GROUNDWATER PROTECTION COUNCIL

Case Study: Design and Construction of Cost-Effective Produced Water Infrastructure for Start-Up Operators and Midstream Companies

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Case Studies - Summary

Background: For a start-up producer or midstream company, initial construction and operations can be a challenging undertaking, based upon available capital and manpower resources.

Case Study	A	B	C	D	E
Type	**Producer A**	**Producer B**	**Producer C**	**Water Midstream D**	**Producer E**
Pipeline	25 mi	15 mi	5 mi	15 mi	Multiple
Wellsites	Multiple	Multiple	Multiple	Multiple	Multiple
SWDs	1	2	1	7	Multiple
Recycle	2 Facilities	None	None	5 Facilities	Multiple

Producer A

Problem: Needed to maximize flowrate of existing produced water pipeline to reduce frac feed time

- 10” HDPE, SDR 11 pipeline
- Hydraulic model not available
- Multiple producing wellsites
- Multiple legs and tie-in points
- Large elevation changes

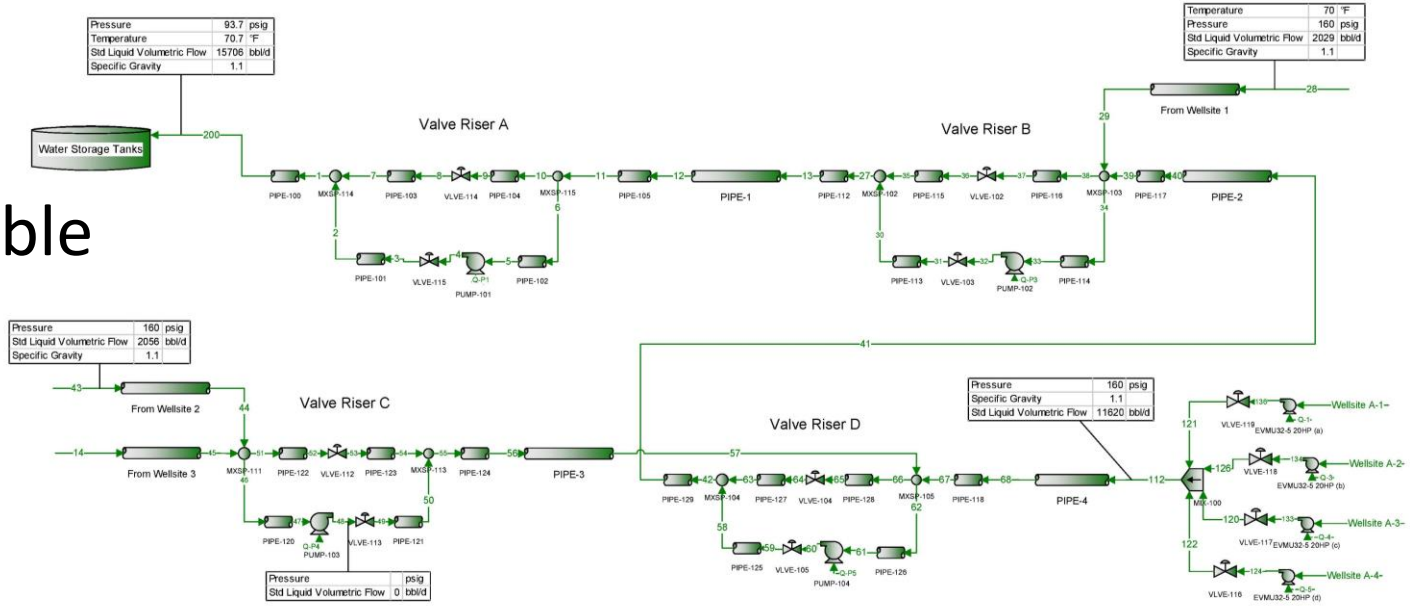
Producer A:

Solution:

- Maximized flowrate of 36,353 BWPD achieved
- Analyzed multiple scenarios
- Optimized pump sizing and locations
- Optimized Maximum Allowable Operating Pressure (MAOP)
- Improved valve stations
- Reduced frac feed time
- Cost savings

Takeaway:

Design pipeline for maximum flowrate to reduce frac feed time



Producer A:

Problem: Needed to improve water quality for existing produced water recycle storage facility treatment within budget constraints

- Total capacity
- Tanks vs. pits
- Pump sizing
- Treatment rate
- Treatment methods
- Reduce H_2S, Fe_2S, Bacteria
- Cost-effective design

Producer A:

Solution:

- Equipment selection
- Pump sizing
- 250,000BBL produced water pit
- Treatment method options
- Construction cost data for future expansion

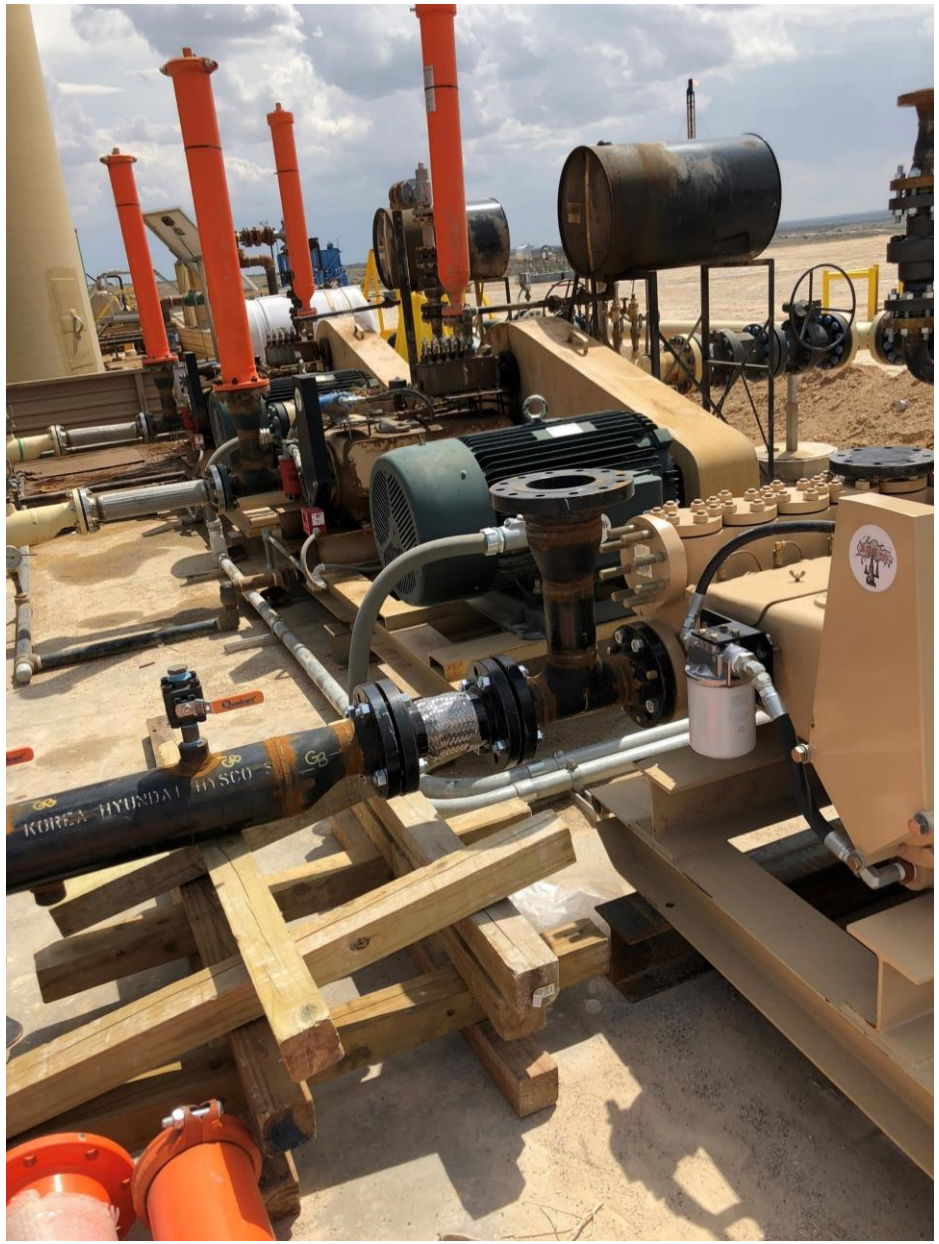
Takeaway:

Determine water quality level and treatment method for facility budgets

Producer B: SWD #1

Problem: High SWD Truck Hauling Costs: isolated wellsites, rough lease roads.
Internally built SWD #1:

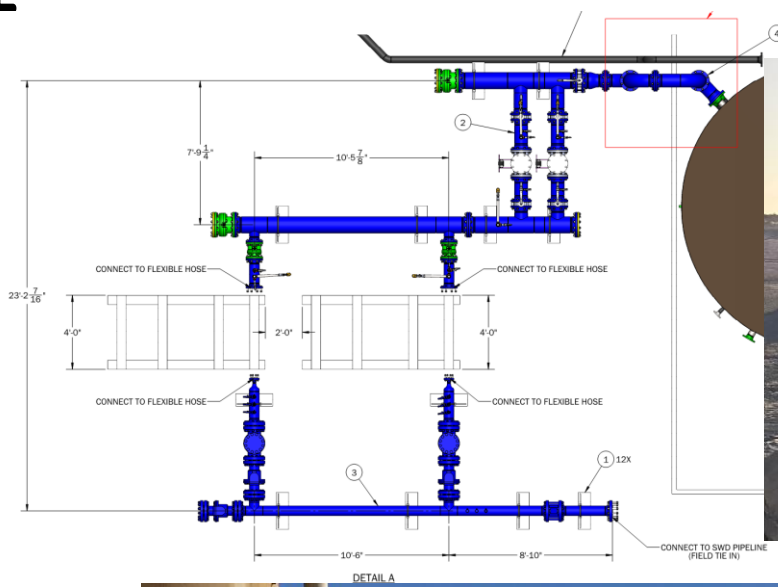
- 5,000 BWPD @ 500psig
- Future expansion to 25,000 BWPD
- Pump redundancy
- Filtration
- Electrical control panel
- Alarm system with SCADA
- 6 week start-up date



Producer B: SWD #1

SWD #1

- Initial schedule: 6 weeks
- Multiple subcontractors
- Difficult management



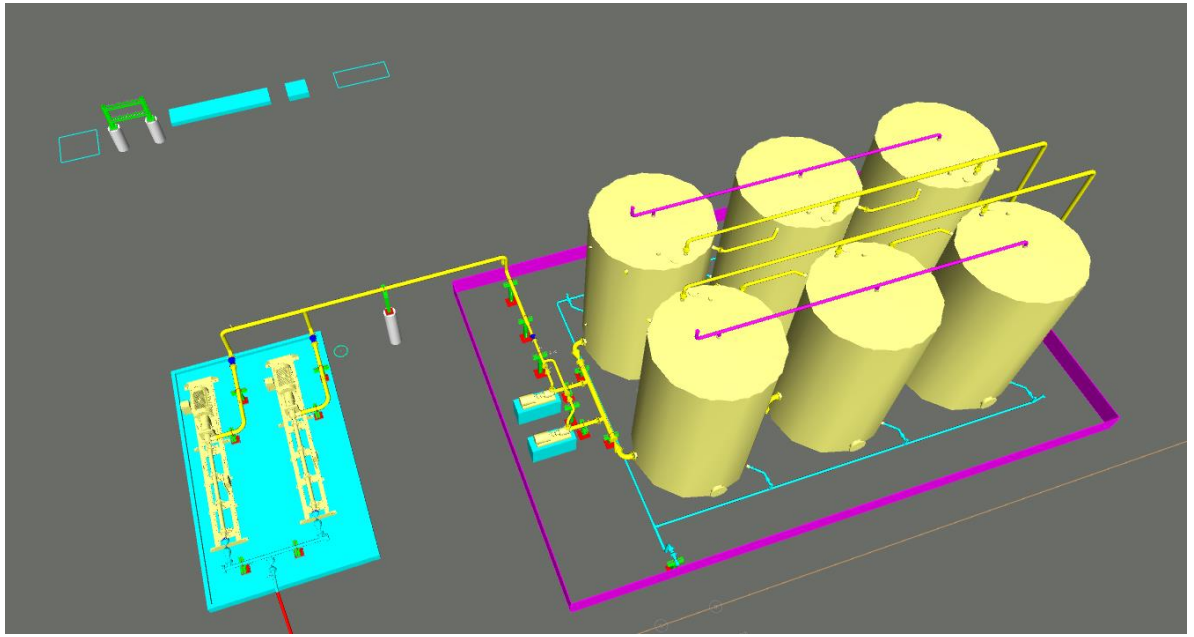
Issues:

- Actual start-up: 3 months
- Continued trucking costs
- Significant cost overruns
- Manual pump operation

Producer B: SWD #2

Solution: Design and construct SWD #2 using EPC methodology:

- 20,000 BWPD @ 1000psig
- 6,000 BBL storage capacity
- 100% pump redundancy
- Fully automated unmanned facility
- SCADA communication
- Engineering, procurement, and construction (EPC) approach

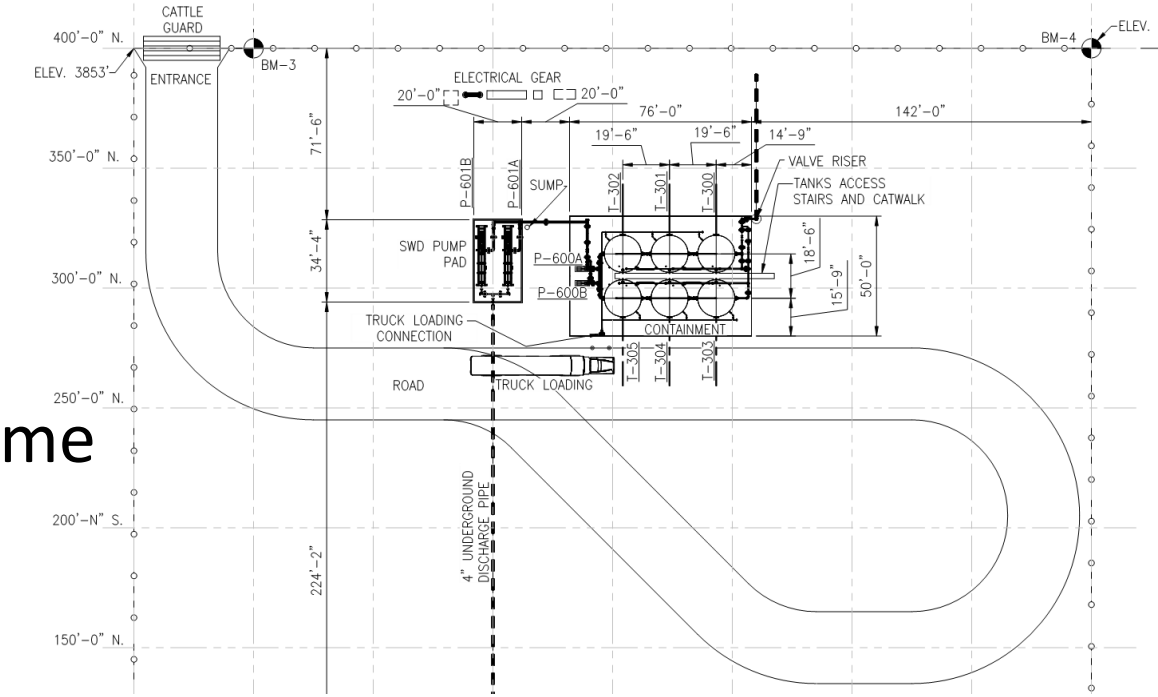


Producer B: SWD #2

EPC methodology

Benefits:

- Significant cost savings
- Fast track 6 week construction timeframe
- Single point of contact
- Quick, efficient, cost-effective
- Utilized a hybrid contract with a fixed price, variable cost bonus/penalty structure



Takeaway:

EPC approach saves money throughout construction

Producer C: SWD Options

Problem: High SWD Truck Hauling Costs

Solution Option 1; SWD #1: Upgrade Existing SWD

- 10,000 BWPD @ 2200 psig

Solution Option 2; SWD #2: New SWD EPC

- 25,000 BWPD @ 2000 psig
- Costs 50% higher than upgrade

Solution Option 3; SWD #3: Tie Into existing E&P or 3rd party water midstream pipeline

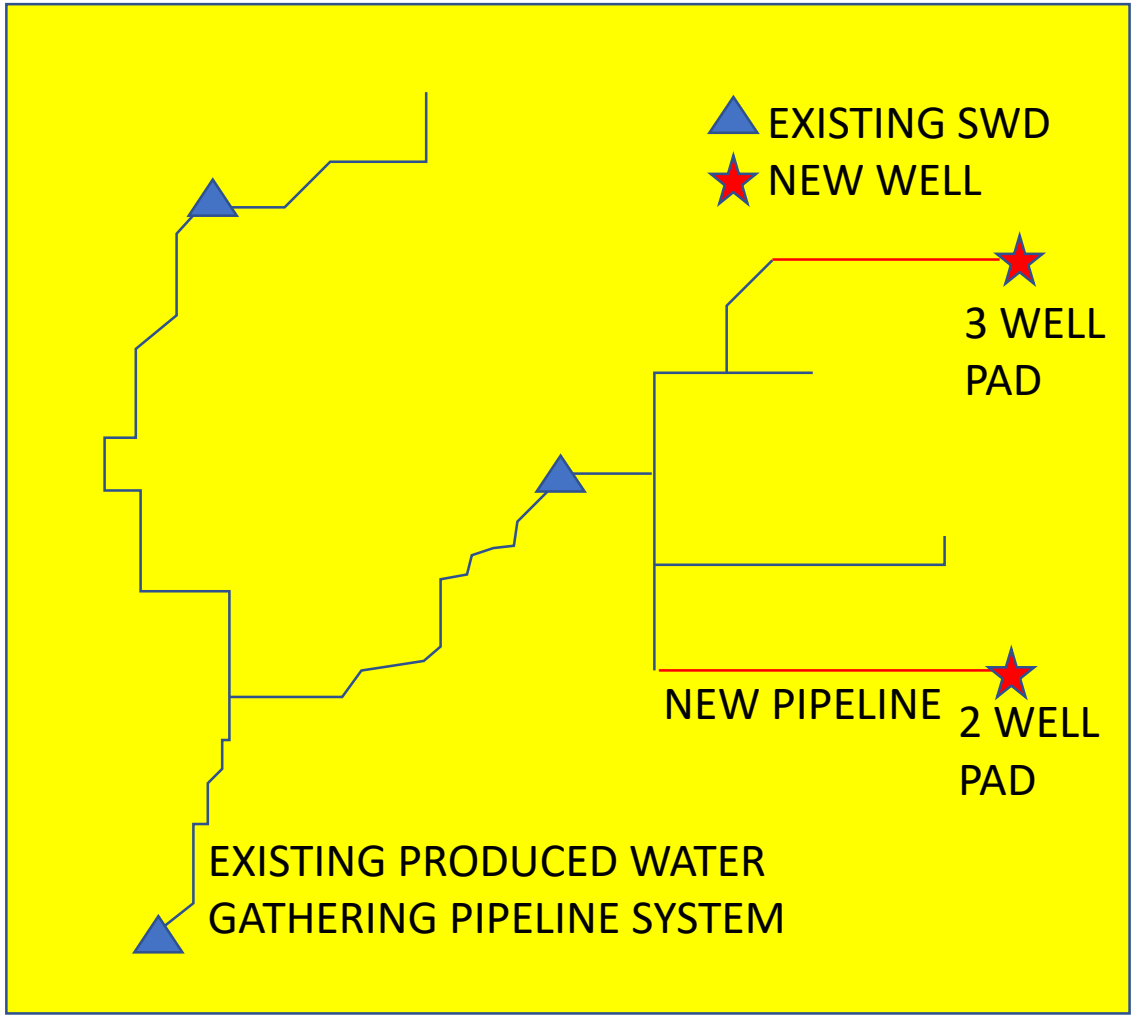
Producer C: SWD #3

Solution Option 3; SWD #3: Tie into existing E&P pipeline or 3rd party water midstream pipeline

- Analyzed existing producing wells
- Optimized pipeline diameter, material, operating pressure
- Least expensive option

Takeaway:

- Conduct cost benefit analysis for multiple options

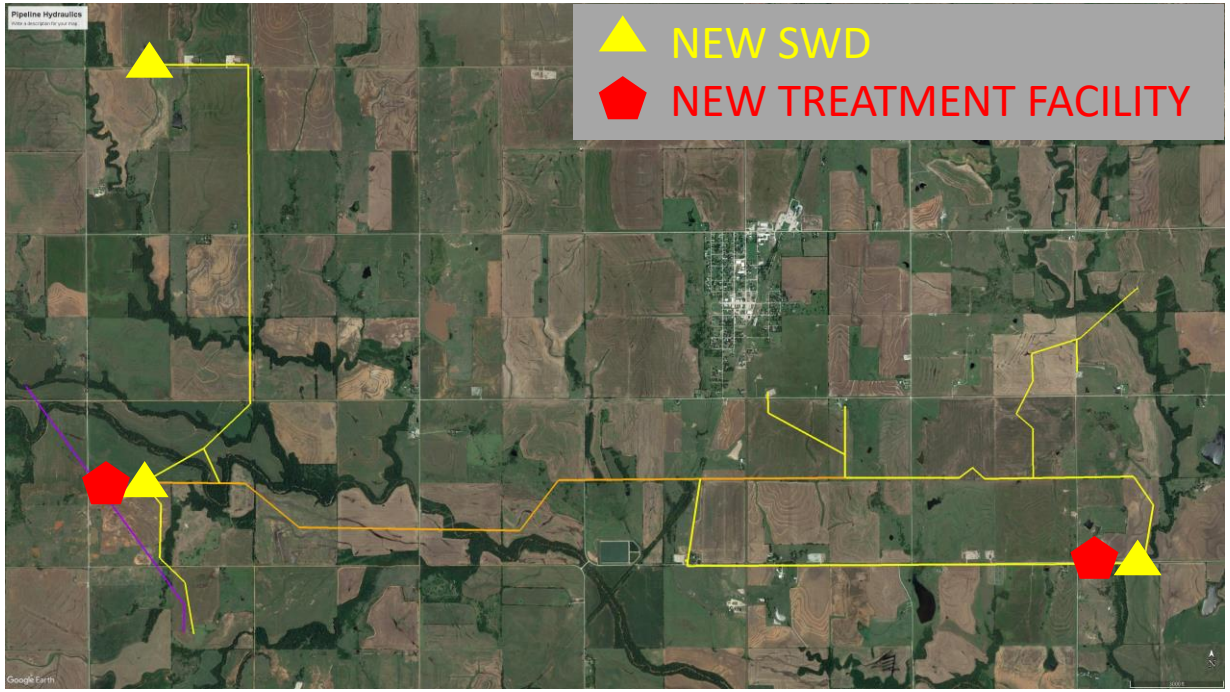


Water Midstream D:

Problem: Need budgetary cost estimate for produced water system with pipeline, SWDs, and recycle treatment for budgetary approval

Solution: Provided design

- 150,000 BWPD max flowrate
- Optimized pipeline diameter, material, operating pressure
- Provided total installed cost estimate/mile

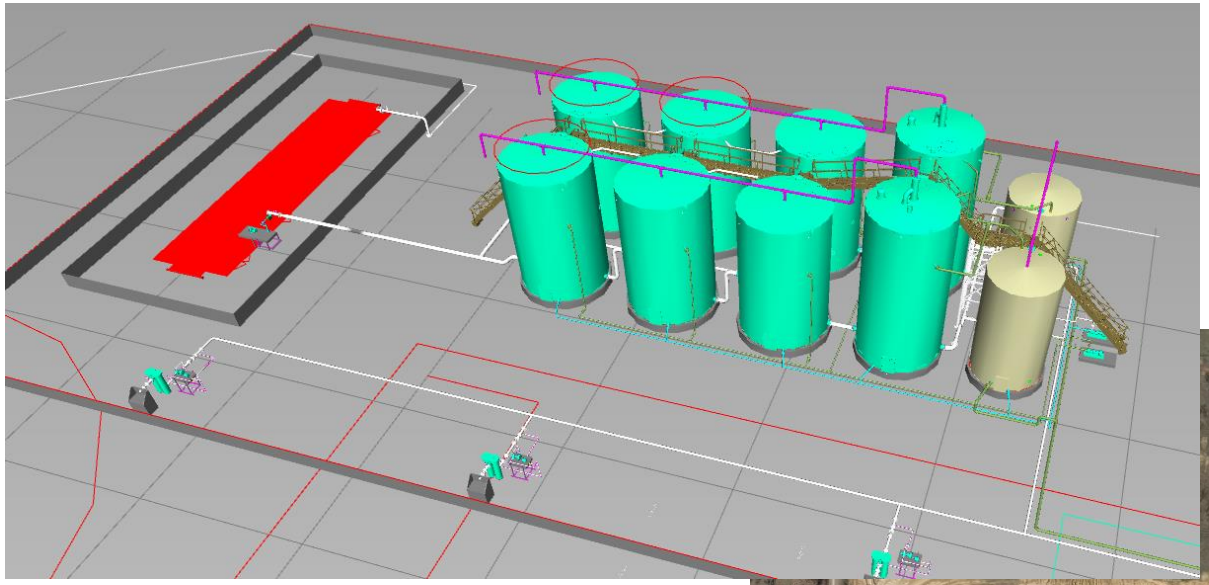


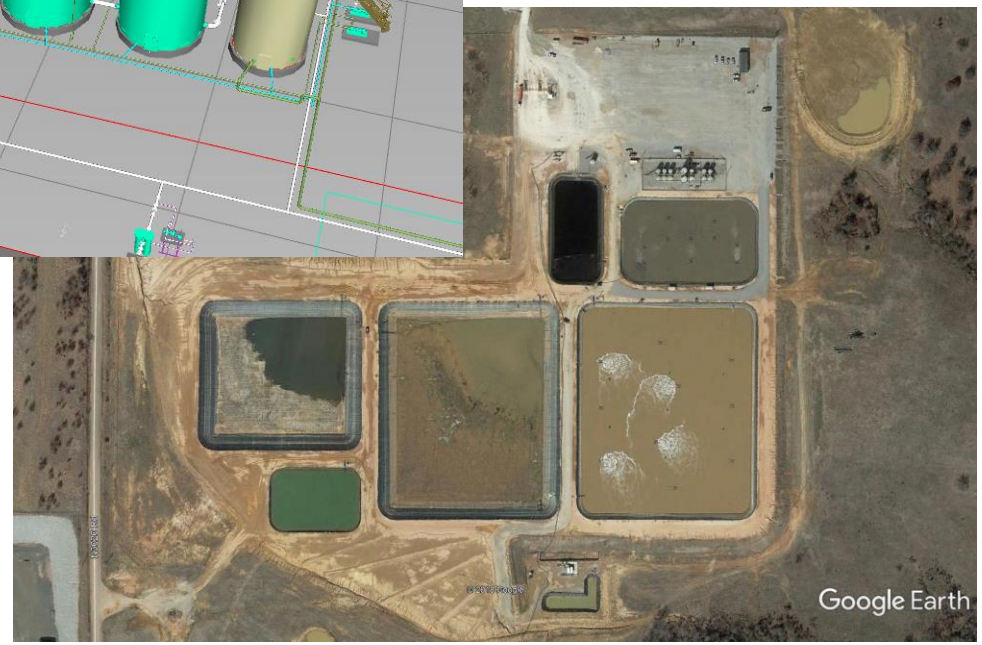
Takeaway:

Use EPC estimates to develop budgets

Case Study E - Large Producer

- Full engineering design
- More complex recycle treatment
- Better water quality results
- Large pipeline
- Multiple SWDs
- Economy of scale
- Larger budgets





Conclusion

- Design pipeline for maximum flowrate to reduce frac feed time
- Determine water treatment quality level and facility budgets
- EPC approach saves money throughout construction
- Conduct cost benefit analysis for multiple options
- Use EPC estimates to develop budgets

Thank you for attending.

Questions? Please contact:

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