Centralized Production Facilities and Infrastructure – Critical Drivers to Infill Development in the Bakken

Mark Pearson, President – Liberty Resources LLC
Chris Clark, Production Engineering Manager – Liberty Resources LLC
Tappan Souther, Production Manager – Liberty Resources LLC
Matt Halker, President – Halker Consulting

Society of Petroleum Engineers
Denver Section
Denver, Colorado
October 21st 2015
Liberty Resources LLC – Denver, CO

• An independent, private-equity backed E&P company with industry leading expertise in developing tight-oil plays using advanced completion/frac designs and other technologies.

• Business plan for Liberty “Chapter 1” was to prove up acreage in the Williston Central Basin and sell the asset in 3 years. Initially funded with $200 Million equity commitment from Riverstone Holdings Fund IV in Sept. 2010 in order to consummate our first land deal. Grew to ~6000 BOEPD and sold the assets to Kodiak Oil & Gas in July 2013.

• Business plan in Liberty II is to develop Tier 1 tight-oil formations with a plan to sell flowing production. We are a dual-basin Rockies operator – in the Williston and Powder River Basins. Initially funded in November 2013 with a $365 Million equity commitment led by Riverstone Holdings Fund V and LSE-listed Riverstone Energy.
Outline

• Single and Dual-Well Facilities
• Liberty II Acreage and Development Plan
• Centralized Production Facility & Infrastructure Corridor Design
  - Centralized artificial lift
  - Spill Containment and Vapor Recovery Units
  - Minimized footprint
  - Production and Reservoir Surveillance to Operate by Exception
  - Infrastructure Corridor
• Project Status and Cost Savings
• Future Plans / Conclusions
Facilities For a Single Rod-Pumped Well
Facilities For a Single Jet-Pumped Well
Facilities For a Rod Pumped Dual-Well Pad
Liberty I Multi-Well Pad

Three well pad with three individual batteries

- Tanks, production equipment, and artificial lift averaged $1.28 Million
- No equipment cost savings for being a multi-well pad
- Gauging of 27 tanks and maintenance of equipment for each well
- Trucked all liquids off location and to location

LOE in Liberty I averaged $10/BBL
LIBERTY II – INITIAL DEVELOPMENT ACREAGE

- ~20,000 net acres and ~3,000 boe/day net production concentrated at the northern end of the Nesson Anticline, just north of Tioga, ND.

- Included a concentrated operated block of ~11,000 high quality net development acres on the Nesson Anticline (9 operated 1280-acre DSU’s).
~29,000 net acres and 18 operated DSU’s.

Core contiguous development area of ~12,000 gross acres and 10 operated DSU’s.

~95 new wells in the core area and 130 wells total to drill with a clean slate for planning an infill program.
### Existing Pad and Well Layouts

**Well Name** | **DSU** | **Pad**
---|---|---
Temple (TF) | 25-36 | 25-12C
Overdorf (MB) | 1-12 | 25-12C
Yogi (TF) | 6-7 | 6-19W
Erling (MB) | 6-7 | 6-19W
Edna (MB) | 18-19 | 6-19W
Erling (TF) | 18-19 | 6-19W
Maybery (MB) | 6-7 | 6-19E
Elroy (TF) | 6-7 | 6-19E
Lorena (MB) | 8-17 | 8-17W
Leon (TF) | 8-17 | 8-17W
Hove (TF) | 21-28 | 9-28W
Morris (MB) | 9-16 | 9-28W
McGreggor (MB) | 21-28 | 9-28C
ND State (TF) | 9-16 | 9-28C
Frank (TF) | 13-24 | 13-36C
Louie (MB) | 25-36 | 13-36C
Louie 1-36 (MB) | 25-36 | 1-36 Stand Alone

13 “modern” wells on production; 7 MB & 6 TF. Four wells waiting on completion: 2 MB & 2 TF.
- Design for 2 drill pads and one central combined drilling & facilities pad per 2560 acre dual-DSU.

- Flowline drill pad wells to central facilities to consolidate operations.

- Design for 6 wells per horizon per DSU.

- Work infill placements around existing well placements to stay as close to concept as possible.
Core Development Concept – aka “The Liberty Oil Factory”

- Single Central Facility (CF) services all wells within DSU
- 2 drilling pads per 1280 or 3 pads per 2560 acre DSU
- Pad-to-pad flowlines connect wells to CF
- Centralized artificial lift equipment
- Build an infrastructure corridor to connect central facilities
Infrastructure Corridor Concept

Central Facility:  
Drill Site:  
Existing Pad:  
Utility Corridor:  
Future Corridor:  
Frac Pond:  

Trench One  
6” Fuel Gas  
16” Gas Gathering  
6.5” Oil Gathering  

Trench Two  
6.5” Produced Water  
16” Frac Water  
6” Freshwater  

“The No. 1 objection to industry’s presence is always trucks.” George King - Apache Corp.  
Wall Street Journal (5th May 2015)  

- Removes trucks during development drilling and frac operations  
- Removes over 200 PW trucks a day at full development
Central Facility Design Elements

- Type Curve Match
- Define Well Life Cycle
- Stages of Separation
- Piping MAOPs and Spec Breaks
- Consolidation of Equipment
- Commingling of Wells
- Site Safety Philosophies
  - API 14C and Production Hazard Analysis
- Surveillance and Testing Requirements
- Relief and Flare Philosophies
- Automation
- Freeze Protection
- Liquid Storage Philosophies
Design of CF’s & Infrastructure Corridor to Match Production Forecast

- Production forecast from type curves and schedules
- Central Tank Battery (CTB) vessel & pipe sizing and specs
- Corridor pipe sizing and specs
- Disposal well schedule to match water forecast
Design for Life Cycle of Wells

Utilized to help define how equipment and safety systems may be adjusted to parallel declining production (rates and pressures)

- The duration of high pressure/high rates is relatively short
- Flexible centralized artificial lift strategy (jet pump, gas lift, hydraulic piston pump, rod pump or ESP)
- Automation and shut-downs need to be varied based on the stage of a well’s life cycle and operation
Central Facility Design – More Oil Yield, More Gas Gathered

Drill Sites

Pad-to-Pad Flowlines

Central Facility

- Commingled Oil & Water
- Dedicated Treater
- Gas Scrubber
- Power Fluid Vessel
- Vertical Treater
- VRT Oil Tank
- VRU
- Water Tank

4 Stages of separation with VRU

- Gas Sales
- Flare

Oil
Water
Gas

Power Fluid (Oil or Water)

WH

Dedicated Treater

Commingled Gas
The Design in 3D
Leon Central Facility
1280 Acre DSU
10 well design
Completed February 2015

McGregor Central Facility
2560 Acre DSU
20 well design
Completed August 2015

Central Facility Pad:
Drill Pad:
Existing Pad:
Utility Corridor:
Utility Corridor Future:
Frac Pond:

Utility Corridor
Completed Existing Tie-in Points May 2015

Gas to Sales
Leon Central Production Facility

- Built for 10 wells
- First Central Facility
- Designed and equipment ordered during the “Boom Times” of mid-2014
- Winter build
- Brought on production in February
- Has met performance objectives but not cost objectives
- Cost per well of $1,670M
  - Cement Pad $89M/well
  - Facility $1,455M/well
  - AL $126M/well
McGregor Central Production Facility

- Built for 20 wells
- Second Central Facility
- Summer build
- Brought on production in August
- Cost per well $1.25 Million
  - Cement Pad $100M/well
  - Facility $1,005M/well
  - AL $145M/well
Maintenance & Emissions

Pads
- Cement stabilized pad

Emissions
- 4 stages of liquid/gas separation
  - Vapor recovery on 3 of the 4 stages
    - RVP – NDIC Regulation: 13.7 psi
    - RVP – Single well: 10.7 psi
    - RVP – Central facility: 8.8 psi
  - Increased sales volumes
    - 92% reduction in tank vapors
    - 0.4% increase in liquid (condensate & oil)
    - 3.2% increase gas

Secondary Containment
- Spills 100% recoverable
  - Full containment around all equipment

Flexibility to implement regulation changes
Footprint

• Single-Well Facility
  - Rod pump
  - Two stages of separation (no vapor recovery)
  - Five 400 BBL tanks (2 water & 3 oil)
  - 8 pieces of equipment
  - 5,500 ft² per well

• Multiple Single-Well Facility Footprint
  - 10 Well design – 80 pieces of equipment & 55,000 ft²
  - 24 Well design – 192 pieces of equipment & 132,000 ft²

• Liberty Central Facility Design
  - Commingled production close to the wellhead
  - 3,000 bbl bolted vs. standard 400 bbl welded tanks
  - Four stages of separation and vapor recovery
  - All rotating equipment for AL located at central facility

• Liberty Multi-Well Central Facility Footprint
  - 10 Well design – 36 pieces of equipment & 51,400 ft²
  - 24 Well design – 60 pieces of equipment & 72,120 ft²
Centralized Facility Versus Multiple Well Trains

Liberty Centralized Facility: 5 x 3000 bbl Tanks

Offset Operator: 12 separate treater-separator units and 60 x 400 bbl Tanks!
Reservoir Surveillance - Production Volumes at the Well Level

• Real Time Measurement
  - Identify down wells & treater issues faster (*reduce downtime*)
  - Reservoir surveillance

• Oil, Water & Gas Measured prior to Commingling
  - Oil – Coriolis meter on dump
  - Water – Coriolis meter on dump
  - Gas – EFM on gas outlet
Capital Cost Comparison

• Liberty I – Single Well Facility & Pad
  - Standard jet pump design
  - $1,280,000 – Average cost per well

• Liberty II – McGregor Facility & Pads
  - $1,250,000 average cost per well
  - $30,000 cost saving per well compared to LR I
  - But... this also includes
    - Cement treat of pads ($100M/well - lowers LOE)
    - Improved containment system (allows spills to be 100% recoverable)
    - Incorporates vapor recovery system ($25M/well - reduces emissions & increases gas sales)
    - Additional stages of separation ($42M/well - increased revenue)
    - Equivalent reservoir surveillance to a single tank battery
LOE Cost Drivers

Liberty Resources Production LOE (Jan-Aug 2015)

- Water handling is largest cost driver (40%)
  - Tie-in all wells at facilities and transfer water via pump & pipeline to SWD facility
  - Eliminate trucking and internalizes transportation & disposal costs

- Labor is second largest cost driver (17%)
  - Centralized facilities minimizes & centralizes equipment
  - Automation allows for operation by exception

- Electricity is third largest cost driver (9%)
  - Centralized horsepower allows for optimized sizing relative to artificial lift needs and lowers overall demand charges
Manpower

• Less ground to cover
  - Centralized moving parts
  - Utility corridor
  - Single point of chemical treatment

• Manage less equipment
  - Five 3,000 BBL tanks vs 38 x 400 BBL (15,000 BBL storage)

• Maximize Automation
  • Real-time surveillance
  • Pump by exception
Utilization of Infrastructure Corridor to Date

Latest two rounds of completion operations:

• Frac operations: Delivered all water to location via pipeline at 70 bpm vs 35 bpm in previous operations
  - No downtime waiting on water. Able to sustain sim-ops: Frac and pump downs.
  - Savings per well of $100M - $200M
  - In winter operations will save $150M-$300M in heating.

• Drill out and flowback operations:
  - No water or oil trucks on location
  - Pipelined all flowback water to SWD
  - Gathered all gas to infrastructure
  - Gathered oil on last three wells decreasing oil differential by $4/bbl
  - Not exposed to frost laws with trucks in spring!!

Production operations:

- Transfer all produced water to Liberty operated salt water disposal well via pipeline
- Currently handling ~10,000 bwpd
- Cost control – reduced LOE for all WIO’s
- For Liberty it has internalized ~$2 Million per month of previously external costs
Central Facility Cost Components

- Roustabout/Contract Labor/Welding
- Location, Roads, Pits (Init)
- Tank Battery
- Pipe/Flowlines/Valves/Fittings
- Automation/Telemetry
- Pipeline
- Separators/Treaters/VRU's
- Miscellaneous Tangibles
- Surface Artificial Lift Equipment
- Other Surface Equipment
- Contract Supervision
- Overhead
- Surface Rentals
- Company Supervision
- Location, Roads, Pits (Maint)
- Fuel/Power/Electricity

Top 5 Components:

- Roustabout/Contract Labor/Welding
- Location, Roads, Pits (Init)
- Tank Battery
- Pipe/Flowlines/Valves/Fittings
- Automation/Telemetry
Central Facility Learning Curves

• Learning curve between build 1 and 2
  • Labor (Roustabout & Welding) was the largest cost driver
    – Summer time build
    – Reduced welded connections by 70%
    – Streamlined layout of build
  • Automation
    – Streamlined layout, minimized copper
    – Second build reduced programming time

• Learning curve for future builds
  – Reduce welded connections further
  – Looking at wireless automation
  – Pipe & material selection review
  – Review ability of prefab modular equipment
  – Investigate main & test separators (*sacrifice reservoir surveillance*)
Future Planned Utilization of Infrastructure Corridor

- Fuel gas line utilization
  - Drilling operations: could eliminate 1,800 gal/day diesel on average ($90M per well savings @ $2.50/gal).
  - Frac operations: will deliver fuel gas to dual-fuel frac fleet (25,000 gal/well of diesel; ~$65M per well savings @ $2.50/gal)

- Fresh water distribution for production operations
  - Deliver fresh water via pipeline vs truck
    - 20 BBLS per day per well
    - $4/BBL delivery fee
    - Eliminates $2,400 of trucking charges per well per month
Conclusions

- Centralized Production Facilities are a necessity for large infill pad development
- Process, safety and automation improvements can be more readily obtained in a centralized process design rather than a facility implementing duplication of single-well facilities.
- Capital construction cost reductions have been realized in building the second of Liberty’s Centralized Facilities.
- LOE reductions are being realized through the utilities offered in our infrastructure corridor.
- This is still a work in process – we expect to have further design and construction modifications as we anticipate building up to ten more Centralized Facilities in our Bakken development program.
Leon Central Facility Startup Feb. 6th 2015

Many thanks to so many of Team Liberty – especially our engineering and construction / startup teams
Questions ?