Mosaic Petroleum Analytics LLC

Overview

Quantified Strategic Decisions

Completion Optimization

Lateral Spacing Optimization

Development Optimization

Acquisition Analysis

February 2019

Make Better Decisions

Be a Pro-Active Leader in Completion Technology Evolution and Development Optimization

Mosaic Solutions

A suite of completion / production surveillance products

- Play-wide analyses: both visual and quantitative results
- See trends in completion practices and well performance

A blend of empirical, physics-based and economic analyses

- Optimize completions, lateral spacings and development plans
- State of the art tools
- ***Extensive operational and business expertise***

We Help You Answer These Questions

What can I learn from how others are completing their wells?

- *How are completion designs changing in the field?*
- *What is the impact on cost and well performance?*

Which completion designs should we choose this year and beyond?

- *Which designs create the most value and financial robustness?*
- *How do we include operational risk in our design strategy?*
- *How does uncertainty influence our decisions?*
- *What is the value uplift of optimizing completions?*

Mosaic Team Has Extensive Experience in Unconventional Resources

Technical

- Experts in data analytics, reservoir simulation, economics
- Fracture design and field QC on thousands of wells
- Three Professors of Practice at Texas A&M University

Owner/Operator Perspective

- Senior executive and board positions for over 20 years in MGV Energy Inc. and UGR Blair Creek Ltd.
- Development drilling of 400 wells/year as operator

Mosaic Principals / History

Principals

George Voneiff – CEO Mosaic Petroleum Analytics LLC – 35 yrs experience

- CEO UGR LLC 2007-2017
- President MGV Energy Inc. 1997-2005
- BSc & MSc Petroleum Engineering
- Professor of Engineering Practice (Texas A&M)

Kin Chow – CEO MP Analytics Ltd. – 34 yrs experience

- President UGR Blair Creek Ltd. 2007-2017
- Executive VP CDX Canada, EnCana, PanCanadian
- BSc Geophysics, MBA

Peter Bastian – President Mosaic Petroleum Analytics LLC - 36 yrs experience

- VP Engineering UGR LLC 2007-2017.
- BSc & MSc Petroleum Engineering
- Professor of Engineering Practice (Texas A&M)

Mike Gatens – Board and Advisor – MP Analytics Ltd. – 38 yrs experience

- CEO UGR Blair Creek Ltd. 2007-2017
- CAPP Chairman 2016-2017, CAPP Board 2004-2008, 2013-2017
- CEO MGV Energy Inc. 1997-2006
- BSc & MSc Petroleum Engineering (Texas A&M)

Unconventional History

Principals have extensive experience and expertise with unconventional resource assessment and development

Several team members were involved with Gas Research Institute low permeability field experiments and fracturing technology assessments while at S.A. Holditch & Associates in the 1980's and 1990's

MGV Energy Inc. founded in 1997, pioneered the Horseshoe Canyon CBM play in Alberta with PanCanadian

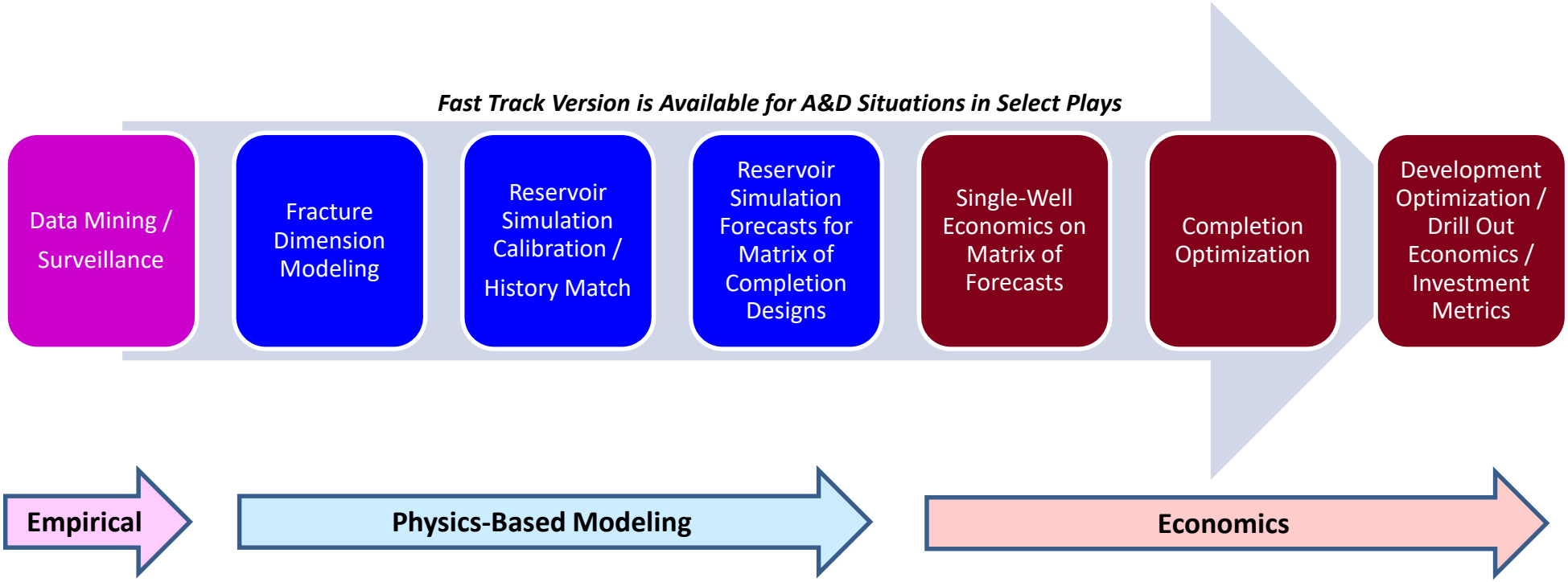
- First commercial CBM development in Canada
- As operator, ramped from zero to 400 wells per year in 5 years
- Sold to Quicksilver Resources in 2005
- Acquired and converted raw land into a $1+ billion asset through completion technology evolution and development planning/execution

UGR Blair Creek Ltd. founded in 2007 to pursue unconventional oil and gas opportunities

- Acquired first Montney land in 2007
- Acquired and evaluated 70,000+ acre position in North Montney
- Discovered over 2 Tcf of 2P reserves, 10+ Tcf recoverable
- Grew production from zero to 50+ MMCFD
- Drilled several of the top North Montney wells
- Sold UGR to Painted Pony Energy in May 2017

Mosaic Process – Analysis Pipeline

Which Completion / Development Strategies Create the Most Value and Financial Robustness?



Data Mining: Surveillance & Calibration Data

Who is Doing What and What are the Implications?

Canadian Example

Commercial
Database
Prod, Well Data
635,000 Wells

+

Commercial
Database
Completion Data
29,000 Wells

+

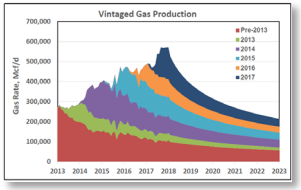
Mosaic Database
Completion Data
4,400 Wells

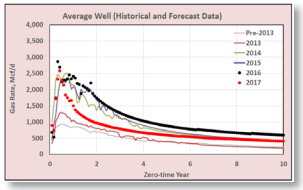
+

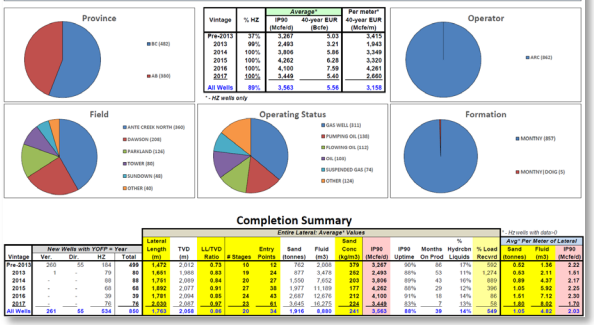
Mosaic Database
Flowback, PVT
Core, Eco Inputs

=

Mosaic Surveillance
Basic Analysis
Maps
Dashboards
Deep Dive Prep







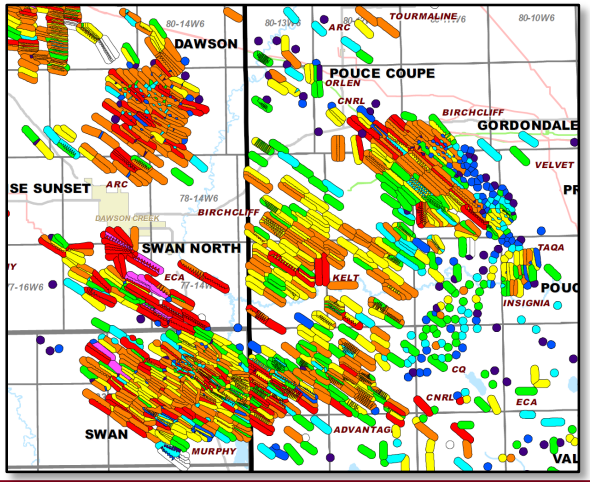
[Data Into Knowledge]

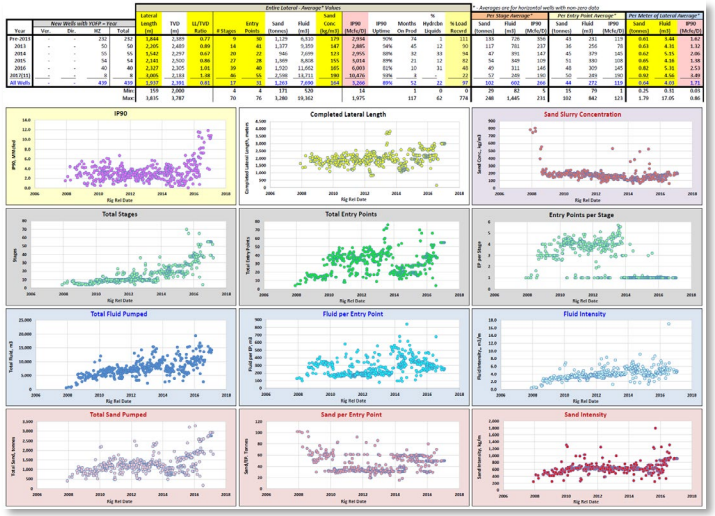
Up to Date and Easy to Understand

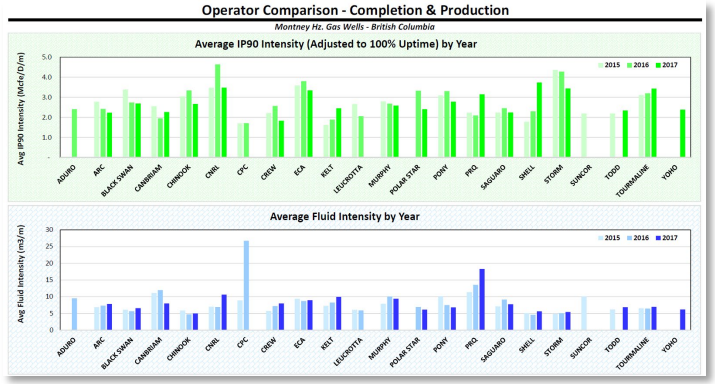
40+ Map Layers
Completion Dashboards
Production Dashboards
Flowback Dashboards
Operator Vintage Comparisons

User-Defined Filters/Groupings

Maps Include Frac Load Recovery & Reservoir Quality Index







Reservoir Simulation: Calibration / History Match

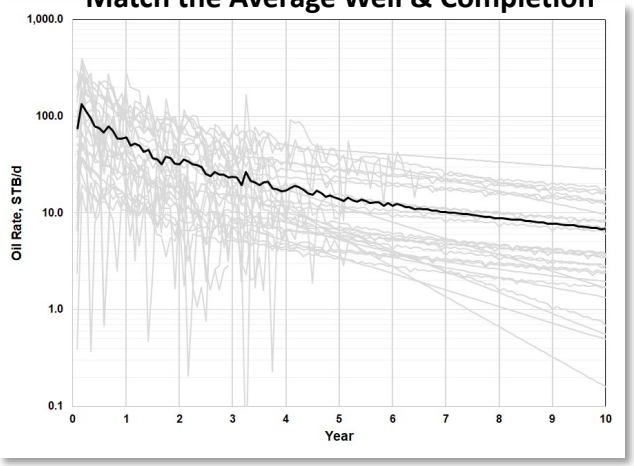
Physics-Based Reservoir Fluid Flow Model ➔ Imposing Reality

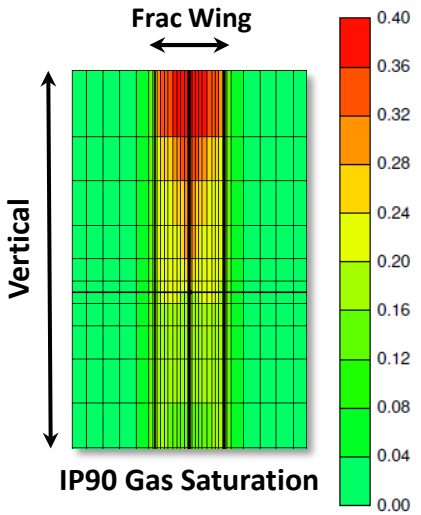
- **Predict production volumes and pressures based on physics**
  - ***Drainage area / Lateral Spacing / oil, gas and water in place***
  - ***Pressure interference between frac wings & wells***
  - Fluid properties
  - Pressure loss through tubulars
- **Calibrated to:**
  - Local production
  - Local completion practices
  - Local rock properties
  - Local reservoir fluids

Calibration Process ➔ History Match

- Simultaneous match of pressure and oil, gas & water production
- Achieve match by altering reservoir and completion variables
- Creates a locally-calibrated reservoir description and fracture dimension model

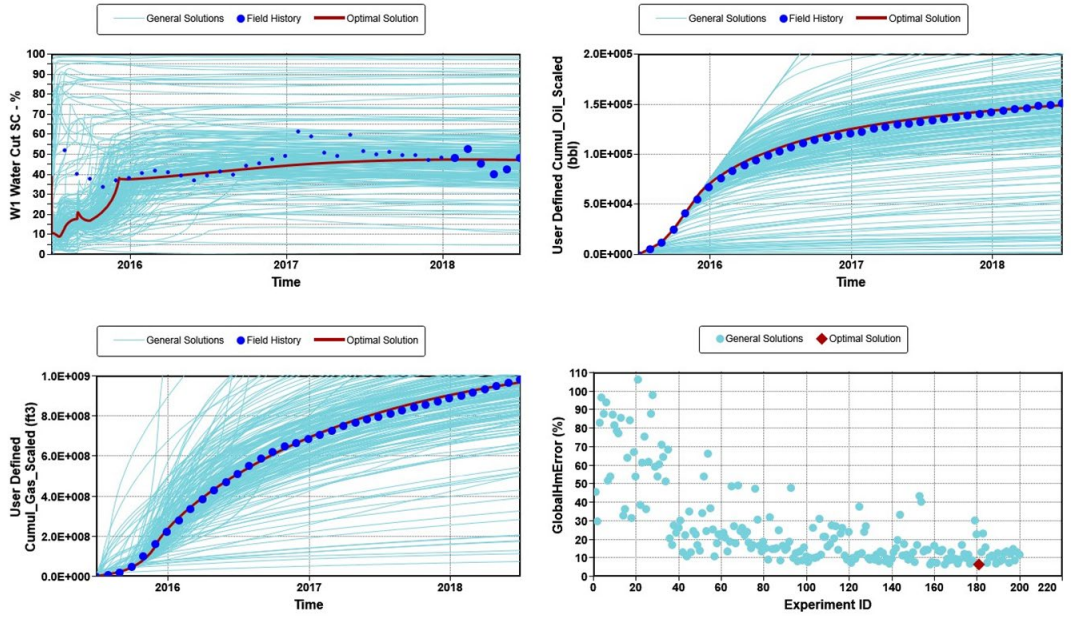
Match the Average Well & Completion



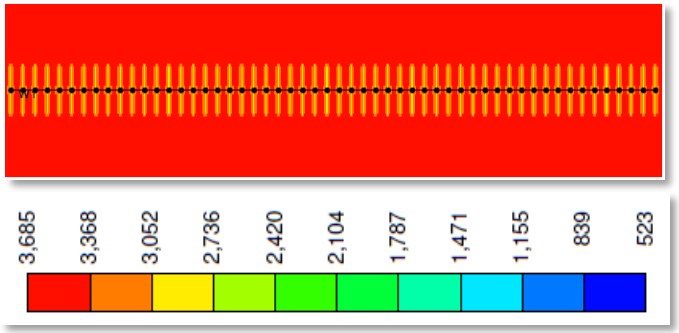


IP90 Gas Saturation

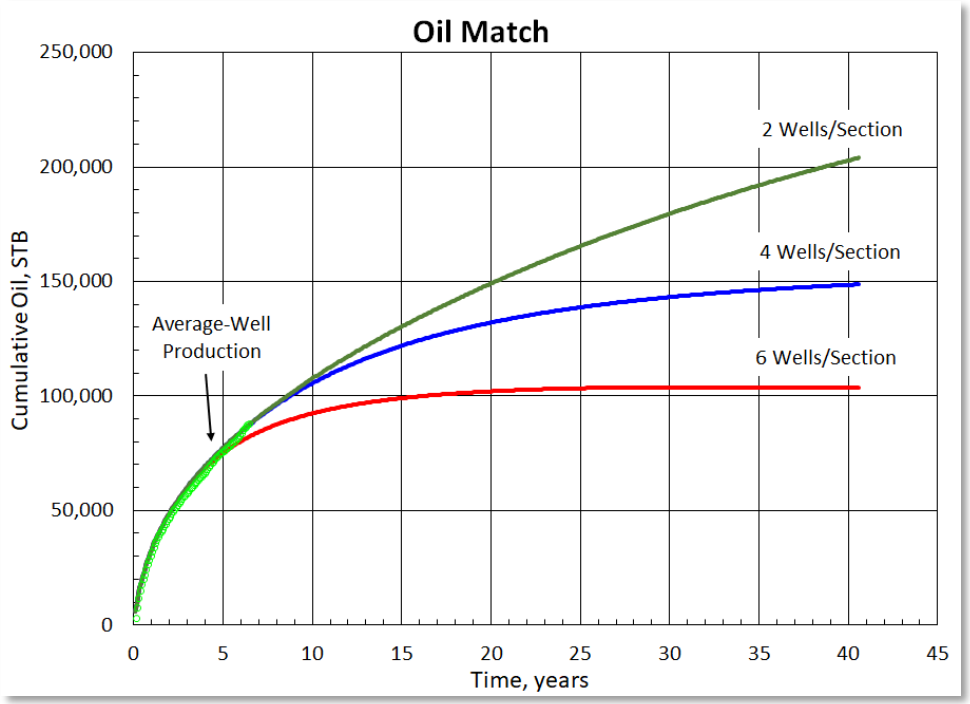
Model Case	Pay, m	Swirr	Perm, md	Xf, ft	Frac perm, md	Sw(i)
I	29.00	0.20	0.00710	186.3	1,347	0.4488



Reservoir Pressure After 3 Months

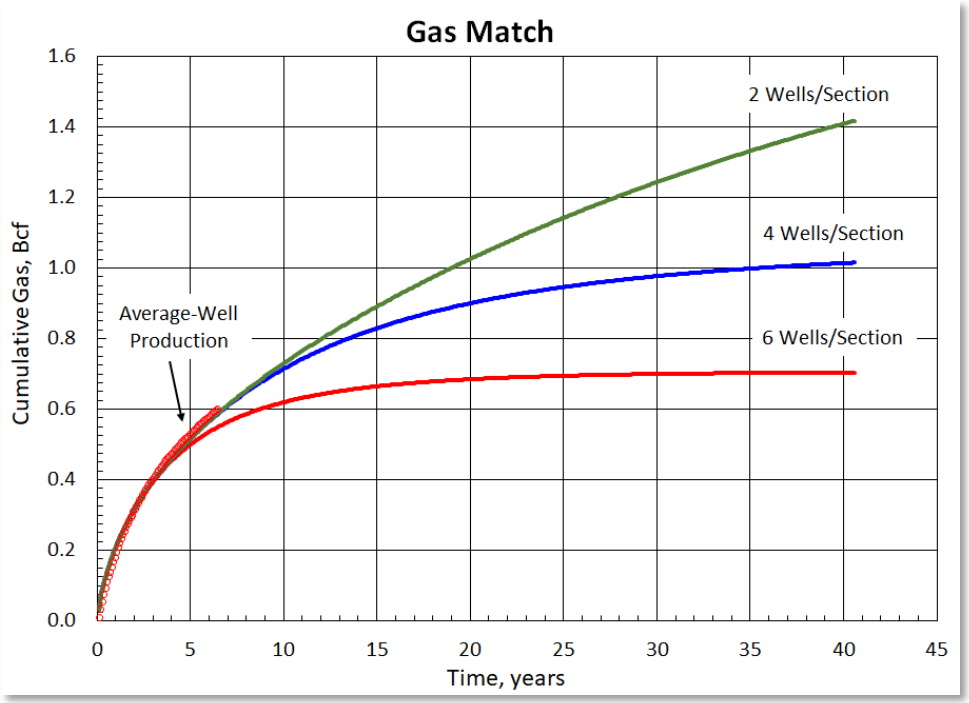


History Match Adds Insight To Lateral Spacing



It may take years to see full boundary effects, therefore completion and lateral spacing optimization is severely handicapped without the use of physics-based models

Calibrate the physics to your local geology and well performance, then explore the completion and lateral spacing possibilities



Reservoir Simulation: Test Thousands of Designs

Impose Physical Realities on a Wide Range of Completion Designs and Lateral Spacings

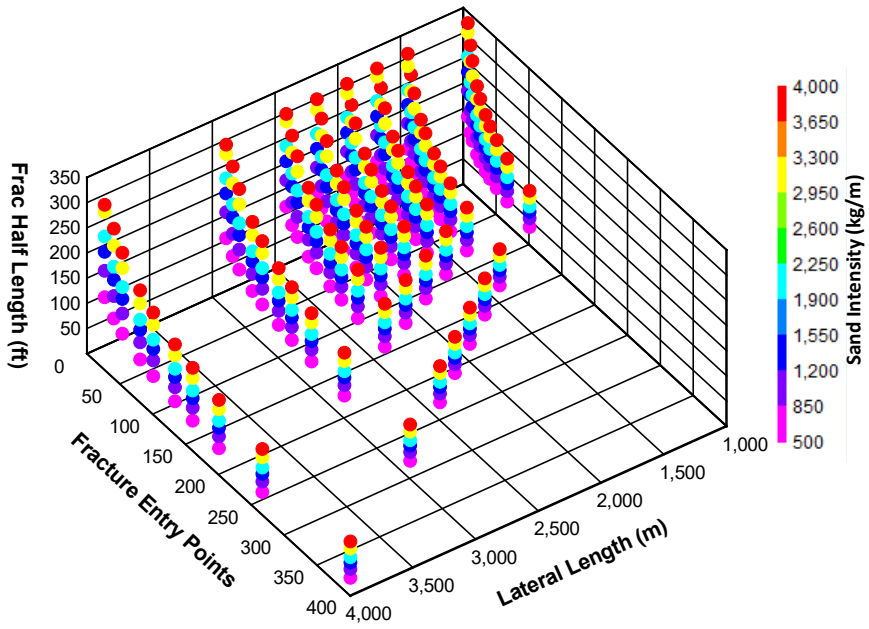
- Calibrated to local reservoir rock and fluid properties (from history match)
- Include completion designs well beyond what is being attempted by industry in the area
- Store 40-yr monthly production forecast of gas, oil and water from each run

Typical Optimization Matrix

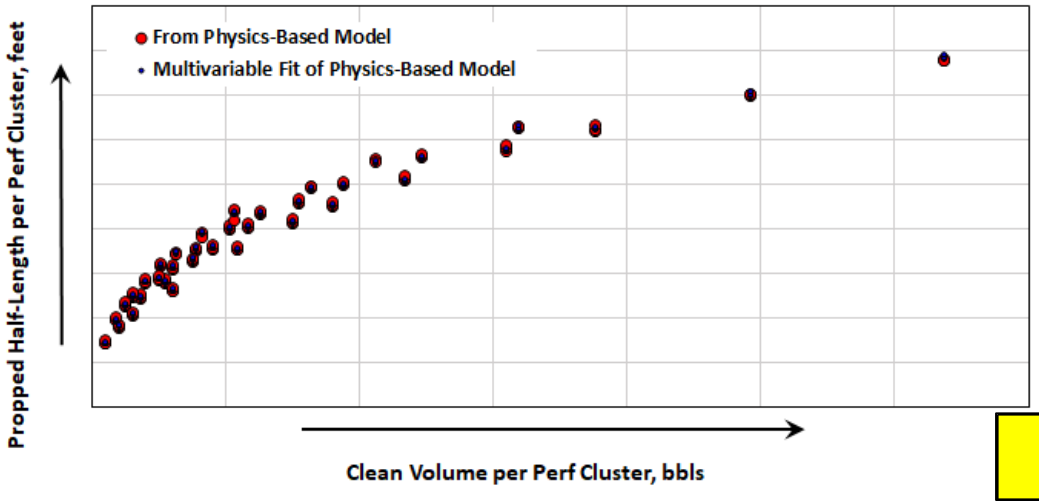
Number of Runs: **5,040** (Per Deep Dive Area)

# values:	8	10	7	3	3
Count	Lateral Length (m)	Entry Point Spacing (m)	Sand Intensity (kg/m)	Perm	Completion Technology
1	1,000	10	500	Low	OH Ball Drop Sleeves
2	1,500	15	750	Expected	CTubing & Sleeves
3	1,750	20	1,000	High	P&P
4	2,000	25	1,500		
5	2,250	30	2,000		
6	2,500	40	3,000		
7	3,000	50	4,000		
8	4,000	75			
9		100			
10		150			

Frac Half Length vs Completion Design



Predicted Half-Length vs Fluid Volume



Fracture Dimension Model Predicts Propped Fracture Length vs Materials Pumped

- A function of multiple parameters
- Matrix of completion designs and permeabilities

Multivariable Equation Fit to Model Results

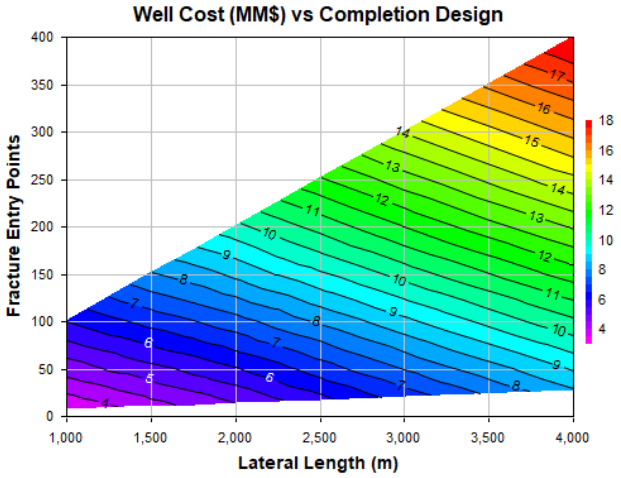
- To predict fracture length starting point in reservoir flow history match
- To scale fracture lengths in matrix of reservoir flow simulations

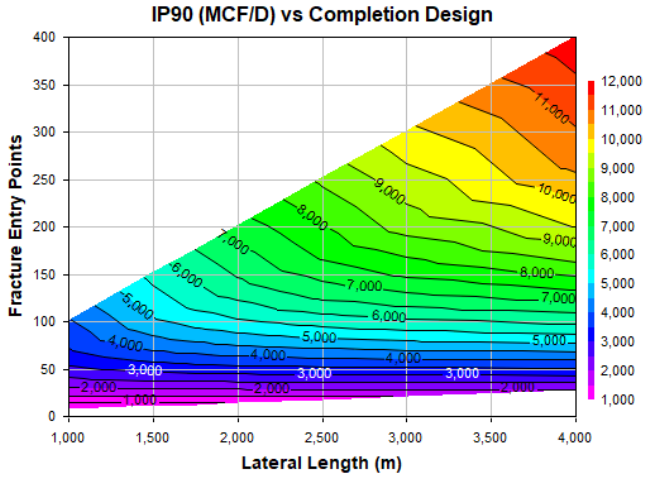
$$xf = \left[a_0 + a_1\,[\ln(ppg) + 1]^{b_1} + a_2\,[\ln(V_c)]^{b_2} + a_3(inj)^{b_3} + a_4[\ln(k) + 5]^{b_4}\right]^{b_0}$$

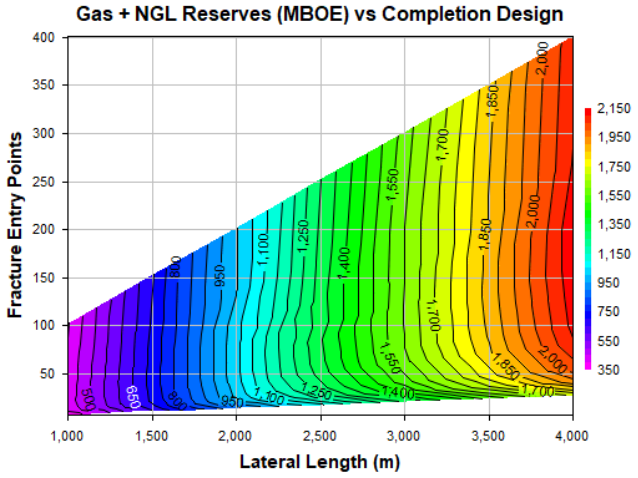
Optimization: Understand The Direction of Your Decisions

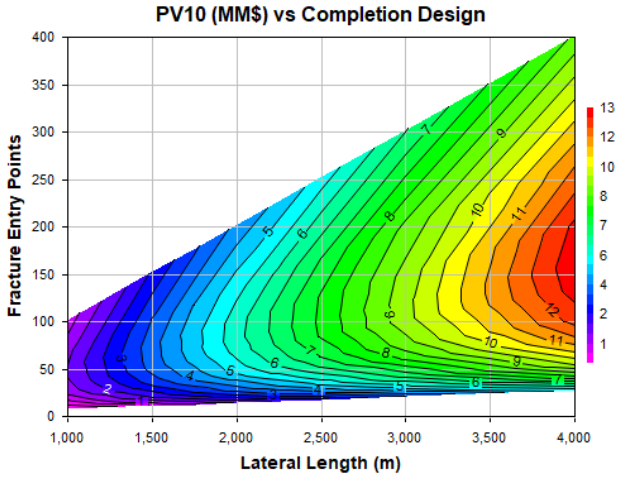
What are the Economic Results Over the Entire Range of Potential Completion Designs?

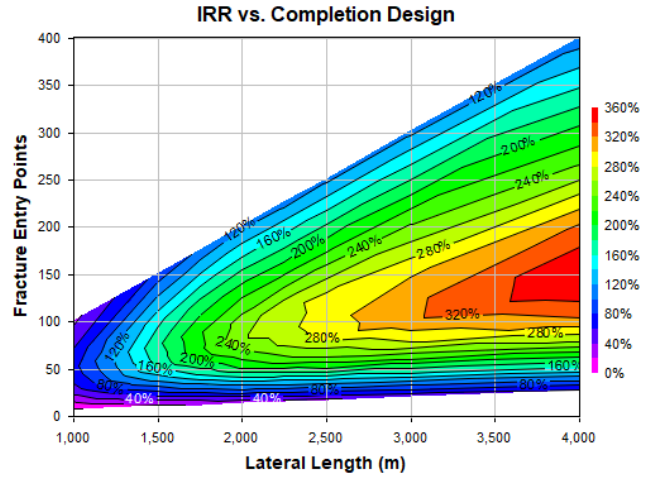
- Standard monthly cashflow analysis for each completion design modeled in matrix of simulations
  - **5,040 simulations = 5,040 single-well economic runs**
- ***Detailed drilling and completion capital cost model***
- Correctly handles complex royalty calculations if needed
- Plot key economic parameters for each drilling and completion design for selection of optimal design

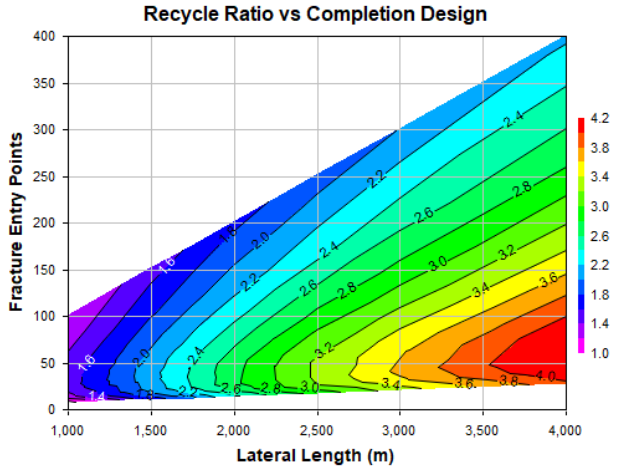








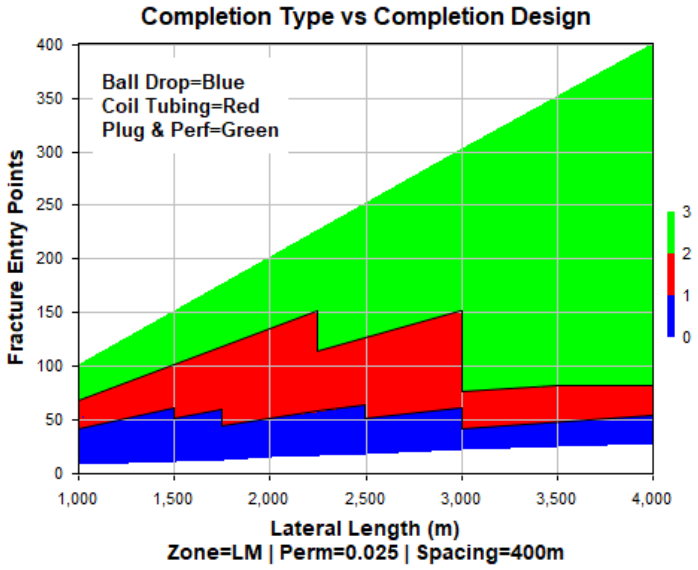


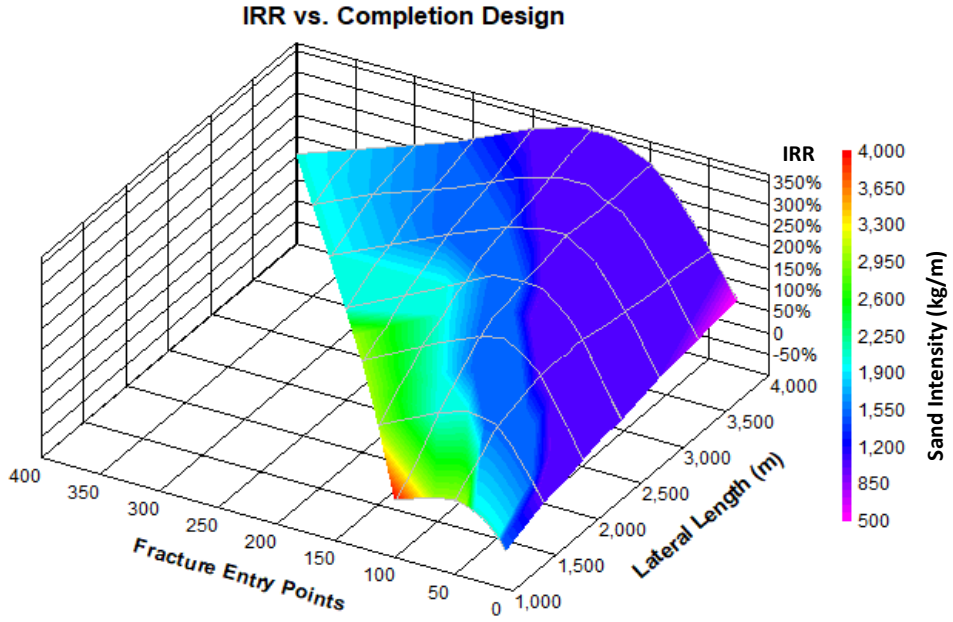


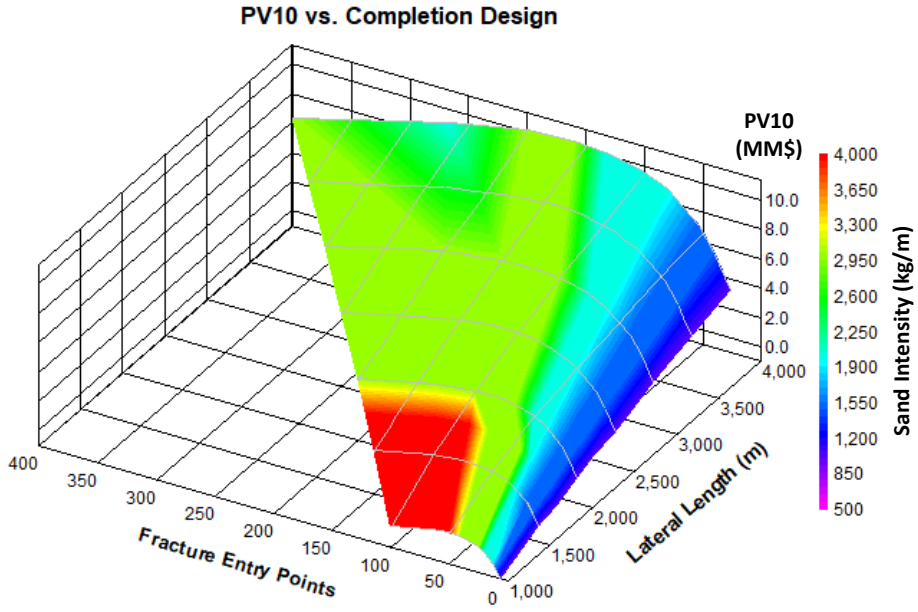
Optimization: A Management Decision

Which Completion Designs Will You Choose This Year, Next Year and Beyond?

- **Operational risks likely guide to a phased approach to completion evolution**
- Chosen completion designs used in full development drill out economics
- Usually model near-term, next-generation and theoretically optimal completion designs
- Important to include operations folks in decisions for operational risk assessment





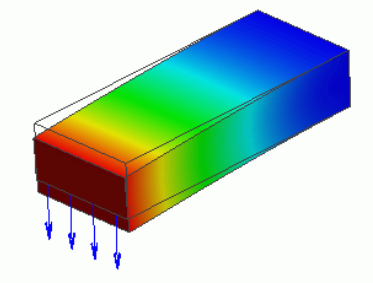


Equate Completion Strategy to Stressed Investor Returns

What are Investment Returns Over a Range of Outcomes?

Determine Completion/Development Strategy that Best Fits Your Risk Appetite

Understand Acquisition/Project Strategy Robustness in the Face of Stress Testing



Full Corporate Drill Out Economics

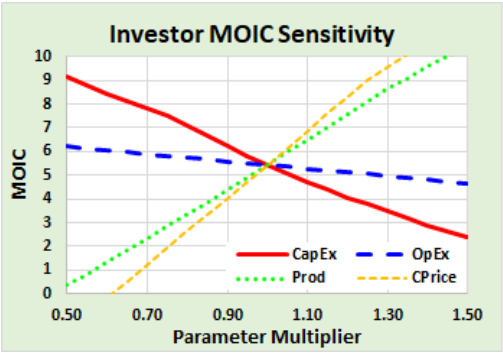
- Requires a well inventory count, drilling pace, zone selection and completion designs selection
  - Multiple rigs, multiple zones, multiple completion designs
  - Area/zone/well type specific economic inputs
- ***Lateral length and lateral spacing impact well inventory***
- Includes infrastructure capital, G&A, debt and any acquisition capital
- Dynamic equity model syncs with debt strategy
- Monthly cash flows are rolled up to quarterly and annual summaries for easier analysis
- ***Presented as MOIC and IRR to the investor*** among other metrics

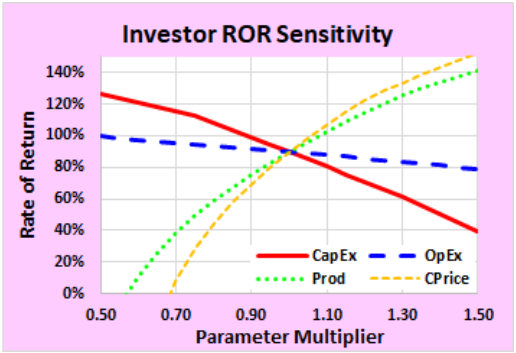
Stress Testing

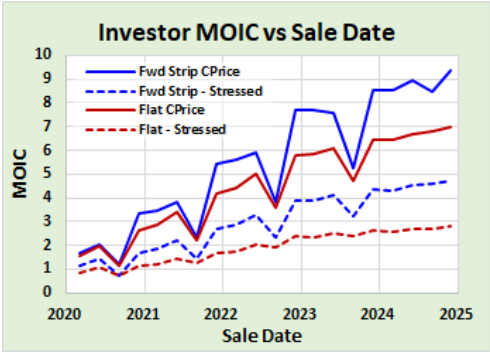
- Capital cost overruns
- Operating cost overruns
- Production underperformance
- Alternate commodity prices
- ***Does the downside kill the investment?***

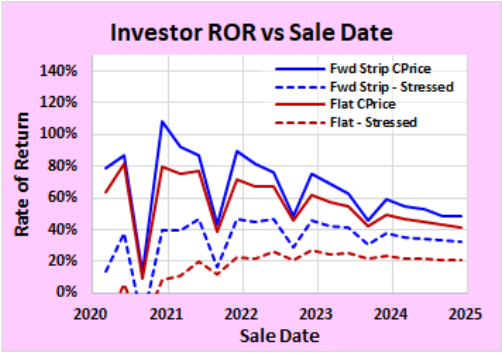
Stress Test Results

	Stress Test Factors				*160-Well Weighted Avg Single-Well Economics*								*Sale Q4 2021 (30 wells on line)*							
	Multiplier				*Reserves*															*Investor Returns*	
Case	CapEx	OpEx	Prod	Commodity Price Deck	Oil/NGL (MSTB)	Gas (Bcf)	Yield (bbl/MMcf)	Well Cost (M$)	ROR	PV10 (M$)	Recycle Ratio	Payout (yrs)	% of Well Inv. Drilled @ Sale	Avg Rate @ Sale Boe/D	Sales Price (MM$)	Debt (MM$)	Equity @Sale (MM$)	Equity Value (MM$)	Enterprise /DACF Ratio	MOIC	ROR
1	1.00	1.00	1.00	Forward Strip	384	2.6	150	$ 7,143	170%	$ 7,169	2.47	0.7	18.8%	15,386	$ 617.5	$ (66.7)	$ 126.0	$ 684.2	3.3	5.43	90%
2	1.25	1.10	0.90	Forward Strip	340	2.2	155	$ 8,929	53%	$ 3,757	1.71	1.4	18.8%	13,847	$ 399.9	$ 16.8	$ 142.0	$ 383.1	2.4	2.70	46%
3	1.00	1.00	1.00	$55/$1.75 WTI/AECO	371	2.3	162	$ 7,143	156%	$ 6,264	2.21	0.7	18.8%	15,386	$ 474.7	$ (50.8)	$ 126.0	$ 525.5	2.7	4.17	72%
4	1.25	1.10	0.90	$55/$1.75 WTI/AECO	328	2.0	167	$ 8,929	47%	$ 2,997	1.55	1.6	18.8%	13,847	$ 273.8	$ 33.5	$ 142.0	$ 240.3	1.8	1.69	22%









Contact Us

United States

Mosaic Petroleum Analytics LLC
George Voneiff
979-574-7179
gvoneiff@mosaicpa.com
4723 Copperfield Drive
Bryan, Texas, USA
77802

www.MosaicPA.com

Canada

MP Analytics Ltd.
Kin Chow
403-651-4360
kchow@mpanalytics.ca
2400, 525 – 8th Ave SW
Calgary, Alberta, Canada
T2P 1G1

www.MPAnalytics.ca