

Inappropriate Separation of Risk and Uncertainty in Probabilistic Assessments*

Charles D. Norman¹

Search and Discovery Article #70074 (2010)

Posted May 14, 2010

*Adapted from oral presentation at AAPG International Conference and Exhibition, Rio de Janeiro, Brazil, November 15-18, 2009

¹GeoKnowledge, Houston, TX (darrel@geoknowledge.com)

Abstract

Assessment of exploration prospect resource potential has traditionally focused on two activities: uncertainty estimation (the range of success case volumes and their associated probabilities), and risking (estimation of the chance of success). The calculations of chance of success and uncertainty estimation are often carried out in near-isolation, independently of one another. Typically, one risks the chance of exceeding the P100 or P99 volume, or “the chance of getting on the curve.”

The process may lead to inaccurate representations of success case volumes. Since all success case probabilities are subsequently multiplied by the chance of success, focusing only on the minimum volume, without regarding the impact of the chance of success on success case probabilities such as the P90, P50, and P10, may create success case volumes with unreasonably high probabilities. As a result, economic decisions are made based on an overly optimistic assessment.

Problems may arise when an optimistic P50 to P10 range (in other words, the upper portion of the uncertainty range) is coupled with a very conservative P100 or P99 volume. The “chance of getting on the curve” may approach 100%. The chance of exceeding the P50 and P10 volumes, however, may be much less than, respectively, 50% and 10%. Since economic value, and therefore the decision to pursue the opportunity, is typically driven by volumes in the upper portion of the uncertainty curve, focusing only on the chance of exceeding the P100 or P99 volume creates an incorrect assessment of the prospect’s economic potential.

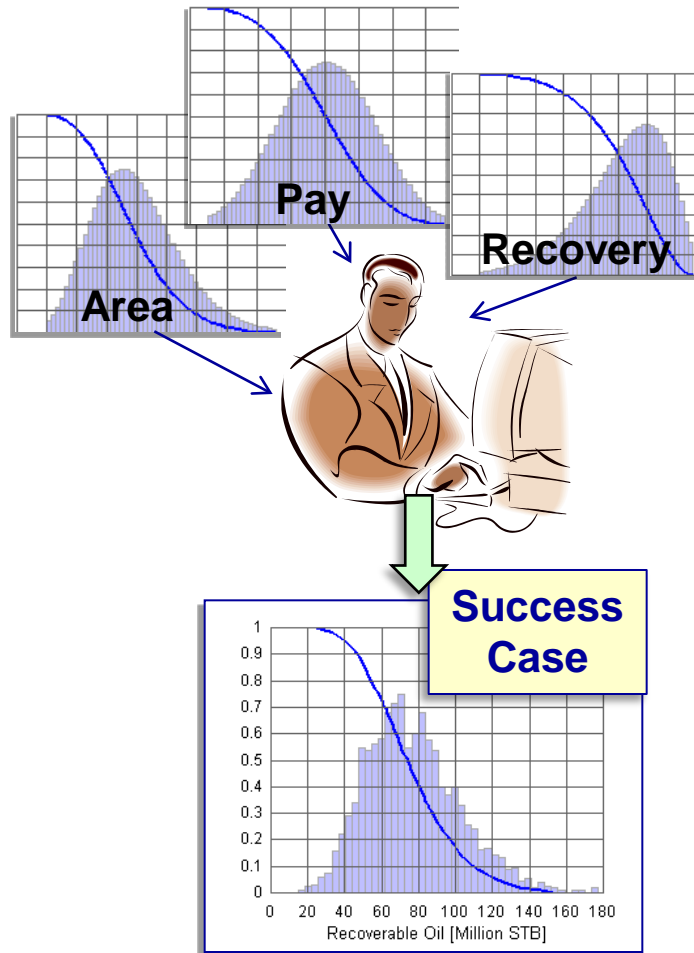
In multiple zone prospects, a traditional separation of risk and uncertainty is not possible. The success case size of the prospect is often a function of the number of zones that succeed. The number of zones that succeed is in turn a function of the chance of success estimated for each individual zone, and the geologic relationships between the zones. The size of the prospect, then, is determined by the chance of success assigned to each zone. The prospect’s uncertainty may be driven more by risk than by volume parameters such as productive area and thickness.



Inappropriate Separation of Risk and Uncertainty in Probabilistic Prospect Assessments

Probabilistic prospect assessment processes

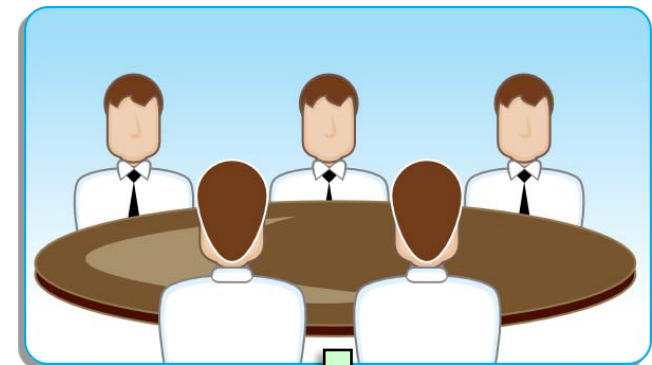
Definition of Uncertainty



"Unrisked" case

Definition of Risk

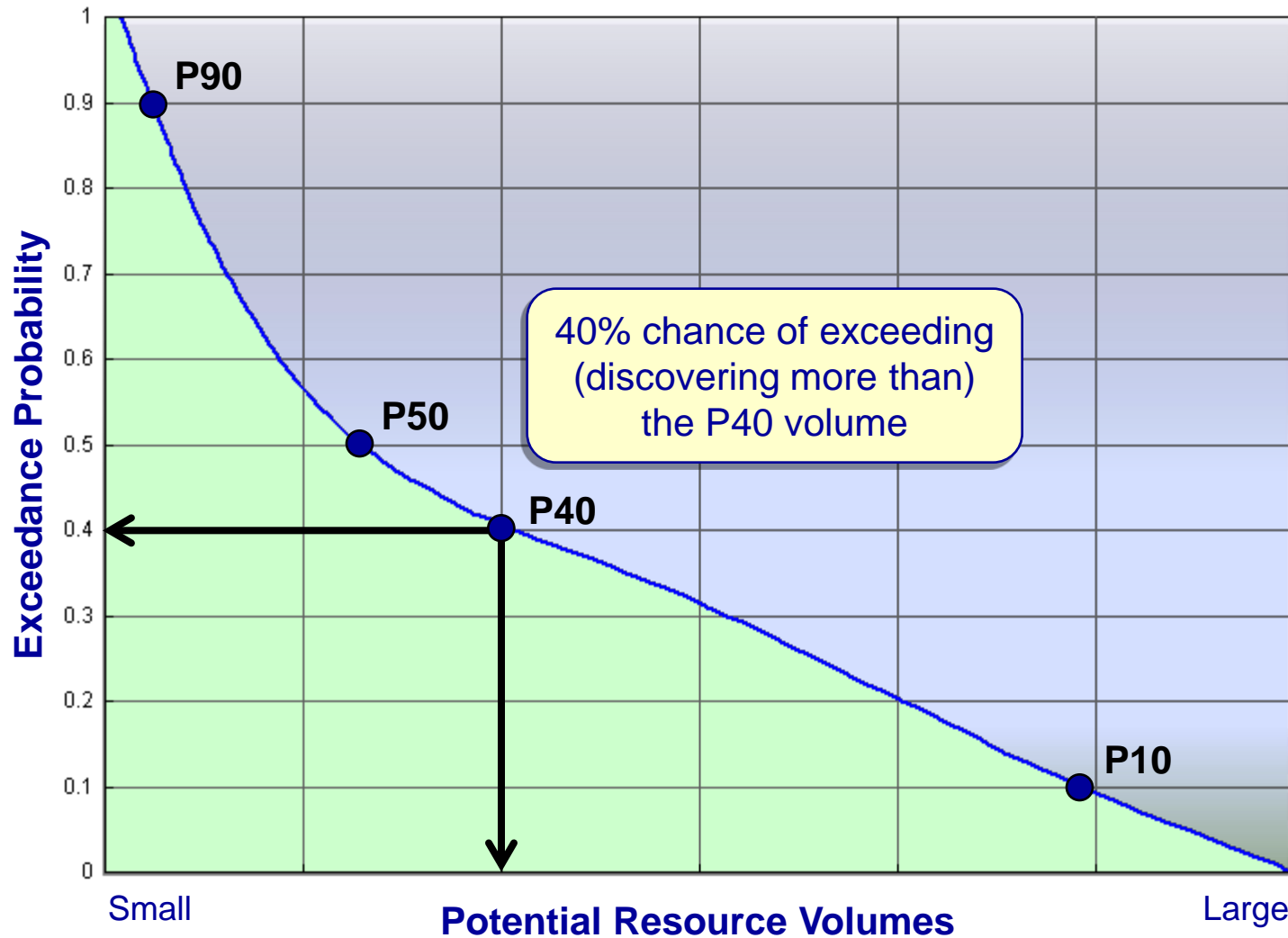
- P(Trap)
- P(Reservoir)
- P(Source)
- P(Migration)



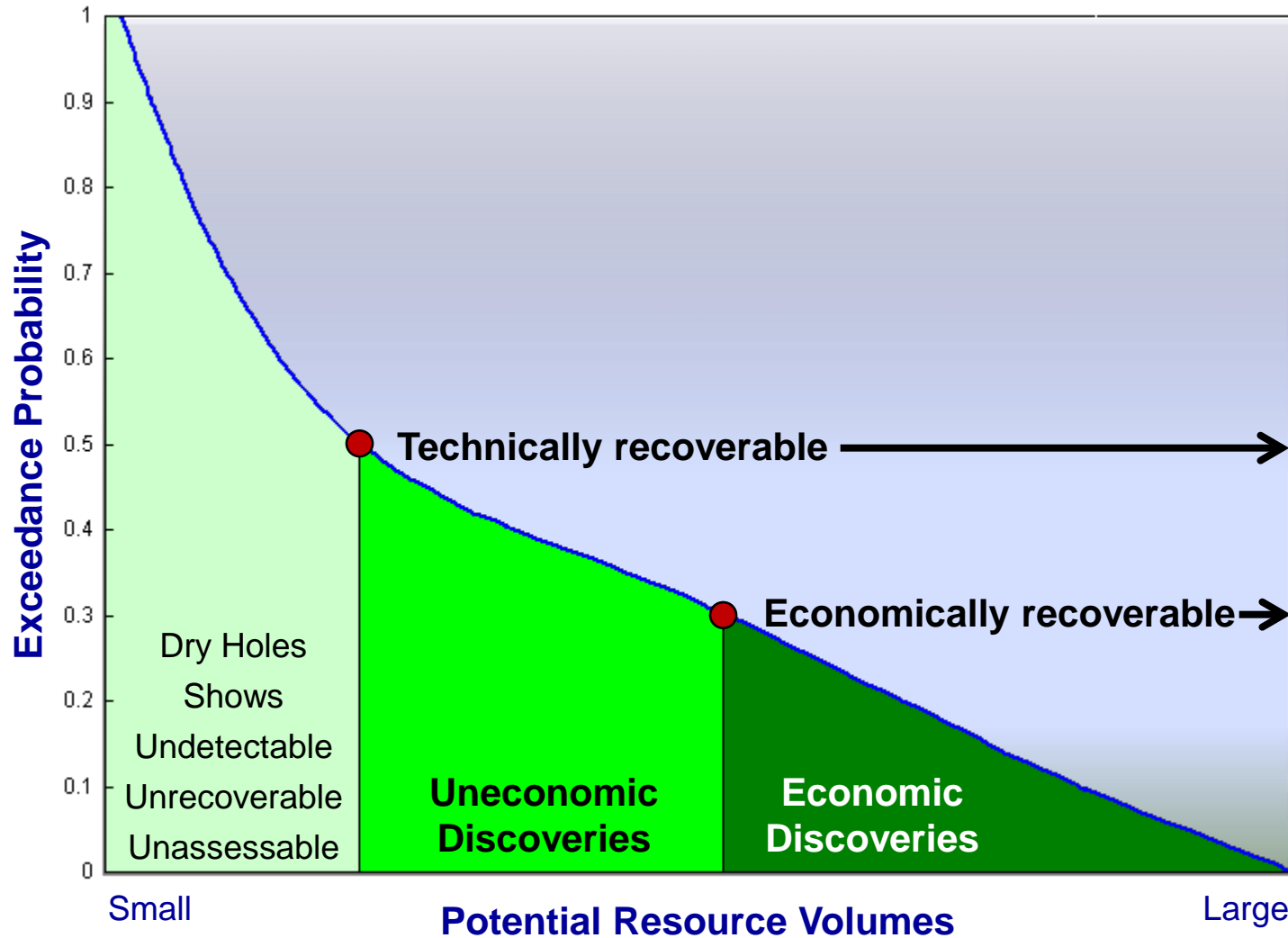
Chance of Success

GCOS,
POS, Ps, Pg

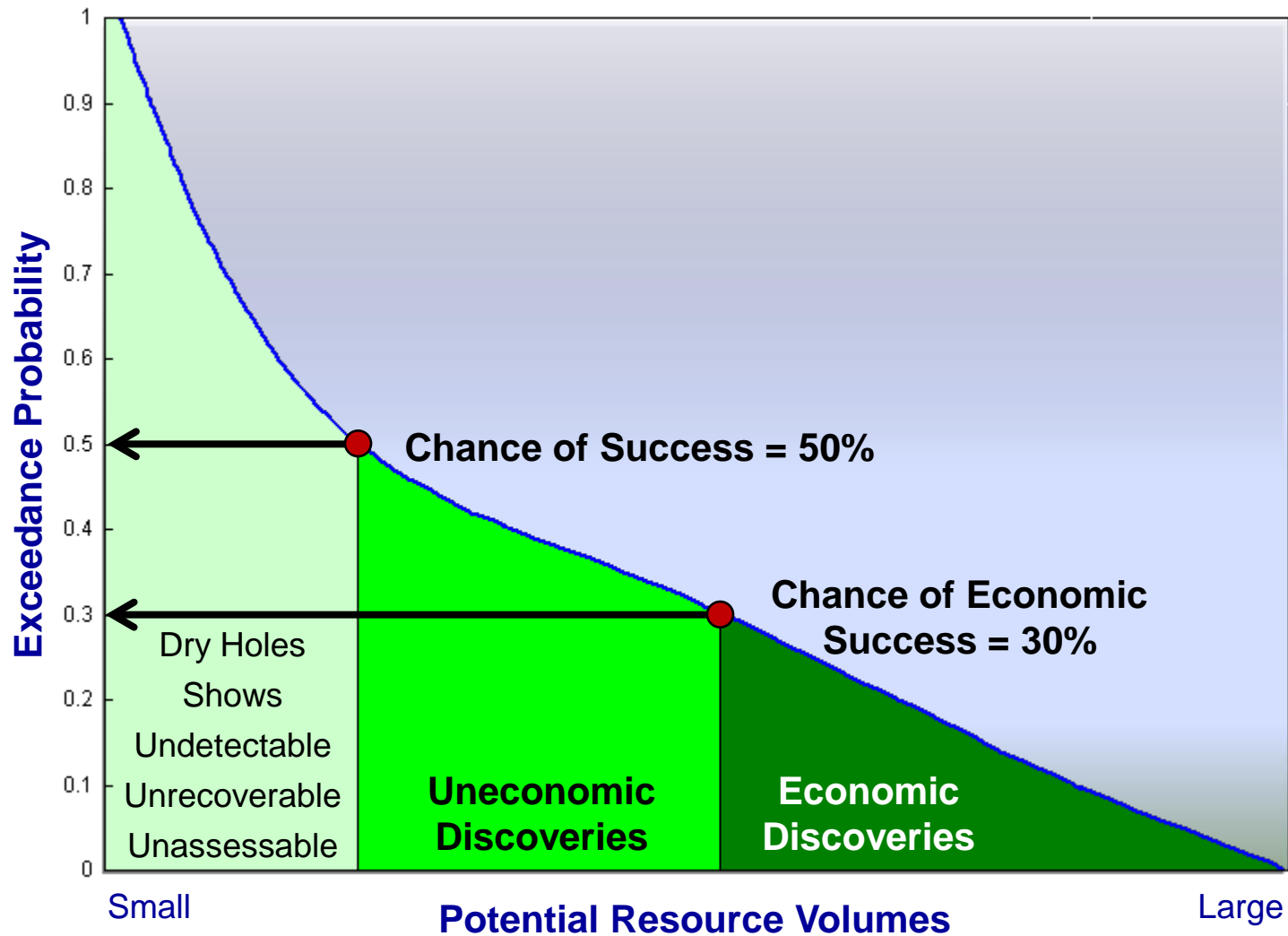
Exceedance probability vs. volume



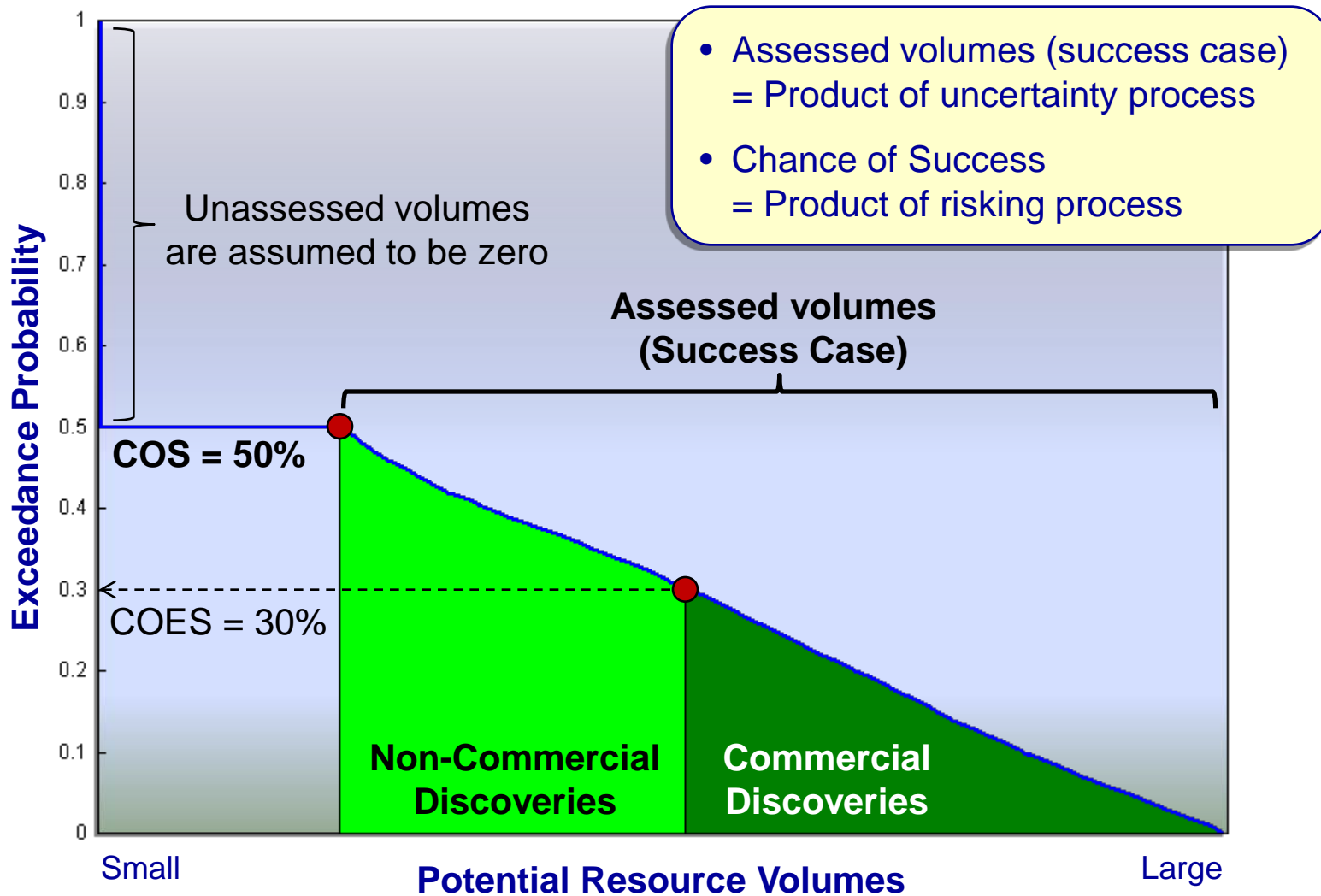
Typical exploration prospect



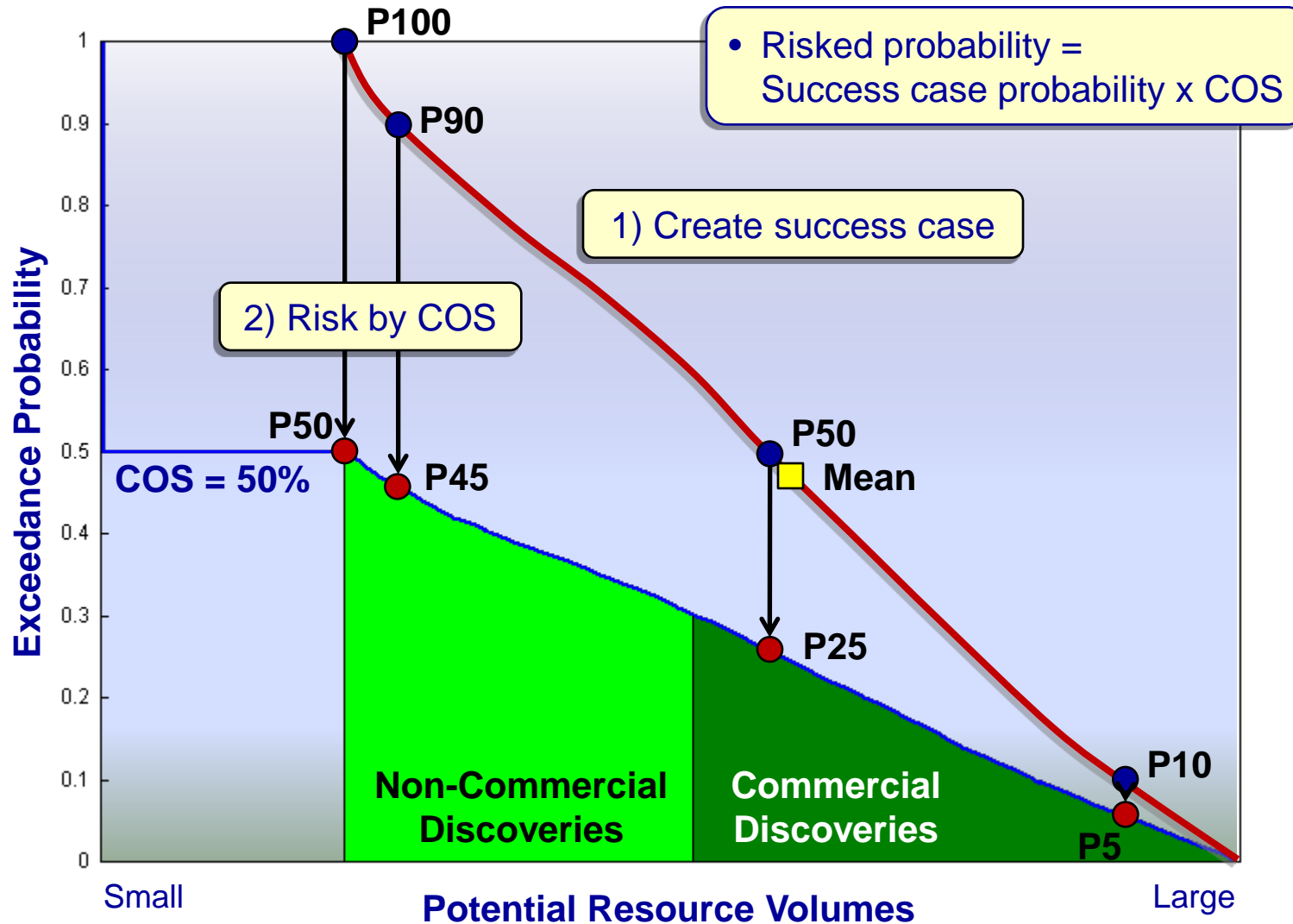
Typical exploration prospect



Risked case



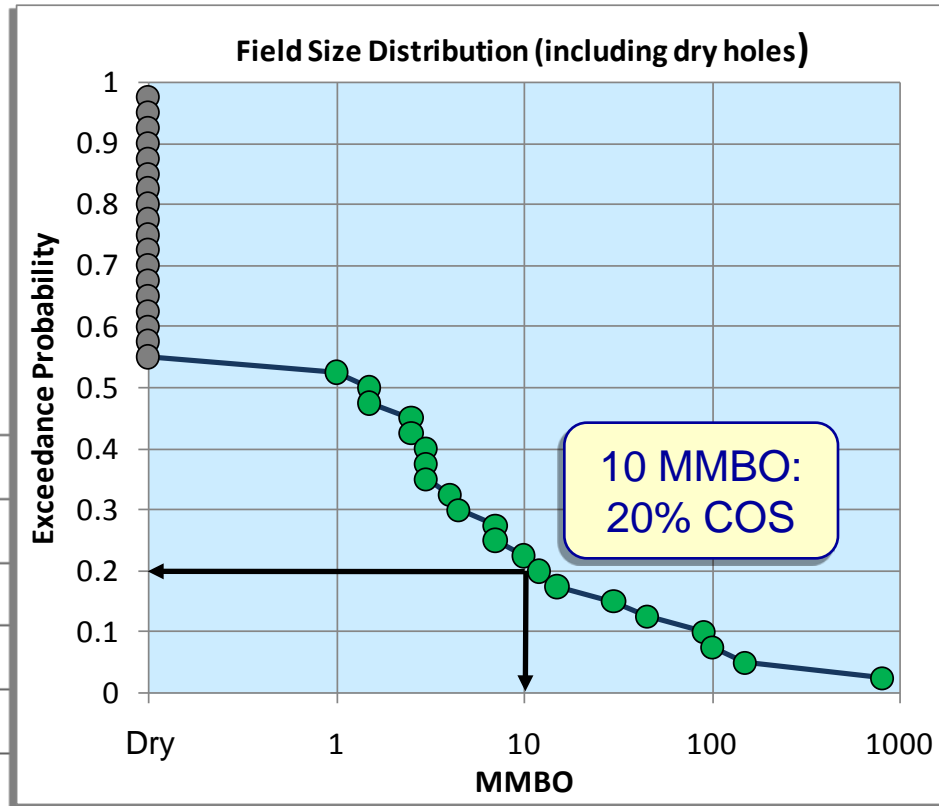
Risked case and success (unrisked) case



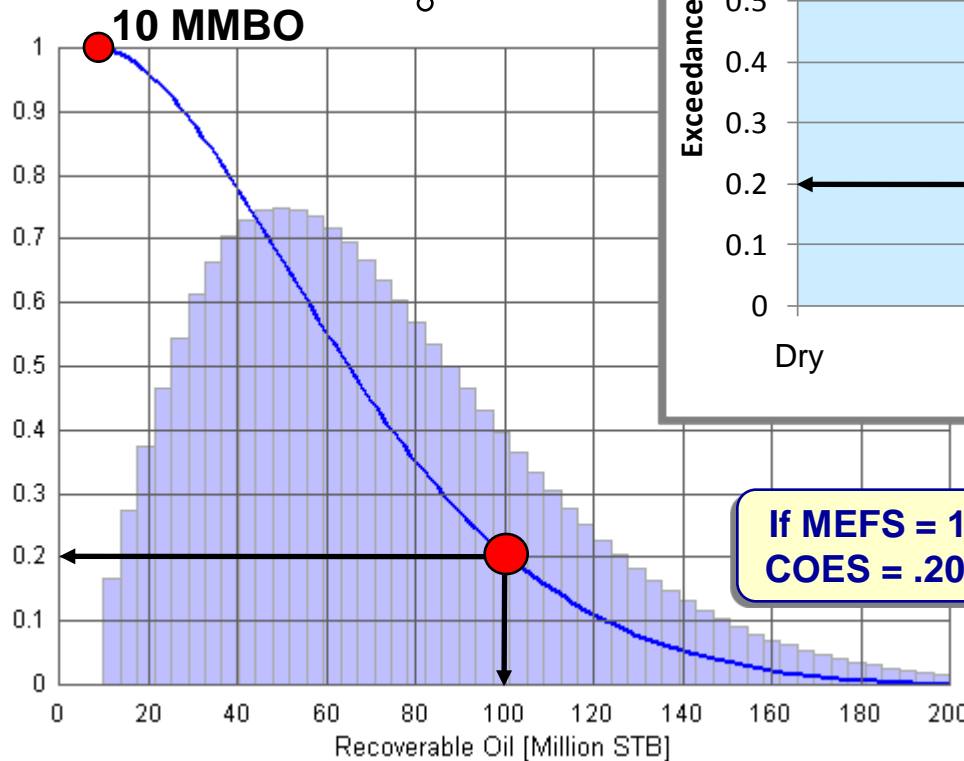
Risking the curve



The chance of exceeding 10 MMBO is 20%.



Tertiary Foredeep Play
Azov-Kuban Basin
USGS 2000

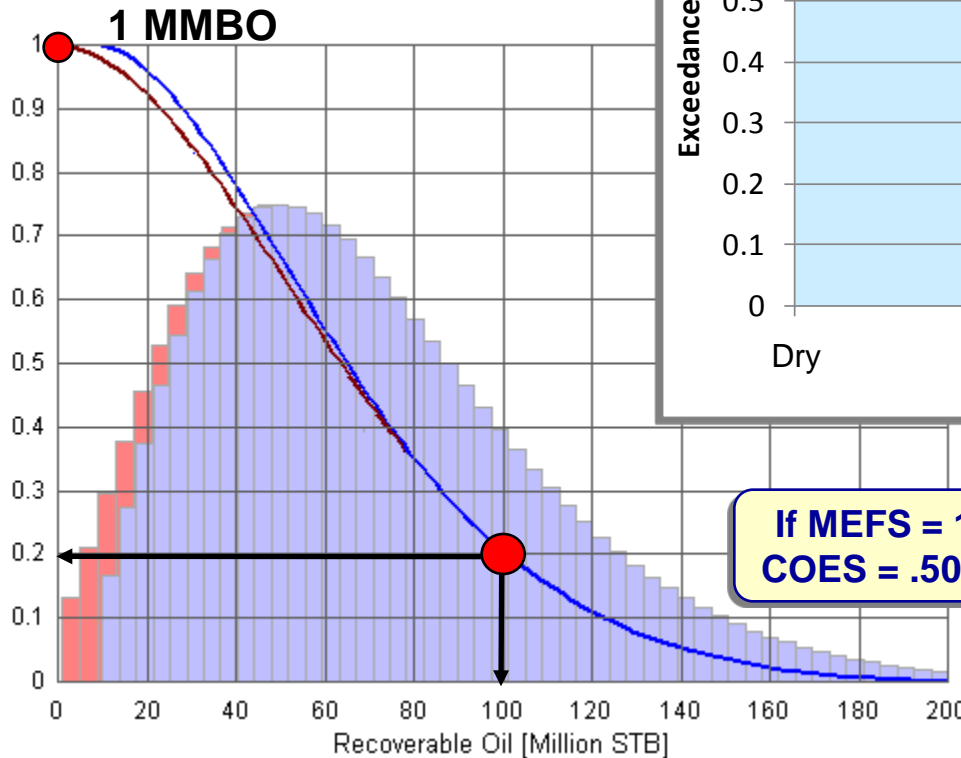
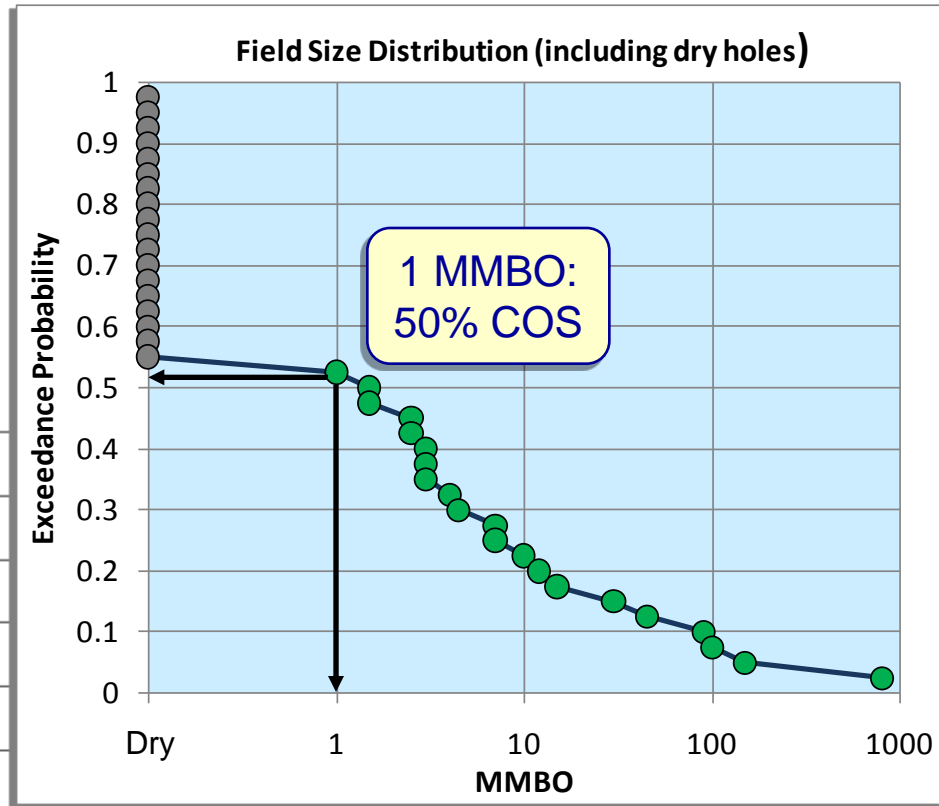


COS risks the entire curve!

Risking the curve



The chance of exceeding 1 MMBO is 50% !



If MEFS = 100 MMBO,
COES = $.50 \times .20 = 10\%$

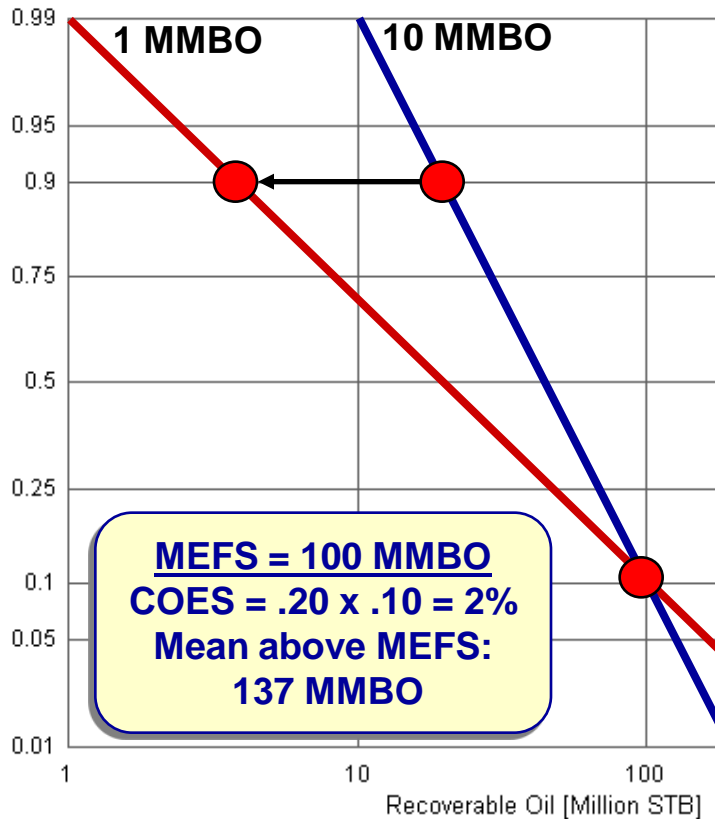
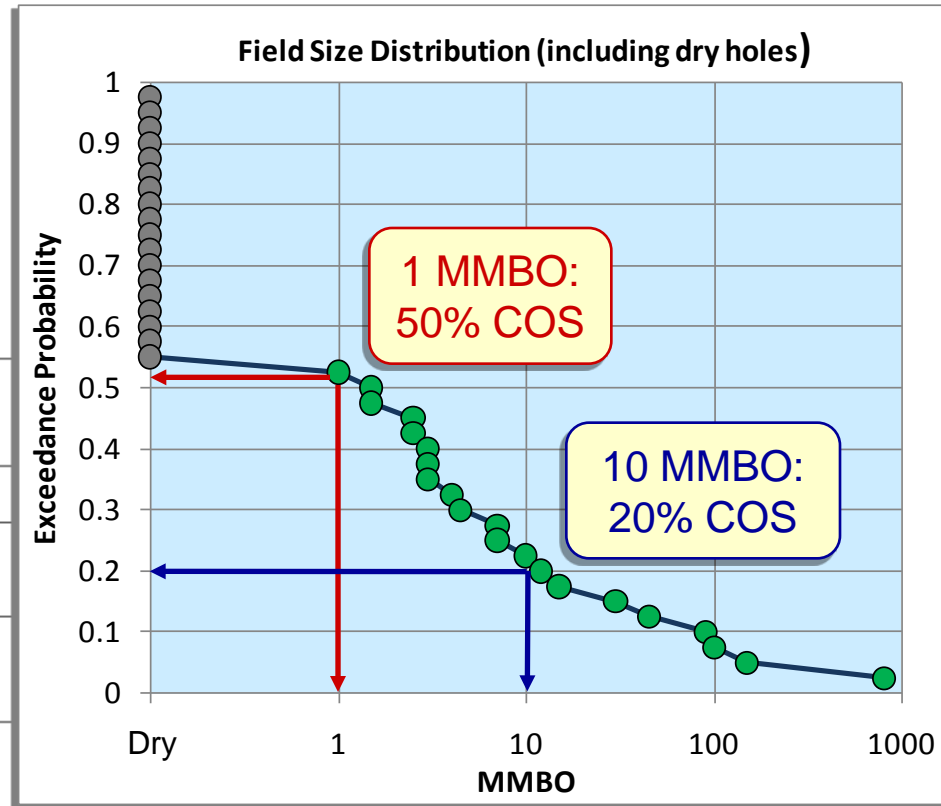
Tertiary Foredeep Play
Azov-Kuban Basin
USGS 2000

COS risks the entire curve!

Strange behavior

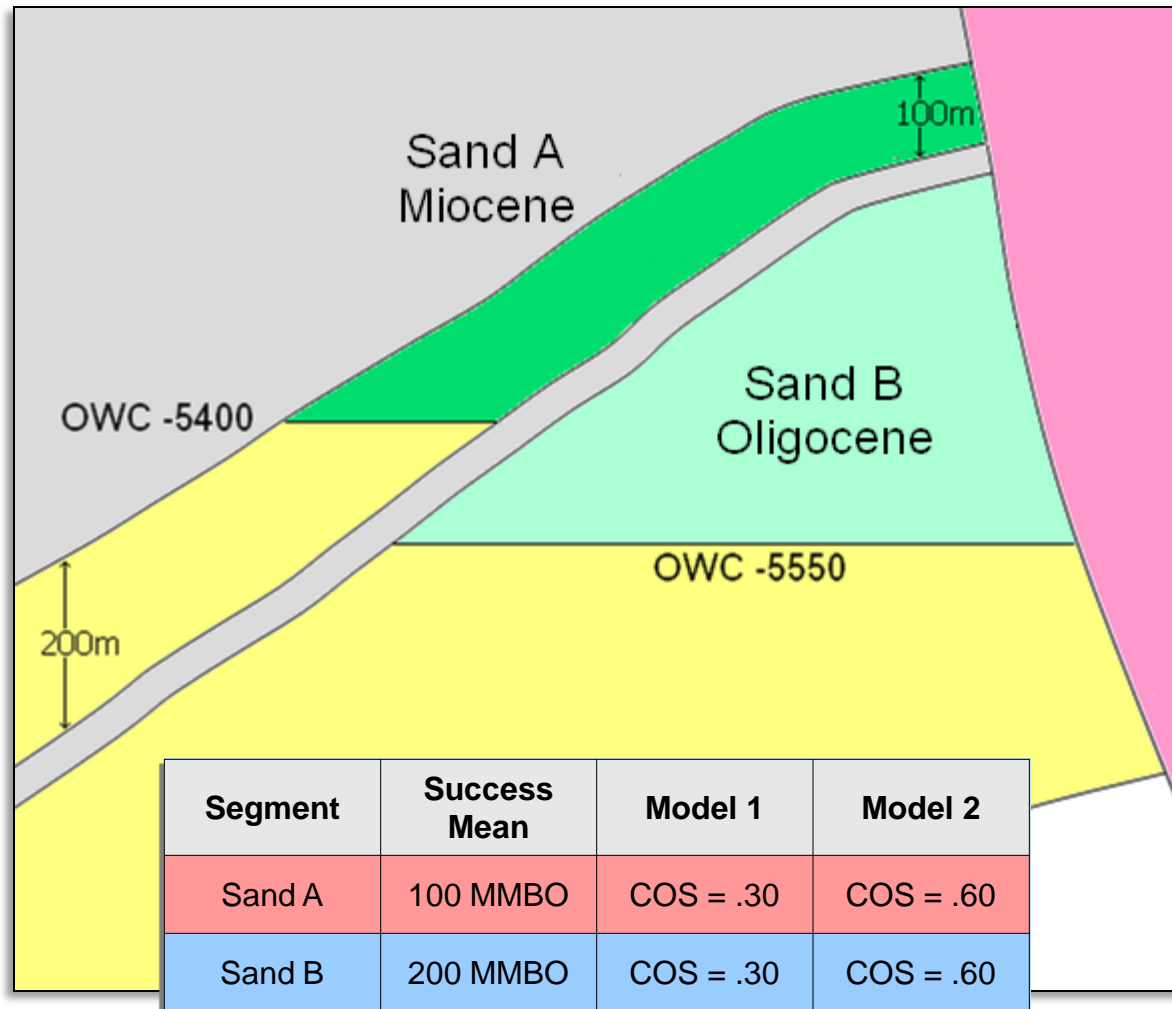


I'll keep the P10 and move the P90!



Tertiary Foredeep Play
Azov-Kuban Basin
USGS 2000

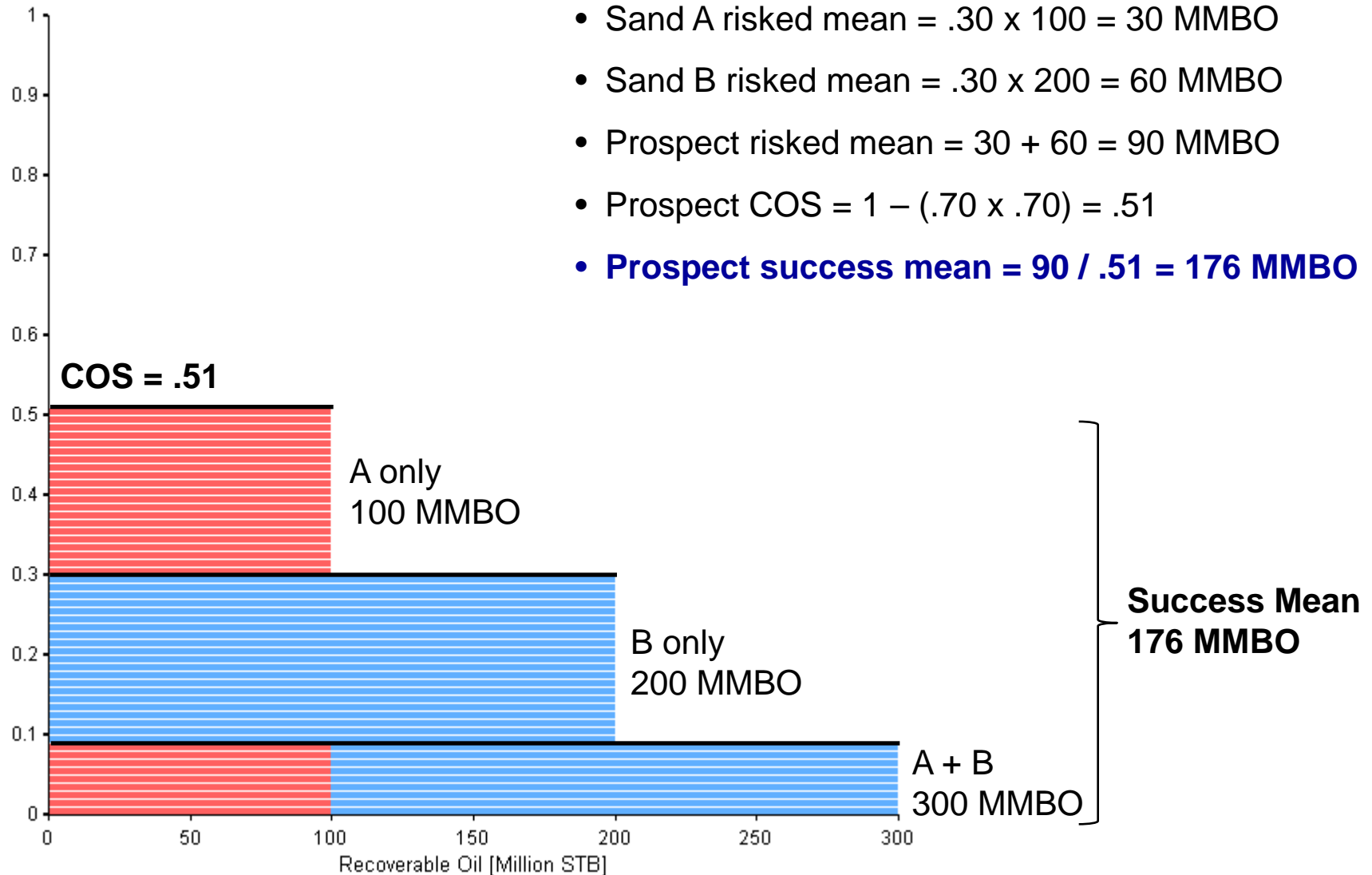
Multiple-zone prospect



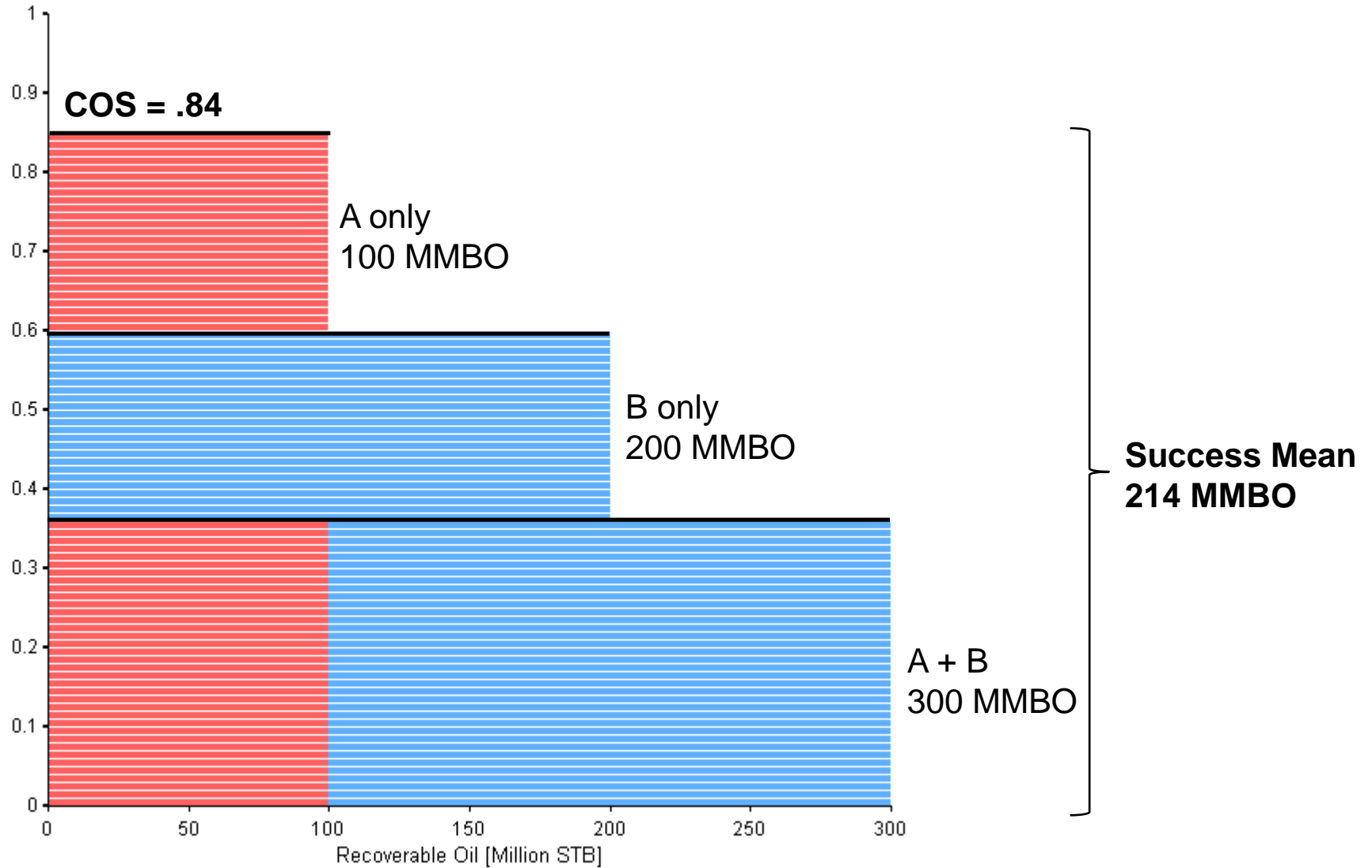
- Assume zones are independent
- Success = at least one zone succeeds

Zone COS = .30

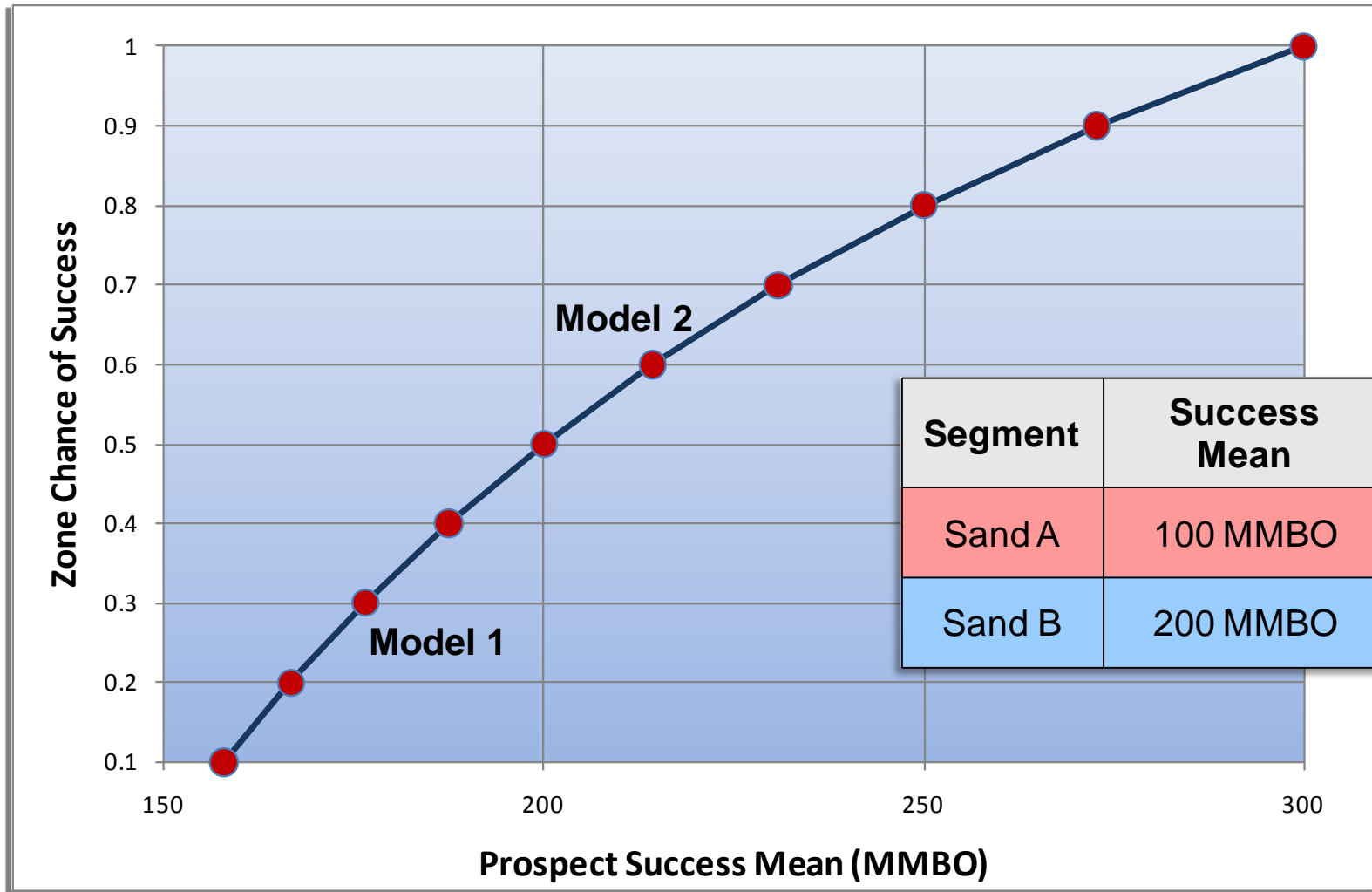
- Sand A risked mean = $.30 \times 100 = 30$ MMBO
- Sand B risked mean = $.30 \times 200 = 60$ MMBO
- Prospect risked mean = $30 + 60 = 90$ MMBO
- Prospect COS = $1 - (.70 \times .70) = .51$
- **Prospect success mean = $90 / .51 = 176$ MMBO**



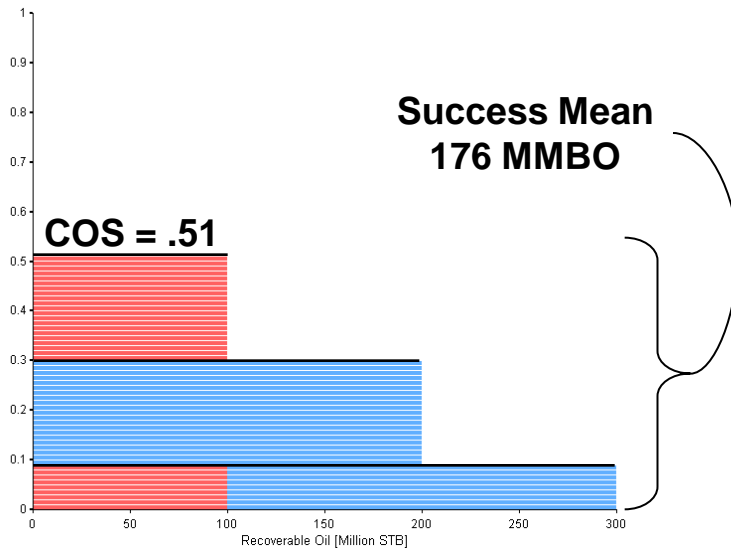
Zone COS = .60



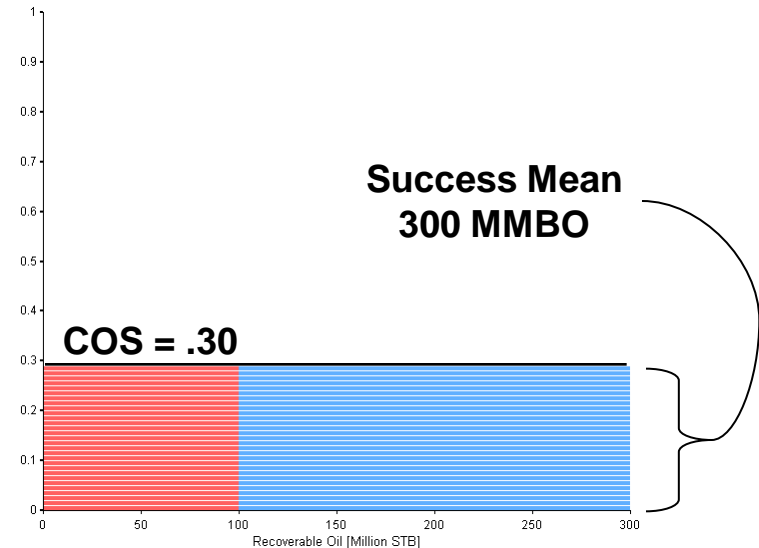
Zone COS vs. prospect success mean



Impact of risk dependency



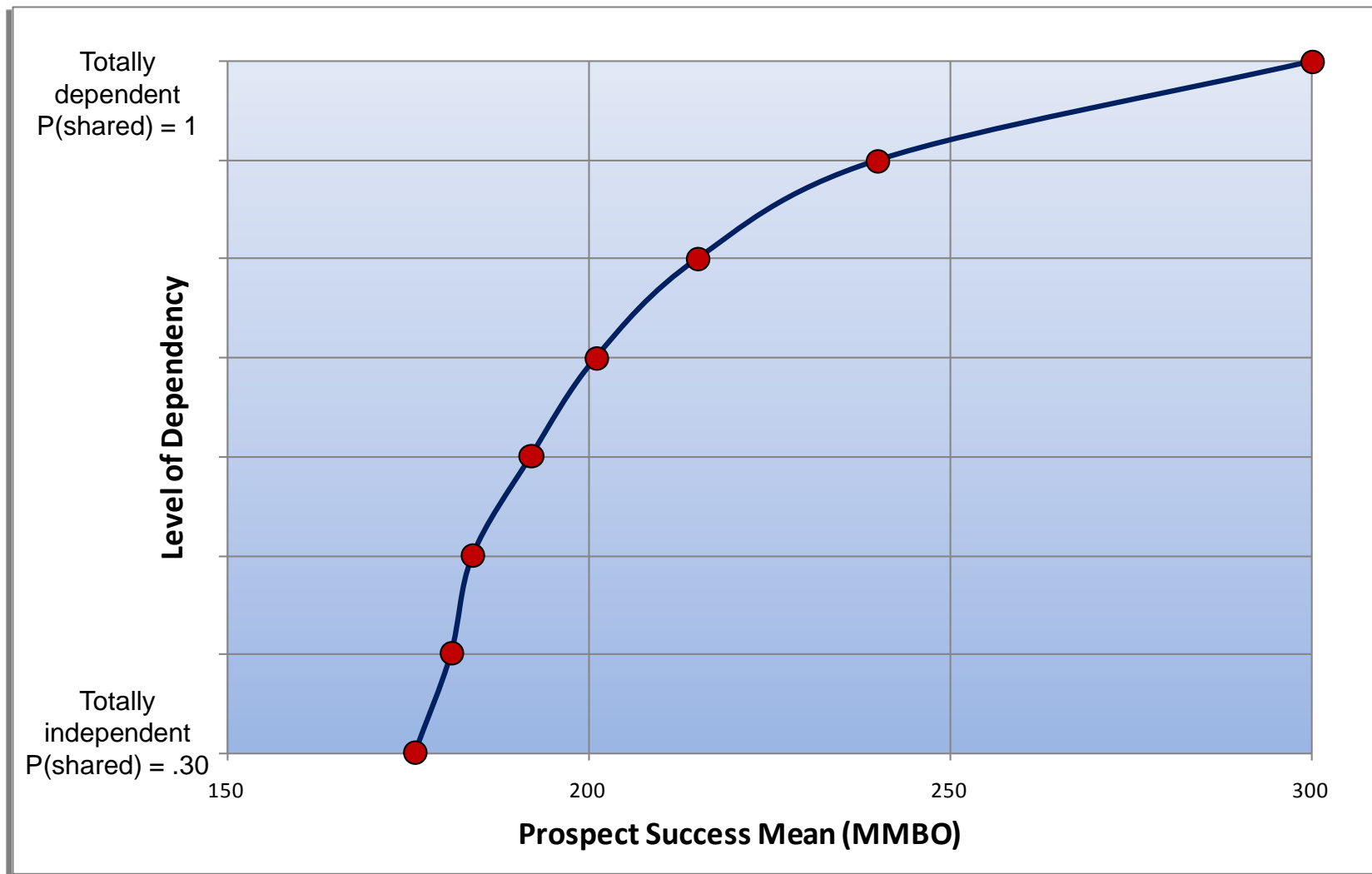
Totally independent
Prospect COS = .51
Success Mean = 176 MMBO



Totally dependent
Prospect COS = .30
Success Mean = 300 MMBO

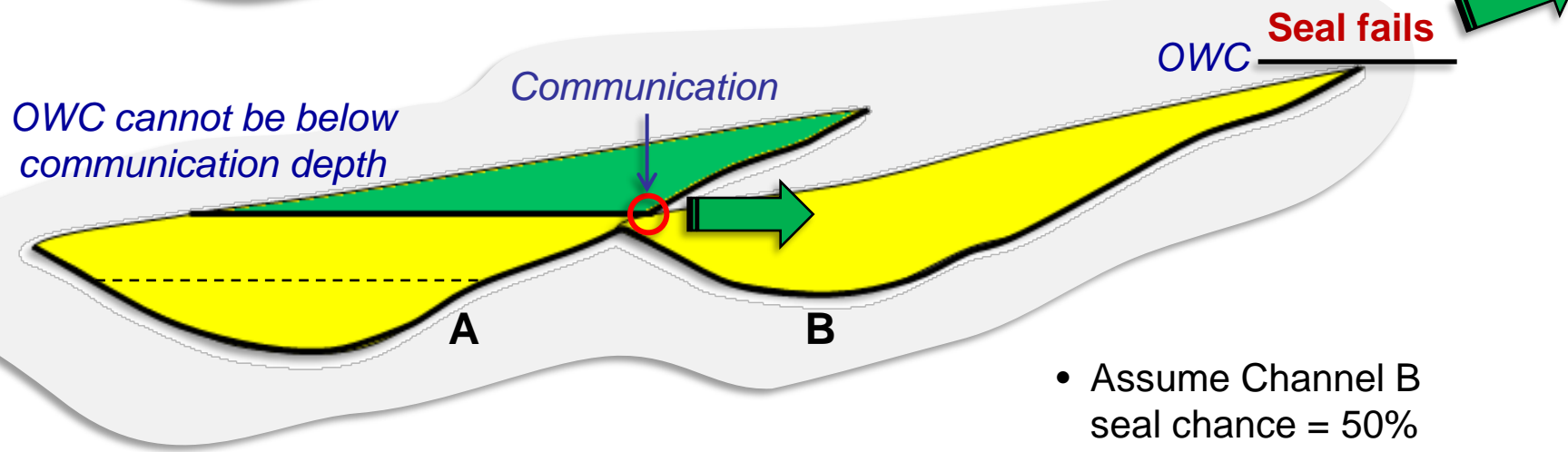
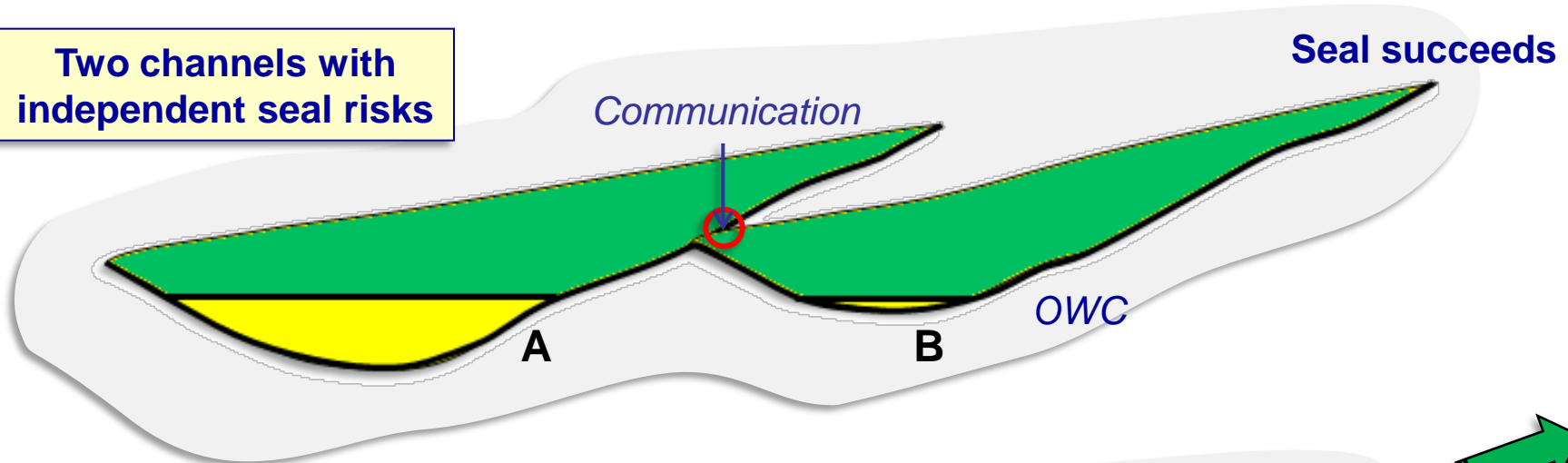
- Risk dependency decreases COS and increases success case mean

Impact of risk dependency



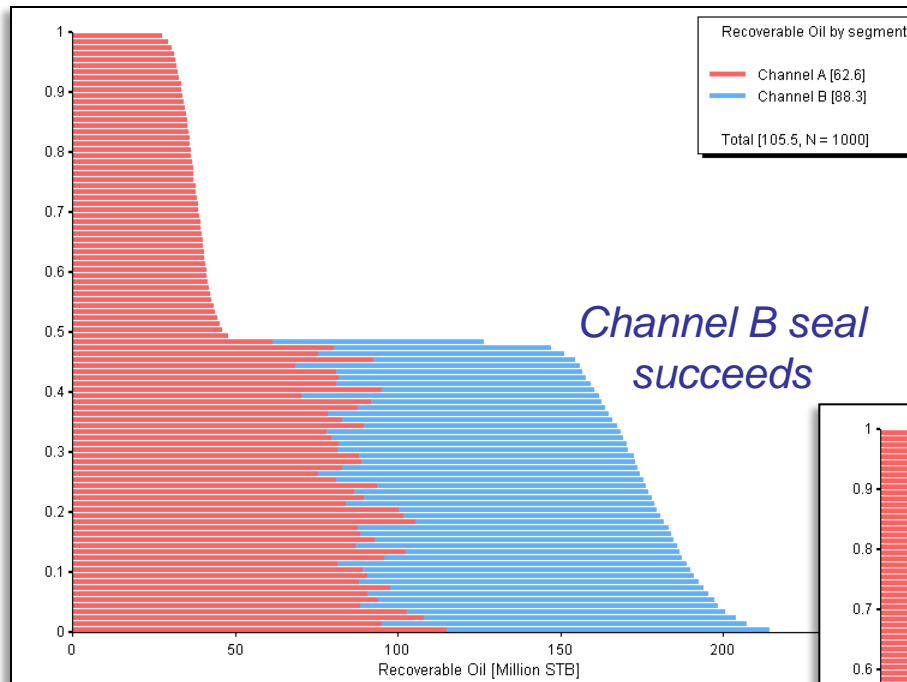
Impact of communication

Two channels with independent seal risks

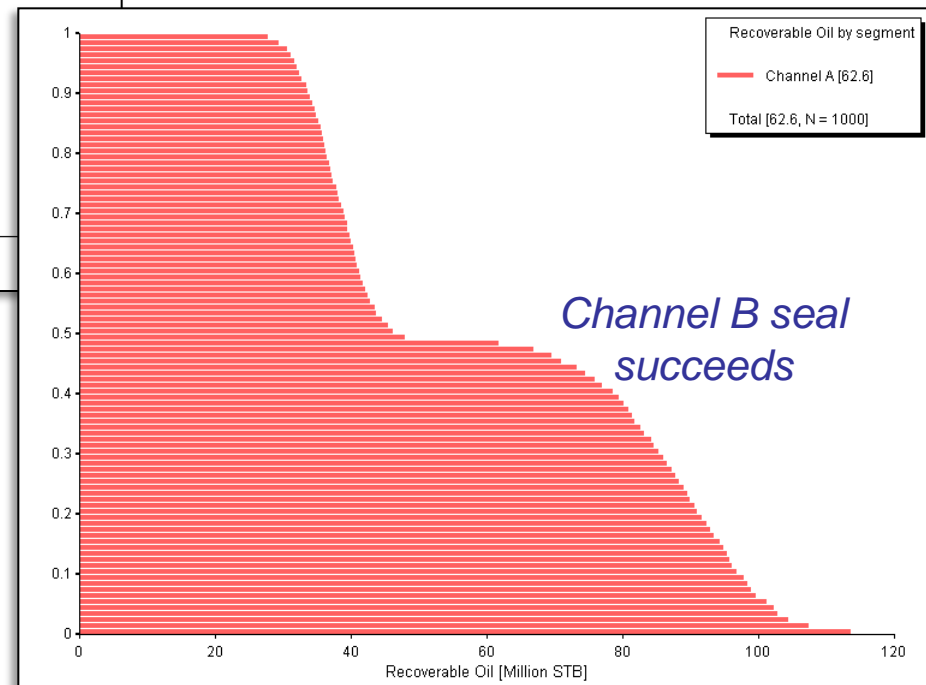


- Assume Channel B seal chance = 50%

Impact of communication



- Assume Channel B seal chance = 50%



- Size of Channel A is controlled by risk on Channel B

Summary

- Single zones
 - The chance of success is the exceedance probability associated with the smallest volume in the success case
 - When we risk the minimum volume, we risk the entire success case
- Multiple zones
 - Traditional views of risk vs uncertainty may not be applicable
 - Prospect risk and uncertainty are impacted by zone COS, and relationships between zones