Sampling & Gas Analysis for Underground Storage

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Mustang Sampling & Valtronics Solutions

Sampling Done Right.®

Presentation Outline

Mustang Sampling®

- Who We Are – Mustang Sampling
- Fundamentals of Gas Sampling & Analysis
- Sampling & Analysis of Stored Products
- Brief Overview on Renewables
- Questions

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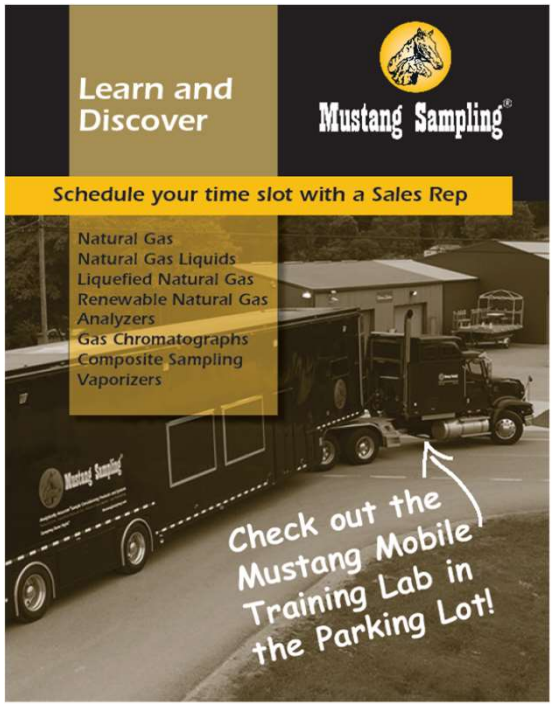



Mustang Sampling®
MUSTANG SAMPLING
Who We Are
ANALYTICALLY ACCURATE®
SAMPLE CONDITIONING
TECHNOLOGY AND SOLUTIONS
Sampling Done Right.®

About Mustang Sampling

Mustang Sampling, LLC is the innovator of Analytically Accurate® solutions within sample conditioning systems. We provide custom solutions of products and services globally to the Natural Gas, Natural Gas Liquids (NGL), and Liquefied Natural Gas (LNG) industries.

Mustang Sampling continues to pioneer integrated control systems, allowing our customers to maintain phase stability from sample extraction at the source through sample analysis. Our products are continuously improved and subjected to the highest quality standards which provides our customers with the best sample conditioning solutions.

Mustang Sampling History

1985

VALTRONICS

Valtronics was formed in 1985 primarily to serve the natural gas industry. And quickly aligned with industry leading manufacturers such as Emerson, Bailey Controls, and Daniel . Company growth driven by expansion of services and integrated systems. Turnkey metering systems expanded into analyzer buildings.

2008

MUSTANG SAMPLING

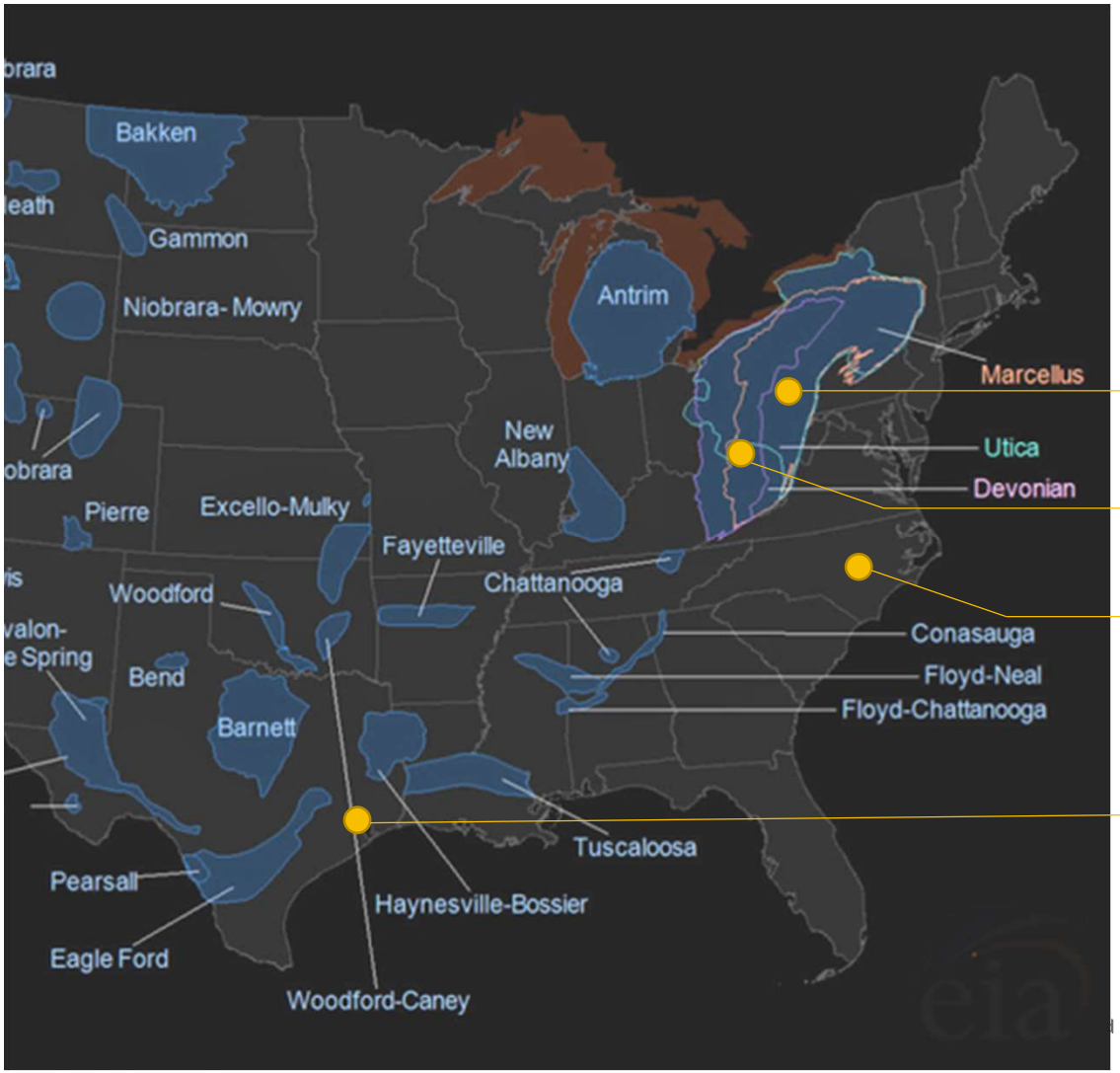
Mustang Sampling was formed in 2008 to further develop intellectual property

2015

Further growth into Natural Gas Liquids (shale), LNG markets and Renewable Natural Gas to drive continual growth

2019

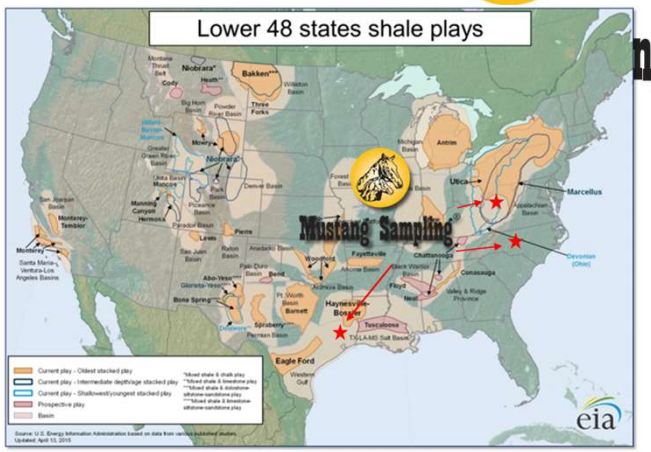
Expansion of Renewable Natural Gas measurement and analysis from anaerobic digestion from agricultural waste, wastewater, and food



Mustang Sampling®

Mustang Sampling – Who We Are

- Mustang Sampling is dedicated to providing Analytically Accurate® solutions, products, systems, and services to all areas of the natural gas industry
  - Complete fiscal metering systems
    - Orifice, Ultrasonic, Coriolis, Turbine Meters
  - Sampling systems for natural gas, liquids, and LNG
  - Energy measurement systems
  - Design, Civil, Construction, Commissioning, Sales, and Maintenance support
- Product Development
  - Sampling products developed primarily from necessity
  - Virtually all products address specific customer need



Mustang Sampling Core Business

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  - Complete fiscal metering systems
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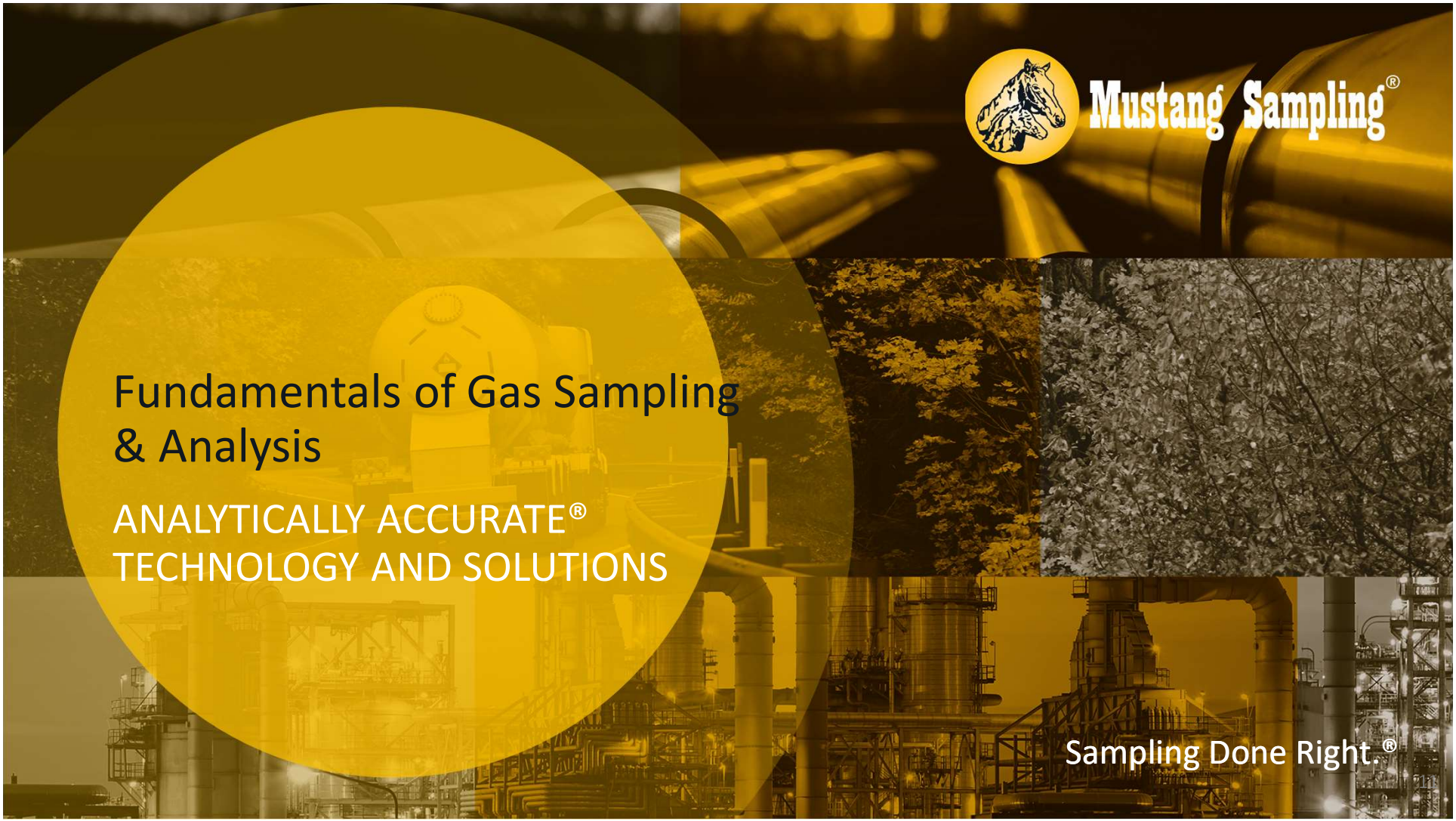
  - Sampling systems for natural gas, liquids, and LNG
  - Energy measurement systems
  - Design, Civil, Construction, Commissioning, Sales, and Maintenance support

Mustang Sampling's Experience

- Natural Gas Liquid Analysis is Core Competency
  - Early experience developed in Texas in and around Mont Belvieu
    - Enterprise Products
    - ONEOK
  - Used vaporizing techniques to convert liquids to gas
  - Expanded to heavier liquids than ethane and propane
  - Created Intellectual property available globally
  - Appalachian Storage Hub will be similar to Mont Belvieu


Mustang Sampling®
Fundamentals of Gas Sampling
& Analysis
ANALYTICALLY ACCURATE®
TECHNOLOGY AND SOLUTIONS
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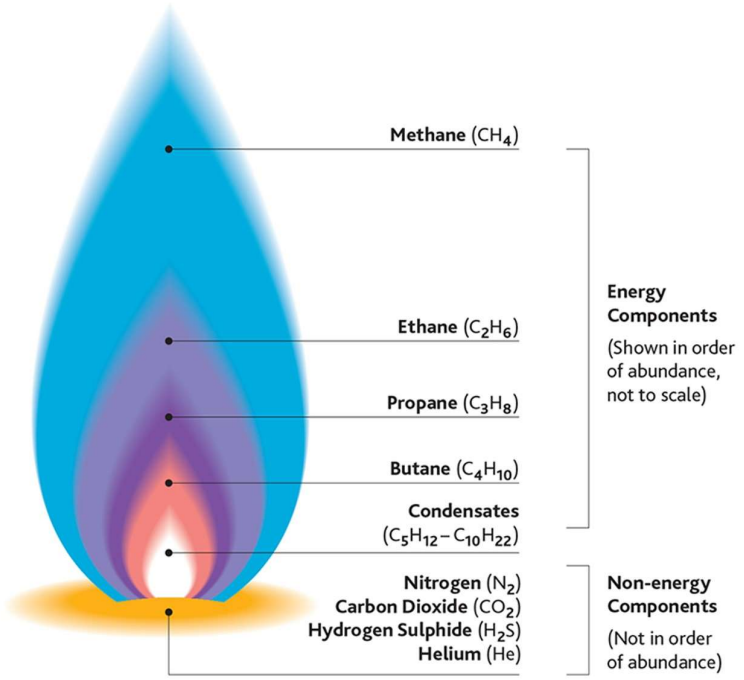
What is Sampling & Why Sample?

- A small, representative sample is extracted from a larger amount for analysis
  - Determination of value (custody transfer)
  - Regulatory or Taxation
  - Process Control
  - Heath & Safety
- Sampling and analysis can be performed online or separately in laboratories



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Fundamentals of Sampling
Analytically Accurate® Methods & Processes

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Fundamentals of Sampling – Part 1
Sampling allows the user to understand the content of their vessel or pipeline

Analytically Accurate sampling requires all of the following:

A Properly Mixed Sample
Tapping sample from vessel or pipeline
Extraction of a representative sample

Fundamentals of Sampling
Analytically Accurate® Methods & Processes

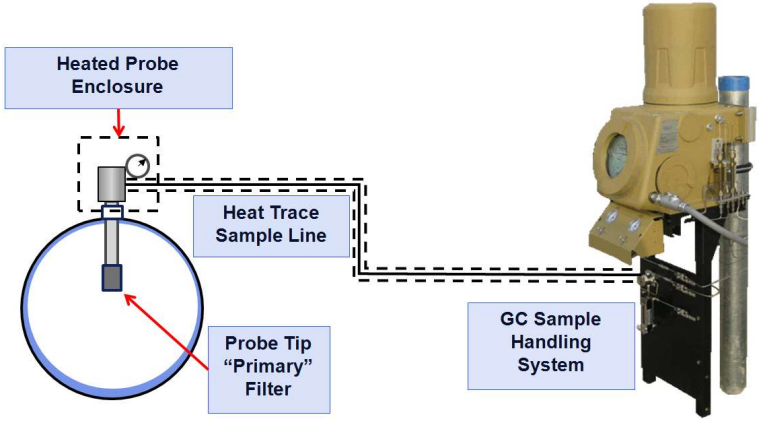
Mustang Sampling®

Fundamentals of Sampling – Part 2

Sampling allows the user to understand the content of their vessel or pipeline

Analytically Accurate sampling requires all of the following:

- Tapping sample from reservoir contained in vessel or pipeline
- Extraction of a representative sample from a vessel or pipeline
- Transportation of sample to sample conditioning system
- Adjustment of sample pressure and temperature
- Transformation to gas phase of sample if needed
- Delivery of sample to analyzer



Sampling Techniques & Requirements

Sample conditioning and sampling systems are customized for the range of products being analyzed

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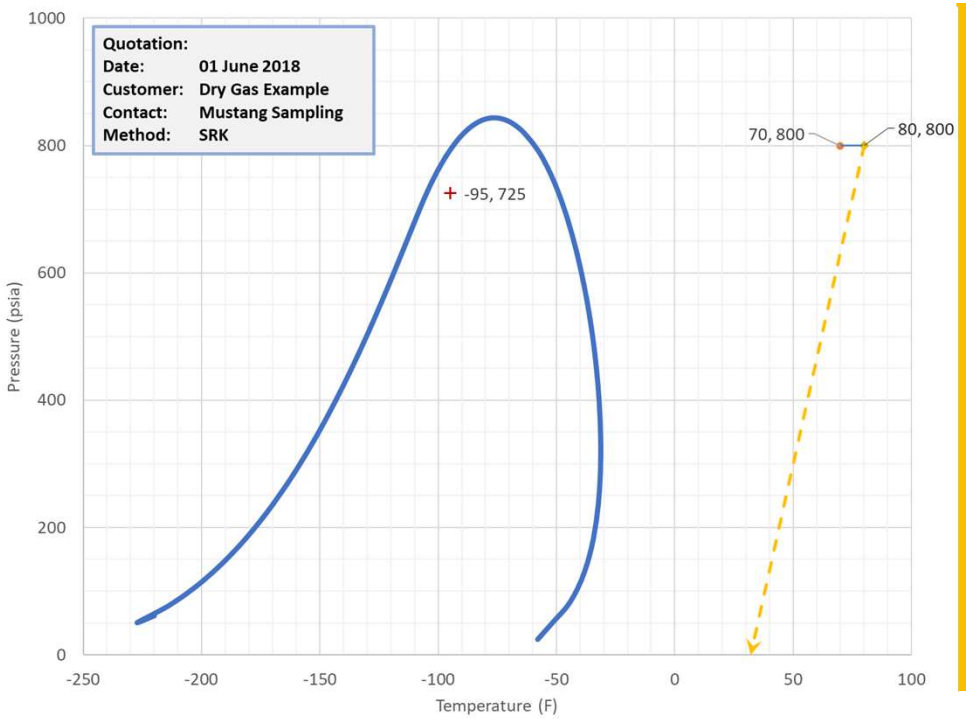
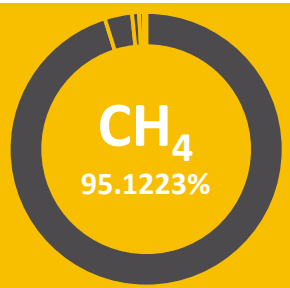
Phase Curve Example with Mustang® Heated Regulator at 80° F

- Sample point
- Critical point
- Mustang Sampling Point
- Temp/Pressure Decrease





No.	Name	Formula	Molar %
1	Methane	CH4	95.1223
2	Ethane	C2H6	3.2142
3	Carbon Dioxide	CO2	0.8215
4	Nitrogen	N2	0.5663
5	Propane	C3H8	0.1977
6	n-Butane	C4H10	0.0263
7	Isobutane	C4H10	0.02385
8	Isopentane	C5H12	0.00885
9	n-Hexane	C6H14	0.00809
10	n-Pentane	C5H12	0.00536
11	n-Heptane	C7H16	0.00405
12	n-Octane	C8H18	0.00135

Sampling & Analysis of Natural Gas Liquid

Analytically Accurate® Methods & Processes

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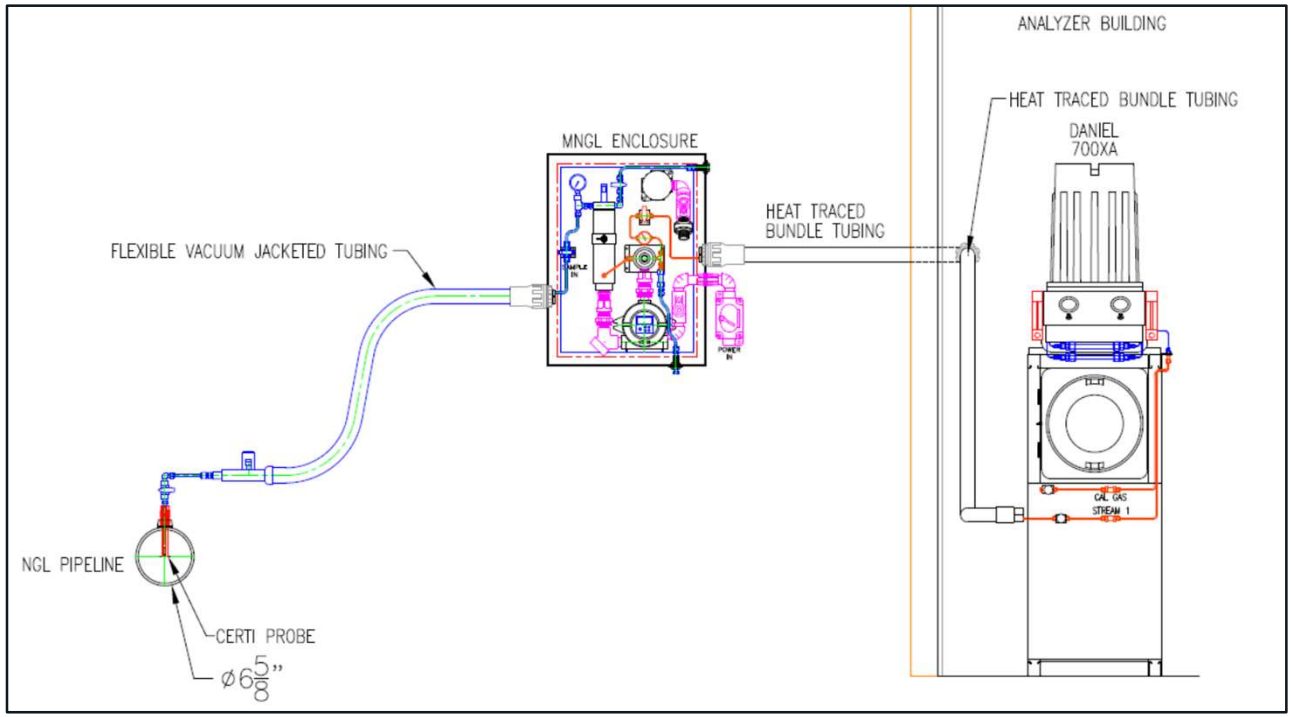

Bespoke NGL Sample Conditioning

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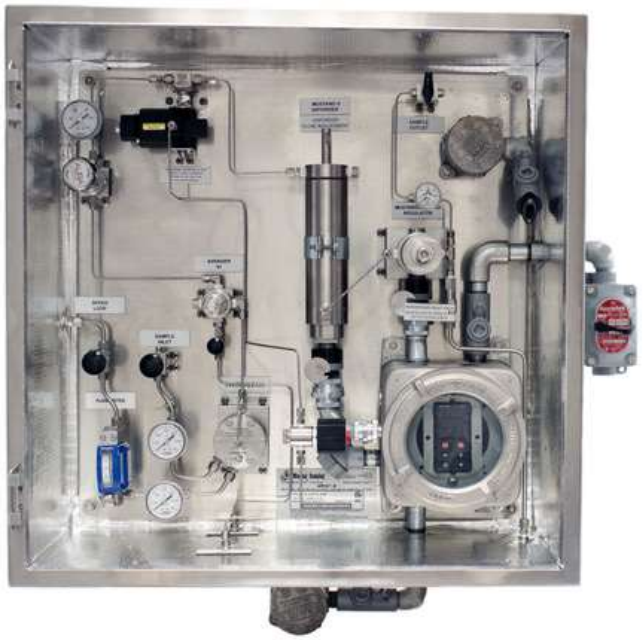
- Vaporization is necessary for heavy or liquid samples
  - Boiling point determines requirement
  - Line between liquid and vapor not clear
- Required temperature may exceed limits of equipment in some cases
- Sample points may not be ideal
  - Sample point often inside two phase envelope
  - Liquid volume fractions fluctuate widely near critical points



Sampling & Analysis of Natural Gas

Analytically Accurate® Methods & Processes

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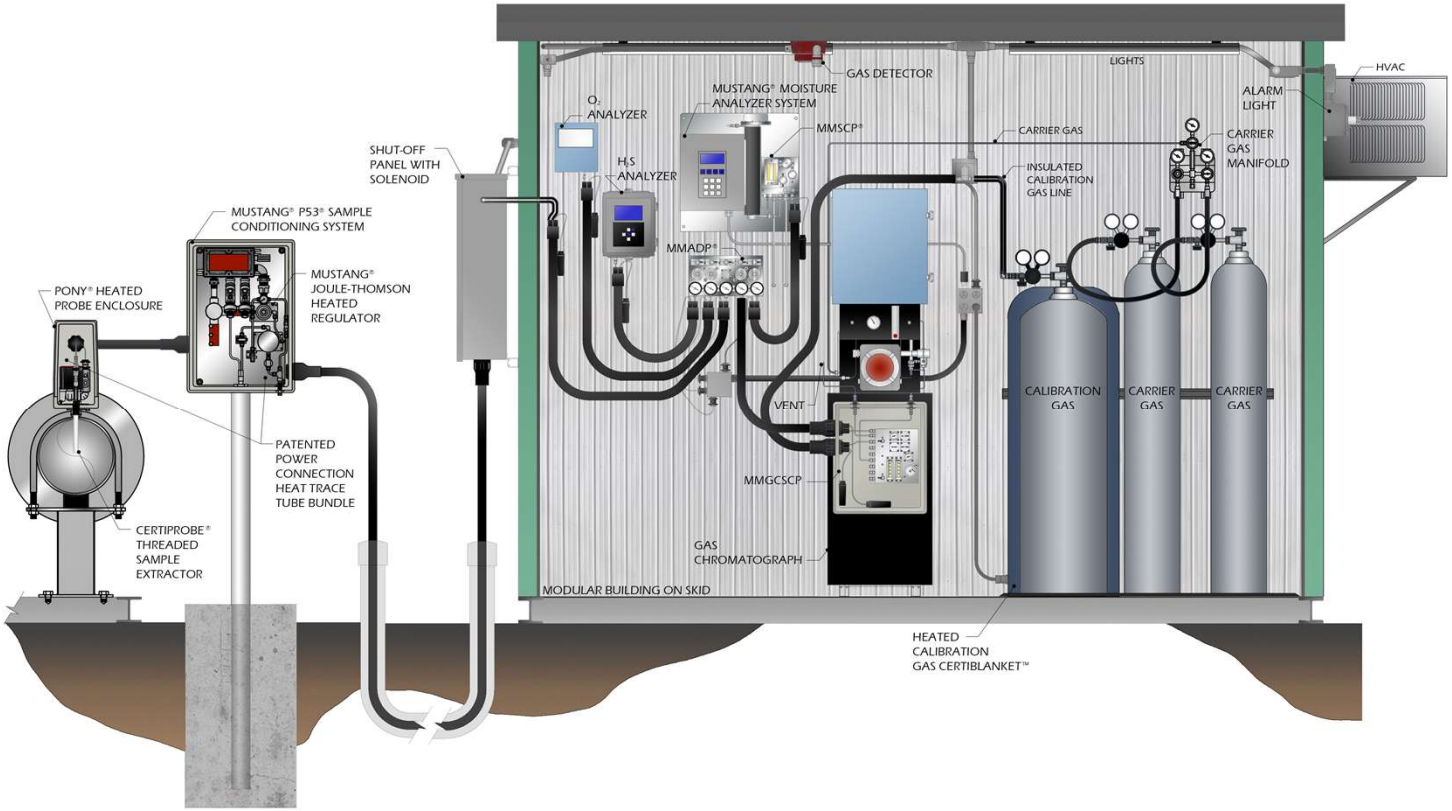


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Sampling of Products Stored Underground
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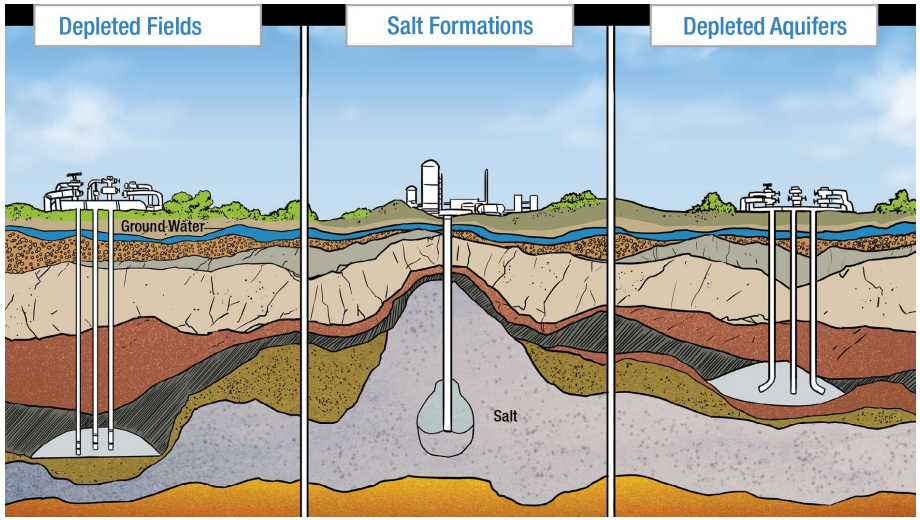
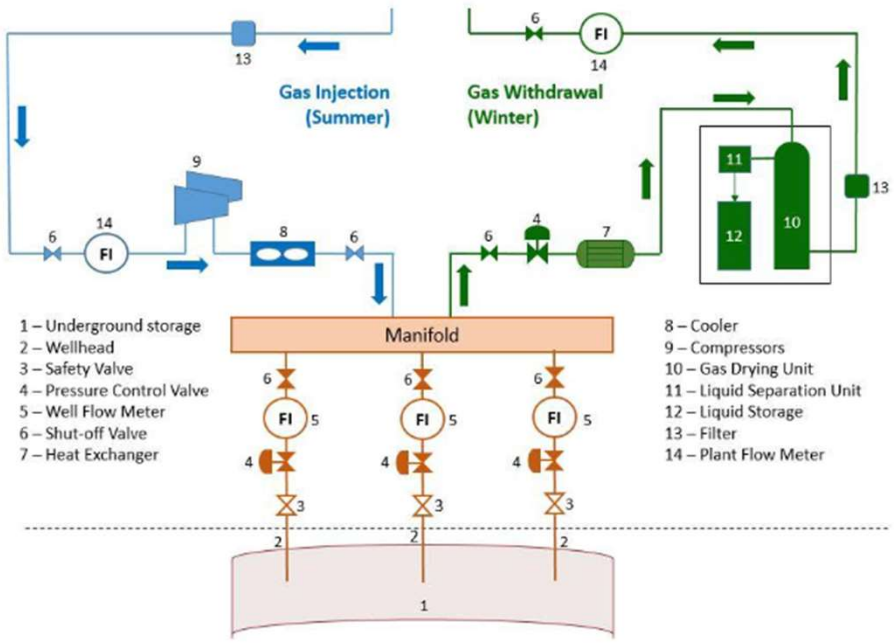
Underground Storage Structures

- Underground storage hubs are actually dozens of independently formed voids of various types
  - Salt caverns
  - Manmade structures
  - Depleted porous structures
- Networks are created to connect each structure
- Storage hubs grow for decades as additional formation are created
- Natural gas storage in the US is about 4,000 Billion Cubic Feet



Challenges with Underground Storage Measurement & Analysis

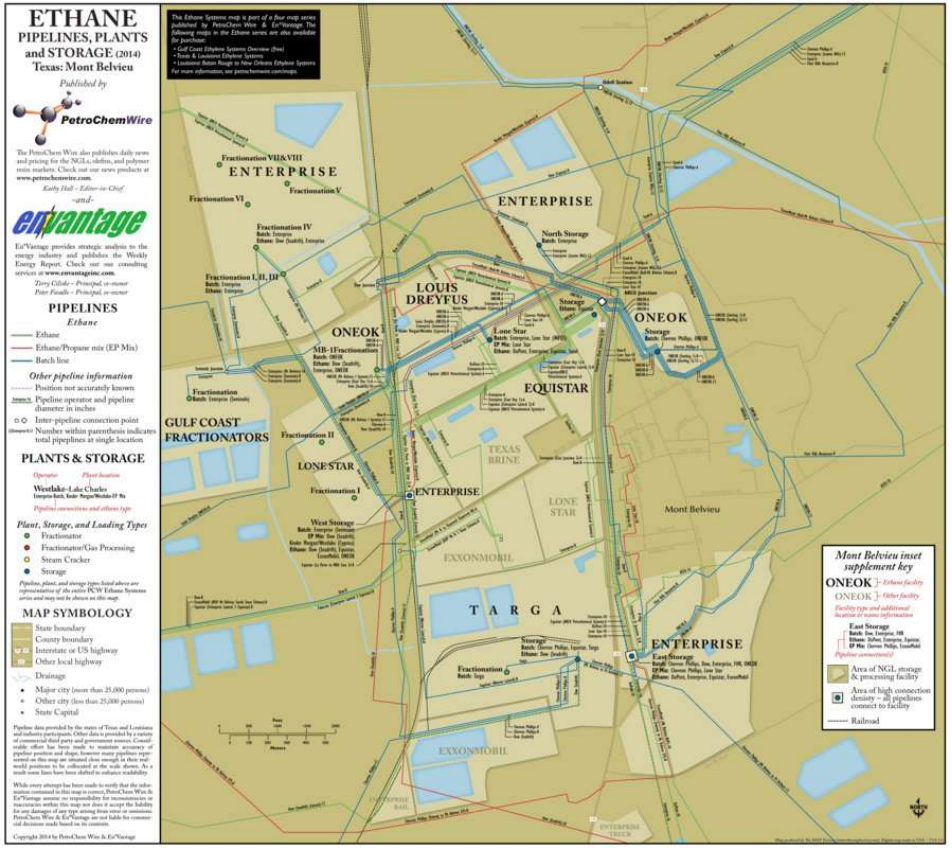
- Measurements are inherently bi-directional
  - Flow measurement balance
  - Composition balance
- Contamination within structures is common
  - Water
  - Chemically reacted products
- Operations tend to be seasonal



Mont Belvieu, TX Storage Hub

Key Features Associated with NGL

- Map is approximately 10 square miles
- Facility has roots more than 60 years old
- Enterprise, ONEOK, Lone Star NGL, & Targa Resources have major facilities
- Area includes Natural Gas Processing Plants, Fractionation Plants, NGL Pipelines, NGL Storage, Import & Export Facilities, Rail & Truck Facilities
- Facility is located within 30 miles of Houston, Texas (4.7M people)
- Facility is often confused with Strategic Oil Reserve due to its size and location



Potential & Existing Ethane Impact in Appalachian Valley

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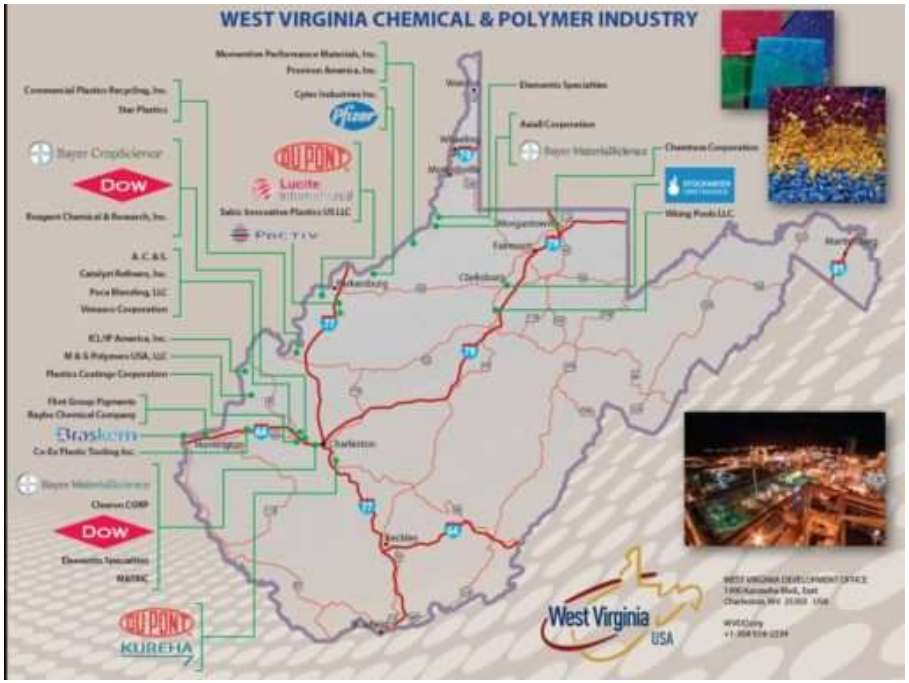

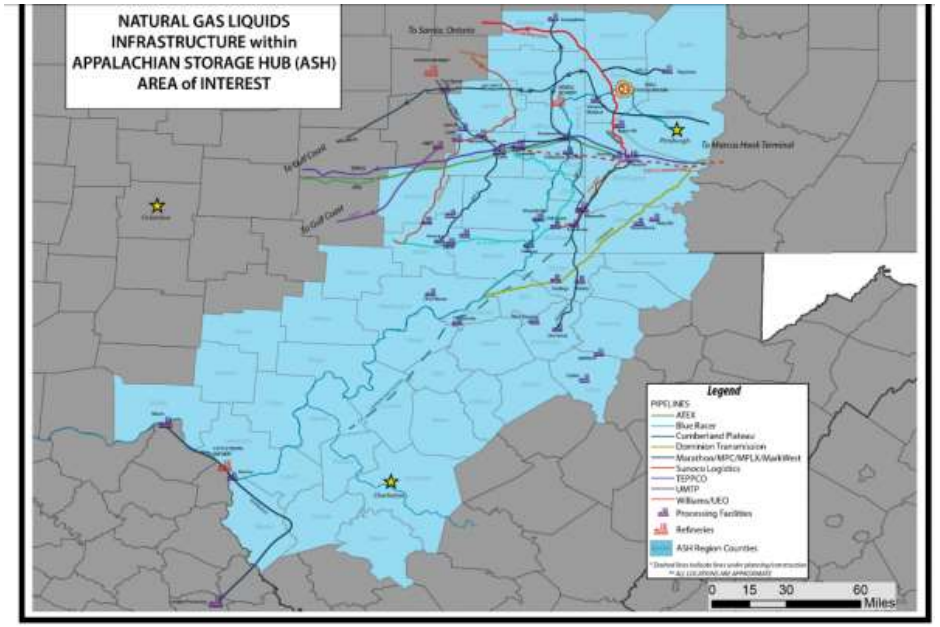

Figure 4-26. Natural gas liquids infrastructure (existing and planned) within the AOI. All locations are approximate.


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Renewables Impact on Underground Storage
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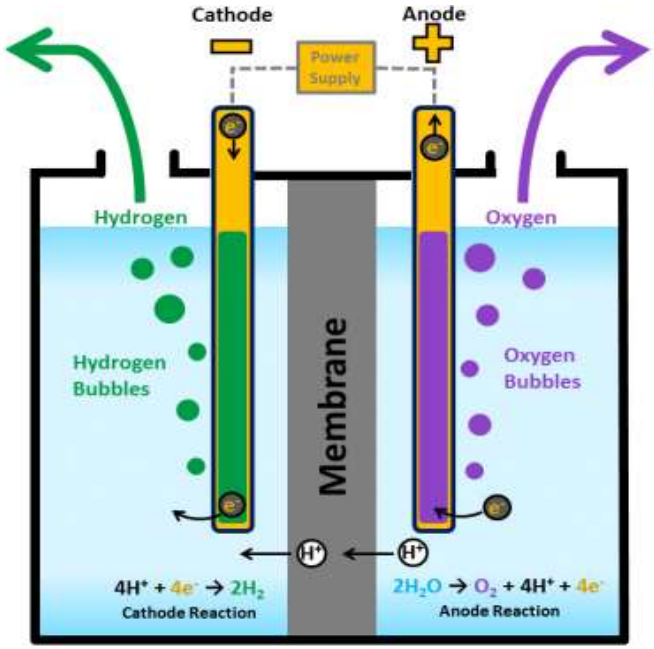
Mustang Sampling Renewables

- Renewable Natural Gas (RNG) is the fastest growing segment for energy sources & Mustang Sampling
- Landfills and agriculture were the first applications
- RNG is methane from anaerobic digesters that is interchangeable with natural gas
- RNG requires specially designed sampling systems and analyzers

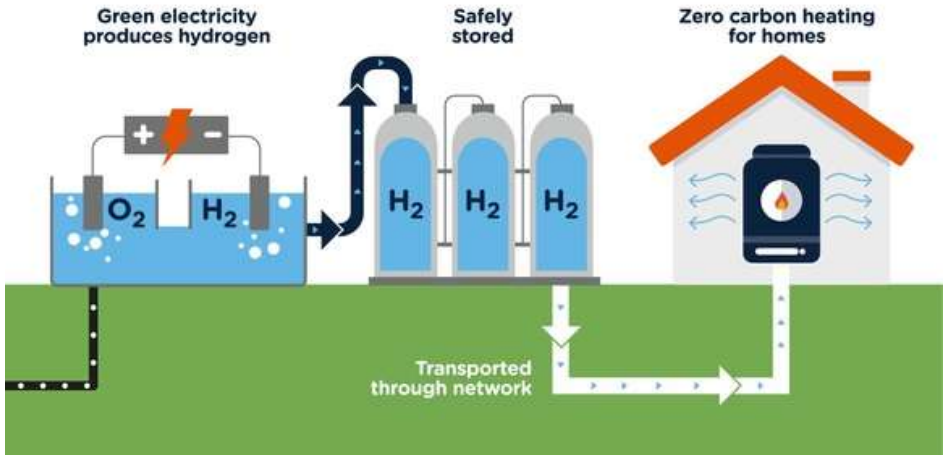
Hydrogen as Renewable Energy

- Hydrogen is a carbon-free energy source that can stored similarly to natural gas
- Hydrogen can be generated through the electrolysis of water by a variety of methods
- Stranded electricity sources (especially from solar or wind) can be used to create hydrogen, which can be injected into the energy grid
- Hydrogen injected underground or into pipelines requires special attention because of hydrogen's active chemical nature



Hydrogen as Renewable Energy

- Hydrogen has tremendous appeal as a renewable fuel and can replace batteries as a storage medium
- Hydrogen can be transported and stored through existing pipelines and storage caverns
- Net Energy output remains a significant technical obstacle for hydrogen as an energy source
  - Energy “in” vs. Energy “out”



Challenges Presented by Hydrogen

- Hydrogen is highly reactive and requires attention since it permeates metals and elastomers
- Hydrogen is a “Group B” gas
- Hydrogen challenges include energy density, efficiency, durability, cost, and life cycle
- Hydrogen may supplement energy, especially in the short term, but infrastructure costs are currently very high

Hydrogen cavern in Australia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Questions?
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