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Removal Action Report for the P-Area Groundwater Operable Unit Non-Time Critical Removal Action

SEMS Number: 81

SRNS-RP-2020-00021

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~~July~~November 2020

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

exception of Panel B at PGF010, Panel D at PGF001, Panel E at PGF009, and Panel F at PGF001-PGF003 and PGF005-PGF007. Panel F received less ZVI injections than the rest of the ZVI-PRB, which may be a factor in the injections wells not experiencing PPR at six locations. At the completion of the ZVI-PRB, 115 of 124 expansion casings that received injections experienced PPR. Therefore, strong evidence was provided through visual observations that ZVI was propagating along the azimuth of the ZVI-PRB for the entire length of the barrier.

Throughout the construction of the ZVI-PRB, there were no observed bypasses, short-circuiting, daylighting, or breaches to the surface of amendment through any abandoned or active wells or boreholes or surface expansion.

5.1.3 Construction Quantities

Installation of the ZVI-PRB concluded with a total of 684.5 metric tons (754.6 US tons) of ZVI injected, as shown in Table 5 and in Appendix C. Accounting for the weight of ZVI in the washout of each injection well, the final total amount of ZVI that was emplaced in the subsurface is 672.3 metric tons (741.1 US tons). The completed ZVI-PRB installation is ~80.5 LM (264 LF) with a height of 27.4 m (90 ft) for 65.8 LM (216 LF) and 22.9 m (75 ft) for the remaining 14.6 LM (48 LF) to the south with varying thicknesses, depending on the "hot-spot" locations along the alignment as well as adjustments to Panel F. Using the bulk density of the delivered ZVI (2,419 kg/m^3 [151 pcf]), the average thickness is 13.0 cm (5.11 in.), which is 28% greater than the design thickness to achieve the RAO. Across the ZVI-PRB Panels A through Panel E, the maximum thickness is 17.0 cm (6.71 in.) and the minimum thickness is 12.3 cm (4.84 in.). The thickness in Panel F at all locations is 7.82 cm (3.08 in). Therefore, the thickness at all locations across the ZVI-PRB exceeds the design specifications, with deviations described in Section 3.0.

5.1.4 Post-Construction HPIT

HPIT was conducted prior to and following the installation of the ZVI-PRB to qualitatively verify that installation of the ZVI-PRB did not impact the natural groundwater flow. HPIT

is highly sensitive and defines the degree of hydraulic continuity between a source and receiver well pair. Post-construction HPIT was conducted on four monitoring well pairs beginning January 27, 2020, along the ZVI-PRB alignment with upgradient wells as the source wells and downgradient wells as the receiver wells. The same pairs were tested in reverse for repeatability. A majority of the well pairs tested post-construction were the same as the pairs tested pre-construction of the ZVI-PRB, allowing for a direct comparison.

The HPIT arrangement, typical data, and type-curve matching are shown on outputs in Appendix G for pre- and post-construction HPIT. The HPIT was conducted across the monitoring well pairs as follows with the last four pairs measured for repeatability:

Source Well	Receiver Well
1DU	2DU
1DL	2DL
3DU	4DU
3DL	4DL
2DU	1DU
2DL	1DL
4DU	3DU
4DL	3DL

The hydraulic conductivity and storativity values computed for each well pair are detailed in Table 10 for comparison between pre- and post-construction HPIT results. Background into the application and usefulness of HPIT is provided in the RADP (SRNS 2019a). The hydraulic conductivity calculated for the ZVI-PRB ranged from 0.09 to 146 meters per day (m/day) (0.30 to 479 feet per day [ft/day]) with an average of 37.1 m/day (122 ft/day). The calculated storativity values ranged from 5.84×10^{-6} to 1.28×10^{-4} m^{-1} (1.78×10^{-6} to 3.91×10^{-5} ft^{-1}).

HPIT is intended to be conducted parallel to groundwater flow direction for reliable data. In the case of this project, the available monitoring well pairs and varying flow directions of the UAZ in the ZVI-PRB area did not allow for ideal HPIT conditions. Therefore, the data was assessed qualitatively and was not considered to be reliable results for subsurface properties in the ZVI-PRB area. In comparing the data of the post-construction and pre-

construction HPIT, there are discernable responses in the receiver wells, indicating the well pairs are communicating and providing confidence that there is flow through the ZVI-PRB (Appendix G.2). While this is a qualitative evaluation, the results indicate that the ZVI-PRB installation did not cause any negative impacts to the natural aquifer characteristics or to the natural groundwater flow through the area targeted by the NTC RA. This provides further confidence that the ZVI-PRB achieves the performance criteria.

5.2 Final Inspection for Acceptance of PAGW OU RA Construction Completion

An internal FAI was performed on 02/05/2020 by the PAGW OU project team, SRNS safety and operations personnel, and USDOE. The FAI was accepted by SRNS on 03/02/2020, marking completion of construction of the ZVI-PRB. Performance of the NTC RA will be monitored and assessed as identified in the EMP.

6.0 AS-BUILT DOCUMENTATION

6.1 As-Built Drawings

The following as-built drawings are provided for the completion of the PAGW OU NTC RA:

- Appendix J.1 – PAGW OU NTC RA As-Built of Resistivity Strings and Injection Wells, Plan View
- Appendix J.2 – PAGW OU NTC RA As-Built of Monitoring Wells in Support of the EMP, Plan View
- Appendix J.3 – PAGW OU NTC RA As-Built of the ZVI-PRB Trace, Plan View

6.2 Well Modifications

In support of this NTC RA, seven downgradient groundwater monitoring wells (PRW005DL, PRW005DU, PRW006C, PRW006DL, PRW006DU, PRW007DL, and PRW007DU) and four in-wall groundwater monitoring wells (PIW001D, PIW002D, PIW003D, and PIW004D) were installed in the PAGW OU for effectiveness monitoring

(Figure 8). The newly installed wells will be sampled and analyzed under the EMP in support of this NTC RA, as described in Section 7.1. Well records and soil boring installation reports for the newly installed wells are provided in Appendix H, and in Appendix D for the new in-wall monitoring wells.

7.0 POST-CONSTRUCTION ACTIVITIES

Construction activities in support of the ZVI-PRB NTC RA at the PAGW OU are complete. Land use of the entire PAGW OU area will be controlled consistent with the SRS Land Use Control Assurance Plan (WSRC 1999). There is no current or projected future use of groundwater or surface water as a drinking water source at the PAGW OU and site access is controlled by SRS facility security and administrative controls. Site specific land use controls are expected to be addressed as part of the final remedial action for the PAGW OU. Post-construction effectiveness monitoring for the ZVI-PRB will be completed through the implementation of the EMP, as detailed below.

7.1 Removal Action Effectiveness Monitoring

The RAO to protect human health and the environment is to reduce the mass and downgradient transport of volatile organic compounds present in groundwater. This will reduce the mass flux downgradient to Steel Creek. The PAGW OU NTC RA, consisting of initiating vertical fractures perpendicular to groundwater flow, and injecting a ZVI mixture that will leave, in-situ, a permeable barrier. The ZVI-PRB will degrade cVOCs in groundwater to harmless end products, and is expected to achieve the mass flux reduction in TCE that is required to meet the RAO. Verification will be provided by the results of the approved EMP in support of the RADP (SRNS 2019a).

The EMP consists of eight upgradient monitoring wells, 14 downgradient monitoring wells, and four in-wall monitoring wells. Table 12 and Figure 8 depict the location and construction details of the monitoring wells to be used for the EMP. Wells will be sampled quarterly for all wells, except one well cluster farthest downgradient of the ZVI-PRB (PRW006), which will be sampled annually. Sampling will be conducted for five years

and results will be reported annually in an Effectiveness Monitoring Report (EMR). In accordance with the closure requirements of the RADP, the annual EMRs for the PAGW OU NTC RA will evaluate the overall effectiveness of the NTC RA in reducing TCE mass flux in the contaminated groundwater as well as the sustainability of the ZVI-PRB. After five years of effectiveness monitoring and reporting as part of the NTC RA Effectiveness Monitoring Plan, long-term monitoring of the ZVI-PRB will continue as necessary and will be reported in the Biennial PAGW Groundwater Monitoring Report. Any potential future actions will be addressed by the USDOE, USEPA, and SCDHEC as part of the PAGW OU final remedial decision process.

8.0 PROJECT COSTS

Table 13 provides a cost comparison of the final costs for the NTC RA to the original RSER/EE/CA cost estimate. The RSER/EE/CA capital cost estimate was $2,901,583 and the O&M cost estimate was $1,709,506, for a total project cost estimate of $4,611,089 (SRNS 2018a). There was a significant difference in actual cost versus the estimate in the total capital cost for this project and therefore the costs have been broken down in Table 13 for further explanation below.

The capital cost incurred in each phase is detailed in Table 13 with a combined total actual capital cost of $9,349,456, which is 222% higher than estimated in the RSER/EE/CA. The ZVI-PRB project activities, and respective costs, occurred in three phases, the data design acquisition plan (DDAP) phase, the design phase, and the construction phase. Due to the unique subsurface at the ZVI-PRB target location, an extensive DDAP was required to optimize the NTC RA design which consisted of installing two upgradient monitoring well clusters (consisting of 3 wells/cluster), installing two downgradient monitoring well clusters (consisting of 3 wells/cluster), continuous coring, soil sampling and analysis, and geophysical logging at nine locations, treatability study to determine contaminant degradation rates and long-term performance of the ZVI, and pre-construction HPIT. This effort was not accounted for in the RSER/EE/CA cost estimate and therefore is a major factor in the large overall variance in cost. The design phase consisted of analyzing the DDAP data and producing a final design report. The cost of the design phase was in line with the estimate.

Table 10. Comparison of Pre- and Post-Construction HPIT Data

Direction of Test	Source Well	Receiver Well	Distance Between Wells [ft]	Pre-Construction HPIT				Post-Construction HPIT			
				K [ft day^{-1}]	K [cm sec^{-1}]	S_s [ft^{-1}]	Groundwater Flow Velocity[1] [ft day^{-1}]	K [ft day^{-1}]	K [cm sec^{-1}]	S_s [ft^{-1}]	Groundwater Flow Velocity[1] [ft day^{-1}]
Upgradient to Downgradient	PRW001DU	PRW002DU	40.6	6.19E+01	2.18E-02	5.27E-05	2.17E+00	-	-	-	-
	PRW001DL	PRW002DL	40.1	3.40E-01	1.20E-04	1.78E-06	1.19E-02	2.03E+01	7.15E-03	3.14E-05	7.09E-01
	PRW003DU	PRW004DU	44.0	-	-	-	-	3.01E+00	1.06E-03	-	1.05E-01
	PRW003DL	PRW004DL	40.0	5.06E+01	1.78E-02	2.26E-06	1.77E+00	3.39E+00	1.20E-03	1.31E-09	1.19E-01
Downgradient to Upgradient	PRW002DU	PRW001DU	40.6	4.79E+02	1.69E-01	3.91E-05	1.68E+01	5.83E+01	2.06E-02	1.62E-05	2.04E+00
	PRW002DL	PRW001DL	40.1	2.36E+00	8.33E-04	7.50E-06	8.26E-02	8.89E+01	3.13E-02	1.19E-05	3.11E+00
	PRW004DU	PRW003DU	44.0	1.36E+02	4.81E-02	8.87E-06	4.77E+00	-	-	-	-
	PRW004DL	PRW003DL	40.0	-	-	-	-	-	-	-	-
			Average	1.22E+02	4.29E-02	1.87E-05	4.26E+00	3.48E+01 ~~4.26E+00~~	1.23E-02~~4.26E+00~~	1.49E-05~~4.26E+00~~	1.22E+00~~4.26E+00~~

[1] Groundwater flow velocity calculated using 0.007 ft/ft horizontal gradient and 20% effective porosity.

K - hydraulic conductivity

S_s - specific storage

cm sec^{-1} - centimeters per second

APPENDIX G

Hydraulic Pulse Interference Testing Data

Appendix G.1 – Pre-Construction HPIT
Appendix G.2 – Post-Construction HPIT

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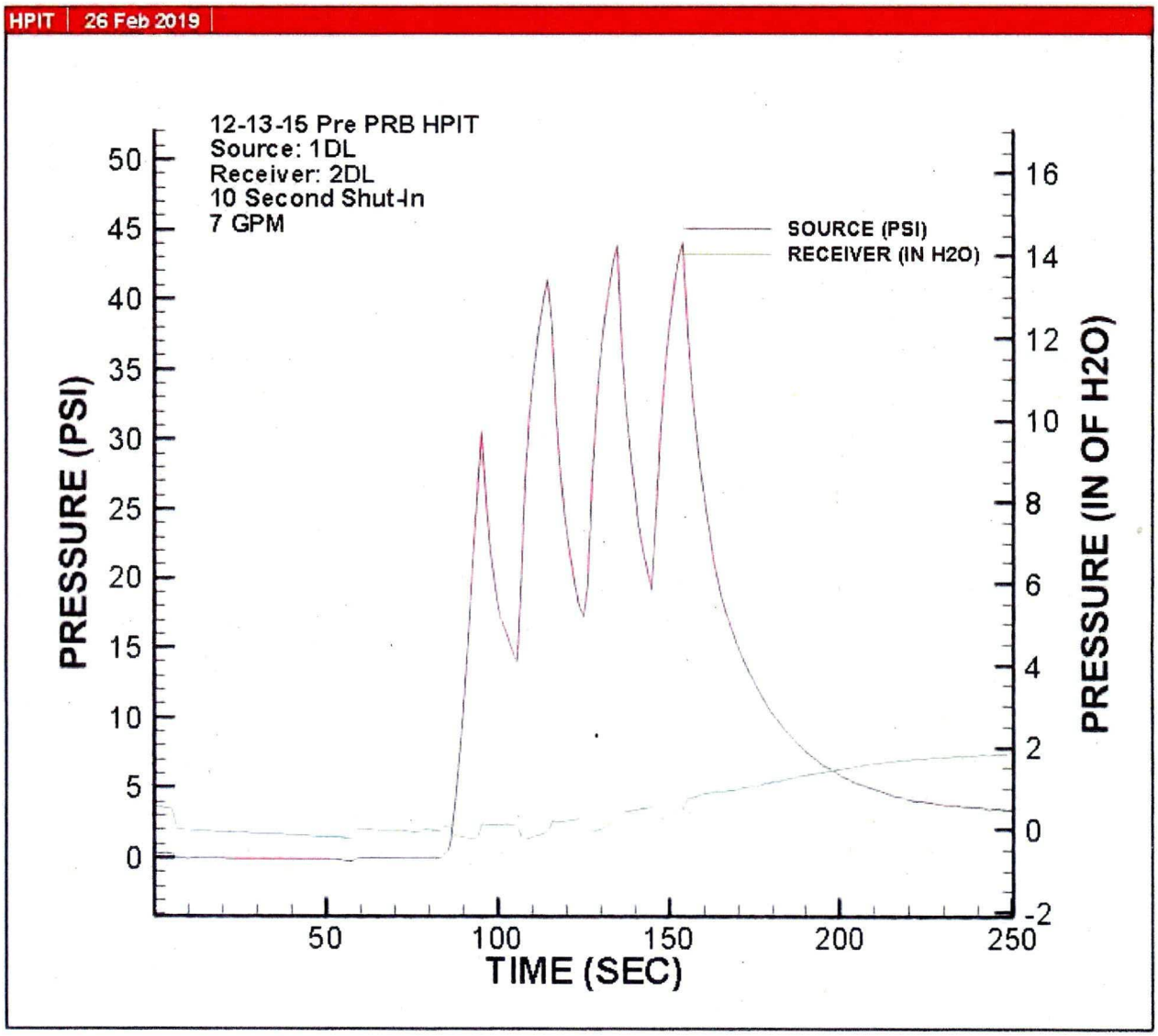
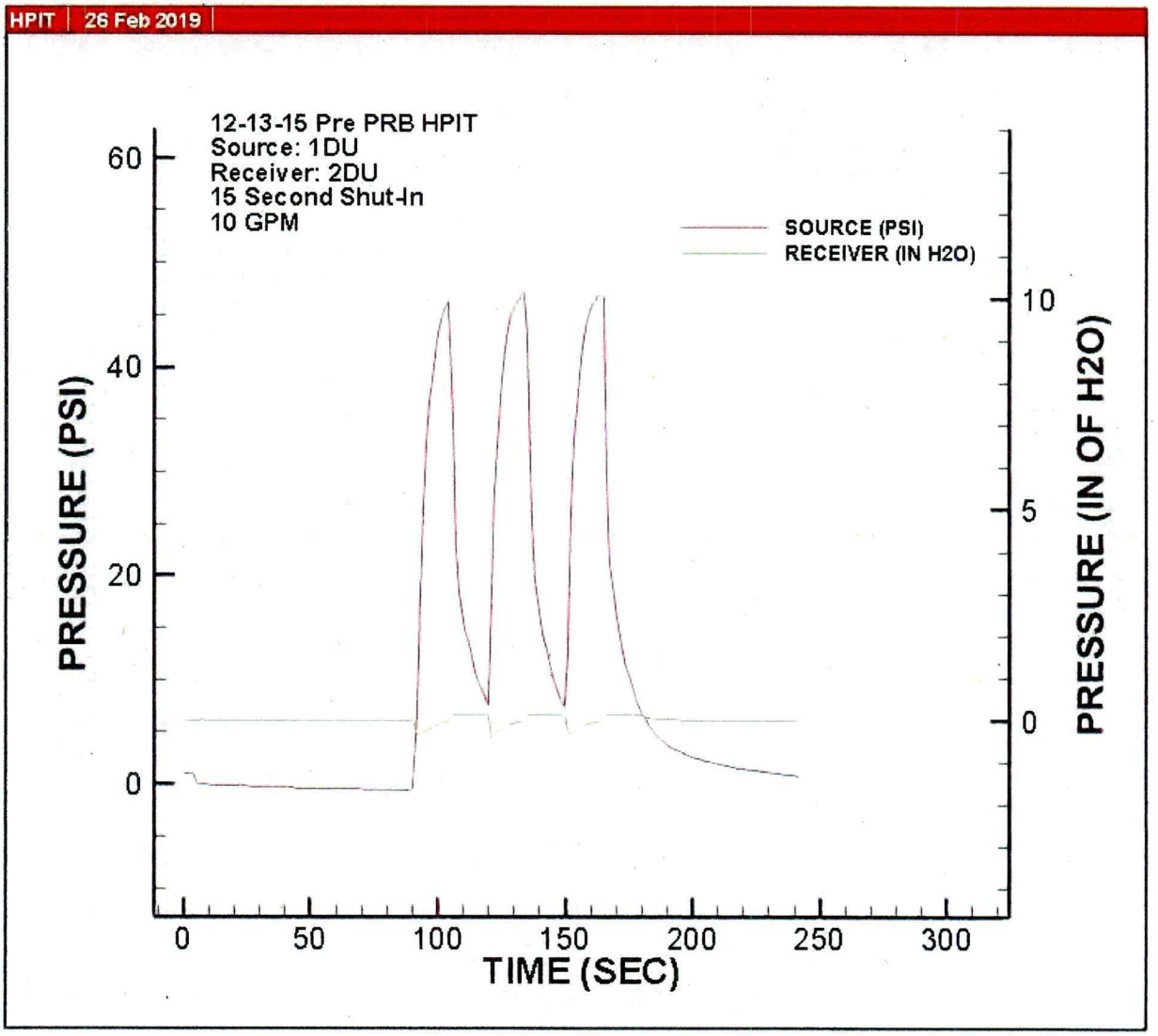
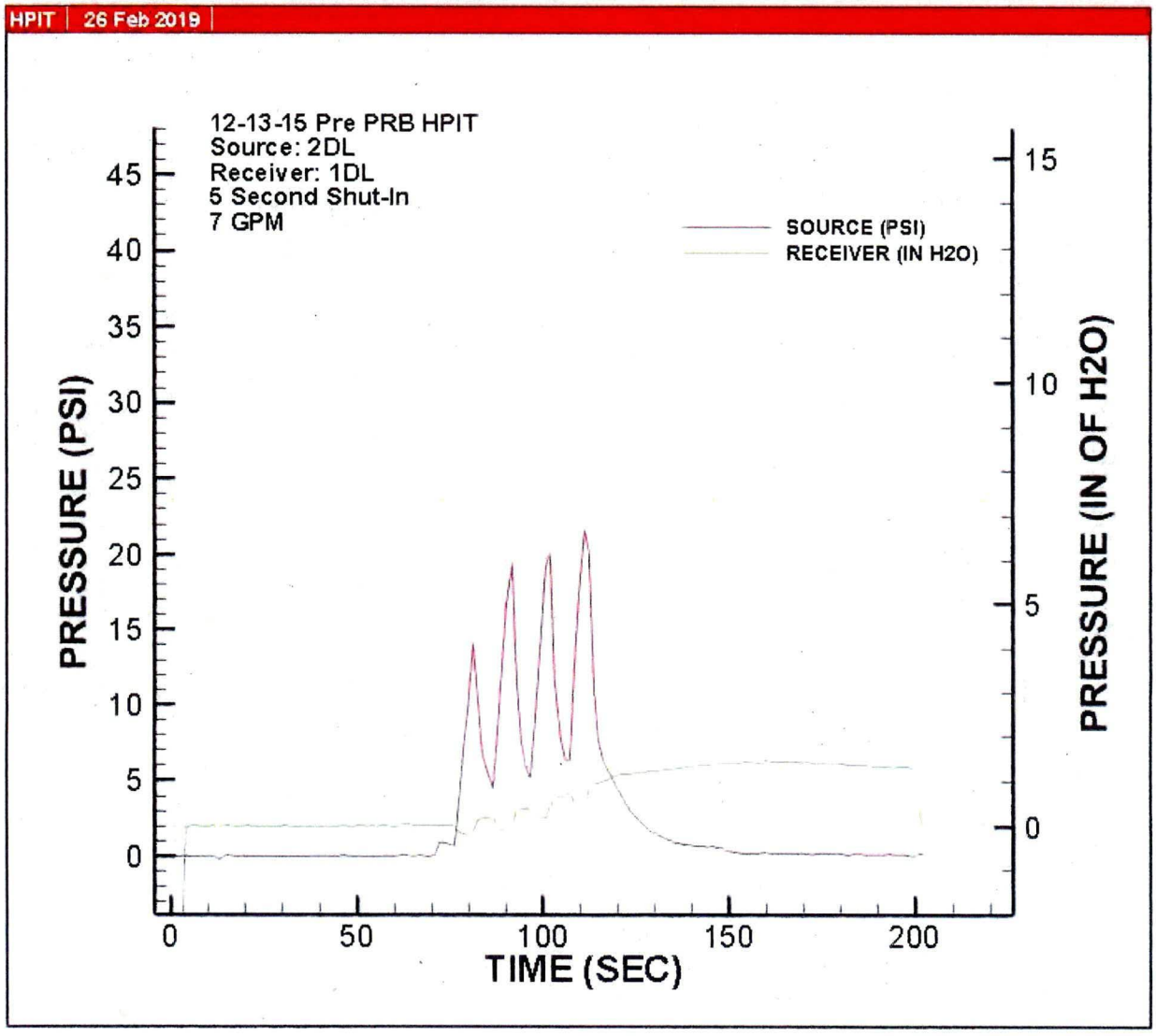
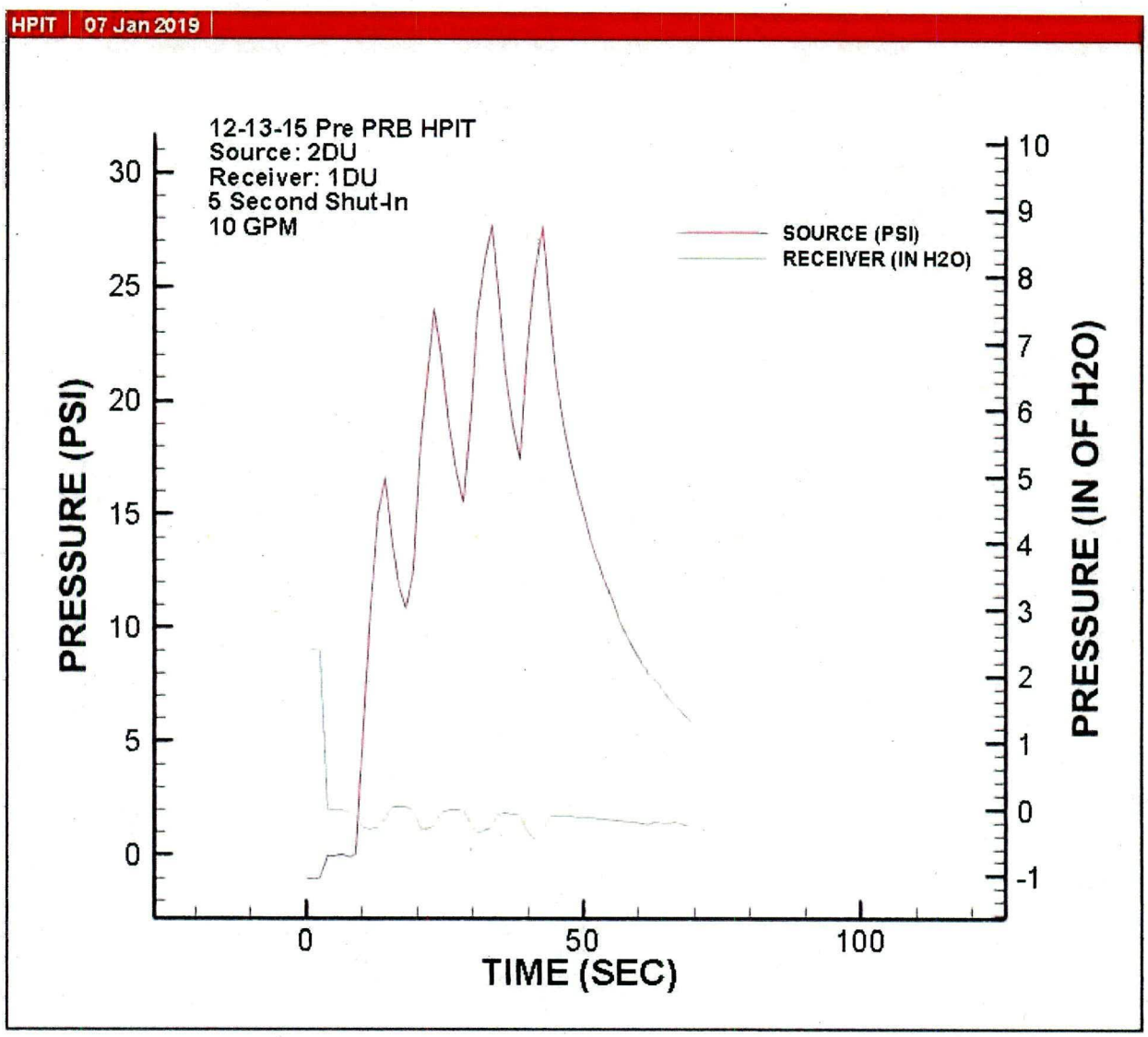
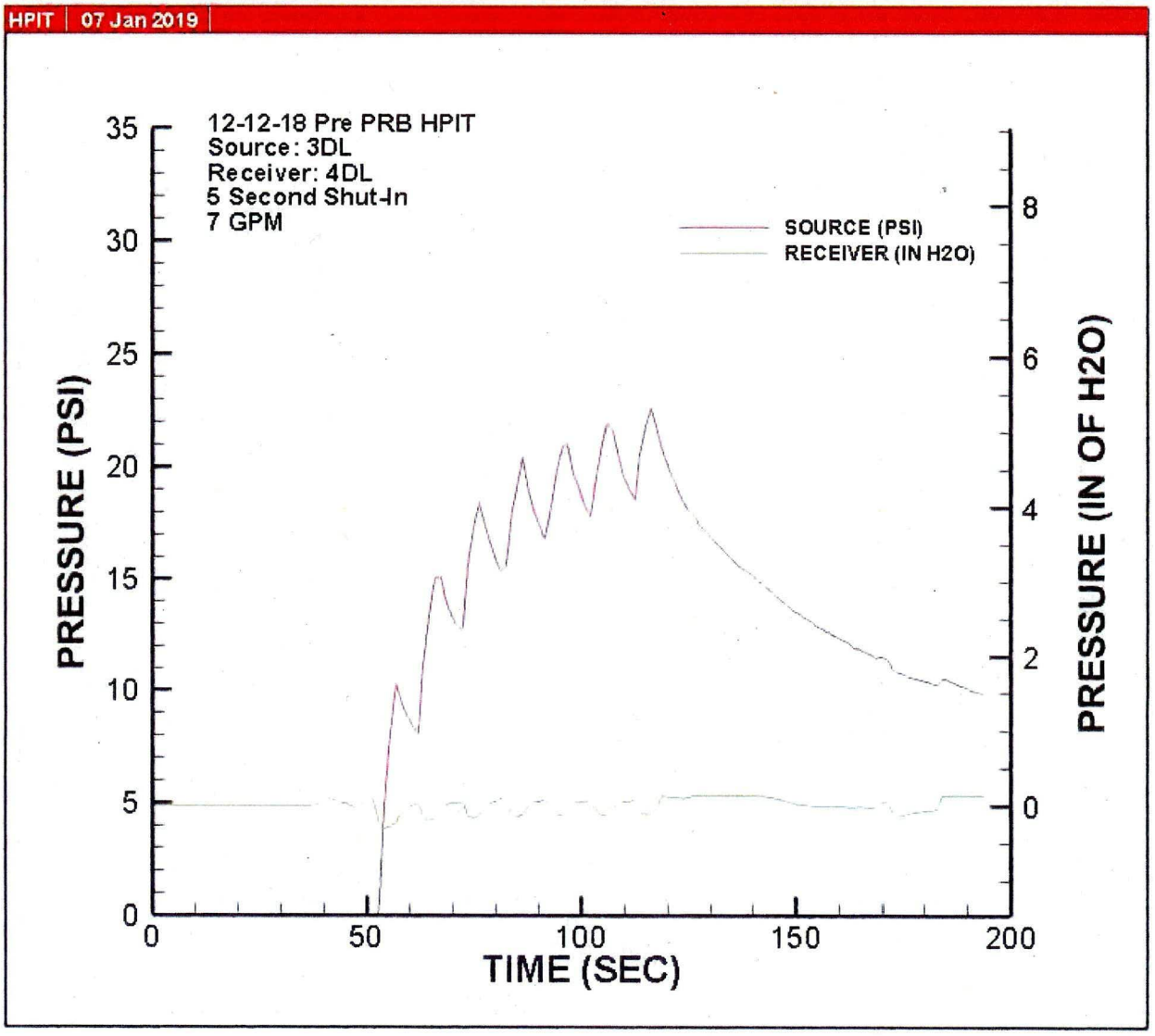
APPENDIX G.1 –
Pre-Construction HPIT Data

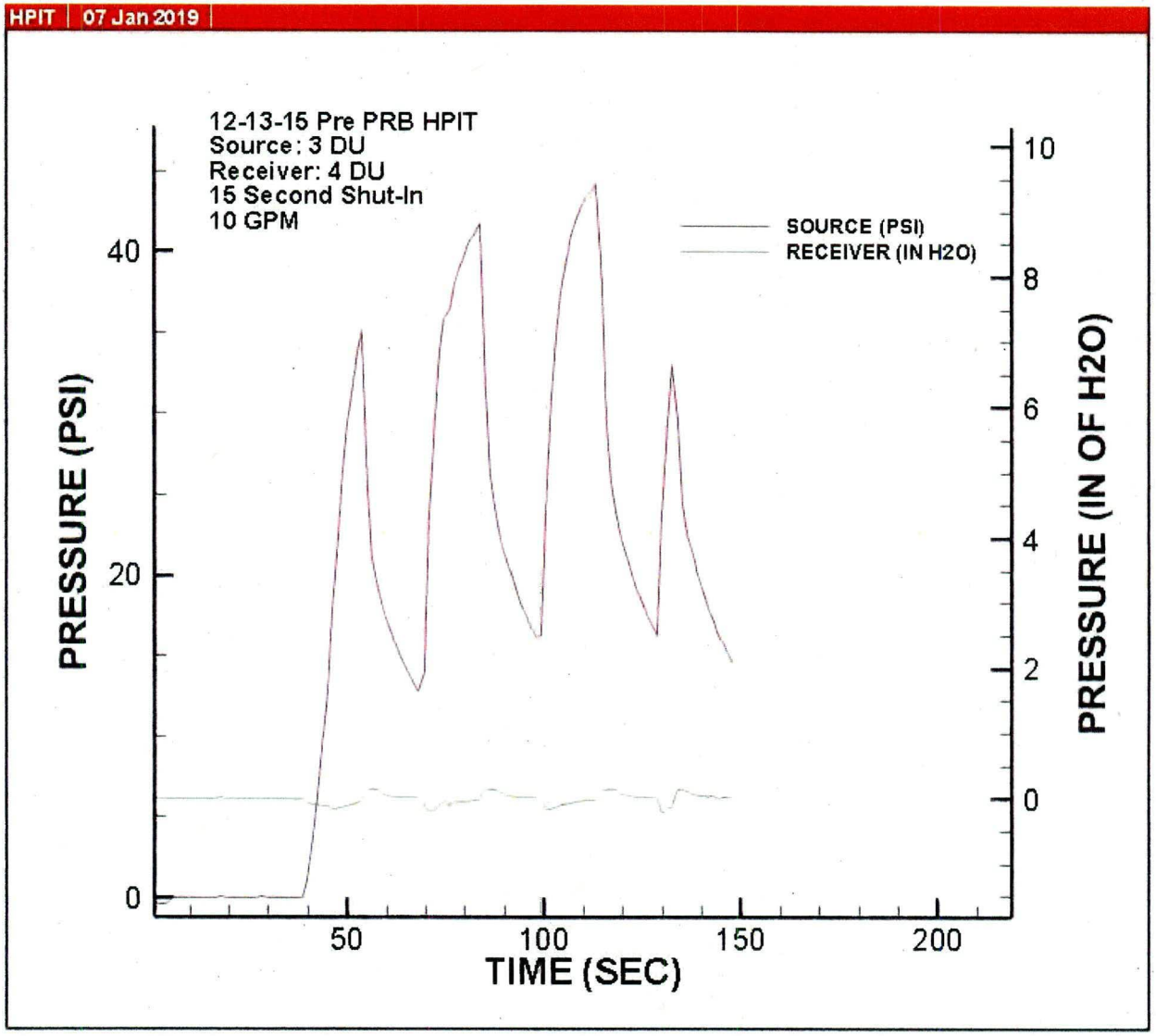



HPIT | 26 Feb 2019
12-13-15 Pre PRB HPIT
Source: 1DU
Receiver: 2DU
15 Second Shut-In
10 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
20
40
60
0
5
10
0
50
100
150
200
250
300


HPIT | 26 Feb 2019
12-13-15 Pre PRB HPIT
Source: 2DL
Receiver: 1DL
5 Second Shut-In
7 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
25
30
35
40
45
0
50
100
150
200
0
5
10
15


HPIT
07 Jan 2019
12-13-15 Pre PRB HPIT
Source: 2DU
Receiver: 1DU
5 Second Shut-In
10 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
25
30
-1
0
1
2
3
4
5
6
7
8
9
10
0
50
100


HPIT
07 Jan 2019
12-12-18 Pre PRB HPIT
Source: 3DL
Receiver: 4DL
5 Second Shut-In
7 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
25
30
35
0
2
4
6
8
0
50
100
150
200


HPIT | 07 Jan 2019
12-13-15 Pre PRB HPIT
Source: 3 DU
Receiver: 4 DU
15 Second Shut-In
10 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
20
40
0
2
4
6
8
10
50
100
150
200

January 2019 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
PRE-PRB TEST SAVANNAH RIVER SITE SOURCE: 1DL RECEIVER: 2DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

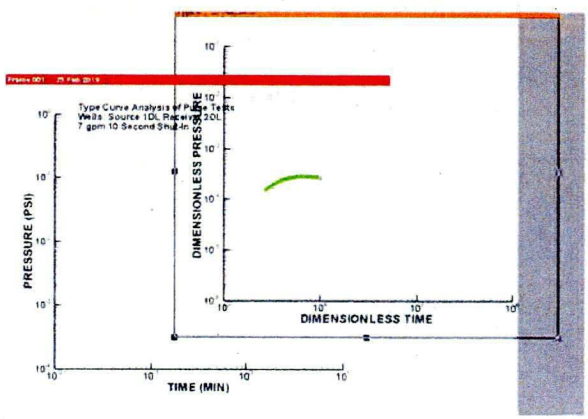
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where:
- q = flow rate
- p_D = dimensionless pressure
- r_w = well bore radius of source well
- Δp = pressure
- t = time
- t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	7.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	1.10E+00	ft/day
Δp =	0.1005	ft. of H_2O	S_s =	7.39E-06	1/ft
pD =	2.59E-04				
t =	2.51	mins			
t_D =	4169.39				



Project Name Savannah River Site, Aiken, SC
Project No G801181002
Test Date 12/12/2018

Analysis By KCK
Checked By DLS
Reference Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

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HYDRAULIC PULSE INTERFERENCE TEST
PRE-PRB TEST SAVANNAH RIVER SITE SOURCE: 2DU RECEIVER: 1DU

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

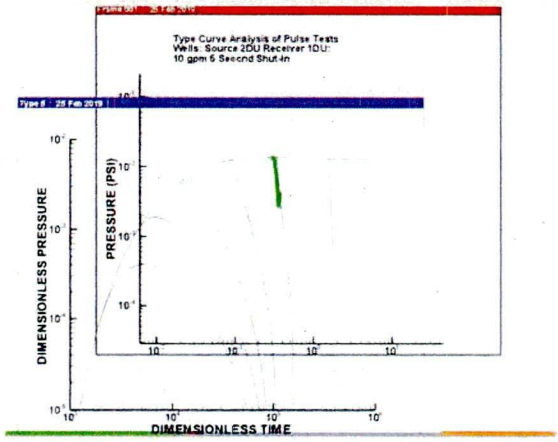
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where:
- q = flow rate
- p_D = dimensionless pressure
- r_w = well bore radius of source well
- Δp = pressure
- t = time
- t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	10.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	1.05E+02	ft/day
Δp =	0.0029	ft. of H_2O	S_s =	2.25E-05	1/ft
pD =	4.93E-04				
t =	0.09	mins			
t_D =	4538.92				



Project Name: Savannah River Site, Aiken, SC
Project No: G801181002
Test Date: 12/12/2018

Analysis By: KCK
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2019 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
PRE-PRB TEST SAVANNAH RIVER SITE SOURCE: 2DL RECEIVER: 1DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

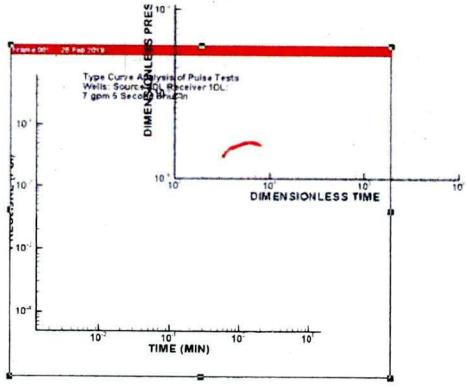
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where: q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	7.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	2.50E+00	ft/day
Δp =	0.0398	ft. of H_2O	S_s =	6.48E-06	1/ft
pD =	2.32E-04				
t =	1.60	mins			
t_D =	6440.72				



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Project No G801181002
Test Date 12/12/2018

Analysis By KCK
Checked By DLS
Reference Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2019 G801181002

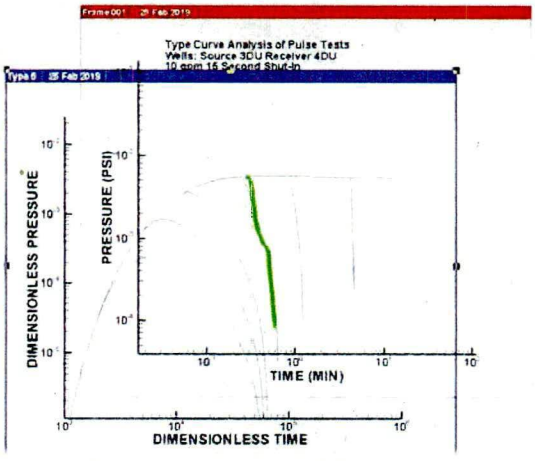
HYDRAULIC PULSE INTERFERENCE TEST
PRE-PRB TEST SAVANNAH RIVER SITE SOURCE: 3DU RECEIVER: 4DU

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$ K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$ S_s = formation specific storage

where: q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	10.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	1.29E+00	ft/day
Δp =	0.0129	ft. of H_2O	S_s =	1.20E-05	1/ft
pD =	2.72E-05				
t =	1.63	mins			
t_D =	1943.59				



Project Name: Savannah River Site, Aiken, SC
Project No: G801181002
Test Date: 12/12/2018

Analysis By: KCK
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2019 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
PRE-PRB TEST SAVANNAH RIVER SITE SOURCE: 3DL RECEIVER: 4DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

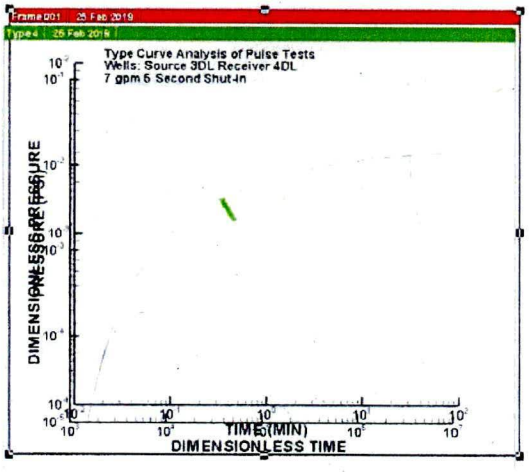
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	7.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	3.39E+00	ft/day
Δp =	0.3740	ft. of H_2O	S_s =	1.31E-09	1/ft
pD =	2.96E-03				
t =	0.0015	mins			
t_D =	42145.50				

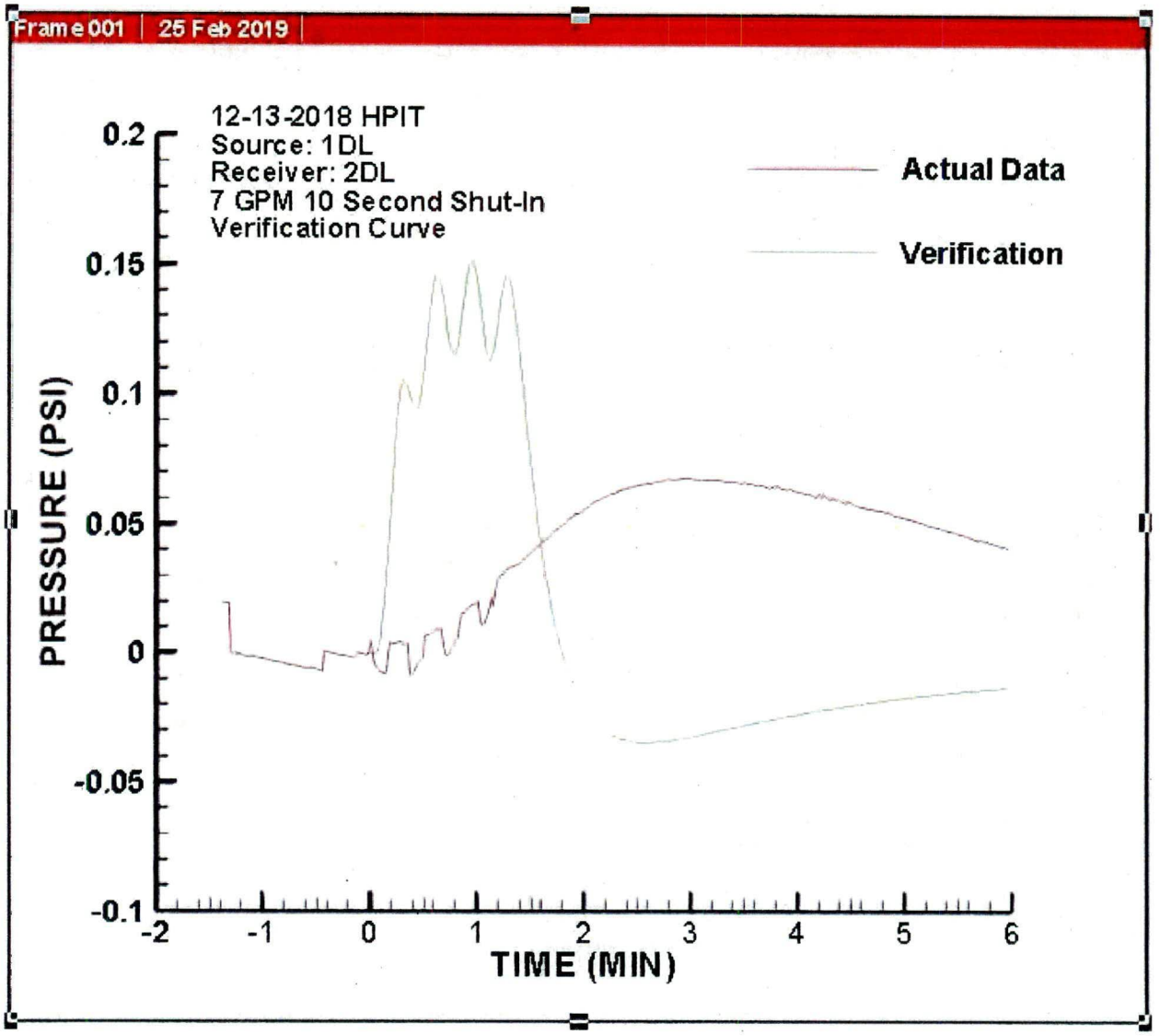


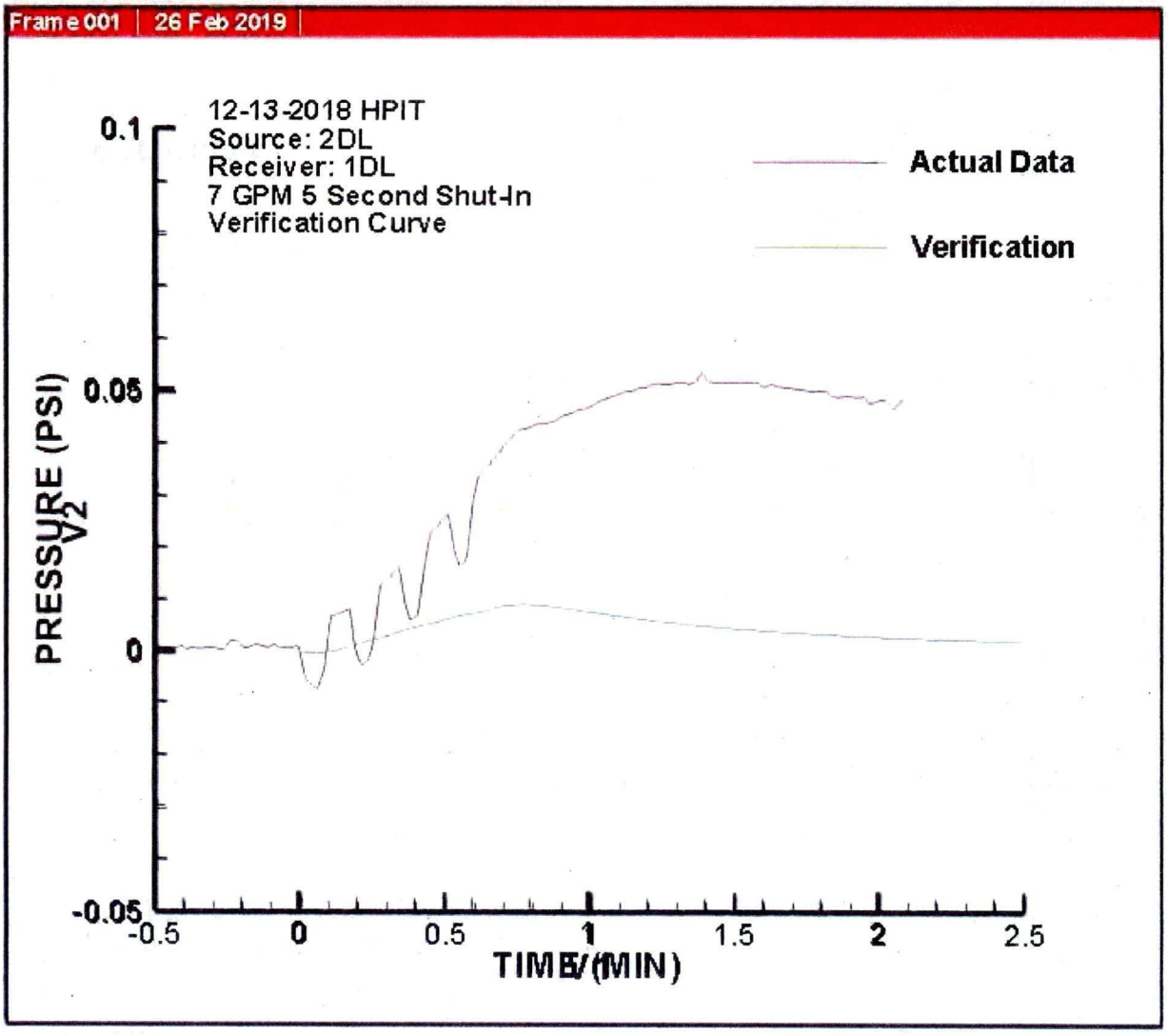
Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 12/12/2018

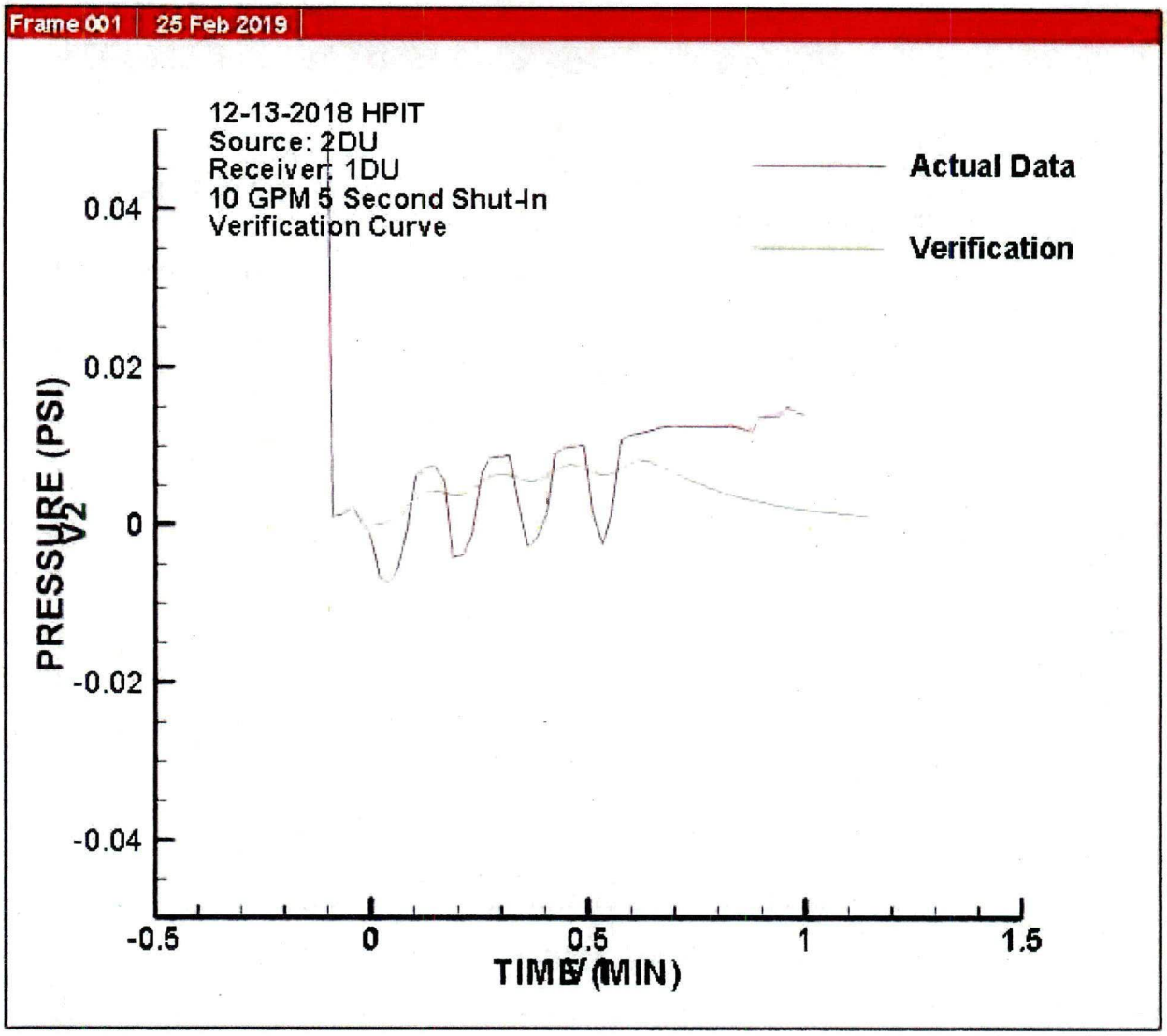
Analysis By: KCK
Checked By: DLS
Reference: Hocking (2001)

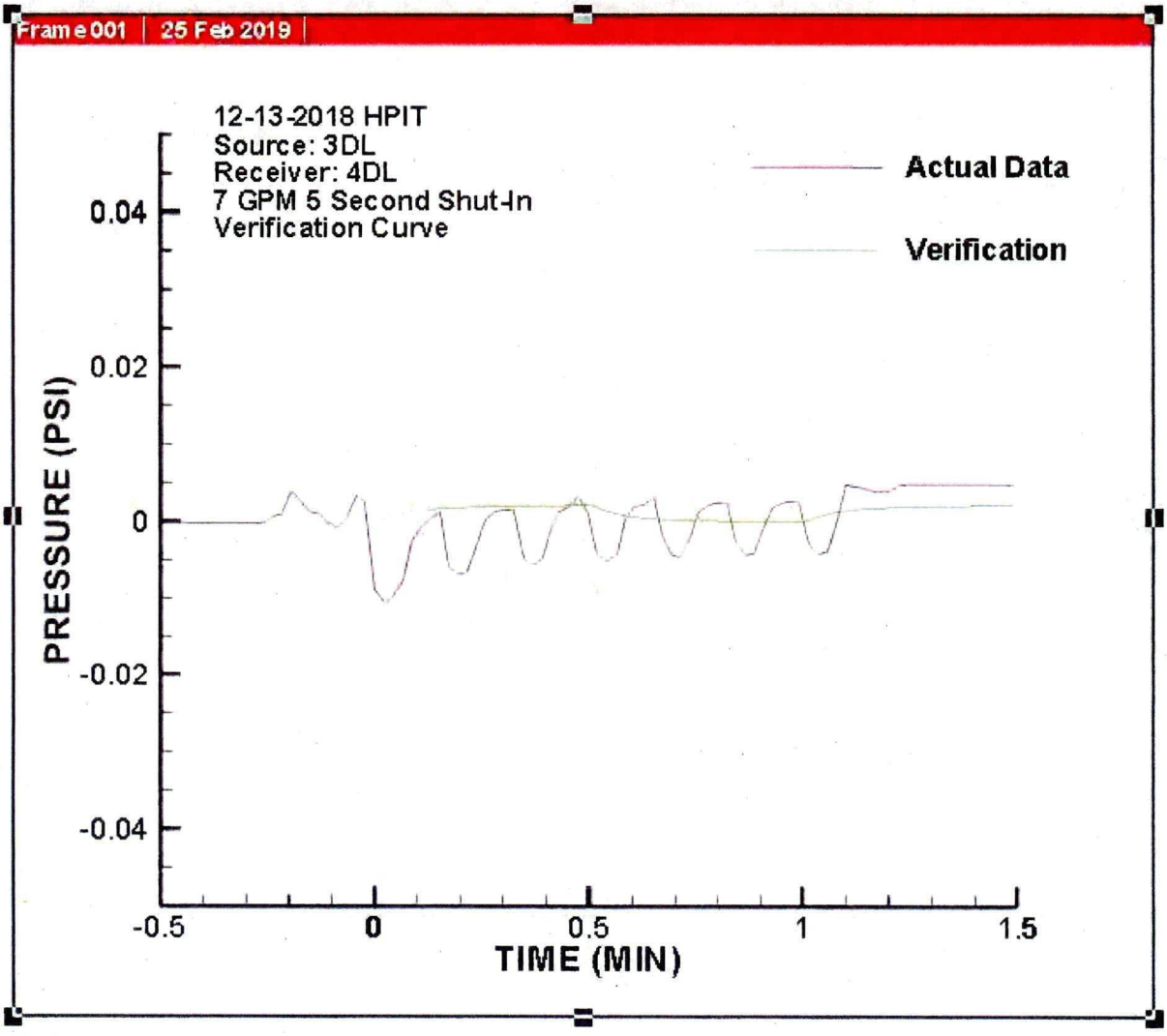
GEOSIERRA ENVIRONMENTAL

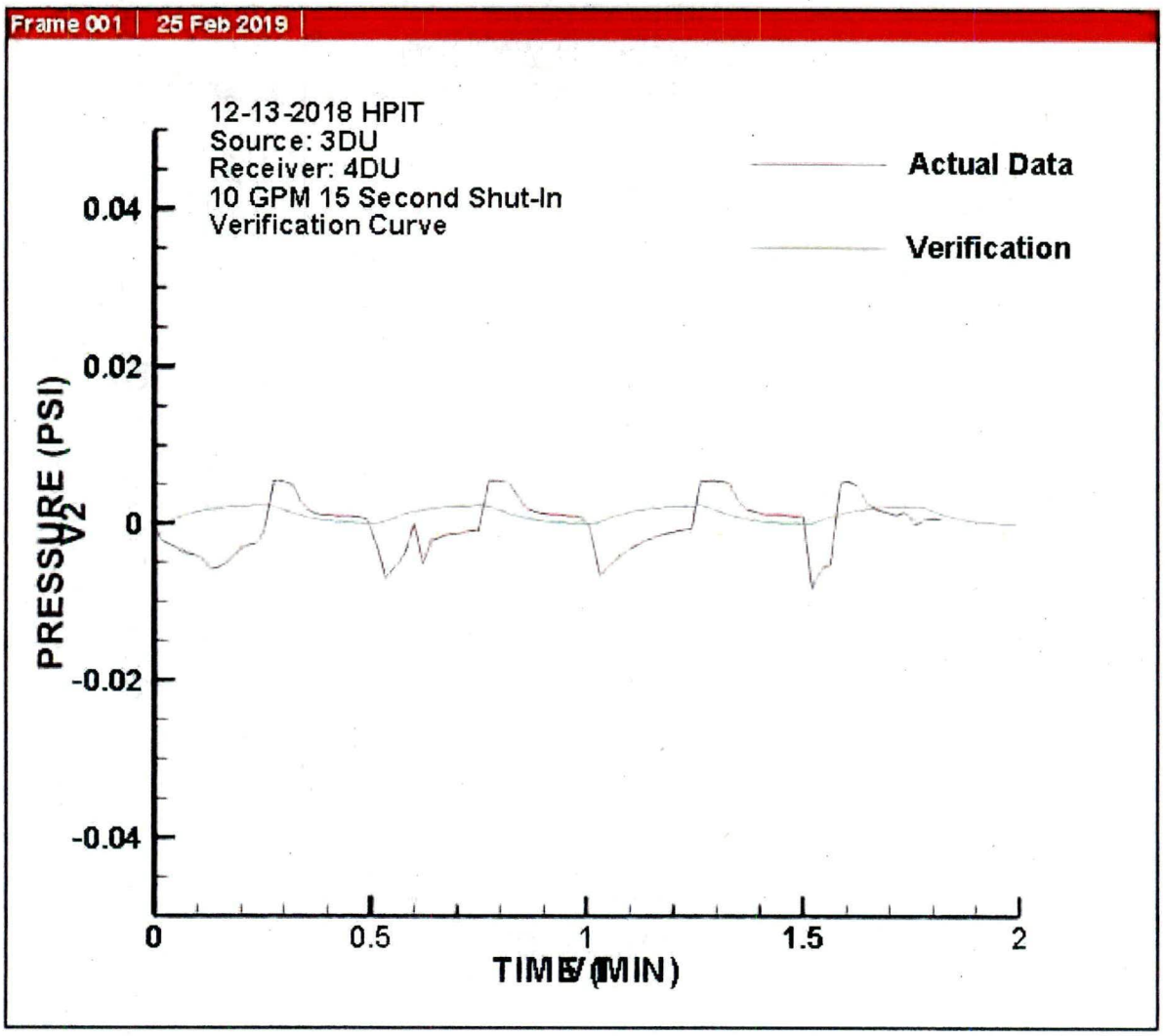
Data Calculation Sheets


Frame 001 | 25 Feb 2019
12-13-2018 HPIT
Source: 1DL
Receiver: 2DL
7 GPM 10 Second Shut-In
Verification Curve
Actual Data
Verification
PRESSURE (PSI)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-2
-1
0
1
2
3
4
5
6
TIME (MIN)

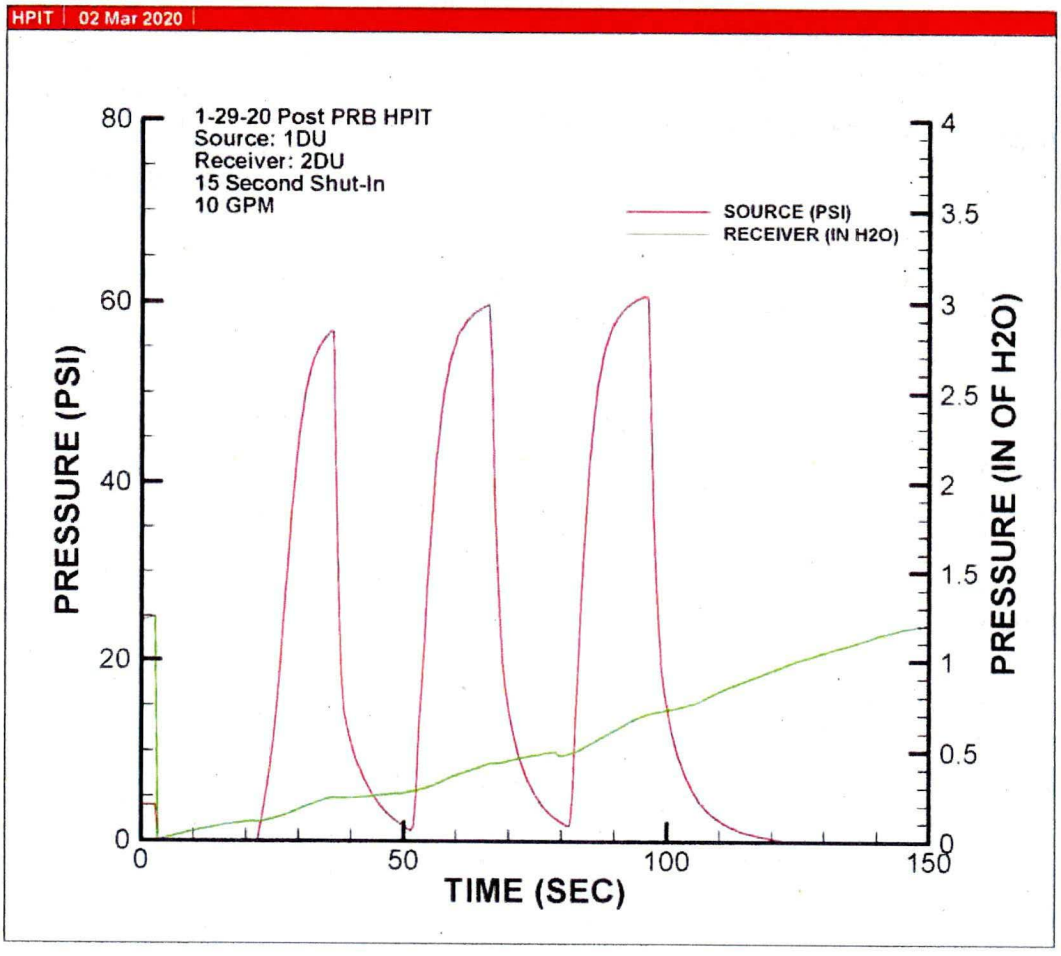

Frame 001 | 26 Feb 2019
12-13-2018 HPIT
Source: 2DL
Receiver: 1DL
7 GPM 5 Second Shut-In
Verification Curve
Actual Data
Verification
PRESSURE (PSI)
V2
0.1
0.05
0
-0.05
-0.5
0
0.5
1
1.5
2
2.5
TIME (MIN)

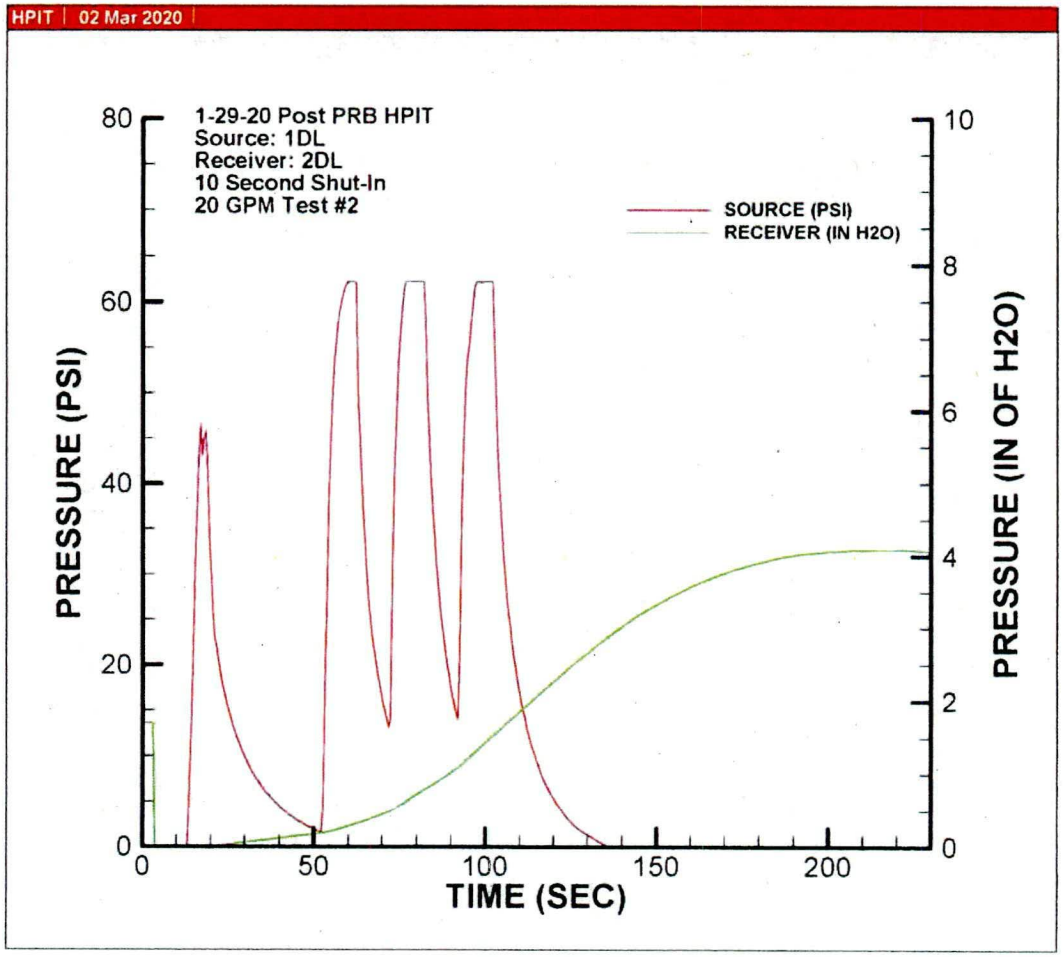

Frame 001
25 Feb 2019
12-13-2018 HPIT
Source: 2DU
Receiver: 1DU
10 GPM 5 Second Shut-In
Verification Curve
Actual Data
Verification
PRESSURE (PSI)
0.04
0.02
0
-0.02
-0.04
-0.5
0
0.5
1
1.5
TIME (MIN)

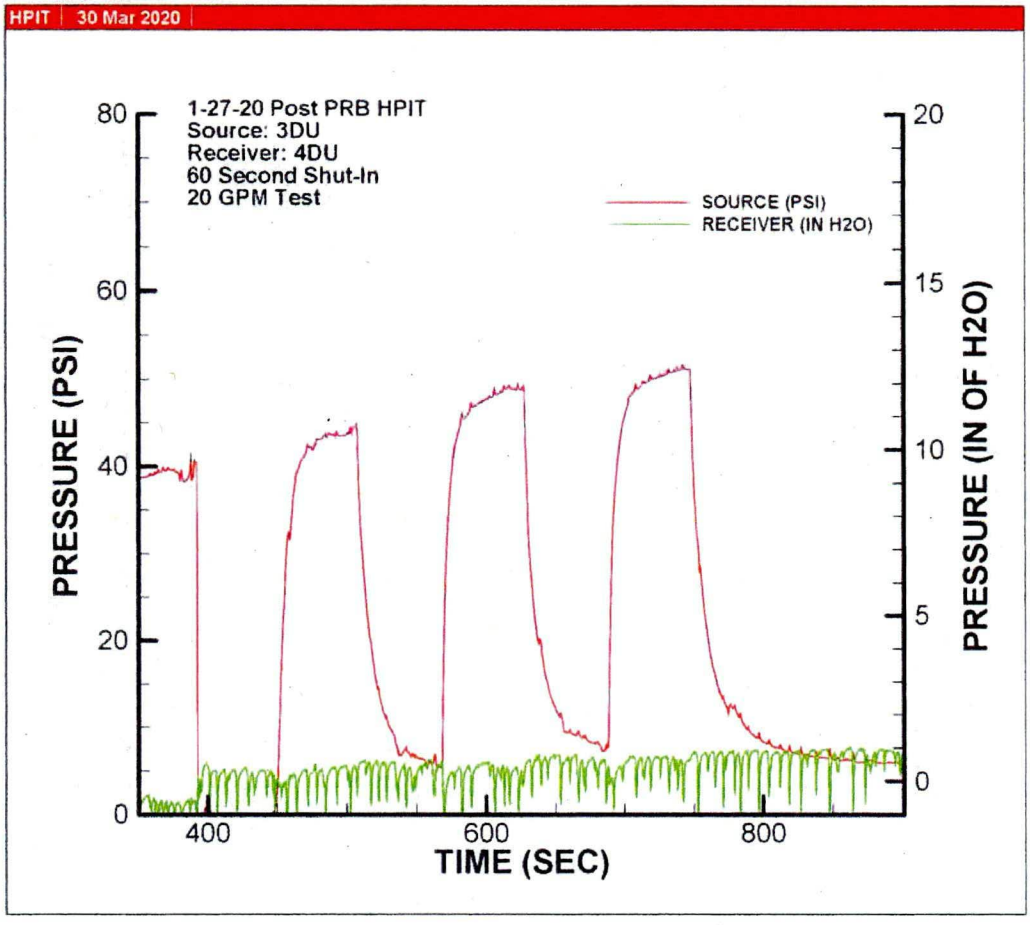

Frame 001 | 25 Feb 2019
12-13-2018 HPIT
Source: 3DL
Receiver: 4DL
7 GPM 5 Second Shut-In
Verification Curve
Actual Data
Verification
PRESSURE (PSI)
0.04
0.02
0
-0.02
-0.04
-0.5
0
0.5
1
1.5
TIME (MIN)

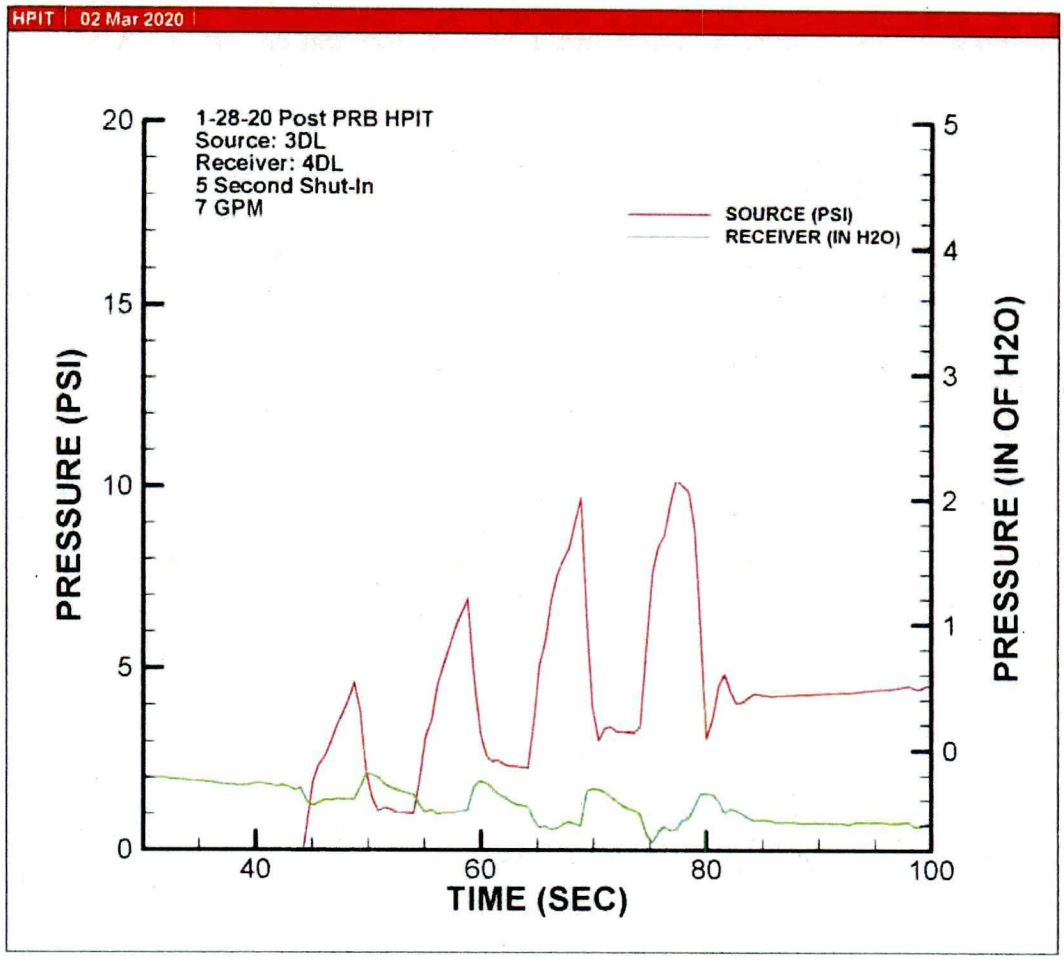

Frame 001 | 25 Feb 2019
12-13-2018 HPIT
Source: 3DU
Receiver: 4DU
10 GPM 15 Second Shut-In
Verification Curve
Actual Data
Verification
PRESSURE (PSI)
0.04
0.02
0
-0.02
-0.04
0
0.5
1
1.5
2
TIME (MIN)

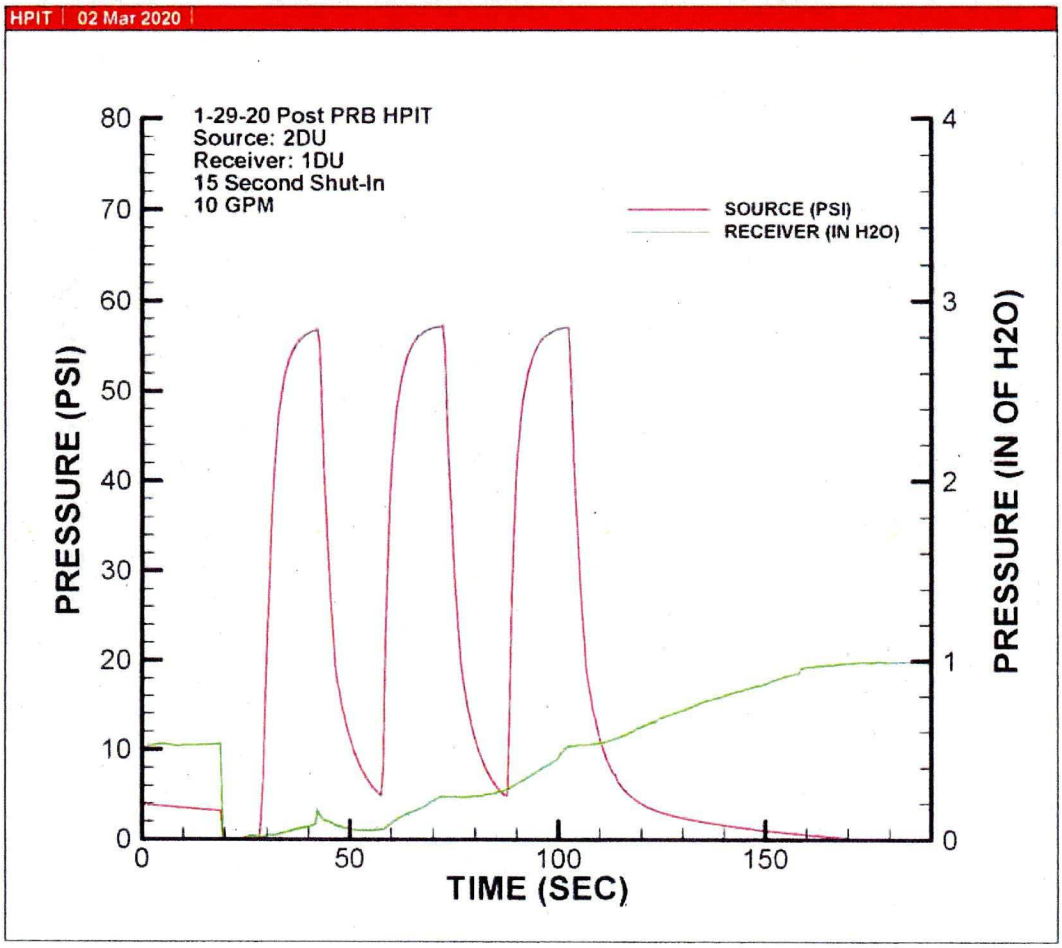
APPENDIX G.2
Post-Construction HPIT Data

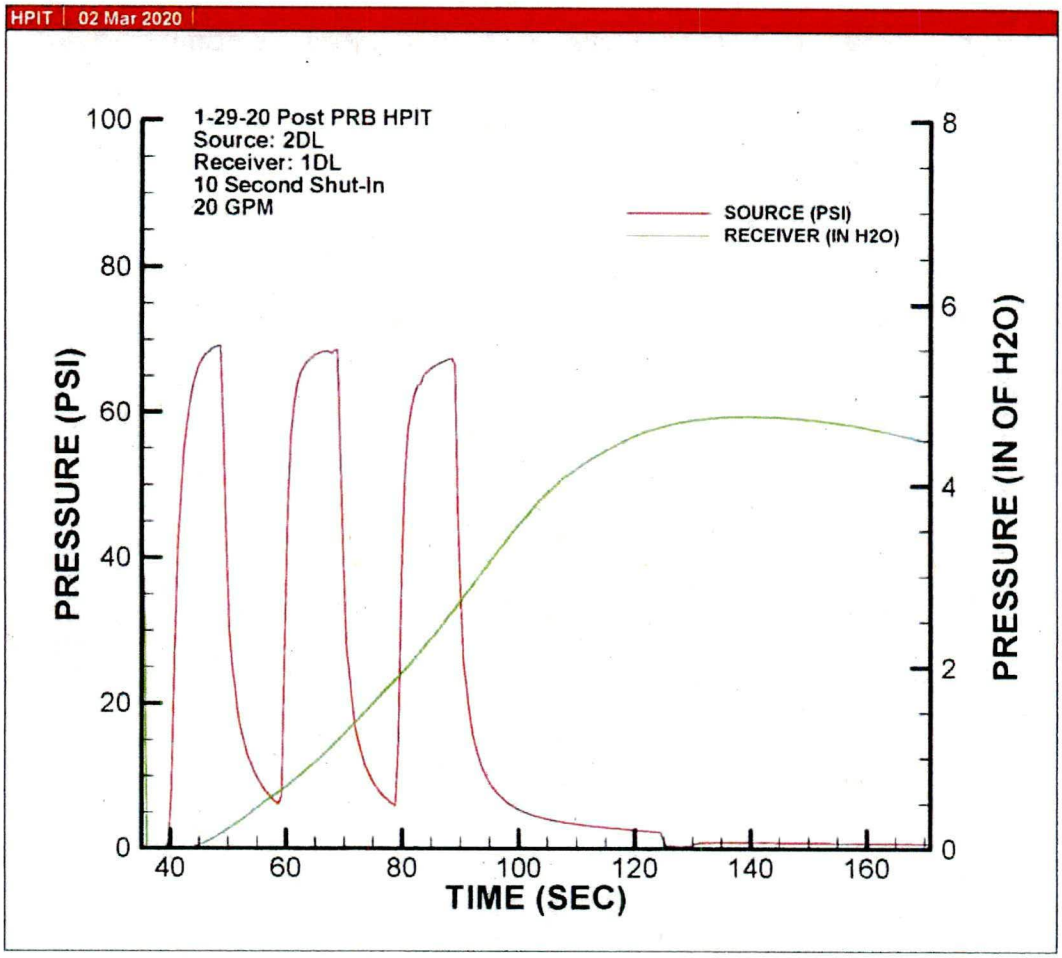


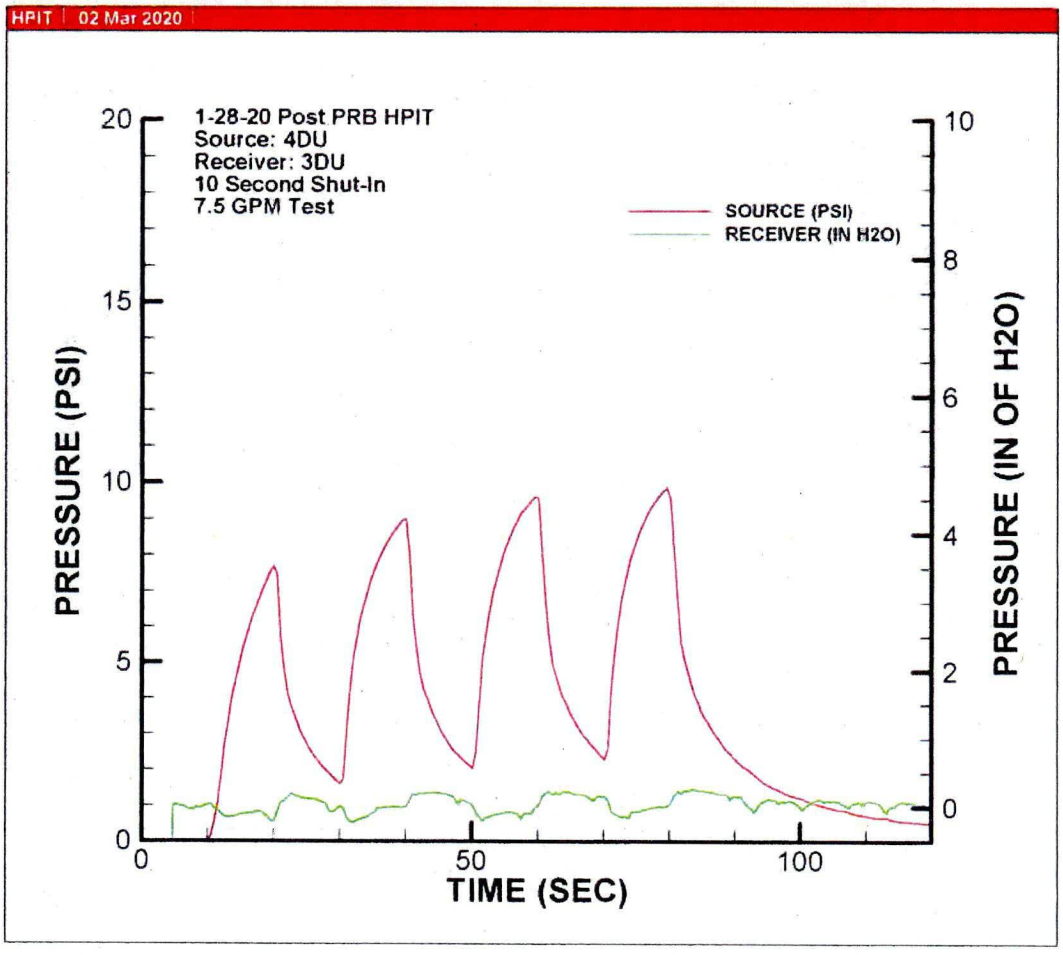

HPIT | 02 Mar 2020
1-29-20 Post PRB HPIT
Source: 1DL
Receiver: 2DL
10 Second Shut-In
20 GPM Test #2
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
20
40
60
80
0
2
4
6
8
10
0
50
100
150
200

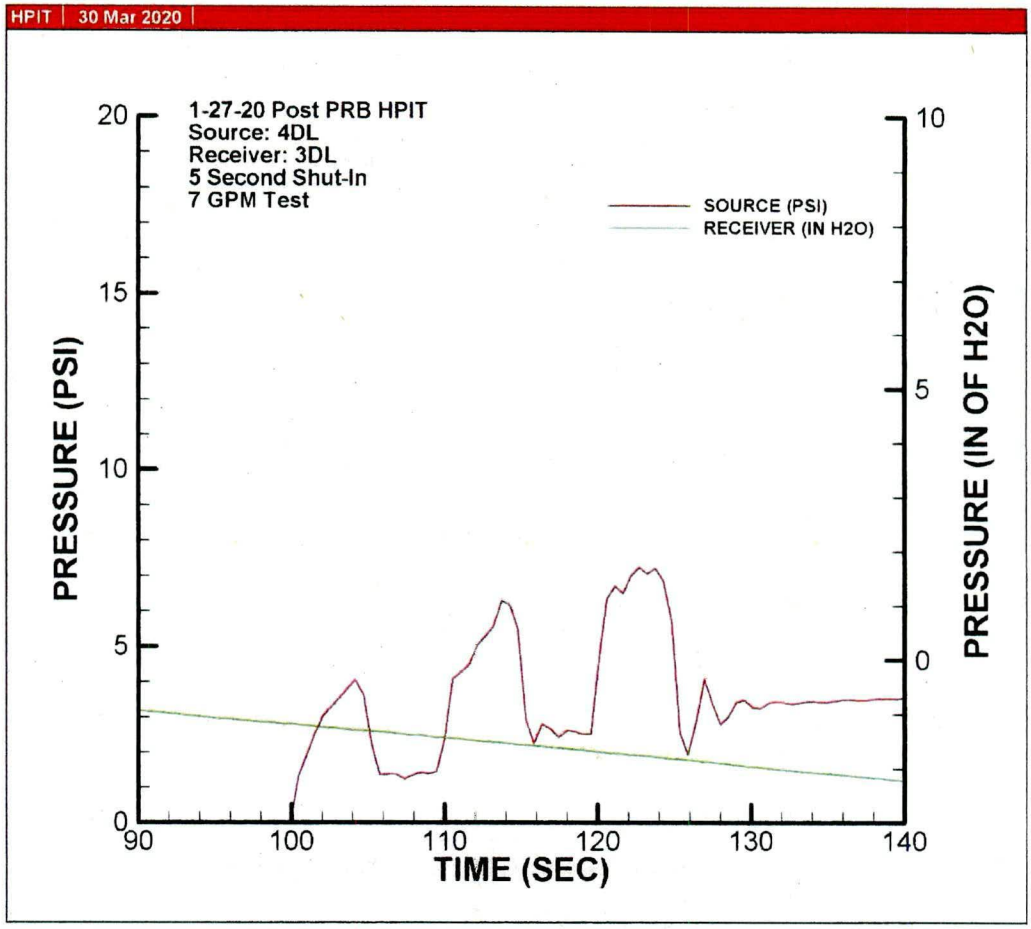

HPIT
30 Mar 2020
1-27-20 Post PRB HPIT
Source: 3DU
Receiver: 4DU
60 Second Shut-In
20 GPM Test
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
20
40
60
80
0
5
10
15
20
400
600
800


HPIT | 02 Mar 2020
1-28-20 Post PRB HPIT
Source: 3DL
Receiver: 4DL
5 Second Shut-In
7 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
0
1
2
3
4
5
40
60
80
100


HPIT | 02 Mar 2020
1-29-20 Post PRB HPIT
Source: 2DU
Receiver: 1DU
15 Second Shut-In
10 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
0
50
100
150


HPIT | 02 Mar 2020
1-29-20 Post PRB HPIT
Source: 2DL
Receiver: 1DL
10 Second Shut-In
20 GPM
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
20
40
60
80
100
0
2
4
6
8
40
60
80
100
120
140
160


HPIT 02 Mar 2020
1-28-20 Post PRB HPIT
Source: 4DU
Receiver: 3DU
10 Second Shut-In
7.5 GPM Test
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
0
2
4
6
8
10
0
50
100


HPIT | 30 Mar 2020
1-27-20 Post PRB HPIT
Source: 4DL
Receiver: 3DL
5 Second Shut-In
7 GPM Test
SOURCE (PSI)
RECEIVER (IN H2O)
PRESSURE (PSI)
PRESSURE (IN OF H2O)
TIME (SEC)
0
5
10
15
20
90
100
110
120
130
140

January 2020 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 1DU RECEIVER: 2DU

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

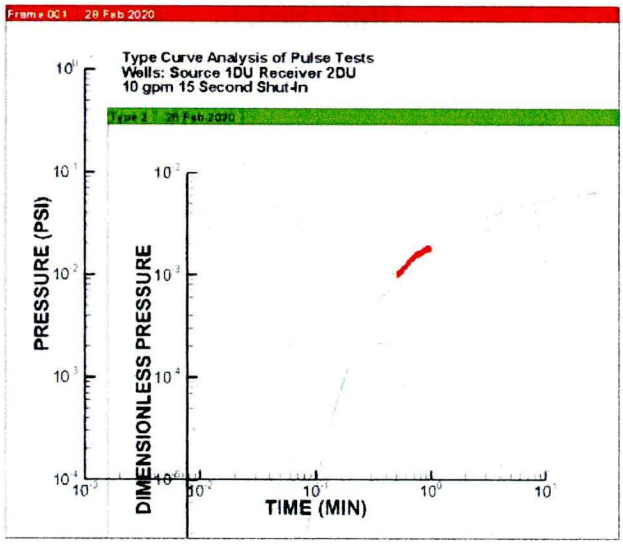
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where: q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	10.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	6.19E+01	ft/day
Δp =	0.0163	ft. of H_2O	S_s =	5.27E-05	1/ft
pD =	1.64E-03				
t =	0.82	mins			
t_D =	10704.30				



Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/29/2020

Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2020 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 1DL RECEIVER: 2DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

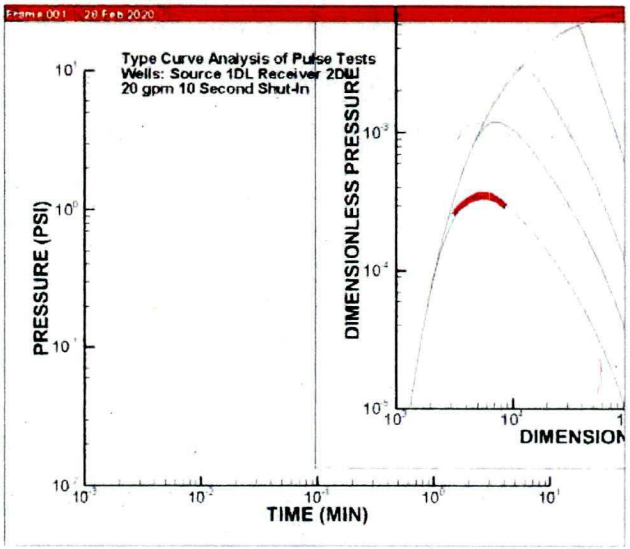
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where: q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	20.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	3.39E-01	ft/day
Δp =	1.2551	ft. of H_2O	S_s =	1.78E-06	1/ft
pD =	3.47E-04				
t =	2.61	mins			
t_D =	5523.64				



Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/29/2020

Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

January 2020 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 3DL RECEIVER: 4DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

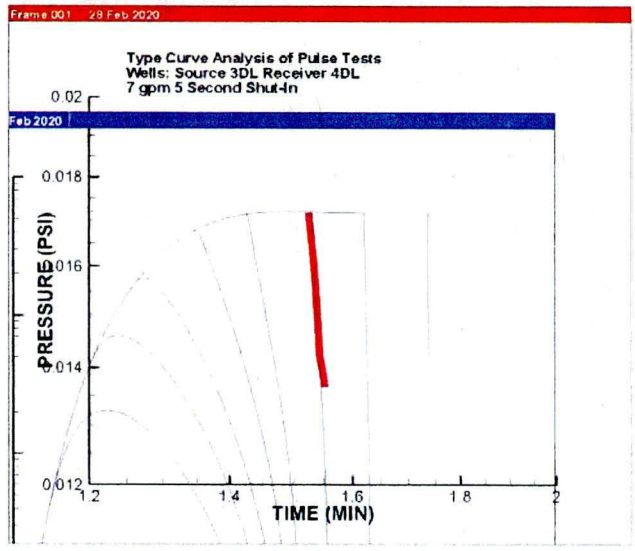
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where: q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	7.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	5.05E+01	ft/day
Δp =	0.0158	ft. of H_2O	S_s =	2.26E-06	1/ft
pD =	1.86E-03				
t =	1.54	mins			
t_D =	382052.51				



Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/28/2020

Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2020

GB01181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 2DU RECEIVER: 1DU

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

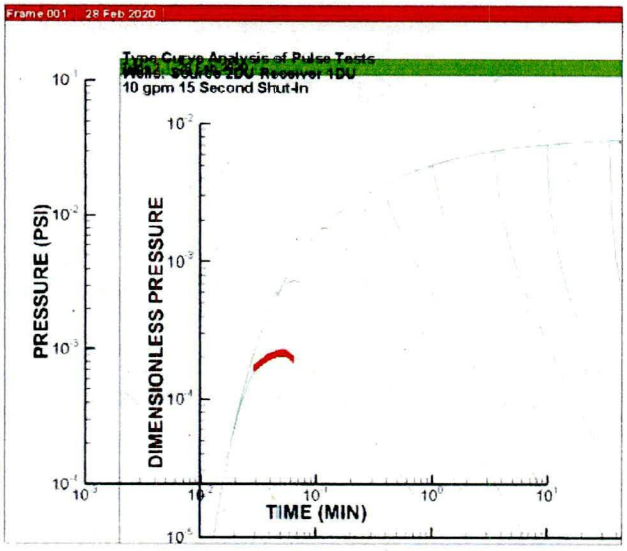
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where:
q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	10.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	4.79E+02	ft/day
Δp =	0.0009	ft. of H_2O	S_s =	3.91E-05	1/ft
pD =	7.26E-04				
t =	0.05	mins			
t_D =	7072.38				



Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/29/2020

Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2020

G801181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 2DL RECEIVER: 1DL

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

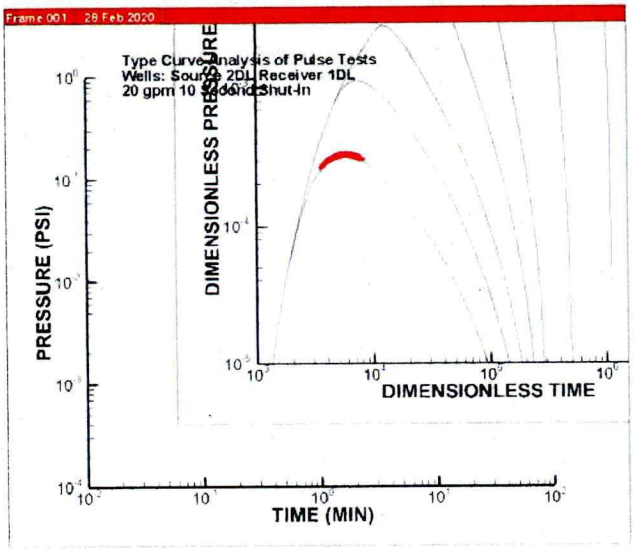
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where:
q = flow rate
p_D = dimensionless pressure
r_w = well bore radius of source well
Δp = pressure
t = time
t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	20.00	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	2.36E+00	ft/day
Δp =	0.1677	ft. of H_2O	S_s =	7.51E-06	1/ft
pD =	3.23E-04				
t =	1.51	mins			
t_D =	5288.83				



Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/29/2020

Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

GEOSIERRA ENVIRONMENTAL

Data Calculation Sheets

January 2020 G801181002

HYDRAULIC PULSE INTERFERENCE TEST
POST-PRB TEST SAVANNAH RIVER SITE SOURCE: 4DU RECEIVER: 3DU

$$K = \frac{qp_D}{4\pi r_w \Delta p}$$

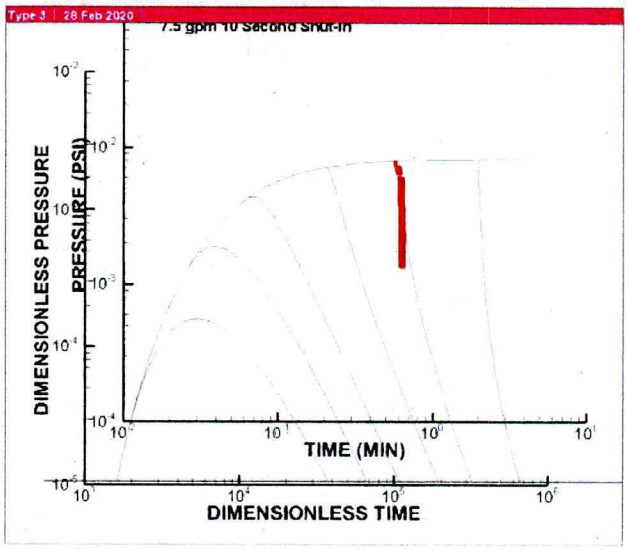
K = formation hydraulic conductivity

$$S_s = \frac{Kt}{r_w^2 t_D}$$

S_s = formation specific storage

where:
- q = flow rate
- p_D = dimensionless pressure
- r_w = well bore radius of source well
- Δp = pressure
- t = time
- t_D = dimensionless time

PULSE TEST DATA			RESULTS		
q =	7.50	gpm			
r_w =	0.25	ft			
TYPE CURVE MATCH PARAMETERS			K =	1.36E+02	ft/day
Δp =	0.0059	ft. of H_2O	S_s =	8.87E-06	1/ft
pD =	1.74E-03				
t =	0.62	mins			
t_D =	105526.86				

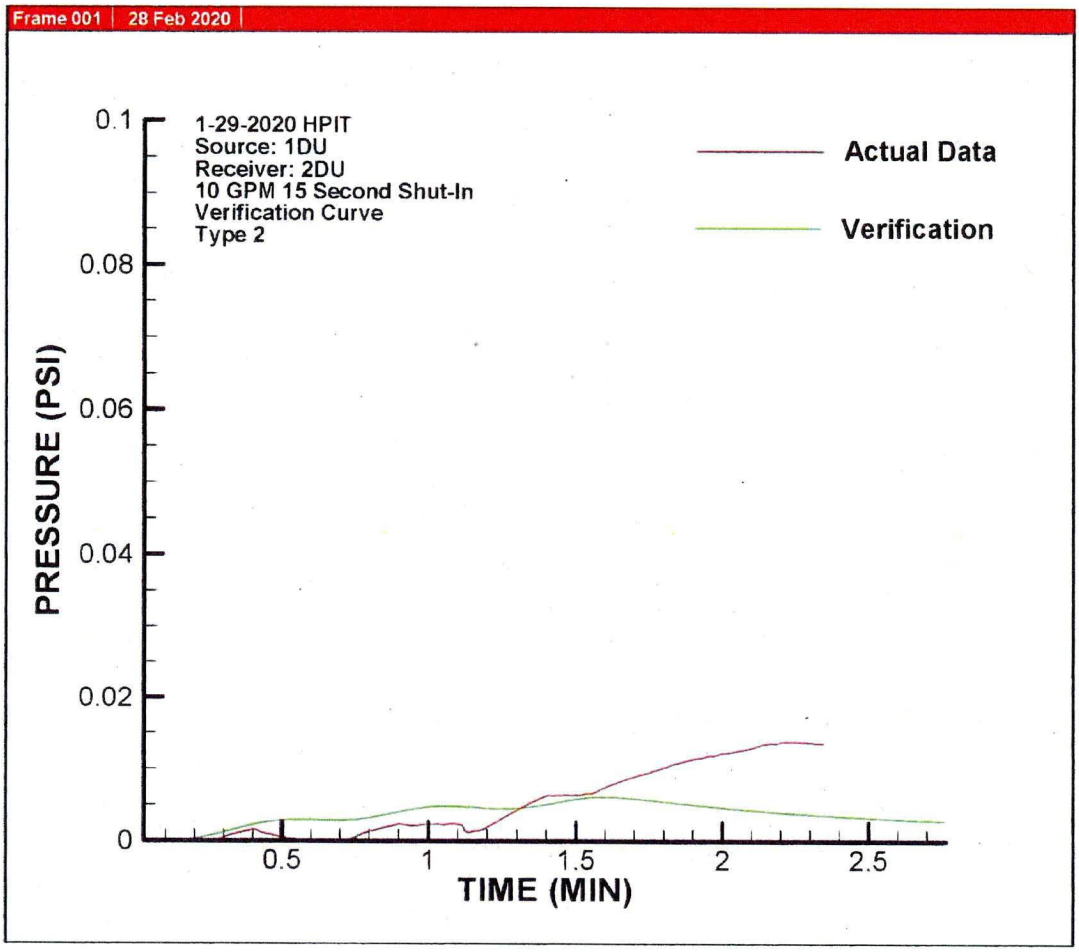


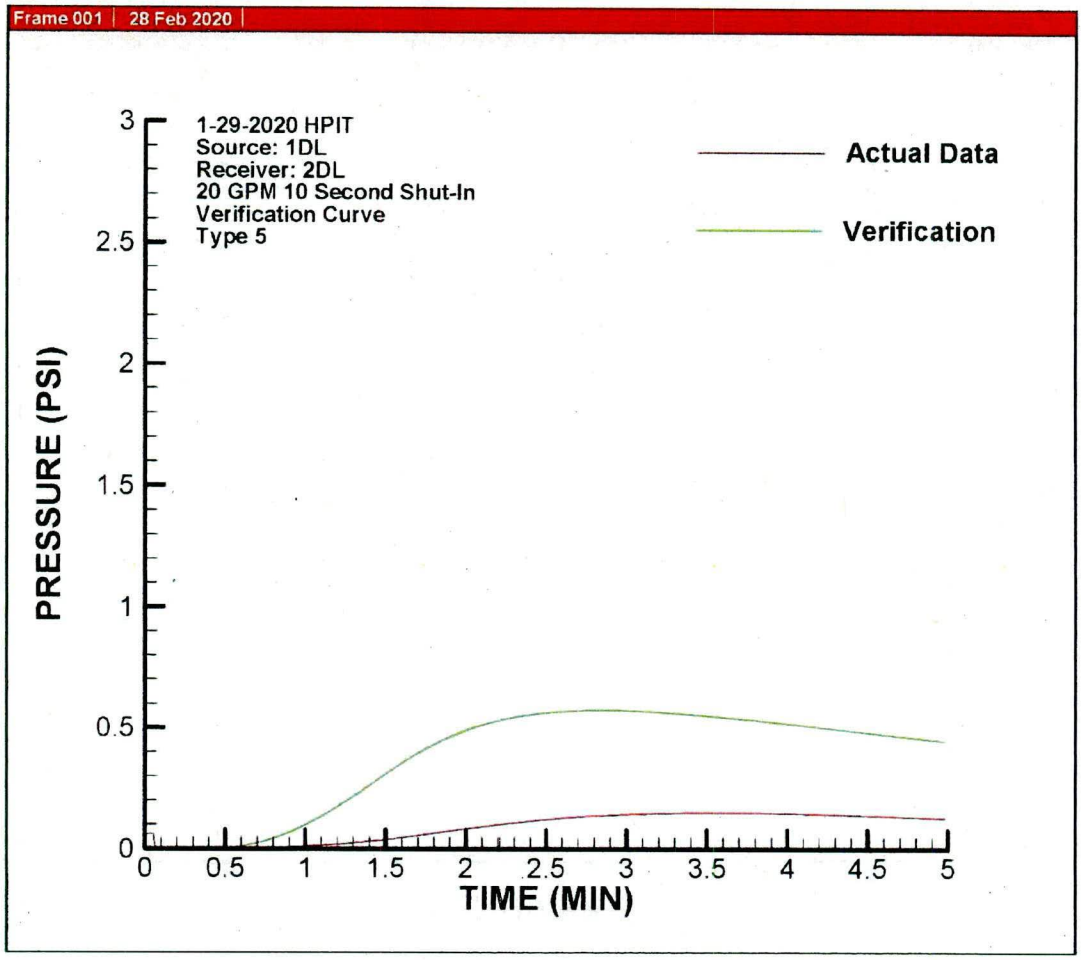
Project Name: Savannah River Site, Aiken, SC
Project No.: G801181002
Test Date: 1/28/2020

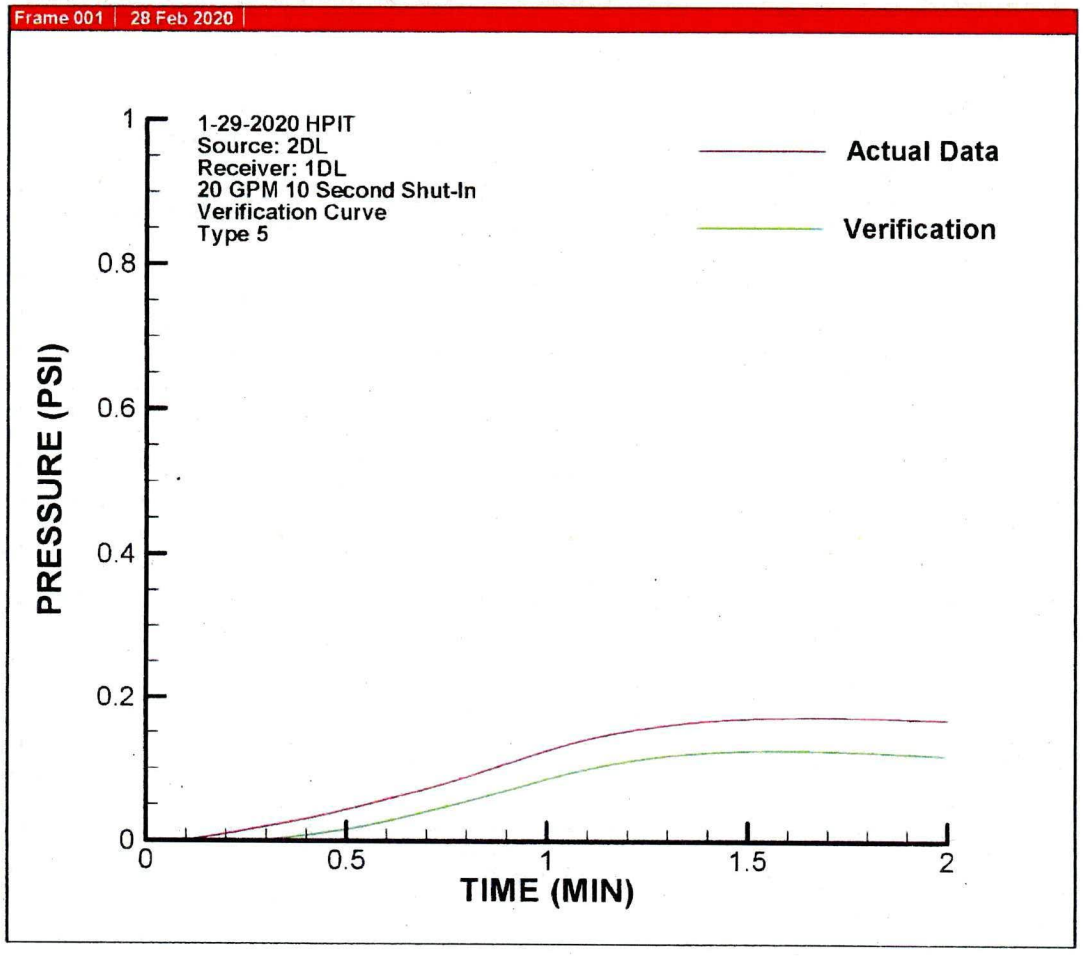
Analysis By: GSF
Checked By: DLS
Reference: Hocking (2001)

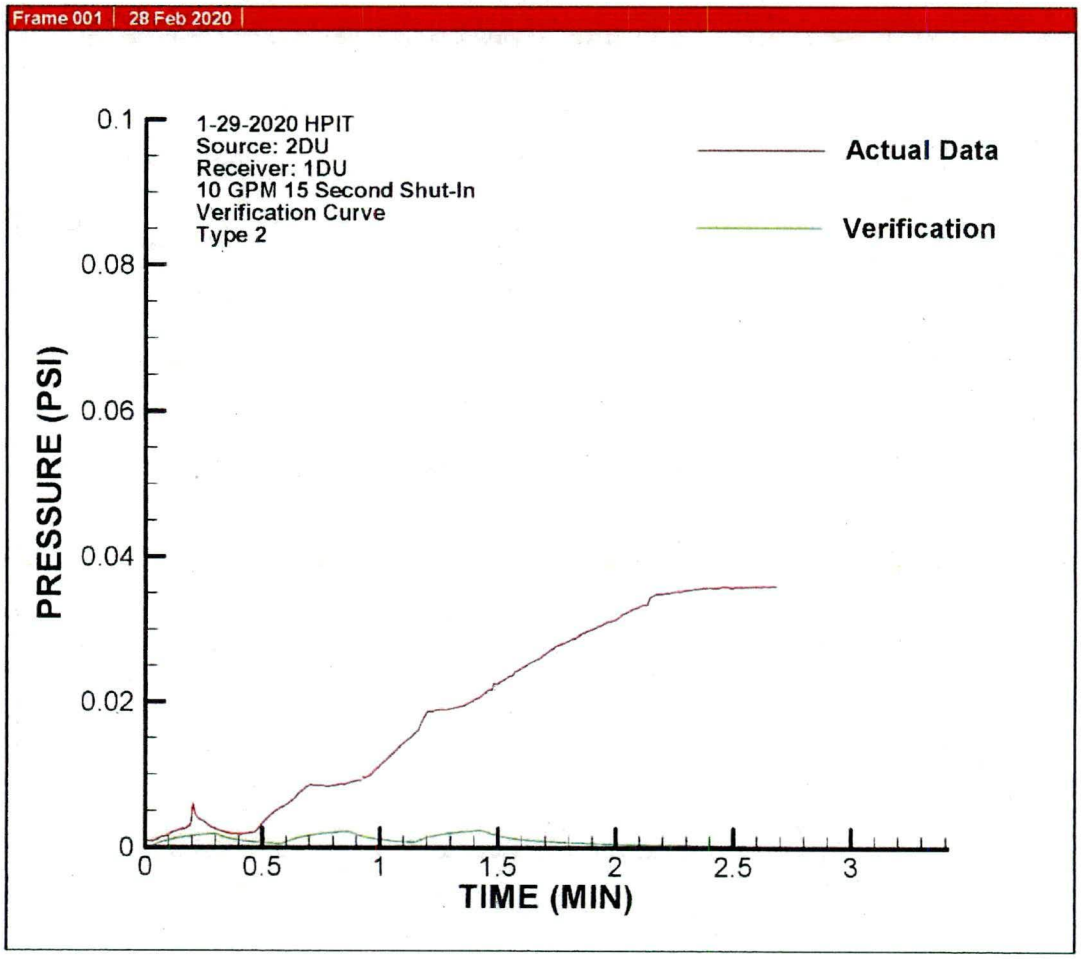
GEOSIERRA ENVIRONMENTAL

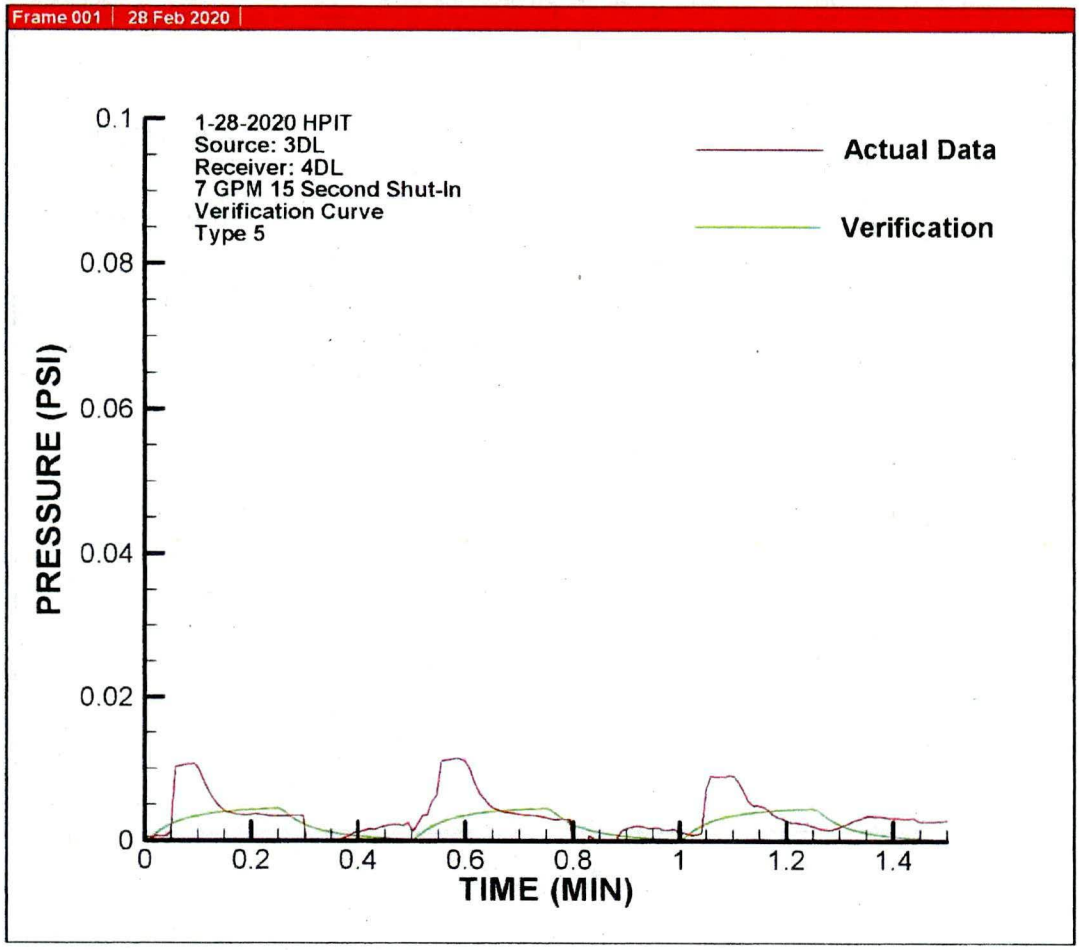
Data Calculation Sheets

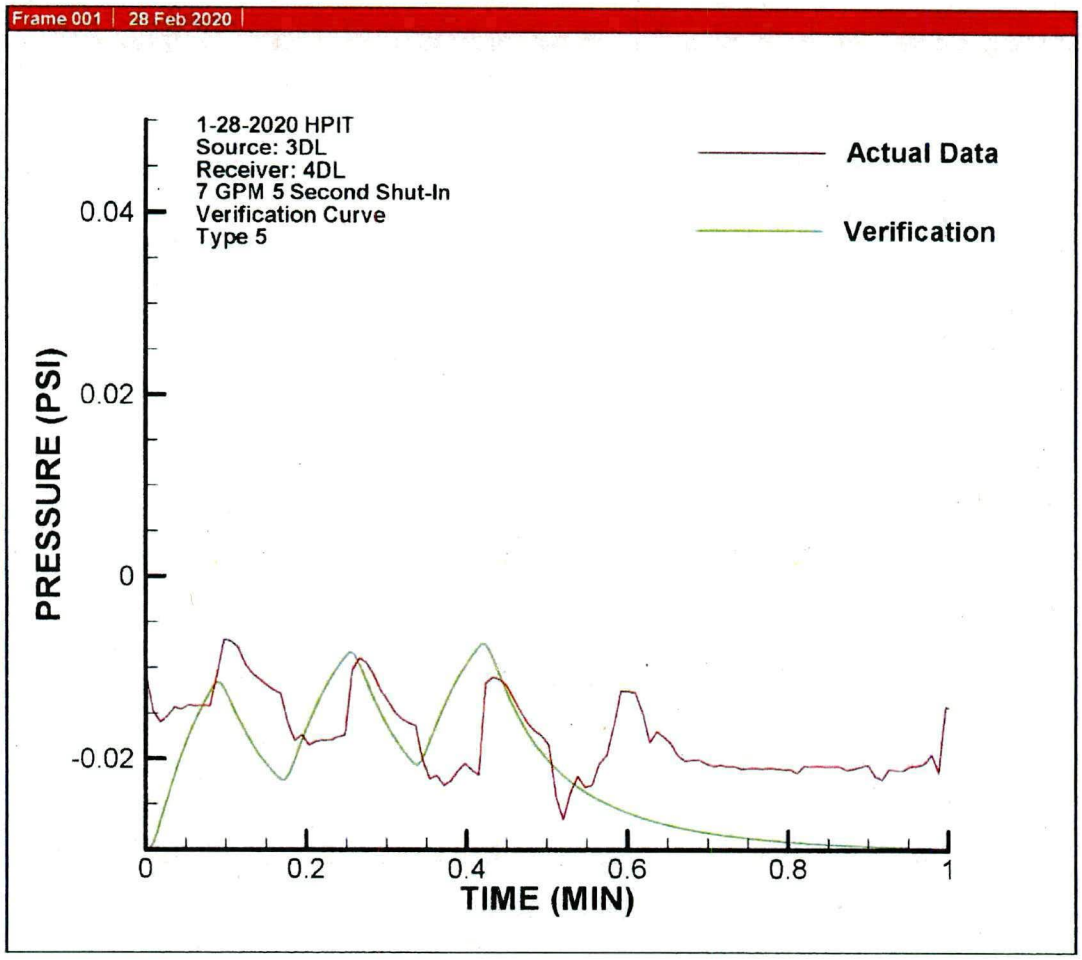

Frame 001 | 28 Feb 2020
1-29-2020 HPIT
Source: 1DU
Receiver: 2DU
10 GPM 15 Second Shut-In
Verification Curve
Type 2
Actual Data
Verification
PRESSURE (PSI)
0.1
0.08
0.06
0.04
0.02
0
0.5
1
1.5
2
2.5
TIME (MIN)

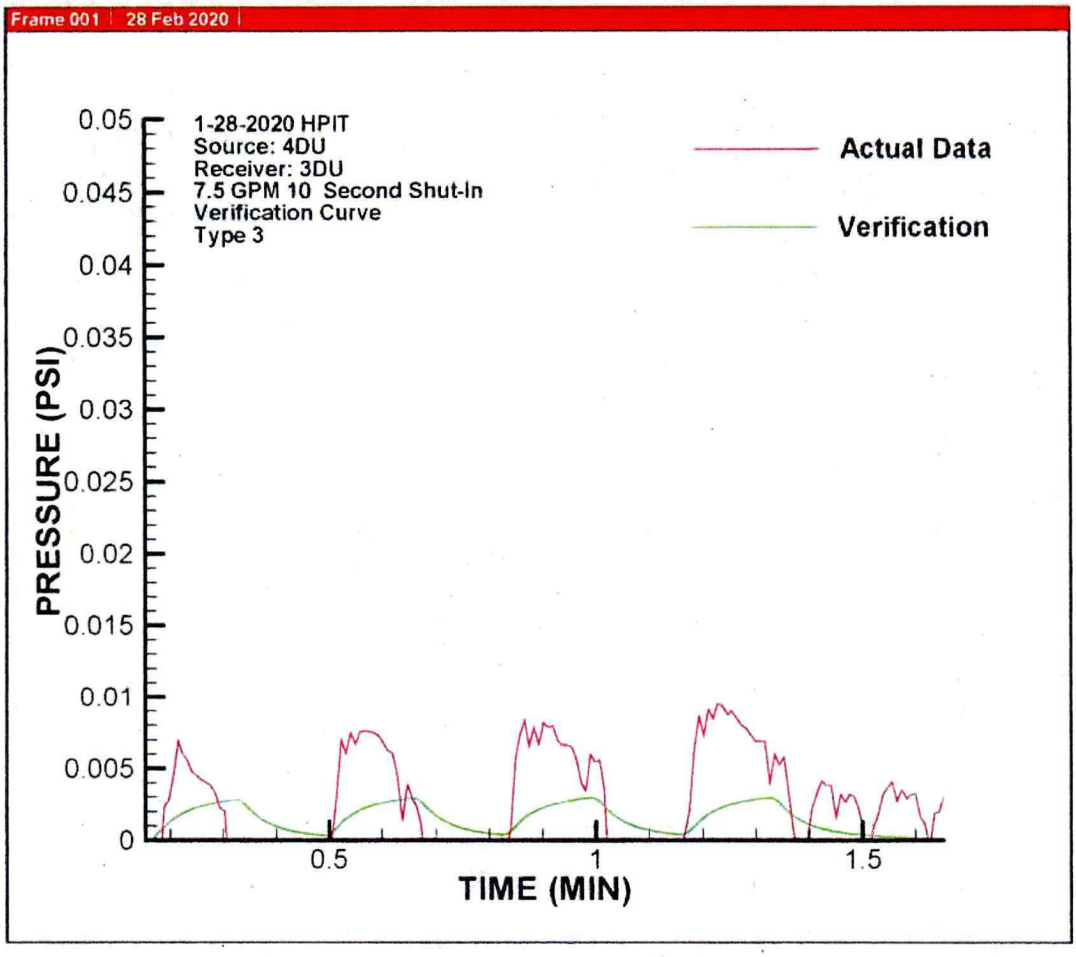

Frame 001 | 28 Feb 2020
1-29-2020 HPIT
Source: 1DL
Receiver: 2DL
20 GPM 10 Second Shut-In
Verification Curve
Type 5
Actual Data
Verification
PRESSURE (PSI)
TIME (MIN)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


Frame 001 | 28 Feb 2020
1-29-2020 HPIT
Source: 2DL
Receiver: 1DL
20 GPM 10 Second Shut-In
Verification Curve
Type 5
Actual Data
Verification
PRESSURE (PSI)
TIME (MIN)
0
0.2
0.4
0.6
0.8
1
0
0.5
1
1.5
2


Frame 001 | 28 Feb 2020
1-29-2020 HPIT
Source: 2DU
Receiver: 1DU
10 GPM 15 Second Shut-In
Verification Curve
Type 2
Actual Data
Verification
PRESSURE (PSI)
0.1
0.08
0.06
0.04
0.02
0
0
0.5
1
1.5
2
2.5
3
TIME (MIN)


Frame 001 | 28 Feb 2020
1-28-2020 HPIT
Source: 3DL
Receiver: 4DL
7 GPM 15 Second Shut-In
Verification Curve
Type 5
Actual Data
Verification
PRESSURE (PSI)
0.1
0.08
0.06
0.04
0.02
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
TIME (MIN)


Frame 001 | 28 Feb 2020 |
1-28-2020 HPIT
Source: 3DL
Receiver: 4DL
7 GPM 5 Second Shut-In
Verification Curve
Type 5
Actual Data
Verification
PRESSURE (PSI)
0.04
0.02
0
-0.02
0
0.2
0.4
0.6
0.8
1
TIME (MIN)


Frame 001 | 28 Feb 2020
1-28-2020 HPIT
Source: 4DU
Receiver: 3DU
7.5 GPM 10 Second Shut-In
Verification Curve
Type 3
Actual Data
Verification
PRESSURE (PSI)
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.5
1
1.5
TIME (MIN)

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