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The Impact of Stress Shadowing with variations in Cluster Spacing on the Production for Wells Completed in the Marcellus Shale

Joshua Dietz

Thesis Submitted to the

Benjamin M. Statler College of Engineering and Mineral Resources at

West Virginia University

In partial fulfillment of the requirements for the degree of

Master of Science in

Petroleum and Natural Gas Engineering

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Morgantown, West Virginia

December 3, 2020

Keywords: Stress Shadowing; Hydraulic Fracturing, Marcellus Shale

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Abstract

The Impact of Stress Shadowing on The Production from the Horizontal Wells Completed in Marcellus Shale

Joshua Dietz

The design of the well stimulation treatment has significantly changed over the last decade because of the advancement of hydraulic fracturing. The cluster and stage spacing design component of hydraulic fracturing has been a key factor in enhancing the production from the horizontal wells. Recently, the treatment designs are moving towards lower cluster spacing. The reduction of the spacing alters the in-situ stresses in the formation and begin to impact the propagation of next set of future fractures and the properties of previous fractures. These stress alterations from hydraulic fracturing is referred to as stress shadowing.

The objective of study was to investigate the impact of the cluster spacing and the completion design on the production from a horizontal shale gas well. The available completion, drilling, and reservoir data from a horizontal shale gas well located at Marcellus Shale Energy and Environment Laboratory (MSEEL) in Morgantown, WV was used to develop the base model for this study using GOHFER 3D fracture modeling software coupled with CMG reservoir simulation software. Subsequently, different the cluster spacings and the completion designs were modeled with GOHFER 3D to evaluate the impact that stress shadowing has on fractures properties. The predicted fractures properties were then imported into CMG reservoir simulation to predict the production performance. The results of the study provided a better understanding of the stress shadowing in shale gas reservoirs relative to the cluster spacing of the completion design.

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Nomenclature

γ_g = *Specific Gravity of Gas, frac.*

Z = *True Vertical Depth, feet*

$\bar{z}$ = *Average z-factor*

$\bar{T}$ = *Average Temperature, °R*

P_c =*closure pressure, psi*

v =*Poisson's Ratio*

D_{tv} =*True Vertical Depth, feet*

γ_{ob} =*Overburden Stress Gradient, psi/ft*

γ_p =*Pore Fluid Gradient, psi/ft*

α_v =*Vertical Biot's Poroelastic Constant*

α_h =*Horizontal Biot's Poroelastic Constant*

P_{off} =*Pore Pressure Offset, psi*

ε_x =*Regional Horizontal Strain, microstrains*

E =*Young's Modulus, million psi*

σ_t =*Regional Horizontal Tectonic Stress*

D =*depth*

f_{ij} =*fugacity of component i in phase j*

F =*function*

g =*phase-equilibrium function*

n_b =*number of gridblocks*

n_c =*number of components*

N_i =*moles of component i per unit block volume*

p =*pressure*

P_{cog} =*oil-gas capillary pressure*

P_{cwo} =*water-oil capillary pressure*

q =*injection/production rate*

t =*time*

T_j =*transmissibility of phase j*

V =*gridblock volume*

y_{ij} =*mole fraction of component i in phase j*

γ =*specific gravity or gravity term in flow equation*

Δt =*timestep*

ρ_m =*molar density of phase*

ϕ =*porosity*

ψ =*function*

I. Introduction

The recent boom in gas production from the Marcellus shale has led the oil and gas industry into a technology advancement growth. The rapid growth in hydraulic fracturing technology has enabled the ability to drill longer laterals and more perforations. As time goes on, more and more companies are moving to smaller cluster spacing designs to be able to gain access to more of the shale reservoir. With knowing, hydraulic fracturing changes the in-situ stresses of the shale formation when being stimulated, there is a point that these stress changes will start effecting future and/or previous stimulated fractures. This effect that the changes in stresses has on the propagation of future or previous fractures is defined as "stress shadowing."

Through studying literature, there are not many studies conducted on the impact of stress shadowing in shale reservoirs. The potential for stress shadowing to impact the production when reducing cluster spacings is an important issue to investigate. By understanding this problem, potential guidance for cluster spacings could be established which would help maximize production for a well. However, this is a very complex problem that is impacted by many factors. The focus of this study is to look at just the impact that stress shadowing has on the production based on the cluster spacing.

II. Review of Literature

The propagation of a fracture that is created during a hydraulic fracture treatment is dependent on the formation stress field. A fracture will always propagate perpendicular to the minimum horizontal stress. During the propagation of a fracture, the local stress field around the fracture will change. This change in stress is also referred to as stress shadowing. More specifically stress shadowing is, when a hydraulic fracture is opened the compressive stress normal to the fracture faces is increased above the initial in-situ stress by an amount equal to the net fracturing pressure. Figure 1 depicts the stress shadow that created by a stimulated hydraulic fracture (Fisher, et al., 2004).

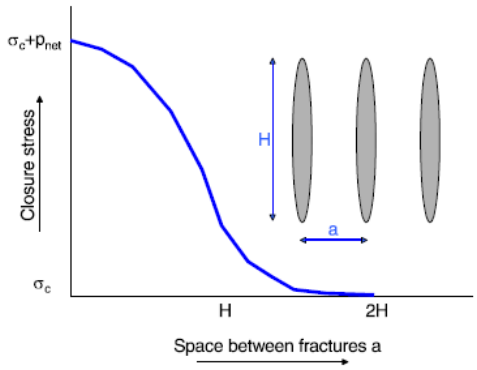

Figure 1: Relationship between Closure Stress increase and distance away from fracture (stress shadow) as a function of fracture height (Fisher, et al., 2004)

Stress shadowing can lead to restrictions on the propagation of future fractions, deviations in future fractures or damage to previously created fractures. Also, for stages with multiple clusters (2 or more), the interior fractures see the effects of stress shadowing (Fisher, et al., 2004). This is because of the lower net pressure inside the fracture, which causes a smaller aperture, which generates a lower transmissibility, causing less fluid to enter, and retarding the rate of growth of the interior fractures (Barree, 2015). Figure 2 illustrates stress shadowing when there are multiple fractures in a close proximity.

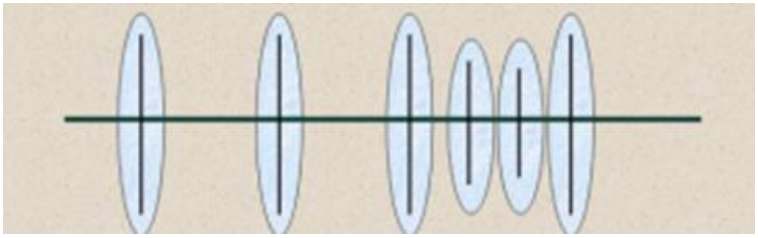

Figure 2: Illustration of "stress shadowing" for multiple fractures (Barree, 2015).

Chapter 2.1 - GOHFER

The fracture software used for this study was GOHFER (Grid Oriented Hydraulic Fracture Extension Replicator). It is a planar 3-D geometry fracture simulator with a fully coupled fluid/solid transport simulator. The main building blocks of the fracture model comes from well logs to be able to model fracture growth and post-frac production. Depending on the type of fracture model created, either synthetic or actual field well logs are used. GOHFER can directly import log data (LAS files) and has a log analysis tool to help create a lithologic description. The log analysis creates an in-situ stress profile that is internally calculated from pore pressure, poroelasticity, elastic moduli, and geologically consistent boundary conditions (Barree, 2018).

The way that GOHFER simulates their fracture models is by using a grid system similar to what reservoir models use. The grid system for GOHFER is used for elastic rock displacement calculations and planar finite difference for the fluid flow solutions. Fracture properties such as, fluid composition, proppant concentration, shear, leakoff, width, pressure, viscosity, etc. are defined in each grid block generated for the model created. In-situ stress is one of the primary factors for determining fracture characteristics. When modeling in-situ stress, GOHFER internally calculates in-situ stress from pore pressure, poroelasticity, elastic moduli and geologically consistent boundary conditions. The calculation is completed using Equation 2.1.1 (Barree, 2018).

$$P_c = \frac{\nu}{1-\nu}\left[D_{tv} - \alpha_v\left(D_{tv}\gamma_p + P_{off}\right)\right] + \alpha_h\left(D_{tv}\gamma_p + P_{off}\right) + \varepsilon_x E + \sigma_t \quad (2.1.1)$$

Fracture extension and proppant transport is best explained by the following from GOHFER's software manual:

> Fracture extension is based on a smoothly closing tip model and eliminates the fictitious singularity at the tip as well as the stress intensity factor. The fracture extension and deformation model in GOHFER is based on a formulation that expects the formation to fail in shear and be essentially decoupled. Most models assume linear-elastic deformation of a fully coupled rock mass. In shales, the assumption of shear is critical. Along with this GOHFER accounts for pressure dependent leakoff, transverse storage in horizontal and off-angle fracture components, and pressure dependent modulus of the bulk rock mass. All these things happen as the formation is stressed to the shear failure point. The result is higher treating pressures, smaller fracture heights, and more difficulty in placing proppant. The proppant transport model in GOHFER also includes modeling of non-uniform solid and liquid velocities, solid holdup, and variable transmissibility linked to fracture offsets and irregularities. (Barree, 2018, p. 2).

Chapter 2.2 - CMG

The reservoir modeling software used for this study was CMG GEM, which is a multidimensional equation-of-state computational simulator. GEM utilizes either the Peng-Robinson or the Soave- Redlich-Kwong equation of state to predict the phase equilibrium compositions and densities of the oil and gas phases, and supports various schemes for computing related properties such as oil and gas viscosities. CMG Builder is used to create the physical reservoir model with creating and importing grids and grid properties, locating wells, importing well production data, importing or creating fluid models, rock-fluid properties, and initial conditions (Builder User Guide: Simulation Model Building Application, 2018).

The principle equations used for CMG GEM, from CMG GEM manual, are defined below (GEM User Guide: Conventional & Unconventional Simulator, 2018):

- Flow Equations:

$$\psi_i \equiv \Delta T_o^m y_{io}^m (\Delta p^{n+1} - \gamma_o^m \Delta D) + \Delta T_g^m y_{ig}^m \left(\Delta p^{n+1} + \Delta P_{cog}^m - \gamma_g^m \Delta D\right) + q_i^m - \frac{V}{\Delta t}\left[N_i^{n+1} - N_i^n\right] = 0 \quad (2.2.1)$$

$$\psi_{n_c+1} \equiv \Delta T_w^m (\Delta p^{n+1} + \Delta P_{cwo}^m - \gamma_w^m \Delta D) + q_{n_c+1}^m - \frac{V}{\Delta t}\left[N_{n_c+1}^{n+1} - N_{n_c+1}^n\right] = 0 \quad (2.2.2)$$

$$N_i = \phi(\rho_o S_o y_{io} + \rho_g S_g y_{ig}) \quad (2.2.3)$$

$$N_{n_c+1} = \phi \rho_w S_w \quad (2.2.4)$$

- Phase-Equilibrium Equations

$$g_i \equiv \ln f_{ig} - \ln f_{io} = 0 \quad (2.2.5)$$

$$N_{io} = N_i - N_{ig} \quad (2.2.6)$$

- Saturation Equation

$$S_w = N_{n_c+1}/(\phi \rho_w) \quad (2.2.7)$$

$$S_o = (1 - S_w)\frac{N_o/\rho_o}{N_o/\rho_o + N_g/\rho_g} \quad (2.2.8)$$

$$S_g = (1 - S_w)\frac{N_g/\rho_g}{N_o/\rho_o + N_g/\rho_g} = 1 - S_w - S_o \quad (2.2.9)$$

- Mole or Volume Consistency Equations

$$\psi_p \equiv V \frac{\sum_{i=1}^{n_c+1} N_i^{n+1}}{\left(\rho_o S_o + \rho_g S_g + \rho_w S_w\right)^{n+1}} - V\phi^{n+1} = 0 \quad (2.2.10)$$

The primary setup in CMG required selecting which simulator to build from and the type of porosity model. The porosity model could be single porosity, dual porosity, dual permeability, subdomain or minc depending on the specified type of model desired. Dual permeability was used for this study. The grid system is the next major component of building the reservoir model. This is because the size of the size and location of the grids is directly related to the transmissibility calculations. The grids being to large will miss critical data and the grids too small with require large computational power. Along with the type of grid selected between cartesian, orthogonal corner point, non-orthogonal corner point, or radial (Builder User Guide: Simulation Model Building Application, 2018).

III. Methodology

Chapter 3.1 - Data Collection

The data used in this study was gathered from Marcellus Shale Energy and Environment Laboratory (MSEEL). The study started with analyzing and modeling well MIP-6H and MIP-4H but focused on well MIP-3H due to the vast amount of data available in drilling, completions, reservoir engineering and fiber optics. All the data available may be seen in Figure 3.

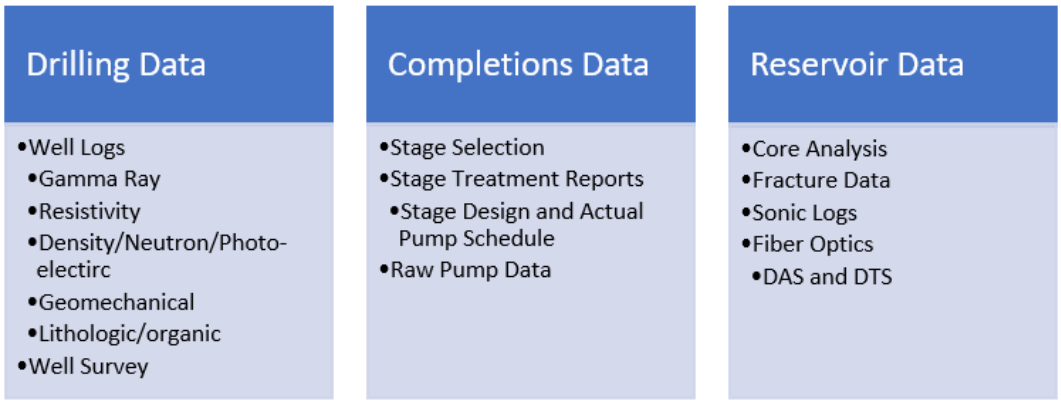

Figure 3: Detailed data available for MIP-3H

For this study, 1,434 days of daily production records were available for MIP-3H. The well was completed with twenty-eight stages and a lateral length of 6,058 ft. The stimulation treatment was conducted with an average injection pressure of 8,500 psi. There were four different pump schedules used to stimulate the well. The pump schedule for each stage may be seen in Table 1 and Figure 4.

- Pump schedule A used a slurry rate of 90 bpm, 8,430 barrels of slick water, 155,200 pounds of 100-mesh, 284,800 pounds of 40/70-mesh.
- Pump schedule B used a slurry rate of 90 bpm, 8,184 barrels of slick water, 330,000 pounds of 100-mesh, 110,000 pounds of 40/70-mesh.
- Pump schedule C used a slurry rate of 72 bpm, 7,090 barrels of slick water, 127,600 pounds of 100-mesh, 232,400 pounds of 40/70-mesh.
- Pump schedule D used a slurry rate of 90 bpm, 7,424 barrels of slick water, 155,200 pounds of 100-mesh, 284,800 pounds of 40/70-mesh.

Table 1: Pump schedule used per stage.

Stage Number	Pump Schedule	Stage Number	Pump Schedule
1	A	15	C
2	A	16	C
3	A	17	C
4	A	18	C
5	A	19	C
6	A	20	D
7	B	21	D
8	B	22	A
9	B	23	A
10	B	24	B
11	B	25	B
12	B	26	B
13	A	27	B
14	A	28	C

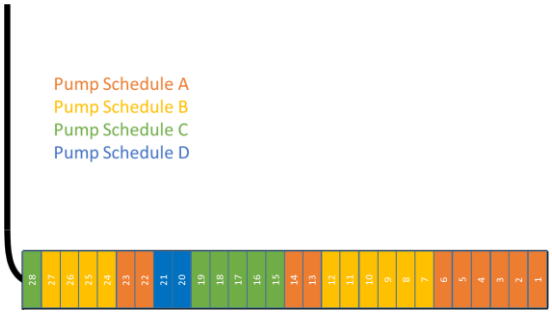

Figure 4: Stage Pump Schedule

Chapter 3.2 - Data Processing and Evaluation

The data available required processing to be able to use in the for further studying. The main processing occurred with the pump data for the fracture treatment. In order to have a consistent reporting for the stage pump schedule, a python code was generated to process the pump data for each stage and generate a pump schedule based on the proppant and stage times.

Chapter 3.3 - Model Development

This study required a reservoir model, created through CMG, that would be able to use different fracture model data, generated using GOHFER, to study the impact of stress shadowing with variations in cluster spacing on the well's production.. The first section goes through the full development of the base reservoir model, while the second section goes through the development of the base fracture model.

Chapter 3.3a - Reservoir Model

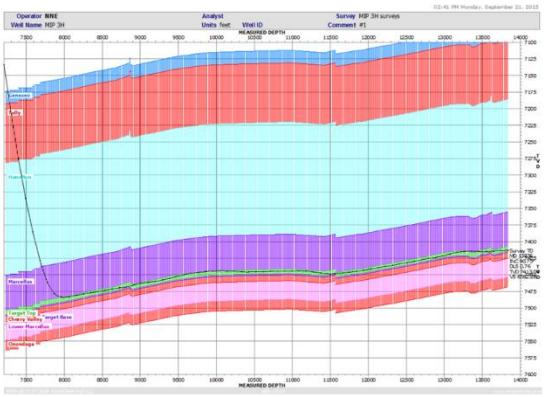

Figure 5: Well Trajectory (MSEEL - Research - MIP Wells, 2018)

Before the reservoir model was designed, a formation top mesh map was created using well trajectory and available geological data. This was first done by using a grid system of 90 x 60 with a grid size of 100ft. x 100ft. and then implementing the formation top depths across the field as seen in Figure 6.

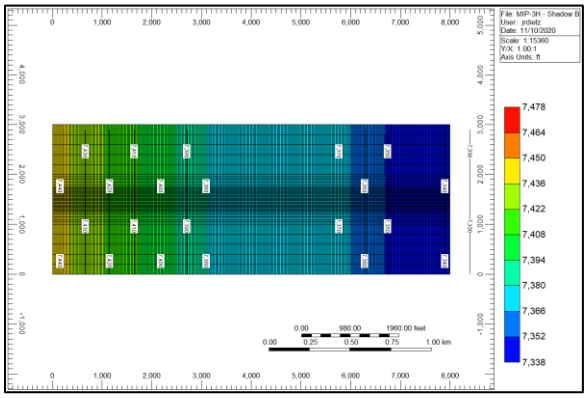

Figure 6: Reservoir Model Top Map

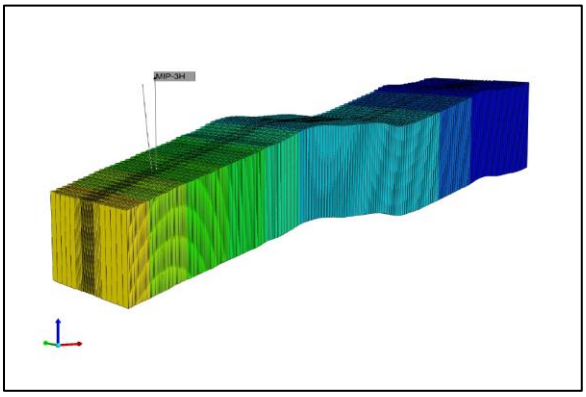

Figure 7: 3D Reservoir Model

The top map was then implemented into the reservoir model with a more refined grid of 400 x 45 x 1 using corner point style grids. The refined grid was used to help with reducing the computational processing the reservoir mode would require. The reservoir parameters used for the model are provided in Table 2.

.

Table 2: Reservoir Model Properties

Reservoir Parameters	Values	Units
Model Dimensions (LxWxH)	8000x3000x90	ft.
Initial Reservoir Pressure	4850	psi
Initial Temperature	146	° F
Fissure Porosity	0.0001	Fraction
Matrix Porosity	0.07	Fraction
Water Saturation	0.15	Fraction
Fissure Permeability (i,j,k)	0.001,0.001,0.0001	md
Matrix Permeability (i,j,k)	0.0004,0.0004,0.00004	md
Langmuir Pressure	400	psi
Langmuir Volume	0.12	gmol/lb

The well trajectory and well perforations were then imported into CMG for MIP-3H. The well trajectory can be seen and checked in 3D view as seen in Figure 7. The fracture data would be imported into CMG using a .cmg file created by the GOHFER fracture model. To make sure that all the files imported correctly, the well trajectory, well perforations, and hydraulic fractures needed to be manually verified.

The last step in building the reservoir model was to set well constraints. There are many different types of constraints that can be set for the well, such as minimum bottom-hole pressure, maximum flow rate, water cut and more. For this study, the important constraint for this model was setting the well constraint for flow rate. These constraints were used because, the best way to make sure that the model would accurately predict was to set the flow constraint to the real daily production and match the pressure from the model to the actual field pressure. MIP-3H shut-in dates were also added to this model to help build a strong predictive reservoir model.

Chapter 3.3b – Fracture Model

With all the available data properly gathered and processed, the fracture model for well MIP-3H could be created. The base fracture model created was designed specifically using all the raw data from MIP-3H to enhance the reservoir model's accuracy in predicting production and pressure.

The fracture model development started with constructing a well with a vertical section using pilot surveys and a lateral section using lateral surveys. The different surveys and their respective well logs were then implemented into the software. For this study, eight well logs were used with the pilot section, which included gamma ray, resistivity, density/neutron/photo-electric, geomechanical and lithological/organic well logs and a gamma ray log was used for the lateral section. Table 3 provides the values used to develop the fracture model, which were gathered from the well log analysis.

Table 3: GOHFER reservoir parameters

Reservoir Parameters	Values	Units
Initial Reservoir Pressure	4850	psi
Initial Temperature	146	° F
Matrix Porosity	0.07	Fraction
Water Saturation	0.15	Fraction
Gas Saturation	0.85	Fraction
PDL Coefficient	0.0002	1/psi
Transverse Storage Coefficient	0.0005	1/psi

The formation tops were then implemented into the software and used, along with horizontal well logs, to help created a three-dimensional map for the formations. Gamma ray logs and water saturation logs were used to help create the structural map for the formations as seen in Figure 8 and Figure 9.

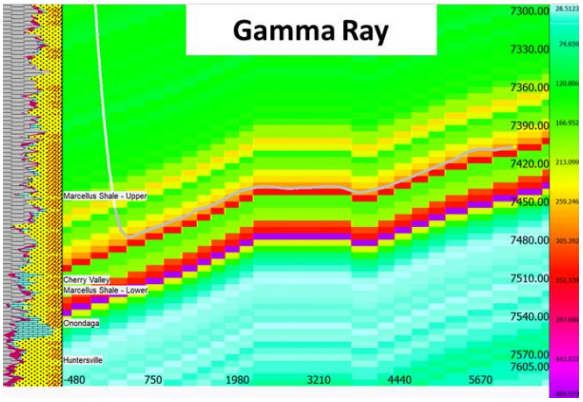

Figure 8: Structural Map - Gamma Ray Log

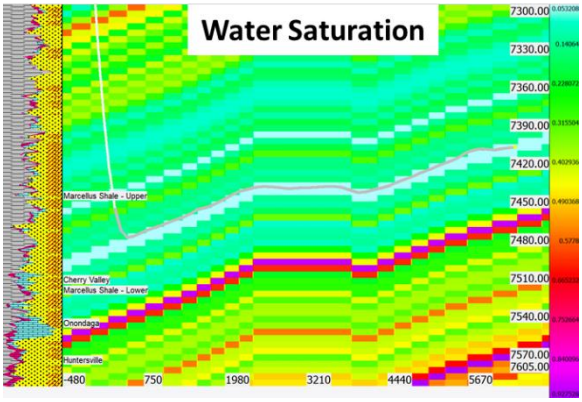

Figure 9: Structural Map - Water Saturation

This led into creating a treatment design for the well using the actual perforation and pumping schedule, with each stage designed separately. Table 4 is an example of a perforation design for a stage and Table 5 is an example of a pump schedule design for a stage.

Table 4: Example of perforation placement for a single stage.

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	13625.00	13627.00	0.42	10
4	13672.00	13674.00	0.42	10
3	13720.00	13722.00	0.42	10
2	13767.00	13769.00	0.42	10
1	13809.00	13811.00	0.42	10

Table 5: Example of stage pump schedule

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.41	SlickWater	824.60	824.60	<None>	0.00	0.00	11.82	19.90	11.66
2	1.41	4.29	HCl 7.5%	2999.99	3824.59	<None>	0.00	0.00	15.93	91.33	15.93
3	6.10	17.04	SlickWater	41986.72	45811.30	<None>	0.00	0.00	58.63	1092.02	58.58
4	23.14	4.14	SlickWater	13163.08	58974.38	100 Mesh Sand	0.24	3212.00	74.82	1408.76	74.03
5	27.28	5.13	SlickWater	14018.61	72992.99	100 Mesh Sand	0.49	10140.00	65.40	1749.92	63.98
6	32.41	6.23	SlickWater	18566.17	91559.16	100 Mesh Sand	0.74	23914.00	71.67	2207.40	69.25
7	39.04	6.23	SlickWater	23066.84	114625.99	100 Mesh Sand	1.00	46879.00	89.91	2781.34	86.04
8	45.27	9.56	SlickWater	35311.51	149937.51	100 Mesh Sand	1.50	99752.00	90.39	3679.26	84.64
9	55.23	8.11	SlickWater	28478.54	178416.05	100 Mesh Sand	1.99	156394.00	90.36	4418.69	82.86
10	63.34	6.29	SlickWater	23970.17	202386.22	40/70 White	0.53	169066.00	90.13	5003.01	88.03
11	70.03	5.04	SlickWater	18531.22	220917.44	40/70 White	0.75	182897.00	90.05	5459.26	87.08
12	75.07	5.09	SlickWater	18556.08	239473.52	40/70 White	1.00	201382.00	89.67	5921.05	85.79
13	80.16	10.10	SlickWater	36301.45	275774.97	40/70 White	1.33	249521.00	90.14	6837.51	85.02
14	90.26	4.32	SlickWater	16455.77	292230.74	<None>	0.00	249521.00	86.42	7229.26	86.43
15	94.58	7.00	Gel (WF110)	23851.14	316081.88	40/70 White	0.49	261201.00	82.93	7809.79	81.13
16	101.58	5.14	Gel (WF110)	17025.18	333107.06	40/70 White	0.74	273837.00	80.08	8228.87	77.46
17	107.12	11.51	Gel (WF110)	38269.91	371376.97	40/70 White	1.00	312035.00	80.39	9181.51	76.89
18	119.03	7.44	Gel (WF110)	24431.64	395808.61	40/70 White	1.49	348473.00	80.34	9802.81	75.22
19	126.47	12.41	Gel (WF110)	39455.71	435264.32	40/70 White	1.89	423076.00	80.44	10823.05	74.07
20	139.28	4.02	SlickWater	13021.04	448285.36	<None>	0.00	423076.00	76.56	11131.83	76.87

The model was then processed, and the results provided the fracture half-length based on proppant concentration and fracture conductivity. These results were imported into a reservoir model created using CMG.

Chapter 3.4 – Sensitivity Analysis

The actual field pressure was calculated using daily wellhead pressure and production data available in SCADA. Utilizing this data in Equation 3.4.1, the reservoir pressure could be calculated and compared to the reservoir pressure generated from CMG.

$$P_{ws} = P_{hs} \times e^{\frac{0.0375\gamma_g Z}{\bar{z}\times\bar{T}}/2} \tag{3.4.1}$$

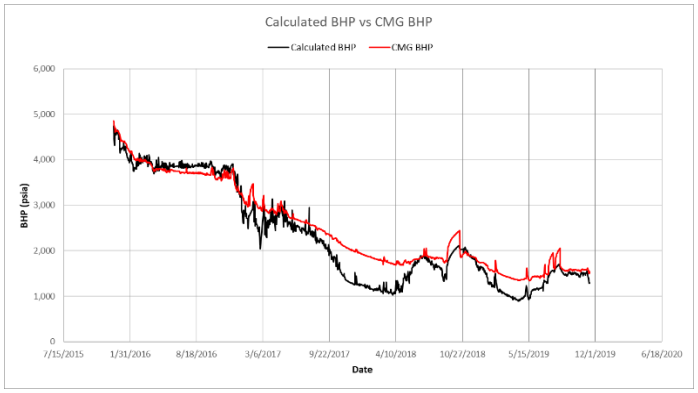

Figure 10: Actual Reservoir Pressure vs CMG Reservoir Pressure

Figure 10 shows the comparison of the calculated reservoir pressure versus the CMG modeled reservoir pressure. A sensitivity analysis was conducted for this reservoir model. Some of the key parameters tested were fissure/matrix permeability, fracture conductivity, and reservoir porosity. Table 6 represents the final

parameters used for the reservoir model. After running the sensitivity analysis, it was determined that the model created would be sufficient for this study.

Table 6: Final Reservoir Model Parameter Values

Reservoir Parameters	Values	Units
Model Dimensions (LxWxH)	8000x3000x90	ft.
Initial Reservoir Pressure	4850	psi
Initial Temperature	146	° F
Fissure Porosity	0.0001	Fraction
Matrix Porosity	0.07	Fraction
Water Saturation	0.15	Fraction
Fissure Permeability (i,j,k)	0.0025,0.0025,0.00025	md
Matrix Permeability (i,j,k)	0.000435,0.000435,0.0000435	md
Langmuir Pressure	400	psi
Langmuir Volume	0.12	gmol/lb

Chapter 3.5 - Stress Shadowing

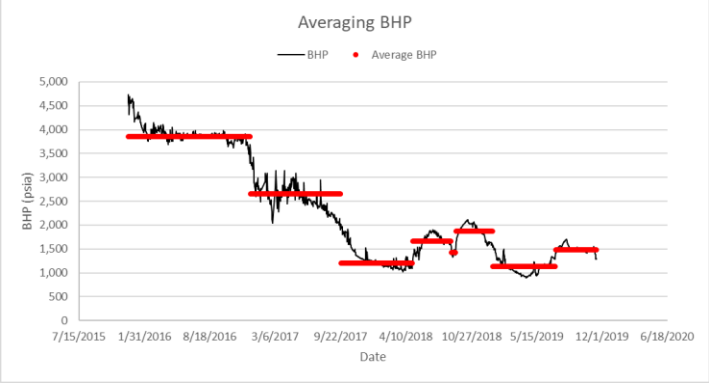

Figure 11: Averaging BHP

Once the initial reservoir model was created and met the desired match, the next step was designing the fracture model for stress shadowing and change the reservoir model from a flow constraint to a pressure constraint. Changing to a pressure constraint allows for the model to show the potential of the well when there is not a restriction on the daily flow. To help simplify the model, average pressures were used for different time periods, as seen in Figure 11.

Table 7: Average Pressures over Production Periods

Start Date	End Date	Average Pressure (psia)
12/12/2015	12/19/2016	3,850
12/20/2016	09/22/2017	2,660
09/23/2017	04/30/2018	1,196
05/01/2018	08/26/2018	1,665
08/27/2018	09/09/2018	1,421
09/10/2018	12/31/2018	1,873
01/01/2019	07/11/2019	1,129
07/12/2019	11/14/2019	1,486

Two case studies were decided upon for studying the effect of stress shadowing on production when changing the cluster spacing per stage. The first case had three designs with cluster spacing of 45ft. for each stage, 40ft. for each stage and 35ft. for each stage. To implement these options, the first thing to consider was keeping the number of clusters per stage the same and keep the same pump schedules. Then inside each stage change the location of each perforation based on the stage length as seen in Figure 12, Figure 13, and Figure 14. The second case had the same design, expect additional clusters would be added to the stage when room permitted as seen in Figure 15, Figure 16, and Figure 17.

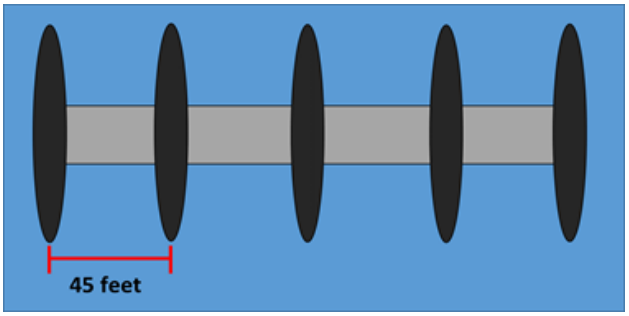

Figure 12: Case Study 1 - 45ft Cluster Spacing Design

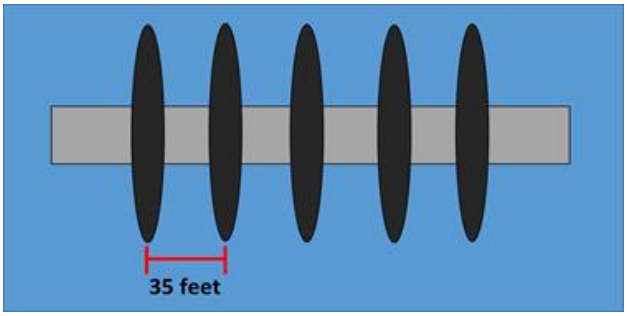

Figure 14: Case Study 1 - 35ft Cluster Spacing Design

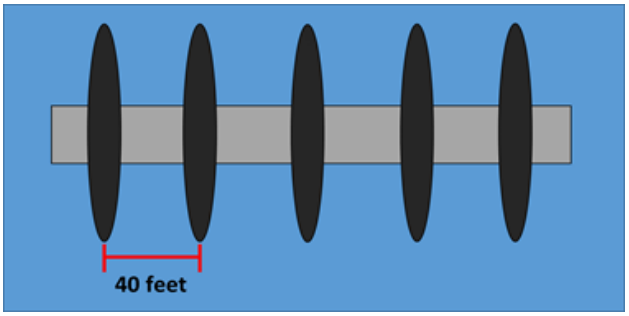

Figure 13: Case Study 1 - 40ft Cluster Spacing Design

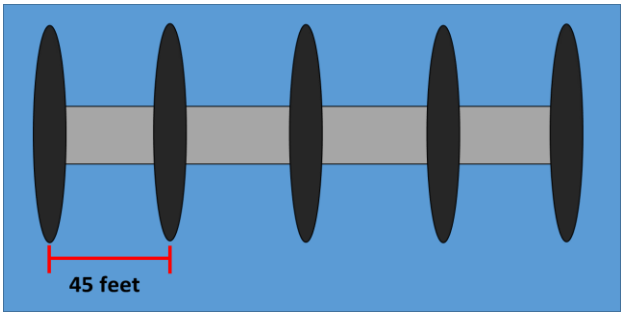

Figure 15: Case Study 2 - 45ft Cluster Spacing Design

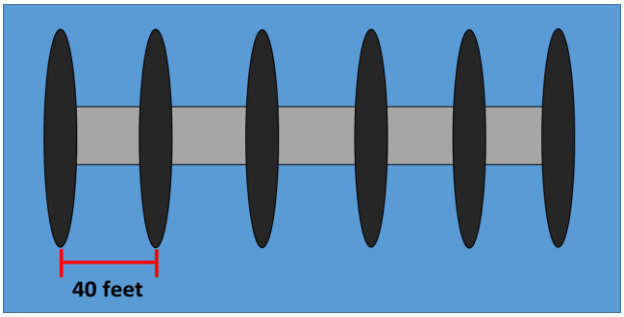

Figure 16: Case Study 2 - 40ft Cluster Spacing Design

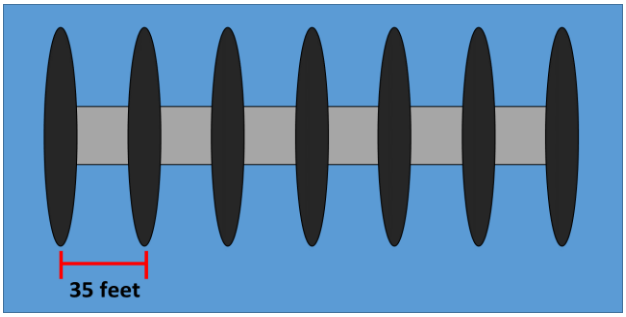

Figure 17: Case Study 2 - 35ft Cluster Spacing Design

IV. Results and Discussion

Chapter 4.1 - Initial Fracture Results

The first part of the study was generating hydraulic fractures using log data in GOHFER and studying the difference between a model implementing stress shadowing and a model without implementing stress shadowing. After the models were created and processed, the average geometrical properties of the stages were gathered and visually compared through Figure 18, Figure 19, Figure 20 and Figure 21 .

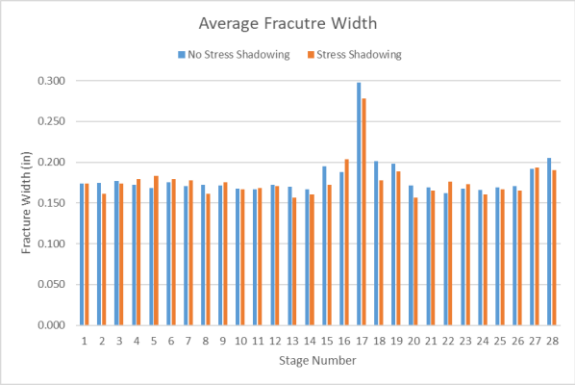

Figure 18: Comparison of Average Fracture Width for Base Model

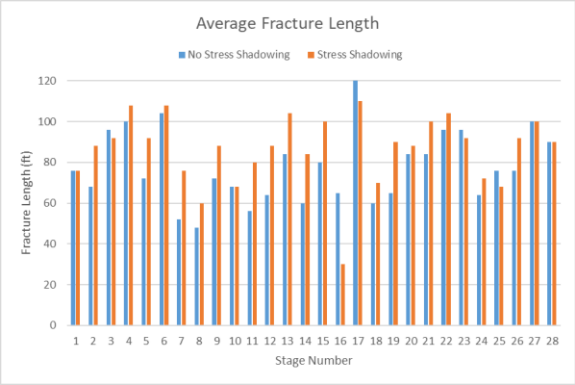

Figure 19: Comparison of Average Fracture Length for Base Model

Figure 18 shows the average fracture width of each stage's cluster and the main observation was that there is little change between the model with stress shadowing and the model without. Figure 19 shows the average fracture length of each stage's cluster and there is a clear indication that the stress shadowing model will generate longer fracture lengths compared to the model without stress shadowing. This is because of the geomechanical properties, when the in-situ stress is greater in the region the fractures will want to propagate longer, but with less of a fracture height. This can be seen through Figure 20 with the stress shadowing model having a smaller average fracture height. Another property that was considered was the average proppant concentration of each stage's cluster. This property also provided insight into how the stress shadowing affects the proppant placement.

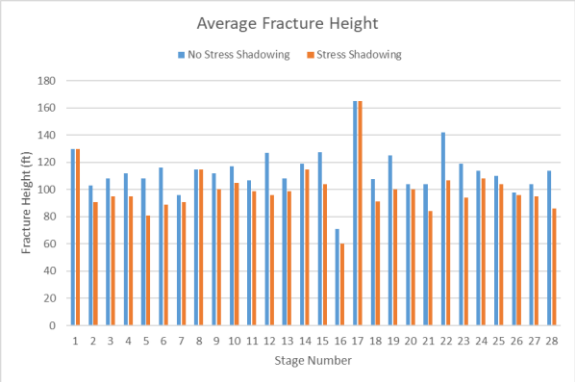

Figure 20: Comparison of Average Fracture Height for Base Model

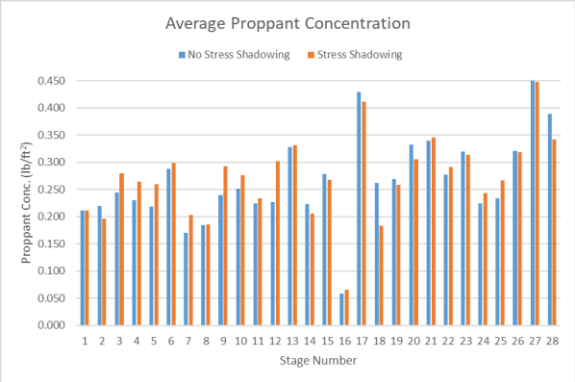

Figure 21: Comparison of Average Proppant Concentration for Base Model

Looking deeper into the results between stress shadowing and no stress shadowing models. The average fracture properties were taken for all stages as seen in Table 8. The main conclusion from this is that the fracture length (proppant cuttoff length) is generally longer when stress shadowing is implemented, yet the fracture height is reduced.

Table 8: Average Fracture Geometric Properties Comparison Base Models

Average of Fracture Geometric Properties						
Model	**Proppant Cutoff Length (ft)**	**Est Flowing Frac Length (ft)**	**Est Inf Conductivity Length (ft)**	**Fracture Height (ft)**	**Average Proppant Conc (lb/ft²)**	**Average Fracture Width (in)**
No Stress Shadowing	77.71	9.61	9.55	113.67	0.266	0.180
Stress Shadowing	86.36	9.94	9.87	99.83	0.271	0.177

Chapter 4.2 - Initial Reservoir Model

The next part of this study was to create a reservoir model that closely matched the field production/pressure. The first model created was made with a pressure constraint and tried to match field production. The results from this can be seen in Figure 22. The model created with pressure constraint did not show reliable results, so the model was adjusted to flow constraints.

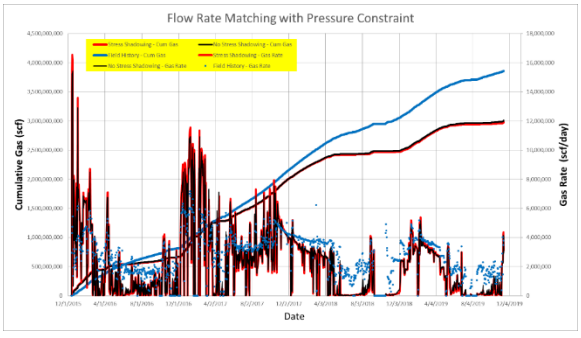

Figure 22: Production Matching with Pressure Constraint

This led into the making of a model with a flow constraint instead of a pressure constraint. The results are seen in Figure 23 with pressure matching the field and Figure 24 showing the daily production for each model and the field. While both models follow similar trends, the percent error between the field and the no stress shadowing model is 17.2% and 15.9% for the stress shadowing model.

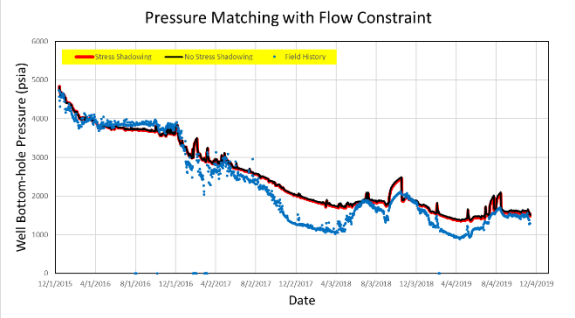

Figure 23: Pressure Matching with Flow Constraint

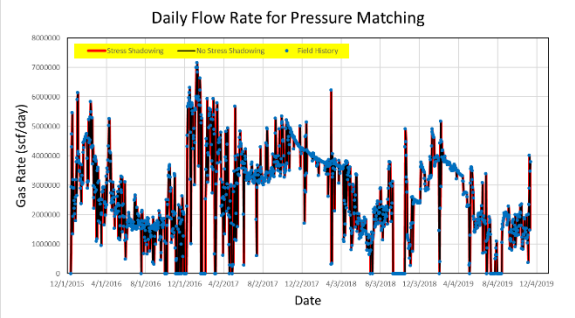

Figure 24: Daily Flow Rate for Pressure Matching

Chapter 4.3 - Cluster Spacing Fracture Model

With the base reservoir model completed, the next step was generating hydraulic fracturing models that simulated different cluster spacings while keeping other properties constant. As in the first fracture model created for the base model, the geometric properties of the stage's cluster were analyzed after the models were completed.

Chapter 4.3a – Case Study 1

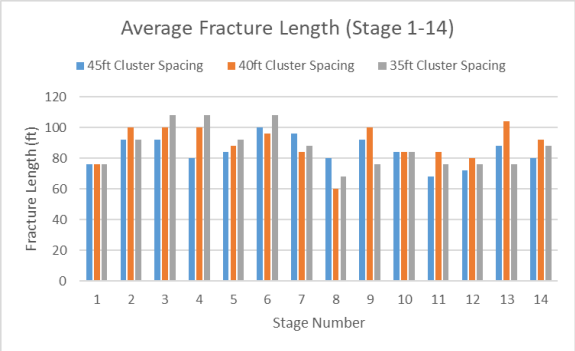

Figure 25: Comparison of Average Fracture Length for Different Cluster Spacings (Stage 1-14)

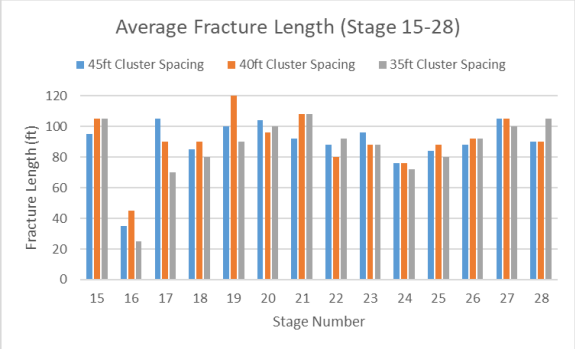

Figure 26: Comparison of Average Fracture Length for Different Cluster Spacings (Stage 15-28)

Figure 25 shows the average fracture length of each stage's cluster for stages 1-14 and Figure 26 shows the average fracture length of each stage's cluster for stages 15-28. The results show that there are minimal changes between the variation of cluster spacings and that there is no clear indication for the effect that changing the cluster spacings have on the average fracture length.

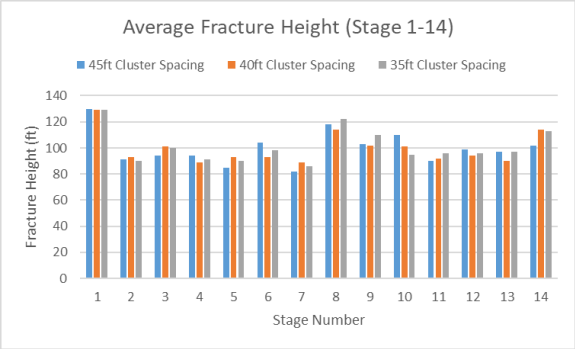

Figure 27: Comparison of Average Fracture Height for Different Cluster Spacings (Stage 1-14)

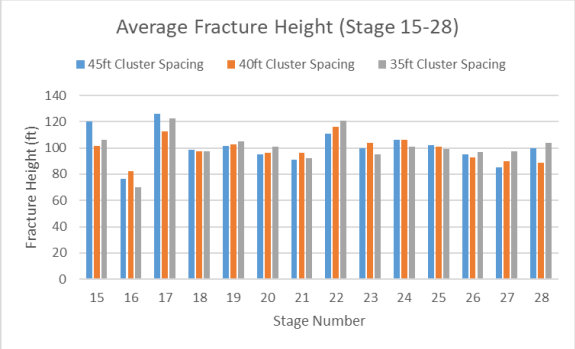

Figure 28: Comparison of Average Fracture Height for Different Cluster Spacings (Stage 15-28)

Figure 27 shows the average fracture height of each stage's cluster for stages 1-14 and Figure 28 shows the average fracture height of each stage's cluster for stages 15-28. The results show that there are minimal changes between the variation of cluster spacings and that there is no clear indication for the effect that changing the cluster spacings have on the average fracture height.

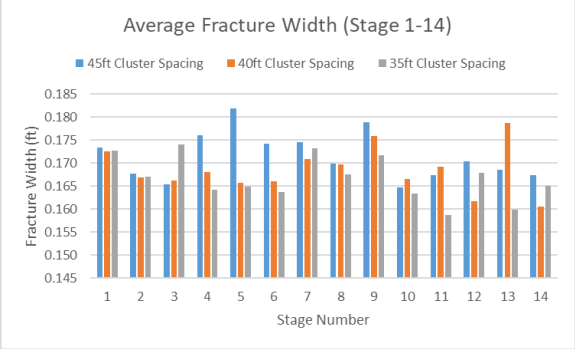

Figure 29: Comparison of Average Fracture Width for Different Cluster Spacings (Stage 1-14)

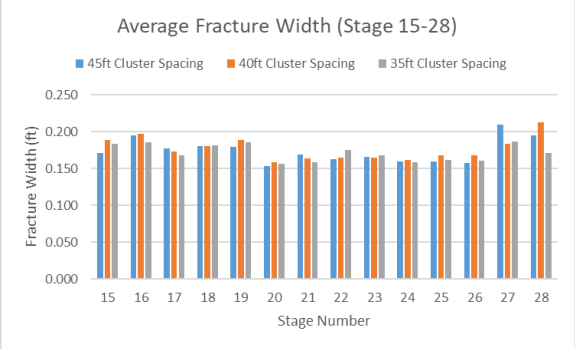

Figure 30: Comparison of Average Fracture Width for Different Cluster Spacings (Stage 15-28)

Figure 29 shows the average fracture width of each stage's cluster for stages 1-14 and Figure 30 shows the average fracture width of each stage's cluster for stages 15-28. The results show that there are minimal changes between the variation of cluster spacings and that there is no clear indication for the effect that changing the cluster spacings have on the average fracture width.

Table 9: Case Study 1 - Average Fracture Geometric Properties for Stages

Average of Fracture Geometric Properties							
Case Study	**Cluster Spacing**	**Proppant Cutoff Length (ft)**	**Est Flowing Frac Length (ft)**	**Est Inf Conductivity Length (ft)**	**Fracture Height (ft)**	**Average Proppant Conc (lb/ft²)**	**Average Fracture Width (in)**
Case 1	**45 ft**	87	9.85	9.79	100	0.259	0.173
	40 ft	90	9.91	9.85	99	0.261	0.172
	35 ft	87	9.83	9.77	101	0.255	0.169

The average fracture properties were taken for all stages as seen in Table 9.Table 8 The main conclusion from this is that the fracture geometric properties do not significantly change through this case study.

Chapter 4.3b – Case Study 2

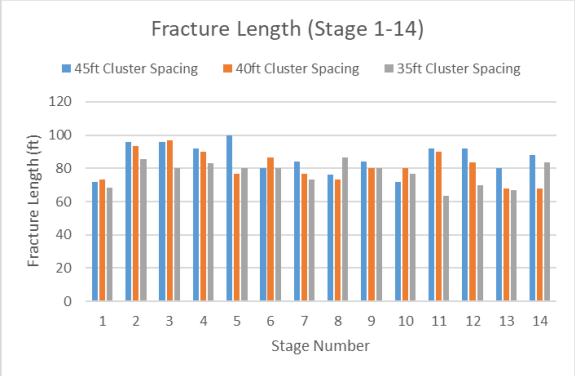

Figure 31: Comparison of Average Fracture Length for Different Cluster Spacings (Stage 1-14)

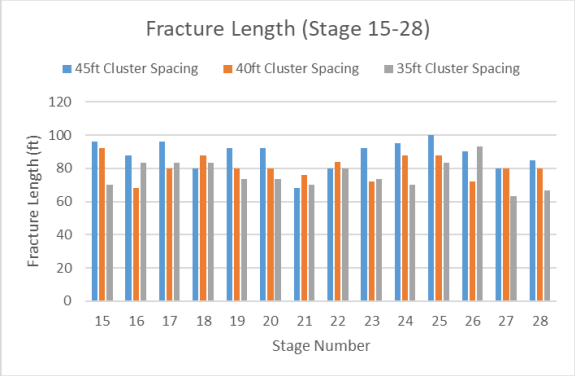

Figure 32: Comparison of Average Fracture Length for Different Cluster Spacings (Stage 15-28)

Figure 31 shows the average fracture length of each stage's cluster for stages 1-14 and Figure 32 shows the average fracture length of each stage's cluster for stages 15-28. The results show that as the cluster spacing decreases in length, the average fracture length also decreases.

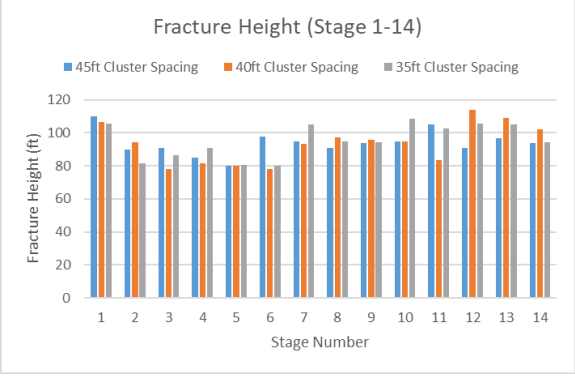

Figure 33: Comparison of Average Fracture Height for Different Cluster Spacings (Stage 1-14)

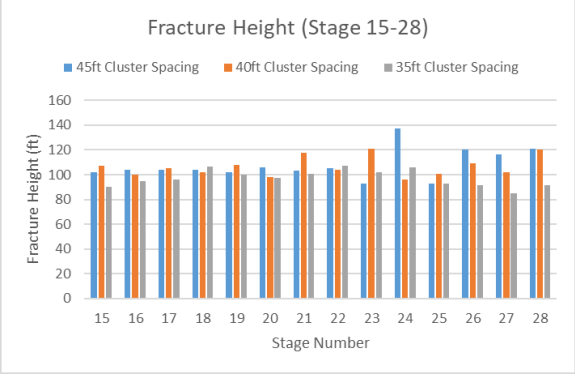

Figure 34: Comparison of Average Fracture Height for Different Cluster Spacings (Stage 15-28)

Figure 33 shows the average fracture height of each stage's cluster for stages 1-14 and Figure 34 shows the average fracture height of each stage's cluster for stages 15-28. The results show that as the cluster spacing decreases in length, the average fracture height does not significantly change between the different cluster spacings.

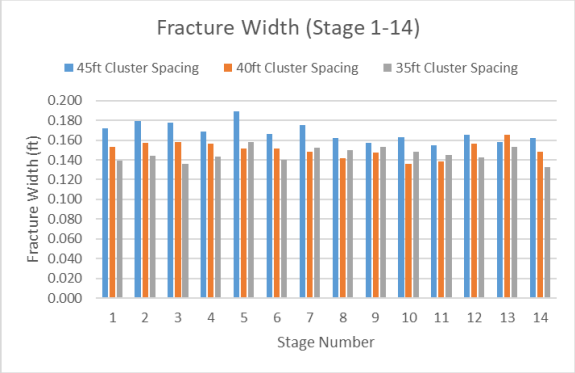

Figure 35: Comparison of Average Fracture Width for Different Cluster Spacings (Stage 1-14)

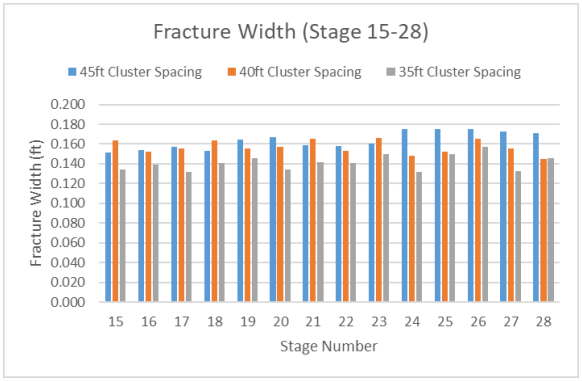

Figure 36: Comparison of Average Fracture Width for Different Cluster Spacings (Stage 15-28)

Figure 35 shows the average fracture width of each stage's cluster for stages 1-14 and Figure 36 shows the average fracture width of each stage's cluster for stages 15-28. The results show that as the cluster spacing decreases in length, the average fracture width also decreases.

Table 10: Case Study 2 - Average Fracture Geometric Properties for Stages

Average of Fracture Geometric Properties							
Case Study	**Cluster Spacing**	**Proppant Cutoff Length (ft)**	**Est Flowing Frac Length (ft)**	**Est Inf Conductivity Length (ft)**	**Fracture Height (ft)**	**Average Proppant Conc (lb/ft²)**	**Average Fracture Width (in)**
Case 2	**45 ft**	87	9.92	9.85	101	0.271	0.166
	40 ft	81	9.67	9.60	100	0.253	0.154
	35 ft	77	9.56	9.50	96	0.238	0.143

The average fracture properties were taken for all stages as seen in Table 10. The main conclusion from this is that the fracture geometric properties do not significantly change through this case study.

Chapter 4.4 - Cluster Spacing Reservoir Model

The fracture results were then imported into the CMG reservoir model and ran for the current life of the well.

Chapter 4.4a – Cast Study 1

The results are seen in Figure 37 and detailed in Table 11. The first observation was that with smaller cluster spacings, there is a larger amount of early produced gas rate. However, this rate falls off very quickly when the pressure settles in the reservoir. This leads to the understanding that if there are no changes in operation

conditions with controlling flowing pressure, the production of a well will be slightly less for smaller cluster spacings. The actual change in production when decreasing the cluster spacings is seen in Table 11 with a negative 0.55% change in production from 45ft. cluster spacing to 40ft. cluster spacing and a negative 0.67% change in production from 45ft. cluster spacing to 35ft. cluster spacing.

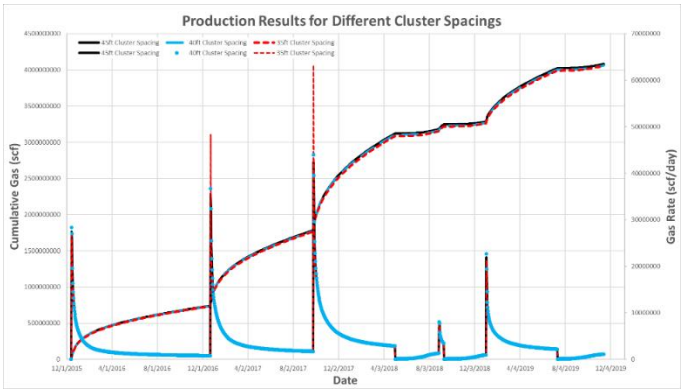

Figure 37: Case Study 1 - Production Results for Different Cluster Spacings

Table 11: Case Study 1 - Detailed Final Production for Different Cluster Spacing Models

Model	Final Production (scf)	Production Change
45ft Cluster Spacing	4,083,804,672	
40ft Cluster Spacing	4,061,278,464	-0.55%
35ft Cluster Spacing	4,056,321,536	-0.67%

Chapter 4.4a – Cast Study 2

The results are seen in Figure 38 and detailed in Table 12. The first observation was that with smaller cluster spacings, there is a larger amount of early produced gas rate. However, this rate falls off very quickly when the pressure settles in the reservoir. This case study, the smaller cluster spacing with greater number of clusters has more production, except for the 40 ft. cluster spacing design. The actual change in production when decreasing the cluster spacings is seen in Table 12 with a -0.51% change in production from 45ft. cluster spacing to 40ft. cluster spacing and a 5.77% change in production from 45ft. cluster spacing to 35ft. cluster spacing.

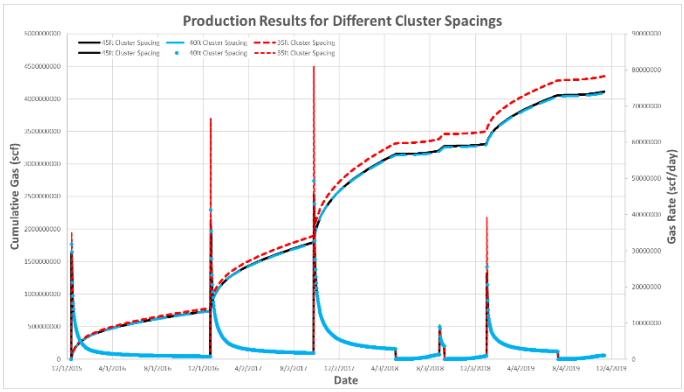

Figure 38: Case Study 2 - Production Results for Different Cluster Spacings

Table 12: Case Study 2 - Detailed Final Production for Different Cluster Spacing Models

Model	Final Production (scf)	Production Change
45ft Cluster Spacing	4,111,501,824	
40ft Cluster Spacing	4,090,338,560	-0.51%
35ft Cluster Spacing	4,348,771,328	5.77%

V. Conclusion/Recommendations

- When building a reservoir model with hydraulic fracture data, Stress Shadowing must be included for more accurate results
- Stress shadowing has a slight impact on production when only reducing the length of cluster spacing (~<1% change)
- When incorporating more clusters when reducing the cluster spacing, the overall fracture properties are reduced while production still increases because of the increase in reservoir stimulation
- This is a very complex problem that requires future studies. Some ways to improve the study would be to incorporate:
    - Engineering Design Cluster Spacing
    - Fracture Flowback
    - Applying Same Study to other Marcellus Wells

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Appendix

Fracture Model

Table 13: Fracture Model - Wellbore Constuction

Well Construction	
Overview	
Site Information	
Customer Name	WVU
Site Name	MIP
Site Location	
Coordinate System	State Plane
Easting.Ft	1834344.90
Northing.Ft	401656.60
Elevation.Ft	1058.00
UTM Zone	WV N-4701
Lattitude	N 39° 36' 6.420070"
Longitude	W 79° 58' 34.04266"
Coordinate Reference System	NAD83
Zone	N-4701
Lat.dec	39.6017834
Lon.dec	-79.9761230
Well Azimuth.°	0
Azimuth of Max Stress	0
Project Settings	
Depth Units	Feet
Well Units	Oil Field
Sea Water Depth.ft	0.00
Sea Water Gradiet.psi/ft	0.44
OBG.psi/ft	1.00
Stress Anistropy.frac	<CFOP>

Table 14: Fracture Model - Wellbore Location

Well 1 - MIP 3H			
MIP 3H		**MIP 3H - Pilot**	
Wellbore String		**Wellbore String**	
Pump down Annulus	FALSE		
CLAT.Ft	0.00		
Well Information		**Well Information**	
Well Identity	MIP 3H	Well Identity	MIP 3H
Field	Marcellus	Field	Marcellus
Site Location		**Site Location**	
Coordinate System	State Plane	Coordinate System	State Plane
Easting.Ft	1834344.90	Easting.Ft	1834344.90
Northing.Ft	401656.60	Northing.Ft	401656.60
Elevation.Ft	1058.00	Elevation.Ft	1058.00
UTM Zone	WV N-4701	UTM Zone	WV N-4701
Lattitude	N 39° 36' 6.420070"	Lattitude	N 39° 36' 6.420070"
Longitude	W 79° 58' 34.04266"	Longitude	W 79° 58' 34.04266"
Coordinate Reference System	NAD83	Coordinate Reference System	NAD83
Zone	N-4701	Zone	N-4701
Elevation Offset.Ft	0	Elevation Offset.Ft	0
North Offset.Ft	0	North Offset.Ft	0
East Offset.Ft	0	East Offset.Ft	0
Lat.dec	39.6017834	Lat.dec	39.6017834
Lon.dec	-79.976123	Lon.dec	-79.976123
Well Azimuth.°	321.361	Well Azimuth.°	0

Table 15: Fracture Model - Wellbore Tubulars

Wellbore Tubulars						
Casing	**Hole Size (in)**	**Casing Size (in)**	**Casing Grade**	**Lb / Ft**	**I.D. (in)**	**Setting Depth (ft)**
Conductor	24	20	STD	78.67	19.25	42
Surface	17.5	13.375	J-55	54.5	12.615	508
Intermediate	12.25	9.625	J-55	40	8.835	1803
Production	8.75	5.5	P-110	20	4.778	13869

Table 16: Fracture Model - Pilot Survey

Pilot Survey (Part 1)			Pilot Survey (Part 2)		
MD (ft)	Incl (°)	Azim Grid (°)	MD (ft)	Incl (°)	Azim Grid (°)
0.00	0.00	0.00	4012.00	1.62	301.18
112.00	0.42	156.90	4112.00	1.35	301.72
212.00	0.63	185.61	4212.00	1.83	295.88
312.00	0.69	182.45	4312.00	1.81	297.96
412.00	0.88	231.58	4412.00	1.87	293.98
512.00	0.28	276.25	4512.00	1.95	292.56
612.00	0.29	271.92	4612.00	1.96	286.72
712.00	0.44	270.09	4712.00	1.69	281.17
812.00	0.45	262.83	4812.00	1.84	279.39
912.00	0.41	227.92	4912.00	1.90	291.08
1012.00	0.63	235.53	5012.00	2.30	301.03
1112.00	0.82	250.18	5112.00	2.25	306.39
1212.00	0.94	258.21	5212.00	1.88	304.40
1312.00	1.08	248.39	5312.00	1.49	305.76
1412.00	1.12	246.63	5412.00	1.57	317.94
1512.00	1.14	243.23	5512.00	1.42	317.22
1612.00	1.12	216.81	5612.00	1.12	333.06
1712.00	0.67	208.16	5712.00	0.52	323.22
1812.00	0.72	248.96	5812.00	0.72	2.11
1912.00	0.70	221.83	5912.00	0.51	60.49
2012.00	0.45	231.01	6012.00	0.32	13.28
2112.00	0.39	257.87	6112.00	0.27	14.02
2212.00	0.38	279.40	6212.00	0.52	357.71
2312.00	0.83	288.12	6312.00	0.79	329.34
2412.00	1.12	285.37	6412.00	1.05	305.37
2512.00	0.95	283.79	6512.00	0.66	309.59
2612.00	0.94	287.25	6612.00	0.76	307.88
2712.00	1.09	300.82	6712.00	0.73	288.99
2812.00	1.20	282.59	6812.00	1.18	295.18
2912.00	1.33	286.36	6890.00	1.30	287.01
3012.00	1.39	289.94	6911.00	1.14	289.50
3112.00	1.47	266.38	7005.00	2.37	267.49
3212.00	1.31	297.88	7099.00	3.87	274.48
3312.00	1.57	286.93	7194.00	4.92	277.43
3412.00	1.22	288.22	7239.00	5.45	281.76
3512.00	1.43	294.24	7288.00	4.48	285.77
3612.00	1.63	293.51	7383.00	2.81	282.40
3712.00	1.30	286.90	7398.00	2.55	286.08
3812.00	1.26	285.87	7445.00	1.20	281.15
3912.00	1.45	299.91	8003.00	0.00	275.00

Table 17: Fracture Model - Lateral Survey

Treatment Survey (Part 1)			Treatment Survey (Part 2)			Treatment Survey (Part 3)			Treatment Survey (Part 4)		
MD (ft)	Incl (°)	Azim Grid (°)	MD (ft)	Incl (°)	Azim Grid (°)	MD (ft)	Incl (°)	Azim Grid (°)	MD (ft)	Incl (°)	Azim Grid (°)
0.00	0.00	0.00	4012.00	1.62	301.18	7871.00	84.42	325.25	11656.00	90.57	322.73
112.00	0.42	156.90	4112.00	1.35	301.72	7966.00	89.16	327.68	11751.00	90.84	322.39
212.00	0.63	185.61	4212.00	1.83	295.88	8061.00	91.71	325.82	11845.00	90.48	323.37
312.00	0.69	182.45	4312.00	1.81	297.96	8156.00	91.01	324.72	11940.00	91.45	324.81
412.00	0.88	231.58	4412.00	1.87	293.98	8251.00	91.54	322.60	12034.00	91.10	324.90
512.00	0.28	276.25	4512.00	1.95	292.56	8346.00	90.66	323.35	12129.00	91.28	324.96
612.00	0.29	271.92	4612.00	1.96	286.72	8441.00	91.28	324.41	12224.00	90.92	324.68
712.00	0.44	270.09	4712.00	1.69	281.17	8535.00	91.10	324.27	12319.00	91.28	324.72
812.00	0.45	262.83	4812.00	1.84	279.39	8630.00	91.28	323.32	12413.00	91.28	324.55
912.00	0.41	227.92	4912.00	1.90	291.08	8725.00	90.92	323.60	12508.00	91.01	324.35
1012.00	0.63	235.53	5012.00	2.30	301.03	8819.00	91.01	324.20	12603.00	91.36	324.98
1112.00	0.82	250.18	5112.00	2.25	306.39	8913.00	92.15	324.34	12697.00	91.28	324.43
1212.00	0.94	258.21	5212.00	1.88	304.40	9008.00	91.28	324.06	12792.00	91.19	325.29
1312.00	1.08	248.39	5312.00	1.49	305.76	9101.00	90.48	322.17	12886.00	90.92	325.39
1412.00	1.12	246.63	5412.00	1.57	317.94	9196.00	90.92	324.34	12981.00	91.80	323.86
1512.00	1.14	243.23	5512.00	1.42	317.22	9291.00	91.71	323.86	13075.00	91.98	324.14
1612.00	1.12	216.81	5612.00	1.12	333.06	9386.00	91.45	323.89	13170.00	90.75	324.86
1712.00	0.67	208.16	5712.00	0.52	323.22	9480.00	91.63	324.29	13264.00	90.75	324.73
1812.00	0.72	248.96	5812.00	0.72	2.11	9575.00	91.80	324.90	13359.00	89.78	324.91
1912.00	0.70	221.83	5912.00	0.51	60.49	9670.00	90.84	322.95	13454.00	89.69	325.04
2012.00	0.45	231.01	6012.00	0.32	13.28	9765.00	90.57	322.42	13549.00	89.96	325.61
2112.00	0.39	257.87	6112.00	0.27	14.02	9860.00	90.92	322.92	13643.00	90.92	323.98
2212.00	0.38	279.40	6212.00	0.52	357.71	9954.00	90.13	322.97	13738.00	90.04	323.07
2312.00	0.83	288.12	6259.00	1.32	179.82	10049.00	90.22	324.03	13836.00	90.75	323.29
2412.00	1.12	285.37	6355.00	9.41	200.86	10143.00	89.52	325.14	13874.00	90.75	323.29
2512.00	0.95	283.79	6450.00	10.38	213.06	10238.00	90.13	324.89			
2612.00	0.94	287.25	6544.00	17.24	195.08	10332.00	89.08	324.25			
2712.00	1.09	300.82	6639.00	21.28	186.82	10426.00	90.40	323.91			
2812.00	1.20	282.59	6733.00	19.43	208.22	10521.00	90.04	323.18			
2912.00	1.33	286.36	6828.00	23.30	227.97	10616.00	90.22	322.93			
3012.00	1.39	289.94	6922.00	27.44	243.12	10710.00	90.13	323.54			
3112.00	1.47	266.38	7017.00	29.02	262.98	10805.00	90.04	323.20			
3212.00	1.31	297.88	7111.00	31.22	272.68	10899.00	90.40	322.42			
3312.00	1.57	286.93	7206.00	36.32	281.48	10993.00	89.78	322.35			
3412.00	1.22	288.22	7302.00	40.89	291.21	11088.00	90.31	321.45			
3512.00	1.43	294.24	7396.00	48.36	296.42	11183.00	89.43	321.53			
3612.00	1.63	293.51	7491.00	54.69	305.18	11277.00	88.99	321.68			
3712.00	1.30	286.90	7586.00	60.67	315.50	11372.00	88.99	322.59			
3812.00	1.26	285.87	7680.00	65.42	320.01	11466.00	89.43	323.04			
3912.00	1.45	299.91	7776.00	74.39	322.89	11561.00	90.84	323.22			

Table 18: Fracture Model - Reservoir Properties Part 1

Treatment Configuration					
Marcellus - No Shading					
Simulation Mode:			Transverse + Longitudinal		
Est Reservoir Properties					
Zone:	Marcellus		Fraction CO2:	0.00	(fraction)
Reservoir Porosisty:	0.07	(fraction)	Fraction N2:	0.00	(fraction)
TVD at Pore Pressure:	7412.23	(ft)	Fraction H2S:	0.00	(fraction)
Fluid Gradient (Well):	0.44	(psi/ft)	OBG:	1.00	(psi/ft)
Reservoir Pore Pressure:	4850.00	(psi)	Oil Compressibility:	1.53E-06	(1/psi)
Water Saturation:	0.15	(fraction)	Water Compressibility:	2.77E-06	(1/psi)
Gas Saturation:	0.85	(fraction)	Gas Compressibility:	1.16E-04	(1/psi)
Oil Saturation:	0.00	(fraction)	Rock Compressibility:	1.25E-05	(1/psi)
Oil Specific Gravity:	35.00	(API)	Total Compressibility:	1.12E-04	(1/psi)
Gas Specific Gravity:	0.70		Gas Viscosity:	0.0284	(cp)
Reservoir Temperature:	146.00	(° F)	Oil Viscosity:	0.4814	(cp)
Reservoir Conduction Factor:	1.00		Fluid Viscosity:	0.0284	(cp)

Table 19: Fracture Model - Reservoir Properties Part 2

Stage - Reservoir Properties		
PDL Coefficient	0.0002	(1/psi)
Transverse Storage Coefficient	0.0005	(1/psi)
Rel Perm Factor	5.00	
Coefficient of Discharge	0.70	
Tortuosity Factor	0.00	(psi/Vbpm)
Tortuosity Erosion Factor	1.00	
Transverse Exponent	1.20	
Width Exponent	3.20	
BHP Datum	Grid Top	(ft)
Modulus Stiffness Factor	7.00E-06	(1/psi)

Table 20: Fracture Model - Grid Properties

Grid Properties	
Property	**Value**
Perf Type	Asymmetrical
Node Size.ft	5.00
Aspect Ratio	2.00
# Columns	50
Total Columns	738
Length.ft	2000
Transverse Columns	100
Transverse Aspect	4.00
Grid Top.ft	7300.00
Frid Bottom.ft	7600.00
Angle Around Hole.deg	45.00
Show Regional Dip	FALSE
Regional Dip	0.00

Table 21: Fracture Model - Formation Tops

Formation Tops	
Description	**TVD.FT**
Genesea	7176.00
Tully	7196.00
Hamilton	7284.00
Marcellus Shale - Upper	7454.00
Cherry Valley	7520.00
Marcellus Shale - Lower	7528.00
Onondaga	7554.00
Huntersville	7583.00

Table 22: Fracture Model - Overview Stage 1

Stage 01		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/6/2015	
Stage Length	233.00	ft
Frac Gradient	1.22	psi/ft
ISIP	5867.00	psi
5 Min ISIP	5314.00	psi
10 Min ISIP	5126.00	psi
15 Min ISIP	4986.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6995.00	psi
Breakdown Volume	10.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	10671.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	420600.00	lbs
Proppant Concentration	1805.15	lb/ft
Proppant Concentration	0.94	lb/gal
Chemical Data		
Acid % Strength	15.00	
Total Acid	6000.00	gal
Total Slickwater	7195.00	bbls
Total Linear	3405.00	bbls
Total XL	0.00	bbls
FR Amount	388.00	gal
Gel Amount	1440.00	gal or lbs
Breaker Amount	85.00	gal or lbs
Scale Inhibitor	45.00	gal
Biocide	132.00	gal

Table 23: Fracture Model - Perfs Stage 1

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	13625.00	13627.00	0.42	10
4	13672.00	13674.00	0.42	10
3	13720.00	13722.00	0.42	10
2	13767.00	13769.00	0.42	10
1	13809.00	13811.00	0.42	10

Table 24: Fracture Model - Pump Schedule Stage 1

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.41	SlickWater	824.60	824.60	<None>	0.00	0.00	11.82	19.90	11.66
2	1.41	4.29	HCl 7.5%	2999.99	3824.59	<None>	0.00	0.00	15.93	91.33	15.93
3	6.10	17.04	SlickWater	41986.72	45811.30	<None>	0.00	0.00	58.63	1092.02	58.58
4	23.14	4.14	SlickWater	13163.08	58974.38	100 Mesh Sand	0.24	3212.00	74.82	1408.76	74.03
5	27.28	5.13	SlickWater	14018.61	72992.99	100 Mesh Sand	0.49	10140.00	65.40	1749.92	63.98
6	32.41	6.23	SlickWater	18566.17	91559.16	100 Mesh Sand	0.74	23914.00	71.67	2207.40	69.25
7	39.04	6.23	SlickWater	23066.84	114625.99	100 Mesh Sand	1.00	46879.00	89.91	2781.34	86.04
8	45.27	9.56	SlickWater	35311.51	149937.51	100 Mesh Sand	1.50	99752.00	90.39	3679.26	84.64
9	55.23	8.11	SlickWater	28478.54	178416.05	100 Mesh Sand	1.99	156394.00	90.36	4418.69	82.86
10	63.34	6.29	SlickWater	23970.17	202386.22	40/70 White	0.53	169066.00	90.13	5003.01	88.03
11	70.03	5.04	SlickWater	18531.22	220917.44	40/70 White	0.75	182897.00	90.05	5459.26	87.08
12	75.07	5.09	SlickWater	18556.08	239473.52	40/70 White	1.00	201382.00	89.67	5921.05	85.79
13	80.16	10.10	SlickWater	36301.45	275774.97	40/70 White	1.33	249521.00	90.14	6837.51	85.02
14	90.26	4.32	SlickWater	16455.77	292230.74	<None>	0.00	249521.00	86.42	7229.26	86.43
15	94.58	7.00	Gel (WF110)	23851.14	316081.88	40/70 White	0.49	261201.00	82.93	7809.79	81.13
16	101.58	5.14	Gel (WF110)	17025.18	333107.06	40/70 White	0.74	273837.00	80.08	8228.87	77.46
17	107.12	11.51	Gel (WF110)	38269.91	371376.97	40/70 White	1.00	312035.00	80.39	9181.51	76.89
18	119.03	7.44	Gel (WF110)	24431.64	395808.61	40/70 White	1.49	348473.00	80.34	9802.81	75.22
19	126.47	12.41	Gel (WF110)	39455.71	435264.32	40/70 White	1.89	423076.00	80.44	10823.05	74.07
20	139.28	4.02	SlickWater	13021.04	448285.36	<None>	0.00	423076.00	76.56	11131.83	76.87

Table 25: Fracture Model - Pump Details Stage 1

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	14.3	16.0	6501	6994	3944	6010
2	7.5% HC	15.9	16.0	6789	6965	6675	6785
3	PAD	63.4	80.8	9019	9258	6674	8957
4	0.25 PPA	75.2	78.9	9187	9240	9132	9183
5	0.5 PPA	65.6	70.0	9189	9258	9106	9188
6	0.75 PPA	72.4	89.7	8889	9232	8370	8898
7	1.00 PPA	90.0	90.5	8899	9028	8835	8898
8	1.5 PPA	90.4	91.0	8856	8906	8806	8857
9	2.00 PPA	90.4	90.5	9014	9093	8902	9015
10	0.50 PPA	90.1	90.5	9026	9149	8922	9025
11	0.75 PPA	90.1	90.2	8916	8937	8898	8916
12	1.0 PPA	89.7	90.4	8905	8919	8886	8905
13	1.5 PPA	90.1	90.6	8917	9223	8829	8919
14	Flush	86.5	89.0	9173	9242	9048	9171
15	0.50 PPA	83.1	85.8	9131	9250	9016	9132
16	0.75 PPA	80.1	80.5	8923	9054	8858	8921
17	1.0 PPA	80.4	80.6	8797	8864	8743	8797
18	1.5 PPA	80.3	80.5	8684	8754	8633	8683
19	2.0 PPA	80.4	80.6	8665	8813	8566	8666
20	Flush	79.3	80.5	8865	9088	5663	8723

Table 26: Fracture Model - Overview Stage 2

Stage 02		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/7/2015	
Stage Length	223.00	ft
Frac Gradient	1.24	psi/ft
ISIP	6048.00	psi
5 Min ISIP	5311.00	psi
10 Min ISIP	5135.00	psi
15 Min ISIP	5015.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6078.00	psi
Breakdown Volume	288.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7912.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	346380.00	lbs
Proppant Concentration	1553.27	lb/ft
Proppant Concentration	1.04	lb/gal
Chemical Data		
Acid % Strength	15.00	
Total Acid	3000.00	gal
Total Slickwater	7841.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	249.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	27.00	gal
Biocide	76.00	gal

Table 27: Fracture Model - Perfs Stage 2

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	13398.00	13400.00	0.42	10
4	13443.00	13445.00	0.42	10
3	13490.00	13492.00	0.42	10
2	13532.00	13534.00	0.42	10
1	13576.00	13578.00	0.42	10

Table 28: Fracture Model - Pump Schedule Stage 2

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.32	SlickWater	594.16	594.16	<None>	0.00	0.00	9.40	14.42	9.23
2	1.32	4.49	HCl 15%	3008.39	3602.55	<None>	0.00	0.00	14.87	86.03	14.87
3	6.21	24.55	SlickWater	41981.66	45584.21	<None>	0.00	0.00	40.15	1086.55	40.12
4	31.16	3.45	SlickWater	13160.62	58744.83	100 Mesh Sand	0.24	3211.00	84.51	1403.46	83.56
5	35.01	3.51	SlickWater	13989.72	72734.55	100 Mesh Sand	0.49	10108.00	88.48	1744.12	86.52
6	38.52	5.03	SlickWater	18541.20	91275.75	100 Mesh Sand	0.74	23881.00	90.37	2200.50	87.42
7	43.55	6.22	SlickWater	23117.66	114393.41	100 Mesh Sand	0.99	46866.00	90.36	2775.77	86.45
8	50.17	9.58	SlickWater	35296.55	149689.96	100 Mesh Sand	1.50	99660.00	90.05	3673.28	84.32
9	60.15	7.28	SlickWater	25762.78	175452.74	100 Mesh Sand	2.00	151061.00	89.58	4342.14	82.15
10	67.43	6.30	SlickWater	24009.72	199462.46	40/70 White	0.53	163691.00	90.03	4927.35	87.95
11	74.13	5.05	SlickWater	18563.71	218026.17	40/70 White	0.74	177493.00	89.87	5384.18	86.95
12	79.18	5.07	SlickWater	18510.50	236536.67	40/70 White	0.99	195896.00	90.04	5844.90	86.14
13	84.25	9.08	SlickWater	32393.75	268930.41	40/70 White	1.50	244343.00	90.19	6668.64	84.45
14	93.33	14.48	SlickWater	50467.16	319397.57	40/70 White	1.93	341566.00	88.30	7975.41	81.19
15	108.21	5.09	SlickWater	12945.94	332343.51	<None>	0.00	341566.00	59.61	8282.41	59.85

Table 29: Fracture Model - Pump Details Stage 2

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.2	16.0	5552	6313	3702	5089
2	Acid 15% HC	15.0	16.0	6194	6321	6022	6187
3	PAD	70.4	81.2	8779	8946	5878	7395
4	0.25 PPA	84.6	85.7	8440	8510	8245	8434
5	0.5 PPA	88.5	90.5	8598	8702	8452	8599
6	0.75 PPA	90.4	90.5	8731	8746	8696	8732
7	1.00 PPA	90.4	90.5	8748	8765	8730	8748
8	1.50 PPA	90.1	90.5	8734	8825	8501	8731
9	2.00 PPA	89.6	91.1	8811	8920	8730	8812
10	0.50 PPA	90.0	90.1	8897	9032	8783	8896
11	0.75 PPA	89.9	90.6	8749	8783	8726	8749
12	1.00 PPA	90.0	90.2	8758	8779	8740	8758
13	1.50 PPA	90.2	91.1	8823	8892	8752	8824
14	2.00 PPA	88.5	91.1	8932	9248	8687	8936
15	Flush	64.5	74.8	9046	9258	6066	8902

Table 30: Fracture Model - Overview Stage 3

Stage 03		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/7/2015	
Stage Length	238.00	ft
Frac Gradient	1.20	psi/ft
ISIP	5703.00	psi
5 Min ISIP	5242.00	psi
10 Min ISIP	5144.00	psi
15 Min ISIP	5070.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6214.00	psi
Breakdown Volume	315.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8537.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	399320.00	lbs
Proppant Concentration	1677.82	lb/ft
Proppant Concentration	1.11	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8465.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	300.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	95.00	gal

Table 31: Fracture Model - Perfs Stage 3

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	13162.00	13164.00	0.42	10
4	13212.00	13214.00	0.42	10
3	13259.00	13261.00	0.42	10
2	13305.00	13307.00	0.42	10
1	13353.00	13355.00	0.42	10

Table 32: Fracture Model - Pump Schedule Stage 3

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.33	SlickWater	827.75	827.75	<None>	0.00	0.00	12.88	19.97	12.72
2	1.33	2.18	HCl 7.5%	1509.20	2336.95	<None>	0.00	0.00	15.62	55.90	15.62
3	3.51	3.12	SlickWater	2100.91	4437.86	<None>	0.00	0.00	15.63	105.92	15.63
4	7.03	2.18	HCl 7.5%	1509.97	5947.83	<None>	0.00	0.00	15.63	141.88	15.63
5	9.21	23.31	SlickWater	41982.75	47930.57	<None>	0.00	0.00	42.56	1142.71	42.51
6	32.52	3.31	SlickWater	13172.24	61102.81	100 Mesh Sand	0.24	3206.00	90.18	1459.84	89.18
7	36.23	3.47	SlickWater	14011.75	75114.56	100 Mesh Sand	0.49	10105.00	90.16	1800.93	88.18
8	40.10	5.03	SlickWater	18501.27	93615.83	100 Mesh Sand	0.74	23843.00	90.17	2256.29	87.23
9	45.13	6.23	SlickWater	23130.53	116746.36	100 Mesh Sand	0.99	46855.00	90.18	2831.92	86.28
10	51.36	9.57	SlickWater	35282.16	152028.52	100 Mesh Sand	1.50	99648.00	90.17	3729.06	84.43
11	61.33	8.31	SlickWater	29575.61	181604.12	100 Mesh Sand	1.99	158597.00	90.17	4496.98	82.68
12	70.04	6.31	SlickWater	23989.60	205593.73	40/70 White	0.53	171264.00	89.74	5081.75	87.65
13	76.35	5.04	SlickWater	18555.38	224149.10	40/70 White	0.74	185049.00	90.16	5538.58	87.20
14	81.39	5.07	SlickWater	18531.43	242680.54	40/70 White	1.00	203503.00	90.15	5999.83	86.23
15	86.46	11.28	SlickWater	40648.12	283328.66	40/70 White	1.49	264253.00	90.16	7033.70	84.40
16	98.14	21.11	SlickWater	72235.74	355564.41	40/70 White	1.94	404588.00	88.36	8905.44	81.19
17	119.25	4.00	SlickWater	11139.32	366703.73	<None>	0.00	404588.00	66.16	9170.08	66.31

Table 33: Fracture Model - Pump Details Stage 3

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	14.5	15.8	6409	6787	4020	6088
2	Acid 7.5% HC	15.6	15.7	6620	6746	6531	6614
3	Spacer	15.6	15.7	6415	6524	6288	6410
4	Acid 7.5% HC	15.6	15.7	6288	6312	6264	6288
5	PAD	63.6	90.3	8154	9113	6125	7347
6	0.25 PPA	90.2	90.3	8666	8676	8657	8667
7	0.5 PPA	90.2	90.2	8672	8687	8651	8672
8	0.75 PPA	90.2	90.3	8663	8693	8642	8663
9	1.00 PPA	90.2	90.3	8670	8693	8651	8670
10	1.5 PPA	90.2	90.3	8735	8822	8661	8736
11	2.0 PPA	90.2	90.3	8960	9130	8822	8963
12	.50 PPA	89.7	90.3	9138	9216	9072	9138
13	.75 PPA	90.2	90.3	9035	9091	9007	9035
14	1.0 PPA	90.2	90.3	9011	9032	8992	9011
15	1.5 PPA	90.2	90.3	9018	9055	8953	9018
16	2.0 PPA	88.4	90.3	8890	9188	8717	8890
17	Flush	67.1	82.8	8922	9229	6678	8996

Table 34: Fracture Model - Overview Stage 4

Stage 04		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/7/2015	
Stage Length	230.00	ft
Frac Gradient	1.24	psi/ft
ISIP	5978.00	psi
5 Min ISIP	5372.00	psi
10 Min ISIP	5256.00	psi
15 Min ISIP	5176.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	5940.00	psi
Breakdown Volume	280.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	9135.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440060.00	lbs
Proppant Concentration	1913.30	lb/ft
Proppant Concentration	1.15	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	9063.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	299.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	95.00	gal

Table 35: Fracture Model - Perfs Stage 4

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	12932.00	12934.00	0.42	10
4	12977.00	12979.00	0.42	10
3	13025.00	13027.00	0.42	10
2	13068.00	13070.00	0.42	10
1	13118.00	13120.00	0.42	10

Table 36: Fracture Model - Pump Schedule Stage 4

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	2.56	SlickWater	824.88	824.88	<None>	0.00	0.00	6.78	19.89	6.70
2	2.56	2.20	HCl 7.5%	1511.37	2336.25	<None>	0.00	0.00	15.43	55.89	15.42
3	5.16	3.15	SlickWater	2105.46	4441.71	<None>	0.00	0.00	15.42	106.01	15.42
4	8.31	2.20	HCl 7.5%	1512.84	5954.55	<None>	0.00	0.00	15.44	142.03	15.44
5	10.51	22.52	SlickWater	41971.85	47926.40	<None>	0.00	0.00	43.76	1142.62	43.70
6	33.43	3.31	SlickWater	13234.97	61161.36	100 Mesh Sand	0.24	3205.00	90.60	1461.22	89.61
7	37.14	3.45	SlickWater	13955.96	75117.33	100 Mesh Sand	0.49	10070.00	90.59	1800.95	88.61
8	40.59	5.02	SlickWater	18523.04	93640.36	100 Mesh Sand	0.74	23814.00	90.58	2256.86	87.62
9	46.01	6.21	SlickWater	23113.98	116754.35	100 Mesh Sand	0.99	46802.00	90.58	2832.06	86.67
10	52.22	9.54	SlickWater	35266.49	152020.84	100 Mesh Sand	1.50	99585.00	90.58	3728.81	84.82
11	62.16	7.52	SlickWater	27443.78	179464.61	100 Mesh Sand	1.99	154177.00	90.58	4441.39	83.06
12	70.08	6.28	SlickWater	24032.04	203496.65	40/70 White	0.53	166842.00	90.59	5027.23	88.48
13	76.36	5.02	SlickWater	18517.31	222013.96	40/70 White	0.75	180657.00	90.57	5483.13	87.59
14	81.38	5.06	SlickWater	18557.96	240571.92	40/70 White	1.00	199143.00	90.58	5945.08	86.64
15	86.44	9.06	SlickWater	32414.56	272986.48	40/70 White	1.49	247526.00	90.59	6769.47	84.81
16	95.50	27.41	SlickWater	95048.85	368035.34	40/70 White	2.00	437390.00	89.19	9238.47	81.75
17	123.31	1.02	SlickWater	3522.05	371557.39	40/70 White	1.47	442570.00	86.42	9327.76	81.15
18	123.31	3.29	SlickWater	12340.79	383898.18	<None>	0.00	442570.00	83.94	9620.16	84.35

Table 37: Fracture Model - Pump Details Stage 4

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	7.4	10.6	5372	6072	3933	5229
2	Acid 7.5% HC	15.4	15.5	6094	6246	6011	6089
3	Spacer	15.4	15.5	5966	6010	5948	5965
4	Acid 7.5% HC	15.4	15.5	5935	5953	5915	5934
5	PAD	90.6	91.4	8631	8951	5133	7294
6	0.25 PPA	90.6	90.8	8640	8657	8616	8640
7	0.5 PPA	90.6	90.8	8606	8632	8584	8605
8	0.75 PPA	90.6	90.7	8576	8597	8553	8577
9	1.00 PPA	90.6	90.7	8583	8594	8563	8583
10	1.5 PPA	90.6	90.7	8580	8606	8528	8580
11	2.0 PPA	90.6	90.7	8621	8709	8553	8622
12	.50 PPA	90.6	90.7	8724	8849	8633	8723
13	.75 PPA	90.6	90.7	8585	8637	8553	8584
14	1.00 PPA	90.6	90.7	8563	8587	8542	8563
15	1.5 PPA	90.6	90.7	8589	8624	8537	8590
16	2.00 PPA	89.2	90.7	8898	9195	8620	8899
17	2.5 PPA	86.4	86.5	8872	8912	8859	8875
18	Flush	85.7	86.5	8990	9138	5507	8875

Table 38: Fracture Model - Overview Stage 5

Stage 05		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/8/2015	
Stage Length	234.00	ft
Frac Gradient	#N/A	psi/ft
ISIP	#N/A	psi
5 Min ISIP	#N/A	psi
10 Min ISIP	#N/A	psi
15 Min ISIP	#N/A	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6222.00	psi
Breakdown Volume	286.00	bbls
Cut Short	X	X
Screen Out	X	X
Fluid and Proppant Data		
Total Clean Fluid	8037.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	337620.00	lbs
Proppant Concentration	1442.82	lb/ft
Proppant Concentration	1.00	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	7966.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	240.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	85.00	gal

Table 39: Fracture Model - Perfs Stage 5

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	12697.00	12699.00	0.42	10
4	12746.00	12748.00	0.42	10
3	12793.00	12795.00	0.42	10
2	12837.00	12839.00	0.42	10
1	12884.00	12886.00	0.42	10

Table 40: Fracture Model - Pump Schedule Stage 5

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.38	SlickWater	833.49	833.49	<None>	0.00	0.00	12.31	20.10	12.15
2	1.38	3.19	HCl 7.5%	2158.24	2991.73	<None>	0.00	0.00	15.49	71.49	15.49
3	3.19	21.07	Slickwater	26605.97	29597.70	<None>	0.00	0.00	29.99	704.71	30.00
4	21.07	10.11	Slickwater	33589.98	63187.68	<None>	0.00	0.00	78.68	1505.97	78.54
5	10.11	3.32	Slickwater	13204.03	76391.71	100 Mesh Sand	0.24	3206.00	89.97	1823.85	88.98
6	3.32	3.47	Slickwater	13984.39	90376.11	100 Mesh Sand	0.49	10088.00	89.98	2164.27	88.01
7	3.47	5.04	Slickwater	18521.57	108897.68	100 Mesh Sand	0.74	23830.00	89.97	2620.14	87.04
8	5.04	6.24	Slickwater	23138.27	132035.94	100 Mesh Sand	0.99	46851.00	89.97	3195.95	86.08
9	6.24	9.58	Slickwater	35264.54	167300.48	100 Mesh Sand	1.50	99616.00	89.97	4092.62	84.24
10	9.58	6.24	Slickwater	22172.59	189473.07	100 Mesh Sand	1.99	143774.00	89.95	4668.31	82.49
11	6.24	6.30	Slickwater	23989.16	213462.23	40/70 White	0.53	156401.00	89.96	5253.05	87.87
12	6.30	5.04	Slickwater	18515.14	231977.37	40/70 White	0.75	170228.00	89.97	5708.90	87.01
13	5.04	5.08	Slickwater	18551.75	250529.12	40/70 White	1.00	188712.00	89.95	6170.65	86.05
14	5.08	9.09	Slickwater	32365.25	282894.37	40/70 White	1.49	237097.00	89.96	6993.78	84.22
15	9.09	14.20	Slickwater	48579.70	331474.07	40/70 White	1.89	329111.00	87.63	8249.82	80.70
16	14.20	2.05	Slickwater	5023.83	336497.90	<None>	0.00	329111.00	56.83	8368.23	57.42

Table 41: Fracture Model - Pump Details Stage 5

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	14.5	15.5	5283	5711	3747	5044
2	7.5% HC	15.5	15.5	5936	5996	5722	5922
3	PAD	52.5	90.1	7501	8847	30	6601
4	PAD	85.7	90.1	8475	8753	4468	8194
5	0.25 PPA	90.0	90.1	8596	8630	8548	8594
6	0.5 PPA	90.0	90.1	8496	8547	8457	8495
7	0.75 PPA	90.0	90.1	8460	8480	8441	8460
8	1.00 PPA	90.0	90.1	8443	8459	8425	8443
9	1.5 PPA	90.0	90.1	8455	8490	8409	8456
10	2.0 PPA	90.0	90.1	8531	8651	8465	8533
11	.50 PPA	90.0	90.1	8768	8902	8651	8769
12	.75 PPA	90.0	90.0	8674	8709	8619	8673
13	1.0 PPA	90.0	90.1	8601	8621	8582	8601
14	1.5 PPA	90.0	90.1	8634	8701	8571	8635
15	2.00 PPA	87.9	90.1	8797	9039	8646	8797
16	Flush	53.7	72.7	8616	9498	6711	8884

Table 42: Fracture Model - Overview Stage 6

Stage 06		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/8/2015	
Stage Length	245.00	ft
Frac Gradient	1.27	psi/ft
ISIP	6205.00	psi
5 Min ISIP	5469.00	psi
10 Min ISIP	5348.00	psi
15 Min ISIP	5266.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6005.00	psi
Breakdown Volume	185.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	9544.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440180.00	lbs
Proppant Concentration	1796.65	lb/ft
Proppant Concentration	1.10	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	9473.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	350.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	95.00	gal

Table 43: Fracture Model - Perfs Stage 6

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	12452.00	12454.00	0.42	10
4	12512.00	12514.00	0.42	10
3	12558.00	12560.00	0.42	10
2	12606.00	12608.00	0.42	10
1	12650.00	12652.00	0.42	10

Table 44: Fracture Model - Pump Schedule Stage 6

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.34	SlickWater	833.56	833.56	<None>	0.00	0.00	12.83	20.10	12.67
2	1.34	4.38	HCl 7.5%	2994.18	3827.74	<None>	0.00	0.00	15.39	91.39	15.39
3	6.12	33.18	SlickWater	71354.42	75182.15	<None>	0.00	0.00	51.06	1791.55	51.02
4	39.30	3.31	SlickWater	13155.59	88337.74	100 Mesh Sand	0.24	3200.00	90.06	2108.25	89.07
5	43.01	3.48	SlickWater	14003.16	102340.90	100 Mesh Sand	0.49	10129.00	89.69	2449.06	87.74
6	46.49	5.04	SlickWater	18571.05	120911.95	100 Mesh Sand	0.74	23948.00	90.21	2906.15	87.27
7	51.53	6.23	SlickWater	23097.38	144009.33	100 Mesh Sand	1.00	46934.00	90.05	3480.95	86.15
8	58.16	9.57	SlickWater	35244.37	179253.70	100 Mesh Sand	1.50	99663.00	90.07	4377.15	84.34
9	68.13	7.54	SlickWater	27398.13	206651.82	100 Mesh Sand	1.99	154268.00	90.04	5088.49	82.57
10	76.07	6.30	SlickWater	24013.28	230665.10	40/70 White	0.53	166933.00	90.06	5673.91	87.96
11	82.37	5.03	SlickWater	18470.47	249135.56	40/70 White	0.75	180720.00	90.05	6128.64	87.08
12	87.40	5.07	SlickWater	18511.62	267647.18	40/70 White	1.00	199153.00	90.05	6589.42	86.14
13	92.47	9.09	SlickWater	32401.23	300048.41	40/70 White	1.49	247566.00	90.05	7413.42	84.31
14	101.56	15.37	SlickWater	54139.58	354187.99	40/70 White	2.00	355829.00	90.06	8819.79	82.54
15	117.33	10.23	SlickWater	34329.40	388517.39	40/70 White	2.42	438921.00	87.38	9727.11	78.72
16	127.56	4.09	SlickWater	12265.83	400783.22	<None>	0.00	438921.00	70.04	10017.76	70.37

Table 45: Fracture Model - Pump Details Stage 6

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	14.5	15.4	5497	5848	3954	5313
2	Acid 7.5% HC	15.4	15.5	5967	6002	5856	5968
3	PAD	90.0	90.8	8431	9002	5096	7173
4	0.25 PPA	90.1	90.1	8401	8424	8381	8401
5	0.5 PPA	89.7	91.0	8373	8402	8349	8372
6	0.75 PPA	90.2	91.1	8372	8388	8342	8372
7	1.00 PPA	90.0	90.1	8384	8400	8367	8384
8	1.5 PPA	90.1	90.2	8405	8456	8342	8406
9	2.0 PPA	90.0	90.2	8537	8651	8434	8539
10	.50 PPA	90.1	90.2	8650	8791	8539	8648
11	.75 PPA	90.1	90.2	8520	8549	8501	8520
12	1.0 PPA	90.0	90.2	8516	8533	8498	8516
13	1.5 PPA	90.0	90.1	8557	8641	8490	8558
14	2.00 PPA	90.1	90.2	8703	8889	8594	8704
15	2.5 PPA	87.5	90.2	8725	9142	8355	8719
16	Flush	74.6	83.7	8974	9272	6879	8919

Table 46: Fracture Model - Overview Stage 7

Stage 07		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/9/2015	
Stage Length	224.00	ft
Frac Gradient	1.22	psi/ft
ISIP	5867.00	psi
5 Min ISIP	5538.00	psi
10 Min ISIP	5418.00	psi
15 Min ISIP	5340.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6053.00	psi
Breakdown Volume	288.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	9212.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440880.00	lbs
Proppant Concentration	1968.21	lb/ft
Proppant Concentration	1.14	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	9140.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	261.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	116.00	gal

Table 47: Fracture Model - Perfs Stage 7

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	12239.00	12241.00	0.42	10
4	12285.00	12287.00	0.42	10
3	12325.00	12327.00	0.42	10
2	12367.00	12369.00	0.42	10
1	12418.00	12420.00	0.42	10

Table 48: Fracture Model - Pump Schedule Stage 7

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.03	SlickWater	401.10	401.10	<None>	0.00	0.00	9.33	9.80	9.10
2	1.03	4.47	HCl 7.5%	2999.63	3400.73	<None>	0.00	0.00	14.93	81.22	14.93
3	5.50	19.37	SlickWater	24934.54	28335.27	<None>	0.00	0.00	30.32	676.05	30.26
4	25.27	6.02	SlickWater	22016.57	50351.85	100 Mesh Sand	0.25	5434.00	87.86	1206.14	86.88
5	31.29	8.55	SlickWater	33057.66	83409.51	100 Mesh Sand	0.50	21845.00	90.27	2011.00	88.27
6	40.24	10.00	SlickWater	36676.71	120086.22	100 Mesh Sand	0.75	49247.00	90.29	2913.92	87.33
7	50.24	12.44	SlickWater	46193.70	166279.92	100 Mesh Sand	1.00	95415.00	90.30	4063.71	86.38
8	63.08	11.23	SlickWater	40351.31	206631.23	100 Mesh Sand	1.49	155737.00	90.13	5089.70	84.40
9	74.31	2.25	SlickWater	8451.24	215082.48	100 Mesh Sand	1.86	171454.00	90.31	5307.94	83.26
10	76.56	10.27	SlickWater	36589.52	251671.99	100 Mesh Sand	1.75	235554.00	90.00	6248.43	83.37
11	87.23	8.20	SlickWater	28829.24	280501.23	100 Mesh Sand	2.00	293162.00	89.84	6997.12	82.37
12	95.43	4.35	SlickWater	15566.39	296067.62	100 Mesh Sand	2.49	331924.00	90.01	7409.69	80.86
13	100.18	2.00	SlickWater	7342.86	303410.48	40/70 White	0.62	336447.00	89.77	7589.24	87.41
14	102.18	3.01	SlickWater	10966.42	314376.89	40/70 White	0.74	344590.00	89.49	7859.19	86.55
15	105.19	4.10	SlickWater	15022.64	329399.53	40/70 White	0.99	359518.00	89.74	8233.11	85.84
16	109.29	4.15	SlickWater	15014.16	344413.69	40/70 White	1.49	381853.00	89.82	8614.86	84.11
17	113.44	5.39	SlickWater	19577.39	363991.08	40/70 White	1.99	420823.00	89.99	9123.32	82.50
18	119.23	1.28	SlickWater	4981.27	368972.35	40/70 White	2.47	433107.00	89.99	9255.30	80.86
19	120.51	0.54	SlickWater	2996.07	371968.42	40/70 White	2.95	441952.00	89.97	9336.28	79.26
20	121.45	4.10	SlickWater	15068.83	387037.25	<None>	0.28	446204.00	86.83	9698.08	86.11

Table 49: Fracture Model - Pump Details Stage 7

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	12.5	15.3	5640	6489	3952	5203
2	Acid 7.5% HC	14.9	15.0	6212	6589	5937	6204
3	PAD	53.8	85.5	7549	9210	5808	6523
4	0.25 PPA	88.0	91.7	8249	8601	8026	8241
5	0.5 PPA	90.3	90.5	8247	8275	8220	8247
6	0.75 PPA	90.3	90.7	8255	8283	8222	8256
7	1.00 PPA	90.3	90.6	8286	8321	8228	8285
8	1.50 PPA	90.1	90.8	8318	8368	8215	8316
9	2.00 PPA	90.3	90.7	8342	8358	8309	8339
10	1.75 PPA	90.0	90.6	8416	8509	8311	8416
11	2.00 PPA	89.8	90.7	8541	8598	8441	8539
12	2.50 PPA	90.0	90.5	8612	8691	8528	8610
13	0.50 PPA	89.8	90.5	8717	8807	8669	8722
14	0.75 PPA	89.5	89.8	8719	8860	8535	8713
15	1.00 PPA	89.7	90.0	8529	8544	8514	8530
16	1.50 PPA	89.8	90.2	8519	8550	8475	8518
17	2.00 PPA	90.0	90.3	8568	8630	8520	8568
18	2.5 PPA	90.0	90.4	8532	8593	8447	8524
19	3.0 PPA	90.0	90.1	8410	8446	8346	8401
20	Flush	88.5	89.7	8435	8721	5531	8315

Table 50: Fracture Model - Overview Stage

Stage 08		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/9/2015	
Stage Length	222.00	ft
Frac Gradient	1.24	psi/ft
ISIP	5992.00	psi
5 Min ISIP	5624.00	psi
10 Min ISIP	5505.00	psi
15 Min ISIP	5419.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6458.00	psi
Breakdown Volume	167.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8773.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440500.00	lbs
Proppant Concentration	1984.23	lb/ft
Proppant Concentration	1.20	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8702.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	262.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	37.00	gal
Biocide	110.00	gal

Table 51: Fracture Model - Perfs Stage 8

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	12015.00	12017.00	0.42	10
4	12058.00	12060.00	0.42	10
3	12098.00	12100.00	0.42	10
2	12143.00	12145.00	0.42	10
1	12194.00	12196.00	0.42	10

Table 52: Fracture Model - Pump Schedule Stage 8

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.42	SlickWater	829.78	829.78	<None>	0.00	0.00	11.77	20.01	11.62
2	1.42	4.46	HCl 7.5%	3003.35	3833.13	<None>	0.00	0.00	15.00	91.52	15.00
3	6.28	17.39	SlickWater	24919.86	28752.99	<None>	0.00	0.00	33.70	686.24	33.62
4	24.07	5.19	SlickWater	21996.30	50749.28	100 Mesh Sand	0.25	5589.00	99.65	1216.06	98.51
5	29.26	4.00	SlickWater	16405.90	67155.18	100 Mesh Sand	0.50	13749.00	99.86	1615.51	97.65
6	33.26	4.56	SlickWater	20018.03	87173.21	100 Mesh Sand	0.74	28579.00	99.87	2108.18	96.61
7	38.22	11.32	SlickWater	46266.93	133440.13	100 Mesh Sand	1.00	74694.00	99.84	3259.63	95.51
8	49.54	12.01	SlickWater	47180.21	180620.34	100 Mesh Sand	1.50	145335.00	99.84	4459.33	93.48
9	61.55	11.41	SlickWater	45025.09	225645.43	100 Mesh Sand	1.75	224065.00	99.04	5616.42	91.76
10	73.36	7.47	SlickWater	28779.87	254425.30	100 Mesh Sand	2.00	281523.00	96.02	6363.75	88.04
11	81.23	5.46	SlickWater	20928.76	275354.06	100 Mesh Sand	2.49	333715.00	96.19	6918.44	86.41
12	87.09	1.52	SlickWater	7326.76	282680.83	40/70 White	0.62	338290.00	96.07	7097.76	93.45
13	89.01	2.52	SlickWater	11026.26	293707.08	40/70 White	0.79	347009.00	94.89	7369.77	91.58
14	91.53	3.47	SlickWater	14976.01	308683.09	40/70 White	1.00	361935.00	98.54	7742.60	94.25
15	95.40	3.52	SlickWater	15020.18	323703.28	40/70 White	1.49	384271.00	98.75	8124.44	92.49
16	99.32	5.14	SlickWater	19508.80	343212.08	40/70 White	1.99	423095.00	96.81	8631.05	88.76
17	104.46	1.44	SlickWater	6329.82	349541.90	40/70 White	2.47	438710.00	96.73	8798.71	86.95
18	106.30	1.51	SlickWater	7244.16	356786.06	40/70 White	1.34	448439.00	98.91	8981.70	93.23
19	108.21	2.58	SlickWater	11653.60	368439.65	<None>	0.00	448439.00	92.98	9257.53	93.53

Table 53: Fracture Model - Pump Details Stage 8

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.8	15.0	5470	5833	4303	5270
2	Acid 7.5% HC	15.0	15.1	6028	6106	5839	6032
3	PAD	57.2	98.2	7996	9143	6028	6965
4	0.25 PPA	99.6	100.0	8991	9089	8900	8990
5	0.5 PPA	99.9	100.0	8877	8902	8855	8878
6	0.75 PPA	99.9	100.0	8913	8948	8893	8914
7	1.00 PPA	99.8	100.0	8951	8988	8915	8952
8	1.5 PPA	99.8	100.0	9058	9150	8944	9059
9	1.75 PPA	99.1	100.0	9153	9197	9124	9153
10	2.0 PPA	96.1	98.3	9066	9200	8361	9059
11	2.5 PPA	96.2	96.6	9127	9195	9059	9127
12	.50 PPA	96.1	96.2	9139	9190	9096	9141
13	.75 PPA	94.9	96.8	9040	9219	8889	9036
14	1.0 PPA	98.5	99.2	9129	9188	9004	9132
15	1.50 PPA	98.8	99.2	9171	9203	9135	9170
16	2.00 PPA	96.8	97.9	9123	9182	9047	9122
17	2.5 PPA	96.7	96.9	8937	9074	8777	8926
18	3.0 PPA	98.8	99.3	8904	9037	8770	8914
19	Flush	95.6	99.3	9059	9167	6093	8900

Table 54: Fracture Model - Overview Stage 9

Stage 09		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/9/2015	
Stage Length	237.00	ft
Frac Gradient	1.27	psi/ft
ISIP	6210.00	psi
5 Min ISIP	5600.00	psi
10 Min ISIP	5455.00	psi
15 Min ISIP	5363.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6553.00	psi
Breakdown Volume	254.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8696.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440960.00	lbs
Proppant Concentration	1860.59	lb/ft
Proppant Concentration	1.21	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8622.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	305.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	36.00	gal
Biocide	91.00	gal

Table 55: Fracture Model - Perfs Stage 9

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	11782.00	11784.00	0.42	10
4	11828.00	11830.00	0.42	10
3	11880.00	11882.00	0.42	10
2	11925.00	11927.00	0.42	10
1	11971.00	11973.00	0.42	10

Table 56: Fracture Model - Pump Schedule Stage 9

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.29	SlickWater	830.97	830.97	<None>	0.00	0.00	13.51	20.04	13.34
2	1.29	2.18	HCl 7.5%	1513.47	2344.44	<None>	0.00	0.00	15.67	56.08	15.67
3	3.47	3.11	SlickWater	2095.94	4440.38	<None>	0.00	0.00	15.68	105.98	15.68
4	6.58	2.18	HCl 7.5%	1513.40	5953.78	<None>	0.00	0.00	15.67	142.02	15.67
5	9.16	14.31	SlickWater	24952.28	30906.06	<None>	0.00	0.00	41.02	737.51	40.93
6	23.47	5.19	SlickWater	21965.39	52871.45	100 Mesh Sand	0.25	5403.00	99.47	1266.37	98.37
7	29.06	4.20	SlickWater	17722.34	70593.79	100 Mesh Sand	0.50	14179.00	99.57	1697.86	97.38
8	33.26	4.48	SlickWater	19431.31	90025.10	100 Mesh Sand	0.74	28578.00	99.65	2176.18	96.39
9	38.14	11.33	SlickWater	46240.85	136265.94	100 Mesh Sand	1.00	74701.00	99.64	3327.05	95.32
10	49.47	10.18	SlickWater	40362.56	176628.51	100 Mesh Sand	1.50	135098.00	99.65	4353.41	93.30
11	60.05	11.49	SlickWater	44936.65	221565.15	100 Mesh Sand	1.75	213691.00	97.73	5508.31	90.54
12	71.54	7.33	SlickWater	28935.07	250500.22	100 Mesh Sand	2.00	271436.00	99.52	6259.68	91.25
13	79.27	6.19	SlickWater	23714.20	274214.42	100 Mesh Sand	2.49	330429.00	99.49	6888.10	89.39
14	85.46	1.51	SlickWater	7380.66	281595.08	40/70 White	0.62	335001.00	97.53	7068.53	94.99
15	87.37	2.51	SlickWater	11012.75	292607.83	40/70 White	0.79	343689.00	95.32	7340.20	92.00
16	90.28	3.48	SlickWater	14979.09	307586.92	40/70 White	1.00	358600.00	98.09	7712.95	93.85
17	94.16	3.51	SlickWater	15023.33	322610.26	40/70 White	1.49	380922.00	99.21	8094.90	92.91
18	98.07	4.00	SlickWater	15266.22	337876.48	40/70 White	1.99	411247.00	99.10	8491.29	90.87
19	102.07	1.24	SlickWater	5170.48	343046.96	40/70 White	2.46	423958.00	97.82	8628.24	87.93
20	103.31	2.57	SlickWater	10894.38	353941.34	40/70 White	2.39	450026.00	97.42	8915.64	87.93
21	103.31	3.12	SlickWater	11443.46	365384.80	<None>	0.00	450026.00	84.64	9186.49	85.14

Table 57: Fracture Model - Pump Details Stage 9

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	14.8	15.7	5373	5766	4017	5245
2	Acid 7.5% HC	15.7	15.7	5964	6081	5772	5972
3	spacer	15.7	15.7	6026	6057	6008	6026
4	Acid 7.5% HC	15.7	15.7	6063	6085	6041	6064
5	PAD	99.5	99.6	8995	9125	6017	7348
6	0.25 PPA	99.5	99.6	8963	9002	8919	8962
7	0.5 PPA	99.6	99.8	8883	8919	8858	8883
8	0.75 PPA	99.6	99.8	8875	8892	8857	8874
9	1.00 PPA	99.6	99.8	8901	8956	8860	8902
10	1.5 PPA	99.7	99.8	8988	9080	8907	8989
11	1.75 PPA	97.8	99.9	8965	9240	8620	8961
12	2.0 PPA	99.5	99.7	8940	8991	8889	8941
13	2.5 PPA	99.5	99.7	8980	9182	8885	8982
14	.50 PPA	97.7	99.5	9164	9195	9124	9163
15	.75 PPA	95.3	97.0	9087	9182	9018	9084
16	1.0 PPA	98.1	99.4	9075	9113	9030	9076
17	1.50 PPA	99.2	99.4	9125	9169	9095	9126
18	2.00 PPA	99.1	99.4	9157	9194	9131	9157
19	2.5 PPA	97.8	98.0	9166	9177	9147	9165
20	3.0 PPA	97.5	97.8	9151	9184	9122	9152

Table 58: Fracture Model - Overview Stage 10

Stage 10		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/9/2015	
Stage Length	227.00	ft
Frac Gradient	1.27	psi/ft
ISIP	6241.00	psi
5 Min ISIP	5730.00	psi
10 Min ISIP	5515.00	psi
15 Min ISIP	5390.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6785.00	psi
Breakdown Volume	254.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8408.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440020.00	lbs
Proppant Concentration	1938.41	lb/ft
Proppant Concentration	1.25	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8336.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	249.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	108.00	gal

Table 59: Fracture Model - Perfs Stage 10

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	11557.00	11559.00	0.42	10
4	11601.00	11603.00	0.42	10
3	11649.00	11651.00	0.42	10
2	11695.00	11697.00	0.42	10
1	11735.00	11737.00	0.42	10

Table 60: Fracture Model - Pump Schedule Stage 10

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.10	SlickWater	424.13	424.13	<None>	0.00	0.00	8.88	10.36	8.66
2	1.10	2.23	HCl 7.5%	1508.01	1932.14	<None>	0.00	0.00	15.06	46.25	15.07
3	3.33	3.19	SlickWater	2094.33	4026.47	<None>	0.00	0.00	15.04	96.12	15.03
4	6.52	2.23	HCl 7.5%	1505.63	5532.10	<None>	0.00	0.00	15.04	131.97	15.04
5	9.15	15.56	SlickWater	24913.66	30445.76	<None>	0.00	0.00	37.30	726.31	37.23
6	25.11	4.58	SlickWater	20357.81	50803.57	100 Mesh Sand	0.25	5015.00	98.74	1216.73	97.59
7	30.09	3.16	SlickWater	13464.70	64268.26	100 Mesh Sand	0.49	11598.00	100.33	1544.46	98.14
8	33.25	3.11	SlickWater	12976.67	77244.93	100 Mesh Sand	0.74	21177.00	100.32	1863.80	97.06
9	36.36	11.28	SlickWater	46229.10	123474.03	100 Mesh Sand	1.00	67211.00	100.33	3014.27	95.99
10	48.04	10.14	SlickWater	40376.26	163850.29	100 Mesh Sand	1.50	127594.00	100.32	4040.93	93.94
11	58.18	11.31	SlickWater	44955.40	208805.69	100 Mesh Sand	1.75	206153.00	100.31	5196.21	92.94
12	69.49	11.08	SlickWater	43008.49	251814.18	100 Mesh Sand	2.00	292058.00	100.32	6313.08	91.98
13	80.57	3.59	SlickWater	15078.34	266892.52	100 Mesh Sand	2.49	329608.00	100.33	6712.72	90.13
14	84.56	1.48	SlickWater	7384.30	274276.82	40/70 White	0.62	334187.00	100.32	6893.29	97.68
15	86.44	1.56	SlickWater	7882.07	282158.89	40/70 White	0.73	339979.00	100.33	7087.26	97.07
16	88.40	3.44	SlickWater	15050.22	297209.10	40/70 White	0.99	354896.00	100.32	7461.80	95.98
17	92.24	3.48	SlickWater	14994.36	312203.47	40/70 White	1.49	377215.00	100.33	7843.07	93.95
18	96.12	3.57	SlickWater	15258.19	327461.66	40/70 White	1.99	407546.00	100.31	8239.31	91.97
19	100.09	0.55	SlickWater	3474.87	330936.53	40/70 White	2.43	415979.00	100.28	8331.24	90.26
20	101.04	2.57	SlickWater	11209.52	342146.05	40/70 White	2.42	443054.00	100.34	8627.24	90.47
21	101.04	2.42	SlickWater	10930.57	353076.62	<None>	0.00	443054.00	95.78	8885.84	96.39

Table 61: Fracture Model - Pump Details Stage 10

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	11.4	15.6	5268	5778	4447	5050
2	Acid 7.5% HC	15.1	15.6	6031	6171	5787	6042
3	Spacer	15.0	15.1	6199	6212	6174	6200
4	Acid 7.5% HC	15.0	15.1	6241	6261	6214	6242
5	PAD	87.5	89.2	8729	8905	6140	7247
6	0.25 PPA	98.7	100.4	8226	8749	8106	8222
7	0.5 PPA	100.3	100.4	8107	8126	8095	8107
8	0.75 PPA	100.3	100.4	8117	8128	8106	8117
9	1.00 PPA	100.3	100.5	8134	8175	8103	8134
10	1.50 PPA	100.3	100.4	8209	8269	8154	8210
11	1.75PPA	100.3	100.5	8315	8347	8265	8315
12	2.00 PPA	100.3	100.5	8349	8382	8312	8349
13	2.50 PPA	100.3	100.4	8384	8408	8366	8385
14	0.50 PPA	100.3	100.4	8407	8448	8377	8409
15	0.75 PPA	100.3	100.4	8410	8482	8312	8406
16	1.00 PPA	100.3	100.4	8261	8315	8223	8259
17	1.50PPA	100.3	100.5	8191	8232	8158	8191
18	2.00 PPA	100.3	100.4	8171	8198	8136	8171
19	2.50 PPA	100.3	100.4	8199	8208	8187	8199
20	3.00 PPA	100.3	100.5	8180	8234	8154	8181
21	Flush	99.3	100.4	8370	8578	5706	8242

Table 62: Fracture Model - Overview Stage 11

Stage 11		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/11/2015	
Stage Length	232.00	ft
Frac Gradient	1.24	psi/ft
ISIP	6022.00	psi
5 Min ISIP	5510.00	psi
10 Min ISIP	5277.00	psi
15 Min ISIP	5116.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	5930.00	psi
Breakdown Volume	255.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8052.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440520.00	lbs
Proppant Concentration	1898.79	lb/ft
Proppant Concentration	1.30	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	7981.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	253.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	38.00	gal
Biocide	116.00	gal

Table 63: Fracture Model - Perfs Stage 11

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	11324.00	11326.00	0.42	10
4	11371.00	11373.00	0.42	10
3	11416.00	11418.00	0.42	10
2	11457.00	11459.00	0.42	10
1	11509.00	11511.00	0.42	10

Table 64: Fracture Model - Pump Schedule Stage 11

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.22	SlickWater	544.39	544.39	<None>	0.00	0.00	9.68	13.22	9.48
2	1.22	4.31	HCl 7.5%	3008.25	3552.64	<None>	0.00	0.00	15.86	84.84	15.86
3	5.53	16.44	SlickWater	24966.10	28518.73	<None>	0.00	0.00	35.60	680.54	35.52
4	22.37	3.16	SlickWater	13657.63	42176.37	100 Mesh Sand	0.24	3315.00	100.66	1009.36	99.55
5	25.53	3.26	SlickWater	14208.26	56384.63	100 Mesh Sand	0.49	10288.00	100.73	1355.21	98.53
6	29.19	1.44	SlickWater	7090.16	63474.79	100 Mesh Sand	0.73	15443.00	100.62	1529.62	97.39
7	31.03	8.36	SlickWater	34799.94	98274.73	100 Mesh Sand	0.99	50023.00	100.70	2395.65	96.35
8	39.39	10.11	SlickWater	40380.36	138655.08	100 Mesh Sand	1.50	110408.00	100.82	3422.39	94.41
9	49.50	11.33	SlickWater	45005.47	183660.55	100 Mesh Sand	1.75	189059.00	100.14	4578.97	92.78
10	61.23	13.04	SlickWater	50398.15	234058.70	100 Mesh Sand	2.00	289710.00	100.16	5887.71	91.83
11	74.27	4.16	SlickWater	16135.76	250194.47	100 Mesh Sand	2.49	329884.00	100.24	6315.39	90.04
12	78.43	1.48	SlickWater	7350.07	257544.54	40/70 White	0.62	334452.00	99.85	6495.11	97.22
13	80.31	2.43	SlickWater	11007.64	268552.18	40/70 White	0.74	342575.00	99.73	6766.06	96.47
14	83.14	3.45	SlickWater	15032.92	283585.10	40/70 White	0.99	357487.00	99.77	7140.18	95.45
15	86.59	3.48	SlickWater	14947.39	298532.48	40/70 White	1.49	379720.00	100.02	7520.24	93.66
16	90.47	3.53	SlickWater	14966.42	313498.91	40/70 White	1.99	409434.00	100.07	7908.85	91.76
17	94.40	1.00	SlickWater	3790.71	317289.62	40/70 White	2.44	418673.00	100.34	8009.19	90.26
18	95.40	2.34	SlickWater	9835.84	327125.46	40/70 White	2.14	439757.00	100.05	8265.98	91.24
19	98.14	2.45	SlickWater	11103.47	338228.93	<None>	0.00	439757.00	95.61	8528.91	96.13

Table 65: Fracture Model - Pump Details Stage 11

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	11.7	15.8	5653	6322	3754	5272
2	Acid 7.5% HC	15.9	15.9	6151	6317	6041	6147
3	PAD	94.7	100.3	8250	8689	5874	6652
4	0.25 PPA	100.6	100.9	8158	8178	8143	8159
5	0.5 PPA	100.7	100.9	8116	8168	8095	8114
6	0.75 PPA	100.6	100.9	8097	8110	8085	8097
7	1.00 PPA	100.7	100.6	8098	8111	8074	8098
8	1.50 PPA	100.8	100.4	8069	8101	8025	8069
9	1.75 PPA	100.1	100.6	8113	8183	8001	8113
10	2.00 PPA	100.2	100.7	8219	8248	8182	8219
11	2.50 PPA	100.2	100.8	8199	8229	8175	8199
12	0.50 PPA	99.9	100.8	8220	8271	8188	8222
13	0.75 PPA	99.7	99.9	8210	8309	8130	8206
14	1.00 PPA	99.8	100.2	8116	8150	8091	8115
15	1.50 PPA	100.0	100.3	8090	8118	8063	8090
16	2.00 PPA	100.1	100.5	8088	8124	8056	8088
17	2.50 PPA	100.3	100.7	8113	8125	8092	8111
18	3.00 PPA	100.1	100.7	8066	8111	8043	8067
19	Flush	98.7	99.9	8169	8434	5525	8061

Table 66: Fracture Model - Overview Stage 12

Stage 12		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/11/2015	
Stage Length	231.00	ft
Frac Gradient	1.23	psi/ft
ISIP	5898.00	psi
5 Min ISIP	5580.00	psi
10 Min ISIP	5457.00	psi
15 Min ISIP	5360.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6085.00	psi
Breakdown Volume	147.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8984.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 Resin	
Total Proppant Amount	440680.00	lbs
Proppant Concentration	1907.71	lb/ft
Proppant Concentration	1.17	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8913.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	188.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	30.00	gal
Biocide	75.00	gal

Table 67: Fracture Model - Perfs Stage 12

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	11093.00	11095.00	0.42	10
4	11140.00	11142.00	0.42	10
3	11187.00	11189.00	0.42	10
2	11230.00	11232.00	0.42	10
1	11277.00	11279.00	0.42	10

Table 68: Fracture Model - Pump Schedule Stage 12

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.54	SlickWater	826.70	826.70	<None>	0.00	0.00	10.48	19.92	10.36
2	1.54	5.06	HCl 7.5%	3003.07	3829.77	<None>	0.00	0.00	14.02	91.42	14.02
3	6.60	25.46	SlickWater	47208.62	51038.39	<None>	0.00	0.00	43.68	1216.86	43.62
4	32.46	2.35	SlickWater	10627.26	61665.65	100 Mesh Sand	0.24	2547.00	99.02	1472.67	97.95
5	35.21	3.28	SlickWater	14100.95	75766.60	100 Mesh Sand	0.49	9488.00	99.02	1815.93	96.85
6	38.49	5.10	SlickWater	20787.84	96554.44	100 Mesh Sand	0.74	24942.00	99.04	2327.62	95.80
7	43.59	11.37	SlickWater	46215.57	142770.01	100 Mesh Sand	1.00	71023.00	99.01	3477.81	94.72
8	55.36	10.22	SlickWater	40355.90	183125.91	100 Mesh Sand	1.50	131415.00	98.99	4503.98	92.69
9	65.58	11.40	SlickWater	44944.55	228070.46	100 Mesh Sand	1.75	209988.00	99.01	5659.05	91.72
10	77.38	7.34	SlickWater	28848.40	256918.86	100 Mesh Sand	2.00	267585.00	99.01	6408.20	90.78
11	85.12	8.06	SlickWater	30194.57	287113.43	100 Mesh Sand	2.51	343251.00	98.84	7208.79	88.76
12	93.18	1.49	SlickWater	7351.33	294464.76	40/70 White	0.63	347867.00	99.00	7388.63	96.35
13	95.07	2.45	SlickWater	11038.72	305503.48	40/70 White	0.78	356529.00	99.00	7660.87	95.57
14	97.52	3.47	SlickWater	15048.24	320551.72	40/70 White	0.99	371418.00	99.00	8035.40	94.70
15	101.39	3.51	SlickWater	14993.85	335545.57	40/70 White	1.49	393703.00	99.02	8416.64	92.73
16	105.30	4.49	SlickWater	18362.83	353908.39	40/70 White	1.99	430231.00	99.00	8893.50	90.77
17	110.19	1.21	SlickWater	5045.11	358953.50	40/70 White	2.46	442663.00	99.01	9027.16	88.98
18	111.40	2.03	SlickWater	7756.56	366710.06	40/70 White	2.20	459743.00	99.00	9230.11	90.09
19	113.43	2.36	SlickWater	10637.76	377347.82	<None>	0.00	459743.00	97.05	9482.44	97.42

Table 69: Fracture Model - Pump Details Stage 12

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.6	14.1	5194	5644	3952	4959
2	Acid 7.5% HC	14.0	14.1	5902	6010	5648	5906
3	PAD	69.3	99.2	7545	9105	5124	6780
4	0.25 PPA	99.0	99.2	8063	8077	8053	8062
5	0.5 PPA	99.0	99.1	8059	8083	8037	8059
6	0.75 PPA	99.0	99.2	8036	8054	8014	8035
7	1.00 PPA	99.0	99.1	8009	8052	7968	8009
8	1.5 PPA	99.0	99.1	8049	8082	8020	8062
9	1.75 PPA	99.0	99.2	8061	8102	8016	8061
10	2.00 PPA	99.0	99.1	8103	8131	8072	8103
11	2.5 PPA	98.9	100.7	8210	8297	8130	8212
12	.50 PPA	99.0	99.1	8283	8328	8254	8285
13	.75 PPA	99.0	99.1	8256	8370	8176	8252
14	1.0 PPA	99.0	99.1	8169	8200	8151	8168
15	1.50 PPA	99.0	99.1	8161	8182	8127	8161
16	2.00 PPA	99.0	99.2	8167	8190	8145	8167
17	2.5 PPA	99.0	99.1	8204	8220	8179	8207
18	3.0 PPA	99.0	99.1	8309	8394	8219	8315
19	Flush	98.6	99.1	8531	8727	5756	8424

Table 70: Fracture Model - Overview Stage 13

Stage 13		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/11/2015	
Stage Length	230.00	ft
Frac Gradient	1.24	psi/ft
ISIP	6015.00	psi
5 Min ISIP	5535.00	psi
10 Min ISIP	5424.00	psi
15 Min ISIP	5337.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6312.00	psi
Breakdown Volume	134.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7466.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	360380.00	lbs
Proppant Concentration	1566.87	lb/ft
Proppant Concentration	1.15	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	7391.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	140.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	30.00	gal
Biocide	75.00	gal

Table 71: Fracture Model - Perfs Stage 13

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	10863.00	10865.00	0.42	6
4	10909.00	10911.00	0.42	6
3	10955.00	10957.00	0.42	6
2	11000.00	11002.00	0.42	6
1	11046.00	11048.00	0.42	6

Table 72: Fracture Model - Pump Schedule Stage 13

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.47	SlickWater	828.80	828.80	<None>	0.00	0.00	11.20	19.97	11.07
2	1.47	5.05	HCl 7.5%	2993.27	3822.07	<None>	0.00	0.00	14.02	91.24	14.02
3	6.52	22.23	SlickWater	41934.85	45756.92	<None>	0.00	0.00	44.66	1090.82	44.61
4	29.15	3.27	SlickWater	12020.34	57777.25	100 Mesh Sand	0.24	2914.00	83.87	1380.18	82.96
5	32.42	3.18	SlickWater	12036.08	69813.33	100 Mesh Sand	0.49	8852.00	88.85	1673.39	86.84
6	36.00	3.55	SlickWater	15255.73	85069.06	100 Mesh Sand	0.74	20090.00	95.87	2048.86	92.74
7	39.55	4.52	SlickWater	18917.98	103987.05	100 Mesh Sand	0.99	38876.00	96.73	2519.62	92.55
8	44.47	7.35	SlickWater	28850.13	132837.18	100 Mesh Sand	1.49	81990.00	96.73	3253.19	90.58
9	52.22	6.20	SlickWater	23592.07	156429.25	100 Mesh Sand	1.99	128990.00	96.72	3865.76	88.69
10	58.42	4.45	SlickWater	18842.66	175271.91	40/70 - Treated	0.54	139121.00	96.73	4325.24	94.45
11	63.27	3.50	SlickWater	15061.69	190333.60	40/70 - Treated	0.74	150288.00	96.72	4695.99	93.55
12	67.17	3.54	SlickWater	15158.29	205491.89	40/70 - Treated	0.99	165334.00	96.73	5073.24	92.54
13	71.11	6.57	SlickWater	26431.65	231923.54	40/70 White	1.49	204820.00	96.72	5745.47	90.55
14	78.08	10.09	SlickWater	37798.28	269721.82	40/70 White	1.99	280205.00	96.73	6727.24	88.67
15	88.17	6.17	SlickWater	22627.68	292349.50	40/70 White	2.49	336542.00	95.47	7327.09	85.74
16	94.34	3.05	SlickWater	10895.43	303244.93	40/70 White	2.58	364661.00	93.94	7616.74	84.13
17	97.39	2.41	SlickWater	10371.13	313616.06	<None>	0.00	364661.00	91.69	7862.79	92.02

Table 73: Fracture Model - Pump Details Stage 13

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	12.9	14.1	5237	5554	4313	5096
2	Acid 7.5% HC	14.0	14.1	5809	5915	5562	5813
3	PAD	84.7	96.4	9135	9188	5794	7388
4	0.25 PPA	83.9	84.0	9031	9114	8965	9028
5	0.5 PPA	88.8	94.9	8832	9044	8546	8829
6	0.75 PPA	95.9	96.8	8885	8954	8813	8882
7	1.00 PPA	96.7	96.9	8791	8871	8741	8789
8	1.50 PPA	96.7	96.9	8714	8752	8688	8714
9	2.0 PPA	96.7	96.8	8713	8735	8673	8714
10	.50 PPA	96.7	96.9	8628	8714	8517	8626
11	.75 PPA	96.7	96.8	8532	8549	8514	8531
12	1.0 PPA	96.7	96.8	8527	8544	8508	8527
13	1.50 PPA	96.7	96.8	8521	8545	8489	8521
14	2.00 PPA	96.7	96.8	8569	8632	8506	8570
15	2.5 PPA	95.5	96.9	8762	9016	8609	8761
16	3.0 PPA	93.9	94.0	8563	8630	8515	8564
17	Flush	93.1	94.1	8778	8963	6630	8699

Table 74: Fracture Model - Overview Stage 14

Stage 14		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/11/2015	
Stage Length	228.00	ft
Frac Gradient	1.22	psi/ft
ISIP	5867.00	psi
5 Min ISIP	5488.00	psi
10 Min ISIP	5369.00	psi
15 Min ISIP	5273.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6905.00	psi
Breakdown Volume	233.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8788.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	437060.00	lbs
Proppant Concentration	1916.93	lb/ft
Proppant Concentration	1.18	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8724.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	225.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	85.00	gal

Table 75: Fracture Model - Perfs Stage 14

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	10639.00	10641.00	0.42	6
4	10683.00	10685.00	0.42	6
3	10731.00	10733.00	0.42	6
2	10774.00	10776.00	0.42	6
1	10822.00	10824.00	0.42	6

Table 76: Fracture Model - Pump Schedule Stage 14

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.06	SlickWater	454.02	454.02	<None>	0.00	0.00	10.06	11.07	9.83
2	1.06	4.11	HCl 7.5%	2676.38	3130.40	<None>	0.00	0.00	15.23	74.79	15.23
3	5.17	21.30	SlickWater	41964.53	45094.93	<None>	0.00	0.00	46.54	1075.33	46.47
4	26.47	3.14	SlickWater	13197.65	58292.58	100 Mesh Sand	0.23	3095.00	98.23	1392.92	97.18
5	30.01	3.25	SlickWater	13984.32	72276.90	100 Mesh Sand	0.48	9829.00	99.60	1733.21	97.45
6	33.26	4.34	SlickWater	18519.05	90795.95	100 Mesh Sand	0.74	23622.00	99.83	2189.08	96.55
7	37.60	5.46	SlickWater	23135.21	113931.16	100 Mesh Sand	0.99	46610.00	99.84	2764.81	95.52
8	43.46	8.59	SlickWater	35272.70	149203.86	100 Mesh Sand	1.49	99330.00	99.83	3661.64	93.49
9	52.45	6.13	SlickWater	23899.26	173103.12	100 Mesh Sand	1.99	146979.00	99.82	4282.19	91.53
10	58.58	5.51	SlickWater	23957.97	197061.09	40/70 - Treated	0.53	159648.00	99.83	4866.21	97.51
11	64.49	4.35	SlickWater	18590.73	215651.81	40/70 - Treated	0.74	173426.00	99.84	5323.81	96.58
12	69.24	4.37	SlickWater	18515.43	234167.25	40/70 - Treated	0.99	191816.00	99.82	5784.64	95.49
13	74.01	8.15	SlickWater	32384.38	266551.62	40/70 White	1.49	240222.00	99.83	6608.26	93.46
14	82.16	24.30	SlickWater	92406.60	358958.22	40/70 White	1.96	421088.00	97.79	9004.16	89.80
15	106.46	3.08	SlickWater	10137.75	369095.97	<None>	0.00	421088.00	76.61	9244.21	77.03

Table 77: Fracture Model - Pump Details Stage 14

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.9	15.2	5339	5774	4340	5110
2	Acid 7.5% HC	15.2	15.3	6139	6272	5782	6147
3	PAD	94.4	98.3	8779	9011	6046	7346
4	0.25 PPA	98.2	98.3	8887	8938	8861	8888
5	0.5 PPA	99.6	99.9	8831	8927	8809	8828
6	0.75 PPA	99.8	99.9	8775	8821	8748	8774
7	1.00 PPA	99.8	100.0	8717	8747	8699	8716
8	1.50 PPA	99.8	100.0	8695	8723	8652	8695
9	2.00 PPA	99.8	100.0	8704	8749	8646	8704
10	0.50 PPA	99.8	99.9	8660	8765	8539	8658
11	0.75 PPA	99.8	100.0	8518	8546	8497	8517
12	1.00 PPA	99.8	99.9	8504	8521	8492	8503
13	1.50 PPA	99.8	99.9	8513	8569	8457	8513
14	2.00 PPA	97.9	100.0	8721	9083	8396	8726
15	Flush	78.3	82.5	8950	9094	6564	8830

Table 78: Fracture Model - Overview Stage 15

Stage 15		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/12/2015	
Stage Length	186.00	ft
Frac Gradient	1.20	psi/ft
ISIP	5681.00	psi
5 Min ISIP	4909.00	psi
10 Min ISIP	4788.00	psi
15 Min ISIP	4712.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	7138.00	psi
Breakdown Volume	228.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8590.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	359960.00	lbs
Proppant Concentration	1935.27	lb/ft
Proppant Concentration	1.00	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8520.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	210.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	85.00	gal

Table 79: Fracture Model - Perfs Stage 15

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
4	10456.00	10458.00	0.42	6
3	10503.00	10505.00	0.42	6
2	10547.00	10549.00	0.42	8
1	10594.00	10596.00	0.42	6

Table 80: Fracture Model - Pump Schedule Stage 15

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.27	SlickWater	723.10	723.10	<None>	0.00	0.00	12.02	17.43	11.87
2	1.27	4.37	HCl 7.5%	2928.32	3651.42	<None>	0.00	0.00	15.10	87.15	15.10
3	6.04	22.38	SlickWater	39985.72	43637.14	<None>	0.00	0.00	42.11	1040.27	42.06
4	28.42	3.37	SlickWater	12003.11	55640.25	100 Mesh Sand	0.24	2921.00	79.90	1329.24	79.02
5	32.19	3.40	SlickWater	12035.30	67675.55	100 Mesh Sand	0.49	8831.00	79.90	1622.23	78.15
6	35.59	4.41	SlickWater	15199.52	82875.07	100 Mesh Sand	0.75	20171.00	79.90	1996.42	77.27
7	40.40	5.54	SlickWater	18941.62	101816.69	100 Mesh Sand	1.00	39043.00	79.90	2467.84	76.44
8	46.34	9.11	SlickWater	28858.10	130674.79	100 Mesh Sand	1.49	82176.00	79.90	3201.60	74.82
9	55.45	5.54	SlickWater	18157.44	148832.23	100 Mesh Sand	1.99	118344.00	79.91	3673.05	73.27
10	61.39	5.46	SlickWater	18898.98	167731.21	40/70 - Treated	0.53	128305.00	79.89	4133.75	78.03
11	67.25	4.38	SlickWater	15038.31	182769.53	40/70 - Treated	0.74	139482.00	79.90	4503.95	77.28
12	72.03	4.42	SlickWater	15087.89	197857.42	40/70 - Treated	0.99	154474.00	79.90	4879.47	76.43
13	76.45	8.25	SlickWater	26441.48	224298.90	40/70 White	1.49	193965.00	79.89	5551.91	74.80
14	85.10	7.52	SlickWater	24395.44	248694.34	40/70 White	1.80	237973.00	79.89	6180.36	73.84
15	93.02	2.58	SlickWater	9955.20	258649.54	<None>	0.00	237973.00	79.90	6417.39	79.90
16	96.00	0.07	SlickWater	391.44	259040.98	<None>	0.00	237973.00	79.87	6426.71	79.89
17	96.07	4.00	SlickWater	13130.66	272171.63	40/70 White	0.48	244308.00	79.89	6746.27	78.16
18	100.07	4.17	SlickWater	13753.96	285925.60	40/70 White	0.99	257860.00	79.90	7088.50	76.45
19	104.24	4.41	SlickWater	14717.86	300643.45	40/70 White	1.49	279731.00	79.90	7462.69	74.82
20	109.05	4.42	SlickWater	14459.54	315103.00	40/70 White	1.99	308498.00	79.90	7838.22	73.25
21	113.47	4.25	SlickWater	13310.70	328413.70	40/70 White	2.49	341587.00	79.89	8191.09	71.76
22	118.12	2.06	SlickWater	6442.87	334856.57	40/70 White	2.09	355043.00	79.90	8358.88	73.05
23	120.18	3.01	SlickWater	9904.45	344761.01	<None>	0.00	355043.00	77.91	8593.92	78.17

Table 81: Fracture Model - Pump Details Stage 15

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.4	15.1	5661	6268	4109	5452
2	Acid 7.5% HC	15.1	15.2	6420	6458	6270	6423
3	PAD	79.7	80.0	8388	8807	6147	7543
4	0.25 PPA	79.9	80.0	8444	8475	8422	8445
5	0.5 PPA	79.9	80.0	8267	8475	8154	8261
6	0.75 PPA	79.9	80.0	8115	8161	8081	8114
7	1.00 PPA	79.9	80.0	8036	8082	8007	8035
8	1.50 PPA	79.9	80.0	7958	8021	7858	7956
9	2.00 PPA	79.9	80.0	7876	7960	7780	7877
10	0.50 PPA	79.9	80.0	8042	8154	7912	8042
11	0.75 PPA	79.9	80.0	7985	8028	7956	7984
12	1.00PPA	79.9	80.0	7954	7974	7896	7952
13	1.50 PPA	79.9	80.0	7915	7975	7871	7915
14	2.00 PPA	79.9	80.0	8102	8486	7955	8106
15	Flush	79.9	80.0	8652	8761	8487	8653
16	0.75 PPA	79.9	79.9	8534	8549	8508	8499
17	0.50 PPA	79.9	80.0	8410	8500	8375	8408
18	1.00PPA	79.9	80.0	8322	8390	8275	8320
19	1.50 PPA	79.9	80.0	8197	8301	8118	8195
20	2.00 PPA	79.9	80.0	8123	8162	8079	8123
21	2.5 PPA	79.9	80.0	8170	8229	8139	8171
22	3.0 PPA	79.9	80.0	8195	8234	8131	8193
23	Flush	79.2	79.9	8427	8717	6373	8352

Table 82: Fracture Model - Overview Stage 16

Stage 16		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/12/2015	
Stage Length	178.00	ft
Frac Gradient	1.26	psi/ft
ISIP	5961.00	psi
5 Min ISIP	5024.00	psi
10 Min ISIP	4848.00	psi
15 Min ISIP	4746.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	7161.00	psi
Breakdown Volume	223.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	6137.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	188460.00	lbs
Proppant Concentration	1058.76	lb/ft
Proppant Concentration	0.73	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	6066.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	100.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	25.00	gal
Biocide	80.00	gal

Table 83: Fracture Model - Perfs Stage 16

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
4	10278.00	10280.00	0.42	6
3	10316.00	10318.00	0.42	8
2	10365.00	10367.00	0.42	6
1	10408.00	10410.00	0.42	6

Table 84: Fracture Model - Pump Schedule Stage 16

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.10	SlickWater	446.67	446.67	<None>	0.00	0.00	9.34	10.90	9.12
2	1.10	4.38	HCl 7.5%	2999.85	3446.52	<None>	0.00	0.00	15.41	82.31	15.42
3	5.48	21.24	SlickWater	41976.16	45422.67	<None>	0.00	0.00	46.75	1082.80	46.70
4	27.12	3.40	SlickWater	11984.08	57406.75	100 Mesh Sand	0.24	2921.00	78.68	1371.31	77.82
5	30.52	3.43	SlickWater	12012.71	69419.46	100 Mesh Sand	0.49	8836.00	78.68	1663.74	76.96
6	34.35	4.45	SlickWater	15183.61	84603.06	100 Mesh Sand	0.74	20121.00	78.68	2037.47	76.11
7	39.20	5.59	SlickWater	18915.40	103518.46	100 Mesh Sand	1.00	38980.00	78.68	2508.25	75.27
8	45.19	9.20	SlickWater	28882.03	132400.49	100 Mesh Sand	1.49	82155.00	78.68	3242.62	73.68
9	54.39	9.40	SlickWater	29288.48	161688.97	100 Mesh Sand	1.99	140545.00	78.67	4003.12	72.14
10	64.19	5.50	SlickWater	18823.80	180512.77	40/70 - Treated	0.53	150565.00	78.67	4462.04	76.83
11	70.09	4.43	SlickWater	15072.52	195585.29	40/70 - Treated	0.74	161787.00	78.67	4833.10	76.09
12	74.52	4.46	SlickWater	15065.20	210650.49	40/70 White	1.00	176805.00	78.67	5208.11	75.25
13	79.38	9.27	SlickWater	29357.01	240007.49	40/70 White	1.38	217304.00	78.60	5950.84	73.97
14	89.05	6.27	SlickWater	17783.73	257791.22	<None>	0.00	217304.00	65.46	6373.03	65.65

Table 85: Fracture Model - Pump Details Stage 16

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	11.9	15.6	5009	5628	3914	4759
2	Acid 7.5% HC	15.4	15.5	6196	6337	5642	6204
3	PAD	78.8	80.5	9016	9189	6183	7671
4	0.25 PPA	78.7	78.7	8963	8979	8949	8962
5	0.5 PPA	78.7	78.8	8719	8950	8615	8711
6	0.75 PPA	78.7	78.7	8538	8615	8475	8535
7	1.00 PPA	78.7	78.8	8415	8499	8353	8413
8	1.50 PPA	78.7	78.8	8285	8365	8206	8283
9	2.00 PPA	78.7	78.7	8246	8451	8189	8247
10	0.50 PPA	78.7	78.8	8614	8701	8451	8614
11	0.75PPA	78.7	78.7	8555	8600	8523	8552
12	1.00 PPA	78.7	78.7	8441	8523	8390	8439
13	1.50 PPA	78.6	78.8	8555	9241	8395	8562
14	Flush	66.5	74.5	9003	9241	5786	8950

Table 86: Fracture Model - Overview Stage 17

Stage 17		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/12/2015	
Stage Length	181.00	ft
Frac Gradient	#N/A	psi/ft
ISIP	#N/A	psi
5 Min ISIP	#N/A	psi
10 Min ISIP	#N/A	psi
15 Min ISIP	#N/A	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	7960.00	psi
Breakdown Volume	218.00	bbls
Cut Short	X	X
Screen Out	X	X
Fluid and Proppant Data		
Total Clean Fluid	6976.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	337760.00	lbs
Proppant Concentration	1866.08	lb/ft
Proppant Concentration	1.15	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	6910.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	190.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	25.00	gal
Biocide	65.00	gal

Table 87: Fracture Model - Perfs Stage 17

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
4	10090.00	10092.00	0.42	8
3	10092.00	10094.00	0.42	8
2	10134.00	10136.00	0.42	8
1	10139.00	10141.00	0.42	8

Table 88: Fracture Model - Pump Schedule Stage 17

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.19	SlickWater	549.01	549.01	<None>	0.00	0.00	10.12	13.33	9.93
2	1.19	4.23	HCl 7.5%	2786.84	3335.85	<None>	0.00	0.00	15.14	79.68	15.14
3	5.42	25.19	SlickWater	42018.75	45354.61	<None>	0.00	0.00	39.55	1080.97	39.52
4	31.01	4.24	SlickWater	12013.96	57368.57	100 Mesh Sand	0.24	2925.00	65.73	1370.20	65.01
5	35.25	5.37	SlickWater	15132.47	72501.04	100 Mesh Sand	0.49	10408.00	65.60	1738.62	64.15
6	41.02	5.02	SlickWater	15234.39	87735.43	100 Mesh Sand	0.74	21721.00	74.54	2113.83	72.06
7	46.04	5.53	SlickWater	18906.23	106641.66	100 Mesh Sand	1.00	40550.00	79.98	2584.36	76.51
8	51.57	9.10	SlickWater	28834.22	135475.88	100 Mesh Sand	1.49	83633.00	79.98	3317.49	74.89
9	61.07	6.10	SlickWater	18993.77	154469.64	100 Mesh Sand	1.99	121492.00	79.98	3810.69	73.34
10	67.17	5.44	SlickWater	18807.09	173276.73	40/70 White	0.53	131463.00	79.97	4269.18	78.10
11	73.01	4.38	SlickWater	15050.01	188326.74	40/70 White	0.74	142647.00	79.96	4639.67	77.34
12	77.39	4.43	SlickWater	15153.12	203479.86	40/70 White	0.99	157697.00	79.96	5016.80	76.49
13	82.22	8.25	SlickWater	26467.53	229947.39	40/70 White	1.49	197204.00	79.97	5689.89	74.87
14	90.47	12.16	SlickWater	37760.90	267708.29	40/70 White	2.00	272644.00	79.97	6670.82	73.29
15	103.03	8.35	SlickWater	24810.43	292518.72	40/70 White	2.29	329436.00	75.92	7322.48	68.82
16	111.38	0.35	SlickWater	559.16	293077.88	<None>	0.00	329436.00	21.63	7335.09	22.82

Table 89: Fracture Model - Pump Details Stage 17

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.8	15.1	6647	7514	3827	6004
2	Acid 7.5% HC	15.1	15.2	7454	7520	7363	7451
3	PAD	51.0	65.8	8606	9157	6989	8198
4	0.25 PPA	65.7	65.8	8889	8958	8804	8887
5	0.5 PPA	65.6	67.8	9001	9184	8799	9001
6	0.75 PPA	79.4	80.0	8751	8930	8711	8781
7	1.00 PPA	80.0	80.0	8532	8739	8356	8528
8	1.50 PPA	80.0	80.1	8199	8359	8095	8198
9	2.0 PPA	80.0	80.1	8051	8127	8002	8049
10	0.50 PPA	80.0	80.0	8005	8062	7946	8005
11	0.75 PPA	80.0	80.1	7932	7999	7901	7931
12	1.00 PPA	80.0	80.0	7871	7903	7853	7870
13	1.50 PPA	80.0	80.1	7824	7857	7794	7824
14	2.00 PPA	80.0	80.1	7863	8179	7737	7866
15	2.5 PPA	76.8	80.1	8631	9198	8151	8660
16	Flush	31.1	48.9	9086	9342	1	9154

Table 90: Fracture Model - Overview Stage 18

Stage 18		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/13/2015	
Stage Length	180.00	ft
Frac Gradient	1.30	psi/ft
ISIP	6427.00	psi
5 Min ISIP	5695.00	psi
10 Min ISIP	5393.00	psi
15 Min ISIP	5200.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6236.00	psi
Breakdown Volume	222.00	bbls
Cut Short	X	X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	6904.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	291860.00	lbs
Proppant Concentration	1621.44	lb/ft
Proppant Concentration	1.01	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	6832.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	130.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	30.00	gal
Biocide	90.00	gal

Table 91: Fracture Model - Perfs Stage 18

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
4	9912.00	9914.00	0.42	8
3	9959.00	9961.00	0.42	8
2	10002.00	10004.00	0.42	8
1	10048.00	10050.00	0.42	8

Table 92: Fracture Model - Pump Schedule Stage 18

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.50	SlickWater	295.82	295.82	<None>	0.00	0.00	8.75	7.29	8.45
2	0.50	2.23	HCl 7.5%	1508.78	1804.60	<None>	0.00	0.00	15.07	43.22	15.07
3	3.13	3.18	SlickWater	2090.69	3895.29	<None>	0.00	0.00	15.08	93.00	15.08
4	6.31	2.23	HCl 7.5%	1508.71	5404.00	<None>	0.00	0.00	15.07	128.92	15.07
5	8.54	18.18	SlickWater	41967.16	47371.16	<None>	0.00	0.00	54.67	1129.34	54.60
6	27.12	3.19	SlickWater	12004.23	59375.39	100 Mesh Sand	0.24	2908.00	87.13	1418.33	86.18
7	30.31	3.19	SlickWater	11993.11	71368.50	100 Mesh Sand	0.49	8818.00	88.04	1710.34	86.10
8	33.50	4.04	SlickWater	15155.76	86524.26	100 Mesh Sand	0.74	20050.00	91.74	2083.42	88.73
9	37.54	5.02	SlickWater	18930.03	105454.29	100 Mesh Sand	0.99	38863.00	93.59	2554.50	89.55
10	42.56	7.52	SlickWater	28956.07	134410.36	100 Mesh Sand	1.49	82038.00	93.59	3290.76	87.64
11	50.48	6.14	SlickWater	22470.44	156880.81	100 Mesh Sand	1.99	126788.00	93.60	3874.18	85.83
12	57.02	4.54	SlickWater	18807.46	175688.27	40/70 White	0.54	136887.00	93.59	4332.79	91.39
13	61.56	3.58	SlickWater	15081.78	190770.05	40/70 White	0.74	148101.00	93.60	4704.06	90.53
14	65.54	4.01	SlickWater	15104.95	205875.00	40/70 White	0.99	163113.00	93.60	5080.01	89.54
15	69.55	9.08	SlickWater	33611.13	239486.12	40/70 White	1.50	213374.00	93.60	5934.86	87.62
16	79.03	11.23	SlickWater	41117.50	280603.62	40/70 White	1.86	290055.00	93.29	6996.85	86.00
17	90.26	2.33	SlickWater	9388.12	289991.74	<None>	0.00	290055.00	87.06	7218.86	87.66

Table 93: Fracture Model - Pump Details Stage 18

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.6	15.7	5682	6459	3866	5127
2	Acid 7.5% HC	15.1	15.1	6554	6615	6477	6554
3	Spacer	15.1	15.1	6370	6508	6276	6365
4	Acid 7.5% HC	15.1	15.1	6276	6291	6265	6275
5	PAD	87.1	87.2	8764	8999	6133	7793
6	0.25 PPA	87.1	87.3	8788	8838	8709	8785
7	0.5 PPA	88.0	90.5	8473	8694	8370	8469
8	0.75 PPA	91.7	93.7	8548	8642	8462	8548
9	1.00 PPA	93.6	93.7	8578	8620	8556	8578
10	1.50 PPA	93.6	93.8	8533	8563	8504	8533
11	2.00 PPA	93.6	93.7	8564	8616	8520	8564
12	0.50 PPA	93.6	93.7	8542	8608	8485	8540
13	0.75PPA	93.6	93.7	8507	8521	8493	8507
14	1.00 PPA	93.6	93.7	8513	8524	8503	8514
15	1.50 PPA	93.6	93.8	8493	8533	8402	8492
16	2.00 PPA	93.3	93.7	8472	8873	8367	8476
17	Flush	90.6	91.7	8909	9091	6080	8755

Table 94: Fracture Model - Overview Stage 19

Stage 19		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/13/2015	
Stage Length	180.00	ft
Frac Gradient	1.24	psi/ft
ISIP	5992.00	psi
5 Min ISIP	5667.00	psi
10 Min ISIP	5555.00	psi
15 Min ISIP	5463.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6001.00	psi
Breakdown Volume	211.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7807.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	360720.00	lbs
Proppant Concentration	2004.00	lb/ft
Proppant Concentration	1.10	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	6000.00	bbls
Total Linear	1408.00	bbls
Total XL	0.00	bbls
FR Amount	105.00	gal
Gel Amount	1117.00	gal or lbs
Breaker Amount	132.00	gal or lbs
Scale Inhibitor	37.00	gal
Biocide	100.00	gal

Table 95: Fracture Model - Perfs Stage 19

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
4	9732.00	9734.00	0.42	6
3	9779.00	9781.00	0.42	6
2	9823.00	9825.00	0.42	6
1	9869.00	9871.00	0.42	6

Table 96: Fracture Model - Pump Schedule Stage 19

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.48	SlickWater	280.98	280.98	<None>	0.00	0.00	8.69	6.95	8.36
2	0.48	2.20	HCl 7.5%	1500.59	1781.57	<None>	0.00	0.00	15.31	42.68	15.31
3	3.08	3.16	SlickWater	2100.21	3881.78	<None>	0.00	0.00	15.31	92.69	15.31
4	6.24	2.20	HCl 7.5%	1500.45	5382.24	<None>	0.00	0.00	15.31	128.41	15.31
5	8.44	16.51	SlickWater	41979.97	47362.21	<None>	0.00	0.00	59.40	1129.29	59.32
6	25.35	2.59	SlickWater	12006.32	59368.53	100 Mesh Sand	0.24	2905.00	96.84	1418.19	95.82
7	28.34	3.00	SlickWater	12014.17	71382.70	100 Mesh Sand	0.49	8792.00	97.49	1710.65	95.35
8	31.34	3.47	SlickWater	15174.33	86557.03	100 Mesh Sand	0.74	20042.00	98.72	2084.14	95.50
9	35.21	4.45	SlickWater	18910.91	105467.94	100 Mesh Sand	0.99	38809.00	99.07	2554.71	94.79
10	40.06	7.23	SlickWater	28836.71	134304.65	100 Mesh Sand	1.49	81885.00	99.30	3287.89	92.99
11	47.29	5.55	SlickWater	22637.08	156941.73	100 Mesh Sand	1.99	126938.00	99.34	3875.63	91.09
12	53.24	4.39	SlickWater	18823.86	175765.59	40/70 White	0.54	137077.00	98.71	4334.63	96.38
13	58.03	3.45	SlickWater	15063.92	190829.51	40/70 White	0.74	148244.00	98.88	4705.43	95.64
14	61.48	3.48	SlickWater	15107.67	205937.18	40/70 White	0.99	163252.00	98.95	5081.45	94.66
15	65.36	14.06	SlickWater	54924.37	260861.55	40/70 White	1.50	245506.00	99.08	6478.49	92.75
16	79.42	11.40	Gel (WF110/WF120)	44428.65	305290.20	40/70 White	1.99	334089.00	98.91	7632.45	90.67
17	91.22	3.26	Gel (WF120)	12942.51	318232.71	40/70 White	2.19	362370.00	98.63	7971.09	89.75
18	94.48	2.23	SlickWater	9664.34	327897.05	<None>	0.00	362370.00	96.05	8200.00	96.55

Table 97: Fracture Model - Pump Details Stage 19

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	12.3	15.5	5108	5619	3966	4774
2	Acid 7.5% HC	15.3	15.4	5993	6062	5651	6004
3	Spacer	15.3	15.3	5979	6050	5942	5977
4	Acid 7.5% HC	15.3	15.4	5954	5977	5933	5955
5	PAD	97.2	99.7	8910	8977	5864	7773
6	0.25 PPA	96.9	97.3	8953	8988	8916	8955
7	0.5 PPA	97.5	97.6	8768	8988	8708	8762
8	0.75 PPA	98.7	100.2	8717	8790	8628	8715
9	1.00 PPA	99.1	99.4	8642	8718	8605	8641
10	1.50 PPA	99.3	99.7	8589	8610	8558	8589
11	2.00 PPA	99.3	99.8	8610	8658	8573	8611
12	0.50 PPA	98.7	99.8	8607	8672	8545	8606
13	0.75 PPA	98.9	99.1	8541	8551	8530	8541
14	1	99.0	99.3	8534	8546	8519	8533
15	1.50 PPA	99.1	99.7	8494	8598	8391	8493
16	2.00 PPA	98.9	99.4	8439	8630	8283	8440
17	2.5 PPA	98.6	98.9	8615	8644	8579	8614
18	Flush	97.9	98.7	8550	8759	5492	8442

Table 98: Fracture Model - Overview Stage 20

Stage 20		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/14/2015	
Stage Length	240.00	ft
Frac Gradient	1.22	psi/ft
ISIP	5867.00	psi
5 Min ISIP	5685.00	psi
10 Min ISIP	5630.00	psi
15 Min ISIP	5578.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6332.00	psi
Breakdown Volume	205.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7497.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	439320.00	lbs
Proppant Concentration	1830.50	lb/ft
Proppant Concentration	1.40	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	2314.00	bbls
Total Linear	5109.00	bbls
Total XL	0.00	bbls
FR Amount	250.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	29.00	gal
Biocide	85.00	gal

Table 99: Fracture Model - Perfs Stage 20

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	9504.00	9506.00	0.42	8
4	9552.00	9554.00	0.42	8
3	9594.00	9596.00	0.42	8
2	9639.00	9641.00	0.42	8
1	9685.00	9687.00	0.42	8

Table 100: Fracture Model - Pump Schedule Stage 20

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.08	SlickWater	484.54	484.54	<None>	0.00	0.00	10.40	11.79	10.18
2	1.08	2.19	HCl 7.5%	1457.47	1942.01	<None>	0.00	0.00	14.98	46.49	14.98
3	3.27	3.16	SlickWater	2056.53	3998.54	<None>	0.00	0.00	14.99	95.46	14.99
4	6.43	2.36	HCl 7.5%	1636.32	5634.86	<None>	0.00	0.00	14.98	134.42	14.98
5	9.19	15.36	SlickWater	39933.99	45568.85	<None>	0.00	0.00	61.04	1086.64	60.95
6	24.55	3.12	SlickWater	13205.08	58773.93	100 Mesh Sand	0.24	3201.00	99.34	1404.51	98.25
7	28.07	3.26	SlickWater	14012.03	72785.96	100 Mesh Sand	0.49	10102.00	99.35	1745.63	97.17
8	31.33	4.35	SlickWater	18499.38	91285.34	100 Mesh Sand	0.74	23857.00	99.35	2201.00	96.10
9	36.08	5.48	Gel(Spphire VF105)	23157.32	114442.66	100 Mesh Sand	0.99	46806.00	99.36	2777.26	95.06
10	41.56	7.14	Gel(Spphire VF105)	26578.02	141020.68	100 Mesh Sand	1.98	99509.00	95.38	3467.17	87.49
11	49.10	5.08	Gel(Spphire VF105)	18154.55	159175.23	100 Mesh Sand	2.99	153878.00	95.67	3958.26	84.20
12	54.18	5.20	Gel(Spphire VF105)	20467.79	179643.02	40/70 - Treated	1.04	175205.00	95.68	4468.56	91.37
13	59.38	9.18	Gel(Spphire VF105)	34990.35	214633.37	40/70 - Treated	1.50	227531.00	95.69	5358.48	89.58
14	68.56	9.50	Gel(Spphire VF105)	36226.00	250859.37	40/70 White	1.99	299775.00	95.69	6299.42	87.71
15	78.46	8.39	Gel(Spphire VF105)	31223.70	282083.06	40/70 White	2.48	377335.00	95.70	7127.18	85.94
16	87.25	6.42	Gel(Spphire VF105)	23925.07	306008.14	40/70 White	2.76	443466.00	95.69	7768.32	85.02
17	94.07	2.19	SlickWater	9051.07	315059.21	<None>	0.00	443466.00	92.54	7982.69	93.02

Table 101: Fracture Model - Pump Details Stage 20

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.4	15.0	5398	5692	4440	5177
2	Acid 7.5% HC	15.0	15.0	5911	6021	5702	5920
3	Spacer	15.0	15.0	6021	6039	6011	6021
4	Acid 7.5% HC	15.0	15.0	6029	6054	6012	6030
5	PAD	98.6	99.5	8212	8536	5967	7425
6	0.25 PPA	99.3	99.4	8594	8680	8529	8596
7	0.5 PPA	99.3	99.5	8593	8634	8564	8592
8	0.75 PPA	99.4	99.5	8561	8585	8535	8560
9	1.00 PPA	99.4	99.5	8489	8537	8452	8488
10	2.00 PPA	95.5	99.5	8255	8459	8003	8250
11	3.0 PPA	95.7	95.8	8287	8324	8245	8287
12	1.0 PPA	95.7	95.9	8215	8320	8135	8213
13	1.50 PPA	95.7	95.9	8127	8163	8095	8127
14	2.0 PPA	95.7	95.9	8112	8145	8065	8112
15	2.5 PPA	95.7	95.9	8140	8176	8087	8141
16	3.0 PPA	95.7	95.8	8219	8331	8159	8221
17	Flush	94.8	95.8	8299	8471	5405	8176

Table 102: Fracture Model - Overview Stage 21

Stage 21		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/14/2015	
Stage Length	218.00	ft
Frac Gradient	1.22	psi/ft
ISIP	5898.00	psi
5 Min ISIP	5654.00	psi
10 Min ISIP	5592.00	psi
15 Min ISIP	5513.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6506.00	psi
Breakdown Volume	197.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7279.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	441000.00	lbs
Proppant Concentration	2022.94	lb/ft
Proppant Concentration	1.44	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	3356.00	bbls
Total Linear	3851.00	bbls
Total XL	0.00	bbls
FR Amount	306.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	41.00	gal
Biocide	90.00	gal

Table 103: Fracture Model - Perfs Stage 21

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	9271.00	9273.00	0.42	8
4	9318.00	9320.00	0.42	8
3	9365.00	9367.00	0.42	8
2	9410.00	9412.00	0.42	8
1	9445.00	9447.00	0.42	8

Table 104: Fracture Model - Pump Schedule Stage 21

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.23	SlickWater	646.24	646.24	<None>	0.00	0.00	11.31	15.64	11.12
2	1.23	2.19	HCl 7.5%	1457.19	2103.43	<None>	0.00	0.00	14.98	50.34	14.98
3	3.42	3.20	SlickWater	2097.62	4201.05	<None>	0.00	0.00	14.98	100.28	14.98
4	7.02	2.14	HCl 7.5%	1404.76	5605.81	<None>	0.00	0.00	14.98	133.73	14.98
5	9.16	8.22	SlickWater	12016.06	17621.87	<None>	0.00	0.00	34.34	421.01	34.19
6	17.38	1.45	SlickWater	3578.61	21200.49	<None>	0.00	0.00	47.87	504.79	48.69
7	19.23	7.00	SlickWater	24547.68	45748.17	<None>	0.00	0.00	83.71	1090.77	83.50
8	26.23	3.30	SlickWater	13221.68	58969.84	100 Mesh Sand	0.24	3201.00	90.93	1409.01	89.94
9	29.53	3.29	SlickWater	13994.68	72964.53	100 Mesh Sand	0.49	10090.00	97.85	1749.87	95.66
10	33.22	4.34	SlickWater	18485.47	91450.00	100 Mesh Sand	0.74	23838.00	99.64	2204.88	96.38
11	37.56	5.47	SlickWater	23161.20	114611.20	100 Mesh Sand	0.99	46791.00	99.66	2781.25	95.35
12	43.43	6.54	Gel(Spphire VF105)	26487.25	141098.45	100 Mesh Sand	1.99	99411.00	99.66	3468.88	91.40
13	50.37	4.50	Gel(Spphire VF105)	17806.94	158905.39	100 Mesh Sand	2.99	152724.00	99.66	3950.56	87.72
14	55.27	5.08	SlickWater	20519.03	179424.42	40/70 White	1.04	174137.00	99.66	4462.15	95.17
15	60.35	4.33	Gel(Spphire VF105)	17833.41	197257.84	40/70 White	1.49	200685.00	99.66	4915.60	93.32
16	65.08	9.27	Gel(Spphire VF105)	36256.01	233513.85	40/70 White	1.99	272854.00	99.65	5857.33	91.35
17	74.35	8.17	Gel(Spphire VF105)	31130.47	264644.32	40/70 White	2.49	350486.00	99.65	6682.79	89.48
18	82.52	8.44	Gel(Spphire VF105)	32267.88	296912.19	40/70 White	2.92	444722.00	99.65	7553.07	87.97
19	91.36	2.14	SlickWater	9005.08	305917.27	<None>	0.00	444722.00	95.26	7765.82	96.00

Table 105: Fracture Model - Pump Details Stage 21

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.7	15.0	5385	5640	4602	5242
2	Acid 7.5% HC	15.0	15.0	5752	5821	5644	5757
3	spacer	15.0	15.0	5824	5840	5816	5824
4	Acid 7.5% HC	15.0	15.0	5843	5881	5823	5845
5	PAD	50.3	85.9	7670	8513	5838	6918
6	Stepdown	61.6	86.1	7242	8300	5266	6712
7	PAD	87.6	91.1	8500	8638	5280	8378
8	0.25 PPA	91.0	91.0	8488	8519	8417	8485
9	0.5 PPA	97.8	99.7	8658	8740	8417	8659
10	0.75 PPA	99.6	99.8	8667	8703	8627	8666
11	1.00 PPA	99.7	99.8	8605	8629	8572	8604
12	2.00 PPA	99.7	99.8	8550	8595	8515	8550
13	3.0 PPA	99.6	99.8	8518	8550	8469	8518
14	1.0 PPA	99.7	99.9	8475	8546	8412	8473
15	1.50 PPA	99.7	99.8	8348	8412	8308	8347
16	2.00 PPA	99.7	99.8	8325	8353	8295	8325
17	2.50 PPA	99.7	99.8	8315	8331	8295	8315
18	3.0 PPA	99.6	99.8	8326	8400	8295	8327
19	Flush	98.9	99.7	8424	8597	5444	8279

Table 106: Fracture Model - Overview Stage 22

Stage 22		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/14/2015	
Stage Length	220.00	ft
Frac Gradient	1.25	psi/ft
ISIP	6022.00	psi
5 Min ISIP	5771.00	psi
10 Min ISIP	5604.00	psi
15 Min ISIP	5498.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6837.00	psi
Breakdown Volume	195.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	10779.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	439940.00	lbs
Proppant Concentration	1999.73	lb/ft
Proppant Concentration	0.97	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8284.00	bbls
Total Linear	2423.00	bbls
Total XL	0.00	bbls
FR Amount	140.00	gal
Gel Amount	1843.00	gal or lbs
Breaker Amount	88.00	gal or lbs
Scale Inhibitor	55.00	gal
Biocide	128.00	gal

Table 107: Fracture Model - Perfs Stage 22

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	9051.00	9053.00	0.42	8
4	9087.00	9089.00	0.42	8
3	9136.00	9138.00	0.42	8
2	9183.00	9185.00	0.42	8
1	9227.00	9229.00	0.42	8

Table 108: Fracture Model - Pump Schedule Stage 22

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.52	SlickWater	325.50	325.50	<None>	0.00	0.00	9.23	8.00	8.94
2	0.52	2.22	HCl 7.5%	1506.26	1831.76	<None>	0.00	0.00	15.15	43.86	15.15
3	2.22	3.18	Slickwater	2100.49	3932.25	<None>	0.00	0.00	15.16	93.87	15.16
4	3.18	2.21	HCl 7.5%	1495.27	5427.52	<None>	0.00	0.00	15.15	129.47	15.15
5	2.21	16.15	Slickwater	41916.43	47343.94	<None>	0.00	0.00	61.50	1128.77	61.42
6	16.15	3.19	Slickwater	13265.14	60609.08	100 Mesh Sand	0.24	3214.00	96.32	1448.25	95.23
7	3.19	3.26	Slickwater	14009.94	74619.03	100 Mesh Sand	0.49	10080.00	99.32	1789.26	97.16
8	3.26	4.37	Slickwater	18591.31	93210.33	100 Mesh Sand	0.74	23904.00	99.12	2246.86	95.88
9	4.37	5.48	Slickwater	23102.19	116312.52	100 Mesh Sand	0.99	46865.00	99.12	2821.75	94.84
10	5.48	9.03	Slickwater	35278.17	151590.69	100 Mesh Sand	1.50	99618.00	99.12	3718.76	92.81
11	9.03	7.03	Slickwater	26955.46	178546.15	100 Mesh Sand	1.99	153340.00	99.28	4418.69	91.03
12	7.03	5.53	Slickwater	24009.51	202555.65	40/70 White	0.53	166017.00	99.47	5003.94	97.17
13	5.53	4.35	Slickwater	18522.20	221077.86	40/70 White	0.74	179746.00	99.47	5459.85	96.22
14	4.35	4.38	Slickwater	18521.08	239598.94	40/70 White	0.99	198124.00	99.49	5920.80	95.18
15	4.38	16.47	Slickwater	59330.34	298929.28	40/70 White	1.39	280515.00	89.44	7421.95	84.17
16	16.47	6.11	Slickwater	14100.65	313029.92	40/70 White	0.00	280515.00	54.15	7756.76	54.30
17	6.11	0.02	Slickwater	0.07	313029.99	<None>	0.00	280515.00	0.15	7756.77	0.05
18	0.02	8.31	Slickwater	25165.25	338195.25	<None>	0.00	280515.00	70.53	8357.46	70.35
19	8.31	6.16	Slickwater	23344.91	361540.16	<None>	0.49	291975.00	90.69	8925.78	88.70
20	6.16	3.54	Slickwater	14371.76	375911.92	40/70 White	0.74	302631.00	90.71	9279.55	87.74
21	3.54	2.48	WF115	10204.11	386116.03	40/70 White	0.99	312729.00	90.69	9533.49	86.77
22	2.48	3.07	WF115	11118.94	397234.97	40/70 White	1.48	329168.00	90.68	9816.11	84.94
23	3.07	6.25	WF115	22406.13	419641.10	40/70 Treated	1.99	373787.00	90.69	10398.04	83.14
24	6.25	2.10	WF115	7398.65	427039.75	40/70 White	2.51	392332.00	90.70	10594.55	81.30
25	2.10	1.30	WF115	5121.83	432161.58	40/70 White	2.54	405361.00	90.69	10730.58	81.30
26	1.30	3.32	WF115	11973.29	444134.87	40/70 White	2.74	438127.00	90.68	11050.98	80.68
27	3.32	2.28	Slickwater	8735.16	452870.03	<None>	0.00	438127.00	83.74	11257.54	84.32

Table 109: Fracture Model - Pump Details Stage 22

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	12.0	15.2	5238	5458	4727	5104
2	Acid 7.5% HC	15.2	15.2	5627	5702	5469	5634
3	Spacer	15.2	15.2	5772	5825	5701	5775
4	Acid 7.5% HC	15.1	15.2	5867	5900	5825	5869
5	PAD	88.2	92.5	8894	9129	5785	7970
6	0.25 PPA	96.3	99.9	8479	8772	8360	8470
7	0.5 PPA	99.3	99.9	8272	8356	8231	8270
8	0.75 PPA	99.1	99.2	8200	8241	8168	8199
9	1.00 PPA	99.1	99.3	8159	8173	8142	8159
10	1.50 PPA	99.1	99.3	8159	8176	8122	8159
11	2.0 PPA	99.3	99.7	8193	8240	8124	8193
12	0.50 PPA	99.5	99.6	8148	8215	8097	8147
13	0.75 PPA	99.5	99.6	8094	8106	8083	8094
14	1.00 PPA	99.5	99.6	8086	8095	8073	8086
15	1.50 PPA	95.7	99.7	7964	8258	5092	7776
16	Flush	55.2	0.0	6713	5928	5928	6689
17	Rate	5.4	0.0	5645	5928	4175	4175
18	Flush	81.3	90.8	8200	8740	4175	7684
19	.5 PPA	90.7	90.8	8278	8562	8106	8279
20	.75 PPA	90.7	90.8	8016	8393	7881	8009
21	1.0 PPA	90.7	90.8	7912	7962	7857	7910
22	1.5 PPA	90.7	90.8	7847	7873	7817	7847
23	2.0 PPA	90.7	90.8	7823	7849	7792	7823
24	2.5 PPA	90.7	90.8	7810	7826	7798	7809
25	2.5 PPA	90.7	90.8	7815	7847	7796	7817
26	3.0 PPA	90.7	90.8	7844	7877	7814	7844
27	Flush	89.3	90.8	8017	8289	5810	7854

Table 110: Fracture Model - Overview Stage 23

Stage 23		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/14/2015	
Stage Length	237.00	ft
Frac Gradient	1.27	psi/ft
ISIP	6223.00	psi
5 Min ISIP	5885.00	psi
10 Min ISIP	5777.00	psi
15 Min ISIP	5698.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	7562.00	psi
Breakdown Volume	188.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8646.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	436160.00	lbs
Proppant Concentration	1840.34	lb/ft
Proppant Concentration	1.20	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	6772.00	bbls
Total Linear	1944.00	bbls
Total XL	0.00	bbls
FR Amount	160.00	gal
Gel Amount	1451.00	gal or lbs
Breaker Amount	82.00	gal or lbs
Scale Inhibitor	36.00	gal
Biocide	85.00	gal

Table 111: Fracture Model - Perfs Stage 23

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	8814.00	8816.00	0.42	8
4	8863.00	8865.00	0.42	8
3	8910.00	8912.00	0.42	8
2	8959.00	8961.00	0.42	8
1	9005.00	9007.00	0.42	8

Table 112: Fracture Model - Pump Schedule Stage 23

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.50	SlickWater	432.32	432.32	<None>	0.00	0.00	12.59	10.49	12.35
2	0.50	2.18	HCl 7.5%	1454.74	1887.06	<None>	0.00	0.00	15.06	45.13	15.06
3	3.08	3.13	SlickWater	2034.06	3921.12	<None>	0.00	0.00	15.06	93.56	15.06
4	6.21	2.20	HCl 7.5%	1476.09	5397.21	<None>	0.00	0.00	15.06	128.70	15.06
5	8.41	15.10	SlickWater	41943.37	47340.58	<None>	0.00	0.00	65.94	1128.77	65.85
6	23.51	3.11	SlickWater	13204.02	60544.60	100 Mesh Sand	0.24	3142.00	99.83	1446.56	98.76
7	27.02	3.25	SlickWater	14021.13	74565.74	100 Mesh Sand	0.48	9914.00	99.86	1787.75	97.71
8	30.27	4.34	SlickWater	18522.62	93088.35	100 Mesh Sand	0.74	23656.00	99.83	2243.64	96.57
9	35.01	5.45	SlickWater	23065.78	116154.13	100 Mesh Sand	0.99	46578.00	99.82	2817.62	95.51
10	40.46	8.59	SlickWater	35257.93	151412.06	100 Mesh Sand	1.50	99308.00	99.80	3714.15	93.45
11	49.45	7.19	SlickWater	28120.40	179532.45	100 Mesh Sand	1.99	155340.00	99.79	4444.29	91.51
12	57.04	5.52	SlickWater	24016.07	203548.52	40/70 White	0.53	168027.00	99.78	5029.70	97.47
13	62.56	4.34	SlickWater	18515.55	222064.07	40/70 White	0.74	181744.00	99.80	5485.43	96.54
14	67.30	4.37	SlickWater	18512.48	240576.56	40/70 White	0.99	200122.00	99.80	5946.18	95.47
15	72.07	8.15	SlickWater	32372.47	272949.02	40/70 White	1.50	248524.00	99.80	6769.51	93.43
16	80.22	6.39	Gel (WF115)	25553.72	298502.75	40/70 White	1.99	299285.00	99.80	7433.20	91.49
17	87.01	8.47	Gel (WF115)	33059.80	331562.55	40/70 - Treated	2.49	381676.00	99.80	8309.76	89.62
18	95.48	6.12	Gel (WF115)	23085.15	354647.70	40/70 - Treated	2.77	445643.00	99.80	8928.54	88.65
19	102.00	2.05	SlickWater	8535.03	363182.72	<None>	0.00	445643.00	96.83	9130.26	97.54

Table 113: Fracture Model - Pump Details Stage 23

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.5	15.1	5339	5597	4607	5280
2	Acid 7.5% HC	15.1	15.1	5870	6034	5605	5882
3	Spacer	15.1	15.1	6084	6100	6035	6085
4	Acid 7.5% HC	15.1	15.1	6124	6176	6098	6126
5	PAD	99.8	100.0	8403	8680	6098	7779
6	0.25 PPA	99.8	100.0	8107	8133	8080	8108
7	0.5 PPA	99.9	100.0	8131	8246	8089	8134
8	0.75 PPA	99.8	99.9	8332	8367	8253	8333
9	1.00 PPA	99.8	100.0	8342	8378	8284	8343
10	1.50 PPA	99.8	99.9	8367	8426	8323	8368
11	2.0 PPA	99.8	99.9	8527	8640	8392	8529
12	0.50 PPA	99.8	99.9	8564	8683	8491	8562
13	0.75 PPA	99.8	99.9	8484	8500	8470	8484
14	1.00 PPA	99.8	99.9	8487	8497	8474	8487
15	1.50 PPA	99.8	99.9	8422	8516	8313	8422
16	2.00 PPA	99.8	99.9	8428	8511	8287	8429
17	2.5 PPA	99.8	99.9	8473	8517	8427	8473
18	3.0 PPA	99.8	100.0	8466	8497	8441	8466
19	Flush	99.0	99.9	8533	8735	6368	8401

Table 114: Fracture Model - Overview Stage 24

Stage 24		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/15/2015	
Stage Length	222.00	ft
Frac Gradient	1.29	psi/ft
ISIP	6333.00	psi
5 Min ISIP	5848.00	psi
10 Min ISIP	5687.00	psi
15 Min ISIP	5585.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6373.00	psi
Breakdown Volume	181.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8264.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440280.00	lbs
Proppant Concentration	1983.24	lb/ft
Proppant Concentration	1.27	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8197.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	205.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	90.00	gal

Table 115: Fracture Model - Perfs Stage 24

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	8587.00	8589.00	0.42	8
4	8634.00	8636.00	0.42	8
3	8678.00	8680.00	0.42	8
2	8724.00	8726.00	0.42	8
1	8763.00	8765.00	0.42	8

Table 116: Fracture Model - Pump Schedule Stage 24

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.55	SlickWater	353.85	353.85	<None>	0.00	0.00	9.47	8.68	9.19
2	0.55	2.18	HCl 7.5%	1446.97	1800.82	<None>	0.00	0.00	14.98	43.14	14.98
3	3.13	3.17	SlickWater	2065.91	3866.73	<None>	0.00	0.00	14.98	92.32	14.98
4	6.30	2.11	HCl 7.5%	1374.03	5240.76	<None>	0.00	0.00	14.98	125.04	14.98
5	8.41	11.01	SlickWater	24910.54	30151.30	<None>	0.00	0.00	53.95	719.37	53.84
6	19.42	4.26	SlickWater	16650.42	46801.72	100 Mesh Sand	0.24	4077.00	90.44	1120.32	89.42
7	24.08	3.53	SlickWater	15235.91	62037.63	100 Mesh Sand	0.49	11570.00	95.52	1491.24	93.41
8	28.01	4.28	SlickWater	17645.38	79683.01	100 Mesh Sand	0.74	24610.00	97.23	1925.54	94.06
9	32.29	9.07	SlickWater	36541.67	116224.68	100 Mesh Sand - Treated	1.00	60982.00	99.75	2834.91	95.43
10	41.36	10.17	SlickWater	40342.17	156566.85	100 Mesh Sand	1.50	121322.00	99.75	3860.68	93.41
11	51.53	11.36	SlickWater	45014.33	201581.18	100 Mesh Sand	1.75	199997.00	99.73	5017.52	92.39
12	63.29	11.30	SlickWater	44159.19	245740.37	100 Mesh Sand	1.99	288079.00	99.72	6164.28	91.43
13	74.59	4.49	SlickWater	18110.83	263851.20	100 Mesh Sand	2.50	333422.00	99.71	6644.53	89.52
14	79.48	1.48	SlickWater	7337.47	271188.67	40/70 White	0.63	338018.00	99.72	6824.02	97.06
15	81.36	2.43	SlickWater	11005.19	282193.86	40/70 White	0.74	346127.00	99.70	7094.87	96.45
16	84.19	3.45	SlickWater	15028.59	297222.45	40/70 White	0.99	361024.00	99.73	7468.85	95.42
17	88.04	3.49	SlickWater	14968.24	312190.70	40/70 White	1.49	383288.00	99.72	7849.44	93.38
18	91.53	3.44	SlickWater	14338.53	326529.22	40/70 White	1.99	411752.00	99.73	8221.75	91.44
19	95.37	1.20	SlickWater	5022.36	331551.58	40/70 White	2.44	424030.00	99.70	8354.69	89.69
20	96.57	1.54	SlickWater	7261.45	338813.04	40/70 White	2.14	439573.00	99.75	8544.21	91.00
21	98.51	2.01	SlickWater	8261.61	347074.64	<None>	0.00	439573.00	97.05	8739.93	97.54

Table 117: Fracture Model - Pump Details Stage 24

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	12.5	15.0	5599	5855	4930	5430
2	Acid 7.5% HC	15.0	15.0	6085	6188	5860	6094
3	Spacer	15.0	15.0	6163	6197	6055	6161
4	Acid 7.5% HC	15.0	15.0	6023	6054	6007	6022
5	PAD	93.0	95.1	9029	9110	5900	7618
6	0.25 PPA	90.4	95.1	8870	9016	8719	8866
7	0.5 PPA	95.5	96.9	8771	8856	8713	8769
8	0.75 PPA	97.2	99.8	8678	8776	8634	8678
9	1.00 PPA	99.7	99.8	8707	8769	8642	8706
10	1.50PPA	99.7	99.9	8598	8679	8538	8597
11	1.75 PPA	99.7	99.9	8582	8609	8548	8582
12	2.00 PPA	99.7	99.9	8441	8617	8390	8440
13	2.5 PPA	99.7	99.8	8454	8489	8419	8455
14	0.50 PPA	99.7	99.8	8497	8558	8451	8500
15	0.75 PPA	99.7	99.8	8522	8617	8478	8520
16	1.00 PPA	99.7	99.9	8433	8482	8395	8432
17	1.50 PPA	99.7	99.8	8385	8414	8353	8385
18	2.00 PPA	99.7	99.9	8339	8392	8289	8337
19	2.5 PPA	99.7	99.8	8313	8319	8306	8313
20	3.0 PPA	99.7	99.9	8282	8315	8257	8281
21	Flush	99.0	99.8	8371	8572	6203	8258

Table 118: Fracture Model - Overview Stage 25

Stage 25		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/15/2015	
Stage Length	231.00	ft
Frac Gradient	1.30	psi/ft
ISIP	6459.00	psi
5 Min ISIP	6004.00	psi
10 Min ISIP	5846.00	psi
15 Min ISIP	5741.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6640.00	psi
Breakdown Volume	175.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	8066.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	442700.00	lbs
Proppant Concentration	1916.45	lb/ft
Proppant Concentration	1.31	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	8546.00	bbls
Total Linear	0.00	bbls
Total XL	0.00	bbls
FR Amount	165.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	90.00	gal

Table 119: Fracture Model - Perfs Stage 25

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
5	8356.00	8358.00	0.42	8
4	8400.00	8402.00	0.42	8
3	8448.00	8450.00	0.42	8
2	8495.00	8497.00	0.42	8
1	8541.00	8543.00	0.42	8

Table 120: Fracture Model - Pump Schedule Stage 25

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	0.43	SlickWater	313.18	313.18	<None>	0.00	0.00	10.74	7.70	10.40
2	0.43	2.18	HCl 7.5%	1447.25	1760.43	<None>	0.00	0.00	14.98	42.15	14.98
3	3.01	3.21	SlickWater	2107.21	3867.64	<None>	0.00	0.00	14.98	92.32	14.98
4	6.22	2.37	HCl 7.5%	1646.12	5513.76	<None>	0.00	0.00	14.98	131.52	14.98
5	8.59	11.37	SlickWater	24934.07	30447.83	<None>	0.00	0.00	51.21	726.39	51.10
6	20.36	3.23	SlickWater	12257.62	42705.46	100 Mesh Sand	0.24	2977.00	87.22	1021.50	86.26
7	23.59	3.55	SlickWater	15206.60	57912.06	100 Mesh Sand	0.49	10429.00	94.55	1391.84	92.44
8	27.54	3.20	SlickWater	13478.50	71390.55	100 Mesh Sand	0.74	20368.00	99.51	1723.54	96.27
9	31.14	7.45	SlickWater	31061.88	102452.44	100 Mesh Sand - Treated	0.99	51258.00	99.74	2496.49	95.43
10	38.59	10.17	SlickWater	40330.07	142782.51	100 Mesh Sand	1.50	111601.00	99.73	3522.01	93.38
11	49.16	11.36	SlickWater	45019.70	187802.21	100 Mesh Sand	1.75	190269.00	99.74	4678.96	92.40
12	60.52	12.03	SlickWater	46277.81	234080.02	100 Mesh Sand	2.00	282612.00	99.73	5880.75	91.44
13	72.55	5.20	SlickWater	20058.57	254138.59	100 Mesh Sand	2.51	332872.00	99.74	6412.67	89.55
14	78.15	1.48	SlickWater	7336.14	261474.73	40/70 White	0.63	337477.00	99.70	6592.13	97.04
15	80.03	2.43	SlickWater	11006.66	272481.39	40/70 White	0.74	345581.00	99.72	6863.03	96.47
16	82.46	3.45	SlickWater	15025.30	287506.69	40/70 White	0.99	360480.00	99.72	7236.96	95.40
17	86.31	3.49	SlickWater	14969.30	302475.99	40/70 White	1.49	382745.00	99.73	7617.58	93.38
18	90.20	4.05	SlickWater	15680.01	318156.00	40/70 White	1.99	413891.00	99.72	8024.77	91.43
19	94.25	1.20	SlickWater	5024.25	323180.25	40/70 White	2.44	426166.00	99.74	8157.75	89.72
20	95.45	2.01	SlickWater	7695.45	330875.70	40/70 White	2.18	442922.00	99.74	8358.90	90.86
21	97.46	1.57	SlickWater	7991.20	338866.90	<None>	0.00	442922.00	97.07	8548.18	97.57

Table 121: Fracture Model - Pump Details Stage 25

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	12.6	15.0	5358	5562	4757	5270
2	Acid 7.5% HC	15.0	15.0	5898	6078	5573	5913
3	spacer	15.0	15.0	6132	6163	6080	6133
4	Acid 7.5% HC	15.0	15.0	6124	6147	6108	6125
5	PAD	85.8	87.2	8856	9023	6077	7896
6	0.25 PPA	87.2	89.1	8872	9057	8716	8863
7	0.5 PPA	94.6	98.0	8771	8816	8677	8768
8	0.75 PPA	99.5	99.9	8817	8871	8751	8817
9	1.00 PPA	99.7	99.9	8695	8751	8654	8695
10	1.50 PPA	99.7	99.9	8624	8671	8557	8623
11	1.75 PPA	99.7	99.9	8582	8597	8565	8582
12	2.00 PPA	99.7	99.9	8548	8651	8401	8547
13	2.50 PPA	99.7	99.9	8417	8437	8387	8417
14	0.50 PPA	99.7	99.9	8421	8465	8389	8423
15	0.75 PPA	99.7	99.8	8399	8497	8351	8397
16	1.00 PPA	99.7	99.8	8346	8374	8328	8346
17	1.50 PPA	99.7	99.9	8325	8348	8298	8324
18	2.00 PPA	99.7	99.8	8326	8348	8298	8326
19	2.5 PPA	99.8	99.9	8348	8356	8340	8348
20	3.0 PPA	99.8	99.8	8354	8376	8344	8357
21	Flush	99.0	99.8	8531	8793	6612	8437

Table 122: Fracture Model - Overview Stage 26

Stage 26		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/15/2015	
Stage Length	225.00	ft
Frac Gradient	1.27	psi/ft
ISIP	6205.00	psi
5 Min ISIP	5985.00	psi
10 Min ISIP	5860.00	psi
15 Min ISIP	5765.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6945.00	psi
Breakdown Volume	142.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7240.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	440500.00	lbs
Proppant Concentration	1957.78	lb/ft
Proppant Concentration	1.45	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	4472.00	bbls
Total Linear	2696.00	bbls
Total XL	0.00	bbls
FR Amount	338.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	125.00	gal

Table 123: Fracture Model - Perfs Stage 26

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
5	8128.00	8130.00	0.42	8
4	8175.00	8177.00	0.42	8
3	8220.00	8222.00	0.42	8
2	8264.00	8266.00	0.42	8
1	8310.00	8312.00	0.42	8

Table 124: Fracture Model - Pump Schedule Stage 26

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.10	SlickWater	494.48	494.48	<None>	0.00	0.00	10.32	12.04	10.09
2	1.10	2.20	HCl 7.5%	1517.95	2012.43	<None>	0.00	0.00	15.49	48.18	15.49
3	3.30	3.08	SlickWater	2037.21	4049.64	<None>	0.00	0.00	15.48	96.68	15.48
4	6.38	2.20	HCl 7.5%	1517.39	5567.03	<None>	0.00	0.00	15.48	132.81	15.48
5	8.58	8.21	SlickWater	24960.19	30527.22	<None>	0.00	0.00	71.34	728.51	71.17
6	17.19	5.34	SlickWater	23053.51	53580.73	100 Mesh Sand	0.25	5676.00	99.71	1283.55	98.60
7	22.53	7.11	SlickWater	29428.48	83009.21	100 Mesh Sand	0.49	20227.00	99.73	1999.97	97.54
8	30.04	4.09	SlickWater	16813.37	99822.58	100 Mesh Sand	0.74	32669.00	99.71	2413.77	96.46
9	34.13	5.14	SlickWater	20972.92	120795.50	100 Mesh Sand	0.99	53503.00	99.73	2935.68	95.42
10	39.27	5.54	SlickWater	23145.95	143941.45	101 Mesh Sand	1.49	88029.00	99.74	3524.14	93.41
11	45.21	10.57	SlickWater	42055.48	185996.93	100 Mesh Sand	1.99	171885.00	99.74	4616.28	91.44
12	56.18	10.03	Gel(Spphire VF105)	37790.90	223787.83	100 Mesh Sand	2.51	266561.00	99.72	5618.42	89.53
13	66.21	6.14	Gel(Spphire VF105)	22974.77	246762.60	100 Mesh Sand	3.00	335489.00	99.72	6239.98	87.76
14	72.35	3.17	Gel(Spphire VF105)	12587.75	259350.35	40/70 White	2.04	361121.00	99.72	6567.39	91.28
15	75.52	5.37	Gel(Spphire VF105)	21114.25	280464.60	40/70 White	2.49	413763.00	99.71	7127.45	89.51
16	81.29	4.15	Gel(Spphire VF105)	15823.21	296287.81	40/70 White	2.75	457326.00	99.70	7551.17	88.65
17	85.44	1.57	SlickWater	7909.51	304197.32	<None>	0.00	457326.00	95.92	7738.21	96.58

Table 125: Fracture Model - Pump Details Stage 26

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.5	15.7	5567	5824	4862	5395
2	Acid 7.5%	15.5	15.5	6048	6179	5825	6059
3	spacer	15.5	15.5	6215	6262	6180	6216
4	Acid 7.5%	15.5	15.5	6305	6347	6263	6305
5	PAD	82.7	99.8	8328	8848	6226	8190
6	0.25 PPA	99.7	99.8	8575	8650	8371	8568
7	0.5 PPA	99.7	99.9	8546	8576	8523	8546
8	0.75 PPA	99.7	99.9	8518	8533	8506	8517
9	1.00 PPA	99.7	99.9	8501	8516	8484	8501
10	1.5 PPA	99.7	99.8	8488	8502	8457	8488
11	2.00 PPA	99.7	100.0	8487	8535	8455	8488
12	2.5 PPA	99.7	99.8	8488	8528	8435	8487
13	3.0 PPA	99.7	99.9	8460	8480	8441	8460
14	2.00 PPA	99.7	99.8	8400	8461	8336	8397
15	2.5 PPA	99.7	99.8	8344	8370	8310	8344
16	3.0 PPA	99.7	99.8	8374	8422	8344	8375
17	Flush	97.9	99.8	8399	8600	5654	8279

Table 126: Fracture Model - Overview Stage 27

Stage 27		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/15/2015	
Stage Length	184.00	ft
Frac Gradient	1.29	psi/ft
ISIP	6335.00	psi
5 Min ISIP	6003.00	psi
10 Min ISIP	5911.00	psi
15 Min ISIP	5827.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	6895.00	psi
Breakdown Volume	166.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	6538.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	453260.00	lbs
Proppant Concentration	2463.37	lb/ft
Proppant Concentration	1.65	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	3618.00	bbls
Total Linear	2840.00	bbls
Total XL	0.00	bbls
FR Amount	202.00	gal
Gel Amount	0.00	gal or lbs
Breaker Amount	0.00	gal or lbs
Scale Inhibitor	40.00	gal
Biocide	105.00	gal

Table 127: Fracture Model - Perfs Stage 27

Perfs				
Cluster	**Start.FT**	**Stop.FT**	**Perf_Diam.IN**	**Perf_Shots.**
4	7944.00	7946.00	0.42	10
3	7993.00	7995.00	0.42	10
2	8042.00	8044.00	0.42	10
1	8085.00	8087.00	0.42	10

Table 128: Fracture Model - Pump Schedule Stage 27

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.07	SlickWater	490.49	490.49	<None>	0.00	0.00	10.68	11.92	10.46
2	1.07	2.19	HCl 7.5%	1515.08	2005.57	<None>	0.00	0.00	15.57	47.99	15.57
3	3.26	3.13	SlickWater	2100.77	4106.34	<None>	0.00	0.00	15.55	98.01	15.55
4	6.39	2.19	HCl 7.5%	1514.03	5620.37	<None>	0.00	0.00	15.56	134.06	15.56
5	8.58	9.53	SlickWater	24918.03	30538.40	<None>	0.00	0.00	60.17	728.75	60.03
6	18.51	5.50	SlickWater	24155.39	54693.79	100 Mesh Sand	0.25	5950.00	99.70	1310.34	98.59
7	24.41	4.07	SlickWater	16845.23	71539.02	100 Mesh Sand	0.49	14275.00	99.62	1720.45	97.43
8	28.48	4.11	SlickWater	16749.95	88288.97	100 Mesh Sand	0.99	30782.00	99.61	2137.16	95.33
9	32.59	4.18	SlickWater	16850.96	105139.94	100 Mesh Sand	1.49	55864.00	99.62	2565.50	93.31
10	37.17	10.58	SlickWater	41411.87	146551.80	100 Mesh Sand	2.00	138656.00	98.11	3641.42	89.91
11	48.15	12.03	Gel(Spphire VF105)	42012.40	188564.20	100 Mesh Sand	2.50	243732.00	92.41	4755.02	83.01
12	60.18	9.52	Gel(Spphire VF105)	34318.68	222882.88	100 Mesh Sand	3.00	346785.00	94.15	5683.94	82.82
13	70.10	3.27	Gel(Spphire VF105)	12632.19	235515.08	40/70 White	2.03	372458.00	95.24	6012.51	87.18
14	73.37	3.29	Gel(Spphire VF105)	12551.70	248066.78	40/70 White	2.50	403831.00	95.58	6345.45	85.79
15	77.06	2.42	Gel(Spphire VF105)	9533.93	257600.70	40/70 White	2.98	432249.00	95.58	6603.51	84.07
16	79.48	2.47	Gel(Spphire VF105)	9445.87	267046.57	40/70 White	4.02	470187.00	95.58	6869.53	80.80
17	82.35	2.03	SlickWater	7714.21	274760.78	<None>	0.03	470417.00	88.82	7051.62	89.60

Table 129: Fracture Model - Pump Details Stage 27

Step#	Name	Avg S Rate (bbl/min)	Max S Rate (bbl/min)	Avg Tr Pres (psi)	Max Tr Pres (psi)	Min Tr Pressure (psi)	Calc Avg TR P (psi)
1	Rate	13.9	15.7	5361	5658	4465	5148
2	Acid 7.5%	15.6	15.7	5891	6015	5664	5901
3	Spacer	15.5	15.6	6061	6105	6016	6063
4	Acid 7.5%	15.6	15.6	6129	6158	6105	6129
5	PAD	76.4	99.9	8548	8932	6067	8082
6	0.25 PPA	99.7	100.0	8729	8822	8634	8727
7	0.5 PPA	99.6	99.8	8606	8641	8584	8606
8	1.00 PPA	99.6	99.7	8554	8607	8520	8553
9	1.5 PPA	99.6	99.7	8519	8548	8495	8519
10	2.00 PPA	99.3	99.8	8529	8598	8471	8530
11	2.5 PPA	92.5	97.8	8500	8958	8261	8497
12	3.0 PPA	94.2	94.3	8416	8460	8399	8415
13	2.00 ppa	95.2	95.7	8426	8454	8374	8426
14	2.5 ppa	95.6	95.7	8399	8438	8365	8400
15	3.0 ppa	95.6	95.7	8401	8435	8383	8401
16	4.0 PPA	95.6	95.7	8476	8675	8414	8482
17	Flush	94.1	95.7	8599	8781	5999	8429

Table 130: Fracture Model - Overview Stage 28

Stage 28		
Treatment Summary		
Formation	Marcellus	
Formation Type	Shale	
Stage Data		
Report Date	11/15/2015	
Stage Length	191.00	ft
Frac Gradient	1.29	psi/ft
ISIP	6335.00	psi
5 Min ISIP	5612.00	psi
10 Min ISIP	5370.00	psi
15 Min ISIP	5269.00	psi
Breakdown Rate	15.00	bpm
Breakdown Pressure	7185.00	psi
Breakdown Volume	157.00	bbls
Cut Short		X
Screen Out		X
Fluid and Proppant Data		
Total Clean Fluid	7376.00	bbls
Prop.1-Type	100 Mesh	
Prop.2-Type	40/70 White	
Total Proppant Amount	360560.00	lbs
Proppant Concentration	1887.75	lb/ft
Proppant Concentration	1.16	lb/gal
Chemical Data		
Acid % Strength	7.50	
Total Acid	3000.00	gal
Total Slickwater	5764.00	bbls
Total Linear	1539.00	bbls
Total XL	0.00	bbls
FR Amount	105.00	gal
Gel Amount	820.00	gal or lbs
Breaker Amount	88.00	gal or lbs
Scale Inhibitor	35.00	gal
Biocide	100.00	gal

Table 131: Fracture Model - Perfs Stage 28

Perfs				
Cluster	Start.FT	Stop.FT	Perf_Diam.IN	Perf_Shots.
4	7753.00	7755.00	0.42	10
3	7803.00	7805.00	0.42	10
2	7852.00	7854.00	0.42	10
1	7901.00	7903.00	0.42	10

Table 132: Fracture Model - Pump Schedule Stage 28

Stage	Tot Time mm:ss	Stage Time mm:ss	Fluid	Clean Stg Vol (gal)	Cum Cln Vol (gal)	Proppant	Slurry Conc (ppa)	Cum Prop (lbs)	Slurry Rate (bbl/min)	Cum Slurry (bbl)	Clean Rate (bbl/min)
1	0.00	1.26	SlickWater	540.82	540.82	<None>	0.00	0.00	9.16	13.13	8.98
2	1.26	2.22	HCl 7.5%	1518.86	2059.68	<None>	0.00	0.00	15.28	49.30	15.28
3	3.48	3.16	SlickWater	2097.69	4157.37	<None>	0.00	0.00	15.29	99.24	15.29
4	7.04	2.43	HCl 7.5%	1565.76	5723.13	<None>	0.00	0.00	13.72	136.52	13.72
5	9.47	14.05	SlickWater	41938.76	47661.89	<None>	0.00	0.00	70.98	1136.15	70.90
6	23.52	3.24	SlickWater	12037.13	59699.02	100 Mesh Sand	0.24	2925.00	85.23	1425.94	84.29
7	27.16	3.26	SlickWater	12020.40	71719.43	100 Mesh Sand	0.49	8849.00	85.23	1718.57	83.36
8	30.42	4.03	SlickWater	15214.08	86933.51	100 Mesh Sand	0.74	20143.00	92.51	2093.21	89.44
9	34.45	4.55	SlickWater	18896.01	105829.52	100 Mesh Sand	0.99	38906.00	95.64	2563.42	91.51
10	39.40	7.41	SlickWater	28900.61	134730.13	100 Mesh Sand - Treated	1.49	81981.00	95.63	3298.21	89.56
11	47.21	7.33	SlickWater	27796.51	162526.64	100 Mesh Sand	1.99	137291.00	95.60	4019.98	87.66
12	54.54	4.52	SlickWater	19083.67	181610.31	40/70 White	0.53	147334.00	95.60	4485.23	93.36
13	59.46	3.54	SlickWater	15151.29	196761.60	40/70 White	0.74	158508.00	95.62	4858.15	92.50
14	63.40	3.56	SlickWater	15112.24	211873.84	40/70 White	0.99	173504.00	95.62	5234.26	91.48
15	67.36	7.05	SlickWater	26630.39	238504.22	40/70 White	1.49	213097.00	95.61	5911.51	89.51
16	74.41	5.57	Gel (WF115)	21908.22	260412.44	40/70 White	1.98	256583.00	95.62	6480.48	87.67
17	80.38	4.32	Gel (WF115)	16349.64	276762.09	40/70 White	2.49	297280.00	95.62	6913.97	85.87
18	85.10	2.45	Gel (WF115)	9699.97	286462.05	40/70 White	3.01	326525.00	95.62	7176.93	83.98
19	87.55	2.58	Gel (WF115)	10462.06	296924.11	40/70 White	3.05	358403.00	95.60	7460.55	83.97
20	90.53	1.45	Gel (WF115)	6283.34	303207.45	40/70 White	2.65	375049.00	95.64	7627.92	85.49
21	92.38	1.50	SlickWater	7277.69	310485.14	<None>	0.00	375049.00	94.20	7800.62	94.52

Table 133: Fracture Model - Pump Details Stage 28

Step#	Name	Avg S Rate	Max S Rate	Avg Tr Pres	Max Tr Pres	Min Tr Pressure	Calc Avg TR P
		(bbl/min)	(bbl/min)	(psi)	(psi)	(psi)	(psi)
1	Rate	13.5	15.7	5565	5857	4697	5283
2	Acid 7.5% HC	15.3	15.3	6059	6133	5866	6066
3	PAD	15.3	15.3	6151	6182	6131	6152
4	acid 7.5%	14.3	15.3	6142	6233	5817	6116
5	PAD	85.2	89.3	8582	9042	6179	8447
6	0.25 PPA	85.2	85.3	8305	8392	8201	8301
7	0.5 PPA	85.2	85.3	8056	8200	7982	8052
8	0.75 PPA	92.6	95.8	8278	8412	7980	8276
9	1.00 PPA	95.6	95.7	8361	8372	8346	8361
10	1.5 PPA	95.6	95.8	8343	8373	8308	8343
11	2.00 PPA	95.6	95.7	8300	8356	8218	8299
12	.5 ppa	95.6	95.7	8308	8367	8239	8309
13	.75 ppa	95.6	95.8	8324	8360	8296	8323
14	1.0 ppa	95.6	95.7	8330	8355	8305	8331
15	1.5 ppa	95.6	95.8	8257	8329	8186	8256
16	2.0 ppa	95.6	95.7	8276	8310	8204	8277
17	2.5 ppa	95.6	95.8	8330	8372	8302	8330
18	3.0 ppa	95.6	95.8	8318	8350	8281	8317
19	3.0 ppa	95.6	95.7	8319	8379	8294	8321
20	4.0 ppa	95.6	95.7	8426	8484	8379	8431
21	Flush	95.4	95.7	8726	8961	7582	8669

Table 134: Water-Oil Table

Water-Oil Table		
Sw	**krw**	**krow**
0.0000	0.0000	1.0000
0.0527	0.0027	0.8777
0.1101	0.0083	0.7642
0.1643	0.0199	0.6627
0.2186	0.0255	0.5612
0.2744	0.0371	0.4805
0.3287	0.0576	0.3939
0.3814	0.0751	0.3192
0.4372	0.0956	0.2504
0.4915	0.1191	0.1905
0.5504	0.1485	0.1396
0.6016	0.1780	0.1006
0.6558	0.2134	0.0646
0.7132	0.2517	0.0374
0.7628	0.2901	0.0133
0.8202	0.3285	0.0011
0.8744	0.3817	0.0007
0.9380	0.4319	0.0006
1.0000	0.4940	0.0000

Table 135: Liquid-Gas Table

Liquid-Gas Table: Gas Saturation		
Sg	**krg**	**krog**
0.0000	0.0000	1.0000
0.0431	0.0032	0.8786
0.0873	0.0122	0.7658
0.1303	0.0270	0.6676
0.1745	0.0505	0.5636
0.2163	0.0711	0.4769
0.2628	0.1092	0.3932
0.3046	0.1500	0.3181
0.3475	0.1909	0.2518
0.3916	0.2492	0.1941
0.4346	0.3046	0.1423
0.4787	0.3658	0.1049
0.5227	0.4386	0.0705
0.5644	0.5142	0.0418
0.6097	0.5928	0.0218
0.6525	0.6743	0.0077
0.6953	0.7703	0.0060
0.7477	0.8895	0.0053
0.7940	1.0000	0.0000

Table 136: Well Data and Calculated BHP

SCADA DATA									Calculated BHP
Date	Flow Time (hh:mm:ss)	Stat (PSIA)	Diff (inH2O)	Temp (°F)	Gas (MCFD)	Water (BBL/D)	P_{casing} (PSIG)	P_{tubing} (PSIG)	BHP (PSIG)
12/12/2015	16:03:08	213.44	2.19	66.8	665	1,395	3,654	2,393	4,737
12/13/2015	24:00:00	210.85	19.52	80.5	2,944	1,097	3,496	2,638	4,564
12/14/2015	23:42:21	224.59	37.64	65.4	4,305	676	3,404	2,752	4,463
12/15/2015	24:00:00	228.23	41.78	56.5	4,740	424	3,270	2,617	4,316
12/16/2015	23:14:34	217.59	61.69	49.2	5,462	181	3,612	3,327	4,692
12/17/2015	16:46:23	213.58	8.13	60.3	1,354	167	3,582	3,209	4,659
12/18/2015	21:40:50	213.86	63.69	58.1	1,945	196	3,486	3,071	4,553
12/19/2015	24:00:00	225.85	130.53	57.0	3,197	145	3,483	3,094	4,550
12/20/2015	24:00:00	218.86	115.1	79.9	2,896	88	3,484	3,112	4,551
12/21/2015	24:00:00	213.01	123.43	79.0	2,917	71	3,534	3,187	4,606
12/22/2015	24:00:00	215.78	69.81	86.1	2,225	72	3,509	3,160	4,579
12/23/2015	23:12:47	212.17	93.88	73.7	2,475	86	3,542	3,213	4,615
12/24/2015	20:47:14	207.49	83.02	90.0	2,036	72	3,531	3,212	4,603
12/25/2015	24:00:00	227.27	80.98	83.3	2,366	88	3,576	3,285	4,652
12/26/2015	20:58:17	223.74	61.54	78.6	1,800	46	3,508	3,174	4,577
12/27/2015	24:00:00	227.52	91.28	72.5	2,591	80	3,461	3,145	4,526
12/28/2015	24:00:00	226.69	130.29	59.6	3,196	98	3,391	3,051	4,449
12/29/2015	22:52:42	239.93	193.36	58.7	3,800	150	3,514	983	4,584
12/30/2015	14:31:19	225.88	256.92	55.9	2,659	91	3,391	3,077	4,449
12/31/2015	22:35:15	224.59	231.82	45.6	3,924	100	3,203	2,763	4,242
1/1/2016	24:00:00	236.1	425.01	41.8	5,917	190	3,124	2,688	4,154
1/2/2016	24:00:00	238.45	451.88	40.1	6,145	168	3,210	2,941	4,249
1/3/2016	24:00:00	232.25	223.93	59.6	4,143	64	3,205	2,923	4,244
1/4/2016	24:00:00	236.61	205.95	63.2	4,074	115	3,190	2,890	4,228
1/5/2016	24:00:00	276.44	188.8	66.0	4,058	89	3,197	2,934	4,236
1/6/2016	24:00:00	252.25	177.26	66.7	3,850	68	3,195	2,936	4,233
1/7/2016	24:00:00	237.59	174.25	67.0	3,751	63	3,208	2,962	4,248
1/8/2016	24:00:00	237.53	151.76	69.7	3,495	55	3,210	2,970	4,250
1/9/2016	24:00:00	249.55	146.35	69.1	3,462	51	3,234	3,009	4,276
1/10/2016	24:00:00	227.64	128.92	70.1	3,157	39	3,234	2,997	4,276
1/11/2016	24:00:00	232.72	130.92	68.3	3,219	50	3,270	3,202	4,316
1/12/2016	16:07:31	271.33	204.39	60.4	2,899	45	3,323	3,092	4,375
1/13/2016	19:30:38	240.55	104.84	64.8	2,378	12	3,236	3,015	4,210
1/14/2016	24:00:00	242.56	163.13	58.1	3,703	44	3,232	3,021	4,274
1/15/2016	24:00:00	235.25	138.42	64.2	3,342	35	3,242	3,041	4,285
1/16/2016	24:00:00	232.17	121.64	66.8	3,108	33	3,246	3,047	4,289
1/17/2016	24:00:00	231.38	115.92	67.3	3,029	31	3,244	3,033	4,287
1/18/2016	24:00:00	232.15	119	67.0	3,069	36	3,168	2,768	4,203
1/19/2016	24:00:00	243.74	201.54	58.1	4,119	49	3,123	2,837	4,153
1/20/2016	24:00:00	267.95	217.18	57.7	4,445	49	3,113	2,779	4,142
1/21/2016	24:00:00	259.63	208.77	59.1	4,275	47	3,079	2,805	4,104
1/22/2016	24:00:00	246.89	237.4	57.2	4,496	53	3,058	2,782	4,080
1/23/2016	24:00:00	247.2	237.32	58.1	4,494	50	3,035	2,758	4,056
1/24/2016	24:00:00	247.38	244.24	57.2	4,564	51	3,020	2,745	4,038
1/25/2016	24:00:00	246.63	242.58	57.3	4,541	48	3,000	2,716	4,016
1/26/2016	24:00:00	249.16	252.71	57.1	4,657	52	2,984	2,705	3,998
1/27/2016	24:00:00	248.99	250.46	57.6	4,633	49	2,969	2,693	3,982
1/28/2016	24:00:00	249.04	247.43	57.4	4,607	48	2,950	2,665	3,960
1/29/2016	24:00:00	253.62	255.63	57.1	4,725	51	2,931	2,644	3,939
1/30/2016	24:00:00	254.76	257.94	57.7	4,754	50	2,983	2,767	3,998
1/31/2016	24:00:00	250.2	181.04	61.9	3,920	32	3,072	2,922	4,097
2/1/2016	24:00:00	239.35	107.12	70.0	2,906	15	3,086	2,922	4,043
2/2/2016	24:00:00	228.94	121.96	64.8	3,098	21	3,095	2,928	4,122
2/3/2016	24:00:00	229.63	124.81	63.9	3,141	21	3,100	2,935	4,128
2/4/2016	24:00:00	230.17	123.93	63.1	3,136	22	2,955	2,567	3,967
2/5/2016	24:00:00	250.41	331.69	52.1	5,227	67	2,937	2,677	3,946
2/6/2016	24:00:00	255.55	249.22	58.5	4,602	38	2,928	2,667	3,936
2/7/2016	24:00:00	246.9	232.77	58.7	4,446	43	2,912	2,646	3,918
2/8/2016	24:00:00	247.25	238.14	58.8	4,499	44	2,898	2,632	3,903
2/9/2016	24:00:00	248.63	240.44	57.9	4,537	43	2,836	2,508	3,833
2/10/2016	24:00:00	259.45	318.78	55.1	5,328	57	2,775	2,406	3,765
2/11/2016	24:00:00	267.71	373.14	55.4	5,839	59	2,762	2,431	3,750
2/12/2016	24:00:00	267.07	331.56	57.5	5,497	48	2,806	2,526	3,800
2/13/2016	20:33:28	259.18	293.66	59.5	4,310	32	2,826	2,584	3,821
2/14/2016	24:00:00	251.6	215.69	65.9	4,291	31	2,828	2,583	3,824
2/15/2016	24:00:00	250.54	216.18	66.6	4,283	35	2,821	2,571	3,816
2/16/2016	27:19:37	249.93	194.67	66.2	5,292	37	2,814	2,562	3,808
2/17/2016	20:34:17	250.96	222.99	66.5	3,731	39	2,807	2,554	3,800
2/18/2016	24:00:00	251.31	222.84	67.3	4,351	38	2,801	2,551	3,794
2/19/2016	24:00:00	250.94	221.33	68.1	4,329	39	2,917	2,830	3,923
2/20/2016	23:00:53	251.92	127.31	80.8	2,982	22	2,989	2,886	4,005
2/21/2016	20:58:36	242.13	83.96	81.1	2,226	7	3,011	2,902	3,890
2/22/2016	24:00:00	224.51	88.88	79.9	2,584	10	2,981	2,836	3,856
2/23/2016	26:26:58	248.5	148.1	67.2	3,882	17	2,962	2,806	3,904
2/24/2016	20:01:10	242.02	77.19	67.9	2,927	21	2,997	2,873	4,012
2/25/2016	22:06:41	247.23	58.56	65.5	2,769	14	2,932	2,739	3,871
2/26/2016	24:00:00	247.04	96.65	63.2	3,981	28	2,906	2,711	3,912

2/27/2016	24:00:00	243.58	95.38	65.1	3,920	26	2,897	2,704	3,901
2/28/2016	24:00:00	242.32	90.84	66.5	3,812	27	3,112	3,110	4,141
2/29/2016	7:50:33	288.72	68.32	70.4	1,104	6	3,033	2,939	3,915
3/1/2016	23:59:38	236.33	51.24	57.2	2,847	11	3,139	3,138	4,102
3/2/2016	10:48:01	237.08	43.44	45.4	1,179	6	3,034	2,908	3,916
3/3/2016	23:30:47	246.55	75.28	46.2	3,502	15	2,996	2,851	3,942
3/4/2016	24:00:00	246.29	73.87	47.8	3,540	13	2,968	2,805	3,911
3/5/2016	24:00:00	244.1	79.1	56.0	3,612	23	2,966	2,844	3,978
3/6/2016	21:01:06	242	75.19	47.8	3,087	19	3,094	3,083	4,052
3/7/2016	11:57:29	242.73	76.59	37.9	1,790	11	3,030	2,924	3,981
3/8/2016	24:00:00	235.58	62.86	61.3	3,147	11	3,029	2,912	3,979
3/9/2016	23:01:59	235.2	43.91	66.1	2,496	9	3,052	2,953	3,936
3/10/2016	24:00:00	220.12	42.95	73.1	2,492	8	3,103	3,074	3,994
3/11/2016	16:31:50	232.83	42.38	72.9	1,727	6	3,093	3,002	3,982
3/12/2016	23:10:34	220.73	41.31	68.8	2,372	6	3,089	2,990	3,978
3/13/2016	24:00:00	221.27	42.97	68.1	2,511	8	3,087	2,984	3,975
3/14/2016	24:00:00	222.62	43.92	68.3	2,545	9	3,182	3,177	4,082
3/15/2016	9:48:27	238.69	36.96	72.4	963	3	3,147	3,076	3,973
3/16/2016	24:00:00	219.13	28.39	80.0	2,009	3	3,148	3,065	3,974
3/17/2016	24:00:00	222.16	29.09	76.0	2,056	4	3,131	3,031	3,955
3/18/2016	24:00:00	225.25	41.87	66.7	2,503	9	3,116	3,012	4,008
3/19/2016	24:00:00	228.46	50.3	63.3	2,772	11	3,099	2,996	4,058
3/20/2016	24:00:00	229.82	50.85	63.2	2,796	10	3,086	2,974	4,043
3/21/2016	24:00:00	231.13	54.73	61.0	2,914	54	3,068	2,956	4,092
3/22/2016	24:00:00	231.97	55.68	60.7	2,945	11	3,062	2,944	4,016
3/23/2016	24:00:00	236.32	54.51	61.4	2,939	11	3,054	2,938	4,007
3/24/2016	24:00:00	244.72	52.44	63.0	2,928	0	3,136	3,127	3,884
3/25/2016	14:38:36	252.64	45.17	58.6	1,656	2	3,107	3,033	3,851
3/26/2016	24:00:00	241.77	36.49	70.2	2,413	3	3,097	3,002	3,916
3/27/2016	24:00:00	242.65	37.65	74.2	2,445	5	3,173	3,172	4,002
3/28/2016	23:10:52	242.53	37.7	74.6	2,362	11	3,137	2,170	4,100
3/29/2016	20:49:43	198.23	39.68	61.4	1,991	7	3,147	3,062	4,043
3/30/2016	24:00:00	212.42	40.11	78.3	2,250	5	3,091	2,994	3,980
3/31/2016	25:01:29	227.53	39.49	63.5	3,307	4	3,092	2,877	3,911
4/1/2016	21:47:15	248.03	40.63	66.3	2,340	9	3,069	2,929	3,955
4/2/2016	23:53:25	243.22	61.84	74.5	3,085	10	3,026	2,856	3,907
4/3/2016	24:00:00	237.87	82.93	72.3	3,583	15	3,011	2,857	3,959
4/4/2016	24:00:00	245.01	74.98	76.4	3,447	12	2,987	2,820	3,932
4/5/2016	23:58:12	243.04	75.88	71.3	3,468	17	2,954	2,754	3,895
4/6/2016	24:00:00	242.19	94.06	71.5	3,854	56	2,911	2,682	3,917
4/7/2016	24:00:00	245.17	115.93	65.5	4,329	26	2,844	2,551	3,842
4/8/2016	24:00:00	252.33	150.84	57.9	5,036	34	2,798	2,504	3,791
4/9/2016	24:00:00	253.3	164.02	57.3	5,265	32	2,764	2,470	3,752
4/10/2016	24:00:00	253.56	164.21	58.6	5,263	31	2,819	2,654	3,814
4/11/2016	24:00:00	253.75	110.1	72.6	4,162	19	2,859	2,711	3,788
4/12/2016	24:00:00	246.84	67.25	87.3	3,150	6	2,833	2,663	3,689
4/13/2016	24:00:00	246.25	91.37	75.1	3,815	64	2,800	2,574	3,792
4/14/2016	24:00:00	248.39	105.02	72.1	4,104	19	2,885	2,800	3,818
4/15/2016	23:37:21	243.24	55	94.9	2,748	5	2,924	2,831	3,792
4/16/2016	23:39:05	239.57	42.91	105.7	2,411	5	2,943	2,848	3,740
4/17/2016	24:00:00	239.06	44.12	100.7	2,507	5	2,971	2,891	3,845
4/18/2016	24:00:00	244.92	33.27	110.4	2,159	3	2,991	2,924	3,795
4/19/2016	24:00:00	242.32	32.83	109.4	2,149	46	2,979	2,875	3,993
4/20/2016	24:00:00	225.91	47.02	96.5	2,570	7	2,957	2,859	3,830
4/21/2016	24:00:00	248.44	63.68	86.3	3,109	10	2,959	2,848	3,900
4/22/2016	24:00:00	249.94	48.81	95.0	2,710	8	2,976	2,845	3,851
4/23/2016	21:31:51	242.47	52.85	97.6	2,441	4	2,956	2,829	3,754
4/24/2016	24:00:00	249.13	54.18	96.3	2,837	9	2,962	2,859	3,835
4/25/2016	23:58:09	250.48	47.14	101.6	2,593	6	3,026	2,974	3,908
4/26/2016	20:52:26	245.61	24.73	125.6	1,533	44	3,028	2,963	4,048
4/27/2016	22:49:57	236.32	30.77	115.2	1,939	1	3,029	2,945	3,762
4/28/2016	23:57:23	228.61	30.14	90.9	2,066	2	3,028	2,943	3,837
4/29/2016	23:58:08	229.63	33.17	90.3	2,176	3	3,027	2,939	3,836
4/30/2016	24:00:00	228.74	35.07	89.1	2,241	4	3,034	2,937	3,844
5/1/2016	23:00:25	229.85	35.05	88.2	2,146	3	3,042	2,955	3,854
5/2/2016	22:39:45	233.59	32.84	90.0	2,033	3	3,046	2,959	3,858
5/3/2016	23:29:18	232.98	31.23	92.7	2,051	3	3,036	2,945	3,846
5/4/2016	23:59:22	227.52	36.08	85.1	2,287	4	3,020	2,921	3,828
5/5/2016	23:59:08	238.24	45.44	80.1	2,625	9	3,003	2,901	3,881
5/6/2016	24:00:00	237.47	50.86	76.9	2,787	7	3,008	2,920	3,887
5/7/2016	20:30:30	240.02	51.11	74.8	2,373	6	3,073	3,025	3,960
5/8/2016	12:25:51	246.89	41.28	93.2	1,211	2	3,043	2,975	3,855
5/9/2016	18:18:07	242.91	53.09	78.7	2,123	5	3,010	2,907	3,817
5/10/2016	24:00:00	241.66	56.72	76.0	2,962	8	3,022	2,922	3,902
5/11/2016	18:39:45	237.4	61.51	74.5	2,326	7	3,041	2,939	3,924
5/12/2016	16:44:14	249.37	53.11	80.3	1,928	2	3,083	3,017	3,900
5/13/2016	11:17:09	252.77	45.07	93.1	1,148	1	3,080	2,998	3,821
5/14/2016	15:28:49	250.44	44.55	86.7	1,620	3	3,013	2,890	3,820
5/15/2016	23:52:48	240.25	62.93	69.0	3,122	10	2,978	2,843	3,853
5/16/2016	24:00:00	236.93	69.93	67.3	3,308	11	2,984	2,870	3,929
5/17/2016	23:55:49	241.56	53.95	78.5	2,836	9	2,981	2,862	3,857
5/18/2016	23:59:49	242.45	50.85	80.8	2,754	8	2,945	2,796	3,816

5/19/2016	24:00:00	237.85	68.75	69.2	3,278	13	2,975	2,871	3,919
5/20/2016	20:01:36	244.47	52.79	80.8	2,315	5	3,030	2,921	3,840
5/21/2016	12:01:52	252.87	55.07	83.4	1,429	2	3,031	2,950	3,764
5/22/2016	23:11:19	248.33	34.07	90.7	1,955	4	3,012	2,929	3,819
5/23/2016	23:47:43	254.05	38.45	89.2	2,364	4	3,043	3,019	3,855
5/24/2016	17:18:28	295.96	29.89	97.6	1,619	1	3,041	2,961	3,775
5/25/2016	23:41:07	231.43	27.38	88.8	1,936	1	3,046	2,943	3,781
5/26/2016	23:40:46	227.43	26.79	83.7	1,924	2	3,049	2,955	3,784
5/27/2016	23:37:41	226.89	27.29	81.6	1,937	1	3,039	2,951	3,773
5/28/2016	35:08:34	240.08	29.19	77.3	3,115	2	3,037	2,949	3,771
5/29/2016	12:51:22	247.13	27.97	76.7	1,134	2	3,116	3,046	3,938
5/30/2016	5:42:04	294.45	25.15	79.3	503	0	3,107	3,095	3,852
5/31/2016	23:16:00	220.91	13.43	112.0	1,306	1	3,114	3,086	3,860
6/1/2016	24:00:00	221.06	12.3	113.8	1,287	1	3,123	3,080	3,869
6/2/2016	24:00:00	221.32	11.8	114.4	1,261	1	3,132	3,131	3,880
6/3/2016	16:44:50	266.78	21.85	104.2	1,177	0	3,124	3,118	3,871
6/4/2016	23:05:08	236.39	21.47	98.9	1,587	1	3,116	3,069	3,862
6/5/2016	21:57:06	232.47	22.67	92.1	1,606	1	3,111	3,040	3,857
6/6/2016	22:16:13	227.37	25.26	80.0	1,741	1	3,114	3,070	3,859
6/7/2016	21:38:54	231	23.51	80.9	1,640	1	3,104	3,035	3,848
6/8/2016	21:32:49	231.01	27.62	66.3	1,827	4	3,091	3,016	3,909
6/9/2016	24:00:00	222.01	28.57	60.1	2,071	1	3,090	3,017	3,832
6/10/2016	23:24:00	223.6	27.17	59.4	1,962	2	3,098	3,017	3,917
6/11/2016	23:45:45	234.68	23.6	107.2	1,779	1	3,105	3,018	3,849
6/12/2016	23:45:25	237.26	20.26	109.7	1,626	1	3,096	3,022	3,839
6/13/2016	23:45:34	234.7	25.49	103.9	1,855	2	3,100	3,040	3,843
6/14/2016	21:51:13	235.12	29.78	102.3	1,811	2	3,100	3,030	3,843
6/15/2016	21:43:06	235.76	29.28	102.7	1,794	1	3,106	3,023	3,850
6/16/2016	21:54:40	235.81	26.6	103.8	1,668	1	3,100	3,001	3,843
6/17/2016	22:16:02	235.48	28.86	100.8	1,823	2	3,102	3,018	3,846
6/18/2016	22:12:16	236.5	27.37	103.1	1,752	2	3,110	3,001	3,854
6/19/2016	21:20:57	237.45	25.06	106.6	1,575	1	3,116	3,035	3,862
6/20/2016	21:14:20	238.25	22.47	110.2	1,478	1	3,116	3,028	3,861
6/21/2016	21:17:23	237.42	25.48	104.6	1,603	1	3,115	3,016	3,861
6/22/2016	20:54:05	236.95	26.57	103.9	1,614	1	3,115	3,031	3,861
6/23/2016	21:21:36	236.69	26.42	103.4	1,650	1	3,113	3,020	3,858
6/24/2016	21:53:00	236.47	27.51	100.7	1,750	2	3,116	3,023	3,862
6/25/2016	20:37:38	236.61	27.8	101.9	1,617	1	3,120	2,991	3,867
6/26/2016	19:47:34	236.68	27.1	105.1	1,531	1	3,083	2,985	3,824
6/27/2016	24:00:00	226.23	42.82	84.1	2,492	5	3,066	2,958	3,953
6/28/2016	24:00:00	225.72	43.83	84.1	2,518	5	3,047	2,931	3,859
6/29/2016	24:00:00	226.76	48.88	81.1	2,673	8	3,039	2,931	3,922
6/30/2016	22:08:22	230.27	53.23	79.2	2,569	7	3,074	2,949	3,961
7/1/2016	18:07:11	238.67	36.21	95.2	1,613	2	3,086	2,974	3,828
7/2/2016	16:25:28	239.83	39.69	90.6	1,546	1	3,093	2,966	3,835
7/3/2016	16:30:09	239.84	39.15	91.0	1,532	1	3,098	2,992	3,841
7/4/2016	18:08:51	240.24	32.31	96.5	1,511	2	3,080	2,994	3,820
7/5/2016	19:45:04	231.74	52.13	77.5	2,248	6	3,094	3,007	3,984
7/6/2016	16:08:21	240.67	39.1	91.8	1,533	1	3,081	2,995	3,822
7/7/2016	19:39:54	250.41	42.08	86.0	2,028	3	3,092	2,970	3,910
7/8/2016	16:16:54	243.63	41.18	89.8	1,623	1	3,085	2,992	3,827
7/9/2016	18:26:54	242.22	41.28	87.2	1,812	1	3,090	3,009	3,832
7/10/2016	18:39:11	240.1	37.78	92.1	1,731	1	3,074	2,984	3,813
7/11/2016	21:31:09	245.08	33.24	93.6	1,968	2	3,074	3,016	3,814
7/12/2016	23:05:19	244.52	29.12	99.0	1,962	2	3,084	2,985	3,901
7/13/2016	18:49:32	244.8	35.36	94.2	1,735	2	3,089	3,005	3,831
7/14/2016	19:09:49	244.3	32.25	96.7	1,662	0	3,088	3,011	3,829
7/15/2016	21:32:58	243.21	26.53	103.6	1,685	2	3,084	3,012	3,824
7/16/2016	22:49:06	279.08	22.55	104.9	1,722	1	3,087	3,038	3,829
7/17/2016	18:49:21	271.65	24.92	103.2	1,523	1	3,158	3,121	3,910
7/18/2016	0:00:02	-0.78	1.04	91.0	0	0	3,108	3,081	3,853
7/19/2016	18:57:41	244.02	35.05	107.0	1,805	1	3,086	3,061	3,827
7/20/2016	24:00:00	243.14	29.06	101.4	2,092	0	3,069	2,980	3,808
7/21/2016	23:53:08	242.74	31.64	98.9	2,148	3	3,092	3,065	3,911
7/22/2016	23:53:32	241.46	19.1	126.9	1,539	1	3,089	3,036	3,831
7/23/2016	23:59:56	242.53	17.56	105.1	1,605	0	3,091	2,997	3,833
7/24/2016	24:00:00	243.3	17.98	100.7	1,648	1	3,087	3,015	3,828
7/25/2016	24:00:00	243.42	21.24	95.3	1,791	2	3,140	3,132	3,889
7/26/2016	8:18:08	242.7	25.11	86.4	680	0	3,098	3,073	3,841
7/27/2016	20:15:04	243.36	18.68	-11.5	1,602	0	3,094	3,037	3,836
7/28/2016	17:49:58	244.32	28.95	88.5	1,566	0	3,122	3,073	3,868
7/29/2016	15:02:15	240.25	27.43	100.3	1,234	0	3,108	3,069	3,852
7/30/2016	15:59:08	264.52	46.5	95.9	1,805	0	3,088	3,017	3,830
7/31/2016	12:11:16	231.31	27.42	104.2	1,121	0			#N/A
8/1/2016	20:25:51	230.74	21.21	90.8	1,473	0	3,103	3,055	3,847
8/2/2016	23:57:17	238.33	21.52	96.6	1,766	0	3,109	3,030	3,854
8/3/2016	26:50:08	220.55	13.31	123.8	1,668	0			#N/A
8/4/2016	18:36:08	218.52	13.63	128.1	993	0	3,102	3,060	3,846
8/5/2016	21:45:38	239.18	26.45	48.1	1,797	0	3,149	177	3,900
8/6/2016	9:25:00	232	23.3	33.8	668	0	3,104	3,078	3,848
8/7/2016	20:54:36	241.99	31.99	102.2	1,897	0	3,098	2,948	3,841
8/8/2016	22:09:54	242.13	25.29	80.3	1,773	0	3,093	3,016	3,835

8/9/2016	21:39:19	242.3	31.14	108.4	1,876	0	3,115	3,097	3,861
8/10/2016	16:03:13	256.45	19.53	25.8	1,168	0	3,103	3,048	3,847
8/11/2016	23:41:09	240.4	21.66	120.5	1,682	0	3,106	3,040	3,851
8/12/2016	23:18:45	240.6	19.28	113.6	1,554	0	3,110	3,012	3,855
8/13/2016	20:36:47	240.83	21.53	91.6	1,458	0	3,138	3,109	3,887
8/14/2016	11:16:09	250.79	20.75	92.6	764	0	3,116	3,082	3,861
8/15/2016	16:19:06	241.54	30.47	94.3	1,420	0	3,120	3,028	3,866
8/16/2016	20:49:41	240.1	23.83	105.7	1,528	0	3,123	3,108	3,869
8/17/2016	20:41:49	238.05	17.37	52.4	1,307	0	3,132	2,772	3,880
8/18/2016	19:18:24	237.79	18.41	63.4	1,245	0	3,123	3,037	3,870
8/19/2016	20:56:08	238.05	24.24	68.0	1,601	0	3,120	3,012	3,867
8/20/2016	20:46:15	238.78	23.17	67.6	1,534	0	3,116	3,039	3,862
8/21/2016	21:08:49	240.09	23.7	56.6	1,620	0	3,111	3,034	3,856
8/22/2016	22:58:28	237.9	17.85	31.4	1,559	0	3,162	3,122	3,914
8/23/2016	5:07:49	234.25	24.19	31.1	394	0	3,119	3,097	3,866
8/24/2016	23:56:36	239.26	24.91	84.3	1,910	0	3,117	3,061	3,863
8/25/2016	22:31:11	239.4	20.57	53.2	1,652	0	3,118	3,016	3,864
8/26/2016	22:14:49	239.55	17.97	37.9	1,520	0	3,165	3,074	3,918
8/27/2016	5:09:00	237.79	16.31	36.7	324	0	3,132	3,120	3,880
8/28/2016	23:30:52	241.13	18.08	62.2	1,599	0	3,128	3,097	3,876
8/29/2016	20:34:11	240.63	21.27	52.6	1,490	0	3,136	3,062	3,884
8/30/2016	17:00:30	240.96	21.83	45.0	1,271	0	3,115	3,053	3,861
8/31/2016	23:55:06	239.92	18.68	34.2	1,711	2	3,134	3,114	3,882
9/1/2016	21:29:49	234.88	7.77	-25.2	1,009	1	3,116	3,094	3,862
9/2/2016	17:07:21	236.78	35.49	88.4	1,575	3	3,112	3,062	3,934
9/3/2016	22:17:00	237.97	23.17	82.0	1,683	1	3,114	3,075	3,859
9/4/2016	19:28:09	239.93	24.26	109.6	1,480	0	3,115	2,987	3,860
9/5/2016	21:49:28	239.53	23.49	109.0	1,578	1	3,107	3,006	3,852
9/6/2016	23:27:11	238.66	23.79	108.4	1,730	2	3,103	3,002	3,846
9/7/2016	21:16:09	240.56	30.37	96.7	1,806	2	3,107	2,985	3,928
9/8/2016	20:15:00	237.35	26.87	105.0	1,545	1	3,109	2,995	3,854
9/9/2016	19:20:49	236.82	28.54	99.1	1,546	1	3,104	2,998	3,848
9/10/2016	20:51:06	237.19	27.32	88.6	1,642	1	3,098	2,980	3,841
9/11/2016	22:41:49	238.86	25.19	89.9	1,747	1	3,079	2,972	3,819
9/12/2016	23:56:32	243.1	29.86	69.8	2,132	1	3,113	3,106	3,858
9/13/2016	13:36:00	236.7	28.21	74.8	1,151	3	3,085	3,001	3,903
9/14/2016	23:49:22	237.53	27.13	73.8	1,990	1	3,075	2,963	3,815
9/15/2016	21:18:15	236.44	33.62	80.5	1,972	0	3,093	2,907	3,835
9/16/2016	14:45:06	235.86	30.51	67.6	1,267	2	3,107	3,090	3,928
9/17/2016	1:11:45	213.9	14.89	127.2	471	0	3,134	3,129	3,882
9/18/2016	12:31:48	216.54	12.74	102.1	719	0	3,130	3,124	3,877
9/19/2016	24:00:00	218.64	10.6	77.2	1,233	0	3,106	3,083	3,851
9/20/2016	23:02:52	242.5	23.53	44.3	1,866	0	3,103	3,009	3,846
9/21/2016	20:57:52	262.55	23.77	71.0	1,650	0	3,100	2,997	3,843
9/22/2016	22:02:58	259.85	22.56	82.1	1,648	1	3,092	2,974	3,834
9/23/2016	22:39:58	245.9	25.97	72.7	1,821	2	3,097	2,977	3,840
9/24/2016	21:58:43	265.35	19.75	67.5	1,563	1	3,089	2,972	3,831
9/25/2016	22:13:41	247.75	22.13	50.8	1,697	2	3,087	2,970	3,905
9/26/2016	22:24:43	248.36	21.46	49.7	1,660	3	3,085	2,956	3,902
9/27/2016	20:58:39	252.15	24.69	43.5	1,721	3	3,071	2,953	3,887
9/28/2016	22:12:13	239.29	25.72	27.5	1,877	3	3,106	2,287	3,927
9/29/2016	12:22:38	252.52	28.19	22.5	1,105	2	3,148	2,038	3,973
9/30/2016	0:00:00	-0.73	0	77.7	0	0	3,160	3,161	3,912
10/1/2016	11:19:04	207.87	1.99	-8.9	243	0	3,177	3,178	3,932
10/2/2016	0:57:26	200.41	1.1	-14.0	17	0	3,189	3,189	3,945
10/3/2016	0:02:04	238.01	1.17	59.7	1	0	3,160	3,156	3,913
10/4/2016	20:08:32	269.89	10.26	84.8	1,034	1	3,104	3,069	3,848
10/5/2016	23:24:35	659.82	20.97	84.4	2,514	0	3,108	3,076	3,853
10/6/2016	1:31:11	514.11	14.68	95.7	180	0			#N/A
10/7/2016	21:13:22	228.86	25.11	102.8	1,637	0	3,107	3,081	3,852
10/8/2016	23:50:09	227.04	27.95	101.0	1,941	0	3,073	3,041	3,812
10/9/2016	24:00:00	226.09	38.01	83.8	2,349	0	3,051	2,939	3,787
10/10/2016	23:59:13	227.14	42.89	78.5	2,509	0	3,001	2,819	3,728
10/11/2016	24:00:00	239.23	68.63	54.7	3,336	1	2,972	2,781	3,695
10/12/2016	24:00:00	248.31	73.45	47.3	3,541	5	2,960	2,782	3,833
10/13/2016	24:00:00	253.31	63.26	53.2	3,291	2	2,933	2,748	3,650
10/14/2016	24:00:00	252.2	75.38	42.1	3,638	4	2,913	2,731	3,705
10/15/2016	24:00:00	249.5	78.85	43.3	3,696	3	2,913	2,749	3,705
10/16/2016	24:00:00	255.96	62.64	56.6	3,273	1	2,984	2,984	3,708
10/17/2016	17:16:36	249.34	46.38	22.3	1,898	4	2,943	2,871	3,740
10/18/2016	22:58:28	262.13	48.58	29.7	2,802	2	2,930	2,814	3,725
10/19/2016	24:00:00	264.33	48.18	39.1	2,914	1	3,002	2,946	3,730
10/20/2016	10:37:08	296.94	34.38	79.1	1,055	0	2,986	2,928	3,712
10/21/2016	20:47:21	275.38	28.45	37.9	1,854	1	3,010	2,976	3,739
10/22/2016	20:02:24	274.02	17.96	35.0	1,280	1	3,018	3,016	3,749
10/23/2016	21:36:32	254.5	13.09	-105.5	1,449	0	3,031	3,027	3,764
10/24/2016	22:19:15	342.18	6.23	-54.9	1,256	0	3,014	2,968	3,744
10/25/2016	15:18:51	299.36	70.07	45.4	2,108	1	3,006	2,968	3,735
10/26/2016	18:03:02	251.23	23.99	22.2	1,529	1	2,974	2,940	3,697
10/27/2016	23:58:43	265.42	24.44	35.6	2,099	1	2,982	2,891	3,706
10/28/2016	23:51:28	265.22	11.97	53.9	1,397	2	2,976	2,897	3,699
10/29/2016	21:32:45	264.74	29.55	74.9	1,983	1	2,923	2,772	3,637

10/30/2016	24:00:00	689.24	25.74	58.6	3,391	0	2,902	2,752	3,613
10/31/2016	23:44:47	719.88	22.44	53.5	3,319	2	2,937	2,846	3,733
11/1/2016	23:45:28	266.71	26.4	65.6	2,044	1	3,006	464	3,734
11/2/2016	10:50:38	479.48	11.87	70.1	878	0	3,056	3,057	3,793
11/3/2016	0:00:04	235	1.16	102.1	0	0	3,065	3,011	3,803
11/4/2016	7:44:52	246.95	16.32	80.7	459	0	3,032	2,909	3,764
11/5/2016	19:13:58	243.72	27.69	79.9	1,608	0	3,072	2,530	3,811
11/6/2016	7:23:13	242.44	17.21	42.2	511	0	3,097	3,003	3,840
11/7/2016	0:00:08	47.72	1.16	57.1	0	0	3,110	2,593	3,854
11/8/2016	1:03:39	252.98	18.98	52.7	74	0	3,122	1,422	3,869
11/9/2016	0:00:09	254.98	1.1	57.9	0	0	3,132	3,134	3,880
11/10/2016	0:16:58	247.74	31.44	45.7	26	0	3,081	3,054	3,821
11/11/2016	15:57:30	241.98	31.22	45.5	1,514	1	3,030	3,006	3,762
11/12/2016	23:49:43	243.01	31.52	23.1	2,336	1	3,051	3,048	3,787
11/13/2016	23:47:56	235.06	15.79	-91.3	1,890	1	3,071	3,071	3,810
11/14/2016	21:57:39	233.49	4.56	-200.0	1,405	1	3,111	3,113	3,856
11/15/2016	0:00:04	246.04	1.36	36.4	0	0	3,128	3,044	3,875
11/16/2016	0:00:02	244.39	1.14	49.4	0	0	3,080	3,024	3,820
11/17/2016	22:18:58	243.43	22.06	77.3	1,697	0	3,063	3,039	3,801
11/18/2016	22:10:21	250.78	23.13	80.8	1,754	1	3,039	3,014	3,773
11/19/2016	24:00:00	260.19	28.95	62.2	2,243	0	3,081	2,927	3,822
11/20/2016	13:25:09	243.18	21.1	81.3	1,002	0	3,113	2,969	3,859
11/21/2016	0:00:26	229.14	2.22	72.6	0	0	3,046	2,963	3,782
11/22/2016	16:08:00	245.19	41.24	21.5	1,823	1	3,006	2,839	3,735
11/23/2016	23:44:00	248.42	40.29	27.7	2,648	1	2,973	2,535	3,697
11/24/2016	21:16:41	255.45	34.19	24.7	2,126	2	3,074	871	3,813
11/25/2016	23:09:54	230.17	3.59	48.1	580	1	3,027	2,998	3,759
11/26/2016	24:00:00	249.62	26	51.7	2,094	1	3,049	2,987	3,785
11/27/2016	24:00:00	237.87	11.48	99.5	1,278	1	2,991	2,894	3,717
11/28/2016	23:41:43	249.74	24.35	33.6	2,019	1	3,077	492	3,817
11/29/2016	1:12:06	228.49	8.62	14.6	53	0	3,104	3,106	3,848
11/30/2016	0:00:17	239.56	1.13	69.9	0	0	3,117	93	3,863
12/1/2016	1:04:39	7.48	1.54	61.0	6	0	3,127	90	3,874
12/2/2016	0:00:11	-1.35	1.01	40.3	0	0	3,136	87	3,885
12/3/2016	0:00:04	-1.25	1	38.1	0	0	3,144	83	3,894
12/4/2016	0:00:00	-1.1	1	37.2	0	0	3,152	81	3,903
12/5/2016	0:00:11	-1.09	1.01	42.5	0	0	3,157	78	3,909
12/6/2016	0:04:26	-1.13	1.07	53.4	0	0	3,056	2,992	3,793
12/7/2016	13:54:28	239.01	93.77	36.2	2,297	1	2,952	2,831	3,672
12/8/2016	23:57:47	240.69	113.3	40.5	4,328	2	2,890	2,651	3,678
12/9/2016	24:00:00	241.4	132.79	43.1	4,705	15	2,809	2,497	3,732
12/10/2016	24:00:00	246.5	190.78	45.2	5,669	26	2,760	2,450	3,747
12/11/2016	24:00:00	245.45	194.01	46.2	5,697	24	2,718	2,404	3,700
12/12/2016	24:00:00	244.72	197.15	48.1	5,721	22	2,677	2,358	3,653
12/13/2016	24:00:00	250.27	197.92	49.1	5,787	22	2,630	2,293	3,601
12/14/2016	24:00:00	245.92	215.11	49.0	5,979	25	2,585	2,228	3,549
12/15/2016	24:00:00	246.1	229.84	54.2	6,141	22	2,536	2,159	3,494
12/16/2016	24:00:00	245.95	243.45	54.2	6,315	21	2,527	2,252	3,483
12/17/2016	24:00:00	250.63	208.73	54.3	5,889	22	2,659	2,573	3,634
12/18/2016	23:55:22	255.14	68.97	90.6	3,206	3	2,565	2,293	3,295
12/19/2016	24:00:00	254.63	137.59	59.6	4,801	13	2,767	2,724	3,684
12/20/2016	4:11:22	251.94	196.71	45.5	1,010	86	2,547	2,220	3,507
12/21/2016	24:00:00	281.26	169.05	46.3	5,666	9	2,490	2,174	3,290
12/22/2016	24:00:00	290.58	173.71	58.7	5,787	18	2,446	2,101	3,317
12/23/2016	24:00:00	287.25	177.13	60.3	5,800	19	2,418	2,100	3,285
12/24/2016	24:00:00	293.06	169.96	63.2	5,724	18	2,395	2,072	3,258
12/25/2016	24:00:00	298.45	155.96	64.7	5,530	18	2,374	2,054	3,234
12/26/2016	24:00:00	298.98	146.17	54.8	5,419	18	2,437	2,262	3,307
12/27/2016	24:00:00	300.49	90.32	53.5	4,245	9	2,396	2,117	3,177
12/28/2016	24:00:00	299.72	100.95	36.9	4,588	15	2,358	2,068	3,216
12/29/2016	24:00:00	299.72	103.05	29.7	4,680	18	2,324	1,985	3,176
12/30/2016	24:00:08	345.79	126.25	27.2	4,934	10	2,538	2,541	3,423
12/31/2016	12:31:24	357.07	128.96	26.9	3,015	3	2,392	2,114	3,083
1/1/2017	20:31:22	270.83	148.08	50.1	4,451	0	2,299	1,933	2,887
1/2/2017	24:00:00	274.44	169.68	60.2	5,549	0	2,263	1,900	2,843
1/3/2017	24:00:00	274.99	173.99	63.7	5,604	0	2,236	1,858	2,810
1/4/2017	24:00:00	274.39	172.22	64.7	5,562	0	2,183	1,760	2,743
1/5/2017	24:00:00	268.95	205.49	62.6	6,020	0	2,086	1,397	2,622
1/6/2017	24:00:00	288.1	264.47	68.6	7,002	0	2,069	1,392	2,600
1/7/2017	19:38:30	303.54	261.27	53.6	5,941	25	2,013	1,339	2,888
1/8/2017	24:00:00	304.79	255.83	59.5	7,168	33	1,977	1,316	2,845
1/9/2017	24:00:00	301.24	247.11	59.2	7,008	33	1,951	1,319	2,813
1/10/2017	22:41:47	306	265.03	64.7	6,839	34	1,958	1,383	2,822
1/11/2017	21:35:58	300.06	216.8	35.7	5,994	33	1,988	1,650	2,858
1/12/2017	24:00:00	313.54	179.41	51.2	6,023	31	2,104	1,789	2,995
1/13/2017	19:47:54	325.62	92.17	42.1	3,655	10	1,981	1,451	2,755
1/14/2017	23:45:39	320.33	172.45	62.2	5,893	30	1,958	1,508	2,822
1/15/2017	23:39:21	319.66	172.04	66.9	5,732	37	1,937	1,503	2,796
1/16/2017	24:00:00	319.79	173.95	66.8	5,908	39	1,863	1,169	2,706
1/17/2017	24:00:00	298.56	232.09	69.7	6,642	52	1,867	1,289	2,710
1/18/2017	24:00:00	323.41	190.67	71.1	6,231	42	1,863	1,375	2,705
1/19/2017	0:00:00	367.97	155.13	70.2	5,718	4	2,074	1,848	2,681

1/20/2017	0:00:00	181.96	65.37	68.9	174	5	1,922	1,533	2,484
1/21/2017	23:58:28	322.86	137.87	58.2	5,398	20	1,912	1,443	2,766
1/22/2017	24:00:00	330.53	124.51	66.1	5,113	24	1,888	1,181	2,736
1/23/2017	23:03:11	330.91	141.02	68.4	5,273	32	0	0	#N/A
1/24/2017	0:00:00	245.76	0	52.4	0	0	0	0	#N/A
1/25/2017	0:00:00	252.46	0	41.5	0	0	0	0	#N/A
1/26/2017	0:00:00	270.04	0	53.4	0	0	0	0	#N/A
1/27/2017	0:00:00	256.69	0	36.0	0	0	0	0	#N/A
1/28/2017	0:00:00	256.05	0	29.9	0	0	0	0	#N/A
1/29/2017	0:00:00	255.89	0	32.6	0	0	0	0	#N/A
1/30/2017	0:00:00	255.99	0	30.3	0	0	0	0	#N/A
1/31/2017	0:00:00	256.67	0	29.0	0	0	0	0	#N/A
2/1/2017	0:00:00	256.67	0	39.1	0	0	0	0	#N/A
2/2/2017	0:00:00	256.35	0	34.6	0	0	0	0	#N/A
2/3/2017	0:00:00	256.77	0	30.9	0	0	2,324	2,326	2,918
2/4/2017	20:21:39	262.08	49.12	38.9	2,541	14	2,246	2,247	3,083
2/5/2017	24:00:00	263.66	68.18	38.8	3,544	25	2,119	2,120	3,013
2/6/2017	24:00:00	276.19	99.35	40.6	4,352	44	2,031	2,031	2,910
2/7/2017	24:00:00	297.69	103.23	48.1	4,578	58	1,999	1,999	2,871
2/8/2017	24:00:00	308.98	93.57	51.7	4,402	59	1,807	1,806	2,635
2/9/2017	24:00:00	289.77	199.01	49.4	5,938	112	2,187	1,198	3,093
2/10/2017	12:51:52	268.65	214.55	33.6	3,338	20	2,042	2,043	2,922
2/11/2017	18:43:13	287.88	81.21	52.9	3,103	5	1,970	1,971	2,547
2/12/2017	24:00:00	301.17	83.74	61.4	4,097	16	1,937	1,938	2,696
2/13/2017	23:51:17	302.86	82.27	63.5	4,031	20	1,862	1,863	2,704
2/14/2017	23:58:34	307.47	123.64	59.2	4,954	45	1,791	1,791	2,614
2/15/2017	24:00:00	302.91	156.37	59.5	5,606	50	1,763	1,763	2,577
2/16/2017	23:55:00	292.19	154.04	60.8	5,359	41	1,747	1,748	2,556
2/17/2017	23:34:24	279.24	168.26	60.6	5,432	34	1,706	1,706	2,501
2/18/2017	23:42:41	302.95	158.84	64.0	5,554	37	1,706	1,706	2,501
2/19/2017	24:00:00	320.63	123.53	68.8	5,033	33	1,665	1,665	2,444
2/20/2017	24:00:00	306.5	154.65	65.2	5,565	39	1,651	1,651	2,424
2/21/2017	24:00:00	312.46	138.58	69.4	5,255	34	1,689	1,689	2,478
2/22/2017	24:00:00	324.49	96.02	77.2	4,384	22	1,724	1,724	2,525
2/23/2017	24:00:00	328.16	74.17	83.1	3,836	12	1,745	1,745	2,433
2/24/2017	24:00:00	328.05	66.69	84.9	3,625	2	1,812	1,812	2,273
2/25/2017	21:55:38	333.58	51.54	102.6	2,746	2	1,695	1,695	2,123
2/26/2017	23:33:22	294.27	149.57	58.8	5,230	2	1,629	747	2,038
2/27/2017	15:11:30	268	178.25	61.6	3,541	2	0	0	#N/A
2/28/2017	14:03:30	253.65	94.53	64.6	5,947	3	0	1,699	#N/A
3/1/2017	23:59:30	274.58	174.73	78.6	5,387	30	0	1,670	#N/A
3/2/2017	24:00:00	246	152.72	77.3	4,899	26	0	1,666	#N/A
3/3/2017	24:00:00	246.44	143.13	77.4	4,742	30	0	0	#N/A
3/4/2017	3:23:34	254.61	138.67	76.9	670	1	0	0	#N/A
3/5/2017	0:00:00	249.28	0	58.8	0	0	0	0	#N/A
3/6/2017	0:00:00	252.08	0	71.0	0	0	0	0	#N/A
3/7/2017	0:00:00	253.21	0	72.4	0	0	2,226	1,984	2,797
3/8/2017	11:39:19	292.56	87.05	95.3	1,895	56	2,225	1,953	3,136
3/9/2017	23:57:22	254.31	58.63	96.2	3,039	32	2,161	1,836	3,062
3/10/2017	24:00:00	272.97	70.7	90.4	3,460	31	1,922	1,186	2,778
3/11/2017	24:00:00	282.84	167.28	65.0	5,568	58	1,809	1,063	2,637
3/12/2017	23:35:41	283.2	179.2	44.0	5,798	1	1,874	1,430	2,353
3/13/2017	22:35:49	245.49	88.41	16.7	3,753	32	1,884	1,497	2,732
3/14/2017	24:00:00	250.44	106.94	85.2	4,119	23	1,876	1,477	2,721
3/15/2017	24:00:00	248.27	106.62	82.2	4,108	24	1,876	1,486	2,722
3/16/2017	24:00:00	265.77	98.75	84.0	4,081	2	1,839	1,405	2,308
3/17/2017	24:00:00	271.4	114.9	81.5	4,457	1	1,820	1,379	2,284
3/18/2017	24:00:00	278.54	113.71	66.5	4,559	18	1,830	1,463	2,552
3/19/2017	23:47:04	307.03	83.84	23.6	4,210	21	1,807	1,414	2,635
3/20/2017	23:50:11	304.23	92.87	25.7	4,469	20	1,785	1,354	2,607
3/21/2017	24:00:00	302.96	111.55	86.2	4,616	21	1,833	1,508	2,668
3/22/2017	22:55:49	318.74	82.6	98.0	3,779	13	1,789	1,381	2,495
3/23/2017	25:33:56	253.86	129.59	102.8	4,804	18	1,848	1,545	2,577
3/24/2017	19:35:04	254.57	99.81	105.8	3,206	8	1,991	1,860	2,662
3/25/2017	20:33:52	326.33	42.33	126.5	2,292	3	2,058	1,959	2,661
3/26/2017	21:08:34	331.3	28.99	132.6	1,970	2	2,053	1,896	2,580
3/27/2017	22:43:11	330.21	42.49	120.1	2,567	3	2,084	1,965	2,694
3/28/2017	22:01:15	328.38	38.88	125.1	2,326	4	2,039	1,768	2,636
3/29/2017	23:05:26	312.52	59.87	38.2	3,107	3	2,198	2,198	2,840
3/30/2017	3:58:34	280.11	71.75	11.3	628	3	2,179	2,147	2,816
3/31/2017	24:00:00	298.28	26.67	129.2	2,035	1	2,141	2,021	2,691
4/1/2017	23:45:04	300.88	44.68	112.9	2,609	2	2,102	1,988	2,641
4/2/2017	19:59:52	292.89	70.64	103.6	2,924	6	2,126	2,027	2,839
4/3/2017	17:41:49	272.6	75.57	104.0	2,524	68	2,226	2,214	3,138
4/4/2017	13:04:00	281.92	42.28	87.3	1,356	1	2,080	1,843	2,614
4/5/2017	22:19:30	253.22	90.43	77.0	3,560	8	2,101	1,973	2,807
4/6/2017	23:58:00	293.87	51.29	101.4	2,921	8	1,993	1,726	2,665
4/7/2017	24:00:00	258.19	95.49	76.7	3,959	11	1,884	1,462	2,626
4/8/2017	23:55:08	299.3	124.8	79.6	4,829	55	1,896	1,535	2,746
4/9/2017	24:00:00	300.13	82.18	92.4	3,836	9	1,985	1,848	2,654
4/10/2017	24:00:00	300.39	42.63	110.5	2,691	5	2,060	1,965	2,753
4/11/2017	23:18:30	300.39	29.57	119.8	2,122	2	2,032	1,859	2,554

4/12/2017	23:59:41	300.1	53.11	101.6	3,041	5	1,895	1,511	2,448
4/13/2017	24:00:00	295.53	109.09	85.9	4,395	57	1,817	1,466	2,647
4/14/2017	24:00:00	296.67	137.03	89.8	4,949	26	1,935	1,749	2,794
4/15/2017	23:46:30	300.76	51.51	105.5	2,914	7	2,012	1,918	2,690
4/16/2017	23:43:30	300.03	29.63	118.4	2,217	2	2,052	1,945	2,578
4/17/2017	23:01:34	300.16	26.36	120.4	1,995	3	2,148	2,094	2,776
4/18/2017	12:19:26	289.62	26.43	120.0	983	1	2,241	2,243	2,816
4/19/2017	1:38:34	301.95	9.79	140.3	82	2	2,281	2,265	2,865
4/20/2017	5:44:49	272.79	18.6	119.1	291	0	2,242	2,216	2,817
4/21/2017	23:18:26	304.3	22.8	119.3	1,918	1	2,196	2,093	2,760
4/22/2017	24:00:00	294.21	35.62	105.3	2,473	3	2,139	2,015	2,765
4/23/2017	24:00:00	239.45	59.07	83.1	3,009	4	2,111	1,987	2,729
4/24/2017	24:00:00	263.96	53.77	89.4	2,978	31	2,087	1,947	2,975
4/25/2017	24:00:00	241.09	59.61	86.9	3,022	4	2,166	2,090	2,799
4/26/2017	23:35:26	288.65	22.11	126.5	1,712	2	2,275	2,275	2,857
4/27/2017	3:07:22	291.06	13.43	107.9	190	0	2,322	2,321	2,916
4/28/2017	4:30:56	291.48	9.71	127.1	241	0	2,352	2,352	2,953
4/29/2017	5:27:19	300.14	7.32	135.0	251	0	2,374	2,375	2,980
4/30/2017	7:28:56	300.98	5.53	140.2	300	0	2,396	2,389	3,007
5/1/2017	4:21:49	272.8	17.84	87.7	309	0	2,353	2,323	2,954
5/2/2017	23:33:49	285.18	17.39	113.6	1,657	1	2,282	2,167	2,867
5/3/2017	24:00:00	282.31	45.17	89.1	2,781	1	2,202	2,078	2,767
5/4/2017	24:00:00	254.24	73.44	73.2	3,481	3	2,190	2,080	2,830
5/5/2017	24:00:00	285.79	50.82	87.8	2,969	4	2,302	2,282	2,970
5/6/2017	10:47:04	277.93	43.36	89.9	1,161	1	2,011	1,531	2,527
5/7/2017	24:00:00	251.6	201.81	70.0	5,690	22	2,017	1,810	2,892
5/8/2017	24:00:00	254.27	104.39	89.7	3,986	7	1,981	1,722	2,650
5/9/2017	24:00:00	294.47	83.16	91.3	3,878	41	2,184	678	3,089
5/10/2017	10:20:49	284.87	42.64	98.1	1,130	4	2,176	2,115	2,811
5/11/2017	24:00:00	269.28	27.06	116.1	2,043	2	2,106	1,993	2,722
5/12/2017	24:00:00	254.76	59.98	94.8	3,080	4	2,039	1,859	2,636
5/13/2017	24:00:00	253.55	77.69	87.1	3,529	5	2,052	1,896	2,744
5/14/2017	23:42:34	290.76	58.97	100.1	3,066	4	2,153	2,152	2,783
5/15/2017	11:12:30	296.38	61.32	51.1	1,590	47	2,012	1,744	2,887
5/16/2017	24:00:00	294.75	91.53	83.5	4,033	8	2,009	1,840	2,686
5/17/2017	24:00:00	309.42	62.72	100.5	3,386	8	1,977	1,746	2,644
5/18/2017	23:04:15	307.39	76.92	96.5	3,564	12	1,969	1,725	2,739
5/19/2017	21:08:49	307.94	74.91	74.6	3,341	9	1,897	1,527	2,536
5/20/2017	20:34:34	278.56	145.92	79.3	4,314	14	1,853	1,520	2,584
5/21/2017	24:00:00	290.57	119.45	82.3	4,631	27	1,809	1,439	2,637
5/22/2017	24:00:00	283.78	132.22	80.6	4,843	29	1,805	1,465	2,633
5/23/2017	24:00:00	286.9	114.25	81.7	4,465	25	1,802	1,504	2,628
5/24/2017	24:00:00	300.95	101.66	83.1	4,347	20	1,791	1,468	2,614
5/25/2017	24:00:00	302.02	99.77	81.9	4,322	24	1,772	1,443	2,589
5/26/2017	24:00:00	299.4	104.71	82.0	4,409	25	1,788	1,526	2,610
5/27/2017	24:00:00	308.96	85.07	84.7	4,053	20	1,806	1,601	2,633
5/28/2017	24:00:00	309.9	73.68	86.4	3,765	16	1,820	1,611	2,539
5/29/2017	24:00:00	310.19	66.68	86.3	3,586	15	1,805	1,549	2,517
5/30/2017	24:00:00	309.68	74.73	84.7	3,798	16	1,799	1,574	2,509
5/31/2017	24:00:00	310.64	72.46	87.0	3,745	18	1,765	1,463	2,461
6/1/2017	24:00:00	308.27	88.71	83.0	4,143	131	1,930	213	2,788
6/2/2017	11:08:45	308.28	96.6	84.0	2,016	12	2,085	380	2,887
6/3/2017	3:05:34	216.36	55.76	55.0	292	2	1,954	1,845	2,454
6/4/2017	24:00:00	307.32	66.31	74.1	3,576	2	1,913	1,774	2,472
6/5/2017	24:00:00	309.9	60.5	80.5	3,448	4	1,869	1,676	2,414
6/6/2017	24:00:00	308.55	72.67	79.8	3,745	12	1,814	1,520	2,530
6/7/2017	24:00:00	309.33	82.01	81.1	3,989	16	1,761	1,472	2,456
6/8/2017	24:00:00	308.31	92.09	82.0	4,231	24	1,771	1,525	2,588
6/9/2017	24:00:00	309.74	78.15	84.9	3,893	21	1,796	1,611	2,621
6/10/2017	24:00:00	309.52	65.63	88.4	3,532	16	1,826	1,671	2,546
6/11/2017	24:00:00	309.95	53.38	92.2	3,172	8	1,819	1,637	2,431
6/12/2017	24:00:00	309.79	61.91	89.0	3,424	9	1,825	1,660	2,439
6/13/2017	24:00:00	309.91	57.44	91.9	3,282	9	1,823	1,652	2,436
6/14/2017	24:00:00	309.88	58.41	89.7	3,317	11	1,820	1,638	2,538
6/15/2017	24:00:00	309.79	60.07	90.1	3,354	12	1,815	1,645	2,531
6/16/2017	24:00:00	309.84	61.93	89.3	3,408	13	1,817	1,653	2,535
6/17/2017	24:00:00	309.87	56.78	90.3	3,262	12	1,833	1,684	2,557
6/18/2017	24:00:00	309.97	50.6	94.1	3,056	10	1,829	1,664	2,552
6/19/2017	24:00:00	309.92	54.54	90.2	3,193	12	1,809	1,610	2,524
6/20/2017	24:00:00	309.84	61.57	86.0	3,412	12	1,804	1,620	2,517
6/21/2017	24:00:00	309.78	59.41	87.9	3,345	11	1,813	1,648	2,529
6/22/2017	24:00:00	309.8	55.98	90.6	3,224	11	1,813	1,646	2,529
6/23/2017	24:00:00	309.77	56.13	90.2	3,228	11	1,810	1,645	2,524
6/24/2017	24:00:00	309.53	57.27	88.1	3,265	11	1,796	1,625	2,506
6/25/2017	24:00:00	301.79	67.14	87.5	3,407	13	1,778	1,568	2,479
6/26/2017	24:00:00	309.76	63.23	84.8	3,484	12	1,758	1,511	2,452
6/27/2017	24:00:00	310.04	71.08	82.8	3,717	19	1,741	1,496	2,428
6/28/2017	24:00:00	310.75	72.94	82.3	3,782	17	1,752	1,557	2,443
6/29/2017	24:00:00	310.07	63.91	85.4	3,503	13	1,771	1,607	2,469
6/30/2017	24:00:00	309.66	57.93	89.4	3,291	10	1,786	1,646	2,385
7/1/2017	24:00:00	309.9	53.17	91.3	3,126	11	1,788	1,644	2,494
7/2/2017	24:00:00	310.03	52.07	88.7	3,125	11	1,784	1,591	2,489

7/3/2017	24:00:00	308.54	58.93	87.1	3,283	13	1,785	1,635	2,490
7/4/2017	24:00:00	309.9	53.33	90.2	3,137	12	1,793	1,639	2,500
7/5/2017	24:00:00	309.75	51.59	90.8	3,077	11	1,786	1,628	2,492
7/6/2017	24:00:00	309.65	55.53	87.6	3,214	10	1,771	1,597	2,470
7/7/2017	24:00:00	309.78	60.12	85.0	3,365	15	1,762	1,578	2,457
7/8/2017	24:00:00	309.71	60.29	84.3	3,376	16	1,753	1,572	2,444
7/9/2017	24:00:00	309.98	60.73	83.6	3,403	16	1,751	1,580	2,442
7/10/2017	24:00:00	309.64	58.73	84.3	3,347	16	1,744	1,539	2,431
7/11/2017	24:00:00	309.51	63.98	82.6	3,495	16	1,872	1,865	2,610
7/12/2017	24:00:00	302.4	34.67	122.4	1,850	9	1,992	1,992	2,664
7/13/2017	24:00:00	307.27	2.39	127.9	607	1	1,909	1,843	2,398
7/14/2017	24:00:00	310.17	47.75	80.3	2,926	1	1,870	1,779	2,348
7/15/2017	24:00:00	309.8	50.45	77.2	3,150	6	1,810	1,559	2,418
7/16/2017	24:00:00	295.36	78.29	74.5	3,688	9	1,788	1,639	2,389
7/17/2017	24:00:00	297.62	74.33	82.0	3,501	9	1,778	1,598	2,374
7/18/2017	24:00:00	309.53	61.45	83.5	3,355	9	1,784	1,661	2,382
7/19/2017	24:00:00	309.9	53.97	86.3	3,154	9	1,786	1,665	2,386
7/20/2017	24:00:00	310.3	48.71	85.8	3,078	9	1,782	1,648	2,380
7/21/2017	24:00:00	309.37	50.35	84.1	3,131	9	1,777	1,651	2,373
7/22/2017	24:00:00	309.71	51.14	82.9	3,161	10	1,822	1,631	2,541
7/23/2017	24:00:00	310.06	51.69	80.9	3,187	12	2,136	1,512	2,951
7/24/2017	24:00:00	309.17	64.72	78.9	3,538	17	1,744	1,288	2,431
7/25/2017	24:00:00	306.78	95.33	77.1	4,301	27	1,716	1,533	2,515
7/26/2017	24:00:00	309.6	62.44	80.8	3,450	14	1,688	1,424	2,351
7/27/2017	24:00:00	309.48	68.27	80.5	3,605	14	1,704	1,508	2,374
7/28/2017	24:00:00	309.6	64.21	80.7	3,498	15	1,723	1,569	2,401
7/29/2017	24:00:00	309.9	57.42	81.0	3,287	13	1,722	1,570	2,400
7/30/2017	24:00:00	309.75	54.8	79.5	3,231	10	1,738	1,584	2,423
7/31/2017	24:00:00	309.94	49.96	83.2	3,069	9	1,737	1,572	2,317
8/1/2017	24:00:00	308.38	56.25	81.7	3,213	11	1,730	1,583	2,412
8/2/2017	24:00:00	308.21	59.13	83.0	3,264	11	1,741	1,606	2,427
8/3/2017	24:00:00	310.16	48.59	82.9	3,012	8	1,729	1,583	2,307
8/4/2017	24:00:00	309.87	53.34	80.3	3,185	10	1,731	1,590	2,414
8/5/2017	24:00:00	310.06	52.01	79.8	3,132	10	1,726	1,582	2,302
8/6/2017	24:00:00	309.86	52.93	78.6	3,175	10	1,727	1,567	2,407
8/7/2017	24:00:00	310.1	51.36	79.4	3,126	11	1,724	1,574	2,403
8/8/2017	24:00:00	309.9	53.1	78.7	3,189	11	1,713	1,536	2,387
8/9/2017	24:00:00	309.94	53.9	77.4	3,241	11	1,697	1,521	2,364
8/10/2017	24:00:00	310.13	57.28	77.6	3,363	14	1,604	1,232	2,229
8/11/2017	24:00:00	272.21	120.96	74.4	4,441	29	1,677	1,516	2,461
8/12/2017	24:00:00	309.93	55.71	80.1	3,280	10	1,677	1,469	2,234
8/13/2017	24:00:00	301.83	67.24	78.0	3,456	14	1,564	1,141	2,168
8/14/2017	24:00:00	254.01	150.95	73.9	4,938	28	1,531	1,119	2,247
8/15/2017	24:00:00	255.02	150.36	75.9	4,914	23	1,558	1,379	2,288
8/16/2017	24:00:00	271.29	120.9	79.4	4,349	12	1,612	1,446	2,240
8/17/2017	24:00:00	310.21	59.88	79.4	3,421	8	1,646	1,525	2,191
8/18/2017	24:00:00	309.88	51.73	80.0	3,144	7	1,656	1,540	2,206
8/19/2017	24:00:00	309.84	51.43	77.7	3,144	7	1,664	1,543	2,216
8/20/2017	24:00:00	310.05	50.09	77.2	3,109	7	1,666	1,528	2,219
8/21/2017	24:00:00	309.93	51.64	76.8	3,162	7	1,661	1,515	2,213
8/22/2017	24:00:00	309.91	54.35	76.6	3,240	8	1,659	1,512	2,209
8/23/2017	24:00:00	310.3	53.11	75.9	3,214	8	1,639	1,458	2,181
8/24/2017	24:00:00	310.11	59.34	73.0	3,431	11	1,627	1,432	2,261
8/25/2017	24:00:00	310.44	61.13	73.3	3,487	11	1,621	1,452	2,254
8/26/2017	24:00:00	310.33	59.51	73.8	3,449	12	1,625	1,455	2,259
8/27/2017	24:00:00	309.96	55.67	75.1	3,327	10	1,624	1,451	2,257
8/28/2017	24:00:00	310.27	57.12	74.6	3,372	12	1,608	1,403	2,233
8/29/2017	24:00:00	309.46	64.77	73.8	3,576	15	1,595	1,395	2,214
8/30/2017	24:00:00	309.68	65.02	73.4	3,598	14	1,603	1,434	2,226
8/31/2017	24:00:00	309.97	58.49	75.5	3,405	13	1,592	1,376	2,211
9/1/2017	24:00:00	309.57	63.45	74.0	3,547	15	1,555	1,296	2,155
9/2/2017	24:00:00	308.2	83.35	72.3	4,058	19	1,582	1,442	2,196
9/3/2017	24:00:00	309.76	62.17	74.1	3,492	13	1,591	1,406	2,209
9/4/2017	24:00:00	310.08	55.14	73.2	3,316	10	1,601	1,427	2,223
9/5/2017	24:00:00	310.4	54.85	75.3	3,287	10	1,586	1,399	2,107
9/6/2017	24:00:00	310.09	60.82	72.7	3,475	12	1,556	1,296	2,156
9/7/2017	24:00:00	308.61	72.62	71.8	3,791	20	1,533	1,282	2,122
9/8/2017	24:00:00	309.03	80.78	72.8	3,980	17	1,486	1,077	2,051
9/9/2017	24:00:00	306.26	122.02	78.3	4,771	26	1,411	773	2,053
9/10/2017	24:00:00	295.16	153.99	82.7	5,279	29	1,468	1,129	2,146
9/11/2017	24:00:00	310	81.42	79.3	3,982	12	1,480	1,199	2,042
9/12/2017	24:00:00	310.18	80.25	80.1	3,941	14	1,491	1,222	2,060
9/13/2017	24:00:00	309.93	75.71	81.2	3,802	15	1,497	1,309	2,068
9/14/2017	24:00:00	309.91	69.27	80.9	3,660	11	1,487	1,271	2,054
9/15/2017	24:00:00	310.26	74.27	82.9	3,804	14	1,483	1,272	2,048
9/16/2017	24:00:00	310.02	75.54	84.5	3,807	14	1,496	1,318	2,067
9/17/2017	24:00:00	310.2	63.49	85.2	3,517	11	1,471	1,225	2,029
9/18/2017	24:00:00	310.67	71.54	83.4	3,756	14	1,446	1,072	1,992
9/19/2017	24:00:00	307.39	83.41	85.0	4,006	21	1,460	1,262	2,133
9/20/2017	24:00:00	310.77	71.7	86.8	3,720	12	1,476	1,237	2,037
9/21/2017	24:00:00	310.06	70.53	85.5	3,655	13	1,382	988	1,895
9/22/2017	24:00:00	308.85	126.25	87.7	4,912	27	1,398	1,112	2,031

9/23/2017	24:00:00	309.59	97.3	86.1	4,334	18	1,459	1,313	2,011
9/24/2017	24:00:00	310.96	57.03	86.9	3,326	8	1,478	1,301	1,955
9/25/2017	24:00:00	310.27	56.6	85.8	3,316	8	1,477	1,292	1,955
9/26/2017	24:00:00	310.67	61.46	84.5	3,450	9	1,459	1,264	1,929
9/27/2017	24:00:00	310.39	69.74	84.2	3,679	13	1,432	1,143	1,971
9/28/2017	24:00:00	309.99	78.94	84.7	3,907	12	1,324	675	1,807
9/29/2017	24:00:00	286.03	164.82	90.6	5,353	34	1,304	735	1,875
9/30/2017	24:00:00	282.61	154.19	89.9	5,108	25	1,267	472	1,814
10/1/2017	24:00:00	272.12	163.96	90.3	5,163	25	1,279	707	1,834
10/2/2017	24:00:00	275.93	151.02	89.9	4,967	22	1,294	819	1,858
10/3/2017	24:00:00	289.98	120.17	89.4	4,500	17	1,301	907	1,773
10/4/2017	24:00:00	282.65	128.44	90.7	4,542	17	1,347	1,132	1,842
10/5/2017	24:00:00	309.57	71.05	88.5	3,697	9	1,332	1,047	1,751
10/6/2017	24:00:00	310.38	82.02	86.5	3,997	12	1,368	1,197	1,873
10/7/2017	24:00:00	309.7	65.32	87.9	3,550	9	1,398	1,274	1,844
10/8/2017	24:00:00	310.17	56.05	89.1	3,285	6	1,403	1,238	1,850
10/9/2017	24:00:00	310.48	60.34	86.3	3,420	8	1,406	1,219	1,854
10/10/2017	24:00:00	310.91	62.27	86.5	3,465	9	1,401	1,223	1,847
10/11/2017	24:00:00	310.65	62.84	86.2	3,492	7	1,394	1,211	1,838
10/12/2017	24:00:00	310.1	68.17	85.4	3,621	10	1,263	466	1,654
10/13/2017	24:00:00	260.77	159.67	88.9	4,932	27	1,223	456	1,740
10/14/2017	24:00:00	237.12	185.73	93.7	5,217	30	1,327	1,145	1,913
10/15/2017	24:00:00	296.12	85.3	91.0	3,759	11	1,336	1,026	1,825
10/16/2017	24:00:00	309.14	73.94	87.0	3,734	9	1,216	454	1,588
10/17/2017	24:00:00	261.71	165.31	90.8	5,124	24	1,192	448	1,688
10/18/2017	24:00:00	240.51	177.44	92.8	5,123	25	1,177	444	1,663
10/19/2017	23:59:56	242.18	171.45	94.7	5,036	23	1,200	631	1,702
10/20/2017	24:00:00	302.4	111.48	93.7	4,533	14	1,182	508	1,595
10/21/2017	24:00:00	294.2	121.66	94.5	4,656	18	1,227	862	1,662
10/22/2017	24:00:00	308.64	88.01	92.7	4,085	13	1,278	1,010	1,739
10/23/2017	24:00:00	309.84	64.93	90.8	3,513	9	1,226	792	1,602
10/24/2017	24:00:00	298.83	105.95	88.2	4,382	14	1,162	451	1,565
10/25/2017	24:00:00	281.08	141.94	94.1	4,941	19	1,144	435	1,538
10/26/2017	24:00:00	242.02	163.28	93.0	4,950	14	1,132	433	1,520
10/27/2017	24:00:00	257.26	151.93	94.7	4,897	14	1,127	459	1,513
10/28/2017	24:00:00	298.23	125.75	98.5	4,794	15	1,117	449	1,498
10/29/2017	24:00:00	285.87	131.55	95.8	4,817	11	1,107	430	1,484
10/30/2017	24:00:00	251.56	148.76	93.0	4,813	11	1,103	453	1,478
10/31/2017	24:00:00	294.44	123.86	96.2	4,744	10	1,100	478	1,473
11/1/2017	24:00:00	293.44	122.1	97.7	4,682	11	1,094	457	1,465
11/2/2017	24:00:00	300.84	120.61	100.3	4,708	14	1,088	451	1,456
11/3/2017	24:00:00	297.97	120.24	100.8	4,679	13	1,081	434	1,445
11/4/2017	24:00:00	282.84	126.32	99.2	4,667	12	1,078	452	1,441
11/5/2017	24:00:00	299.74	118.2	105.6	4,630	14	1,113	717	1,492
11/6/2017	24:00:00	306.94	96.62	102.4	4,232	13	1,074	443	1,435
11/7/2017	24:00:00	291.91	121.65	102.2	4,653	11	1,064	417	1,421
11/8/2017	24:00:00	254.7	137.82	100.2	4,629	10	1,061	445	1,373
11/9/2017	24:00:00	289.94	119.87	110.6	4,565	8	1,057	441	1,367
11/10/2017	24:00:00	294.86	116.6	110.8	4,541	9	1,050	422	1,358
11/11/2017	24:00:00	276.82	124.19	108.9	4,542	8	1,048	440	1,354
11/12/2017	24:00:00	291.55	116.51	110.5	4,512	8	1,045	441	1,351
11/13/2017	24:00:00	297.39	112.89	111.5	4,484	8	1,041	439	1,345
11/14/2017	24:00:00	295.6	112.44	111.4	4,463	9	1,036	436	1,339
11/15/2017	24:00:00	293.69	112.51	111.4	4,451	8	1,034	437	1,336
11/16/2017	24:00:00	295.67	111.06	111.9	4,435	8	1,030	436	1,330
11/17/2017	24:00:00	295.16	110.15	111.6	4,414	8	1,027	436	1,325
11/18/2017	24:00:00	295.61	109.45	111.9	4,402	8	1,025	435	1,323
11/19/2017	24:00:00	298.98	107.56	112.1	4,385	9	1,018	412	1,314
11/20/2017	24:00:00	274.26	117.81	110.7	4,397	7	1,017	435	1,312
11/21/2017	24:00:00	297.98	106.42	112.1	4,356	7	1,015	439	1,310
11/22/2017	24:00:00	304.99	103.41	112.8	4,334	9	1,011	439	1,304
11/23/2017	24:00:00	303.66	103.19	112.0	4,325	8	1,008	434	1,300
11/24/2017	24:00:00	303.75	102.5	112.4	4,310	8	1,007	440	1,298
11/25/2017	28:01:45	308.76	99.84	113.5	5,010	9	1,004	432	1,294
11/26/2017	19:58:15	307.54	100.11	113.1	3,561	9	1,001	436	1,290
11/27/2017	24:00:00	305.48	93.5	78.0	4,276	9	999	451	1,287
11/28/2017	24:00:00	305.81	89.02	66.8	4,194	9	1,006	437	1,297
11/29/2017	24:00:00	306.64	88.95	76.9	4,078	7	1,000	433	1,289
11/30/2017	24:00:00	305.66	90.97	73.9	4,219	8	995	431	1,282
12/1/2017	24:00:00	305.32	91.67	70.1	4,266	9	991	427	1,276
12/2/2017	24:00:00	301.24	91.63	65.6	4,262	8	987	428	1,272
12/3/2017	24:00:00	301.55	90.78	65.0	4,247	8	984	425	1,267
12/4/2017	24:00:00	301.73	90.07	65.2	4,231	8	983	428	1,266
12/5/2017	24:00:00	303.84	89.16	66.1	4,218	8	979	423	1,260
12/6/2017	24:00:00	300.63	89.19	63.6	4,210	8	976	422	1,256
12/7/2017	24:00:00	296.92	89.67	63.0	4,202	7	973	421	1,252
12/8/2017	24:00:00	296.13	89.25	63.0	4,188	7	1,166	1,145	1,519
12/9/2017	24:00:00	309.53	18.4	32.0	1,713	1	1,136	971	1,402
12/10/2017	24:00:00	309.77	38.04	30.1	2,828	1	1,120	841	1,382
12/11/2017	24:00:00	308.65	52.06	38.6	3,343	2	1,017	448	1,279
12/12/2017	24:00:00	312.49	109.33	83.6	4,654	5	1,135	686	1,435
12/13/2017	15:01:04	273.99	113.04	73.1	2,773	3	1,012	452	1,273

12/14/2017	24:00:00	324.3	102.08	59.9	4,694	5	994	445	1,248
12/15/2017	28:35:26	266.99	35.9	58.9	5,150	6	987	447	1,271
12/16/2017	19:21:15	328.13	81.9	61.6	3,407	7	982	445	1,264
12/17/2017	24:00:00	330.65	81.09	67.6	4,199	7	978	449	1,259
12/18/2017	24:00:00	335.98	82.1	86.6	4,169	7	975	443	1,254
12/19/2017	24:00:00	337.83	81.05	86.4	4,154	7	971	441	1,249
12/20/2017	24:00:00	337.66	81.75	93.3	4,141	7	966	443	1,243
12/21/2017	24:00:00	332.92	82.37	94.0	4,129	11	965	447	1,277
12/22/2017	24:00:00	336.23	79.29	83.7	4,112	10	963	454	1,238
12/23/2017	24:00:00	340.55	78.01	84.4	4,098	8	958	442	1,231
12/24/2017	24:00:00	335.37	75.84	66.7	4,092	12	955	439	1,262
12/25/2017	24:00:00	333.38	75.19	62.0	4,085	12	951	438	1,258
12/26/2017	24:00:00	331.04	75.07	61.0	4,075	13	949	438	1,254
12/27/2017	24:00:00	330.6	74.81	61.2	4,064	12	946	437	1,250
12/28/2017	24:00:00	331.65	73.87	60.5	4,048	12	945	442	1,248
12/29/2017	24:00:00	338.5	71.76	60.8	4,030	13	943	444	1,246
12/30/2017	24:00:00	341.37	70.72	61.4	4,016	14	941	441	1,242
12/31/2017	24:00:00	339.93	70.56	60.6	4,007	15	938	440	1,238
1/1/2018	24:00:00	339.44	70.34	60.4	3,999	17	937	447	1,237
1/2/2018	24:00:00	347.41	67.97	59.3	3,979	16	942	436	1,244
1/3/2018	24:00:00	329.57	69.92	57.0	3,826	13	940	450	1,241
1/4/2018	24:00:00	343.28	70.26	60.7	4,000	17	931	397	1,228
1/5/2018	24:00:00	292.46	85.28	57.8	4,083	19	926	392	1,221
1/6/2018	24:00:00	267.78	93.15	57.4	4,094	21	922	390	1,258
1/7/2018	24:00:00	266.78	92.67	57.8	4,075	21	928	457	1,267
1/8/2018	24:00:00	346.99	69.5	62.4	3,969	9	927	449	1,189
1/9/2018	24:00:00	353.76	71.26	96.2	3,953	8	926	454	1,187
1/10/2018	24:00:00	355.38	71.64	101.5	3,948	11	924	451	1,219
1/11/2018	24:00:00	356.48	72.48	110.0	3,943	10	928	496	1,225
1/12/2018	24:00:00	356.69	70.65	110.6	3,892	8	921	447	1,181
1/13/2018	24:00:00	355.89	66.98	75.2	3,929	14	917	444	1,208
1/14/2018	24:00:00	350.85	65.78	60.7	3,931	15	913	413	1,202
1/15/2018	24:00:00	322.45	72.53	60.7	3,942	19	940	545	1,242
1/16/2018	24:00:00	348.33	64.82	59.6	3,653	14	914	395	1,204
1/17/2018	24:00:00	302.62	79.52	59.1	3,930	18	913	431	1,202
1/18/2018	24:00:00	328.04	70	58.2	3,913	15	915	451	1,205
1/19/2018	24:00:00	360.77	61.48	59.9	3,831	8	914	462	1,172
1/20/2018	24:00:00	361.3	66.56	96.7	3,855	6	920	492	1,179
1/21/2018	24:00:00	356.89	64.74	112.9	3,716	6	952	627	1,223
1/22/2018	24:00:00	360.09	51.47	111.3	3,329	4	923	474	1,156
1/23/2018	24:00:00	356.45	69.18	111.8	3,843	7	914	454	1,171
1/24/2018	24:00:00	361.02	70.24	115.7	3,883	6	910	452	1,166
1/25/2018	24:00:00	359.89	69.51	115.3	3,859	7	907	448	1,162
1/26/2018	24:00:00	359.43	68.19	106.5	3,853	6	906	451	1,160
1/27/2018	24:00:00	358.92	66.64	96.5	3,845	6	904	443	1,158
1/28/2018	24:00:00	352.64	67.57	96.7	3,841	5	901	449	1,154
1/29/2018	24:00:00	356.44	66.78	97.5	3,834	8	899	446	1,151
1/30/2018	24:00:00	357.69	67.91	110.8	3,820	8	897	441	1,148
1/31/2018	24:00:00	351.02	65.75	86.3	3,823	9	898	451	1,150
2/1/2018	23:59:59	360.46	63.76	87.9	3,803	5	894	442	1,118
2/2/2018	24:00:00	357.44	64.03	86.4	3,803	9	891	440	1,141
2/3/2018	24:00:00	351.32	65.48	89.7	3,804	8	891	441	1,141
2/4/2018	24:00:00	351.62	64.99	89.3	3,792	6	889	440	1,137
2/5/2018	24:00:00	351.98	63.86	81.5	3,793	12	887	440	1,165
2/6/2018	24:00:00	351.72	61.23	62.7	3,790	10	886	439	1,165
2/7/2018	24:00:00	351.21	61.08	63.3	3,780	11	884	438	1,161
2/8/2018	24:00:00	351.07	60.93	62.2	3,779	13	883	438	1,160
2/9/2018	24:00:00	352.67	60.35	62.7	3,767	7	883	449	1,130
2/10/2018	24:00:00	359.3	59.27	64.5	3,756	9	912	631	1,168
2/11/2018	24:00:00	361.88	52.52	61.1	3,505	6	904	515	1,158
2/12/2018	24:00:00	357.14	56.33	61.3	3,604	11	885	439	1,163
2/13/2018	24:00:00	358.61	59.85	62.5	3,712	10	883	439	1,160
2/14/2018	24:00:00	351.85	60.37	65.1	3,754	6	882	439	1,127
2/15/2018	24:00:00	351.89	60.16	65.7	3,745	7	918	648	1,176
2/16/2018	24:00:00	356.24	48.9	59.7	3,374	6	880	436	1,125
2/17/2018	24:00:00	351.39	61.5	63.3	3,794	15	877	437	1,151
2/18/2018	24:00:00	351.29	59.94	63.8	3,743	13	875	437	1,149
2/19/2018	24:00:00	351.78	59.6	64.8	3,731	12	883	528	1,161
2/20/2018	24:00:00	354.8	56.35	65.6	3,636	6	965	875	1,241
2/21/2018	24:00:00	361.19	29.59	51.5	2,621	2	908	447	1,135
2/22/2018	24:00:00	354.89	51.12	56.5	3,378	7	884	440	1,131
2/23/2018	24:00:00	351.2	64.53	64.9	3,877	7	893	567	1,144
2/24/2018	24:00:00	354.44	57.09	64.4	3,657	4	878	442	1,097
2/25/2018	24:00:00	354.35	60.14	65.5	3,757	3	873	438	1,090
2/26/2018	24:00:00	357	59.27	66.0	3,739	9	870	435	1,111
2/27/2018	24:00:00	350.23	59.49	65.4	3,717	9	868	435	1,109
2/28/2018	24:00:00	352.25	59.3	66.5	3,717	7	867	440	1,108
3/1/2018	24:00:00	354.41	58.8	66.9	3,709	9	864	434	1,103
3/2/2018	0:00:00	315.08	69.42	62.3	6,230	0	864	433	1,057
3/3/2018	0:00:00	301.76	74.51	62.4	316	0	919	282	1,126
3/4/2018	0:00:00	289.06	28.26	46.1	3,819	0	1,060	805	1,306
3/5/2018	3:18:53	249.73	5.37	32.0	346	9	921	635	1,181

3/6/2018	24:40:33	340.46	46.48	59.1	4,068	4	941	641	1,179
3/7/2018	23:14:53	354.63	50.93	54.1	3,281	4	899	446	1,123
3/8/2018	24:00:00	337.13	63.25	55.6	3,390	17	892	445	1,173
3/9/2018	24:00:00	360.64	60	57.6	3,584	3	877	437	1,096
3/10/2018	24:00:00	353.66	63.44	63.2	3,864	5	871	440	1,113
3/11/2018	24:00:00	353.07	60.96	64.5	3,780	6	868	439	1,109
3/12/2018	24:00:00	353.78	59.32	64.0	3,728	6	1,014	892	1,309
3/13/2018	24:00:00	322.51	28.21	48.2	2,139	3	910	452	1,139
3/14/2018	24:00:00	333.68	56.21	49.4	3,543	3	878	440	1,097
3/15/2018	24:00:00	353.22	64.26	61.7	3,892	5	870	437	1,086
3/16/2018	24:00:00	352.57	60.81	63.2	3,778	9	865	437	1,105
3/17/2018	24:00:00	352.19	59.39	63.3	3,731	9	862	437	1,101
3/18/2018	24:00:00	352.17	58.71	63.6	3,709	9	859	435	1,097
3/19/2018	24:00:00	352.45	58.54	65.2	3,698	8	858	436	1,096
3/20/2018	24:00:00	351.96	58.18	65.1	3,685	4	855	432	1,066
3/21/2018	24:00:00	351.8	57.73	62.4	3,681	8	852	434	1,087
3/22/2018	24:00:00	351.33	57.41	62.4	3,669	7	850	433	1,085
3/23/2018	24:00:00	352.01	57.36	63.7	3,660	7	848	433	1,082
3/24/2018	24:00:00	352.2	57.07	63.8	3,656	6	847	432	1,080
3/25/2018	24:00:00	353.32	56.54	63.3	3,647	3	864	472	1,078
3/26/2018	24:00:00	353.81	45.62	58.7	3,068	51	852	437	1,152
3/27/2018	24:00:00	352.29	63.04	64.3	3,838	6	849	434	1,083
3/28/2018	24:00:00	352.26	57.88	65.5	3,676	4	860	559	1,073
3/29/2018	24:00:00	356.23	52.5	63.8	3,519	2	868	543	1,061
3/30/2018	24:00:00	358.48	49.06	61.7	3,403	2	845	433	1,054
3/31/2018	24:00:00	353.39	57.18	64.0	3,665	5	844	432	1,052
4/1/2018	24:00:00	352.93	56.46	65.7	3,633	2	840	433	1,026
4/2/2018	24:00:00	353.77	56.13	64.1	3,632	7	838	431	1,069
4/3/2018	24:00:00	353.37	56.16	65.0	3,627	8	838	430	1,069
4/4/2018	24:00:00	353.63	55.62	65.8	3,609	7	834	428	1,063
4/5/2018	24:00:00	351.56	55.81	63.8	3,613	12	833	430	1,089
4/6/2018	24:00:00	352.7	55.41	65.5	3,598	9	832	430	1,061
4/7/2018	24:00:00	354.44	53.78	64.2	3,559	7	829	431	1,056
4/8/2018	24:00:00	352.78	55.14	64.1	3,595	8	828	430	1,056
4/9/2018	24:00:00	352.08	54.63	64.3	3,575	9	1,001	155	1,290
4/10/2018	24:00:00	209.92	13.35	46.0	1,163	2	1,064	367	1,341
4/11/2018	24:00:00	198.34	13.07	39.8	1,096	1	924	607	1,132
4/12/2018	24:00:00	355.19	56.59	53.5	3,690	3	987	942	1,239
4/13/2018	24:00:00	365.49	27.32	49.2	2,477	2	1,061	1,039	1,306
4/14/2018	24:00:00	365.32	7.16	40.6	1,310	1	1,083	1,073	1,335
4/15/2018	24:00:00	364.61	12.12	38.8	1,683	1	1,049	856	1,291
4/16/2018	24:00:00	362.52	24.79	38.2	2,367	3	948	631	1,188
4/17/2018	24:00:00	352.35	59.9	52.5	3,796	3	910	549	1,138
4/18/2018	24:00:00	351.48	61.68	57.5	3,824	3	1,004	927	1,262
4/19/2018	24:00:00	364.74	20.85	40.1	2,228	2	915	573	1,145
4/20/2018	24:00:00	353.02	58.94	56.1	3,745	3	886	497	1,107
4/21/2018	24:00:00	353.26	61.52	62.4	3,807	2	872	445	1,089
4/22/2018	24:00:00	357.38	59.99	65.0	3,769	6	895	639	1,145
4/23/2018	24:00:00	363.99	46.41	59.1	3,350	6	905	646	1,159
4/24/2018	24:00:00	362.19	42.1	56.0	3,185	4	873	517	1,091
4/25/2018	24:00:00	360.17	54.29	62.0	3,604	6	864	437	1,104
4/26/2018	24:00:00	356.29	50.61	60.0	3,436	5	864	526	1,103
4/27/2018	24:00:00	359.59	52.33	64.1	3,518	8	960	824	1,233
4/28/2018	24:00:00	364.43	19.47	45.1	2,107	2	911	500	1,139
4/29/2018	24:00:00	358.85	41.43	51.3	3,027	4	874	442	1,092
4/30/2018	24:00:00	354.66	56.06	60.7	3,619	5	891	603	1,141
5/1/2018	24:00:00	360.13	47.49	60.7	3,311	5	990	881	1,275
5/2/2018	24:00:00	365.28	19.4	47.0	1,986	2	1,055	1,052	1,298
5/3/2018	24:00:00	372.68	11.21	50.3	1,540	1	1,134	1,134	1,400
5/4/2018	24:00:00	474.28	2.43	71.8	816	0	1,128	1,115	1,392
5/5/2018	24:00:00	359.8	8.33	41.5	1,382	0	1,141	1,112	1,409
5/6/2018	24:00:00	360.17	9.48	42.6	1,366	0	1,205	1,180	1,492
5/7/2018	24:00:00	327.46	6.58	49.3	964	1	1,190	1,159	1,471
5/8/2018	24:00:00	351.34	6.65	48.3	1,463	1	1,126	998	1,389
5/9/2018	24:00:00	352.96	13.05	40.8	2,790	3	1,099	1,031	1,387
5/10/2018	24:00:00	359.31	14.92	44.0	3,030	3	1,073	931	1,353
5/11/2018	24:00:00	359.39	14.23	42.6	3,004	2	1,063	982	1,340
5/12/2018	24:00:00	360.45	13.02	44.0	2,879	3	1,127	1,098	1,424
5/13/2018	24:00:00	360.49	6.62	40.3	2,036	1	1,147	1,088	1,416
5/14/2018	24:00:00	360	7.09	40.0	2,056	6	1,120	1,033	1,455
5/15/2018	24:00:00	360.68	9.74	39.5	2,497	3	1,134	1,105	1,434
5/16/2018	24:00:00	361.11	8.26	41.3	2,271	2	1,213	1,196	1,539
5/17/2018	24:00:00	355.37	4.45	50.0	1,589	1	1,144	1,046	1,412
5/18/2018	24:00:00	359.51	11.12	38.8	2,664	3	1,078	901	1,359
5/19/2018	24:00:00	357.28	18.2	45.6	3,380	4	1,054	910	1,328
5/20/2018	24:00:00	364.31	18.03	50.5	3,373	3	1,017	804	1,279
5/21/2018	24:00:00	358.38	18.44	52.6	3,357	4	1,136	1,112	1,437
5/22/2018	24:00:00	360.28	4.88	43.3	1,750	3	1,214	1,201	1,540
5/23/2018	24:00:00	362.44	3.56	56.1	1,433	1	1,188	1,143	1,469
5/24/2018	24:00:00	359.92	6.68	32.1	2,053	1	1,207	1,185	1,494
5/25/2018	24:00:00	360.5	4.88	34.1	1,770	1	1,233	1,190	1,527
5/26/2018	24:00:00	359.84	4.75	42.5	1,701	1	1,225	1,175	1,516

5/27/2018	24:00:00	360.03	5.77	38.0	1,889	1	1,219	1,138	1,510
5/28/2018	24:00:00	359.87	6.79	37.9	2,025	3	1,233	933	1,566
5/29/2018	24:00:00	370.32	5.68	42.2	1,873	2	1,303	610	1,618
5/30/2018	24:00:00	354.73	2.63	73.9	1,196	0	1,314	1,313	1,631
5/31/2018	24:00:00	350.53	2.88	51.7	1,322	1	1,338	1,338	1,662
6/1/2018	24:00:00	352.58	2.53	56.1	1,238	0	1,352	1,352	1,681
6/2/2018	24:00:00	353.14	2.53	51.4	1,250	0	1,368	1,369	1,701
6/3/2018	24:00:00	353.54	2.44	51.7	1,230	0	1,376	1,365	1,711
6/4/2018	24:00:00	353.21	3.18	48.8	1,366	0	1,341	1,310	1,666
6/5/2018	24:00:00	326.3	5.63	29.1	1,781	3	1,363	1,344	1,739
6/6/2018	24:00:00	342.5	4.1	38.5	1,529	2	1,347	1,317	1,674
6/7/2018	24:00:00	352.07	4.31	21.1	1,677	2	1,388	1,385	1,773
6/8/2018	24:00:00	349.59	2.94	43.4	1,331	1	1,377	1,369	1,713
6/9/2018	24:00:00	352.55	4.16	29.1	1,630	1	1,400	1,397	1,742
6/10/2018	24:00:00	350.87	3.35	42.4	1,419	1	1,396	1,386	1,738
6/11/2018	24:00:00	351.93	4.47	33.1	1,638	1	1,400	1,379	1,743
6/12/2018	24:00:00	269.45	5.15	36.9	1,477	1	1,389	1,360	1,728
6/13/2018	24:00:00	350.86	5.53	31.0	1,801	1	1,381	1,367	1,718
6/14/2018	24:00:00	322.73	7.88	33.2	1,922	3	1,413	1,408	1,807
6/15/2018	24:00:00	351.6	3.45	37.4	1,439	1	1,424	1,416	1,773
6/16/2018	24:00:00	350.73	3.59	36.7	1,461	1	1,417	1,395	1,764
6/17/2018	24:00:00	351.13	5.13	32.1	1,729	1	1,409	1,390	1,754
6/18/2018	24:00:00	342.16	6.13	33.1	1,846	2	1,433	1,426	1,785
6/19/2018	24:00:00	333.37	3.48	69.4	1,338	2	1,441	1,431	1,795
6/20/2018	24:00:00	350.67	3.69	43.9	1,431	1	1,464	1,465	1,825
6/21/2018	24:00:00	280.7	2.47	62.9	1,050	2	1,484	1,485	1,851
6/22/2018	24:00:00	225.21	1.63	72.2	793	1	1,498	1,499	1,869
6/23/2018	24:00:00	223.76	1.67	70.3	802	1	1,510	1,511	1,884
6/24/2018	24:00:00	222.62	1.67	70.5	800	1	1,508	1,509	1,882
6/25/2018	24:00:00	289.04	2.09	50.1	1,017	1	1,489	1,471	1,858
6/26/2018	12:34:32	353.45	6.99	103.7	1,002	0	1,476	1,453	1,841
6/27/2018	15:37:34	353.95	6.99	99.1	1,225	0	1,471	1,465	1,834
6/28/2018	15:38:10	332.01	9.92	114.7	1,326	1	1,486	1,473	1,854
6/29/2018	9:25:41	356.78	4.99	67.2	659	0	1,488	1,484	1,856
6/30/2018	10:29:16	360.72	5.21	59.2	766	0	1,491	1,483	1,860
7/1/2018	10:11:09	360.67	5.18	60.9	743	0	1,495	1,481	1,865
7/2/2018	10:17:47	359.97	5.49	62.5	769	0	1,523	145	1,901
7/3/2018	1:43:59	359.94	6.98	68.5	145	0	1,508	1,487	1,881
7/4/2018	9:46:52	360.19	6.47	62.3	796	0	1,497	1,462	1,868
7/5/2018	12:51:31	359.7	6.5	67.6	1,042	1	1,480	1,423	1,846
7/6/2018	14:32:27	359.33	7.48	62.6	1,266	1	1,468	1,407	1,830
7/7/2018	16:14:50	357.79	7.43	54.2	1,415	1	1,465	1,441	1,826
7/8/2018	16:00:06	354.87	5.79	58.5	1,152	1	1,507	1,488	1,881
7/9/2018	4:29:09	353.55	3.25	67.9	243	1	1,487	1,458	1,855
7/10/2018	15:10:15	357.84	7.57	95.2	1,276	1	1,484	1,449	1,850
7/11/2018	15:21:34	357.58	6.69	99.0	1,197	0	1,474	1,429	1,838
7/12/2018	16:40:24	357.24	7.53	96.9	1,387	0	1,446	1,420	1,802
7/13/2018	20:11:29	291.58	16.27	99.5	2,094	2	1,447	1,417	1,853
7/14/2018	0:00:00	355.45	6.17	100.9	2,196	0	1,438	1,397	1,792
7/15/2018	22:48:57	356.11	7.22	101.3	1,849	0	1,425	1,382	1,775
7/16/2018	23:53:16	354.89	7.95	97.7	2,078	0	1,411	1,360	1,757
7/17/2018	24:00:00	353.41	9.31	95.0	2,254	1	1,428	1,399	1,778
7/18/2018	18:08:48	355.43	8.32	95.2	1,578	2	1,429	1,398	1,828
7/19/2018	22:15:04	355.33	5.8	93.3	1,638	1	1,426	1,392	1,776
7/20/2018	21:58:08	355.1	6.57	93.7	1,713	1	1,423	1,392	1,771
7/21/2018	23:54:05	354.74	6.31	89.8	1,843	1	1,413	1,380	1,760
7/22/2018	23:58:08	354.89	6.9	89.8	1,966	1	1,400	1,355	1,742
7/23/2018	24:00:00	354.96	8.36	92.3	2,163	1	1,384	1,335	1,722
7/24/2018	23:38:14	353.95	10.5	95.1	2,362	1	1,367	1,312	1,700
7/25/2018	24:00:00	353.96	10.74	93.8	2,445	1	1,354	1,304	1,684
7/26/2018	23:39:27	352.22	11.51	91.3	2,471	2	1,388	1,361	1,773
7/27/2018	23:58:21	356.02	5.55	93.0	1,705	1	1,388	1,357	1,727
7/28/2018	22:33:58	355.04	6.44	89.1	1,743	0	1,377	1,340	1,712
7/29/2018	24:00:00	354.72	7.34	89.9	2,040	0	1,370	1,324	1,704
7/30/2018	23:47:49	354.24	8.28	93.2	2,082	1	1,361	1,310	1,691
7/31/2018	23:59:49	353.84	9.09	90.5	2,244	1	1,360	1,319	1,691
8/1/2018	23:49:38	353.14	8.16	91.6	2,081	1	1,365	1,314	1,697
8/2/2018	20:42:30	349.11	8.76	90.8	1,858	1	1,316	1,237	1,634
8/3/2018	24:00:00	330.86	16.02	92.9	2,887	1	1,292	1,217	1,603
8/4/2018	24:00:00	324.06	16.58	90.8	2,915	1	1,282	1,200	1,591
8/5/2018	21:57:34	324.81	13.78	73.1	2,432	1	1,340	1,310	1,665
8/6/2018	20:10:38	348.91	5.63	65.1	1,461	2	1,345	1,308	1,671
8/7/2018	21:37:14	348.6	6.53	66.7	1,720	0	1,364	1,332	1,696
8/8/2018	17:23:56	347.87	8.31	67.3	1,539	2	1,319	1,260	1,637
8/9/2018	23:49:01	322.87	10.95	67.3	2,271	0	1,370	1,364	1,704
8/10/2018	13:21:23	348.16	7.82	62.8	1,143	1	1,361	676	1,691
8/11/2018	14:36:56	417.92	11.68	62.8	1,670	0	1,344	1,296	1,670
8/12/2018	21:02:23	345.62	10.06	80.5	2,019	0	1,332	1,275	1,655
8/13/2018	22:37:45	342.19	9.91	81.8	2,162	1	1,317	1,252	1,635
8/14/2018	22:03:22	335.99	11.46	78.4	2,242	1	1,334	1,298	1,657
8/15/2018	17:39:00	343.92	9.18	79.3	1,602	1	1,338	1,300	1,663
8/16/2018	18:53:36	343.05	9.66	84.9	1,761	1	1,341	1,306	1,667

8/17/2018	19:28:32	343.08	9.61	84.4	1,806	1	1,333	1,286	1,655
8/18/2018	19:43:56	338.26	10.5	82.6	1,901	1	1,331	1,293	1,653
8/19/2018	20:33:32	335.76	10.67	81.2	1,984	1	1,314	1,263	1,632
8/20/2018	22:42:34	342.82	9.74	81.6	2,143	1	1,314	1,256	1,631
8/21/2018	21:25:02	342.47	9.78	83.9	2,018	1	1,299	1,230	1,612
8/22/2018	22:16:30	339.73	10.87	80.7	2,222	1	1,288	1,220	1,597
8/23/2018	22:37:38	337.17	11.22	80.0	2,296	1	1,301	1,254	1,614
8/24/2018	20:50:15	343.22	9.4	77.7	1,939	1	1,305	1,233	1,620
8/25/2018	18:38:09	342.22	8.74	59.5	1,677	1	1,274	1,219	1,579
8/26/2018	23:59:38	339.25	11.29	60.1	2,528	1	1,289	1,240	1,600
8/27/2018	23:44:26	345.18	8.77	79.7	2,154	0	1,243	1,109	1,541
8/28/2018	24:00:00	345.14	14.96	68.4	2,907	0	1,177	984	1,455
8/29/2018	24:00:00	334.65	23.69	87.0	3,553	1	1,142	912	1,410
8/30/2018	24:00:00	321.96	25.93	86.0	3,634	1	1,114	869	1,374
8/31/2018	24:00:00	305.6	30.2	87.2	3,797	1	1,093	867	1,347
9/1/2018	24:00:00	305.78	29.13	71.3	3,802	1	1,075	841	1,324
9/2/2018	24:00:00	312.72	27.69	68.4	3,791	1	1,109	1,025	1,367
9/3/2018	24:00:00	308.33	21.72	69.8	3,062	2	1,162	1,120	1,435
9/4/2018	24:00:00	345.11	9	67.4	2,244	0	1,164	1,109	1,438
9/5/2018	23:59:19	345.38	9.17	70.8	2,251	0	1,199	1,161	1,483
9/6/2018	23:59:45	345.26	6.06	89.1	1,777	1	1,196	1,153	1,479
9/7/2018	24:00:00	345.49	7.63	69.0	2,049	0	1,178	1,116	1,457
9/8/2018	24:00:00	345	10.43	83.9	2,387	0	1,138	1,039	1,405
9/9/2018	24:00:00	345.37	14.97	52.9	2,975	1	1,115	1,035	1,376
9/10/2018	24:00:00	344.1	16.75	55.8	3,130	2	1,271	1,270	1,617
9/11/2018	0:45:21	346.03	10.16	57.1	76	0	1,327	1,325	1,648
9/12/2018	0:00:00	-1.51	0	66.3	0	0	1,362	1,361	1,694
9/13/2018	0:00:00	-1.49	0	71.6	0	0	1,389	1,388	1,728
9/14/2018	0:00:00	-1.39	0	78.9	0	0	1,412	1,411	1,758
9/15/2018	0:00:00	-1.44	0	79.4	0	0	1,430	1,429	1,781
9/16/2018	0:00:00	-1.55	0	75.9	0	0	1,447	1,446	1,803
9/17/2018	0:00:00	-1.54	0	76.2	0	0	1,462	1,461	1,823
9/18/2018	0:00:00	-1.57	0	71.5	0	0	1,475	1,475	1,840
9/19/2018	0:00:00	-1.55	0	68.0	0	0	1,487	2	1,855
9/20/2018	0:00:00	-1.55	0	68.0	0	0	1,499	3	1,871
9/21/2018	0:00:00	-1.55	0	68.0	0	0	1,509	1	1,883
9/22/2018	0:00:00	-1.55	0	68.0	0	0	1,520	1	1,897
9/23/2018	0:00:00	-1.55	0	68.0	0	0	1,531	1	1,911
9/24/2018	0:00:00	-1.55	0	68.0	0	0	1,541	746	1,924
9/25/2018	0:00:00	-1.55	0	68.0	0	0	1,551	1,552	1,937
9/26/2018	0:00:00	-1.04	0	-21.3	0	0	1,558	1,560	1,947
9/27/2018	0:00:00	0	0	-200.0	0	0	1,567	1,569	1,957
9/28/2018	0:00:00	0	0	-200.0	0	0	1,574	1,576	1,967
9/29/2018	0:00:00	0	0	-200.0	0	0	1,582	1,584	1,977
9/30/2018	0:00:00	0	0	-200.0	0	0	1,590	1,591	1,987
10/1/2018	0:00:00	0	0	-200.0	0	0	1,597	1,599	1,997
10/2/2018	0:00:00	0	0	-200.0	0	0	1,604	1,606	2,006
10/3/2018	0:00:00	0	0	-200.0	0	0	1,611	1,612	2,015
10/4/2018	0:00:00	0	0	-200.0	0	0	1,617	1,619	2,022
10/5/2018	0:00:00	0	0	-200.0	0	0	1,623	1,625	2,031
10/6/2018	0:00:00	0	0	-200.0	0	0	1,629	1,631	2,038
10/7/2018	0:00:00	0	0	-200.0	0	0	1,635	1,637	2,046
10/8/2018	0:00:00	0	0	-200.0	0	0	1,641	1,643	2,054
10/9/2018	0:00:00	0	0	-200.0	0	0	1,647	1,649	2,061
10/10/2018	0:00:00	0	0	-200.0	0	0	1,653	1,654	2,069
10/11/2018	0:00:00	-0.23	0	-200.0	0	0	1,656	1,659	2,073
10/12/2018	0:00:00	-0.22	0	-200.0	0	0	1,661	1,664	2,080
10/13/2018	0:00:00	-0.41	0	-200.0	0	0	1,666	1,669	2,086
10/14/2018	0:00:00	-0.51	0	-200.0	0	0	1,673	1,675	2,094
10/15/2018	0:00:00	-0.15	0	-200.0	0	0	1,676	1,679	2,099
10/16/2018	0:00:00	-0.17	0	-200.0	0	0	1,681	1,684	2,105
10/17/2018	0:00:00	0.36	0	-200.0	0	0	1,685	1,689	2,111
10/18/2018	0:00:00	1.82	0	-200.0	0	0	1,651	1,623	2,067
10/19/2018	22:14:11	332.43	7.09	-200.0	4,303	1	1,639	1,583	2,051
10/20/2018	24:00:00	343.86	6.94	-200.0	4,913	1	1,633	1,545	2,043
10/21/2018	24:00:00	336.83	6.28	-200.0	4,477	1	1,627	1,498	2,036
10/22/2018	24:00:00	286.96	7.36	-200.0	4,013	1	1,625	1,456	2,033
10/23/2018	24:00:00	339.83	6.08	-200.0	3,276	1	1,622	1,425	2,029
10/24/2018	24:00:00	328.02	6.14	-200.0	3,116	1	1,621	1,387	2,027
10/25/2018	23:59:58	306.24	6.23	-200.0	2,775	1	1,621	1,367	2,027
10/26/2018	24:00:00	329.13	5.59	57.3	1,318	0	1,621	1,364	2,028
10/27/2018	24:00:00	297.28	5.86	60.0	1,264	1	1,623	1,328	2,030
10/28/2018	24:00:00	269.26	5.86	60.0	1,198	1	1,625	1,300	2,033
10/29/2018	24:00:00	256.9	5.58	60.0	1,145	1	1,626	1,283	2,035
10/30/2018	24:00:00	224.02	6.1	60.0	1,125	1	1,633	1,617	2,044
10/31/2018	19:13:45	250.4	6.03	60.0	856	0	1,570	1,511	1,962
11/1/2018	10:16:24	346.06	17.83	60.0	932	1	1,627	489	2,035
11/2/2018	8:00:45	342.69	9.17	60.0	519	0	1,626	1,622	2,034
11/3/2018	23:59:41	320.78	3.05	60.0	945	1	1,628	1,624	2,036
11/4/2018	24:00:00	272.09	4	60.0	993	1	1,655	1,656	2,072
11/5/2018	6:13:11	304.84	4.34	60.0	277	0	1,625	1,594	2,032
11/6/2018	23:59:52	344.31	7.88	60.0	1,564	0	1,615	1,585	2,020

11/7/2018	24:00:00	341.41	8.9	60.0	1,678	1	1,608	1,573	2,011
11/8/2018	23:59:39	314.13	10.82	60.0	1,717	1	1,573	1,531	1,966
11/9/2018	23:58:32	341.44	21.46	60.0	2,599	1	1,556	1,512	1,943
11/10/2018	23:59:56	344.08	21.19	60.0	2,593	1	1,542	1,500	1,926
11/11/2018	24:00:00	310.82	23.9	60.0	2,610	1	1,603	1,600	2,004
11/12/2018	8:07:00	335.31	16.83	60.0	762	1	1,575	1,540	1,969
11/13/2018	17:44:43	312.41	18.92	60.0	1,724	1	1,556	1,520	1,944
11/14/2018	24:00:00	297.12	20.69	60.0	2,368	1	1,543	1,505	1,927
11/15/2018	24:00:00	278.92	23.17	60.0	2,431	1	1,536	1,498	1,918
11/16/2018	23:59:06	236.09	26.22	60.0	2,387	1	1,524	1,484	1,902
11/17/2018	24:00:00	280.25	25.22	60.0	2,525	1	1,516	1,475	1,892
11/18/2018	24:00:00	322.58	21.16	60.0	2,510	1	1,510	1,469	1,884
11/19/2018	23:59:26	341.21	19.89	60.0	2,503	1	1,504	1,463	1,876
11/20/2018	23:59:49	337.97	19.88	60.0	2,490	1	1,498	1,458	1,869
11/21/2018	24:00:00	272.92	24.46	60.0	2,473	2	1,493	1,454	1,914
11/22/2018	24:00:00	228.99	28.47	60.0	2,457	1	1,488	1,449	1,856
11/23/2018	24:00:00	224.46	28.88	60.0	2,450	2	1,483	1,442	1,850
11/24/2018	24:00:00	318.25	21.17	60.0	2,485	1	1,479	1,439	1,845
11/25/2018	24:00:00	341.92	19.29	60.0	2,469	1	1,475	1,434	1,839
11/26/2018	24:00:00	343.62	19.2	60.0	2,469	1	1,471	1,433	1,834
11/27/2018	24:00:00	254.54	25.38	60.0	2,423	2	1,468	1,430	1,880
11/28/2018	24:00:00	222.53	27.92	60.0	2,399	2	1,465	1,427	1,826
11/29/2018	24:00:00	222.67	27.71	60.0	2,391	2	1,461	1,422	1,821
11/30/2018	24:00:00	304.96	21.12	60.0	2,418	1	1,458	1,419	1,817
12/1/2018	24:00:00	343.64	18.52	60.0	2,426	1	1,455	1,416	1,814
12/2/2018	24:00:00	345.11	18.36	60.0	2,421	1	1,452	1,413	1,809
12/3/2018	24:00:00	337.25	18.9	60.0	2,416	3	1,448	1,410	1,854
12/4/2018	24:00:00	322.37	19.29	60.0	2,395	1	1,442	1,395	1,797
12/5/2018	24:00:00	271.29	25.11	60.0	2,486	3	1,421	1,368	1,817
12/6/2018	24:00:00	242.95	37.05	60.0	2,872	4	1,376	1,281	1,756
12/7/2018	24:00:00	295.51	49.43	60.0	3,625	6	1,344	1,240	1,767
12/8/2018	24:00:00	274.42	57.74	60.0	3,788	4	1,327	1,226	1,692
12/9/2018	24:00:00	233.91	63.39	60.0	3,691	5	1,312	1,209	1,671
12/10/2018	24:00:00	300.83	49.62	60.0	3,676	5	1,299	1,197	1,654
12/11/2018	24:00:00	227.08	62.98	60.0	3,629	5	1,288	1,181	1,639
12/12/2018	24:00:00	301.58	47.9	60.0	3,628	5	1,279	1,174	1,677
12/13/2018	24:00:00	338.34	41.48	60.0	3,595	3	1,272	1,170	1,617
12/14/2018	24:00:00	339.2	40.09	60.0	3,540	4	1,265	1,164	1,609
12/15/2018	24:00:00	342.94	39.01	60.0	3,512	2	1,258	1,157	1,559
12/16/2018	24:00:00	344.54	38.48	60.0	3,496	3	1,250	1,153	1,589
12/17/2018	24:00:00	337.36	38.55	60.0	3,462	8	1,255	1,174	1,642
12/18/2018	24:00:00	318	36.26	60.0	3,241	4	1,239	1,143	1,574
12/19/2018	24:00:00	271.82	48.03	60.0	3,434	7	1,255	1,189	1,642
12/20/2018	24:00:00	243.55	41.76	60.0	3,048	6	1,261	1,198	1,651
12/21/2018	24:00:00	324.15	27.9	60.0	2,875	4	1,263	1,202	1,605
12/22/2018	24:00:00	270.47	32.3	60.0	2,819	6	1,258	1,193	1,647
12/23/2018	24:00:00	233.25	38.45	60.0	2,873	6	1,254	1,186	1,641
12/24/2018	24:00:00	268.61	34.58	60.0	2,910	5	1,251	1,181	1,637
12/25/2018	24:00:00	225.46	40.29	60.0	2,897	5	1,249	1,179	1,635
12/26/2018	24:00:00	224.6	39.78	60.0	2,874	6	1,247	1,171	1,631
12/27/2018	24:00:00	232.73	38.77	60.0	2,877	6	1,245	1,175	1,629
12/28/2018	24:00:00	317.68	29.42	60.0	2,911	4	1,244	1,172	1,580
12/29/2018	23:59:56	278.78	32.92	60.0	2,857	6	1,241	1,158	1,623
12/30/2018	24:00:00	226.27	39.37	60.0	2,868	8	1,222	1,130	1,597
12/31/2018	24:00:00	295.27	38.22	60.0	3,196	7	1,216	1,118	1,588
1/1/2019	24:00:00	326.56	34.86	60.0	3,211	4	1,207	1,108	1,531
1/2/2019	24:00:00	332.61	33.83	60.0	3,220	8	1,201	1,096	1,567
1/3/2019	24:00:00	324.63	34.89	60.0	3,229	7	1,192	1,040	1,555
1/4/2019	24:00:00	256.25	47.06	60.0	3,300	9	1,156	1,007	1,504
1/5/2019	24:00:00	331.89	52	60.0	3,972	6	1,143	973	1,486
1/6/2019	24:00:00	343.35	47.6	60.0	3,879	5	1,158	1,063	1,507
1/7/2019	24:00:00	296.02	39.96	60.0	3,262	9	1,157	1,054	1,506
1/8/2019	24:00:00	315.79	37.73	60.0	3,294	7	1,152	996	1,499
1/9/2019	24:00:00	330.82	36.83	60.0	3,330	9	1,101	817	1,428
1/10/2019	24:00:00	286.8	73.91	60.0	4,339	11	1,056	699	1,409
1/11/2019	24:00:00	242.08	110.1	60.0	4,913	13	1,037	696	1,381
1/12/2019	24:00:00	318.2	82.25	60.0	4,820	7	1,022	682	1,320
1/13/2019	24:00:00	346.91	70.68	60.0	4,746	4	1,009	666	1,269
1/14/2019	24:00:00	345.94	69.87	60.0	4,712	9	998	650	1,286
1/15/2019	24:00:00	343.17	69.4	60.0	4,676	10	987	640	1,310
1/16/2019	24:00:00	343.4	68.52	60.0	4,646	7	978	632	1,259
1/17/2019	24:00:00	347.03	66.94	60.0	4,620	4	1,005	858	1,263
1/18/2019	24:00:00	345.36	49.15	60.0	3,936	5	1,013	842	1,306
1/19/2019	24:00:00	345.88	42.84	60.0	3,695	5	1,016	832	1,310
1/20/2019	24:00:00	345.81	42.06	60.0	3,661	5	1,006	798	1,297
1/21/2019	24:00:00	298.69	53.55	60.0	3,788	8	1,002	796	1,291
1/22/2019	24:00:00	334.35	47.08	60.0	3,799	8	1,002	838	1,292
1/23/2019	24:00:00	352.79	44.57	60.0	3,798	5	990	751	1,276
1/24/2019	24:00:00	347.98	48.89	60.0	3,955	1	981	736	1,205
1/25/2019	24:00:00	345.84	49.92	60.0	3,987	4	975	728	1,224
1/26/2019	24:00:00	339.68	50.62	60.0	3,978	8	970	720	1,248
1/27/2019	24:00:00	343.23	50.55	60.0	3,996	3	964	712	1,210

1/28/2019	24:00:00	341.43	50.48	60.0	3,982	9	961	716	1,236
1/29/2019	24:00:00	346.02	49.66	60.0	3,978	4	958	722	1,202
1/30/2019	24:00:00	346.18	48.62	60.0	3,936	8	955	724	1,228
1/31/2019	24:00:00	344.52	46.7	60.0	3,850	4	953	719	1,195
2/1/2019	24:00:00	346.37	46.43	60.0	3,848	6	1,091	82	1,415
2/2/2019	9:13:32	405.3	39.68	60.0	1,467	1	1,173	57	1,450
2/3/2019	0:00:00	32.04	0	60.0	0	0	1,206	375	1,492
2/4/2019	3:33:54	321.57	29.48	60.0	414	1	1,132	954	1,397
2/5/2019	33:19:19	291.72	49.6	60.0	4,439	4	1,066	890	1,343
2/6/2019	14:40:39	232.25	62.76	60.0	2,223	4	989	694	1,242
2/7/2019	26:45:30	307.9	73.98	60.0	5,173	8	997	739	1,285
2/8/2019	20:52:41	299.74	54.66	75.6	2,959	10	930	387	1,193
2/9/2019	24:00:00	244.35	115	82.6	4,536	9			#N/A
2/10/2019	24:00:00	240.64	113.1	83.4	4,474	0			#N/A
2/11/2019	24:00:00	252.5	83.69	78.2	3,956	0			#N/A
2/12/2019	24:00:00	325.91	73.61	84.7	4,187	2			#N/A
2/13/2019	24:00:00	331.98	72.07	84.8	4,179	2	877	446	1,095
2/14/2019	24:00:00	285.01	85.25	83.2	4,191	3	884	541	1,104
2/15/2019	24:00:00	345.69	60.12	83.0	3,917	4	879	520	1,098
2/16/2019	24:00:00	323.21	62.59	81.9	3,846	10	874	518	1,147
2/17/2019	24:00:00	288.89	70.1	81.0	3,858	12	873	521	1,145
2/18/2019	24:00:00	313.2	62.94	82.3	3,802	11	864	473	1,133
2/19/2019	24:00:00	236.22	85.07	79.7	3,865	14	852	434	1,117
2/20/2019	24:00:00	328.55	66.28	84.6	3,990	14	853	476	1,117
2/21/2019	24:00:00	344.42	59.16	85.3	3,870	9	848	474	1,083
2/22/2019	24:00:00	345.1	57.89	85.0	3,833	11	845	473	1,106
2/23/2019	24:00:00	345.16	57.04	84.5	3,808	11	842	473	1,102
2/24/2019	24:00:00	345.66	56.19	84.5	3,783	9	836	448	1,066
2/25/2019	24:00:00	329.75	59.33	83.6	3,784	16	832	439	1,088
2/26/2019	24:00:00	314.92	62.87	83.9	3,786	15	825	414	1,079
2/27/2019	24:00:00	288.5	69.73	82.9	3,811	15	826	463	1,080
2/28/2019	24:00:00	341.17	55.73	85.7	3,729	10	823	462	1,076
3/1/2019	24:00:00	344.23	54.05	85.0	3,698	13	820	449	1,071
3/2/2019	24:00:00	334.24	55.99	85.2	3,705	15	817	448	1,066
3/3/2019	24:00:00	335.66	55.43	85.3	3,695	14	811	415	1,059
3/4/2019	24:00:00	305.57	62.34	83.2	3,719	15	807	411	1,053
3/5/2019	24:00:00	297.66	63.8	83.8	3,711	14	800	389	1,043
3/6/2019	24:00:00	234.45	82.24	81.1	3,784	14	796	386	1,037
3/7/2019	24:00:00	231.33	82.67	82.5	3,765	14	795	424	1,036
3/8/2019	24:00:00	258.31	73.37	84.3	3,709	13	792	404	1,032
3/9/2019	24:00:00	239.5	77.31	83.5	3,698	14	797	458	1,039
3/10/2019	24:00:00	339.04	51.33	86.2	3,564	11	796	449	1,037
3/11/2019	24:00:00	340.46	50.11	86.9	3,533	10	792	421	1,007
3/12/2019	24:00:00	313.09	56.74	85.8	3,564	13	785	392	1,022
3/13/2019	24:00:00	243.3	74.32	83.7	3,643	15	789	442	1,027
3/14/2019	23:33:39	324.2	54.43	87.6	3,501	13	790	453	1,029
3/15/2019	24:00:00	346.88	48.29	88.7	3,499	8	786	434	998
3/16/2019	24:00:00	328.84	51.8	87.7	3,498	12	777	391	1,011
3/17/2019	24:00:00	239.01	74.41	85.7	3,617	15	775	391	1,008
3/18/2019	24:00:00	245.21	71.88	86.2	3,594	13	771	389	1,003
3/19/2019	24:00:00	233.72	74.96	85.9	3,592	13	768	389	999
3/20/2019	23:33:51	237.86	73.22	86.2	3,510	13	763	327	992
3/21/2019	24:00:00	286.88	65.39	89.5	3,668	12	757	306	983
3/22/2019	24:00:00	270.54	70.34	89.3	3,709	13	754	325	979
3/23/2019	24:00:00	290.31	64.48	89.3	3,664	14	752	327	976
3/24/2019	24:00:00	306.02	59.4	90.0	3,616	12	753	365	978
3/25/2019	23:58:43	335.88	52.01	90.5	3,556	11	748	324	970
3/26/2019	24:00:00	296.62	60.47	89.1	3,595	12	745	315	966
3/27/2019	24:00:00	299.27	60.16	90.1	3,579	12	762	475	990
3/28/2019	23:58:52	299.88	53.12	87.1	3,213	3	751	377	933
3/29/2019	24:00:02	346.87	48.77	90.9	3,508	2	748	376	928
3/30/2019	24:00:00	346.62	48.34	91.0	3,491	5	746	376	946
3/31/2019	24:00:00	347.3	47.79	91.1	3,474	6	742	358	940
4/1/2019	24:00:00	334.54	49.55	90.1	3,471	11	738	348	957
4/2/2019	24:00:00	327.25	51.25	90.7	3,489	11	737	357	956
4/3/2019	24:00:00	337.08	48.9	91.1	3,459	11	737	369	956
4/4/2019	24:00:00	344.05	47.03	91.3	3,428	11	737	376	956
4/5/2019	24:00:00	346.33	46.2	91.0	3,411	5	735	375	931
4/6/2019	24:00:00	346.26	45.92	91.2	3,400	6	733	375	929
4/7/2019	24:00:00	346.29	45.78	91.8	3,393	7	733	375	928
4/8/2019	24:00:00	346.48	45.67	91.7	3,390	6	732	376	926
4/9/2019	24:00:00	346.65	45.17	91.5	3,373	5	729	373	923
4/10/2019	24:00:00	345.94	45	91.7	3,363	10	728	373	922
4/11/2019	24:00:00	345.85	44.8	91.4	3,356	8	728	376	922
4/12/2019	24:00:00	346.66	44.5	92.0	3,347	6	726	376	919
4/13/2019	24:00:00	351.73	43.47	91.9	3,330	3	725	375	898
4/14/2019	23:59:52	347	43.98	91.9	3,330	5	723	374	896
4/15/2019	24:00:00	345.99	43.88	91.0	3,323	8	720	372	911
4/16/2019	24:00:00	345.11	43.81	90.8	3,317	10	729	378	923
4/17/2019	22:56:30	283.81	18.75	87.9	3,152	3	734	546	910
4/18/2019	24:00:00	398.56	34.81	91.5	3,138	2	757	613	922
4/19/2019	24:00:00	397.38	25.14	88.4	2,686	1	763	588	929

4/20/2019	24:00:00	366.04	27.14	87.1	2,698	2	764	585	931
4/21/2019	24:00:00	349.84	29.12	86.3	2,737	2	766	585	933
4/22/2019	24:00:00	343.39	29.96	85.9	2,752	3	768	586	954
4/23/2019	24:00:00	344.95	29.81	86.7	2,749	3	771	595	958
4/24/2019	24:00:00	355.31	28.96	87.2	2,745	2	772	589	940
4/25/2019	24:00:00	345.99	29.83	86.7	2,755	1	774	591	943
4/26/2019	24:00:00	349.92	29.34	86.4	2,747	2	773	587	941
4/27/2019	24:00:00	341.07	30.05	85.5	2,748	5	773	592	961
4/28/2019	24:00:00	343.75	29.94	86.1	2,752	4	773	603	961
4/29/2019	24:00:00	320.55	31.92	85.2	2,736	6	783	624	995
4/30/2019	24:00:00	345.15	26.77	86.6	2,607	2	795	668	989
5/1/2019	21:26:30	345.69	25.66	85.8	2,282	2	807	705	984
5/2/2019	24:00:00	345.85	21.2	84.0	2,330	1	813	703	992
5/3/2019	24:00:00	352.79	20.33	84.5	2,301	2	818	709	1,018
5/4/2019	24:00:00	362.88	19.91	84.4	2,304	2	821	707	1,002
5/5/2019	24:00:00	346.07	20.93	83.3	2,317	2	823	711	1,004
5/6/2019	24:00:00	345.23	21.13	82.7	2,327	1	929	200	1,138
5/7/2019	4:22:08	344.54	11.32	87.2	292	2	975	237	1,224
5/8/2019	1:53:49	344.18	25.95	67.3	195	0	988	989	1,214
5/9/2019	8:58:04	349.88	3.66	89.9	353	1	969	936	1,189
5/10/2019	22:18:08	349.3	7.89	84.5	1,309	0	880	661	1,077
5/11/2019	24:00:00	347.94	38.47	81.9	3,082	2	825	508	1,027
5/12/2019	24:00:00	345.57	50.2	84.7	3,571	3	797	472	992
5/13/2019	24:00:00	346.24	49.92	87.0	3,558	3	771	378	958
5/14/2019	24:00:00	345.68	52.13	88.8	3,627	3	758	377	942
5/15/2019	24:00:00	345.97	50.69	89.5	3,576	3	751	375	932
5/16/2019	24:00:00	346.92	48.34	89.9	3,496	3	765	529	950
5/17/2019	24:00:00	348.76	40.37	88.0	3,196	3	783	632	974
5/18/2019	24:00:00	348.89	34.42	86.8	2,931	2	791	682	964
5/19/2019	24:00:00	349.62	30.08	85.9	2,756	2	792	621	966
5/20/2019	22:27:34	349.79	29.61	86.0	2,565	3	825	734	1,028
5/21/2019	20:49:34	313.38	22.74	82.3	1,950	1	853	754	1,043
5/22/2019	24:00:00	375.24	12.98	84.8	1,841	1	888	855	1,086
5/23/2019	24:00:00	375.18	7.69	86.8	1,444	1	902	868	1,104
5/24/2019	24:00:00	375.49	8.27	85.4	1,502	1	915	883	1,120
5/25/2019	24:00:00	375.36	7.2	86.0	1,406	0	922	890	1,130
5/26/2019	24:00:00	374.53	8.13	85.0	1,496	1	928	892	1,137
5/27/2019	24:00:00	374.59	8.28	84.9	1,505	1	924	858	1,132
5/28/2019	24:00:00	375.54	10.71	83.9	1,709	1	933	887	1,144
5/29/2019	24:00:00	374.61	9.58	84.5	1,618	1	941	902	1,153
5/30/2019	24:00:00	375.12	9.22	84.0	1,590	0	933	876	1,144
5/31/2019	24:00:00	375.85	12.34	82.5	1,848	1	940	899	1,152
6/1/2019	24:00:00	375.83	10.68	83.2	1,716	0	951	910	1,166
6/2/2019	24:00:00	376.18	8.81	84.0	1,559	0	940	863	1,152
6/3/2019	24:00:00	376.18	12.29	82.1	1,846	2	932	836	1,143
6/4/2019	24:00:00	374.94	14.17	82.1	1,978	2	940	879	1,152
6/5/2019	24:00:00	375.72	12.58	82.6	1,863	1	935	821	1,146
6/6/2019	24:00:00	375.95	15.32	81.7	2,047	1	944	894	1,157
6/7/2019	24:00:00	375.5	12.63	82.9	1,852	1	950	905	1,164
6/8/2019	24:00:00	375.38	11.22	82.6	1,763	1	956	905	1,172
6/9/2019	24:00:00	375.27	10.73	82.9	1,720	1	963	912	1,182
6/10/2019	24:00:00	375.89	9.87	83.0	1,645	1	947	842	1,161
6/11/2019	24:00:00	375.97	15.4	80.9	2,057	1	945	872	1,159
6/12/2019	24:00:00	375.82	14.72	80.9	2,017	1	943	875	1,156
6/13/2019	24:00:00	375.43	15.73	85.2	2,075	2	926	811	1,135
6/14/2019	24:00:00	374.46	19.35	85.5	2,306	2	935	863	1,171
6/15/2019	24:00:00	375.09	16.47	86.5	2,119	1	949	903	1,164
6/16/2019	24:00:00	375.78	12.73	87.4	1,862	1	945	889	1,159
6/17/2019	37:47:56	376.02	13.67	86.6	3,085	1	959	923	1,176
6/18/2019	10:06:56	374.35	10.12	87.3	692	1	957	905	1,174
6/19/2019	24:00:00	375.17	12.2	86.3	1,832	1	959	901	1,176
6/20/2019	24:00:00	375.29	12.08	86.9	1,824	1	955	888	1,171
6/21/2019	24:00:00	375.16	13.92	85.6	1,959	2	962	922	1,180
6/22/2019	24:00:00	374.41	11.5	86.4	1,780	1	963	911	1,182
6/23/2019	24:00:00	375.04	11.53	86.7	1,783	1	969	915	1,189
6/24/2019	24:00:00	375.53	11.02	87.2	1,742	1	971	908	1,191
6/25/2019	24:00:00	374.13	11.74	86.7	1,793	1	976	933	1,198
6/26/2019	24:00:00	374.95	10.61	87.1	1,702	2	1,027	1,007	1,263
6/27/2019	14:59:30	375.12	6.37	91.1	733	3	896	466	1,121
6/28/2019	24:00:00	376.32	44.34	89.4	3,394	7	1,009	1,010	1,301
6/29/2019	12:19:34	379.56	22.4	92.3	1,097	1	1,064	1,066	1,311
6/30/2019	0:00:00	378.88	0	96.1	0	0	1,092	1,095	1,346
7/1/2019	0:00:00	379.01	0	91.4	0	0	1,085	1,075	1,337
7/2/2019	14:33:11	380.35	8.11	91.5	866	1	1,075	1,062	1,324
7/3/2019	20:59:15	380.28	6.83	90.5	1,161	0	1,075	1,062	1,324
7/4/2019	23:41:00	379.48	6.28	91.2	1,240	1	1,072	1,050	1,321
7/5/2019	24:00:00	379.61	6.63	90.4	1,320	0	1,070	1,055	1,319
7/6/2019	23:59:08	379.66	7.68	89.3	1,401	0	1,073	1,059	1,321
7/7/2019	23:57:26	379.74	7.33	89.1	1,367	0	1,067	1,035	1,314
7/8/2019	24:00:00	379.58	8.46	88.5	1,502	1	1,048	1,004	1,290
7/9/2019	24:00:00	380.35	13.89	84.9	1,931	1	1,050	1,017	1,292
7/10/2019	24:00:00	379.54	11.4	86.7	1,737	1	1,045	1,009	1,285

7/11/2019	24:00:00	379.89	12.22	84.6	1,814	1	1,074	1,074	1,323
7/12/2019	15:57:45	374.36	18.91	85.1	1,333	7	1,121	1,124	1,456
7/13/2019	1:02:56	381.97	1.81	96.5	30	0	1,147	1,149	1,417
7/14/2019	0:00:00	384.45	0	93.2	0	0	1,163	1,165	1,437
7/15/2019	1:01:52	381.94	9.09	108.7	64	0	1,178	1,180	1,457
7/16/2019	0:17:19	379.22	1.27	101.1	7	0	1,192	1,194	1,474
7/17/2019	0:00:00	383.67	0	88.1	0	0	1,203	1,205	1,489
7/18/2019	0:00:00	383.66	0	85.3	0	0	1,214	1,216	1,503
7/19/2019	0:00:00	384.7	0	87.6	0	0	1,225	1,227	1,517
7/20/2019	0:00:00	384.32	0	90.6	0	0	1,233	1,235	1,527
7/21/2019	0:00:00	383.6	0	91.6	0	0	1,241	1,243	1,538
7/22/2019	0:00:56	379.41	1.13	100.7	0	0	1,249	1,251	1,547
7/23/2019	0:00:19	379.16	1.1	79.2	0	0	1,256	1,259	1,557
7/24/2019	0:00:22	379.85	1.09	80.3	0	0	1,263	1,266	1,566
7/25/2019	0:06:34	378.9	1.13	85.2	3	0	1,265	1,258	1,568
7/26/2019	3:42:30	381.03	11.63	85.5	249	1	1,259	1,259	1,560
7/27/2019	16:06:22	379.49	2.19	94.9	513	1	1,258	1,259	1,560
7/28/2019	15:33:08	380.09	2.44	94.7	530	0	1,253	1,250	1,553
7/29/2019	18:28:08	380	2.59	93.7	642	0	1,248	1,238	1,547
7/30/2019	19:28:38	379.94	4.69	91.2	876	1	1,237	1,219	1,533
7/31/2019	19:56:56	380.48	7.14	88.3	1,101	1	1,251	1,252	1,551
8/1/2019	15:11:11	380.19	4.07	91.6	637	1	1,277	1,279	1,584
8/2/2019	0:00:00	384.18	0	91.5	0	0	1,289	1,292	1,599
8/3/2019	0:00:00	383.36	0	82.8	0	0	1,299	1,301	1,612
8/4/2019	0:00:00	383.51	0	82.3	0	0	1,307	1,309	1,622
8/5/2019	0:00:00	334.74	0	77.3	0	0	1,313	1,316	1,631
8/6/2019	0:52:26	338.35	8.29	80.7	73	0	1,317	1,319	1,636
8/7/2019	3:32:15	351.28	3.19	81.4	117	0	1,326	1,328	1,647
8/8/2019	0:00:00	374.01	0	74.7	0	0	1,333	1,335	1,655
8/9/2019	0:00:00	366.26	0	75.1	0	0	1,338	1,341	1,662
8/10/2019	0:00:00	375.33	0	71.5	0	0	1,344	1,347	1,670
8/11/2019	0:00:00	375.94	0	69.6	0	0	1,349	1,352	1,677
8/12/2019	0:00:00	378.16	0	71.7	0	0	1,356	1,358	1,685
8/13/2019	0:00:00	381.77	0	80.0	0	0	1,361	1,363	1,692
8/14/2019	0:00:00	368.59	0	76.3	0	0	1,366	1,368	1,698
8/15/2019	0:00:00	377.76	0	76.1	0	0	1,369	1,370	1,702
8/16/2019	1:58:19	379.21	2.78	100.7	70	0	1,337	1,310	1,661
8/17/2019	23:05:26	380.31	4.78	81.4	1,063	0	1,315	1,281	1,633
8/18/2019	24:00:00	379.83	8.06	75.8	1,504	0	1,297	1,262	1,610
8/19/2019	24:00:00	379.14	10.01	73.6	1,679	0	1,290	1,260	1,600
8/20/2019	24:00:00	379.91	8.88	74.6	1,583	0	1,274	1,242	1,580
8/21/2019	24:00:00	380.4	11.36	71.8	1,805	0	1,266	1,234	1,569
8/22/2019	24:00:00	379.39	11.23	72.3	1,791	0	1,254	1,216	1,554
8/23/2019	24:00:00	380.17	12.36	72.0	1,882	0	1,239	1,201	1,535
8/24/2019	24:00:00	380.24	14.75	70.3	2,063	0	1,232	1,196	1,526
8/25/2019	24:00:00	379.69	13.35	71.6	1,962	0	1,225	1,187	1,516
8/26/2019	24:00:00	379.95	13.87	71.5	1,998	0	1,215	1,170	1,504
8/27/2019	24:00:00	379.61	14.84	71.9	2,062	0	1,211	1,172	1,499
8/28/2019	24:00:00	379.84	14.41	72.1	2,031	0	1,202	1,155	1,487
8/29/2019	24:00:00	379.72	14.79	72.1	2,058	0	1,195	1,149	1,478
8/30/2019	24:00:00	380.13	15.31	72.1	2,096	0	1,192	1,148	1,475
8/31/2019	24:00:00	379.15	14.66	73.0	2,047	0	1,186	1,140	1,466
9/1/2019	24:00:00	379.88	14.87	72.9	2,063	0	1,185	1,141	1,466
9/2/2019	24:00:00	379.83	13.23	73.7	1,944	0	1,197	1,159	1,480
9/3/2019	24:00:00	380.05	10.19	75.3	1,656	0	1,199	1,165	1,483
9/4/2019	24:00:00	379.45	10.65	75.1	1,730	0	1,189	1,152	1,471
9/5/2019	24:00:00	379.78	12.92	73.5	1,915	0	1,190	1,152	1,472
9/6/2019	24:00:00	380.54	11.54	72.0	1,810	0	1,166	1,109	1,441
9/7/2019	24:00:00	380.47	18.12	68.7	2,290	0	1,172	1,134	1,448
9/8/2019	24:00:00	380.07	13.85	69.9	1,992	0	1,173	1,135	1,449
9/9/2019	24:00:00	380	12.82	68.8	1,918	0	1,195	1,166	1,478
9/10/2019	23:58:34	379.72	7.35	71.1	1,415	0	1,223	1,219	1,514
9/11/2019	15:39:52	334.74	8.06	72.7	864	0	1,222	1,183	1,513
9/12/2019	24:00:00	380.31	4.88	74.9	1,160	0	1,227	1,214	1,520
9/13/2019	24:00:00	379.65	5.28	74.8	1,198	0	1,230	1,211	1,523
9/14/2019	24:00:00	379.77	4.89	76.5	1,162	0	1,231	1,206	1,525
9/15/2019	23:56:19	379.55	4.72	77.0	1,108	0	1,218	1,187	1,508
9/16/2019	24:00:00	380.13	7.88	74.2	1,497	0	1,246	1,239	1,543
9/17/2019	15:25:38	354.38	6.82	57.3	799	0	1,226	1,193	1,518
9/18/2019	24:00:00	380.31	7.04	73.7	1,399	0	1,211	1,168	1,499
9/19/2019	24:00:00	379.62	10.46	71.8	1,724	0	1,203	1,165	1,489
9/20/2019	24:00:00	380.08	11.22	71.4	1,788	0	1,197	1,155	1,480
9/21/2019	24:00:00	380.09	11.73	71.8	1,833	0	1,193	1,157	1,476
9/22/2019	24:00:00	379.55	11.89	72.1	1,840	0	1,214	1,198	1,503
9/23/2019	23:16:41	377.66	7.36	75.7	1,363	0	1,228	1,212	1,520
9/24/2019	22:53:08	379.51	4.72	76.0	1,061	0	1,214	1,181	1,503
9/25/2019	24:00:00	379.76	8.1	72.9	1,515	0	1,207	1,175	1,494
9/26/2019	24:00:00	379.61	9.47	72.9	1,642	0	1,199	1,164	1,483
9/27/2019	28:25:37	376.93	6.99	76.7	2,000	0	1,219	1,189	1,509
9/28/2019	18:53:56	379.7	5.18	77.4	919	0	1,225	1,203	1,517
9/29/2019	23:27:15	379.89	6.44	76.5	1,296	0	1,228	1,207	1,521
9/30/2019	23:13:11	379.55	7.42	75.9	1,348	0	1,217	1,189	1,506

10/1/2019	24:00:00	379.87	8.6	73.1	1,560	0	1,218	1,189	1,507
10/2/2019	24:00:00	379.91	7.3	75.1	1,437	0	1,226	1,184	1,518
10/3/2019	23:59:56	380.63	5.99	76.3	1,296	0	1,200	1,139	1,484
10/4/2019	24:00:00	379.44	11.97	72.5	1,814	0	1,190	1,144	1,471
10/5/2019	24:00:00	379.61	13.11	69.5	1,937	0	1,210	1,183	1,497
10/6/2019	24:00:00	379.97	7.81	73.2	1,468	0	1,185	1,112	1,465
10/7/2019	23:46:52	378.79	9.03	69.3	2,009	1	1,210	1,174	1,497
10/8/2019	23:49:19	379.58	6.3	63.5	1,327	0	1,204	1,169	1,489
10/9/2019	24:00:00	380.23	9.12	61.2	1,624	0	1,201	1,164	1,485
10/10/2019	24:00:00	379.79	9.16	61.3	1,614	0	1,202	1,165	1,487
10/11/2019	24:00:00	380.02	9.3	61.8	1,623	0	1,188	1,149	1,470
10/12/2019	24:00:00	380.14	12.7	61.1	1,930	0	1,159	1,094	1,432
10/13/2019	24:00:00	379.5	18.5	59.7	2,328	0	1,163	1,045	1,437
10/14/2019	23:41:52	379.57	17.88	66.9	2,093	2	1,157	1,121	1,429
10/15/2019	23:58:34	379.96	13.54	63.9	2,063	1	1,171	1,136	1,447
10/16/2019	24:00:00	380.21	9.6	74.5	1,644	0	1,145	965	1,413
10/17/2019	23:55:22	379.84	22.83	72.0	2,365	1	1,196	1,177	1,479
10/18/2019	19:49:52	379.73	4.25	78.1	857	1	1,198	1,166	1,482
10/19/2019	23:56:45	379.98	5.73	76.3	1,227	0	1,213	1,188	1,502
10/20/2019	22:30:19	380.42	4.18	79.1	998	0	1,216	1,186	1,506
10/21/2019	23:49:41	380.04	4.83	78.5	1,104	1	1,235	1,229	1,529
10/22/2019	19:37:49	380.26	3.76	80.3	826	1	1,218	1,182	1,507
10/23/2019	23:58:08	380.14	6.71	75.0	1,330	0	1,205	1,168	1,491
10/24/2019	24:00:00	379.61	8.68	71.4	1,547	0	1,215	1,158	1,504
10/25/2019	23:53:19	380.07	7.67	74.1	1,328	1	1,177	1,052	1,455
10/26/2019	23:07:15	379.62	17.65	71.7	1,897	0	1,192	1,165	1,475
10/27/2019	24:00:00	380.27	13.04	71.3	1,856	3	1,198	1,164	1,519
10/28/2019	24:00:00	379.77	8.18	72.2	1,508	2	1,212	1,180	1,500
10/29/2019	23:17:11	380.66	6.01	74.8	1,201	1	1,211	1,178	1,498
10/30/2019	24:00:00	379.84	7.15	72.8	1,417	1	1,215	1,191	1,504
10/31/2019	24:00:00	380.8	7.08	72.1	1,413	1	1,206	1,155	1,492
11/1/2019	24:00:00	380.16	9.27	71.1	1,543	1	1,187	1,148	1,468
11/2/2019	24:00:00	379.85	14.12	67.6	1,993	1	1,215	1,186	1,504
11/3/2019	24:00:00	380.06	5.32	73.4	1,184	1	1,215	1,178	1,504
11/4/2019	23:59:49	379.85	5.51	72.8	1,220	1	1,230	1,212	1,523
11/5/2019	23:53:26	380.27	4.01	73.5	1,044	1	1,221	1,196	1,512
11/6/2019	21:48:30	379.7	7.31	70.4	1,309	0	1,256	1,253	1,556
11/7/2019	12:06:52	379.45	2.05	75.3	375	0	1,197	1,121	1,481
11/8/2019	23:14:08	379.12	16.02	66.1	2,015	2	1,152	997	1,457
11/9/2019	18:51:26	379.14	31.88	63.6	2,343	3	1,128	1,035	1,425
11/10/2019	24:00:00	380.32	28.87	66.0	2,900	3	1,109	1,008	1,400
11/11/2019	36:33:11	380.06	23.16	68.7	4,020	3	1,096	928	1,383
11/12/2019	11:26:34	378.4	33.8	67.1	1,474	5	1,020	680	1,283
11/13/2019	0:00:00	379.92	55.06	71.4	3,474	9	999	737	1,288
11/14/2019	24:00:00	379.88	50.3	71.0	3,802	7	1,004	881	1,295

45 ft Cluster Spacing

Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		233	223	238	232	234	232	224	222	236	227	232	231	224	228	186	179	181	179	185	240	218	223	242	222	231	224	184	194
New Cluster #		5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	5	5	5	5	5	5	5	4	4
New Spacing		45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Cluster Top TD	**1**	13,805	13,577	13,346	13,111	12,878	12,645	12,417	12,194	11,965	11,734	11,505	11,274	11,046	10,820	10,590	10,408	10,228	10,048	9,866	9,676	9,448	9,228	8,996	8,764	8,537	8,309	8,083	7,893
	2	13,760	13,532	13,301	13,066	12,833	12,600	12,372	12,149	11,920	11,689	11,460	11,229	11,001	10,775	10,545	10,363	10,183	10,003	9,821	9,631	9,403	9,183	8,951	8,719	8,492	8,264	8,038	7,848
	3	13,715	13,487	13,256	13,021	12,788	12,555	12,327	12,104	11,875	11,644	11,415	11,184	10,956	10,730	10,500	10,318	10,138	9,958	9,776	9,586	9,358	9,138	8,906	8,674	8,447	8,219	7,993	7,803
	4	13,670	13,442	13,211	12,976	12,743	12,510	12,282	12,059	11,830	11,599	11,370	11,139	10,911	10,685	10,455	10,273	10,093	9,913	9,731	9,541	9,313	9,093	8,861	8,629	8,402	8,174	7,948	7,758
	5	13,625	13,397	13,166	12,931	12,698	12,465	12,237	12,014	11,785	11,554	11,325	11,094	10,866	10,640						9,496	9,268	9,048	8,816	8,584	8,357	8,129		
	6																												
	7																												

Figure 39: Case Study 1 - 45 ft Cluster Spacing Design

40 ft Cluster Spacing

Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		233	223	238	232	234	232	224	222	236	227	232	231	224	228	186	179	181	179	185	240	218	223	242	222	231	224	184	194
New Cluster #		5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	5	5	5	5	5	5	5	4	4
New Spacing		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Cluster Top TD	**1**	13,792	13,564	13,334	13,099	12,866	12,633	12,405	12,182	11,953	11,721	11,492	11,261	11,034	10,808	10,580	10,398	10,218	10,038	9,856	9,664	9,435	9,215	8,983	8,751	8,525	8,297	8,073	7,883
	2	13,747	13,519	13,289	13,054	12,821	12,588	12,360	12,137	11,908	11,676	11,447	11,216	10,989	10,763	10,535	10,353	10,173	9,993	9,811	9,619	9,390	9,170	8,938	8,706	8,480	8,252	8,028	7,838
	3	13,702	13,474	13,244	13,009	12,776	12,543	12,315	12,092	11,863	11,631	11,402	11,171	10,944	10,718	10,490	10,308	10,128	9,948	9,766	9,574	9,345	9,125	8,893	8,661	8,435	8,207	7,983	7,793
	4	13,657	13,429	13,199	12,964	12,731	12,498	12,270	12,047	11,818	11,586	11,357	11,126	10,899	10,673	10,445	10,263	10,083	9,903	9,721	9,529	9,300	9,080	8,848	8,616	8,390	8,162	7,938	7,748
	5	13,612	13,384	13,154	12,919	12,686	12,453	12,225	12,002	11,773	11,541	11,312	11,081	10,854	10,628						9,484	9,255	9,035	8,803	8,571	8,345	8,117		
	6																												
	7																												

Figure 40: Case Study 1 - 40 ft Cluster Spacing Design

35 ft Cluster Spacing																														
Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		233	223	238	232	234	232	224	222	236	227	232	231	224	228	186	179	181	179	185	240	218	223	242	222	231	224	184	194
New Cluster #		5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	5	5	5	5	5	5	5	4	4
New Spacing		35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Cluster Top TD	1	13,780	13,552	13,321	13,086	12,853	12,620	12,392	12,169	11,940	11,709	11,480	11,249	11,021	10,795	10,570	10,388	10,208	10,028	9,846	9,651	9,423	9,203	8,971	8,739	8,512	8,284	8,063	7,873
	2	13,735	13,507	13,276	13,041	12,808	12,575	12,347	12,124	11,895	11,664	11,435	11,204	10,976	10,750	10,525	10,343	10,163	9,983	9,801	9,606	9,378	9,158	8,926	8,694	8,467	8,239	8,018	7,828
	3	13,690	13,462	13,231	12,996	12,763	12,530	12,302	12,079	11,850	11,619	11,390	11,159	10,931	10,705	10,480	10,298	10,118	9,938	9,756	9,561	9,333	9,113	8,881	8,649	8,422	8,194	7,973	7,783
	4	13,645	13,417	13,186	12,951	12,718	12,485	12,257	12,034	11,805	11,574	11,345	11,114	10,886	10,660	10,435	10,253	10,073	9,893	9,711	9,516	9,288	9,068	8,836	8,604	8,377	8,149	7,928	7,738
	5	13,600	13,372	13,141	12,906	12,673	12,440	12,212	11,989	11,760	11,529	11,300	11,069	10,841	10,615						9,471	9,243	9,023	8,791	8,559	8,332	8,104		
	6																												
	7																												

Figure 41: Case Study 1 - 35 ft Cluster Spacing Design

45 ft Cluster Spacing																														
Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	180	180	180	180	180
New Cluster #		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4
New Spacing		45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Cluster Top TD	1	13809	13584	13359	13134	12909	12684	12459	12234	12009	11784	11559	11334	11109	10884	10659	10434	10209	9984	9759	9534	9309	9084	8859	8634	8454	8274	8094	7914
	2	13764	13539	13314	13089	12864	12639	12414	12189	11964	11739	11514	11289	11064	10839	10614	10389	10164	9939	9714	9489	9264	9039	8814	8589	8409	8229	8049	7869
	3	13719	13494	13269	13044	12819	12594	12369	12144	11919	11694	11469	11244	11019	10794	10569	10344	10119	9894	9669	9444	9219	8994	8769	8544	8364	8184	8004	7824
	4	13674	13449	13224	12999	12774	12549	12324	12099	11874	11649	11424	11199	10974	10749	10524	10299	10074	9849	9624	9399	9174	8949	8724	8499	8319	8139	7959	7779
	5	13629	13404	13179	12954	12729	12504	12279	12054	11829	11604	11379	11154	10929	10704	10479	10254	10029	9804	9579	9354	9129	8904	8679					
	6																												
	7																												

Figure 42: Case Study 2 - 45 ft Cluster Spacing Design

40 ft Cluster Spacing																														
Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		240	240	240	240	240	240	240	240	240	240	240	240	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
New Cluster #		6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
New Spacing		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Cluster Top TD	1	13809	13569	13329	13089	12849	12609	12369	12129	11889	11649	11409	11169	10929	10729	10529	10329	10129	9929	9729	9529	9329	9129	8929	8729	8529	8329	8129	7929
	2	13769	13529	13289	13049	12809	12569	12329	12089	11849	11609	11369	11129	10889	10689	10489	10289	10089	9889	9689	9489	9289	9089	8889	8689	8489	8289	8089	7889
	3	13729	13489	13249	13009	12769	12529	12289	12049	11809	11569	11329	11089	10849	10649	10449	10249	10049	9849	9649	9449	9249	9049	8849	8649	8449	8249	8049	7849
	4	13689	13449	13209	12969	12729	12489	12249	12009	11769	11529	11289	11049	10809	10609	10409	10209	10009	9809	9609	9409	9209	9009	8809	8609	8409	8209	8009	7809
	5	13649	13409	13169	12929	12689	12449	12209	11969	11729	11489	11249	11009	10769	10569	10369	10169	9969	9769	9569	9369	9169	8969	8769	8569	8369	8169	7969	7769
	6	13609	13369	13129	12889	12649	12409	12169	11929	11689	11449	11209	10969																
	7																												

Figure 43: Case Study 2 - 40 ft Cluster Spacing Design

35 ft Cluster Spacing																														
Stage Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Stage Length		245	245	245	245	245	245	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
New Cluster #		7	7	7	7	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
New Spacing		35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Cluster Top TD	1	13809	13564	13319	13074	12829	12584	12339	12129	11919	11709	11499	11289	11079	10869	10659	10449	10239	10029	9819	9609	9399	9189	8979	8769	8559	8349	8139	7929
	2	13774	13529	13284	13039	12794	12549	12304	12094	11884	11674	11464	11254	11044	10834	10624	10414	10204	9994	9784	9574	9364	9154	8944	8734	8524	8314	8104	7894
	3	13739	13494	13249	13004	12759	12514	12269	12059	11849	11639	11429	11219	11009	10799	10589	10379	10169	9959	9749	9539	9329	9119	8909	8699	8489	8279	8069	7859
	4	13704	13459	13214	12969	12724	12479	12234	12024	11814	11604	11394	11184	10974	10764	10554	10344	10134	9924	9714	9504	9294	9084	8874	8664	8454	8244	8034	7824
	5	13669	13424	13179	12934	12689	12444	12199	11989	11779	11569	11359	11149	10939	10729	10519	10309	10099	9889	9679	9469	9259	9049	8839	8629	8419	8209	7999	7789
	6	13634	13389	13144	12899	12654	12409	12164	11954	11744	11534	11324	11114	10904	10694	10484	10274	10064	9854	9644	9434	9224	9014	8804	8594	8384	8174	7964	7754
	7	13599	13354	13109	12864	12619	12374																						

Figure 44: Case Study 2 - 35 ft Cluster Spacing Design

Table 137: Case Study 1 - 45 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)	Max Fracture Width (in)
1	Transverse 5	120	10.32	10.27	155	0.360	0.322	0.439
	Transverse 4	40	7.20	7.13	110	0.072	0.030	0.079
	Transverse 3	80	9.50	9.43	120	0.183	0.174	0.402
	Transverse 2	40	7.48	7.40	110	0.072	0.027	0.079
	Transverse 1	100	10.28	10.23	155	0.359	0.314	0.432
2	Transverse 5	100	10.53	10.47	140	0.357	0.311	0.433
	Transverse 4	60	8.75	8.64	110	0.145	0.054	0.305
	Transverse 3	80	9.91	9.84	85	0.216	0.165	0.370
	Transverse 2	120	9.16	9.07	75	0.125	0.071	0.345
	Transverse 1	100	10.61	10.56	45	0.220	0.237	0.384
3	Transverse 5	100	10.97	10.92	155	0.455	0.329	0.446
	Transverse 4	40	5.47	5.44	60	0.168	0.017	0.239
	Transverse 3	80	10.01	9.94	125	0.179	0.180	0.391
	Transverse 2	100	9.23	9.15	90	0.255	0.082	0.294
	Transverse 1	140	10.63	10.58	40	0.344	0.219	0.367
4	Transverse 5	100	11.16	11.12	175	0.439	0.340	0.469

	Transverse 4	80	8.15	8.05	115	0.120	0.044	0.224
	Transverse 3	80	9.83	9.77	100	0.154	0.139	0.369
	Transverse 2	80	10.17	10.12	60	0.110	0.147	0.317
	Transverse 1	60	10.91	10.86	20	0.139	0.210	0.393
5	Transverse 5	120	10.65	10.59	145	0.389	0.307	0.435
	Transverse 4	60	8.91	8.81	110	0.107	0.073	0.376
	Transverse 3	60	10.04	9.97	90	0.246	0.176	0.406
	Transverse 2	80	9.89	9.82	50	0.148	0.136	0.291
	Transverse 1	100	10.23	10.17	30	0.400	0.218	0.420
6	Transverse 5	120	11.16	11.12	155	0.501	0.322	0.439
	Transverse 4	60	9.26	9.17	110	0.120	0.070	0.358
	Transverse 3	100	10.01	9.95	105	0.209	0.174	0.366
	Transverse 2	80	7.69	7.63	90	0.162	0.079	0.362
	Transverse 1	140	10.88	10.83	60	0.281	0.226	0.365
7	Transverse 5	100	10.73	10.68	150	0.318	0.317	0.446
	Transverse 4	100	9.12	9.04	110	0.114	0.078	0.331
	Transverse 3	80	10.07	10.02	85	0.186	0.191	0.419
	Transverse 2	100	9.45	9.38	35	0.131	0.101	0.299
	Transverse 1	100	10.24	10.18	30	0.334	0.185	0.393
8	Transverse 5	100	10.69	10.65	185	0.324	0.306	0.435
	Transverse 4	100	8.76	8.68	105	0.126	0.064	0.337
	Transverse 3	60	9.83	9.77	90	0.148	0.170	0.396
	Transverse 2	60	9.16	9.09	110	0.101	0.091	0.336
	Transverse 1	80	10.63	10.59	100	0.304	0.219	0.385
9	Transverse 5	120	10.97	10.93	190	0.446	0.315	0.448
	Transverse 4	80	8.62	8.51	110	0.208	0.053	0.257
	Transverse 3	80	10.27	10.22	100	0.222	0.184	0.424
	Transverse 2	80	8.98	8.91	65	0.169	0.123	0.306
	Transverse 1	100	10.43	10.38	50	0.304	0.220	0.387
10	Transverse 5	100	10.80	10.76	195	0.442	0.313	0.448
	Transverse 4	60	7.96	7.86	145	0.149	0.038	0.231
	Transverse 3	80	10.08	10.03	110	0.211	0.157	0.375
	Transverse 2	80	8.96	8.89	70	0.178	0.099	0.299
	Transverse 1	100	10.54	10.50	30	0.425	0.217	0.415
11	Transverse 5	100	11.04	10.99	185	0.399	0.314	0.449
	Transverse 4	20	9.34	9.26	90	0.090	0.055	0.307
	Transverse 3	80	10.56	10.50	85	0.194	0.137	0.335
	Transverse 2	60	8.80	8.73	65	0.183	0.129	0.334
	Transverse 1	80	10.78	10.72	25	0.281	0.202	0.381
12	Transverse 5	100	10.96	10.92	190	0.424	0.319	0.455
	Transverse 4	40	5.92	5.90	70	0.218	0.038	0.142
	Transverse 3	80	10.42	10.37	120	0.254	0.200	0.418
	Transverse 2	40	9.48	9.42	70	0.169	0.076	0.272
	Transverse 1	100	10.80	10.76	45	0.279	0.219	0.404
13	Transverse 5	100	10.98	10.93	115	0.472	0.301	0.426
	Transverse 4	60	9.38	9.29	110	0.153	0.086	0.339
	Transverse 3	100	9.92	9.85	110	0.268	0.143	0.324
	Transverse 2	120	9.99	9.93	95	0.152	0.111	0.323
	Transverse 1	60	10.19	10.13	55	0.168	0.201	0.411
14	Transverse 5	120	10.80	10.75	145	0.376	0.299	0.428
	Transverse 4	20	9.01	8.92	145	0.117	0.070	0.376
	Transverse 3	80	10.06	10.00	110	0.223	0.164	0.353
	Transverse 2	100	9.70	9.64	75	0.195	0.096	0.312
	Transverse 1	80	9.99	9.94	35	0.189	0.207	0.427
15	Transverse 4	100	10.32	10.26	185	0.388	0.271	0.406
	Transverse 3	80	5.86	5.84	105	0.159	0.052	0.265
	Transverse 2	100	9.42	9.35	110	0.179	0.122	0.344
	Transverse 1	100	10.65	10.60	80	0.210	0.238	0.426
16	Transverse 4	0	10.42	10.36	90	0.027	0.273	0.410
	Transverse 3	60	9.80	9.72	125	0.044	0.155	0.398
	Transverse 2	40	8.05	7.98	50	0.170	0.118	0.302
	Transverse 1	40	9.97	9.89	40	0.006	0.235	0.401
17	Transverse 4	100	10.40	10.34	115	0.422	0.285	0.411
	Transverse 3	80	9.24	9.16	125	0.157	0.091	0.332
	Transverse 2	120	9.30	9.22	125	0.184	0.097	0.327
	Transverse 1	120	10.25	10.19	140	0.391	0.236	0.355
18	Transverse 4	100	10.53	10.48	145	0.343	0.296	0.424
	Transverse 3	80	8.50	8.39	135	0.108	0.074	0.306
	Transverse 2	80	9.48	9.41	90	0.169	0.125	0.312
	Transverse 1	80	10.01	9.95	25	0.215	0.227	0.419
19	Transverse 4	120	10.77	10.73	160	0.399	0.295	0.430
	Transverse 3	80	9.03	8.95	95	0.190	0.071	0.315
	Transverse 2	80	9.62	9.55	90	0.211	0.117	0.337
	Transverse 1	120	10.58	10.53	60	0.199	0.236	0.387
20	Transverse 5	120	11.37	11.33	175	0.524	0.285	0.426
	Transverse 4	40	8.86	8.79	90	0.124	0.064	0.190
	Transverse 3	120	9.68	9.61	90	0.449	0.103	0.331
	Transverse 2	100	9.21	9.12	75	0.161	0.080	0.283
	Transverse 1	140	11.26	11.21	45	0.376	0.232	0.418
21	Transverse 5	120	11.62	11.57	145	0.570	0.306	0.425
	Transverse 4	60	9.56	9.48	110	0.184	0.066	0.338
	Transverse 3	80	10.56	10.51	90	0.220	0.152	0.331

	Transverse 2	120	9.90	9.83	90	0.165	0.108	0.347
	Transverse 1	80	10.38	10.32	20	0.293	0.209	0.360
22	Transverse 5	120	10.47	10.42	215	0.495	0.320	0.461
	Transverse 4	80	8.51	8.41	130	0.159	0.049	0.269
	Transverse 3	80	9.80	9.74	110	0.236	0.144	0.383
	Transverse 2	80	9.48	9.41	70	0.190	0.121	0.330
	Transverse 1	80	9.86	9.80	30	0.442	0.178	0.391
23	Transverse 5	140	10.78	10.74	175	0.505	0.282	0.405
	Transverse 4	60	9.02	8.95	140	0.209	0.089	0.358
	Transverse 3	120	9.31	9.25	110	0.228	0.128	0.324
	Transverse 2	80	9.57	9.51	50	0.168	0.103	0.309
	Transverse 1	80	10.61	10.57	25	0.343	0.226	0.372
24	Transverse 5	100	10.61	10.56	195	0.366	0.280	0.415
	Transverse 4	20	8.58	8.48	130	0.096	0.041	0.268
	Transverse 3	80	10.03	9.98	110	0.207	0.174	0.344
	Transverse 2	80	9.35	9.28	65	0.140	0.088	0.307
	Transverse 1	100	10.22	10.17	30	0.370	0.214	0.394
25	Transverse 5	100	10.78	10.73	200	0.372	0.276	0.414
	Transverse 4	80	9.01	8.92	110	0.195	0.054	0.356
	Transverse 3	80	10.26	10.20	90	0.190	0.156	0.331
	Transverse 2	80	9.37	9.29	80	0.157	0.102	0.365
	Transverse 1	80	10.58	10.53	30	0.432	0.212	0.368
26	Transverse 5	120	11.08	11.03	155	0.432	0.261	0.401
	Transverse 4	40	9.04	8.95	110	0.125	0.055	0.249
	Transverse 3	80	10.19	10.13	90	0.222	0.153	0.353
	Transverse 2	100	9.33	9.26	90	0.258	0.109	0.311
	Transverse 1	100	10.88	10.83	30	0.457	0.207	0.370
27	Transverse 4	120	11.79	11.75	150	0.672	0.299	0.437
	Transverse 3	100	10.09	10.03	90	0.380	0.130	0.300
	Transverse 2	100	11.08	11.04	70	0.491	0.201	0.429
	Transverse 1	100	11.06	11.02	30	0.622	0.208	0.381
28	Transverse 4	100	10.88	10.84	150	0.557	0.313	0.452
	Transverse 3	100	9.31	9.24	120	0.127	0.076	0.404
	Transverse 2	100	10.20	10.15	100	0.285	0.198	0.417
	Transverse 1	60	10.26	10.21	30	0.362	0.191	0.380

Table 138: Case Study 1 - 40 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)	Max Fracture Width (in)
1	Transverse 5	120	10.35	10.29	155	0.360	0.327	0.446
	Transverse 4	40	7.67	7.58	110	0.081	0.026	0.088
	Transverse 3	80	9.47	9.40	115	0.163	0.161	0.391
	Transverse 2	40	7.49	7.41	110	0.076	0.027	0.082
	Transverse 1	100	10.40	10.35	155	0.371	0.322	0.440
2	Transverse 5	100	10.61	10.55	145	0.346	0.305	0.424
	Transverse 4	80	8.49	8.37	105	0.140	0.052	0.346
	Transverse 3	80	9.81	9.74	80	0.169	0.153	0.364
	Transverse 2	120	9.35	9.26	95	0.147	0.084	0.340
	Transverse 1	120	10.62	10.57	40	0.264	0.240	0.376
3	Transverse 5	100	11.00	10.95	155	0.441	0.324	0.440
	Transverse 4	60	8.50	8.39	125	0.120	0.047	0.349
	Transverse 3	80	10.14	10.08	105	0.224	0.182	0.399
	Transverse 2	120	8.99	8.91	75	0.125	0.067	0.288
	Transverse 1	140	10.54	10.48	45	0.292	0.211	0.398
4	Transverse 5	100	11.02	10.98	175	0.408	0.324	0.450
	Transverse 4	140	9.31	9.22	110	0.131	0.076	0.384
	Transverse 3	80	9.99	9.93	85	0.229	0.157	0.346
	Transverse 2	120	9.70	9.63	45	0.188	0.068	0.381
	Transverse 1	60	10.37	10.31	30	0.142	0.215	0.367
5	Transverse 5	100	10.60	10.55	145	0.375	0.298	0.428
	Transverse 4	60	8.17	8.06	95	0.126	0.041	0.224
	Transverse 3	80	9.97	9.90	100	0.160	0.179	0.398
	Transverse 2	100	9.32	9.24	95	0.197	0.086	0.304
	Transverse 1	100	10.33	10.27	30	0.357	0.224	0.374
6	Transverse 5	100	11.16	11.12	155	0.499	0.305	0.431
	Transverse 4	40	9.13	9.04	90	0.098	0.058	0.354
	Transverse 3	100	9.91	9.85	105	0.255	0.151	0.344
	Transverse 2	100	7.71	7.65	60	0.173	0.075	0.340
	Transverse 1	140	11.13	11.09	55	0.308	0.242	0.391
7	Transverse 5	100	10.79	10.74	145	0.336	0.320	0.449
	Transverse 4	60	7.77	7.67	105	0.137	0.019	0.203
	Transverse 3	80	10.30	10.25	110	0.150	0.202	0.414
	Transverse 2	80	9.72	9.66	55	0.119	0.111	0.296
	Transverse 1	100	10.48	10.43	30	0.303	0.202	0.387
8	Transverse 5	100	10.90	10.85	195	0.351	0.327	0.468
	Transverse 4	0	8.31	8.18	110	0.085	0.036	0.238
	Transverse 3	60	9.92	9.86	85	0.135	0.185	0.395

	Transverse 2	60	8.98	8.90	90	0.087	0.086	0.338
	Transverse 1	80	10.80	10.75	90	0.316	0.215	0.401
9	Transverse 5	120	10.93	10.89	190	0.430	0.315	0.449
	Transverse 4	80	8.59	8.49	105	0.221	0.048	0.291
	Transverse 3	100	10.22	10.16	110	0.227	0.193	0.423
	Transverse 2	100	8.75	8.69	75	0.214	0.110	0.314
	Transverse 1	100	10.58	10.53	30	0.440	0.213	0.400
10	Transverse 5	100	10.76	10.72	195	0.416	0.300	0.437
	Transverse 4	100	9.52	9.45	105	0.148	0.073	0.377
	Transverse 3	80	10.38	10.33	110	0.236	0.166	0.327
	Transverse 2	40	9.16	9.08	65	0.197	0.085	0.290
	Transverse 1	100	10.38	10.33	30	0.406	0.209	0.376
11	Transverse 5	100	10.88	10.84	185	0.385	0.310	0.449
	Transverse 4	80	9.22	9.14	105	0.178	0.046	0.332
	Transverse 3	80	10.50	10.45	85	0.245	0.194	0.358
	Transverse 2	80	9.48	9.40	55	0.153	0.077	0.295
	Transverse 1	80	10.97	10.92	30	0.304	0.218	0.385
12	Transverse 5	100	11.15	11.10	195	0.437	0.332	0.472
	Transverse 4	40	6.15	6.08	75	0.201	0.019	0.125
	Transverse 3	100	10.34	10.29	100	0.311	0.178	0.398
	Transverse 2	60	9.67	9.60	60	0.164	0.058	0.288
	Transverse 1	100	10.72	10.67	40	0.319	0.223	0.397
13	Transverse 5	100	11.12	11.08	115	0.473	0.292	0.402
	Transverse 4	100	9.33	9.25	110	0.152	0.078	0.353
	Transverse 3	120	9.88	9.81	90	0.287	0.162	0.399
	Transverse 2	120	10.21	10.14	80	0.161	0.150	0.341
	Transverse 1	80	10.64	10.59	55	0.241	0.213	0.419
14	Transverse 5	100	10.54	10.49	145	0.369	0.293	0.420
	Transverse 4	140	9.04	8.96	160	0.130	0.090	0.338
	Transverse 3	60	9.49	9.43	140	0.171	0.128	0.308
	Transverse 2	60	9.46	9.40	90	0.236	0.098	0.374
	Transverse 1	100	9.94	9.88	35	0.310	0.193	0.363
15	Transverse 4	100	10.72	10.67	145	0.406	0.293	0.426
	Transverse 3	140	9.92	9.85	125	0.205	0.165	0.428
	Transverse 2	60	9.09	9.00	80	0.210	0.061	0.314
	Transverse 1	120	10.52	10.46	55	0.250	0.235	0.402
16	Transverse 4	40	10.55	10.49	90	0.113	0.282	0.415
	Transverse 3	60	9.69	9.62	130	0.049	0.141	0.398
	Transverse 2	20	9.99	9.92	60	0.043	0.128	0.326
	Transverse 1	60	10.05	9.98	50	0.021	0.238	0.408
17	Transverse 4	100	10.31	10.25	145	0.384	0.270	0.398
	Transverse 3	60	9.30	9.22	90	0.153	0.081	0.307
	Transverse 2	80	9.91	9.85	90	0.115	0.116	0.352
	Transverse 1	120	10.19	10.13	125	0.348	0.223	0.398
18	Transverse 4	100	10.32	10.26	140	0.304	0.273	0.399
	Transverse 3	100	9.62	9.55	130	0.176	0.143	0.418
	Transverse 2	80	8.82	8.72	85	0.130	0.081	0.336
	Transverse 1	80	10.20	10.14	35	0.209	0.223	0.367
19	Transverse 4	140	10.71	10.67	150	0.402	0.297	0.437
	Transverse 3	120	9.53	9.46	120	0.188	0.122	0.402
	Transverse 2	100	9.06	8.99	90	0.327	0.101	0.315
	Transverse 1	120	10.41	10.35	50	0.237	0.234	0.362
20	Transverse 5	120	11.32	11.28	170	0.461	0.282	0.411
	Transverse 4	80	9.05	8.96	115	0.221	0.072	0.291
	Transverse 3	100	9.98	9.91	90	0.222	0.129	0.332
	Transverse 2	100	9.26	9.18	75	0.190	0.084	0.294
	Transverse 1	80	10.96	10.91	30	0.461	0.223	0.391
21	Transverse 5	120	11.25	11.20	195	0.487	0.270	0.412
	Transverse 4	80	9.25	9.17	110	0.216	0.066	0.262
	Transverse 3	100	10.42	10.37	100	0.318	0.163	0.363
	Transverse 2	100	9.73	9.66	55	0.186	0.112	0.351
	Transverse 1	140	11.10	11.05	20	0.585	0.206	0.374
22	Transverse 5	120	10.42	10.37	215	0.491	0.321	0.462
	Transverse 4	20	8.73	8.65	125	0.138	0.045	0.312
	Transverse 3	80	10.01	9.96	110	0.239	0.173	0.363
	Transverse 2	100	7.47	7.41	80	0.198	0.105	0.377
	Transverse 1	80	9.80	9.75	50	0.302	0.179	0.402
23	Transverse 5	120	10.70	10.66	185	0.477	0.276	0.407
	Transverse 4	40	8.48	8.38	130	0.130	0.051	0.265
	Transverse 3	100	10.19	10.14	110	0.296	0.184	0.394
	Transverse 2	100	9.45	9.38	65	0.132	0.094	0.294
	Transverse 1	80	9.99	9.94	30	0.362	0.217	0.363
24	Transverse 5	100	10.53	10.48	195	0.357	0.280	0.412
	Transverse 4	40	8.55	8.46	130	0.122	0.048	0.261
	Transverse 3	80	10.04	9.98	110	0.212	0.174	0.388
	Transverse 2	80	9.06	9.00	65	0.121	0.092	0.304
	Transverse 1	80	10.37	10.32	30	0.361	0.212	0.384
25	Transverse 5	100	10.86	10.81	180	0.344	0.281	0.410
	Transverse 4	100	9.62	9.55	105	0.138	0.094	0.393
	Transverse 3	80	9.25	9.18	110	0.207	0.120	0.326
	Transverse 2	80	9.71	9.65	75	0.192	0.122	0.330
	Transverse 1	80	10.78	10.73	35	0.274	0.220	0.396

26	Transverse 5	120	11.12	11.08	180	0.457	0.279	0.412
	Transverse 4	80	8.90	8.81	100	0.237	0.044	0.298
	Transverse 3	80	10.69	10.64	90	0.310	0.195	0.376
	Transverse 2	100	9.97	9.91	55	0.286	0.109	0.285
	Transverse 1	80	10.45	10.39	40	0.311	0.209	0.390
27	Transverse 4	120	11.73	11.69	150	0.644	0.301	0.432
	Transverse 3	100	9.64	9.57	110	0.240	0.100	0.309
	Transverse 2	100	10.37	10.31	70	0.280	0.136	0.313
	Transverse 1	100	10.82	10.77	30	0.574	0.199	0.377
28	Transverse 4	100	11.07	11.03	150	0.570	0.316	0.448
	Transverse 3	100	10.05	9.99	125	0.345	0.174	0.447
	Transverse 2	100	8.59	8.52	55	0.224	0.141	0.341
	Transverse 1	60	10.89	10.85	25	0.369	0.219	0.395

Table 139: Case Study 1 - 35 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)	Max Fracture Width (in)
1	Transverse 5	120	10.33	10.28	155	0.358	0.327	0.445
	Transverse 4	40	7.75	7.66	110	0.084	0.029	0.110
	Transverse 3	80	9.45	9.38	115	0.169	0.160	0.383
	Transverse 2	40	7.50	7.43	110	0.077	0.027	0.082
	Transverse 1	100	10.37	10.32	155	0.369	0.321	0.439
2	Transverse 5	120	10.75	10.70	145	0.362	0.313	0.435
	Transverse 4	40	8.74	8.64	90	0.091	0.048	0.152
	Transverse 3	80	10.10	10.03	85	0.152	0.165	0.389
	Transverse 2	100	9.29	9.20	85	0.193	0.062	0.300
	Transverse 1	120	10.73	10.67	45	0.233	0.247	0.385
3	Transverse 5	120	10.74	10.69	145	0.387	0.311	0.437
	Transverse 4	80	8.90	8.81	145	0.140	0.067	0.385
	Transverse 3	100	10.14	10.09	130	0.302	0.200	0.405
	Transverse 2	120	9.97	9.91	50	0.188	0.094	0.359
	Transverse 1	120	10.38	10.33	30	0.426	0.198	0.390
4	Transverse 5	100	11.06	11.01	170	0.388	0.316	0.437
	Transverse 4	140	8.86	8.77	105	0.144	0.061	0.319
	Transverse 3	100	10.34	10.28	90	0.257	0.178	0.373
	Transverse 2	60	5.67	5.64	50	0.155	0.032	0.277
	Transverse 1	140	10.86	10.81	40	0.274	0.234	0.413
5	Transverse 5	100	10.67	10.62	145	0.378	0.299	0.430
	Transverse 4	60	8.14	8.01	110	0.167	0.043	0.234
	Transverse 3	60	10.03	9.96	105	0.195	0.195	0.400
	Transverse 2	100	8.36	8.25	60	0.168	0.064	0.293
	Transverse 1	140	10.43	10.37	30	0.388	0.223	0.374
6	Transverse 5	140	10.91	10.86	170	0.425	0.293	0.419
	Transverse 4	80	9.45	9.38	110	0.156	0.117	0.373
	Transverse 3	80	9.17	9.09	85	0.133	0.089	0.303
	Transverse 2	120	8.91	8.83	90	0.244	0.082	0.305
	Transverse 1	120	10.55	10.50	35	0.334	0.237	0.363
7	Transverse 5	120	11.09	11.05	155	0.393	0.344	0.484
	Transverse 4	80	9.72	9.65	80	0.104	0.116	0.402
	Transverse 3	80	9.73	9.66	85	0.086	0.100	0.363
	Transverse 2	60	8.08	8.01	65	0.118	0.099	0.350
	Transverse 1	100	10.64	10.59	45	0.228	0.207	0.410
8	Transverse 5	100	10.87	10.82	190	0.357	0.325	0.463
	Transverse 4	40	8.38	8.28	125	0.099	0.050	0.294
	Transverse 3	60	10.13	10.07	95	0.148	0.159	0.397
	Transverse 2	80	9.07	8.99	110	0.080	0.101	0.340
	Transverse 1	60	10.39	10.34	90	0.313	0.203	0.401
9	Transverse 5	100	10.66	10.61	180	0.403	0.291	0.428
	Transverse 4	20	8.44	8.34	140	0.128	0.051	0.233
	Transverse 3	80	10.14	10.09	110	0.213	0.185	0.392
	Transverse 2	80	8.50	8.44	80	0.202	0.116	0.297
	Transverse 1	100	10.54	10.49	40	0.337	0.216	0.404
10	Transverse 5	100	11.03	10.98	195	0.448	0.313	0.447
	Transverse 4	40	8.57	8.48	90	0.095	0.029	0.169
	Transverse 3	100	10.26	10.20	105	0.255	0.189	0.418
	Transverse 2	80	9.24	9.17	55	0.166	0.066	0.292
	Transverse 1	100	10.82	10.77	30	0.410	0.220	0.424
11	Transverse 5	100	10.80	10.75	180	0.374	0.303	0.445
	Transverse 4	20	8.02	7.92	110	0.089	0.021	0.244
	Transverse 3	80	10.39	10.34	105	0.235	0.199	0.360
	Transverse 2	80	8.58	8.50	55	0.144	0.058	0.299
	Transverse 1	100	10.61	10.56	30	0.307	0.213	0.391
12	Transverse 5	100	10.99	10.95	195	0.429	0.329	0.469
	Transverse 4	40	5.70	5.68	75	0.206	0.017	0.130
	Transverse 3	60	10.14	10.08	110	0.226	0.171	0.363
	Transverse 2	80	10.30	10.25	60	0.192	0.099	0.294
	Transverse 1	100	10.60	10.55	40	0.353	0.222	0.421

13	Transverse 5	100	10.48	10.43	135	0.415	0.266	0.389
	Transverse 4	40	8.99	8.90	135	0.125	0.066	0.390
	Transverse 3	80	9.95	9.89	110	0.232	0.143	0.398
	Transverse 2	100	9.42	9.34	80	0.280	0.112	0.300
	Transverse 1	60	10.85	10.80	25	0.235	0.212	0.426
14	Transverse 5	100	10.57	10.52	145	0.365	0.291	0.417
	Transverse 4	100	9.32	9.24	150	0.172	0.090	0.398
	Transverse 3	60	9.98	9.92	145	0.169	0.150	0.388
	Transverse 2	100	8.79	8.70	85	0.115	0.075	0.280
	Transverse 1	80	10.40	10.35	40	0.265	0.219	0.421
15	Transverse 4	100	10.61	10.56	145	0.403	0.291	0.423
	Transverse 3	120	9.67	9.60	145	0.192	0.147	0.369
	Transverse 2	80	9.36	9.28	70	0.191	0.067	0.295
	Transverse 1	120	10.46	10.41	65	0.237	0.229	0.402
16	Transverse 4	0	10.26	10.20	80	0.010	0.282	0.416
	Transverse 3	20	9.81	9.73	105	0.063	0.135	0.348
	Transverse 2	20	9.96	9.89	65	0.063	0.104	0.299
	Transverse 1	60	10.14	10.07	30	0.065	0.222	0.360
17	Transverse 4	100	10.26	10.20	145	0.367	0.263	0.387
	Transverse 3	40	9.56	9.49	90	0.188	0.102	0.350
	Transverse 2	20	9.13	9.05	110	0.129	0.081	0.319
	Transverse 1	120	10.15	10.10	145	0.369	0.225	0.334
18	Transverse 4	80	10.18	10.12	140	0.279	0.268	0.392
	Transverse 3	80	9.68	9.61	130	0.184	0.139	0.397
	Transverse 2	80	9.43	9.35	80	0.171	0.098	0.320
	Transverse 1	80	10.03	9.96	40	0.180	0.220	0.386
19	Transverse 4	100	10.70	10.65	160	0.395	0.295	0.432
	Transverse 3	40	9.48	9.41	110	0.127	0.106	0.370
	Transverse 2	100	8.76	8.69	90	0.191	0.091	0.330
	Transverse 1	120	10.08	10.03	60	0.264	0.247	0.424
20	Transverse 5	120	11.31	11.26	170	0.447	0.276	0.409
	Transverse 4	60	9.06	8.99	90	0.165	0.057	0.137
	Transverse 3	80	10.27	10.21	90	0.180	0.155	0.336
	Transverse 2	100	8.63	8.57	90	0.197	0.081	0.281
	Transverse 1	140	11.11	11.06	65	0.392	0.213	0.364
21	Transverse 5	120	11.34	11.30	140	0.505	0.277	0.418
	Transverse 4	80	8.95	8.86	110	0.230	0.050	0.267
	Transverse 3	100	10.32	10.26	90	0.300	0.161	0.382
	Transverse 2	100	9.43	9.37	80	0.287	0.113	0.301
	Transverse 1	140	10.85	10.80	40	0.399	0.193	0.359
22	Transverse 5	120	10.22	10.17	215	0.480	0.321	0.467
	Transverse 4	40	8.22	8.14	140	0.141	0.033	0.280
	Transverse 3	80	9.95	9.90	140	0.236	0.198	0.380
	Transverse 2	120	7.73	7.67	75	0.154	0.133	0.340
	Transverse 1	100	10.04	9.99	35	0.408	0.191	0.401
23	Transverse 5	140	10.77	10.73	170	0.514	0.291	0.417
	Transverse 4	40	8.80	8.72	130	0.124	0.055	0.322
	Transverse 3	100	10.25	10.20	110	0.389	0.189	0.351
	Transverse 2	80	9.47	9.41	35	0.088	0.082	0.290
	Transverse 1	80	10.49	10.44	30	0.308	0.224	0.403
24	Transverse 5	100	10.62	10.57	195	0.367	0.280	0.417
	Transverse 4	20	8.98	8.90	105	0.078	0.047	0.346
	Transverse 3	80	9.92	9.86	110	0.213	0.176	0.349
	Transverse 2	60	8.72	8.65	65	0.158	0.089	0.363
	Transverse 1	100	10.14	10.09	30	0.329	0.199	0.352
25	Transverse 5	100	10.79	10.74	200	0.369	0.274	0.411
	Transverse 4	60	8.98	8.89	100	0.119	0.056	0.257
	Transverse 3	80	10.43	10.38	90	0.199	0.161	0.393
	Transverse 2	80	9.34	9.26	75	0.212	0.092	0.293
	Transverse 1	80	10.86	10.82	30	0.389	0.223	0.370
26	Transverse 5	120	11.49	11.45	120	0.516	0.282	0.426
	Transverse 4	40	9.24	9.16	110	0.163	0.067	0.254
	Transverse 3	100	10.53	10.47	90	0.213	0.156	0.360
	Transverse 2	100	9.99	9.93	105	0.225	0.090	0.347
	Transverse 1	100	9.31	9.25	60	0.356	0.209	0.377
27	Transverse 4	120	11.85	11.81	150	0.691	0.303	0.439
	Transverse 3	100	10.00	9.94	120	0.218	0.107	0.330
	Transverse 2	80	9.65	9.59	90	0.391	0.135	0.339
	Transverse 1	100	11.18	11.14	30	0.507	0.198	0.387
28	Transverse 4	100	10.36	10.32	215	0.470	0.253	0.387
	Transverse 3	140	9.06	8.99	85	0.188	0.071	0.315
	Transverse 2	100	10.21	10.16	85	0.339	0.185	0.414
	Transverse 1	80	9.84	9.78	30	0.342	0.176	0.344

Table 140: Case Study 2 - 45 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)	Max Fracture Width (in)

	Transverse 5	120	11.15	11.11	120	0.574	0.314	0.415
	Transverse 4	20	8.21	8.10	110	0.122	0.028	0.122
1	Transverse 3	60	10.08	10.01	90	0.277	0.171	0.387
	Transverse 2	40	8.23	8.13	110	0.132	0.031	0.122
	Transverse 1	120	11.14	11.10	120	0.585	0.316	0.409
	Transverse 5	120	11.36	11.31	150	0.611	0.329	0.449
	Transverse 4	80	8.93	8.83	125	0.213	0.031	0.353
2	Transverse 3	120	10.33	10.27	125	0.377	0.213	0.422
	Transverse 2	80	9.56	9.48	30	0.219	0.103	0.317
	Transverse 1	80	10.31	10.25	20	0.272	0.220	0.384
	Transverse 5	120	11.22	11.18	145	0.533	0.312	0.444
	Transverse 4	100	9.67	9.60	125	0.204	0.100	0.412
3	Transverse 3	100	9.82	9.75	105	0.274	0.127	0.389
	Transverse 2	100	10.75	10.70	60	0.207	0.199	0.357
	Transverse 1	60	10.62	10.56	20	0.250	0.150	0.372
	Transverse 5	120	11.33	11.29	170	0.597	0.317	0.443
	Transverse 4	60	9.40	9.32	105	0.250	0.074	0.332
4	Transverse 3	100	9.91	9.85	90	0.318	0.120	0.346
	Transverse 2	100	10.48	10.42	50	0.245	0.182	0.400
	Transverse 1	80	10.43	10.38	10	0.303	0.151	0.337
	Transverse 5	120	11.38	11.33	155	0.594	0.316	0.433
	Transverse 4	100	9.83	9.76	90	0.188	0.079	0.346
5	Transverse 3	100	9.91	9.85	95	0.302	0.155	0.376
	Transverse 2	100	10.43	10.38	40	0.155	0.176	0.332
	Transverse 1	80	7.28	7.25	20	0.229	0.221	0.394
	Transverse 5	120	11.09	11.05	175	0.527	0.309	0.448
	Transverse 4	60	9.13	9.05	135	0.193	0.080	0.343
6	Transverse 3	80	9.59	9.52	120	0.283	0.137	0.284
	Transverse 2	80	9.79	9.73	40	0.160	0.142	0.370
	Transverse 1	60	10.47	10.42	20	0.355	0.162	0.404
	Transverse 5	120	11.20	11.16	145	0.560	0.316	0.433
	Transverse 4	40	9.01	8.93	115	0.116	0.053	0.369
7	Transverse 3	100	10.45	10.40	105	0.282	0.170	0.365
	Transverse 2	80	9.58	9.52	75	0.244	0.153	0.305
	Transverse 1	80	9.92	9.86	35	0.338	0.182	0.415
	Transverse 5	120	11.19	11.15	170	0.441	0.300	0.435
	Transverse 4	20	8.68	8.58	110	0.143	0.053	0.290
8	Transverse 3	80	10.07	10.01	90	0.284	0.166	0.354
	Transverse 2	80	8.55	8.46	55	0.193	0.095	0.298
	Transverse 1	80	10.22	10.17	30	0.444	0.196	0.404
	Transverse 5	120	11.20	11.15	165	0.497	0.299	0.431
	Transverse 4	40	8.74	8.64	105	0.129	0.062	0.380
9	Transverse 3	80	9.61	9.54	90	0.239	0.144	0.377
	Transverse 2	80	9.60	9.53	65	0.122	0.125	0.332
	Transverse 1	100	10.26	10.21	45	0.381	0.155	0.399
	Transverse 5	120	11.38	11.34	150	0.491	0.303	0.442
	Transverse 4	20	8.59	8.50	90	0.120	0.051	0.274
10	Transverse 3	60	9.94	9.87	90	0.143	0.099	0.324
	Transverse 2	80	10.64	10.59	85	0.236	0.161	0.413
	Transverse 1	80	10.30	10.24	60	0.314	0.199	0.410
	Transverse 5	120	11.29	11.25	165	0.476	0.305	0.437
	Transverse 4	100	8.58	8.48	110	0.216	0.050	0.305
11	Transverse 3	80	9.60	9.53	100	0.229	0.153	0.347
	Transverse 2	80	9.02	8.93	95	0.181	0.108	0.373
	Transverse 1	80	10.08	10.02	55	0.394	0.158	0.401
	Transverse 5	120	11.20	11.16	150	0.441	0.306	0.440
	Transverse 4	80	8.50	8.39	105	0.186	0.045	0.272
12	Transverse 3	80	10.35	10.30	80	0.273	0.166	0.405
	Transverse 2	100	9.32	9.24	70	0.225	0.089	0.342
	Transverse 1	80	10.89	10.84	50	0.309	0.222	0.397
	Transverse 5	120	11.17	11.13	155	0.443	0.305	0.440
	Transverse 4	60	7.72	7.65	110	0.204	0.058	0.265
13	Transverse 3	60	10.37	10.31	80	0.235	0.162	0.397
	Transverse 2	80	9.24	9.16	80	0.157	0.096	0.314
	Transverse 1	80	10.51	10.46	60	0.426	0.170	0.393
	Transverse 5	100	11.18	11.13	150	0.403	0.307	0.442
	Transverse 4	80	8.54	8.44	110	0.218	0.052	0.267
14	Transverse 3	60	9.91	9.85	85	0.196	0.150	0.398
	Transverse 2	100	9.56	9.49	75	0.182	0.106	0.326
	Transverse 1	100	10.85	10.80	50	0.405	0.194	0.428
	Transverse 5	120	11.18	11.14	155	0.414	0.304	0.438
	Transverse 4	80	8.53	8.42	115	0.163	0.040	0.343
15	Transverse 3	100	10.15	10.09	90	0.219	0.173	0.381
	Transverse 2	80	8.69	8.60	85	0.112	0.070	0.312
	Transverse 1	100	10.23	10.17	65	0.449	0.170	0.416
	Transverse 5	120	11.19	11.15	145	0.373	0.298	0.441
	Transverse 4	100	9.33	9.24	105	0.161	0.047	0.312
16	Transverse 3	80	9.85	9.78	80	0.192	0.156	0.394
	Transverse 2	60	8.83	8.75	90	0.077	0.080	0.318
	Transverse 1	80	10.43	10.37	100	0.344	0.187	0.406
17	Transverse 5	120	11.18	11.13	155	0.420	0.300	0.442
	Transverse 4	100	9.10	9.01	115	0.136	0.064	0.382

	Transverse 3	80	10.04	9.98	85	0.179	0.176	0.407
	Transverse 2	80	9.42	9.35	85	0.131	0.089	0.295
	Transverse 1	100	10.09	10.03	80	0.448	0.158	0.403
18	Transverse 5	120	11.04	10.99	180	0.358	0.291	0.416
	Transverse 4	60	9.21	9.14	100	0.139	0.081	0.333
	Transverse 3	80	9.67	9.60	80	0.164	0.141	0.377
	Transverse 2	60	8.92	8.83	85	0.170	0.082	0.311
	Transverse 1	80	10.38	10.33	75	0.467	0.168	0.399
19	Transverse 5	120	11.16	11.12	140	0.331	0.292	0.432
	Transverse 4	100	9.83	9.76	90	0.154	0.088	0.378
	Transverse 3	80	10.10	10.03	100	0.180	0.147	0.343
	Transverse 2	60	9.31	9.23	90	0.197	0.097	0.363
	Transverse 1	100	10.86	10.81	90	0.386	0.198	0.405
20	Transverse 5	120	10.95	10.90	175	0.370	0.288	0.425
	Transverse 4	80	9.41	9.33	85	0.126	0.074	0.337
	Transverse 3	80	9.67	9.60	75	0.192	0.163	0.353
	Transverse 2	80	9.07	8.99	85	0.103	0.105	0.330
	Transverse 1	100	10.29	10.24	110	0.404	0.206	0.405
21	Transverse 5	120	10.96	10.91	155	0.331	0.283	0.415
	Transverse 4	20	8.43	8.35	85	0.085	0.046	0.272
	Transverse 3	80	10.02	9.96	80	0.197	0.174	0.389
	Transverse 2	60	8.97	8.88	90	0.066	0.092	0.334
	Transverse 1	60	10.48	10.43	105	0.349	0.200	0.380
22	Transverse 5	100	11.04	10.99	160	0.278	0.277	0.409
	Transverse 4	40	9.03	8.94	90	0.124	0.050	0.276
	Transverse 3	80	10.04	9.98	80	0.185	0.172	0.402
	Transverse 2	100	9.64	9.57	105	0.116	0.107	0.358
	Transverse 1	80	10.11	10.05	90	0.441	0.184	0.376
23	Transverse 5	120	10.87	10.82	115	0.285	0.283	0.409
	Transverse 4	100	8.78	8.70	80	0.139	0.067	0.396
	Transverse 3	80	10.62	10.57	75	0.185	0.192	0.370
	Transverse 2	60	8.47	8.38	105	0.087	0.069	0.310
	Transverse 1	100	10.28	10.23	90	0.474	0.192	0.395
24	Transverse 4	120	10.76	10.72	190	0.312	0.285	0.421
	Transverse 3	100	9.69	9.63	120	0.189	0.158	0.404
	Transverse 2	80	8.38	8.29	110	0.083	0.086	0.298
	Transverse 1	80	9.32	9.25	130	0.327	0.171	0.379
25	Transverse 4	120	11.01	10.96	135	0.351	0.293	0.446
	Transverse 3	100	10.04	9.98	85	0.137	0.109	0.416
	Transverse 2	80	9.52	9.45	60	0.095	0.116	0.342
	Transverse 1	100	10.10	10.05	90	0.468	0.184	0.389
26	Transverse 4	120	10.71	10.66	210	0.392	0.281	0.421
	Transverse 3	80	8.85	8.77	75	0.104	0.074	0.307
	Transverse 2	80	9.38	9.31	65	0.094	0.159	0.385
	Transverse 1	80	9.29	9.22	130	0.406	0.185	0.383
27	Transverse 4	120	11.00	10.96	215	0.280	0.293	0.441
	Transverse 3	60	9.60	9.53	75	0.126	0.116	0.346
	Transverse 2	60	8.24	8.16	85	0.062	0.089	0.318
	Transverse 1	80	10.07	10.01	90	0.352	0.193	0.425
28	Transverse 4	120	10.69	10.65	215	0.323	0.296	0.445
	Transverse 3	80	9.28	9.21	80	0.119	0.100	0.326
	Transverse 2	40	8.70	8.61	100	0.126	0.081	0.366
	Transverse 1	100	10.29	10.24	90	0.483	0.205	0.383

Table 141: Case Study 2 - 40 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)	Max Fracture Width (in)
1	Transverse 6	120	11.20	11.16	120	0.565	0.308	0.399
	Transverse 5	40	6.81	6.76	110	0.144	0.035	0.119
	Transverse 4	60	9.69	9.61	90	0.221	0.121	0.310
	Transverse 3	60	9.71	9.64	90	0.220	0.121	0.162
	Transverse 2	40	6.94	6.88	110	0.129	0.031	0.119
	Transverse 1	120	11.15	11.11	120	0.554	0.302	0.393
2	Transverse 6	120	11.11	11.06	145	0.511	0.295	0.424
	Transverse 5	80	8.03	7.94	150	0.190	0.056	0.270
	Transverse 4	100	9.74	9.67	125	0.314	0.142	0.320
	Transverse 3	80	8.99	8.90	60	0.190	0.105	0.335
	Transverse 2	80	8.94	8.85	40	0.193	0.101	0.359
	Transverse 1	100	9.95	9.89	45	0.325	0.246	0.397
3	Transverse 6	120	11.29	11.25	150	0.589	0.313	0.425
	Transverse 5	100	9.17	9.08	90	0.150	0.048	0.300
	Transverse 4	100	9.91	9.85	90	0.258	0.136	0.353
	Transverse 3	100	10.16	10.10	85	0.160	0.132	0.324
	Transverse 2	100	9.86	9.79	35	0.184	0.172	0.381
	Transverse 1	60	10.38	10.32	20	0.307	0.146	0.326
4	Transverse 6	120	11.32	11.27	150	0.598	0.317	0.437
	Transverse 5	40	5.47	5.41	65	0.139	0.034	0.268

	Transverse 4	100	9.88	9.81	110	0.178	0.118	0.351
	Transverse 3	100	10.23	10.17	110	0.323	0.136	0.302
	Transverse 2	100	10.05	9.98	35	0.190	0.149	0.366
	Transverse 1	80	10.49	10.43	20	0.303	0.182	0.330
5	Transverse 6	120	11.44	11.39	155	0.584	0.321	0.443
	Transverse 5	60	8.29	8.17	105	0.169	0.039	0.303
	Transverse 4	80	10.22	10.16	90	0.239	0.147	0.348
	Transverse 3	80	9.63	9.56	75	0.200	0.122	0.306
	Transverse 2	80	10.07	10.00	40	0.191	0.134	0.340
	Transverse 1	40	10.54	10.49	15	0.153	0.145	0.393
6	Transverse 6	120	11.26	11.21	145	0.514	0.309	0.443
	Transverse 5	80	9.64	9.57	140	0.160	0.073	0.375
	Transverse 4	100	10.61	10.56	85	0.351	0.180	0.388
	Transverse 3	60	8.37	8.29	55	0.160	0.072	0.298
	Transverse 2	80	10.54	10.48	25	0.166	0.133	0.371
	Transverse 1	80	10.22	10.16	20	0.330	0.140	0.406
7	Transverse 6	120	11.51	11.47	150	0.570	0.316	0.435
	Transverse 5	40	7.75	7.64	130	0.124	0.036	0.228
	Transverse 4	60	9.50	9.42	110	0.154	0.105	0.316
	Transverse 3	100	10.23	10.17	100	0.292	0.142	0.344
	Transverse 2	80	9.36	9.28	40	0.150	0.129	0.376
	Transverse 1	60	10.76	10.71	30	0.424	0.159	0.416
8	Transverse 6	120	11.10	11.05	165	0.444	0.281	0.413
	Transverse 5	80	9.10	9.01	110	0.110	0.057	0.343
	Transverse 4	40	9.17	9.08	90	0.150	0.066	0.258
	Transverse 3	60	10.88	10.83	90	0.211	0.163	0.392
	Transverse 2	60	7.16	7.12	75	0.213	0.093	0.294
	Transverse 1	80	9.69	9.64	55	0.340	0.191	0.400
9	Transverse 6	120	11.09	11.05	150	0.432	0.289	0.423
	Transverse 5	60	9.41	9.32	110	0.192	0.051	0.311
	Transverse 4	80	9.84	9.77	95	0.178	0.129	0.390
	Transverse 3	60	10.73	10.68	85	0.203	0.131	0.313
	Transverse 2	80	9.15	9.08	80	0.159	0.140	0.379
	Transverse 1	80	10.37	10.31	55	0.359	0.146	0.379
10	Transverse 6	120	11.29	11.25	165	0.457	0.287	0.416
	Transverse 5	60	8.09	7.97	100	0.220	0.039	0.243
	Transverse 4	60	10.06	9.99	90	0.177	0.128	0.327
	Transverse 3	60	9.02	8.94	90	0.168	0.119	0.328
	Transverse 2	80	7.72	7.66	70	0.334	0.071	0.300
	Transverse 1	100	10.77	10.72	55	0.429	0.172	0.398
11	Transverse 6	120	10.95	10.90	145	0.386	0.274	0.411
	Transverse 5	100	9.41	9.32	115	0.168	0.080	0.389
	Transverse 4	80	9.98	9.92	80	0.204	0.134	0.372
	Transverse 3	80	9.41	9.33	75	0.182	0.087	0.318
	Transverse 2	80	9.66	9.58	55	0.177	0.103	0.328
	Transverse 1	80	10.10	10.03	30	0.398	0.153	0.375
12	Transverse 6	120	11.11	11.06	180	0.425	0.274	0.404
	Transverse 5	60	7.92	7.83	135	0.237	0.042	0.269
	Transverse 4	80	9.65	9.59	105	0.176	0.131	0.351
	Transverse 3	80	10.59	10.54	75	0.215	0.164	0.403
	Transverse 2	100	10.40	10.35	110	0.204	0.147	0.412
	Transverse 1	60	7.60	7.56	80	0.420	0.179	0.358
13	Transverse 5	120	11.24	11.20	155	0.471	0.317	0.453
	Transverse 4	60	8.52	8.44	95	0.090	0.044	0.302
	Transverse 3	40	9.82	9.76	105	0.187	0.146	0.377
	Transverse 2	40	5.37	5.31	110	0.060	0.121	0.389
	Transverse 1	80	8.36	8.30	80	0.261	0.198	0.413
14	Transverse 5	100	11.12	11.08	165	0.412	0.308	0.449
	Transverse 4	40	7.22	7.13	110	0.170	0.032	0.259
	Transverse 3	60	9.55	9.48	85	0.145	0.147	0.357
	Transverse 2	40	8.08	8.01	85	0.300	0.092	0.281
	Transverse 1	100	10.07	10.01	65	0.407	0.163	0.400
15	Transverse 5	120	11.21	11.17	155	0.410	0.310	0.452
	Transverse 4	60	8.96	8.87	140	0.170	0.076	0.297
	Transverse 3	100	9.63	9.56	100	0.191	0.114	0.327
	Transverse 2	80	9.21	9.13	85	0.201	0.129	0.347
	Transverse 1	100	11.07	11.03	55	0.453	0.189	0.425
16	Transverse 5	100	11.33	11.28	155	0.373	0.305	0.447
	Transverse 4	60	8.80	8.72	90	0.098	0.036	0.297
	Transverse 3	60	10.66	10.60	80	0.189	0.170	0.372
	Transverse 2	40	8.55	8.46	85	0.195	0.064	0.306
	Transverse 1	80	10.02	9.95	90	0.426	0.184	0.404
17	Transverse 5	120	11.19	11.15	165	0.434	0.302	0.441
	Transverse 4	60	8.94	8.85	85	0.138	0.074	0.325
	Transverse 3	80	9.96	9.89	100	0.146	0.152	0.415
	Transverse 2	60	8.80	8.72	85	0.151	0.071	0.285
	Transverse 1	80	8.54	8.49	90	0.469	0.180	0.417
18	Transverse 5	120	11.14	11.10	140	0.403	0.298	0.439
	Transverse 4	100	9.29	9.21	90	0.127	0.054	0.328
	Transverse 3	80	10.20	10.14	100	0.147	0.176	0.408
	Transverse 2	80	9.31	9.23	90	0.192	0.095	0.289
	Transverse 1	60	7.54	7.48	90	0.319	0.196	0.403

	Transverse 5	100	10.86	10.81	175	0.307	0.286	0.429
	Transverse 4	100	8.54	8.44	100	0.131	0.047	0.322
19	Transverse 3	80	10.08	10.02	85	0.199	0.180	0.419
	Transverse 2	40	9.62	9.55	90	0.158	0.086	0.294
	Transverse 1	80	10.32	10.27	90	0.376	0.178	0.388
	Transverse 5	120	11.10	11.05	145	0.343	0.295	0.441
	Transverse 4	80	10.05	9.98	75	0.097	0.056	0.326
20	Transverse 3	60	9.69	9.62	85	0.137	0.156	0.411
	Transverse 2	60	9.56	9.48	95	0.262	0.079	0.273
	Transverse 1	80	7.88	7.85	90	0.427	0.198	0.411
	Transverse 5	120	10.95	10.91	165	0.284	0.290	0.434
	Transverse 4	80	9.31	9.24	70	0.102	0.066	0.337
21	Transverse 3	60	10.03	9.97	120	0.165	0.144	0.366
	Transverse 2	40	9.37	9.30	125	0.088	0.135	0.317
	Transverse 1	80	7.62	7.56	110	0.377	0.190	0.387
	Transverse 5	120	11.09	11.04	165	0.362	0.291	0.435
	Transverse 4	80	9.41	9.34	70	0.089	0.061	0.339
22	Transverse 3	100	9.97	9.91	95	0.183	0.139	0.375
	Transverse 2	40	9.14	9.05	100	0.126	0.092	0.282
	Transverse 1	80	9.50	9.45	90	0.419	0.182	0.390
	Transverse 5	100	10.75	10.71	170	0.229	0.273	0.418
	Transverse 4	80	9.39	9.32	100	0.107	0.066	0.333
23	Transverse 3	40	10.49	10.44	75	0.142	0.190	0.354
	Transverse 2	60	9.54	9.47	150	0.165	0.132	0.396
	Transverse 1	80	9.38	9.31	110	0.407	0.169	0.383
	Transverse 5	100	10.92	10.88	130	0.276	0.279	0.424
	Transverse 4	100	8.72	8.62	95	0.113	0.041	0.332
24	Transverse 3	60	10.28	10.23	80	0.168	0.164	0.406
	Transverse 2	80	9.02	8.93	85	0.093	0.076	0.303
	Transverse 1	100	10.48	10.43	90	0.490	0.183	0.398
	Transverse 5	100	10.86	10.82	145	0.268	0.276	0.413
	Transverse 4	100	9.01	8.92	90	0.124	0.061	0.375
25	Transverse 3	60	9.62	9.55	85	0.146	0.129	0.335
	Transverse 2	80	9.45	9.38	75	0.096	0.111	0.345
	Transverse 1	100	10.45	10.40	110	0.477	0.184	0.397
	Transverse 5	100	10.71	10.66	170	0.267	0.288	0.443
	Transverse 4	40	8.73	8.63	85	0.085	0.052	0.304
26	Transverse 3	100	10.12	10.06	95	0.206	0.171	0.390
	Transverse 2	40	7.59	7.51	105	0.075	0.115	0.314
	Transverse 1	80	8.02	8.00	90	0.476	0.200	0.394
	Transverse 5	120	11.19	11.15	145	0.278	0.296	0.448
	Transverse 4	60	8.76	8.67	85	0.078	0.036	0.303
27	Transverse 3	60	9.92	9.86	70	0.127	0.134	0.384
	Transverse 2	60	9.32	9.23	100	0.101	0.088	0.322
	Transverse 1	100	10.71	10.66	110	0.444	0.225	0.405
	Transverse 5	100	10.95	10.90	190	0.333	0.297	0.434
	Transverse 4	60	8.69	8.60	95	0.090	0.041	0.323
28	Transverse 3	80	9.59	9.53	110	0.117	0.135	0.380
	Transverse 2	60	8.42	8.32	95	0.083	0.056	0.320
	Transverse 1	100	9.87	9.81	110	0.491	0.197	0.421

Table 142: Case Study 2 - 35 ft Cluster Spacing Fracture Results

Stage Number	Fracture	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)	Max Fracture Width (in)
	Transverse 7	120	11.12	11.07	110	0.556	0.288	0.376
	Transverse 6	60	6.77	6.72	115	0.168	0.044	0.222
	Transverse 5	40	9.43	9.34	110	0.175	0.086	0.300
1	Transverse 4	40	9.34	9.26	110	0.189	0.097	0.248
	Transverse 3	40	9.27	9.19	90	0.181	0.097	0.187
	Transverse 2	60	7.67	7.58	95	0.200	0.038	0.254
	Transverse 1	120	11.31	11.27	110	0.534	0.322	0.408
	Transverse 7	120	11.22	11.18	145	0.496	0.286	0.413
	Transverse 6	60	8.71	8.62	110	0.229	0.049	0.243
	Transverse 5	40	9.94	9.87	90	0.204	0.122	0.373
2	Transverse 4	60	9.03	9.01	90	0.493	0.058	0.335
	Transverse 3	100	10.40	10.34	85	0.344	0.166	0.349
	Transverse 2	140	7.12	7.09	30	0.191	0.078	0.262
	Transverse 1	80	10.84	10.79	20	0.424	0.253	0.403
	Transverse 7	120	11.15	11.11	145	0.500	0.291	0.409
	Transverse 6	40	5.03	4.98	100	0.112	0.021	0.127
	Transverse 5	80	8.97	8.90	110	0.145	0.067	0.299
3	Transverse 4	80	9.88	9.81	110	0.227	0.109	0.355
	Transverse 3	100	10.76	10.71	80	0.334	0.198	0.333
	Transverse 2	100	10.78	10.73	40	0.261	0.132	0.348
	Transverse 1	40	7.65	7.60	20	0.168	0.133	0.334
4	Transverse 7	120	10.87	10.82	140	0.430	0.276	0.396
	Transverse 6	40	5.38	5.34	120	0.142	0.038	0.224

	Transverse 5	60	9.52	9.45	130	0.236	0.112	0.347
	Transverse 4	100	8.95	8.86	90	0.421	0.082	0.334
	Transverse 3	100	11.00	10.95	90	0.379	0.165	0.344
	Transverse 2	80	10.18	10.12	45	0.218	0.188	0.341
	Transverse 1	80	10.25	10.19	20	0.294	0.140	0.349
5	Transverse 7	120	10.98	10.93	145	0.464	0.276	0.403
	Transverse 6	80	8.83	8.74	135	0.194	0.049	0.252
	Transverse 5	100	9.57	9.50	90	0.224	0.104	0.335
	Transverse 4	80	10.35	10.29	90	0.327	0.141	0.331
	Transverse 3	60	10.32	10.27	35	0.171	0.168	0.341
	Transverse 2	80	9.01	8.95	60	0.317	0.241	0.388
	Transverse 1	40	10.13	10.08	10	0.204	0.127	0.341
6	Transverse 7	120	11.15	11.10	140	0.462	0.281	0.404
	Transverse 6	40	9.57	9.49	90	0.149	0.062	0.346
	Transverse 5	40	10.03	9.96	110	0.162	0.090	0.308
	Transverse 4	100	10.37	10.31	90	0.215	0.110	0.364
	Transverse 3	100	10.13	10.06	75	0.256	0.172	0.328
	Transverse 2	80	8.77	8.69	35	0.167	0.096	0.339
	Transverse 1	80	10.75	10.69	20	0.389	0.165	0.389
7	Transverse 6	120	10.99	10.95	150	0.514	0.300	0.424
	Transverse 5	40	8.39	8.31	145	0.141	0.058	0.350
	Transverse 4	80	8.96	8.88	105	0.107	0.080	0.294
	Transverse 3	100	10.37	10.32	120	0.237	0.181	0.361
	Transverse 2	20	10.19	10.14	80	0.108	0.117	0.341
	Transverse 1	80	10.18	10.13	30	0.413	0.176	0.384
8	Transverse 6	120	11.04	10.99	165	0.457	0.281	0.414
	Transverse 5	80	9.49	9.41	105	0.142	0.094	0.387
	Transverse 4	60	8.45	8.37	105	0.133	0.073	0.300
	Transverse 3	100	10.20	10.14	95	0.198	0.146	0.328
	Transverse 2	80	10.22	10.16	70	0.249	0.133	0.389
	Transverse 1	80	10.44	10.38	30	0.376	0.174	0.403
9	Transverse 6	120	11.07	11.03	115	0.207	0.280	0.405
	Transverse 5	100	9.51	9.44	130	0.173	0.095	0.365
	Transverse 4	80	9.20	9.12	100	0.126	0.072	0.374
	Transverse 3	80	10.82	10.77	75	0.280	0.215	0.410
	Transverse 2	20	4.28	4.22	90	0.079	0.115	0.355
	Transverse 1	80	9.70	9.64	55	0.398	0.139	0.390
10	Transverse 6	120	10.85	10.80	140	0.395	0.283	0.423
	Transverse 5	40	5.52	5.49	85	0.145	0.043	0.121
	Transverse 4	100	10.12	10.05	120	0.245	0.127	0.404
	Transverse 3	60	10.02	9.96	85	0.178	0.133	0.375
	Transverse 2	60	8.38	8.31	110	0.121	0.073	0.326
	Transverse 1	80	10.92	10.87	110	0.475	0.232	0.381
11	Transverse 6	100	10.90	10.85	150	0.317	0.264	0.404
	Transverse 5	60	8.71	8.61	110	0.255	0.052	0.318
	Transverse 4	80	9.68	9.61	85	0.167	0.102	0.320
	Transverse 3	60	10.33	10.27	70	0.221	0.140	0.352
	Transverse 2	20	9.41	9.34	120	0.096	0.138	0.352
	Transverse 1	60	10.56	10.50	80	0.351	0.176	0.345
12	Transverse 6	100	10.76	10.71	150	0.339	0.269	0.414
	Transverse 5	60	8.10	8.02	155	0.139	0.047	0.294
	Transverse 4	100	9.57	9.50	95	0.383	0.104	0.355
	Transverse 3	60	10.72	10.67	75	0.199	0.171	0.389
	Transverse 2	20	4.85	4.80	100	0.126	0.065	0.337
	Transverse 1	80	7.68	7.66	60	0.376	0.197	0.386
13	Transverse 6	100	10.92	10.88	145	0.332	0.271	0.412
	Transverse 5	20	9.20	9.11	125	0.088	0.044	0.342
	Transverse 4	60	9.59	9.52	80	0.219	0.139	0.338
	Transverse 3	100	9.93	9.87	115	0.236	0.147	0.405
	Transverse 2	40	9.80	9.74	90	0.139	0.144	0.289
	Transverse 1	80	7.71	7.69	75	0.395	0.177	0.380
14	Transverse 6	100	11.06	11.01	155	0.341	0.276	0.419
	Transverse 5	100	9.68	9.61	95	0.134	0.075	0.334
	Transverse 4	80	9.73	9.65	85	0.168	0.098	0.403
	Transverse 3	40	10.12	10.05	75	0.162	0.128	0.378
	Transverse 2	100	7.25	7.22	80	0.245	0.058	0.294
	Transverse 1	80	10.27	10.21	75	0.421	0.162	0.373
15	Transverse 6	120	11.18	11.13	140	0.360	0.279	0.419
	Transverse 5	40	5.45	5.42	65	0.151	0.049	0.265
	Transverse 4	40	10.06	9.99	95	0.153	0.121	0.312
	Transverse 3	60	9.95	9.88	75	0.169	0.137	0.404
	Transverse 2	80	7.84	7.77	85	0.223	0.072	0.292
	Transverse 1	80	9.97	9.90	80	0.424	0.150	0.392
16	Transverse 6	100	11.01	10.96	140	0.314	0.270	0.407
	Transverse 5	20	9.16	9.07	85	0.104	0.047	0.304
	Transverse 4	100	10.26	10.20	110	0.218	0.129	0.343
	Transverse 3	80	9.87	9.80	75	0.133	0.117	0.408
	Transverse 2	100	9.81	9.74	90	0.227	0.105	0.314
	Transverse 1	100	7.94	7.89	70	0.329	0.167	0.372
17	Transverse 6	100	11.06	11.01	145	0.303	0.277	0.419
	Transverse 5	100	9.18	9.09	100	0.141	0.074	0.328
	Transverse 4	60	9.49	9.41	85	0.145	0.101	0.325

	Transverse 3	60	9.91	9.84	80	0.146	0.140	0.397
	Transverse 2	100	8.60	8.50	90	0.335	0.070	0.295
	Transverse 1	80	9.73	9.66	75	0.397	0.131	0.369
18	Transverse 6	100	11.10	11.06	135	0.384	0.288	0.434
	Transverse 5	60	8.77	8.67	125	0.159	0.061	0.299
	Transverse 4	100	9.85	9.78	120	0.232	0.115	0.397
	Transverse 3	60	9.78	9.72	75	0.136	0.132	0.401
	Transverse 2	100	8.29	8.21	95	0.251	0.071	0.282
	Transverse 1	80	10.47	10.42	90	0.413	0.180	0.377
19	Transverse 6	120	11.00	10.96	135	0.366	0.294	0.437
	Transverse 5	20	8.23	8.15	115	0.090	0.035	0.285
	Transverse 4	60	9.39	9.32	85	0.128	0.095	0.311
	Transverse 3	80	10.21	10.15	70	0.215	0.169	0.420
	Transverse 2	80	10.24	10.19	115	0.210	0.120	0.369
	Transverse 1	80	10.03	9.97	80	0.439	0.160	0.392
20	Transverse 6	100	11.11	11.06	135	0.242	0.290	0.436
	Transverse 5	20	8.61	8.49	105	0.068	0.038	0.284
	Transverse 4	100	10.28	10.22	95	0.187	0.122	0.333
	Transverse 3	80	9.91	9.84	75	0.132	0.132	0.359
	Transverse 2	60	7.82	7.76	85	0.276	0.069	0.300
	Transverse 1	80	10.17	10.11	90	0.432	0.152	0.380
21	Transverse 6	100	10.94	10.89	150	0.195	0.283	0.423
	Transverse 5	40	8.01	7.92	90	0.089	0.027	0.297
	Transverse 4	80	9.47	9.39	75	0.142	0.111	0.353
	Transverse 3	80	9.33	9.25	80	0.137	0.125	0.322
	Transverse 2	40	8.88	8.79	100	0.175	0.097	0.308
	Transverse 1	80	10.89	10.84	110	0.396	0.207	0.387
22	Transverse 6	80	10.87	10.82	170	0.269	0.272	0.410
	Transverse 5	100	9.69	9.62	100	0.117	0.094	0.368
	Transverse 4	80	9.46	9.39	90	0.117	0.091	0.339
	Transverse 3	40	10.05	9.99	85	0.103	0.138	0.365
	Transverse 2	80	9.11	9.02	110	0.172	0.088	0.285
	Transverse 1	100	10.57	10.52	90	0.391	0.161	0.364
23	Transverse 6	100	11.15	11.11	135	0.270	0.287	0.417
	Transverse 5	20	8.15	8.08	80	0.088	0.056	0.303
	Transverse 4	100	9.56	9.49	105	0.155	0.091	0.356
	Transverse 3	60	9.87	9.80	65	0.119	0.189	0.376
	Transverse 2	80	6.65	6.61	125	0.128	0.096	0.359
	Transverse 1	80	7.51	7.49	100	0.389	0.181	0.384
24	Transverse 6	100	11.04	10.99	170	0.223	0.281	0.412
	Transverse 5	20	8.35	8.28	90	0.081	0.033	0.290
	Transverse 4	80	9.55	9.48	75	0.144	0.114	0.336
	Transverse 3	80	9.64	9.57	80	0.112	0.124	0.387
	Transverse 2	60	8.60	8.52	110	0.081	0.070	0.289
	Transverse 1	80	9.66	9.59	110	0.433	0.171	0.379
25	Transverse 6	100	10.94	10.89	140	0.249	0.276	0.407
	Transverse 5	40	8.45	8.35	95	0.134	0.036	0.258
	Transverse 4	80	9.66	9.59	75	0.141	0.111	0.359
	Transverse 3	80	10.10	10.03	65	0.118	0.146	0.359
	Transverse 2	120	10.28	10.22	90	0.111	0.178	0.379
	Transverse 1	80	7.82	7.80	90	0.426	0.153	0.401
26	Transverse 6	120	11.29	11.25	110	0.417	0.288	0.435
	Transverse 5	80	9.30	9.22	65	0.107	0.061	0.337
	Transverse 4	100	9.58	9.50	80	0.119	0.091	0.395
	Transverse 3	60	9.60	9.54	60	0.123	0.174	0.329
	Transverse 2	100	9.88	9.82	130	0.156	0.127	0.369
	Transverse 1	100	11.60	11.56	105	0.401	0.202	0.422
27	Transverse 6	100	11.13	11.08	120	0.246	0.275	0.419
	Transverse 5	40	5.74	5.71	65	0.188	0.025	0.137
	Transverse 4	40	10.09	10.03	75	0.113	0.126	0.402
	Transverse 3	20	10.04	9.98	70	0.087	0.120	0.394
	Transverse 2	100	8.82	8.73	90	0.117	0.072	0.298
	Transverse 1	80	10.07	10.00	90	0.444	0.175	0.378
28	Transverse 6	120	11.48	11.44	100	0.359	0.326	0.447
	Transverse 5	20	9.89	9.83	95	0.079	0.122	0.399
	Transverse 4	60	8.95	8.87	90	0.094	0.073	0.317
	Transverse 3	0	9.56	9.49	90	0.068	0.083	0.298
	Transverse 2	100	8.84	8.75	70	0.094	0.075	0.307
	Transverse 1	100	10.12	10.06	105	0.431	0.194	0.391

Table 143: Case Study 1 - 45 ft Cluster Spacing Average Fracture Results

45ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)
1	76	8.96	8.89	130	0.209	0.173
2	92	9.79	9.71	91	0.213	0.168
3	92	9.26	9.21	94	0.280	0.165
4	80	10.04	9.98	94	0.192	0.176
5	84	9.94	9.87	85	0.258	0.182
6	100	9.80	9.74	104	0.255	0.174
7	96	9.92	9.86	82	0.216	0.174
8	80	9.81	9.75	118	0.200	0.170
9	92	9.86	9.79	103	0.270	0.179
10	84	9.67	9.61	110	0.281	0.165
11	68	10.10	10.04	90	0.230	0.167
12	72	9.52	9.47	99	0.269	0.170
13	88	10.09	10.02	97	0.243	0.168
14	80	9.91	9.85	102	0.220	0.167
15	95	9.06	9.01	120	0.234	0.171
16	35	9.56	9.49	76	0.062	0.195
17	105	9.80	9.73	126	0.289	0.177
18	85	9.63	9.56	99	0.209	0.180
19	100	10.00	9.94	101	0.250	0.180
20	104	10.08	10.01	95	0.327	0.153
21	92	10.40	10.34	91	0.286	0.168
22	88	9.62	9.56	111	0.304	0.163
23	96	9.86	9.80	100	0.290	0.166
24	76	9.76	9.70	106	0.236	0.160
25	84	10.00	9.93	102	0.269	0.160
26	88	10.10	10.04	95	0.299	0.157
27	105	11.00	10.96	85	0.541	0.209
28	90	10.16	10.11	100	0.333	0.194

Table 144: Case Study 1 - 40 ft Cluster Spacing Average Fracture Results

40ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)
1	76	9.07	9.01	129	0.210	0.173
2	100	9.78	9.70	93	0.213	0.167
3	100	9.83	9.76	101	0.240	0.166
4	100	10.08	10.01	89	0.220	0.168
5	88	9.68	9.60	93	0.243	0.166
6	96	9.81	9.75	93	0.267	0.166
7	84	9.81	9.75	89	0.209	0.171
8	60	9.78	9.71	114	0.195	0.170
9	100	9.81	9.75	102	0.306	0.176

10	84	10.04	9.98	101	0.281	0.166
11	84	10.21	10.15	92	0.253	0.169
12	80	9.61	9.55	94	0.286	0.162
13	104	10.24	10.17	90	0.263	0.179
14	92	9.69	9.63	114	0.243	0.161
15	105	10.06	10.00	101	0.268	0.188
16	45	10.07	10.00	83	0.056	0.197
17	90	9.93	9.86	113	0.250	0.173
18	90	9.74	9.67	98	0.204	0.180
19	120	9.93	9.87	103	0.289	0.189
20	96	10.11	10.05	96	0.311	0.158
21	108	10.35	10.29	96	0.358	0.163
22	80	9.29	9.23	116	0.274	0.165
23	88	9.76	9.70	104	0.279	0.164
24	76	9.71	9.65	106	0.235	0.161
25	88	10.04	9.98	101	0.231	0.167
26	92	10.23	10.17	93	0.320	0.167
27	105	10.64	10.59	90	0.434	0.184
28	90	10.15	10.10	89	0.377	0.213

Table 145: Case Study 1 - 35 ft Cluster Spacing Average Fracture Results

35ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)
1	76	9.08	9.01	129	0.211	0.173
2	92	9.92	9.85	90	0.206	0.167
3	108	10.02	9.96	100	0.289	0.174
4	108	9.36	9.30	91	0.243	0.164
5	92	9.53	9.44	90	0.259	0.165
6	108	9.80	9.73	98	0.258	0.164
7	88	9.85	9.79	86	0.186	0.173
8	68	9.77	9.70	122	0.200	0.168
9	76	9.66	9.59	110	0.256	0.172
10	84	9.98	9.92	95	0.275	0.163
11	76	9.68	9.61	96	0.230	0.159
12	76	9.55	9.50	96	0.281	0.168
13	76	9.94	9.87	97	0.257	0.160
14	88	9.81	9.75	113	0.217	0.165
15	105	10.03	9.96	106	0.256	0.183
16	25	10.04	9.97	70	0.050	0.186
17	70	9.77	9.71	123	0.263	0.168
18	80	9.83	9.76	98	0.203	0.181
19	90	9.76	9.70	105	0.244	0.185
20	100	10.08	10.02	101	0.276	0.156
21	108	10.18	10.12	92	0.344	0.159
22	92	9.23	9.17	121	0.284	0.175
23	88	9.96	9.90	95	0.285	0.168
24	72	9.68	9.62	101	0.229	0.158
25	80	10.08	10.02	99	0.258	0.161
26	92	10.11	10.05	97	0.295	0.161

27	100	10.67	10.62	98	0.452	0.186
28	105	9.87	9.81	104	0.335	0.171

Table 146: Case Study 2 - 45 ft Cluster Spacing Average Fracture Results

45ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)
1	72	9.76	9.69	110	0.338	0.172
2	96	10.10	10.03	90	0.339	0.179
3	96	10.41	10.36	91	0.294	0.177
4	92	10.31	10.25	85	0.342	0.169
5	100	9.77	9.71	80	0.294	0.189
6	80	10.02	9.96	98	0.304	0.166
7	84	10.03	9.97	95	0.308	0.175
8	76	9.74	9.67	91	0.301	0.162
9	84	9.88	9.81	94	0.274	0.157
10	72	10.17	10.11	95	0.261	0.163
11	92	9.72	9.64	105	0.299	0.155
12	92	10.05	9.99	91	0.287	0.166
13	80	9.80	9.74	97	0.293	0.158
14	88	10.01	9.94	94	0.281	0.162
15	96	9.76	9.68	102	0.271	0.151
16	88	9.93	9.86	104	0.229	0.153
17	96	9.97	9.90	104	0.263	0.157
18	80	9.84	9.78	104	0.260	0.153
19	92	10.25	10.19	102	0.250	0.165
20	92	9.88	9.81	106	0.239	0.167
21	68	9.77	9.71	103	0.206	0.159
22	80	9.97	9.90	105	0.229	0.158
23	92	9.80	9.74	93	0.234	0.161
24	95	9.54	9.47	138	0.228	0.175
25	100	10.17	10.11	93	0.263	0.175
26	90	9.56	9.49	120	0.249	0.175
27	80	9.73	9.67	116	0.205	0.173
28	85	9.74	9.68	121	0.263	0.171

Table 147: Case Study 2 - 40 ft Cluster Spacing Average Fracture Results

40ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)
1	73	9.25	9.19	107	0.306	0.153
2	93	9.46	9.39	94	0.287	0.157
3	97	10.13	10.06	78	0.275	0.158
4	90	9.57	9.51	82	0.288	0.156
5	77	10.03	9.96	80	0.256	0.151

6	87	10.11	10.04	78	0.280	0.151
7	77	9.85	9.78	93	0.286	0.148
8	73	9.52	9.45	98	0.245	0.142
9	80	10.10	10.04	96	0.254	0.148
10	80	9.49	9.42	95	0.297	0.136
11	90	9.92	9.85	83	0.252	0.139
12	83	9.55	9.49	114	0.279	0.156
13	68	8.66	8.60	109	0.214	0.165
14	68	9.21	9.14	102	0.287	0.148
15	92	10.02	9.95	107	0.285	0.164
16	68	9.87	9.80	100	0.256	0.152
17	80	9.49	9.42	105	0.268	0.156
18	88	9.49	9.43	102	0.238	0.164
19	80	9.88	9.82	108	0.234	0.155
20	80	9.66	9.60	98	0.253	0.157
21	76	9.46	9.40	118	0.203	0.165
22	84	9.82	9.76	104	0.236	0.153
23	72	9.91	9.85	121	0.210	0.166
24	88	9.88	9.82	96	0.228	0.148
25	88	9.88	9.81	101	0.222	0.152
26	72	9.03	8.97	109	0.222	0.165
27	80	9.98	9.91	102	0.205	0.156
28	80	9.50	9.43	120	0.223	0.145

Table 148: Case Study 2 - 35 ft Cluster Spacing Average Fracture Results

35ft Cluster Spacing						
Stage Number	Proppant Cutoff Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft^2)	Average Fracture Width (in)
1	69	9.27	9.20	106	0.286	0.139
2	86	9.61	9.56	81	0.340	0.144
3	80	9.17	9.12	86	0.250	0.136
4	83	9.45	9.39	91	0.303	0.143
5	80	9.88	9.82	81	0.272	0.158
6	80	10.11	10.04	80	0.257	0.140
7	73	9.85	9.79	105	0.253	0.152
8	87	9.97	9.91	95	0.259	0.150
9	80	9.10	9.04	94	0.211	0.153
10	77	9.30	9.25	108	0.260	0.148
11	63	9.93	9.86	103	0.234	0.145
12	70	8.61	8.56	106	0.260	0.142
13	67	9.53	9.47	105	0.235	0.153
14	83	9.69	9.63	94	0.245	0.133
15	70	9.07	9.01	90	0.247	0.135
16	83	9.67	9.61	95	0.221	0.139
17	83	9.66	9.59	96	0.244	0.132
18	83	9.71	9.64	107	0.262	0.141
19	73	9.85	9.79	100	0.241	0.146
20	73	9.65	9.58	98	0.223	0.134
21	70	9.59	9.51	101	0.189	0.141
22	80	9.96	9.89	108	0.195	0.141

23	73	8.82	8.76	102	0.192	0.150
24	70	9.47	9.41	106	0.179	0.132
25	83	9.54	9.48	93	0.197	0.150
26	93	10.21	10.15	92	0.221	0.157
27	63	9.32	9.26	85	0.199	0.132
28	67	9.81	9.74	92	0.188	0.146

Table 149: No Stress Shadowing Average Fracture Results

No Stress Shadowing						
Stage #	Fracture Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)
1	76	9.07	9.00	130	0.211	0.174
2	68	9.24	9.17	103	0.220	0.174
3	96	9.62	9.55	108	0.244	0.177
4	100	9.59	9.51	112	0.230	0.172
5	72	9.27	9.19	108	0.219	0.168
6	104	9.36	9.30	116	0.288	0.175
7	52	9.32	9.25	96	0.171	0.171
8	48	9.42	9.36	115	0.184	0.172
9	72	9.64	9.58	112	0.239	0.172
10	68	9.40	9.33	117	0.252	0.168
11	56	9.83	9.76	107	0.225	0.166
12	64	9.21	9.16	127	0.227	0.172
13	84	9.66	9.59	108	0.328	0.170
14	60	9.35	9.28	119	0.223	0.167
15	80	9.68	9.62	128	0.279	0.195
16	65	9.57	9.49	71	0.059	0.188
17	120	9.88	9.83	165	0.428	0.298
18	60	9.71	9.64	108	0.263	0.201
19	65	9.78	9.72	125	0.270	0.198
20	84	10.04	9.97	104	0.333	0.171
21	84	10.02	9.95	104	0.340	0.169
22	96	9.21	9.14	142	0.277	0.162
23	96	9.47	9.41	119	0.320	0.167
24	64	9.61	9.55	114	0.225	0.166
25	76	9.95	9.89	110	0.234	0.169
26	76	10.06	10.00	98	0.321	0.170
27	100	10.43	10.38	104	0.452	0.192
28	90	9.74	9.68	114	0.389	0.205

Table 150: Stress Shadowing Average Fracture Results

Stress Shadowing						
Stage #	Fracture Length (ft)	Est Flowing Frac Length (ft)	Est Inf Conductivity Length (ft)	Fracture Height (ft)	Average Proppant Conc (lb/ft²)	Average Fracture Width (in)
1	76	9.07	9.00	130	0.211	0.174
2	88	9.71	9.63	91	0.196	0.161

3	92	9.97	9.90	95	0.280	0.173
4	108	10.28	10.22	95	0.264	0.179
5	92	9.98	9.91	81	0.259	0.183
6	108	10.03	9.96	89	0.298	0.180
7	76	9.22	9.16	91	0.204	0.177
8	60	9.75	9.69	115	0.185	0.161
9	88	10.11	10.05	100	0.292	0.175
10	68	9.90	9.84	105	0.277	0.167
11	80	10.28	10.22	99	0.234	0.169
12	88	10.18	10.12	96	0.302	0.171
13	104	9.89	9.82	99	0.331	0.156
14	84	9.66	9.59	115	0.205	0.160
15	100	9.75	9.69	104	0.268	0.172
16	30	10.05	9.97	60	0.065	0.204
17	110	9.88	9.83	165	0.412	0.278
18	70	9.66	9.59	91	0.183	0.178
19	90	10.12	10.06	100	0.258	0.189
20	88	10.13	10.06	100	0.306	0.157
21	100	10.34	10.28	84	0.345	0.165
22	104	9.57	9.51	107	0.291	0.176
23	92	9.74	9.68	94	0.314	0.173
24	72	9.74	9.67	108	0.243	0.161
25	68	10.09	10.03	104	0.267	0.167
26	92	10.42	10.36	96	0.319	0.165
27	100	10.62	10.57	95	0.448	0.193
28	90	10.08	10.02	86	0.342	0.190

Table 151: Case Study 1 - CMG Results

		45ft Cluster Spacing			40ft Cluster Spacing			35ft Cluster Spacing		
Time (day)	Date	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)
0	12/12/2015		0	0		0	0		0	0
1	12/13/2015	3850	27445836	27445836	3850	28324074	28324074	3850	27370108	27370108
2	12/14/2015	3850	53403064	25957226	3850	55330708	27006630	3850	52147436	24777334
3	12/15/2015	3850	72381336	18978272	3850	74886616	19555910	3850	70451432	18303990
4	12/16/2015	3850	88656720	16275382	3850	91234952	16348335	3850	85811720	15360288
5	12/17/2015	3850	103088448	14431731	3850	105744280	14509332	3850	99540704	13728979
6	12/18/2015	3850	116144896	13056449	3850	118862440	13118156	3850	112022536	12481834
7	12/19/2015	3850	128121984	11977088	3850	130882872	12020429	3850	123513688	11491153
8	12/20/2015	3850	139221216	11099226	3850	142007712	11124840	3850	134192256	10678568
9	12/21/2015	3850	149585904	10364696	3850	152381632	10373940	3850	144186320	9994058
10	12/22/2015	3850	159321584	9735684	3850	162111712	9730063	3850	153590960	9404647
11	12/23/2015	3850	168508336	9186745	3850	171279344	9167628	3850	162478816	8887851
12	12/24/2015	3850	177208576	8700234	3850	179948752	8669406	3850	170907360	8428552
13	12/25/2015	3850	185472720	8264147	3850	188171568	8222829	3850	178922992	8015629
14	12/26/2015	3850	193342144	7869420	3850	195990416	7818839	3850	186564048	7641060
15	12/27/2015	3850	200851568	7509429	3850	203441136	7450725	3850	193862960	7298905
16	12/28/2015	3850	208030720	7179157	3850	210554512	7113378	3850	200847584	6984612
17	12/29/2015	3850	214905456	6874728	3850	217357328	6802808	3850	207542192	6694621
18	12/30/2015	3850	221498496	6593041	3850	223873168	6515837	3850	213968256	6426085
19	12/31/2015	3850	227830080	6331581	3850	230123024	6249863	3850	220144944	6176670
20	1/1/2016	3850	233918336	6088261	3850	236125744	6002719	3850	226089376	5944432
21	1/2/2016	3850	239779648	5861320	3850	241898320	5772577	3850	231817104	5727723
22	1/3/2016	3850	245428896	5649249	3850	247456176	5557859	3850	237342224	5525125
23	1/4/2016	3850	250879632	5450735	3850	252813376	5357200	3850	242677632	5335402
24	1/5/2016	3850	256144272	5264634	3850	257982768	5169398	3850	247835088	5157468
25	1/6/2016	3850	261234192	5089927	3850	262976064	4993283	3850	252825344	4990253
26	1/7/2016	3850	266159792	4925601	3850	267804160	4828098	3850	257658544	4833203
27	1/8/2016	3850	270930944	4771140	3850	272477088	4672925	3850	262343728	4685181
28	1/9/2016	3850	275556384	4625456	3850	277004064	4526982	3850	266889456	4545725
29	1/10/2016	3850	280044512	4488113	3850	281393632	4389568	3850	271303616	4414153
30	1/11/2016	3850	284402976	4358459	3850	285653664	4260050	3850	275593504	4289883
31	1/12/2016	3850	288638912	4235934	3850	289791520	4137853	3850	279765888	4172390
32	1/13/2016	3850	292758944	4120033	3850	293813984	4022453	3850	283827072	4061195

33	1/14/2016	3850	296769216	4010297	3850	297727360	3913371	3850	287782944	3955862
34	1/15/2016	3850	300675520	3906305	3850	301537536	3810166	3850	291638912	3855992
35	1/16/2016	3850	304483200	3807669	3850	305249952	3712437	3850	295400160	3761217
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935	7/4/2018	1665	3131753984	422526	1665	3113940480	403645	1665	3096969984	536916
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939	7/8/2018	1665	3133593600	483991	1665	3115688960	457331	1665	3099321600	620255
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941	7/10/2018	1665	3134620672	524484	1665	3116647424	487244	1665	3100621824	659939
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943	7/12/2018	1665	3135731712	565225	1665	3117665792	516873	1665	3102001152	699575
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1278	6/12/2019	1129	3954611968	2358110	1129	3935057408	2329537	1129	3920517120	2364577
1279	6/13/2019	1129	3956964352	2352387	1129	3937381376	2323960	1129	3922876160	2358973
1280	6/14/2019	1129	3959311104	2346730	1129	3939699712	2318447	1129	3925229568	2353432
1281	6/15/2019	1129	3961652224	2341136	1129	3942012928	2312999	1129	3927577856	2347952
1282	6/16/2019	1129	3963987968	2335605	1129	3944320512	2307612	1129	3929920000	2342533
1283	6/17/2019	1129	3966318080	2330137	1129	3946622720	2302288	1129	3932257280	2337174
1284	6/18/2019	1129	3968642816	2324728	1129	3948919808	2297023	1129	3934589184	2331874
1285	6/19/2019	1129	3970962176	2319381	1129	3951211520	2291818	1129	3936915712	2326631
1286	6/20/2019	1129	3973276160	2314091	1129	3953498112	2286672	1129	3939237120	2321445
1287	6/21/2019	1129	3975585024	2308860	1129	3955779840	2281582	1129	3941553408	2316314
1288	6/22/2019	1129	3977888768	2303685	1129	3958056448	2276549	1129	3943864832	2311239
1289	6/23/2019	1129	3980187136	2298566	1129	3960327936	2271572	1129	3946170880	2306218
1290	6/24/2019	1129	3982480896	2293503	1129	3962594560	2266649	1129	3948472064	2301250
1291	6/25/2019	1129	3984769280	2288493	1129	3964856576	2261780	1129	3950768640	2296334
1292	6/26/2019	1129	3987052800	2283537	1129	3967113216	2256963	1129	3953060352	2291469
1293	6/27/2019	1129	3989331456	2278633	1129	3969365504	2252198	1129	3955346688	2286655
1294	6/28/2019	1129	3991605248	2273781	1129	3971612928	2247484	1129	3957628416	2281891
1295	6/29/2019	1129	3993874176	2268979	1129	3973855744	2242820	1129	3959905792	2277175
1296	6/30/2019	1129	3996138496	2264227	1129	3976093952	2238206	1129	3962178304	2272508
1297	7/1/2019	1129	3998397952	2259524	1129	3978327552	2233640	1129	3964446208	2267889
1298	7/2/2019	1129	4000652800	2254870	1129	3980556800	2229122	1129	3966709504	2263316
1299	7/3/2019	1129	4002903040	2250263	1129	3982781440	2224651	1129	3968968192	2258789
1300	7/4/2019	1129	4005148672	2245703	1129	3985001728	2220226	1129	3971222528	2254307
1301	7/5/2019	1129	4007389952	2241189	1129	3987217408	2215846	1129	3973472512	2249869
1302	7/6/2019	1129	4009626880	2236721	1129	3989428992	2211512	1129	3975717888	2245476
1303	7/7/2019	1129	4011858944	2232297	1129	3991636224	2207221	1129	3977959168	2241126
1304	7/8/2019	1129	4014086912	2227917	1129	3993839104	2202973	1129	3980195840	2236818
1305	7/9/2019	1129	4016310528	2223580	1129	3996037888	2198769	1129	3982428416	2232552
1306	7/10/2019	1129	4018529536	2219286	1129	3998232576	2194606	1129	3984656640	2228327
1307	7/11/2019	1129	4020744960	2215034	1129	4000423168	2190484	1129	3986880768	2224143
1308	7/12/2019	1129	4022955776	2210823	1129	4002609408	2186404	1129	3989100800	2219999
1309	7/13/2019	1486	4022955776	98	1486	4002609408	110	1486	3989100800	0
1310	7/14/2019	1486	4022962176	6319	1486	4002622208	12529	1486	3989112320	11555
1311	7/15/2019	1486	4022998016	35768	1486	4002654464	32315	1486	3989154304	41805
1312	7/16/2019	1486	4023062528	64860	1486	4002715392	60836	1486	3989223936	69760
1313	7/17/2019	1486	4023140352	77695	1486	4002788352	73080	1486	3989306368	82309
1314	7/18/2019	1486	4023226112	85657	1486	4002868992	80603	1486	3989396480	90168
1315	7/19/2019	1486	4023317504	91507	1486	4002955008	86102	1486	3989492480	95973
1316	7/20/2019	1486	4023413760	96248	1486	4003045632	90549	1486	3989593088	100692
1317	7/21/2019	1486	4023514112	100284	1486	4003139840	94331	1486	3989698048	104709
1318	7/22/2019	1486	4023618048	103806	1486	4003237632	97631	1486	3989806080	108216
1319	7/23/2019	1486	4023724800	106920	1486	4003338240	100550	1486	3989917440	111316
1320	7/24/2019	1486	4023834368	109695	1486	4003441152	103151	1486	3990031360	114078
1321	7/25/2019	1486	4023946752	112181	1486	4003546624	105483	1486	3990148096	116553
1322	7/26/2019	1486	4024061184	114423	1486	4003654400	107588	1486	3990266624	118783
1323	7/27/2019	1486	4024177664	116448	1486	4003763712	109491	1486	3990387456	120798
1324	7/28/2019	1486	4024295936	118285	1486	4003875328	111220	1486	3990510080	122625
1325	7/29/2019	1486	4024415744	119961	1486	4003987968	112798	1486	3990634496	124292
1326	7/30/2019	1486	4024537344	121496	1486	4004102144	114246	1486	3990760192	125819
1327	7/31/2019	1486	4024660224	122909	1486	4004217600	115581	1486	3990887424	127223
1328	8/1/2019	1486	4024784384	124214	1486	4004334592	116816	1486	3991015936	128521
1329	8/2/2019	1486	4024910336	125842	1486	4004452352	117965	1486	3991145728	129726
1330	8/3/2019	1486	4025039104	128793	1486	4004571392	119037	1486	3991276544	130849
1331	8/4/2019	1486	4025170176	131031	1486	4004691456	120043	1486	3991408384	131900
1332	8/5/2019	1486	4025303040	132969	1486	4004812544	120989	1486	3991541504	132887
1333	8/6/2019	1486	4025437952	134721	1486	4004934400	121884	1486	3991675136	133819
1334	8/7/2019	1486	4025574144	136339	1486	4005057024	122732	1486	3991809792	134700
1335	8/8/2019	1486	4025712128	137850	1486	4005180672	123539	1486	3991945472	135536
1336	8/9/2019	1486	4025851392	139270	1486	4005305088	124503	1486	3992082432	137085
1337	8/10/2019	1486	4025992192	140613	1486	4005432064	126771	1486	3992221952	139348
1338	8/11/2019	1486	4026134016	141887	1486	4005560832	128543	1486	3992364288	142318
1339	8/12/2019	1486	4026276864	143100	1486	4005690624	130083	1486	3992509184	144976
1340	8/13/2019	1486	4026421248	144258	1486	4005821952	131490	1486	3992657408	148048
1341	8/14/2019	1486	4026567168	145998	1486	4005955328	133239	1486	3992811520	154405
1342	8/15/2019	1486	4026715136	148095	1486	4006090240	134902	1486	3992971008	159503
1343	8/16/2019	1486	4026867200	152075	1486	4006226688	136404	1486	3993138688	167459
1344	8/17/2019	1486	4027022592	155296	1486	4006364416	137811	1486	3993312512	174046

1345	8/18/2019	1486	4027181568	158875	1486	4006505216	140669	1486	3993492224	179687
1346	8/19/2019	1486	4027344896	163127	1486	4006649088	143800	1486	3993677056	184829
1347	8/20/2019	1486	4027512320	167601	1486	4006796032	147197	1486	3993867008	189755
1348	8/21/2019	1486	4027684096	171888	1486	4006947072	150922	1486	3994062080	195202
1349	8/22/2019	1486	4027861760	177698	1486	4007102720	155730	1486	3994265344	203207
1350	8/23/2019	1486	4028044288	182541	1486	4007262976	160167	1486	3994477824	212536
1351	8/24/2019	1486	4028231424	186938	1486	4007426816	164000	1486	3994699008	221140
1352	8/25/2019	1486	4028422912	191513	1486	4007595520	168543	1486	3994928384	229457
1353	8/26/2019	1486	4028620800	197986	1486	4007770624	175279	1486	3995165696	237257
1354	8/27/2019	1486	4028824576	203819	1486	4007953152	182420	1486	3995410944	245380
1355	8/28/2019	1486	4029033472	208973	1486	4008142336	189194	1486	3995665152	254066
1356	8/29/2019	1486	4029249536	215913	1486	4008340224	197790	1486	3995929344	264097
1357	8/30/2019	1486	4029473536	224100	1486	4008549120	209101	1486	3996204800	275584
1358	8/31/2019	1486	4029705472	232003	1486	4008769280	219929	1486	3996491264	286502
1359	9/1/2019	1486	4029944832	239286	1486	4008998912	229873	1486	3996788224	297022
1360	9/2/2019	1486	4030193152	248349	1486	4009238272	239117	1486	3997096448	308026
1361	9/3/2019	1486	4030454528	261207	1486	4009486848	248691	1486	3997417472	321221
1362	9/4/2019	1486	4030729216	274665	1486	4009745408	258609	1486	3997751552	333890
1363	9/5/2019	1486	4031016704	287489	1486	4010014976	269599	1486	3998099968	348491
1364	9/6/2019	1486	4031315456	298880	1486	4010296576	281639	1486	3998461952	362056
1365	9/7/2019	1486	4031624960	309505	1486	4010589952	293375	1486	3998838016	375961
1366	9/8/2019	1486	4031944448	319589	1486	4010894336	304262	1486	3999229440	391550
1367	9/9/2019	1486	4032274176	329625	1486	4011208960	314669	1486	3999636480	407058
1368	9/10/2019	1486	4032613888	339737	1486	4011535360	326318	1486	4000057600	421105
1369	9/11/2019	1486	4032963840	349912	1486	4011872512	337214	1486	4000492800	435073
1370	9/12/2019	1486	4033323776	360025	1486	4012219904	347397	1486	4000943360	450618
1371	9/13/2019	1486	4033694720	370749	1486	4012577024	357142	1486	4001409024	465756
1372	9/14/2019	1486	4034078464	383827	1486	4012943616	366556	1486	4001889280	480102
1373	9/15/2019	1486	4034477824	399468	1486	4013319424	375847	1486	4002383872	494620
1374	9/16/2019	1486	4034892288	414410	1486	4013704960	385500	1486	4002893056	509542
1375	9/17/2019	1486	4035319552	427486	1486	4014101760	396721	1486	4003418112	524741
1376	9/18/2019	1486	4035761408	441853	1486	4014509568	407857	1486	4003958528	540306
1377	9/19/2019	1486	4036219648	457904	1486	4014928640	419044	1486	4004513024	554663
1378	9/20/2019	1486	4036691968	472387	1486	4015359232	430596	1486	4005081600	568552
1379	9/21/2019	1486	4037178368	486296	1486	4015803136	443863	1486	4005664000	582332
1380	9/22/2019	1486	4037677824	499523	1486	4016260096	457170	1486	4006259968	595971
1381	9/23/2019	1486	4038190848	513066	1486	4016730880	470717	1486	4006871040	610948
1382	9/24/2019	1486	4038718976	528023	1486	4017215232	484161	1486	4007496704	625715
1383	9/25/2019	1486	4039262208	543408	1486	4017714688	499702	1486	4008137216	640619
1384	9/26/2019	1486	4039820288	558035	1486	4018228992	514171	1486	4008792064	654857
1385	9/27/2019	1486	4040391936	571554	1486	4018757632	528629	1486	4009461760	669681
1386	9/28/2019	1486	4040976640	584596	1486	4019301120	543396	1486	4010146816	685110
1387	9/29/2019	1486	4041574400	597852	1486	4019858176	557227	1486	4010846976	700199
1388	9/30/2019	1486	4042184960	610728	1486	4020429824	571677	1486	4011562240	715105
1389	10/1/2019	1486	4042809600	624586	1486	4021016832	586859	1486	4012291840	729679
1390	10/2/2019	1486	4043448320	638703	1486	4021619712	603172	1486	4013035264	743274
1391	10/3/2019	1486	4044102400	654029	1486	4022238464	618444	1486	4013791744	756484
1392	10/4/2019	1486	4044770560	668315	1486	4022873088	634692	1486	4014561024	769553
1393	10/5/2019	1486	4045453824	683268	1486	4023524352	651286	1486	4015343616	782344
1394	10/6/2019	1486	4046151168	697341	1486	4024190976	666612	1486	4016138752	795231
1395	10/7/2019	1486	4046863104	711778	1486	4024872960	681973	1486	4016947200	808439
1396	10/8/2019	1486	4047590400	727426	1486	4025570816	697877	1486	4017768960	821704
1397	10/9/2019	1486	4048333312	742748	1486	4026284544	713745	1486	4018603520	834380
1398	10/10/2019	1486	4049090304	757161	1486	4027013376	728739	1486	4019450368	847053
1399	10/11/2019	1486	4049862656	772362	1486	4027758080	744703	1486	4020310016	859680
1400	10/12/2019	1486	4050649088	786270	1486	4028518656	760662	1486	4021181440	871510
1401	10/13/2019	1486	4051449088	799975	1486	4029294336	775756	1486	4022064640	882929
1402	10/14/2019	1486	4052262912	813911	1486	4030085632	791250	1486	4022958592	894050
1403	10/15/2019	1486	4053089792	826960	1486	4030891520	805885	1486	4023868160	909630
1404	10/16/2019	1486	4053928960	839484	1486	4031711232	820049	1486	4024783872	915681
1405	10/17/2019	1486	4054781184	851760	1486	4032545024	833500	1486	4025709824	925956
1406	10/18/2019	1486	4055644928	863511	1486	4033391360	846619	1486	4026646272	936516
1407	10/19/2019	1486	4056529664	885001	1486	4034251008	859237	1486	4027593216	946819
1408	10/20/2019	1486	4057416960	887308	1486	4035122432	871351	1486	4028550144	957260
1409	10/21/2019	1486	4058320640	903719	1486	4036005376	883176	1486	4029517568	967270
1410	10/22/2019	1486	4059230976	910283	1486	4036900608	894998	1486	4030494720	977146
1411	10/23/2019	1486	4060152064	921106	1486	4037806848	906412	1486	4031481344	986561
1412	10/24/2019	1486	4061086720	934703	1486	4038724608	917716	1486	4032476928	995662
1413	10/25/2019	1486	4062028800	942058	1486	4039653376	928865	1486	4033481728	1004498
1414	10/26/2019	1486	4062980864	952006	1486	4040595456	941888	1486	4034494720	1013219
1415	10/27/2019	1486	4063942400	961661	1486	4041545472	950179	1486	4035516416	1021712
1416	10/28/2019	1486	4064913920	971433	1486	4042505984	960420	1486	4036546304	1029968
1417	10/29/2019	1486	4065894912	980926	1486	4043476224	970284	1486	4037584384	1037987
1418	10/30/2019	1486	4066884864	990039	1486	4044456192	979844	1486	4038630400	1045960
1419	10/31/2019	1486	4067883776	998878	1486	4045448192	992141	1486	4039684096	1053809
1420	11/1/2019	1486	4068891136	1007475	1486	4046447616	999402	1486	4040745728	1061515
1421	11/2/2019	1486	4069907200	1016005	1486	4047455488	1007740	1486	4041815040	1069235
1422	11/3/2019	1486	4070931456	1024299	1486	4048471808	1016514	1486	4042891008	1076360
1423	11/4/2019	1486	4071964160	1032548	1486	4049496832	1025029	1486	4043974912	1083536
1424	11/5/2019	1486	4073004544	1040496	1486	4050530304	1033309	1486	4045065472	1090574
1425	11/6/2019	1486	4074052864	1048213	1486	4051571712	1041483	1486	4046162944	1097470
1426	11/7/2019	1486	4075108608	1055725	1486	4052621056	1049428	1486	4047267072	1104143

1427	11/8/2019	1486	4076171520	1063047	1486	4053678336	1057144	1486	4048377600	1110639
1428	11/9/2019	1486	4077241856	1070222	1486	4054743040	1064657	1486	4049494528	1116971
1429	11/10/2019	1486	4078319104	1077263	1486	4055814912	1071978	1486	4050617856	1123149
1430	11/11/2019	1486	4079403008	1084106	1486	4056893696	1079116	1486	4051746816	1129179
1431	11/12/2019	1486	4080493824	1090776	1486	4057980160	1086079	1486	4052881920	1135067
1432	11/13/2019	1486	4081591296	1097285	1486	4059073280	1092871	1486	4054022912	1140866
1433	11/14/2019	1486	4082694912	1103640	1486	4060172544	1099500	1486	4055169536	1146562
1434	11/15/2019	1486	4083804672	1109846	1486	4061278464	1105969	1486	4056321536	1152096

Table 152: Case Study 2 - CMG Results

		45ft Cluster Spacing			40ft Cluster Spacing			35ft Cluster Spacing		
Time (day)	Date	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)	Well Bottom-hole Pressure (psi)	Cumulative Gas SC (ft^3)	Gas Rate (ft^3/day)
0	12/12/2015		0	0		0	0		0	0
1	12/13/2015	3850	29656842	29656842	3850	31805480	31805480	3850	35216988	35216988
2	12/14/2015	3850	57732324	28075484	3850	61466144	29660664	3850	65820860	30603874
3	12/15/2015	3850	77920296	20187970	3850	82695848	21229702	3850	87389848	21568988
4	12/16/2015	3850	94910456	16990160	3850	100259536	17563688	3850	105706880	18317032
5	12/17/2015	3850	109953712	15043259	3850	115722808	15463278	3850	121714616	16007735
6	12/18/2015	3850	123526672	13572959	3850	129596176	13873367	3850	135987168	14272561
7	12/19/2015	3850	135940128	12413447	3850	142215728	12619545	3850	148905200	12918002
8	12/20/2015	3850	147407872	11467746	3850	153813904	11598165	3850	160733648	11828472
9	12/21/2015	3850	158083008	10675151	3850	164557856	10743969	3850	171663536	10929884
10	12/22/2015	3850	168078944	9995927	3850	174571952	10014098	3850	181836352	10172821
11	12/23/2015	3850	177485616	9406664	3850	183951296	9379340	3850	191359776	9523426
12	12/24/2015	3850	186366976	8881370	3850	192771216	8819926	3850	200309088	8949311
13	12/25/2015	3850	194775984	8409001	3850	201093888	8322682	3850	208763248	8454156
14	12/26/2015	3850	202763440	7987464	3850	208966928	7873018	3850	216773232	8009983
15	12/27/2015	3850	210364112	7600680	3850	216435120	7468200	3850	224383728	7610500
16	12/28/2015	3850	217610544	7246422	3850	223532608	7097492	3850	231632752	7249027
17	12/29/2015	3850	224533712	6923168	3850	230293040	6760427	3850	238552720	6919974
18	12/30/2015	3850	231157184	6623470	3850	236742256	6449225	3850	245171600	6618872
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