

# CO<sub>2</sub> Application Guide and Market Analysis for the Permian Basin GFE Project

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# Agenda

Personal Introduction

Project Introduction

Application Guide

- CO<sub>2</sub> Challenges
- Three Tiered Approach – Material Selection; Product; and Real-Time
- Midland Result

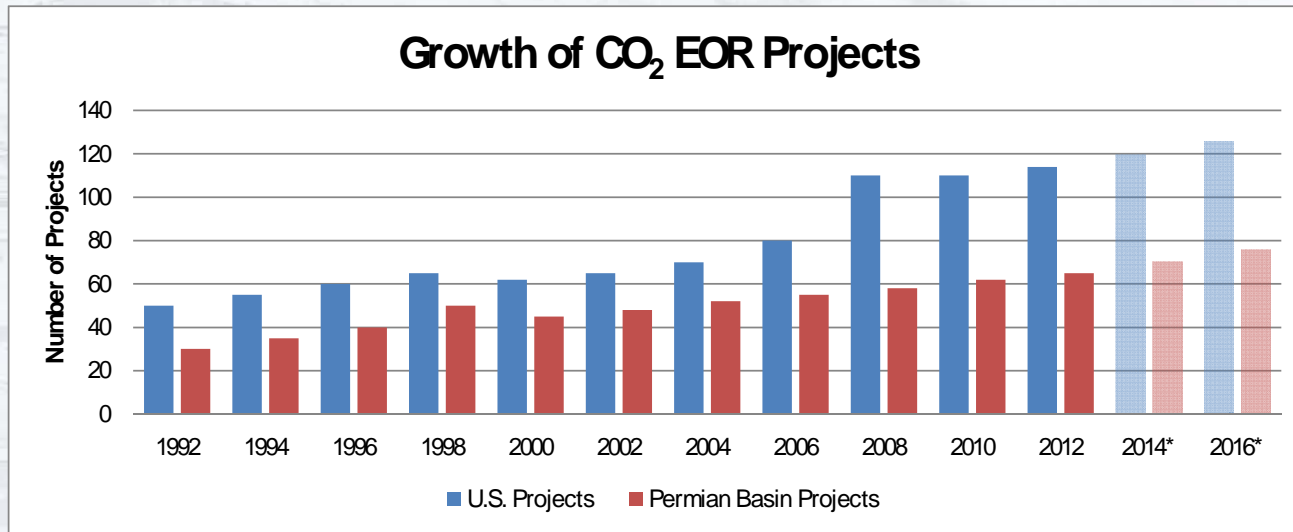
Benefits: Customer and Schlumberger

Way Forward

# Project Introduction

## Why CO<sub>2</sub> as a method of enhanced oil recovery (EOR)?

- What is CO<sub>2</sub> injection?
- Drivers for CO<sub>2</sub> floods vs other EOR methods
- CO<sub>2</sub> ESP market in the Permian = \$53MM Annually



# Application Guideline

## CO<sub>2</sub> Challenges

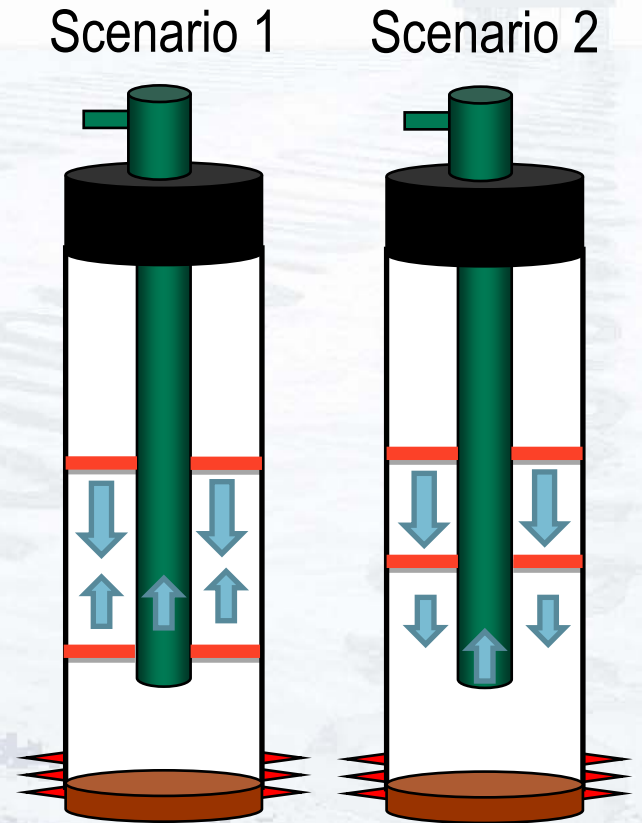
### Reservoir Characteristics

- Low temperature < 130F
- Carbonate or sandstone geology

Corrosion, scale, asphaltene and paraffins

### Operating philosophy

- Scenario 1 – Minimize intake pressure
- Scenario 2 – Maintain intake pressure
- WAG – Water alternating gas



# Application Guideline

## Three Tiered Approach – Material Selection

Applies to all ESP components

Metallurgy - CO<sub>2</sub> vs H<sub>2</sub>S

Carbon steel

Monel trim

Redalloy h

HSN elastomer

| Component | Standard Material | Upgraded Material | Cost Difference (+) |
|-----------|-------------------|-------------------|---------------------|
| Pump      | Carbon Steel      | Redalloy          | 59%                 |
| Protector | Carbon Steel      | Redalloy          | 23%                 |
| Motor     | Carbon Steel      | Redalloy          | 11%                 |
| Cable     | Galvanized        | Monel             | 169%                |

# Application Guideline

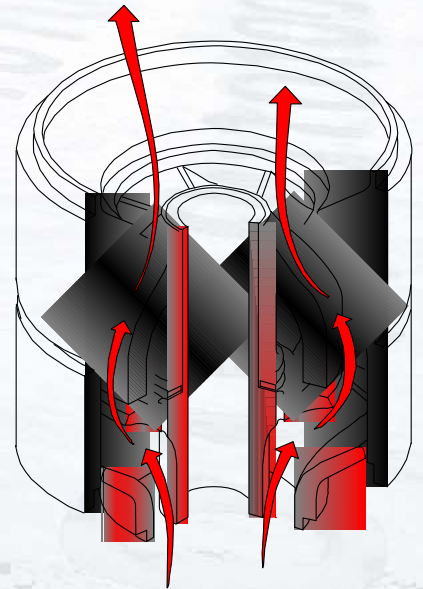
## Three Tiered Approach – Product

### Pump selection

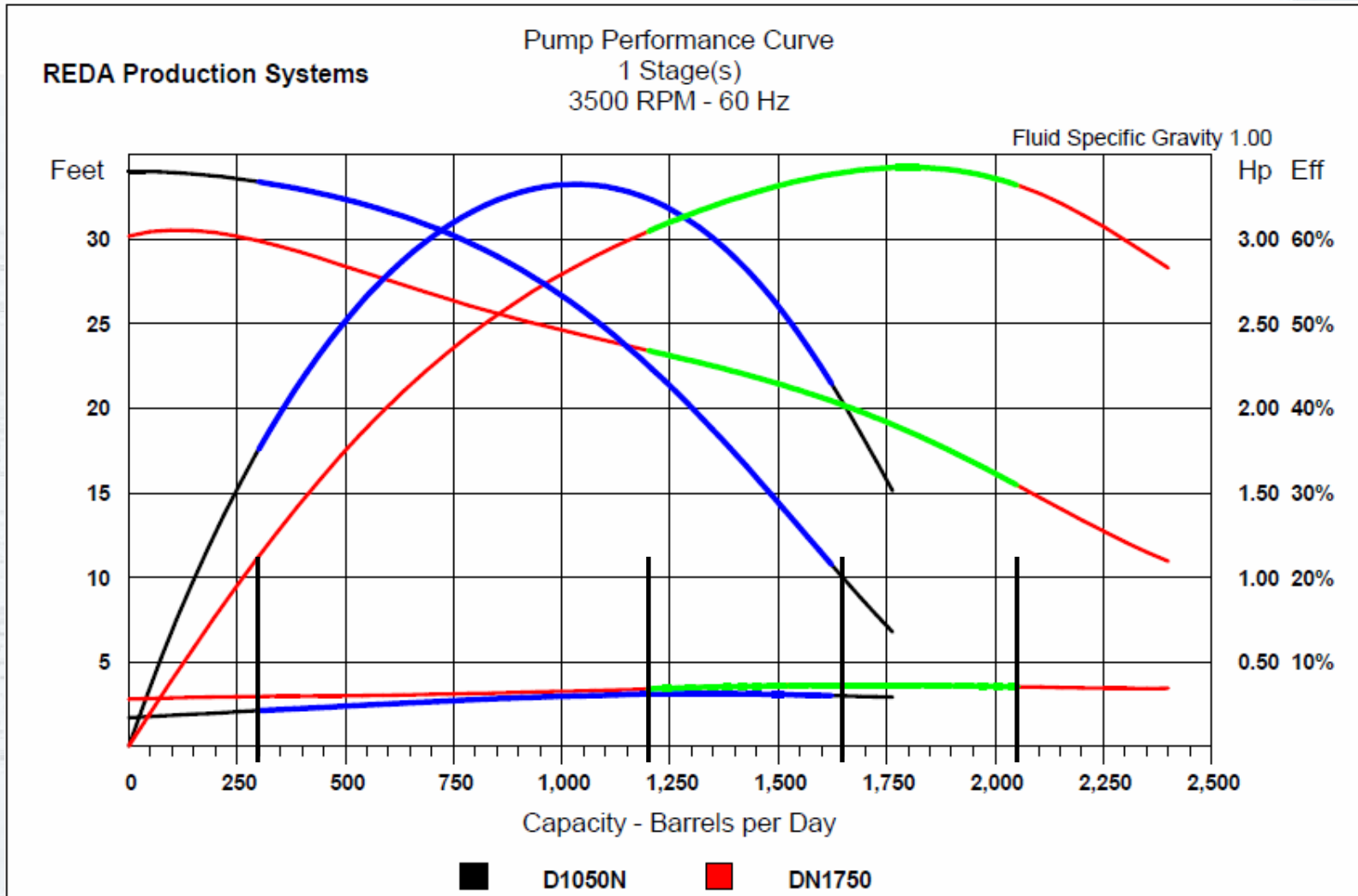
- Mixed flow stages – 20-25% free gas
- Compression pump stages – wide operating ranges - WAG
- Mixed flow stages – DN1750 and D1050N
- Sizing – Current rules of thumb → DesignPro Module

### Gas separation and/or handling

- Scenario 1 allows the use of either
- Scenario 2 allows only the use of gas handling equipment



# Pump Selection – D1050N vs DN1750



# Application Guideline

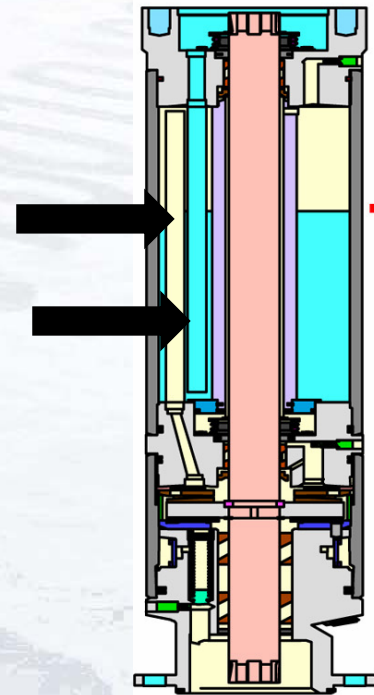
## Three Tiered Approach – Product

### Protector selection

- Labyrinth on top – SS tubes in upper chamber
- High-load thrust bearing

### Motor selection – Maximus advantages

- Tape in vs Plug in
- Benefits for CO<sub>2</sub>
- Impact on well control → HSE considerations





# Application Guideline

## Three Tiered Approach – Product

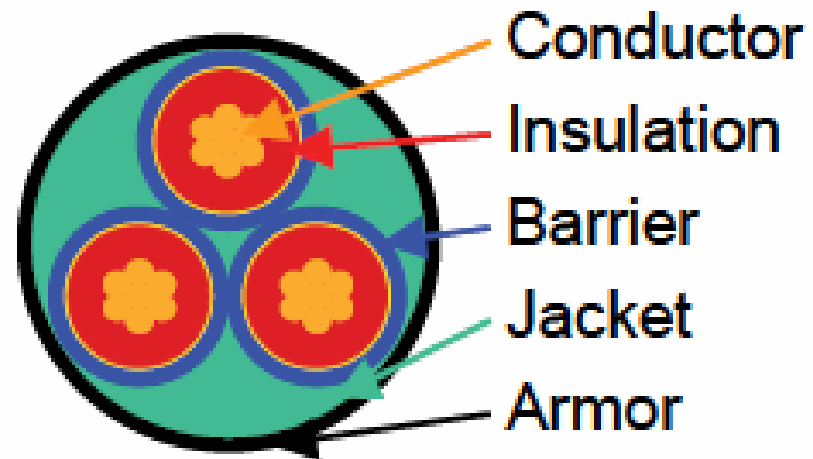
### Cable selection

- Size dependent on motor amps
- Lead barrier

### Actual Client experience

- 37 pulls from 1996-1999
- 17 for downhole ground
- 13 total were cable related

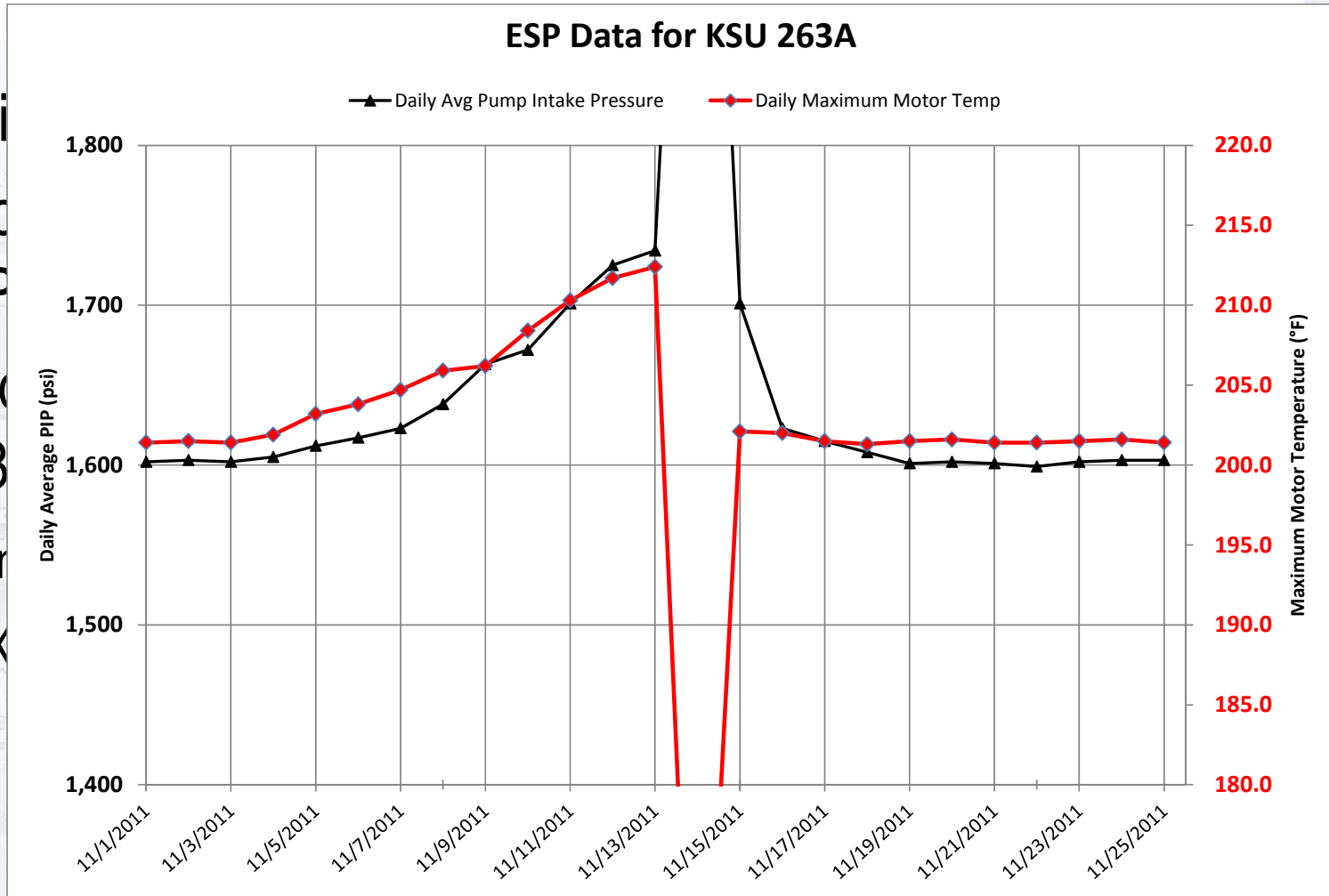
### Application Change to lead barrier



# Application Guideline

## Three Tiered Approach – Real Time Monitoring

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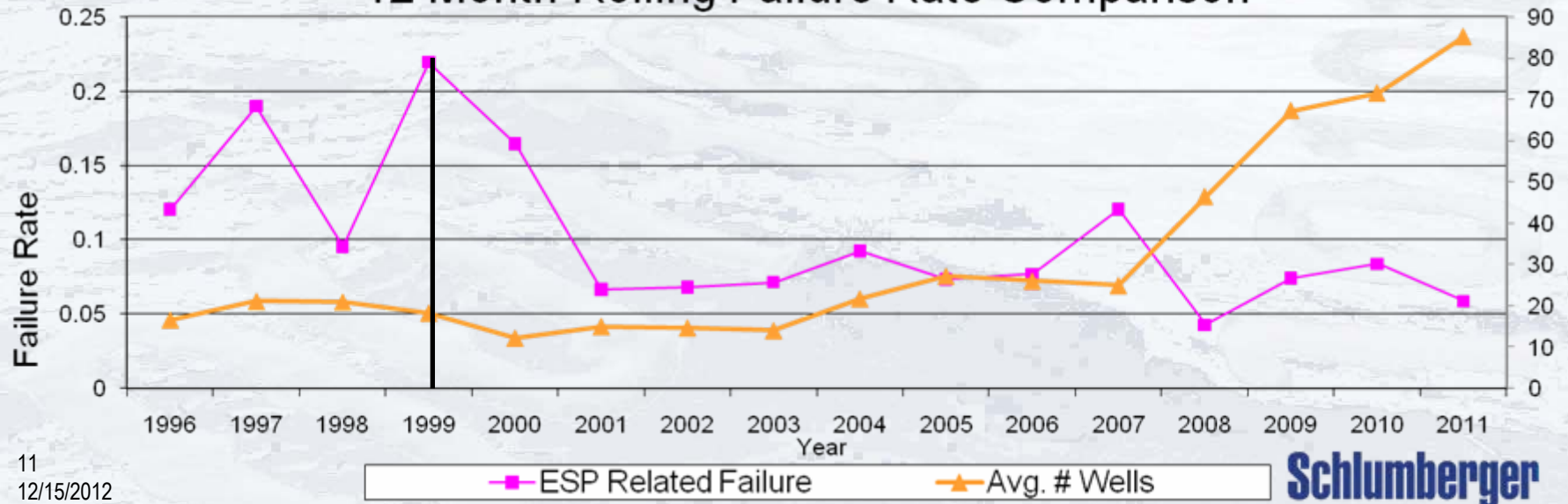
# Application Guideline

## Midland Results – Client Field Experience

### Client Field

- 1996-Present
- Circa 100 ESPs installed by YE 2011

### 12 Month Rolling Failure Rate Comparison



# Application Guideline

## Midland Results – Client Field

### Client Field

- ES Pump Configuration
- BOI – Bolt on intake → Scenario 2 (Maintain intake pressure)
- 3 Chamber Protector, Labyrinth on top
- EZLine and Maximus motors
- Lead Cable
- 2010 - YE 2011 – 39 total pulls
  - **No equipment failures related to application error**

# Market Analysis

## CO<sub>2</sub> First implemented in the 1970s in the Permian

- Estimated that 70 billion bbls of additional oil are technically recoverable in US
- 1300+ ESPs in CO<sub>2</sub> projects with competitor equipment
- Total CO<sub>2</sub> ESP market in the Permian is \$53MM annually
- Estimate of available CO<sub>2</sub> market - \$47MM annually

| Customer       | ESP Spend (kUSD)     | # of ESPs in CO <sub>2</sub> Floods | # CO <sub>2</sub> SLB ESPs | Available CO <sub>2</sub> ESPs | Estimated CO2 ESP Revenue (kUSD) |
|----------------|----------------------|-------------------------------------|----------------------------|--------------------------------|----------------------------------|
| Oxy            | \$ 50,000.00         | 600                                 | 30                         | 570                            | \$ 25,000.00                     |
| Chevron        | \$ 25,000.00         | 250                                 | 13                         | 238                            | \$ 7,812.50                      |
| Kinder Morgan  | \$ 15,000.00         | 480                                 | 31                         | 449                            | \$ 15,000.00                     |
| Apache         | \$ 12,500.00         | 85                                  | 28                         | 57                             | \$ 2,361.11                      |
| Hess           | \$ 3,000.00          | 90                                  | 90                         | N/A                            | \$ 3,000.00                      |
| <b>Total =</b> | <b>\$ 105,500.00</b> | <b>1505</b>                         | <b>192</b>                 | <b>1,314</b>                   | <b>\$ 53,173.61</b>              |

# Project Benefits

## Client

Advantage of working with an established ESP supplier of CO<sub>2</sub> solutions in the Permian Basin

Application of lessons learned from previous clients to size and select ESPs correctly for this environment

Minimize 'learning phase' associated with operating ESPs in new CO<sub>2</sub> floods

Reduced spend attributed to 'learning phase'

Client example – estimated 10% reduction on ESP spend alone

# Project Benefits

Schlumberger

CO<sub>2</sub> Application Guide for the Permian Basin

InTouch best practice - 5809240

Consolidated summary of important lessons learned

Quantified the CO<sub>2</sub> ESP market in the Permian

Locate future opportunities and targets for new business

\$47MM spent annually on competitor equipment in CO<sub>2</sub> floods

\$2MM potentially available within the next year

# Way Forward

CO<sub>2</sub> floods are an expanding market for ESPs in the Permian  
Consistent Application Guide for material selection and sizing

→ Using this to develop DesignPro Module

Maintain best practices for Permian equipment selection

Target the customers identified with the largest amount of CO<sub>2</sub>  
potential





QUESTIONS?