CO₂ TRANSPORT AND DELIVERY: STATUS UPDATE ON OFFSHORE OIL AND GAS INFRASTRUCTURE RE-USE

DARSHAN SACHDE, PHD
KATHERINE DOMBROWSKI, P.E.
JOE LUNDEEN, P.E.
RAY MCKASKLE, P.E.
Trimeric Corporation
DARRELL DAVIS (Consultant)
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Task 5: Infrastructure, Operations, & Permitting

Infrastructure Evaluation Includes Existing O&G Infrastructure
- Pipelines
- Wells
- Platforms
Wells
Scope & Status of Well Review

- Understand type & quality of data
- Develop process to assess/screen data
  - Wellbore status, completion date, well integrity reports
- Apply screening criteria to analog sites
  - HI-10L and HI-24L
- Developed well re-use evaluation “memo”
Data Sources

Texas Railroad Commission (Public)
- GIS map of O&G assets
- Oil and Gas Records Query
- Wells tracked by API number
  - API = 10 digit number

Subscription Databases (via UT BEG)
- IHS Enerdeq: Summary info. per well
- IHS Petra: State and federal waters
- Lexco OWL7: specific to GoM federal waters; source of info = BOEM, BSEE
- Wells tracked by UWI number
  - UWI = 14 digits; allows for tracking of individual wellbore for a single surface location
- Includes access to well integrity reports
Regions of Review: HI-10L & HI-24L
Wells – Age Distribution

• All wells > 20 years old
• < 1970 = “Old” well-construction methods
• Age distribution in these blocks loosely matches broader O&G infrastructure trends
Wells – Wellbore Status

• TX RRC Terminology:
  • Active
  • Plugged
  • Inactive wells – unplugged well with no activity for > 12 months
    • Compliant/Non-compliant: w/ Section 14(b)(2) extension deadline for plugging
    • Orphaned: inactive > 12 mo & operator’s organization report delinquent > 12 mo
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• Beware loose & inexact terminology
  • “Abandoned”:
    • RRC: Purposefully plugged and abandoned
    • Colloquially: May refer to non-compliant well that has not been properly plugged
  • “Dry hole” (non-producing well):
    • RRC: Also indicates plugged
    • Colloquially: No association with plugging status
### Wells – Wellbore Status

<table>
<thead>
<tr>
<th></th>
<th>HI-10L</th>
<th>HI-24L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of UWIs/APIs</strong></td>
<td>34</td>
<td>39</td>
</tr>
<tr>
<td><strong>Wellbore status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plugged</td>
<td>29</td>
<td>16</td>
</tr>
<tr>
<td>Permitted/Cancelled</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Unknown Status</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Active: Producing</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Inactive: Temp Abandoned</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Inactive: Orphan</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

HI-10L: All wells have completion date
HI24L: Some wells missing completion date (10/34)
Orphaned Wells in Texas State Waters

• 113 Orphaned wells in Texas State waters
  • 12 different operators

• HI-LB: 25 orphaned wells
  • HI-24L: 16 orphaned wells
    • All with same operator X
    • Inactive periods from 36 – 260 months
  • HI-55L: 4 orphaned wells
    • All with same operator Y
  • HI-98L: 5 orphaned wells
    • All with same operator Y
Wells – Integrity Reports

• Critical reports for assessing well condition
• Only 3 wells have all 4 reports

More plugging reports than “plugged” wells

Number of wells that have more than one type of report
Analog Site Summary

• Re-use **opportunity** or **risk** for leakage?
  • Wells in HI-10L and HI-24L are > 20 years old
  • Orphaned wells can be substantial (~40% of wells in HI-24L)
  • Of 73 wells in this analysis, only 3 wells had all 4 key reports (plugging, cement logs, pressure tests, caliper logs)

• Publicly available well records are incomplete & inconsistent
  • Non-trivial effort to assess wells beyond a cursory level
  • Project developer will need access to owner’s records
Data Challenges – Inconsistency b/t Sources

• Well numbering systems are different (API vs. UWI)
• Old wells in RRC do not have a full API number
• Subscription database tags wells not physically located in leasing block
• Some Subscription database wells are not in RRC GIS Viewer search (next slide)
Data Challenges – Inconsistency b/t Sources

UWI 42708000160000 in Subscription Databases was located in HI-24L, but was not visible in RRC GIS Viewer.

GIS Viewer does not indicate any features in vicinity of UWI 42708000160000

HI-24L wells from RRC GIS Database
Wells with HI-24L tag in UT's Databases
HI-24L Boundary
Synergy with Other DOE/Federal Efforts

- **DOE Workshop: Undocumented Orphaned Wells**
  - DOE focused on unknown wells (up to 800,000 undocumented wells)
  - DOI focused on known orphaned wells (up to 130,000 wells)
- Federal interest in repurposing these orphaned wells to offset costs
- Common themes with GoMCarb:
  - Inconsistent well terminology between sources, states, etc.
  - Basic well information difficult to find, may be proprietary
  - No single best source of information – no national database (in the works?)
- Onshore can be much more challenging due to age/# of wells
Ongoing/Future Work: “Transect” Analysis
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Port Arthur transect
Ongoing/Future Work: “Transect” Analysis

- Port Arthur transect
- Extend into federal waters
- Extend into deeper waters
Ongoing/Future Work: “Transect” Analysis

- Port Arthur transect
- Louisiana transect
- Extend into federal waters
- Extend into deeper waters
Ongoing/Future Work: “Transect” Analysis

- Port Arthur transect
- Louisiana transect
- Corpus Christi transect
- Extend into federal waters
- Extend into deeper waters
- Look for low density of wells?
Pipeline Re-Use: Past Work Review

- High-level screening
- Identified specific pipelines for more detailed review
  - Included direct engagement with pipeline owners/operators
- Developed re-use workflow
  - Identified major steps required for re-use
  - Attempted to assess cost of these steps
- Developed a pipeline re-use assessment “memo” summarizing work

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<tbody>
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<td>Inactive* Line Screening (Near-Term Opportunity)</td>
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*Inactive = Abandoned in place, Proposed abandonment, Out of service
**Key Segments = Come onshore/near-shore (TX, LA)
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Diagram:

1. Public Data Review
2. Contact Owners, Public Records: Negligible Investment
3. Pursue Evaluation?
   - Yes: Line Inspection
   - No: New Line
4. Line Inspection
   - Divers: Est: $250k for 10 days
   - SMART Pip: Est: $150k < 25 miles
   - Acceptable Integrity?
     - Yes: Line Testing
     - No: New Line
5. Permitting & Regulatory
6. Repair/Reuse?
   - Yes: Total Investment (excl. repairs, permits): ~$750k
   - No: New Line

Cathodic Protection Survey: Est: $250k ~15 miles
Pressure Test: Est: $275k
Pipeline Re-Use: Case Study Evaluation

• Priority candidates from screening to perform a “deeper” dive
• High-level technoeconomic assessment of re-use
  • Comparison to new Class 900
  • Hydraulic Evaluation (transport phase, pressure/velocity limitations, environmental conditions, capacity, offshore recompression requirements)
  • Other considerations (shore crossing, useful life, pipeline records)

• Broader objectives:
  • Not intended to represent a “project”
  • “Pilot” test the re-use workflow – are we missing key steps?
  • Identify/assess specific re-use challenges or benefits
Pipeline Re-Use: Case Study Evaluation

From Panther Companies website (Used with permission):
Maps (panthercompanies.com)
Pipeline Re-Use: Case Study Evaluation

From Panther Companies website (Used with permission):
Maps (panthercompanies.com)
Platforms
Platform Re-Use Overview

• Repurposing platforms for CO$_2$ storage = offset cost of decommissioning idled platforms ("win-win")

• High-Level platform re-use criteria
  • Location/proximity to preferred injection site
  • Age/general condition of platform
  • Space on platform
  • Regulatory/legal considerations
    • How does liability/decommissioning responsibility transfer?

• Platform re-use unlikely to be a project driver
  • Reservoir, pipeline, and in some cases, wells will be prioritized ahead of platforms
Platforms

- Texas State Waters:
  - 95% of platforms (of 89 total) in Texas state waters are inactive
  - Minimal detailed data available (no age, water depth, inspection records)

- Federal Waters:
  - 1,807 platforms offshore TX (136) & LA (1,671)
  - High-level data available (incl. inspection reports in some cases)

- Age:
  - SME: Beyond 30 years, structural integrity risk rises significantly
  - Platforms built after implementation of specific standards represent better candidates
    - MMS – From 1988 on, enhanced inspection requirements

- Critical information such as structural integrity, topsides space, etc. requires contact with operators
Platforms – Mapping & Case Studies

Texas State Waters
Platforms – Mapping & Case Studies

Texas State Waters

GOM-24-1177 - RRC #230456
Platforms – Mapping & Case Studies

- 75% of platforms are fixed platforms
- Tend to be in shallower waters, but older
- More discussion on Thursday
Summary

• Pipelines:
  • **Scale** of pipeline re-use opportunity limited by size and pressure rating
  • Re-use vs. new is not binary
    • Incremental Capacity: Pair existing with new (reduce total investment)
    • “Phased” Investment: Start-up with existing, build-out new (flexibility)
  • Existing right-of-way, existing routes have inherent value

• Wells:
  • Quality of records and condition of wells represent a **risk** to CCS projects
  • Opportunities for re-use will be case specific, risk for leakage will be general

• Platforms:
  • Limited stock of “newer” platforms
  • Cost to retrofit vs. new platform is case-specific

• Engineering studies = drive specific decisions on assets
• Decommissioning “best practices” not always followed. **Urgency to identify assets before abandonment.**
Thank You

- Acknowledgements:
  - Darrell Davis (Consultant) led efforts for pipeline and platform screening
    - davisdw58@hotmail.com
  - UT BEG for data analysis support
  - Trimeric Corporation
    - www.trimeric.com
  - Darshan Sachde
    - darshan.sachde@trimeric.com
Backup Slides
GoMCarb Ongoing Work

• Case Studies:
  • Pipeline Re-use Case Study (Class 600 vs. Class 900 new)
  • Platforms: What can we learn from data available, what additional data is needed (workflow), and what would it cost to get that data?

• Wells:
  • Review select subsets of data throughout GoMCarb region – are there any generalizations or new considerations?

• Continue engagement with stakeholders to identify the infrastructure questions that are still unanswered
Existing Well Assessment “Workflow”

• Verify well integrity for wells within the reservoir
  • Records review to assess potential for leakage: age, well abandonment method, well completion activities, cement type, well type
  • Wellbore evaluation to confirm downhole status: casing condition, cement location, joint locations

• Remediate to address well integrity problems
  • Depends upon whether re-using or plugging

• Future Work: Refine with input from experts
Pipeline Re-Use: Incentives

• Existing Pipelines: ~20k in federal water (+ more in state waters)

• New Pipeline Costs
  • Offshore Lines: ~2 – 3x cost of onshore “equivalent”
  • MAJOR CAVEATS
    • Data comparing on- and offshore is almost exclusively for NG lines
    • Large range in costs - highly project and route-specific

• Hidden risks/costs of new pipelines
  • Shore crossing through env. sensitive/challenging geography
  • Routing risks (right of way, new regulatory requirements vs. existing lines)
Pipeline Re-Use: Challenges

- **Pressure Rating**
  - ANSI Class 600 (working P = 1,480 psig @100 F)
  - ANSI Class 900 (working P = 2,220 psig @100 F)
  - Actual pressure rating of an existing line?

- **Age**
  - Pipeline broker – Up to 85 years usable life
  - Older lines = higher risks (**especially out of service lines**)

- **Condition of Line**
  - Corrosion, repairs, thickness
  - Existing records (or lack thereof) represent essential data

- **Key Issue**: Incentives & feasibility are not always aligned for re-use

<table>
<thead>
<tr>
<th>Case</th>
<th>Inlet Pressure (psig)</th>
<th>CO₂ Flow (Mt/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Class 900</td>
<td>2,000</td>
<td>~3.2</td>
</tr>
<tr>
<td>Existing Class 600</td>
<td>1,400</td>
<td>~1.8</td>
</tr>
</tbody>
</table>

- **8”, 5-mile pipeline**
- **P_{Outlet} > 1,200 psig (CO₂ always above P_{Critical})**
Pipeline Re-use Workflow

1. Public Data Review
   - Contact Owners, Public Records: Negligible Investment

2. Pursue Evaluation?
   - No → New Line
   - Yes → Line Inspection

3. Line Inspection
   - Divers: Est: $250k for 10 days
   - SMART Pig: Est: $150k < 25 miles
   - No → New Line
   - Yes → Acceptable Integrity?

4. Acceptable Integrity?
   - No → New Line
   - Yes → Line Testing
     - Cathodic Protection Survey: Est: $250k ~15 miles
     - Pressure Test: Est: $175k

5. Repair/Reuse?
   - No → New Line
   - Yes → Permitting & Regulatory

Total Investment (excl. repairs, permits): ~$750k+
GoMCarb & SECARB Partnership Meeting, May 16-18, 2022, New Orleans, LA

Select Line to Research

Gather all data from BSEE, Army Corps of Engineers, and current or previous owner.

Decision to Investigate Line

Yes

Get approvals to run SMART pig.

Hire Divers and Inspection Service

Choose another line or install new

No

Investment (Est: $250k for 10 days)

Pump through line and pressure test. Run SMART Pig if advised.

Line Integrity is Good or Repairable?

Yes

Run Cathodic Protection Survey

Repair bad sections and retrofit (if needed)

Investment (Est: $100k ~15 miles)

No

Choose another line or install new

Hydrostatic Test to 1.25 time MAOP

File Paperwork with BSEE, RRC, DNR, and Army Corps of Eng.

Environmental Impact Statement
Archaeological Report
Pipe Location and Profile Drawing
Shallow Hazard Survey Report

Run Public Notice with Army Corps of Eng.

Galveston - Texas
New Orleans - Louisiana

Obtain Permits

Total Investment (Excluding repairs) (Est: ~$750k)

Investment (Est: $150k < 25 miles)

Investment (Est: $175k)
Pipeline Screening Results – Federal Active Lines

Pipeline Size Distribution - Active Lines

- Median Diameter = 21”

Note: Out of Service Median Size = 16”

Pipeline Pressure Distribution - Active Lines

- >1,440 psig = 10 lines

Note: Out of Service Lines >1,440 psig = 0
Pipeline Screening Results – Federal Out of Service

- **Limited stock of large pipelines**
  - ~23% ≥ 8 inches
  - 41% of this subset are 8” lines
- **Class 600 pipelines are most common**
  - 61% of all pipelines at least 1440 psig
- **Nearly half of pipelines meeting size and pressure screen are active**
  - Recent (last 10 years) common practice: fill abandoned lines w/ uninhibited seawater.
- **Less than half (46%) of lines meet the age criteria (< 40 years)**

### FEDERAL WATERS

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</tr>
</thead>
<tbody>
<tr>
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<td>20,274</td>
</tr>
<tr>
<td>8” or larger</td>
<td>4,614</td>
</tr>
<tr>
<td>Max Operating Pressure &gt; 1000 psig</td>
<td>3,875</td>
</tr>
<tr>
<td>Not in Service</td>
<td>1,927</td>
</tr>
<tr>
<td>&gt; 2 miles long</td>
<td>951</td>
</tr>
<tr>
<td>Water Depth &lt; 100’</td>
<td>520</td>
</tr>
<tr>
<td>In Service 1980 or later</td>
<td>355</td>
</tr>
<tr>
<td>Key Segments*</td>
<td>11</td>
</tr>
</tbody>
</table>

*Key Segments = Come onshore & terminate near state waters offshore
## Pipeline Screening Results – Federal Active Lines

<table>
<thead>
<tr>
<th>FEDERAL WATERS</th>
<th>Number of Segments</th>
<th>Inactive* Line Screening (Near-Term Opportunity)</th>
<th>Active Line Screening (Lower-Risk Opportunity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>20,274</td>
<td>11,195</td>
<td>5,568</td>
</tr>
<tr>
<td>Service Status (Inactive/Active)</td>
<td></td>
<td>11,195</td>
<td>5,568</td>
</tr>
<tr>
<td>8” or larger</td>
<td></td>
<td>2,335</td>
<td>1,676</td>
</tr>
<tr>
<td>MAOP &gt; 1000 psig</td>
<td></td>
<td>1,927</td>
<td>1,451</td>
</tr>
<tr>
<td>&gt; 2 miles long</td>
<td></td>
<td>951</td>
<td>755</td>
</tr>
<tr>
<td>Water Depth &lt; 100’</td>
<td></td>
<td>520</td>
<td>327</td>
</tr>
<tr>
<td>In Service 1980 or later</td>
<td></td>
<td>355</td>
<td>Not Applied</td>
</tr>
<tr>
<td>Key Segments**</td>
<td></td>
<td>11</td>
<td>47</td>
</tr>
<tr>
<td>Median Diameter</td>
<td>16”</td>
<td>20”</td>
<td></td>
</tr>
<tr>
<td># of Lines MAOP &gt; 1,440 psig</td>
<td></td>
<td>0</td>
<td>10</td>
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**Key Segments = Come onshore/near-shore (TX, LA)
Pipeline Opportunity: Texas State Waters

Light blue lines are abandoned lines which are 8” or greater

Source: Prepared by Darrell Davis for Trimeric Corporation
Platforms – Federal Waters

Oil and Gas Platforms Installed in Federal Waters off of the Texas Coast

Total Platforms = 136
Installed After 1977 = 113
Installed After 2000 = 41

Oil and Gas Platforms Installed in Federal Waters off the Louisiana Coast

Total Platforms = 1,671
Installed After 1977 = 1,023
Installed After 2000 = 371
Platforms – CO₂ Topsides Requirements

- **General Equipment:** Valving, instrumentation, filters, pig receivers, piping manifold, heaters
- Drill new CO₂ injection wells
  - Weight of a drilling rig or need a separate jack-up rig for drilling
  - Need open slots for injections wells or re-use existing wells
- Booster compression/pumping (in some cases)
  - Additional topsides weight, space, power requirements
- Materials compatibility:
  - Supercritical CO₂ is a solvent, P, T considerations
- Do cost-savings of re-purposing vs. new-build hold up after modifications?
- More detailed engineering studies will be needed to:
  - Assess the integrity and useful life of specific platforms
  - Assess modifications to the topsides for CO₂ injection
  - Understand the cost of a new platform