Progress To Date

- 16 Existing Well Workovers completed:
  - 9 CO2 Injection Wells
  - 3 Production Wells
  - 3 Wells P & A’ed

- Further Field Work is awaiting BLM Environmental Assessment expected by the end of July.

- Further Technical Planning & Design:
  - Geo
    - Static Model
    - 3D Seismic
  - Reservoir
    - History Match
    - Material Balance
    - Reservoir Simulation
Technical Work In Progress

- Start of simulation study
- Goal is to answer gas recycling requirements
- Grieve has High dip, high perm, but is in a single reservoir
- Additional studies:
  - PVT, MMP, and swelling experiments
  - Effects of recycling CO2 with methane
Current Reservoir CO2 Study

- Fine layering with average layer thickness 2 ft. Preserve reservoir heterogeneity
- New Lab swelling and slim-tube tests will validate EOS for CO2 flooding predictions.
- Detailed history matching will be conducted to quantify reservoir parameters (phi, K, aquifer, etc) for realistic predictions
- Effect of methane contamination in the CO2 recycle stream will be evaluated
- New SCAL lab work is being planned end of year to quantify Sorw
Static Modeling (Geology)
Depositional Scenario of Valley fill deposits: Example from Grieve Field
Depositional Facies and Facies Groups

Marine

Estuarine

Fluvial
Surfaces

Marine

Estuarine

Fluvial
Cross Sections and Correlations

Marine

Estuarine

Fluvial
Facies Histograms

### Facies Proportions - Upper Zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Indicators</th>
<th>Variogram Ranges</th>
<th>AZ</th>
<th>Realization 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
<td>Z</td>
</tr>
<tr>
<td>Upper</td>
<td>Est_GQ(1)</td>
<td>2280</td>
<td>1920</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Mar_GQ(3)</td>
<td>1700</td>
<td>1180</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Est_MQ(4)</td>
<td>1680</td>
<td>1270</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mar_MQ(5)</td>
<td>1500</td>
<td>1200</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Shale (7)</td>
<td>1680</td>
<td>1000</td>
<td>11</td>
</tr>
</tbody>
</table>

### Facies Proportions - Lower Zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Indicators</th>
<th>Variogram Ranges</th>
<th>AZ</th>
<th>Realization 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
<td>Z</td>
</tr>
<tr>
<td>Lower</td>
<td>Fluv_GQ(2)</td>
<td>1900</td>
<td>1400</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Fluv_MQ(5)</td>
<td>1000</td>
<td>850</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Shale (7)</td>
<td>1680</td>
<td>1000</td>
<td>11</td>
</tr>
</tbody>
</table>

Data series:
- **FACIES_BLK**
- **FACIES_MODEL**
- **FACIES_RAW**
Porosity Histograms

Good Quality Sand Facies

<table>
<thead>
<tr>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.14</td>
<td>0.29</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Moderate Quality Sand Facies

<table>
<thead>
<tr>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.23</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Zone Realization 1 Realization 2 Realization 3 Realization 4 Realization 5
Upper

<table>
<thead>
<tr>
<th>Zone</th>
<th>SIMPLE_EXTEND/POR_PHI</th>
<th>Realization 1</th>
<th>Realization 2</th>
<th>Realization 3</th>
<th>Realization 4</th>
<th>Realization 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Copy_of_indicators</td>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
<td>Std</td>
<td>Min</td>
</tr>
<tr>
<td>Upper</td>
<td>Upper_GQ</td>
<td>0.1</td>
<td>0.3</td>
<td>0.19</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Upper_MQ</td>
<td>0.1</td>
<td>0.31</td>
<td>0.2</td>
<td>0.04</td>
<td>0.1</td>
</tr>
<tr>
<td>Lower</td>
<td>Lower_GQ</td>
<td>0.1</td>
<td>0.32</td>
<td>0.21</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Lower_MQ</td>
<td>0.1</td>
<td>0.33</td>
<td>0.21</td>
<td>0.04</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Lower

* Upper Zone = Marine + Estuarine, Lower Zone= Fluvial

GQ = Good Quality Facies, MQ = Moderate Quality Facies
Permeability Histograms

Good Quality Sand Facies

Moderate Quality Sand Facies

* Upper Zone = Marine + Estuarine, Lower Zone= Fluvial
GQ= Good Quality Facies, MQ= Moderate Quality Facies
POR-Kh All Sand Facies

![Graph showing data series and facies distribution]

**Data series**
- MODEL
- INPUT

**FACIES_ES**
- Est_GQ
- Fluv_GQ
- Mar_GQ
- Est_MQ
- Fluv_MQ
- Mar_MQ

**Filter information**

<table>
<thead>
<tr>
<th>Series</th>
<th>Zone</th>
<th>Discrete</th>
<th>Wells</th>
<th>Sample</th>
<th>Value</th>
<th>No. of points</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>All</td>
<td>1-2,4-5</td>
<td></td>
<td>31.58 [Auto]</td>
<td>[On]</td>
<td>49568</td>
</tr>
<tr>
<td>INPUT</td>
<td>All</td>
<td>1-5</td>
<td>42/42</td>
<td>100.00 [Auto]</td>
<td>[On]</td>
<td>743</td>
</tr>
</tbody>
</table>

**Statistical information**

- Series: Correlation coefficient (Pearson)
  - MODEL: 0.747381
  - INPUT: 0.795721
POR-Kh Good Quality Sand Facies

Marine

Estuarine

Fluvial

GU#12

GU#14

8A Morton
POR-Kh Moderate Quality Sand Facies

Data series
- MODEL
- INPUT

FACIES ES
- Est_MQ
- Fluv_MQ
- Mar_MQ

Marine

Gu#1

Fluvial

Gu#9

Gu#30

Gu#41

8A Morton
Dynamic Modeling
Gravity Segregation

Effect of Vertical Layering – Multi-Phase

Model sand with one vertical layer

Model sand with 3+ layers allows gas to rise up to top layer as per gravity forces. Relative perm for gas higher in top layer.
Gas Breakthrough Time (box model)

Gas Production Rates from 3 Cases

- FGPR VS TIME COMP-SIM10
- FGPR VS TIME COMP-SIM1
- FGPR VS TIME COMP-SIMP1

Δz = 1 feet

Effect of first “10 foot thick” layer under refined layers

Δz = 0.1 feet

Δz = 10 feet
A validated EOS will help design field development plans.
Plans Moving Forward

2012

- Grieve plant site to be cleared and prepared.
- CO2 injection manifold installed.
- Installation of CO2 supply (3 mile) pipeline to Grieve from Anadarko’s CO2 pipeline.
- Tie-in to Anadarko’s pipeline.
- Installation of field CO2 distribution system and flowlines and the produced fluid gathering system and flowlines.
- Drill and complete 2 Madison water source wells.
- Installation of power supply (substation & transmission lines)
- Commencement of CO2 injection in November.

2013

- 5 Recompletions.
- Continue CO2 injection
- Installation of Grieve processing and compression plant.
- First oil estimated for Mid Year 2014.