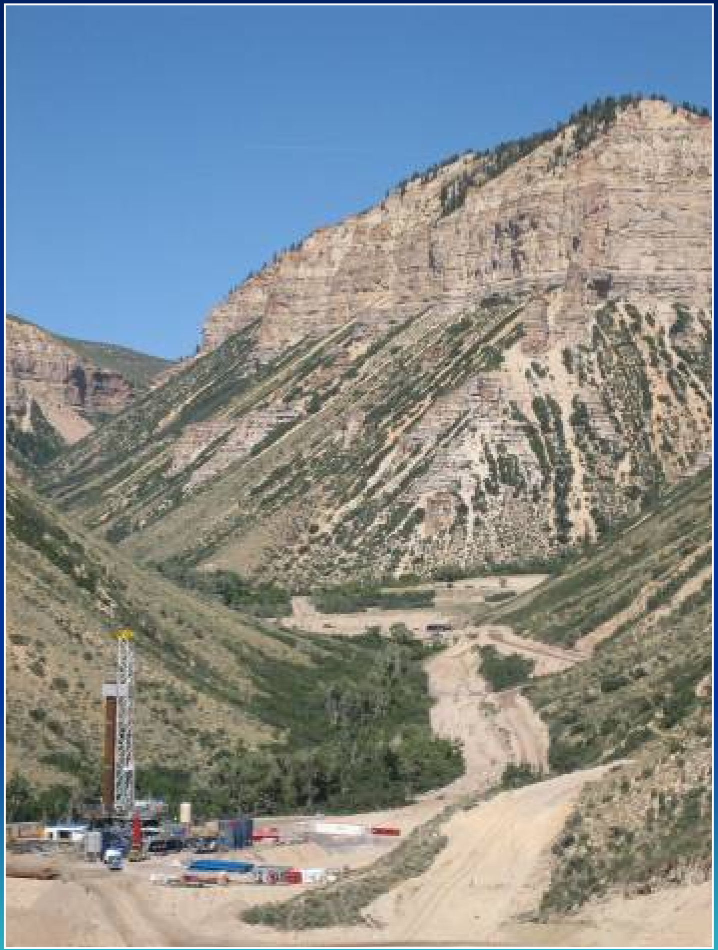
Piceance Basin Drilling Waste Management Planning

21st Century Challenges

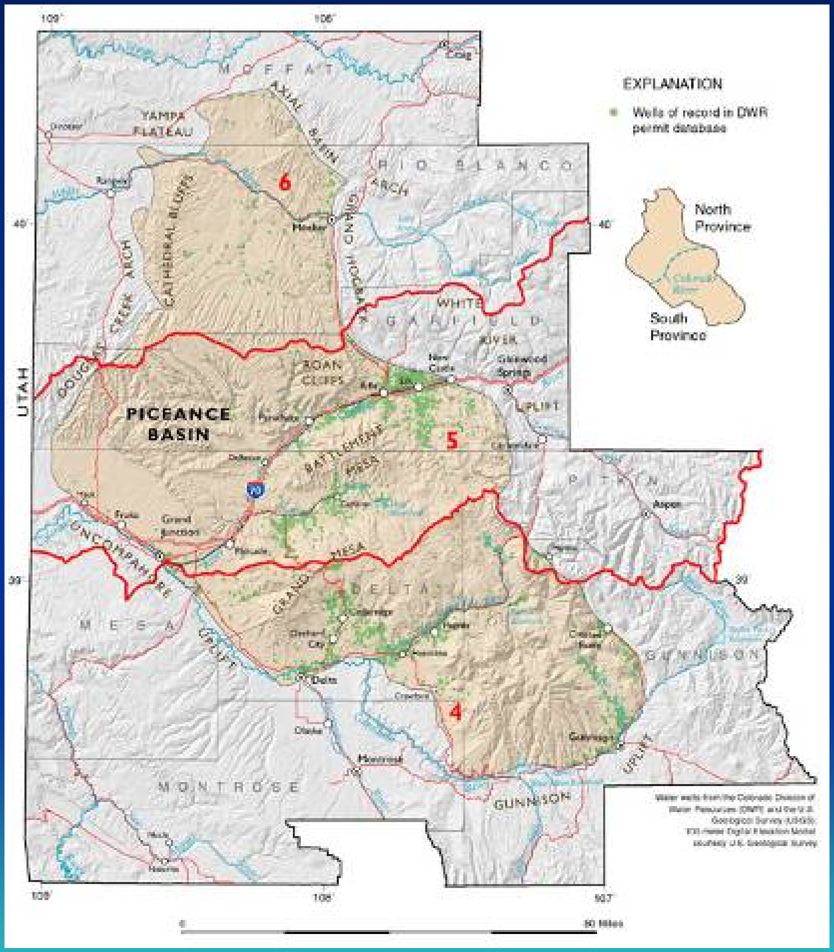
Agenda

- Piceance Project Introduction
- Problem Framing
- System Design
- Comparison and Lessons Learned
- Regulations in a changing environment



Piceance Project Introduction

- ~7000 mi² in NW CO
- Exploration started in ~1980
- Viable Commercial Production began ~1989
- Estimates 80-136 Tcf gas tight sands
- **Overall Well Count & Delineation Drilling**
  - 15-20 years of drilling
  - 3000 - 4000 total wells



Era	System	Series	Stratigraphic Unit	Unit Thickness (feet)	Physical Description	Hydro-geologic Unit	Saturated Thickness (feet)	Hydrologic Characteristics
Cenozoic	Tertiary	Eocene	Uinta Formation	0–1,400	Silty sandstone, siltstone and marlstone	Upper Piceance Basin aquifer		Conductivity range <0.2 to >1.6 ft/day; yield 1 to 900 gpm; transmissivity 610–770 ft^2/day
			Green River Formation	As much as 5,000	*Parachute Creek Member* kergenous, dolomitic marl-stone and shale 500–1,800 ft	Mahogany confining unit		
					Anvil Points Member shale, fine-grained sand-stone and marlstone 0–1,870 ft	Lower Piceance Basin aquifer		Conductivity range <0.1 to >1.2 ft/day; yield 1 to 1,000 gpm; transmissivity 260–380 ft^2/d
					Garden Gulch Member claystone, siltstone, clay-rich oil shale and marlstone 0–900 ft	Confining unit		
					Douglas Creek Member siltstone, shale and channel sandstone 0–900 ft			
			Wasatch Formation	About 5,000	Shale and lenticular sand-stone			
		Paleocene	Fort Union Formation	Very thin	Coarse-grained sandstone	Fort Union aquifer		
Mesozoic	Cretaceous	Upper Cretaceous	Mesaverde Group	Averages 3,000 may be >7,000	*Fox-Hills Sandstone, Lewis Shale, Williams Fork Formation, Iles Formation*; sandstone interbedded shale and coal	Mesaverde aquifer	<500–2,000	
			Mancos Shale	More than 7,000	Mainly shale but Frontier Sandstone may be local aquifer	Mancos confining unit		

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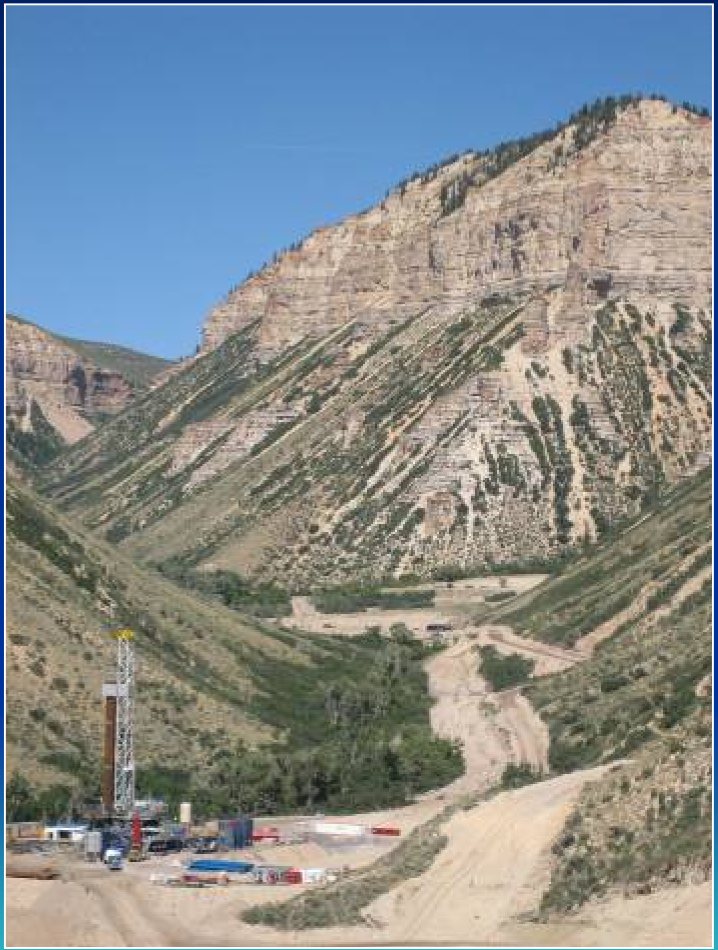
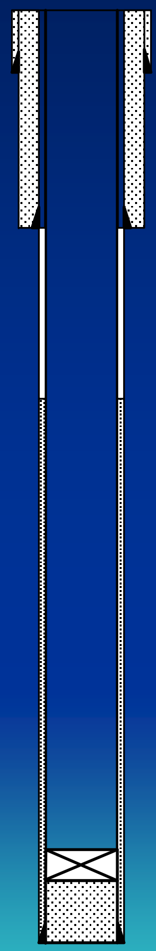


Geography-Topography

Environmental Stewardship

Conditions – Safety, Safety, Safety

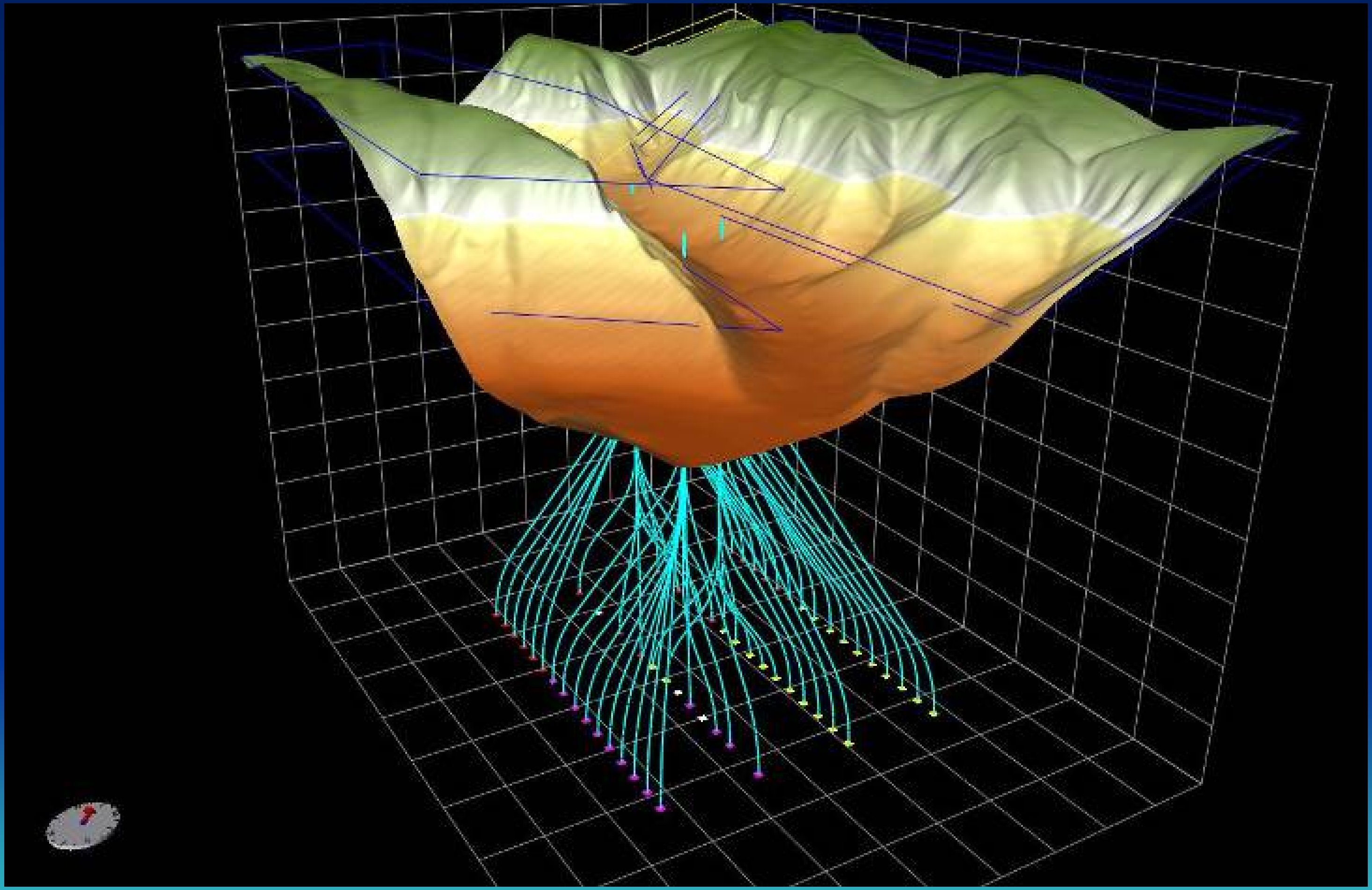
Valley Well Design



- Conductor
  - Hole – 26”
  - Casing – 16”
- Surface (175 bbls)
  - Hole – 12-1/4”
  - Casing – 8-5/8”
- Production (325 bbls)
  - Hole - 7-7/8”
  - Casing – 4-1/2”
- Gage Hole ~ 500 bbls

16" Cond.

Problem Framing-22 Well Pad



Problem Framing
Cuttings Pit Size

- Key assumptions
  - Holistic approach
  - Manage through measurement
- Objectives
  - Improve efficiency
  - Reduce environmental impact
- Estimate waste volume
- Review existing
  - Treatment
  - Storage
  - Transportation practices

Planning and Assumptions

- What will the volume of waste be to manage?
- How can this volume be reduced?

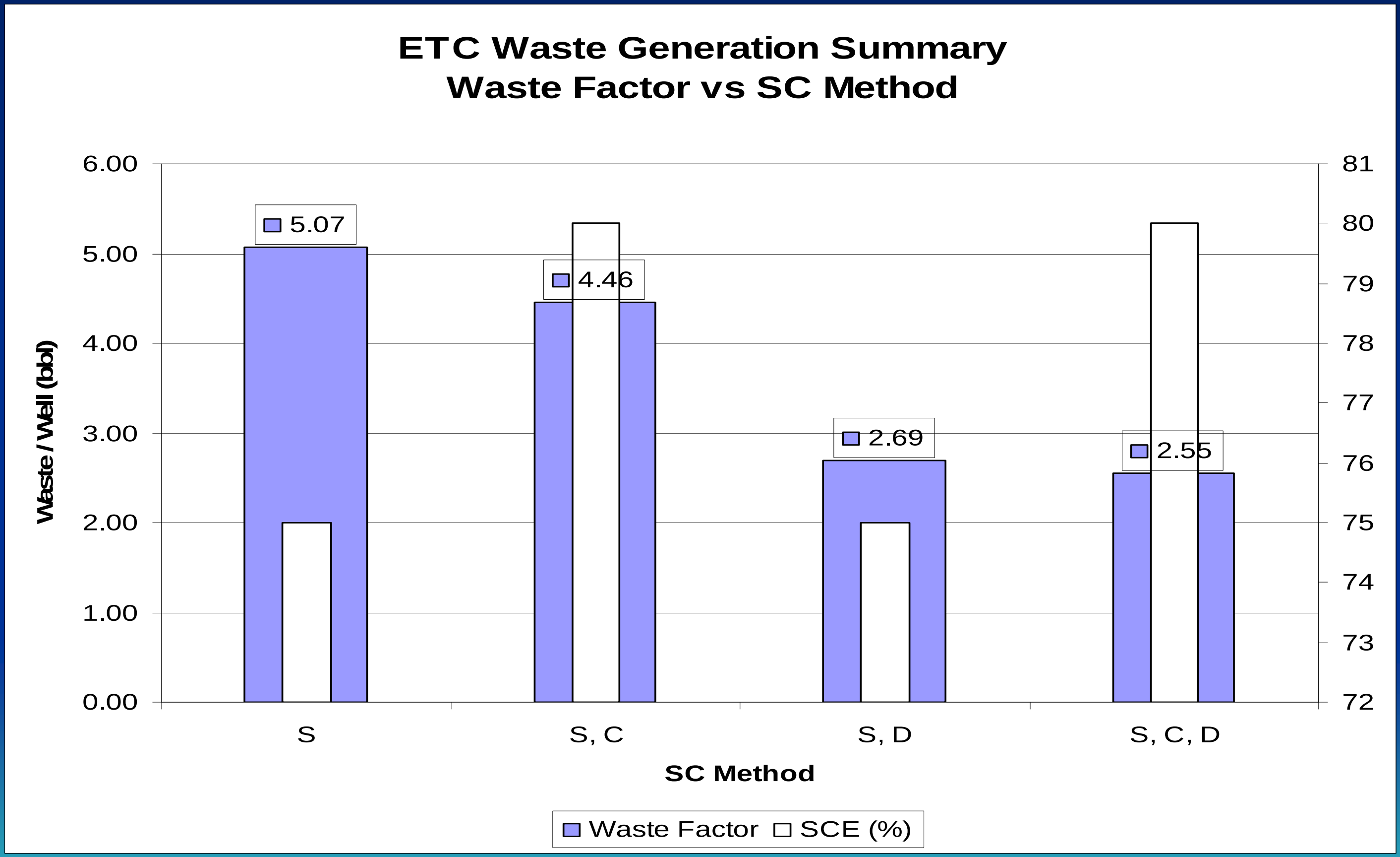
SC Method	SCE (%)	Waste / Well (bbls)	Waste Factor	Waste / Pad (yd^3)
S	75	2536	5.07	11613
S, C	80	2229	4.45	10207
S, D	75	1345	2.69	6159
S, C, D	80	1276	2.55	5843

S – Shakers, C - Centrifuge, D - Dewatering

*Note: A pad is assumed to be 22 wells and mud has **average LGS of 7%**

Assumptions

*Assumes LGS of 7%



S – Shakers, C - Centrifuge, D - Dewatering

Objectives

- Cost Saving Opportunities
  - Reduced site and pit construction costs
  - Reduced water hauling costs
  - Reduced/Eliminate waste transportation costs
  - Reduced pit closing costs
- Minimize Non Productive Time (NPT) due to less Lost Circulation (LC)
  - Drill with clean fluid and minimal LCM
  - Target less than 7% drilled solids
- Reduced Non Productive Time

The Choice to Dewater

- Dewatering has two very good benefits
  - Reduces waste volume and post treatment
  - Recycles water in place of buying new water
- Minimize the volume of waste generated
- Minimize waste handling
- Minimize cost

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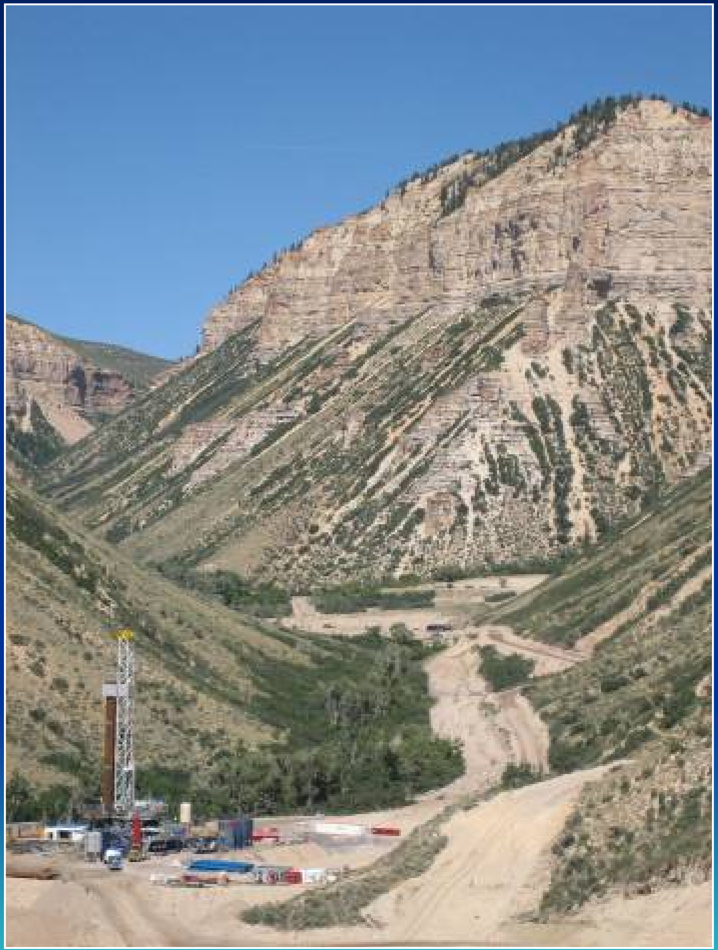
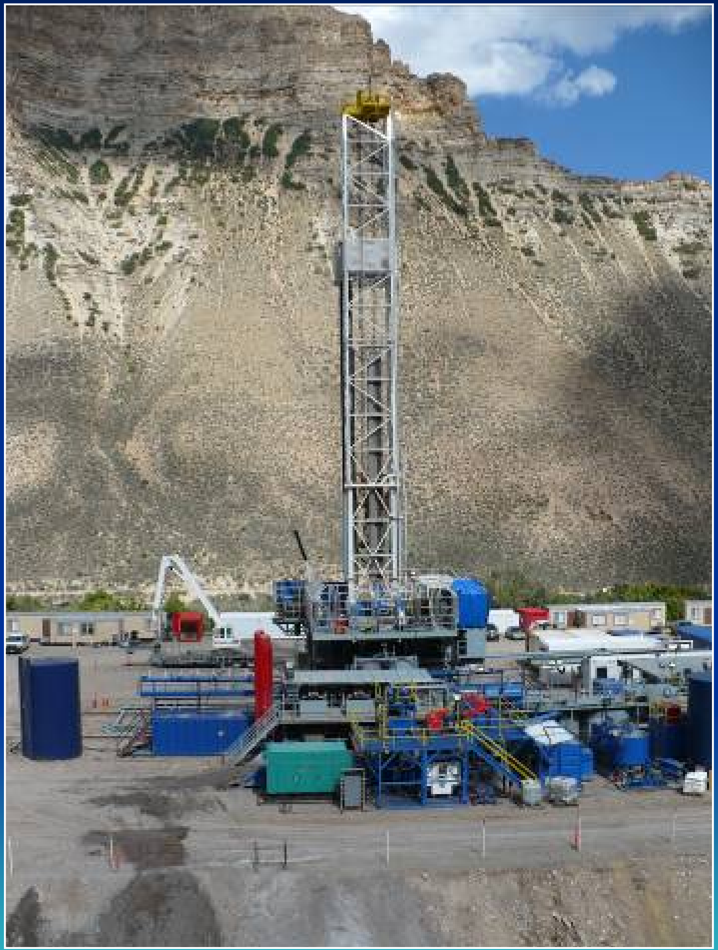


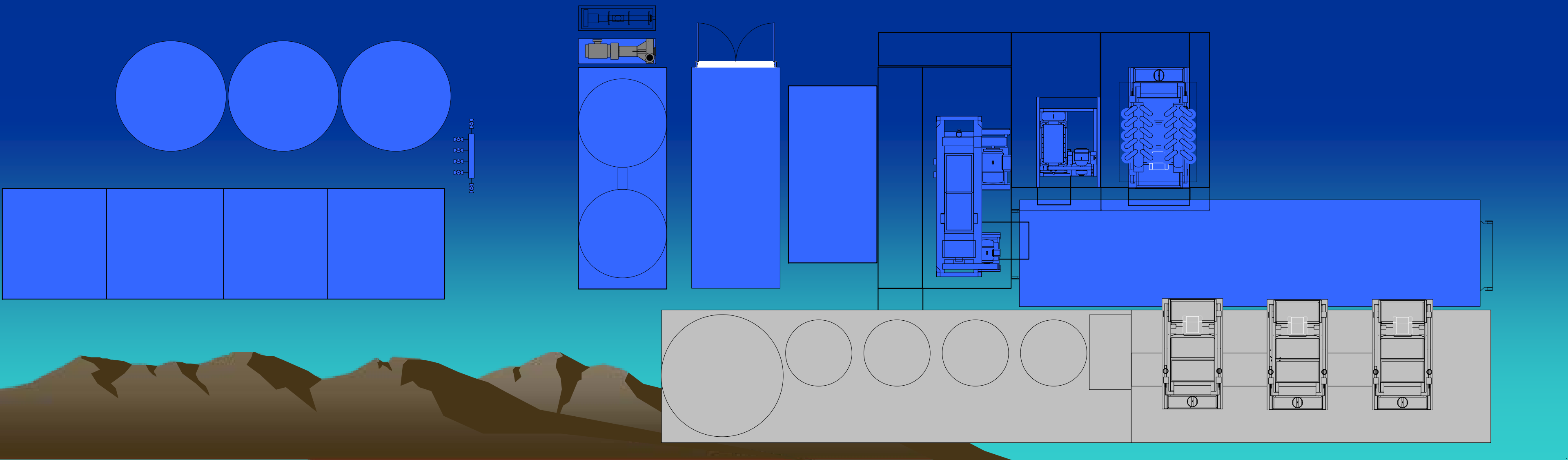
System Design

- Layout
  - Option 1-traditional
  - Option 2-trial
- Performance Comparison
  - Waste Volume
  - SRE



Option 1 Layout
Traditional Drive-In Catch Tank

- Solids Control
  - (1) HS-2172 Centrifuge
  - (1) Generator & Dist Panel
- Dewatering
  - (1) Dewatering Unit
  - (1) HS-3400 Centrifuge
- Fluids Management
  - (1) Premix Tank
  - (1) Process Tank Skids
- Waste Management
  - (1) Three Sided Collection Tank
  - (1) Loader



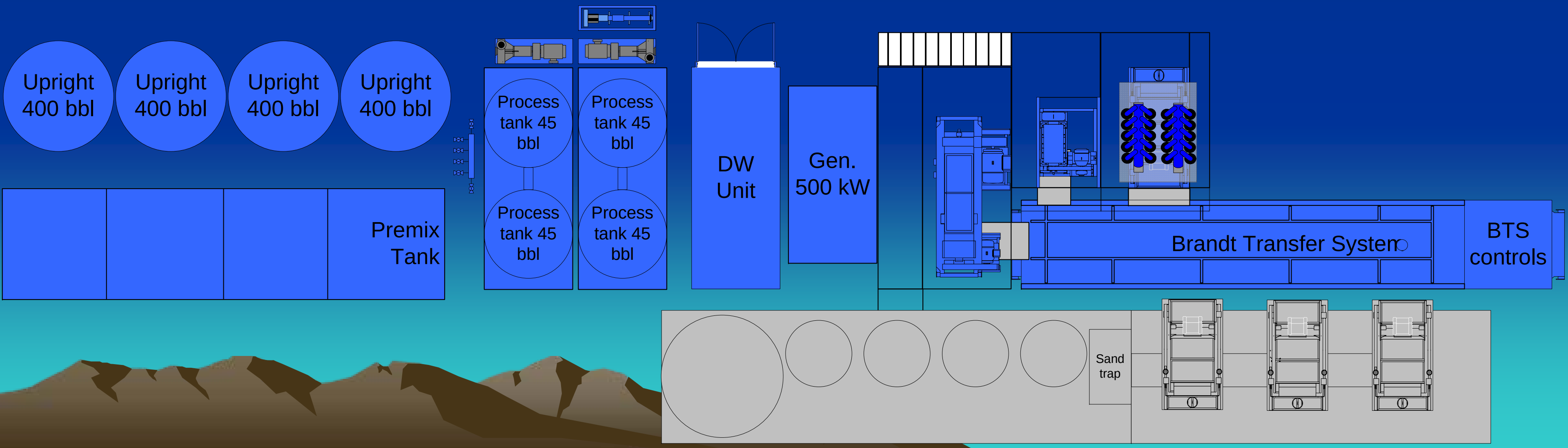
System Design – Option 1

Option 2 Layout
Brandt Transfer System

- Solids Control
  - (1) HS-2172 Centrifuge
  - (1) Generator & Dist Panel
- Dewatering
  - (1) Dewatering Unit
  - (1) HS-3400 Centrifuge

– Fluids Management
  - (1) Premix Tank
  - (2) Process Tank Skids

– Waste Management
  - (1) Brandt Transfer System (BTS)
  - (1) Booster pump



System Design – Option 2
Brandt Transfer System (BTS)

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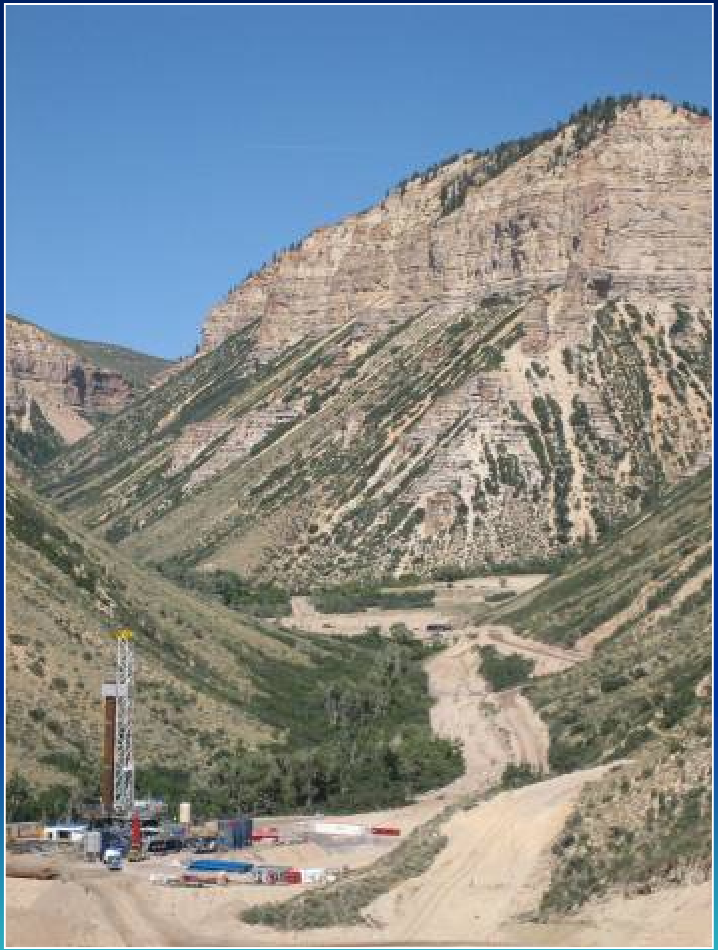


First Pad Results
Option 1 – Traditional Loader

- 37.1% solids by volume
- WF = 4.46 bbl waste/gauge hole
- Dewater ~13,998 bbls

First Pad Results
Option 2 – BTS Homogenization

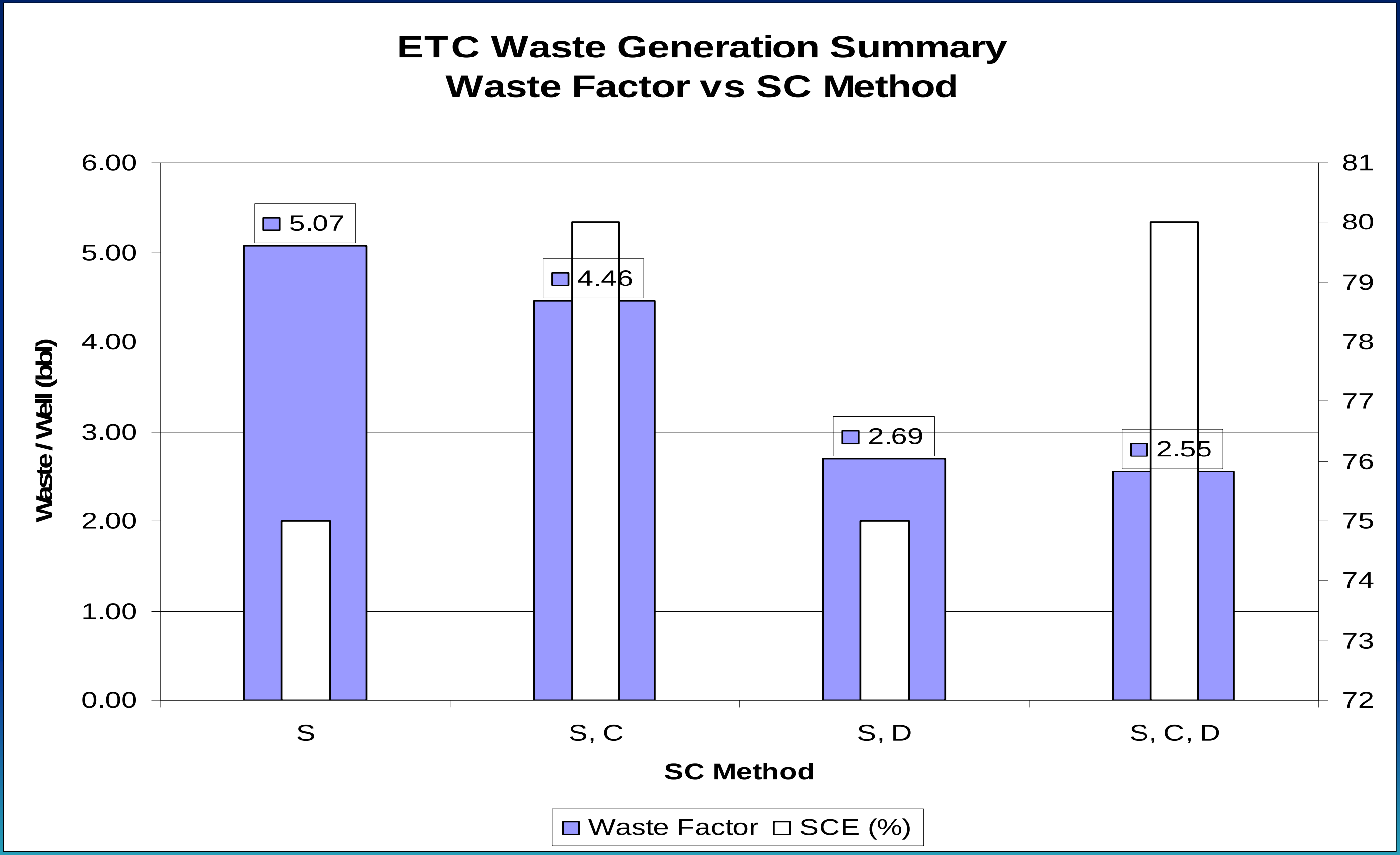
- 35.5% solids by volume
- WF 3.35 bbls waste/gauge hole
- Dewater ~ 8,595 bbls

Options Compared

- Option 1 – catch tank
  - Slightly lower cost/day
  - Slightly dryer cuttings
  - Simpler
  - More adaptable to all location configurations
- Option 2 - BTS
  - Much cleaner location
  - Solids collection and transfer performed by dewatering team
  - Rig crew can devote time to other duties

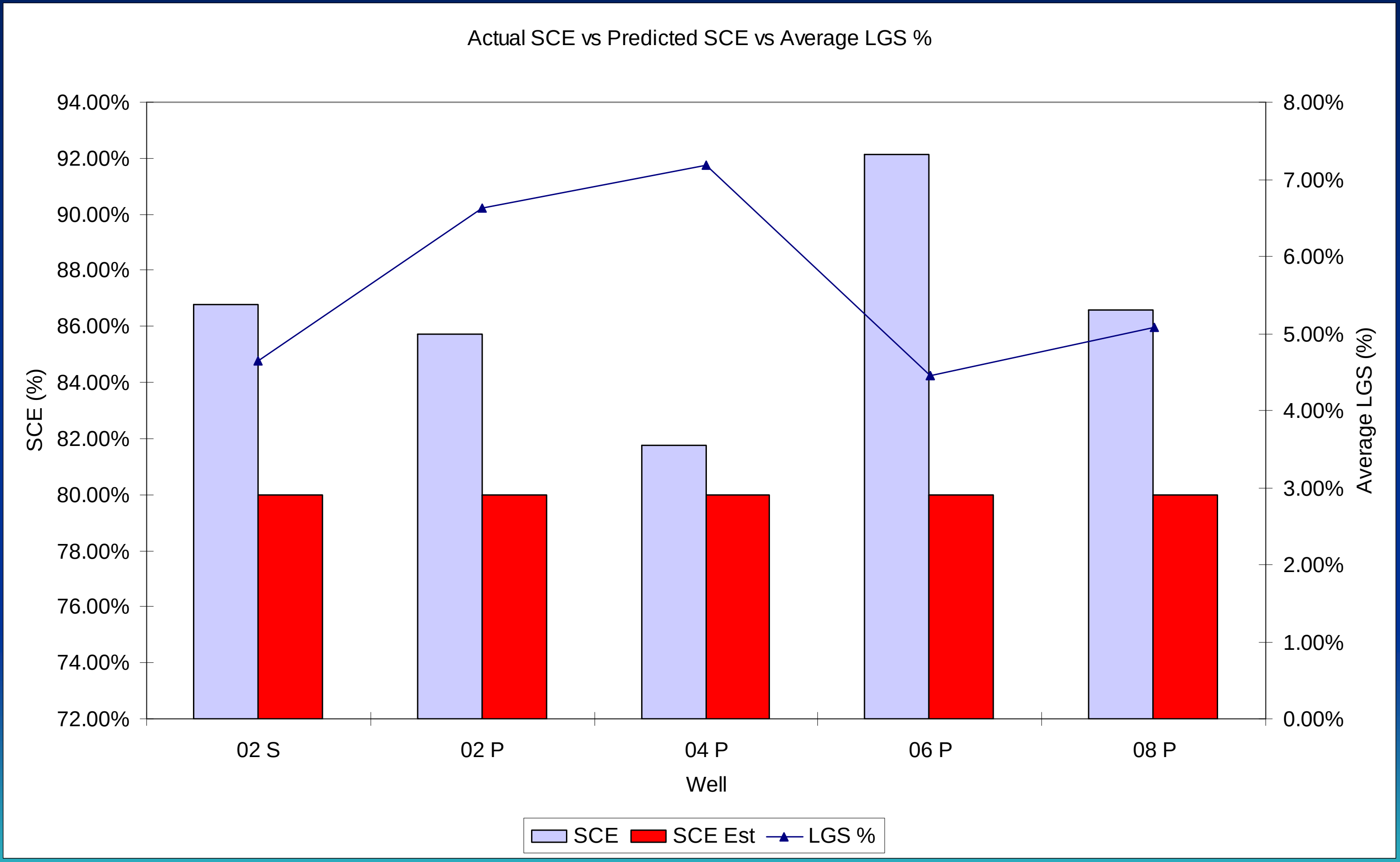
Assumptions-Dewatering

*Assumes LGS of 7%



S – Shakers, C - Centrifuge, D - Dewatering

Performance



Lessons Learned

- Familiarization with all aspects of the drilling process
  - New rigs
  - New crews
  - New area
- Lost circulation zone
- Casing/cementing program
- Solids control changes
  - Shaker screen selection – screen finer on both rigs using API classification
  - Adapt 2^{nd} centrifuge to run conventional or dewatering
  - Use skid time to reduce weight with conventional centrifuging rather than dewater back

Dewatering Changes

- Switch from liquid to granular coagulant
- Dewater at one pad only
  - Reduced personnel
  - However, solids from dewatering process at one site only
  - Recovered water used by whichever rig needs it
- Review and revamp mud program to reduce dewatering frequency

Other DWM Changes Made

- Data collection format
  - New format
  - Developed in conjunction with great help from operator’s Houston based specialists
  - Includes summary roll-up feature
  - Searchable tables

NOV Brandt

Daily Report for Chevron

Pad Name	SKR-598-36-AV	Contractor	H&P	Report Num	2
Well Num	20	Report by	LAURO-LUCATERO	Interval	Production
Rig	318	Activity	DRILLING	Interval TD	
State	Colorado	Date of Rpt	18-Oct-2008	Hole Size	7.785
County	Garfield				

Collected Onsite

Daily Drying Chem Added

Type		[lbs]
Chemical Cost / Unit		
Daily Drying Chem Cost	0	
Bulk Density		[lbs / gal]
Bucket Cap [yd3]		
S.G.	2.6	
Ttl Daily Waste [bbls]	420	

	MW [ppg]	Other bbls	Bucket Loads	Equiv bbls	Solids %	H_2O %	Solids [bbls]	H_2O [bbls]
BTS	13.0	100		0	35%	65%	35	65
BTS	13.1	120		0	36%	64%	43	77
BTS	13.1	100		0	36%	64%	36	64
BTS	13.2	100		0	37%	63%	37	63
Cement Returns								
Cement Flush								
							151	269

Water Recovery / Quality Report

Hours Dewater	MW	Mud In [bbls]	From	Water Out [bbls]	Y/N per Mud Eng If NO why
8.00	10.3	300	598-25-AV	150	
8.00		300		150	

Upright

	MW [ppg]	Fluid Type mud, water, etc	Sent Where	Now -- [bbls] --	Prev	Change
1	8.3	FRESH-WATER		260	120	140
2	8.3	DEWATER		120	50	70
3	10.5	MUD		0	0	0
4	10.5	MUD		0	0	0

Dewatering Chemical Used

Type	Chemical Name	Unit Qty	Unit Cost	Ttl Cost
Coag	5205	3	350	1050
Poly	CIVA 24	1	250	250
Acid	ACID	1	250	250
Dewatering Chemical Cost				1550

Daily Cost Summary

Equipment	3,690
Personnel	2,950
Dewatering Chemical	1,550
Drying Chemical	0
Today's $	**8,190**

Comments

WE TRANSFER 200 BBLS OF MUD FROM ACTIVE TO PREMIX AT 4:00 PM
WE STARTED DEWATER AT 4:30 PM FROM PREMIX STOP AT 6:45 PM TO TRANSFER MORE MUD
AT 7:00 PM WE TRANFER 150 BBLS FROM PREMIX TO UPRIGHT#4
AT 7:30 PM WE STATED DEWATER UPRIGHT#4
AT 11:00 PM WE STOP DEWATER AND TRANSFER 100 BBLS FROM UPRIGHT#4 TO ACTIVE
AT 11:30 PM WE TRANSFER 50 BBLS OF WATER FROM UPRIGHT#1 TO SLUG PIT
AT 5:50 AM WE PUT ON CONVENTIONAL 2172 AND 3400 FROM THE ACTIVE
AT 10:00 AM WE TRANSFER 100 BBLS FROM UPRIGHT#2 TO ACTIVE AT 11:00 AM TRANSFER 50 B
FROM UPRIGHT#2 TO SLUG PIT AT 11:15 AM WE STARTED DEWATER FROM UPRIGHT#4
WE FINISHE DEWATER AT 5:00 PM
CHEVRON REPS (-KEN-BRETT-) BRANDT REPS (-LAURO-SERGIO-SEUZ-ELIAZAR-JEFF-)

Results of Changes

- Mud
  - $30K/well savings
  - Reduced inhibitor use
  - Inhibition requirements are reduced due to less exposure time
- LC minimized by increasing surface depth
- Some LC at surface, but controllable

- Dewatering
  - First pad ~388 bbl/well dewatering
  - Subsequent ~200 bbl/well
  - Recovery rate from 70% to 60% = use mud longer
  - Chemistry selection – trials continue
  - Continuous monitoring
- WF from ~3.8 to ~1.9

Overall Performance Improvements

- Average well time cut from 10 to 5 days
- Rig crew familiarity with all aspects of drilling program
  - Reduced casing time
  - Reduced cement time
  - Increased skid efficiency
- Maximum energy to bit
  - WOB
  - Added 50 gpm to original pump rate
- Reduced open hole time
  - Near gauge hole
  - Enhanced stability
  - Reduced need for back reaming
- Rig NPT about 5%
- Rig repair time 2%
  - Reduced expendable cost
  - Lowest in the field for contractor
- Increased productivity

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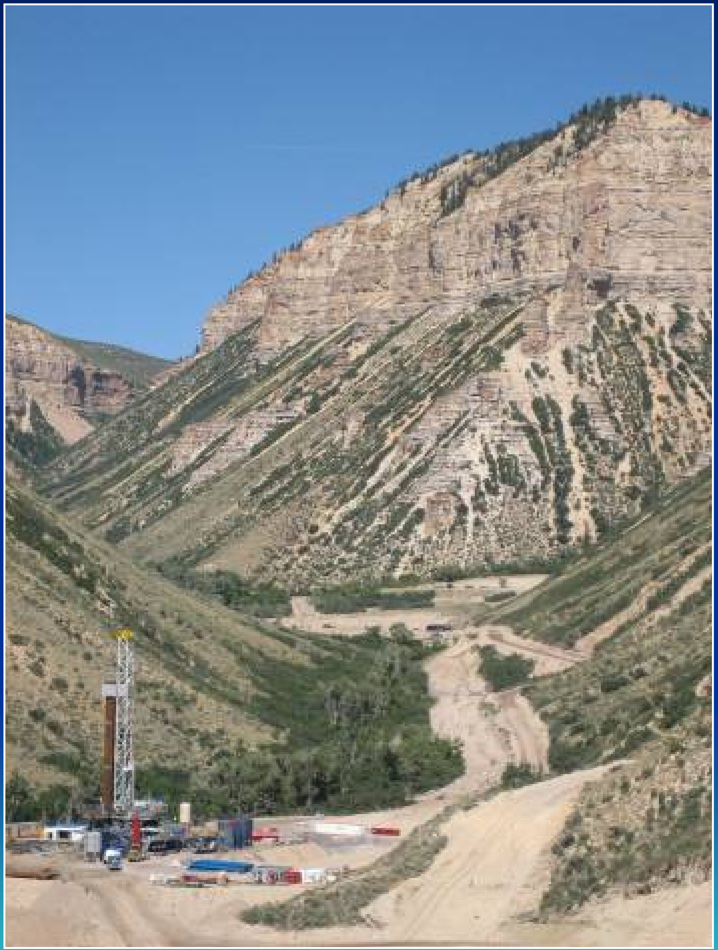
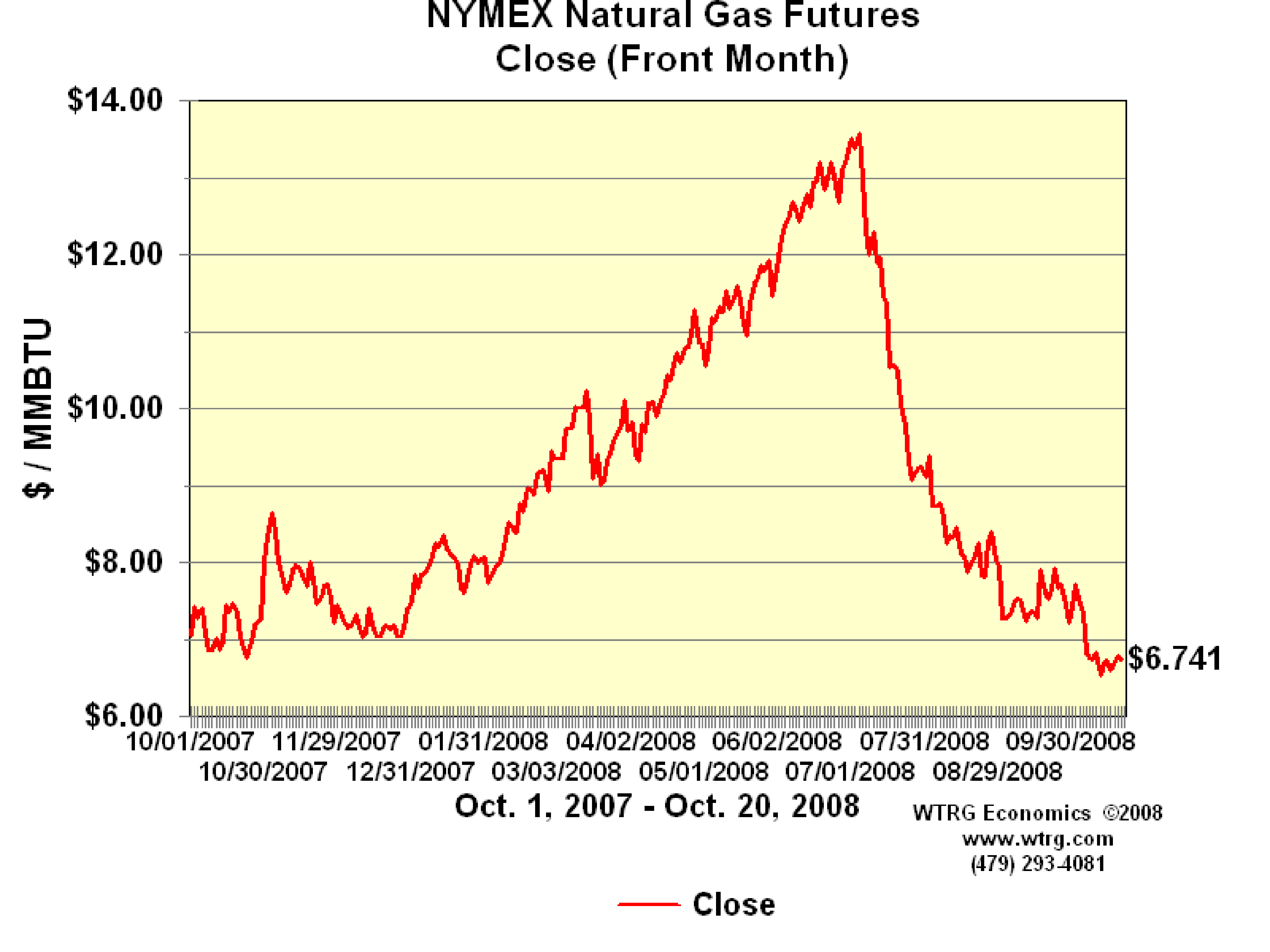


Changing Business Environment

- Economic considerations
  – Natural Gas & Oil Price Fluctuations
  – Maintaining shareholder value
- Political considerations
  – Colorado Amendment 58M – Tax Increase
  – Colorado Oil and Gas Conservation Commission (COGCC) Proposals
  – National Agenda???



NYMEX Natural Gas Futures
Close (Front Month)
$14.00
$12.00
$10.00
$8.00
$6.00
$ / MMBTU
$6.741
10/01/2007
11/29/2007
01/31/2008
04/02/2008
06/02/2008
07/31/2008
09/30/2008
10/30/2007
12/31/2007
03/03/2008
05/01/2008
07/01/2008
08/29/2008
Oct. 1, 2007 - Oct. 20, 2008
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Colorado Amendment 58
Public Vote this Nov.

State taxes shall be increased $321.4 million annually by an amendment to the Colorado revised statutes concerning the severance tax on oil and gas extracted in the state, and, in connection therewith, for taxable years commencing on or after January 1, 2009, changing the tax to 5% of total gross income from the sale of oil and gas extracted in the state when the amount of annual gross income is at least $300,000;

DWM Planning
Non-Industry Personnel (NIP)

- How is the waste regulated?
  - Who are the regulatory bodies?
  - How is the waste categorized?
- Best disposal / storage methods
  - Protect human health
  - Preserve the environment
  - Minimize liabilities

COGCC Rule Changes Appointed Officials vote Dec.

- Proposed 160 page changes to current drilling & production BY NON-INDUSTRY APPOINTEES
- Longer more intense permitting process
- More information required for site prep and closure
- Storm water runoff
  - Implement Best Management Practices
  - Periodic inspections
- Pits
  - Stricter guidelines for constituents
  - Placement restrictions

Define Value

Conclusions

- Holistic Approach
- Project Manager
- Management by Measurement
- Active Project Improvement
- Some things are beyond our control

THANK YOU TO ALL WHO HAVE HELPED WITH THIS PROJECT

THANK YOU FOR YOUR TIME

"Effect Of Amendments On Chemical Properties Of Bentonite" 1990 by M. Voorhees

- Bentonite mine spoil is an unfavorable sub-strate for plant growth. Spoil is typically saline-sodic (Bohn et al. 1979) with an electrical conductivity (EC) that ranges from 9 to 49 decisiemens per meter (dS m^{-1}) and a sodium adsorption ratio (SAR) of 20-56 (Hemmer et al.)