This presentation premiered at WaterSmart Innovations

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INNOVATIONS

“Making Water Fracable”

TERRA Services LLC

Hydraulic Fracturing Solutions

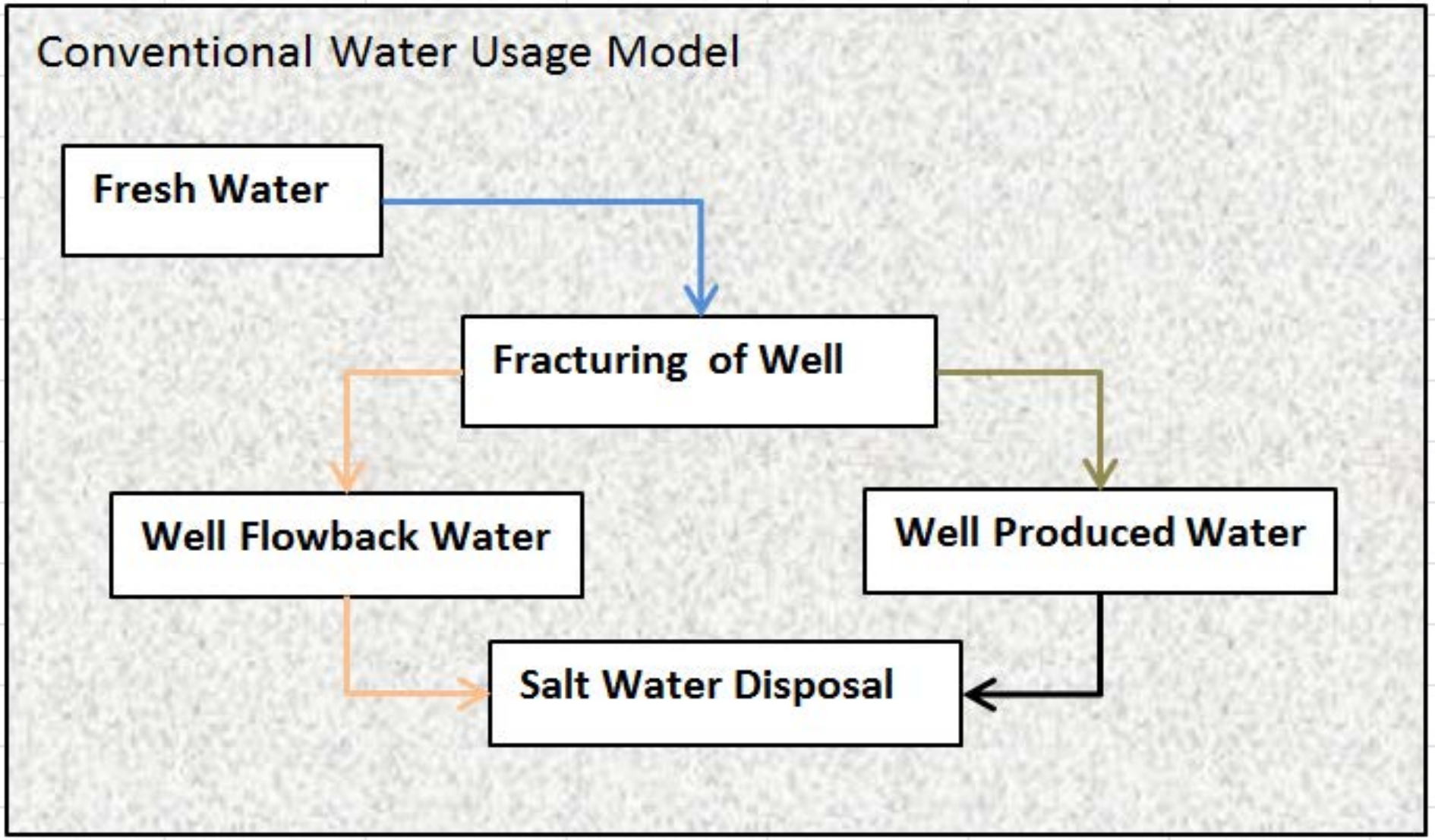
Powered by FracSTAR

“Industry leaders in safety and innovation!”

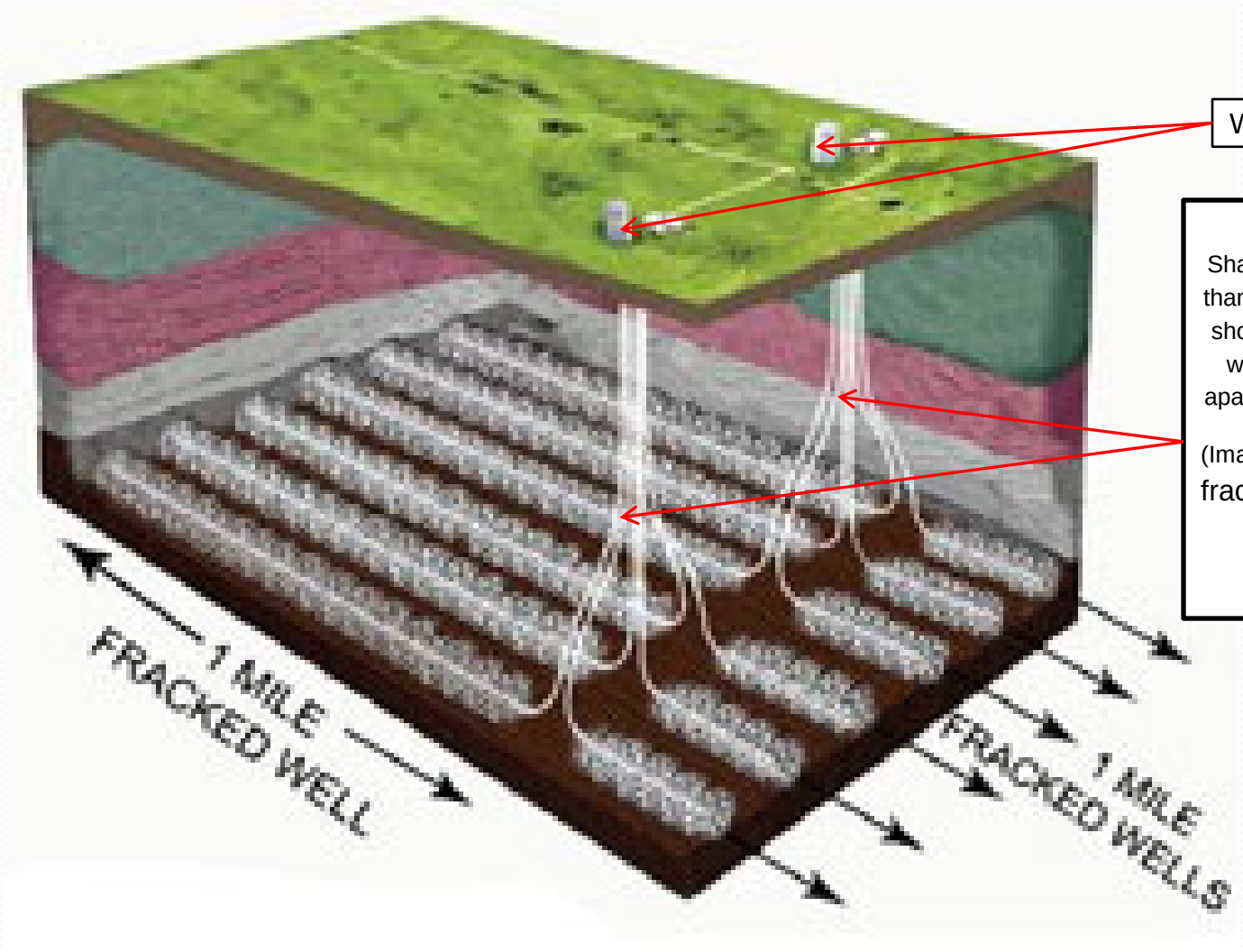
NCH CORPORATION

“Making Water Fracable”

How do you make water “Fracable” if you never look at the water?


Conventional Water Usage Model
Fresh Water
Fracturing of Well
Well Flowback Water
Well Produced Water
Salt Water Disposal

The fracturing process uses an average of 230,000 barrels / 9,660,000 gallons of water per well.
If only 6 wells are located on a pad.
1,380,000 barrels / 57,960,000 gallons of water per 6 well pad

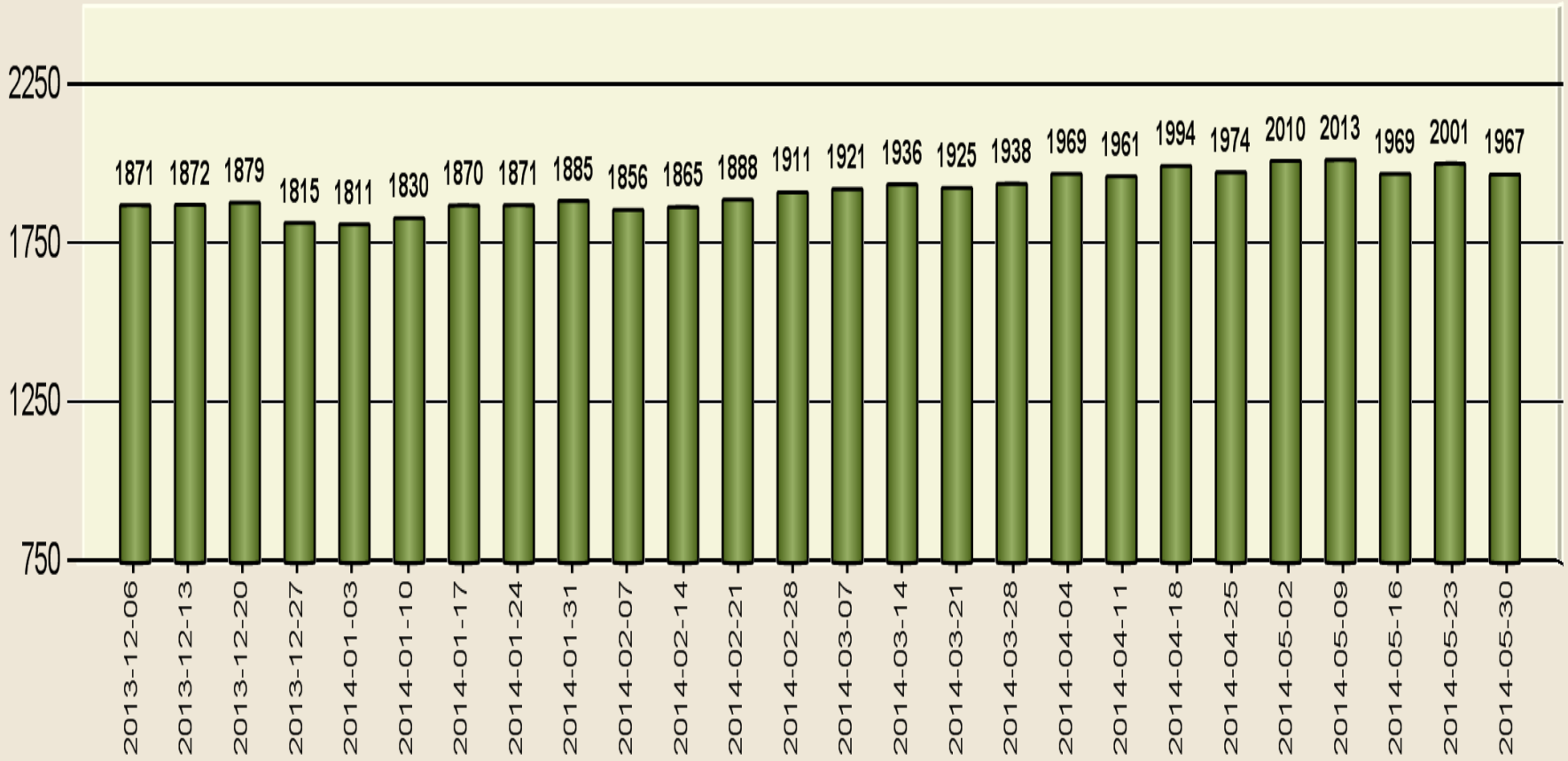


Well Head Locations

Shale gas fields need many more wells than conventional fields. This illustration shows expansion of a single well to 12 wells from two well pads a half-mile apart within the same square-mile area.

(Images courtesy of frackingboom.com)

U. S. Land Working Rig Count



U.S. RIG COUNTS

May 30, 2014

States & Districts	Baker Hughes Rig Count				RigData Rig Count				
	Four Week Average 2013	Four Week Average 2014	Last Week	This Week	Four Week Average 2013	Four Week Average 2014	Last Week	This Week	Waiting to Spud
U.S. Land									
Texas RRC District 1	137	118	116	114	136	123	125	123	14
Texas RRC District 2	87	90	91	90	81	93	91	89	4
Texas RRC District 3	48	55	53	58	50	64	62	64	3
Texas RRC District 4	34	35	33	35	31	29	29	25	5
Texas RRC District 5	13	9	9	9	12	11	12	13	1
Texas RRC District 6	26	33	34	31	24	33	36	35	1
Texas RRC District 7B	13	9	10	9	18	18	16	20	7
Texas RRC District 7C	81	97	97	95	74	102	101	100	7
Texas RRC District 8	278	326	325	334	265	320	318	316	11
Texas RRC District 8A	36	38	41	38	34	41	42	37	3
Texas RRC District 9	21	16	16	16	31	28	30	28	2
Texas RRC District 10	60	64	62	63	64	67	66	65	0
Texas Total	834	890	887	892	820	929	928	915	58

The average well takes 14 days to complete.

890 active drill rigs running for a year will drill 23,203 wells per year

These wells consume would consume 5,336,690,000 Barrels / 224,140,980,000 Gallons of Water each year

No sand, no water, no frac

No frac will take place unless the sand is on hand to complete the stages that are scheduled during a 24hr period.

By the same measure, if there is no water to carry the sand (Proppant) into the formation, there will be NO FRAC.

Water is the most important medium, and part of the Frac. It's the safety, the rinse (Flush) and the carrier of the sand that holds the formation open to let the oil and gas escape.

Water delivery systems to location

- Pumped through pipes that can travel for many miles with no treatment of bacteria
- Trucking

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How is water currently used?

- Water for at least one stage, and/or the number of stages to be completed for the first 24hrs, is on hand at location
- Most locations have a set of working tanks to hold a minimum amount of water that is needed to start the fracturing process
- The amount of water is considered a safety feature should a loss of water being delivered to the frac. As a safety an amount of water will be needed to flush the sand from the pumping equipment and the casing to avoid a screen out.

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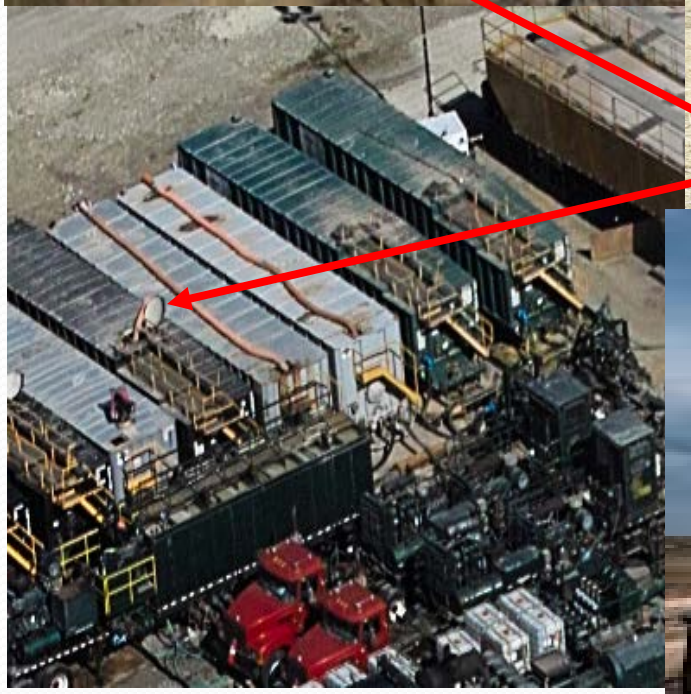
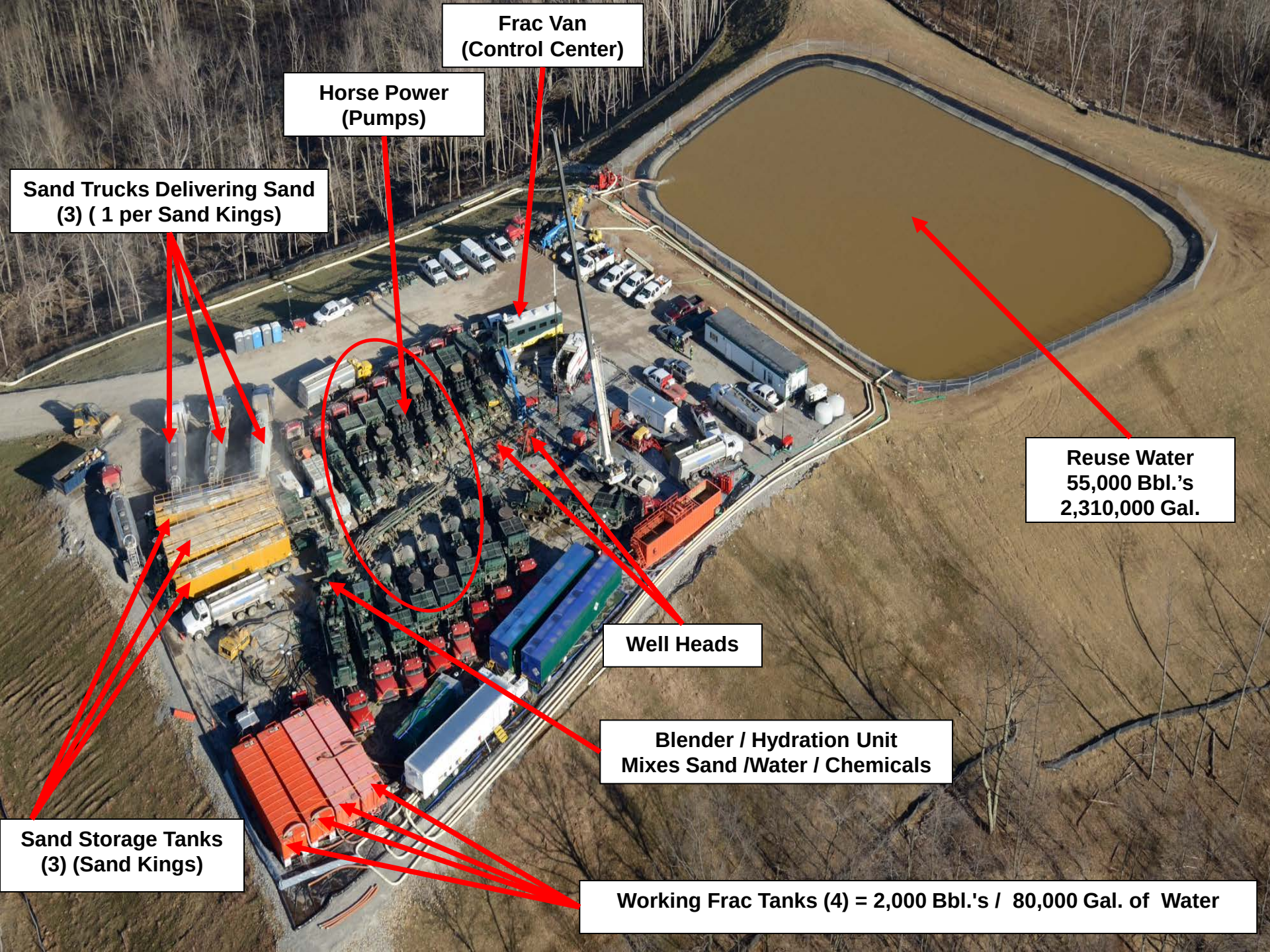
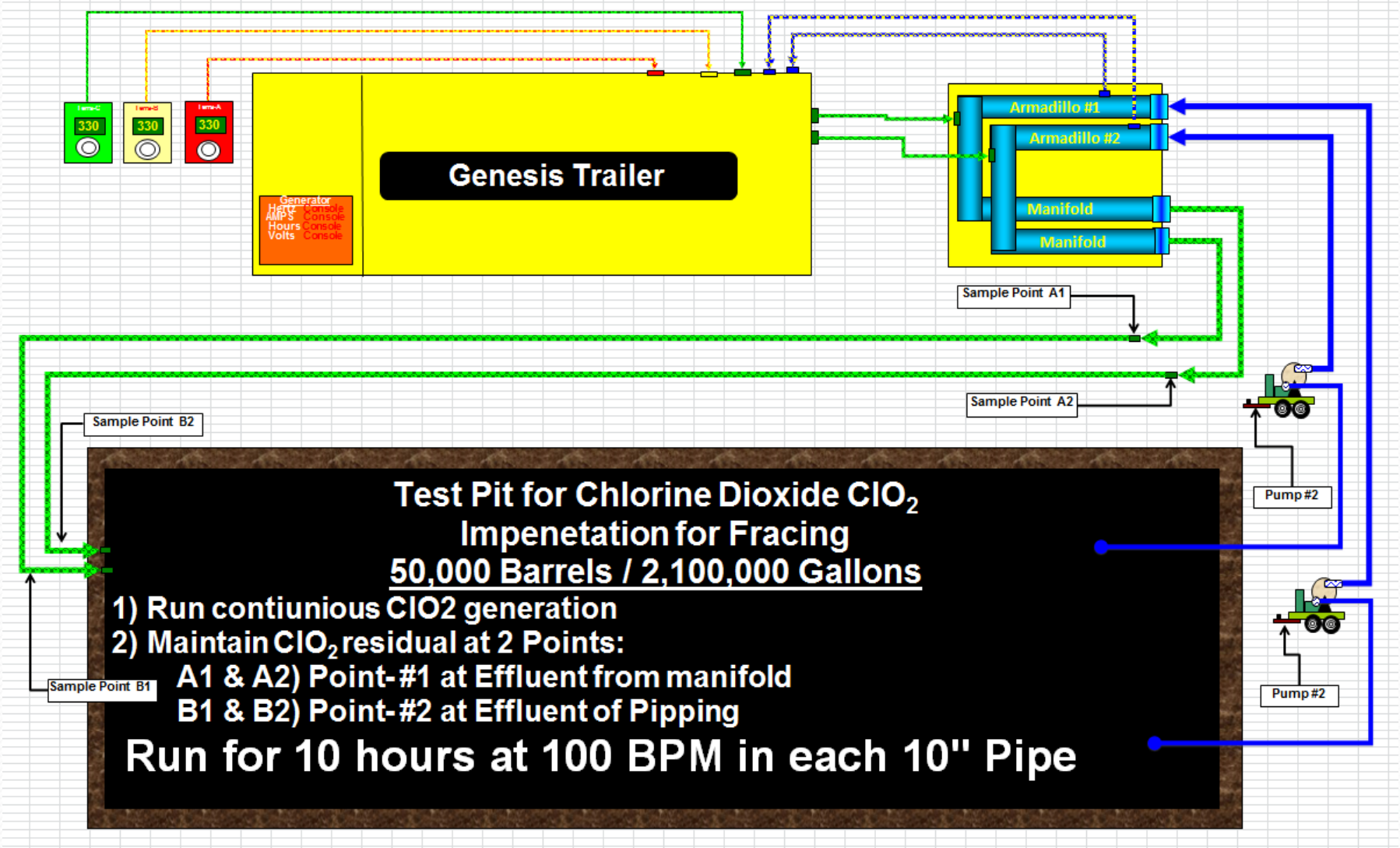
Water Storage



Does the bacteria count go up, down or stay the same?


Frac Van
(Control Center)
Horse Power
(Pumps)
Sand Trucks Delivering Sand
(3) (1 per Sand Kings)
Reuse Water
55,000 Bbl.'s
2,310,000 Gal.
Well Heads
Blender / Hydration Unit
Mixes Sand /Water / Chemicals
Sand Storage Tanks
(3) (Sand Kings)
Working Frac Tanks (4) = 2,000 Bbl.'s / 80,000 Gal. of Water

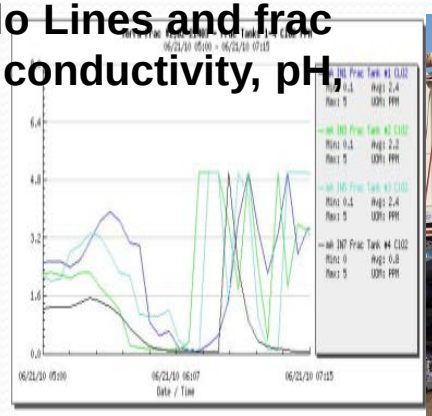
Test Pit for first Frac Simulation

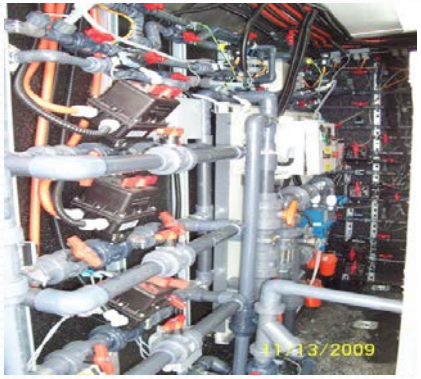


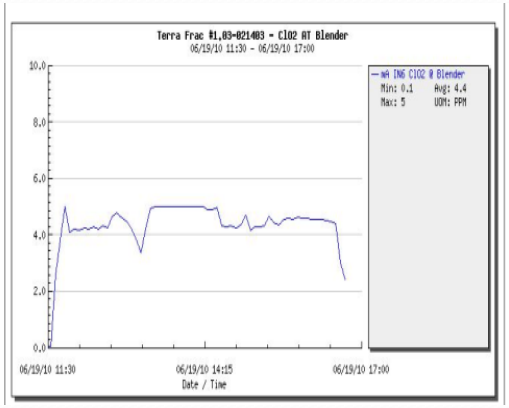
Test #1 Pit For Fracing		ClO_2 Residuals						Untreated Water Cultures	
50,000 Barrel Pit		Immediate			Immediate			Source (Coming Into Unit)	
Date	Stage	A1 ClO_2 Res.	A2 ClO_2 Res.	Average ClO_2 Res.	ClO_2 Res	ClO_2 Res	Average ClO_2 Res	SRB (col/ml)	APB (col/ml)
10/15/2009	Sample #1 @ Pump #1							10,000,000	1,000,000
10/15/2009	Sample #2 @ Pump #2							1,000,000	1,000,000
10/15/2009	Time Sample #3	10.22	11.00	10.61	2.33	1.89	2.11	n/a	n/a
10/15/2009	Time Sample #4	5.30	6.69	6.00	1.12	0.43	0.78	n/a	n/a
10/15/2009	Time Sample #5	6.47	1.73	4.10	0.77	0.08	0.43	n/a	n/a
10/15/2009	Time Sample #6	3.31	1.75	2.53	1.12	0.14	0.63	n/a	n/a
10/15/2009	Time Sample #7	5.30	2.21	3.76	2.88	1.09	1.99	n/a	n/a
10/15/2009	Time Sample #8	4.20	8.00	6.10	1.62	1.99	1.81	n/a	n/a
10/15/2009	Time Sample #9	1.38	4.89	3.14	0.01	0.72	0.37	n/a	n/a
10/15/2009	Time Sample #10	4.92	7.11	6.02	1.44	2.01	1.73	n/a	n/a
10/15/2009	Time Sample #11	5.88	6.54	6.21	2.44	1.88	2.16	n/a	n/a
10/15/2009	Time Sample #12	4.10	5.21	4.66	2.04	1.77	1.91	n/a	n/a
	Averages	5.11	5.51	5.31	1.58	1.20	1.39		

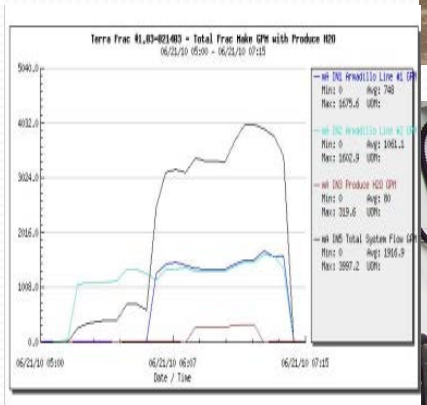
Genesis Trailer

- 24’ Bumper Pull trailer
- 10’ Armadillo Trailer
- 2 Armadillo Lines with NO blending capabilities
- Treat 238 bbls/min
- 456 Points of measurement
- Measures Armadillo Lines and frac tank ClO_2 residual, conductivity, pH, and pressure
- Web based
- PID/PLC Control





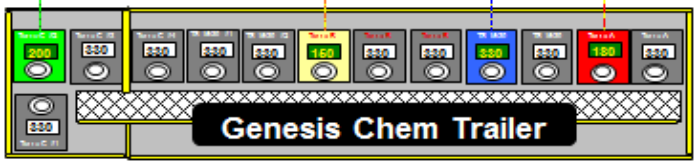




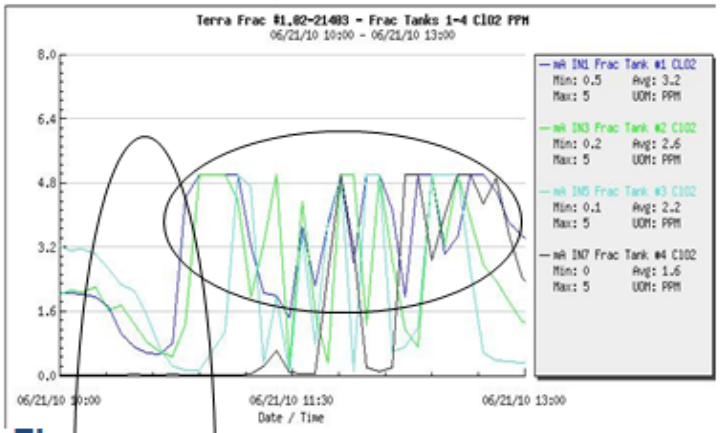
Test #2 Frac #1		ClO_2 Residuals			Treated Samples		Untreated Water Cultures	
120,000 Barrel Pit		Inlet Manifold to the Working Tanks			at Blender		Source (Coming Into Unit)	
Date	Stage	Amadillo #1	Amadillo #2	Average	SRB (col/ml)	APB (col/ml)	SRB (col/ml)	APB (col/ml)
Filling Tanks	Sample #1 @ Inlet Armadillo #1						100,000	1,000
Filling Tanks	Sample #2 @ Inlet Armadillo #2						10,000	100,000
Stage 1	Time Sample #3	7.40	2.44	4.92	1,000	100	n/a	n/a
Stage 2	Time Sample #4	5.33	6.88	6.11	10,000	1,000	n/a	n/a
Stage 3	Time Sample #5	4.21	3.11	3.66	1,000	1,000	n/a	n/a
Stage 4	Time Sample #6	2.55	1.21	1.88	100	0	n/a	n/a
Stage 5	Time Sample #7	5.44	2.07	3.76	10	100	n/a	n/a
Stage 6	Time Sample #8	3.22	4.01	3.62	0	1,000	n/a	n/a
Stage 7	Time Sample #9	0.88	5.12	3.00	0	0	n/a	n/a
Stage 8	Time Sample #10	2.93	1.65	2.29	10	10	n/a	n/a
Stage 9	Time Sample #11	1.47	0.53	1.00	100	1,000	n/a	n/a
Stage 10	Time Sample #12	3.72	3.01	3.37	10	10	n/a	n/a
Stage 11	Time Sample #12	2.99	1.85	2.42	0	0	n/a	n/a
	Averages	3.65	2.90	3.27	100	1,000	n/a	n/a

Test #2 Frac #1		ClO_2 Residuals					
120,000 Barrel Pit		Working Frac Tanks					
Date	Stage	Frac Tank #1	Frac Tank #2	Frac Tank #3	Frac Tank #4	Average	Blender
Stage 1	Time Sample #3	2.46	1.01	0.02	0.85	1.09	0.53
Stage 2	Time Sample #4	1.12	0.55	0.01	0.59	0.57	0.27
Stage 3	Time Sample #5	0.89	1.55	3.89	2.01	2.09	1.44
Stage 4	Time Sample #6	1.05	0.23	0.44	1.67	0.85	0.42
Stage 5	Time Sample #7	3.61	0.74	0.05	0.23	1.43	1.77
Stage 6	Time Sample #8	2.88	0.68	1.88	0.89	1.58	1.51
Stage 7	Time Sample #9	2.10	0.96	1.23	0.99	1.32	1.41
Stage 8	Time Sample #10	1.01	0.01	0.22	0.49	0.82	0.23
Stage 9	Time Sample #11	0.88	0.02	0.44	1.12	0.68	0.51
Stage 10	Time Sample #12	1.52	0.51	0.08	1.10	0.05	1.77
Stage 11	Time Sample #12	1.01	0.73	0.41	0.30	1.01	0.89
	Averages	1.68	0.64	0.79	0.93	1.04	0.98

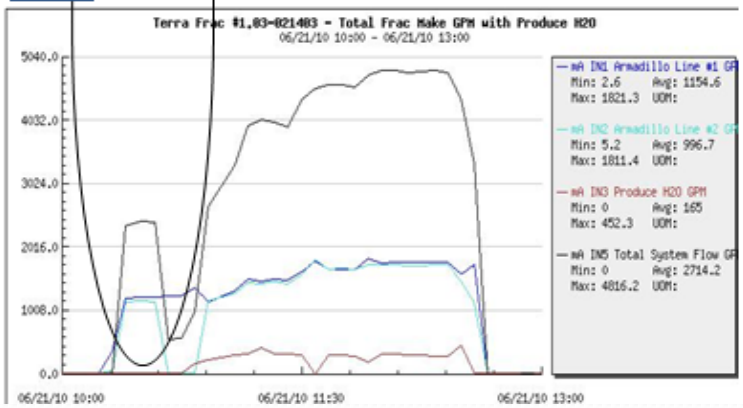
Genisis T1 & T2 LAYOUT

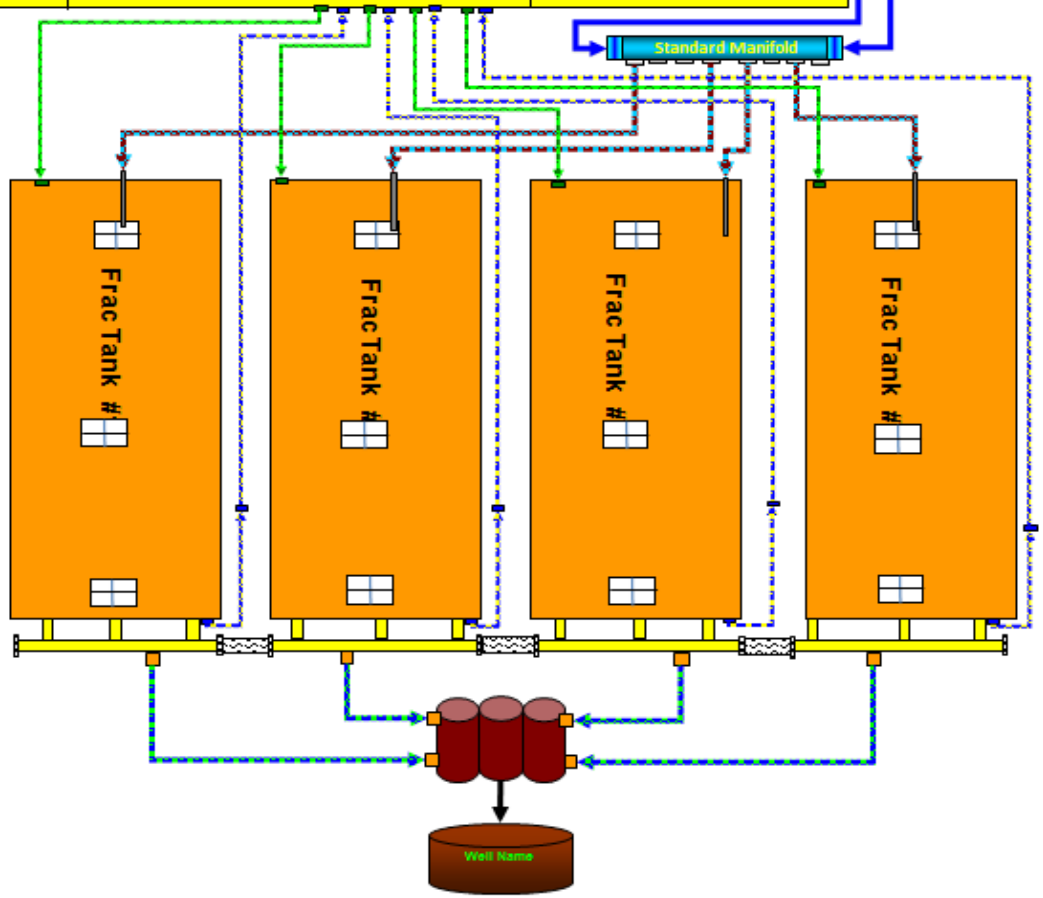


Residual



Flow



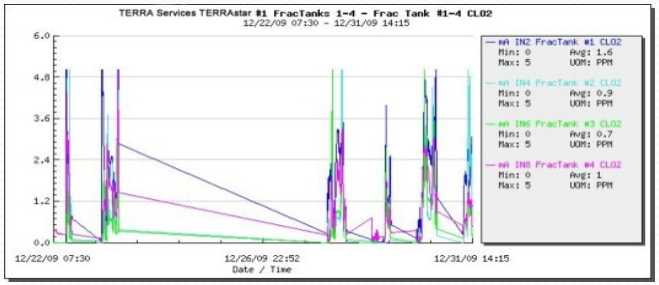


Pilot Frac Research 12-22-09

Source water was high in bacteria

- 9 Stage Frac Test results of Prefrac Bacteria Counts
- SRB's @ 109 (1,000,000,000 cfu/ml) (9 bottles turned)
- APB's @ 104 (10,000 cfu/ml) (4 bottles turned)

Stage #1 thru Stage #9 ClO2 Residual Summary



Net ClO2 Residual During 222.75 Hrs = 1.05ppm

Net ClO2 Residual During Stages Only = 1.46ppm

- After Stage #3 Best and Worst Frac Tanks

Test results of Bacteria Counts
SRB's @ <100 (less than 1 cfu/ml) !!!!
APB's @ <100 (less than 1 cfu/ml) !!!!
IN ALL TANKS!!!

After Stage #6 All Frac Tanks #1 to #4

Test results of Bacteria Counts
SRB's @ <100 (less than 1 cfu/ml) !!!!
APB's @ <100 (less than 1 cfu/ml) !!!!
IN ALL TANKS!!!

Produced Samples 100 Barrels 1-1-10 and 1025 Barrels1-2-10

Test results of Post TERRAfrac Bacteria Counts
SRBS @ <10^0 (less than 1 cfu/ml) !!!!
APBs @ <10^0 (less than 1 cfu/ml) !!!!

In Produced Water After 100 Barrels & 1025 Barrels !!!
1025 Barrels Sample had a ClO2 Residual of 0.23ppm!!
and Chlorides of >18,000ppm

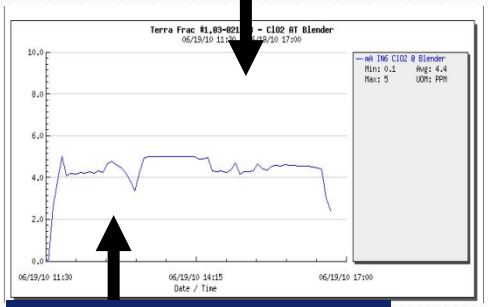
Test #3 Frac #2		ClO_2 Residuals			Treated Samples		Untreated Water Cultures	
90,000 Barrel Frac		Inlet Manifold to the Working Tanks			at Blender		Source (Coming Into Unit)	
Date	Stage	Amadillo #1	Amadillo #2	Average	SRB (col/ml)	APB (col/ml)	SRB (col/ml)	APB (col/ml)
Filling Tanks	Sample #1 @ Inlet Armadillo #1						1,000,000,000	10,000
Stage 1	Time Sample #2	4.22	3.88	4.05	0	0	n/a	n/a
Stage 2	Time Sample #3	5.00	5.50	5.25	0	0	n/a	n/a
Stage 3	Time Sample #4	3.88	4.23	4.06	0	0	n/a	n/a
Stage 4	Time Sample #5	4.11	4.89	4.50	0	0	n/a	n/a
Stage 5	Time Sample #6	5.17	4.86	5.02	0	0	n/a	n/a
Stage 6	Time Sample #7	4.38	3.77	4.08	0	0	n/a	n/a
Stage 7	Time Sample #8	3.65	5.16	4.41	0	0	n/a	n/a
Stage 8	Time Sample #9	4.67	4.44	4.56	0	0	n/a	n/a
Stage 9	Time Sample #10	4.25	4.97	4.61	0	0	n/a	n/a
	Averages	4.37	4.63	4.50	0	0	n/a	n/a

Test #3 Frac #2		ClO_2 Residuals					
90,000 Barrel Frac		Working Frac Tanks					
Date	Stage	Frac Tank #1	Frac Tank #2	Frac Tank #3	Frac Tank #4	Average	Blender
Stage 1	Time Sample #2	3.88	4.00	3.22	2.88	3.50	1.80
Stage 2	Time Sample #3	4.12	4.44	3.75	3.11	3.86	1.44
Stage 3	Time Sample #4	3.12	3.51	3.72	3.00	3.34	1.12
Stage 4	Time Sample #5	3.55	3.44	3.78	3.99	3.69	1.23
Stage 5	Time Sample #6	4.22	4.89	3.93	3.90	1.43	1.56
Stage 6	Time Sample #7	3.52	3.10	3.77	3.65	3.51	1.51
Stage 7	Time Sample #8	5.01	5.00	1.23	0.99	3.06	1.41
Stage 8	Time Sample #9	4.02	3.57	3.12	3.96	0.82	1.62
Stage 9	Time Sample #10	4.11	3.38	3.91	2.88	0.68	1.45
	Averages	3.95	3.93	3.38	3.15	2.65	1.46

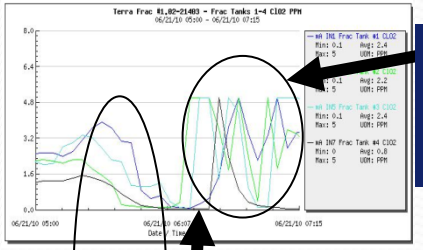
Alpha 1 & Alpha 2 Trailers

- 42’ Gooseneck Trailer
- Two 10” Armadillo lines and a 6” produced water line
- 6” Produced line blends up to 30/bpm into each Armadillo line
- Able to treat 240 bpm
- 712 Points of measurement
- Measures armadillo lines and frac tank ClO2 residual, conductivity, pH, and pressure
- Web based
- PID/PLC Control
- Water treatment test lab
- Supplies its own power through a generator
- Eye wash / safety shower

- Average to blender will approach, but not exceed 5PPM because set 5PPM as max per this test and reasearch.

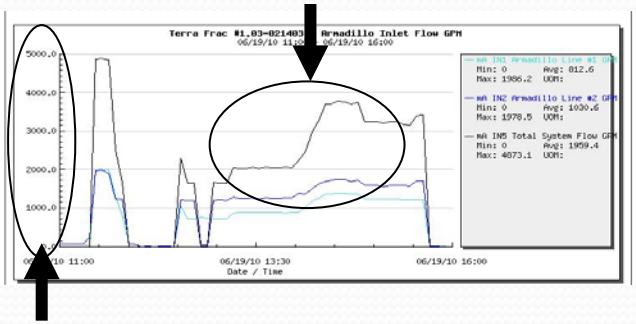


-Able to maintain residual available to blender at steadier rate



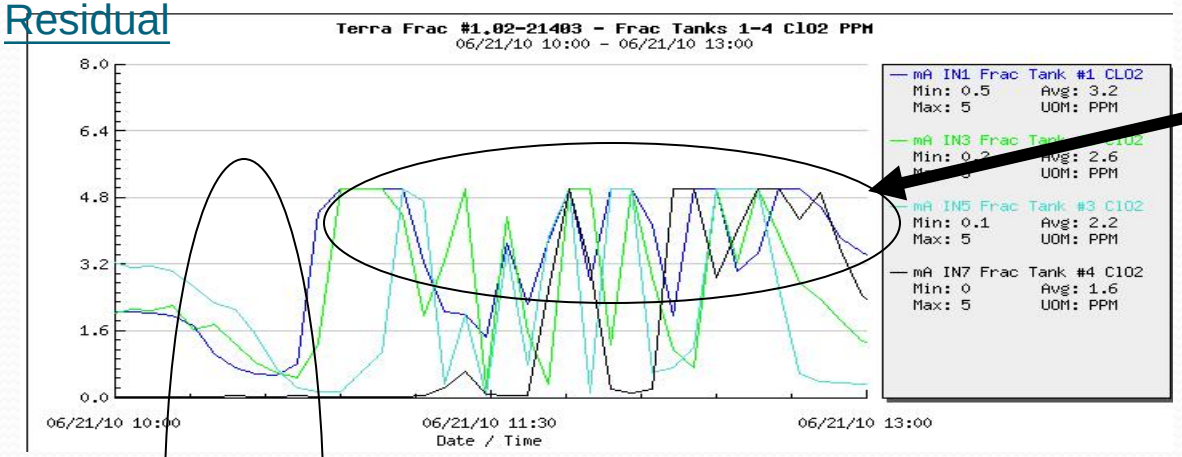
-Rapidly respond and adjust to variation

-Produced water introduces high variability into system



Stage 2A Review – Software Calibration

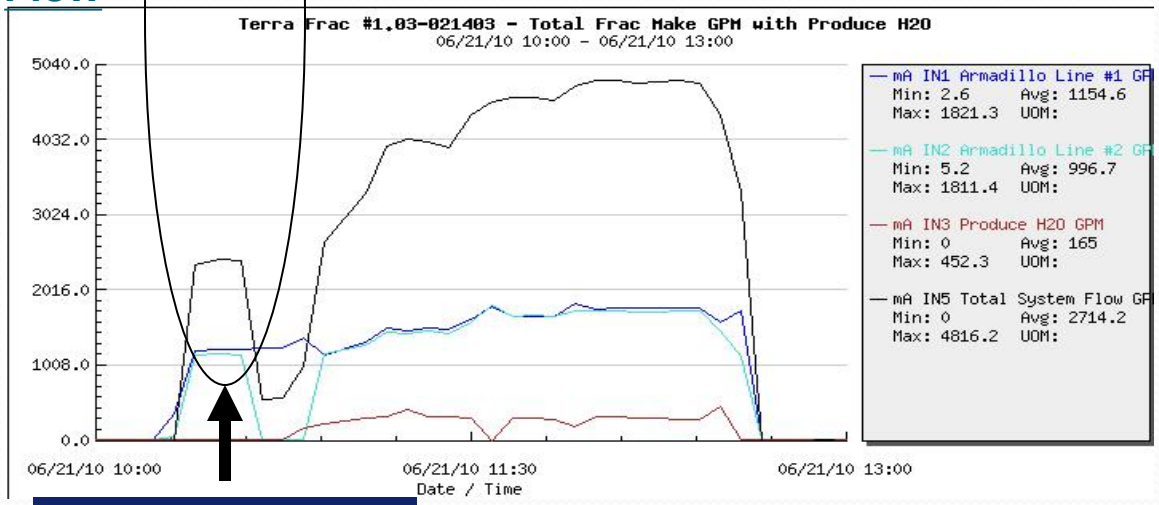
Residual



-Responding to Inorganic and Organic Demand in the water

-Further calibration of "software" required to smooth out our response

Flow



-Initial ramp impact

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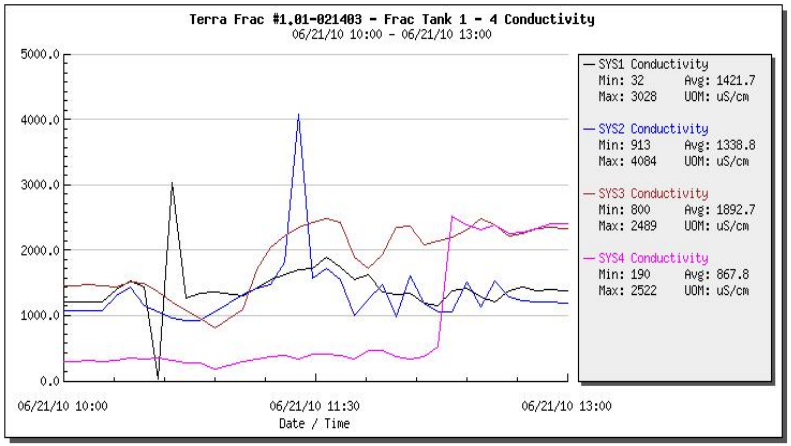
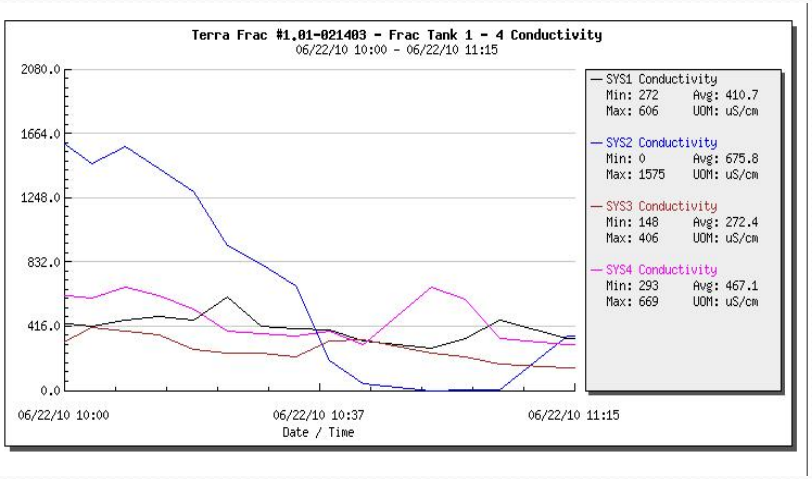
Conductivity Data

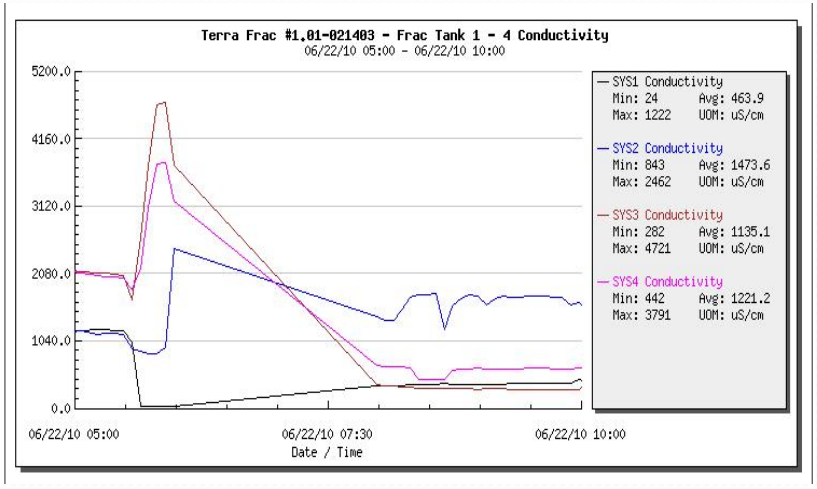
Stage 2A Conductivity at Frac Tanks



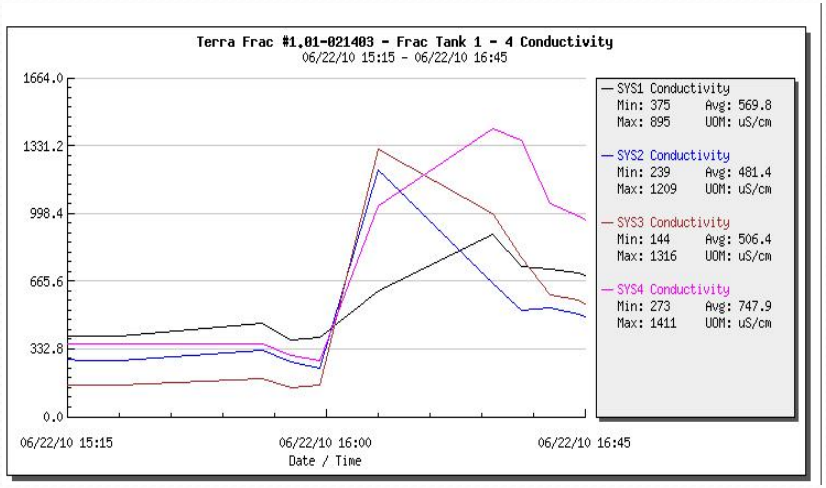
Stage 3A Conductivity Frac Tanks



Stage 2B Conductivity at Frac Tanks



Stage 3B Conductivity Frac Tanks



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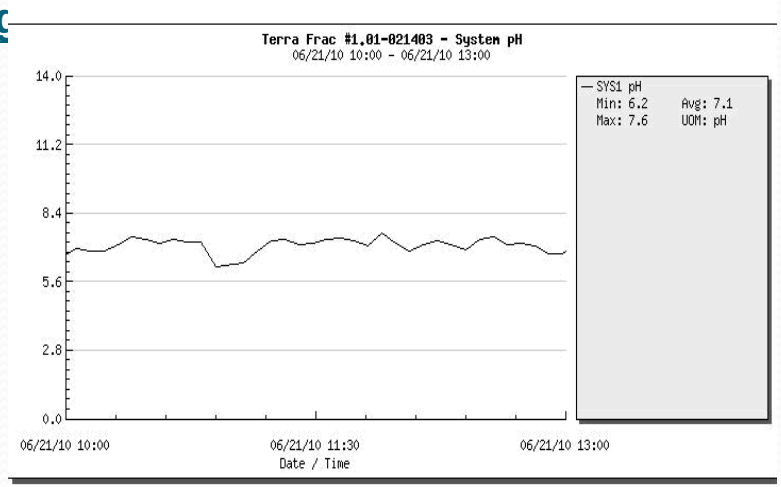
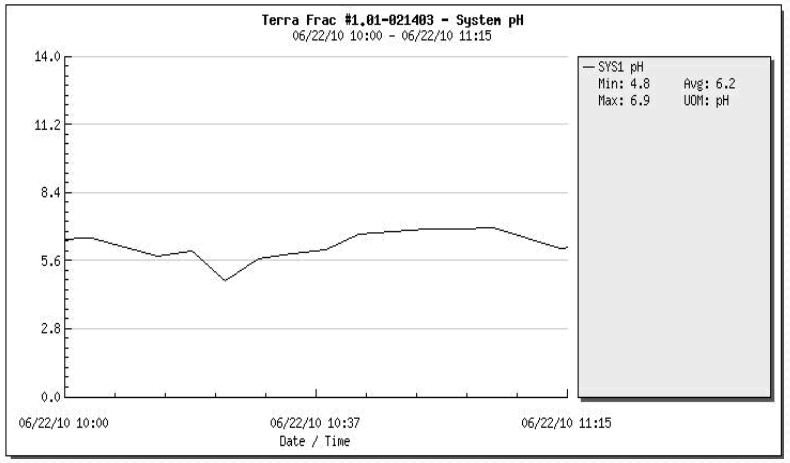
pH Level Data

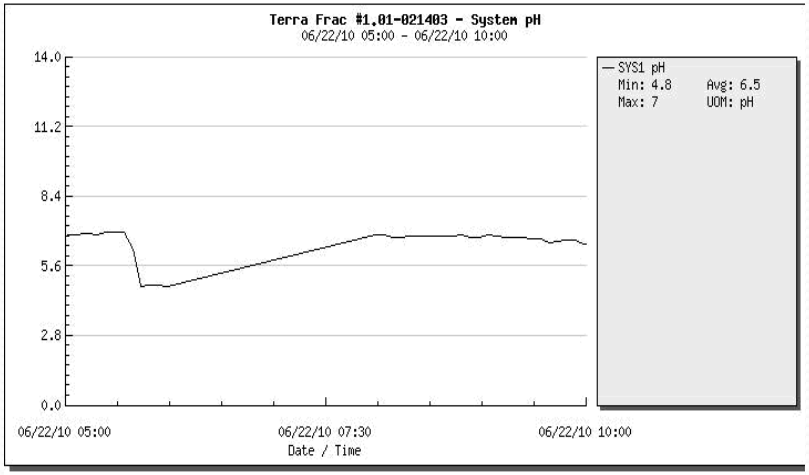
Stag



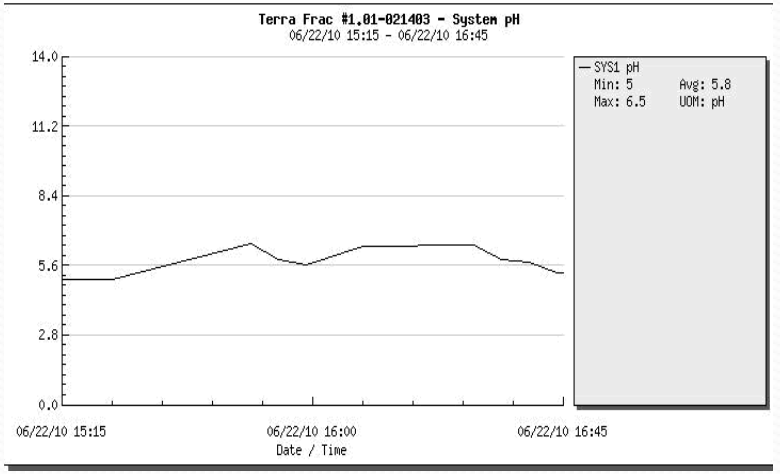
Stage 3A pH at Frac Tanks



Stage 2B pH at Frac Tanks



Stage 3B pH at Frac Tanks

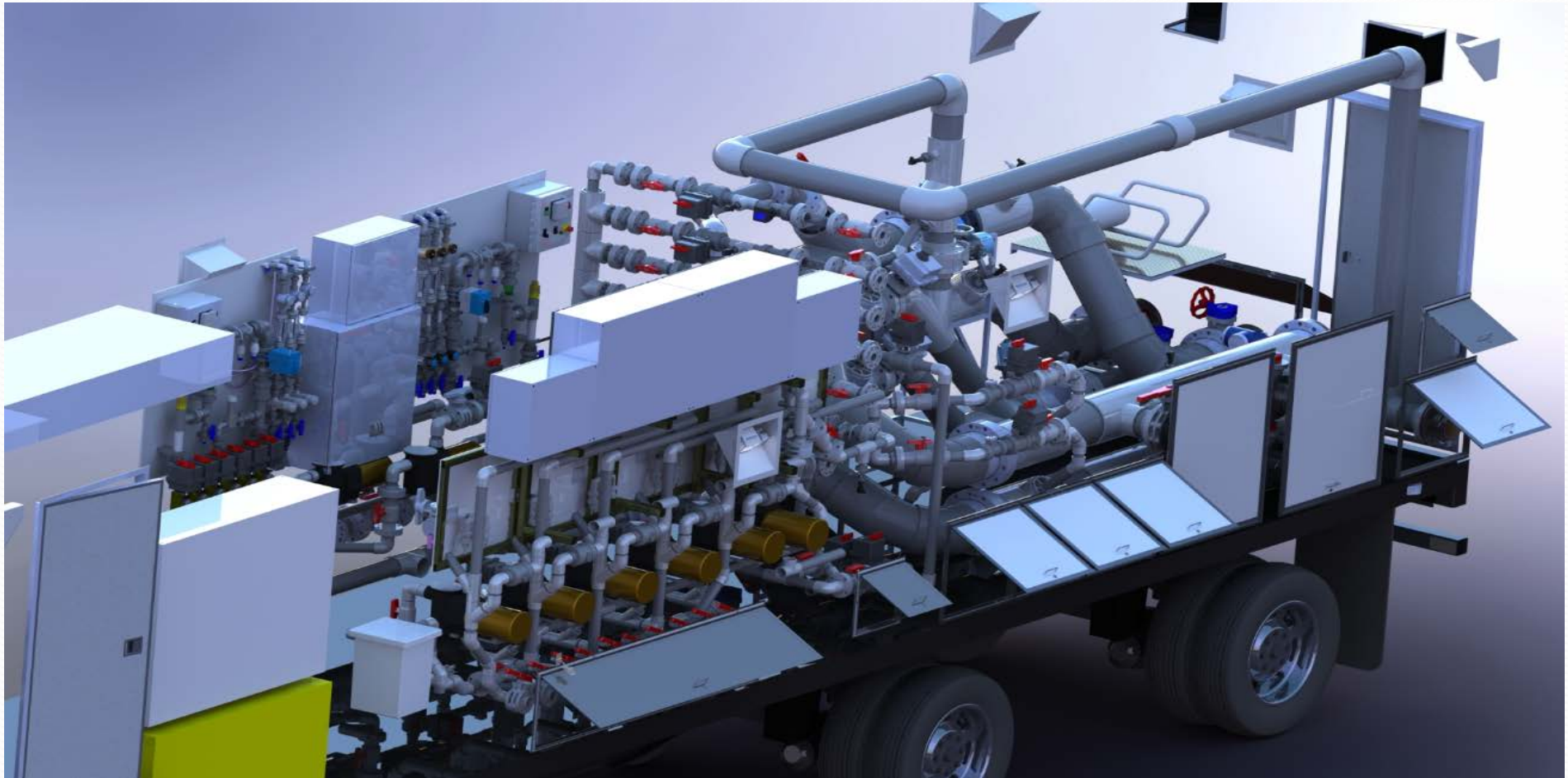


NCH CORPORATION

FracSTAR is a custom built proprietary hardware and software package to integrate points of measurement used in the TerraFrac process. It allows for the blending and treatment of water used in the fracturing process. FracSTAR models the water 100 times per second and can predict the bio-demand to control the blends of reuse and recycled waters.

NCH CORPORATION

The TERRA trailer is a mobile water treatment plant/process that treats water using Chlorine Dioxide ($ClO_{2)}$ to remove all bacteria from water used in hydraulic fracturing. The FracSTAR technology operates in real-time, with 1,489 points of continuous measurements with a proprietary custom built operating system at flow rates of over 345 barrels per minute (BPM). The FracSTAR system is the safest, most advanced form of water treatment using Chlorine Dioxide (ClO_2) that has ever been developed for hydraulic fracturing.



NCH CORPORATION

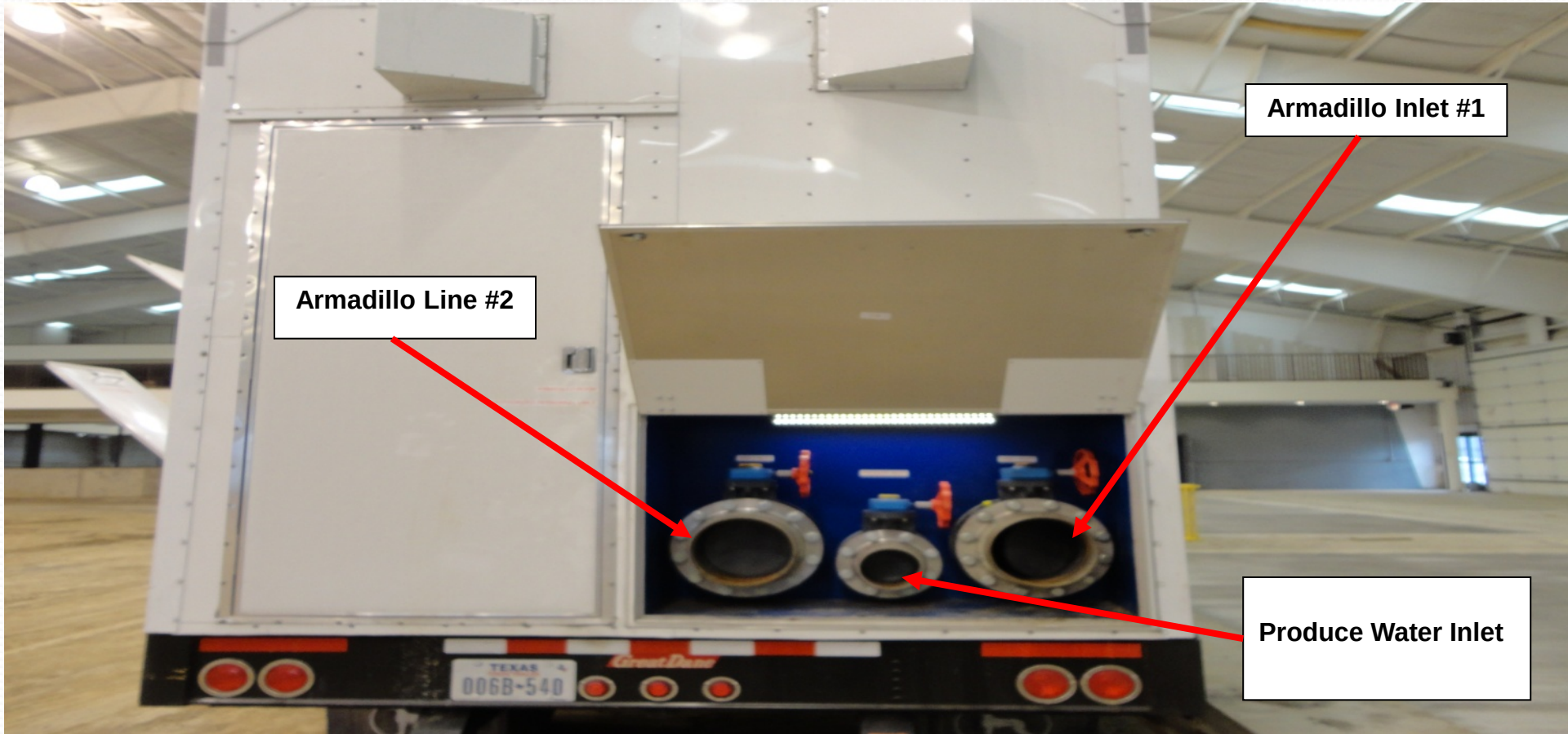
The FracSTAR mobile frac water treatment process was built around water use during the hydraulic fracturing process. It can process large volumes of water, at high velocities, and deliver a 99.99999999% bacteria kill

The TERRA unit was built to follow the same on-pad model as horsepower; first equipment on location and last off. Every drop of water used in the fracturing of an oil & gas well will flow through the TERRA trailer process.

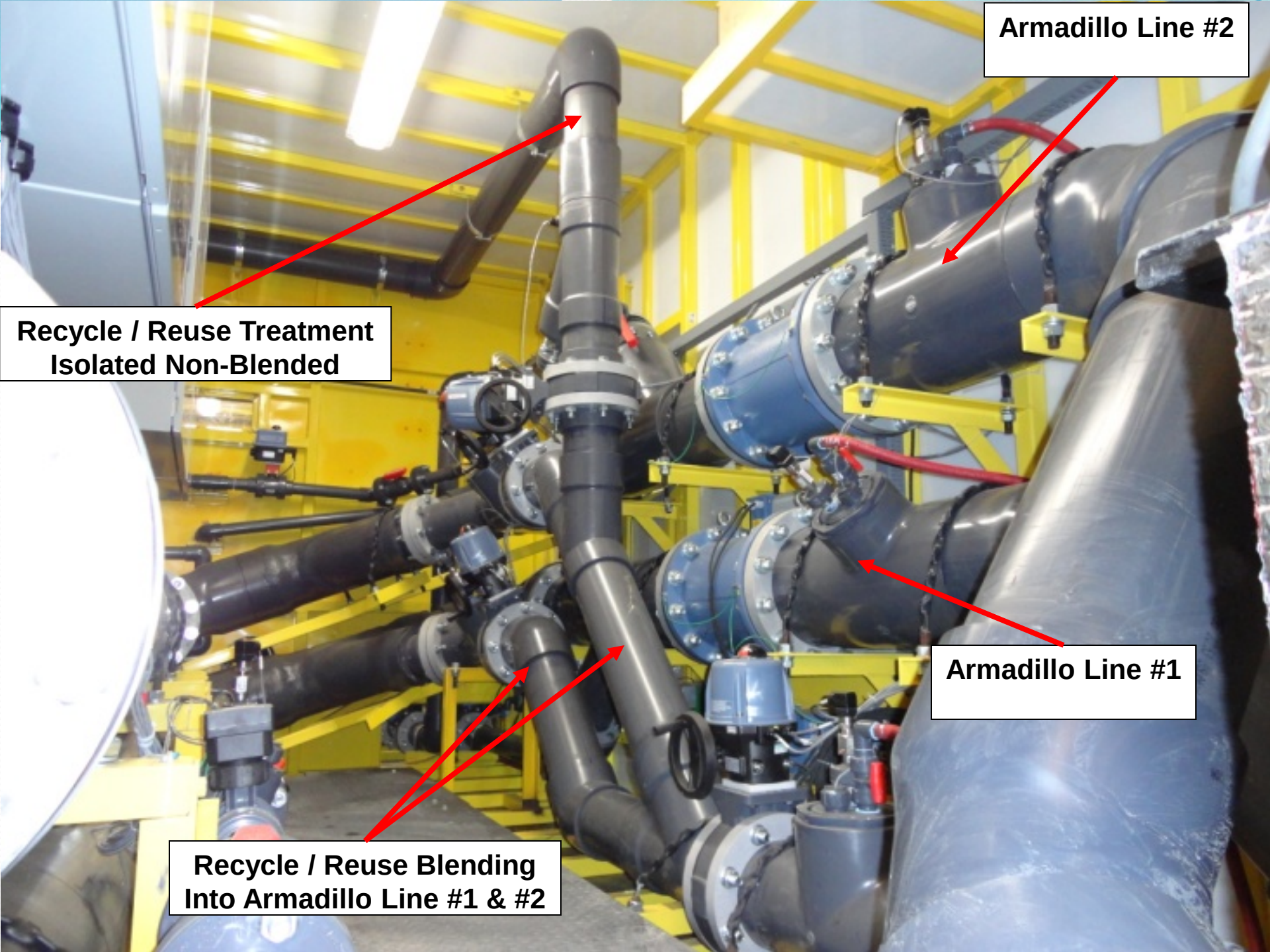
NCH CORPORATION

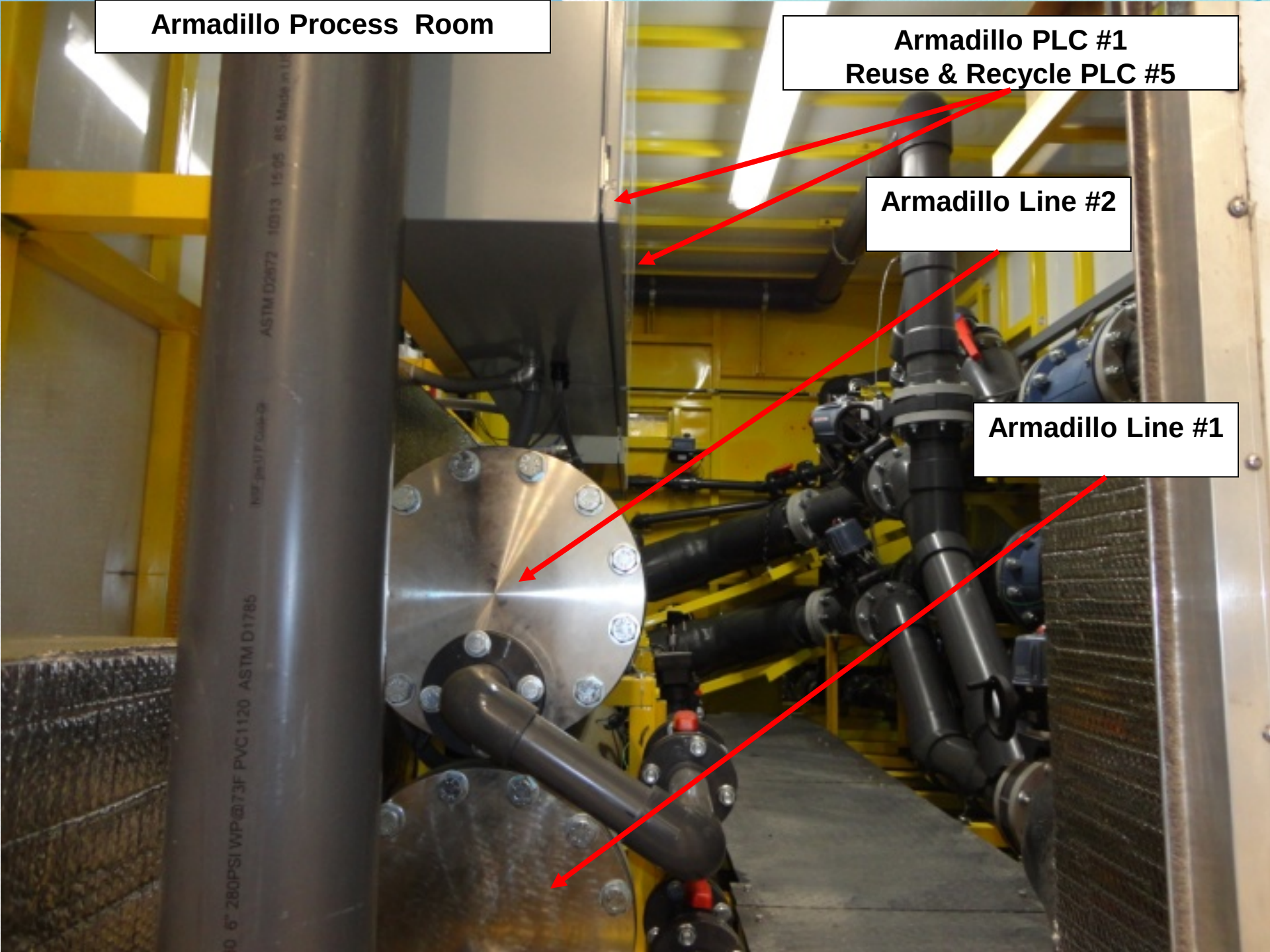
The TERRA trailer has three separate water inlets:

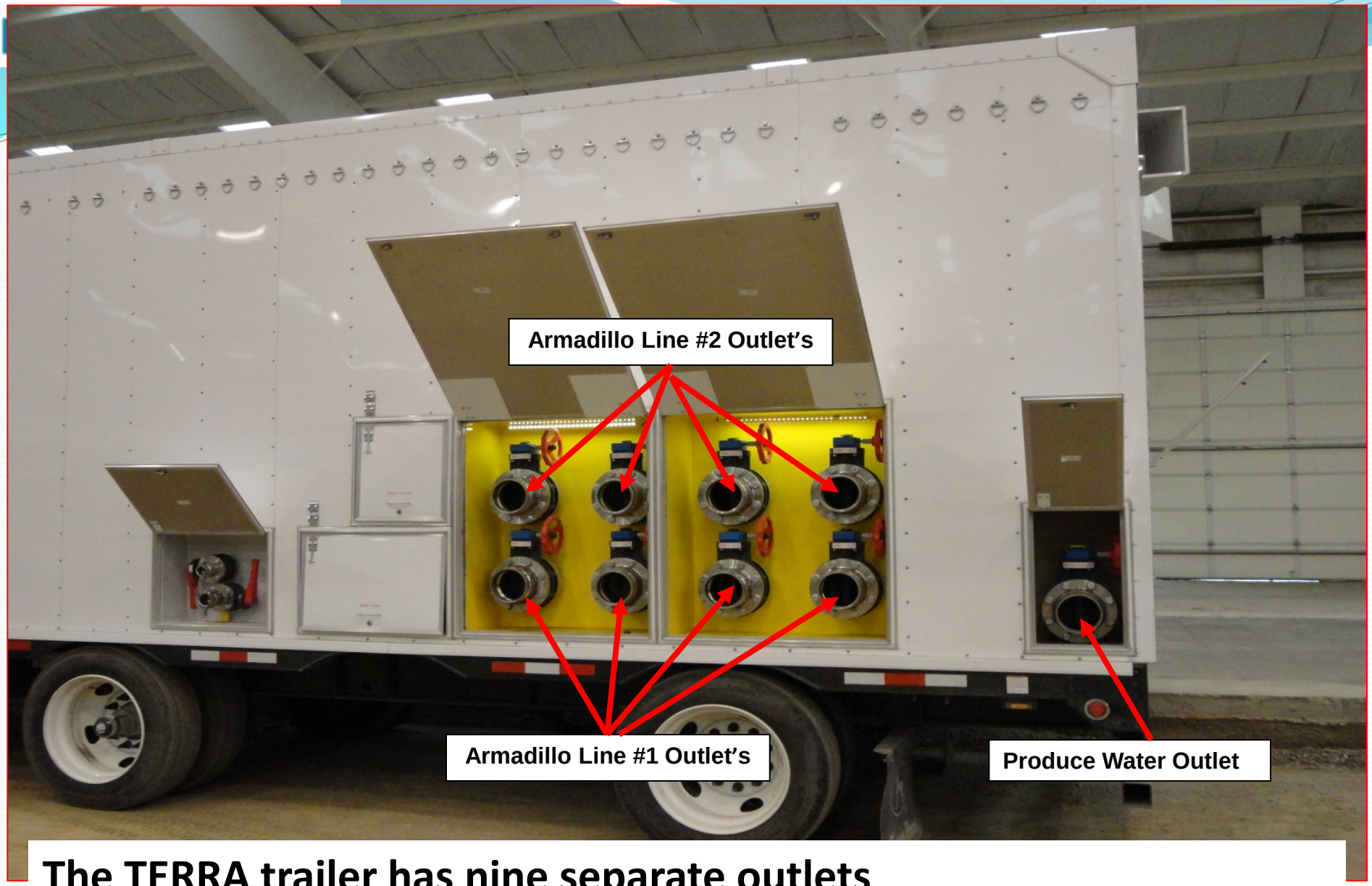
- Armadillo line #1 is a 10” fresh water inlet 142.00 BPM / 6,000 GPM
- Armadillo line #2 is a 10” fresh water inlet 142.00 BPM / 6,000 GPM
- Produce Water is a 6” waste water inlet 59.00 BPM / 2,500 GPM



The TERRA trailer replaces the traditional water transfer distribution manifold. This is to insure that all water passes through the FracSTAR process so that every drop of water is not only measured, but treated. The FracSTAR process can treat between 4 and 8 working tanks.


Armadillo Line #2
Recycle / Reuse Treatment
Isolated Non-Blended
Armadillo Line #1
Recycle / Reuse Blending
Into Armadillo Line #1 & #2


Armadillo Process Room
Armadillo PLC #1
Reuse & Recycle PLC #5
Armadillo Line #2
Armadillo Line #1

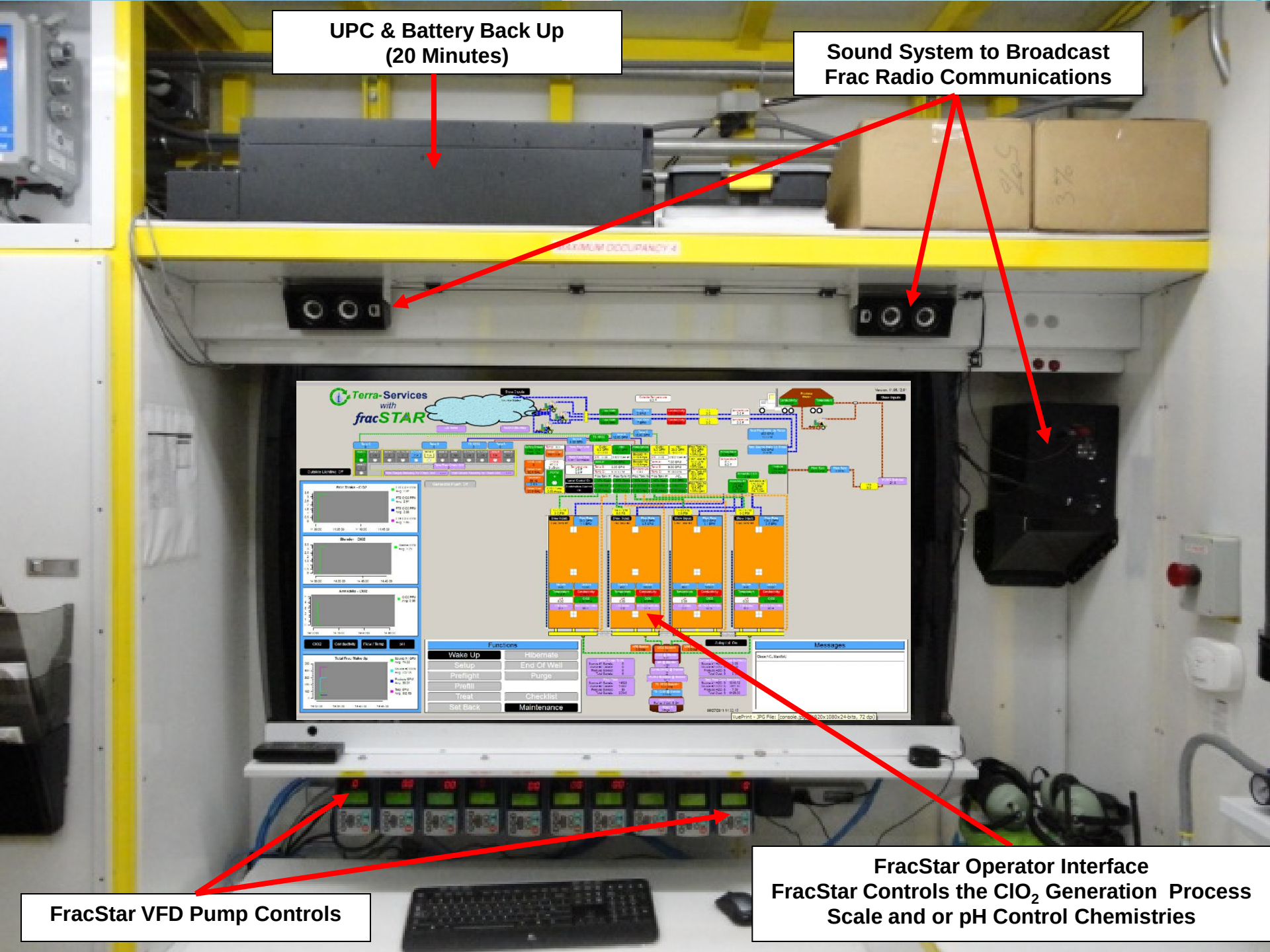


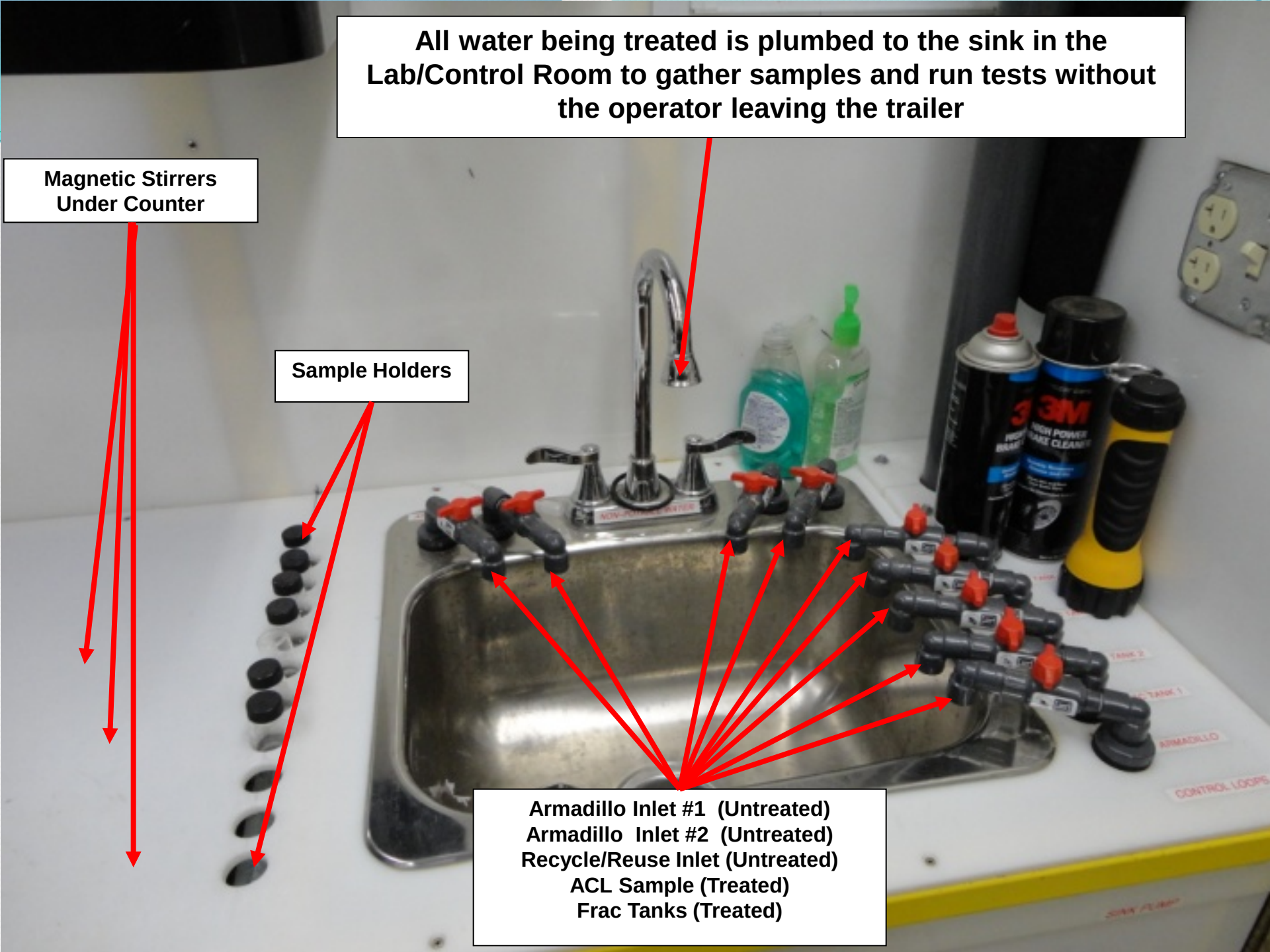
The TERRA trailer has nine separate outlets.

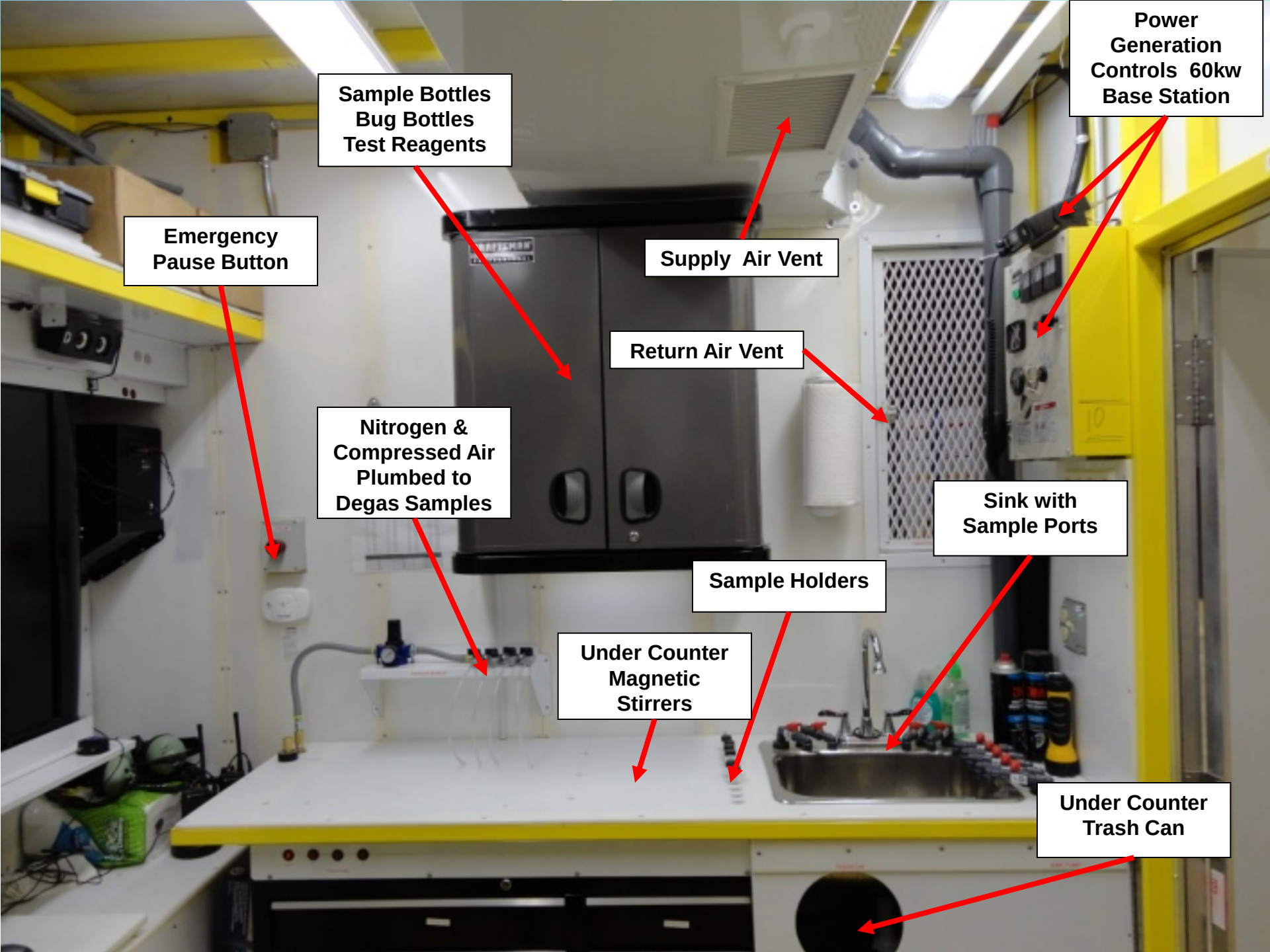
Armadillo Line #1 has four 6" outlets

Armadillo Line #2 has four 6" outlets

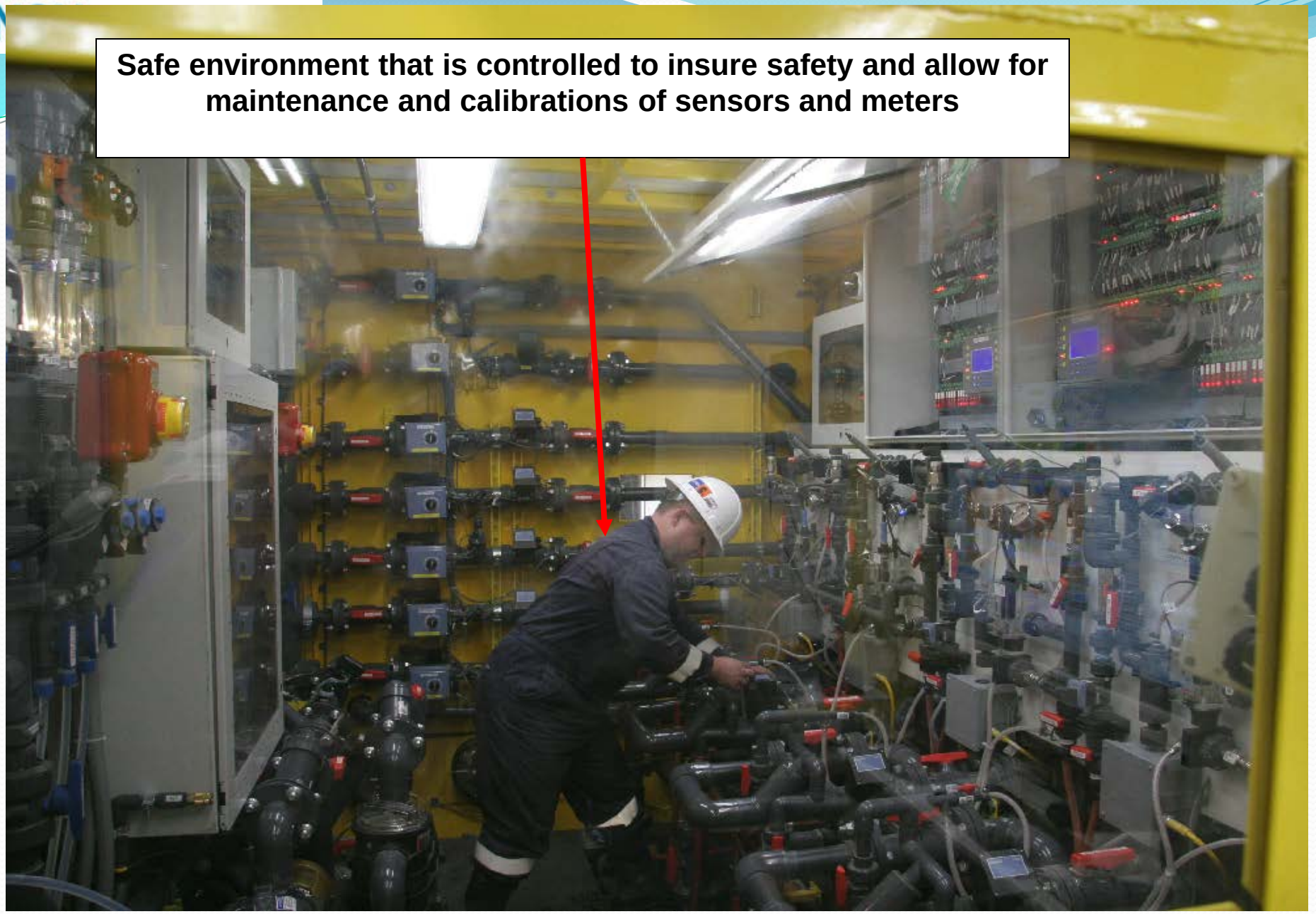
Produce Water Line has one 6" outlet


UPC & Battery Back Up
(20 Minutes)
Sound System to Broadcast
Frac Radio Communications
Terra-Services
with
fracSTAR
Functions
Wake Up
Hibernate
Setup
End Of Well
Preflight
Purge
Prefill
Treat
Checklist
Set Back
Maintenance
Messages
FracStar VFD Pump Controls
FracStar Operator Interface
FracStar Controls the ClO_2 Generation Process
Scale and or pH Control Chemistries


All water being treated is plumbed to the sink in the Lab/Control Room to gather samples and run tests without the operator leaving the trailer
Magnetic Stirrers Under Counter
Sample Holders
Armadillo Inlet #1 (Untreated)
Armadillo Inlet #2 (Untreated)
Recycle/Reuse Inlet (Untreated)
ACL Sample (Treated)
Frac Tanks (Treated)

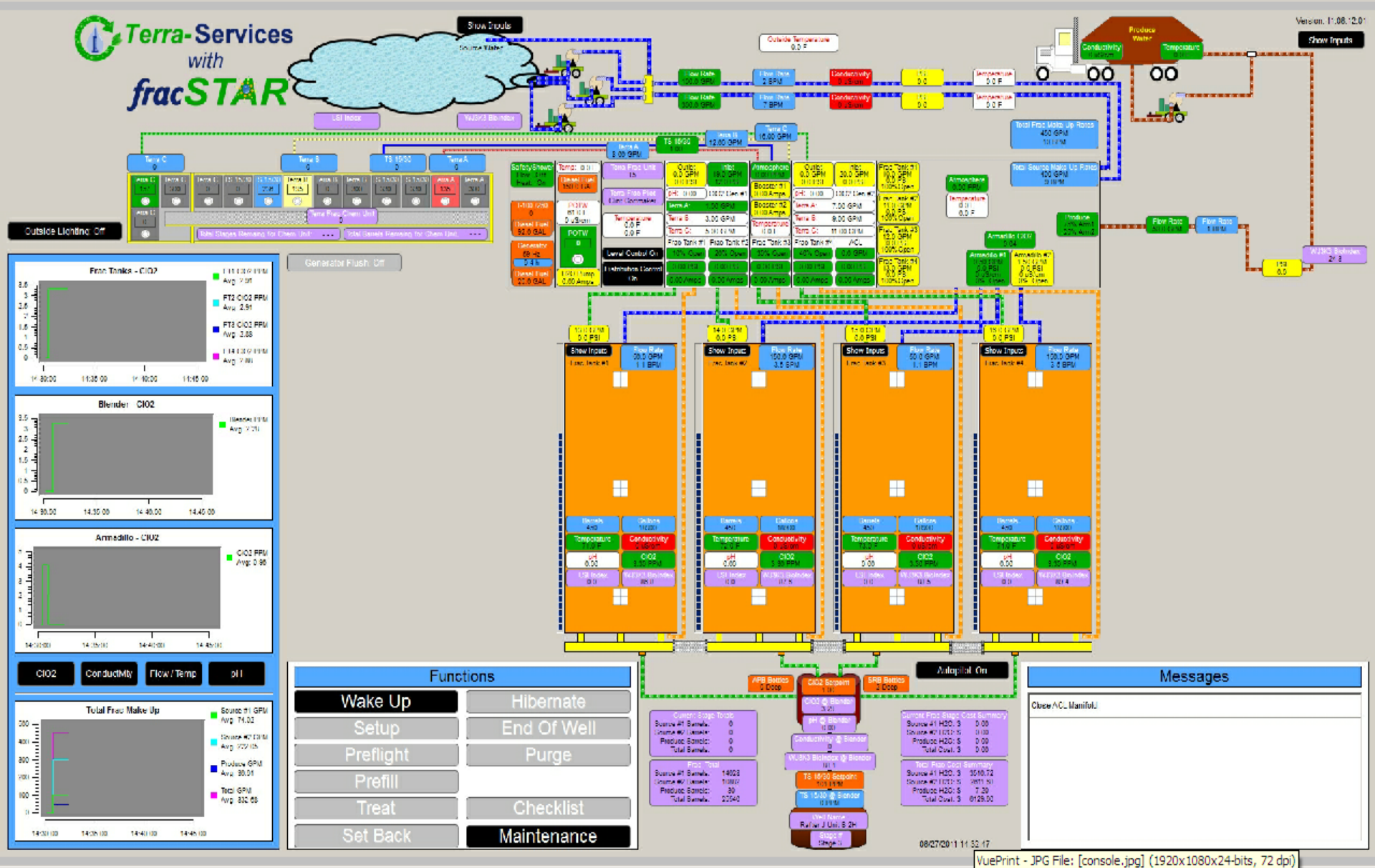

Power Generation Controls 60kw Base Station
Sample Bottles Bug Bottles Test Reagents
Emergency Pause Button
Supply Air Vent
Return Air Vent
Nitrogen & Compressed Air Plumbed to Degas Samples
Sink with Sample Ports
Sample Holders
Under Counter Magnetic Stirrers
Under Counter Trash Can

Safe environment that is controlled to insure safety and allow for maintenance and calibrations of sensors and meters



NCH CORPORATION

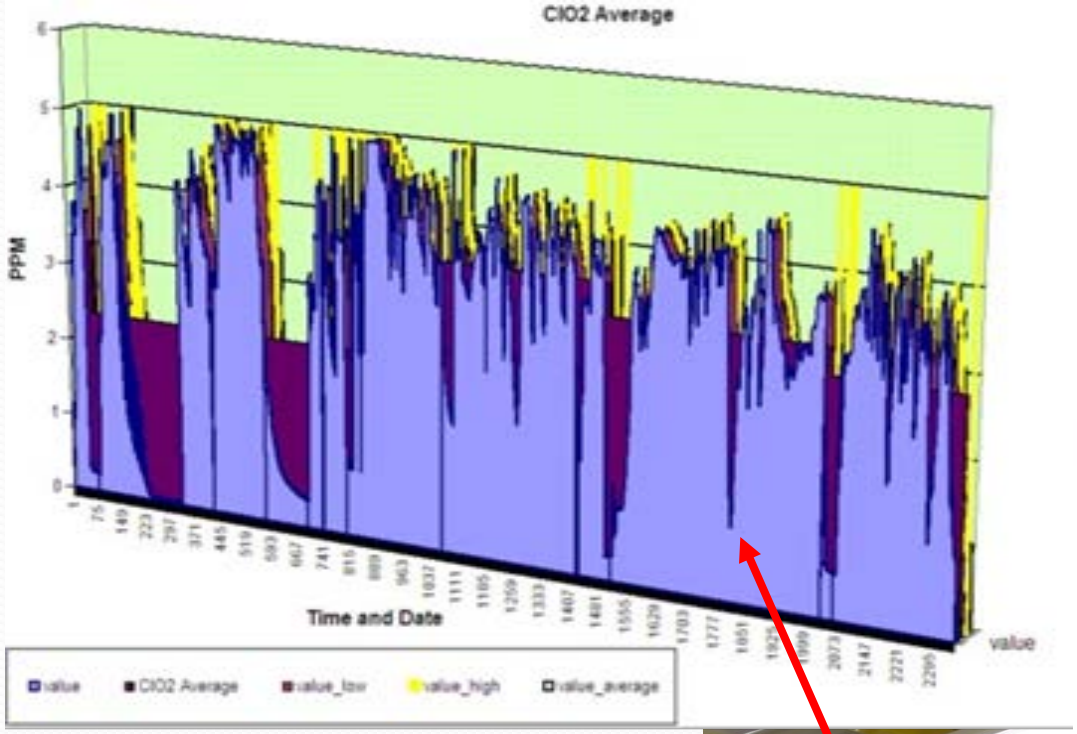
Frac Water Treatment 3D Control

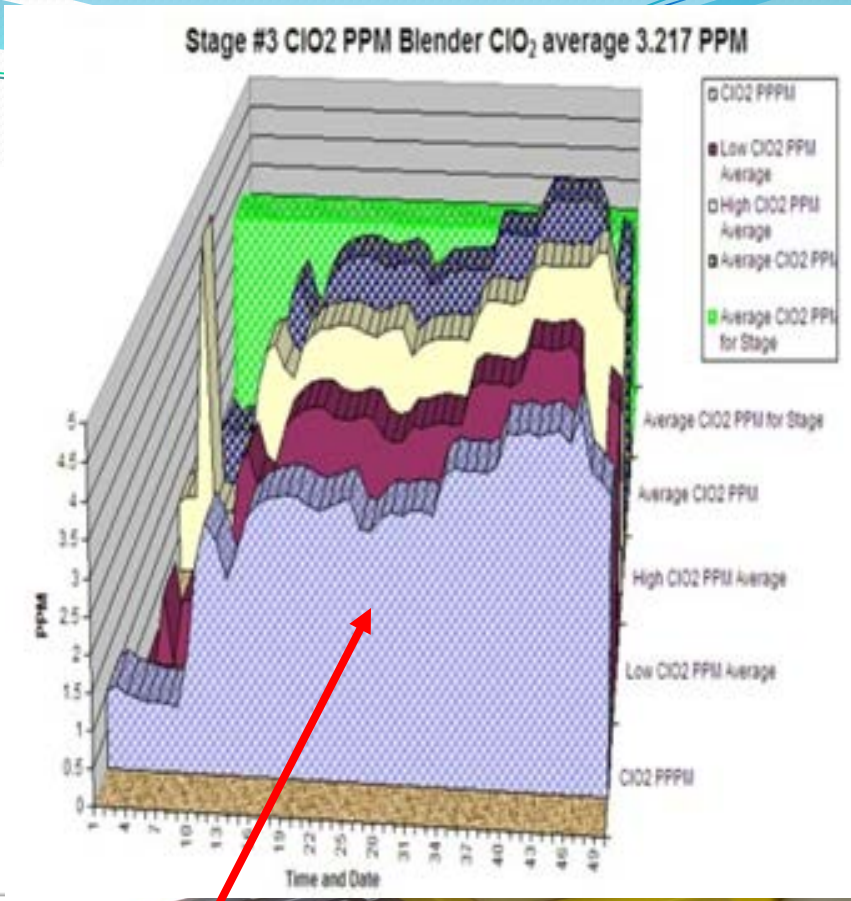


VuePrint - JPG File: [console.jpg] (1920x1080x24-bits, 72 dpi)

NCH CORPORATION

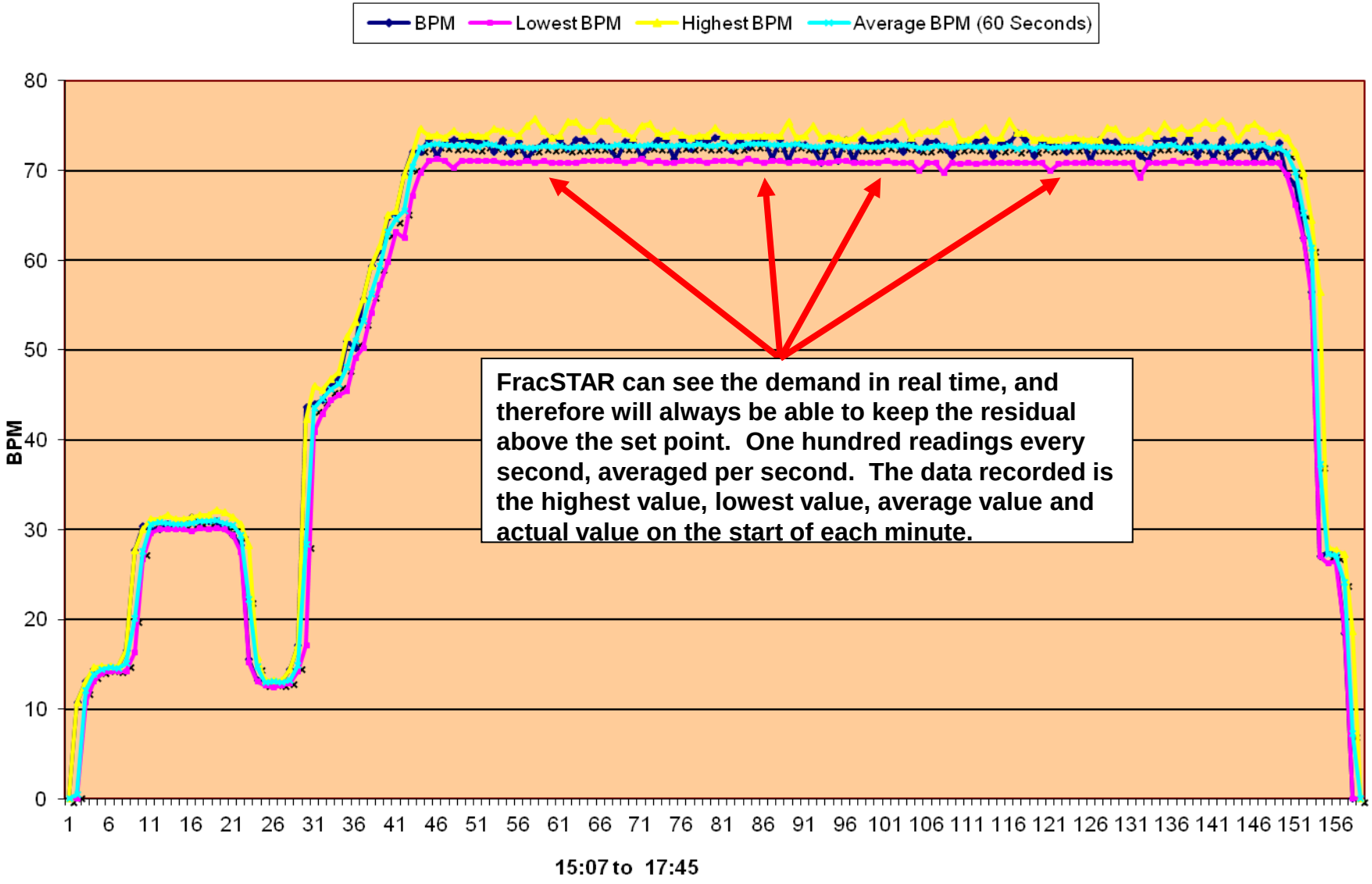
Technology



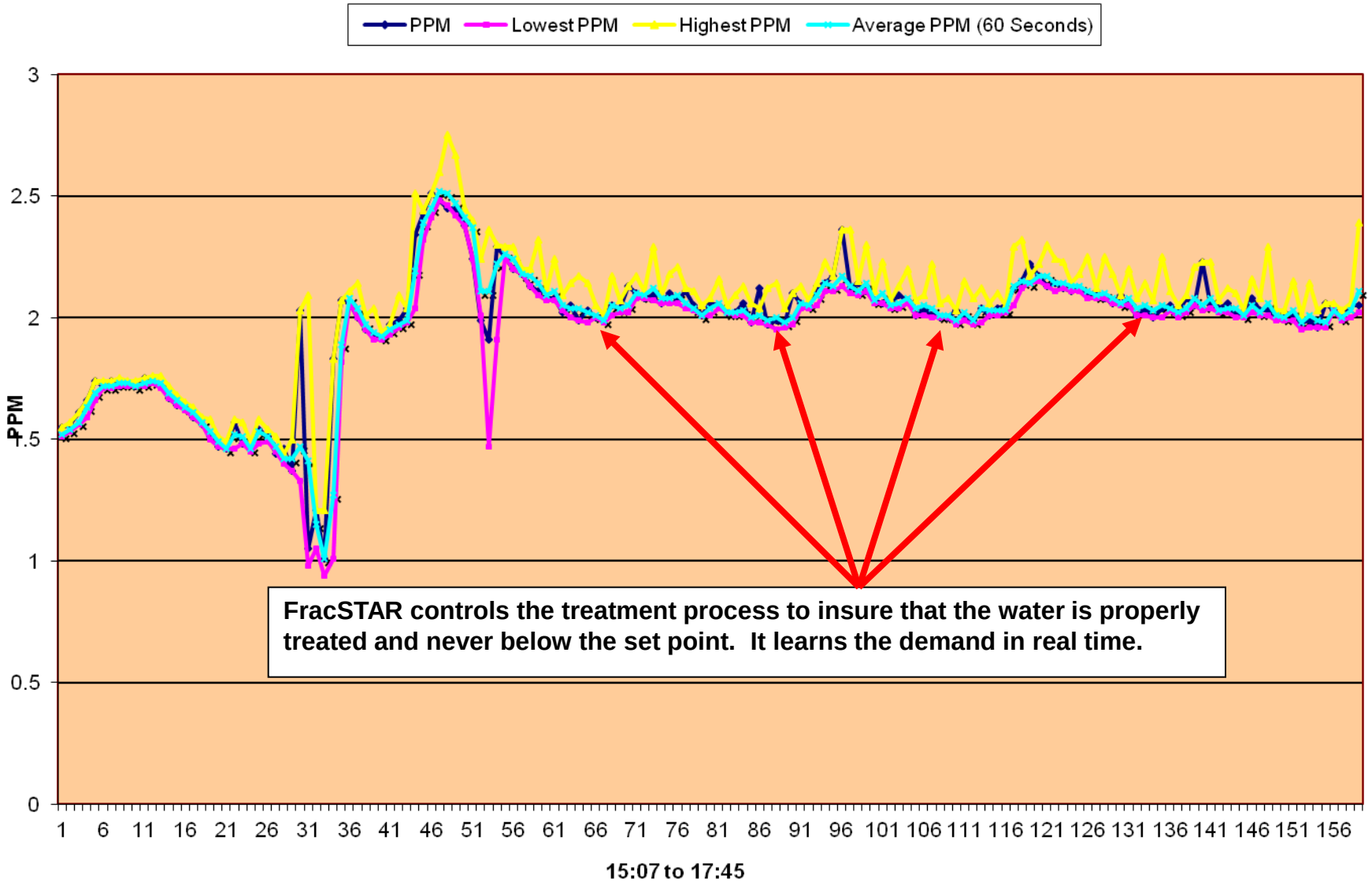


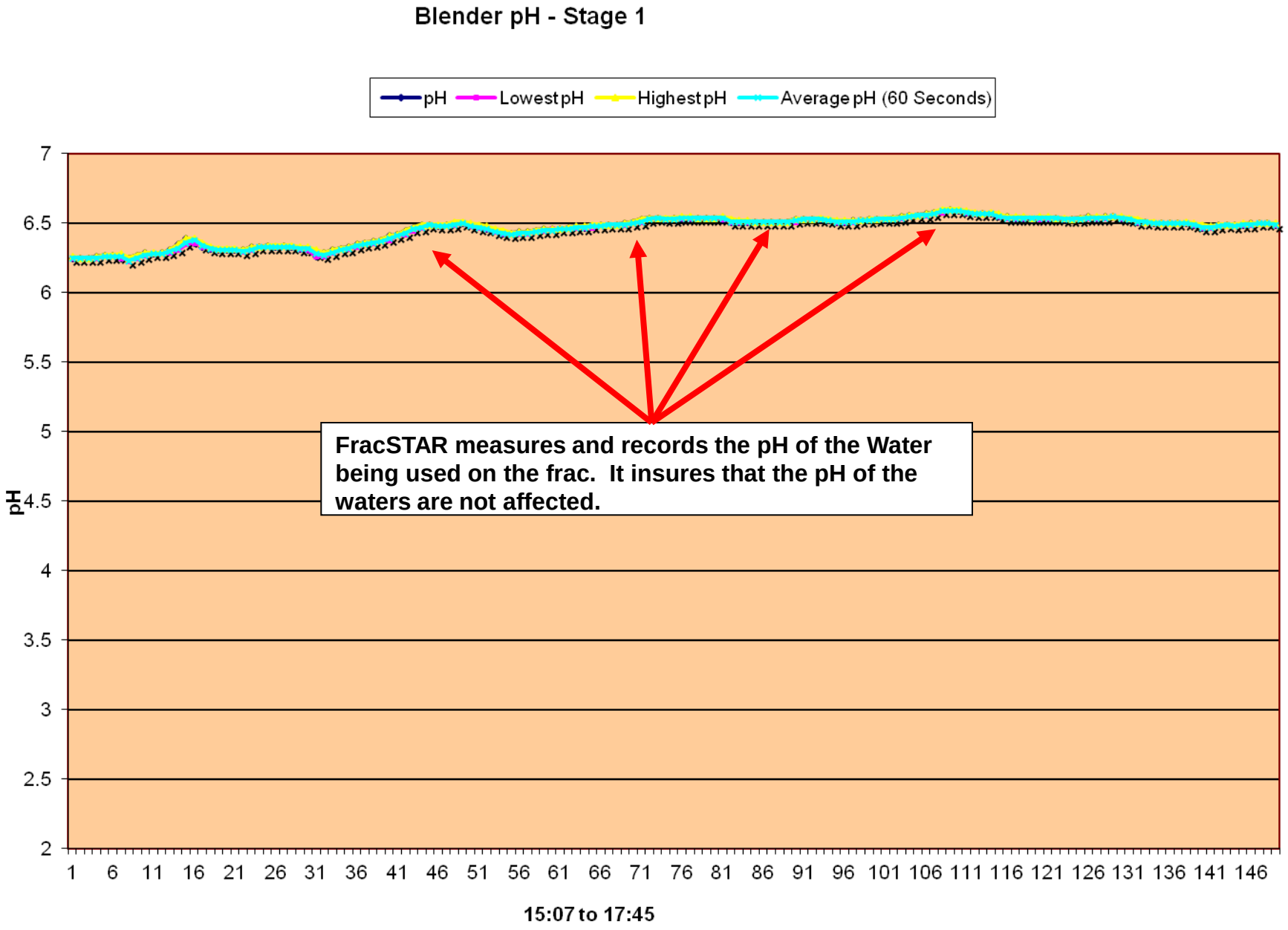
3 Dimensional modeling of the inorganic and biological demand of the water

Total Frac Water Inlet Stage 1



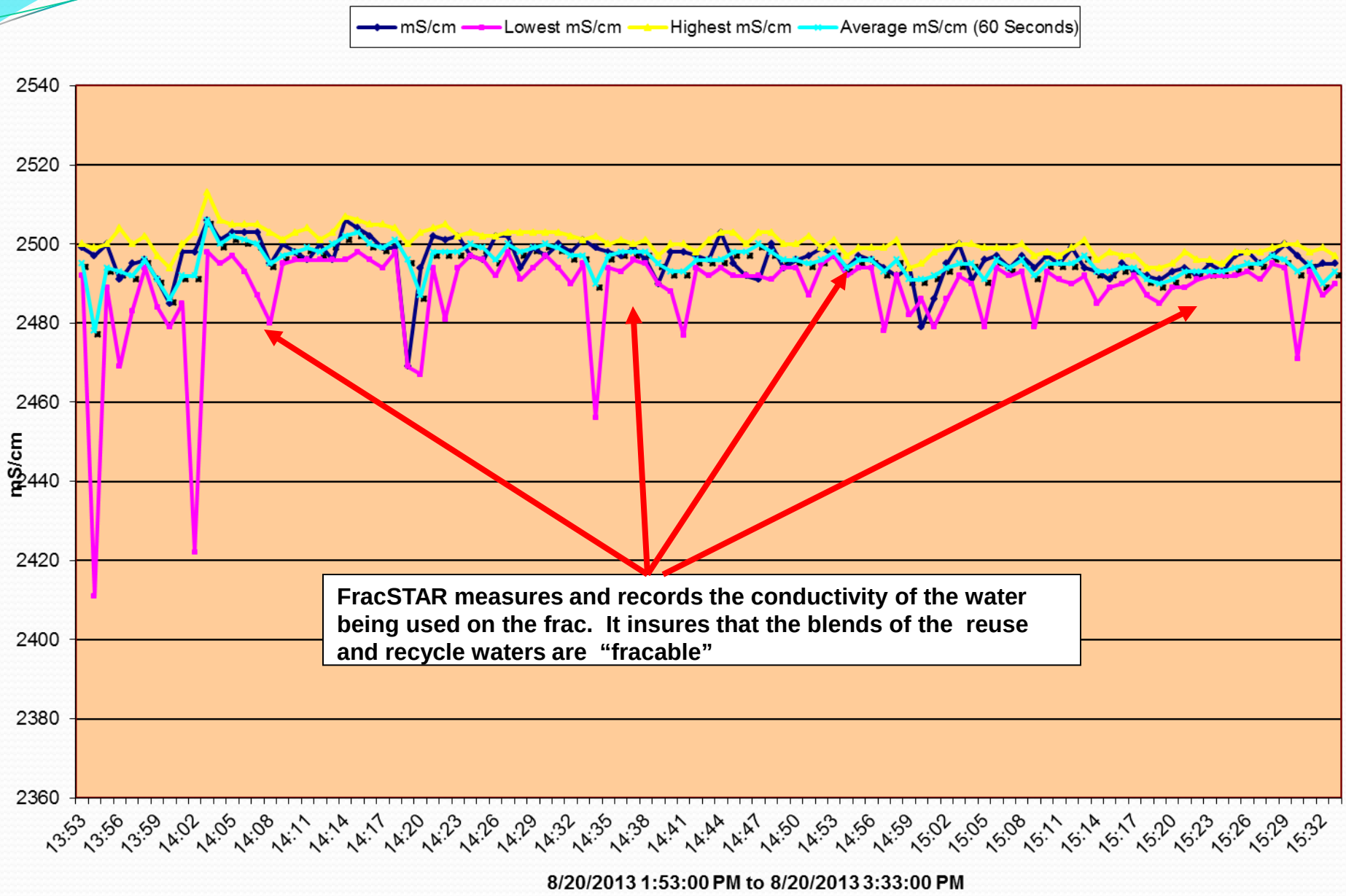
Blender ClO2 Residual - Stage 1




Blender pH - Stage 1
pH
Lowest pH
Highest pH
Average pH (60 Seconds)
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
pH
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101 106 111 116 121 126 131 136 141 146
15:07 to 17:45
FracSTAR measures and records the pH of the Water being used on the frac. It insures that the pH of the waters are not affected.

NCH CORPORATION

EOG Resources - Brown Bear 36 State 1H (AFE# 104918)
Blender Conductivity - Stage 17

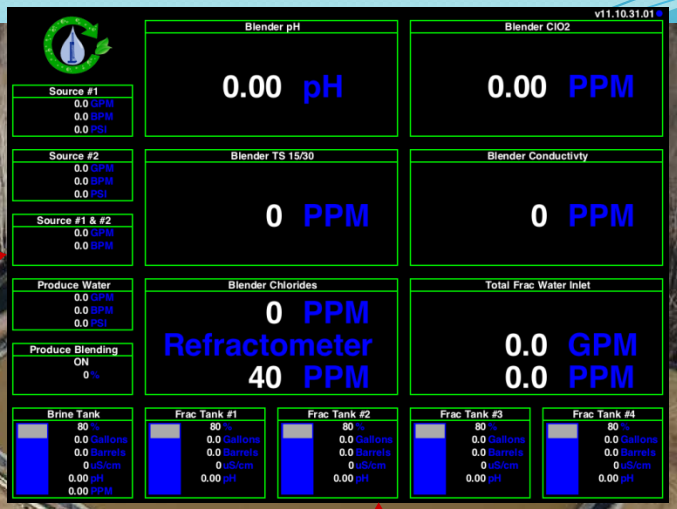


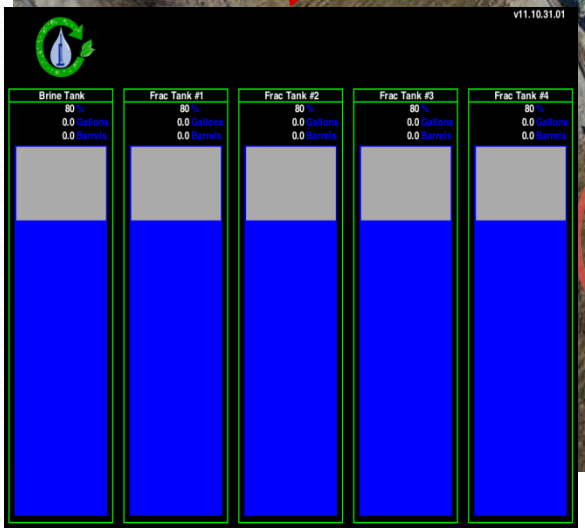
Field Evaluation Case Study

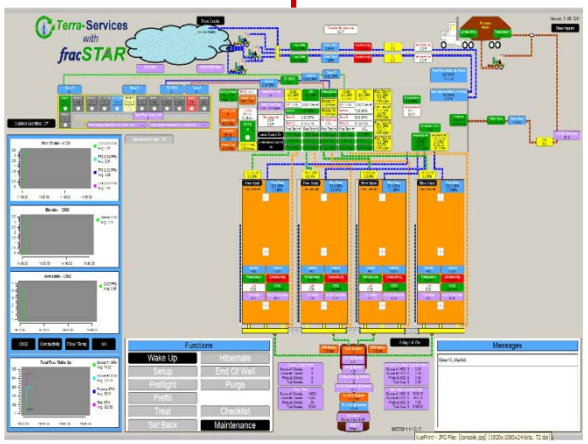
The FracStar control process will send information to two locations :

1) The frac van
2) Water Transfer and the working frac tanks

This information will be displayed on iPads ,

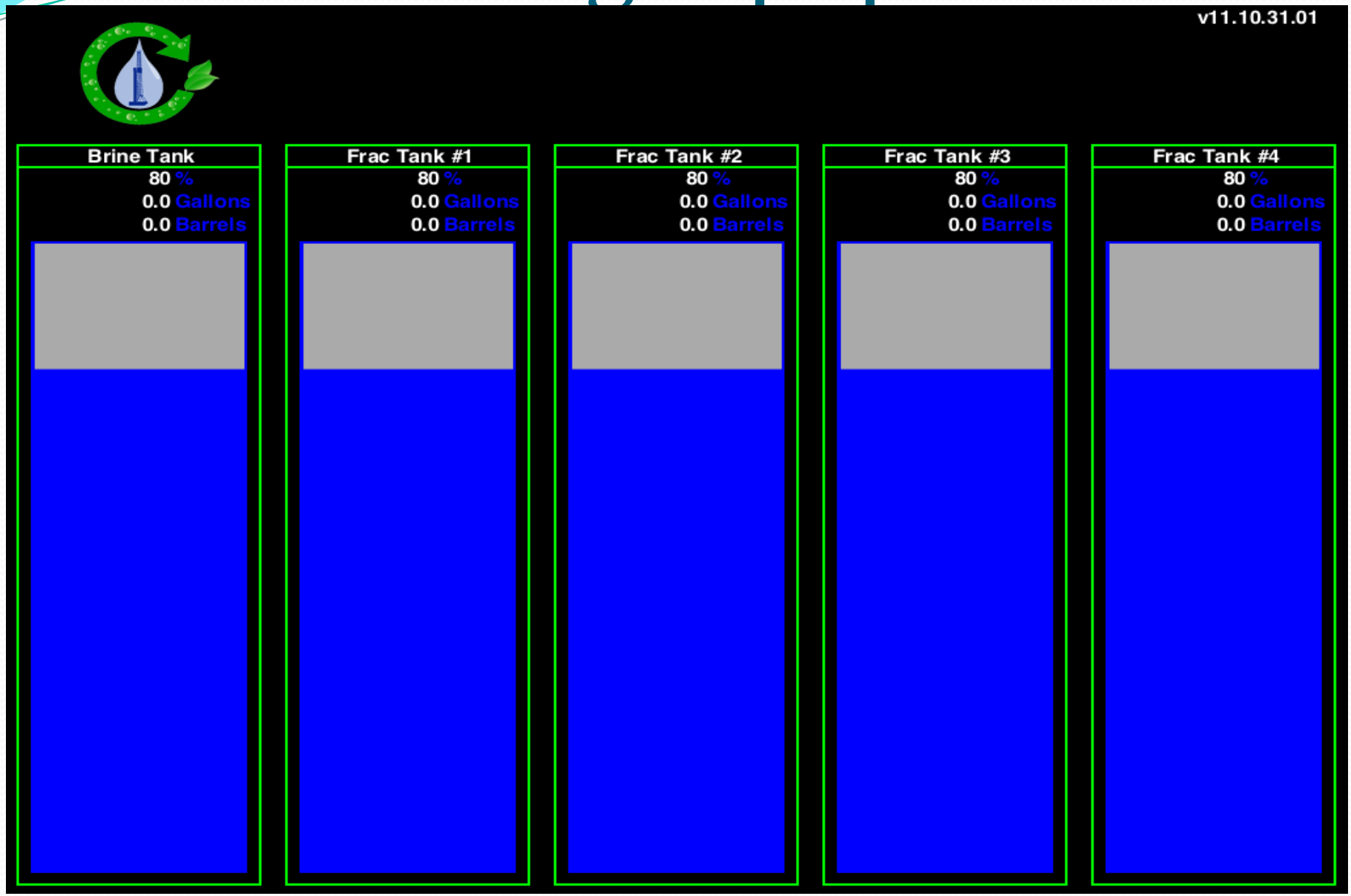






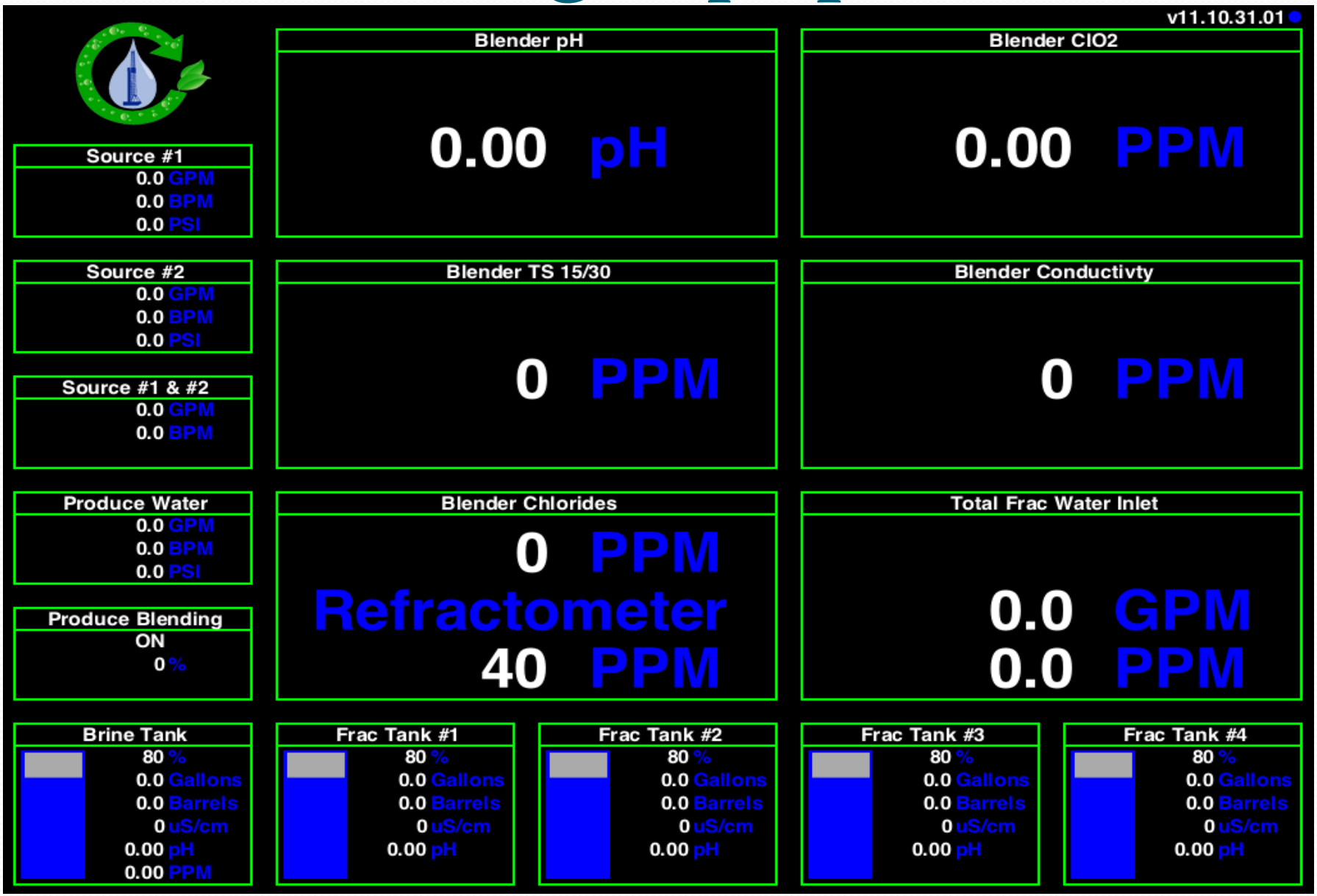
NCH CORPORATION

Monitoring Equipment



NCH CORPORATION

Monitoring Equipment



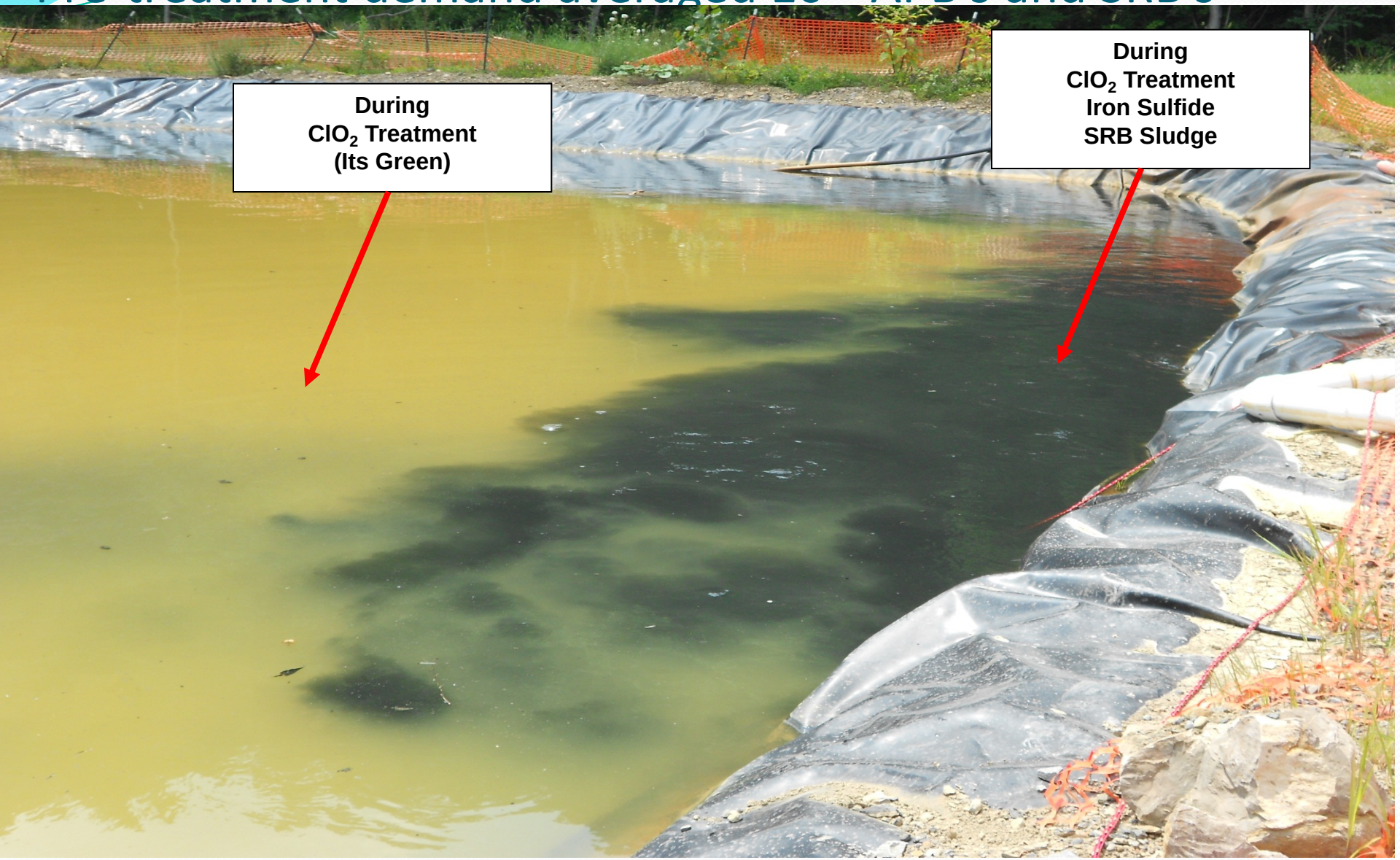
NCH CORPORATION

NCH CORPORATION

Before Treatment

NCH CORPORATION

Pre-treatment demand averaged 10^{12} APB's and SRB's



NCH CORPORATION

Post Treatment

NCH CORPORATION

Post Treatment

NCH CORPORATION

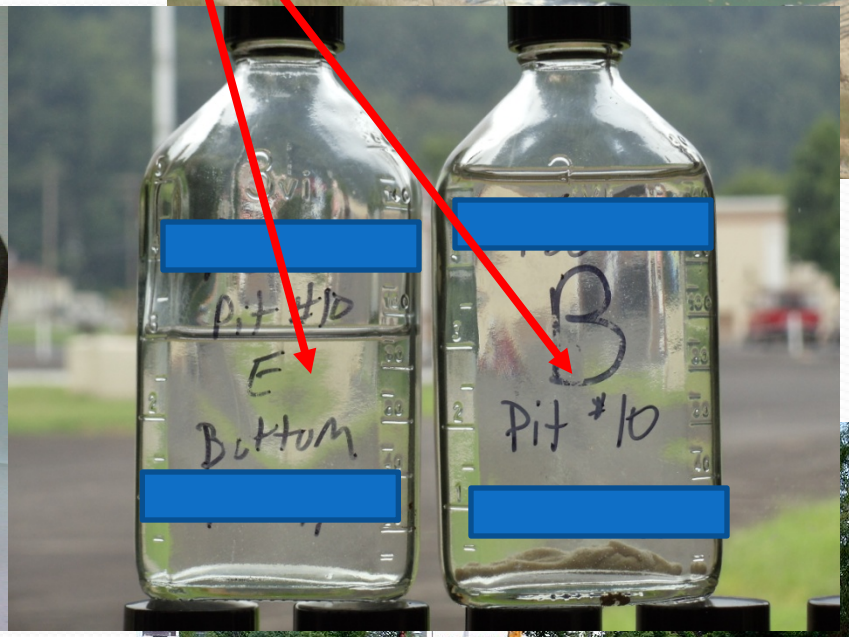
10^0 APB's and 10^0 SRB's

NCH CORPORATION

Reusable water for the next frac

Before ClO_2 treatment

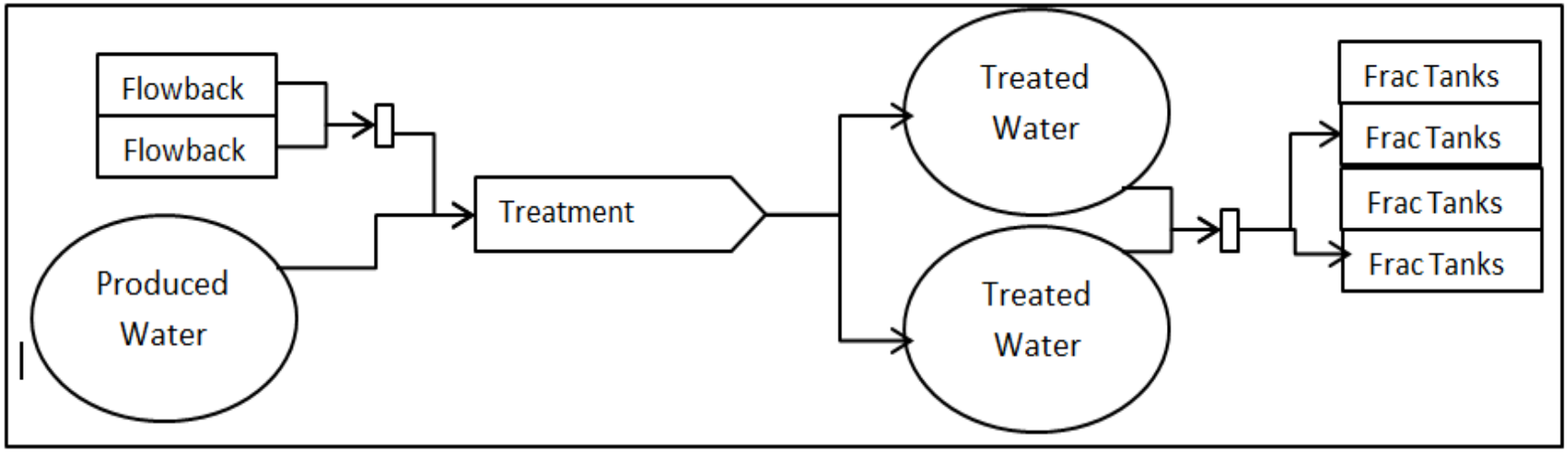
After ClO_2 treatment



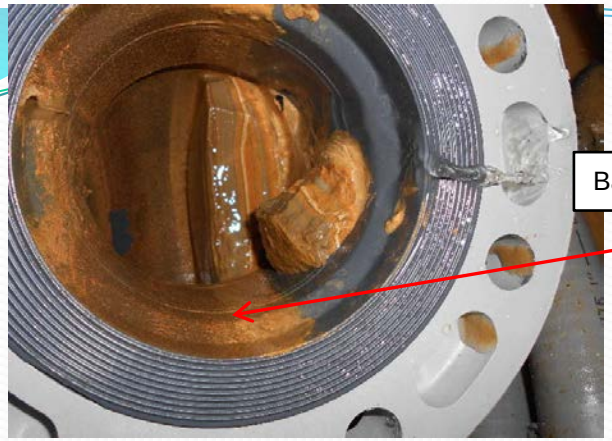
NCH CORPORATION

FracSTAR Development Plan

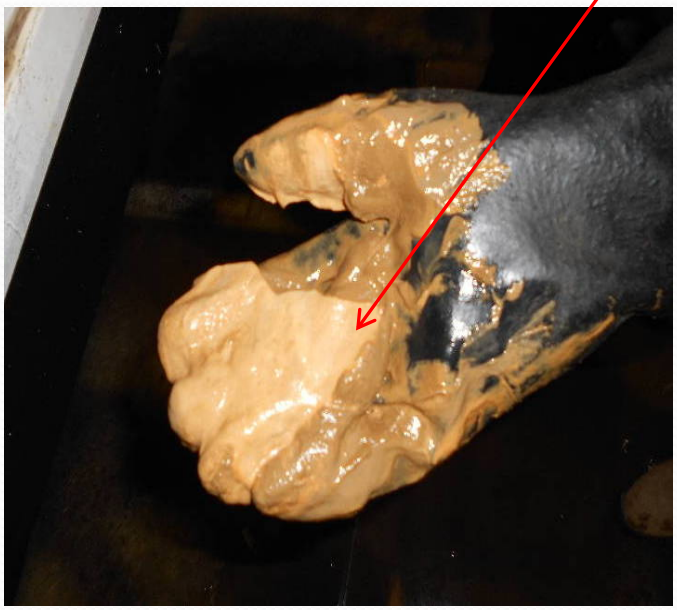
- Total water management
- Zero water foot print
- Treatment concepts
- Stationary plants
- Blending and reuse on-the-fly development

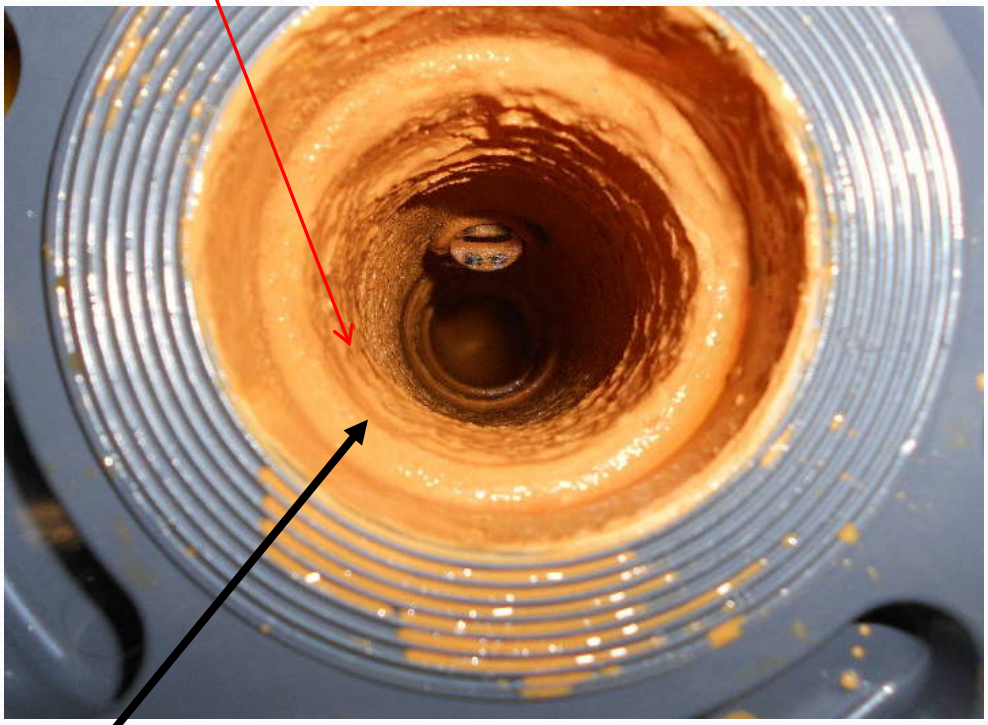


NCH CORPORATION



Barium Sulfate Scale (BaSO4) with Iron (Fe3)

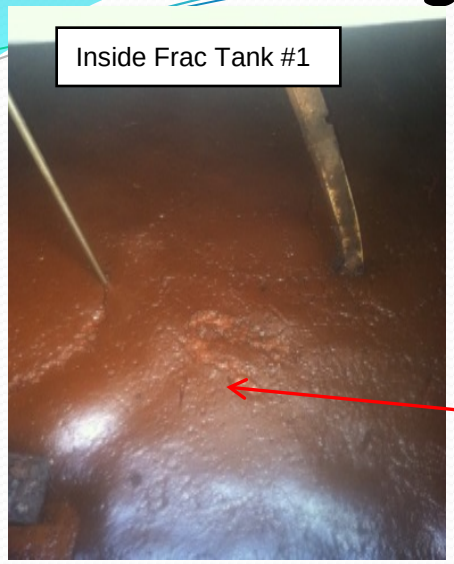


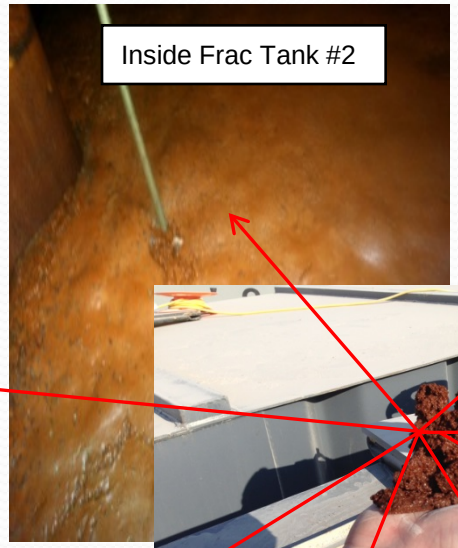


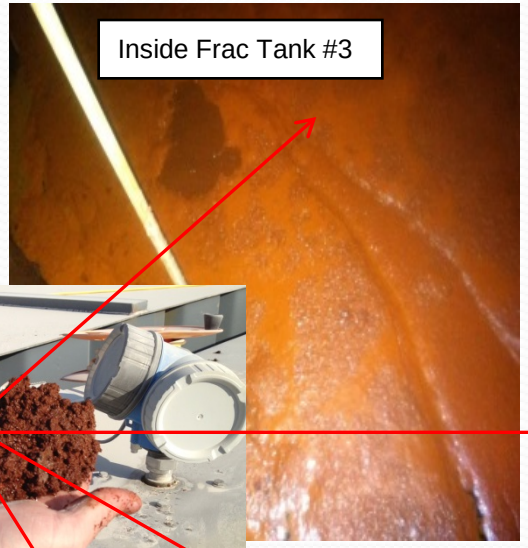
2” Diameter
¼” Buildup

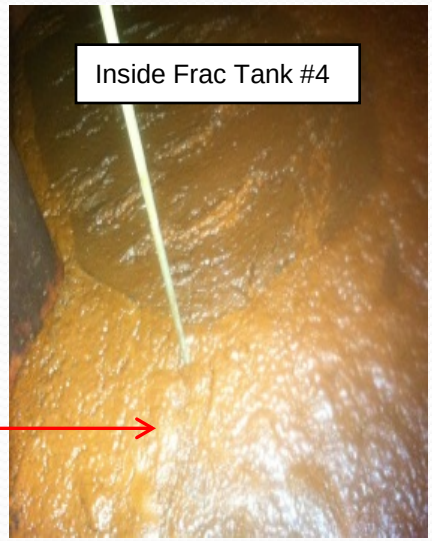
NCH CORPORATION

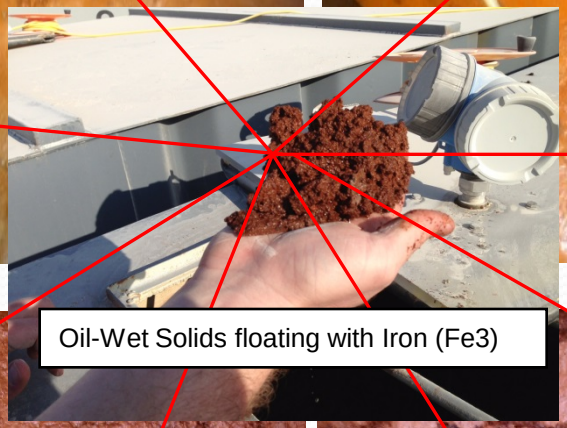
Solids down in the formation

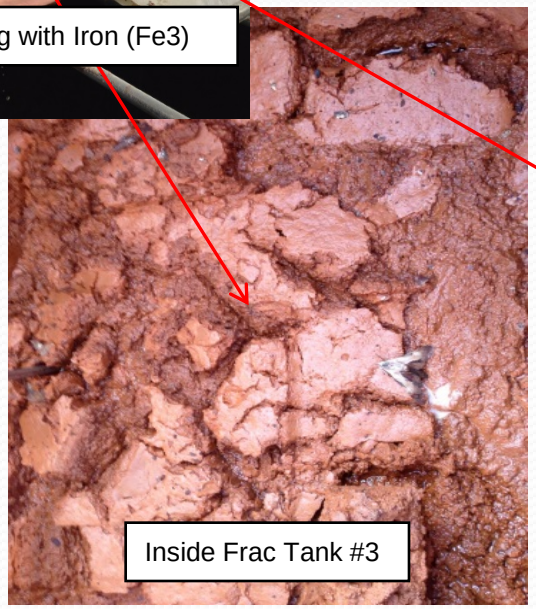


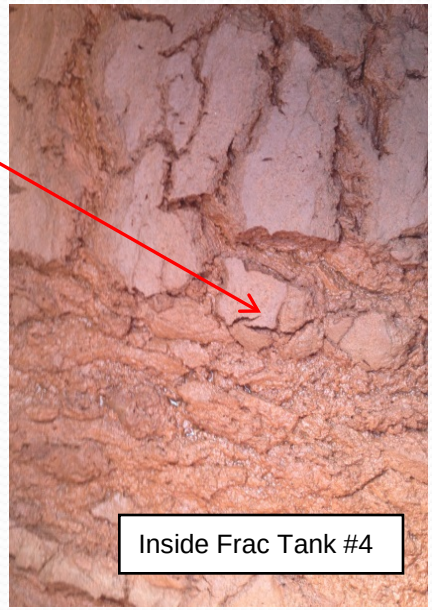












NCH CORPORATION

Sand Down in the formation

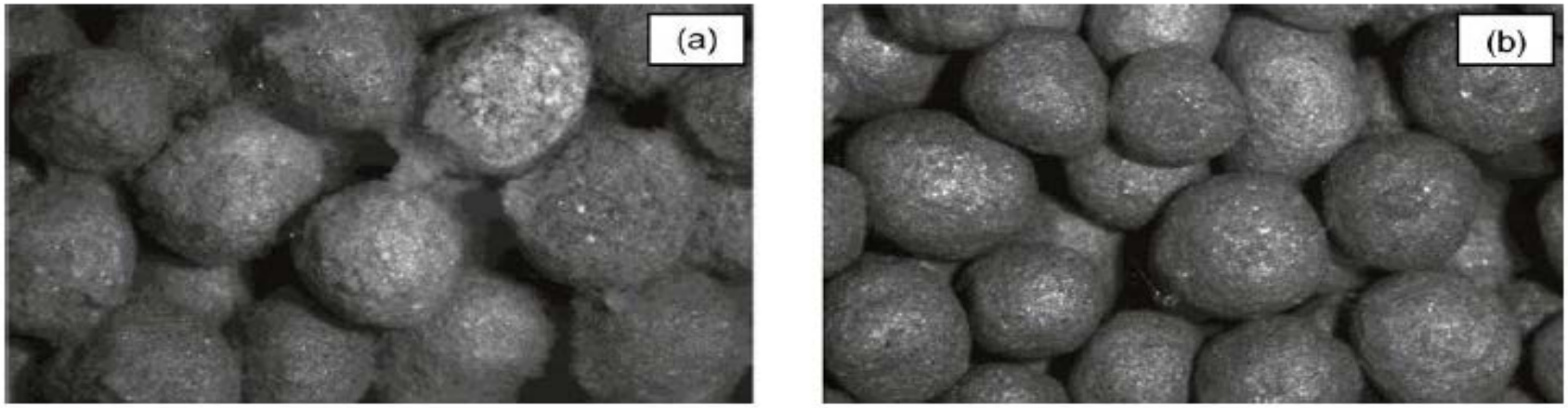


Fig. 6—Representative images of 20/40-mesh ceramic proppant 30 min after introducing (a) Permian produced water, and (b) EC-treated Permian produced water at the flow rate of 100 mL/min.

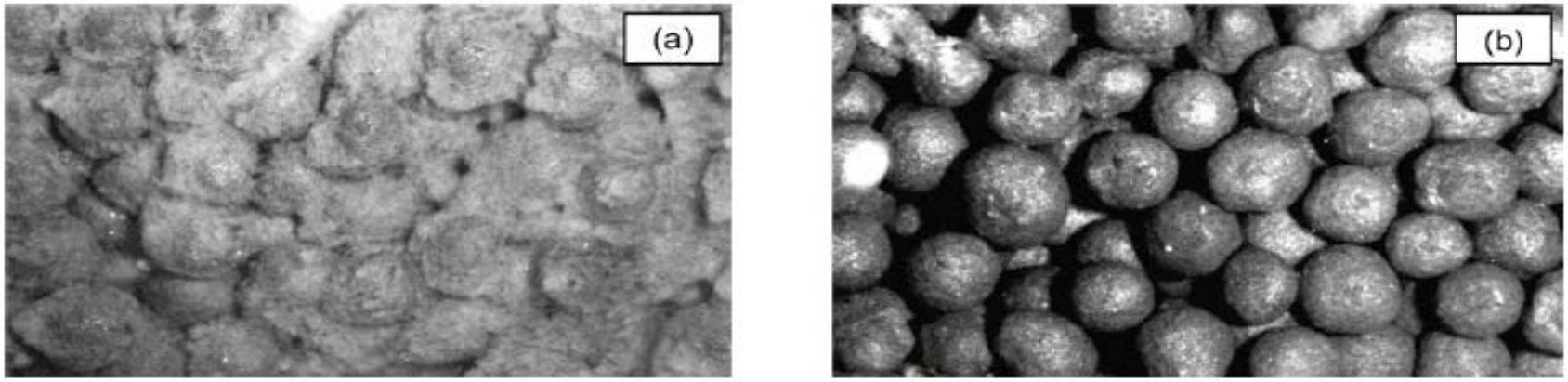


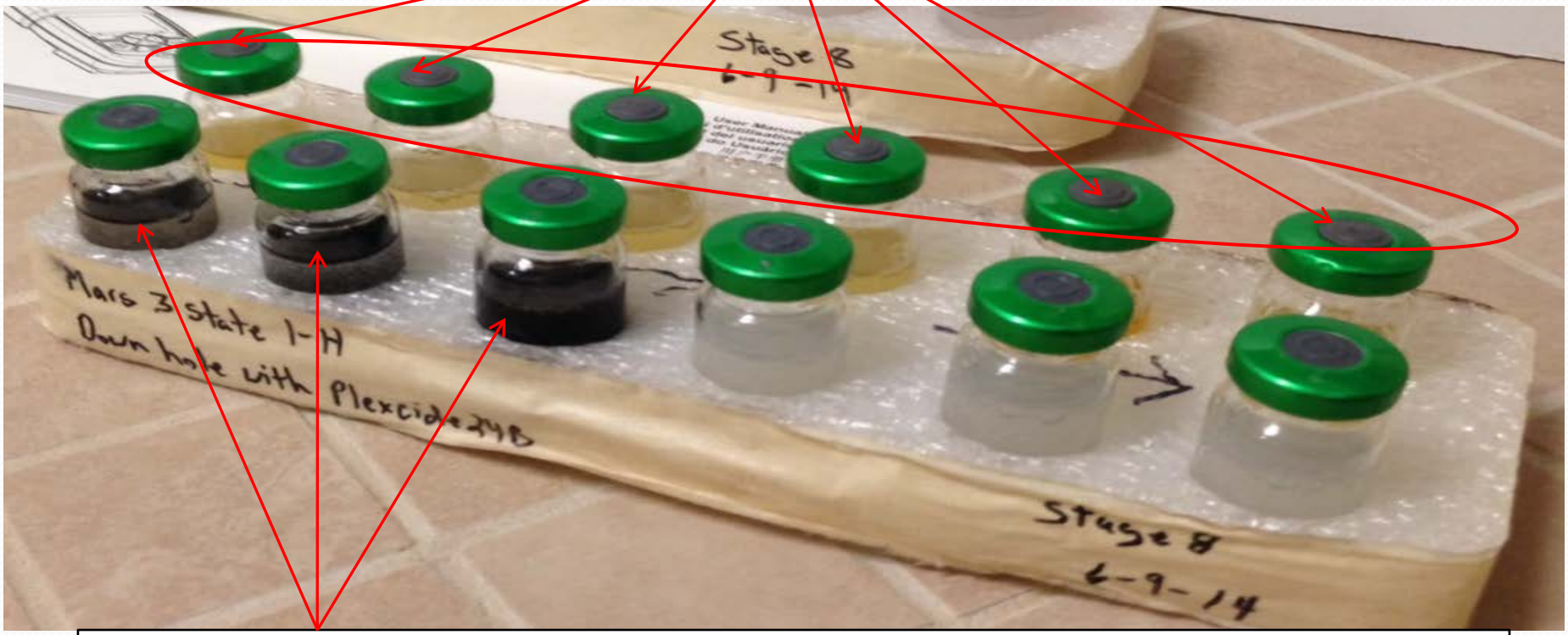
Fig. 7—Representative images of 20/40-mesh ceramic proppant 30 min after introducing (a) Marcellus produced water, and (b) EC-treated Marcellus produced water at the flow rate of 100 mL/min.

Reuse & Recycle Processes

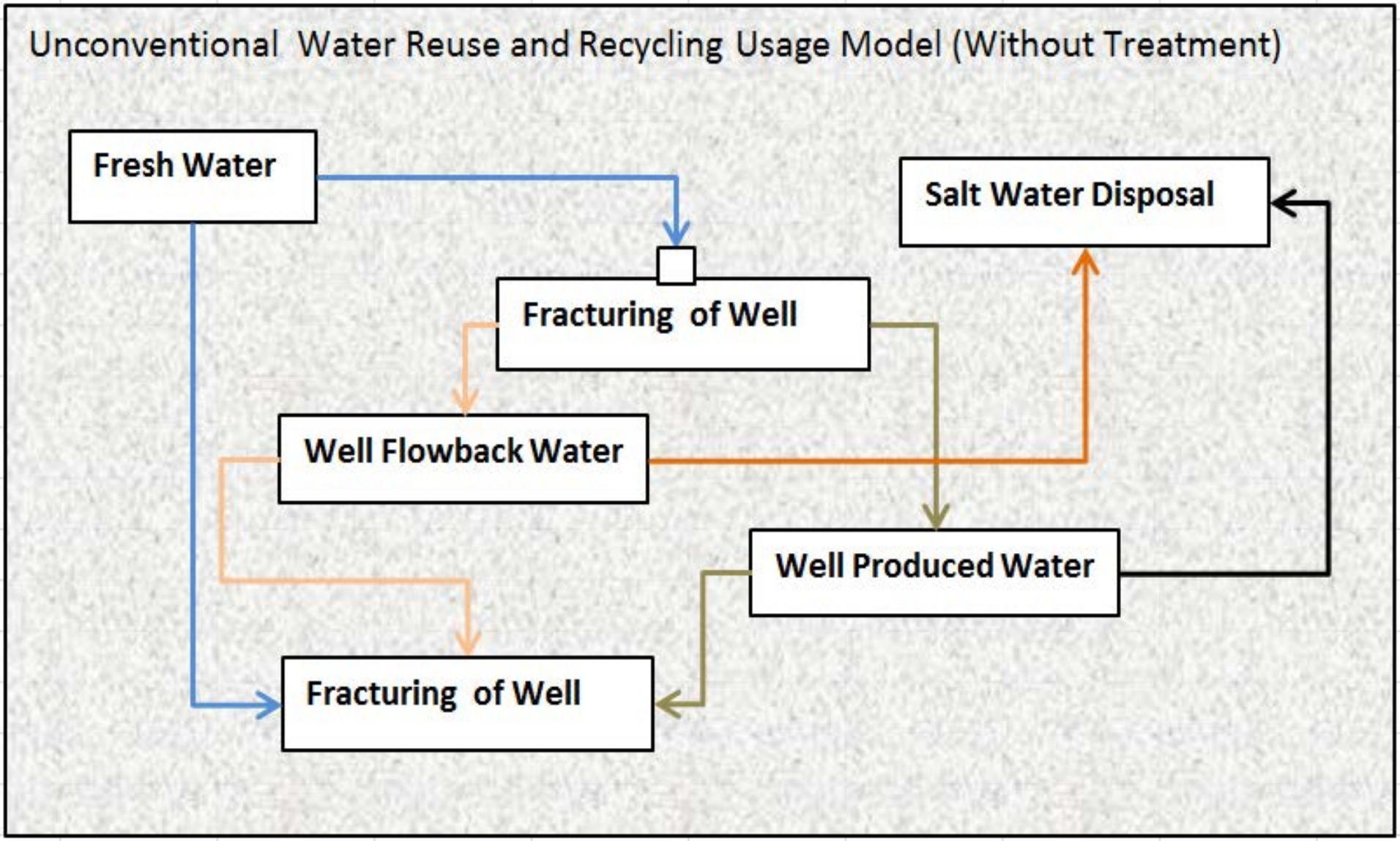
- Treatment and isolation (non-blending processes)
- Centralized facility
- Mobile reuse & recycle

- The need to balance the water to make it fracable and remove:
  - TSS (Total Suspended Solids)
  - Soluble divalent cation's and transition metals that will become insoluble
  - Oil and other TPH's (Total Petroleum Hydrocarbons)
  - Bacteria (MOST IMPORTANT)
  - Do not put bacteria down hole and seed the formation

Six bottles turned = 10^6(1,000,000) CFU (Colony Forming Unit) of APB (Acid Producing Bacteria)

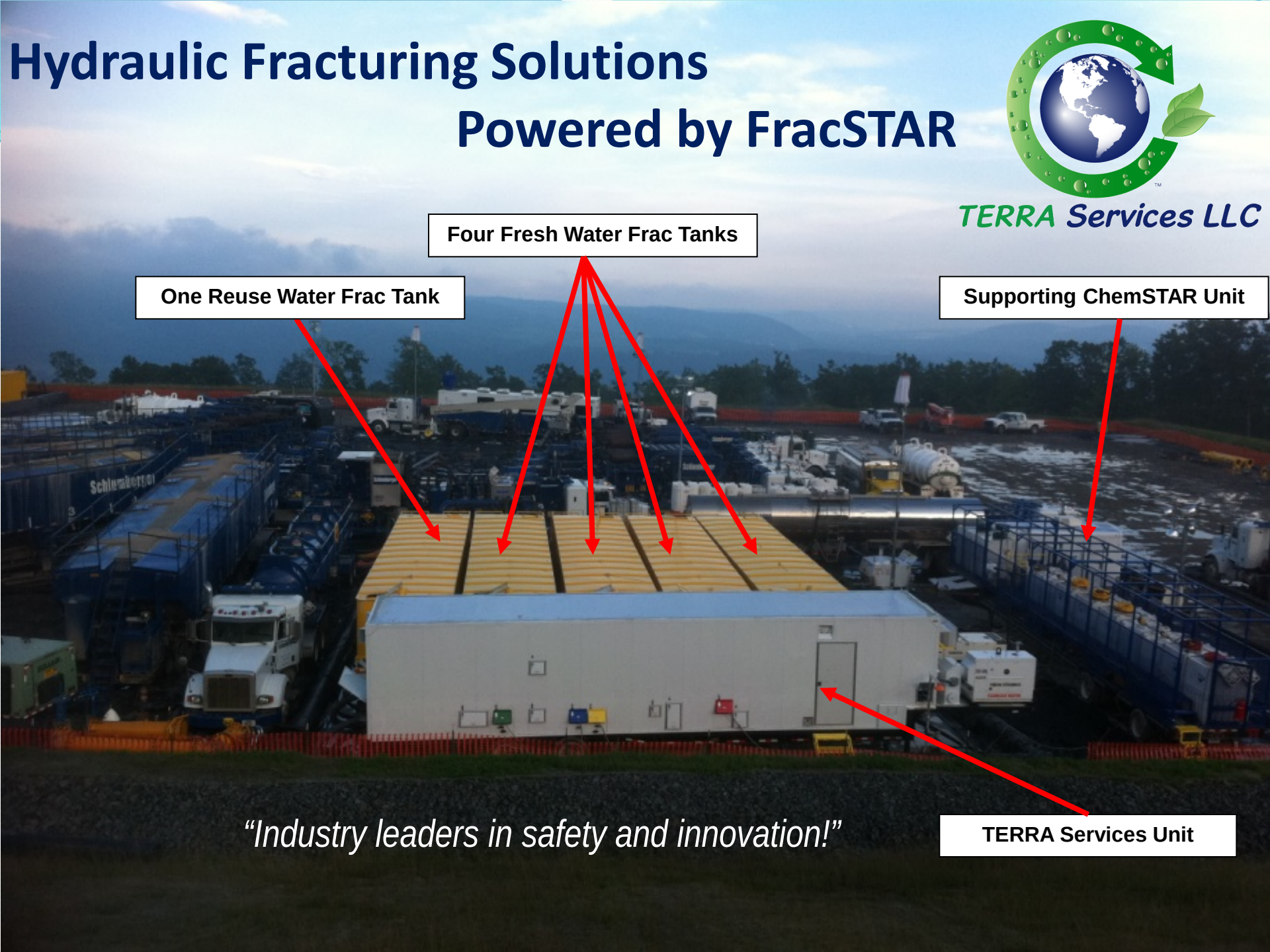


Three bottles turned = 10^3(1,000) CFU (Colony Forming Unit) Of SRB (Sulfate Reducing Bacteria)


Unconventional Water Reuse and Recycling Usage Model (Without Treatment)
Fresh Water
Salt Water Disposal
Fracturing of Well
Well Flowback Water
Well Produced Water
Fracturing of Well

Hydraulic Fracturing Solutions
Powered by FracSTAR

TERRA Services LLC

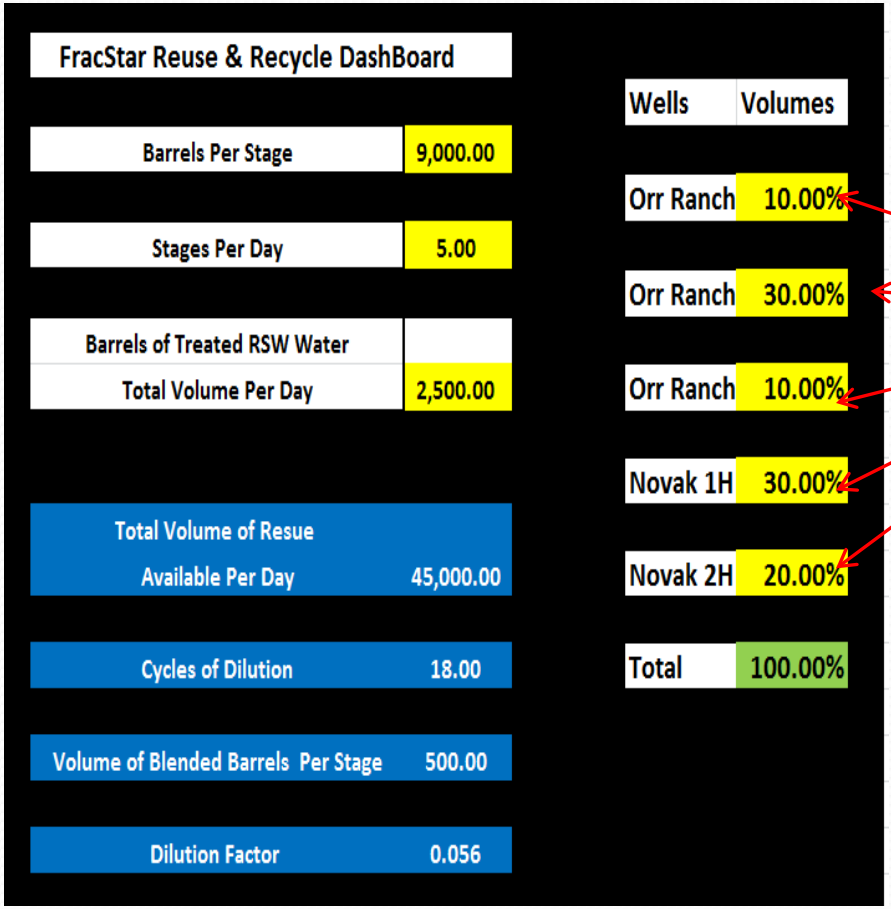


"Industry leaders in safety and innovation!"

Continuous of operation for operators who want to recycle untreated flowback and produced water on-the-fly and let the pump service company's (Horsepower) control the blends/mixing.

The treatment program consists of oxidation to insure no bacteria, and the monitoring of pH residual in the post treated water.
323+ wells
23% Water reused & recycled
17,086,700 barrels / **717,641,400** gallons of water reclaimed with an average disposal rate of **$4.20** for disposal. The producer saved **$71,764,140** in disposal cost.

This FracStar Dashboard takes into account the different waters and their make-up that would be blended with fresh waters to not affect the sand (proppant) chemistry. This helps to insure of no pressure increases and/or flow rate decreases going down hole during the fracturing process.



The FracSTAR Dashboard looks at the number of different water sources that would be used on the reuse and recycle process. FracStar allows different variables to be changed so the modeling and predictive changes to the treatment program can be established. This will ensure that the water is “fracable”

Specs for chemistry that will carry the sand (proppant).
Variances that would affect the frac performance are identified.

FracStar was developed to micromanage the properties of the water to be used on the frac, and in the treatment of water that would be recycled and reused on the next frac. The Cation and Anions relationship must be considered in order to insure that the water is "fracable"

Reuse & Recycle (Eagleford) - Treated Water Comparison								
Location	Date	Indice	Untreated	Treated	EOG Specs (<)	Spec Variance	Dilution Value	Variance
Orr Ranch 1H	11/20/2013	pH	5.9	8.1	5.0 - 8.0	(0.100)		
		Hardness (mg/l)	37,236	44,462	2,000	42,462.000	2,470.11	(470.11)
Barrels Per Stage	9,000.00	Specific Gravity (g/ccm)	1.094	1.084	1.038	0.046	0.06	0.00
		TDS (mg/l)	132,830	115,172	120,000	(4,828.000)	6,398.44	0.00
Stages Per Day	5.00	H2S (mg/l)	1	0		0.000	0.00	0.00
		CO2 (mg/l)	127.96	7.51		7.510	0.42	0.00
Barrels of Treated Water		Resistivity	0.072	0.073		0.073	0.00	0.00
Total Volume Per Day	2,500.00	Barium (mg/l)	0.01	0.01	10	(9.990)	0.00	0.00
		Calcium (mg/l)	11,360	11,680	1,000	10,680.000	648.89	0.00
		Iron (mg/l)	3.86	0.32	10	(9.680)	0.02	0.00
Total Volume of Resue		Magnesium (mg/l)	2,147	3,709	1,200	2,509.000	206.06	0.00
Available Per Stage	45,000.00	Manganese (mg/l)	0.02	0.01	10	(9.990)	0.00	0.00
		Potassium (mg/l)	0	0	1,000	(1,000.000)	0.00	0.00
Cycles of Dilution	18.00	Sodium (mg/l)	36,359	25,362	36,000	(10,638.000)	1,409.00	0.00
		Strontium (mg/l)	0	0	10	(10.000)	0.00	0.00
me of Blended Barrels Per Stage	500.00	**Total Cations (mg/l)**	**49,870**	**40,751**		40,751.000	2,263.94	0.00
		Chloride (mg/l)	82,400	72,800	70,000	2,800.000	4,044.44	0.00
Dilution Factor	0.056	Carbonate	0	0		0.000	0.00	0.00
		Bicarbonate	232	769	1,000	(231.000)	42.72	0.00
		Sulfate	328	852	500	352.000	47.33	0.00
		Boron	0	0	5	(5.000)	0.00	0.00
		Total Anions (mg/l)	**82,960**	**74,421**		74,421.000	4,134.50	0.00
		Calcite (% Saturation)	0.756	145.91				
		Calcite (lbs/1000 bbls)	-0.00269	1.68				
		Gypsum (%Saturation)	0.277	0.676				
		Gypsum (lbs/1000 bbls)	-116.85	-52.14				
		Barite (% Saturation)	0.00527	0.0136				
		Barite (lbs/1000 bbls)	-1.1	-0.429				
		Iron Hydroxide (% Saturation)	0.001	0.001				
		Iron Hydroxide (lbs/1000 bbls)	0.001	0.001				

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Reuse & Recycle (Eagleford) - Treated Water Comparison

Location	Date	Indice	Untreated	Treated	EOG Specs (<)	Spec Variance	Dilution Value	Variance
Orr Ranch 2H	11/20/2013	pH	5.7	8.3	5.0 - 8.0	(0.300)		
		Hardness (mg/l)	62,434	53,641	2,000	51,641.000	2,980.06	(980.06)
Barrels Per Stage	9,000.00	Specific Gravity (g/ccm)	1.182	1.158	1.038	0.120	0.06	0.00
		TDS (mg/l)	256,481	223,210	120,000	103,210.000	12,400.56	0.00
Stages Per Day	5.00	H2S (mg/l)	1	0		0.000	0.00	0.00
		CO2 (mg/l)	157.44	7.84		7.840	0.44	0.00
Barrels of Treated Water		Resistivity	0.052	0.053		0.053	0.00	0.00
Total Volume Per Day	2,500.00	Barium (mg/l)	0.1	0.1	10	(9.900)	0.01	0.00
		Calcium (mg/l)	21,600	17,440	1,000	16,440.000	968.89	0.00
		Iron (mg/l)	0.49	0.91	10	(9.090)	0.05	0.00
Total Volume of Resue		Magnesium (mg/l)	2,050	2,440	1,200	1,240.000	135.56	0.00
Available Per Stage	45,000.00	Manganese (mg/l)	0.01	0.01	10	(9.990)	0.00	0.00
		Potassium (mg/l)	0	0	1,000	(1,000.000)	0.00	0.00
Cycles of Dilution	18.00	Sodium (mg/l)	73,091	64,002	36,000	28,002.000	3,555.67	0.00
		Strontium (mg/l)	0	0	10	(10.000)	0.00	0.00
Volume of Blended Barrels Per Stage	500.00	**Total Cations (mg/l)**	**96,741**	**83,883**		83,883.000	4,660.17	0.00
		Chloride (mg/l)	159,200	137,200	70,000	67,200.000	7,622.22	0.00
Dilution Factor	0.056	Carbonate	0	0		0.000	0.00	0.00
		Bicarbonate	293	1,513	1,000	513.000	84.06	0.00
		Sulfate	247	614	500	114.000	34.11	0.00
		Boron	0	0	5	(5.000)	0.00	0.00
		Total Anions (mg/l)	**159,740**	**139,327**		139,327.000	7,740.39	0.00
		Calcite (% Saturation)	0.81	444.48				

FracStar shows the limiting factor being hardness by 980.06 PPM. The water from this field would have to be used at a lower ratio to avoid the “fracablity” of the fluid.

The expense of removing the hardness by chemical and/or mechanical means would have to be deployed.

FracStar shows that the fluid could be used at greater ratios and not affect the “fracablity” of the fluid.

The spec variance models the water at 100% reuse and identifies the properties that must be diluted and/or treated to be remove.

Resuse & Recycle (Eagleford) - Treated Water Comparison

Location	Date	Indice	Untreated	Treated	EOG Specs (<)	Spec Variance	Dilution Value	Variance
Orr Ranch 9H	11/20/2013	pH	6.9	8.7	5.0 - 8.0	(0.700)		
		Hardness (mg/l)	34,836	32,437	2,000	30,437.000	1,802.06	0.00
Barrels Per Stage	9,000.00	Specific Gravity (g/ccm)	1.092	1.080	1.038	0.042	0.06	0.00
		TDS (mg/l)	129,585	113,724	120,000	(6,276.000)	6,318.00	0.00
Stages Per Day	5.00	H2S (mg/l)	1	0		0.000	0.00	0.00
		CO2 (mg/l)	14.67	2.33		2.330	0.13	0.00
Barrels of Treated Water		Resistivity	0.079	0.081		0.081	0.00	0.00
Total Volume Per Day	2,500.00	Barium (mg/l)	0.1	0.01	10	(9.990)	0.00	0.00
		Calcium (mg/l)	10,400	9,280	1,000	8,280.000	515.56	0.00
		Iron (mg/l)	2.69	0.5	10	(9.500)	0.03	0.00
Total Volume of Resue		Magnesium (mg/l)	2,147	2,245	1,200	1,045.000	124.72	0.00
Available Per Stage	45,000.00	Manganese (mg/l)	0.01	0.01	10	(9.990)	0.00	0.00
		Potassium (mg/l)	0	0	1,000	(1,000.000)	0.00	0.00
Cycles of Dilution	18.00	Sodium (mg/l)	36,123	30,824	36,000	(5,176.000)	1,712.44	0.00
		Strontium (mg/l)	0	0	10	(10.000)	0.00	0.00
Volume of Blended Barrels Per Stage	500.00	**Total Cations (mg/l)**	**48,673**	**42,349**		42,349.000	2,352.72	0.00
		Chloride (mg/l)	80,400	69,600	70,000	(400.000)	3,866.67	0.00
Dilution Factor	0.056	Carbonate	0	0		0.000	0.00	0.00
		Bicarbonate	110	988	1,000	(12.000)	54.89	0.00
		Sulfate	402	787	500	287.000	43.72	0.00
		Boron	0	0	5	(5.000)	0.00	0.00
		Total Anions (mg/l)	**80,912**	**71,375**		71,375.000	3,965.28	0.00
		Calcite (% Saturation)	2.39	339.87				
		Calcite (lbs/1000 bbls)	0.017	5.07				
		Gypsum (%Saturation)	0.325	0.607				
		Gypsum (lbs/1000 bbls)	-119.11	-79.89				
		Barite (% Saturation)	0.0693	0.0165				
		Barite (lbs/1000 bbls)	-0.788	-0.353				
		Iron Hydroxide (% Saturation)	0.001	0.001				
		Iron Hydroxide (lbs/1000 bbls)	0.001	0.001				

Reuse & Recycle (Eagleford) - Treated Water Comparison

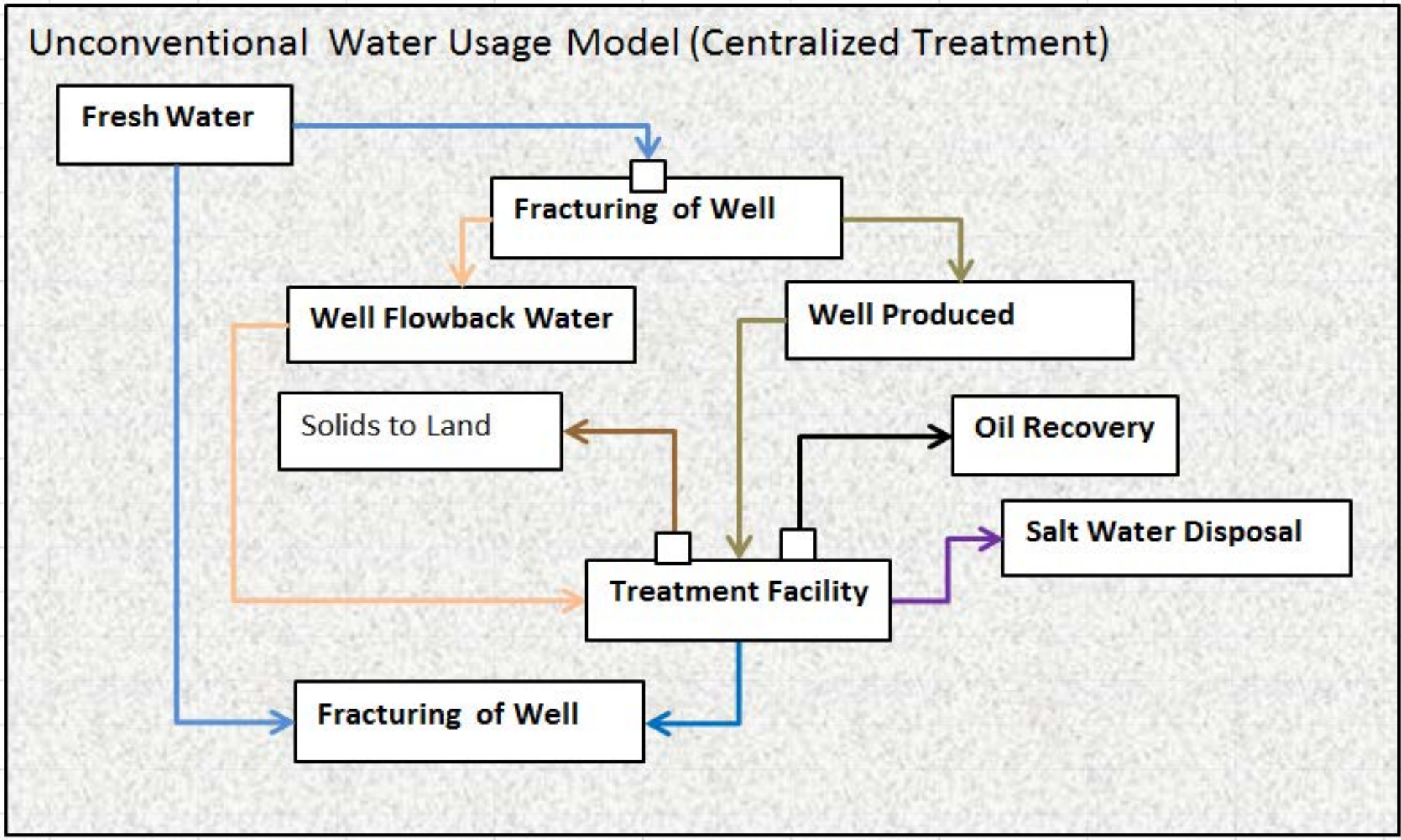
Location	Date	Indice	Untreated	Treated	EOG Specs (<)	Spec Variance	Dilution Value	Variance
Novak 1H	11/20/2013	pH	6.3	8.2	5.0 - 8.0	(0.200)		
		Hardness (mg/l)	5,907	4,304	2,000	2,304.000	239.11	0.00
	9,000.00	Specific Gravity (g/ccm)	1.020	1.020	1.038	(0.018)	0.06	0.00
		TDS (mg/l)	28,959	29,770	120,000	(90,230.000)	1,653.89	0.00
	5.00	H2S (mg/l)	0.5	0		0.000	0.00	0.00
		CO2 (mg/l)	173.93	2.58		2.580	0.14	0.00
		Resistivity	0.238	0.229		0.229	0.00	0.00
	2,500.00	Barium (mg/l)	0.01	0.01	10	(9.990)	0.00	0.00
		Calcium (mg/l)	1,640	1,360	1,000	360.000	75.56	0.00
		Iron (mg/l)	2.84	0.13	10	(9.870)	0.01	0.00
		Magnesium (mg/l)	439	220	1,200	(980.000)	12.22	0.00
	45,000.00	Manganese (mg/l)	0.01	0.01	10	(9.990)	0.00	0.00
		Potassium (mg/l)	0	0	1,000	(1,000.000)	0.00	0.00
	18.00	Sodium (mg/l)	8,707	9,662	36,000	(26,338.000)	536.78	0.00
		Strontium (mg/l)	0	0	10	(10.000)	0.00	0.00
Stage	500.00	**Total Cations (mg/l)**	**10,789**	**11,242**		11,242.000	624.56	0.00
		Chloride (mg/l)	17,300	17,600	70,000	(52,400.000)	977.78	0.00
	0.056	Carbonate	0	0		0.000	0.00	0.00
		Bicarbonate	390	256	1,000	(744.000)	14.22	0.00
		Sulfate	480	672	500	172.000	37.33	0.00
		Boron	0	0	5	(5.000)	0.00	0.00
		Total Anions (mg/l)	**18,170**	**18,528**		18,528.000	1,029.33	0.00
		Calcite (% Saturation)	0.89	21.93				
		Calcite (lbs/1000 bbls)	-0.00804	1.84				
		Gypsum (%Saturation)	0.214	0.271				
		Gypsum (lbs/1000 bbls)	-452.08	-463.39				
		Barite (% Saturation)	0.06	0.0919				
		Barite (lbs/1000 bbls)	-0.0928	-0.0585				
		Iron Hydroxide (% Saturation)	2.76	0.001				
		Iron Hydroxide (lbs/1000 bbls)	0.001	0.001				

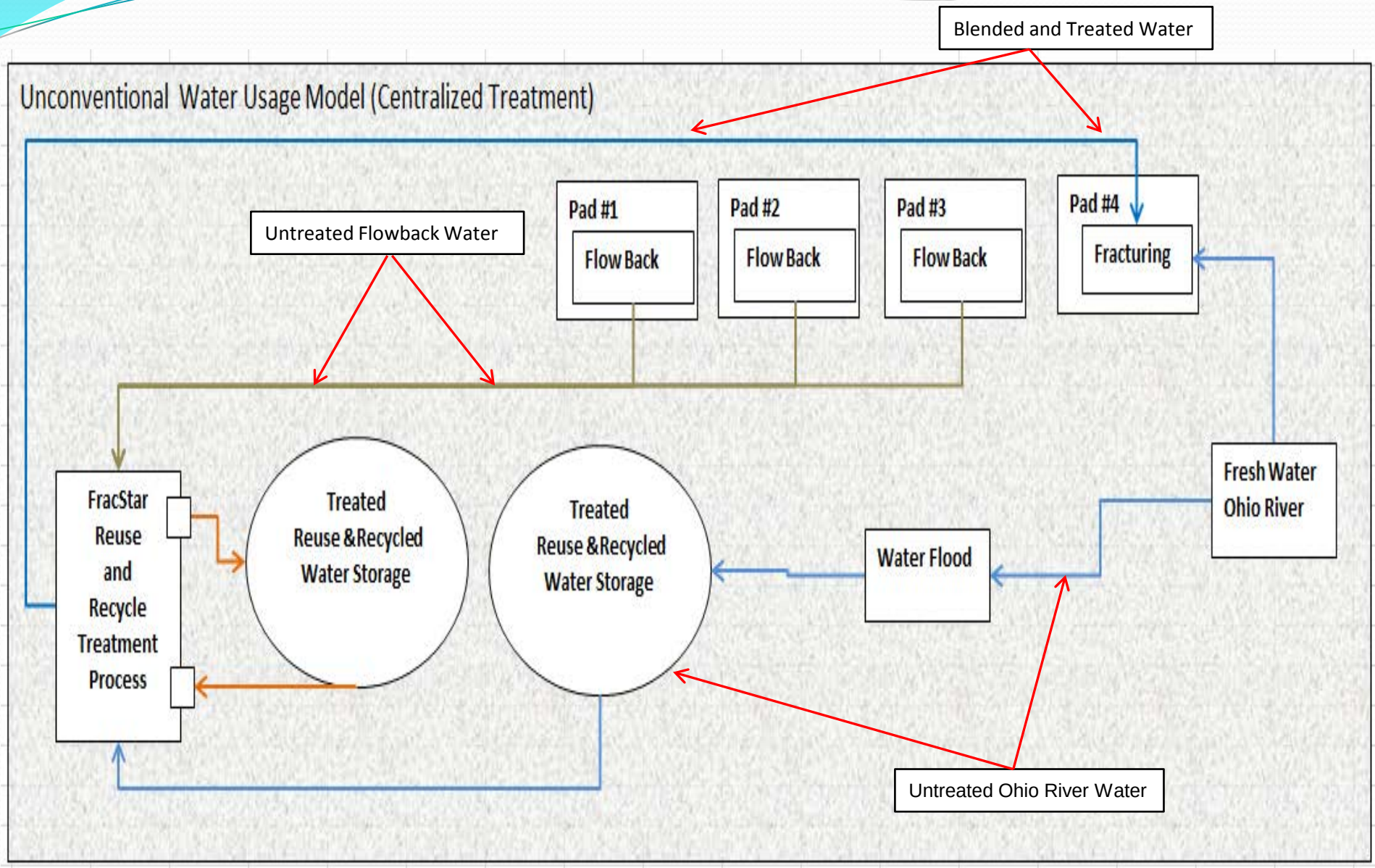
FracStar looks at the blend, and/or a composite of water that was blended prior to treatment. These results show what a 100% reuse and recycle water would look like, and the dilution factor when blended with other fresh waters.

This way knowing what the water will be after treatment helps control the quality of the finished product thereby insuring the performance and the “fracablity” of the treated water.

FracStar shows that this fluid could be used at greater ratios and not affect the “fracablity” of the fluid.

The dilution value models the water at the planned percent of planned reuse, and identifies the properties that must be diluted and/or treated to remove. It also identifies if this water can be used in high concentrations without affecting the performance and the “fracablity” of the treated water.


Unconventional Water Usage Model (Centralized Treatment)
Fresh Water
Fracturing of Well
Well Flowback Water
Well Produced
Solids to Land
Oil Recovery
Salt Water Disposal
Treatment Facility
Fracturing of Well


Blended and Treated Water
Unconventional Water Usage Model (Centralized Treatment)
Untreated Flowback Water
Pad #1
Flow Back
Pad #2
Flow Back
Pad #3
Flow Back
Pad #4
Fracturing
FracStar Reuse and Recycle Treatment Process
Treated Reuse &Recycled Water Storage
Treated Reuse &Recycled Water Storage
Water Flood
Fresh Water Ohio River
Untreated Ohio River Water

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Total Water Management Facility

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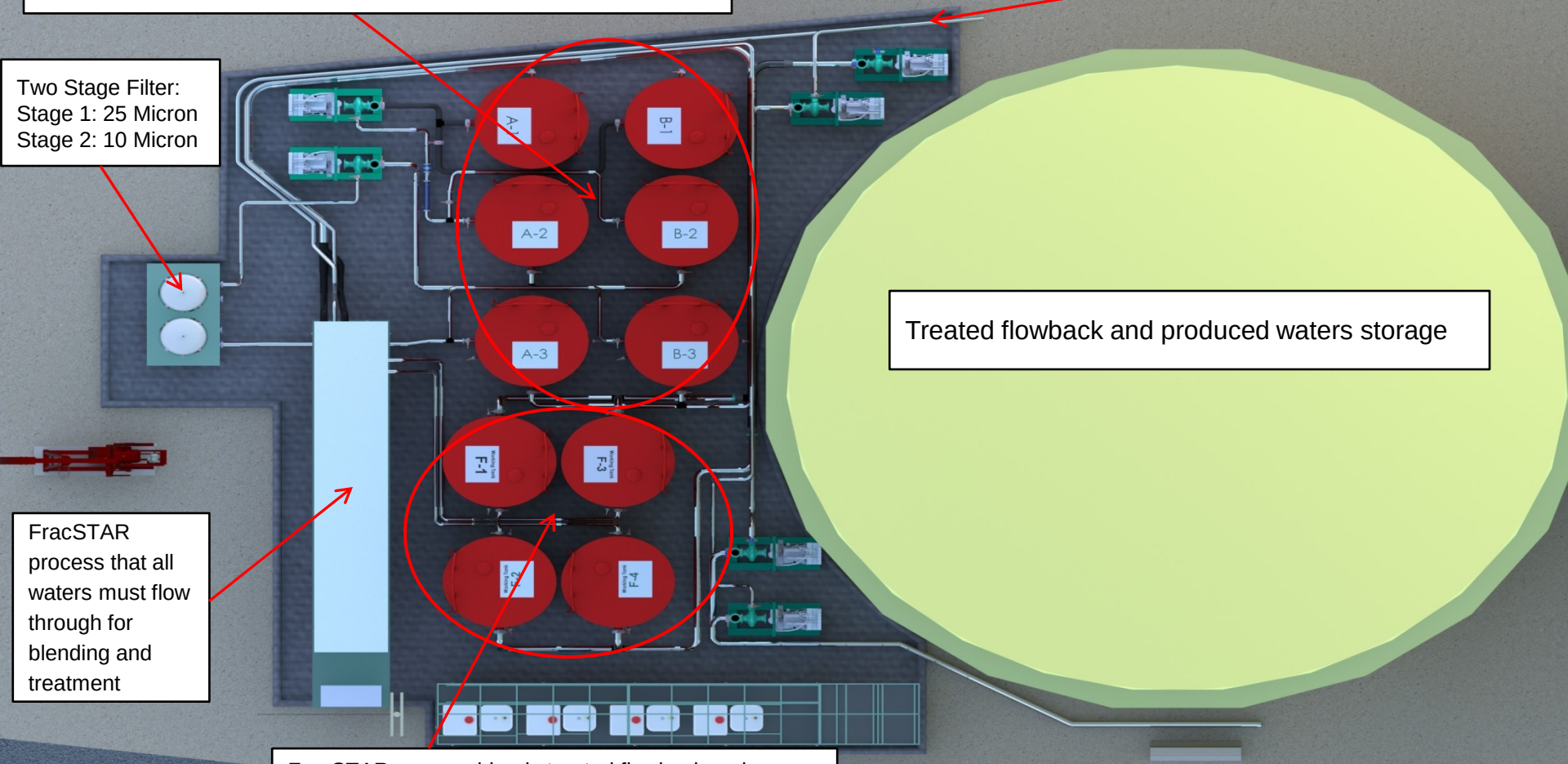
Total Water Management Facility

Treatment process for flowback and produced waters

Flowback and produced water pump from mountains

Two Stage Filter:
Stage 1: 25 Micron
Stage 2: 10 Micron



Treated flowback and produced waters storage

FracSTAR process that all waters must flow through for blending and treatment

FracSTAR process blends treated flowback and produced into fresh water while treating the fresh Water for bacteria and scaling index's

This water was extremely turbid:

- SRB's at 10^7 CFU
- APB's at 10^5 CFU
- Iron Sulfide at 350 ppm
- H2S at 4 ppm
- pH at 5.8

STARTED OUT AS FRESH WATER

This water was not turbid and did not have H2S, Iron Sulfide and the pH was 7.2 going down hole

During the first 18 days of operation, 4,032 serial dilution bug bottles were used and 259 individual samples were taken from 18 different locations from within this operation to help adjust and develop the needed algorithmic equations and operational guidelines to achieve these goals in less than 30 days.

This water had some turbidity:

- SRB's at 10^0 CFU
- APB's at 10^0 CFU
- Iron Sulfide at 0 ppm
- H2S at 0 ppm
- pH at 6.5

Treated REUSE and RECYCLE Water

This water is not turbid and does not have H2S, Iron Sulfide and the pH was 7.5 going down hole with no SRB's and or APB's

"FRACABLE WATER"

Treated REUSE and RECYCLE Water

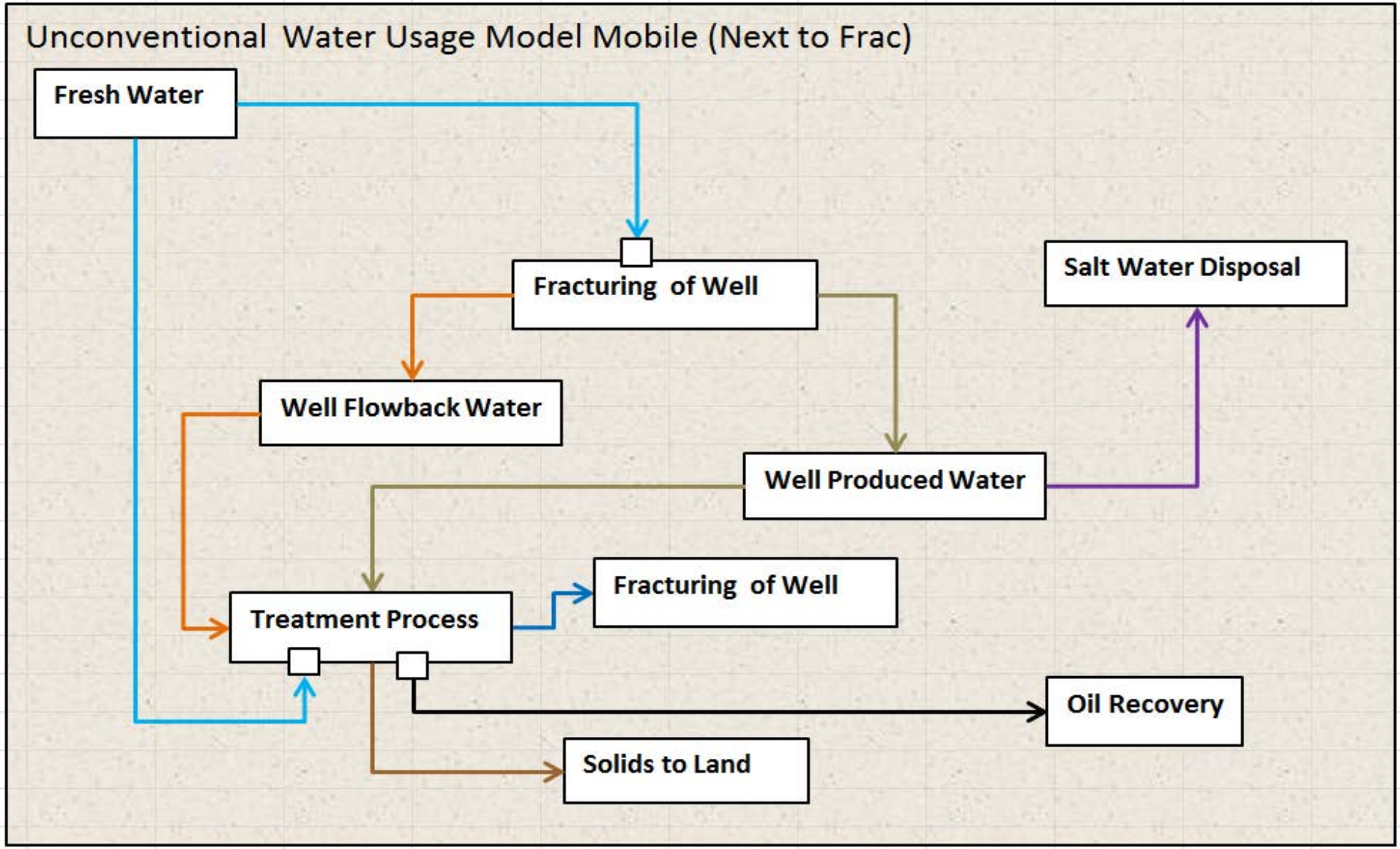
This water is not turbid and does not have H2S, Iron Sulfide and the pH was 7.5 going down hole with no SRB's and or APB's

"**FRACABLE WATER**"

This water had some turbidity:

- SRB's at 10^0 CFU
- APB's at 10^0 CFU
- Iron Sulfide at 0 ppm
- H2S at 0 ppm
- pH at 6.8

14 months of operation
48 wells
99.10% water reused & recycled
6,873,408 barrels / **288,683,136** gallons of fresh water conserved
with an average disposal rate of **$4.20** for disposal the producer saved
$28,490,313.60 in disposal cost.


Unconventional Water Usage Model Mobile (Next to Frac)
Fresh Water
Fracturing of Well
Salt Water Disposal
Well Flowback Water
Well Produced Water
Fracturing of Well
Treatment Process
Oil Recovery
Solids to Land

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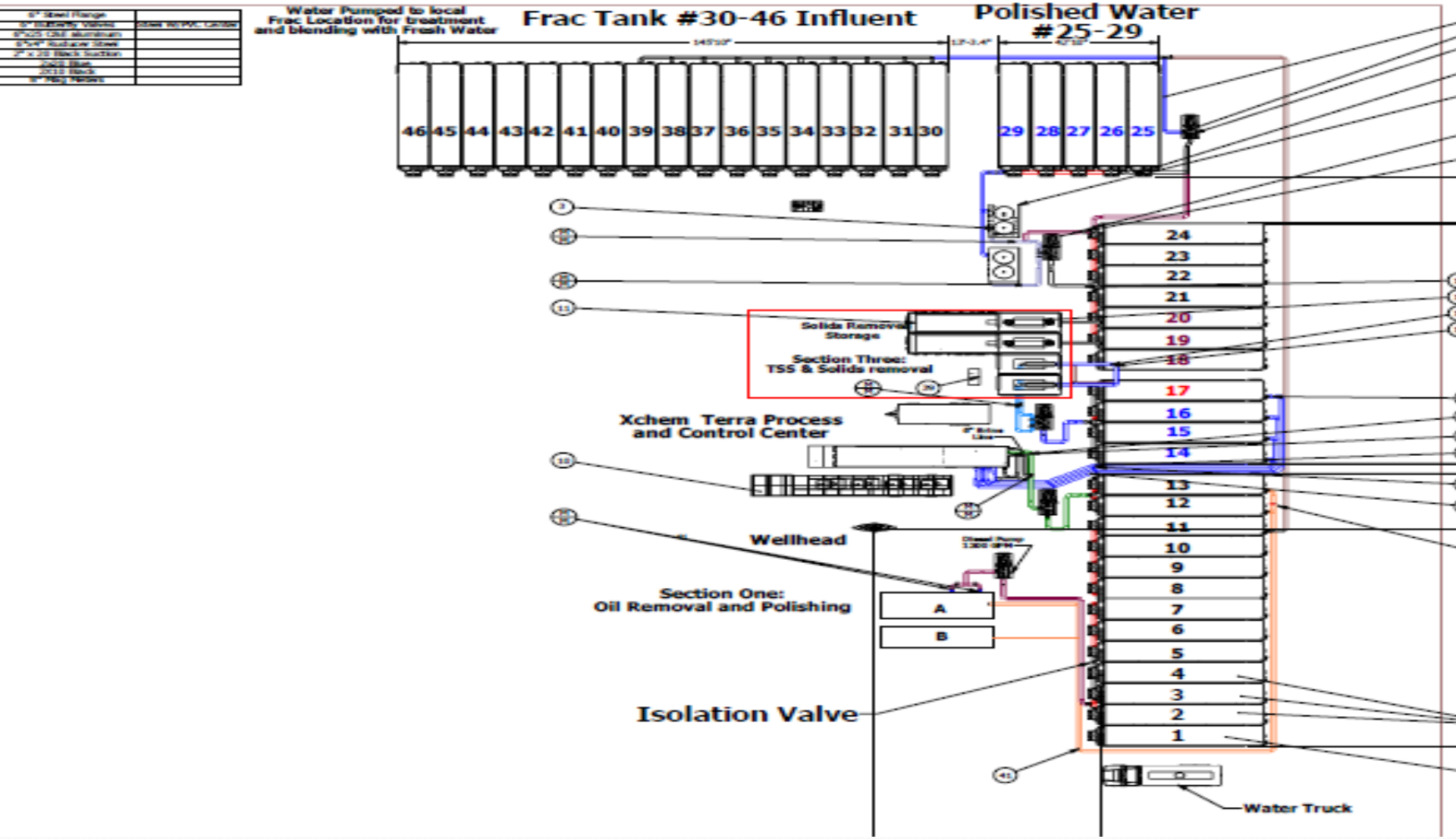
This process was piloted to run for a two well pad with 78 stages with a total of 507,000 Barrels / 21,294,000 Gallons of water to be consumed to Frac these two wells in 18 days. Here are the results of the process that ended up operating for 23 days due to the pump company having maintenance issues with their equipment.

Besides being very mobile it had to accomplish many goals to help make the Reuse and Recycle Project a successful and repeatable process certain KPI (Key Performance Indicators) had to be achieved.

- Oil Removal to <10 ppm
- Solids Removed with Turbidity < 20 NTU's
- Solids Dewatered > 95% Total Influent Volume of Recovered
- Total Iron < 5 ppm
- pH >6.5 and <7.8
- No living SRB's (Sulfate Reducing Bacteria)
- No Living APB's (Acid Producing Bacteria)
- 30,000 BPD (Barrels Per Day) within 18 hrs
- No Spills !!!!!!

Process Through Put 30,000 Barrels Per Day in 18 Hours



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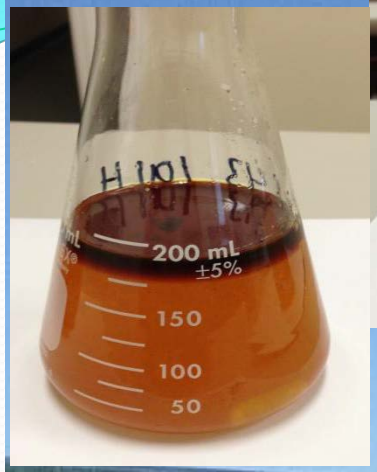

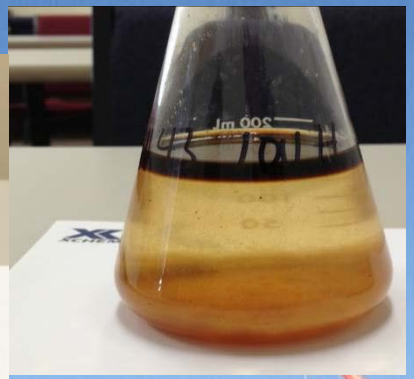

Oil Removal to <50 ppm
Mechanical and or Chemical

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Oxidation and pH Adjustments
ClO_2, $NaCO_3$, NaOH, Ba_2Cl, Polymer

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Solids Concentration with Polymers

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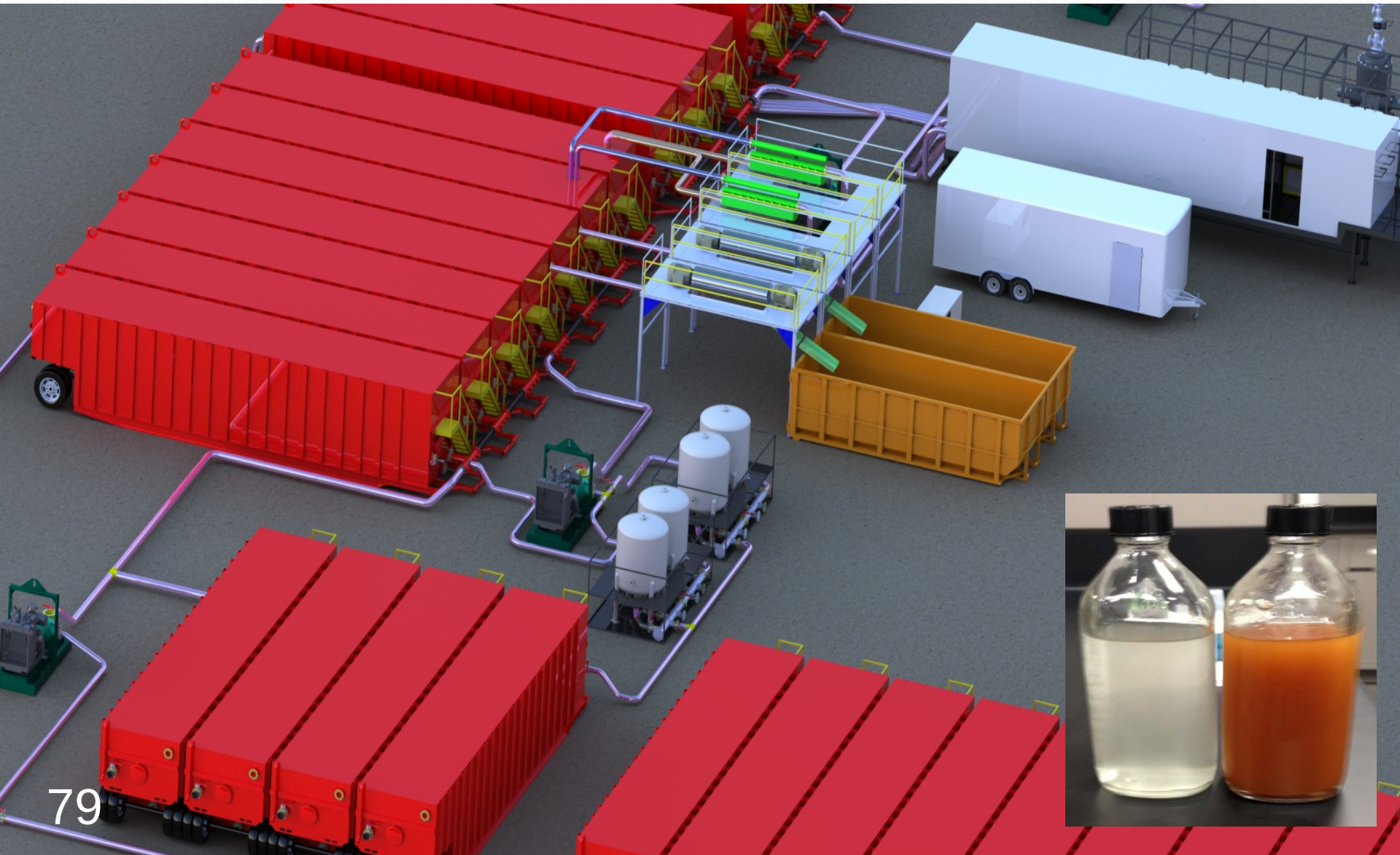
Solids Removal is discharged into bins



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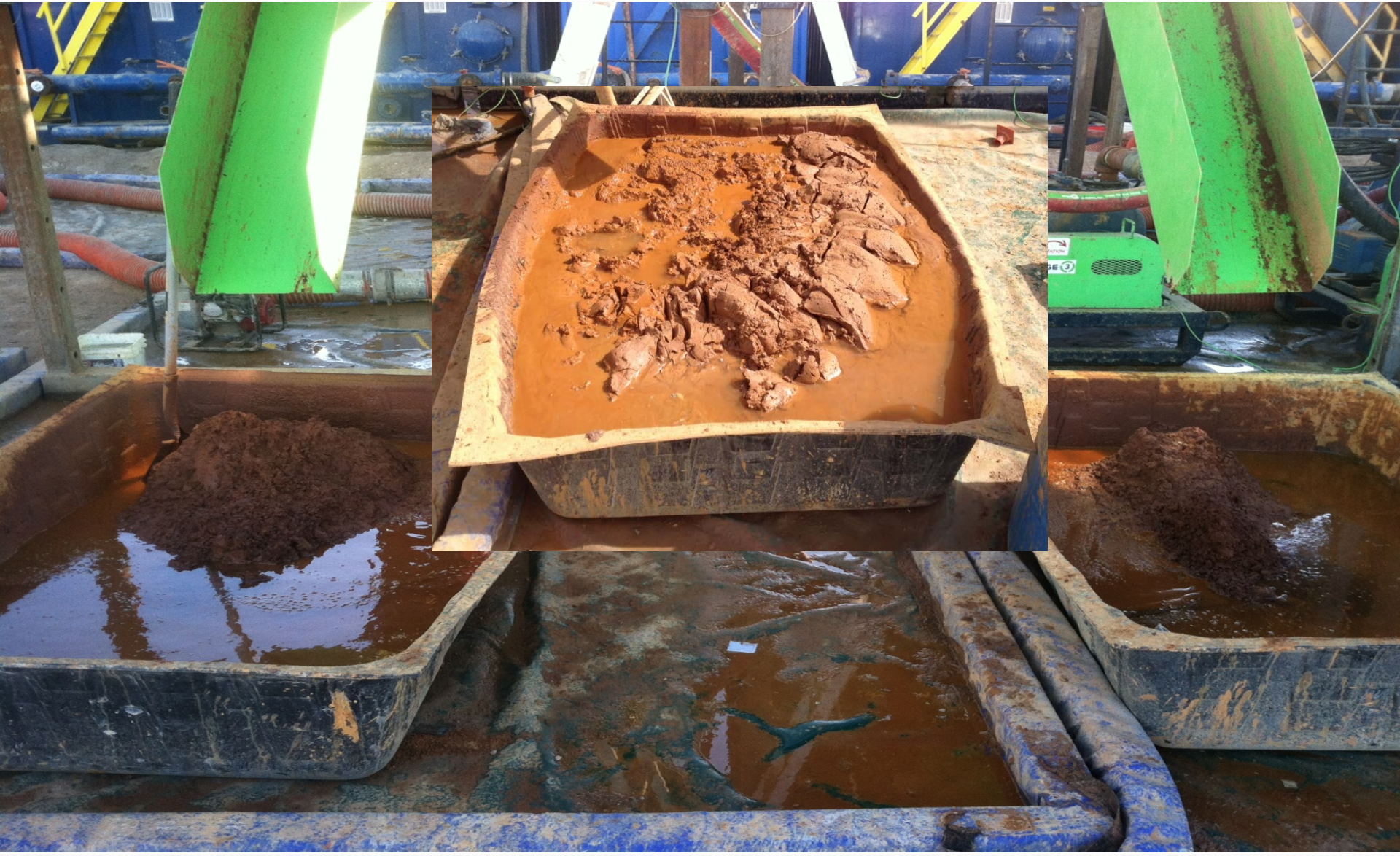
Dewatering of Solids for Disposal to Landfill



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Filtration & Polishing to reduce Post Precipitation

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Filtration & Polishing Keep Solids Out of the Working Frac Tanks

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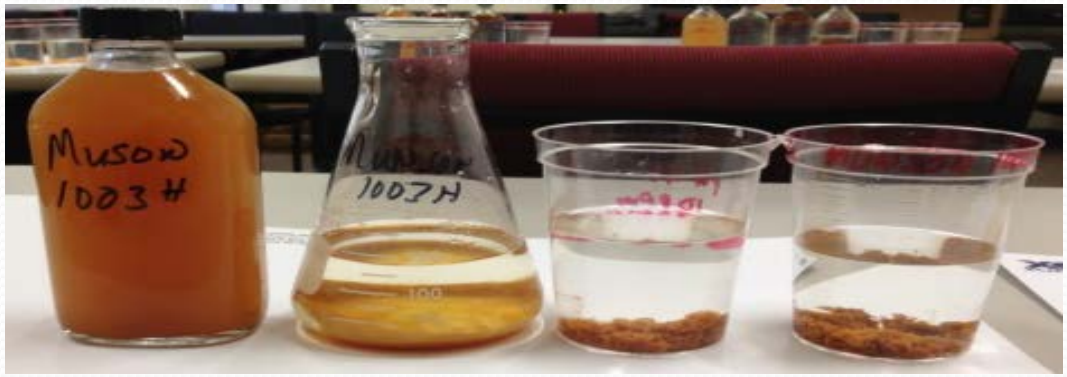
INFLUENT WATER FLOWBACK & PRODUCED H2O
Total Days on RSW Pad
23.00
Total Barrels Treated
269,403.00
Total Gallons Treated
11,314,926.00
Total Pounds of Water Treated
102,859,466.30
Average Weight of Influent LBs/Gal
9.091
Average Weight of Enfluent LBs/Gal
9.086
Percent Total Water Weight Reduction
0.138%

SLUDGE GENERATION
Total Barrels of Sludge Generated
30,774.86
Total Gallons of Sludge Generated
1,292,544.00
Total Pounds of Sludge Generated
11,779,082.73
Average Weight of Sludge LBs /Gal
9.11



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SOLIDS GENERATED FROM DECANTING SLUDGE
Total Barrels of Concentrated Sludge Generated
171.43
Total Gallons of Concentrated Sludge Generated
7,200.00
Total Weight of Concentrated Sludge in LBs
127,292.94
Average Weight of Haul Off LBs Per Gallon
17.68

WATER RECOVERD FROM SLUDGE
Total Barrels of Water Decanted from Sludge Generated
30,603.43
Total Gallons of Water Decanted from Sludge Generated
1,285,344.00
Average Weight of Recovered Water LBs/Gal
9.05
Percent Recovery of Water
99.443%

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This Reuse and Recycle process when completed was successful in:

- Recovering over >99% of the water
- 1,100 Barrels of Oil
- 30,000 Barrels / 1,260,000 Gallons of Sludge that was Decanted to <200 Barrels 8,400 Gallons of Solids
- 0 SRB Bactria
- 0 APB Bacteria
- pH >6.8 and <7.5
- Two Stages completed with 100% Reuse & Recycled water (Fresh Water Pumps Failed)
- Average > 50% Reuse and Recycled Fracable Water

The water leaving the Reuse and Recycled Process was blended using FracStar on location with the untreated Fresh Water being treated for bacteria and a scale inhibitor being added on the fly the layout of the process is shown below.

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After the successes of the first mobile Reuse and Recycle treatment process the piloting of three more operations was approved and the summary of those processes was:

- >850,000 Barrels of Reuse and Recycled Water Treated
- >35,700,000 Gallons of Fresh Water Conserved
- >1,800 Barrels of Oil Recovered
- > 85,000 Barrels of Sludge Generated that was dewatered to < 450 Barrels of Disposal
- > 99% water recovery
- Calcium and Sulfate Scaling Indexes were lowered by >80%
- CO2 (Carbon Dioxide) Dissolved Gasses removed by >70%
- No H2S (Hydrogen Sulfide)
- No SRB's (Sulfate Reducing Bacteria) going down hole
- No APB's (Acid Producing Bacteria) going down hole
- pH > 6.85 and < 7.45

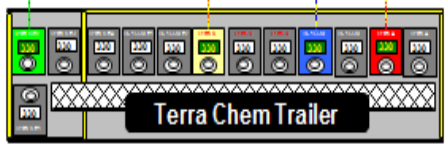
Reuse & Recycle Frac Layout

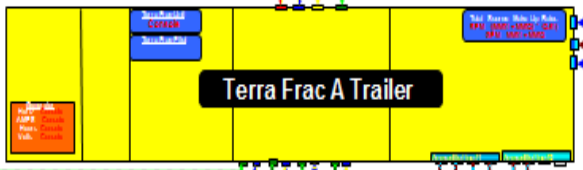
Terra-Services with fracSTAR

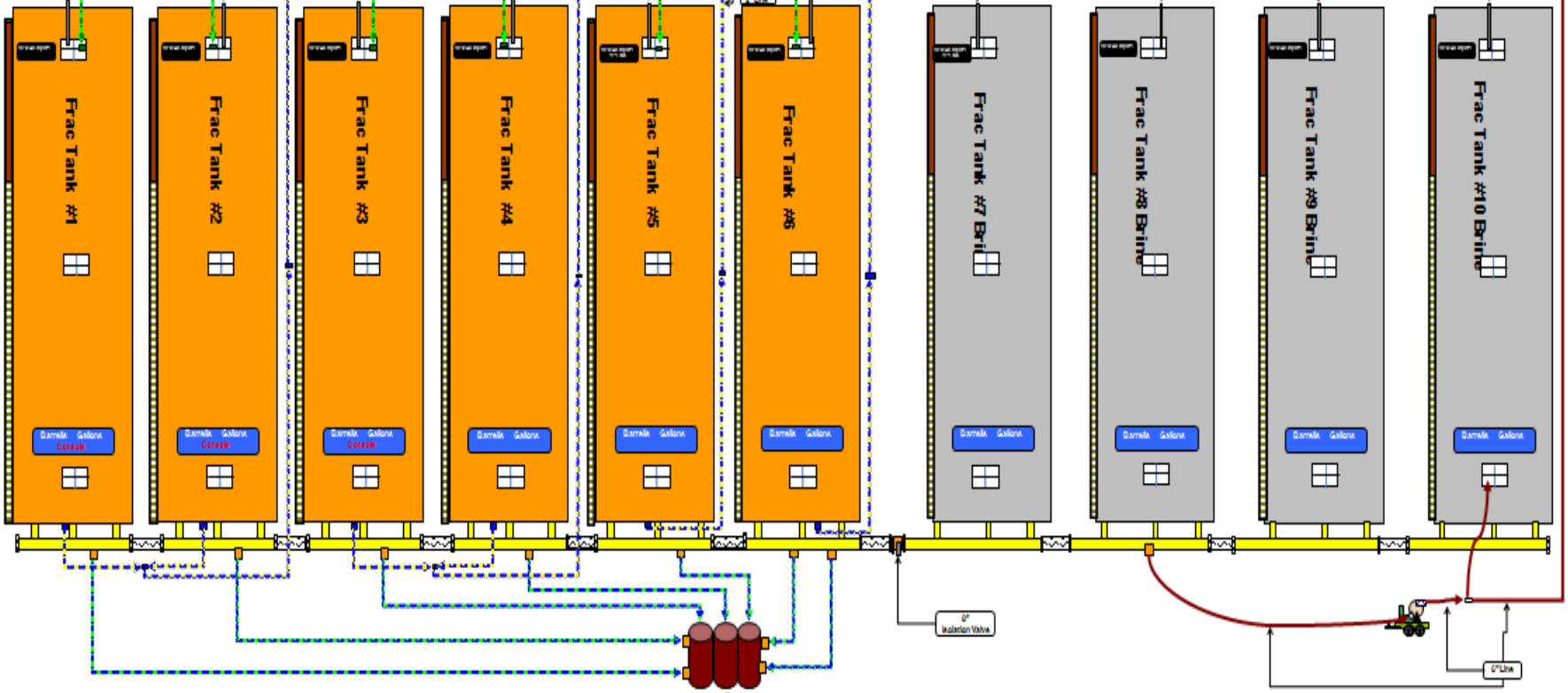
Source Water

All Fresh Water Frac
6 Working Frac Tanks

Treated Water From Reuse and Recycle Treatment Process on adjacent Frac Pad





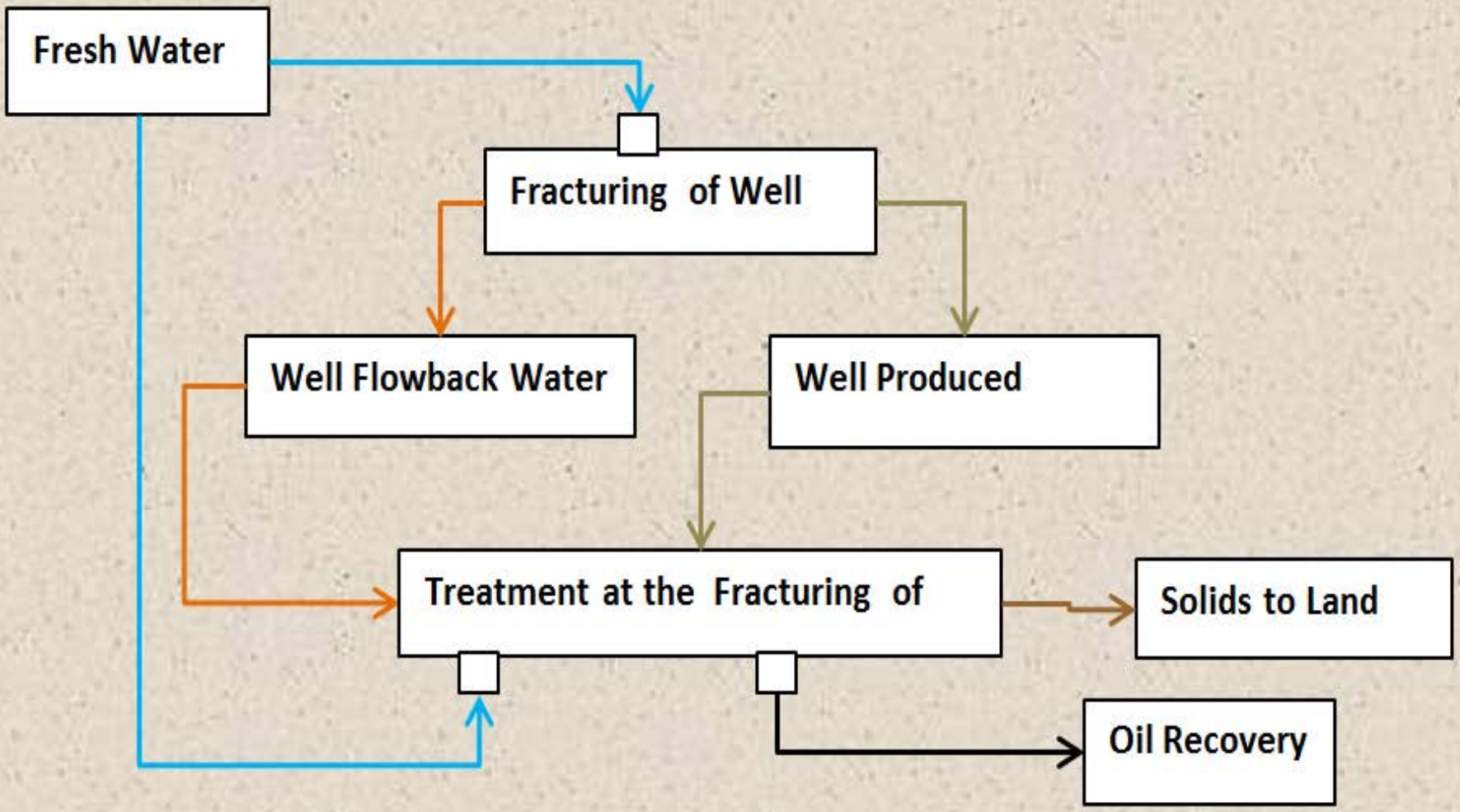


Another development occurred throughout this process that led to another evolution in the development of Reuse and Recycle applications.

This development however is tied to another upfront process which is significant in the ability to consume large volumes of water for Reuse and Recycle that helps reduce the need for additional fresh waters. In the application of the 4 Reuse and Recycle processes the FracStar application was being used for over a year to treat the fresh water being used in the Fracing Process. This had such a significant impact on the waters that were flowing back and being produced by the wells that the need for such a large mobile treatment process system was no longer needed and the foot print and speed of treatment evolved to a new level.

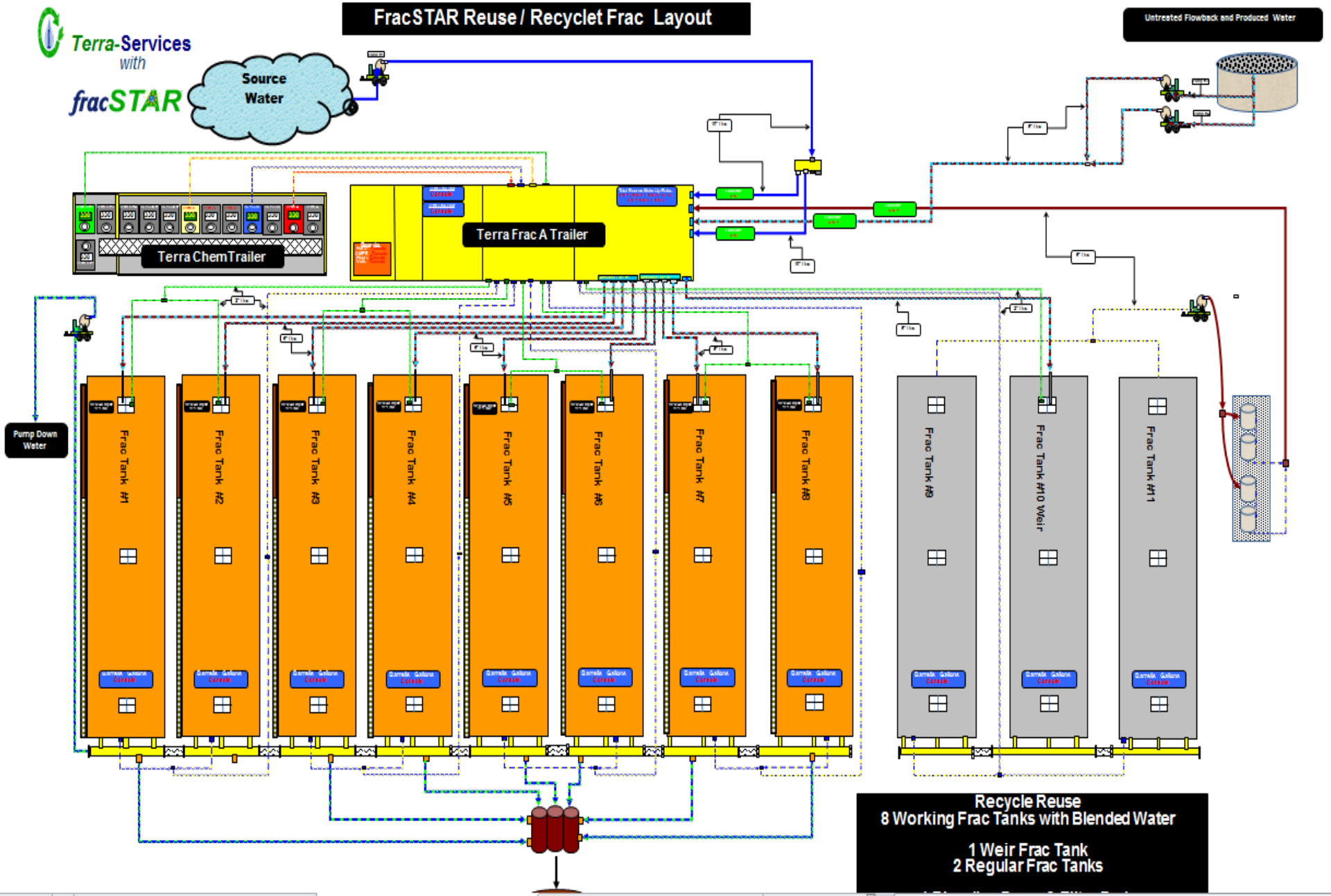
The on the fly Reuse and Recycle treatment process allows for the entire treatment process to occur on the frac pad and move with the pumping company. This also eliminates the risk of having a spill off location and on the ground due to a leaking or ruptured pipe.

Unconventional Water Usage Model (On Frac Pad) no Disposal

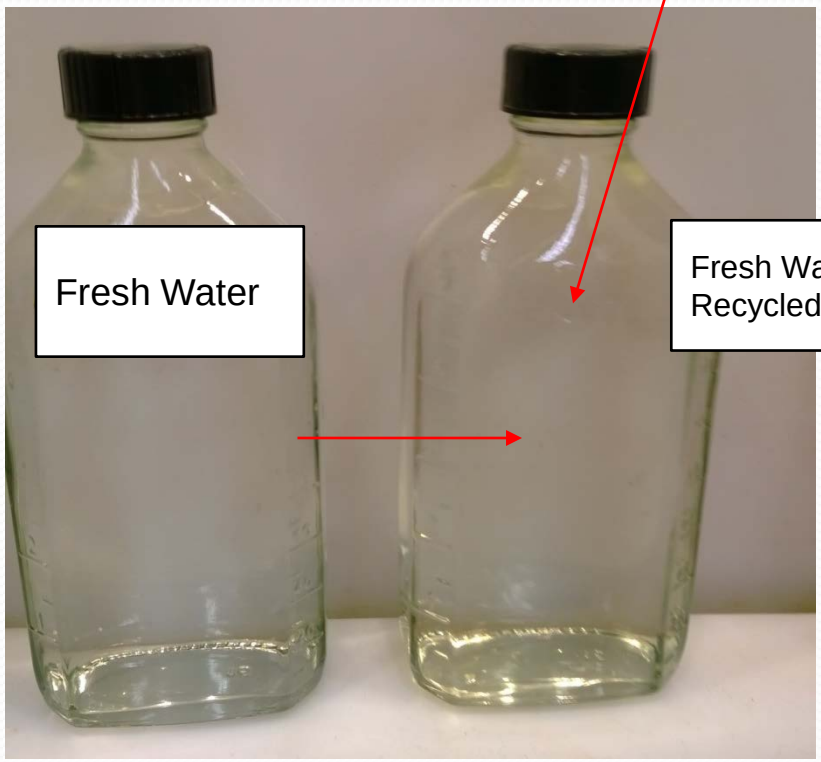


NCH CORPORATION

FracSTAR Reuse / Recyclet Frac Layout



NCH CORPORATION



NCH CORPORATION

This Reuse and Recycle process is constantly running:

- **Recovering over >100% of the water**
- **700 Barrels of Oil**
- **Averages 7,785 Barrels / 326,970 Gallons of Recycled Water Every Day**
- **0 SRB Bactria**
- **0 APB Bacteria**
- **pH >6.8 and <7.5**

The this process has conserved 272,475 Barrels / 11,443,950 Gallons of Water to date.

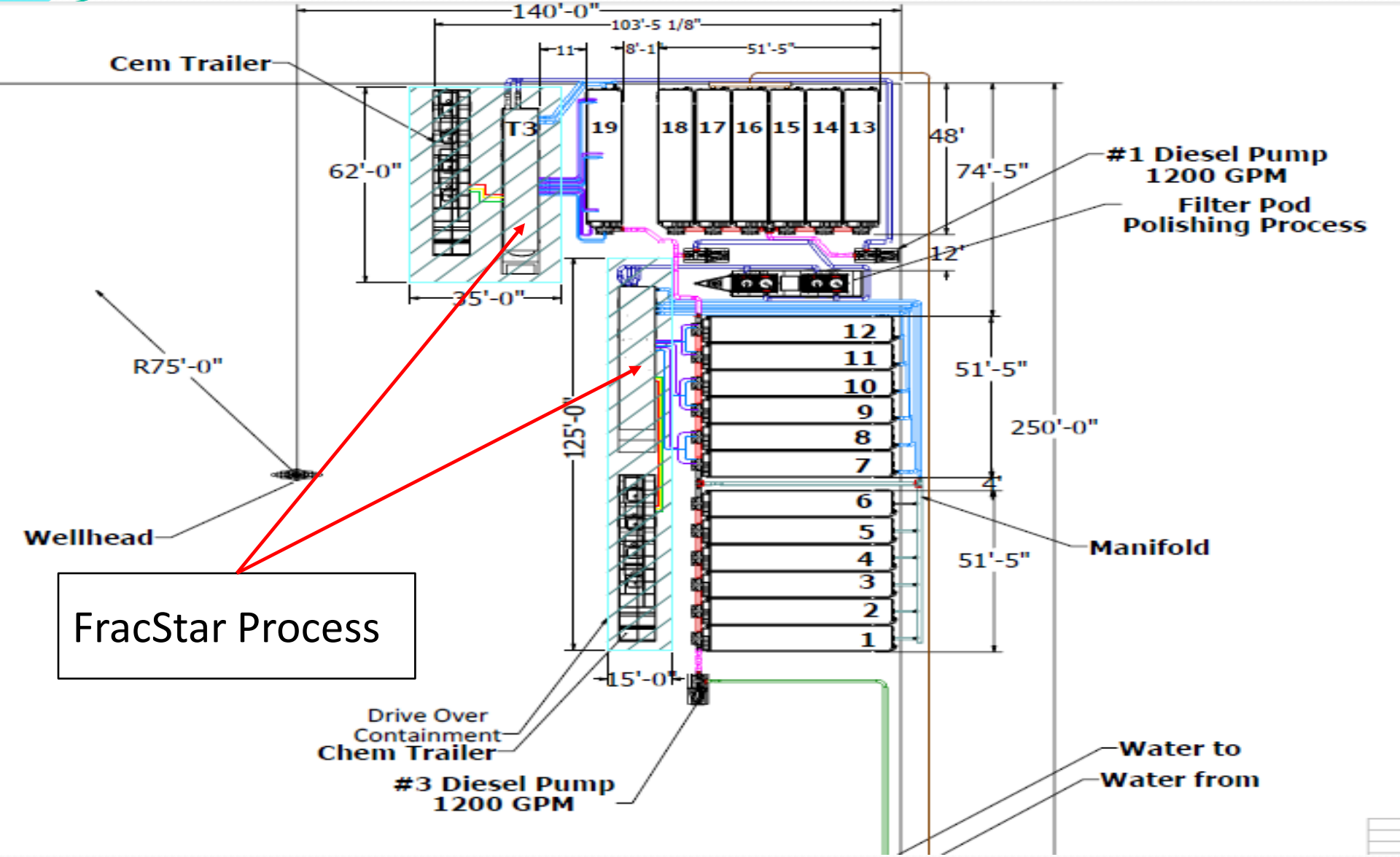
The projected volumes conserved by end of 2014

1,498,612 Barrels / 62,941,725 Gallons of Water

On another Reuse and Recycle process that was using 100% water flood water that had 1% to 2% Oil and >600 ppm H2S (Hydrogen Sulfide) and the presence of SRB and APB Bacteria which was to be 100% of the source water for a 13 Well Program. This water had to be treated to become Fracable and meet certain KPI (Key Performance Indicators)to insure the completion of the wells within the program which were:

- Turbidly <12 NTU's
- <0 ppm H2S (Hydrogen Sulfide)
- No SRB Bactria
- No APB Bactria
- >15 ppm of ClO2 (Chlorine Dioxide)
- pH >6.5 and <7.5
- 100% Reuse Water (No Fresh Water)
- No Water to be disposed of 100% Reuse & Recycle

This process had some safety challenges and previous processes failed to deliver the volume of water to do a 100% Reuse and Recycle and the water quality was affecting the Frac Performance with pressure and flow rate issues. These wells were projected to deliver 65 to 85 BPD (Barrels Per Day) based on the previous results from the Reuse and Recycled program used last year. This very small foot print supplied the water for all 13 wells and allowed for the treatment process to take place on a single shift each day of operating.


140'-0"
103'-5 1/8"
11'
8'-1"
51'-5"
Cem Trailer
T3
19
18
17
16
15
14
13
48'
74'-5"
62'-0"
#1 Diesel Pump
1200 GPM
Filter Pod
Polishing Process
12'
35'-0"
R75'-0"
12
11
10
9
8
7
6
5
4
3
2
1
51'-5"
250'-0"
125'-0"
4'
Wellhead
Manifold
51'-5"
FracStar Process
15'-0"
Drive Over
Containment
Chem Trailer
#3 Diesel Pump
1200 GPM
Water to
Water from

This process was so successful in the treatment of waters used for Reuse and Recycle that a number of developments occurred that had never been seen before:

- **The treated Reuse and Recycle Water had pump times of 45 to 55 minutes, which allowed for this fluid to be used on Horizontal Fracs and not just Vertical Frac's**
- **Due to the length of the pump times and compatibility of the water with chemistry that was carrying the sand (proppant) down hole less Horsepower was needed to complete the wells (Major Cost Savings)**
- **The wells produced 75% to 100% more Oil than was projected (Major Money Maker) an increase from 75 BPD to 180 BPD**

Due to these successes the implementation and use of the FracStar Process the expansion and development of this technology will help lead to the growth in Reuse and Recycle programs that will reduce the practice of disposing of water while consuming fresh water. With the enhanced well performance and major cost reductions in the implementation of Reuse and Recycle treatment programs the reduction and dependence on Fresh Water from the environment can start taking place.

FracSTAR Summary

To date over 170,000,000 Barrels / 7,140,000,000 Gallons of water treated.

Over 1,000 analysis consisting of complete water and bacteria analysis pre, during, and post frac.

7,200,000 Barrels / 302,400,000 Gallons of water treated last month

15,200,000 Barrels / 638,400,000 Gallons of water treated last quarter.

389,050 Barrels / 16,340,100 Gallons of water averaged everyday.

100,000,000 Barrels / 4,200,000,000 Gallons of water projected for this year

Making Water "Fracable"