APPENDIX 2BB

AQUIFER PUMPING TEST RESULTS

APPENDIX 2BB TABLE OF CONTENTS

APPENDIX 2BB LIST OF TABLES

APPENDIX 2BB LIST OF FIGURES

APPENDIX 2BB LIST OF ATTACHMENTS

1.0 PURPOSE

This appendix provides the interpretation of aquifer pumping tests performed adjacent to the locations of the Units 6 & 7 reactor buildings (Figure 2BB-201). The aquifer pumping tests were performed to provide hydrogeologic properties of the subsurface materials for construction dewatering system design, groundwater flow model support, the analysis of postulated accidental releases of radioactive liquid effluents, and to support simulation of radial collector well operation.

2.0 BACKGROUND HYDROGEOLOGY

The Units 6 & 7 subsurface investigation (Reference 1) identified five subsurface units at the plant area:

- Muck — organic calcareous silt
- Miami Formation — oolitic limestone
- Fort Thompson Formation — coralline to sandy limestone
- Tamiami Formation — poorly graded silty sand with interlayered clayey sand, silt, and clay
- Hawthorn Group — poorly graded silty sand grading to dolostone and limestone

Subsequent data interpretation divided the Fort Thompson Formation into two units, with the coralline portion being assigned as the Key Largo Limestone and the sandy limestone being assigned as the Fort Thompson Formation. This interpretation also identified a thin layer of freshwater limestone at the top of the Fort Thompson Formation. This freshwater limestone appears to have much lower porosity and permeability than the overlying Key Largo Limestone and the underlying marine limestone of the Fort Thompson Formation.

The primary aquifer in the vicinity of the Turkey Point plant property is the Biscayne aquifer, which is the main water supply source for Miami-Dade County. The Biscayne aquifer in the area of Units 6 & 7 contains saline to saltwater and is not usable as a potable water supply.

The Biscayne aquifer comprises all or parts of the Pliocene through Holocene-aged upper Tamiami Formation, Fort Thompson Formation, Key Largo Limestone, Miami Limestone (oolite), and surficial deposits. Regional transmissivities from aquifer testing of this aquifer range from 2700 square feet per day (20,196 gallons per day per foot) to greater than 1,000,000 square feet per day (7,480,000 gallons per day per foot) (Reference 2).

Dames & Moore (Reference 3) conducted a hydrogeologic investigation adjacent to the plant area, which included three aquifer pumping tests, and determined the following properties:

Formation	Transmissivity		Storage Coefficient*
	gpd/ft	ft^2/d	
Muck and Miami Oolite	20,000	2,700	0.35
Fort Thompson Formation (void zone)	3,000,000	400,000	0.35
Fort Thompson Formation (lower zone)	1,000,000	134,000	0.20

*Reported as storage coefficient but most probably represents specific yield

3.0 CONCEPTUAL MODEL

The conceptual model for the Biscayne aquifer beneath the Units 6 & 7 plant area is shown on Figure 2BB-202. This conceptual model was created using geologic and hydrogeologic information obtained from the geotechnical investigation of the site (Reference 1) and then refined with additional information from the aquifer pumping tests program. Two test zones were identified for the testing program: the upper zone, which is located in the Key Largo Limestone, and the lower zone, which is located in the Fort Thompson Formation.

The muck and Miami Limestone units are interpreted to have a lower hydraulic conductivity than the underlying Key Largo Limestone. The freshwater limestone layer is interpreted to have a lower hydraulic conductivity than either the overlying Key Largo Limestone or the underlying Fort Thompson Formation. The Tamiami Formation is also interpreted to have a lower hydraulic conductivity than the overlying Fort Thompson Formation. Thus, the Miami Limestone, freshwater limestone, and Tamiami Formation are treated as aquitards in the subsurface.

4.0 METHODOLOGY

4.1 Test Configuration

The aquifer testing program consisted of performing two aquifer pumping tests adjacent to the location of each reactor containment. The pumping wells at Unit 6 were designated PW-6U and PW-6L and at Unit 7 were designated PW-7U and PW-7L. The U/L suffix was used to indicate pumping in either the upper or lower test zone as described in Section 3.0. For each test group, a total of 25 observation wells were installed in five groups of five wells. Each observation well is numbered using the convention CX-#$ where:

X = reactor unit (6 or 7)

= number indicating well position

1 = approximately 10 feet east of upper zone pumping well

2 = approximately 10 feet north of upper zone pumping well

3 = approximately 25 feet north of upper zone pumping well

4 = approximately 40 feet north of upper zone pumping well

5 = approximately 10 feet east of lower zone pumping well

$ = alphabetic character designating the well monitoring zone

A = Miami Limestone

B = Freshwater limestone

C = Tamiami Formation

D = Upper test zone (Key Largo Limestone)

E = Lower test zone (Fort Thompson Formation)

Figures 2BB-203 and 2BB-204 present location plans for the two test groups and Figure 2.4.12-239 shows the general location of the tests. Table 2BB-201 presents the well construction information for the pumping and observation wells.

4.2 Data Collection and Pre-Processing

Groundwater level data were collected using In-Situ, Inc. Level TROLL® or Aqua TROLL® recording pressure transducers. Three data sets were collected during each test:

- Background groundwater levels — to allow assessment of tidal influences
- Pumping levels — to measure drawdown in response to pumping the test well

- Recovery levels — to measure water level recovery after the pumping test stopped

The background levels were recorded on a linear logging interval of every five minutes. The pumping and recovery levels were either recorded on a logarithmic interval starting at 0.251 seconds and increasing as the test progressed, on a linear interval starting at 0.25 seconds for the first five minutes and then increasing to 30 seconds for the remainder of the test, or on a linear interval starting at 1 minute.

The raw water level data were pre-processed to remove tidal effects by using data from background observation wells. The corrections included the following assumptions:

- The first five minutes of the pumping or recovery periods in each observation well were not corrected due to the rapid response to pumping or recovery and relatively slow tidal response.
- One background well cluster (A, B, C, D, and E) was used to correct the observation well data for each test, due to the limited spatial extent of the well array.

The tidal correction was made using the following procedure:

1. Plot the water level change between successive readings in the observation well (ΔW) versus the changes in the background well (ΔR) during the background data collection period prior to the test and determine the tidal efficiency by linear regression. The tidal efficiency is the slope of the fitted line.
2. Determine the water level changes between successive readings in the background well during the pumping and recovery periods of the test.
3. Compute the correction factor at time t by multiplying tidal efficiency (step 1) by the water level change (step 2) and adding the previous correction factor (at start of test, correction factor = 0).
4. Subtract the correction factor from the water level at time t in the observation well to obtain the corrected water level.

5. Determine the drawdown/residual drawdown from the test by subtracting the corrected water level from the static water level (at time of test start) in the observation well.

Water level recovery data was truncated at the point where the static level was encountered (zero drawdown). The raw data may have up to several thousand readings after this point, which are not germane to the test interpretation.

4.3 Data Assessment

Data assessment was conducted for each test to evaluate the pumping rate and water level measurements collected during the test.

The acceptance criteria for the pumping rate measurements were: 1) the manual and electronic flow measurements show reasonable agreement; 2) the short term discharge did not vary more than 10 percent about the mean discharge (Reference 4); and 3) the pumping rate is between 3000 and 12,000 gallons per minute (gpm), which is the calibrated range of the flowmeter.

The acceptance criteria for water level measurements were: 1) comparison of the rate of water level change to the transducer recording interval. When a major change occurs over a single recording time interval, followed by no change in the successive time interval, the recording interval is insufficient to characterize the change, 2) water level responses are consistent between wells screened in the same zone but at different distances from the pumped well and between different monitoring zones in the same well cluster.

4.4 Data Interpretation

The aquifer pumping test results were interpreted using the AQTESOLV™ (Reference 5) computer program. This program contains solution options for different hydrogeologic conditions such as unconfined, confined, and leaky conditions.

Based on the conceptual model described above and the objectives of the test to determine the properties of the aquifers and aquitards at the site, various aquifer test solution methods were evaluated to select the most appropriate method. The test methods included:

- Neuman solution for unconfined aquifer (gravity drainage)
- Theis solution for confined aquifer

- Neuman-Witherspoon solution for leaky aquifer
- Hantush solution for leaky aquifer with aquitard storage

The test results were examined using these methods and it was found that the data did not show significant gravity drainage effects over the testing period, suggesting the pumped aquifer behaves similarly to a confined aquifer. The Neuman and Theis solutions provide information only on the properties of the pumped aquifer. The Neuman-Witherspoon method includes an assumption that the pumped aquifer is bounded on one side by a leaky aquitard and on the other side by an impermeable aquiclude. This situation does not match the conceptual model for the site or the actual field conditions encountered during well installation for the tests. The Hantush solution includes an assumption that the pumped aquifer is bounded on both sides by leaky aquitards. This condition matches the conceptualization of the site and actual conditions observed during well installations. The Theis solution was also retained as a means to determine the upper bound of transmissivity in the pumped aquifer, since this method ignores leakage or gravity drainage effects.

The two interpretation methods selected and used were: the Theis method (Reference 5) and the Hantush leaky aquifer with aquitard storage method (References 5 and 6). The Hantush leaky method with aquitard storage was used to evaluate the distance-drawdown and time-drawdown relationships in the pumping zone observation wells ("D" or "E" series wells).

The physical system represented by the Theis method is shown on Figure 2BB-205.

The method includes the following assumptions:

- Aquifer has infinite areal extent
- Aquifer is homogeneous and of uniform thickness
- Pumping well is fully or partially penetrating
- Flow to pumping well is horizontal when pumping well is fully penetrating
- Aquifer is confined above and below by aquicludes
- Flow is unsteady

- Water is released instantaneously from storage with decline of hydraulic head
- Diameter of pumping well is very small so that storage in the well can be neglected

The equations for representing drawdown (s) for a confined aquifer are (Reference 5):

$$s = \frac{Q}{4\pi T}\int_u^\infty \frac{e^{-y}}{y}dy$$

The integral expression can be represented as W(u), the well function of u, which is represented by the series (Reference 7):

$$W(u) = \left[-0.5772 - \ln u + u - \frac{u^2}{2 \bullet 2!} + \frac{u^3}{3 \bullet 3!} - \frac{u^4}{4 \bullet 4!} + \ldots\right]$$

Where,

$$u = \frac{r^2 S}{4Tt}$$

r	=	radial distance from the pumping well to the observation point [L]
Q	=	pumping rate [L^3/t]
s	=	drawdown [L]
S	=	storativity [dimensionless]
t	=	time
T	=	transmissivity [L^2/t]

The Theis drawdown equation in compact notation is:

$$s = \frac{Q}{4\pi T}W(u)$$

The physical system represented by the Hantush leaky aquifer with aquitard storage method is shown on Figure 2BB-206. The method includes the following assumptions:

- Aquifer has infinite areal extent

- Aquifer is homogeneous and of uniform thickness
- Pumping well is fully or partially penetrating
- Flow to pumping well is horizontal when pumping well is fully penetrating
- Aquifer is leaky confined
- Flow is unsteady
- Water is released instantaneously from storage with decline of hydraulic head
- Diameter of pumping well is very small so that storage in the well can be neglected
- Confining bed(s) has (have) infinite areal extent, uniform vertical hydraulic conductivity and uniform thickness
- Confining bed(s) is (are) overlain or underlain by an infinite constant-head plane source
- Flow is vertical in the aquitard(s)

The inverse Laplace transform solution for unsteady flow to a fully penetrating well in a homogeneous, isotropic leaky confined aquifer with aquitard storage is (Reference 8):

$$s(r,t) = \frac{Q}{4\pi T} H(u,\beta)$$

$$u = \frac{r^2 S}{4Tt} \qquad \beta = \frac{r}{4B}\sqrt{\frac{S'}{S}} \qquad B = \sqrt{\frac{T}{K'/b'}}$$

For a two aquitard system, AQTESOLV™ (Reference 5) determines the B' and B" leakage values, where:

$$B' = \sqrt{\frac{Tb'}{K'}}$$

$$B'' = \sqrt{\frac{Tb''}{K''}}$$

Where,

$H(u,\beta)$	=	Hantush leaky well function
b’	=	thickness of first aquitard [L]
b”	=	thickness of second aquitard [L]
K’	=	vertical hydraulic conductivity of first aquitard [L/t]
K”	=	vertical hydraulic conductivity of second aquitard [L/t]
Q	=	pumping rate [L^3/t]
r	=	radial distance [L]
s	=	drawdown [L]
S	=	storativity of aquifer [dimensionless]
S’	=	storativity of aquitard [dimensionless]
t	=	time [t]
T	=	transmissivity of aquifer [L^2/t]

For the conditions at Units 6 & 7, the Hantush method was applied as follows:

<u>Upper Zone Test</u>

Upper aquitard — Miami Limestone

Upper aquifer — Key Largo Limestone (pumped aquifer)

Lower aquitard — freshwater limestone

Lower aquifer — Fort Thompson Formation (unpumped aquifer)

<u>Lower Zone Test</u>

Upper aquifer — Key Largo Limestone (unpumped aquifer)

Upper aquitard — freshwater limestone

Lower aquifer — Fort Thompson Formation (pumped aquifer)

Lower aquitard — Tamiami Formation

The aquifer test interpretation methods utilized simplified conceptual hydrogeologic models of site conditions. Localized variations in the hydrogeologic properties of the aquifers and aquitards may not conform to these simplified conceptual models. The drawdown response from each test data set was reviewed to evaluate conformance to these conceptual models.

A constant density was applied to the water levels transducer data. This assumption is considered valid over the limited area influenced by pumping. Variations due to deviations from the constant density assumption are considered to be within the uncertainty of the other assumptions underlying aquifer pumping test analysis.

The AQTESOLV™ program allows either automatic or manual curve fitting for both the Theis and Hantush methods. For this analysis, manual curve fitting was used to eliminate data in the early time period of pumping, which may be impacted by casing storage, non-steady state leakage, or other pumping effects. For calculation of average values for the tests, only the Hantush method results were used, since the Theis method results represent an upper bound value.

4.5 Generic Input Parameters

The AQTESOLV™ program includes input for well radii, well equipment radii, screened intervals, and thicknesses of the different units. This information can be used to correct for well storage, partial penetration, and to calculate parameters for the different units. For the purposes of this analysis, all wells were assumed to be fully penetrating. For unit consistency, all measurements are in feet.

The diameter of the pumping well was represented by two components: the diameter of the cased interval (30 inches) and the diameter of the open hole interval (28 inches). The radius of the cased interval was (30 inches/12)/2 = 1.25 feet and of the open hole interval was (28 inches/12)/2 =1.17 feet. The pumping equipment (column/bowls) was 12-inch diameter or a radius of (12 inches/12)/2 = 0.5 feet. The diameter of the observation wells was 2 inches with a radius of (2 inches/12)/2= 0.08 feet.

The screened intervals for the pumping and observation wells were obtained from Table 2BB-201. Based on the drilling program to install the pumping and observation wells, the hydrogeologic unit thicknesses were determined as shown in Table 2BB-202.

5.0 UNIT 6 SHALLOW TEST

5.1 Test Summary

Background water level collection in the pumping well for the test commenced at 10:00 am eastern daylight savings time (EDT) on March 12, 2009 and stopped at 10:10 am EDT on March 13, 2009. The PW-6U aquifer pumping test was started on March 13, 2009 at 10:31 am EDT and pumped at an average rate of 5103 gpm until 6:30 pm EDT when the pump was shut off and recovery occurred. Recovery measurements continued until March 14, 2009 at 2:30 am EDT. There were no precipitation events noted during background data collection or during the test. Well cluster C7-3 was used as the background well cluster for tidal correction during this test. The pumping rates are presented in Attachment 2BB-1. It should be noted that this test was conducted during the week after the time change from eastern standard time (EST) to EDT. The electronic loggers remained on EST; however, during tidal correction, the water level data times were converted to EDT.

5.2 Data Assessment

Figure 2BB-207 presents a plot of flow measurements during the test. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test were considered to be usable for test interpretation. A complete listing of the flow measurements is presented in Attachment 2BB-1.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes. Comparison of water level data at each well cluster (Figures 1 through 4 in Attachment 2BB-1) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C6-1A, C6-1B, C6-2B, C6-3A, C6-4A, C6-4B, and C6-3B. The water level response in wells C6-1A, C6-1B, C6-2B, C6-3A, C6-4A, and C6-4B, screened in the “A” or “B” (Miami Limestone (A) or freshwater limestone (B) aquitard) zones, was essentially identical to the response in the “D” zone (Key Largo Limestone pumping zone). The response from these wells showed the same transmissivity and storage values as the pumped aquifer. This may indicate placement of a portion of the screened interval of these wells within the pumped aquifer or subsurface conditions where the vertical hydraulic conductivity of the aquitard is the same as in the pumped aquifer (aquitard not present). Well C6-3B, screened in the “B” (freshwater limestone aquitard) zone shows less drawdown than in the underlying unpumped aquifer indicating a possible connection between the pumped (Key Largo Limestone) and unpumped (Fort Thompson Formation) aquifers. In either case, the responses from these wells were not consistent with the assumptions used in the Hantush method and thus were not interpreted using this method. With the exception of the seven observation wells identified above, the remaining water level data were considered acceptable for test interpretation.

5.3 Summary of Results

The AQTESOLV™ plots for the observation wells are presented in Attachment 2BB-1. The results of the interpretation are summarized on Table 2BB-203. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 2,331,000 gallons per day per foot (312,000 square feet per day) and a mean storage coefficient of 1.5E-04 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “A” (Miami Limestone) is 103 gallons per day per square foot (14 feet per day) and of lower aquitard zone “B” (freshwater limestone) is 46 gallons per day per square foot (6 feet per day).

6.0 UNIT 6 DEEP TEST

6.1 Test Summary

Background water level collection in the pumping well for the test commenced at 9:32 am EDT on March 19, 2009 and stopped at 9:34 am EDT on March 20, 2009. The PW-6L aquifer pumping test was started on March 20, 2009 at 10:00 am EDT and pumped at an average rate of 3342 gpm until 6:00 pm EDT when the pump was shut off and recovery occurred. Recovery measurements continued until March 21, 2009 at 2:00 am EDT. There was a precipitation event noted immediately before background data collection resulting in measurable rainfall. During the test, some light drizzle was noted but not sufficient to produce measurable precipitation. Unit 3 was in the midst of a scheduled outage, which resulted in higher than normal cooling canal levels. Well cluster C7-3 was used as the background well cluster for tidal correction during this test. The pumping rates are presented in Attachment 2BB-2.

6.2 Data Assessment

Figure 2BB-208 presents the pumping rate measurements for the PW-6L test. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test is considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-2.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes in water levels. Comparison of water level data at each well cluster ((Figures 1 through 4 in Attachment 2BB-2) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C6-3C, C6-2B, C6-2C, and C6-2D. In wells C6-2B and C6-2D water level responses in the “B” zone (freshwater limestone) were essentially identical to the response in the “D” zone (non-pumping zone). This may indicate placement of a portion of the screened interval of these wells within the non-pumped aquifer or subsurface conditions where the vertical hydraulic conductivity of the aquitards are the same as in the non-pumped aquifer (aquitard not present). Wells C6-3C and C6-2C show water level response greater than in the pumped zone (C6-3E or C6-2E), which suggest either anomalous transducer data or some unknown external influence. In either case, the responses from these wells were not consistent with the assumptions used in the Hantush method and thus were not interpreted using this method. The wells with acceptable water level data were all wells in cluster C6-5, all wells in cluster C6-4, C6-3B, D, and E, and C6-2E.

6.3 Summary of Results

The AQTESOLV™ plots for the observation wells are presented in Attachment 2BB-2. The results of the interpretation are summarized on Table 2BB-204. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 122,000 gallons per day per foot (16,000 square feet per day) and a mean storage coefficient of 1.6E-04 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “B” (freshwater limestone) is 2 gallons per day per square foot (0.2 feet per day) and of lower aquitard zone “C” (Tamiami Formation) is 7940 gallons per day per square foot (1061 feet per day). The high vertical hydraulic conductivity measured in the Tamiami Formation is believed to be a result of screening of the observation wells at the top of the formation in comparison to the observation wells at the Unit 7 deep test, which were screened deeper in the Tamiami Formation.

7.0 UNIT 7 SHALLOW TEST

7.1 Test Summary

Background data collection in the pumping well commenced on February 20, 2009 at 8:17 pm EST. The pumping test was started at 7:00 pm EST on February 23, 2009 and the well was pumped at an average rate of 4181 gallons per minute. Recovery was started at 3:45 am EST on February 24, 2009 and measurements were continued until 1:30 pm EST on February 24, 2009. There were no precipitation events noted during background data collection or during the test. Well cluster C6-3 was used for tidal correction during this test. The pumping rate data are presented in Attachment 2BB-3.

7.2 Data Assessment

The flow measurements collected during the test are presented on Figure 2BB-209. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test was considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-3.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes except in observation wells C7-1A and D, which did not have sufficiently detailed measurements to characterize the change. Comparison of water level data at each well cluster ((Figures 1 through 4 in Attachment 2BB-3) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C7-1B and E and C7-4B and E, which show essentially an identical water level response in the aquitard (freshwater limestone) and the unpumped aquifer. This may indicate an absence of the aquitard or placement of a portion of the screened interval of these wells within the unpumped aquifer. Therefore, only the water level data from well clusters C7-2 and C7-3 are considered to be acceptable for time-drawdown and distance-drawdown test interpretation and data from cluster C7-4 are also acceptable with the notation of anomalous behavior discussed above. Data from the C7-1 well cluster are not acceptable except for distance-drawdown comparisons.

7.3 Summary of Results

The results of the test interpretations are presented in Attachment 2BB-3 and summarized on Table 2BB-205. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 2,200,000 gallons per day per foot (294,000 square feet per day) and a mean storage coefficient of 0.002 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “A” (Miami Limestone) is 173 gallons per day per square foot (23 feet per day) and of the lower aquitard zone “B” (freshwater limestone) is 54 gallons per day per square foot (7 feet per day).

8.0 UNIT 7 DEEP TEST

8.1 Test Summary

Background data collection in PW-7L began at 5:20 pm EST on March 4, 2009. The pumping portion of the test started at 12:00 pm EST on March 7, 2009 with an average pumping rate of 3403 gallons per minute. The recovery portion of the test was started at 9:00 pm EST on March 7, 2009 and measurements continued until 7:34 am EST on March 8. 2009. There were periods of light precipitation and drizzle observed during the background period, but no significant precipitation events were noted during background data collection or during the test. The test data are presented in Attachment 2BB-4.

8.2 Data Assessment

The flow measurements collected during the test are presented on Figure 2BB-210. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test were considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-4.

Three of the transducers (C7-3B, C7-4D, and C7-5C) experienced what was referred to as “instrument drift” where the time recorded on these transducers was not synchronized with the other transducers. The times were manually corrected during the tidal correction, however the time shift on two of the transducers (C7-4D and C7-5C) resulted in missing the early time drawdown making the data from these transducers unacceptable for interpretation. Additionally, the transducer in well C7-4B malfunctioned during the test, resulting in only the first 300 minutes of data from the pumping period being acceptable. Therefore, with the exceptions noted above, the water level data from the remaining wells in clusters C7-3, C7-4, and C7-5 were considered acceptable for test interpretation.

8.3 Summary of Results

The results of the test interpretations are presented in Attachment 2BB-4 and summarized on Table 2BB-206. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The test results for the Hantush method indicate a mean transmissivity of 131,000 gallons per day per foot (17,500 square feet per day) and a mean storage coefficient of 0.0003 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “B” (freshwater Limestone) is 3 gallons per day per square foot (0.4 foot per day) and of the lower aquitard zone “C” (Tamiami Formation) is 740 gallons per day per square foot (100 feet per day).

9.0 SUMMARY

Four aquifer pumping tests were conducted at the Units 6 & 7 plant area, with two tests performed adjacent to locations of each reactor building, one in the Key Largo Limestone and the other in the Fort Thompson formation. The tests were performed to measure the hydrogeologic properties of these aquifers and overlying or underlying aquitards. Table 2BB-207 presents a summary of the averages of the aquifer testing results.

10.0 REFERENCES

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Table 2BB-201 (Sheet 1 of 3)
Observation Well and Pumping Well Construction Data

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
PW-7U	875819.3	396935.3	0.47	–0.2	45	22–45	0–22 ft 30” 22–45 ft 28”
PW-7L	875819.4	396985.1	0.67	–0.1	87	67–87	0–67 ft 30” 67–87 ft 28”
PW-6U	876668.7	396938.0	0.37	–0.3	45	23–45	0–23 ft 30” 23–45 ft 28”
PW-6L	876668.2	396987.5	0.37	–0.1	105	66–105	0–66 ft 30” 66–105 ft 28”
C7-1A	875829.5	396932.8	2.88	–0.2	15	10–15	2”
C7-1B			2.92		64	62–64	2”
C7-1C			2.94		120	115–120	2”
C7-1D	875829.6	396937.7	2.55	–0.3	40	30–40	2”
C7-1E			2.45		82	72–82	2”
C7-2A	875822.2	396944.9	2.61	–0.2	15	10–15	2”
C7-2B			2.54		52	50–52	2”
C7-2C			2.57		117	112–117	2”
C7-2D	875817.3	396944.9	2.61	–0.1	40	30–40	2”
C7-2E			2.57		82	72–82	2”
C7-3A	875822.4	396960.2	2.71	–0.3	15	10–15	2”
C7-3B			2.64		55	53–55	2”
C7-3C			2.71		97	92–97	2”
C7-3D	875817.2	396959.9	2.61	–0.2	40	30–40	2”
C7-3E			2.60		87	77–87	2”
C7-4A	875822.3	396975.2	3.09	–0.3	15	10–15	2”
C7-4B			3.10		61	59–61	2”
C7-4C			3.21		117	112–117	2”
C7-4D	875817.3	396974.3	2.64	0.0	40	30–40	2”

Table 2BB-201 (Sheet 2 of 3)
Observation Well and Pumping Well Construction Data

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
C7-4E	875817.3	396974.3	2.60	0.0	82	72–82	2”
C7-5A	875829.5	396984.1	2.72	–0.1	15	10–15	2”
C7-5B			2.81		62	60–62	2”
C7-5C			2.91		117	112–117	2”
C7-5D	875828.1	396989.3	3.16	0.0	40	30–40	2”
C7-5E			3.05		82	72–82	2”
C6-1A	876678.1	396935.4	1.80	–0.3	15	10–15	2
C6-1B			1.66		48	46–48	2
C6-1C			1.73		117	112–117	2
C6-1D	876677.9	396940.4	2.14	–0.4	40	30–40	2
C6-1E			2.26		87	77–87	2
C6-2A	876670.8	396947.3	2.46	–0.4	15	10–15	2
C6-2B			2.48		45	43–45	2
C6-2C			2.47		121	116–121	2
C6-2D	876665.5	396947.4	2.02	–0.4	40	30–40	2
C6-2E			2.10		87	77–87	2
C6-3A	876670.5	396962.6	2.58	–0.4	15	10–15	2
C6-3B			2.57		51	49–51	2
C6-3C			2.57		117	110–117	2
C6-3D	876665.7	396962.5	2.45	–0.4	40	30–40	2
C6-3E			2.42		87	77–87	2
C6-4A	876670.9	396978.1	1.97	0.0	16	11–16	2
C6-4B	876670.9	396978.1	2.08	0.0	48	46–48	2
C6-4C			1.94		122	118–122	2

**Table 2BB-201 (Sheet 3 of 3)
Observation Well and Pumping Well Construction Data**

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
C6-4D	876666.0	396977.9	2.91	–0.2	40	30–40	2
C6-4E			2.94		86	76–86	2
C6-5A	876678.3	396984.8	2.38	–0.2	15	10–15	2
C6-5B			2.35		49	47–49	2
C6-5C			2.48		122	117–122	2
C6-5D	876678.1	396990.3	2.74	–0.4	40	30–40	2
C6-5E			2.71		86	76–86	2

Table 2BB-202
Hydrogeologic Unit Thicknesses[(a)]

PW-6U/L Test			
Unit	**Formation**	**Depth Interval (ft bgs)**	**Approximate Thickness (ft)**
Upper aquitard	Miami Limestone	5–13	8
Upper aquifer	Key Largo Limestone	13–46	33
Middle aquitard	Freshwater limestone/lime mud	46–57	11
Lower aquifer	Fort Thompson Formation	57–114	57
Lower aquitard	Tamiami Formation	114–117+	18[(b)]
PW-7U/L Test			
Upper aquitard	Miami Limestone	5–18	13
Upper aquifer	Key Largo Limestone	18–42	24
Middle aquitard	Freshwater limestone/lime mud	42–61	19
Lower aquifer	Fort Thompson Formation	61–97	36
Lower aquitard	Tamiami Formation	97–115+	18

(a) Based on composite logs, depths and thicknesses are considered approximate.
(b) A thickness of 18 feet is assumed for consistency with the PW-7L test, the thickness of the Tamiami Formation is >18 feet.

Table 2BB-203
Summary of Unit 6 Shallow Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B’ (ft^{-1})	1/B” (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C6-1	10	(a)	(a)	(a)	(a)	(a)	(a)
C6-2	10	2,204,000	2.4E-04	0.0024	0.0017	102	70
C6-3	25	2,867,000	7.98E-06	0.0022	0.0011	111	38
C6-4	40	(a)	(a)	(a)	(a)	(a)	(a)
Distance-Drawdown	—	1,922,000	2.1E-04	0.0025	0.0012	96	30
C6-1 Theis	10	7,330,000	1.8E-06	—	—	—	—
C6-2 Theis	10	5,816,000	1.2E-06	—	—	—	—
C6-3 Theis	25	8,837,000	1.2E-06	—	—	—	—
C6-4 Theis	40	11,130,000	1.2E-06	—	—	—	—

(a) Data not usable from these wells.

Table 2BB-204
Summary of Unit 6 Deep Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B' (ft^{-1})	1/B" (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C6-2	40	(a)	(a)	(a)	(a)	(a)	(a)
C6-3	25	201,000	0.0001	0.0011	0.06	3	13,025
C6-4	10	110,900	0.0001	0.0011	0.06	2	7,186
C6-5	10	30,920	0.0001	0.0011	0.06	0.4	2,068
Distance-Drawdown	—	146,100	0.0003	0.0011	0.06	2	9,467
C6-2 Theis	40	514,000	2.3E-06	—	—	—	—
C6-3 Theis	25	427,000	2.3E-06	—	—	—	—
C6-4 Theis	10	218,900	2.3E-06	—	—	—	—
C6-5 Theis	10	323,600	2.3E-06	—	—	—	—

(a) Data not usable from these wells.

Table 2BB-205
Summary of Unit 7 Shallow Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B’ (ft^{-1})	1/B” (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C7-1	10	(a)	(a)	(a)		(a)	(a)
C7-2	10	2,464,000	0.002	0.002489	0.00115	198	62
C7-3	25	2,056,000	0.002	0.00241	0.0011	155	47
C7-4	40	2,035,000	0.002	0.002484	0.00114	163	50
Distance-Drawdown	—	2,246,000	0.002	0.002455	0.00115	176	56
C7-1 Theis	10	(a)	(a)	—	—	—	—
C7-2 Theis	10	5,819,000	3.0E-05	—	—	—	—
C7-3 Theis	25	5,575,000	3.6E-05	—	—	—	—
C7-4 Theis	40	5,723,000	3.6E-05	—	—	—	—

(a) Data from this well cluster are unusable.

Table 2BB-206
Summary of Unit 7 Deep Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B’ (ft^{-1})	1/B” (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C7-2	40	131,300	0.0003	0.001143	0.0169	3	675
C7-3	25	134,200	0.0003	0.001145	0.0239	3	1383
C7-4	10	126,200	0.0003	0.001148	0.0158	3	570
C7-5	10	132,200	0.0003	0.001148	0.0129	3.3	395
Distance-Drawdown	—	132,200	0.0003	0.001148	0.0170	3	686
C7-2 Theis	40	1,297,000	2.3E-06	—	—	—	—
C7-3 Theis	25	1,180,000	2.0E-06	—	—	—	—
C7-4 Theis	10	454,600	3.5E-05	—	—	—	—
C7-5 Theis	10	432,900	3.6E-05	—	—	—	—

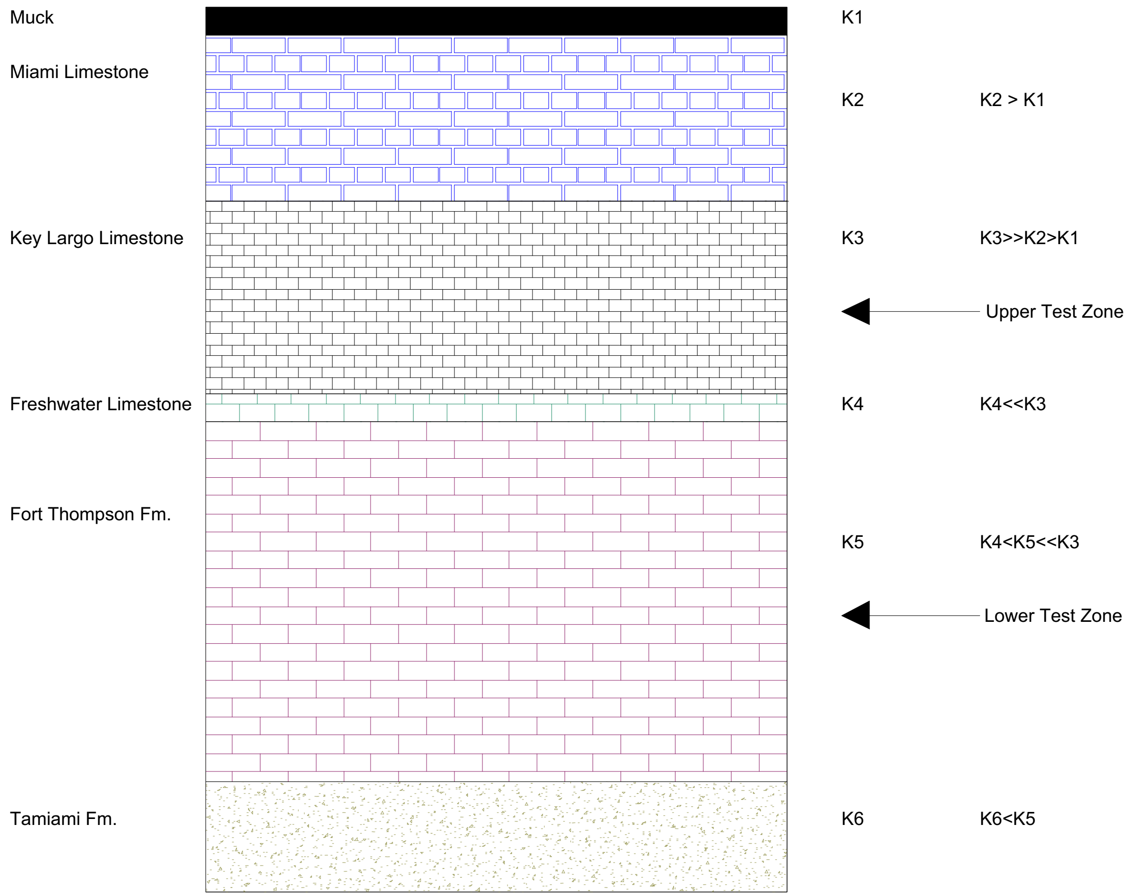
Table 2BB-207
Summary of Aquifer Testing Results

Geologic Unit	Thickness (ft)	Test Well	Aquifer Transmissivity (gpd/ft)[a]	Aquifer Storativity (dimensionless)[a]	Hydraulic Conductivity (K_h or K_v)		
					gpd/ft^{2}[a]	ft/d[a]	cm/s[a]
Miami Limestone (K_v)	8	PW-6U	—	—	103	14	0.005
	13	PW-7U	—	—	173	23	0.008
Key Largo Limestone (K_h)	33	PW-6U	2,331,000	0.00015	71,000	9,400	3.3
	24	PW-7U	2,200,000	0.0022	92,000	12,000	4.3
Freshwater Limestone (K_v)	11	PW-6U	—	—	46	6	0.002
	19	PW-7U	—	—	54	7	0.003
	11	PW-6L	—	—	2	0.2	7E-05
	19	PW-7L	—	—	3	0.4	1E-04
Fort Thompson Formation (K_h)	57	PW-6L	122,000	0.00016	2,140	286	0.1
	36	PW-7L	131,200	0.0003	3,600	490	0.2
Tamiami Formation (K_v)	18	PW-6L	—	—	7,940	1,061	0.4
	18	PW-7L	—	—	740	100	0.04

(a) Average values.

Figure 2BB-201 Site Location Map

Figure 2BB-202 Conceptual Model



Notes:
Not to scale
FM = Formation

Figure 2BB-203 Unit 6 Pumping Test Group

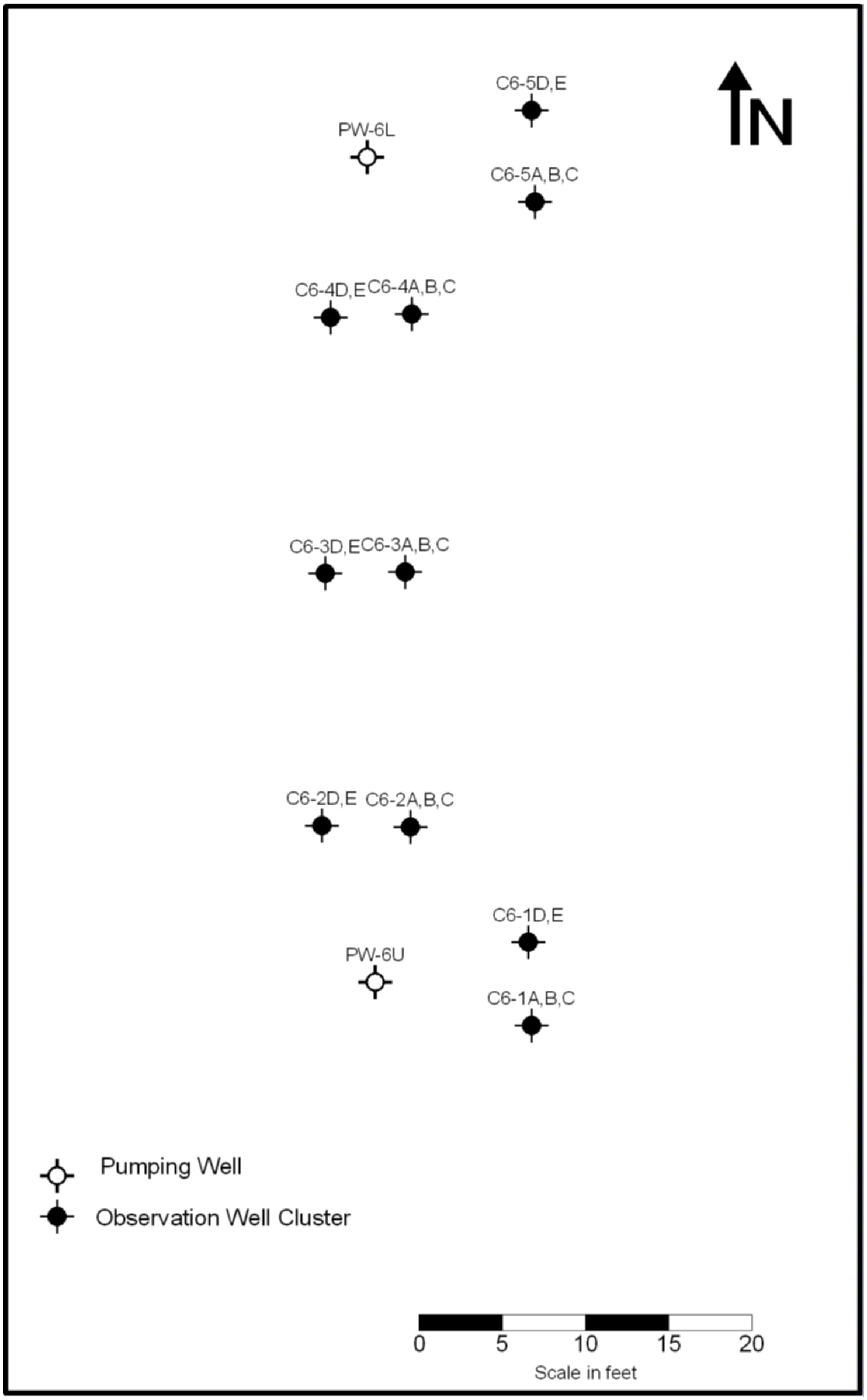


Figure 2BB-204 Unit 7 Pumping Test Group

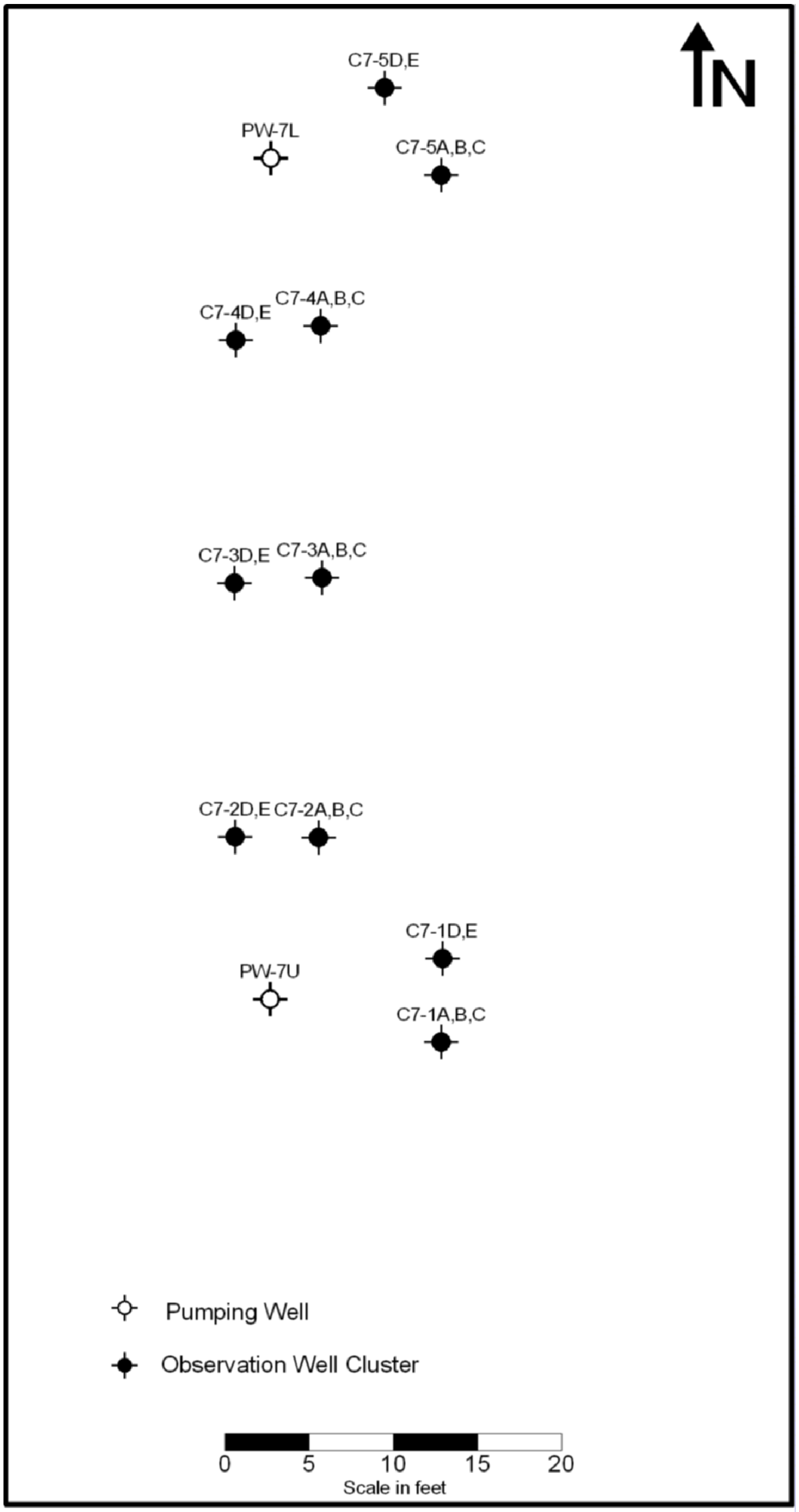
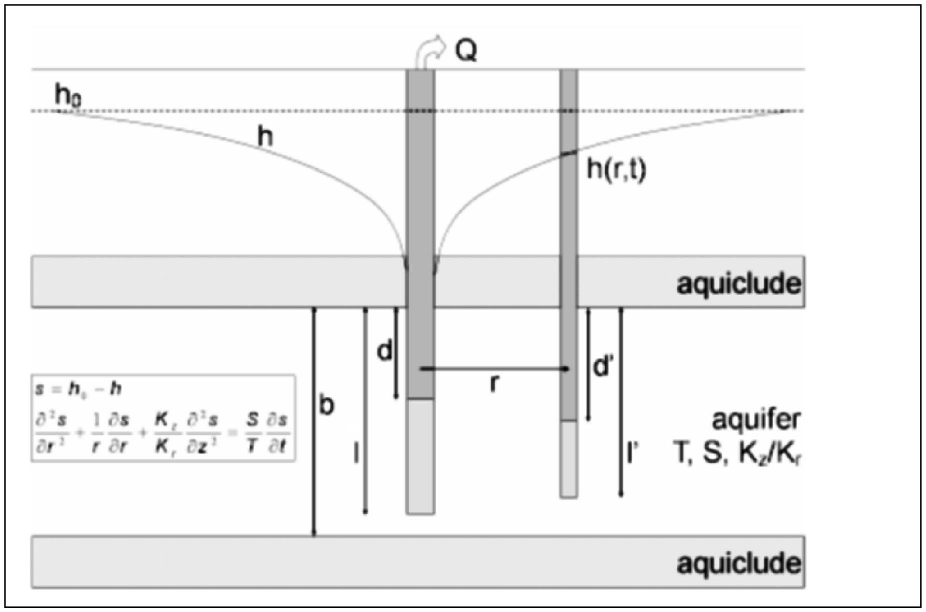
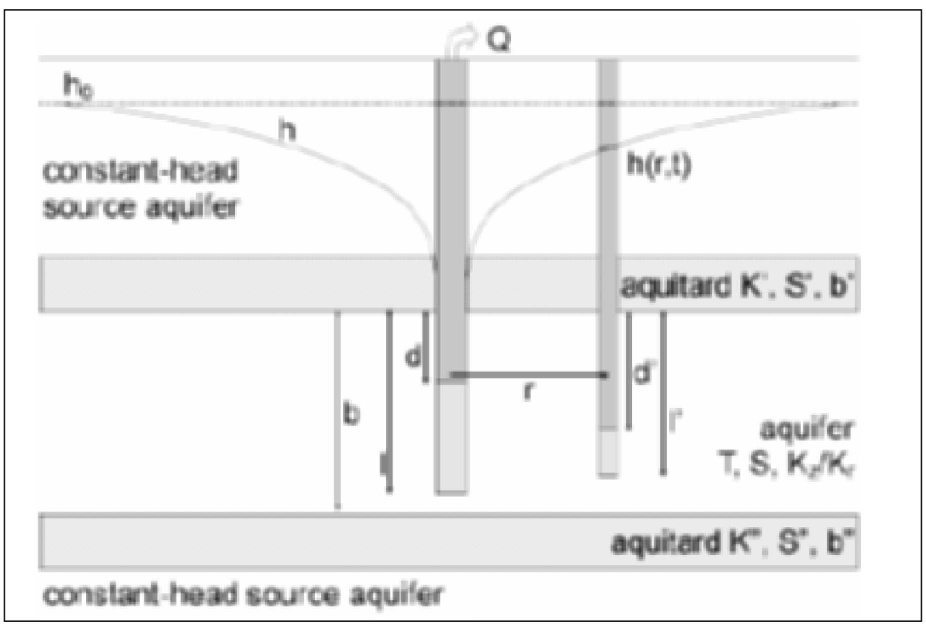


Figure 2BB-205 Physical System for Theis Method



Source: Reference 5

Figure 2BB-206 Physical System for Hantush Leaky Aquifer with Aquitard Storage Method



Source: Reference 5

Figure 2BB-207 Flow Measurements for PW-6U Test

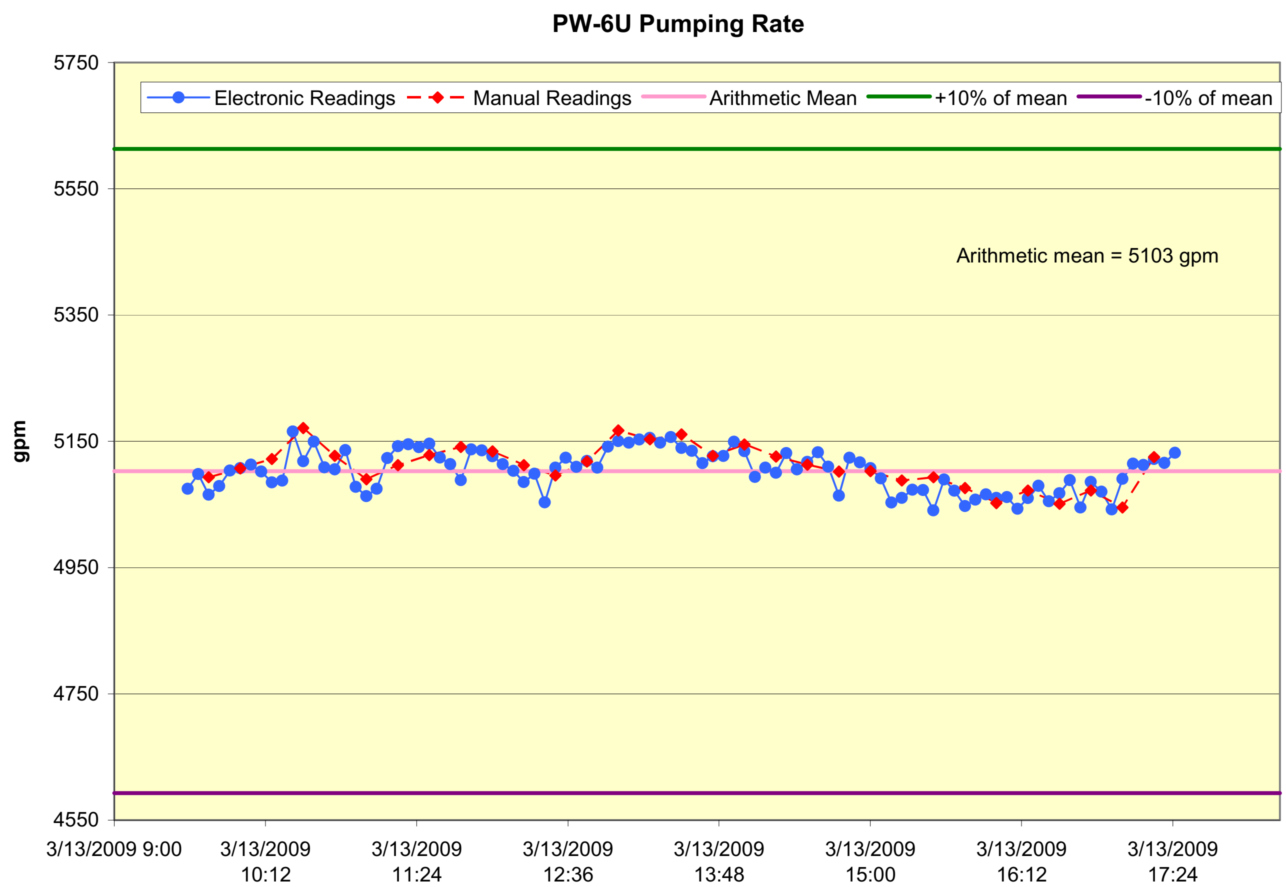


Figure 2BB-208 Flow Measurements for PW-6L Test

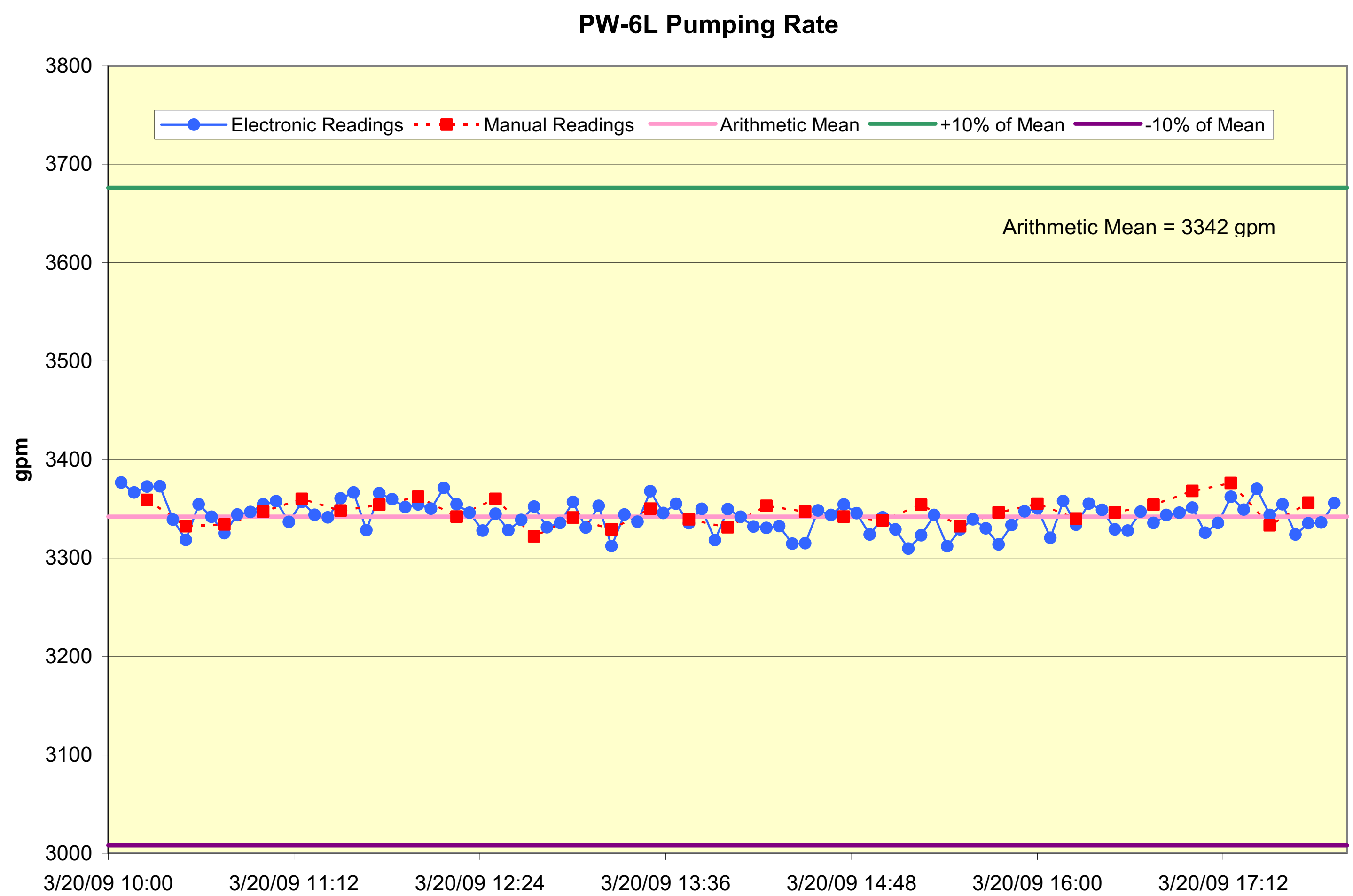


Figure 2BB-209 Flow Measurements for PW-7U Test

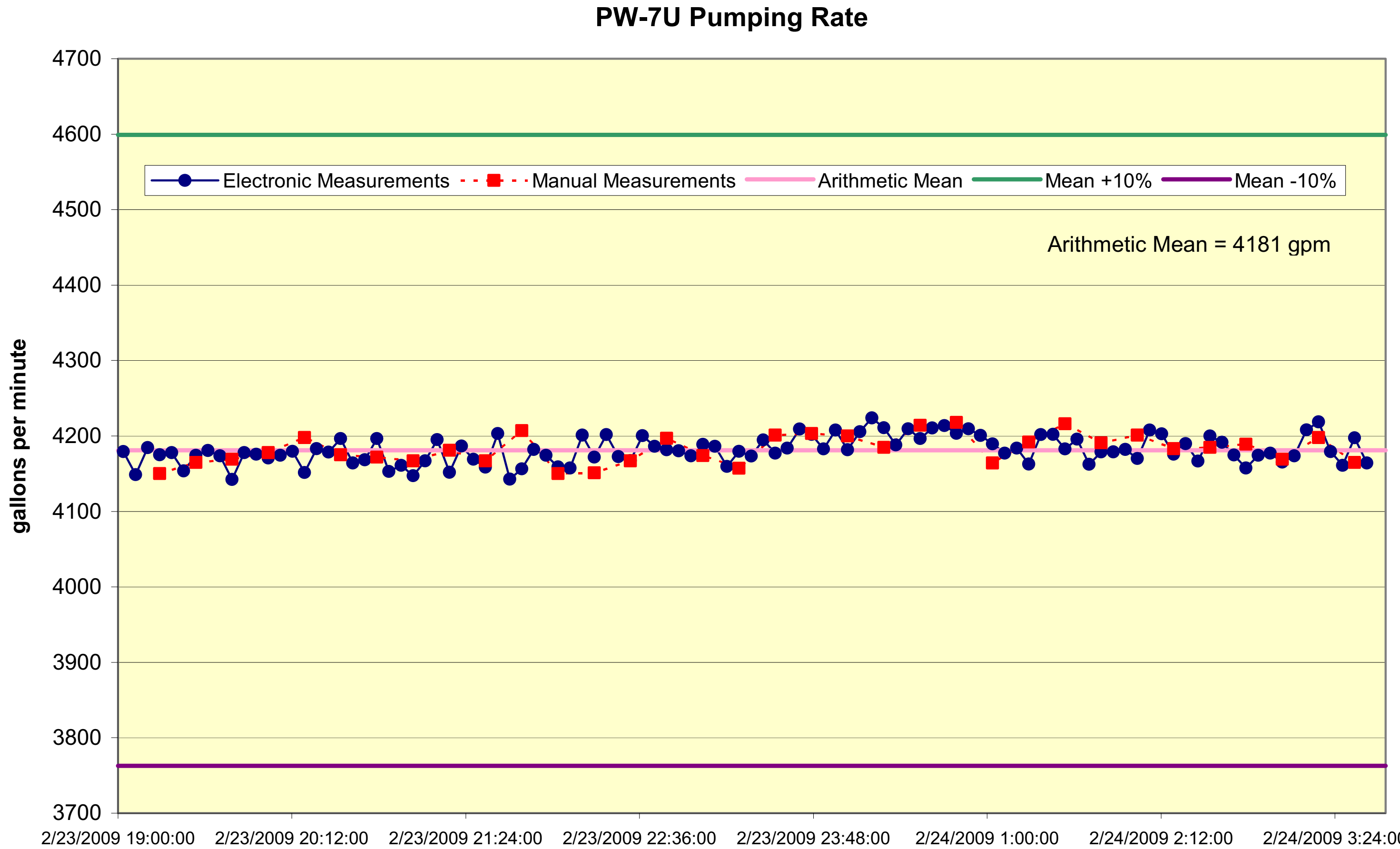
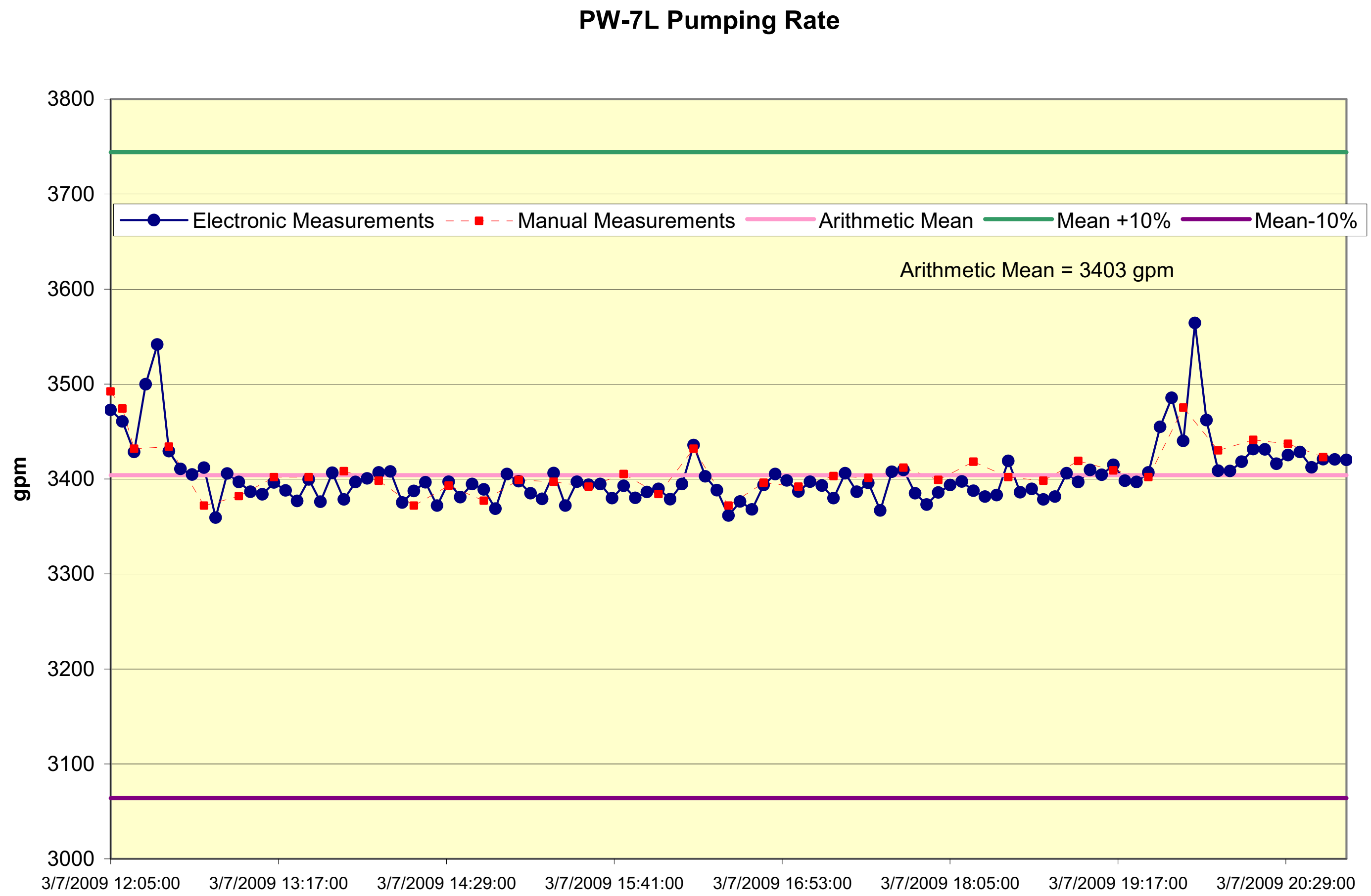


Figure 2BB-210 Flow Measurements for PW-7L Test



ATTACHMENT 2BB-1

UNIT 6 SHALLOW TEST GRAPHS AND PUMPING RATES

**Table 1 of Attachment 2BB-1 (Sheet 1 of 3)
Pumping Rate Measurements for PW-6U**

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[a]
3/13/2009 9:31	0	5075[b]	—
3/13/2009 9:35	4	5075	—
3/13/2009 9:40	9	5098	—
3/13/2009 9:45	14	5065	5093
3/13/2009 9:50	19	5079	—
3/13/2009 9:55	24	5103	—
3/13/2009 10:00	29	5108	5107
3/13/2009 10:05	34	5113	—
3/13/2009 10:10	39	5102	—
3/13/2009 10:15	44	5085	5122
3/13/2009 10:20	49	5088	—
3/13/2009 10:25	54	5165	—
3/13/2009 10:30	59	5119	5171
3/13/2009 10:35	64	5150	—
3/13/2009 10:40	69	5109	—
3/13/2009 10:45	74	5106	5127
3/13/2009 10:50	79	5136	—
3/13/2009 10:55	84	5078	—
3/13/2009 11:00	89	5063	5090
3/13/2009 11:05	94	5075	—
3/13/2009 11:10	99	5123	—
3/13/2009 11:15	104	5142	5112
3/13/2009 11:20	109	5145	—
3/13/2009 11:25	114	5140	—
3/13/2009 11:30	119	5146	5128
3/13/2009 11:35	124	5124	—
3/13/2009 11:40	129	5114	—
3/13/2009 11:45	134	5088	5141
3/13/2009 11:50	139	5137	—
3/13/2009 11:55	144	5136	—
3/13/2009 12:00	149	5126	5134
3/13/2009 12:05	154	5114	—
3/13/2009 12:10	159	5103	—
3/13/2009 12:15	164	5085	5112
3/13/2009 12:20	169	5099	—
3/13/2009 12:25	174	5053	—
3/13/2009 12:30	179	5108	5096

Table 1 of Attachment 2BB-1 (Sheet 2 of 3)
Pumping Rate Measurements for PW-6U

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[(a)]
3/13/2009 12:35	184	5124	—
3/13/2009 12:40	189	5109	—
3/13/2009 12:45	194	5119	5118
3/13/2009 12:50	199	5108	—
3/13/2009 12:55	204	5141	—
3/13/2009 13:00	209	5151	5167
3/13/2009 13:05	214	5148	—
3/13/2009 13:10	219	5153	—
3/13/2009 13:15	224	5155	5153
3/13/2009 13:20	229	5148	—
3/13/2009 13:25	234	5157	—
3/13/2009 13:30	239	5140	5161
3/13/2009 13:35	244	5135	—
3/13/2009 13:40	249	5115	—
3/13/2009 13:45	254	5126	5127
3/13/2009 13:50	259	5127	—
3/13/2009 13:55	264	5149	—
3/13/2009 14:00	269	5134	5145
3/13/2009 14:05	274	5094	—
3/13/2009 14:10	279	5108	—
3/13/2009 14:15	284	5100	5126
3/13/2009 14:20	289	5131	—
3/13/2009 14:25	294	5106	—
3/13/2009 14:30	299	5117	5113
3/13/2009 14:35	304	5132	—
3/13/2009 14:40	309	5110	—
3/13/2009 14:45	314	5064	5102
3/13/2009 14:50	319	5124	—
3/13/2009 14:55	324	5116	—
3/13/2009 15:00	329	5108	5103
3/13/2009 15:05	334	5091	—
3/13/2009 15:10	339	5053	—
3/13/2009 15:15	344	5060	5088
3/13/2009 15:20	349	5073	—
3/13/2009 15:25	354	5073	—
3/13/2009 15:30	359	5040	5092
3/13/2009 15:35	364	5090	—
3/13/2009 15:40	369	5072	—

Table 1 of Attachment 2BB-1 (Sheet 3 of 3)
Pumping Rate Measurements for PW-6U

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[(a)]
3/13/2009 15:45	374	5048	5076
3/13/2009 15:50	379	5057	—
3/13/2009 15:55	384	5066	—
3/13/2009 16:00	389	5060	5052
3/13/2009 16:05	394	5062	—
3/13/2009 16:10	399	5043	—
3/13/2009 16:15	404	5060	5072
3/13/2009 16:20	409	5079	—
3/13/2009 16:25	414	5055	—
3/13/2009 16:30	419	5068	5051
3/13/2009 16:35	424	5088	—
3/13/2009 16:40	429	5045	—
3/13/2009 16:45	434	5086	5072
3/13/2009 16:50	439	5070	—
3/13/2009 16:55	444	5042	—
3/13/2009 17:00	449	5090	5045
3/13/2009 17:05	454	5115	—
3/13/2009 17:10	459	5113	—
3/13/2009 17:15	464	5122	5125
3/13/2009 17:20	469	5116	—
3/13/2009 17:25	474	5132	—
3/13/2009 17:30	479	0	—

(a) Manual readings recorded in EDT.
(b) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-1 Time-Drawdown Graph for C6-1 Well Cluster

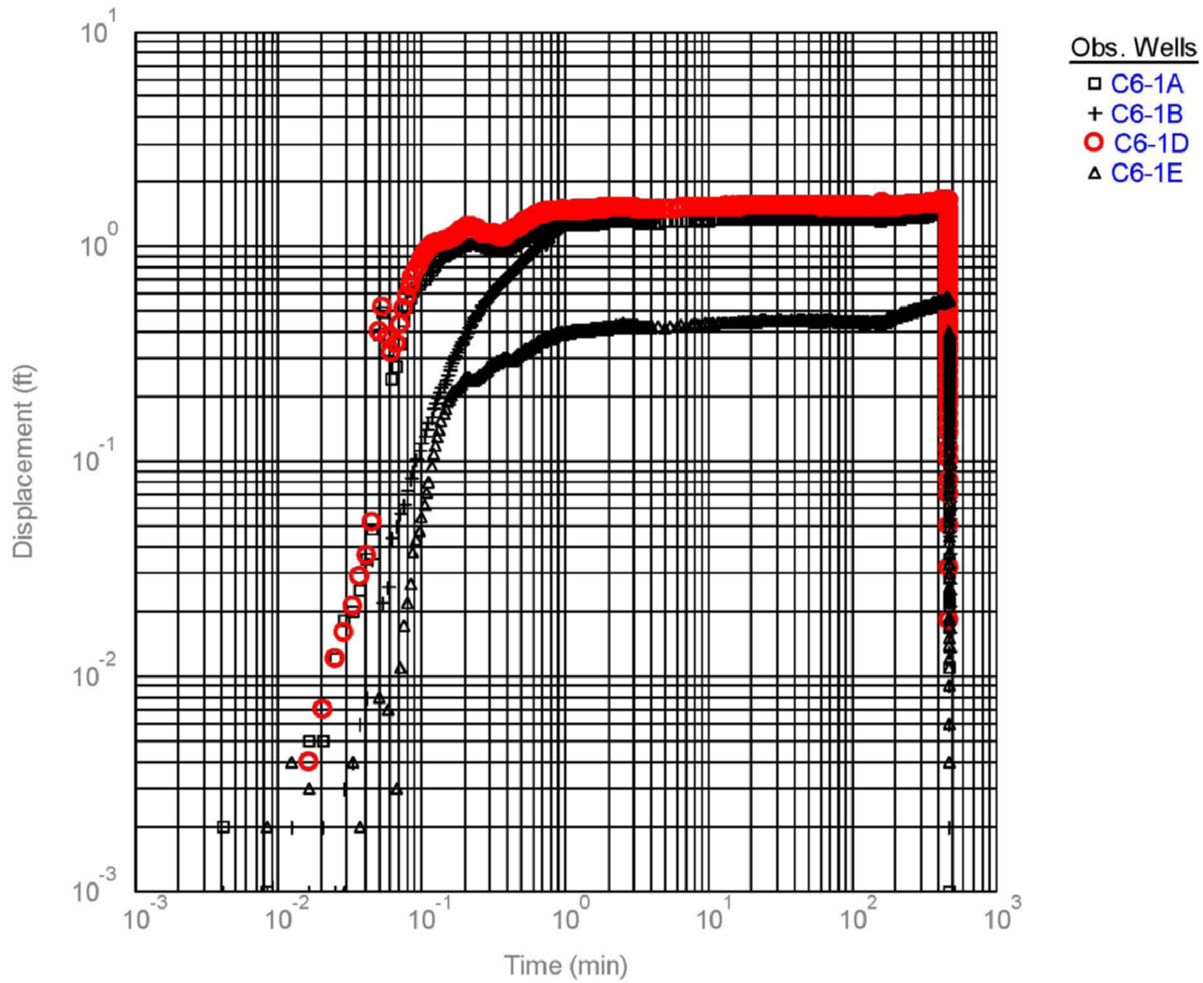


Figure 2 of Attachment 2BB-1 Time-Drawdown Graph for C6-2 Well Cluster

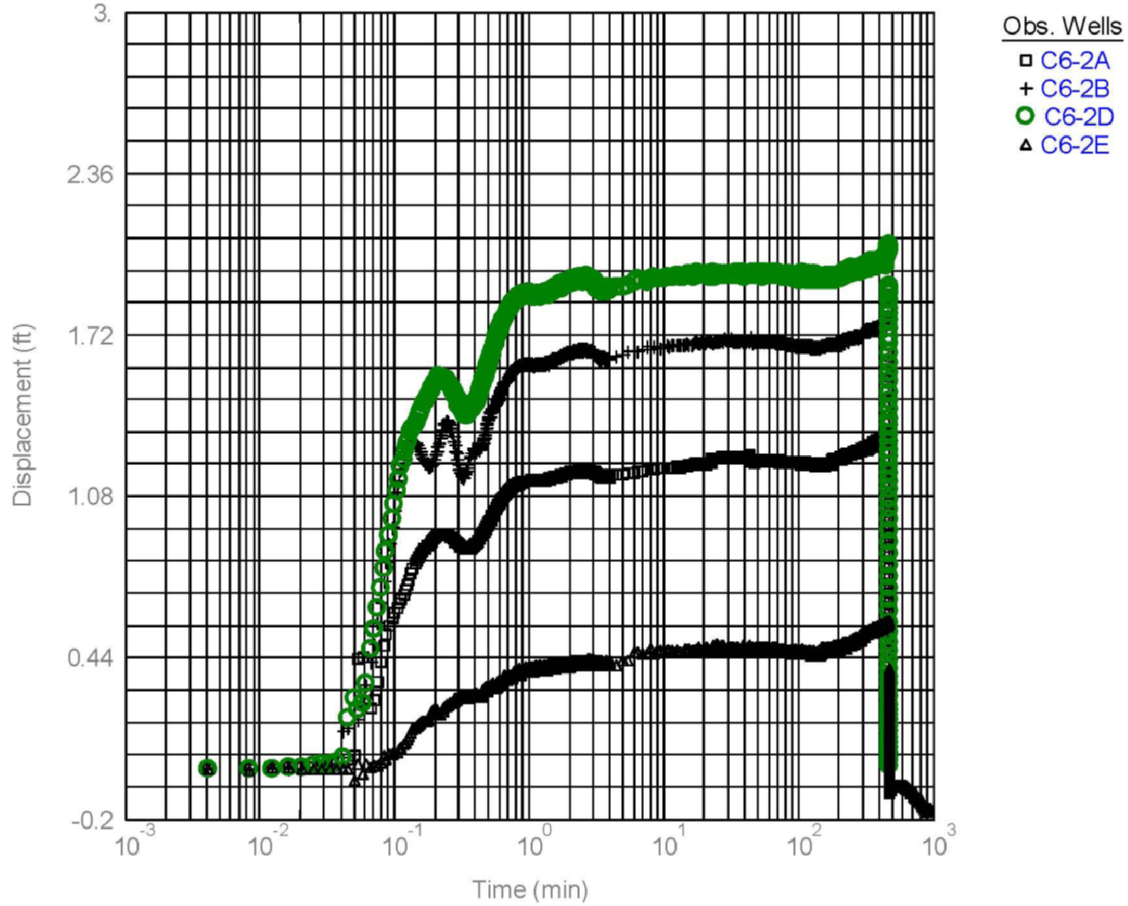


Figure 3 of Attachment 2BB-1 Time-Drawdown Graph for C6-3 Well Cluster

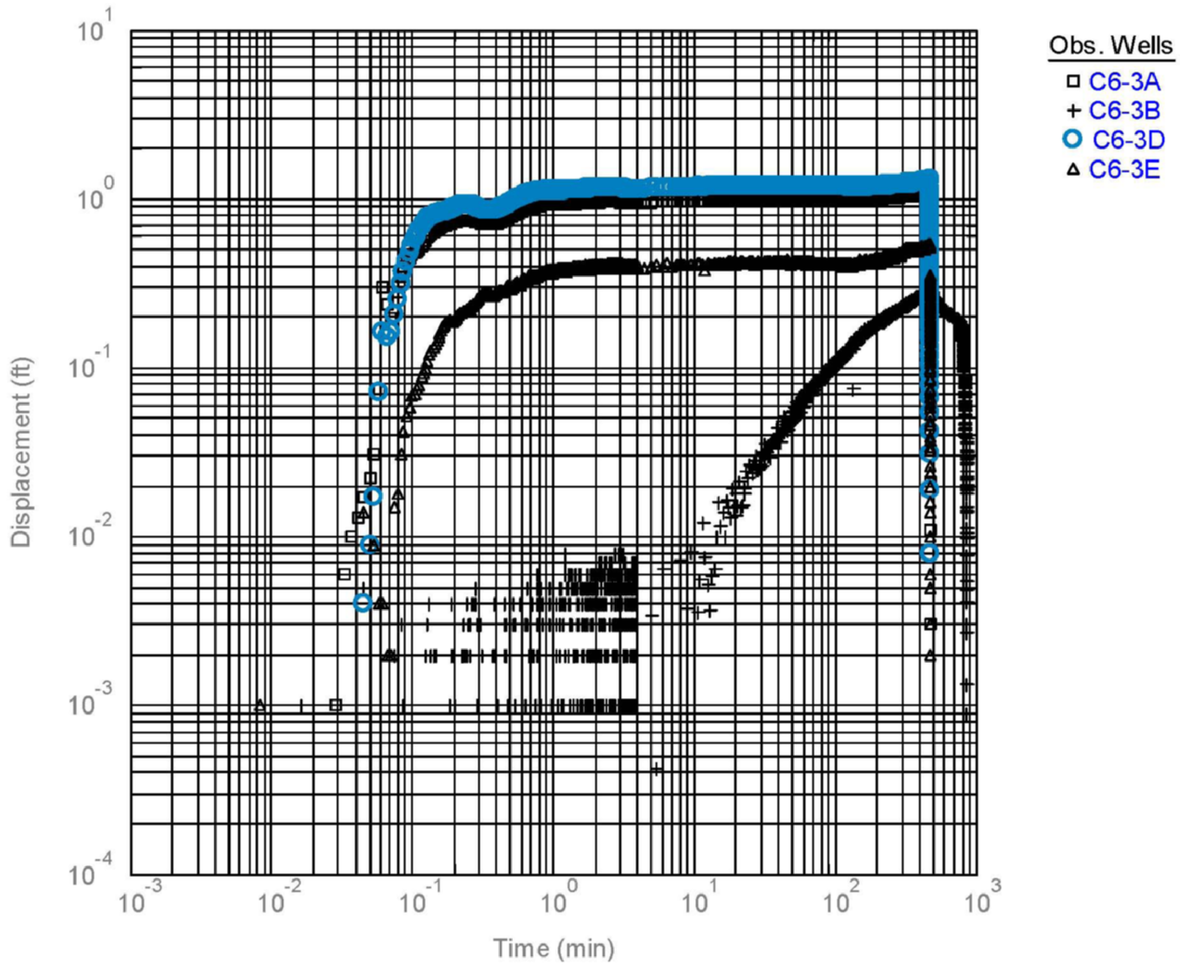


Figure 4 of Attachment 2BB-1 Time-Drawdown Graph for C6-4 Well Cluster

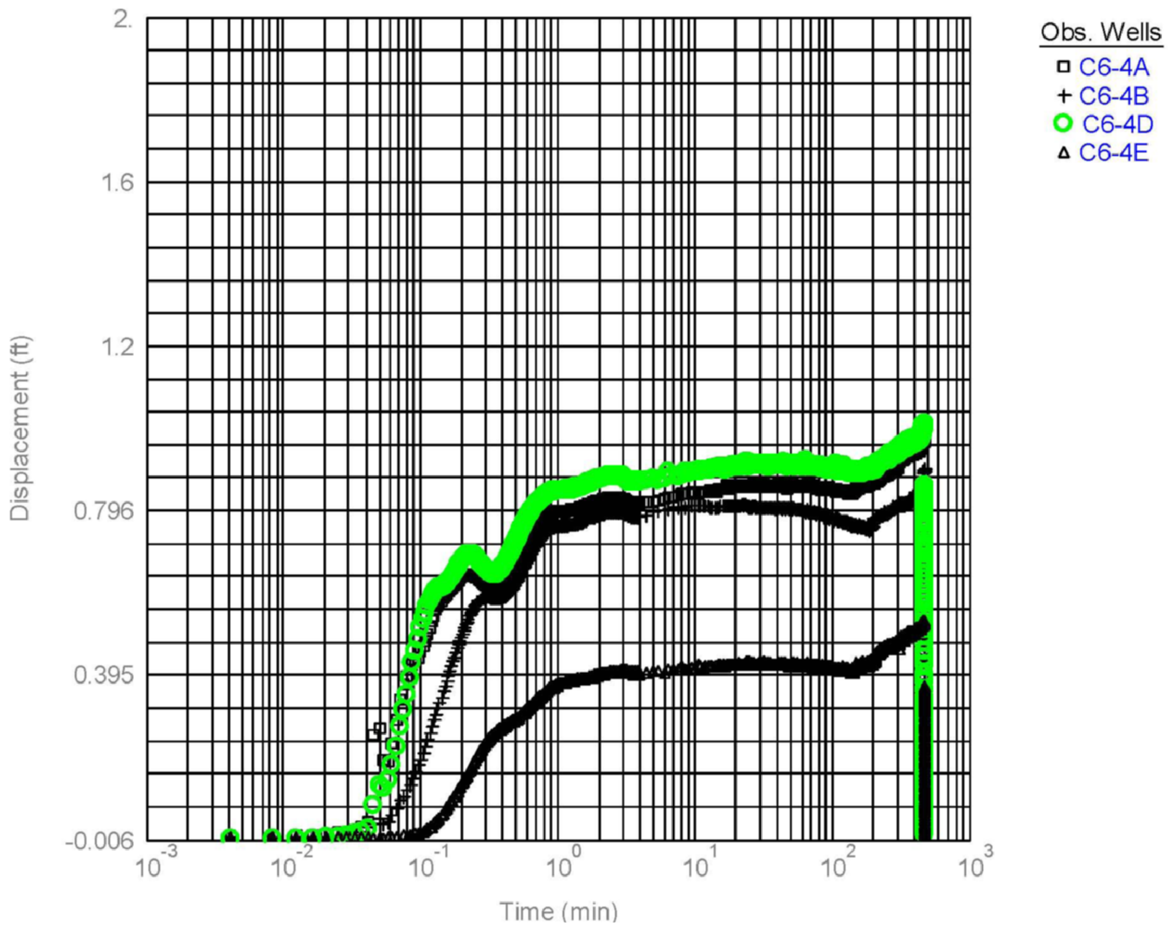


Figure 5 of Attachment 2BB-1 Distance-Drawdown Graph for PW-6U Test (t = 20 minutes)

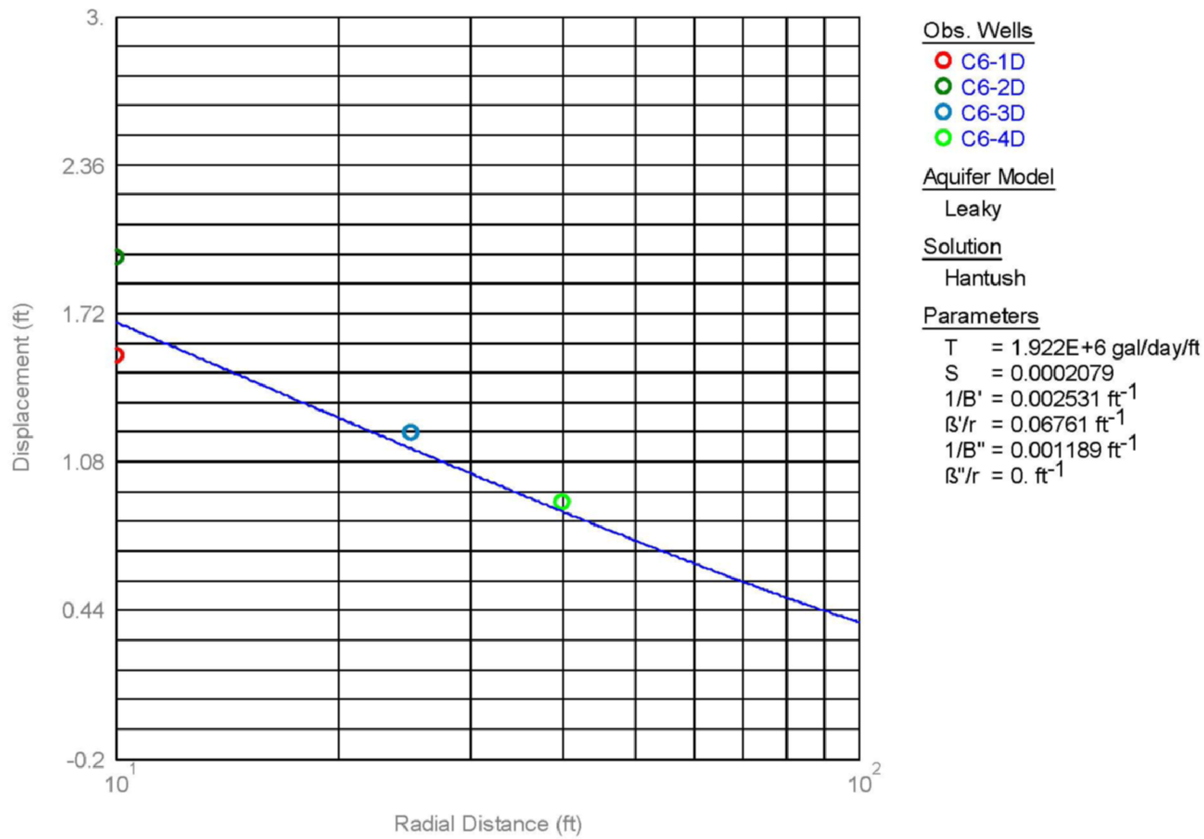


Figure 6 of Attachment 2BB-1 Time-Drawdown Graph for C6-1D Using Theis Method

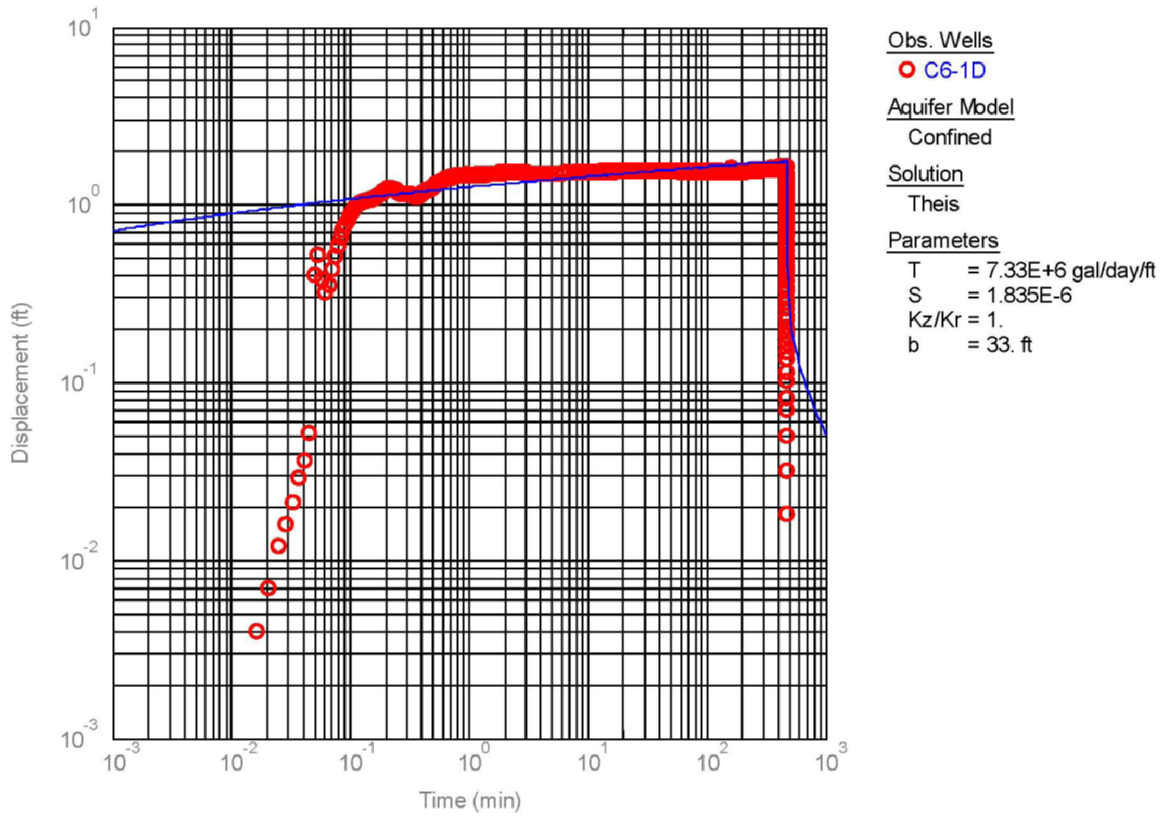


Figure 7 of Attachment 2BB-1 Time-Drawdown Graph for C6-2D Using Theis Method

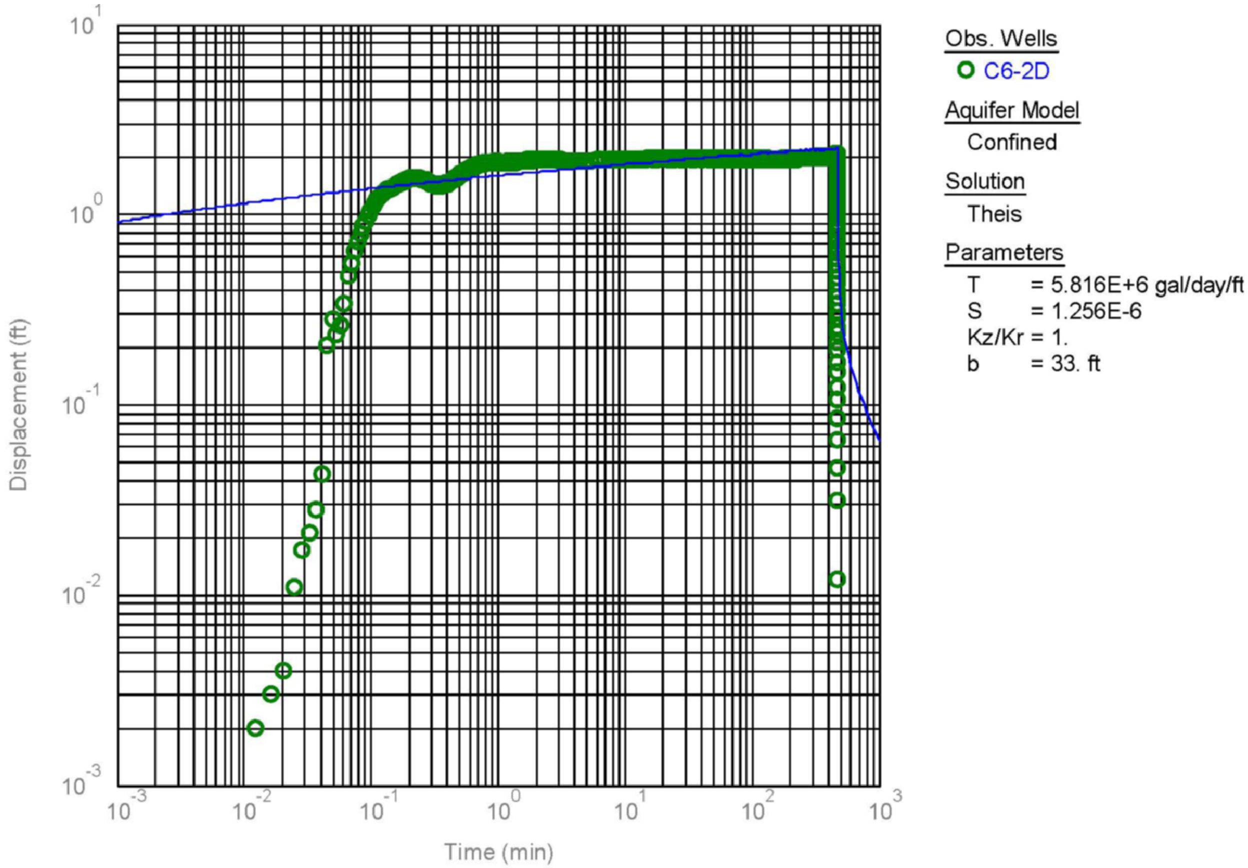


Figure 8 of Attachment 2BB-1 Time-Drawdown Graph for C6-2D Using Hantush Method

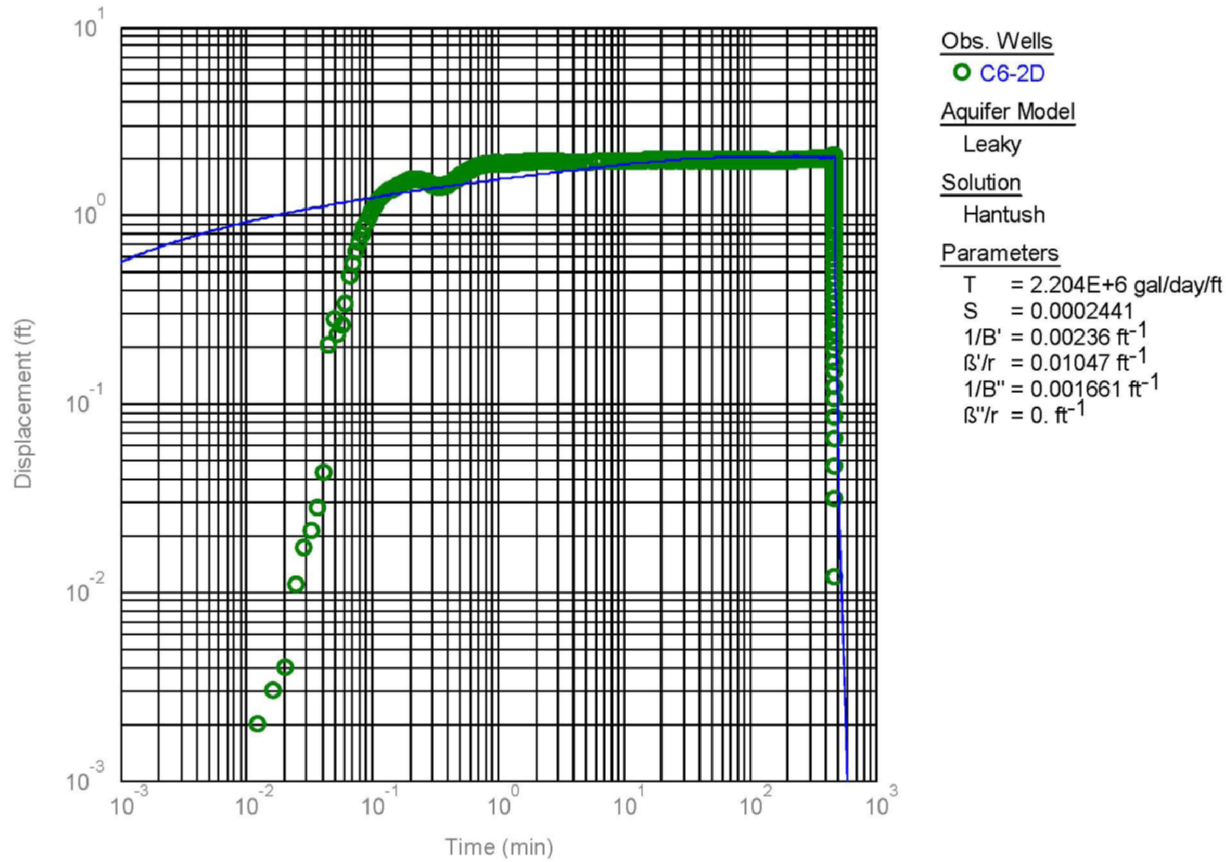


Figure 9 of Attachment 2BB-1 Time-Drawdown Graph for C6-3D Using Theis Method

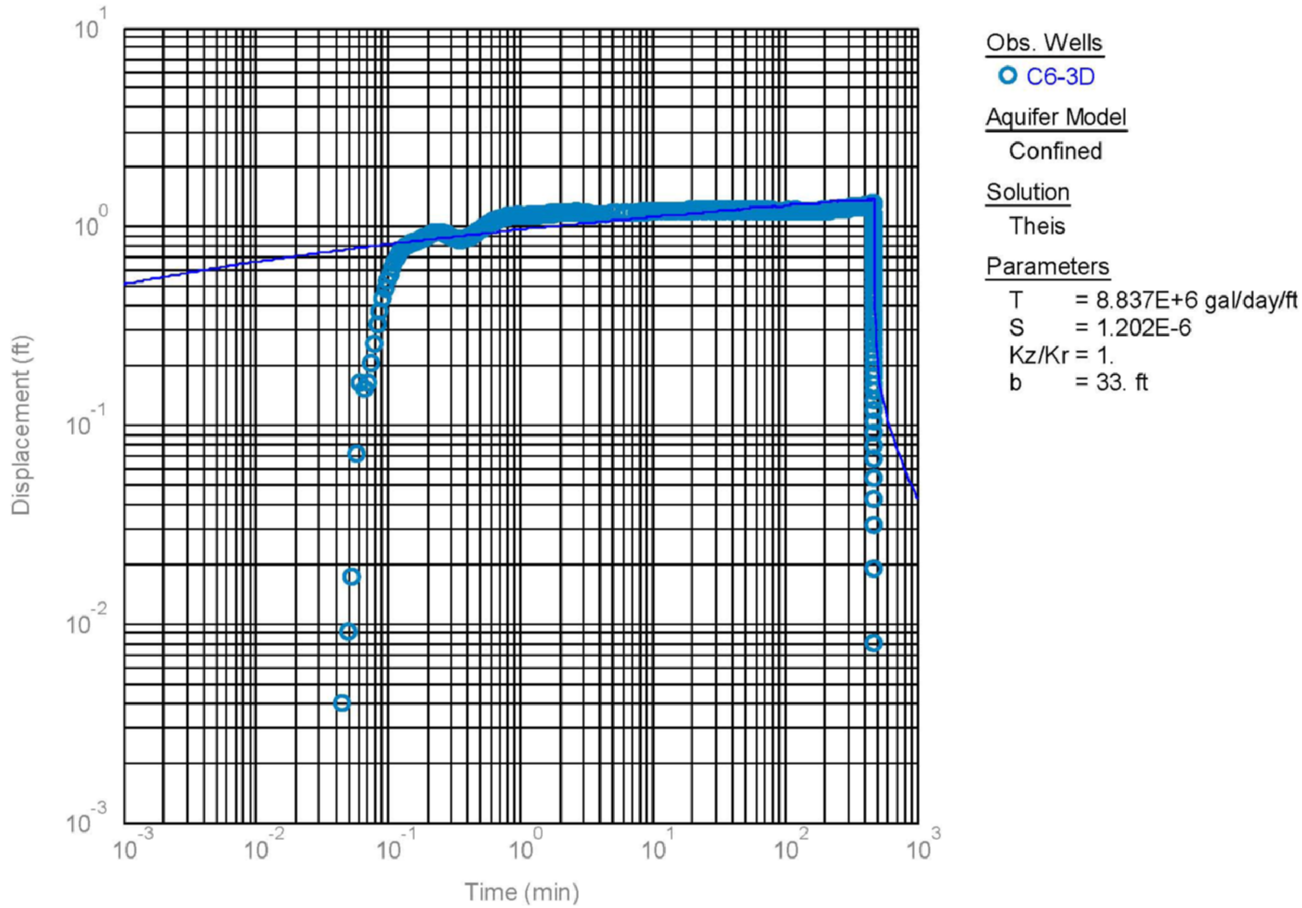


Figure 10 of Attachment 2BB-1 Time-Drawdown Graph for C6-3D Using Hantush Method

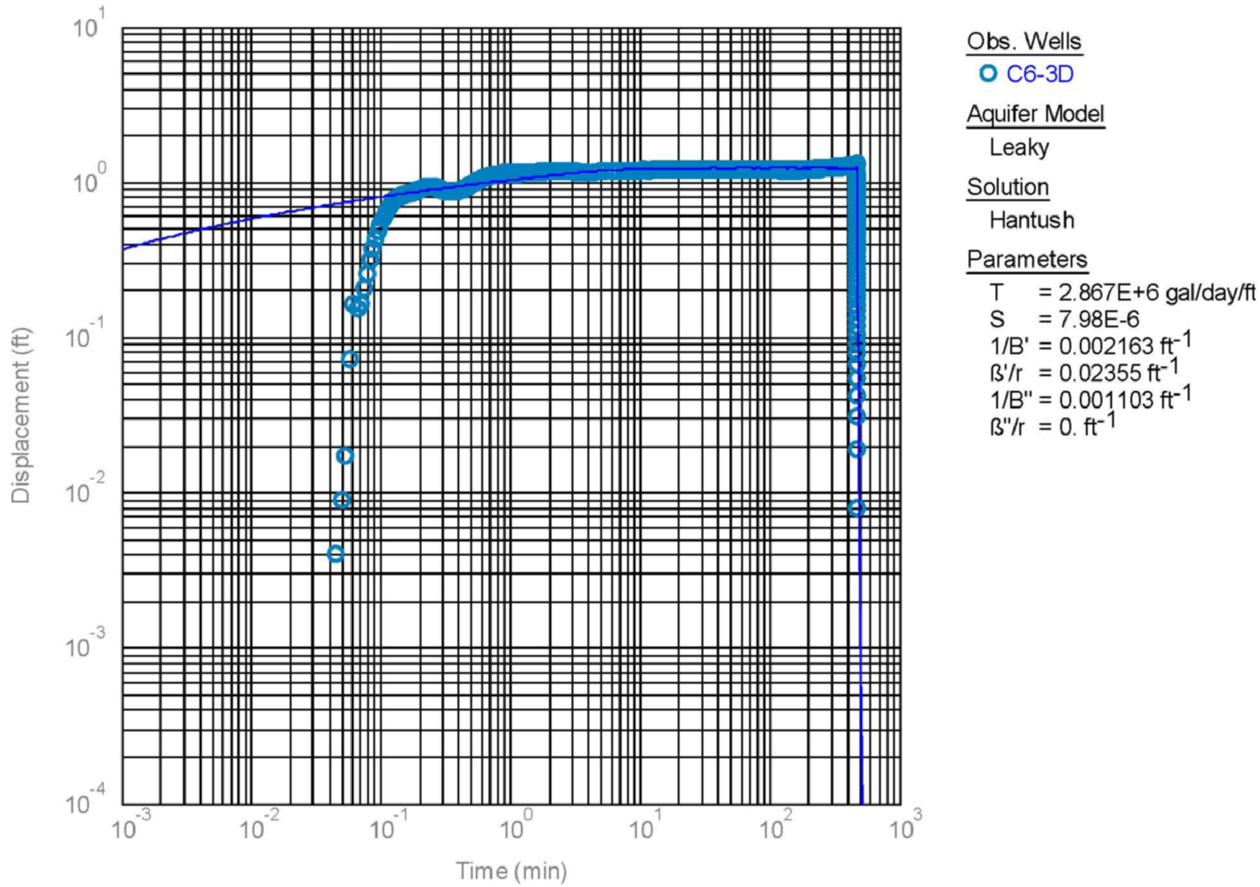
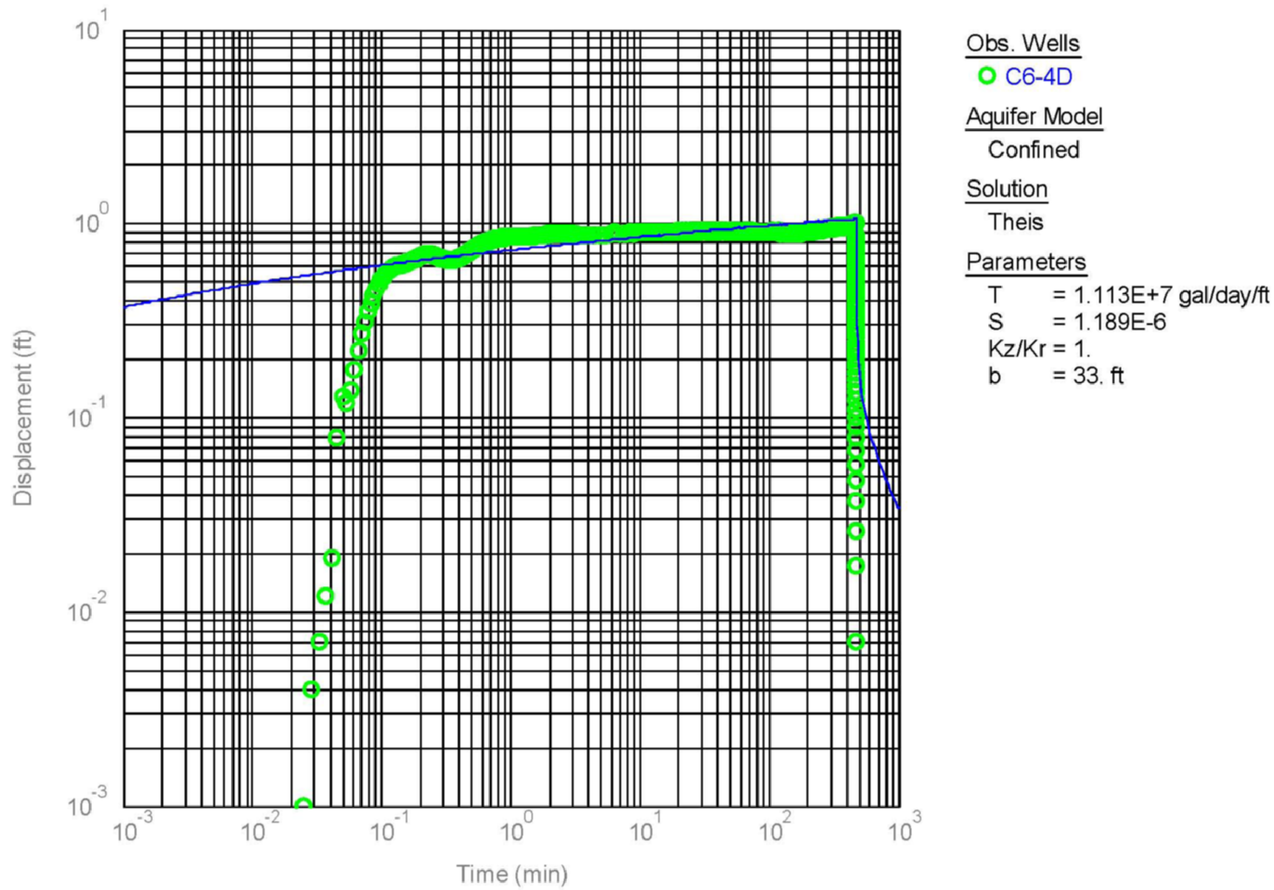


Figure 11 of Attachment 2BB-1 Time-Drawdown Graph for C6-4D Using Theis Method



ATTACHMENT 2BB-2

UNIT 6 DEEP TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-2 (Sheet 1 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 10:05:04	0	3376[a]	—
3/20/2009 10:05:04	5	3376	—
3/20/2009 10:10:04	10	3366	—
3/20/2009 10:15:04	15	3372	3359
3/20/2009 10:20:04	20	3373	—
3/20/2009 10:25:04	25	3339	—
3/20/2009 10:30:04	30	3318	3332
3/20/2009 10:35:04	35	3355	—
3/20/2009 10:40:05	40	3342	—
3/20/2009 10:45:04	45	3325	3334
3/20/2009 10:50:04	50	3344	—
3/20/2009 10:55:04	55	3347	—
3/20/2009 11:00:04	60	3354	3347
3/20/2009 11:05:05	65	3358	—
3/20/2009 11:10:04	70	3336	—
3/20/2009 11:15:04	75	3357	3360
3/20/2009 11:20:04	80	3344	—
3/20/2009 11:25:06	85	3341	—
3/20/2009 11:30:04	90	3360	3348
3/20/2009 11:35:04	95	3366	—
3/20/2009 11:40:04	100	3328	—
3/20/2009 11:45:04	105	3366	3354
3/20/2009 11:50:04	110	3360	—
3/20/2009 11:55:04	115	3352	—
3/20/2009 12:00:04	120	3354	3362
3/20/2009 12:05:04	125	3350	—
3/20/2009 12:10:05	130	3371	—
3/20/2009 12:15:04	135	3354	3342
3/20/2009 12:20:04	140	3346	—
3/20/2009 12:25:04	145	3328	—
3/20/2009 12:30:04	150	3345	3360
3/20/2009 12:35:04	155	3328	—
3/20/2009 12:40:04	160	3339	—
3/20/2009 12:45:04	165	3352	3322
3/20/2009 12:50:04	170	3331	—
3/20/2009 12:55:05	175	3336	—
3/20/2009 13:00:04	180	3357	3341

Table 1 of Attachment 2BB-2 (Sheet 2 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 13:05:04	185	3331	—
3/20/2009 13:10:04	190	3353	—
3/20/2009 13:15:04	195	3312	3329
3/20/2009 13:20:04	200	3344	—
3/20/2009 13:25:04	205	3337	—
3/20/2009 13:30:04	210	3368	3350
3/20/2009 13:35:04	215	3346	—
3/20/2009 13:40:05	220	3355	—
3/20/2009 13:45:04	225	3335	3339
3/20/2009 13:50:04	230	3350	—
3/20/2009 13:55:05	235	3318	—
3/20/2009 14:00:04	240	3350	3331
3/20/2009 14:05:04	245	3342	—
3/20/2009 14:10:04	250	3332	—
3/20/2009 14:15:04	255	3331	3353
3/20/2009 14:20:04	260	3332	—
3/20/2009 14:25:06	265	3314	—
3/20/2009 14:30:04	270	3315	3347
3/20/2009 14:35:05	275	3348	—
3/20/2009 14:40:04	280	3344	—
3/20/2009 14:45:04	285	3354	3342
3/20/2009 14:50:04	290	3345	—
3/20/2009 14:55:05	295	3324	—
3/20/2009 15:00:04	300	3341	3338
3/20/2009 15:05:04	305	3329	—
3/20/2009 15:10:05	310	3309	—
3/20/2009 15:15:04	315	3323	3354
3/20/2009 15:20:04	320	3344	—
3/20/2009 15:25:04	325	3312	—
3/20/2009 15:30:04	330	3329	3332
3/20/2009 15:35:05	335	3339	—
3/20/2009 15:40:04	340	3330	—
3/20/2009 15:45:05	345	3314	3346
3/20/2009 15:50:04	350	3333	—
3/20/2009 15:55:05	355	3347	—
3/20/2009 16:00:04	360	3350	3355
3/20/2009 16:05:04	365	3320	—
3/20/2009 16:10:04	370	3358	—

Table 1 of Attachment 2BB-2 (Sheet 3 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 16:15:04	375	3334	3340
3/20/2009 16:20:04	380	3355	—
3/20/2009 16:25:04	385	3349	—
3/20/2009 16:30:04	390	3329	3346
3/20/2009 16:35:04	395	3328	—
3/20/2009 16:40:05	400	3347	—
3/20/2009 16:45:04	405	3336	3354
3/20/2009 16:50:04	410	3344	—
3/20/2009 16:55:04	415	3346	—
3/20/2009 17:00:05	420	3351	3368
3/20/2009 17:05:04	425	3326	—
3/20/2009 17:10:05	430	3335	—
3/20/2009 17:15:05	435	3362	3376
3/20/2009 17:20:04	440	3349	—
3/20/2009 17:25:05	445	3370	—
3/20/2009 17:30:04	450	3343	3333
3/20/2009 17:35:04	455	3354	—
3/20/2009 17:40:04	460	3324	—
3/20/2009 17:45:04	465	3335	3356
3/20/2009 17:50:04	470	3336	—
3/20/2009 17:55:04	475	3356	—
3/20/2009 18:00	480	0	—

(a) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-2 Time-Drawdown Graph for C6-5 Well Cluster

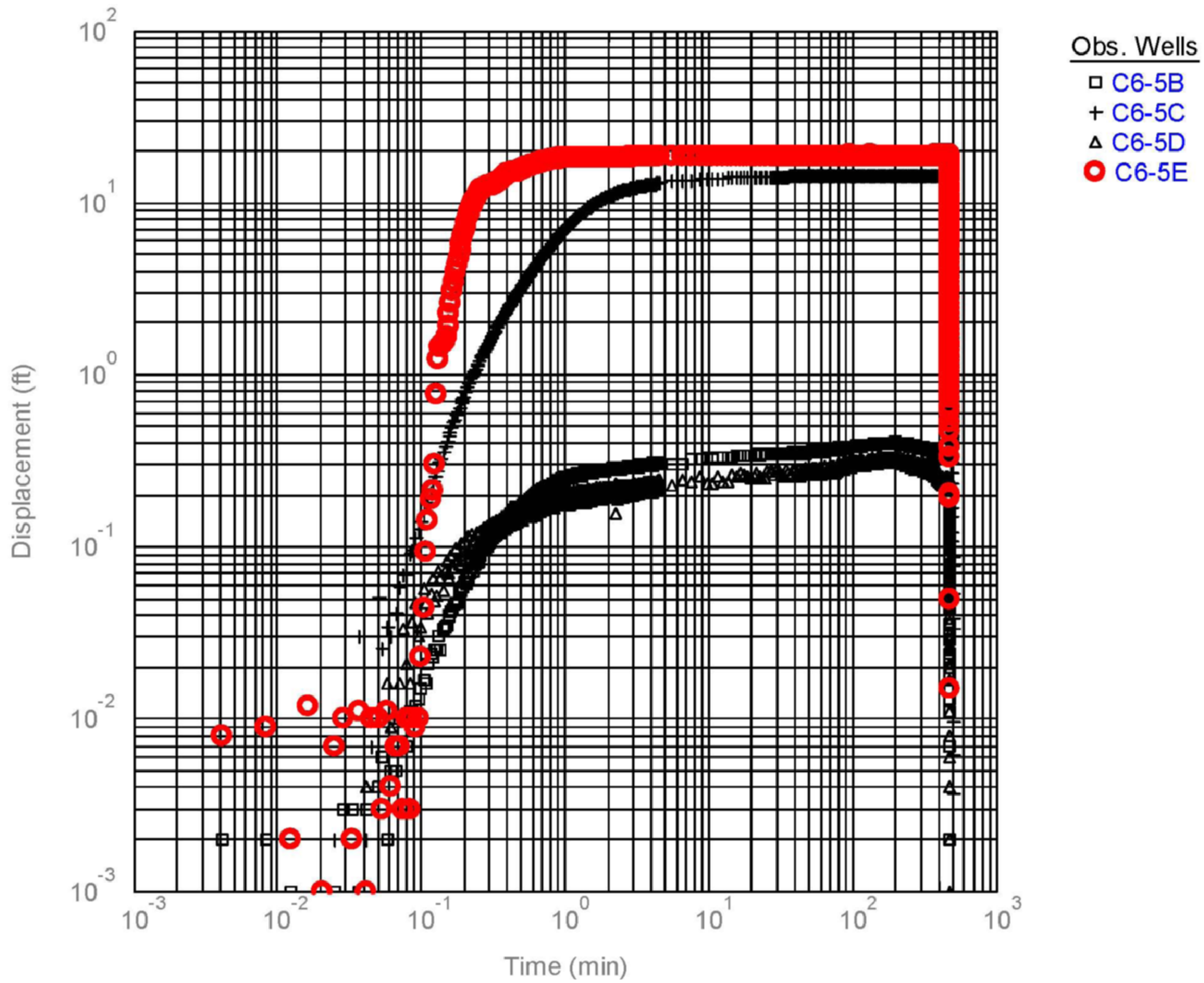


Figure 2 of Attachment 2BB-2 Time-Drawdown Graph for C6-4 Well Cluster

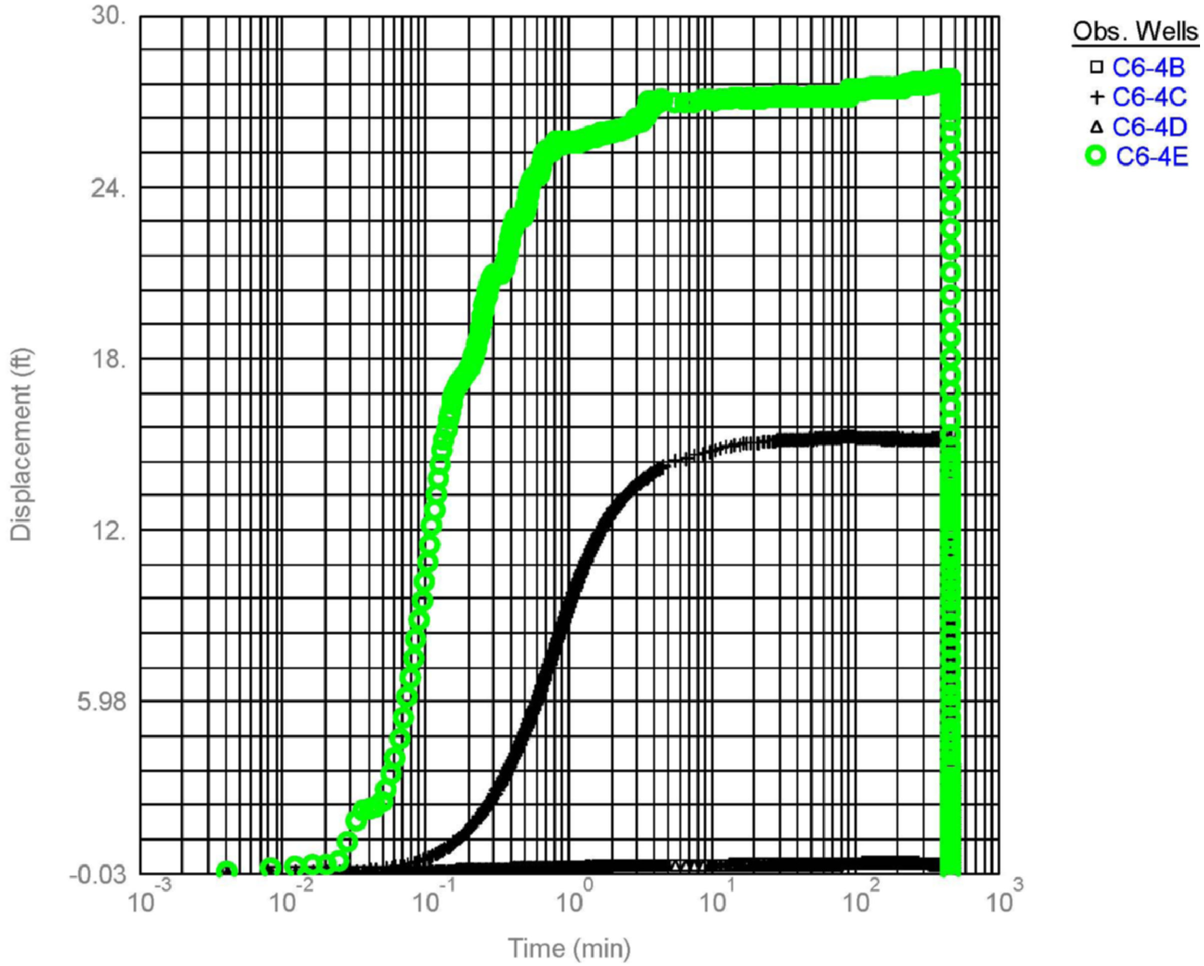


Figure 3 of Attachment 2BB-2 Time-Drawdown Graph for C6-3 Well Cluster

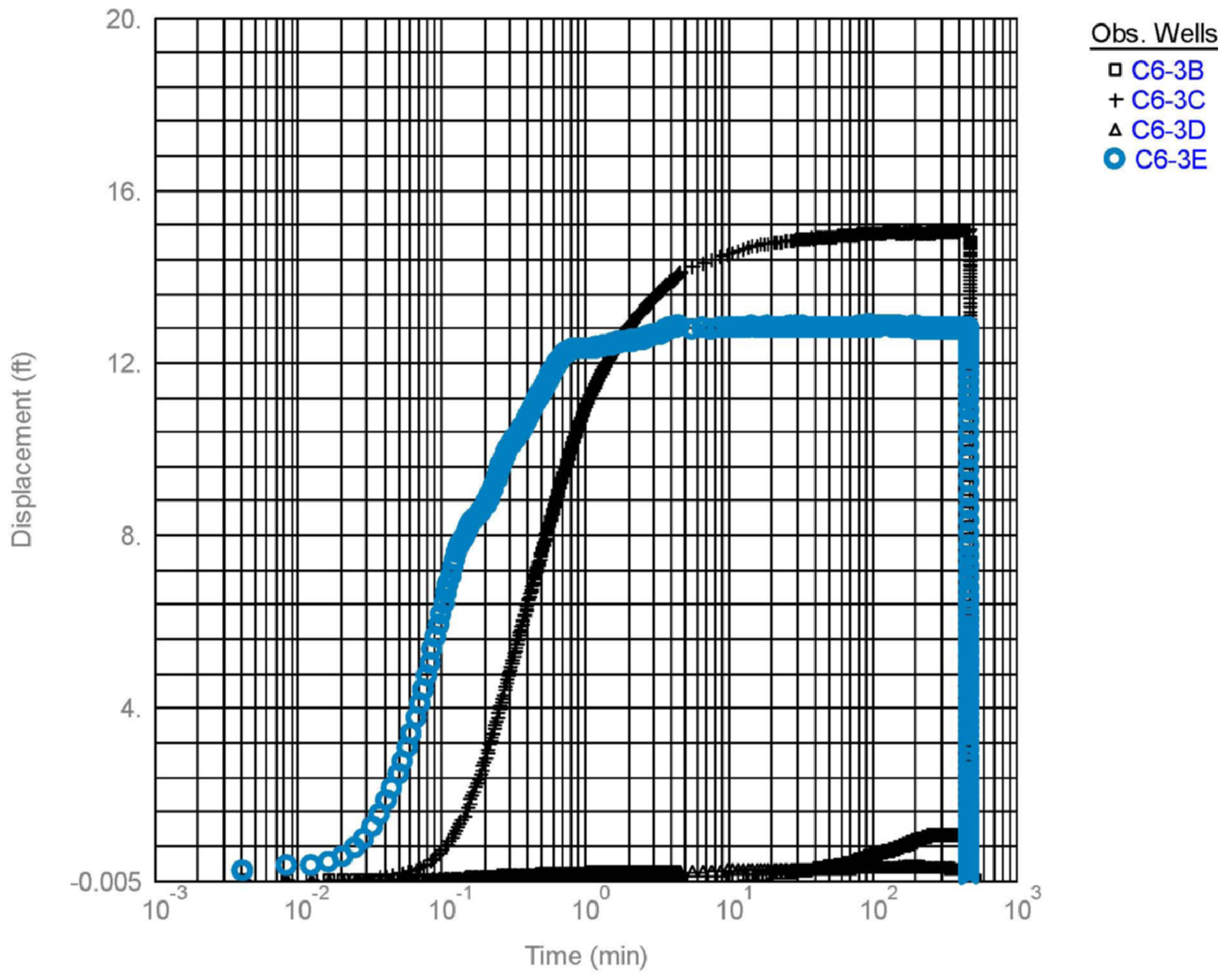


Figure 4 of Attachment 2BB-2 Time-Drawdown Graph for C6-2 Well Cluster

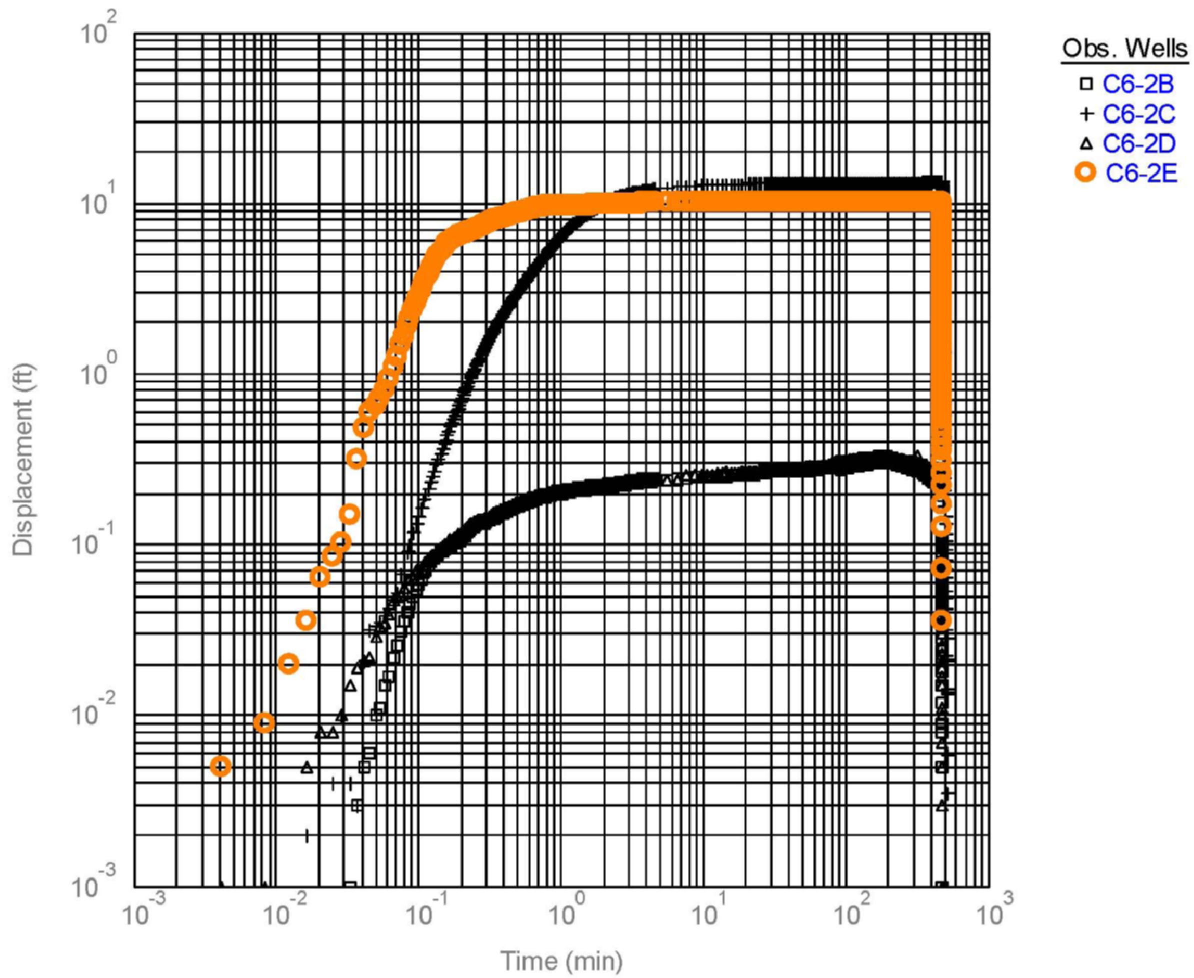


Figure 5 of Attachment 2BB-2 Distance-Drawdown Graph for PW-6L Test (t = 20 minutes)

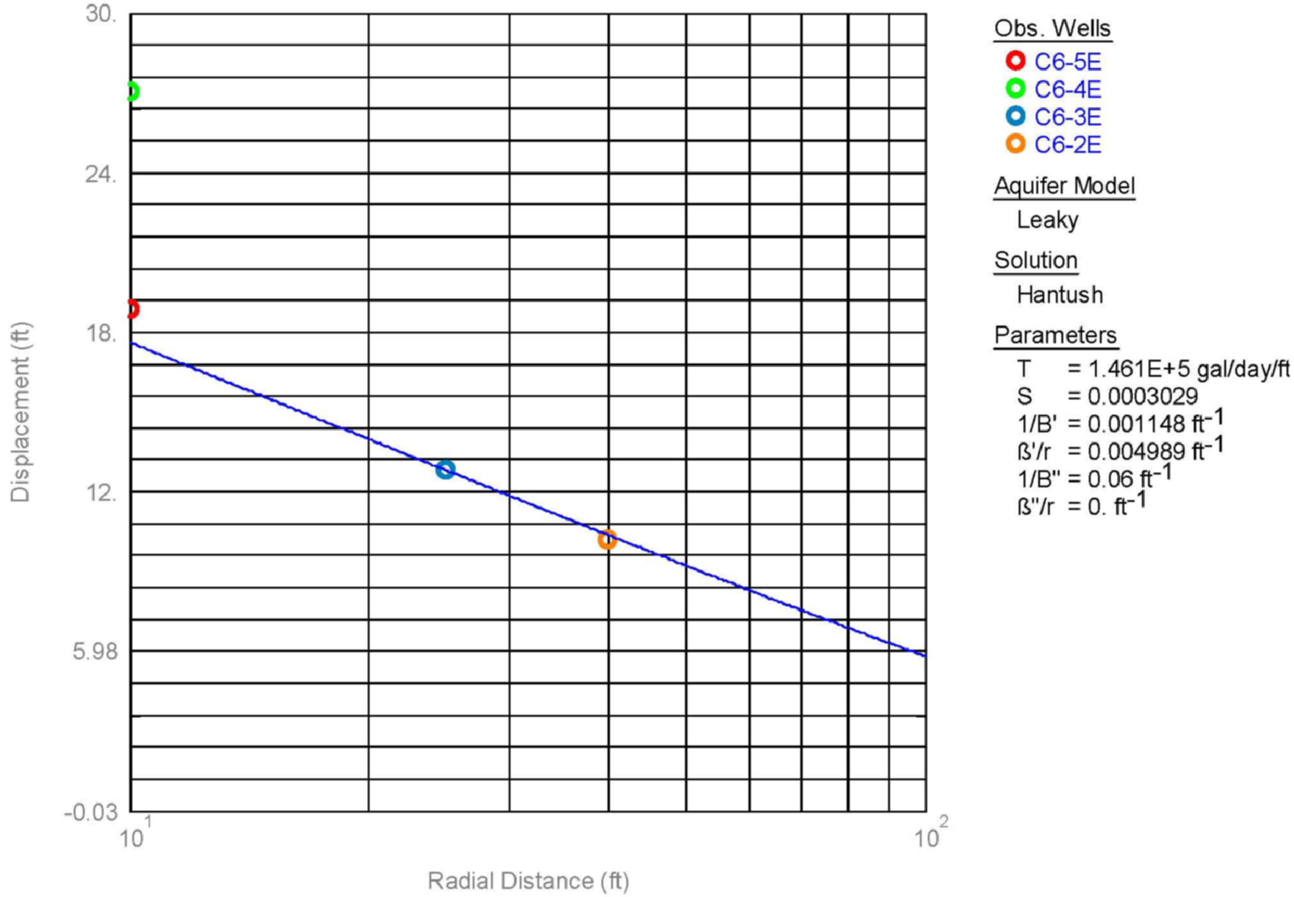


Figure 6 of Attachment 2BB-2 Time-Drawdown Graph for C6-5E Using Theis Method

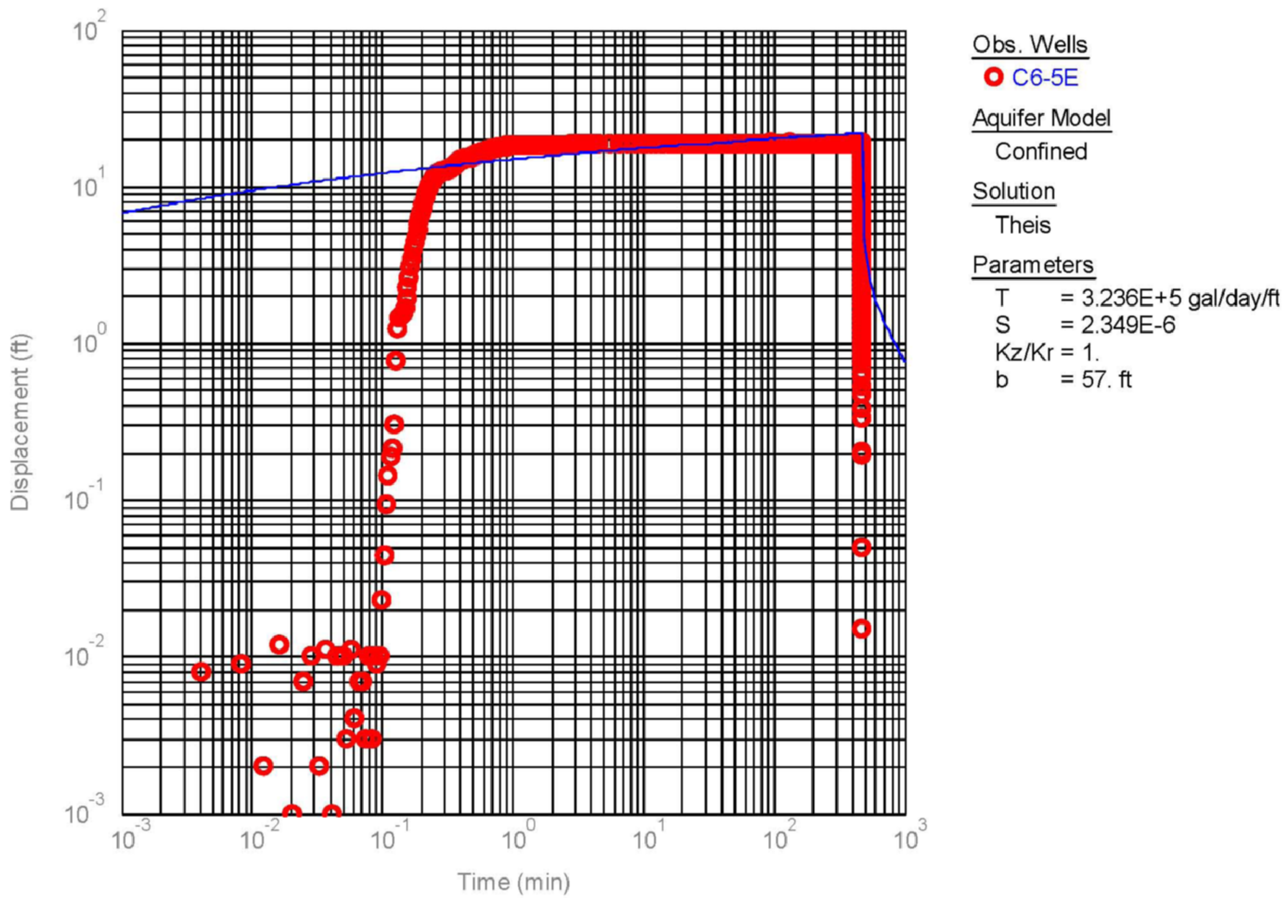


Figure 7 of Attachment 2BB-2 Time-Drawdown Graph for C6-5E Using Hantush Method

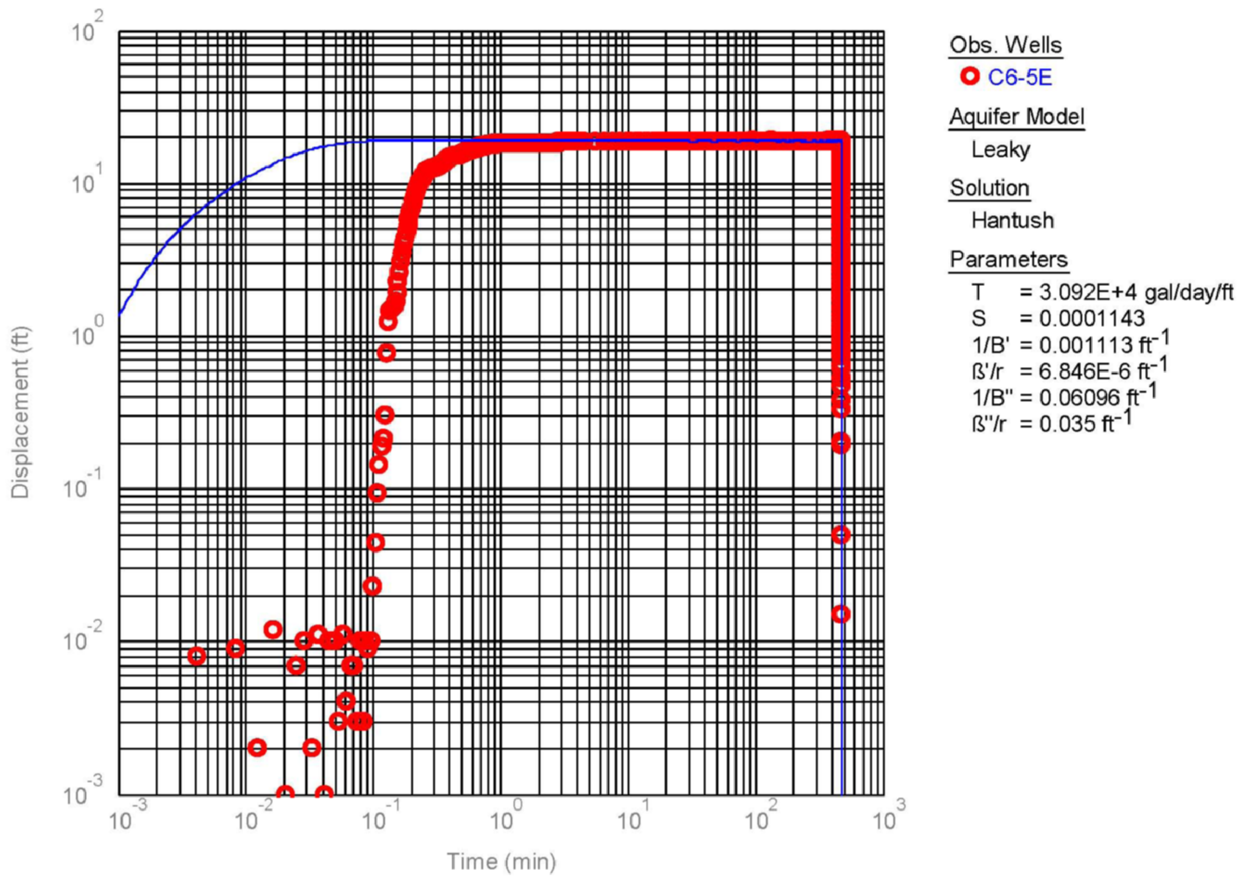


Figure 8 of Attachment 2BB-2 Time-Drawdown Graph for C6-4E Using Theis Method

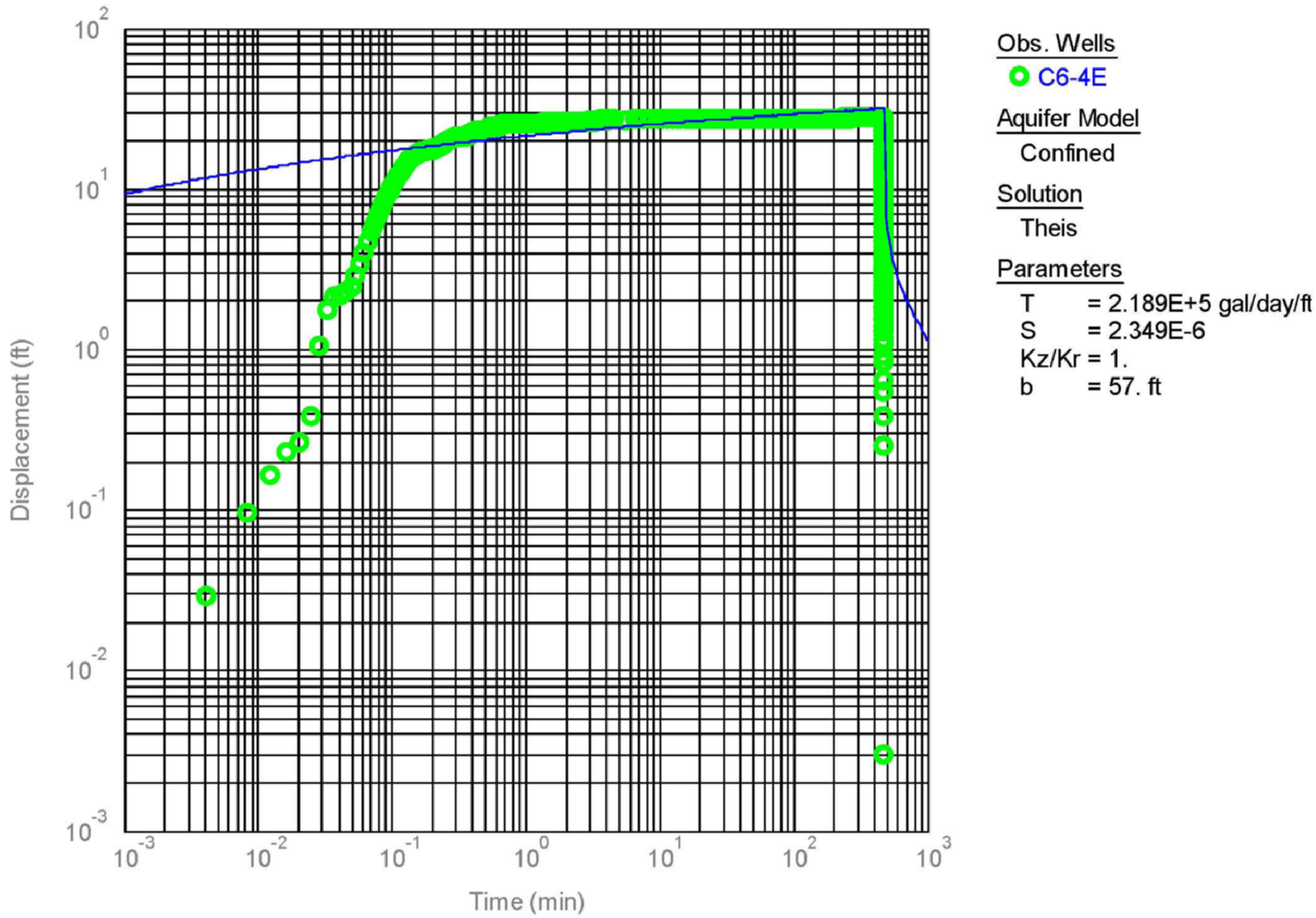


Figure 9 of Attachment 2BB-2 Time-Drawdown Graph for C6-4E Using Hantush Method

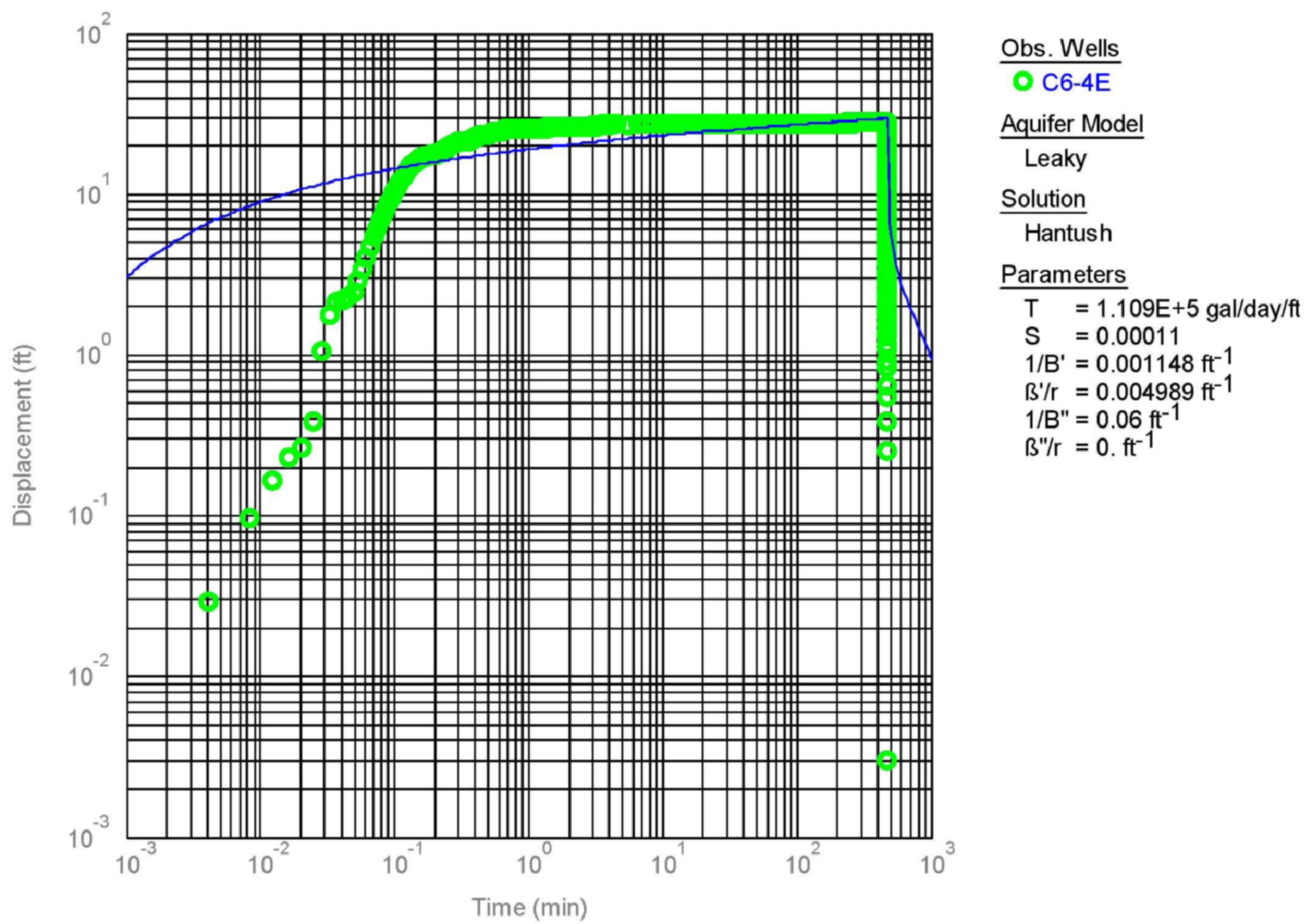


Figure 10 of Attachment 2BB-2 Time-Drawdown Graph for C6-3E Using Theis Method

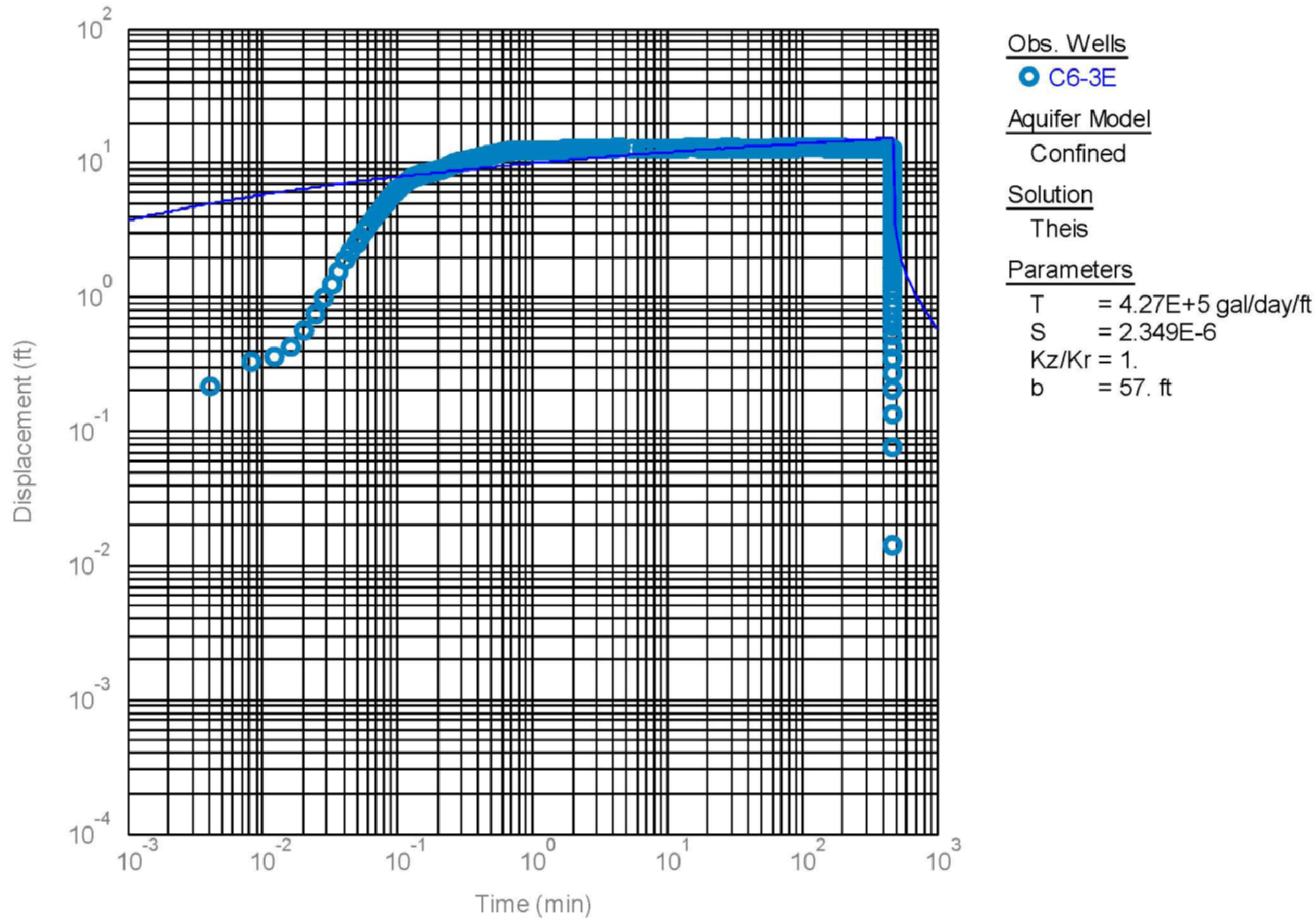


Figure 11 of Attachment 2BB-2 Time-Drawdown Graph for C6-3E Using Hantush Method

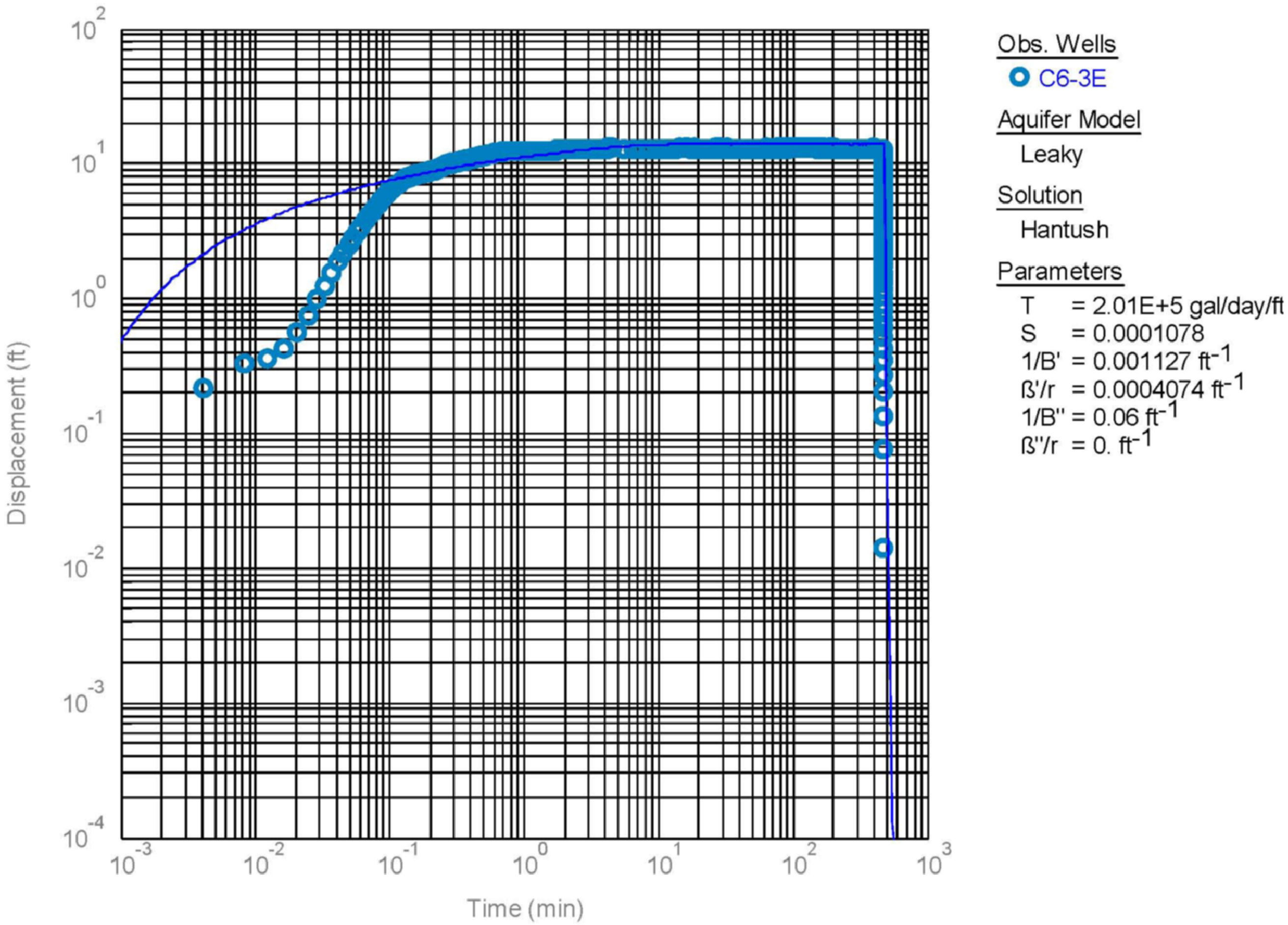
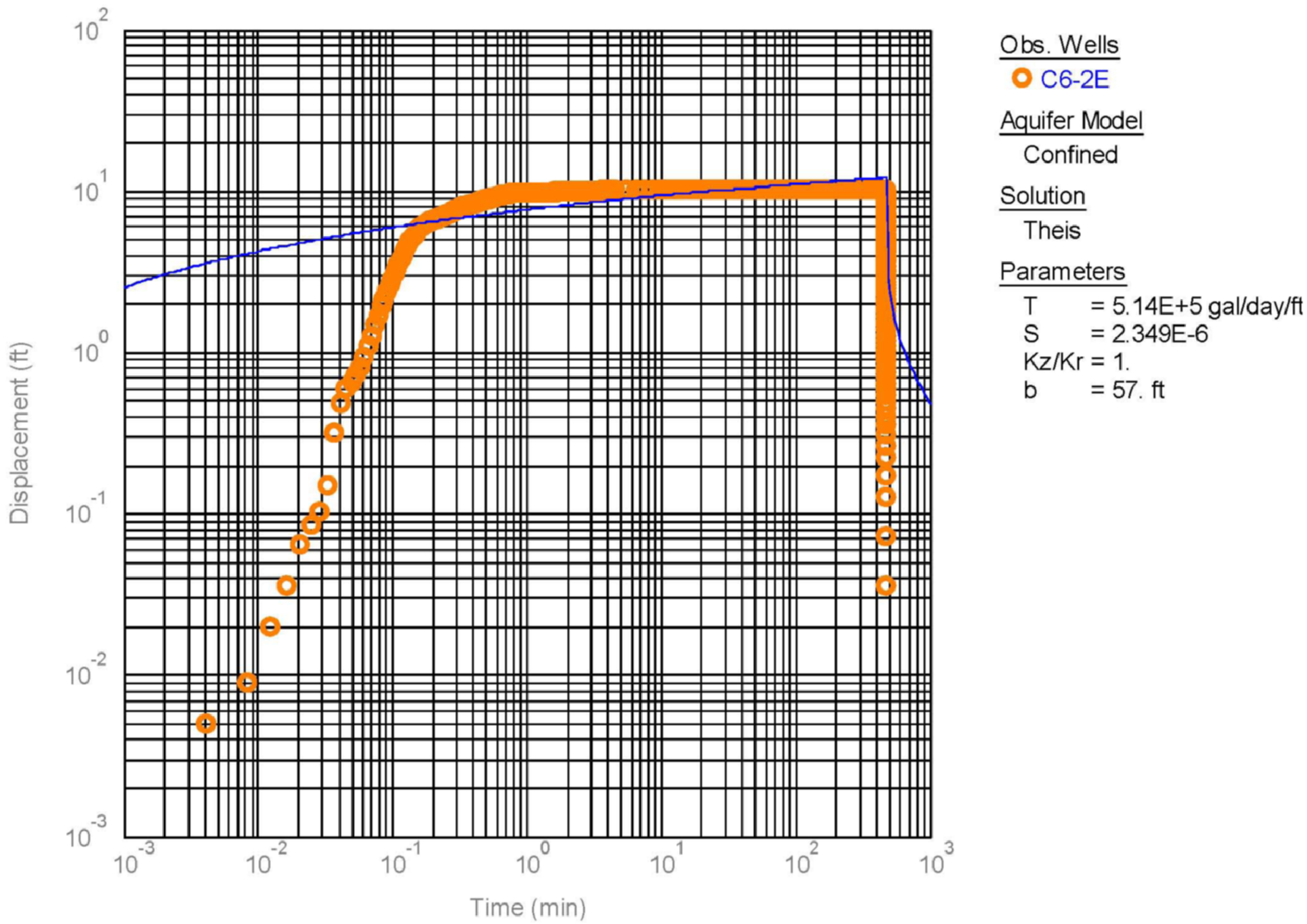


Figure 12 of Attachment 2BB-2 Time-Drawdown Graph for C6-2E Using Theis Method



ATTACHMENT 2BB-3

UNIT 7 SHALLOW TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-3 (Sheet 1 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)[b]
2/23/2009 19:00:15	0	4179[a]	—
2/23/2009 19:02:15	2.25	4179	—
2/23/2009 19:07:15	7.25	4149	—
2/23/2009 19:12:15	12.25	4185	—
2/23/2009 19:17:15	17.25	4175	4150
2/23/2009 19:22:14	22.23	4178	—
2/23/2009 19:27:14	27.23	4154	—
2/23/2009 19:32:14	32.23	4174	4165
2/23/2009 19:37:14	37.23	4181	—
2/23/2009 19:42:14	42.23	4174	—
2/23/2009 19:47:14	47.23	4142	4169
2/23/2009 19:52:14	52.23	4178	—
2/23/2009 19:57:15	57.25	4176	—
2/23/2009 20:02:14	62.23	4171	4178
2/23/2009 20:07:15	67.25	4174	—
2/23/2009 20:12:14	72.23	4180	—
2/23/2009 20:17:14	77.23	4151	4195
2/23/2009 20:22:14	82.23	4183	—
2/23/2009 20:27:14	87.23	4178	—
2/23/2009 20:32:14	92.23	4196	4175
2/23/2009 20:37:14	97.23	4164	—
2/23/2009 20:42:15	102.25	4168	—
2/23/2009 20:47:15	107.25	4196	4172
2/23/2009 20:52:14	112.23	4153	—
2/23/2009 20:57:15	117.25	4161	—
2/23/2009 21:02:14	122.23	4147	4167
2/23/2009 21:07:14	127.23	4167	—
2/23/2009 21:12:14	132.23	4195	—
2/23/2009 21:17:14	137.23	4152	4181
2/23/2009 21:22:14	142.23	4187	—
2/23/2009 21:27:15	147.25	4169	—
2/23/2009 21:32:14	152.23	4158	4167
2/23/2009 21:37:14	157.23	4203	—
2/23/2009 21:42:14	162.23	4143	—
2/23/2009 21:47:15	167.25	4156	4207
2/23/2009 21:52:14	172.23	4182	—

Table 1 of Attachment 2BB-3 (Sheet 2 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)[(b)]
2/23/2009 21:57:14	177.23	4174	—
2/23/2009 22:02:14	182.23	4159	4150
2/23/2009 22:07:14	187.23	4157	—
2/23/2009 22:12:16	192.27	4201	—
2/23/2009 22:17:15	197.25	4172	4151
2/23/2009 22:22:14	202.23	4202	—
2/23/2009 22:27:14	207.23	4172	—
2/23/2009 22:32:14	212.23	4167	4167
2/23/2009 22:37:14	217.23	4200	—
2/23/2009 22:42:14	222.23	4186	—
2/23/2009 22:47:14	227.23	4182	4197
2/23/2009 22:52:14	232.23	4180	—
2/23/2009 22:57:15	237.25	4174	—
2/23/2009 23:02:14	242.23	4189	4174
2/23/2009 23:07:14	247.23	4186	—
2/23/2009 23:12:14	252.23	4159	—
2/23/2009 23:17:14	257.23	4180	4157
2/23/2009 23:22:14	262.23	4173	—
2/23/2009 23:27:14	267.23	4195	—
2/23/2009 23:32:15	272.25	4177	4201
2/23/2009 23:37:14	277.23	4184	—
2/23/2009 23:42:15	282.25	4209	—
2/23/2009 23:47:15	287.25	4202	4203
2/23/2009 23:52:14	292.23	4183	—
2/23/2009 23:57:15	297.25	4208	—
2/24/2009 0:02:14	302.23	4182	4200
2/24/2009 0:07:14	307.23	4205	—
2/24/2009 0:12:14	312.23	4224	—
2/24/2009 0:17:14	317.23	4211	4185
2/24/2009 0:22:14	322.23	4188	—
2/24/2009 0:27:15	327.25	4210	—
2/24/2009 0:32:14	332.23	4196	4214
2/24/2009 0:37:14	337.23	4211	—
2/24/2009 0:42:15	342.25	4214	—
2/24/2009 0:47:14	347.23	4203	4218
2/24/2009 0:52:14	352.23	4209	—
2/24/2009 0:57:14	357.23	4201	—

Table 1 of Attachment 2BB-3 (Sheet 3 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)(b)
2/24/2009 1:02:15	362.25	4189	4164
2/24/2009 1:07:14	367.23	4177	—
2/24/2009 1:12:15	372.25	4184	—
2/24/2009 1:17:14	377.23	4163	4192
2/24/2009 1:22:14	382.23	4202	—
2/24/2009 1:27:14	387.23	4202	—
2/24/2009 1:32:14	392.23	4183	4216
2/24/2009 1:37:15	397.25	4196	—
2/24/2009 1:42:14	402.23	4162	—
2/24/2009 1:47:14	407.23	4179	4191
2/24/2009 1:52:15	412.25	4179	—
2/24/2009 1:57:15	417.25	4182	—
2/24/2009 2:02:14	422.23	4170	4201
2/24/2009 2:07:15	427.25	4208	—
2/24/2009 2:12:14	432.23	4203	—
2/24/2009 2:17:14	437.23	4176	4183
2/24/2009 2:22:15	442.25	4190	—
2/24/2009 2:27:15	447.25	4167	—
2/24/2009 2:32:14	452.23	4200	4185
2/24/2009 2:37:14	457.23	4191	—
2/24/2009 2:42:15	462.25	4175	—
2/24/2009 2:47:15	467.25	4158	4189
2/24/2009 2:52:14	472.23	4174	—
2/24/2009 2:57:14	477.23	4177	—
2/24/2009 3:02:14	482.23	4165	4169
2/24/2009 3:07:14	487.23	4174	—
2/24/2009 3:12:14	492.23	4208	—
2/24/2009 3:17:14	497.23	4219	4198
2/24/2009 3:22:14	502.23	4179	—
2/24/2009 3:27:15	507.25	4161	—
2/24/2009 3:32:14	512.23	4197	4165
2/24/2009 3:37:14	517.23	4164	—
2/24/2009 3:45	525.00	0	—

(a) Value taken from next reading to provide pumping rate at t=0.
(b) Manual measurements reported at the closest electronic measurement time.

Figure 1 of Attachment 2BB-3 Time-Drawdown Graph for C7-1 Well Cluster

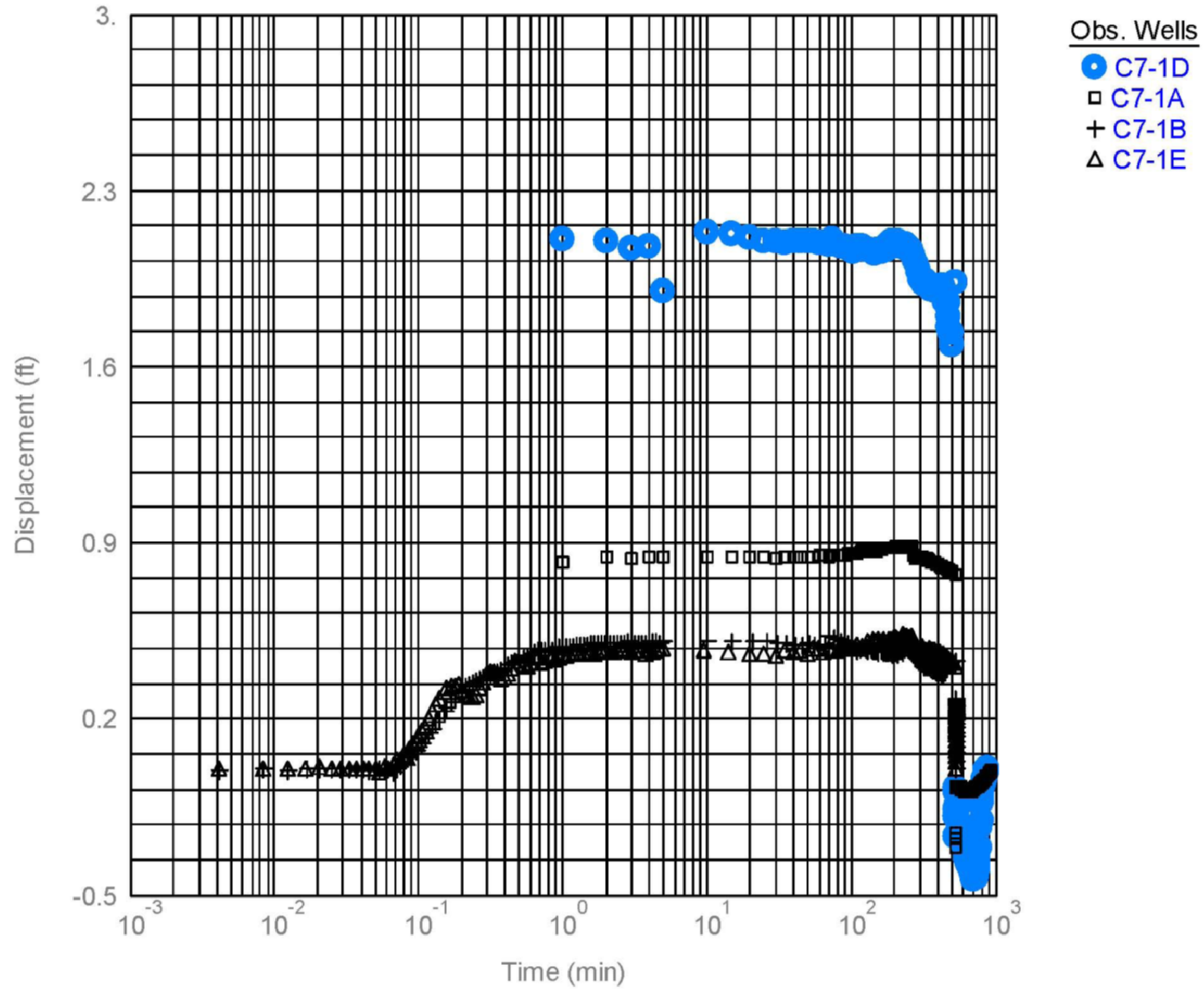


Figure 2 of Attachment 2BB-3 Time-Drawdown Graph for C7-2 Well Cluster

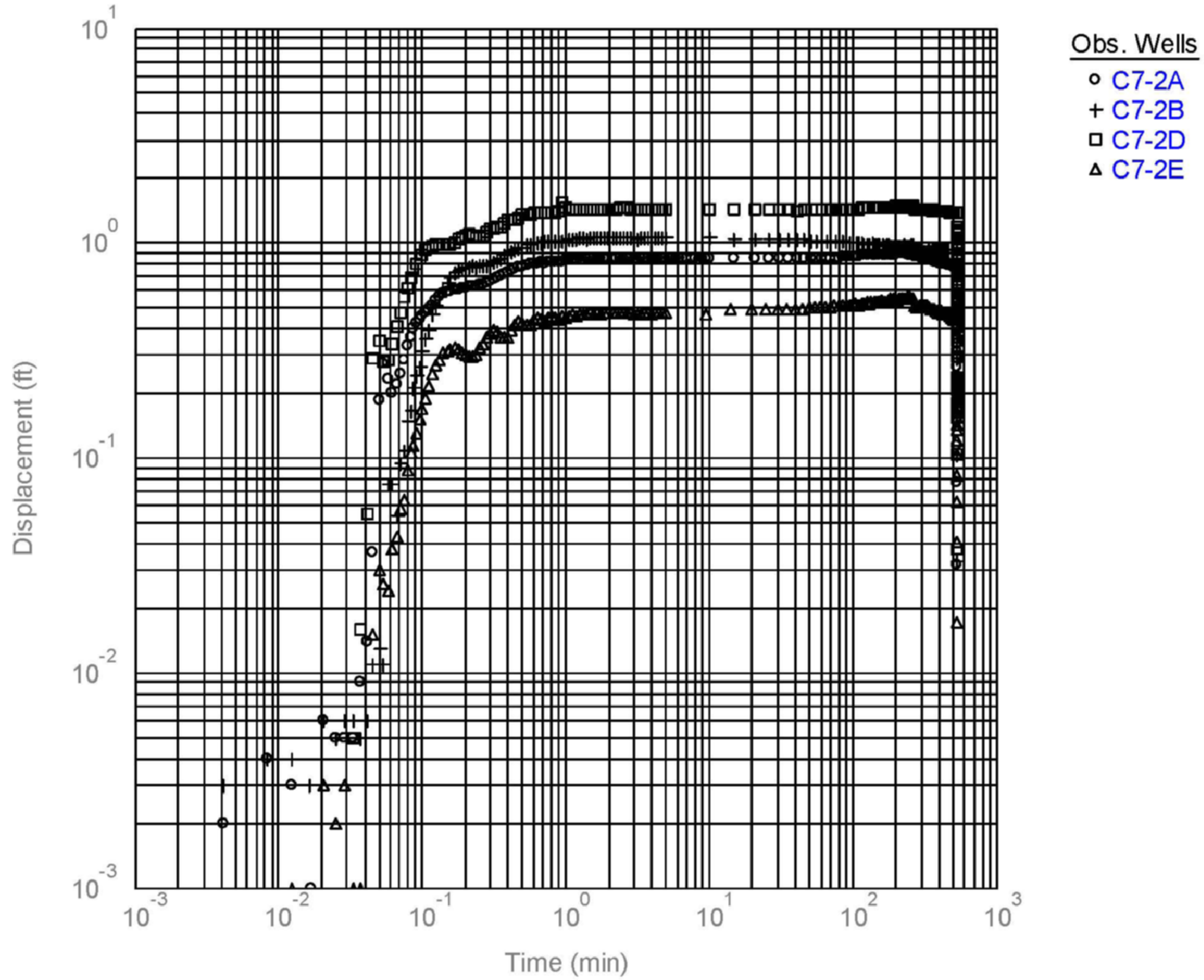


Figure 3 of Attachment 2BB-3 Time-Drawdown Graph for C7-3 Well Cluster

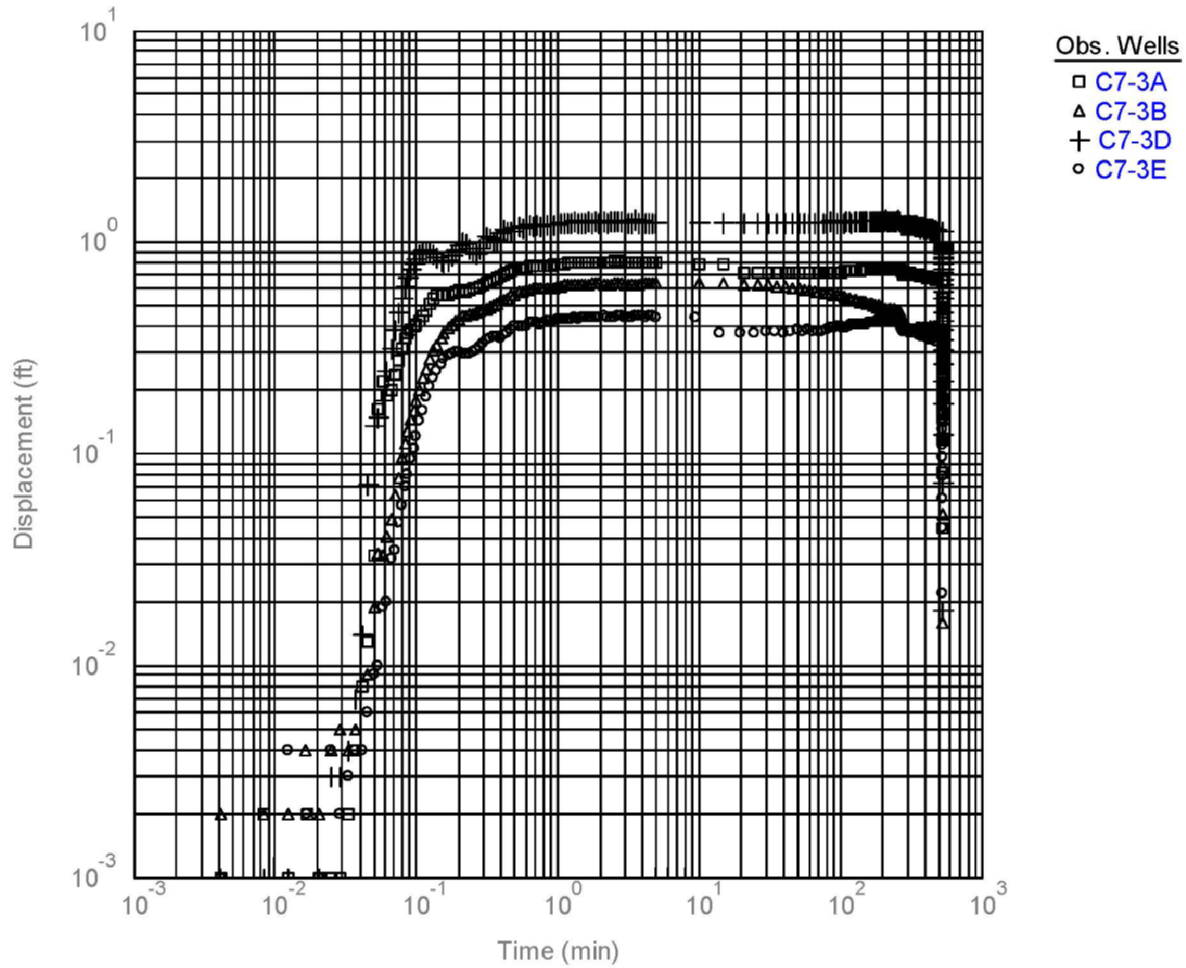


Figure 4 of Attachment 2BB-3 Time-Drawdown Graph for C7-4 Well Cluster

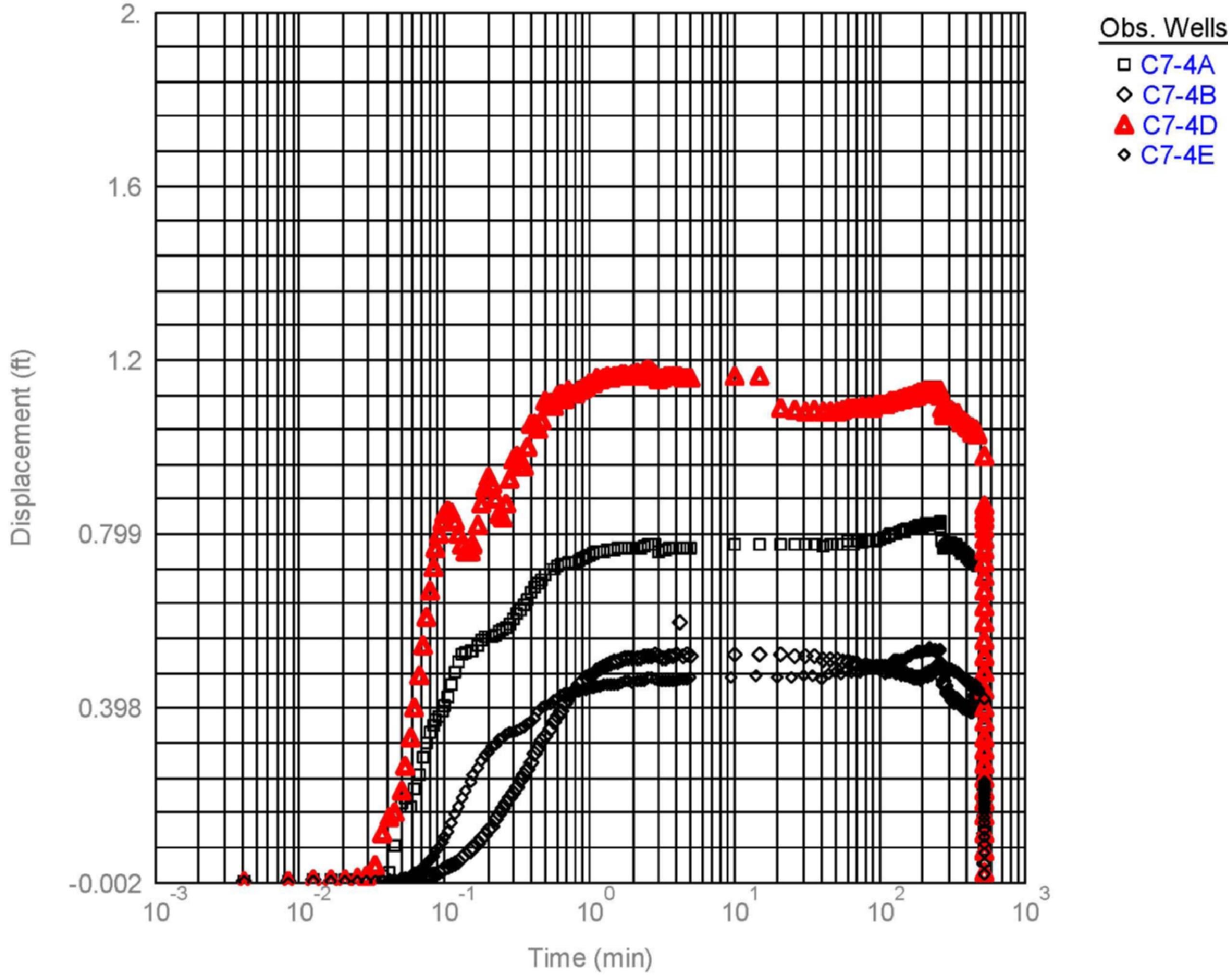


Figure 5 of Attachment 2BB-3 Distance Drawdown Graph (at t= 20 minutes)

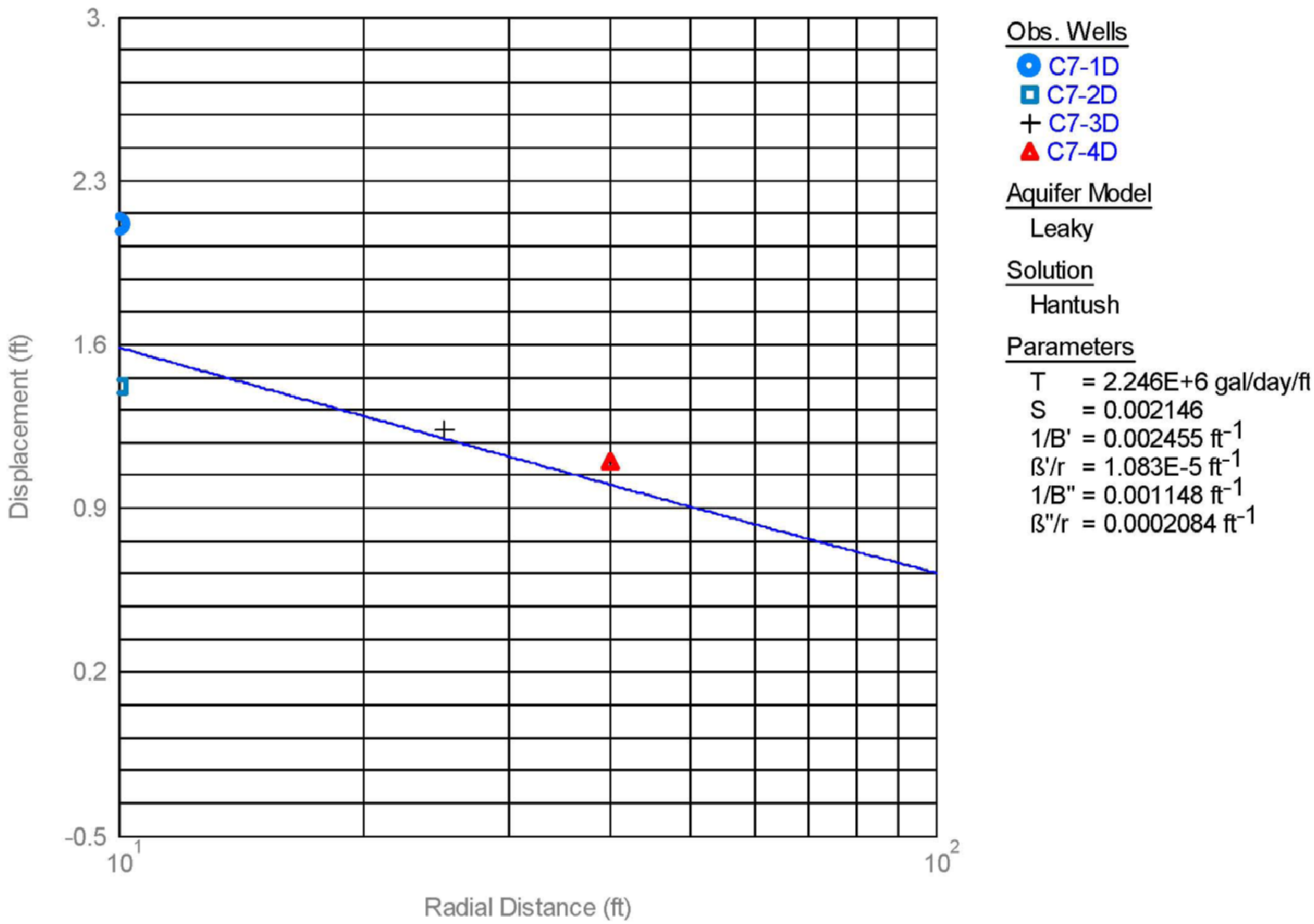


Figure 6 of Attachment 2BB-3 Time-Drawdown Graph for C7-2D Using Theis Method

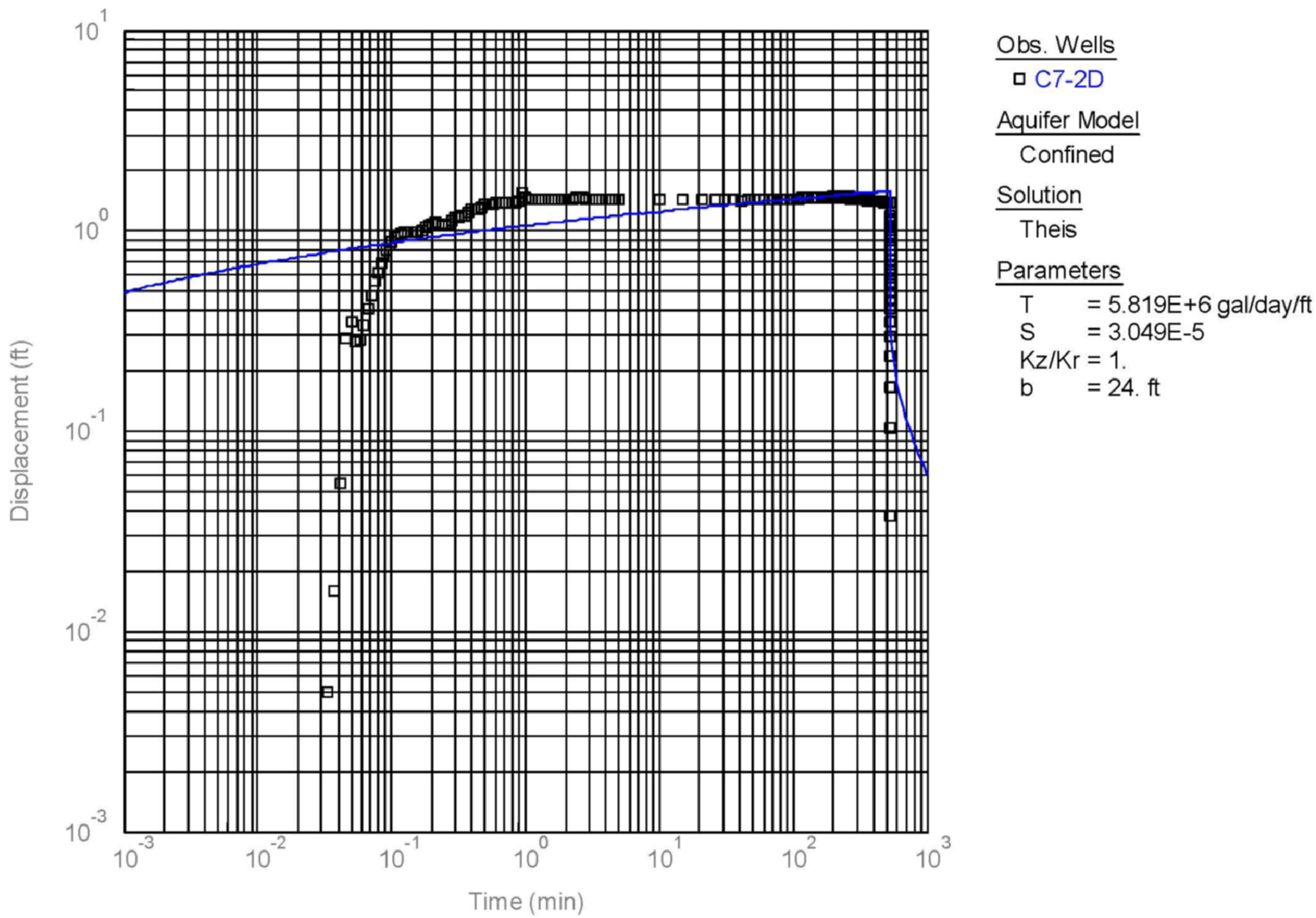


Figure 7 of Attachment 2BB-3 Time-Drawdown Graph for C7-2D Using Hantush Method

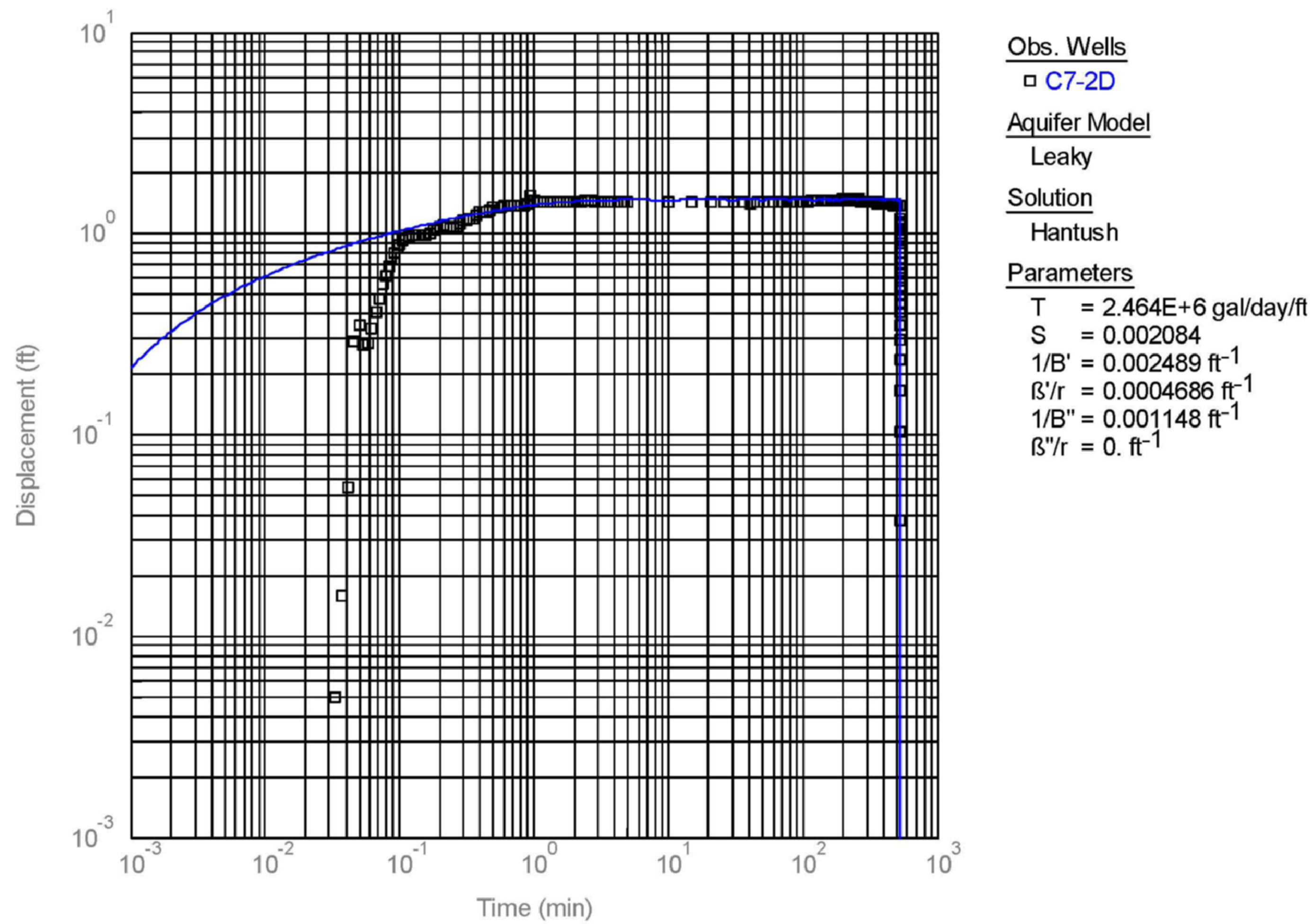


Figure 8 of Attachment 2BB-3 Time-Drawdown Graph for C7-3D Using Theis Method

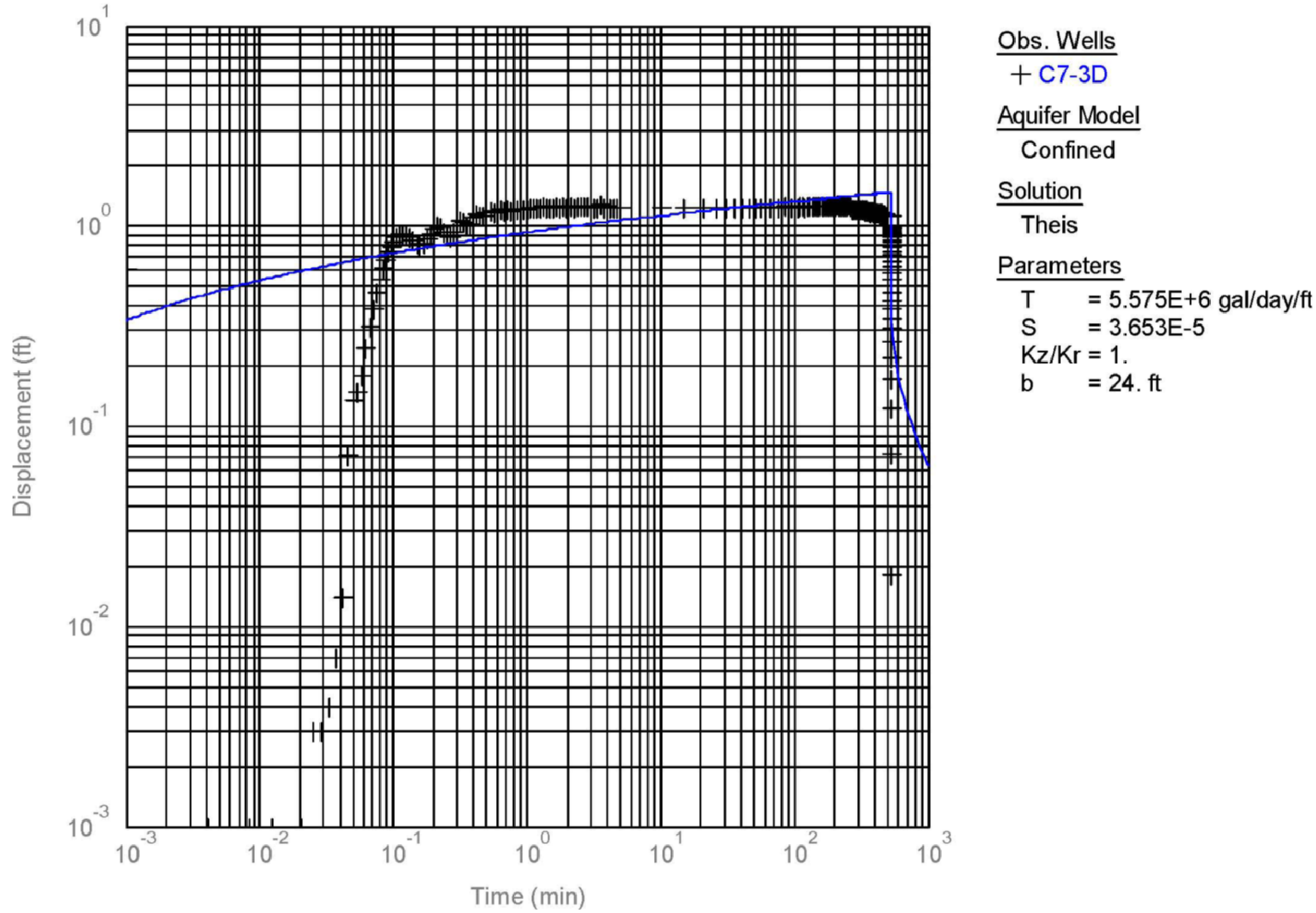


Figure 9 of Attachment 2BB-3 Time-Drawdown Graph for C7-3D Using Hantush Method

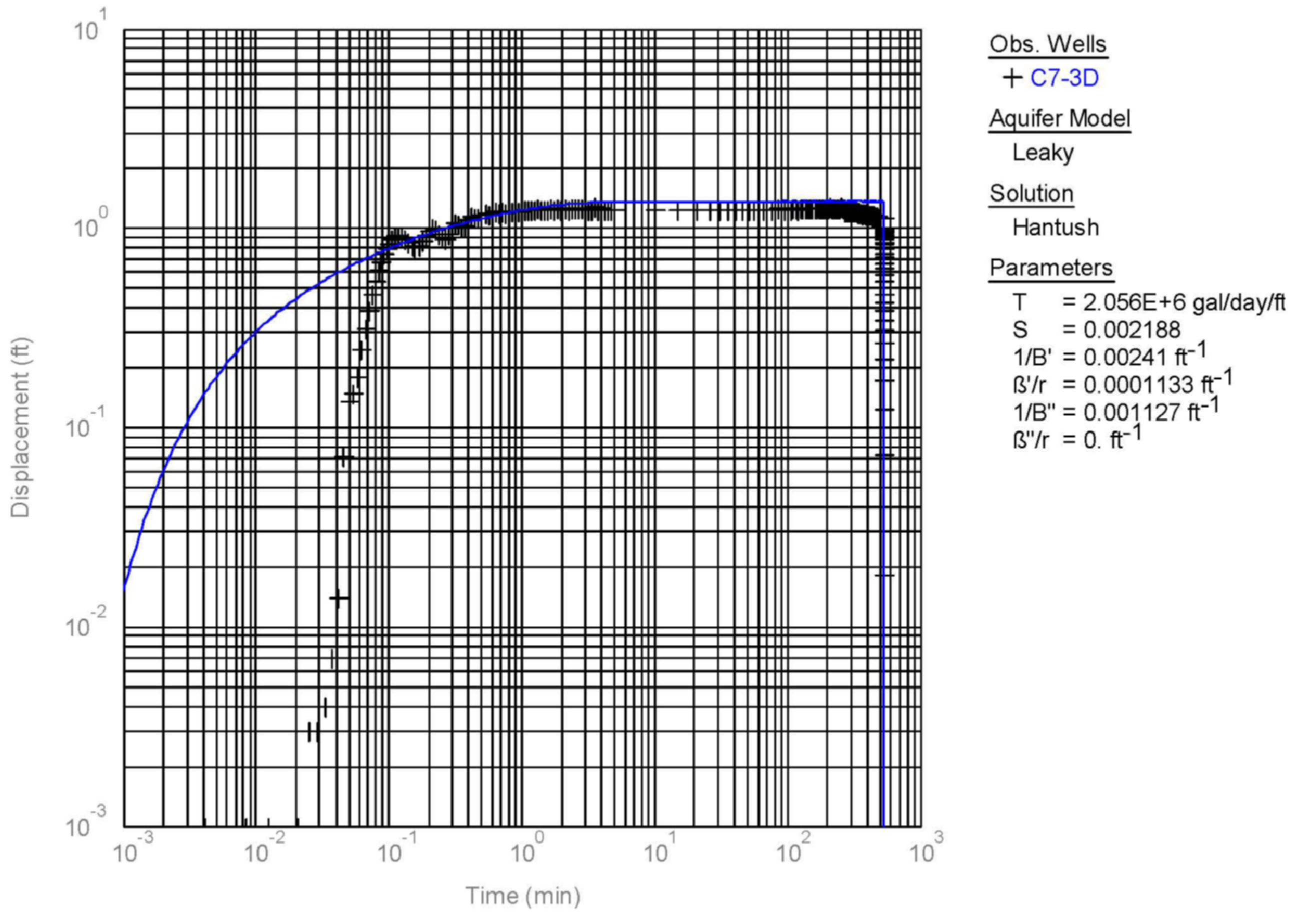


Figure 10 of Attachment 2BB-3 Time-Drawdown Graph for C7-4D Using Theis Method

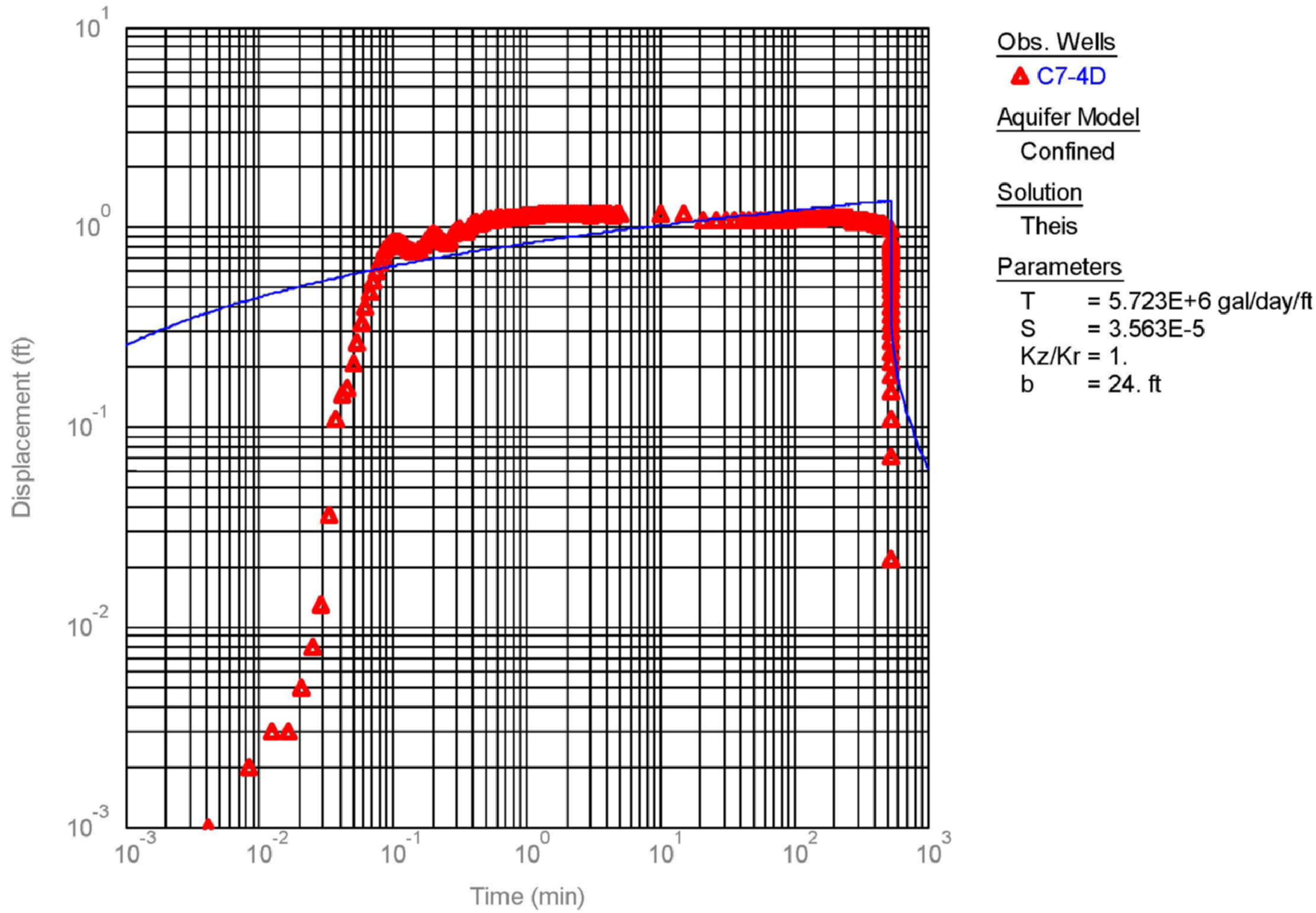
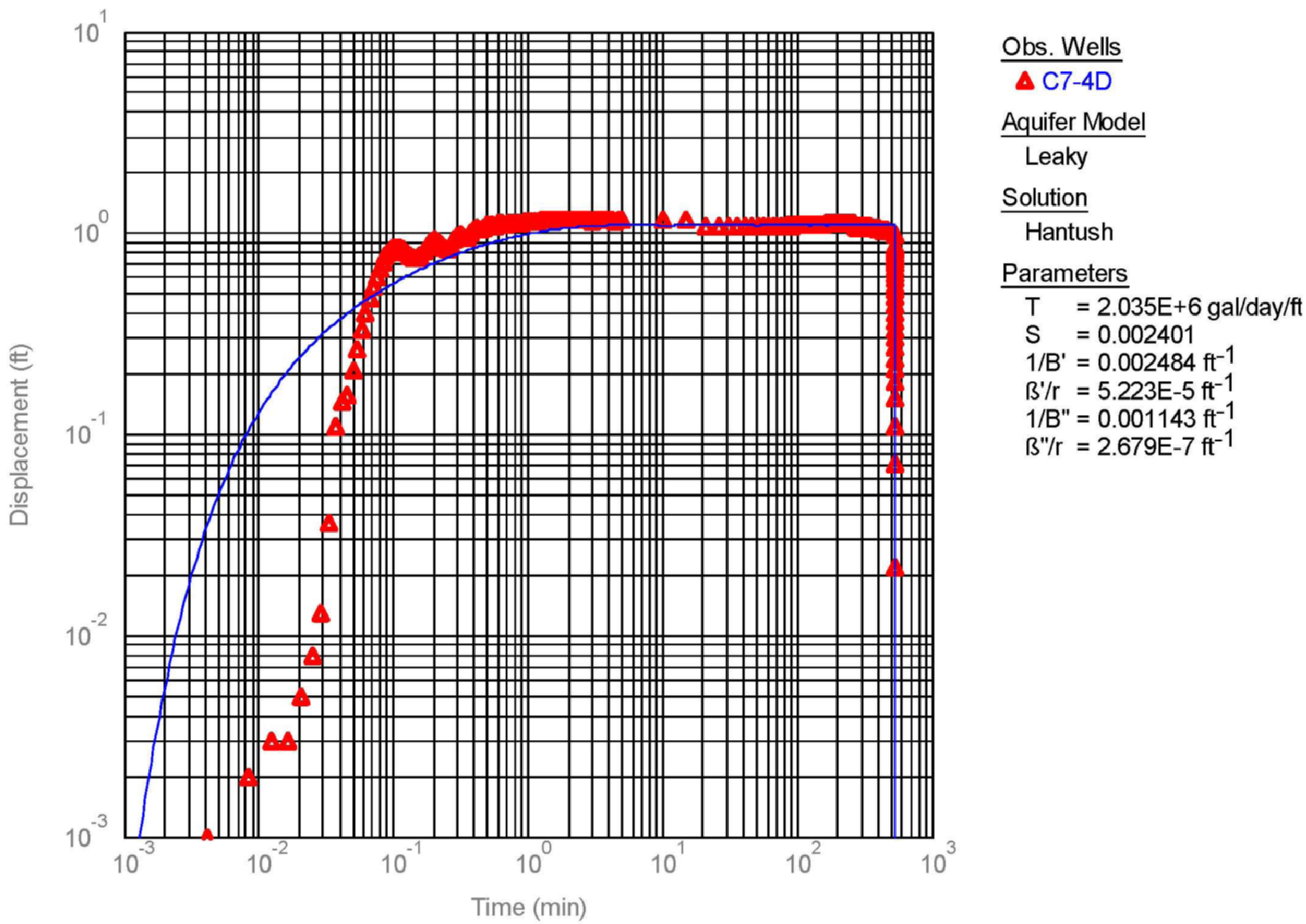


Figure 11 of Attachment 2BB-3 Time-Drawdown Graph for C7-4D Using Hantush Method



ATTACHMENT 2BB-4

UNIT 7 DEEP TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-4 (Sheet 1 of 3)
Pumping Rate Measurements for PW-7L

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 12:00	0	3473[a]	—
3/7/2009 12:05:02	5	3473	3492
3/7/2009 12:10:03	10	3460	3474
3/7/2009 12:15:03	15	3428	3432
3/7/2009 12:20:02	20	3500	—
3/7/2009 12:25:03	25	3542	—
3/7/2009 12:30:03	30	3429	3434
3/7/2009 12:35:02	35	3410	—
3/7/2009 12:40:02	40	3405	—
3/7/2009 12:45:02	45	3412	3372
3/7/2009 12:50:02	50	3359	—
3/7/2009 12:55:02	55	3406	—
3/7/2009 13:00:02	60	3397	3382
3/7/2009 13:05:02	65	3387	—
3/7/2009 13:10:03	70	3384	—
3/7/2009 13:15:02	75	3396	3402
3/7/2009 13:20:02	80	3388	—
3/7/2009 13:25:02	85	3377	—
3/7/2009 13:30:02	90	3399	3402
3/7/2009 13:35:02	95	3376	—
3/7/2009 13:40:02	100	3407	—
3/7/2009 13:45:02	105	3379	3408
3/7/2009 13:50:02	110	3397	—
3/7/2009 13:55:03	115	3400	—
3/7/2009 14:00:02	120	3407	3398
3/7/2009 14:05:02	125	3408	—
3/7/2009 14:10:02	130	3375	—
3/7/2009 14:15:02	135	3387	3372
3/7/2009 14:20:02	140	3396	—
3/7/2009 14:25:03	145	3372	—
3/7/2009 14:30:02	150	3397	3393
3/7/2009 14:35:02	155	3381	—
3/7/2009 14:40:04	160	3395	—
3/7/2009 14:45:02	165	3389	3377
3/7/2009 14:50:03	170	3369	—
3/7/2009 14:55:02	175	3405	—
3/7/2009 15:00:02	180	3398	3399

Table 1 of Attachment 2BB-4 (Sheet 2 of 3)
Pumping Rate Measurements for PW-7L

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 15:05:03	185	3385	—
3/7/2009 15:10:02	190	3379	—
3/7/2009 15:15:02	195	3406	3397
3/7/2009 15:20:02	200	3372	—
3/7/2009 15:25:04	205	3397	—
3/7/2009 15:30:02	210	3394	3392
3/7/2009 15:35:02	215	3395	—
3/7/2009 15:40:02	220	3380	—
3/7/2009 15:45:03	225	3393	3405
3/7/2009 15:50:02	230	3380	—
3/7/2009 15:55:02	235	3386	—
3/7/2009 16:00:02	240	3389	3384
3/7/2009 16:05:02	245	3379	—
3/7/2009 16:10:04	250	3395	—
3/7/2009 16:15:02	255	3436	3432
3/7/2009 16:20:02	260	3403	—
3/7/2009 16:25:02	265	3388	—
3/7/2009 16:30:02	270	3361	3372
3/7/2009 16:35:02	275	3376	—
3/7/2009 16:40:02	280	3368	—
3/7/2009 16:45:03	285	3393	3396
3/7/2009 16:50:03	290	3405	—
3/7/2009 16:55:03	295	3398	—
3/7/2009 17:00:02	300	3387	3392
3/7/2009 17:05:02	305	3397	—
3/7/2009 17:10:03	310	3393	—
3/7/2009 17:15:02	315	3380	3403
3/7/2009 17:20:03	320	3406	—
3/7/2009 17:25:02	325	3387	—
3/7/2009 17:30:02	330	3396	3401
3/7/2009 17:35:03	335	3367	—
3/7/2009 17:40:03	340	3408	—
3/7/2009 17:45:02	345	3409	3412
3/7/2009 17:50:02	350	3385	—
3/7/2009 17:55:02	355	3373	—
3/7/2009 18:00:02	360	3386	3399
3/7/2009 18:05:02	365	3393	—
3/7/2009 18:10:02	370	3397	—

**Table 1 of Attachment 2BB-4 (Sheet 3 of 3)
Pumping Rate Measurements for PW-7L**

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 18:15:02	375	3388	3418
3/7/2009 18:20:02	380	3381	—
3/7/2009 18:25:03	385	3383	—
3/7/2009 18:30:02	390	3419	3402
3/7/2009 18:35:02	395	3386	—
3/7/2009 18:40:02	400	3389	—
3/7/2009 18:45:02	405	3378	3398
3/7/2009 18:50:03	410	3381	—
3/7/2009 18:55:02	415	3406	—
3/7/2009 19:00:02	420	3397	3419
3/7/2009 19:05:02	425	3409	—
3/7/2009 19:10:03	430	3404	—
3/7/2009 19:15:02	435	3415	3409
3/7/2009 19:20:02	440	3398	—
3/7/2009 19:25:02	445	3397	—
3/7/2009 19:30:03	450	3407	3402
3/7/2009 19:35:03	455	3455	—
3/7/2009 19:40:02	460	3485	—
3/7/2009 19:45:02	465	3440	3475
3/7/2009 19:50:02	470	3564	—
3/7/2009 19:55:03	475	3462	—
3/7/2009 20:00:02	480	3409	3430
3/7/2009 20:05:03	485	3408	—
3/7/2009 20:10:02	490	3418	—
3/7/2009 20:15:02	495	3431	3441
3/7/2009 20:20:02	500	3431	—
3/7/2009 20:25:03	505	3416	—
3/7/2009 20:30:02	510	3425	3437
3/7/2009 20:35:03	515	3428	—
3/7/2009 20:40:03	520	3412	—
3/7/2009 20:45:03	525	3421	3423
3/7/2009 20:50:02	530	3420	—
3/7/2009 20:55:02	535	3420	—
3/7/2009 21:00	540	0	—

(a) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-4 Time-Drawdown Graph for C7-2 Well Cluster

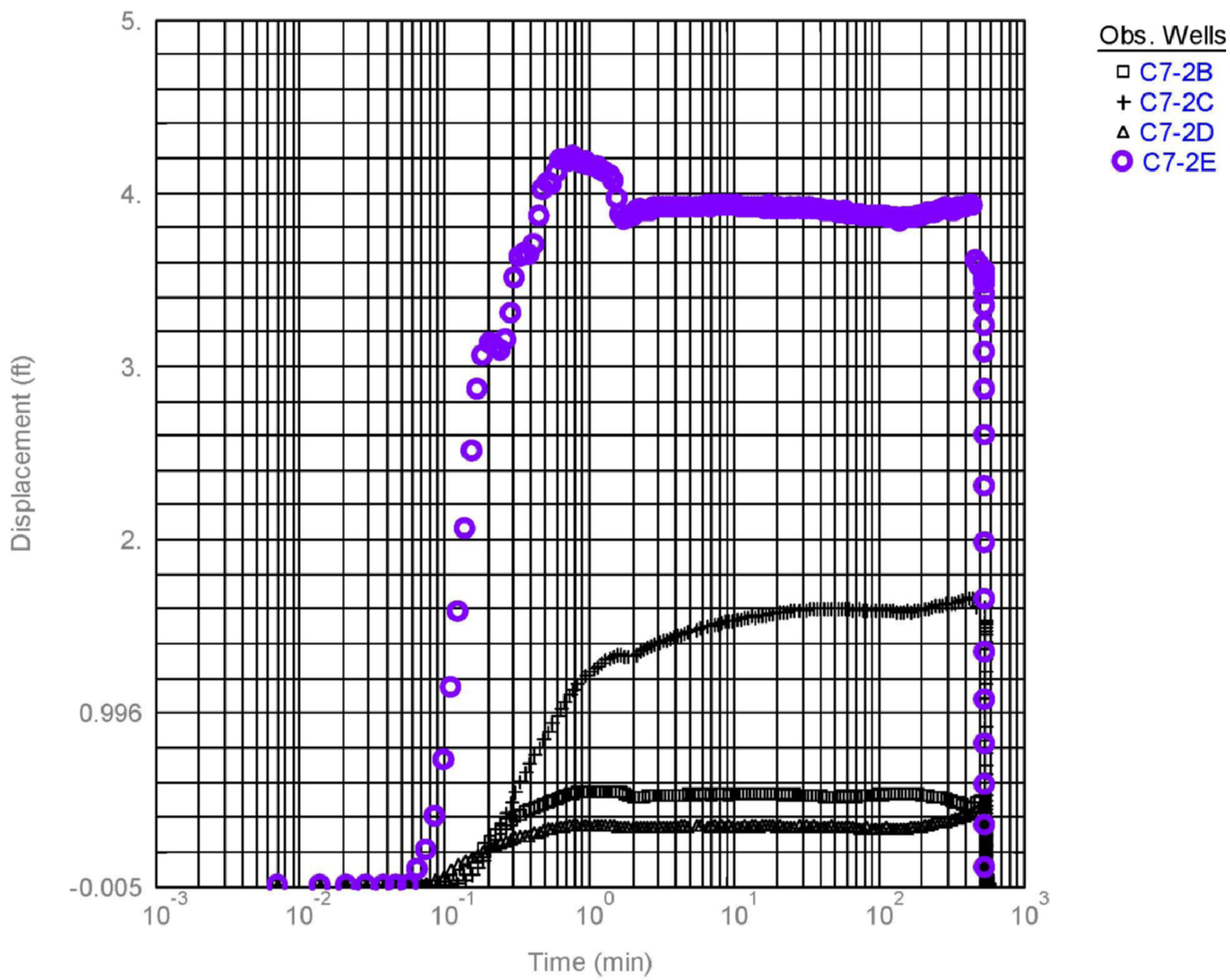


Figure 2 of Attachment 2BB-4 Time-Drawdown Graph for C7-3 Well Cluster

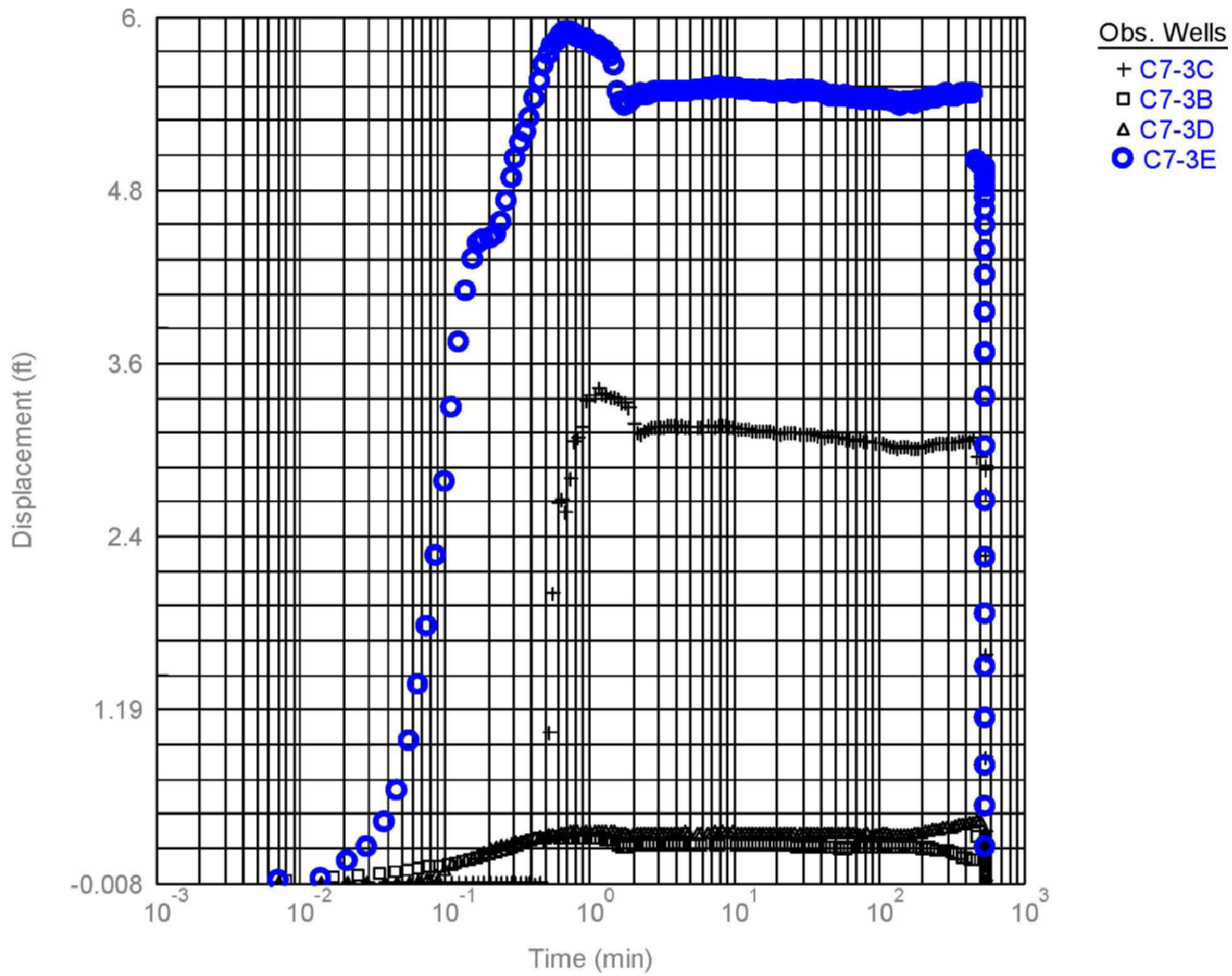


Figure 3 of Attachment 2BB-4 Time-Drawdown Graph for C7-4 Well Cluster

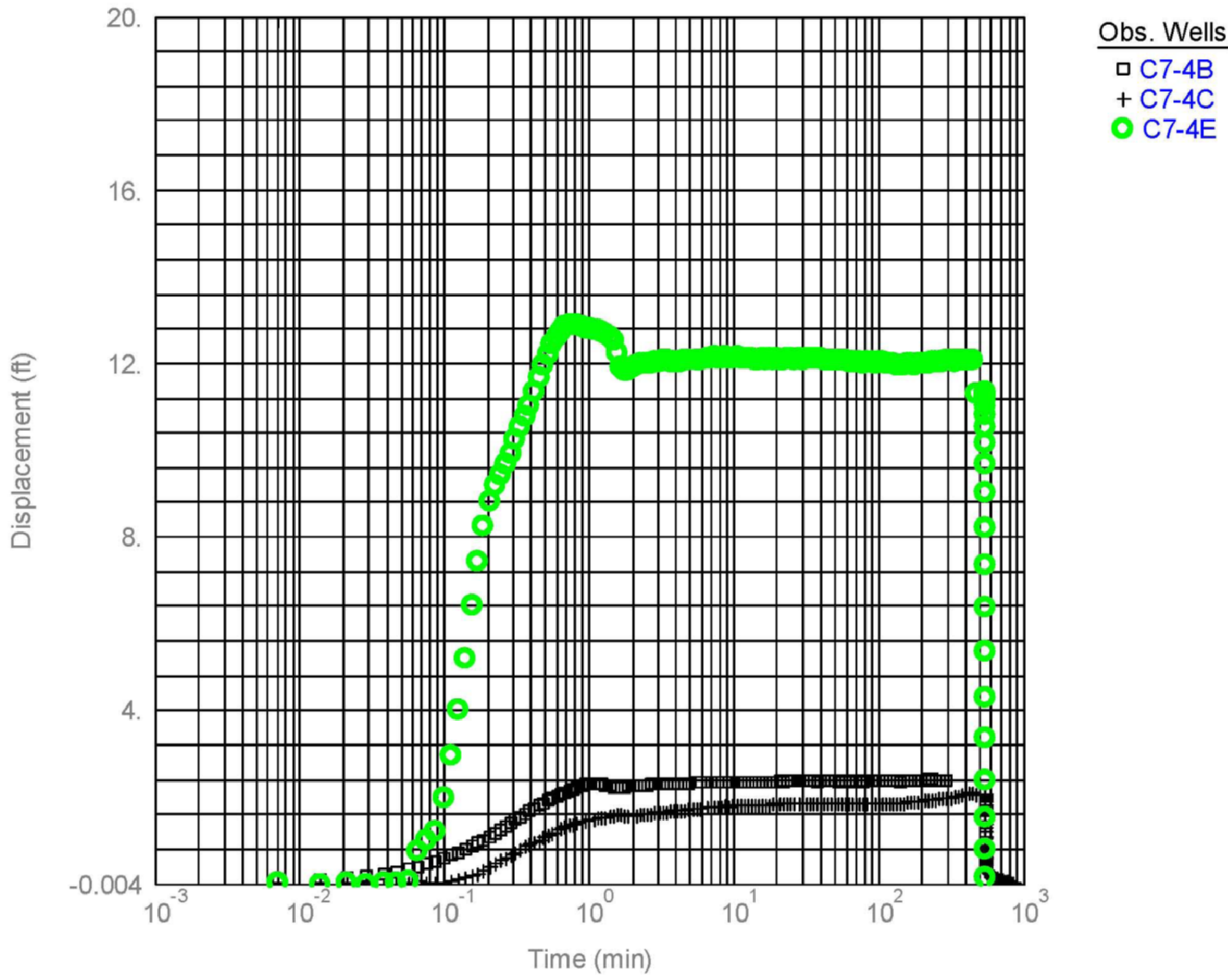


Figure 4 of Attachment 2BB-4 Time-Drawdown Graph for C7-5 Well Cluster

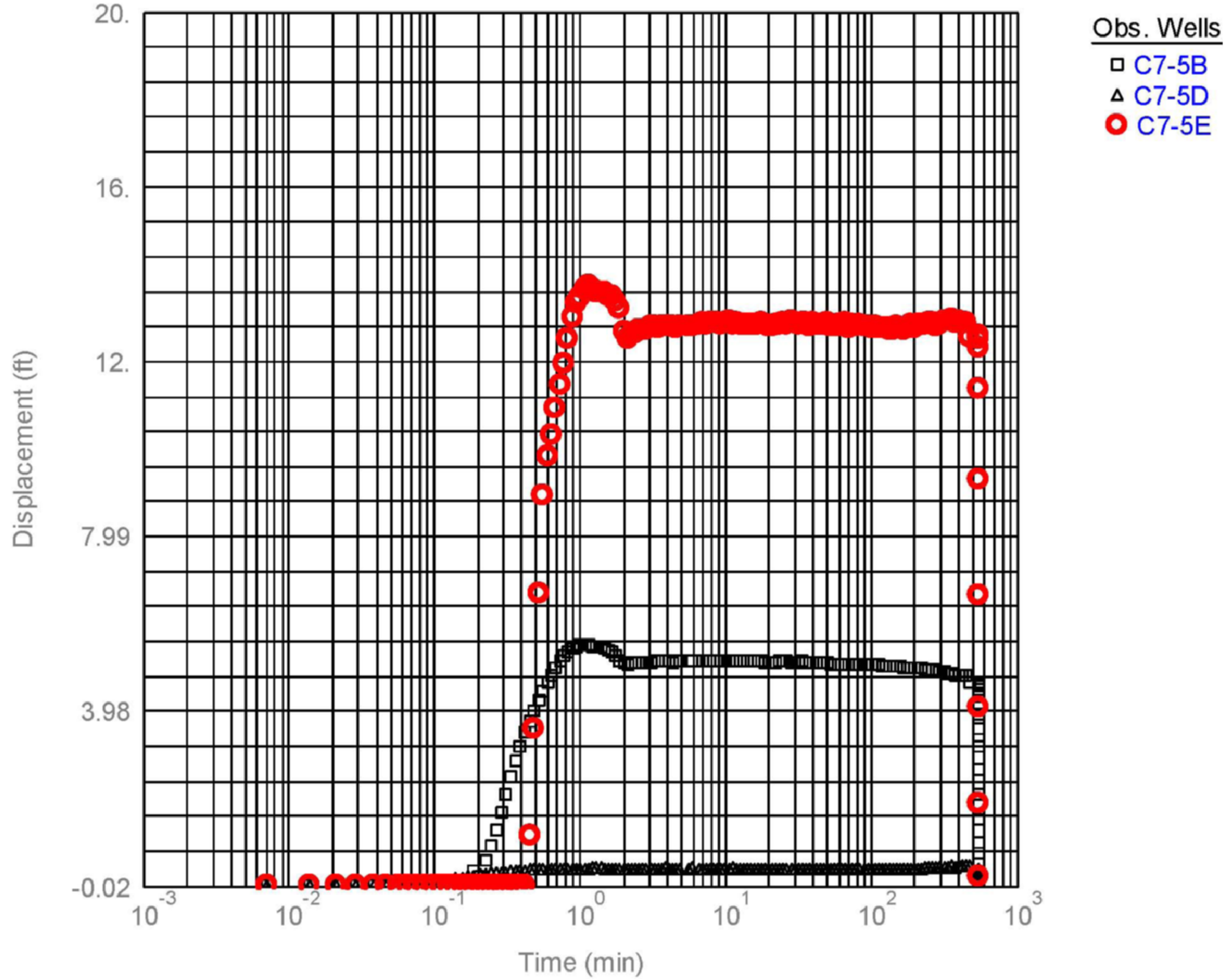


Figure 5 of Attachment 2BB-4 Distance-Drawdown Graph for PW-7L Test (t = 20 minutes)

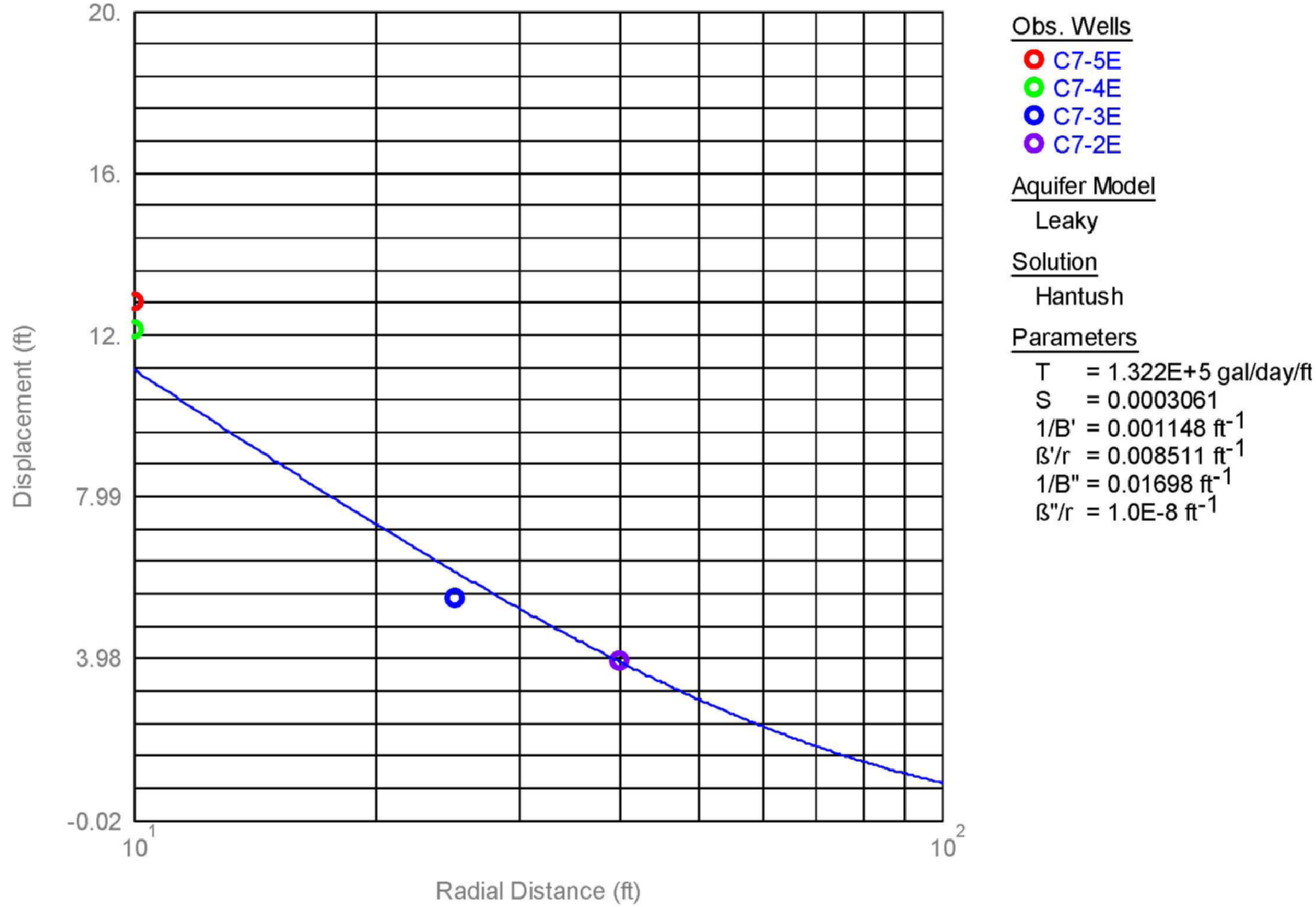


Figure 6 of Attachment 2BB-4 Time-Drawdown Graph for C7-2E Using Theis Method

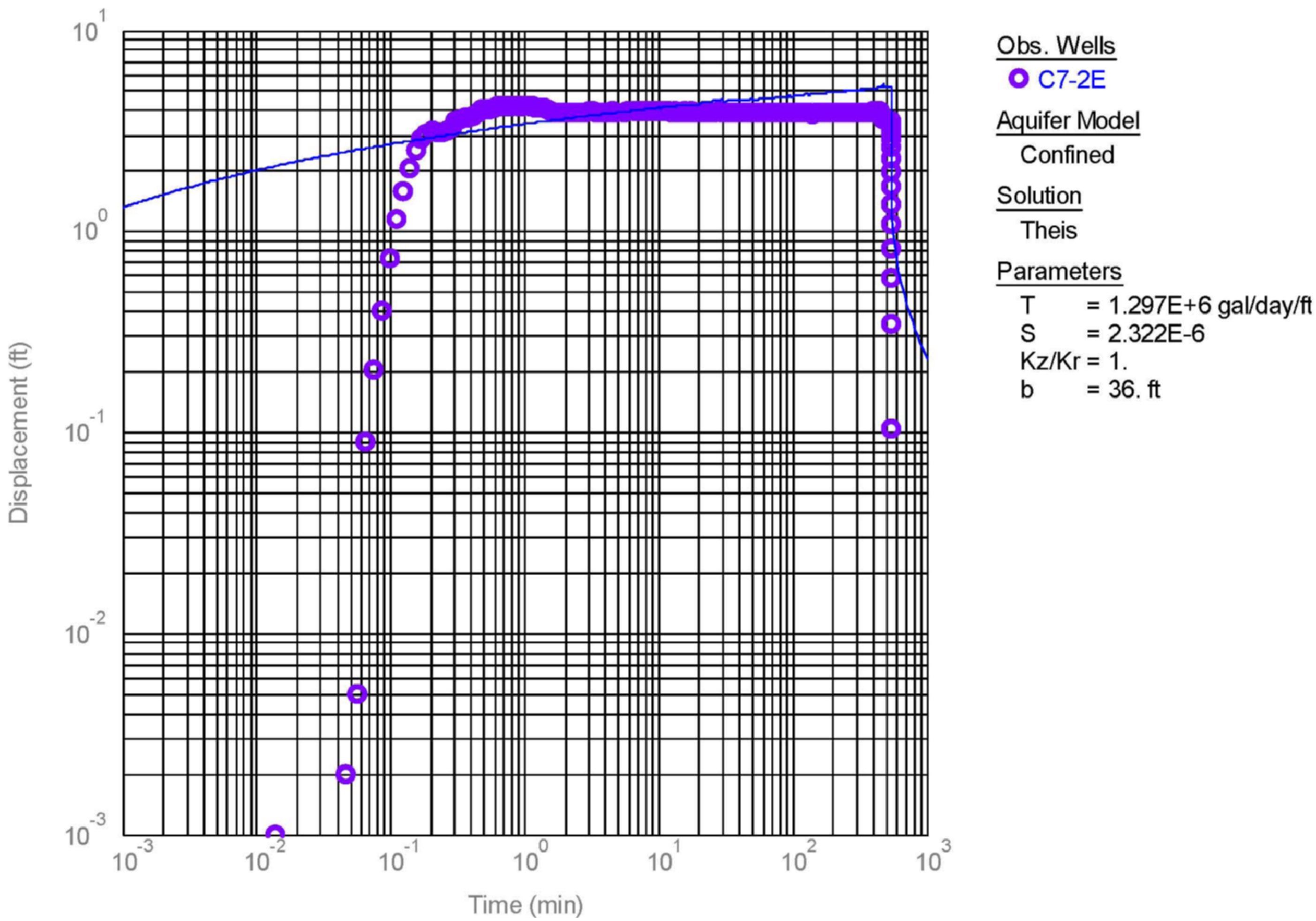


Figure 7 of Attachment 2BB-4 Time-Drawdown Graph for C7-2E Using Hantush Method

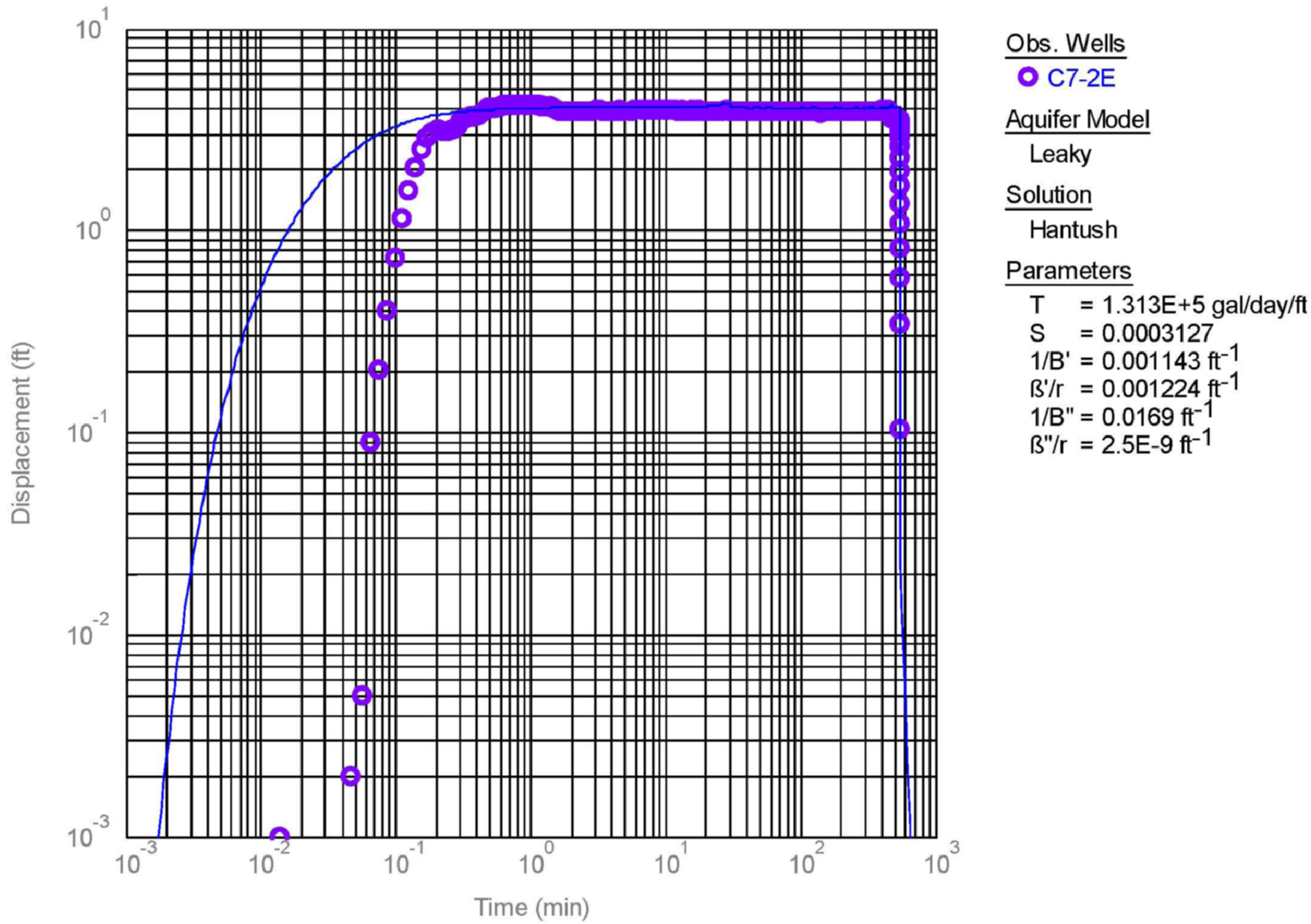


Figure 8 of Attachment 2BB-4 Time-Drawdown Graph for C7-3E Using Theis Method

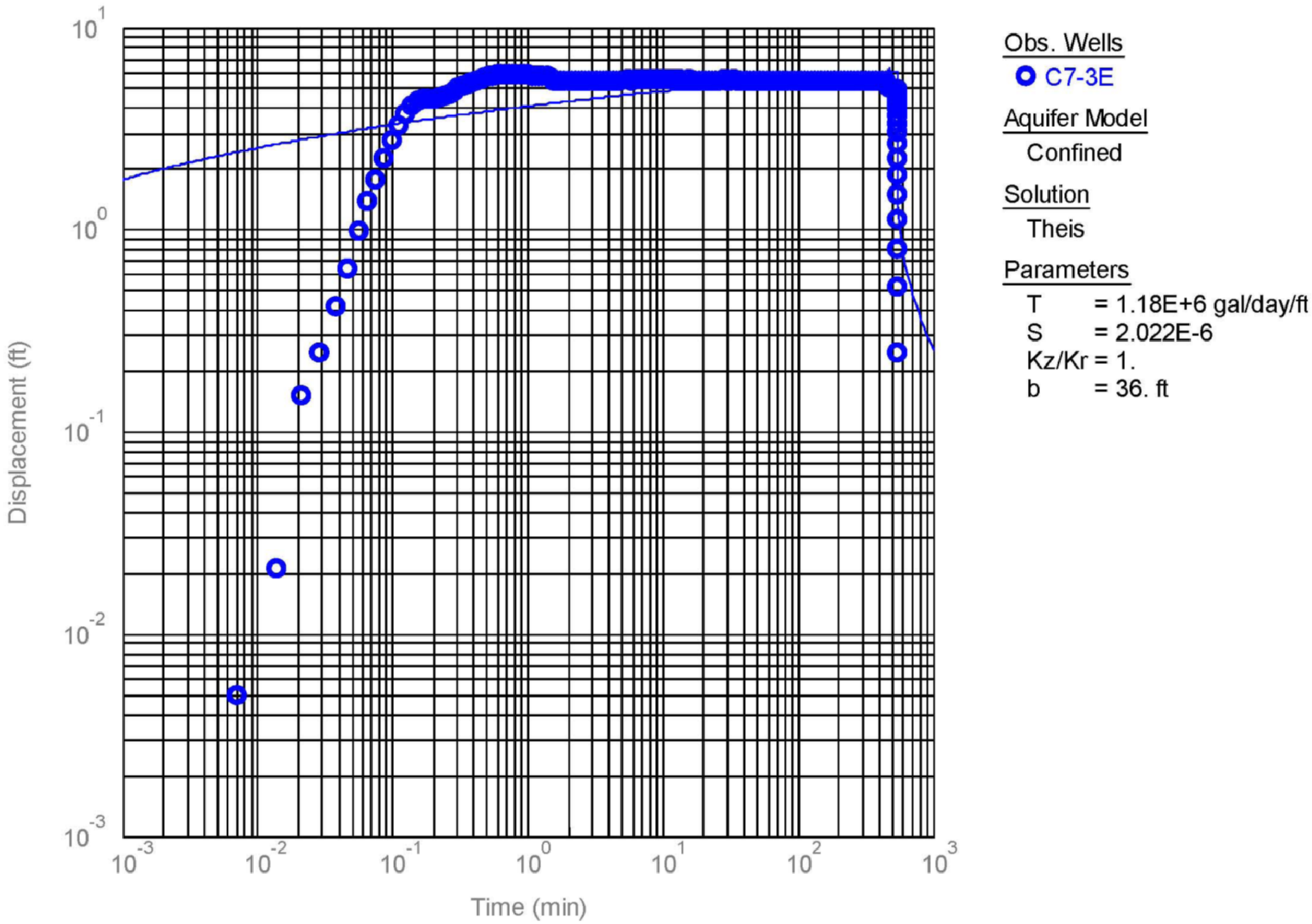


Figure 9 of Attachment 2BB-4 Time-Drawdown Graph for C7-3E Using Hantush Method

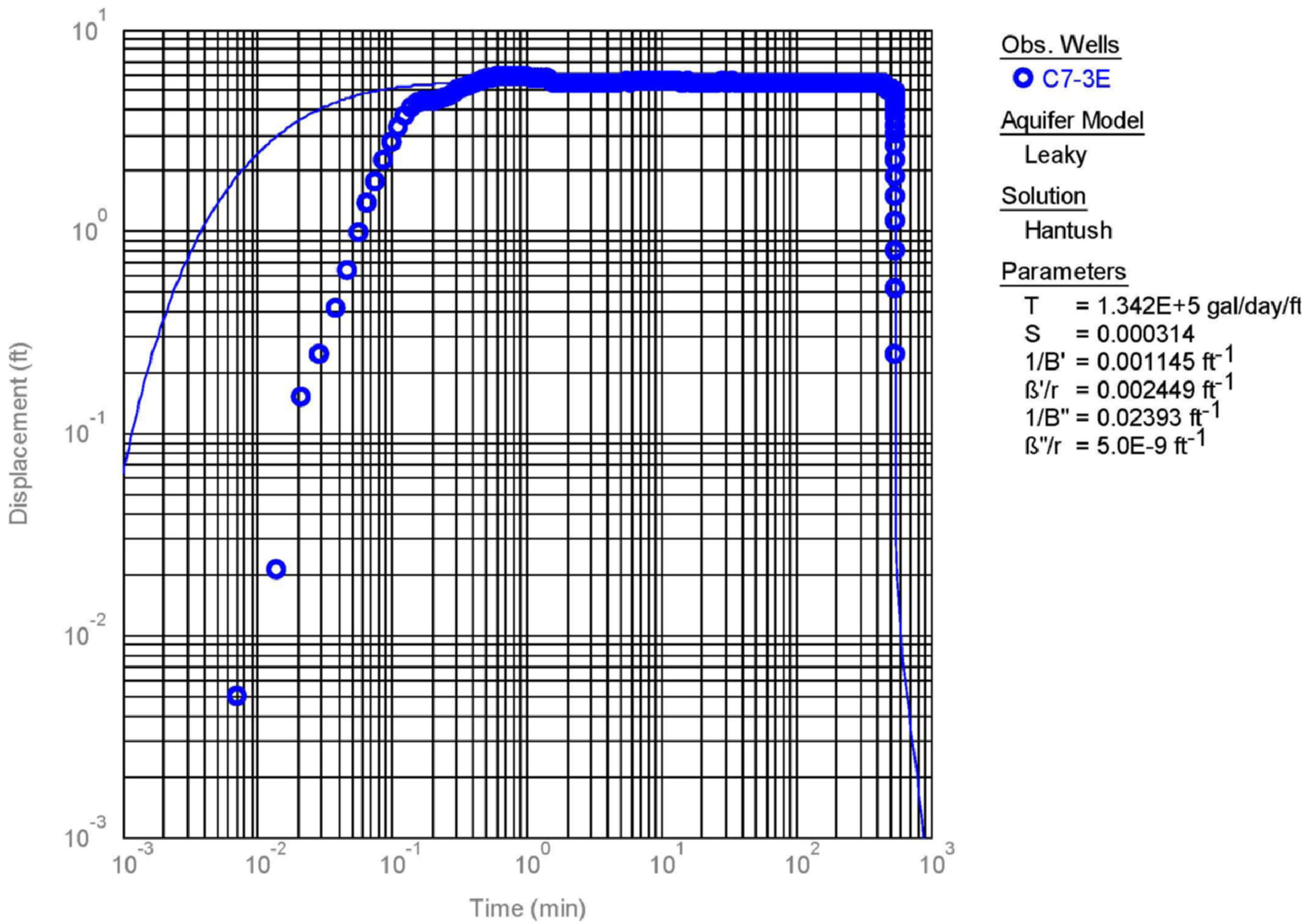


Figure 10 of Attachment 2BB-4 Time-Drawdown Graph for C7-4E Using Theis Method

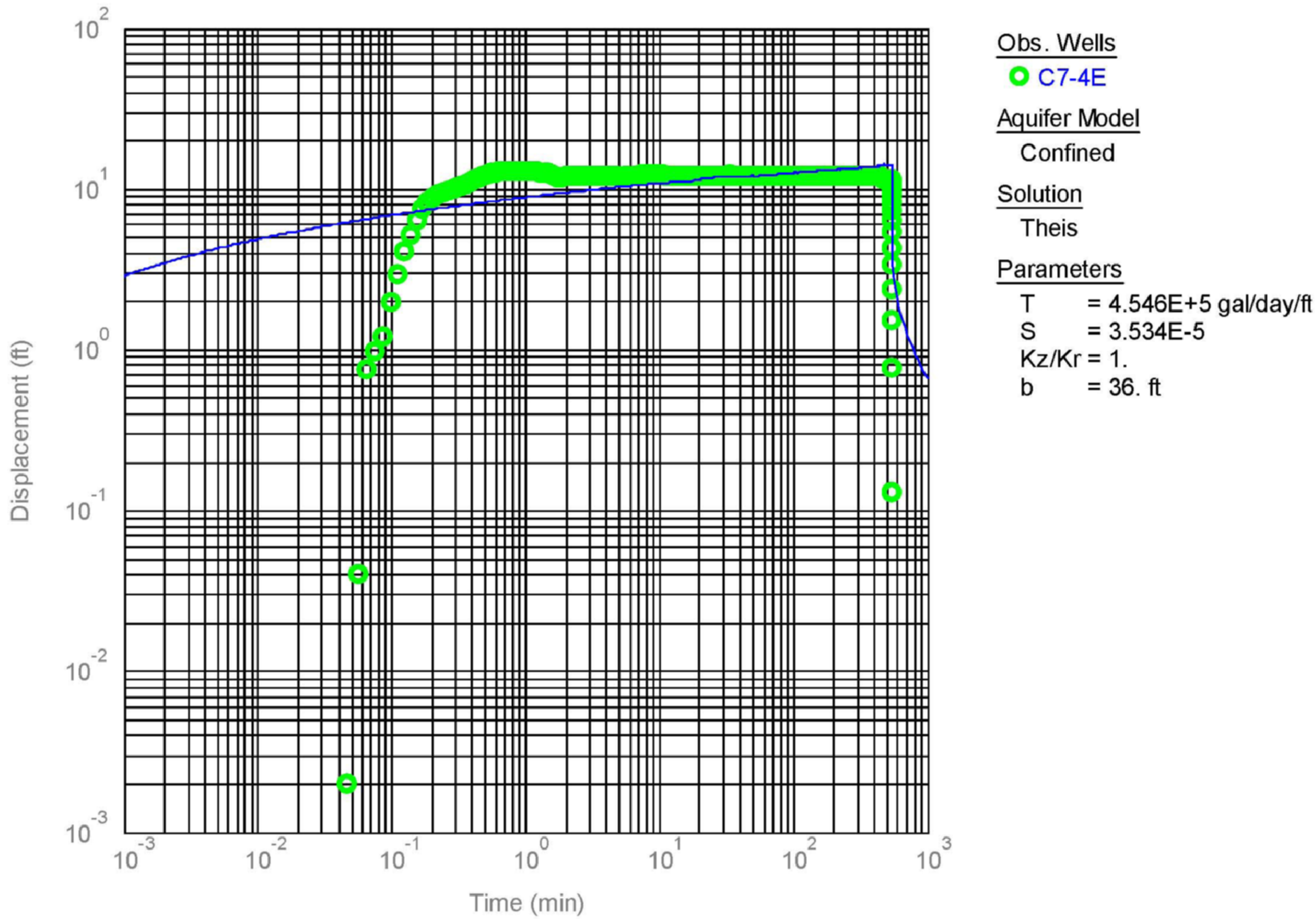


Figure 11 of Attachment 2BB-4 Time-Drawdown Graph for C7-4E Using Hantush Method

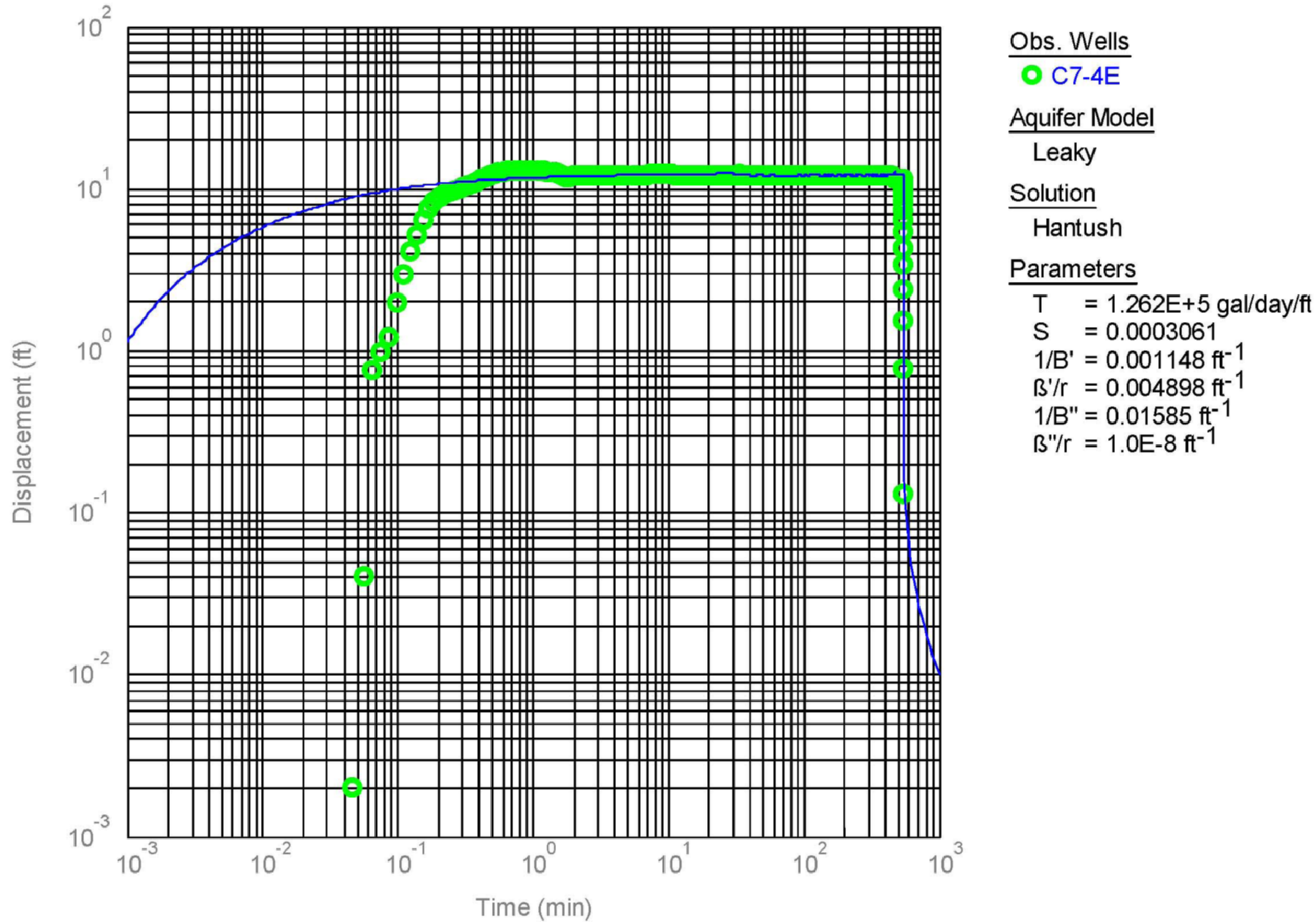


Figure 12 of Attachment 2BB-4 Time-Drawdown Graph for C7-5E Using Theis Method

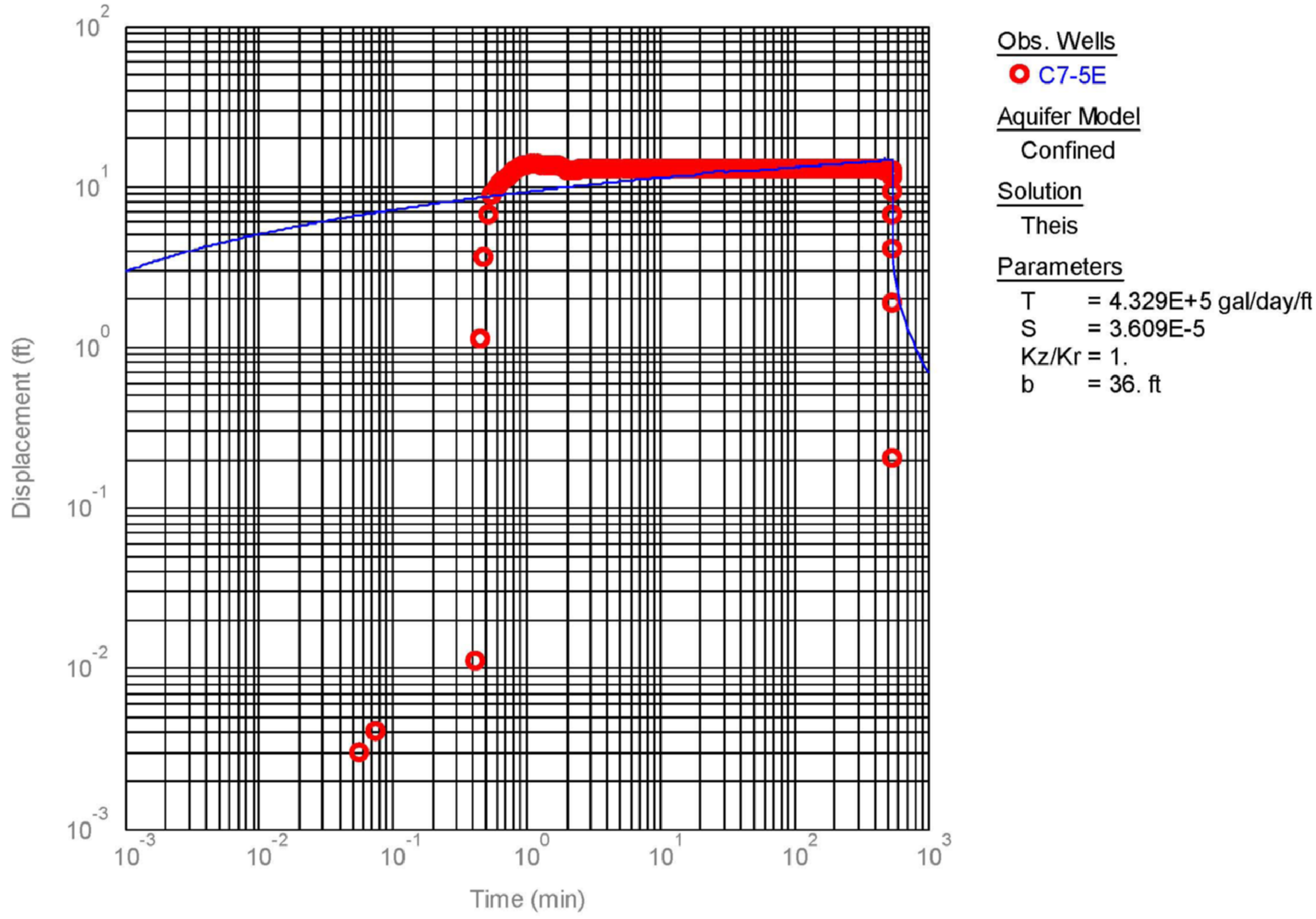


Figure 13 of Attachment 2BB-4 Time-Drawdown Graph for C7-5E Using Hantush Method