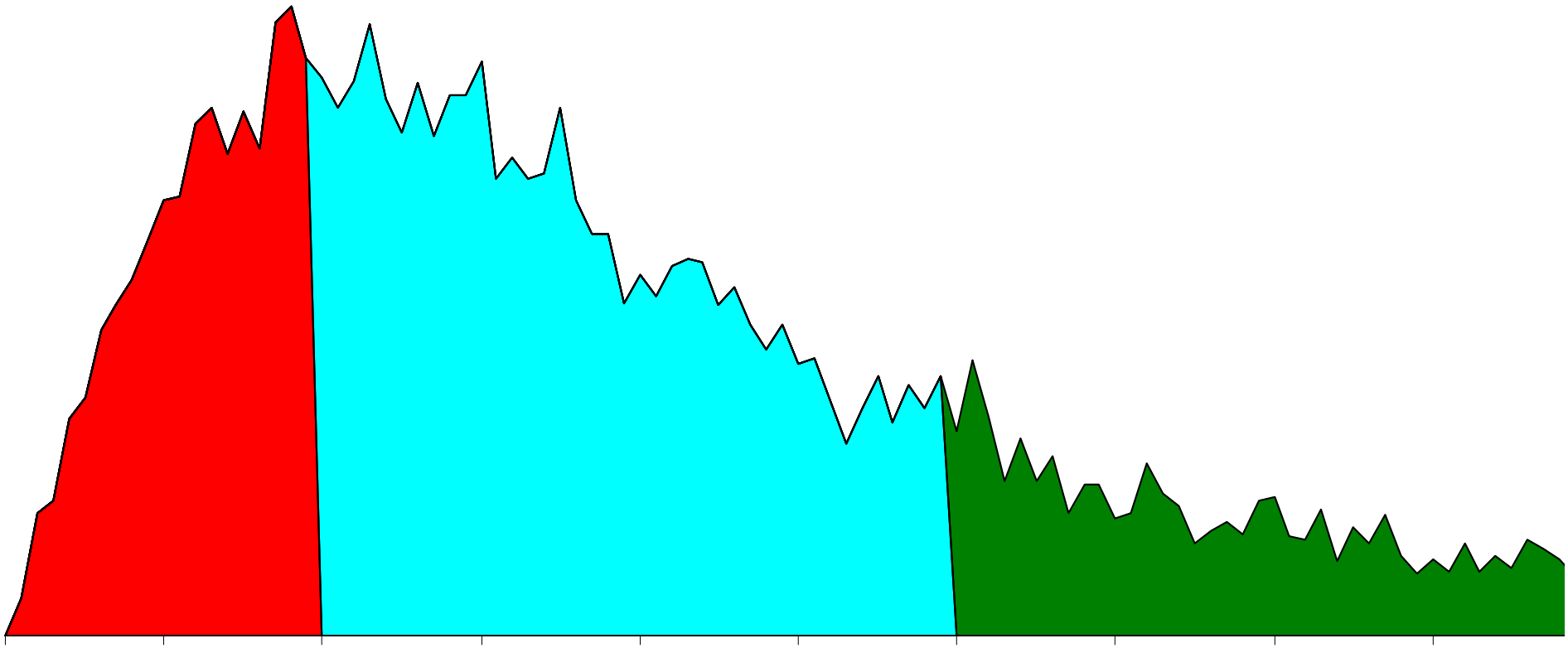
Oil & Gas Valuation Methods

with a focus on Monte Carlo Analysis

Salman Partners



Presented by: **Justin Anderson, MSc., CFA**

October 4, 2012

Calgary

Justin Anderson's Bio & Genesis of Xedge Research

Salman Partners

1997 — High School Graduation

1998 — CDI College (Business • Technology • Health Care) — Programming Diploma

1999

2000 — Teaching English and learning Russian in Russia

2001

2002 — University of Calgary — BSc Degree in Mechanical Engineering

2003 — BA Degree in Russian Studies

2004 — waybe (Design Unfold Print) — Founded **waybe.ca** while at MIT

2005 — Founded **Xedge Research**

History of Xedge Research

- **MIT:** Research used general-equilibrium macroeconomic modelling. Firmed up programming knowledge already acquired at CDI. Thesis and research on the energy industry – Thesis title: "Impact of CO2 Legislation on Canada and Alberta's Oil Sands".
- **Waybe:** Improved programming skill-set necessary for the eventual stream-lining of **Xedge** Research.
- **McKinsey:** Developed basic understanding of running Monte Carlo simulations on exploration portfolios. Significant focus on independent oil & gas companies with Colombian assets - especially Talisman Energy.
- **BMO**: Built deeper international oil & gas industry connections and energy market expertise.
- **Xedge:** Founded Xedge with the goal to produce superior technical research with the constraints of rapid coverage capability on many names.
- Hired by **Salman Partners Inc**. as an Oil & Gas Research Analyst to produce independent research reports using **Xedge-developed** methodology.

2006 — Massachusetts Institute of Technology — Masters in Aeronautics with Economics focus

2007

2008 — McKinsey&Company — Oil & Gas Business Analyst

2009

2010 — BMO Capital Markets — Oil & Gas Investment Banker

2011 — Xedge

2012 — Salman Partners — Oil & Gas Research Analyst

Presentation Outline

Expected Time (mins)	
5	Standard Methods to Value Oil & Gas Companies
15	Using Monte Carlo to Value Oil & Gas Companies
5	Sample Valuation of an Oil & Gas Company
	Q & A

Primary Valuation Methodologies in Oil & Gas

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Multiples

Deterministic DCF

Trading

Company	Share Price	EV* ($mm)	EV / Funds Flow	EV / Prod.	EV / 2P Res.
Pacific Rubiales Energy	$24.68	$8,187	5.3x	$75,042	$16.72
Gran Tierra Energy	$5.19	$1,299	4.5x	$61,988	$21.01
Parex Resources	$4.85	$605	2.5x	$58,216	$56.61
C&C Energia	$6.55	$380	2.5x	$36,161	$20.65
Canacol Energy	$0.48	$293	2.8x	$21,678	$29.65
Petrodorado Energy	$0.17	$40	nmf	nmf	$75.66
PetroNova	$0.42	$54	nmf	nmf	nmf
Sintana Energy	$0.13	$27	nmf	nmf	nmf
ArPetrol	$0.02	$7	nmf	$26,728	$0.83
Peer Group Average			**3.5x**	**$46,635**	**$32**

*EV = Enterprise Value = (Shares Outstanding x Share Price) + Value of Debt

Peer Group Multiples

FF Ratio (EV/FF)[3]	EV / Prod.	EV / 2P Reserves
3.5x	$46,635	$32

SPE Company Metrics **

Funds Flow ($mm)	Production (bbl/d)	2P Reserves (mmbbl)
400	25,000	50

Implied Valuation of SPE

EV ($mm)	EV ($mm)	EV ($mm)
$1,400	$1,166	$1,600

Valuation of SPE (based on Trading Multiples)

Current Share Price	Implied EV ($mm)	Implied Market Cap ($mm)	Implied Share Price ($mm)	Undervauled/ Overvalued
$10	$1,389	$1,289	$14	Undervalued

**90mm Shares Outstanding, $100mm Debt

Transaction

Company	Share Price	EV* ($mm)	EV / Funds Flow	EV / Prod.	EV / 2P Res.
PetroMagdalena (prior to bid)	$1.25	$263	5.3x	$68,434	$11
PetroMagdalena (bid)	$1.60	$332	6.4x	$86,392	$13

Transaction Multiples

FF Ratio (EV/FF)[3]	EV / Prod.	EV / 2P Reserves
6.4x	$86,392	$13

SPE Company Metrics

Funds Flow ($mm)	Production (bbl/d)	2P Reserves (mmbbl)
400	25,000	50

Implied Valuation of SPE

EV ($mm)	EV ($mm)	EV ($mm)
$2,560	$2,160	$650

Valuation of SPE (based on Trading Multiples)

Current Share Price	Implied EV ($mm)	Implied Market Cap ($mm)	Implied Share Price ($mm)	Undervauled/ Overvalued
$10	$1,790	$1,690	$19	Undervalued

Source: Salman Partners Inc.

Primary Valuation Methodologies in Oil & Gas

Salman Partners

Multiples

Deterministic DCF

Inputs

Production (bbl/d)	Economic Life (years)	Annual Decline (%)	Realized Sale Price ($/bbl)	Operating Exp. ($/bbl)	Taxes ($/bbl)	Discount Rate (%)
35,000	5	40	90	30	10	10

Model Engine

$$\text{NPV-10 (\$mm)} = \frac{CF1}{(1+k)} + \frac{CF2}{(1+k)^2} + \frac{CF3}{(1+k)^3} + \frac{CF4}{(1+k)^4} + \frac{CF5}{(1+k)^5}$$

Outputs

	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*
NPV-10 ($mm) =	$581	$317	$173	$94	$51

NPV-10 ($mm) =	**$1,216**

Valuation of SPE (based on DCF)

Current Share Price	Implied EV ($mm)	Implied Market Cap ($mm)	Implied Share Price ($mm)	Undervauled/ Overvalued
$10	$1,216	$1,116	$12	Undervalued

Source: Salman Partners Inc.

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Stochastic vs. Deterministic DCF

Salman Partners

Deterministic DCF

Asset 1

Asset 2

Asset 3

Key G&G Data	**Chance of Success**	24%
	Field Size	24%xP50
	% Gas	2%
	Liquids API	32°
Key Economic Data		
	Working Interest	50%
	% Gas	2%
	Exp. cost	$5mm
	Capex	F(discovery)
	Opex	$10 per boe
	Time to develop	2 years
	Fiscal Regime	Colombia Medium
	Oil Price	Oil WTI Futures

Stochastic DCF (ie. Monte Carlo)

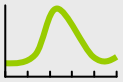
Asset 1

Asset 2

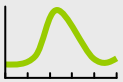
Asset 3

Key Data Same as above except:

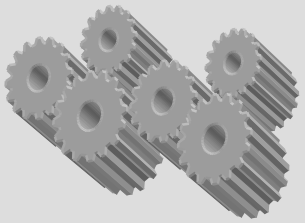
Chance of Success



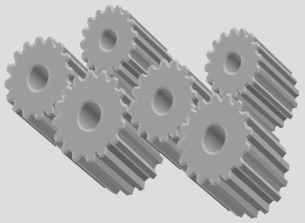
Field Size



Deterministic DCF



Stochastic DCF (ie. Monte Carlo)



Asset 1

Asset 2

Asset 3

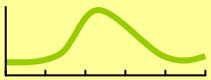
Reserves	50mmboe
Production profiles	Fixed production profile
Cash flows	Fixed cash flows
Appraisal and Development wells	5 appraisal wells, 20 development wells

Asset 1

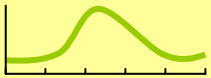
Asset 2

Asset 3

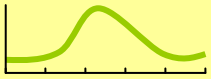
Reserves



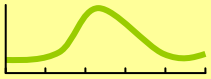
Production profiles



Cash flows



Appraisal and Development wells



Source: Salman Partners Inc.

Valuation Methodologies in Oil & Gas

Salman Partners

Most Common

	Methodology	Considerations	Applicability to O&G Exploration
Multiples	• Enterprise value (market cap + net debt) is divided by a variety of metrics to compare across companies • Possible metrics include reserves, resources (risked and un-risked), production, EBITDA, etc.	**Pro**: Fast and easy **Con**: Requires comparable companies, relative valuations only (will not indicate if entire sector is over or under-valued).	The diversity of companies in oil and gas exploration limits multiples for valuation. Multiples usually are good 1st pass indicators but more analysis is needed to improve valuation accuracy. NAV (net asset value) can be derived using multiples or DCF or a mix of both
Deterministic DCF	• Assets are valued based on estimated future cash-flows discounted at an appropriate discount rate • Model assumptions are deterministic (*single-values*) as are model outputs (ie. A single NAV or NPV)	**Pro:** Reflects fundamental asset value; Useful for diverse companies **Con**: Requires detailed assumptions to develop reliable cash flow forecasts	NAV is the valuation method of choice in oil and gas valuations and can be derived using multiples (simple, less refined) or DCF (harder, more refined) or a mix of both
Stochastic DCF (ie. Monte Carlo)	• Assets are valued based on estimated future cash-flows discounted at an appropriate discount rate (same as deterministic DCF) • Some model assumptions are *probabilistic distributions* rather than *single-values*. (ie. instead of Resource = 50mmbbl, Resource = values in a log-normal distribution ranging from 1 to 100 mmbbl).	**Pro:** Excels when outcome certainty is low but the possible outcomes are well defined (ie. rolling a 6-sided die, black-jack). **Con**: Complicated analysis requiring even more detail than deterministic DCF. Also, if poorly defined inputs are used, subject to garbage-in, garbage-out	Monte Carlo analysis of exploration portfolios is relatively common within E&P companies for internal portfolio assessments

Source: Salman Partners Inc.

Which Methodology is Best?

Salman Partners

Increasing Understanding of Possible Outcomes

Stochastic DCF





Well-defined Exploration Assets (prospects)

Deterministic DCF

Multiples

Producing Assets (discoveries)









Immature Exploration Assets (leads)

Impossible to Value

Increasing Outcome Certainty

Source: Salman Partners Inc.

Current Methodology Used on the Street?

Salman Partners

	Methodology		Rationale
Producing Assets	❖ Multiples (ie. NAV) ❖ Deterministic DCF (ie. NAV, NPV)		❖ Less outcome uncertainty in booked reserves and production suggests deterministic DCF is usually the best approach
Exploration Assets	❖ Multiples (ie. NAV) ❖ Deterministic DCF (ie. "Risked" NAV)		❖ Deterministic modelling fails to capture the impact of downside risk and upside on valuation

Figure 5: Risked exploration upside potential

Block - Prospect	Interest %	Gross Recoverable Reserves (mmbbl) Low	Best	High	Geological Success %	Risked Reserves (Net, Best; mmboe)	Estimated Value (M$)	US$/share (FD)
Cubiro - Barranquero	61%	2.0	4.0	7.0	60%	1.5	9.4	0.06
Cubiro - Tijereto Sur	70%	2.0	4.0	7.0	50%	1.4	9.1	0.05
Cubiro - East side exploration	57%	2.0	4.0	7.0	50%	1.1	7.4	0.04
Santa Cruz - Santa Cruz	70%	3.9	23.7	68.0	10%	1.7	13.7	0.08
Santa Cruz - Victoria	70%	2.8	20.0	72.5	10%	1.4	11.6	0.07
Topoyaco	50%	5.0	25.0	50.0	10%	1.3	16.3	0.10
		17.7	80.8	211.5		8.3	67.5	0.40

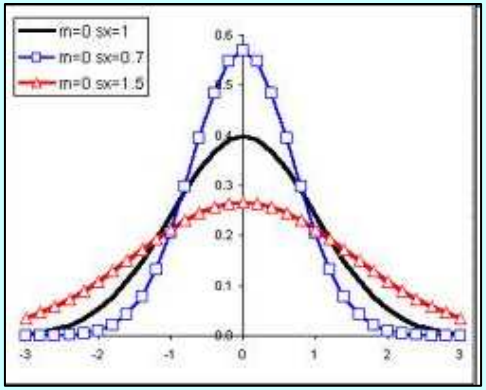
"Risked" NAV

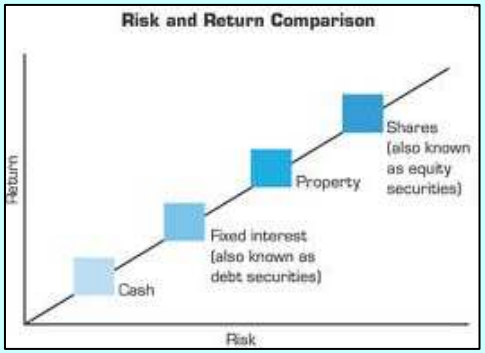
Source: Salman Partners Inc.

Valuing a Single-Attempt Uncertain Outcome

Salman Partners

Game (one attempt allowed)	Adjusting for Risk	Risk Neutral ($mm)	Risked Averse ($mm)
1 **Risk Free**: 100% Chance – you get $1mm; **Pmean of the Game = $1mm**	Amount of Downside Risk?	1	1
2 **Coin Toss**: 50% Chance – you get $2mm; 50% Chance – you get $0; **Pmean of the Game = $1mm**		1	0.8
3 **Unlikely**: 1% Chance – you get $100mm; 99% Chance – you get $0; **Pmean of the Game = $1mm**	Price of Risk?	1	0.3
4 **Impossible**: 0.01% Chance – you get $10bn; 99.99% Chance – you get $0; **Pmean of the Game = $1mm**		1	0.1





Valuation

- **Amount of downside risk** and the **price of risk** are the key drivers
- How to measure the amount of risk?
- How to measure the price of risk?

Source: Salman Partners Inc.

Example of Risked NAV vs. Monte Carlo?

Salman Partners

Imagine this game: A box with bills in it. Each bill has a dollar figure – the amount you receive if you select that bill.

Assume you know the distribution of bills in the box (normal; mean = $1,000; standard deviation = $500).

You must pay $X to play the game. After paying $X, flip a coin, if heads, pick a random bill out of the box and receive the value listed. If tails, pick nothing.

How much should you pay to play?

$275	$346	$1,283	$1,431	$428
$194	$930	$1,182	$720	$125
$1,032	$1,034	$483	$1,011	$1,092
$1,329	$967	$587	$443	$1,183
$597	$754	$767	$1,277	$947
$646	$718	$1,077	$1,371	$1,451
$1,376	$618	$2,246	$899	$880
$769	$154	$5	$395	$219
$1,069	$795	$943	$894	$1,326
$1,008	$1,003	$1,223	$1,835	$1,217
$1,740	$276	$1,222	$351	$1,252
$973	$1,820	$407	$1,283	$981
$768	$1,619	$1,301	$1,482	$1,385
$97	$624	$931	$1,501	$629
$1,222	$1,465	$1,097	$683	$1,395
$280	$1,126	$1,374	$2,560	$1,002
$1,108	$1,461	$739	$643	$1,176
$539	$824	$365	$1,902	$472
$910	$1,131	$1,324	$729	$809
$25	$1,169	$259	$1,576	$1,067

Method 1: "Risked" NAV (Deterministic)

Unrisked Pmean = $1,000

POS = 50%

Value of Game = $500

Risk Neutral

Method 2: Monte Carlo (Stochastic)

Pmean = $499 (100,000 iterations)

Downside Risk Adjust = - $175 (using downside risk adjustment derivation)

Value of Game = $324

Risk Averse

Oil & Gas Exploration Application

- The box represents the *inherent* uncertainty in predicted hydrocarbon accumulations
- Coin toss represents the "chance of success"

Source: Salman Partners Inc.

Presentation Outline

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Assembling the Prospect Portfolio

Salman Partners

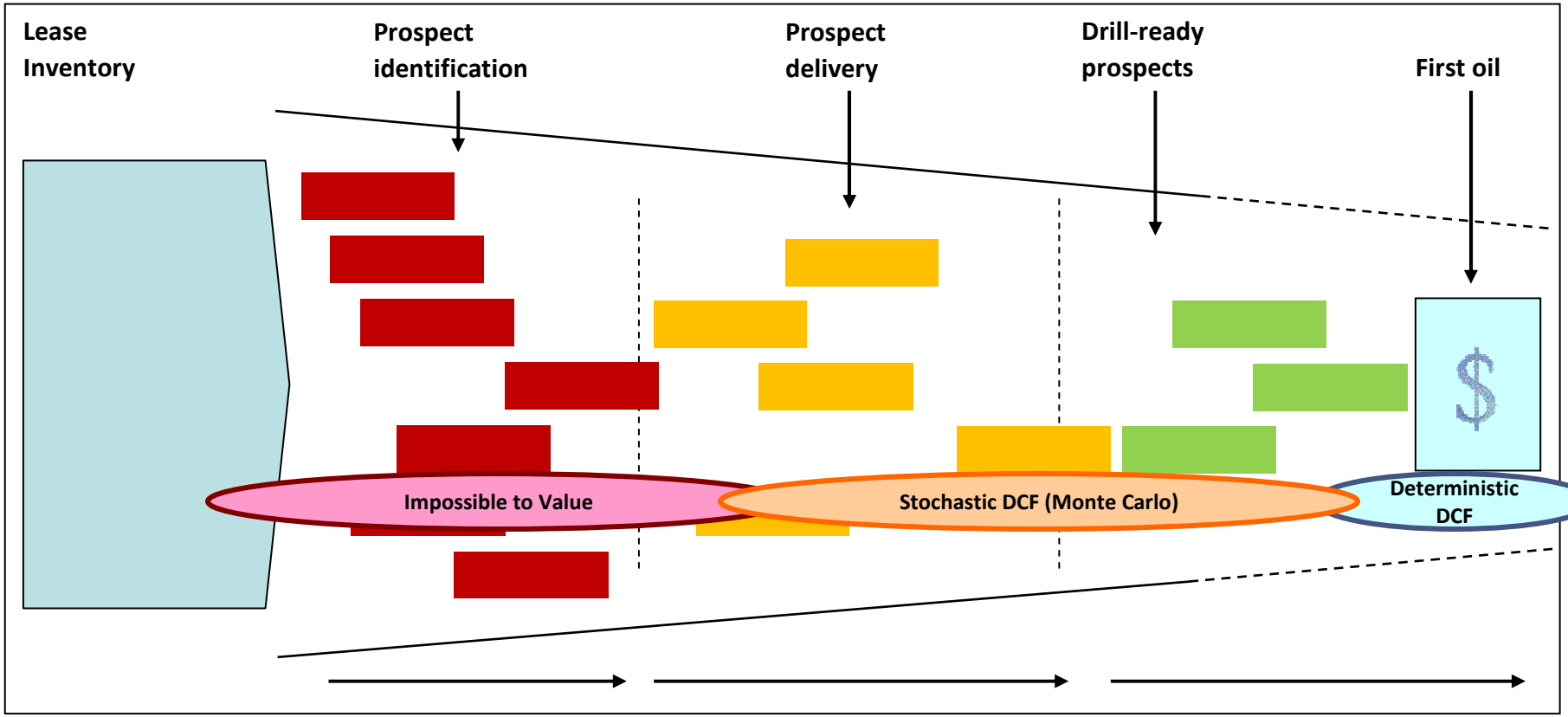
Leads

Prospects

Drill-ready prospects

Leads, prospects and drill-ready prospects data are gathered through public information, field analogs and other estimates

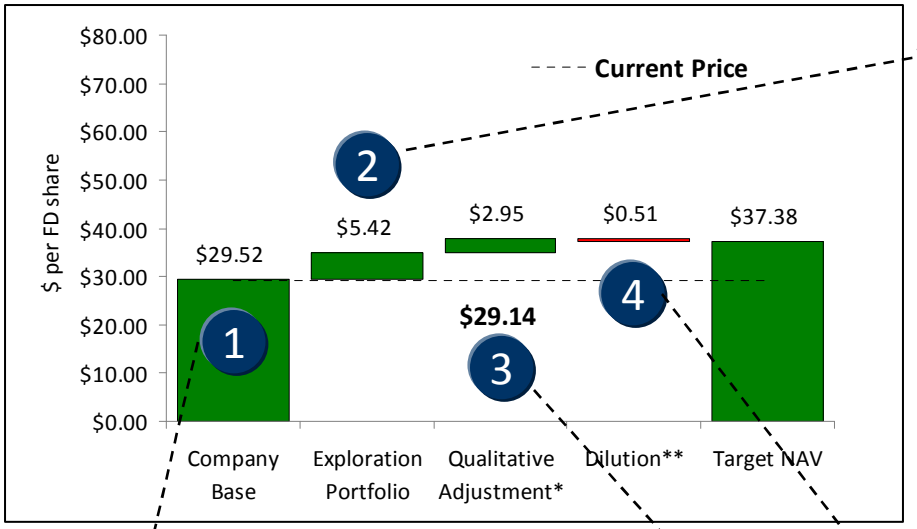
Leads are *qualitatively* assessed. Prospects are generally dependent on other drill-ready discoveries and funding likelihood. Drill-ready prospects are included in the analysis.

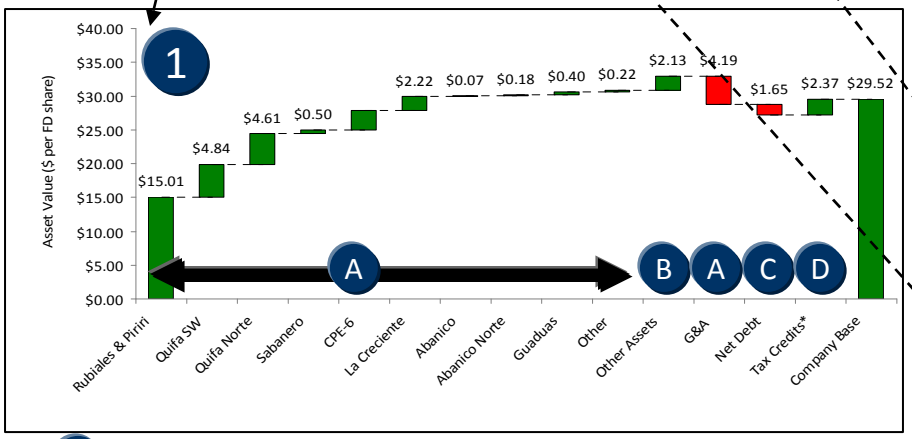


Source: Salman Partners Inc.

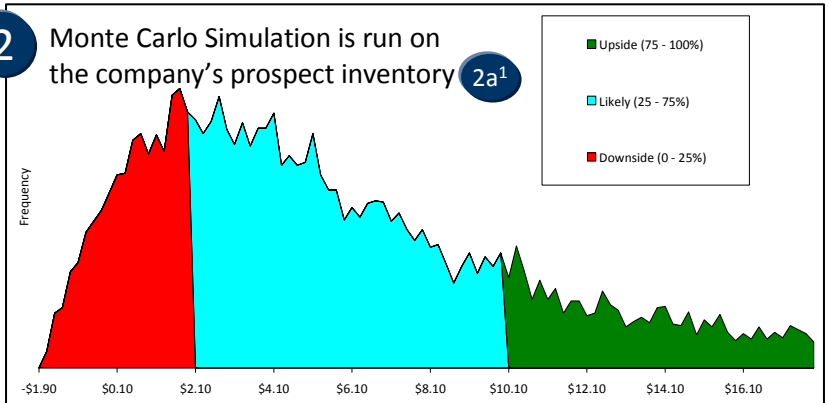
Sample Valuation of Pacific Rubiales Energy

Salman Partners





2 Monte Carlo Simulation is run on the company's prospect inventory 2a[1]



Source: Salman Partners Inc.

Exploration Portfolio Valuation
($ per FD share)

Exploration Portfolio - Pmean Value [A]	**$7.83**
Downside Risk Reduction [B]	**$2.41**
Exploration Portfolio Valuation [A - B]	**$5.42**
Worst Case*	**$0.33**
Mid Case**	**$4.96**
Best Case***	**$17.26**

2b[1]

Exploration Portfolio Risk and Reward

	Best Case*** over Mid Case**	Worst Case* over Mid Case**
Reserve Additions	331%	26%
Exploration Portfolio NAV	348%	24%

*Worst case scenario where only 10% of simulated results are worse
**Mid case scenario where 50% of simulated results are better
***Best case scenario where only 10% of simulated results are better

4 Uses the treasury method to determine incremental dilution beyond the current trading price if the pre-dilution target NAV is reached.

3 Qualitative adjustments to account for intangible valuations such as a management premium/discount, expected M&A, etc.

A Deterministic DCF applied separately to each asset and G&A estimates

B Balance sheet generally used to value other assets

C Debt minus working capital

D Tax credits come from a DCF on tax reduction from unallocated G&A (if offsetting income is available), interest on corporate debt and tax pools.

1. See Appendix for detailed derivation

Benefits of Methodology

- Matches the proper valuation tool to each asset based on the nature of the asset being valued
- Systematic and transparent approach to valuation which allows readers to understand exactly where the target price comes from

Source: Salman Partners Inc.

Expected Time (mins)

Presentation Outline

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Presented by: Justin Anderson, MSc., CFA

More Questions? Please reach out:

Email: janderson@salmanpartners.com

Phone: 403-444-4450

