Kemper CO_2 Storage Complex: Pipeline and Surface Facility Design Considerations

Presentation for Project ECO2S Workshop at 2023 CO2GeoNet Conference

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October 2, 2023

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Trimeric Corporation: Process engineering services

- Founded in 2003 in Buda, TX
- Diversified across industries, specialized in process engineering
- CO_2 capture & processing expertise
  - Pipeline flow analysis
  - Compression and dehydration
  - Pump skids for injection tests
  - Liquefaction and distillation
  - EOR facilities for Gas plant/recycle
  - Source assessments for Carbon SAFE
  - Capture from Power Plants
  - Capture from Industrial Sources
  - Process simulation
  - TEAs
  - Food and beverage grade CO_2 facilities
  - Process safety

1 MM tonne/yr facility design. Blower (left) and compressor (right) skids

Project Consulting Services, Inc.: PCS

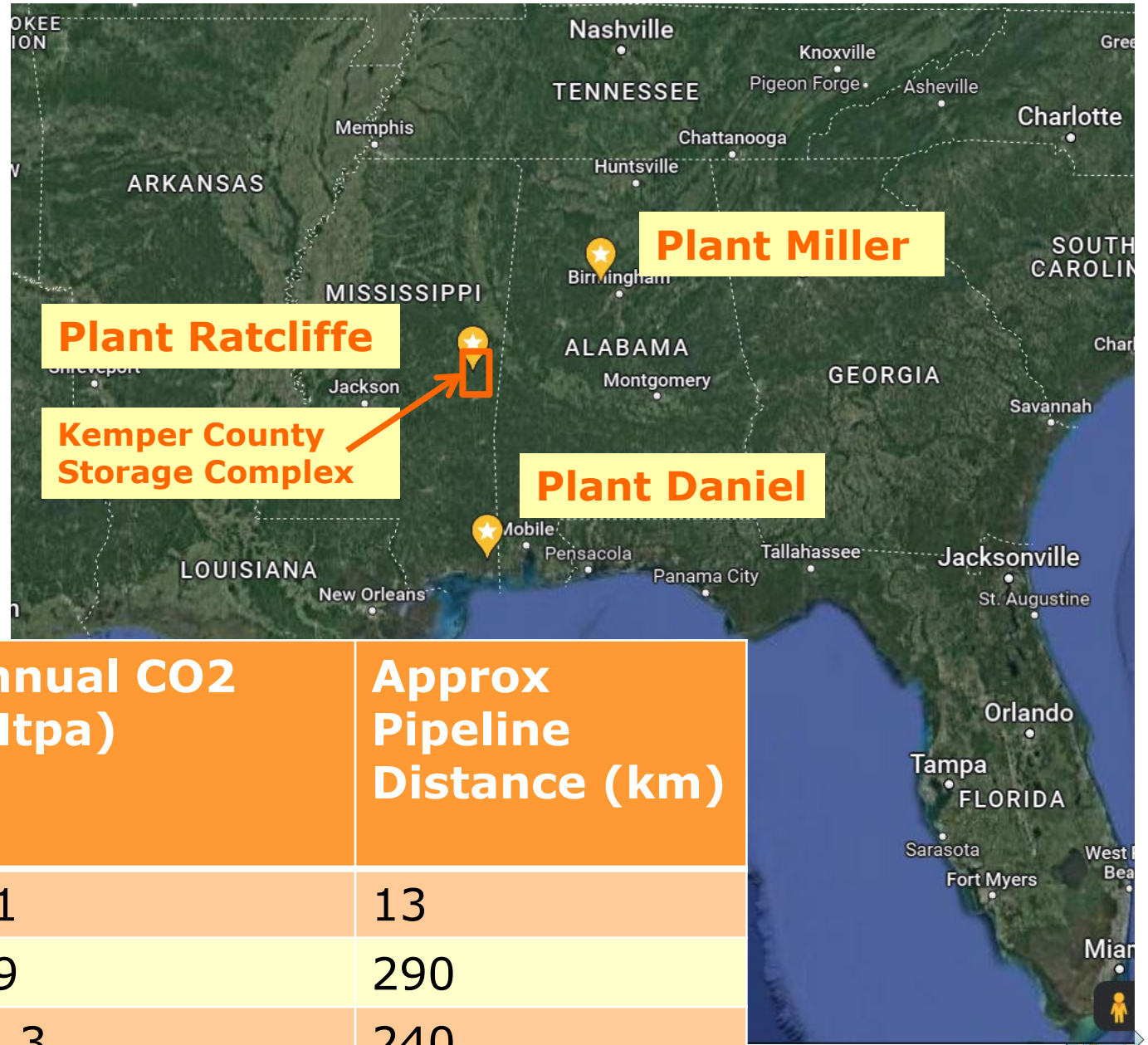
- Founded in 1992 in New Orleans, LA
- Provider of project and design services to the pipeline and pipeline facilities industry
- Thousands of miles of pipeline development projects onshore and offshore
- Over 20 years of CO_2 transportation expertise
  - Approximately 600 miles of CO_2 pipelines, multiple pump, meter and mainline valve stations
  - A history of studies and early-phase development
    - Feasibility, pre-FEED and FEED projects
  - Expertise in transporting CO_2 via pipeline
    - Routing
    - Permitting
    - Procurement
    - Construction

Plant Ratcliffe is closest CO_2 source to Kemper Storage Complex

- Southern Company, Mississippi Power
- NGCC: 2 CT x 1 ST
- 770 MWe nameplate
- Max CO_2 rate: 287 tonne/hr
- Max CO_2 rate: 6,888 t/d
- Min CO_2 rate: 133 tonne/hr
- 85% annual capacity factor
- 2.1 Mtpa
- 64 Mt over 30 years to Storage

Trimeric Corporation

Kemper Storage Complex is near several other large CO_2 sources



Power Plant	Nameplate Generating Capacity (MWe)	Annual CO2 (Mtpa)	Approx Pipeline Distance (km)
Ratcliffe (NGCC)	770	2.1	13
Daniel (NGCC)	1,070	2.9	290
Miller (coal)	2,640	17.3	240

Initial concept for 2 wells for Plant Ratcliffe

- Ratcliffe max CO_2: 6,888 t/d
- Injection wells at 19-2 and 32-1
  - Each designed for 4,000 t/d
  - Required injection P
    - > 1,200 psig
    - > 8.4 MPa
    - > 84 bara

Pipeline FEED Study

- FEED = Front-End Engineering and Design
- 13-km route at Kemper Complex: from Ratcliffe + future phases
- Early-phase, desktop study; no field survey
- Environmental Information already gathered by ECT:
  - Land use
  - Hydrologic and Geologic/Soil conditions
  - Vegetation and wildlife resources
  - Socioeconomic conditions
  - Historic/Cultural resources

Pipeline FEED Study Deliverables

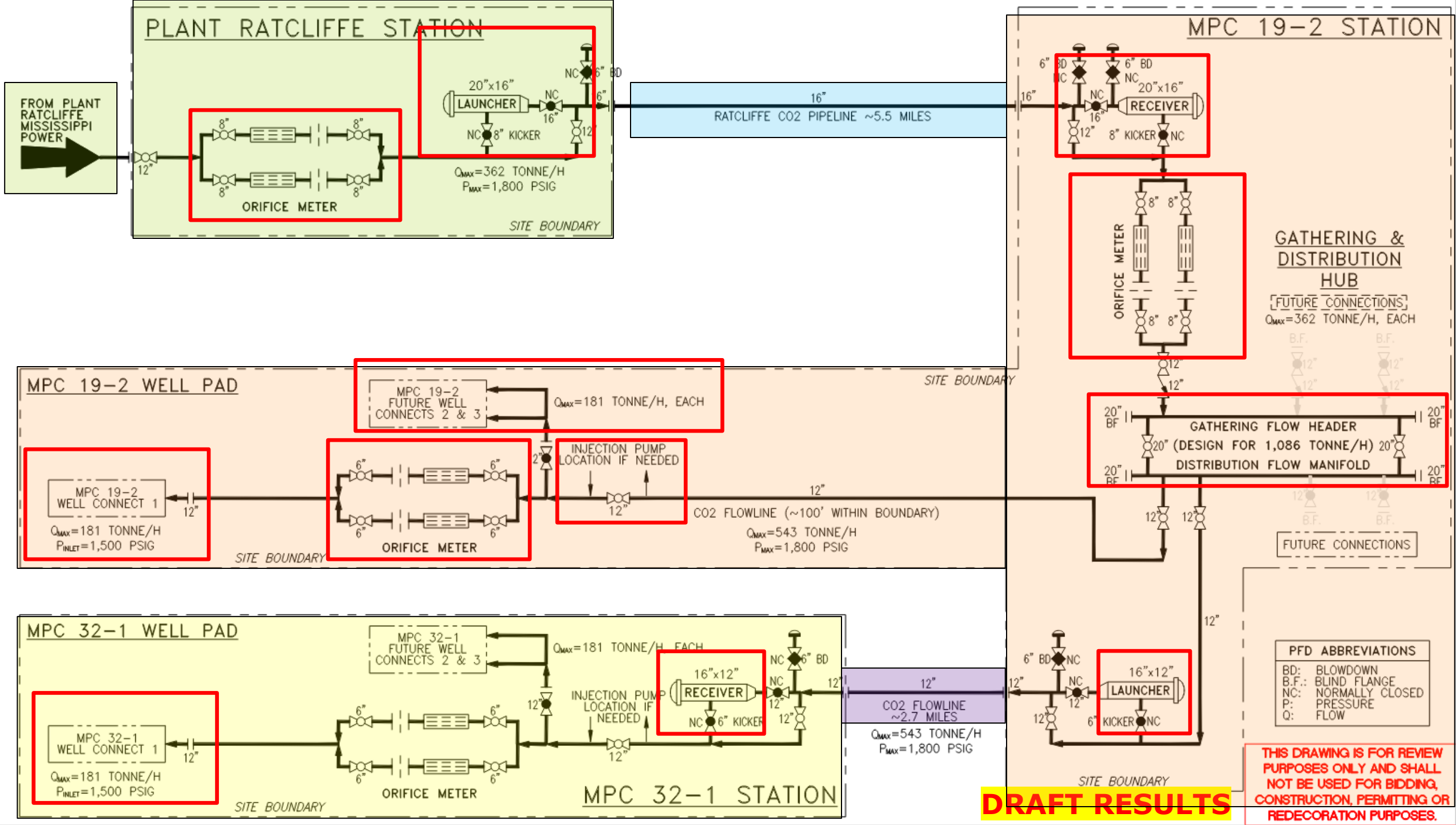
- Basis of Design
- Permit Matrix
- Desktop route study
- Desktop geotechnical study
- Route map books
- PFDs
- P&IDs
- Risk register
- Project management plan
- Project schedule
- Hydraulic analysis (primary and optional routes)
- Bill of Materials
- Total Installed Cost (Class 3)
- Report narrative

FEED Study Results presented here are under review, and not yet finalized

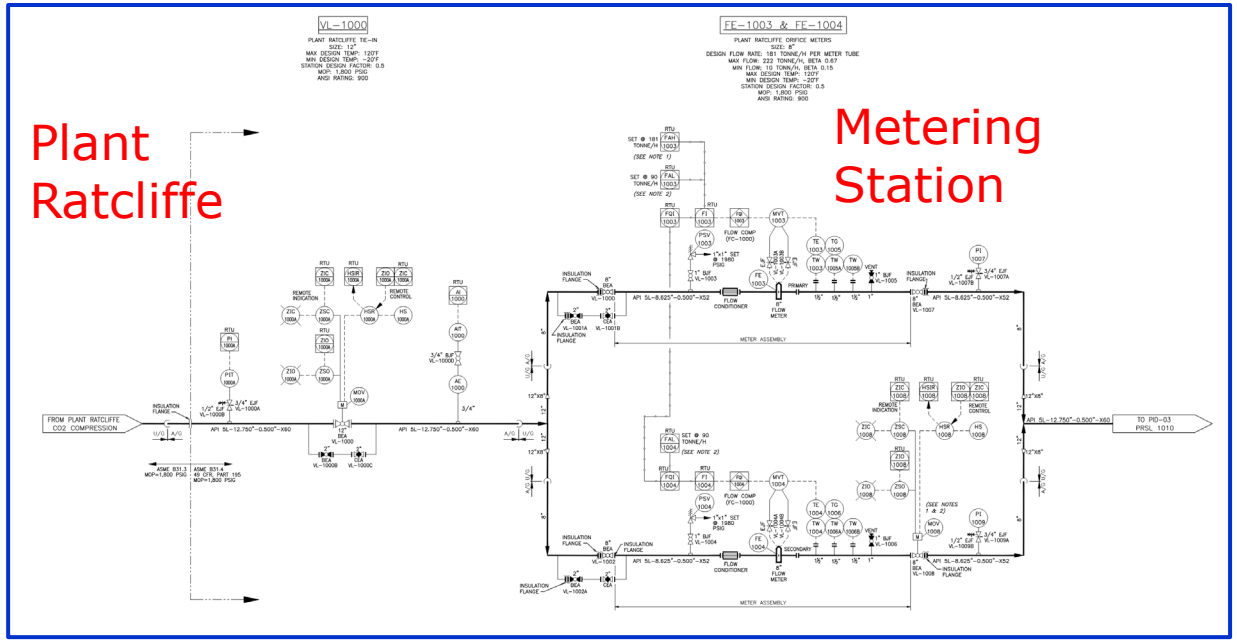
Hydraulic Modeling Parameters

- CO_2 from Plant Ratcliffe:
  - Max flow rate: 362 tonne/hr
  - Normal operating conditions: 1,700 psig, 120°F
- Well Specification:
  - Pressure required: 1,500 psig
  - Maximum injection rate at each well of 181 tonne/hour
- Composition modeled
  - Worst case for hydraulic model
  - Plant Ratcliffe CO_2 will have higher purity

Component	Modeled Mole Basis
CO_2	95.9337%
H_2O	630 ppmv
H_2S	20 ppmv
N_2	2.0%
CH_4	2.0%
O_2	13 ppmv
SUM	100%

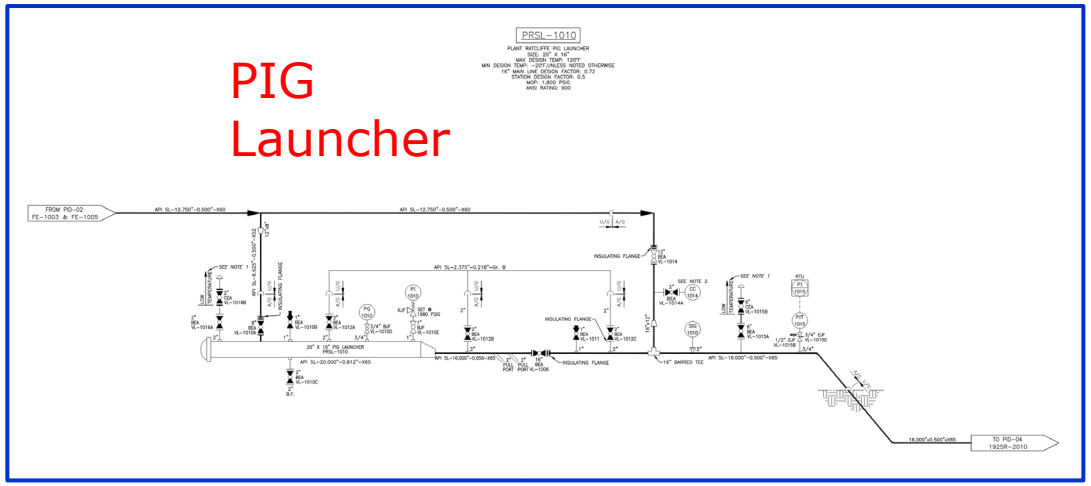

PLANT RATCLIFFE STATION
FROM PLANT RATCLIFFE MISSISSIPPI POWER
12"
8"
ORIFICE METER
20"x16"
LAUNCHER
NC
6" BD
8" KICKER
16"
12"
Q_{MAX}=362 TONNE/H
P_{MAX}=1,800 PSIG
SITE BOUNDARY
16"
RATCLIFFE CO2 PIPELINE ~5.5 MILES
MPC 19-2 STATION
RECEIVER
ORIFICE METER
GATHERING & DISTRIBUTION HUB
FUTURE CONNECTIONS
Q_{MAX}=362 TONNE/H, EACH
GATHERING FLOW HEADER
20" (DESIGN FOR 1,086 TONNE/H)
DISTRIBUTION FLOW MANIFOLD
20" BF
B.F.
MPC 19-2 WELL PAD
MPC 19-2 FUTURE WELL CONNECTS 2 & 3
Q_{MAX}=181 TONNE/H, EACH
INJECTION PUMP LOCATION IF NEEDED
MPC 19-2 WELL CONNECT 1
Q_{MAX}=181 TONNE/H
P_{INLET}=1,500 PSIG
CO2 FLOWLINE (~100' WITHIN BOUNDARY)
Q_{MAX}=543 TONNE/H
P_{MAX}=1,800 PSIG
MPC 32-1 WELL PAD
MPC 32-1 FUTURE WELL CONNECTS 2 & 3
Q_{MAX}=181 TONNE/H, EACH
16"x12"
MPC 32-1 WELL CONNECT 1
Q_{MAX}=181 TONNE/H
P_{INLET}=1,500 PSIG
CO2 FLOWLINE ~2.7 MILES
Q_{MAX}=543 TONNE/H
P_{MAX}=1,800 PSIG
MPC 32-1 STATION
PFD ABBREVIATIONS
BD: BLOWDOWN
B.F.: BLIND FLANGE
NC: NORMALLY CLOSED
P: PRESSURE
Q: FLOW
THIS DRAWING IS FOR REVIEW PURPOSES ONLY AND SHALL NOT BE USED FOR BIDDING, CONSTRUCTION, PERMITTING OR REDECORATION PURPOSES.
DRAFT RESULTS

Plant Ratcliffe

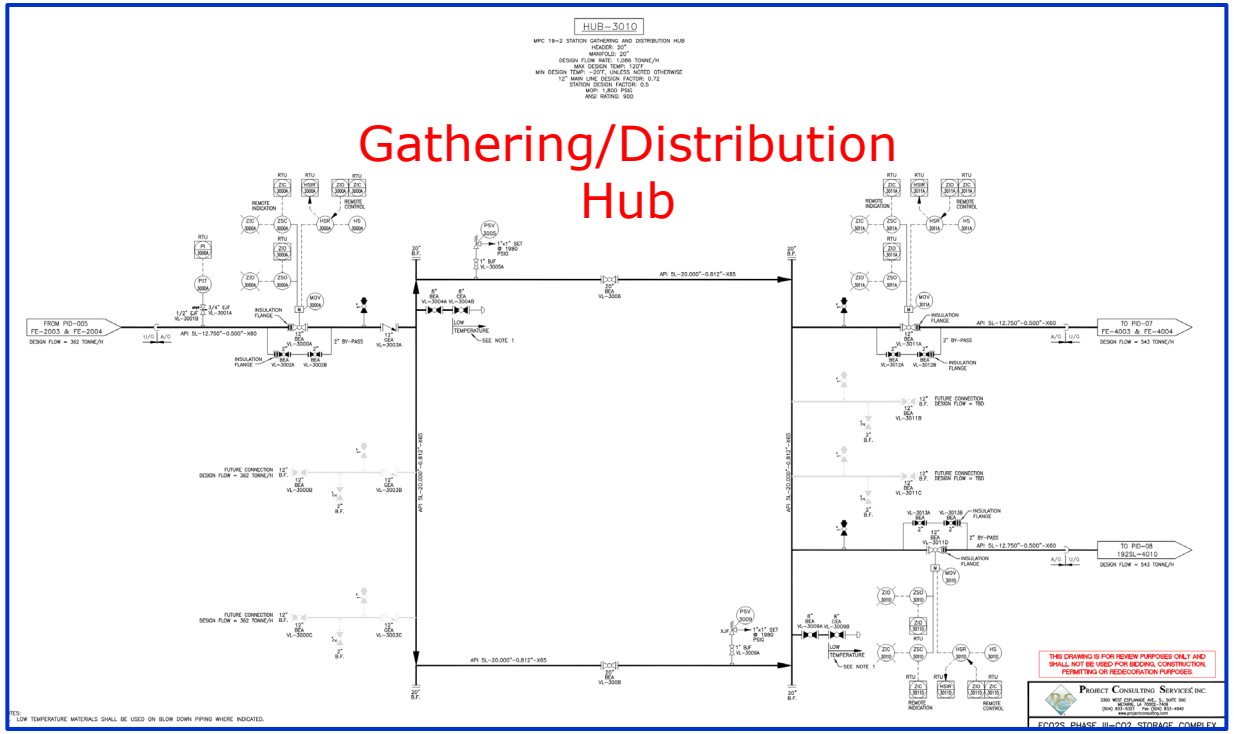


Metering Station

PIG Launcher

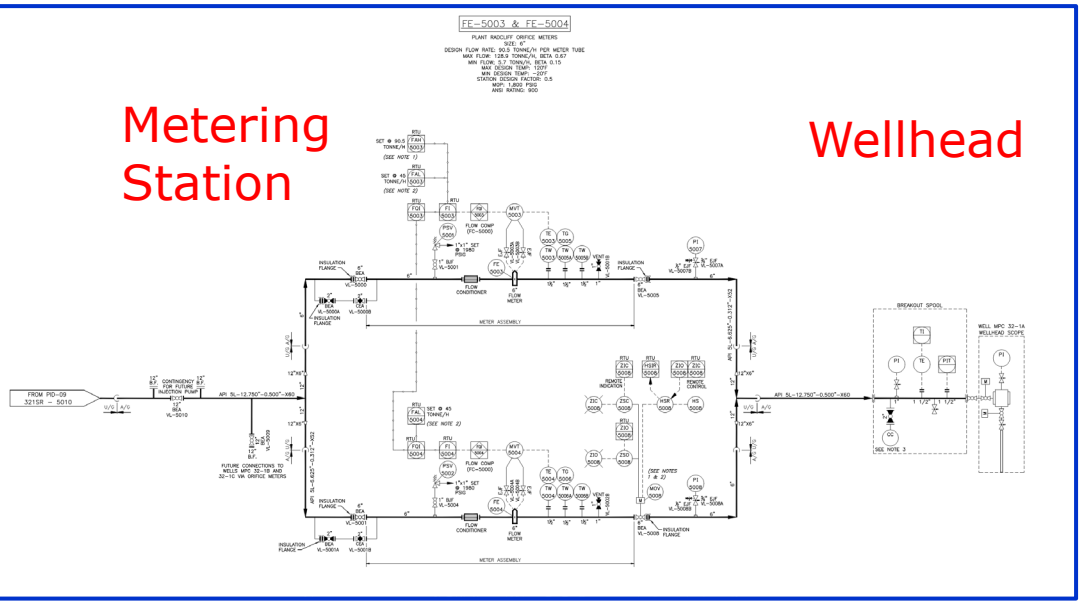


Gathering/Distribution Hub



Metering Station

Wellhead



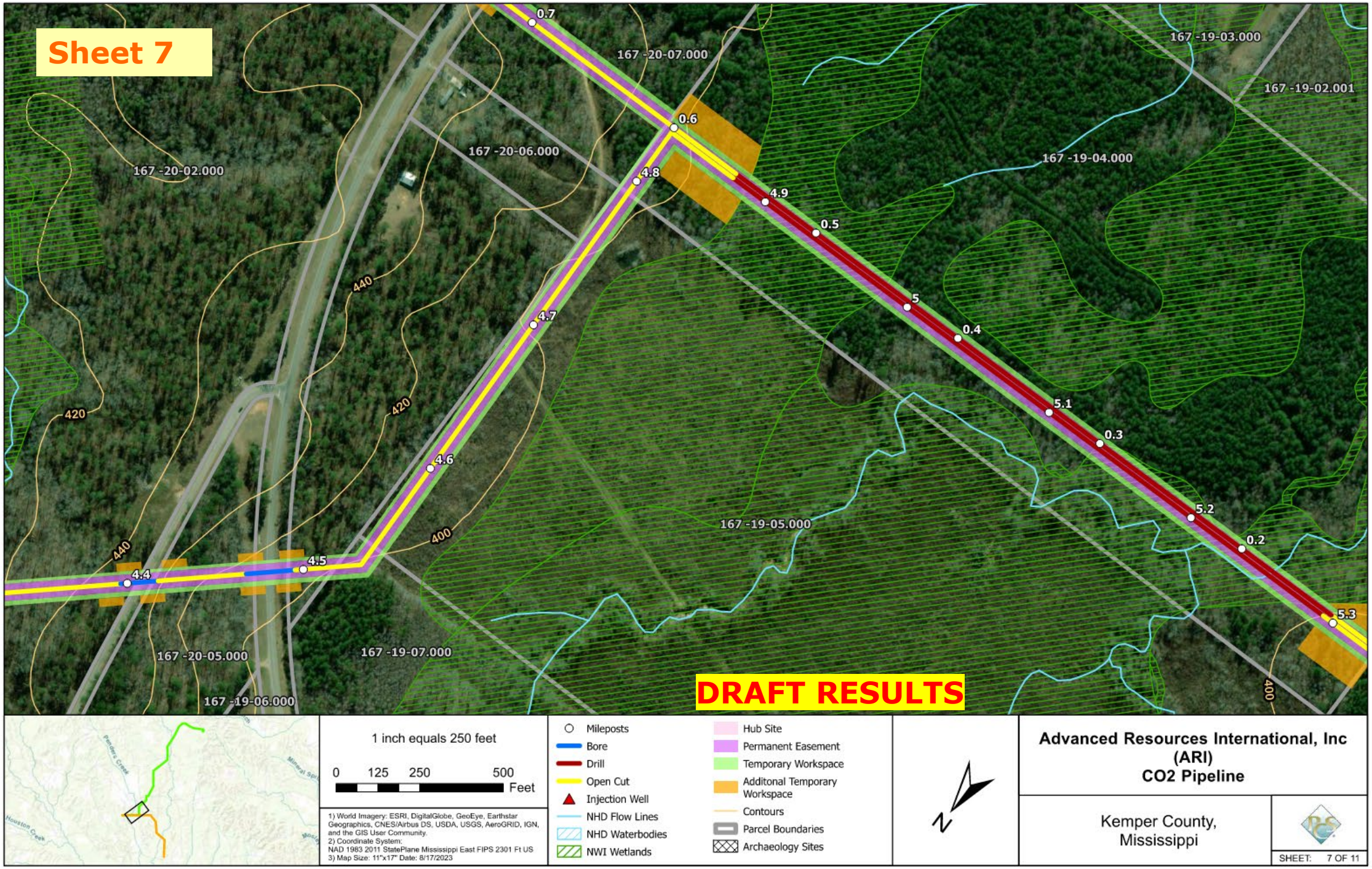
DRAFT RESULTS

Route Selected to Mitigate Permitting and Construction risks

- Other Factors: length, hydraulics, water crossings, soils, topography, public opinion, population density, industrial development areas
- Internal environmental review to minimize impacts to wetlands and archaeological features
  - > 100’ buffer around cultural/archaeological features
  - Wetlands crossed include Freshwater Emergent Wetland and Freshwater Forested/Shrub Wetland

Adjusted route for constructability and workspace requirements

- Permanent Easement: 50 feet
- Temporary Workspace (TWS): Working Side 15 feet / Spoil Side 10 feet
- Additional TWS: each unique, most common is 25 feet wide


Sheet 7
0.7
167 -20-07.000
167 -19-03.000
167 -19-02.001
0.6
167 -20-06.000
167 -20-02.000
4.8
4.9
167 -19-04.000
0.5
440
5
4.7
0.4
420
420
5.1
0.3
4.6
167 -19-05.000
5.2
400
0.2
440
4.5
4.4
5.3
167 -20-05.000
167 -19-07.000
167 -19-06.000
400
DRAFT RESULTS
1 inch equals 250 feet
0 125 250 500 Feet
1) World Imagery: ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
2) Coordinate System: NAD 1983 2011 StatePlane Mississippi East FIPS 2301 Ft US
3) Map Size: 11"x17" Date: 8/17/2023
Mileposts
Bore
Drill
Open Cut
Injection Well
NHD Flow Lines
NHD Waterbodies
NWI Wetlands
Hub Site
Permanent Easement
Temporary Workspace
Additonal Temporary Workspace
Contours
Parcel Boundaries
Archaeology Sites
Advanced Resources International, Inc (ARI)
CO2 Pipeline
Kemper County, Mississippi
SHEET: 7 OF 11

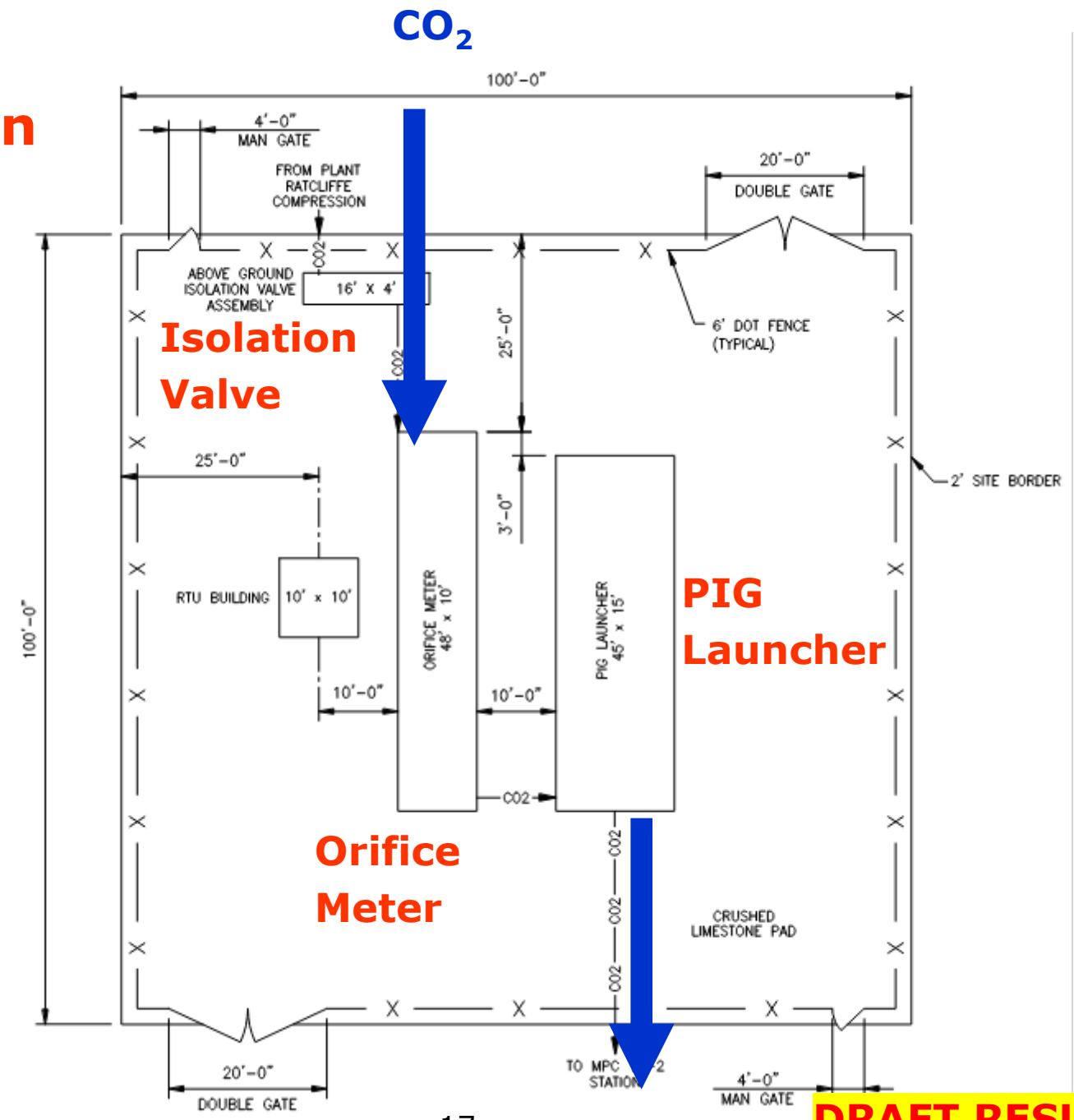
Route Corridor Summary

- Total Length = 43,035 linear feet (LF)
- Est No of HDDs = 3 (5,400 LF) [horizontal directional drilling]
- Est No of Bores = 16 (1,800 LF)
- Est No of Road Crossings = 4
- Est. No of Bends = 20
- No of Pipeline Crossings = 0

Plant Ratcliffe Station Conceptual Layout

100’ x 100’

Crushed limestone pad



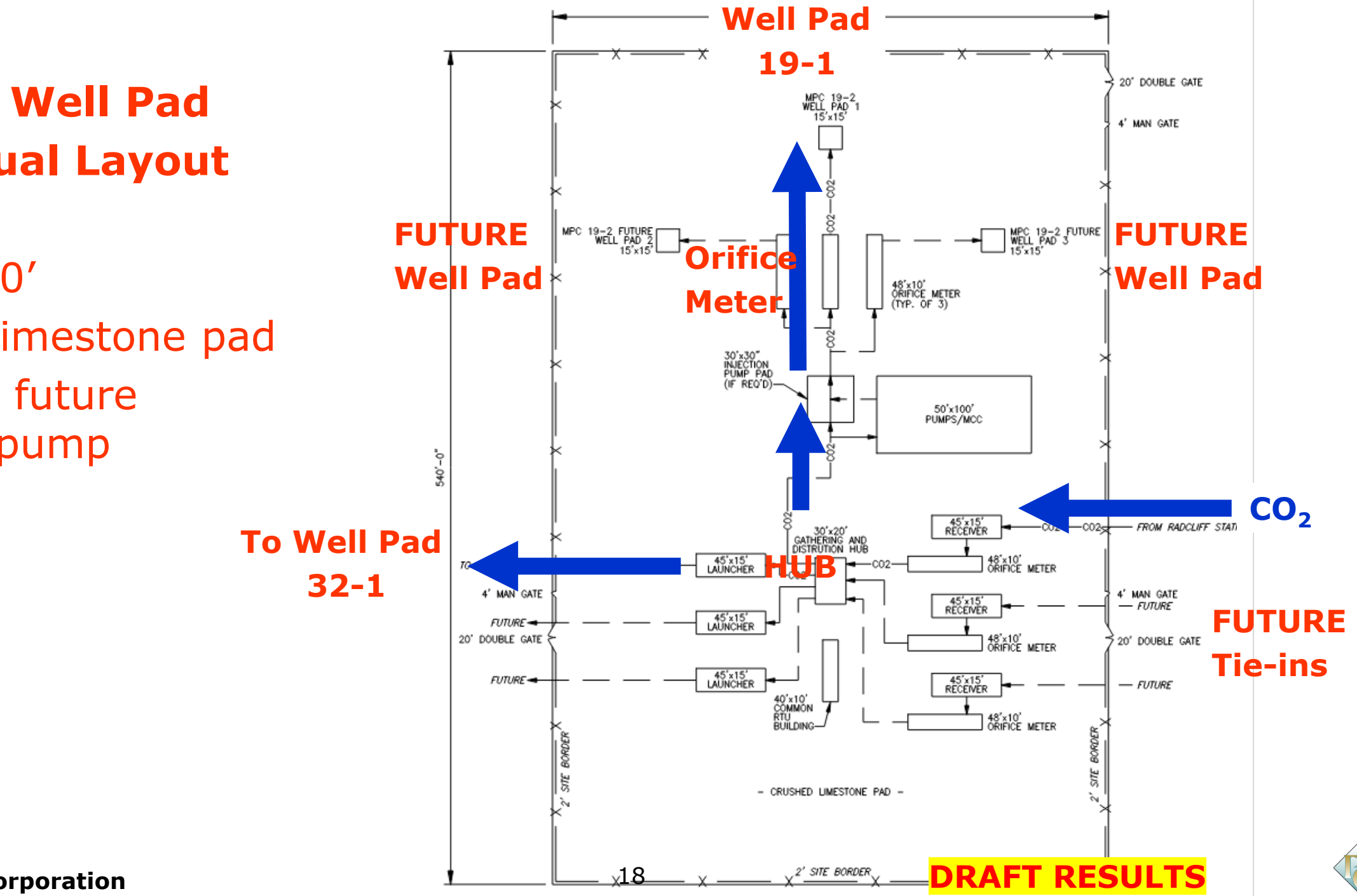
DRAFT RESULTS

Hub and Well Pad Conceptual Layout

540’ x 360’

Crushed limestone pad

Space for future injection pump

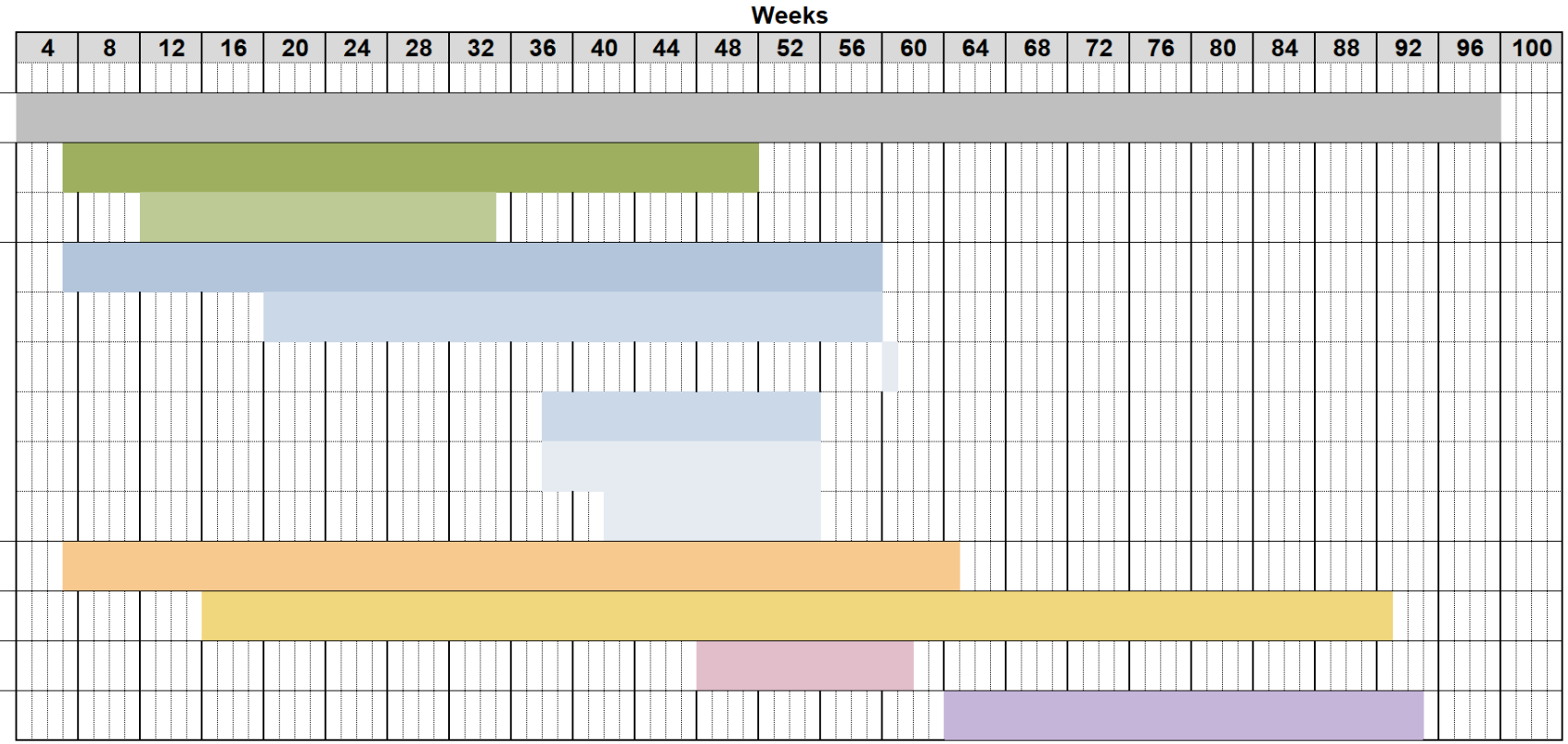


DRAFT RESULTS

Schedule

ECO2S FEED Project Schedule

Task	Start Week	Duration (Weeks)
Total Duration	1	96.6
Engineering	4	44.0
IFR Drawing Package	9	22.0
Permitting	4	52.8
Federal	17	39.6
Federal Consultations	57	0.0
State	35	17.6
Miss Dep of Env. Quality (MDEQ)	35	17.6
Kemper County Permits	39	13.2
Right-of-Way	4	57.2
Survey	13	76.4
Construction RFP	45	13.8
Construction (Representative)	61	30.4



DRAFT RESULTS

Risks and Information Gaps

- Line Pipe: Procure pipe as quickly as possible to guard against price increases
- Specialty Items: Market availability of valves
- Installation: Access and workspace approval from landowners, permitting delays, availability of contractors, weather events
- Construction Mats: Large and considerable project cost, with different quality of mats for different areas

Contact Info and Acknowledgments

- Trimeric Corporation (www.trimeric.com)
  - Katherine.Dombrowski@trimeric.com
  - Joe Lundeen, Roz Jones, Ray McKaskle
- Project Consulting Services (www.projectconsulting.com)
  - Leon Proper: lproper@projectconsulting.com
  - Jean Everett, Ryan Almerico
- Advanced Resources International
  - George Koperna, Dave Riestenberg
- Other ECO2S project team members: SSEB, Southern Company, ECT, Crescent Resource Innovation