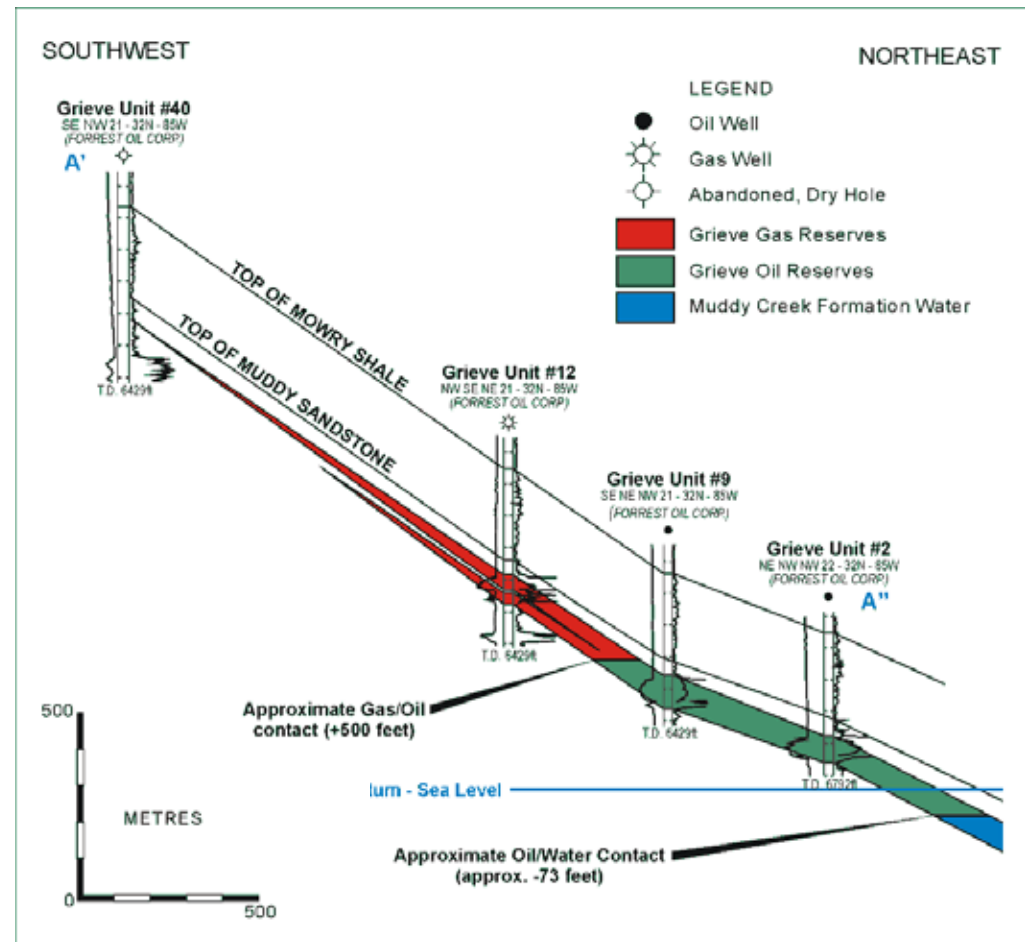
- Thins and pinches out up-dip
- Average Dip: 15°
- Moderately well defined Gas/Oil contact but poorly defined Oil/Water contact

Reservoir Properties

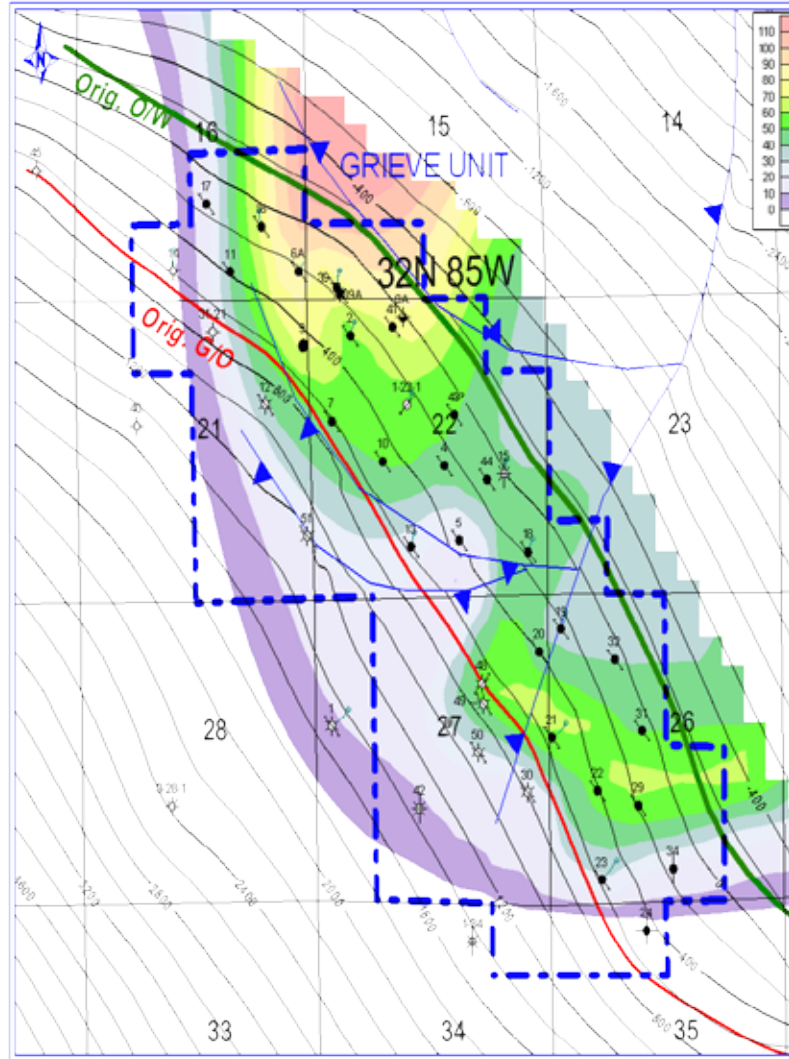
- Porosity: 20.4%; permeability: 220 md
- Average Thickness: 45 feet
- These indicate excellent reservoir characteristics for an EOR project
- Original Hydrocarbon Column:
 - Oil – 700 feet
 - Gas – 900 feet

Production

- Oil gravity –37° API
- Drive Mechanism - Gas cap expansion and partial flank water drive

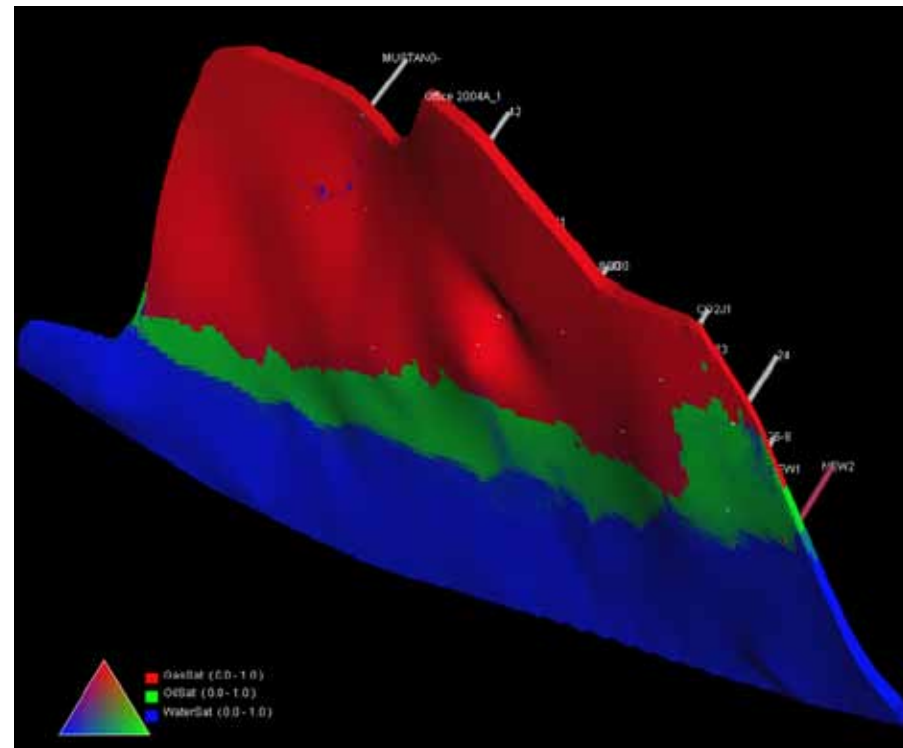
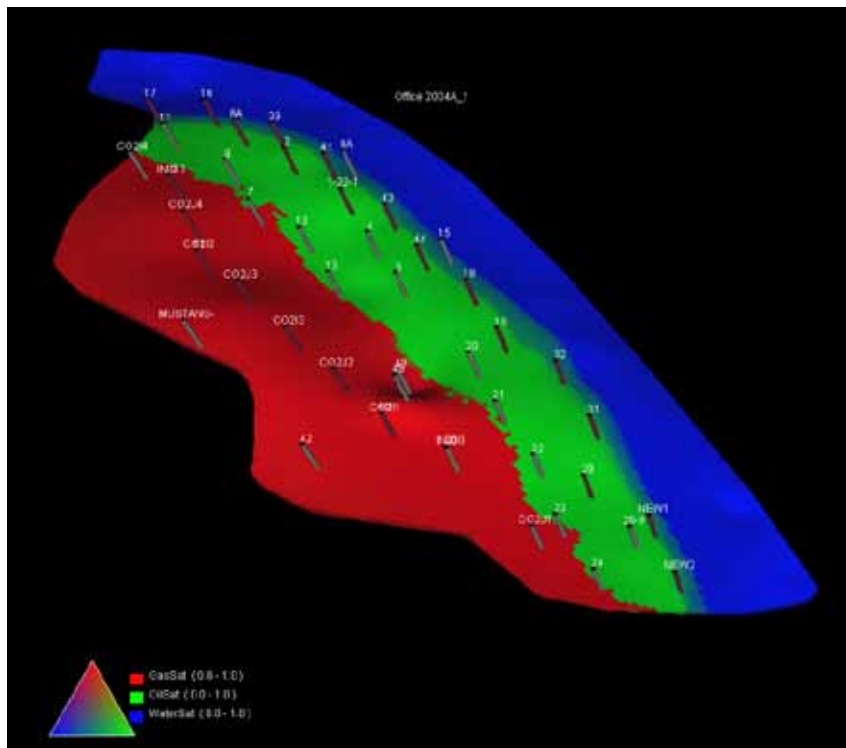


Grieve Field: Gross Sand Map



- n A southeast to northwest trending incised valley system
- n Field developed in an meander loop of the valley system
- n 15° regional dip to the northeast creates the trap
- n Maximum sand thickness of 90 feet is seen at the northwest side of the field

Grieve Field: CO₂ EOR Enhanced Oil Recovery Institute



Ternary view of oil, gas, and water distributions after 27 months of CO₂ injection followed by 21-month injection/production in Scenario 3, top view (left) and bottom view (right).

Grieve Field: CO₂ EOR

Nitec: EOR Sensitivity Groups

Repressure Strategy

Q_000	Base Case, Water & Gas
Q_001	Water, then Water & Gas
Q_002	Water, then Gas Only
Q_003	Water Only
Q_004	Gas Only
Purchase/Production Gas Rates	
Q_005	Purchase/Production 25/50
Q_000	Base Case, Purchase/Production 50/100
Q_006	Purchase/Production 75/150
Q_032	Purchase/Production 110/200
SOR to Miscible CO2	
Q_007	SORCO2 = 2.5, 5.0, 10%
Q_000	Base Case, SORCO2 = 2.5, 7.5, 17.5%
Q_047	SORCO2 = 5.0, 10, 20%
Well GOR Production Limit and Workover Strategy	
Q_000	Base Case, Well GOR Limit 75
Q_010	Well GOR Limit 100
Q_034	No Workovers
BHP Injection	
Q_000	Base Case, BHP Injection 3000
Q_011	BHP Injection 2500
Well Configuration	
Q_000	Base Case, Gas Cap Injection
Q_012	Distributed Injection, Gas Only (C)
Q_021	Distributed Injection, Gas and Water (G)
Q_039	Gas Cap Injection, with Addtl. Water Injs. (N)
Q_045	Gas Cap Inj., with Low Addtl. Water Injs. (O)
BHP Production	
Q_000	Base Case, BHP Production 2070
Q_015	BHP Production 1750
Q_016	BHP Production 1400
Q_017	BHP Production 1100
Q_018	BHP Production 1100 to 2070
Gas Injection Type	
Q_000	Base Case, CO2 Injection
Q_019	HC Gas Injection
Completion Strategy	
Q_000	Base Case, Comingled
Q_020	Layer-Controlled Injection
Q_024	Horizontals L1 (3 inj.)
Q_025	Horizontals L1 (5 inj.)
Q_026	Horizontals L1 (5 inj, 3 prod.)
Q_027	Horizontals L1 (5 inj, 5 prod.)
Q_030	Horizontals L1 2200ft (5 inj, 5 prod.)
Q_046	Horizontals L1 (5 inj, 10 prod.) Addtl Vert Injectors

Repressure Strategy

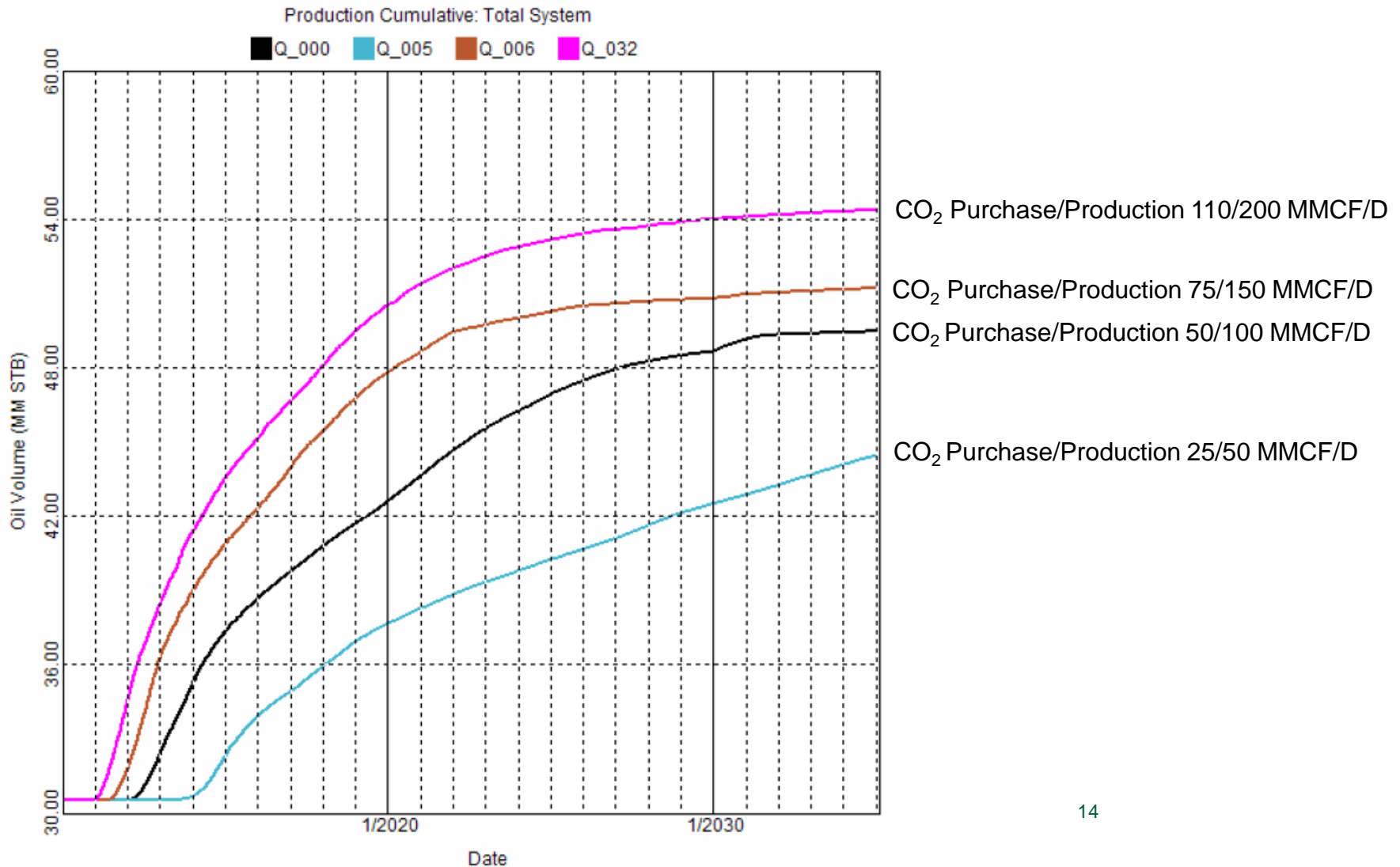
	Q_000	Q_001	Q_002	Q_003	Q_004
Incremental Np@2035 (MSTB)	18,924	18,430	16,401	972	17,354
Incr Recovery (% of OOIP)	28.0%	27.3%	24.3%	1.4%	25.7%
CO2 Purchased (MMSCF)	170,932	157,794	252,229	0	249,543
CO2 Injected (MMSCF)	748,960	707,754	748,377	0	768,485
CO2 Utilization (MSCF/STB)	9.0	8.6	15.4	0.0	14.4
CO2 Injection (MSCF/STB)	39.6	38.4	45.6	0.0	44.3
Time to Oil Peak Rate (months)	48	47	57	228	54
Peak Oil Rate (STB/D)	10,000	9,700	9,300	247	9,300
Np @ fifth year (MSTB)	6,838	5,065	2,423	0	3,381
Time to First Oil Prod (100 STB/D)	22	32	39	131	33

Purchase and Gas Processing Limits

	Q_005	Q_000	Q_006	Q_032
Incremental Np@2035 (MSTB)	13,925	18,924	20,663	23,835
Incr Recovery (% of OOIP)	20.6%	28.0%	30.6%	35.2%
CO2 Purchased (MMSCF)	128,181	170,932	184,420	147,457
CO2 Injected (MMSCF)	502,023	748,960	794,235	794,067
CO2 Utilization (MSCF/STB)	9.2	9.0	8.9	6.2
CO2 Injection (MSCF/STB)	36.1	39.6	38.4	33.3
Time to Oil Peak Rate (months)	58	48	30	23
Peak Oil Rate (STB/D)	6,400	10,000	15,500	15,900
Np @ fifth year (MSTB)	1,793	6,838	10,332	13,031
Time to First Oil Prod (100 STB/D)	42	22	15	12

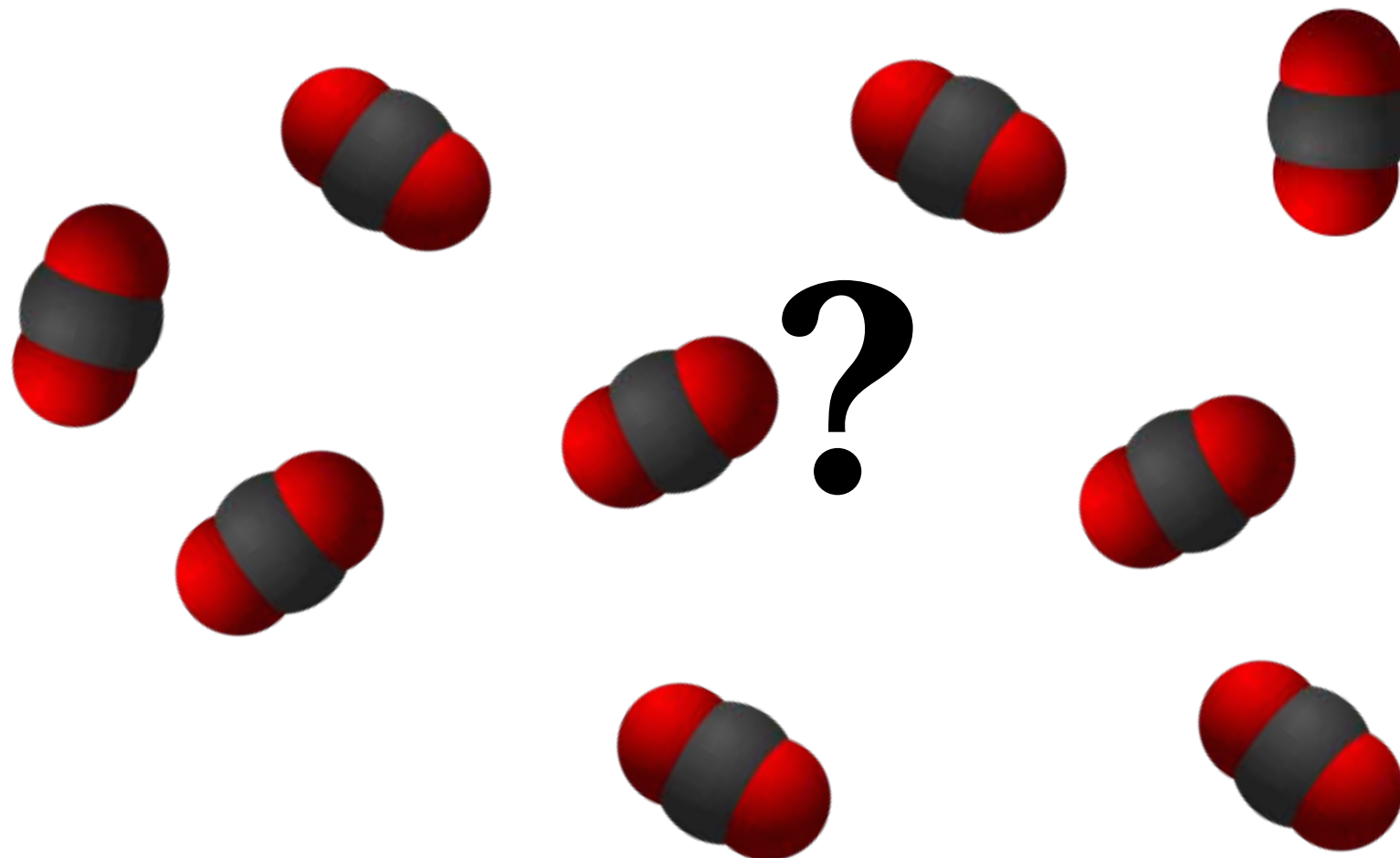
Grieve Field: CO₂ EOR

Cumulative Oil Production by Injection Volume Scenario



Grieve Field:

If CO₂ is not available, then what else will work?



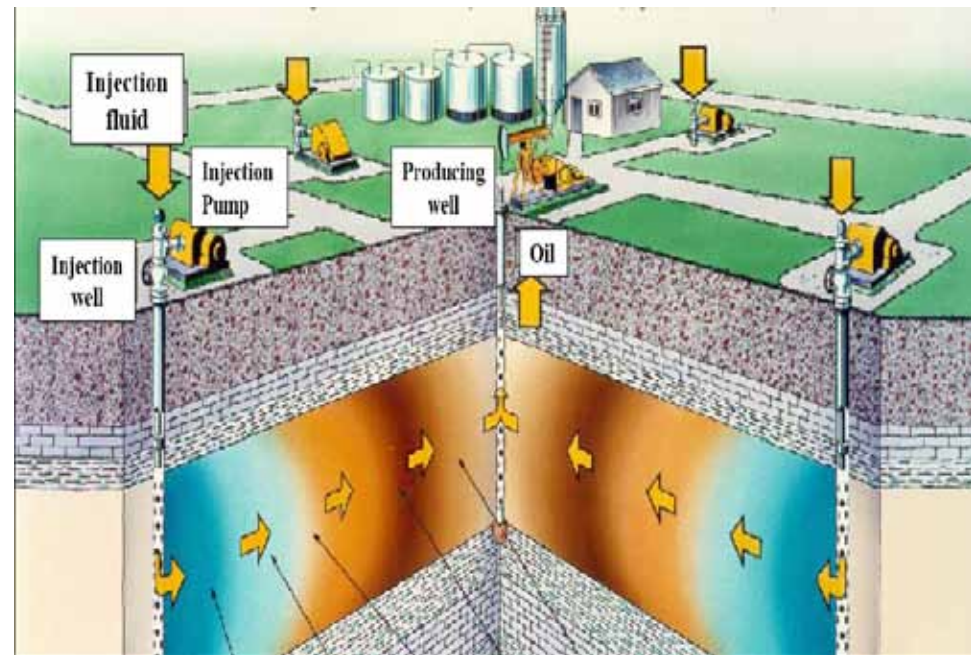
ASP Chemical Flood Process

Chemical Flood Process

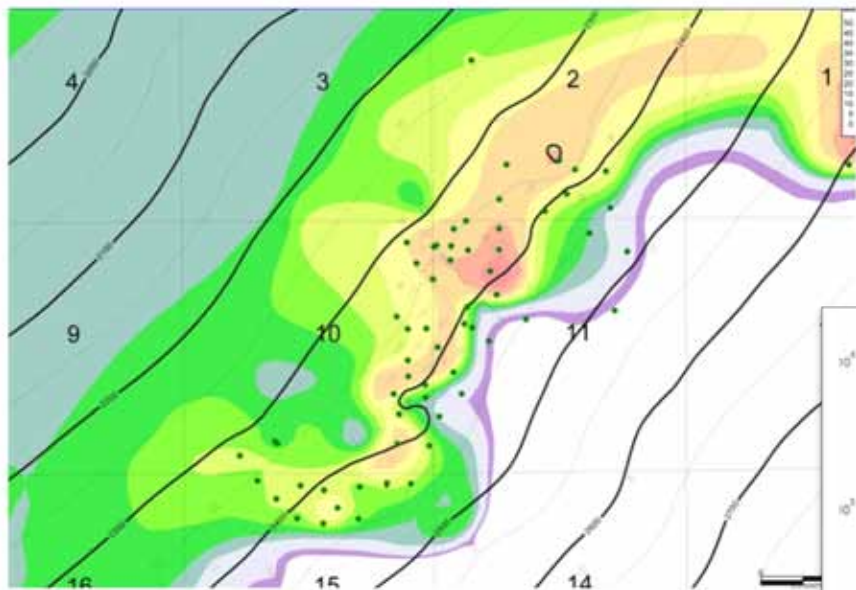
- n Injects chemical “soup” mixed with water into injection wells
- n Chemicals reduce the interfacial tension between the rock and the oil and move fluid towards production wells
- n Fluids are separated at surface; chemicals are re-used

ASP Chemical Flood

- n **A**lkalis; React with oils to produce natural surfactants
- n **S**urfactants; Reduce interfacial tension between oil and water. Mobilize oil and reduce oil content remaining in reservoir rock. Mix with polymers to contact additional oil in reservoir
- n **P**olymers; Increase viscosity of injected water. Improve sweep efficiency. Divert water from high permeability zones to aid additional oil recovery

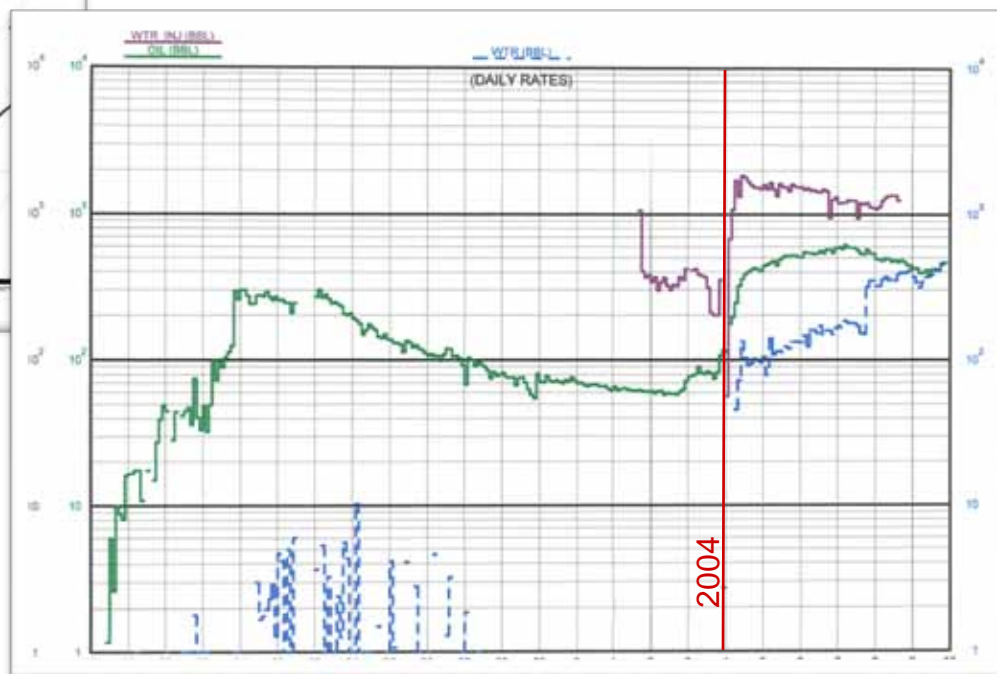


Chemical Flood Analog 1 Thompson Creek



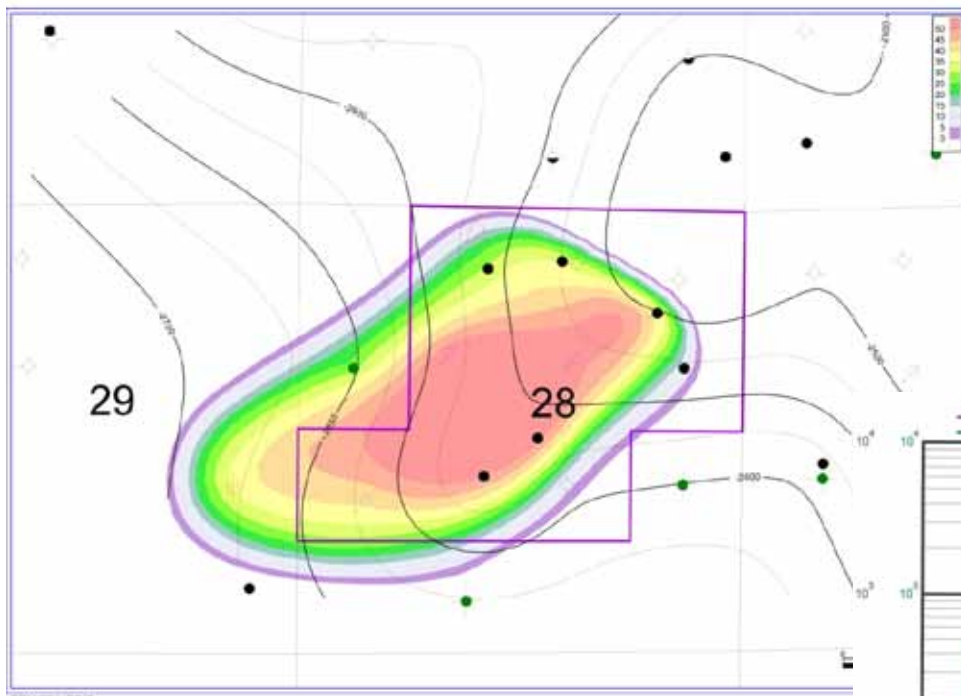
- Located in the Northern Powder River Basin
- Muddy sand channel trending NE to SW
- Down-dip to the Northwest
- Stratigraphic Trap

- Chemical formulation and simulation conducted by Surtek in 2003
- AP Chemical Flood initiated in 2004
- Production increased from 60 BOPD to 600 BOPD



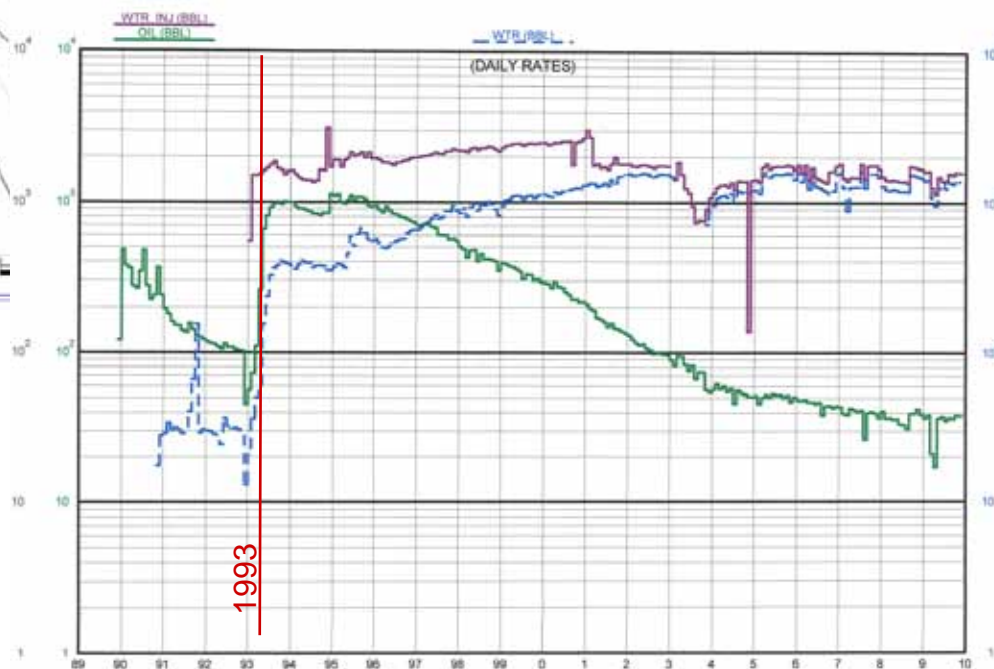
Chemical Flood Analog 2

Cambridge Field



- Located in the Northern Powder River Basin
- Minnelusa Stratigraphic Trap
- Down-dip to the Southwest

- Chemical formulation and simulation conducted by Surtek
- ASP Chemical Flood initiated in February 1993
- In 6 months production increased from 100 BOPD to 1000 BOPD



Grieve Field: Pilot Flood and Simulation

Surtek undertook a pilot flood of a fresh Grieve field core and developed a full field simulation

n Initial Assessment of Grieve

- Good chemical flood prospect
- Phased development proposed

n Fluid Test

- Examined chemicals' effects on Grieve oil & water & rock
- Interfacial tension reductions, phase behavior determined

n Linear Flood

- Examines viscous effects of chemicals on fresh reservoir rock

n Radial Flood

- Simulation of reservoir recoveries using produced water and then chemicals (complete by mid December 2009); 10% to 60% incremental recovery for this core material

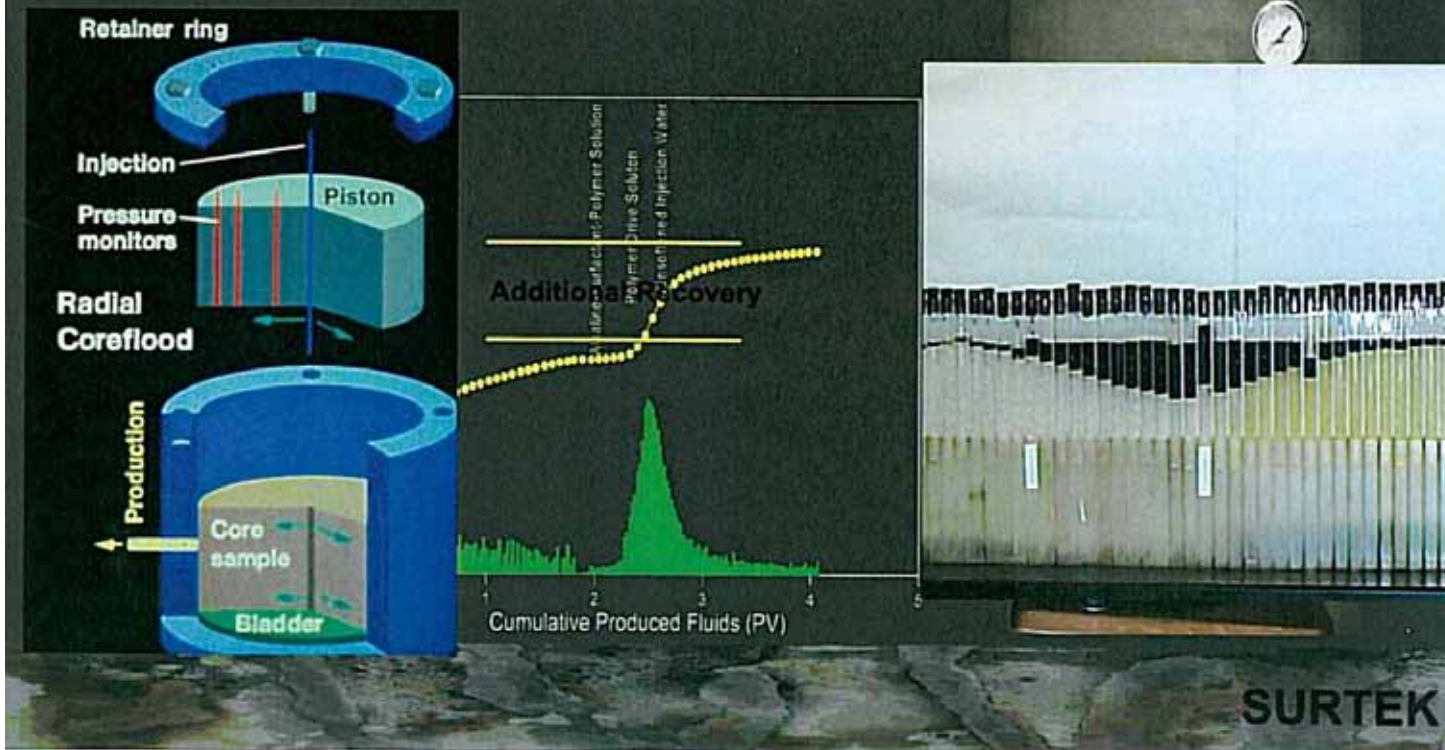
n Model Simulation

- History match to confirm model and OOIP (end Dec. 2009)
- Forecast production from the chemical flood (Feb 2010)

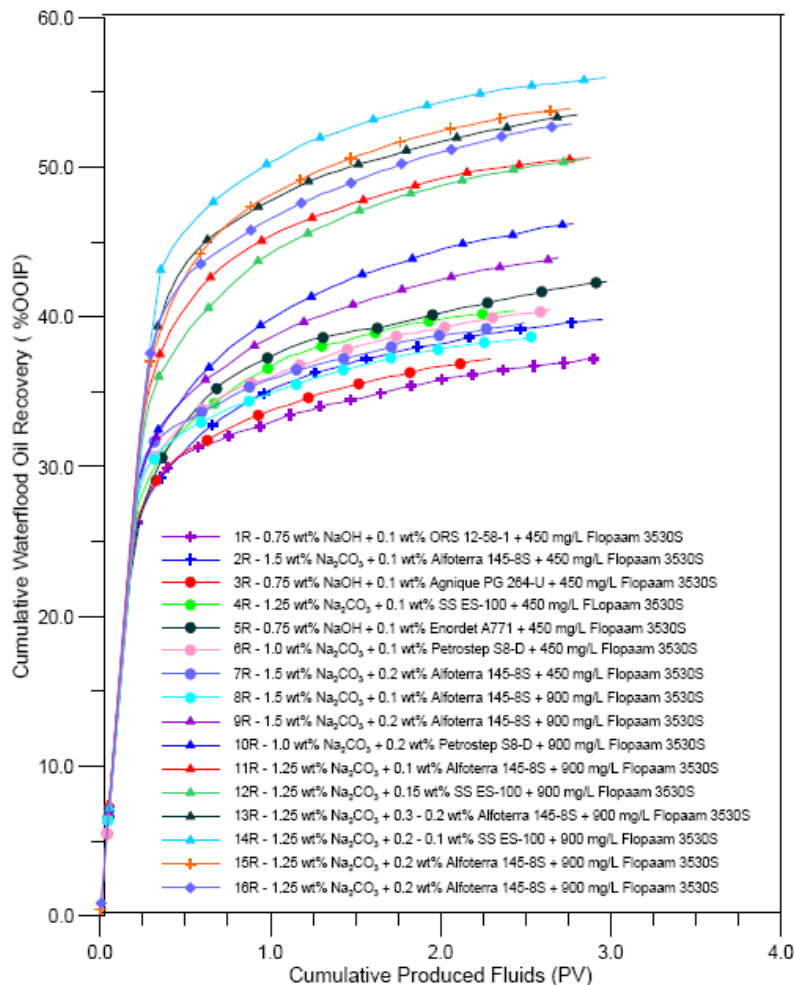
Chemical Flood Pilot; Radial Corefloods

Radial Corefloods

The Optimum Chemical Combination
is Defined in Radial Corefloods

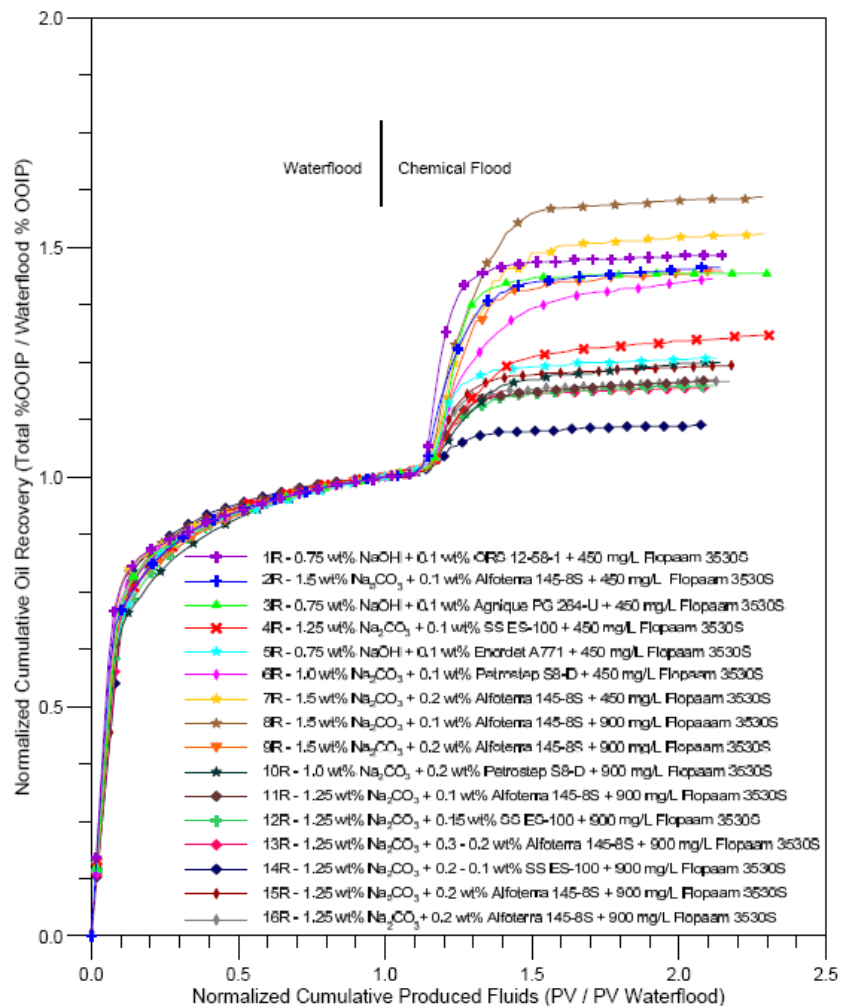


Grieve Field: Water Flush Results



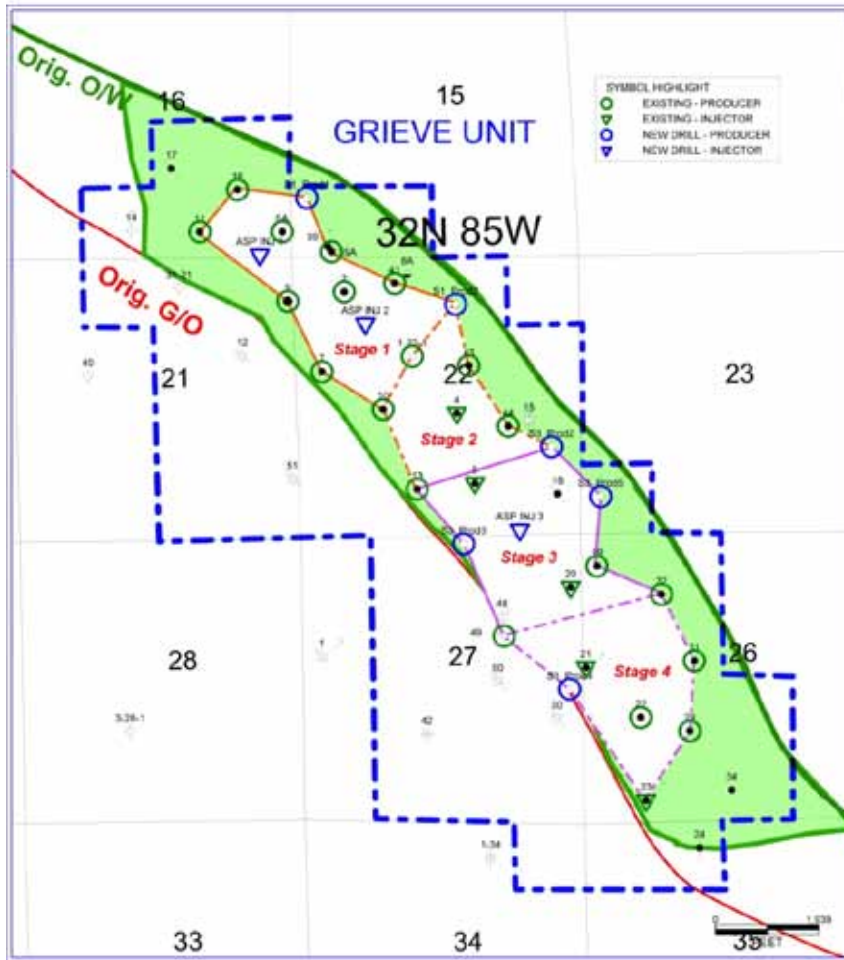
- Drilled the Grieve Unit #39A in July 2009 to recover fresh core for laboratory analysis
- Conducted fluid/fluid analysis with produced waters and oil
- Conducted linear core floods to determine initial chemical and rock compatibility
- Conducted 16 radial core floods to fine tune the chemical mix and define the inputs for the full field simulation model

Grieve Field: ASP Recoveries



	Unit	Average of 16 Core Floods	Average of 8 Core Floods with Specified Chemicals
Average Permeability	millidarcy	273	257
Initial Oil Saturation	pore volume	0.743	0.739
Residual Oil after Waterflood	pore volume	0.408	0.395
Waterflood Recovery	% of OOIP	45.2%	46.6%
Residual Oil after Chemical Flood	pore volume	0.301	0.277
Chemical Flood Recovery	% of OOIP	14.4%	16.0%

Grieve Field: ASP Flood Implementation



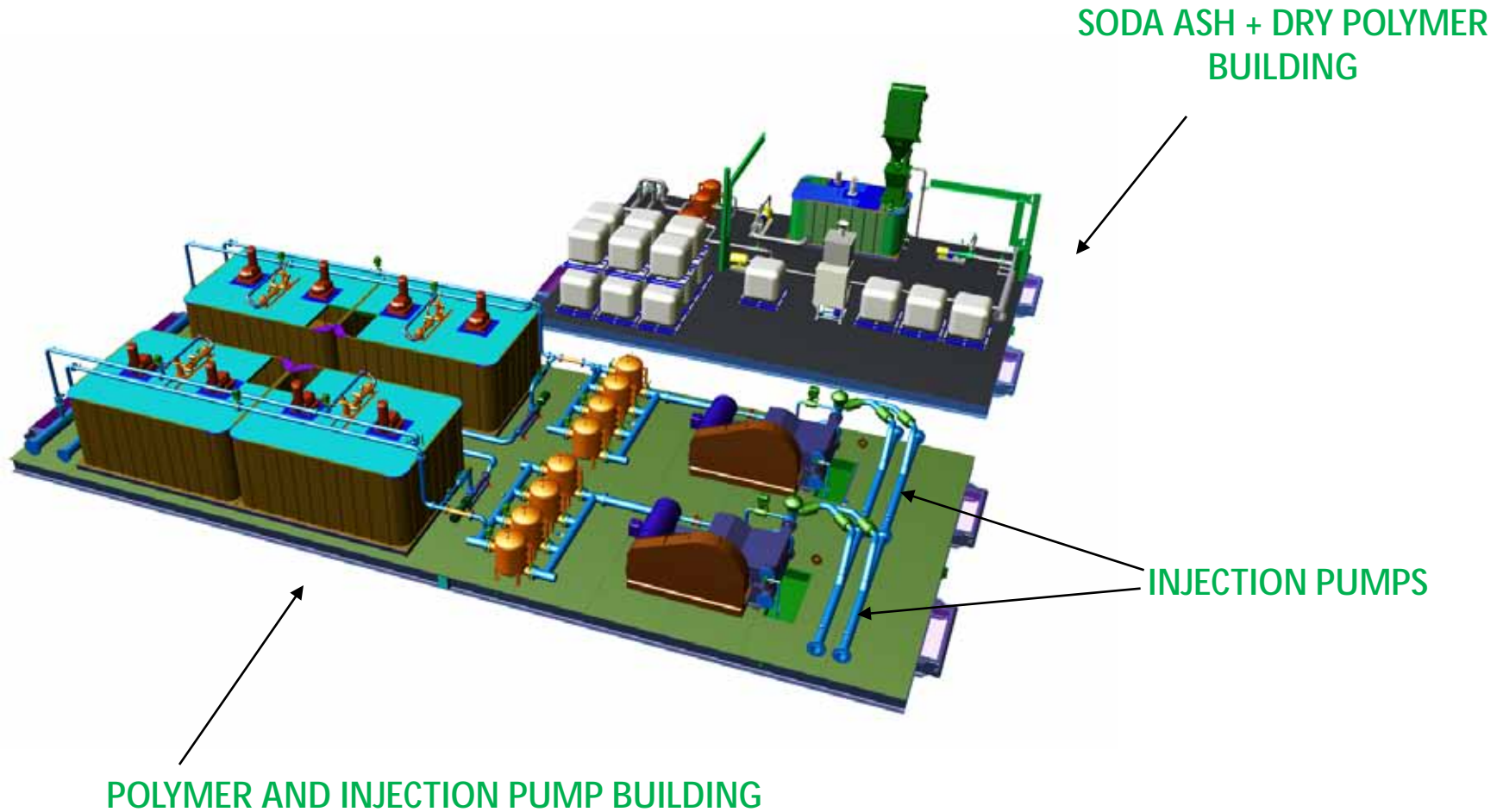
- n Original oil in place (Green outline) is 68.4 MMSTBO (whole field)
- n Area involved in the proposed development Stages 1, 2, 3 and 4 only (Purple outline) contains 36.9 MMSTB OOIP (flooded area)
- n Therefore just over half of the Original Oil in Place is presently targeted by Stages 1, 2, 3 and 4 of the Grieve Development Plan

Development Plan

- n Build a central ASP injection facility capable of injecting 15,000 BFPD
- n 4 Stage approach to field development, moving from north to south
- n Focus effort on the original oil leg of the reservoir
- n Utilize as many of the existing wells and infrastructure as possible and minimize new drilling
- n CAPEX estimate for Stages 1 US\$17.5 MM
Stages 2-4 estimate \$10.1 MM (self funding)
- n Minimize capital expenditures

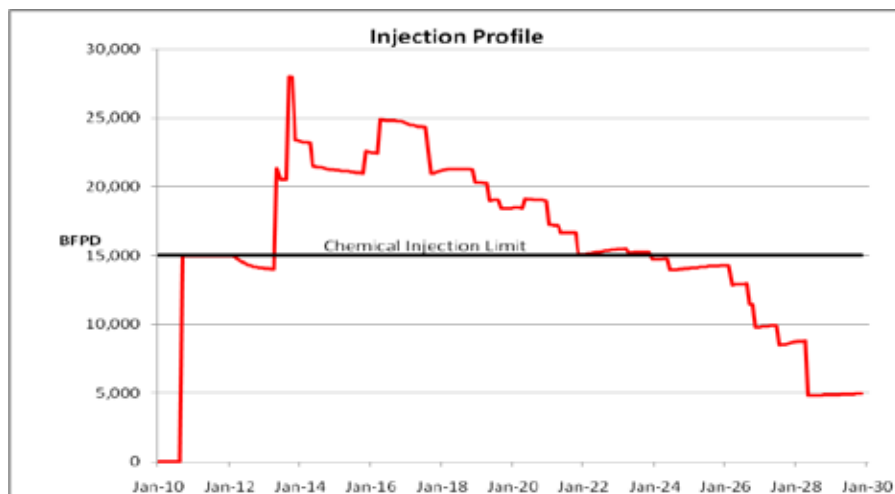
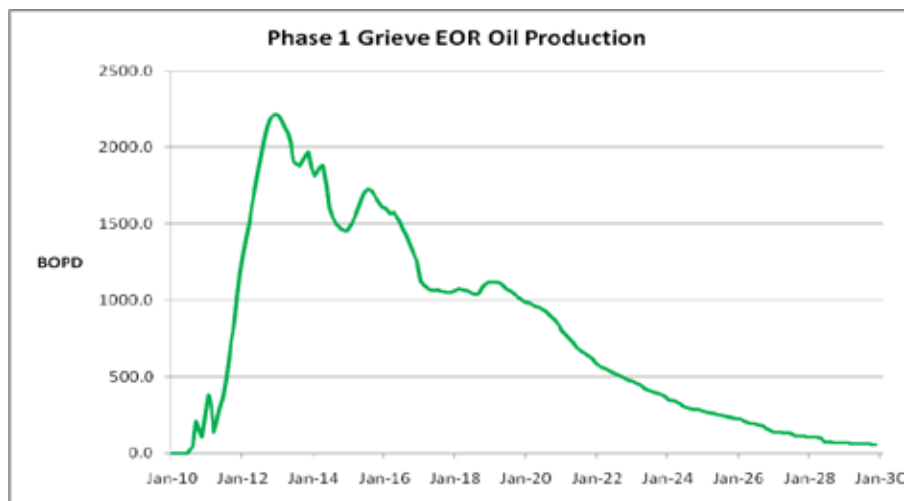
Grieve Field: ASP Injection Plant

Designed by Fabrication Technologies of Casper



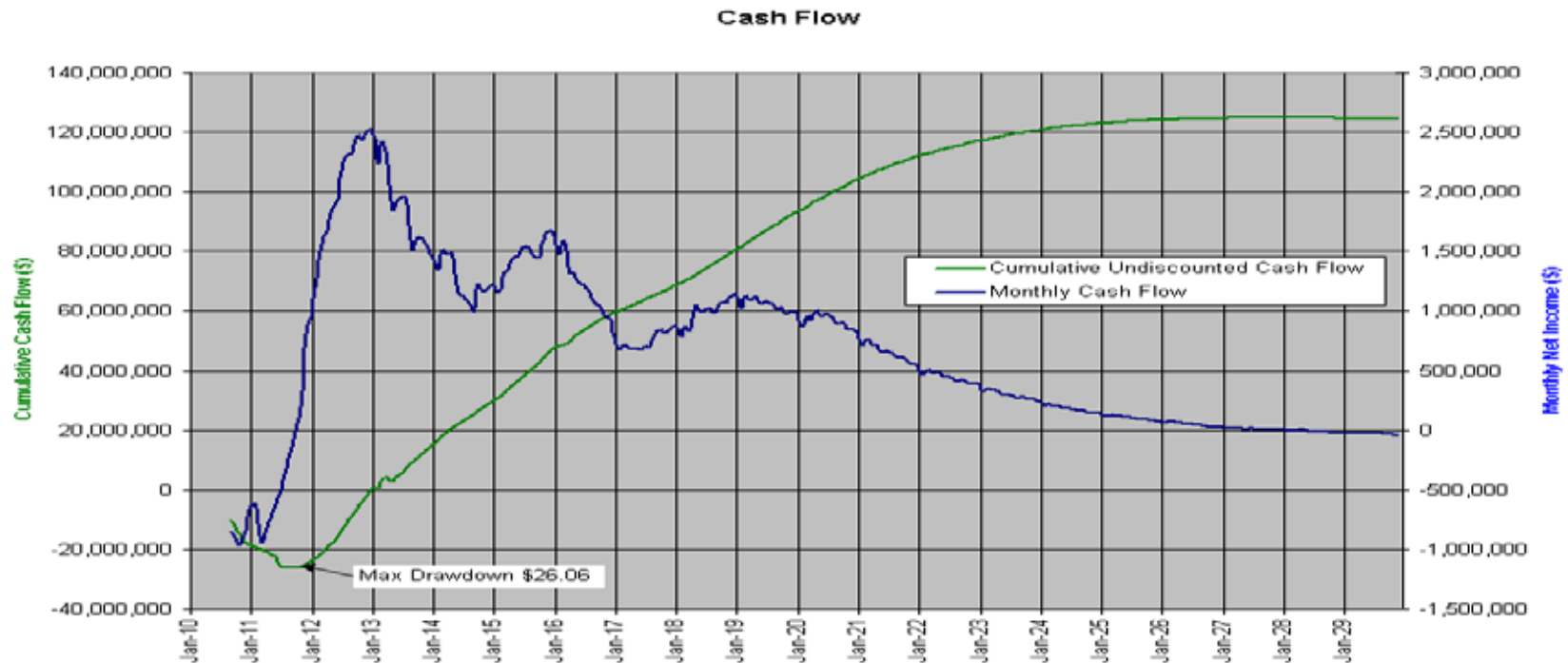
Grieve Field: ASP EOR

Projected Field Response and Simulation



- n Each Stage will inject ASP for 1 to 2 years
- n ASP injection will be followed by polymer injection for 1.5 years to increase sweep efficiency
- n Final stage of injection is only water
- n Peak production is achieved in 2013 at 2,200 BOPD
- n Total recovery within the prescribed 4-stage field development plan is 5.8 million barrels of oil
 - represents an incremental 16% recovery of OOIP within the swept area

Grieve Field: Project Economics*



Elk Economics

- § Maximum drawdown allows for purchase and refurbishment of pipeline
- § NPV₁₀: \$62.8 MM
- § Net Payout Date: 01/2013
- § Rate of Return: 53%
- § Return on Investment: 5.74

Ryder Scott Reserves and Valuation

- § Probable 2,921 MBO NPV₁₀ \$64.882 MM
- § Possible 2,972 MBO NPV₁₀ \$34.667 MM

* All values are in US\$

