

IADC/SPE 87176

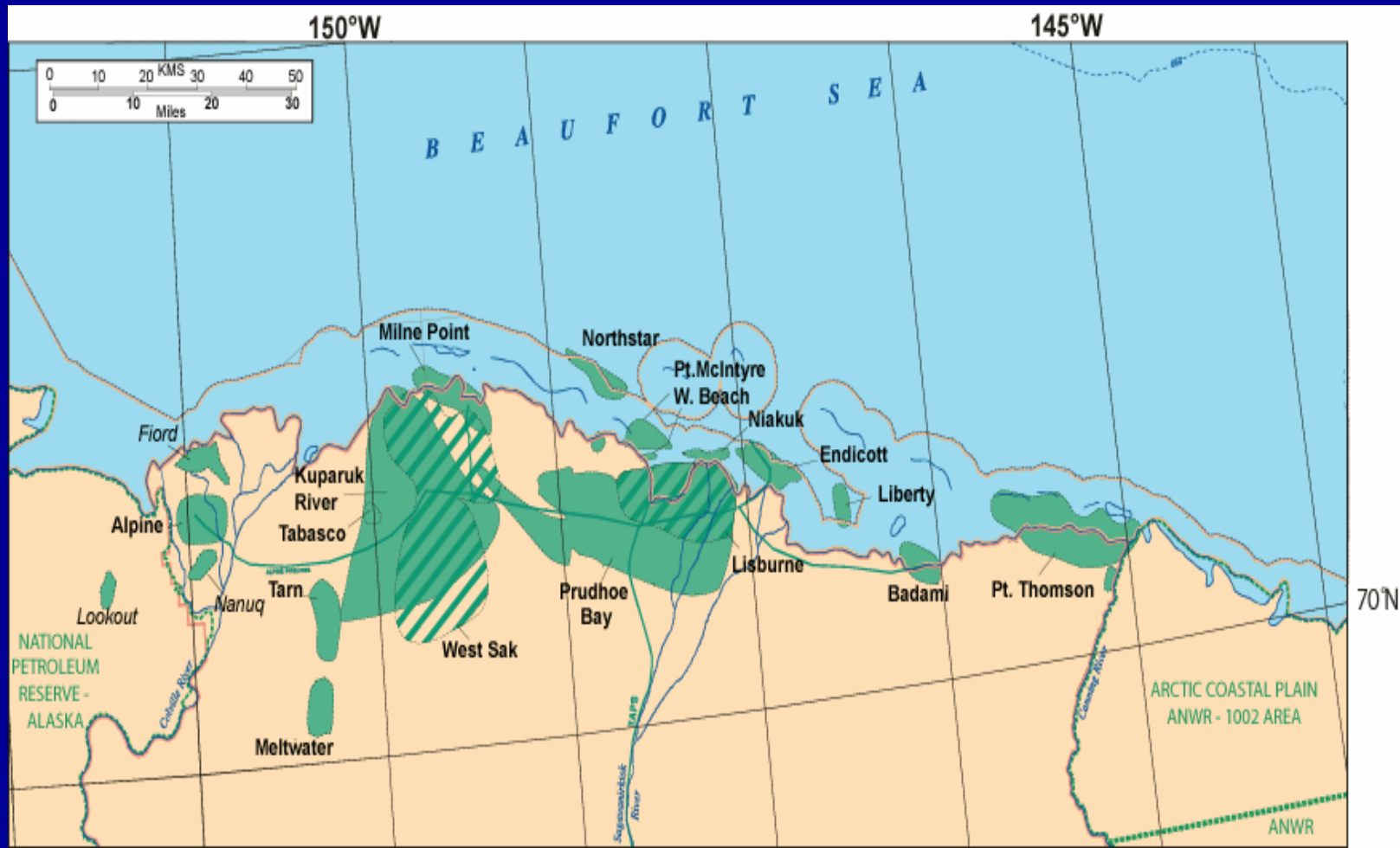
A Step Change in Drilling Efficiency:
Application of New Technology in
the Alpine Development Field

- List co-authors & partners include Anadarko
- Acknowledge ConocoPhillips –others for publishing the paper etc

Overview

- 1 million+ feet of hole drilled (1999-2003)
- More than 70 wells
- Average length increase 14%
- Average efficiency increase 17%
- Estimated \$4 MM savings over next 20 wells

Alpine Location



Formation Description

- Soft tophole section of clays
- Intermediate section of shales
- Production section of Alpine sands

Location Factors

- Remote North Slope location
- Small footprint $> 0.2\%$ of field area
- Zero-discharge facility
- No permanent roads
- Limited access and storage

Drilling Rig Considerations

- Mobile, lightweight
- Highline power
- Unique rig floor transport
- ‘Mobile’ BOP
- On-site fluid disposal



Fluid System Considerations

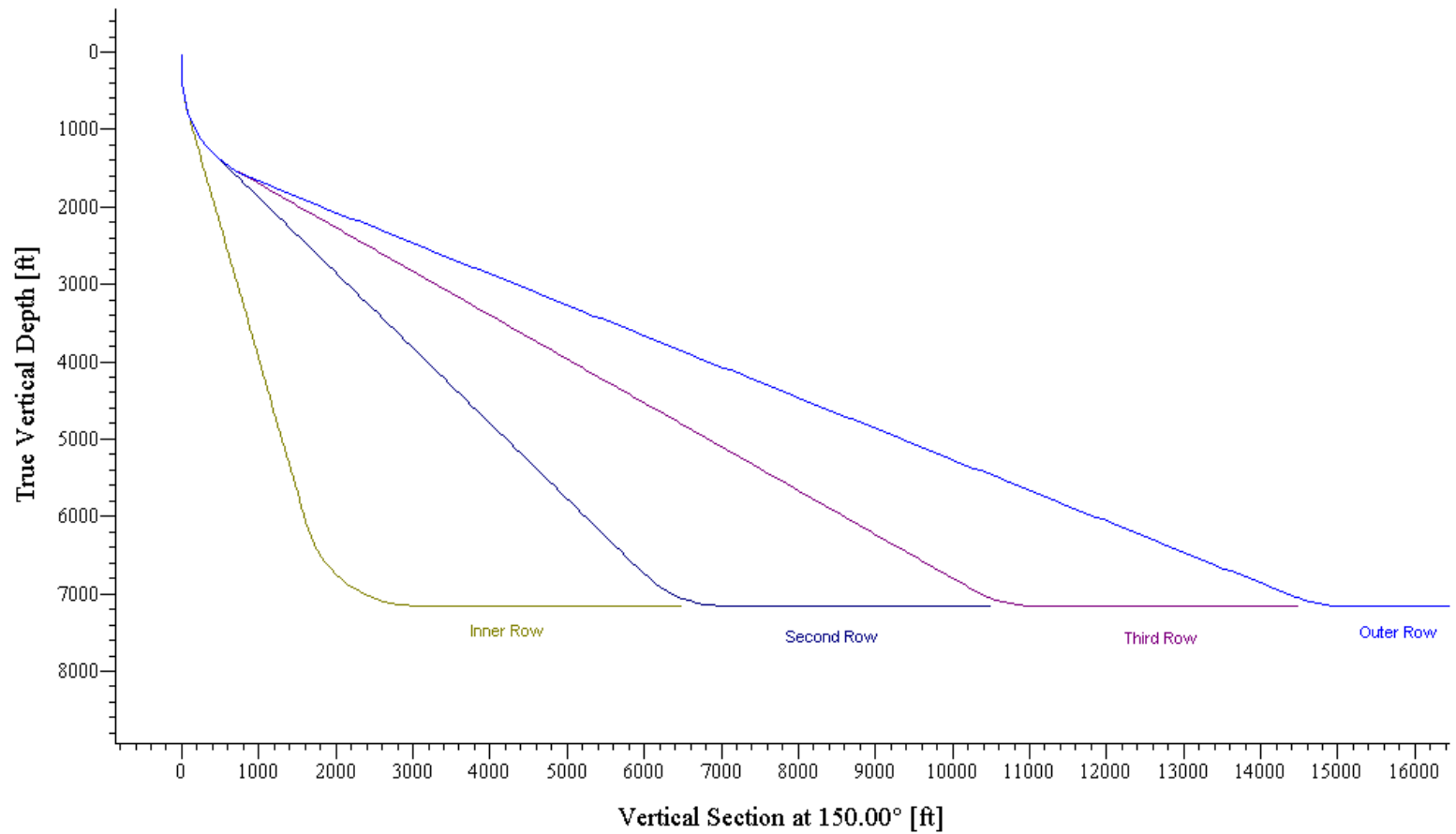
- OBM could not be used
- Low Solids Non-Dispersed (LSND) fresh water fluid
- Glycol additive for shale control
- Optimized rheological properties
 - Mitigate balling, poor hole cleaning
 - Maintain critical ECD control

Well Construction

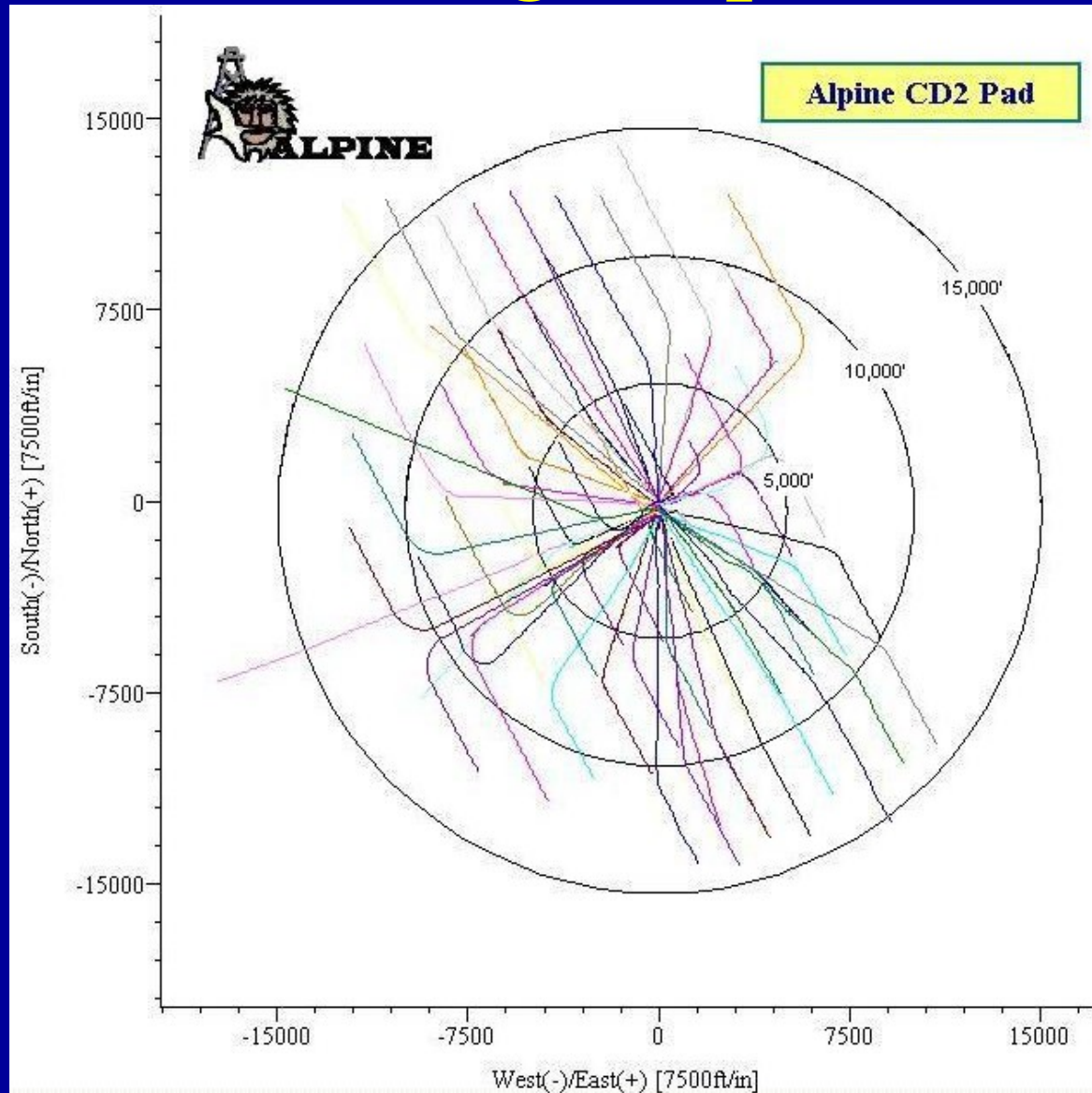
- Tophole section to 0000 ft
- Intermediate section > 10,000 ft
- Total departures > 0000 ft
- Use of 4" drillpipe in 8-1/2" and 6-1/8" sections

Well Profiles

Alpine Profiles/Well Profiles



Increasing Step-Outs

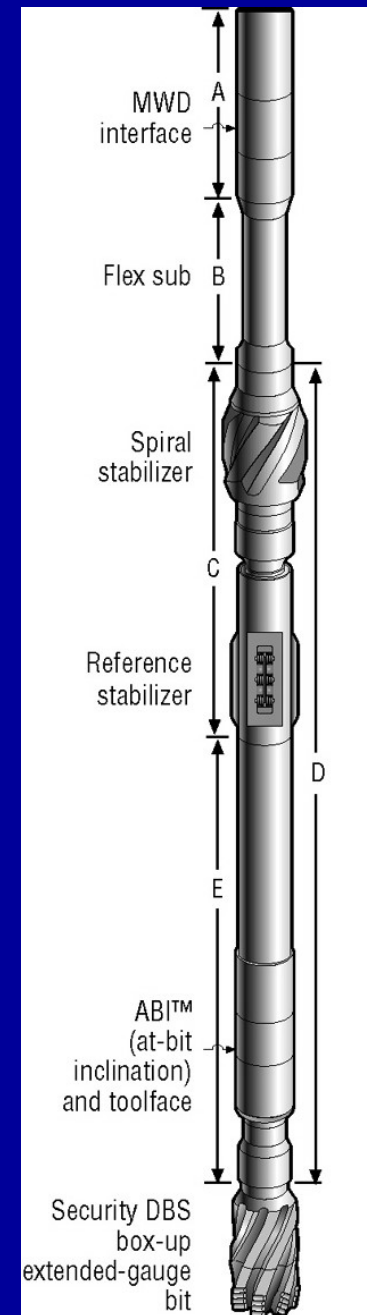


Drilling Practices

- 2 Steerable BHAs with PDC, rock bit
- 1 Steerable BHA with PDC only
- 1 Steerable 'Point-the-Bit' BHA with matched PDC bit

'Point-the-Bit' RSS

- Bit tilt vs. side-cutting
- Continuously variable steering
- Steered by toolface and effective bend angle

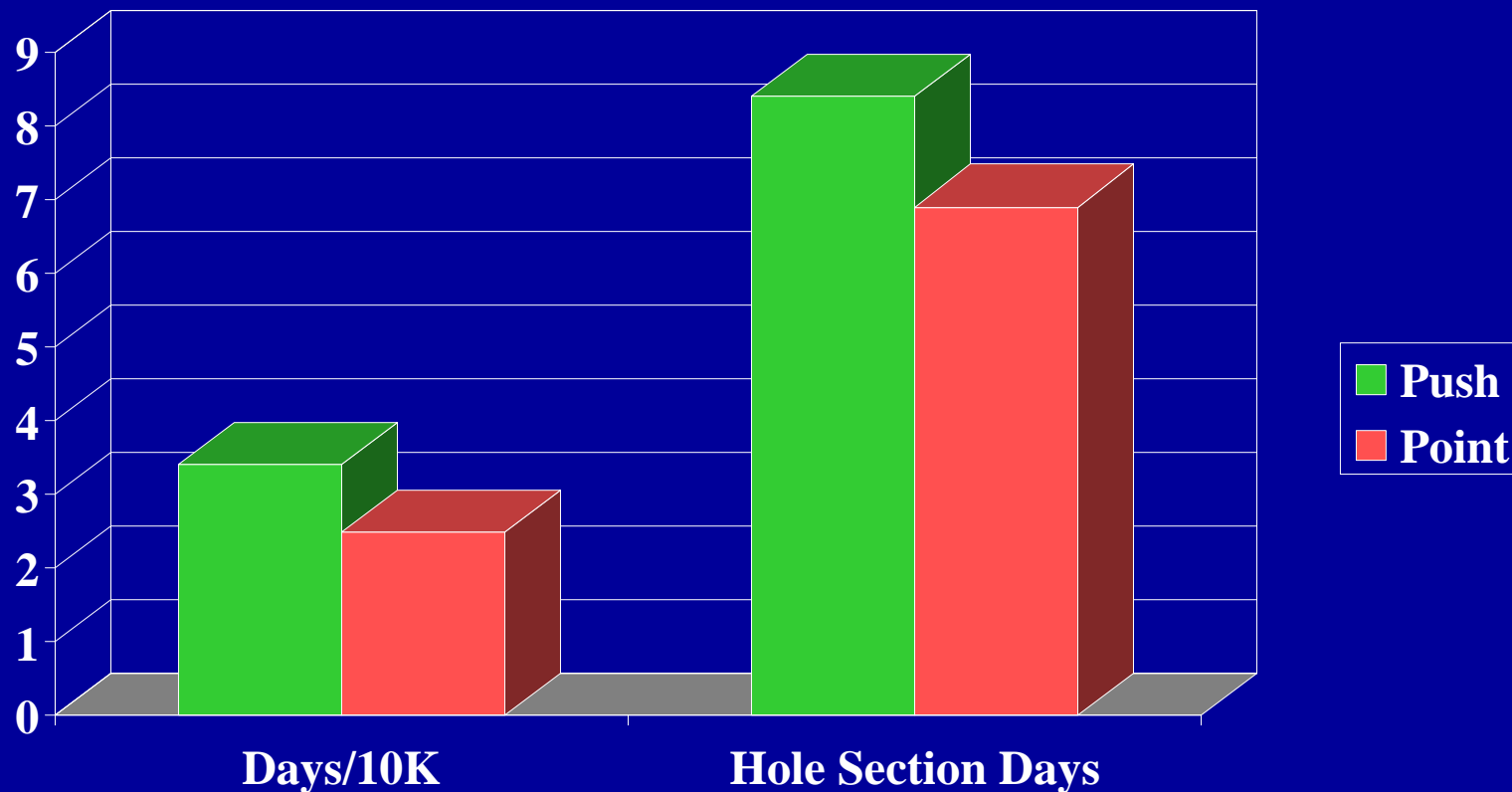


Extended Gauge Bit

- Length = 1.5 x Diameter
- Densely packed, small cutters
- High back rake



BHA Changes: Push vs Point

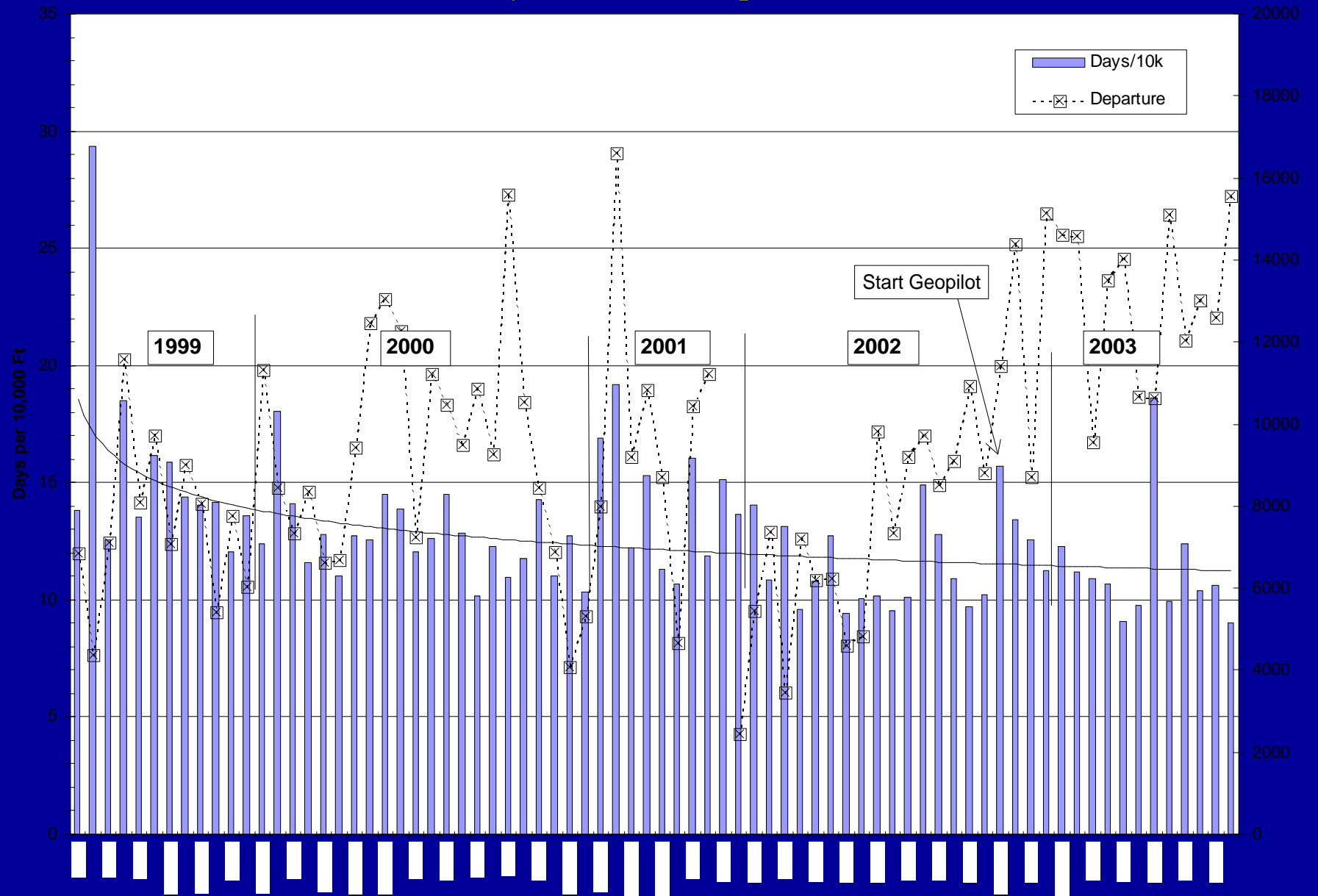


8-1/2” PDC Bit Design Evolution

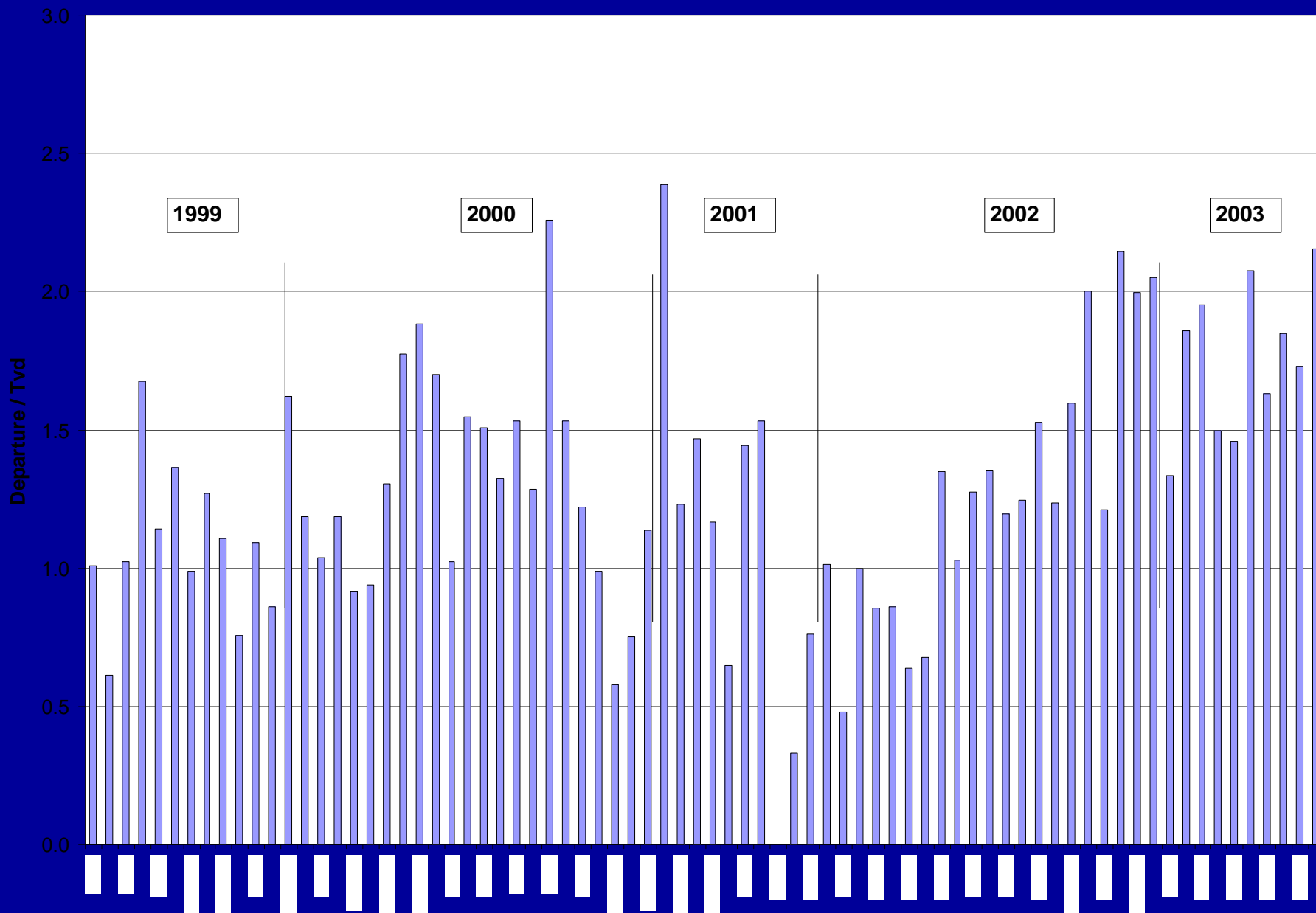
- 5 Bladed, steel body, 3/4” cutters, standard nozzle configuration
- Reduced backrake to increase aggressiveness
- Reduced blade count to 4 to increase aggressiveness
- Opened nozzles to reduce HSI

Alpine CD1&2 Pads

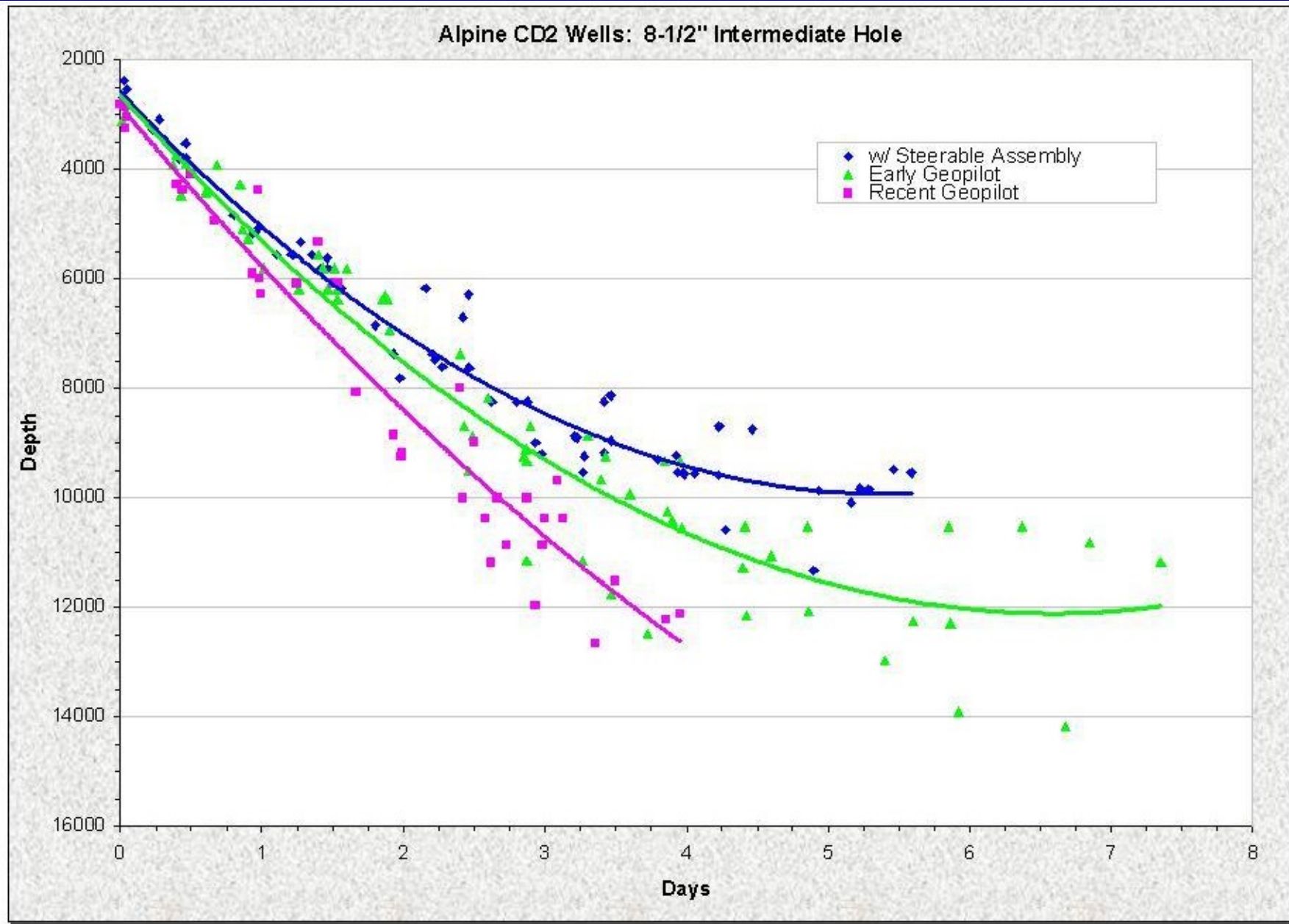
Days / 10K and Departure



Departure / TVD

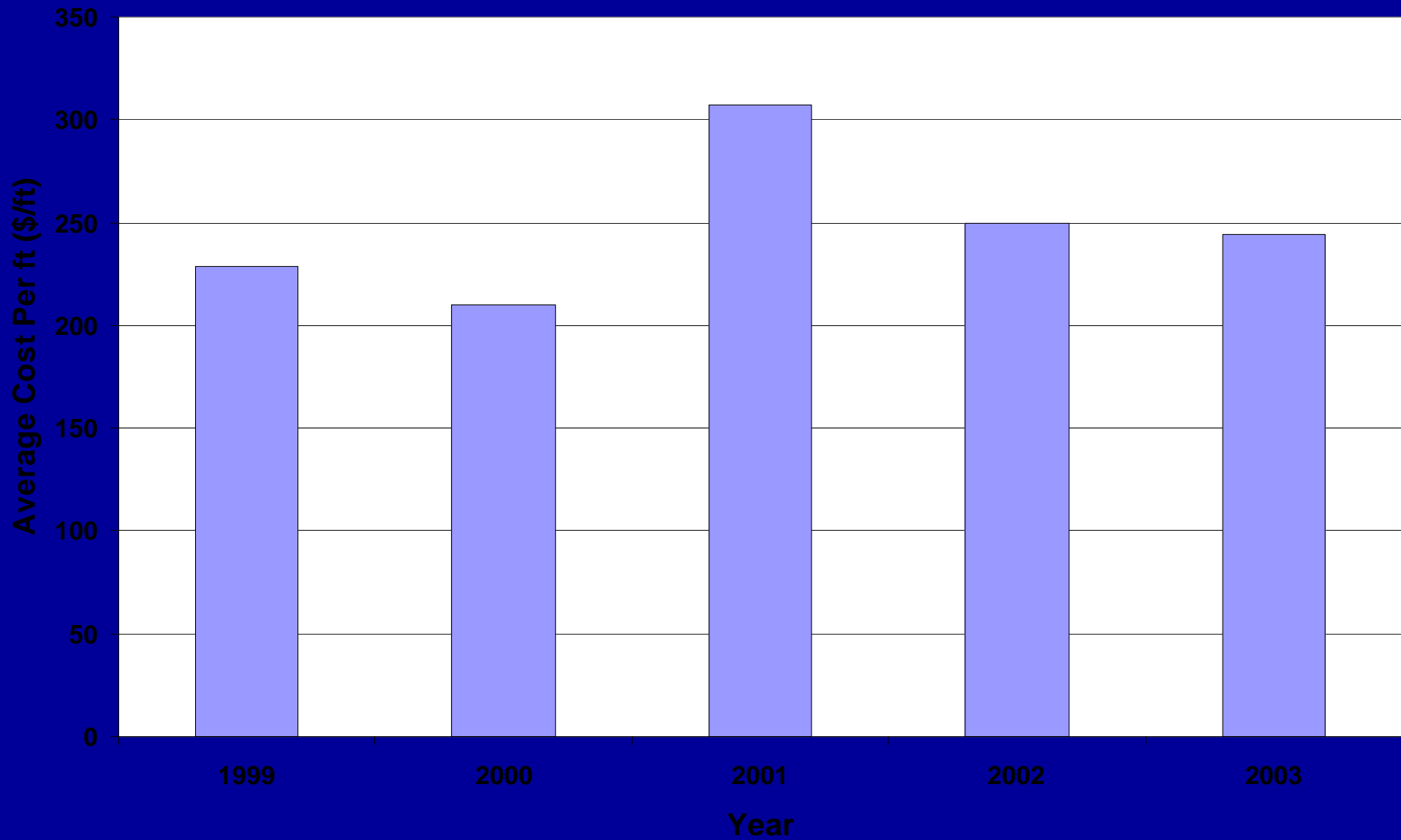


RSS Performance Comparison

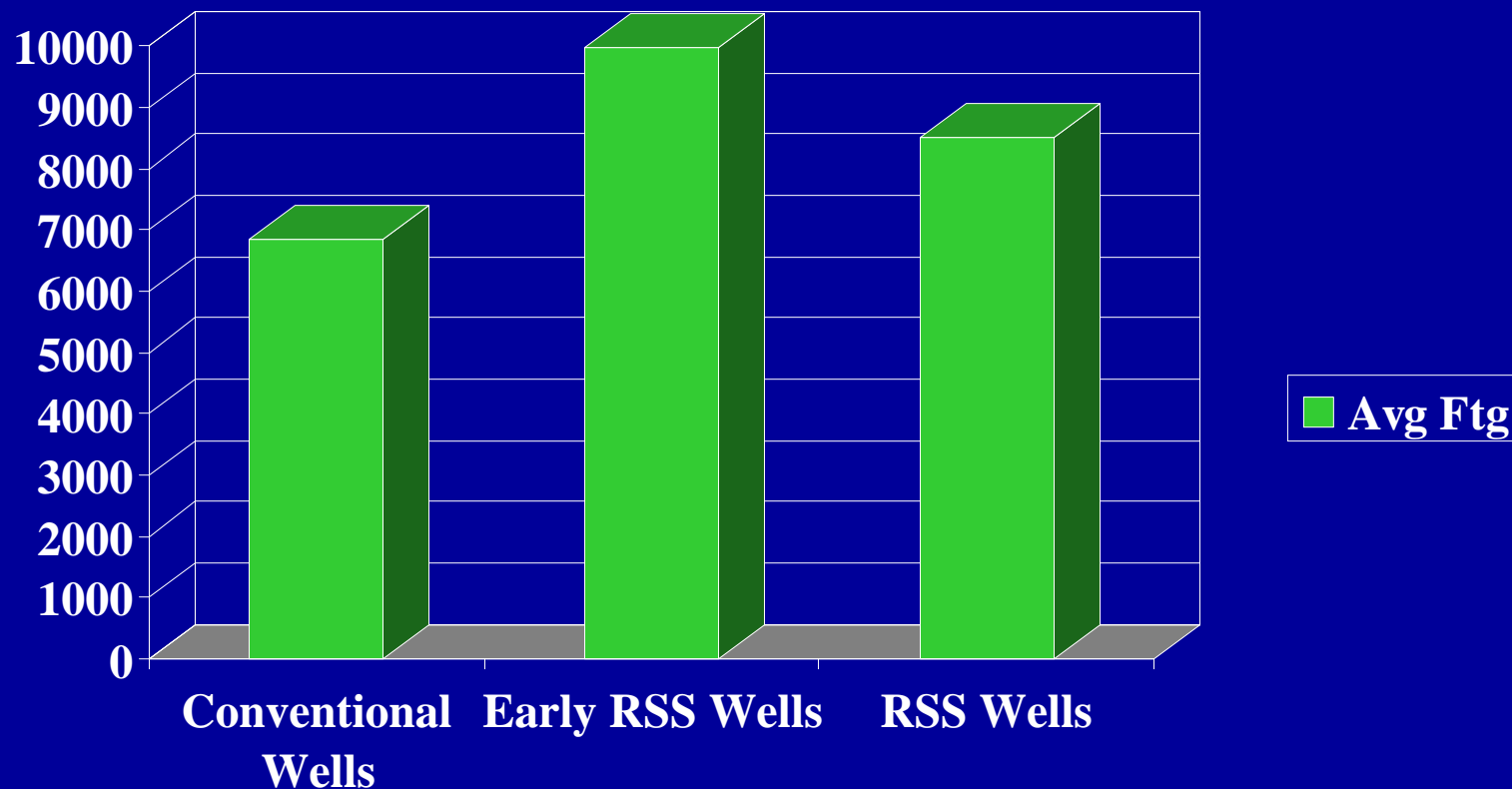


Average Cost / Foot

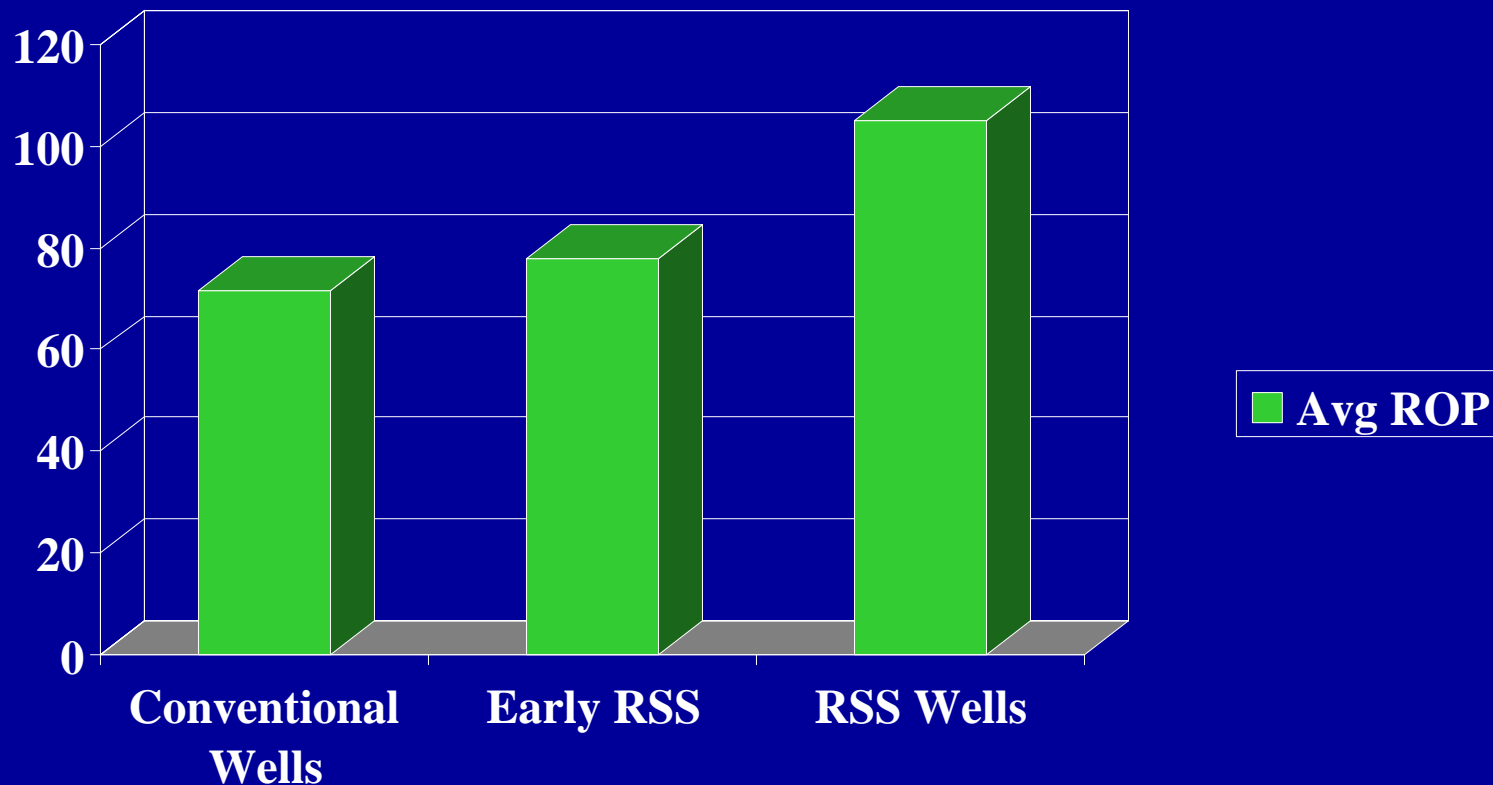
Average Cost Per Foot



Intermediate Ftg. Comparison



Intermediate ROP Comparison



Steerable System Advantages

- Reduced pipe handling
- Elimination of short trips
- Better control of ECDs
- Reduced torque & drag

Conclusions

- All factors optimized: rig, mud, BHA
- RSS provides advantages
- Point-the-bit RSS provides advantages
- Advantages result in increased efficiency
- Efficiency results in savings