

Speaker: Creties Jenkins, Rose and Associates

Speech Title: “Appraising & Developing Your Unconventionals: How to Avoid Squandering Billions of Dollars Next Time”

When: 03/09/2017

Where: Brookhaven College Geotechnology Institute
3939 Valley View Lane, Bldg H
Farmer’s Branch, TX 75244

Luncheon starts: 11:30am

Presentation Begins: 12:00pm

Cost: **\$25 per person.** Members and guests are cordially invited to attend.

Please RSVP by Noon 03/08/2017 (This is important so we will have a correct lunch count)

Link to RSVP and simultaneously pay by credit card:

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If the above link does not work, alternatively go to <https://secure.spee.org/> then select ‘Local Chapters’, the ‘Dallas’, the ‘Click Here to Register’.

Abstract: Over the past two years, more than 100 oil and gas companies in North America with almost \$70B in debt have filed for bankruptcy. While these companies would like you to believe they were all victims of low commodity prices, many failed because of the way they approached appraising and developing opportunities. Two of the most common mistakes have been focusing on production attainment instead of value creation, and incorrectly thinking that enough was understood about a given reservoir to push ahead with development. To mitigate these errors, unconventional reservoirs need to be evaluated in a series of stages. In each stage, we need to (1) identify the key uncertainties and risks, (2) collect the data needed to quantify these, and (3) generate a probabilistic assessment of potential outcomes and their associated values. Only then can a good decision be made whether to advance to the next stage or exit.

A key aspect in this evaluation is not only using rock and fluid data to identify the area with the greatest potential, but drilling enough wells to understand the production variance (irreducible uncertainty) in this area and whether the average well will be economic. This process requires discipline, including maintaining consistent drilling and completion practices so variations in reservoir quality can be understood. To help ensure this process is followed, an assurance procedure consisting of 1) guidelines and workflows, 2) peer reviews and assists, and 3) post-project lookbacks is critical and must be effectively implemented throughout the entire organization. The time to do this is NOW, before prices rise again and we revert to our old habits.

Bio: Creties Jenkins (P.E., P.G.) is a Partner with Rose and Associates where he specializes in the characterization of unconventional reservoirs. Creties has carried out integrated studies, peer reviews, training, and resource assessment work for more than 50 companies around the world. He has also conducted more than 100 industry courses and workshops over the past decade focused on tight oil and gas reservoirs. Creties has served as a technical editor, distinguished lecturer, and distinguished author for SPE and is also a past president of the Energy Minerals Division of AAPG. He is a co-author of SPEE Monograph 4: *Estimating Ultimate Recovery of Developed Wells in Low-Permeability Reservoirs* and serves on the steering committee for the 2017 multi-disciplinary Summit: *Building and Applying the Universal Workflow for Low Permeability Oil and Gas Reservoirs*. Creties received a BSc in Geological Engineering and a MSc in Geology from the South Dakota School of Mines.

Russell Romoser

Secretary SPEE Dallas Chapter

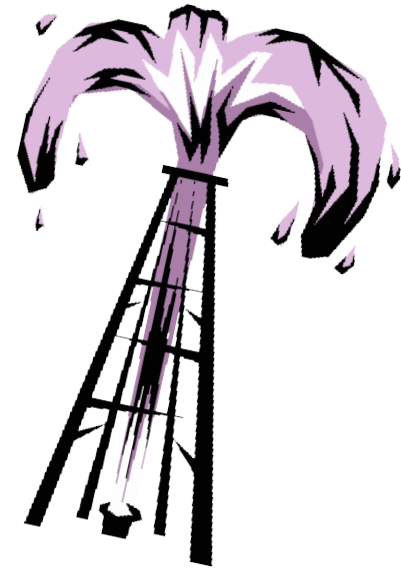
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Appraising and Developing Your Mudrocks: How to Avoid Squandering Billions of Dollars Next Time

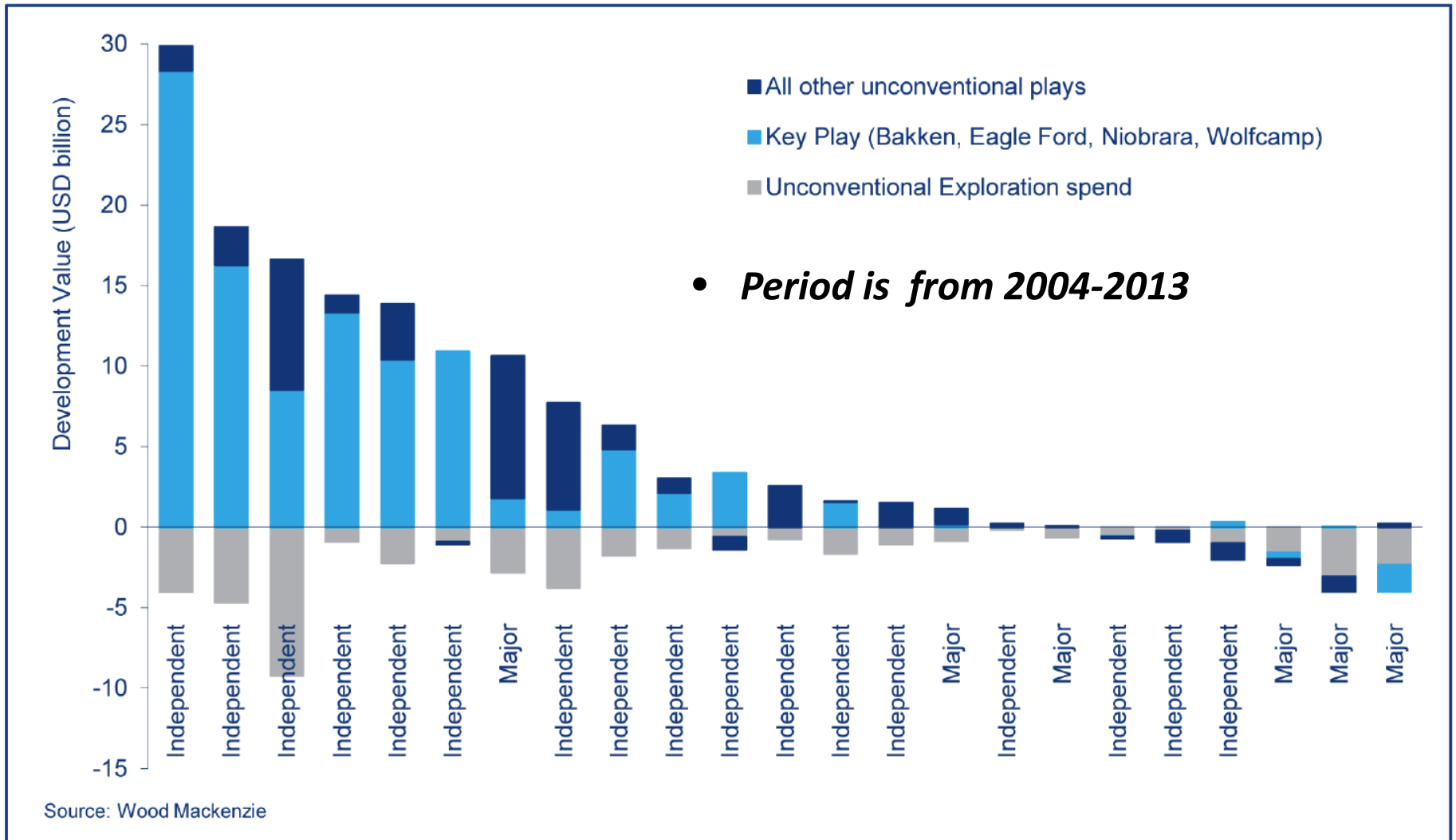


*Creties Jenkins & Mark McLane
Rose and Associates*



**SPEE Dallas Chapter
March 9, 2017**

Development Value in Unconventional Plays



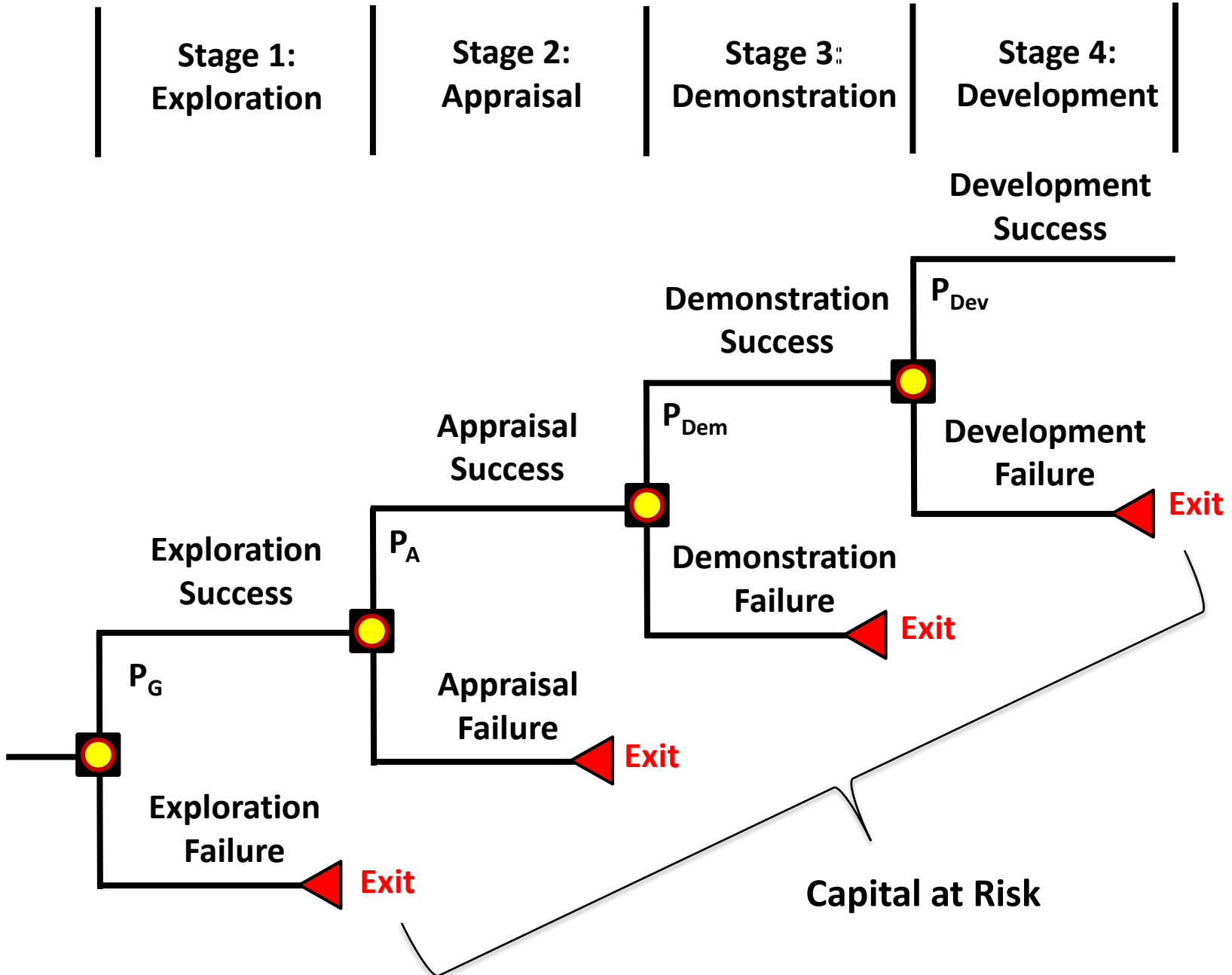
- The 23 companies shown here acquired acreage in 30+ North American plays.
- Only half of these companies delivered significant value.

U.S. Shale Plays

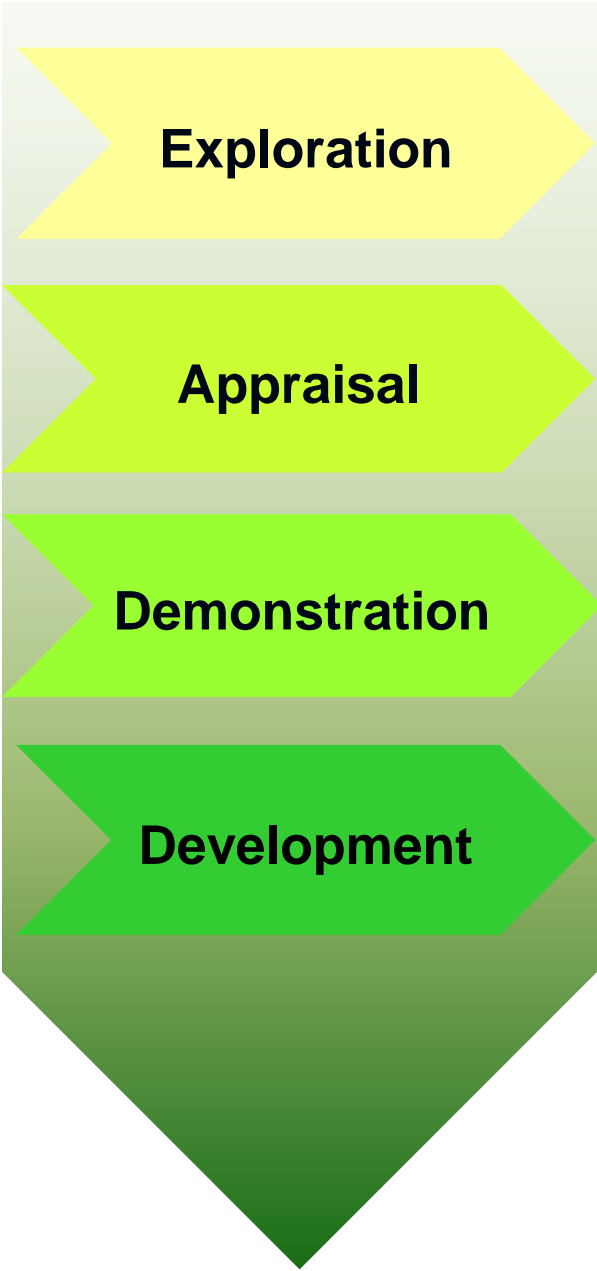


- What percentage of U.S. Shale Plays have been commercially developed?

The Staged Approach



General Workflow



Exploration

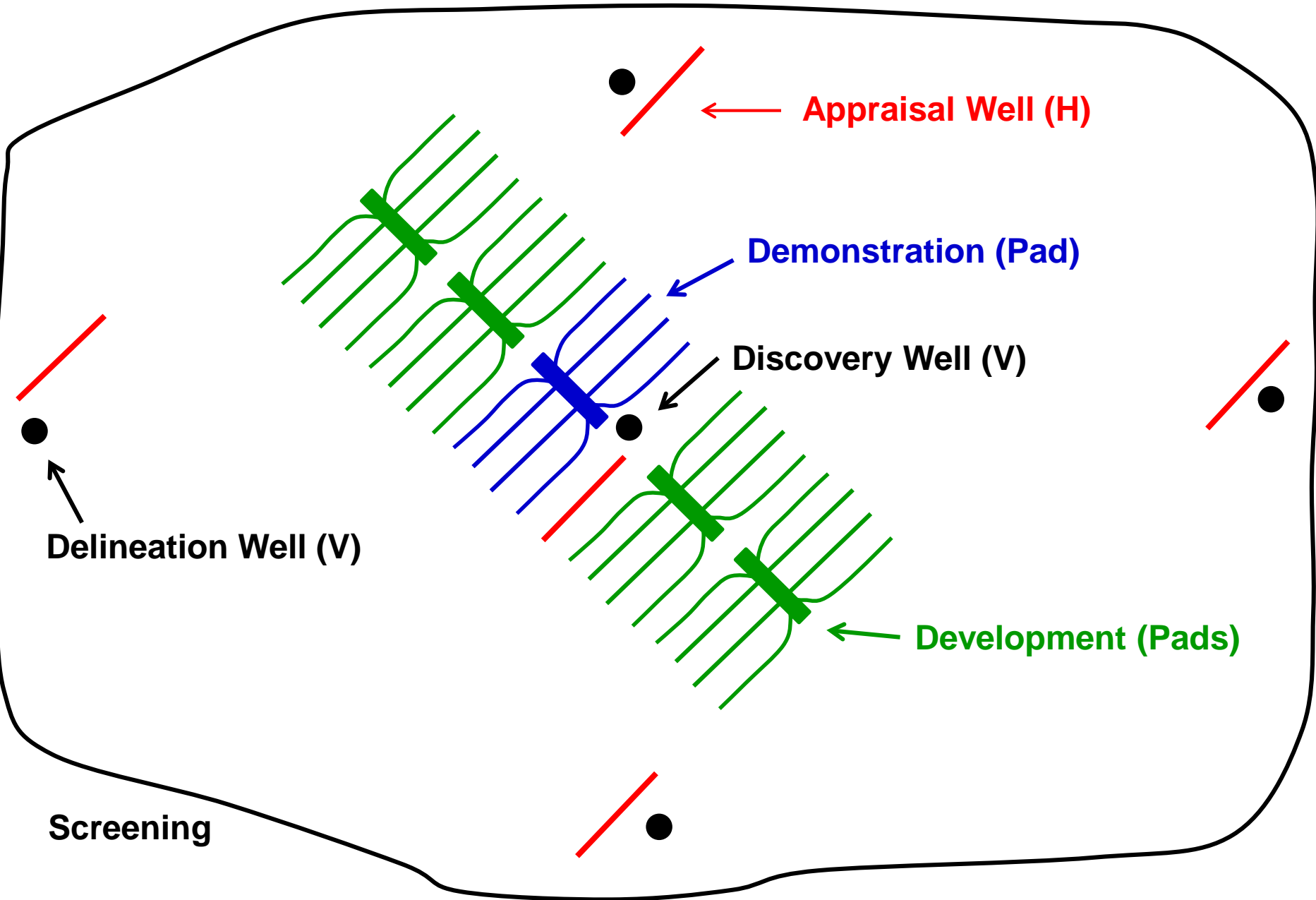
Appraisal

Demonstration

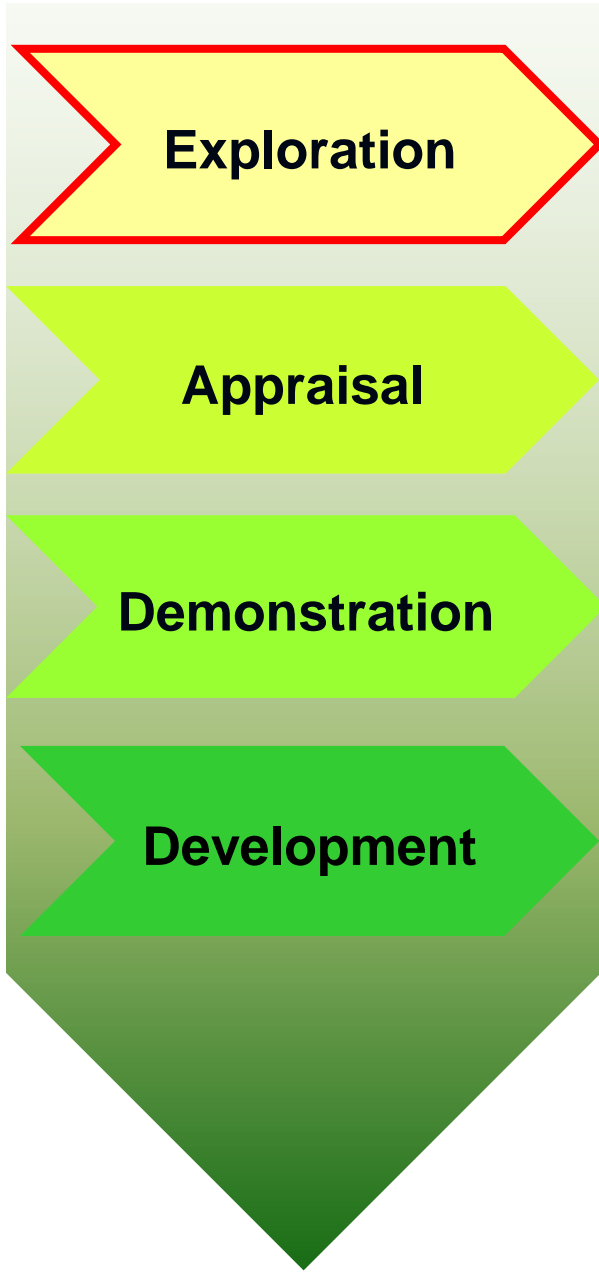
Development

- Identify the stage the project is in
- Assess the key uncertainties and risks in that stage
- Define the data and analyses required to make a good decision whether to proceed to the next stage or exit
- Design a work plan, timeline and budget to acquire this information

Project Stages



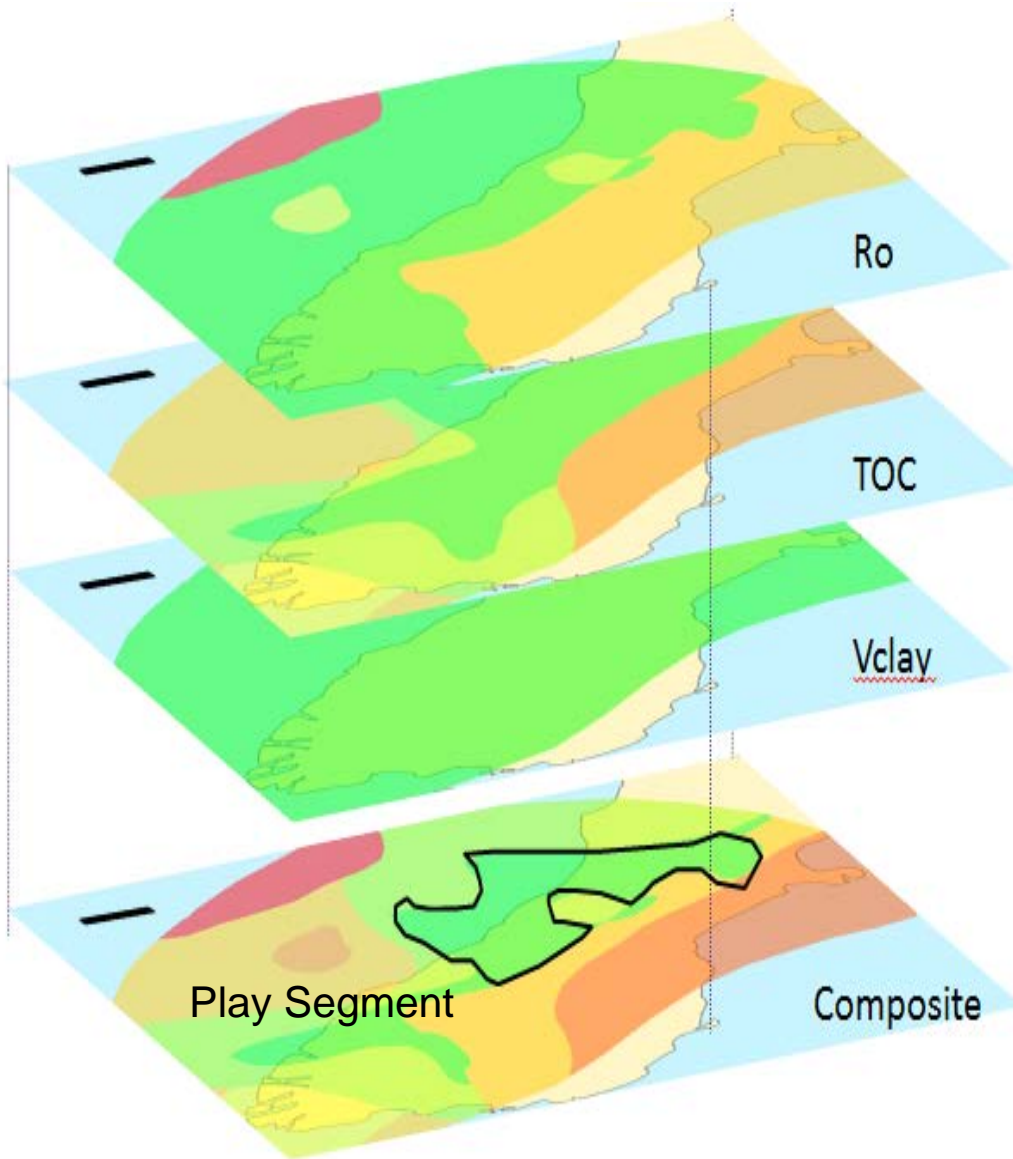
Project Stage: Exploration



Screening

- Target basins with prospectivity and rank opportunities
- Apply criteria for identifying sweetspots
- Collect all existing relevant information
 - Cast a wide net and be resourceful
 - Look for data to fill-in the gaps
 - Evaluate the entire stratigraphic column
- Build maps and spatially composite them
- Identify potential analogs
- Determine chance of geologic success (Pg) for defined play segments

Spatial Compositing of Maps



- Organic richness (TOC)
- Thermal maturity (%Ro)
- Structure/tectonics
- Gross/net thickness
- Lithofacies/mineralogy
- Acoustic impedance
- Geomechanical properties
- Seeps/slicks
- Surface geochemistry
- Porosity/Permeability
- Fluid saturations (Sg, So, Sw)
- Evidence of overpressure
- Overburden thickness
- Seal thickness/rheology
- Reservoir temperature
- Paleogeography
- Key wells
- Acreage held/open
- Restricted/inaccessible areas
- Pipelines, other infrastructure

Project Stage: Exploration



Exploration

Discovery

- Locate a significant quantity of producible hydrocarbons that has the potential for commercial development
- Drill multiple wells if failure is local and not regional
- Determine how many targets to investigate
- Decide what data to gather
- Integrate newly-acquired and existing data
- Acquire open acreage, build land position
- Determine failure criteria & what outcomes trigger an exit

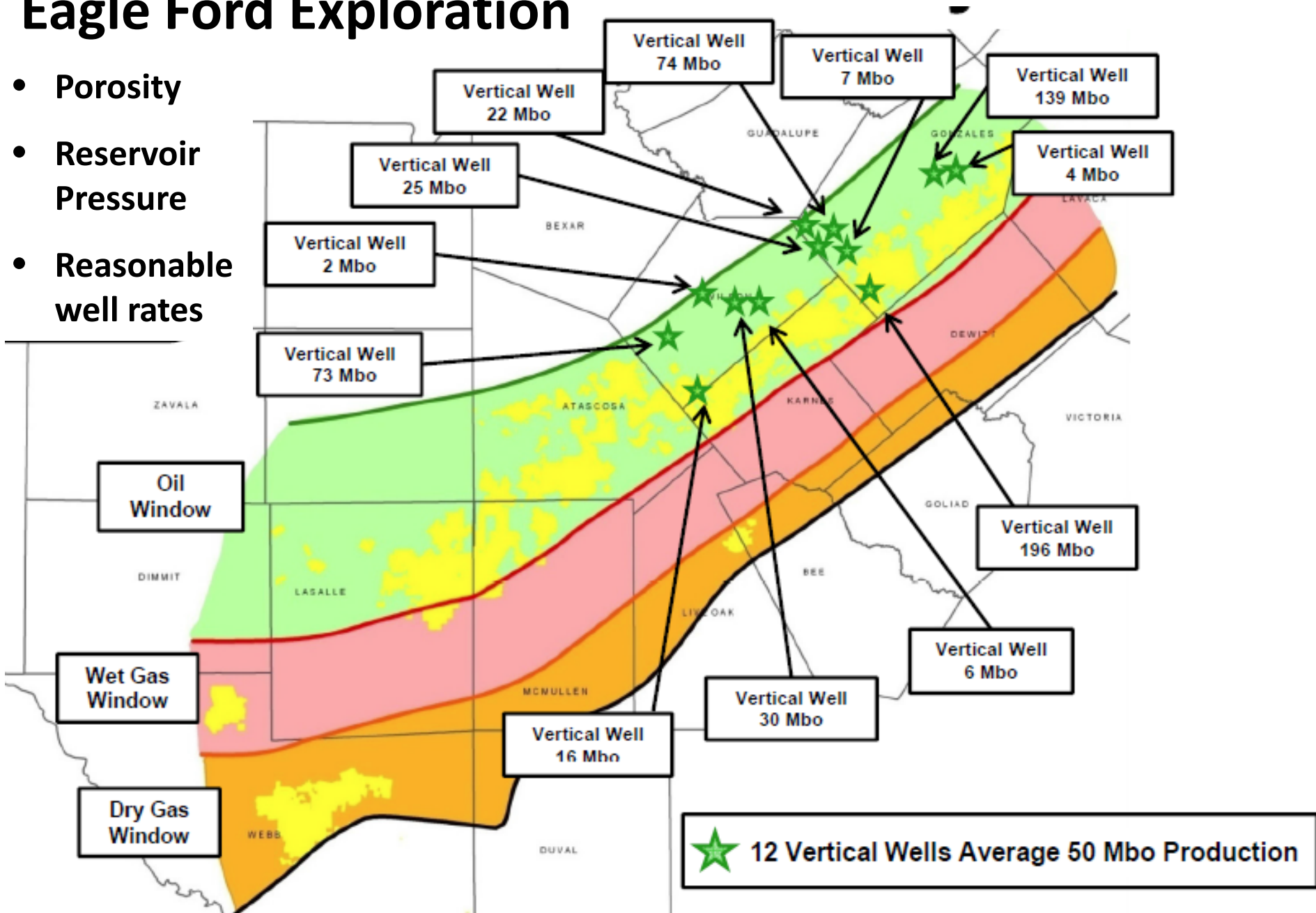
Appraisal

Demonstration

Development

Eagle Ford Exploration

- Porosity
- Reservoir Pressure
- Reasonable well rates



Project Stage: Exploration



Exploration

Appraisal

Demonstration

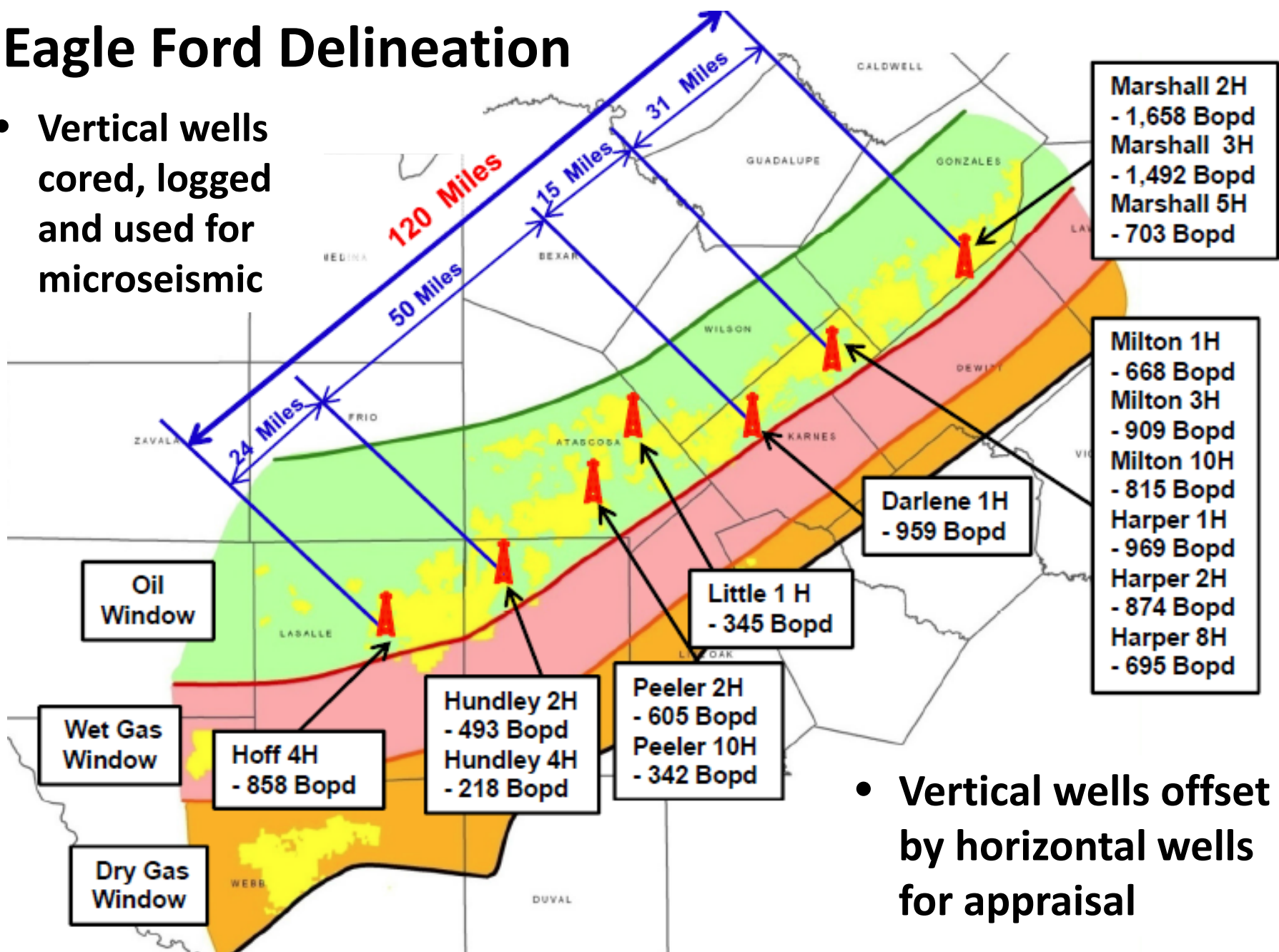
Development

Delineation

- Validate materiality—that the potential is sufficient to justify further investment
- Show that successive wells are as good or better than the discovery well.
- Confirm thickness, lateral continuity, and internal character with 2D seismic, well data
- Demonstrate that wells can be fraced and produce fluids with desirable characteristics
- Determine well count needed to meet a defined percent confidence of achieving some minimum average well rate
- Determine failure criteria & what outcomes trigger an exit

Eagle Ford Delineation

- Vertical wells cored, logged and used for microseismic



- Vertical wells offset by horizontal wells for appraisal

Project Stage: Appraisal



Exploration

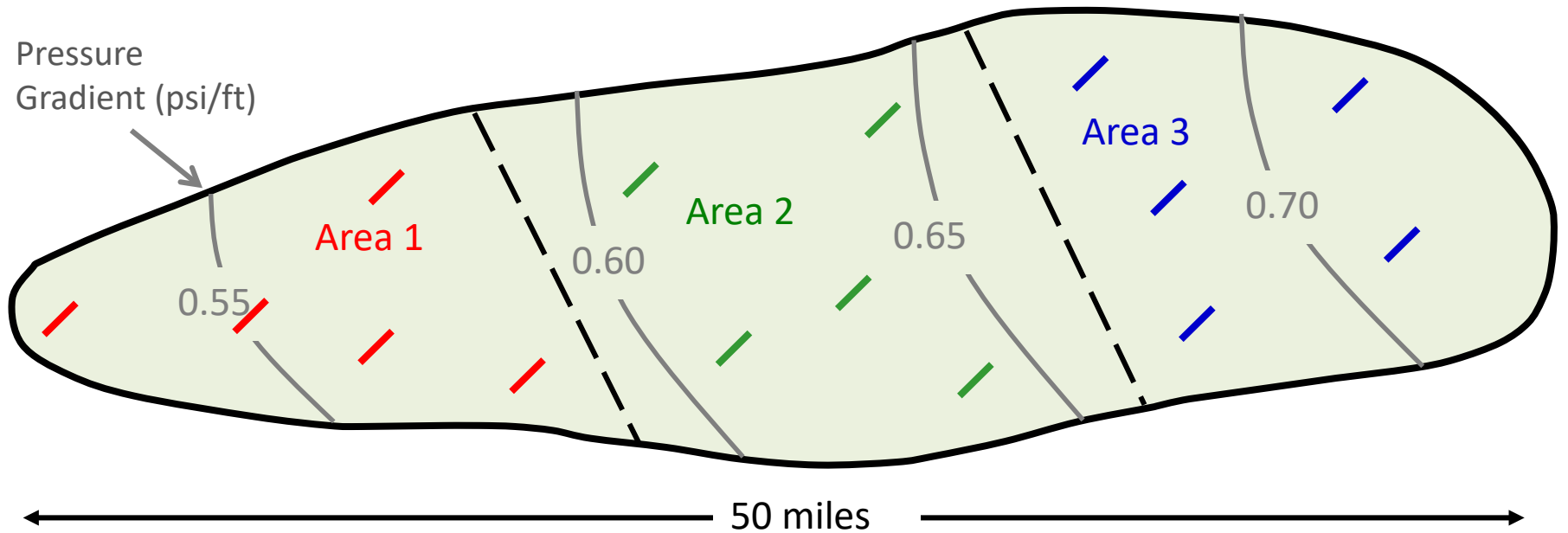
Appraisal

Demonstration

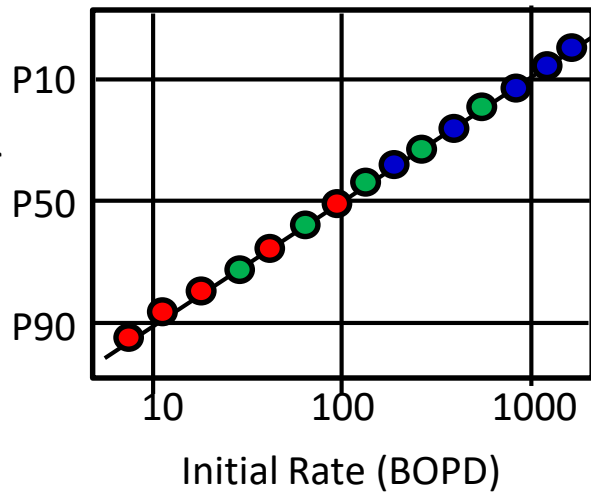
Development

- Validate the ability to drill, complete, and produce hydrocarbons from individual horizontal wells at a rate/decline above some predetermined threshold
- Use consistent drilling/completion practices
- Identify areas of greatest productivity--will become the sites for demonstration projects
- Obtain key reservoir data (rates, pressures) to help quantify performance variability
- Determine well count needed to meet a defined percent confidence of achieving an average well rate that exceeds the threshold
- Determine failure criteria & what outcomes trigger an exit

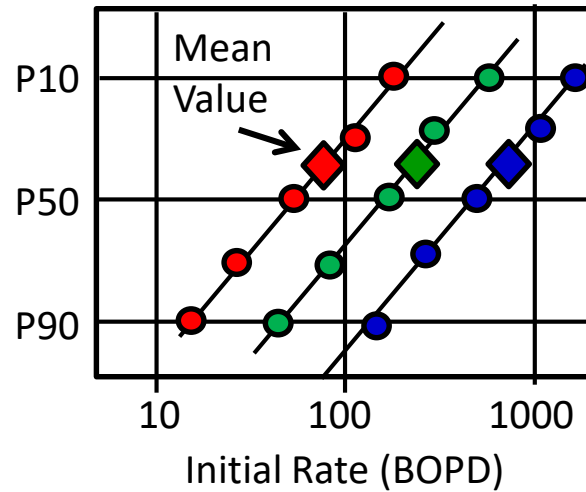
High-Grading with Appraisal Wells



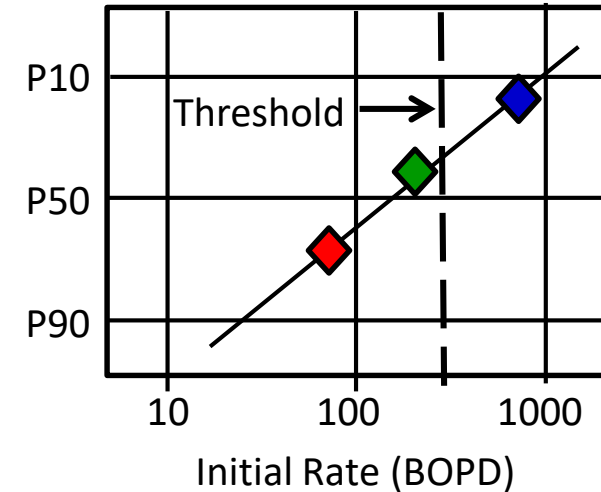
Rate Distribution



Rate Distribution by Area



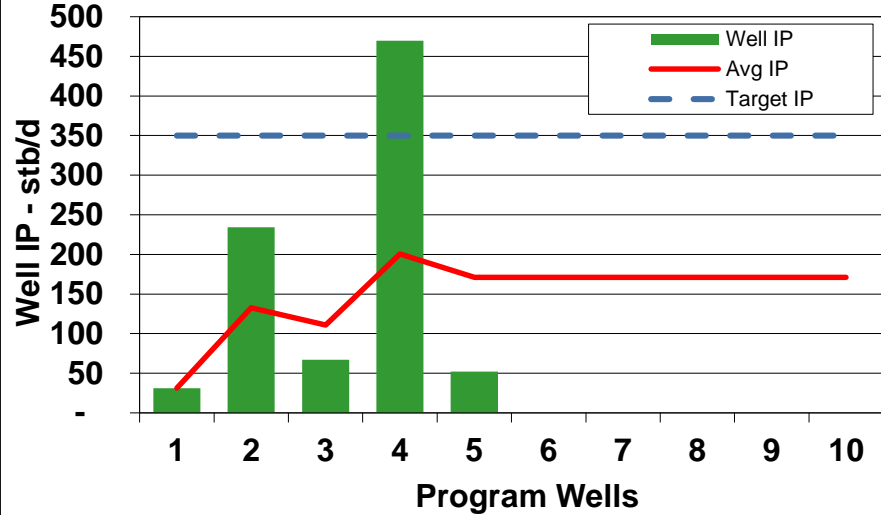
Mean Values by Area



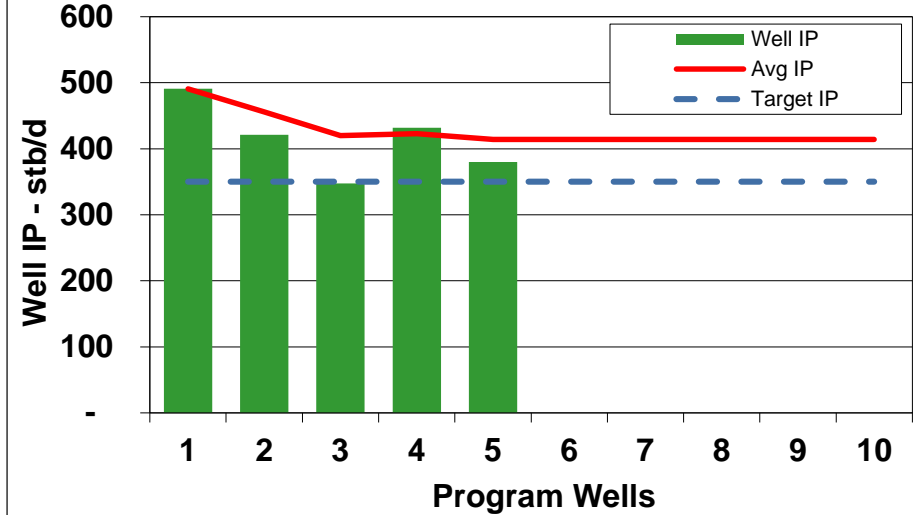
Examples of 5-Well Drilling Programs

Assuming P90 = 80, P10 = 800, Pmean = 350 (threshold)

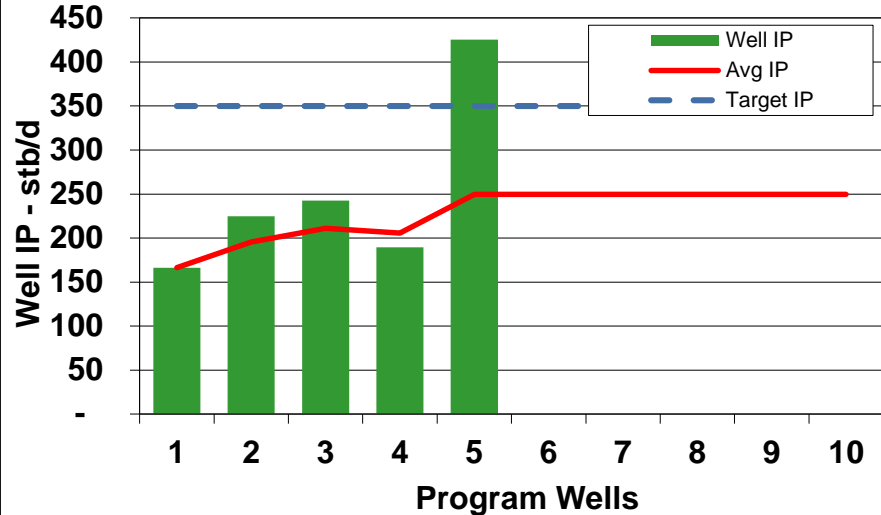
Drilling Program Rate



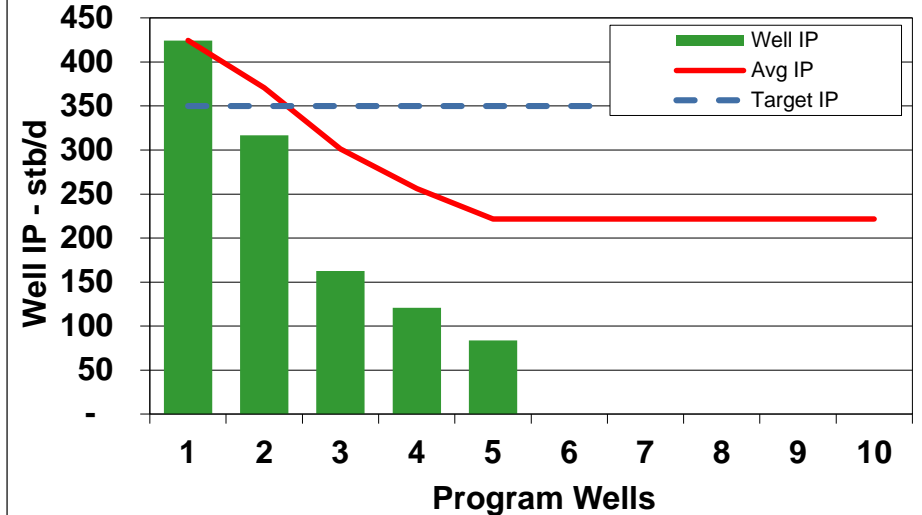
Drilling Program Rate



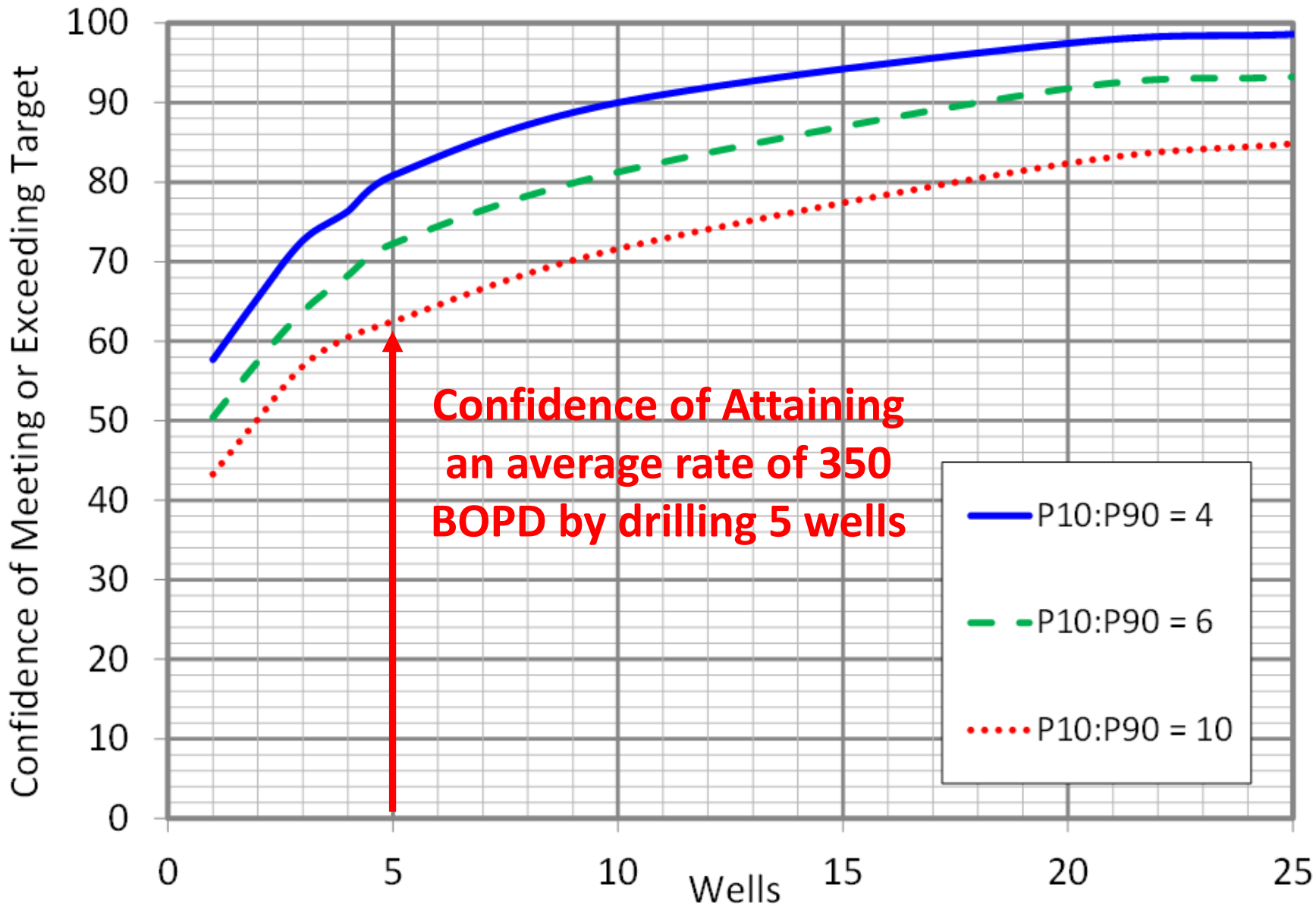
Drilling Program Rate



Drilling Program Rate



Confidence Curves



Project Stage: Demonstration



Exploration

Appraisal

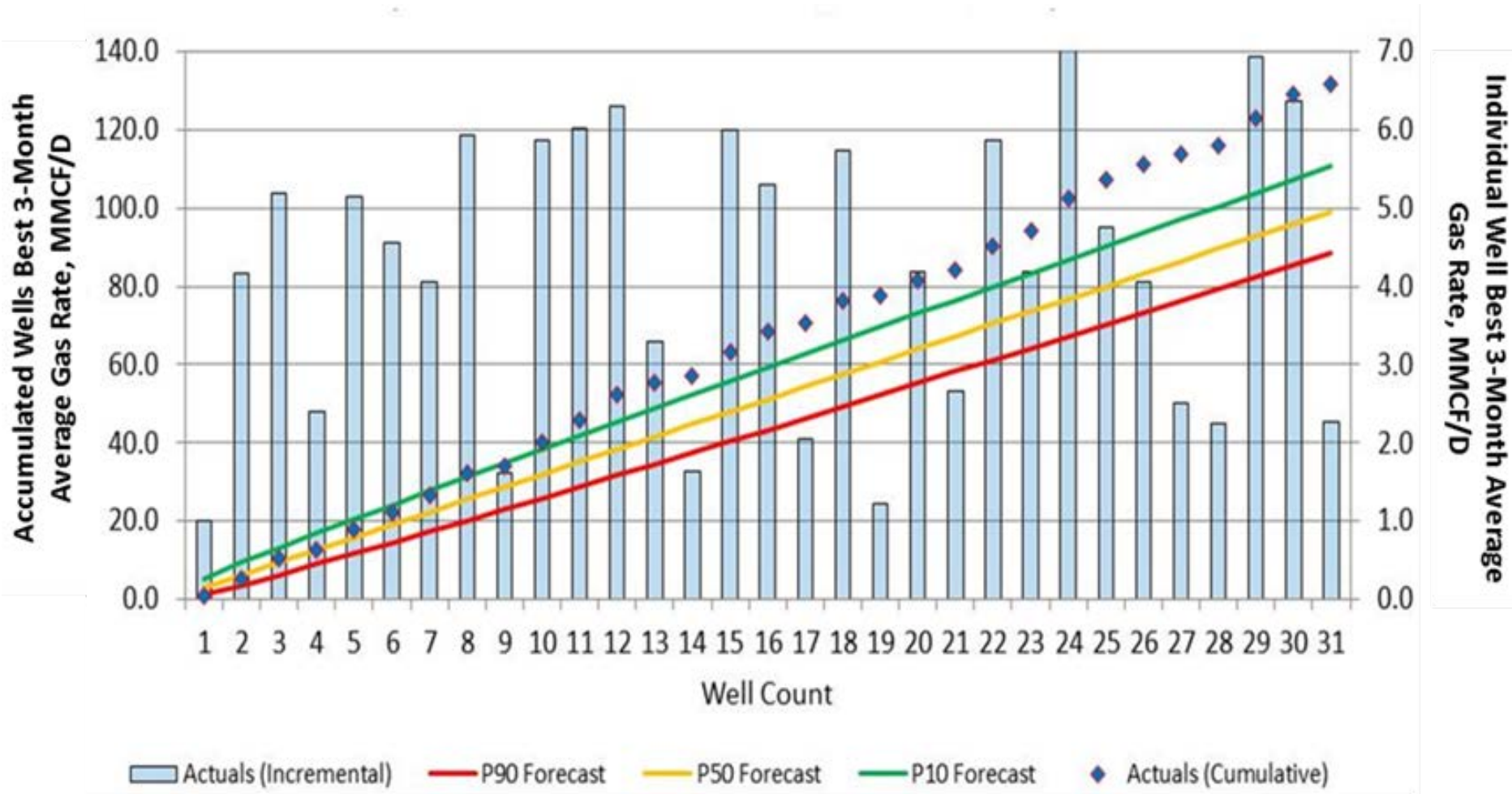
Demonstration

Development

- Validate that you have a commercially viable project above a prescribed confidence level
- May need multiple demonstration projects
- Determine the well count required to meet the prescribed confidence level
- Confirm type curve(s) and ensure that expected cost improvements are achievable
- Determine the well spacing that maximizes project value
- Use sequential aggregation plots to track performance vs forecast for major elements
- Determine failure criteria & what outcomes trigger an exit

Sequential Aggregation Plot

Showing Best 3 Month Average Gas Rate for 31 Wells Compared to Forecasts



Project Stage: Development



Exploration

Appraisal

Demonstration

Development

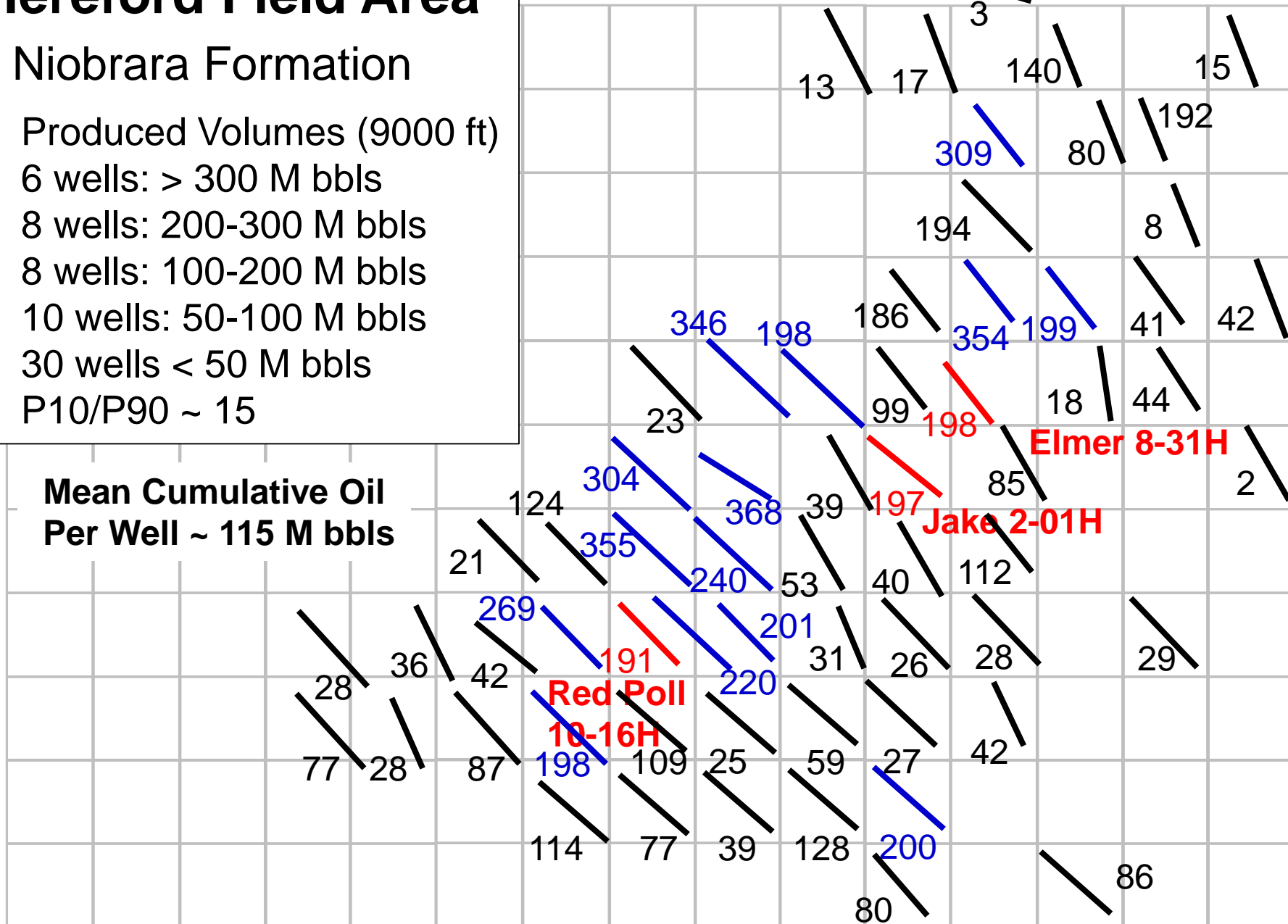
- Proceed if the expected results are competitive with other opportunities in your company's portfolio
- As development drilling expands, ensure that results from new wells continue to meet expectations
- Use continuous learning and KPIs to reduce costs, optimize well spacing and maximize production & reserves
- Synchronize pad construction, well drilling, completion, fluid gathering and processing to maximize profitability

Hereford Field Area

Niobrara Formation

- Produced Volumes (9000 ft)
- 6 wells: > 300 M bbls
- 8 wells: 200-300 M bbls
- 8 wells: 100-200 M bbls
- 10 wells: 50-100 M bbls
- 30 wells < 50 M bbls
- P10/P90 ~ 15

**Mean Cumulative Oil
Per Well ~ 115 M bbls**



From Anderson et al, "A Short History of the "Jake" Niobrara Horizontal Oil Discovery...", Mountain. Geologist, July 2015

From P. Lawless, "Niobrara EUR Estimates for the Powder River and DJ Basins", AAPG RMS-PS meeting, Oct 2016

The Staged Approach

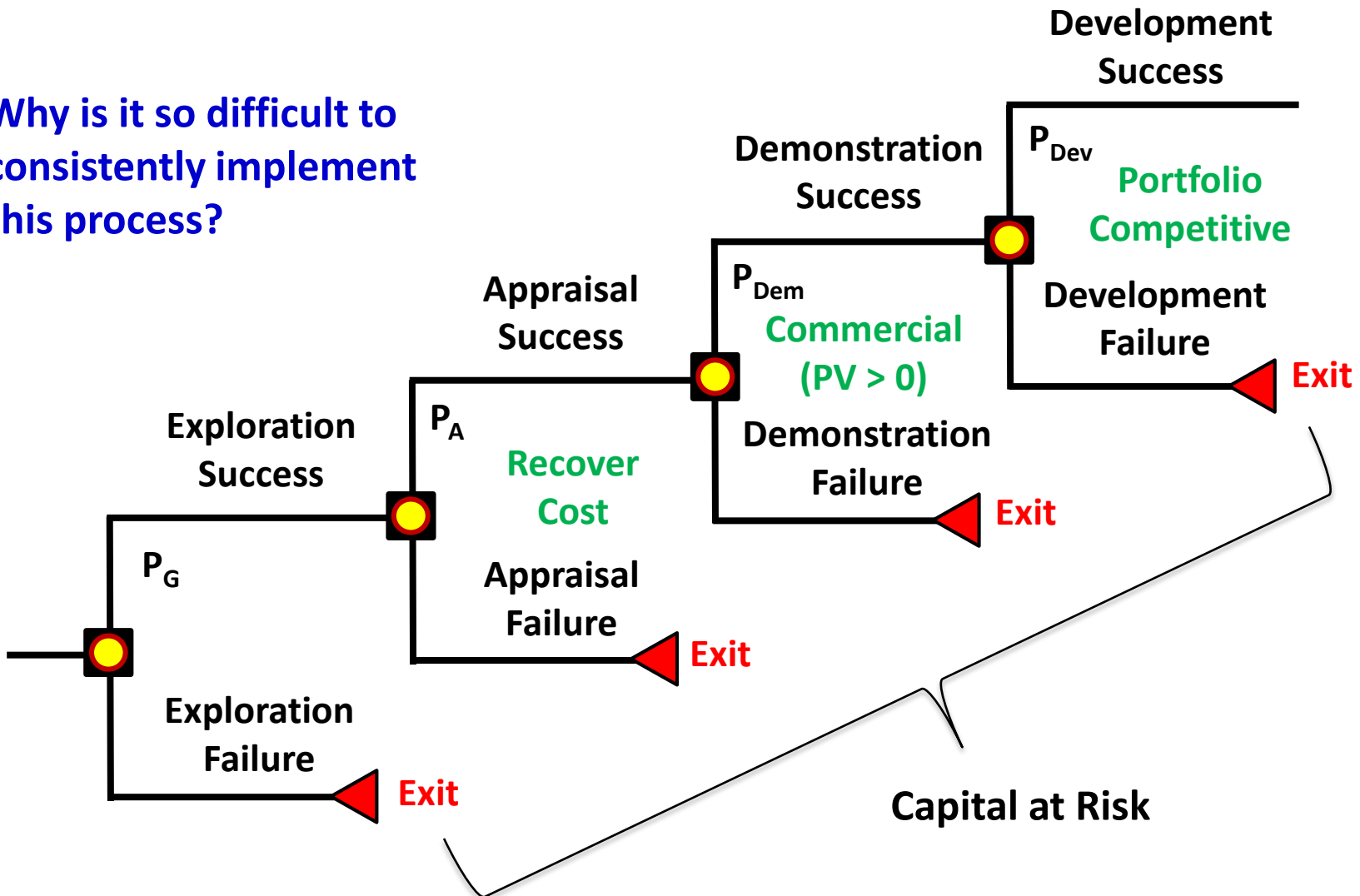
Stage 1:
Exploration

Stage 2:
Appraisal

Stage 3:
Demonstration

Stage 4:
Development

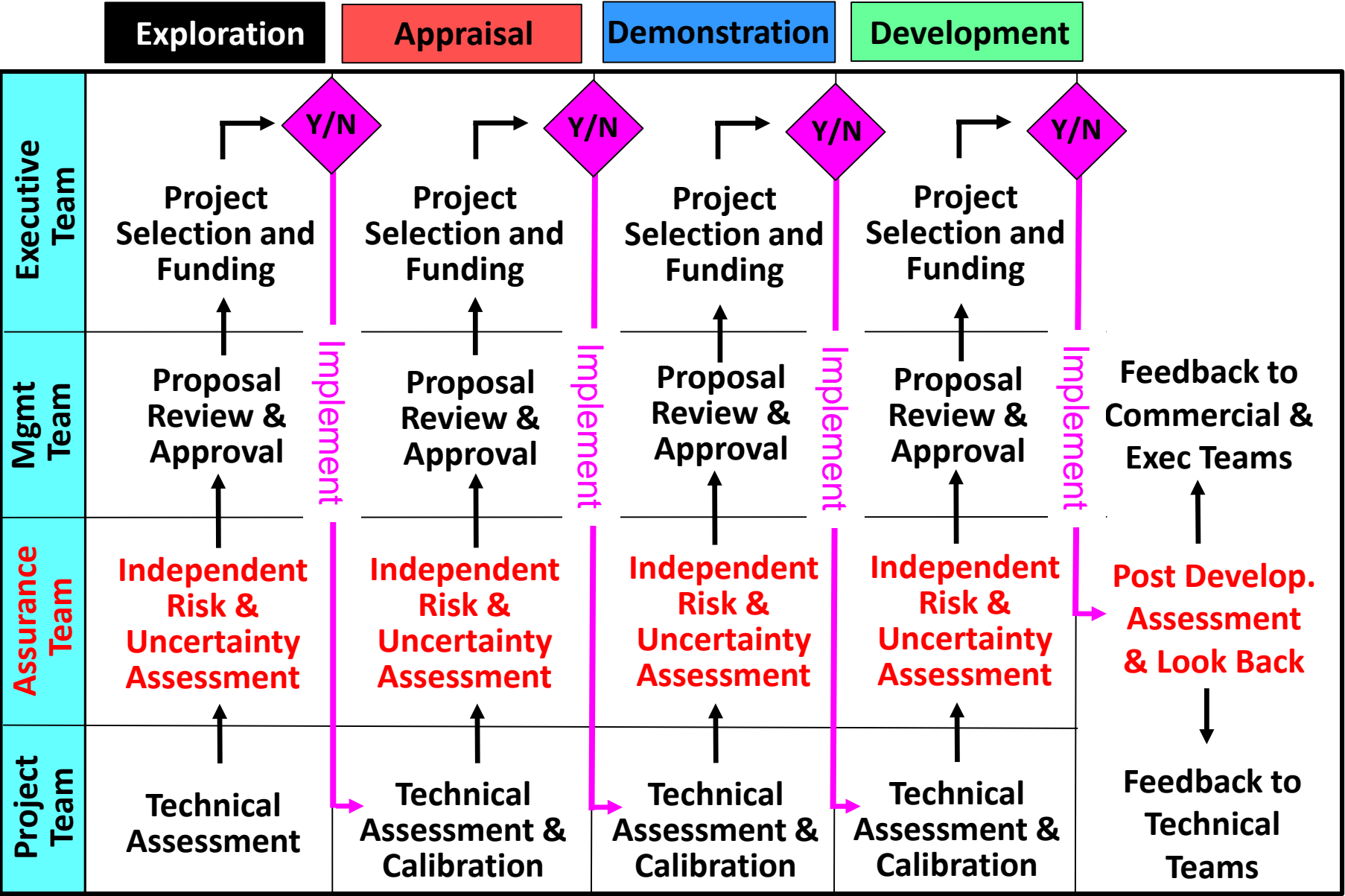
Why is it so difficult to consistently implement this process?



The Assurance Process

- **Standards** such as minimum economic metrics and project size
- **Guidelines** including use of the staged approach
- **Workflows** that are discipline specific and tied to the staged decision tree, sets of deliverables, and KPIs
- **Peer assists** conducted with an independent external prospective to help ensure projects are properly focused
- **Documentation** to create a record of what was planned, predicted, and actually achieved
- **Lookbacks** to calibrate the outcomes and make changes that result in closer correspondence between what's promised and delivered in the future

The Role of the Assurance Team in a Staged Evaluation



Key Questions for Decision Makers to Ask

- What is the source of the numbers that justify the recommendation?
- Does the recommendation assume that an approach that is successful in one area will be just as successful in another?
- Is there an over-attachment to a history of past decisions or to a rare but memorable success?
- Is the base case too optimistic? Too pessimistic?
- Were there dissenting opinions leading up to the recommendation? How was this resolved?
- If we delay a decision on this project for one year, what data would you gather in the interim and what impact could this have?

A Concluding Thought



“If I had one wish, it is to see organizations dedicating some effort to study their own decision processes and their own mistakes, and keep track so as to learn from those mistakes.”

Daniel Kahneman – “Thought Leader” by Michael Scrage

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Thank You! Questions?



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