P-13-24

Äspö Hard Rock Laboratory

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March 2013

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ISSN 1651-4416
SKB P-13-24
ID 1327210

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Keywords: Äspö, Hydrogeology, Hydraulic tests, Injecions tests, Single-hole tests, Hydraulic parameters, Transmissivity, Hydraulic conductivity.

Abstract

Hydraulic injection tests were carried out in the core-drilled boreholes KA3007A01, KA2051A01 and KJ0050F01 in the Äspö Hard Rock Laboratory (HRL) from June to September 2011 by using the High pressure Water Injection Controller (HWIC) and parts of the Underground Hydraulic Test system 1 (UHT1).

The main aim of the injection tests in KA3007A01, KA2051A01 and KJ005F01 was to characterise the hydraulic conditions of the rock adjacent to the borehole. The tests were made with a 5 m test section between two packers. The exception was for the last part of the borehole, where the test section was limited by a single packer and the end of the borehole. Hydraulic parameters such as transmissivity and hydraulic conductivity were determined using analysis methods for stationary as well as transient conditions together with the dominating flow regime and possible outer hydraulic boundaries. Pseudo-radial flow regime was more common during the injection period than during the recovery period. The inverse relationship was observed for pseudo-spherical flow, i.e. it was more common during the recovery period than during the injection period.

The injection tests provide a database for statistical analysis of the hydraulic conductivity distribution along the boreholes. Basic statistical analysis has been made within this project and basic statistical parameters are presented in this report.

Sammanfattning

Hydrauliska injektionstester har utförts kärnborrhålen KA3007A01, KA2051A01 och KJ0050F01 i Äspölaboratoriet (HRL) från juni till september 2011 med hjälp av utrustningarna HWIC och delar av UHT1.

Huvudsyftet med injektionstesterna var att karaktärisera de hydrauliska förhållandena i berget i anslutning till borrhålen. Testerna utfördes i 5 m sektioner mellan två manschetter. Undantaget var i slutet av borrhålet där mätsektionen begränsades av en manschett och borrhålsänden. Hydrauliska parametrar såsom transmissivitet och hydraulisk konduktivitet tillsammans med dominerande flödesregim och eventuella yttre hydrauliska randvillkor bestämdes med hjälp av analysmetoder för såväl stationära som transienta förhållanden. Pseudo-radiellt flöde var mer vanligt förekommande under injektionsfasen än under återhämtningen. Det omvända förhållandet konstaterades för pseudo-sfäriskt flöde, dvs det var mer vanligt förekommande under återhämtningen än under injektionsfasen.

Resultaten från injektionstesterna utgör en databas för statistisk analys av den hydrauliska konduktivitetens fördelning längs borrhålen. Viss statistisk analys har utförts inom ramen för denna aktivitet och grundläggande statistiska parametrar presenteras i rapporten.

Contents

1 Introduction

Injection tests were carried out by Geosigma AB in the core-drilled boreholes KA3007A01, KA2051A01 and KJ0050F01 in the Äspö Hard Rock Laboratory (HRL) from June to September 2011. The locations of the boreholes are shown in Figure 1-1.

This report includes execution, analysis and results of the injection tests in boreholes KA2051A01, KA3007A01 and KJ0050F01. Data and results are also available in the SKB database, Sicada.

Measurements and results presented in this report were undertaken in the framework of the project TUDP002 towards extending the tunnel system at the Äspö Hard Rock Laboratory (HRL). The measurements were carried out in accordance to SKB's internal controlling document AP TUDP002-11-01 for KA2051A01 and KA3007A01 and AP TUDP002-11-03 for KJ0050F01.

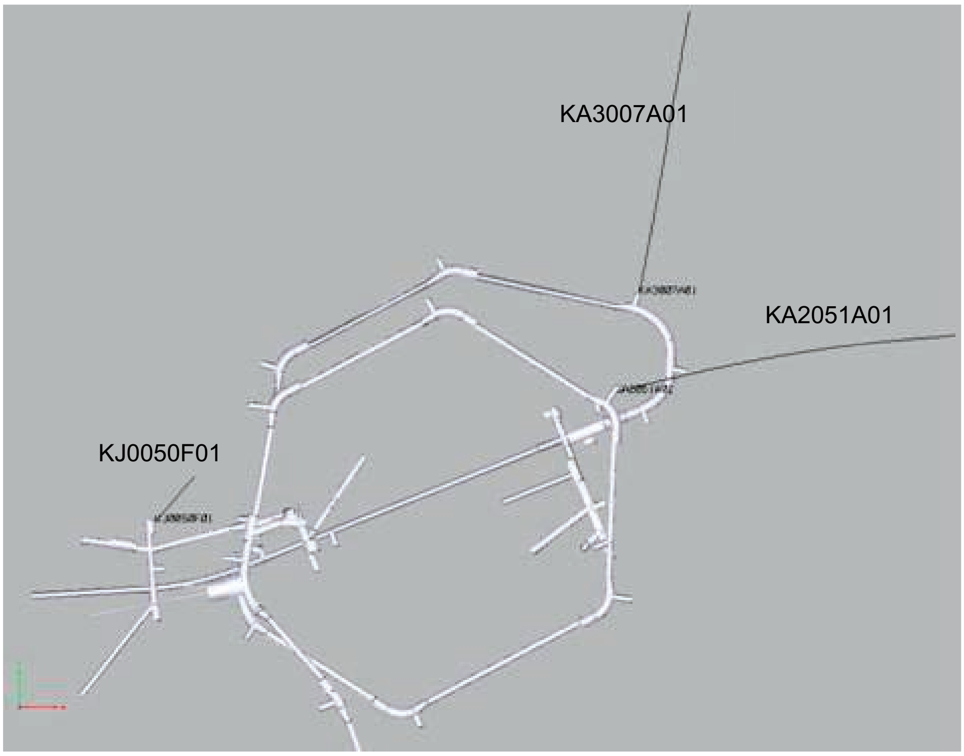

Figure 1-1. *Position of the tested boreholes in the Äspö HRL. The image shows a view from above.*

2 Objectives

The main aim of the injection tests in boreholes KA2051A01, KA3007A01 and KJ0050F01was to characterize the hydraulic properties of the rock adjacent to the boreholes. The primary parameter to be determined was hydraulic transmissivity from which hydraulic conductivity can be derived. The results of the injection tests provide a database which can be used for statistical analyses of the hydraulic conductivity distribution along the boreholes. Basic statistical analyses are presented in this report.

Other hydraulic parameters of interest were flow regimes and outer hydraulic boundaries. These parameters were analysed using transient evaluation on the test responses during the flow- and recovery periods.

3 Scope

3.1 Borehole data

Technical data of the tested boreholes are shown in Table 3-1, Table 3-2 and Table 3-3. The reference point of the borehole, i.e. borehole length 0 m, is defined as the tunnel wall. The local coordinate system (Äspö96) is used for the horizontal coordinates and the elevation.

Casings are installed in the upper part of the boreholes, below which the borehole diameter is c. 76 mm.

Table 3-1. Pertinent technical data of borehole KA3007A01 (printout from SKB database, Sicada).

Title	Value					
	Information about cored borehole KA3007A01 (2011-11-09)					
Borehole length:	Length (m)	Reference Level				
	227.76	Rock surface				
Drilling periods:	From Date	To Date	Secup (m)	Seclow (m)	Drilling Type	
	2011-04-13	2011-05-17	0.00	227.76	Core drilling	
Starting point coordinate:	Length (m)	Northing (m)	Easting (m)	Elevation	Coord System	Comment
	0.00	7,410.09	2,369.57	–400.64	ÄSPÖ96	Bergyta
Starting point angles:	Length (m)	Bearing	Inclination (– = down)	Coord System		
	0.00	22.16	–14.35	ÄSPÖ96		
Borehole diameters:	Secup (m)	Seclow (m)	Hole Diam (m)			
	0.00	3.04	0.1160			
	3.04	227.76	0.0758			
Core diameters:	Secup (m)	Seclow (m)	Core Diam (m)			
	0.00	3.04	0.0800			
	3.04	227.76	0.0500			
Casing diameters:	Secup (m)	Seclow (m)	Case In (m)	Case Out (m)	Comment	
	0.00	2.54	0.8000	0.1000		

Table 3-2. Pertinent technical data of borehole KA2051A01 (printout from SKB database, Sicada).

Title	Value					
	Information about cored borehole KA2051A01 (2011-11-09)					
Borehole length:	Length (m)	Reference Level				
	319.84	Rock surface				
Drilling periods:	From Date	To Date	Secup (m)	Seclow (m)	Drilling Type	
	2011-02-01	2011-03-25	0.00	319.84	Core drilling	
Starting point coordinate:	Length (m)	Northing (m)	Easting (m)	Elevation	Coord System	Comment
	0.00	7,339.25	2,336.55	–276.64	ÄSPÖ96	Bergyta
Starting point angles:	Length (m)	Bearing	Inclination (– = down)	Coord System		
	0.00	86.62	–35.01	ÄSPÖ96		
Borehole diameters:	Secup (m)	Seclow (m)	Hole Diam (m)			
	0.00	3.10	0.1160			
	3.10	319.84	0.0760			
Core diameters:	Secup (m)	Seclow (m)	Core Diam (m)			
	0.00	3.10	0.1000			
	3.10	319.84	0.0502			
Casing diameters:	Secup (m)	Seclow (m)	Case In (m)	Case Out (m)	Comment	
	0.00	2.63	0.8000	0.1000		

Table 3-3. Pertinent technical data of borehole KJ0050F01 (printout from SKB database, Sicada).

Title	Value					
	Information about cored borehole KJ0050F01 (2011-11-09)					
Borehole length:	Length (m)	Reference Level				
	46.79	Unknown				
Drilling periods:	From Date	To Date	Secup (m)	Seclow (m)	Drilling Type	
	1999-03-09	1999-03-12	0.00	46.79	Core drilling	
Starting point coordinate:	Length (m)	Northing (m)	Easting (m)	Elevation	Coord System	Comment
	0.00	7,313.63	1,970.72	–447.16	ÄSPÖ96	
	3.00	7,315.47	1,973.08	–447.41	ÄSPÖ96	
	6.00	7,317.30	1,975.44	–447.66	ÄSPÖ96	
Starting point angles:	Length (m)	Bearing	Inclination (– = down)	Coord System		
	3.00	52.17	–4.80	ÄSPÖ96		
Borehole diameters:	Secup (m)	Seclow (m)	Hole Diam (m)			
	0.00	2.22	0.1160			
	2.22	46.79	0.0750			
Core diameters:	Secup (m)	Seclow (m)	Core Diam (m)			
	0.00	2.22	0.0930			
	2.22	46.79	0.0450			
Casing diameters:	Secup (m)	Seclow (m)	Case In (m)	Case Out (m)	Comment	
	–0.33	2.22	0.0780	0.1000		

3.2 Tests performed

The injection tests in borehole KA2051A01, KA3007A01 and KJ0050F01, are listed in Table 3-4. The injection tests were carried out with the *High pressure Water Injection Controller* (HWIC). Test procedure and equipment are described in Section 4 and 5 below.

Some of the tests were not performed as intended because the time required for achieving a constant head in the test section was judged to be too long or, in other cases, equipment malfunctions caused pressure and/or flow rate disturbances. Whenever such disturbances were expected to affect data evaluation, the test was repeated. Test number (Test no in Table 3-4) refers to the number of tests performed in the actual section. For evaluation, data from the last test in each section were used.

No injection tests were performed in KA3007A01 0–148 m due to problems with the borehole grouting during drilling. This caused concern that this portion of the borehole was grouted to some extent and that transmissivities derived from there may not be representative for the virgin rock but rather for the grouted rock.

Table 3-4. Single-hole injection tests performed in boreholes KA2051A01, KA3007A01 and KJ0050F01.

Borehole ID	Test section Secup	Seclow	Section length	Test no	Test start date, time YYYYMMDD hh:mm	Test stop date, time YYYYMMDD hh:mm
KA2051A01	4.00	9.00	5.00	1	2011-07-07 14:28	2011-07-07 15:57
KA2051A01	9.00	14.00	5.00	1	2011-07-07 16:53	2011-07-07 17:42
KA2051A01	14.00	19.00	5.00	1	2011-07-07 18:34	2011-07-07 19:42
KA2051A01	19.00	24.00	5.00	1	2011-07-08 08:26	2011-07-08 09:12
KA2051A01	24.00	29.00	5.00	1	2011-07-08 09:35	2011-07-08 10:25
KA2051A01	29.00	34.00	5.00	1	2011-07-08 10:47	2011-07-08 12:06
KA2051A01	34.00	39.00	5.00	1	2011-07-08 12:18	2011-07-08 15:03
KA2051A01	39.00	44.00	5.00	1	2011-07-08 15:22	2011-07-08 16:38
KA2051A01	44.00	49.00	5.00	1	2011-07-08 17:00	2011-07-08 17:43
KA2051A01	49.00	54.00	5.00	1	2011-07-08 18:07	2011-07-08 19:34
KA2051A01	54.00	59.00	5.00	1	2011-07-09 08:08	2011-07-09 09:26
KA2051A01	59.00	64.00	5.00	1	2011-07-09 09:41	2011-07-09 10:59
KA2051A01	64.00	69.00	5.00	1	2011-07-09 11:16	2011-07-09 13:54

Borehole ID	Test section Secup	Seclow	Section length	Test no	Test start date, time YYYYMMDD hh:mm	Test stop date, time YYYYMMDD hh:mm
KA2051A01	118.00	123.00	5.00	1	2011-07-09 15:33	2011-07-09 16:14
KA2051A01	123.00	128.00	5.00	1	2011-07-09 16:33	2011-07-09 17:51
KA2051A01	128.00	133.00	5.00	2	2011-07-09 18:06	2011-07-09 19:27
KA2051A01	133.00	138.00	5.00	1	2011-07-10 08:40	2011-07-10 09:54
KA2051A01	138.00	143.00	5.00	1	2011-07-10 10:08	2011-07-10 11:22
KA2051A01	143.00	148.00	5.00	1	2011-07-10 11:34	2011-07-10 14:08
KA2051A01	148.00	153.00	5.00	1	2011-08-15 15:42	2011-08-15 17:49
KA2051A01	153.00	158.00	5.00	1	2011-08-15 18:06	2011-08-15 19:25
KA2051A01	158.00	163.00	5.00	1	2011-08-16 08:07	2011-08-16 08:51
KA2051A01	163.00	168.00	5.00	1	2011-08-16 09:03	2011-08-16 10:38
KA2051A01	168.00	173.00	5.00	1	2011-08-16 10:49	2011-08-16 12:03
KA2051A01	173.00	178.00	5.00	1	2011-08-16 12:14	2011-08-16 14:48
KA2051A01	178.00	183.00	5.00	1	2011-08-16 15:02	2011-08-16 15:55
KA2051A01	183.00	188.00	5.00	1	2011-08-16 16:05	2011-08-16 16:46
KA2051A01	188.00	193.00	5.00	1	2011-08-16 16:58	2011-08-16 18:12
KA2051A01	193.00	198.00	5.00	1	2011-08-17 08:06	2011-08-17 09:21
KA2051A01	198.00	203.00	5.00	1	2011-08-17 09:30	2011-08-17 10:42
KA2051A01	203.00	208.00	5.00	1	2011-08-17 10:52	2011-08-17 11:37
KA2051A01	208.00	213.00	5.00	1	2011-08-17 11:49	2011-08-17 14:10
KA2051A01	213.00	218.00	5.00	1	2011-08-17 14:20	2011-08-17 15:36
KA2051A01	218.00	223.00	5.00	1	2011-08-17 15:48	2011-08-17 16:58
KA2051A01	223.00	228.00	5.00	1	2011-08-17 17:05	2011-08-17 17:48
KA2051A01	228.00	233.00	5.00	1	2011-08-18 09:49	2011-08-18 10:35
KA2051A01	233.00	238.00	5.00	1	2011-08-18 10:45	2011-08-18 11:58
KA2051A01	238.00	243.00	5.00	1	2011-08-18 12:06	2011-08-18 14:36
KA2051A01	243.00	248.00	5.00	1	2011-08-18 14:46	2011-08-18 16:01
KA2051A01	248.00	253.00	5.00	1	2011-08-18 16:11	2011-08-18 17:22
KA2051A01	253.00	258.00	5.00	1	2011-08-19 08:05	2011-08-19 09:00
KA2051A01	258.00	263.00	5.00	1	2011-08-19 09:09	2011-08-19 10:24
KA2051A01	263.00	268.00	5.00	1	2011-08-19 10:34	2011-08-19 11:50
KA2051A01	268.00	273.00	5.00	1	2011-08-19 11:58	2011-08-19 14:06
KA2051A01	273.00	278.00	5.00	1	2011-08-19 14:14	2011-08-19 15:36
KA2051A01	278.00	283.00	5.00	1	2011-08-19 16:30	2011-08-19 18:02
KA2051A01	283.00	288.00	5.00	1	2011-08-20 10:44	2011-08-20 13:35
KA2051A01	288.00	293.00	5.00	2	2011-08-20 16:01	2011-08-20 17:29
KA2051A01	293.00	298.00	5.00	1	2011-08-21 10:24	2011-08-21 11:11
KA2051A01	298.00	303.00	5.00	1	2011-08-21 11:32	2011-08-21 14:06
KA2051A01	303.00	308.00	5.00	1	2011-08-21 14:30	2011-08-21 15:43
KA2051A01	308.00	313.00	5.00	1	2011-08-21 16:21	2011-08-21 17:34
KA2051A01	313.00	319.84	6.84	1	2011-08-23 15:21	2011-08-23 17:04
KA3007A01	148.00	153.00	5.00	1	2011-06-30 11:33	2011-06-30 15:15
KA3007A01	153.00	158.00	5.00	1	2011-06-30 16:04	2011-06-30 16:45
KA3007A01	158.00	163.00	5.00	1	2011-06-30 17:15	2011-06-30 18:25
KA3007A01	163.00	168.00	5.00	1	2011-07-01 08:07	2011-07-01 09:30
KA3007A01	168.00	173.00	5.00	1	2011-07-01 09:44	2011-07-01 11:00
KA3007A01	173.00	178.00	5.00	1	2011-07-01 11:19	2011-07-01 12:25
KA3007A01	178.00	183.00	5.00	1	2011-07-01 14:13	2011-07-01 15:03
KA3007A01	183.00	188.00	5.00	1	2011-07-01 15:17	2011-07-01 16:00
KA3007A01	188.00	193.00	5.00	1	2011-07-01 16:12	2011-07-01 16:57
KA3007A01	193.00	198.00	5.00	1	2011-07-01 17:15	2011-07-01 18:01
KA3007A01	198.00	203.00	5.00	1	2011-07-02 08:49	2011-07-02 09:33
KA3007A01	203.00	208.00	5.00	1	2011-07-02 10:53	2011-07-02 11:09
KA3007A01	208.00	213.00	5.00	1	2011-07-02 11:19	2011-07-02 12:31
KA3007A01	213.00	218.00	5.00	1	2011-07-02 14:42	2011-07-02 15:54
KA3007A01	218.00	227.76	9.76	1	2011-07-03 11:43	2001-07-03 14:22
KJ0050F01	3.50	8.50	5.00	1	2011-09-13 14:57	2011-09-13 17:09
KJ0050F01	8.50	13.50	5.00	1	2011-09-13 17:56	2011-09-13 19:23
KJ0050F01	13.50	18.50	5.00	1	2011-09-14 08:20	2011-09-14 09:49
KJ0050F01	18.50	23.50	5.00	1	2011-09-14 10:13	2011-09-14 13:11
KJ0050F01	23.50	28.50	5.00	1	2011-09-14 13:28	2011-09-14 14:56
KJ0050F01	28.50	33.50	5.00	1	2011-09-14 17:23	2011-09-14 18:39
KJ0050F01	33.50	38.50	5.00	1	2011-09-15 07:46	2011-09-15 09:02
KJ0050F01	38.50	43.50	5.00	1	2011-09-15 09:15	2011-09-15 10:31
KJ0050F01	43.50	46.79	3.29	1	2011-09-15 16:01	2011-09-15 17:39

4 Description of equipment

The equipment used during the injection tests were the HWIC, parts of the UHT1 (Underground Hydraulic Test system 1) and a hoisting rig.

The HWIC is a device that control injection and pumping tests with constant pressure. It can handle high pressures and contains:

- Pumping system
- Regulation equipment
- Data acquisition system
- Flow meter
- Pressure transducer

In the HWIC there is a data program that regulates a pump so that desired pressure is achieved in the test section. On the HWIC display parameters can be adjusted and the test can be monitored. Water is pumped from a water tank, through the HWIC, to the borehole, as showed in Figure 4-1.

Parts of the UHT1 equipment was used for down-hole equipment, packer expansion and connecting to the casing. At the casing, a sealing unit was used in order to maintain a normal and rather stable pressure in the borehole surrounding the test section.

The hoisting rig is of a hydraulic type where the clamping jaws, holding the pipe string, are closed hydraulically and opened mechanically by springs.

Figure 4-1. *A photograph of the HWIC and the water tank.*

The down-hole equipment is mostly part of the UHT1. A schematic drawing of the down-hole equipment is shown in Figure 4-2. The pipe string consists of aluminium pipes of 3 m length, connected by stainless steel taps sealed with double o-rings. Two packers that are hydraulically operated by a water filled pressure vessels isolate the test section.

The pressure in the test section was measured with an external pressure transducer outside the borehole connected by a water filled polyamid tube to the test section. In the long boreholes of KA2051A01 and KA3007A01, this tube was c. 300 m.

It is possible to use the internal HWIC pressure transducer for regulation of the flow period. However, if the flow rate is high, the frictional losses in the pipe string may be significant so that the internal HWIC transducer display a stable pressure while the external pressure transducer show a decreasing trend. An option is to use the external pressure transducer connected to HWIC for regulation. In this case the pressure in the test section is rather stable since frictional losses in the pipe string do not affect the regulation. The downside of this way of regulation is that the tube between the transducer and the test section delays the response time, causing a more scattered pressure and flow rate data during the flow period.

In KJ0050F01, no high flow rates were expected so the tests there were regulated with the internal HWIC pressure transducer. High flow rates were expected in KA2051A01 and KA3007A01, so there was the external pressure transducer used for regulation.

The section below and above the test section are short circuited by a by-pass line in the packers. The surrounding pressure (p_{surr}) is then measured via a lead through the sealing unit where a pressure transducer is situated.

The hydraulic connection between the pipe string and the test section can be closed or opened by a mechanically operated test valve.

All data (pressure, flow rate, time) were stored on a memory card in HWIC, from where it later could be downloaded to a PC.

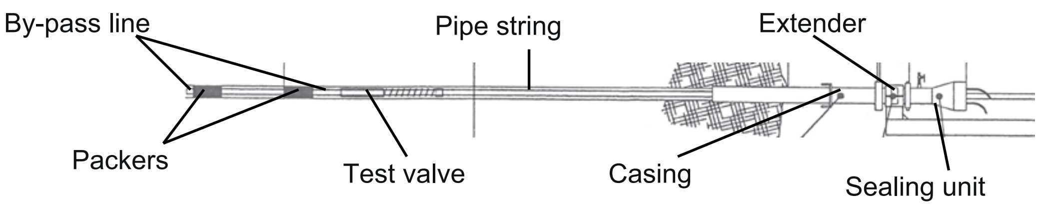

Figure 4-2. *Schematic drawing of the down-hole equipment.*

5 Execution

5.1 Preparation

The pressure transducers were prior to the tests calibrated at the Geosigma engineering service station in Uppsala. The flow meters in the HWIC use the calibration curves from the supplier which are transmitted to fit the HWIC output signal. Simple equipment functioning checks were performed during the establishment of the equipment at the test site and continuously during the tests.

5.2 Test performance

The injection tests in KA2051A01, KA3007A01 and KJ0050F01 were carried out while maintaining a constant head above formation pressure of generally 500 kPa in the 5 m test section. Before start of the injection period, approximately steady-state pressure conditions prevailed in the test section. After the injection period, the pressure recovery was measured.

A test cycle of a standard injection test includes the following phases:

1) Transfer of down-hole equipment to the next section
2) Packer inflation (c. 25 min)
3) Pressure stabilisation (c. 5 min)
4) Injection period (c. 20 min)
5) Pressure recovery period (c. 20 min)
6) Packer deflation

The injection period was interrupted if the flow rate was clearly below the measurement limit, in this case 5 mL/min. Thereafter, the recovery was measured for at least 5 minutes to verify the low conductivity of the section.

The down-hole equipment is not supplied with a level indicator and consequently no length correction was possible during this test campaign. Other precautions were still taken to ensure that all tests were performed at the correct location in the boreholes. The precautions included counting the sections of pipe string and continuously putting batches of pipe-string-sections to the side to make sure that at any given moment it was possible to re-count the number of pipe sections already inserted in the borehole. Also, for every section of pipe string installed, a mark was made on paper.

5.3 Data handling

With the HWIC system data are continuously logged in *.csv-files during a test. After the test is finished, a report file (*.csv) with comma separated data is generated. The *.csv-file contains logged parameters as well as test-specific information, such as background data. The parameters are presented in engineering units. The report file in *.csv -format is the raw data file delivered to the data base Sicada.

The *.csv- files were converted to *.xls-files and parameter files suitable for plotting and analysis with the AQTESOLV software.

A backup of data files was created on a regular basis by USB-storage and by sending the files to the Geosigma office in Uppsala. A file description table is presented in Appendix 1.

5.4 Analysis and interpretation

5.4.1 General

As described in Section 5.2, the injection tests in KA2051A01, KA3007A01 and KJ0050F01 were performed as transient constant head tests followed by a pressure recovery period. From the injection period, the (reciprocal) flow rate versus time was plotted in log-log and lin-log diagrams together with the corresponding derivative. From the recovery period, the pressure was plotted versus Agarwal equivalent time based on multi-rate in lin-log and log-log diagrams, respectively, together with the corresponding derivative.

For evaluation of the test data, no corrections of the measured flow rate and absolute pressure data (e.g. due to barometric pressure variations or tidal fluctuations) have been made. For short-time single-hole tests, such corrections are generally not needed, unless very small pressure changes are applied. No subtraction of the barometric pressure from the measured absolute pressure has been made, since the length of the test periods are short relative to the time scale for barometric pressure changes. In addition, pressure differences rather than the pressure magnitudes are used by the evaluation.

Normally, the data were not processed before analysis. However, as mentioned in Section 4 above, the flow rate data could be very scattered due to the long tube between the test section and pressure transducer. In order to facilitate identification of trends and flow regimes, scattering and outliers in the flow rate data was reduced by replacing a specific flow rate value with the median of the surrounding 11 flow rate data. This was made for tests were the final flow rate was below c. 30 mL min^{-1}.

5.4.2 Measurement limit for flow rate and specific flow rate

The lower measurement limit for flow rate for injection tests with the test setup in KA3007A01 and KA2051A01 was estimated to 5 mL min^{-1} ($8.3 \cdot 10^{-8}$ m^{3}s^{-1}). The lower measurement limit for HWIC it self is considerably lower. But the scattering in flow rate, due to the distance between the pressure transducer and test section in this case, makes it necessary to elevate the lower measurement limit. For the test in KJ0050F01 where the regulation was made using the internal pressure transducer in HWIC, the lower measurement limit for flow rate was estimated to 2 mL min^{-1} ($3.3 \cdot 10^{-8}$ m^{3}s^{-1}).

The lower measurement limit for transmissivity is defined in terms of the specific flow rate (*Q/s*). The minimum specific flow rate corresponds to the estimated lower measurement limit of the flow rate together with the actual injection pressure during the test. The intention during this test campaign was to use a standard injection pressure of 500 kPa. Still, the injection pressure can be considerably different. A low injection pressure is often the result of a test section of low conductivity due to a pressure increase, caused by packer expansion, before the injection start. A highly conductive section may also result in a low injection pressure due to limited flow capacity of HWIC.

Whenever the final flow rate (Q_p) was not defined (i.e. below the measurement limit), the lower measurement limit for specific flow rate was based on the lower measurement limit for flow rate and a standard injection pressure of 500 kPa. This is done in order to avoid excessively high, apparent estimates of the specific flow rate for these low conductivity sections, which would have resulted if the actual pressure difference at start of injection had been used as injection pressure. The lower measurement limit for flow rate, specific flow rate and steady-state analysis of transmissivity according to Moye's formula (see Equation 5-1) are shown in Table 5-1.

The practical upper measurement limit of hydraulic transmissivity for the HWIC system is estimated at a flow rate of c. 90 L min^{-1} ($1.5 \cdot 10^{-3}$ m^{3}s^{-1}) and an injection pressure of c. 1 m. Thus, the upper measurement limit for the specific flow rate is $1.5 \cdot 10^{-3}$ m^{2}s^{-1}. However, the practical upper measurement limit may vary, depending on e.g. depth of the test section (friction losses in the pipe string).

Table 5-1. Estimated lower measurement limit for specific flow rate and steady-state transmissivity for injection tests with borehole radius 0.038 m, section length 5 m and injection pressure of 500 kPa.

Borehole	Q-measl-L (m^3/s)	Q/s-measl-L (m^2/s)	T_M-measl-L (m^2/s)
KA2051A01, KA3007A01	8.3E–08	1.6E–09	1.4E–09
KJ0050F01	3.3E–08	6.5E–10	5.4E–10

5.4.3 Qualitative analysis

Initially, a qualitative evaluation of actual flow regimes, e.g. wellbore storage (WBS), pseudo-linear flow regime (PLF), pseudo-radial flow regime (PRF), pseudo-spherical flow regime (PSF) and pseudo-stationary flow regime (PSS), respectively, was performed. In addition, indications of outer boundary conditions during the tests were identified. The qualitative evaluation was mainly interpreted from the log-log plots of flow rate and pressure together with the corresponding derivatives.

In particular, time intervals with pseudo-radial flow, reflected by a constant (horizontal) derivative in the test diagrams, were identified. Pseudo-linear flow may, at the beginning of the test, be reflected by a straight line of slope 0.5 or less in log-log diagrams, both for the measured variable (flow rate or pressure) and the derivative. A true spherical flow regime is reflected by a straight line with a slope of –0.5 for the derivative. However, other slopes may indicate transitions to pseudo-spherical (leaky) or pseudo-stationary flow. The latter flow regime corresponds to almost stationary conditions with a derivative approaching zero.

The interpreted flow regimes can also be described in terms of the distance from the borehole:

- **Inner zone:** Representing very early responses that may correspond to the fracture properties close to the borehole which may possibly be affected by turbulent head losses. These properties are generally reflected by the skin factor.
- **Middle zone:** Representing the first response from which it is considered possible to evaluate the hydraulic properties of the formation close to the borehole.
- **Outer zone:** Representing the response at late times of hydraulic structure(s) connected to the hydraulic feature for the middle zone. Sometimes it is possible to deduce the possible character of the actual feature or boundary and evaluate the hydraulic properties.

Due to the limited resolution of the flow meter and pressure sensor, the derivative may sometimes indicate a false horizontal line by the end of periods with pseudo-stationary flow. Apparent no-flow (NFB) and constant head boundaries (CHB), or equivalent boundary conditions of fractures, are reflected by an increase/decrease of the derivative, respectively.

5.4.4 Quantitative analysis

A preliminary steady-state analysis of transmissivity according to Moye's formula (Moye 1967) (denoted T_M) was made for the injection period for all tests in conjunction with the qualitative analysis according to the following equations:

$$T_M = \frac{Q_p \cdot \rho_w \cdot g}{dp_p} \cdot C_M$$ Equation 5-1

$$C_M = \frac{1 + \ln\left(\frac{L_w}{2r_w}\right)}{2\pi}$$ Equation 5-2

Q_p = flow rate by the end of the flow period (m^3s^{-1})

ρ_w = density of water (kg m^{-3})

g = acceleration of gravity (m s^{-2})

C_M = geometrical shape factor (–)

dp_p = injection pressure $p_p - p_i$ (Pa)

r_w = borehole radius (m)

L_w = section length (m)

From the results of the qualitative evaluation, appropriate interpretation models for the quantitative evaluation of the tests were selected. When possible, transient analysis was made on both the injection and recovery periods of the tests.

The transient analysis was performed using a version 4.5 of the test analysis software AQTESOLV, which enables both visual and automatic type curve matching. The quantitative transient evaluation is generally carried out as an iterative process of manual type curve matching and automatic matching. For the injection period, a model based on the solution of Jacob and Lohman (1952) was applied for estimating the transmissivity and skin factor for an estimated value of the storativity, Equation 5-4, when a certain period with pseudo-radial flow could be identified. The model is based on the effective wellbore radius concept to account for non-zero (negative) skin factors according to Hurst et al. (1969).

For transient analysis of the recovery period, a model presented by Dougherty and Babu (1984) was used when a certain period with pseudo-radial flow could be identified. In this model, a variety of transient solutions for flow in fractured porous media are available, accounting for e.g. wellbore storage and skin effects, double porosity etc.

For tests characterized by pseudo-spherical (leaky) flow or pseudo-stationary flow during the injection period, a model by Hantush (1959) for constant head tests was adopted for the evaluation. In this model, the skin factor is not separated but can be calculated from the simulated effective borehole radius according to Equation 5-3. Besides, the leakage coefficient *K'/b'* can be calculated from the simulated leakage factor *r/B*. The corresponding model for constant flow rate tests (Hantush and Jacob 1955), was applied for evaluation of the recovery period for tests showing pseudo-spherical- or pseudo-stationary flow during this period.

$\xi = ln(r_w/r_{wf})$ Equation 5-3

ξ = skin factor

r_w = borehole radius (m)

r_{wf} = effective borehole radius

The storativity was calculated using an empirical relationship between storativity and transmissivity presented in SKB (2006):

$S = 0.0007 \cdot T^{0.5}$ Equation 5-4

S = storativity (–)

T = transmissivity (m^2s^{-1})

Firstly, the transmissivity and skin factor were obtained by type curve matching on the data curve using a fixed storativity value of 10^{-6}. From the transmissivity value obtained, the storativity was then calculated according to Equation 5-4 and the type curve matching was repeated. In most cases the change of storativity did not significantly alter the calculated transmissivity by the new type curve matching. Instead, the estimated skin factor, which is strongly correlated to the storativity using the effective borehole radius concept, was altered correspondingly.

Some tests showed fracture responses (initial slope of 0.5 or less in a log-log plot). A model for an equivalent single fracture was then used for the transient analysis as a complement to standard models for pseudo-radial flow. The model presented in Ozkan and Raghavan (1991a, b) for a uniform-flux vertical fracture embedded in a porous medium was employed. With this model the hydraulic conductivity of the rock perpendicular (K_x) and parallel (K_y) to the fracture can be estimated. In this case, the quotient K_x/K_y was assumed to be 1.0 (one). Type curve matching provided values of K_x and L_f assuming a value on the specific storativity S_s based on Equation 5-4, where L_f is the theoretical fracture length. The test section length was then used to convert K_x and S_s to transmissivity $T = K_x \cdot L$ and to storativity $S = S_s \cdot L$, respectively of the rock in analysis by fracture models. Such estimates of transmissivity from fracture models may be compared with corresponding values from models for pseudo-radial flow in the same test section.

When using the model by Dougherty and Babu (1984) or Hantush and Jacob (1955), the wellbore storage, C, is represented by a radius of a fictive standpipe, *r(c)*. This value can then be used for calculating C as Almén et al. (1986):

$$C = \frac{\pi \cdot r(c)^2}{\rho \cdot g} \qquad \text{Equation 5-5}$$

The different transient estimates of transmissivity from the injection and recovery period, respectively, were compared and examined. One of these was chosen as the best representative value of the transient transmissivity of the formation adjacent to the test section. This value is denoted T_T. In cases with more than one pseudo-radial flow regime during the injection or recovery period, the first one was in most cases assumed as the most representative for the hydraulic conditions in the rock close to the tested section.

Finally, a representative value of transmissivity of the test section, T_R, was chosen from T_T and T_M. The latter transmissivity is to be chosen whenever a transient evaluation of the test data is not possible or not being considered as reliable. If the flow rate by the end of an injection period (Q_p) is too low to be defined, and thus neither T_T nor T_M can be estimated, the representative transmissivity for the test section is considered to be less than T_M based on the estimated lower measurement limit for Q/s (i.e. $T_R<T_{M\text{-}measl\text{-}L}$).

The radius of influence at a certain time may be estimated from Jacob's approximation of the Theis' well function (Cooper and Jacob 1946):

$$r_i = \sqrt{\frac{2.25Tt}{S}} \qquad \text{Equation 5-6}$$

T = representative transmissivity from the test (m^{2}s^{-1})

S = storativity estimated from Equation 5-4

r_i = radius of influence (m)

t = time after start of injection (s)

If a certain time interval of pseudo-radial flow (PRF) from t_1 to t_2 can be identified during the test, the radius of influence is estimated using time t_2 in Equation 5-6. If no interval of PRF can be identified, the actual total flow time t_p is used. The radius of influence can be used to deduce the length of the hydraulic feature(s) tested.

Furthermore, an r_i-*index* (–1, 0 or 1) is defined to characterize the hydraulic conditions by the end of the test. The r_i-*index* is defined as shown below. It is assumed that a certain time interval of PRF can be identified between t_1 and t_2 during the test.

- r_i-*index* = 0: The transient response indicates that the size of the hydraulic feature tested is greater than the radius of influence based on the actual test time ($t_2=t_p$), i.e. the PRF is continuing at stop of the test. This fact is reflected by a flat derivative at this time.
- r_i-*index* = 1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with lower transmissivity or an apparent barrier boundary (NFB). This fact is reflected by an increase of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.
- r_i-*index* = –1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with higher transmissivity or an apparent constant head boundary (CHB). This fact is reflected by a decrease of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.

If a certain time interval of PRF cannot be identified during the test, the r_i-indices –1 and 1 are defined as above. In such cases the radius of influence is estimated using the flow time t_p in Equation 5-6.

In some tests there may be signs of pressure interference in the section surrounding the test section due to a hydraulic interconnection of the sections. This kind of pressure interference may result in an overestimation of the transmissivity in the test section. If pressure interference was detected during a test, a qualitative evaluation was performed to determine if it is likely that the estimated transmissivity of the test section is overestimated or not. The qualitative evaluation includes a comparison of the injection pressure and evaluated transmissivity of the test section with the corresponding pressure interference and transmissivity of the borehole interval in which interference is observed. Furthermore, the type of dominating flow regime in the test section may also support the qualitative evaluation whether the interference is likely to affect the evaluated transmissivity or not.

6 Results

6.1 Nomenclature and symbols

The nomenclature and symbols used for the results of the injection tests in KA2051A01, KA3007A01 and KJ0050F01 are explained in the text. Symbols used by the AQTESOLV software are explained in Appendix 3.

Original data from the reported activity are stored in the primary database Sicada. Only data in databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. However, such revision of the database will not necessarily result in a revision of this report.

6.2 Routine evaluation of the single-hole injection tests

6.2.1 General results

General test data and selected pressure and flow data from all tests are listed in Appendix 2.1 and 2.2, respectively.

For the injection tests, transient evaluation was conducted, whenever possible, both on the injection and recovery periods (e.g. transmissivity T_f and T_s, respectively) according to the methods described in Section 5.4.4. The steady-state transmissivity (T_M) was calculated by Moye's formula according to Equation 5-1. Injection tests with a final flow rate, Q_p, below the measurement limit or with a non-definable flow regime were only evaluated by the steady-state method. All other tests were evaluated with both transient and steady-state methods. The quantitative analysis was conducted using the AQTESOLV software. A summary of the results of the routine evaluation of the injection tests, including dominating transient flow regimes and selection of T_T and T_R are shown in Table 6-1. The test are further commented in Appendix 4.1 to Appendix 4.3.

For 45 out of 49 tests with a definable final flow rate in the three boreholes, the transient evaluation of the injection period was considered to give the most representative transient transmissivity value. The corresponding number for the recovery period was 3. Several of the responses during the recovery period were strongly influenced by wellbore storage effects. On the other hand, during the injection period a certain time interval with pseudo-radial flow could, in about 80% of the tests, be identified. Consequently, standard methods for single-hole tests with wellbore storage and skin effects were commonly used for the routine evaluation of the tests. The approximate start and stop times of the pseudo-radial flow regime used for the transient evaluation are also listed in Table 6-1.

For those tests where transient evaluation was not possible or not considered representative, T_M was chosen as the representative transmissivity value, T_R. In 3 out of 49 tests with a definable final flow rate in the three boreholes the steady-state transmissivity, T_M, was chosen as the most representative value. If the final flow rate Q_p was below the estimated measurement limit, the representative transmissivity value was assumed to be less than the estimated T_M, based on *Q/s-measl-L*.

Selected test diagrams are presented in Appendix 3. In general, one linear diagram showing the entire test sequence together with lin-log and log-log diagrams from the injection and recovery periods, respectively, are presented for the injection tests. The quantitative analysis was performed from such diagrams using the AQTESOLV software. From injection tests with a flow rate below the estimated lower measurement limit for the specific test, only the linear diagram is presented.

For a few tests, a type curve fit is displayed in the diagrams in Appendix 3 despite the fact that the estimated parameters from the fit are judged as ambiguous or non-representative and not included in the result tables in Sicada. For these tests, the type curve fit is presented as an example, e.g. to illustrate that an assumption of pseudo-radial flow regime is not justified for the test and some other flow regime is dominating or, alternatively, to show one possible fit in the case of unambiguous evaluation. For example, for test responses showing only wellbore storage or no flow boundary response, no unambiguous transient evaluation is possible.

Table 6-1. Summary of the routine evaluation of the single-hole injection tests in boreholes KA2051A01, KA3007A01 and KJ0050F01.

Borehole Bh ID	Secup (m)	Seclow (m)	Flow regime [1] injection	Recovery	T_M (m^2/s)	T_f (m^2/s)	T_s (m^2/s)	T_T (m^2/s)	T_R [2] (m^2/s)	ξ (–)	t_1 (s)	t_2 (s)	dte_1 (s)	dte_2 (s)	r_i (m)	r_i–index (–)
KA2051A01	4.00	9.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	9.00	14.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	14.00	19.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	19.00	24.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	24.00	29.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	29.00	34.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	34.00	39.00	>PRF	WBS–>PRF	6.57E–07	1.64E–06	2.36E–06	1.64E–06	1.64E–06	5.32	70	1,800	300	600	86.08	0
KA2051A01	39.00	44.00	PRF	WBS–>PSS?	2.08E–07	3.25E–07	2.92E–06	3.25E–07	3.25E–07	0.85	600	1,450			51.55	0
KA2051A01	44.00	49.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	49.00	54.00	>PRF	WBS–>PSF–>PSS	9.82E–08	2.50E–07	2.23E–07	2.50E–07	2.50E–07	5.94	100	1,200			43.90	0
KA2051A01	54.00	59.00	PRF?	WBS–>PSF>PSS	3.49E–08	1.00E–07		1.00E–07	3.49E–08	8.05	100	1,250			–	0
KA2051A01	59.00	64.00	PRF–>PSF	(PRF)–>PSF	1.78E–06	2.37E–06	1.63E–06	2.37E–06	2.37E–06	–0.39	90	200			31.46	–1
KA2051A01	64.00	69.00	PRF–>PSF	PSF–>	1.50E–06	1.78E–06	1.67E–06	1.78E–06	1.78E–06	–0.91	90	200			29.30	–1
KA2051A01	118.00	123.00	PRF–> (PSF)	WBS–>PRF–>(PSF)	8.57E–07	1.36E–06	2.17E–06	1.36E–06	1.36E–06	0.74	70	1,277	10	100	69.19	–1
KA2051A01	123.00	128.00	PSF	PLF–>PSF	1.81E–07	7.60E–08	5.15E–08	7.60E–08	7.60E–08	–3.91					33.04	–1
KA2051A01	128.00	133.00	PRF>(PSF)	PLF?	3.29E–06	2.62E–06	2.90E–06	2.62E–06	2.62E–06	–3.53	100	800			64.52	0
KA2051A01	133.00	138.00	PRF>PSF	WBS–>(PRF)–>PSF	4.17E–07	6.55E–07	6.70E–07	6.55E–07	6.55E–07	1.22					57.90	–1
KA2051A01	138.00	143.00	>PSF	WBS–>PSF	2.34E–08	1.62E–08	5.51E–09	1.62E–08	1.62E–08	–2.23					22.50	–1
KA2051A01	143.00	148.00	PSF	WBS–>PSF	3.34E–09	2.21E–09	1.00E–09	2.21E–09	2.21E–09	–2.34					14.62	–1
KA2051A01	148.00	153.00	PSF	–	6.63E–08	1.72E–08	9.50E–09	1.72E–08	1.72E–08	–4.83					22.75	–1
KA2051A01	153.00	158.00	PRF–>(NFB)	PLF–>PSF	1.98E–08	1.29E–08	5.66E–09	1.29E–08	1.29E–08	–3.10	300	1,000			19.11	1
KA2051A01	158.00	163.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	163.00	168.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	168.00	173.00	PRF?	WBS–>PSF–>PSS	1.78E–08	2.43E–08	4.03E–08	2.43E–08	2.43E–08	0.69	100	1,200			24.52	0
KA2051A01	173.00	178.00	PRF–>(NFB)	WBS–>PRF	2.42E–07	3.10E–07	3.46E–07	3.10E–07	3.10E–07	–0.57	200	1,000	150	650	42.31	1
KA2051A01	178.00	183.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	183.00	188.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	188.00	193.00	PRF	WBS–>PRF	1.04E–08	7.54E–09	7.40E–09	7.54E–09	7.54E–09	–2.37	150	900	20	500	15.85	–1
KA2051A01	193.00	198.00	PRF–>PSF	WBS–>PSF	9.22E–09	7.83E–09	8.26E–09	7.83E–09	7.83E–09	–1.47	30	1,000			16.86	–1
KA2051A01	198.00	203.00	PRF	WBS–>PSF	2.91E–09	4.39E–09		4.39E–09	4.39E–09	1.82	90	1,229			16.18	0
KA2051A01	203.00	208.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	208.00	213.00	PLF–>	PLF–>	2.20E–09	6.64E–10	2.21E–10	6.64E–10	6.64E–10	–3.55					10.33	0
KA2051A01	213.00	218.00	PLF–>(PRF)	PLF–>PRF–>NFB?	5.83E–08	2.39E–08	2.58E–08	2.58E–08	2.58E–08	–4.48			100	1,351	26.41	1
KA2051A01	218.00	223.00	PRF–>PSF	PLF–>PSF	6.33E–09	1.53E–09	9.80E–10	1.53E–09	1.53E–09	–4.60	60	500			7.93	–1
KA2051A01	223.00	228.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	228.00	233.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	233.00	238.00	>PRF	>PRF–>(PSF)	1.55E–08	8.28E–09	8.99E–09	8.28E–09	8.28E–09	–3.50	100	1,200	200	400	18.73	0
KA2051A01	238.00	243.00	PRF	WBS–>PSF?	6.00E–09	6.46E–09	1.92E–08	6.46E–09	6.46E–09	–0.20	65	1,217			17.73	0
KA2051A01	243.00	248.00	PRF>(PSF)	WBS–>PRF–>(NFB)	1.38E–07	9.87E–08	3.48E–07	9.87E–08	9.87E–08	–3.17	100	1,223			35.14	–1

Borehole Bh ID	Secup (m)	Seclow (m)	Flow regime [1] injection	Recovery	T_M (m^2/s)	T_f (m^2/s)	T_s (m^2/s)	T_T (m^2/s)	T_R [2] (m^2/s)	ξ (–)	t_1 (s)	t_2 (s)	dte_1 (s)	dte_2 (s)	r_i (m)	r_i–index (–)
KA2051A01	248.00	253.00	PRF	WBS–>PSF?	1.01E–08	9.86E–09	2.27E–08	9.86E–09	9.86E–09	–0.57	20	1,215			19.69	0
KA2051A01	253.00	258.00	–	–	<1.35E–09				<1.35E–09						–	–
KA2051A01	258.00	263.00	>NFB?	PLF?	<1.35E–09				<1.35E–09						–	–
KA2051A01	263.00	268.00	PRF?–>NFB?–>PSF?	WBS–>PRF?–>NFB?	2.99E–08	4.49E–08	7.08E–08	4.49E–08	4.49E–08	–2.87			10	30	28.85	–1
KA2051A01	268.00	273.00	PRF–>PSF	WBS–>PSF	3.78E–08	1.13E–08	9.54E–09	1.13E–08	1.13E–08	–4.32	30	200			8.27	–1
KA2051A01	273.00	278.00	PRF1–>PRF2	No evaluation	3.08E–07	3.05E–07		3.05E–07	3.05E–07	–1.81	10	250			21.07	0
KA2051A01	278.00	283.00	PRF	WBS–>PRF>PSF?	6.09E–08	8.69E–08	1.47E–07	8.69E–08	8.69E–08	0.76	10	970	200	400	30.31	0
KA2051A01	283.00	288.00	PRF?	WBS–>PSF>PSS	7.68E–08	1.46E–07	6.24E–08	6.24E–08	6.24E–08	–1.50	200	1,210			31.16	–1
KA2051A01	288.00	293.00	PRF	WBS–>PSF–>PSS	2.06E–07	3.60E–07	1.80E–07	3.60E–07	3.60E–07	1.83	70	1,261			49.31	0
KA2051A01	293.00	298.00	PSF–>PSF–>NFB	WBS–>PSF–>PSS	1.31E–07	2.99E–07	2.95E–07	2.95E–07	2.95E–07	6.50					46.13	1
KA2051A01	298.00	303.00	PRF–>NFB?	WBS–>PSF–>PSS	1.55E–07	4.20E–07	3.57E–07	4.20E–07	1.55E–07	6.49					–	1
KA2051A01	303.00	308.00	PRF	WBS–>PSF>PSS	3.93E–07	4.77E–07	4.61E–07	4.77E–07	4.77E–07	–0.97	20	1,280			53.31	0
KA2051A01	308.00	313.00	PRF	WBS–>PSF>PSS	1.42E–07	2.36E–07		2.36E–07	2.36E–07	1.53	15	1,221			43.65	0
KA2051A01	313.00	319.84	PRF–>NFB–>PSF?	WBS–>PSF>PSS	1.13E–07	1.47E–07	4.14E–07	1.47E–07	1.47E–07	–1.04	10	200			15.71	–1
KA3007A01	148.00	153.00	PRF	WBS–>PSF	1.11E–07	3.11E–07	2.73E–07	3.11E–07	3.11E–07	7.30	5	1,204			46.45	0
KA3007A01	153.00	158.00	PRF/PSF	WBS–>PSF	1.18E–07	1.48E–07	2.65E–07	1.48E–07	1.48E–07	0.14					38.58	–1
KA3007A01	158.00	163.00	PSF	WBS–>PSF	4.73E–08	3.48E–08	1.54E–08	3.48E–08	3.48E–08	–2.14					27.20	–1
KA3007A01	163.00	168.00	PRF	WBS–>PSF	2.63E–08	7.17E–08	9.02E–08	7.17E–08	7.17E–08	7.55	20	1,269			33.05	0
KA3007A01	168.00	173.00	PRF	WBS–>PSF	1.29E–08	2.75E–08		2.75E–08	2.75E–08	4.77	50	1,148			24.73	0
KA3007A01	173.00	178.00	PRF–>PSF?	PRF–>PSF	1.31E–06	1.79E–06	2.07E–06	1.79E–06	1.79E–06	0.00	20	200	30	100	29.33	–1
KA3007A01	178.00	183.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	183.00	188.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	188.00	193.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	193.00	198.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	198.00	203.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	203.00	208.00	–	–	<1.35E–09				<1.35E–09						–	–
KA3007A01	208.00	213.00	PSF–>(NFB?)	WBS–>PSF–>PSS	8.72E–07	1.21E–06	1.56E–06	1.21E–06	1.21E–06	0.64					66.24	1
KA3007A01	213.00	218.00	PSF	PSF–>PSS	1.52E–06	1.66E–06	1.53E–06	1.66E–06	1.66E–06	–1.29					71.49	–1
KA3007A01	218.00	227.76	PRF/PSF?	PRF–>PSF	5.06E–05	1.23E–04	9.88E–05	1.23E–04	1.23E–04	1.27	100	1,822	80	600	254.85	0
KJ0050F01	3.50	8.50	PRF–>PSF	WBS–>PSF	1.36E–08	4.66E–09	2.70E–09	4.66E–09	4.66E–09	–3.21	20	40			2.96	–1
KJ0050F01	8.50	13.50	PRF	WBS–>PRF>(PSF)	8.25E–08	1.65E–07	1.87E–07	1.65E–07	1.65E–07	3.35	5	1,210	10	100	39.74	0
KJ0050F01	13.50	18.50	–	–	9.02E–10				9.02E–10						–	–
KJ0050F01	18.50	23.50	–	–	<5.40E–10				<5.40E–10						–	–
KJ0050F01	23.50	28.50	–	–	<5.40E–10				<5.40E–10						–	–
KJ0050F01	28.50	33.50	–	–	<5.40E–10				<5.40E–10						–	–
KJ0050F01	33.50	38.50	–	–	<5.40E–10				<5.40E–10						–	–
KJ0050F01	38.50	43.50	–	–	<5.40E–10				<5.40E–10						–	–

[1] The acronyms in the column “Flow regime” are as follows: wellbore storage (WBS), pseudo-linear flow (PLF), pseudo-radial flow (PRF), pseudo-spherical flow (PSF), pseudo-stationary flow (PSS) and apparent no-flow boundary (NFB). The flow regime definitions are further discussed in Section 5.4.3 above.

[2] For the tests where Q_p was not detected, T_R was assumed to be less than T_M based on *Q/s-measl-L*.

In Figure 6-1, a comparison of calculated transmissivities in 5 m sections from steady-state evaluation (T_M) and transmissivity values from the transient evaluation (T_T) is shown. The agreement between the two populations is good. Steady-state analysis of transmissivity according to Moye's formula (denoted T_M) may slightly overestimate the transmissivity if steady-state conditions do not prevail in the borehole. In addition, skin effects (both positive and negative) may cause discrepancies between transient and steady-state evaluation. For example, a test showing a strong negative skin factor (fracture response) with an interpreted PLF from the transient evaluation of the injection period may result in a much higher (c one order of magnitude) steady-state transmissivity. For low values of transmissivity, discrepancies in transmissivity may also occur due to the definition of the lower measurement limit in transient and steady-state evaluation, respectively. In the latter evaluation the measurement limit is based on the test-specific flow rate while in transient evaluation, the transmissivity is based on the change of the (inverse) flow rate during the injection period.

In cases where apparent no-flow boundaries appear at the end of the injection period and transient evaluation is performed on the early part of the data curve, the steady-state transmissivity T_M may be low in comparison with the transient estimate of transmissivity. In this case, two different zones of the bedrock are measured during the early and late parts of the injection period, respectively.

Transmissivity values chosen as representative, T_R, are shown in Figure 6-2 to Figure 6-4 along the boreholes. The qualitative evaluation of pressure interference in the surrounding sections during the tests indicated that some reported transmissivity values possibly are overestimated. Those sections are shaded in grey in Figure 6-2 to Figure 6-4.

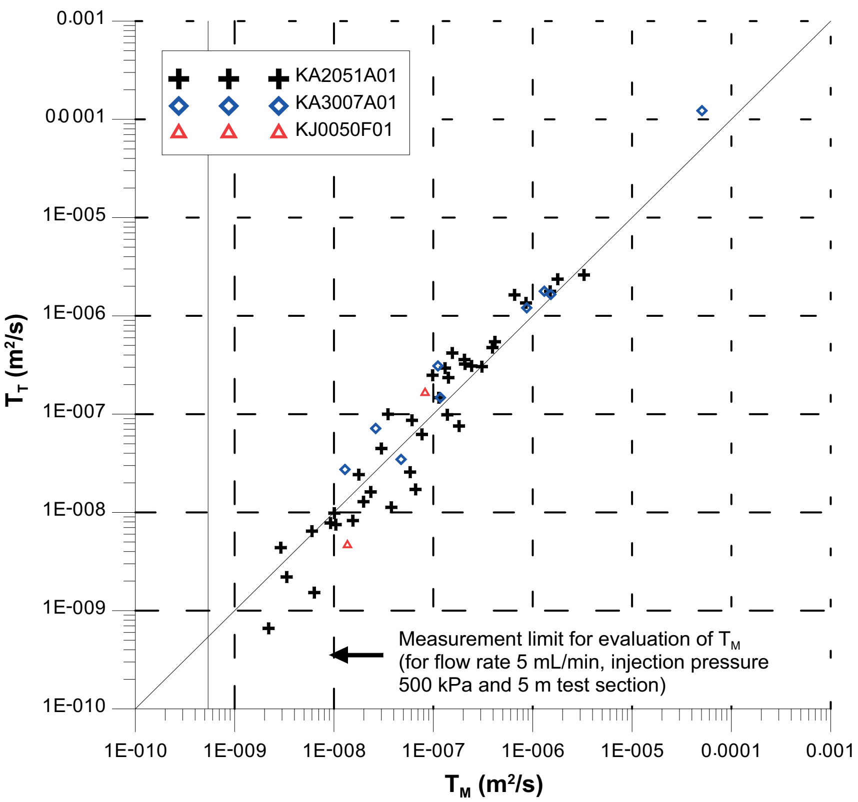

***Figure 6-1**. Estimated transmissivities in 5 m sections from steady-state (T_M) and transient (T_T) evaluation for the injection tests in KA2051A01, KA3007A01 and KJ0050F01.*

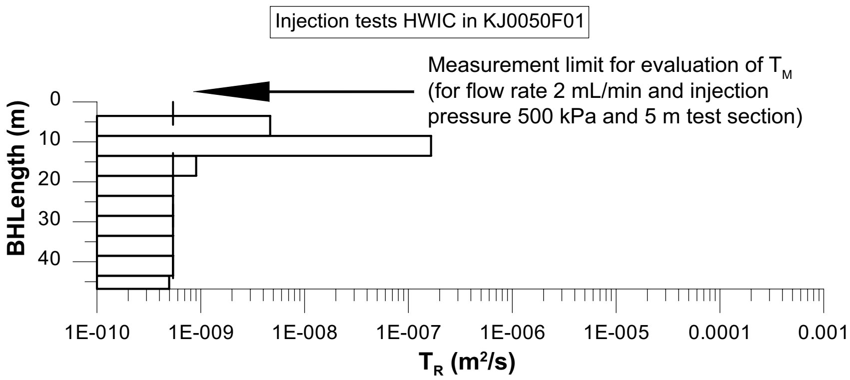

Figure 6-2. *Estimated best representative transmissivity values (T_R) from injection tests in borehole KJ0050F01.*

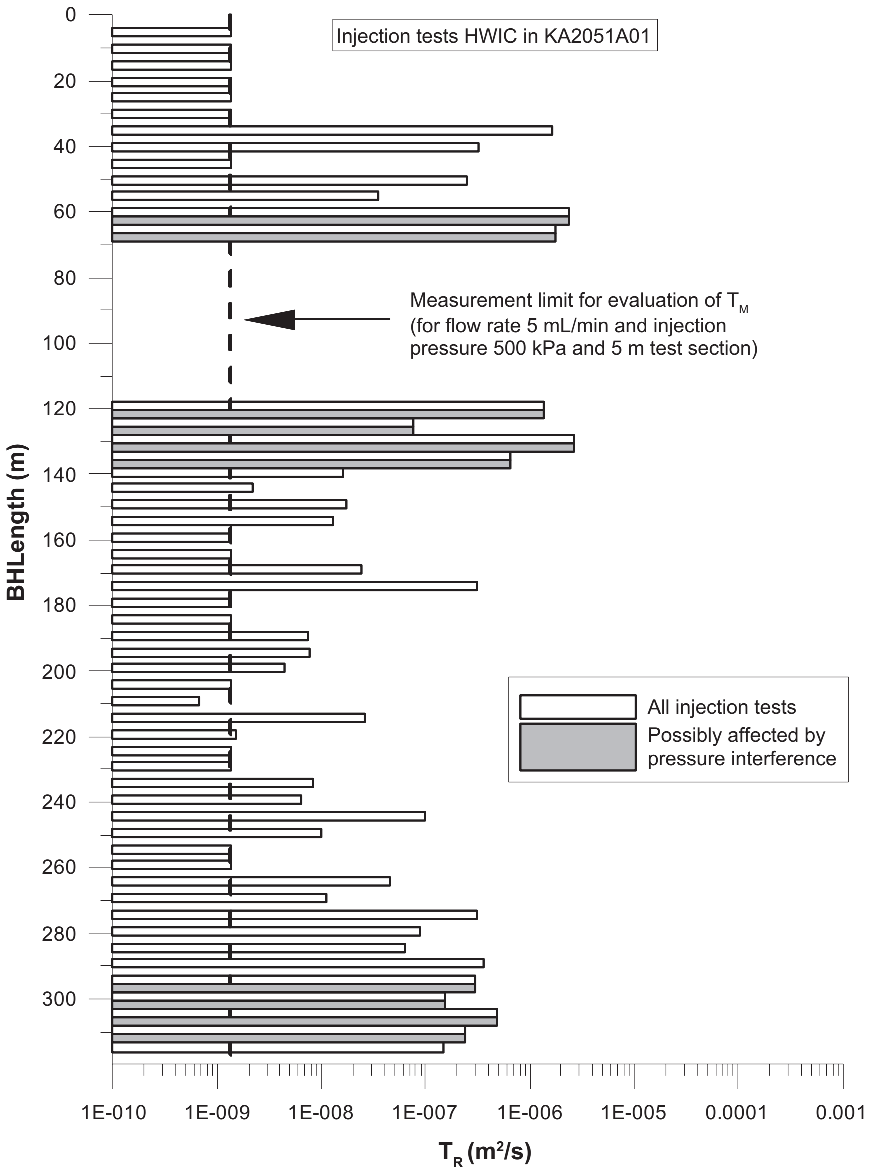

Figure 6-3. *Estimated best representative transmissivity values (T_R) from injection tests in borehole KA2051A01.*

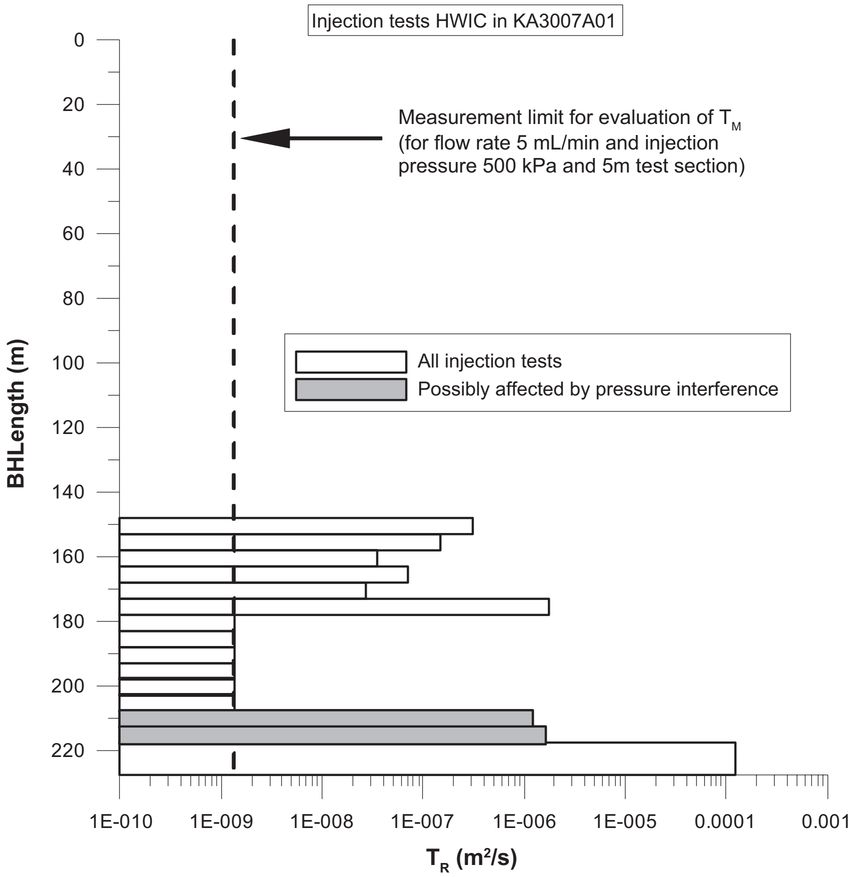

Figure 6-4. *Estimated best representative transmissivity values (T_R) from injection tests in borehole KA3007A01.*

6.2.2 Flow regimes

A summary of the frequency of identified flow regimes on different scales is presented in Table 6-2, which shows all identified flow regimes during the tests. For example, a pseudo-radial flow regime (PRF) transitioning to a pseudo-spherical flow regime (PSF) will contribute to one observation of PRF and one observation of PSF. The numbers within parenthesis denote the number of tests where the actual flow regime is the only one present.

It should be noted that the interpretation of flow regimes is only tentative and just based on visual inspection of the data curves. It should also be observed that the number of tests with a pseudo-linear flow regime during the beginning of the injection period may be underestimated due to the fact that a certain time is required for achieving a constant pressure, which may mask the initial flow regime.

Table 6-2. Interpreted flow regimes during the injection tests in KA2051A01, KA3007A01 and KJ0050F01. The figure within the parenthesis shows the number of tests with only one interpreted flow regime.

Bh ID	Number of tests	Number of tests with definable Q_p	Injection period					Recovery period					
			PLF	PRF	PSF	PSS	NFB	WBS	PLF	PRF	PSF	PSS	NFB
KA2051A01	53	37	2(1)	31(16)	16(4)	0(0)	7(1)	26(0)	7(3)	11(0)	26(1)	11(0)	3(0)
KA3007A01	15	9	0(0)	6(3)	6(2)	0(0)	1(0)	6(0)	0(0)	2(0)	9(0)	2(0)	0(0)
KJ0050F01	9	3	0(0)	2(1)	1(0)	0(0)	0(0)	2(0)	0(0)	1(0)	2(0)	0(0)	0(0)

Table 6-2 shows that a certain period of pseudo-radial flow could be identified from the injection period in 80% of the tests with a definable final flow rate for the three boreholes. For the recovery period, the corresponding result is 29%. Noticeable is that pseudo spherical flow, unlike pseudo radial flow, is much more common during the recovery period than the injection period. The reasons for this effect are not clear. For 88% of the tests in the boreholes, more than one flow regime during the injection period could be identified.

6.3 Basic statistics of hydraulic conductivity distributions

Some basic statistical parameters were calculated for the steady-state hydraulic conductivity (K_M) distributions from the injection tests in boreholes KA2051A01, KA3007A01 and KJ0050F01. The hydraulic conductivity is obtained by dividing the transmissivity by the section length, in this case T_M/L_w. Results from all tests are included in the statistical analyses of both K_R and K_M. Tests below the measurement limit are assigned a transmissivity value corresponding to the lower measurement limit. The same basic statistical parameters were derived for the hydraulic conductivity considered most representative ($K_R=T_R/L_w$), including all tests. In the statistical analysis, the logarithm (base 10) of K_M and K_R was used. Selected results are shown in Table 6-3.

Table 6-3. Basic statistical parameters for steady-state hydraulic conductivity (K_M) and hydraulic conductivity considered most representative (K_R) in boreholes KA2051A01, KA3007A01 and KJ0050F01. m=arithmetic mean, s=standard deviation.

Parameter Measured borehole interval	Unit m	KA3007A01 148.00–227.76	KA2051A01 4.00–319.84	KJ0050F01 3.50–46.79
Number of tests	–	15	53	9
N:o of tests below L.M.L.[1)]	–	6	16	6
m (Log10(KM))	Log10(m/s)	–8.18	–8.38	–9.53
s (Log10(KM))	–	1.42	1.04	0.80
m (Log10(KR))	Log10(m/s)	–8.06	–8.40	–9.55
s (Log10(KR))	–	1.51	1.11	0.83

[1)] Number of tests where Q_p could not be defined (L.M.L. = lower measurement limit).

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Appendix 1

File description tables

File description table, KA3007A01

Bh ID Idcode	Test section (m)	(m)	Test type (1–6) [1)]	Test no	Test start Date, time YYYYMMDD hh:mm	Test stop Date, time YYYYMMDD hh:mm	Data files of raw and primary data	Parameters in file	Comments
KA3007A01	148.00	153.00	3	1	2011-06-30 11:33	2011-06-30 15:15	148-153.CSV	P, Q	
KA3007A01	153.00	158.00	3	1	2011-06-30 16:04	2011-06-30 16:45	153-158.CSV	P, Q	
KA3007A01	158.00	163.00	3	1	2011-06-30 17:15	2011-06-30 18:25	158-163.CSV	P, Q	
KA3007A01	163.00	168.00	3	1	2011-07-01 08:07	2011-07-01 09:30	163-168.CSV	P, Q	
KA3007A01	168.00	173.00	3	1	2011-07-01 09:44	2011-07-01 11:00	168-173.CSV	P, Q	
KA3007A01	173.00	178.00	3	1	2011-07-01 11:19	2011-07-01 12:25	173-178.CSV	P, Q	
KA3007A01	178.00	183.00	3	1	2011-07-01 14:13	2011-07-01 15:03	178-183_test2.CSV	P, Q	
KA3007A01	183.00	188.00	3	1	2011-07-01 15:17	2011-07-01 16:00	183-188.CSV	P, Q	
KA3007A01	188.00	193.00	3	1	2011-07-01 16:12	2011-07-01 16:57	188-193.CSV	P, Q	
KA3007A01	193.00	198.00	3	1	2011-07-01 17:15	2011-07-01 18:01	193-198.CSV	P, Q	
KA3007A01	198.00	203.00	3	1	2011-07-02 08:49	2011-07-02 09:33	198-203.CSV	P, Q	
KA3007A01	203.00	208.00	3	1	2011-07-02 10:53	2011-07-02 11:09	203-208.CSV	P, Q	
KA3007A01	208.00	213.00	3	1	2011-07-02 11:19	2011-07-02 12:31	208-213.CSV	P, Q	
KA3007A01	213.00	218.00	3	1	2011-07-02 14:42	2011-07-02 15:54	213-218.CSV	P, Q	
KA3007A01	218.00	227.76	3	1	2011-07-03 11:43	2001-07-03 14:22	218- _M	P, Q	Single packer

[1)] 3: Injection test.

File description table, KA2051A01

Bh ID Idcode	Test section (m)	(m)	Test type (1–6) [1]	Test no	Test start Date, time YYYYMMDD hh:mm	Test stop Date, time YYYYMMDD hh:mm	Data files of raw and primary data	Parameters in file	Comments
KA2051A01	4.00	9.00	3	1	2011-07-07 14:28	2011-07-07 15:57	51A1004.CSV	P, Q	
KA2051A01	9.00	14.00	3	1	2011-07-07 16:53	2011-07-07 17:42	51A1009.CSV	P, Q	
KA2051A01	14.00	19.00	3	1	2011-07-07 18:34	2011-07-07 19:42	51A1014.CSV	P, Q	
KA2051A01	19.00	24.00	3	1	2011-07-08 08:26	2011-07-08 09:12	51A1019.CSV	P, Q	
KA2051A01	24.00	29.00	3	1	2011-07-08 09:35	2011-07-08 10:25	51A1024.CSV	P, Q	
KA2051A01	29.00	34.00	3	1	2011-07-08 10:47	2011-07-08 12:06	51A1029.CSV	P, Q	
KA2051A01	34.00	39.00	3	1	2011-07-08 12:18	2011-07-08 15:03	51A1034.CSV	P, Q	
KA2051A01	39.00	44.00	3	1	2011-07-08 15:22	2011-07-08 16:38	51A1039.CSV	P, Q	
KA2051A01	44.00	49.00	3	1	2011-07-08 17:00	2011-07-08 17:43	51A1044.CSV	P, Q	
KA2051A01	49.00	54.00	3	1	2011-07-08 18:07	2011-07-08 19:34	51A1049.CSV	P, Q	
KA2051A01	54.00	59.00	3	1	2011-07-09 08:08	2011-07-09 09:26	51A1054.CSV	P, Q	
KA2051A01	59.00	64.00	3	1	2011-07-09 09:41	2011-07-09 10:59	51A1059.CSV	P, Q	
KA2051A01	64.00	69.00	3	1	2011-07-09 11:16	2011-07-09 13:54	51A1064.CSV	P, Q	
KA2051A01	118.00	123.00	3	1	2011-07-09 15:33	2011-07-09 16:14	51A1118.CSV	P, Q	
KA2051A01	123.00	128.00	3	1	2011-07-09 16:33	2011-07-09 17:51	51A1123.CSV	P, Q	
KA2051A01	128.00	133.00	3	2 [2]	2011-07-09 18:06	2011-07-09 19:27	51A1128B.CSV	P, Q	
KA2051A01	133.00	138.00	3	1	2011-07-10 08:40	2011-07-10 09:54	51A1133.CSV	P, Q	
KA2051A01	138.00	143.00	3	1	2011-07-10 10:08	2011-07-10 11:22	51A1138.CSV	P, Q	
KA2051A01	143.00	148.00	3	1	2011-07-10 11:34	2011-07-10 14:08	51A1143.CSV	P, Q	
KA2051A01	148.00	153.00	3	1	2011-08-15 15:42	2011-08-15 17:49	51A1148.CSV	P, Q	
KA2051A01	153.00	158.00	3	1	2011-08-15 18:06	2011-08-15 19:25	51A1153.CSV	P, Q	
KA2051A01	158.00	163.00	3	1	2011-08-16 08:07	2011-08-16 08:51	51A1158.CSV	P, Q	
KA2051A01	163.00	168.00	3	1	2011-08-16 09:03	2011-08-16 10:38	51A1163.CSV	P, Q	
KA2051A01	168.00	173.00	3	1	2011-08-16 10:49	2011-08-16 12:03	51A1168.CSV	P, Q	
KA2051A01	173.00	178.00	3	1	2011-08-16 12:14	2011-08-16 14:48	51A1173.CSV	P, Q	
KA2051A01	178.00	183.00	3	1	2011-08-16 15:02	2011-08-16 15:55	51A1178.CSV	P, Q	
KA2051A01	183.00	188.00	3	1	2011-08-16 16:05	2011-08-16 16:46	51A1183.CSV	P, Q	
KA2051A01	188.00	193.00	3	1	2011-08-16 16:58	2011-08-16 18:12	51A1188.CSV	P, Q	
KA2051A01	193.00	198.00	3	1	2011-08-17 08:06	2011-08-17 09:21	51A1193.CSV	P, Q	
KA2051A01	198.00	203.00	3	1	2011-08-17 09:30	2011-08-17 10:42	51A1198.CSV	P, Q	
KA2051A01	203.00	208.00	3	1	2011-08-17 10:52	2011-08-17 11:37	51A1203.CSV	P, Q	
KA2051A01	208.00	213.00	3	1	2011-08-17 11:49	2011-08-17 14:10	51A1208.CSV	P, Q	
KA2051A01	213.00	218.00	3	1	2011-08-17 14:20	2011-08-17 15:36	51A1213.CSV	P, Q	
KA2051A01	218.00	223.00	3	1	2011-08-17 15:48	2011-08-17 16:58	51A1218.CSV	P, Q	
KA2051A01	223.00	228.00	3	1	2011-08-17 17:05	2011-08-17 17:48	51A1223.CSV	P, Q	
KA2051A01	228.00	233.00	3	1	2011-08-18 09:49	2011-08-18 10:35	51A1228.CSV	P, Q	
KA2051A01	233.00	238.00	3	1	2011-08-18 10:45	2011-08-18 11:58	51A1233.CSV	P, Q	
KA2051A01	238.00	243.00	3	1	2011-08-18 12:06	2011-08-18 14:36	51A1238.CSV	P, Q	
KA2051A01	243.00	248.00	3	1	2011-08-18 14:46	2011-08-18 16:01	51A1243.CSV	P, Q	
KA2051A01	248.00	253.00	3	1	2011-08-18 16:11	2011-08-18 17:22	51A1248.CSV	P, Q	
KA2051A01	253.00	258.00	3	1	2011-08-19 08:05	2011-08-19 09:00	51A1253.CSV	P, Q	
KA2051A01	258.00	263.00	3	1	2011-08-19 09:09	2011-08-19 10:24	51A1258.CSV	P, Q	
KA2051A01	263.00	268.00	3	1	2011-08-19 10:34	2011-08-19 11:50	51A1263.CSV	P, Q	
KA2051A01	268.00	273.00	3	1	2011-08-19 11:58	2011-08-19 14:06	51A1268.CSV	P, Q	
KA2051A01	273.00	278.00	3	1	2011-08-19 14:14	2011-08-19 15:36	51A1273.CSV	P, Q	
KA2051A01	278.00	283.00	3	1	2011-08-19 16:30	2011-08-19 18:02	51A1278.CSV	P, Q	
KA2051A01	283.00	288.00	3	1	2011-08-20 10:44	2011-08-20 13:35	51A1283.CSV	P, Q	
KA2051A01	288.00	293.00	3	1	2011-08-20 16:01	2011-08-20 17:29	51A1288.CSV	P, Q	
KA2051A01	293.00	298.00	3	2 [2]	2011-08-21 10:24	2011-08-21 11:11	51A1293B.CSV	P, Q	
KA2051A01	298.00	303.00	3	1	2011-08-21 11:32	2011-08-21 14:06	51A1298.CSV	P, Q	
KA2051A01	303.00	308.00	3	1	2011-08-21 14:30	2011-08-21 15:43	51A1303.CSV	P, Q	
KA2051A01	308.00	313.00	3	1	2011-08-21 16:21	2011-08-21 17:34	51A1308.CSV	P, Q	
KA2051A01	313.00	319.84	3	1	2011-08-23 15:21	2011-08-23 17:04	51A1313.CSV	P, Q	Single packer

[1] 3: Injection test.

[2] The tests were interrupted for various reasons or did not provide satisfying data for the evaluation and were hence re-performed later.

File description table, KJ0050F01

Bh ID Idcode	Test section (m)	(m)	Test type (1–6)[1]	Test no	Test start Date, time YYYYMMDD hh:mm	Test stop Date, time YYYYMMDD hh:mm	Data files of raw and primary data	Parameters in file	Comments
KJ0050F01	3.50	8.50	3	1	2011-09-13 14:57	2011-09-13 17:09	50F1L35.CSV	P, Q	
KJ0050F01	8.50	13.50	3	1	2011-09-13 17:56	2011-09-13 19:23	50F1L85.CSV	P, Q	
KJ0050F01	13.50	18.50	3	1	2011-09-14 08:20	2011-09-14 09:49	50F1L135.CSV	P, Q	
KJ0050F01	18.50	23.50	3	1	2011-09-14 10:13	2011-09-14 13:11	50F1L185.CSV	P, Q	
KJ0050F01	23.50	28.50	3	1	2011-09-14 13:28	2011-09-14 14:56	50F1L235.CSV	P, Q	
KJ0050F01	28.50	33.50	3	1	2011-09-14 17:23	2011-09-14 18:39	50F1L285.CSV	P, Q	
KJ0050F01	33.50	38.50	3	1	2011-09-15 07:46	2011-09-15 09:02	50F1L335.CSV	P, Q	
KJ0050F01	38.50	43.50	3	1	2011-09-15 09:15	2011-09-15 10:31	50F1L385.CSV	P, Q	
KJ0050F01	43.50	46.79	3	1	2011-09-15 16:01	2011-09-15 17:39	50F1L435.CSV	P, Q	

[1] 3: Injection test.

Appendix 2

General test data

A2.1 General test data

General test data, KA3007A01

Test section Secup (m)	Test section Seclow (m)	Test start YYYYMMDD hh:mm	Start of flow period YYYYMMDD hh:mm:ss	Stop of flow period YYYYMMDD hh:mm:ss	Test stop YYYYMMDD hh:mm	Total flow time t_p (min)	Total recovery time t_F (min)
148.00	153.00	2011-06-30 11:33	2011-06-30 14:34:01	2011-06-30 14:54:05	2011-06-30 15:15	20	22
153.00	158.00	2011-06-30 16:04	2011-06-30 16:04:49	2011-06-30 16:24:54	2011-06-30 16:45	20	20
158.00	163.00	2011-06-30 17:15	2011-06-30 17:44:20	2011-06-30 18:04:54	2011-06-30 18:25	21	21
163.00	168.00	2011-07-01 08:07	2011-07-01 08:40:50	2011-07-01 09:01:59	2011-07-01 09:30	21	29
168.00	173.00	2011-07-01 09:44	2011-07-01 10:17:57	2011-07-01 10:37:05	2011-07-01 11:00	19	24
173.00	178.00	2011-07-01 11:19	2011-07-01 11:43:44	2011-07-01 12:04:15	2011-07-01 12:25	21	21
178.00	183.00	2011-07-01 14:13	2011-07-01 14:49:51	2011-07-01 14:57:56	2011-07-01 15:03	8	6
183.00	188.00	2011-07-01 15:17	2011-07-01 15:48:21	2011-07-01 15:54:41	2011-07-01 16:00	6	6
188.00	193.00	2011-07-01 16:12	2011-07-01 16:45:17	2011-07-01 16:52:02	2011-07-01 16:57	7	6
193.00	198.00	2011-07-01 17:15	2011-07-01 17:47:48	2011-07-01 17:55:05	2011-07-01 18:01	7	6
198.00	203.00	2011-07-02 08:49	2011-07-02 09:21:13	2011-07-02 09:27:44	2011-07-02 09:33	7	6
203.00	208.00	2011-07-02 10:53	2011-07-02 10:56:21	2011-07-02 11:02:59	2011-07-02 11:09	7	7
208.00	213.00	2011-07-02 11:19	2011-07-02 11:50:54	2011-07-02 12:11:35	2011-07-02 12:31	21	20
213.00	218.00	2011-07-02 14:42	2011-07-02 15:13:16	2011-07-02 15:33:50	2011-07-02 15:54	21	21
218.00	227.76	2011-07-03 11:43	2001-07-03 13:19:20	2001-07-03 13:49:42	2001-07-03 14:22	30	33

General test data, KA2051A01

Test section Secup (m)	Test section Seclow (m)	Test start YYYYMMDD hh:mm	Start of flow period YYYYMMDD hh:mm:ss	Stop of flow period YYYYMMDD hh:mm:ss	Test stop YYYYMMDD hh:mm	Total flow time tp (min)	Total recovery time tF (min)
4.00	9.00	2011-07-07 14:28	2011-07-07 15:17:16	2011-07-07 15:36:58	2011-07-07 15:57	20	21
9.00	14.00	2011-07-07 16:53	2011-07-07 17:36:55	2011-07-07 17:37:41	2011-07-07 17:42	1	4
14.00	19.00	2011-07-07 18:34	2011-07-07 19:10:45	2011-07-07 19:27:11	2011-07-07 19:42	16	15
19.00	24.00	2011-07-08 08:26	2011-07-08 09:00:18	2011-07-08 09:06:58	2011-07-08 09:12	7	5
24.00	29.00	2011-07-08 09:35	2011-07-08 10:13:52	2011-07-08 10:20:27	2011-07-08 10:25	7	5
29.00	34.00	2011-07-08 10:47	2011-07-08 11:24:12	2011-07-08 11:46:54	2011-07-08 12:06	23	20
34.00	39.00	2011-07-08 12:18	2011-07-08 14:15:49	2011-07-08 14:39:02	2011-07-08 15:03	23	24
39.00	44.00	2011-07-08 15:22	2011-07-08 15:53:55	2011-07-08 16:18:06	2011-07-08 16:38	24	20
44.00	49.00	2011-07-08 17:00	2011-07-08 17:31:45	2011-07-08 17:38:09	2011-07-08 17:43	6	5
49.00	54.00	2011-07-08 18:07	2011-07-08 18:40:01	2011-07-08 19:01:09	2011-07-08 19:34	21	34
54.00	59.00	2011-07-09 08:08	2011-07-09 08:40:20	2011-07-09 09:01:12	2011-07-09 09:26	21	25
59.00	64.00	2011-07-09 09:41	2011-07-09 10:15:03	2011-07-09 10:38:36	2011-07-09 10:59	24	21
64.00	69.00	2011-07-09 11:16	2011-07-09 11:51:32	2011-07-09 12:15:20	2011-07-09 13:54	24	100
118.00	123.00	2011-07-09 15:33	2011-07-09 15:33:02	2011-07-09 15:54:19	2011-07-09 16:14	21	21
123.00	128.00	2011-07-09 16:33	2011-07-09 17:11:00	2011-07-09 17:31:32	2011-07-09 17:51	21	20
128.00	133.00	2011-07-09 18:06	2011-07-09 18:44:03	2011-07-09 19:07:37	2011-07-09 19:27	24	20
133.00	138.00	2011-07-10 08:40	2011-07-10 09:12:41	2011-07-10 09:34:10	2011-07-10 09:54	21	20
138.00	143.00	2011-07-10 10:08	2011-07-10 10:41:41	2011-07-10 11:02:18	2011-07-10 11:22	21	20
143.00	148.00	2011-07-10 11:34	2011-07-10 13:21:21	2011-07-10 13:44:56	2011-07-10 14:08	24	24
148.00	153.00	2011-08-15 15:42	2011-08-15 17:08:36	2011-08-15 17:29:04	2011-08-15 17:49	20	20
153.00	158.00	2011-08-15 18:06	2011-08-15 18:43:15	2011-08-15 19:04:04	2011-08-15 19:25	21	21
158.00	163.00	2011-08-16 08:07	2011-08-16 08:40:10	2011-08-16 08:46:35	2011-08-16 08:51	6	5
163.00	168.00	2011-08-16 09:03	2011-08-16 10:15:09	2011-08-16 10:25:48	2011-08-16 10:38	11	13
168.00	173.00	2011-08-16 10:49	2011-08-16 11:22:20	2011-08-16 11:42:52	2011-08-16 12:03	21	20
173.00	178.00	2011-08-16 12:14	2011-08-16 14:08:07	2011-08-16 14:28:54	2011-08-16 14:48	21	19
178.00	183.00	2011-08-16 15:02	2011-08-16 15:42:00	2011-08-16 15:47:31	2011-08-16 15:55	6	8
183.00	188.00	2011-08-16 16:05	2011-08-16 16:36:26	2011-08-16 16:42:16	2011-08-16 16:46	6	5
188.00	193.00	2011-08-16 16:58	2011-08-16 17:30:18	2011-08-16 17:51:07	2011-08-16 18:12	21	21
193.00	198.00	2011-08-17 08:06	2011-08-17 08:40:49	2011-08-17 09:01:14	2011-08-17 09:21	20	20

Test section Secup (m)	Test section Seclow (m)	Test start YYYYMMDD hh:mm	Start of flow period YYYYMMDD hh:mm:ss	Stop of flow period YYYYMMDD hh:mm:ss	Test stop YYYYMMDD hh:mm	Total flow time tp (min)	Total recovery time tF (min)
198.00	203.00	2011-08-17 09:30	2011-08-17 10:02:19	2011-08-17 10:22:44	2011-08-17 10:42	20	20
203.00	208.00	2011-08-17 10:52	2011-08-17 11:24:28	2011-08-17 11:29:43	2011-08-17 11:37	5	8
208.00	213.00	2011-08-17 11:49	2011-08-17 13:28:35	2011-08-17 13:50:04	2011-08-17 14:10	21	21
213.00	218.00	2011-08-17 14:20	2011-08-17 14:53:05	2011-08-17 15:13:39	2011-08-17 15:36	21	23
218.00	223.00	2011-08-17 15:48	2011-08-17 16:18:24	2011-08-17 16:39:01	2011-08-17 16:58	21	20
223.00	228.00	2011-08-17 17:05	2011-08-17 17:36:26	2011-08-17 17:42:38	2011-08-17 17:48	6	6
228.00	233.00	2011-08-18 09:49	2011-08-18 10:22:59	2011-08-18 10:29:11	2011-08-18 10:35	6	6
233.00	238.00	2011-08-18 10:45	2011-08-18 11:17:03	2011-08-18 11:37:11	2011-08-18 11:58	20	21
238.00	243.00	2011-08-18 12:06	2011-08-18 13:55:38	2011-08-18 14:15:43	2011-08-18 14:36	20	20
243.00	248.00	2011-08-18 14:46	2011-08-18 15:18:48	2011-08-18 15:39:11	2011-08-18 16:01	20	22
248.00	253.00	2011-08-18 16:11	2011-08-18 16:42:45	2011-08-18 17:03:00	2011-08-18 17:22	20	20
253.00	258.00	2011-08-19 08:05	2011-08-19 08:39:40	2011-08-19 08:48:49	2011-08-19 09:00	9	11
258.00	263.00	2011-08-19 09:09	2011-08-19 09:43:06	2011-08-19 10:03:26	2011-08-19 10:24	20	21
263.00	268.00	2011-08-19 10:34	2011-08-19 11:09:29	2011-08-19 11:29:51	2011-08-19 11:50	20	21
268.00	273.00	2011-08-19 11:58	2011-08-19 13:25:56	2011-08-19 13:46:10	2011-08-19 14:06	20	20
273.00	278.00	2011-08-19 14:14	2011-08-19 14:48:59	2011-08-19 15:14:48	2011-08-19 15:36	26	22
278.00	283.00	2011-08-19 16:30	2011-08-19 17:22:02	2011-08-19 17:38:12	2011-08-19 18:02	16	24
283.00	288.00	2011-08-20 10:44	2011-08-20 11:26:36	2011-08-20 11:46:46	2011-08-20 13:35	20	109
288.00	293.00	2011-08-20 16:01	2011-08-20 16:39:41	2011-08-20 17:00:42	2011-08-20 17:29	21	28
293.00	298.00	2011-08-21 10:24	2011-08-21 10:30:33	2011-08-21 10:50:52	2011-08-21 11:11	20	21
298.00	303.00	2011-08-21 11:32	2011-08-21 12:08:04	2011-08-21 12:28:11	2011-08-21 14:06	20	98
303.00	308.00	2011-08-21 14:30	2011-08-21 15:01:33	2011-08-21 15:22:52	2011-08-21 15:43	21	20
308.00	313.00	2011-08-21 16:21	2011-08-21 16:53:19	2011-08-21 17:13:40	2011-08-21 17:34	20	21
313.00	319.84	2011-08-23 15:21	2011-08-23 16:22:34	2011-08-23 16:43:31	2011-08-23 17:04	21	21

General test data, KJ0050F01

Test section Secup (m)	Test section Seclow (m)	Test start YYYYMMDD hh:mm	Start of flow period YYYYMMDD hh:mm:ss	Stop of flow period YYYYMMDD hh:mm:ss	Test stop YYYYMMDD hh:mm	Total flow time t_p (min)	Total recovery time t_F (min)
3.50	8.50	2011-09-13 14:57	2011-09-13 16:27:47	2011-09-13 16:48:34	2011-09-13 17:09	21	20
8.50	13.50	2011-09-13 17:56	2011-09-13 18:43:35	2011-09-13 19:03:45	2011-09-13 19:23	20	20
13.50	18.50	2011-09-14 08:20	2011-09-14 09:04:13	2011-09-14 09:24:46	2011-09-14 09:49	21	25
18.50	23.50	2011-09-14 10:13	2011-09-14 11:08:12	2011-09-14 11:28:17	2011-09-14 13:11	20	103
23.50	28.50	2011-09-14 13:28	2011-09-14 14:04:07	2011-09-14 14:24:06	2011-09-14 14:56	20	32
28.50	33.50	2011-09-14 17:23	2011-09-14 17:58:08	2011-09-14 18:18:10	2011-09-14 18:39	20	21
33.50	38.50	2011-09-15 07:46	2011-09-15 08:21:41	2011-09-15 08:42:01	2011-09-15 09:02	20	20
38.50	43.50	2011-09-15 09:15	2011-09-15 09:51:40	2011-09-15 10:11:43	2011-09-15 10:31	20	20
43.50	46.79	2011-09-15 16:01	2011-09-15 16:50:20	2011-09-15 17:12:09	2011-09-15 17:39	22	27

A2.2 Pressure and flow data

Pressure and flow data, KA3007A01

Test section		Pressure			Flow
Secup (m)	Seclow (m)	p_i (kPa)	p_p (kPa)	p_F (kPa)	Q_p 1) (m^3/s)
148.00	153.00	3,911.07	4,407.89	3,913.55	6.82E–06
153.00	158.00	3,913.82	4,414.87	3,917.48	7.273E–06
158.00	163.00	3,922.69	4,414.34	3,921.38	2.871E–06
163.00	168.00	3,930.80	4,440.51	3,938.34	1.653E–06
168.00	173.00	3,945.03	4,448.11	3,946.92	8E–07
173.00	178.00	3,949.40	4,447.55	3,950.72	0.0000809
178.00	183.00	3,965.67	4,468.69	4,388.14	
183.00	188.00	3,887.25	4,391.74	4,318.18	
188.00	193.00	3,952.94	4,465.61	4,361.69	
193.00	198.00	3,972.92	4,463.21	4,416.83	
198.00	203.00	3,898.01	4,405.81	4,353.71	
203.00	208.00	3,942.00	4,426.00	4,374.00	
208.00	213.00	3,949.90	4,449.20	3,948.80	5.372E–05
213.00	218.00	3,949.33	4,450.64	3,950.81	9.427E–05
218.00	227.76	3,937.80	4,060.75	3,941.94	0.0006804
148.00	153.00	3,911.07	4,407.89	3,913.55	6.82E–06
153.00	158.00	3,913.82	4,414.87	3,917.48	7.273E–06
158.00	163.00	3,922.69	4,414.34	3,921.38	2.871E–06
163.00	168.00	3,930.80	4,440.51	3,938.34	1.653E–06
168.00	173.00	3,945.03	4,448.11	3,946.92	8E–07
173.00	178.00	3,949.40	4,447.55	3,950.72	0.0000809
178.00	183.00	3,965.67	4,468.69	4,388.14	
183.00	188.00	3,887.25	4,391.74	4,318.18	
188.00	193.00	3,952.94	4,465.61	4,361.69	
193.00	198.00	3,972.92	4,463.21	4,416.83	
198.00	203.00	3,898.01	4,405.81	4,353.71	
203.00	208.00	3,942.00	4,426.00	4,374.00	
208.00	213.00	3,949.90	4,449.20	3,948.80	5.372E–05
213.00	218.00	3,949.33	4,450.64	3,950.81	9.427E–05
218.00	227.76	3,937.80	4,060.75	3,941.94	0.0006804

Pressure and flow data, KA2051A01

Test section		Pressure			Flow
Secup	Seclow	p_i	p_p	p_F	Q_p
(m)	(m)	(kPa)	(kPa)	(kPa)	(m^3/s)
4.00	9.00	2,370.40	2,866.83	2,527.87	
9.00	14.00	2,763.35	3,002.98	2,620.45	
14.00	19.00	2,304.14	2,800.06	2,785.78	
19.00	24.00	2,289.32	2,790.66	2,765.33	
24.00	29.00	2,316.94	2,816.75	2,786.58	
29.00	34.00	2,204.44	2,705.57	2,301.19	1.26E–08
34.00	39.00	2,086.55	2,584.84	2,095.80	0.0000404
39.00	44.00	2,101.75	2,602.86	2,104.84	1.286E–05
44.00	49.00	2,285.77	2,788.72	2,745.14	
49.00	54.00	2,164.61	2,663.24	2,168.85	6.043E–06
54.00	59.00	2,178.30	2,676.81	2,181.07	2.149E–06
59.00	64.00	2,267.58	2,765.23	2,279.49	0.0001097
64.00	69.00	2,266.83	2,764.98	2,268.98	9.238E–05
118.00	123.00	2,324.31	2,823.24	2,335.87	5.276E–05
123.00	128.00	2,310.56	2,829.88	2,314.95	1.163E–05
128.00	133.00	2,344.34	2,825.24	2,401.65	0.0001948
133.00	138.00	2,340.94	2,840.18	2,337.11	2.491E–05
138.00	143.00	2,329.53	2,830.31	2,335.83	1.448E–06
143.00	148.00	2,366.42	2,844.67	2,399.47	2.052E–07
148.00	153.00	2,310.65	2,807.21	2,346.32	4.063E–06
153.00	158.00	2,281.67	2,780.55	2,332.68	1.222E–06
158.00	163.00	2,360.00	2,859.30	2,715.17	
163.00	168.00	2,441.97	2,939.66	2,898.04	
168.00	173.00	2,370.68	2,868.51	2,374.85	1.091E–06
173.00	178.00	2,396.02	2,892.36	2,422.49	1.487E–05
178.00	183.00	2,762.07	3,265.60	3,206.20	
183.00	188.00	2,359.18	2,862.32	2,780.46	
188.00	193.00	2,403.59	2,903.72	2,451.35	6.386E–07
193.00	198.00	2,441.47	2,938.14	2,451.31	5.653E–07
198.00	203.00	2,463.28	2,953.11	2,439.03	1.76E–07
203.00	208.00	2,444.12	2,945.36	2,648.16	
208.00	213.00	2,350.03	2,851.07	2,463.98	1.358E–07
213.00	218.00	2,457.51	2,955.56	2,552.44	3.585E–06
218.00	223.00	2,472.03	2,975.46	2,533.98	3.914E–07
223.00	228.00	2,530.24	3,032.21	2,886.49	
228.00	233.00	2,577.90	3,068.46	3,013.67	
233.00	238.00	2,504.41	3,004.52	2,547.87	9.546E–07
238.00	243.00	2,521.50	3,024.73	2,529.22	3.725E–07
243.00	248.00	2,537.60	3,035.45	2,564.03	0.0000085
248.00	253.00	2,461.70	2,962.55	2,459.43	6.225E–07
253.00	258.00	2,476.11	2,974.95	2,685.39	
258.00	263.00	2,450.39	2,945.70	2,650.06	8.237E–08
263.00	268.00	2,492.36	2,990.86	2,613.02	1.843E–06
268.00	273.00	2,488.24	2,987.21	2,516.36	2.326E–06
273.00	278.00	2,561.95	3,056.17	2,571.82	1.879E–05
278.00	283.00	2,539.51	3,028.80	2,547.09	3.677E–06
283.00	288.00	2,557.52	3,056.97	2,566.99	4.734E–06
288.00	293.00	2,325.92	2,821.67	2,359.16	1.262E–05
293.00	298.00	2,385.91	2,887.58	2,389.68	8.091E–06
298.00	303.00	2,395.61	2,890.79	2,406.50	9.563E–06
303.00	308.00	2,444.70	2,941.21	2,465.97	2.411E–05
308.00	313.00	2,367.44	2,865.71	2,383.24	8.717E–06
313.00	319.84	2,501.60	2,999.59	2,517.88	6.568E–06

Pressure and flow data, KJ0050F01

Test section		Pressure			Flow
Secup (m)	Seclow (m)	p_i (kPa)	p_p (kPa)	p_F (kPa)	Q_p (m^3/s)
3.50	8.50	1,826.46	2,335.09	1,812.18	8.565E–07
8.50	13.50	1,986.757	2,497.122	2,003.07	5.201E–06
13.50	18.50	2,299.158	2,818.807	2,359.03	5.787E–08
18.50	23.50	2,042.532	2,557.35	2,546.82	
23.50	28.50	1,967.597	2,480.47	2,455.29	
28.50	33.50	2,019.643	2,530.30	2,509.48	
33.50	38.50	1,961.37	2,480.97	2,463.33	
38.50	43.50	2,154.87	2,666.59	2,699.46	
43.50	46.79	1,969.99	2,483.36	2,280.41	

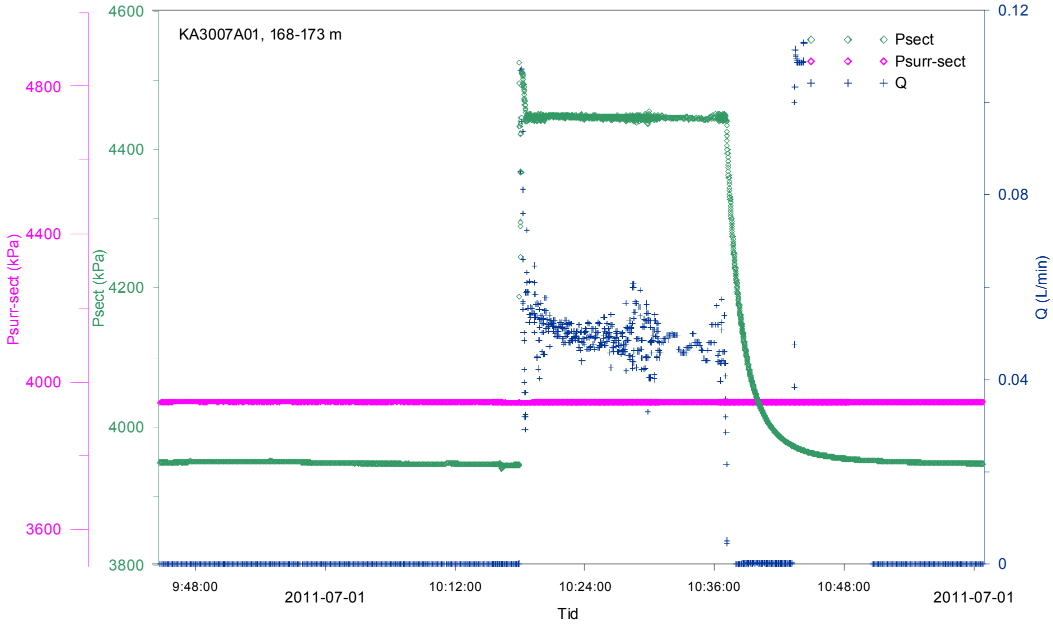
Appendix 3

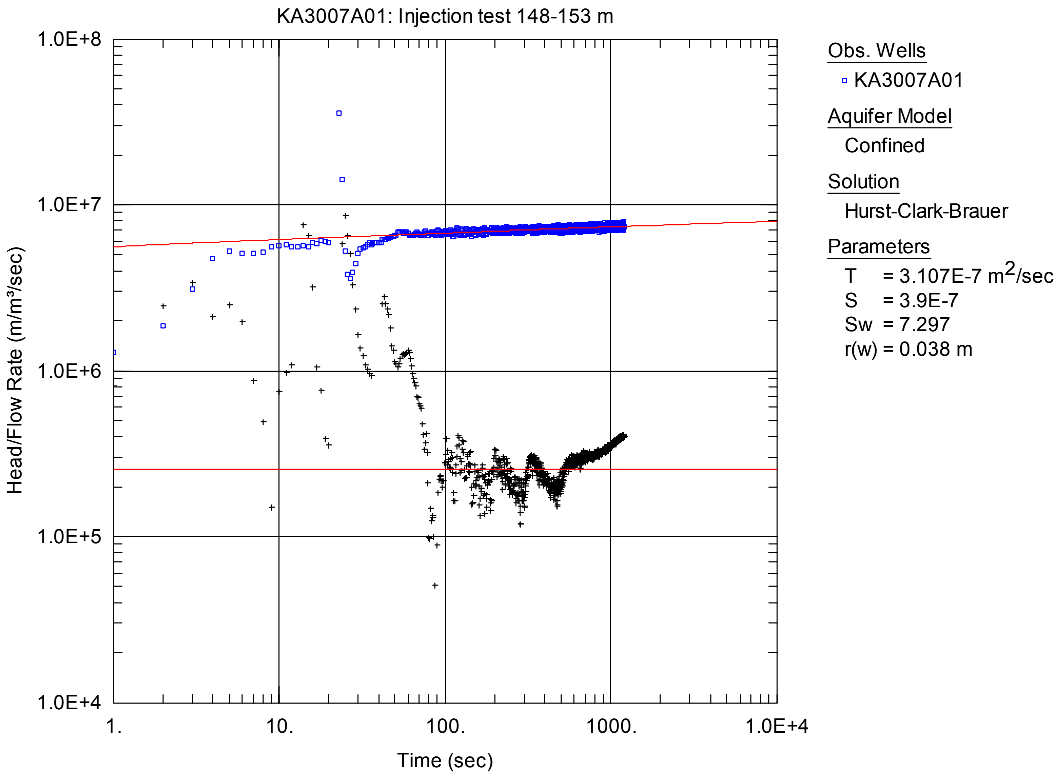
Test diagrams

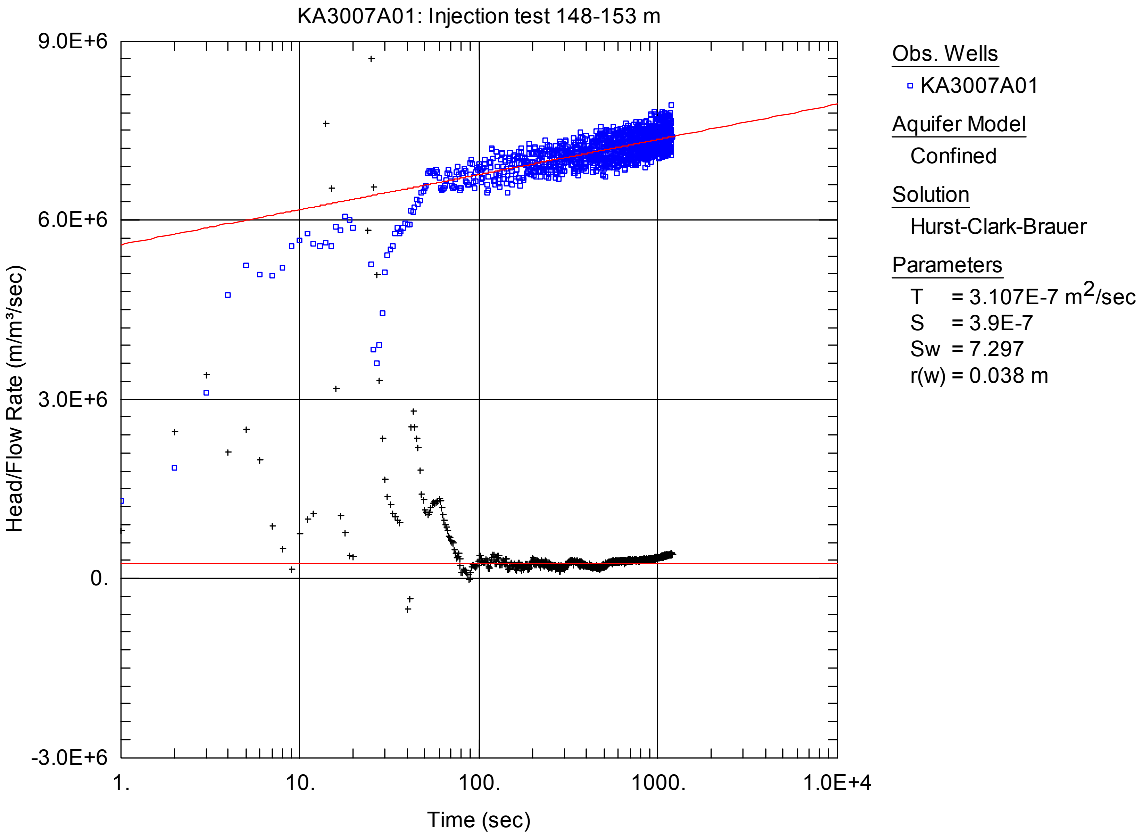
A3.1 Test diagrams – Injection tests KA3007A01

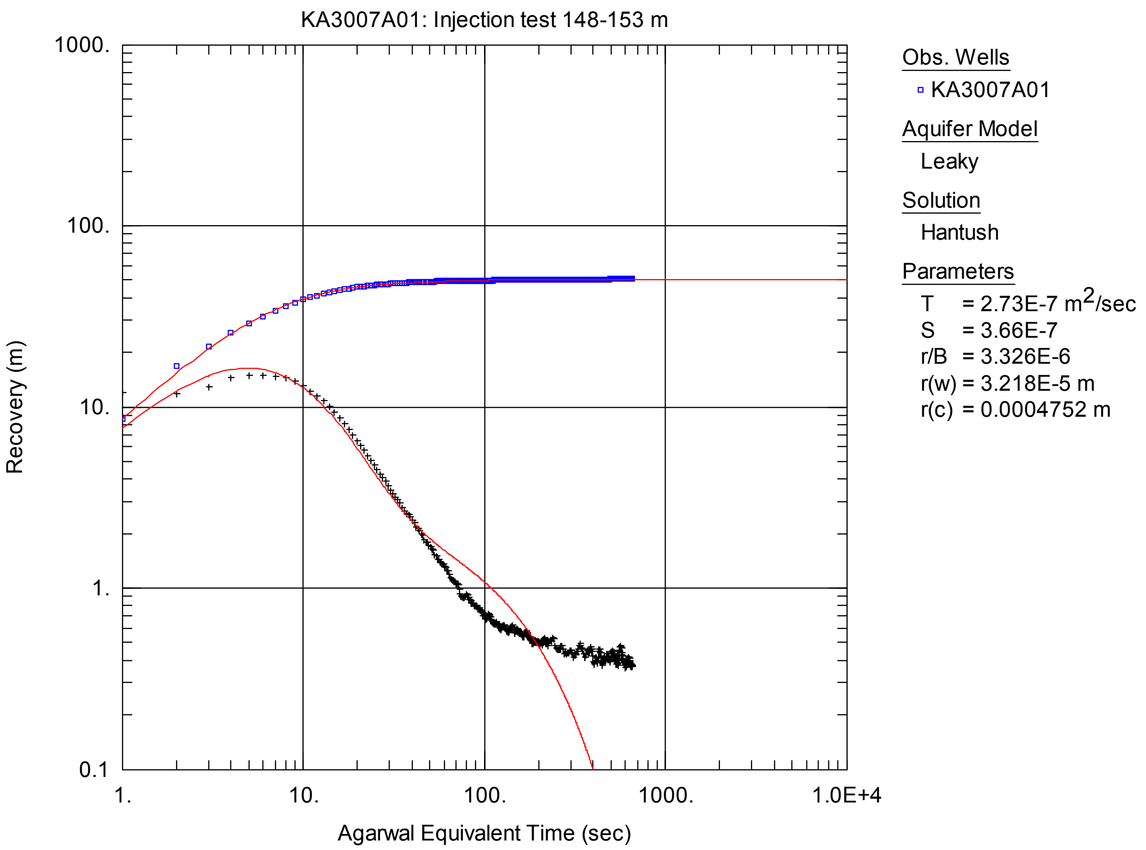
In general, one linear diagram showing the entire test sequence together with lin-log and log-log diagrams from the injection and recovery periods, respectively, are presented for the injection tests. From the injection period, the (reciprocal) flow rate versus time is plotted in log-log and lin-log diagrams together with the corresponding derivative. From the recovery period, the pressure is plotted versus Agarwal equivalent time in lin-log and log-log diagrams, respectively, together with the corresponding derivative.

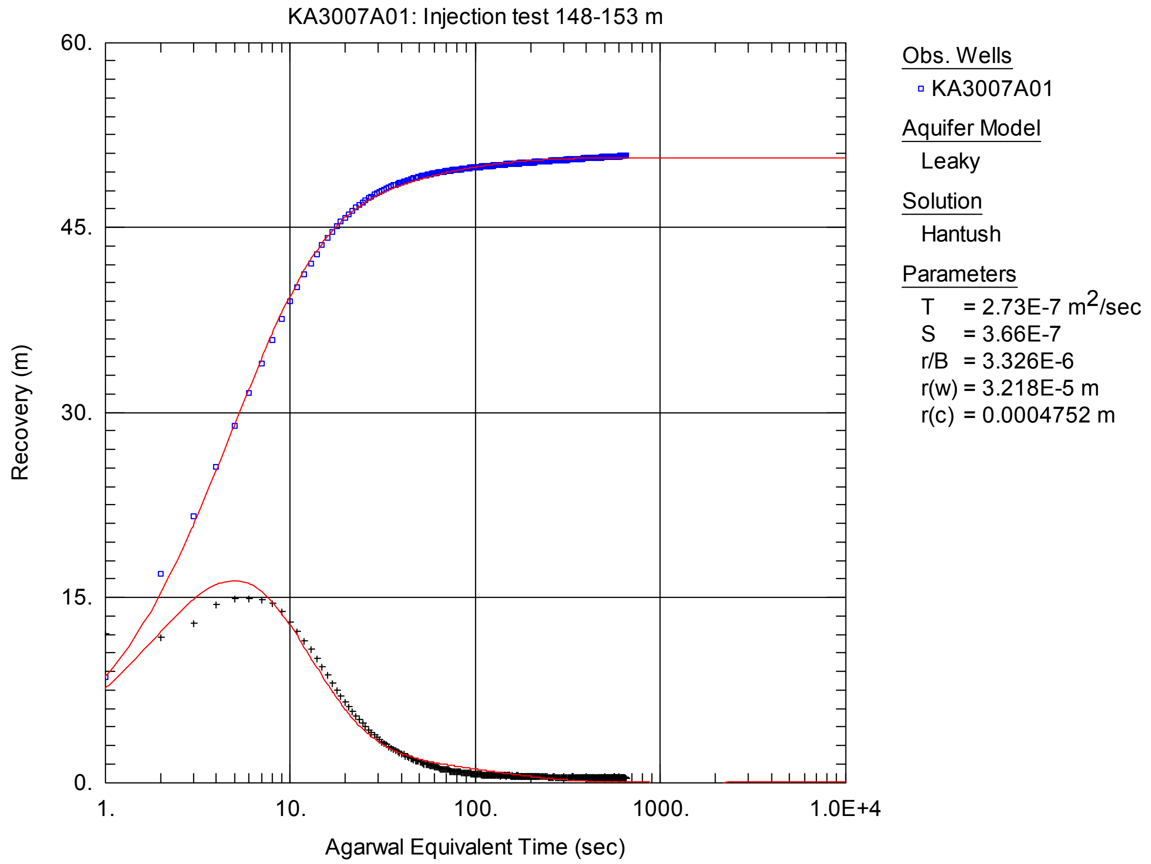
Diagrams are presented in borehole position order. Borehole, test section and test period are given by the headline in each figure. Special information is given for some figures in comments below the figure.

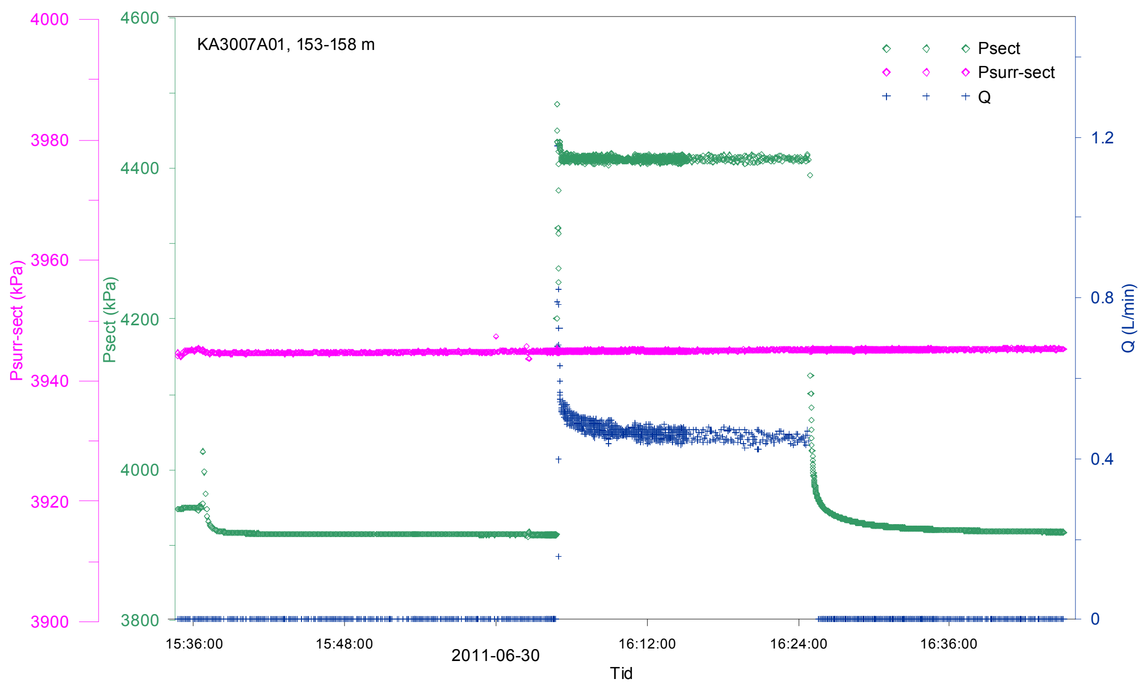


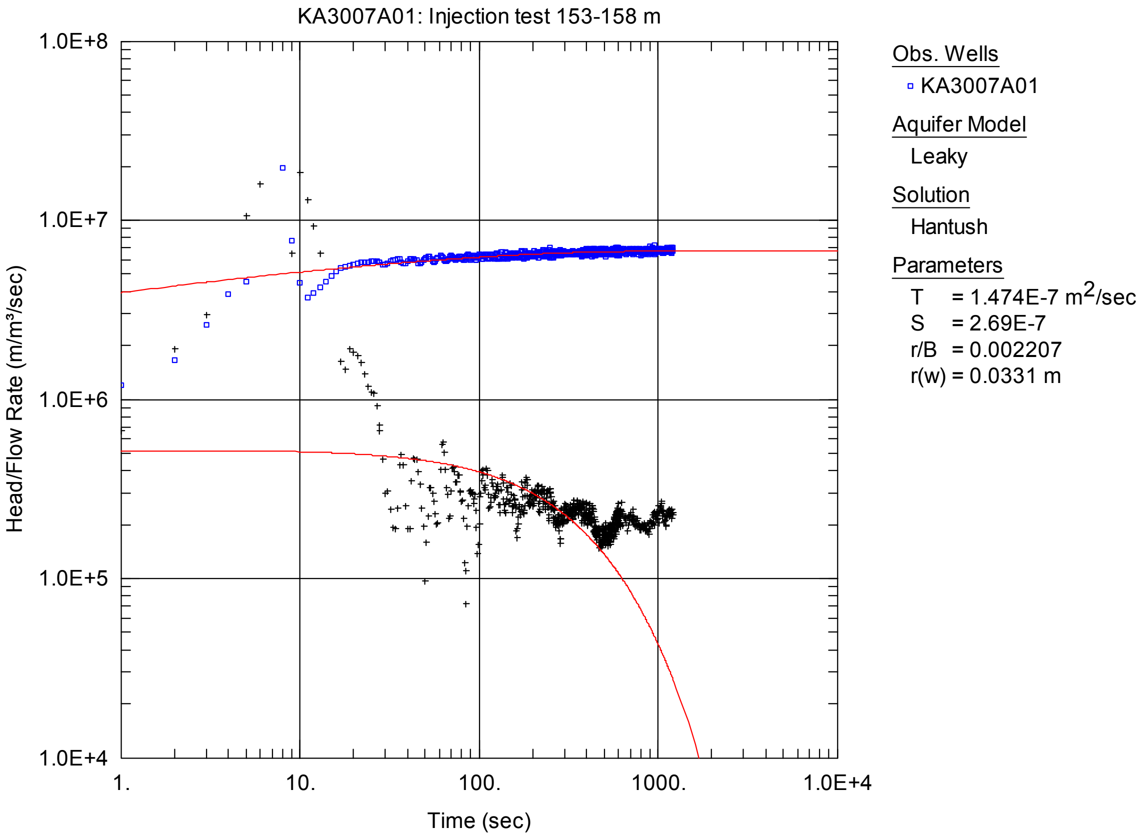


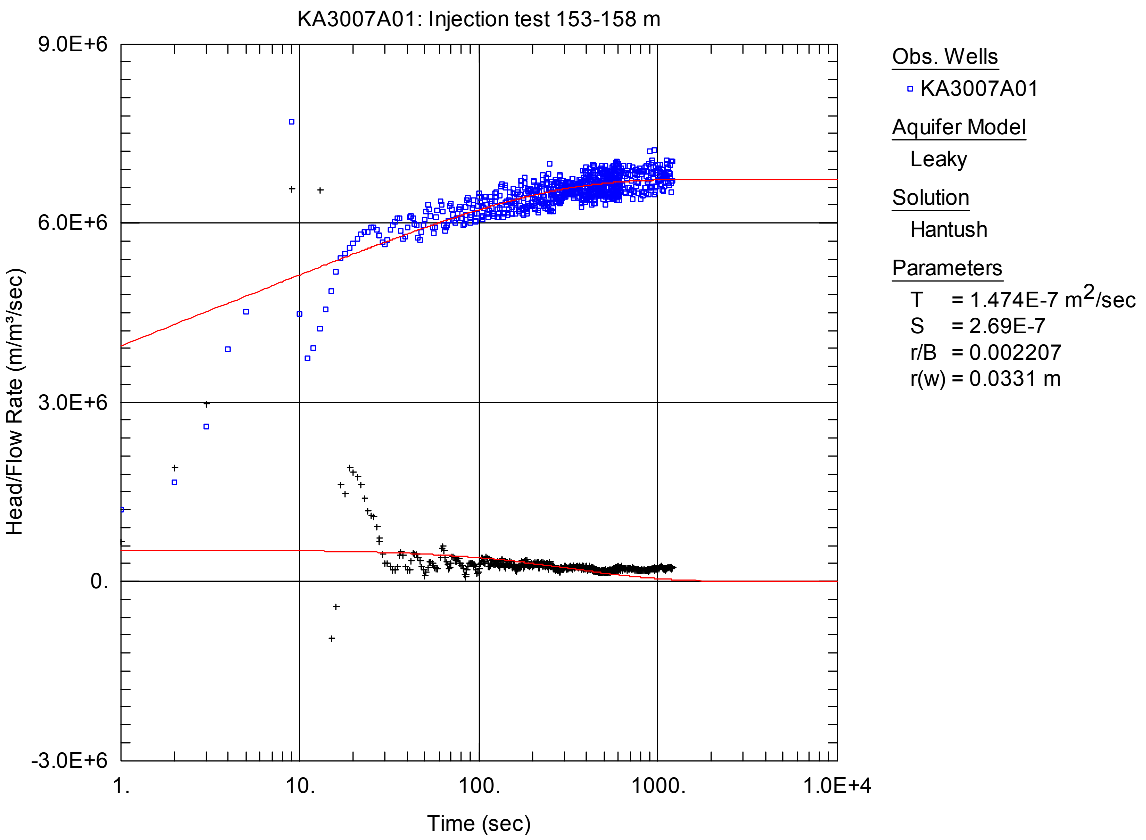

KA3007A01: Injection test 148-153 m
9.0E+6
6.0E+6
3.0E+6
0.
-3.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.107E-7 m2/sec
S = 3.9E-7
Sw = 7.297
r(w) = 0.038 m

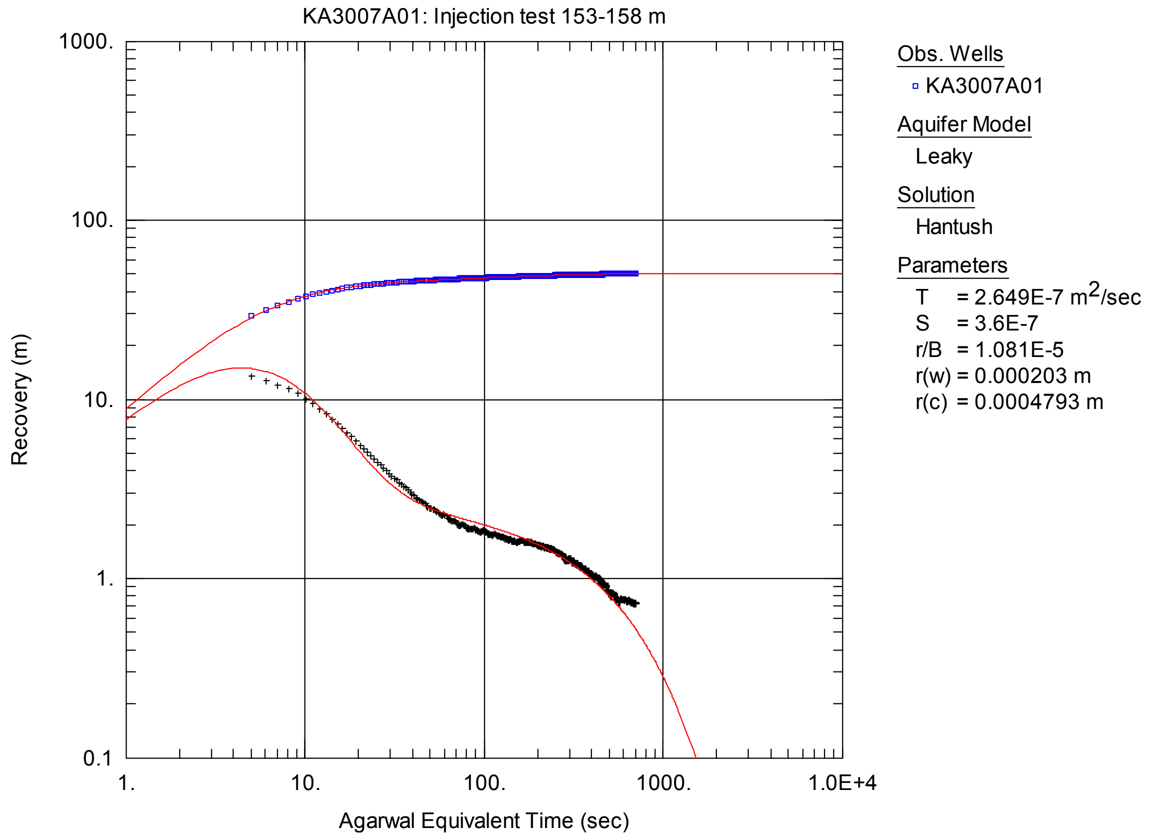

KA3007A01: Injection test 148-153 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.73E-7 m2/sec
S = 3.66E-7
r/B = 3.326E-6
r(w) = 3.218E-5 m
r(c) = 0.0004752 m

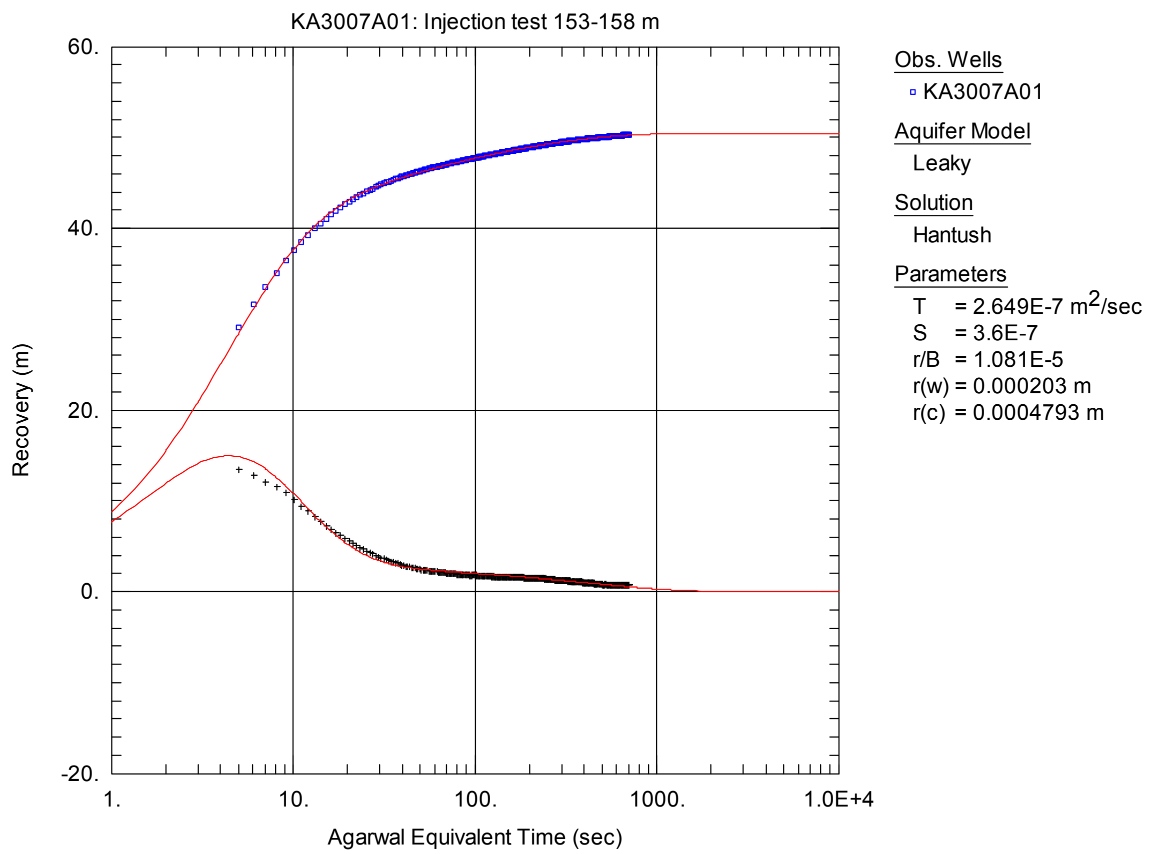

KA3007A01: Injection test 148-153 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
45.
30.
15.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.73E-7 m2/sec
S = 3.66E-7
r/B = 3.326E-6
r(w) = 3.218E-5 m
r(c) = 0.0004752 m

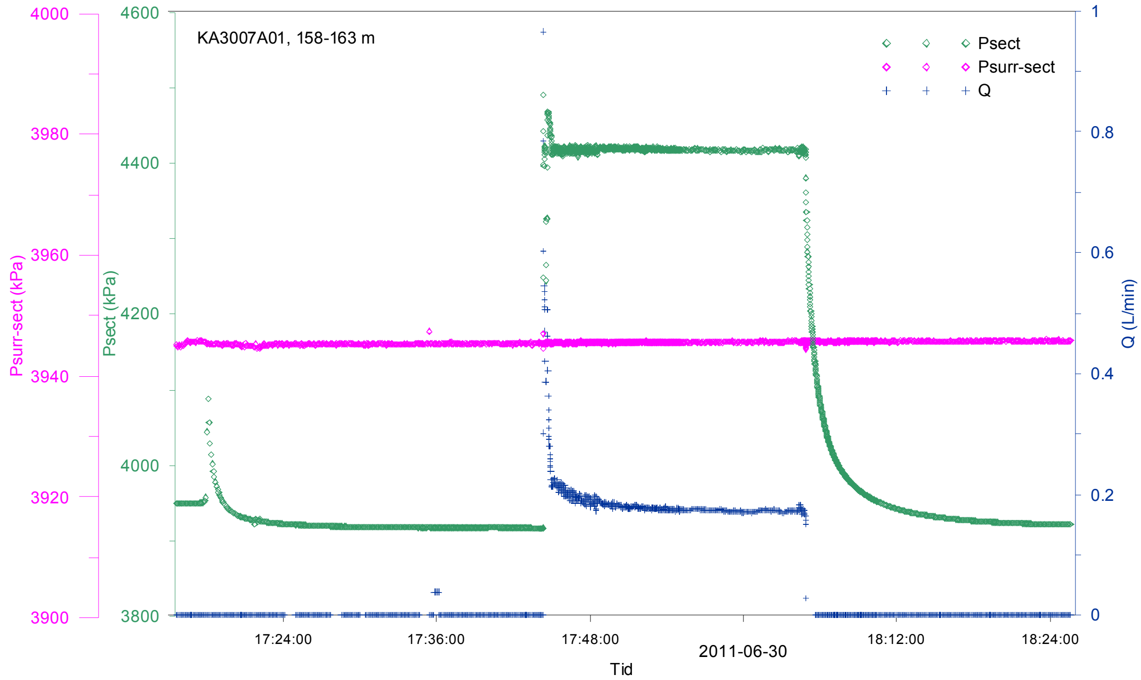

KA3007A01, 153-158 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
4000
3980
3960
3940
3920
3900
4600
4400
4200
4000
3800
1.2
0.8
0.4
0
15:36:00
15:48:00
2011-06-30
16:12:00
16:24:00
16:36:00
Tid


KA3007A01: Injection test 153-158 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
r/B = 0.002207
r(w) = 0.0331 m

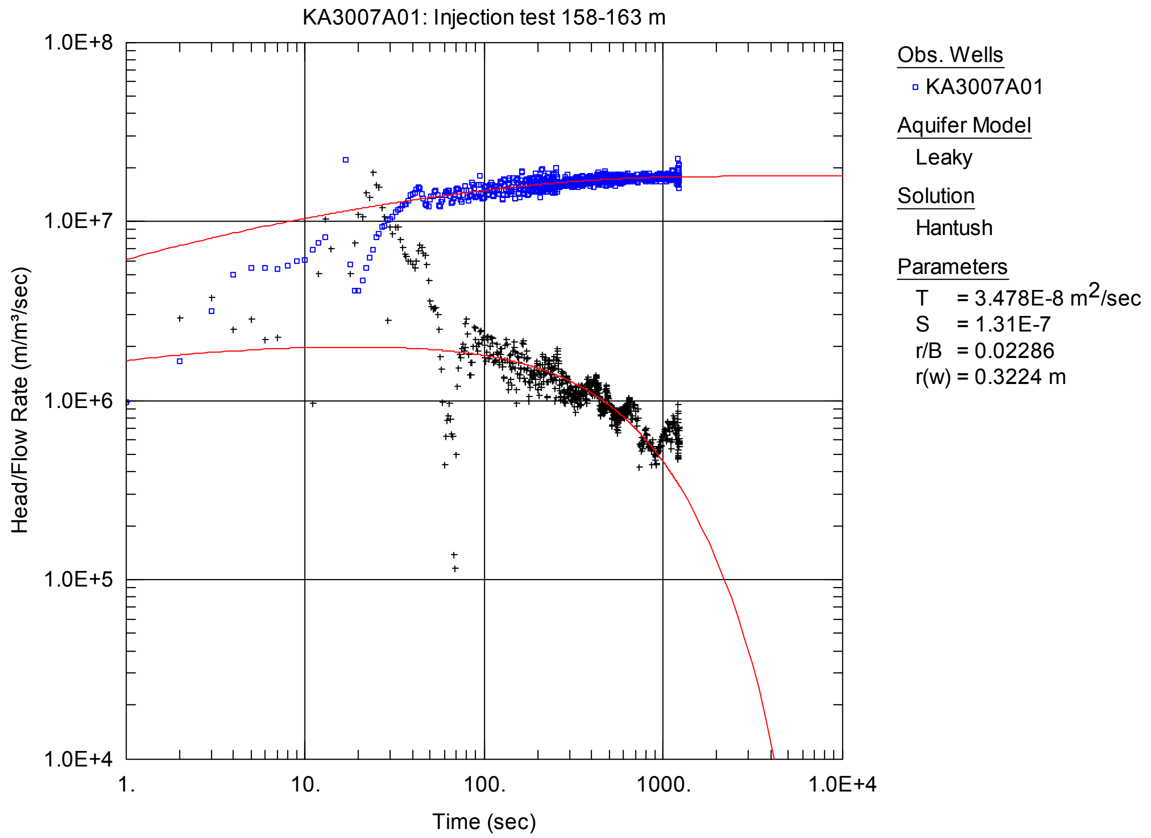

KA3007A01: Injection test 153-158 m
Head/Flow Rate (m/m³/sec)
Time (sec)
9.0E+6
6.0E+6
3.0E+6
0.
-3.0E+6
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
r/B = 0.002207
r(w) = 0.0331 m


KA3007A01: Injection test 153-158 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.649E-7 m2/sec
S = 3.6E-7
r/B = 1.081E-5
r(w) = 0.000203 m
r(c) = 0.0004793 m

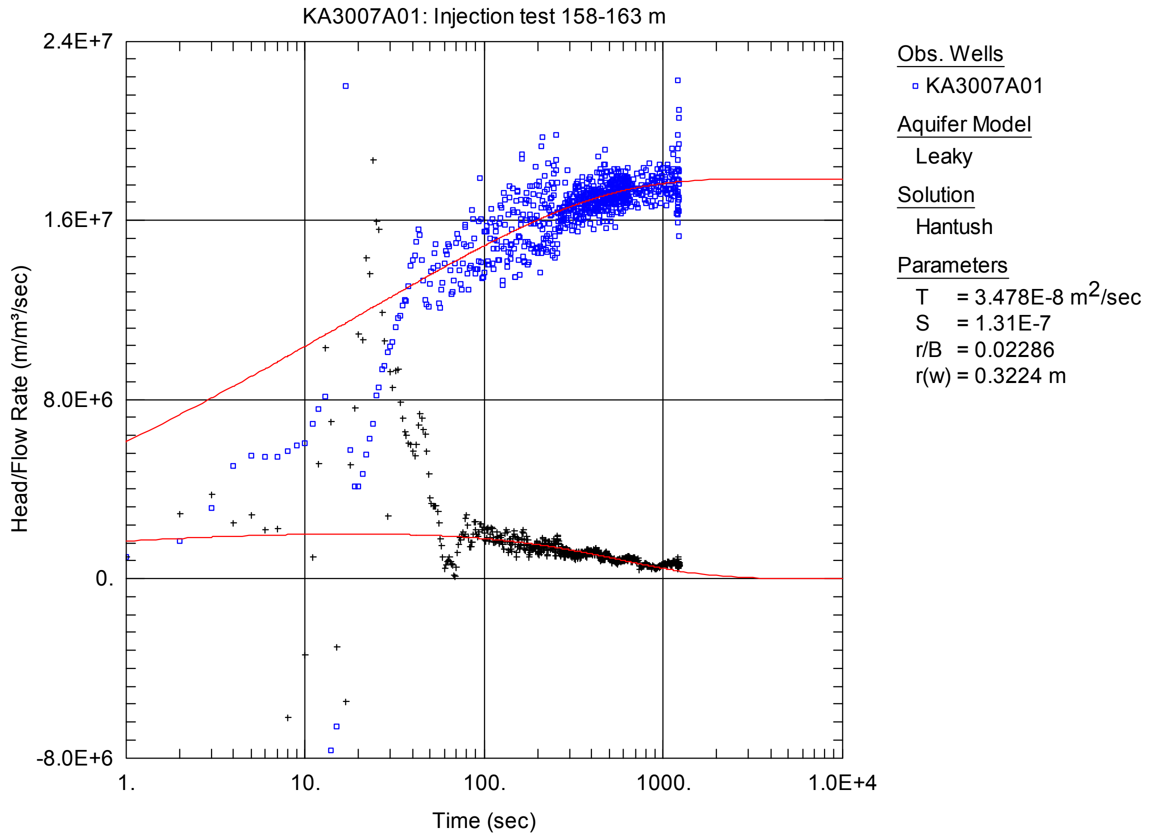

KA3007A01: Injection test 153-158 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.649E-7 m2/sec
S = 3.6E-7
r/B = 1.081E-5
r(w) = 0.000203 m
r(c) = 0.0004793 m

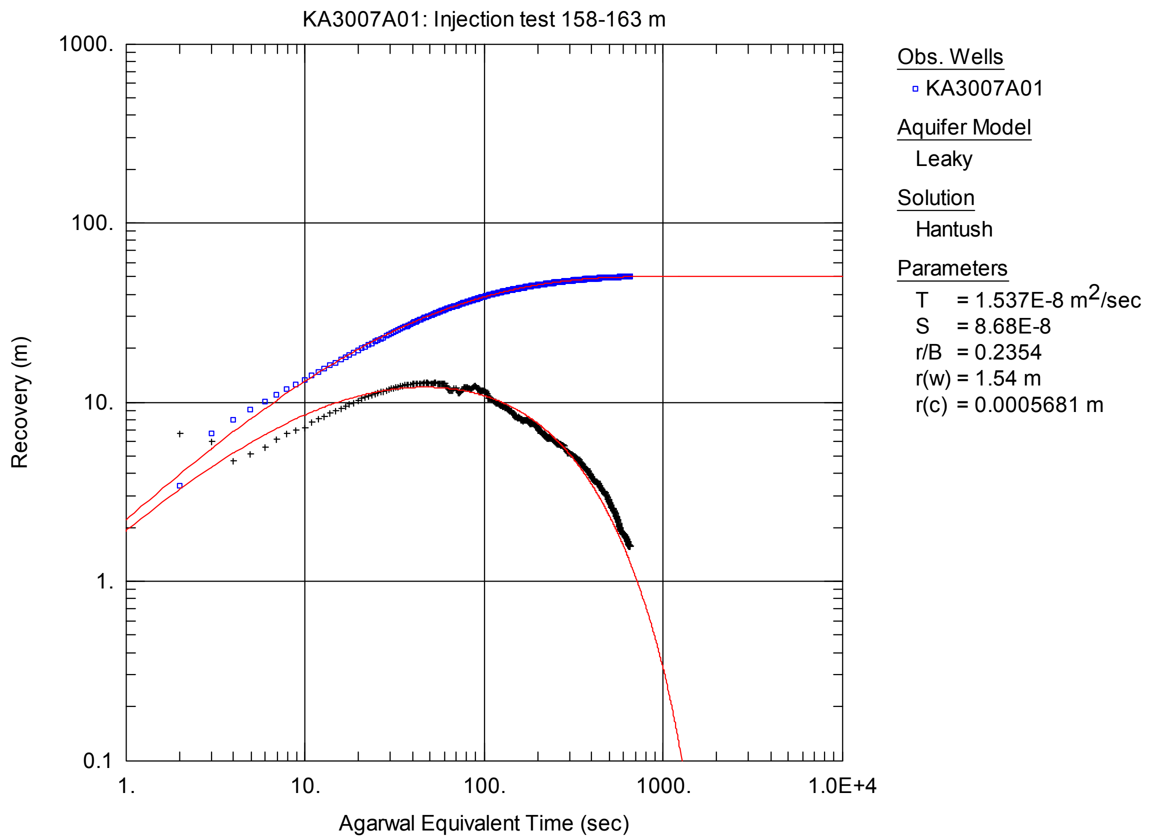


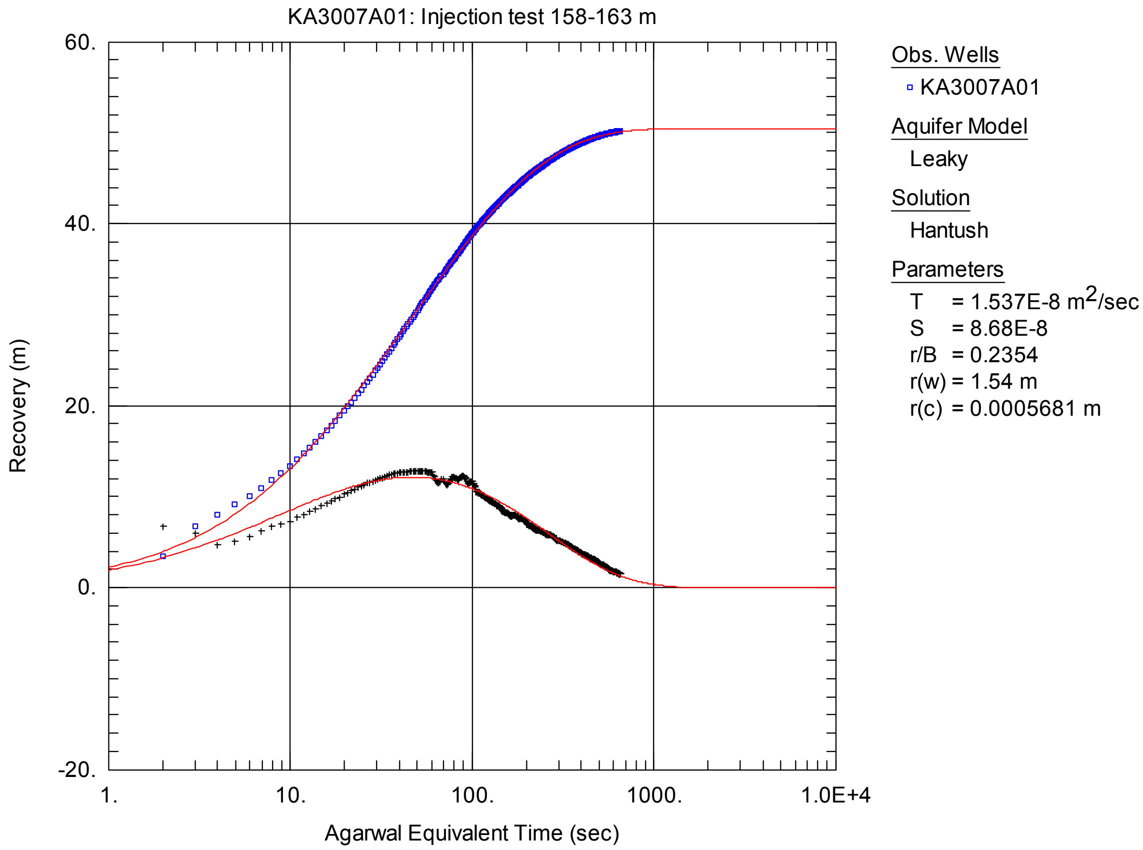
KA3007A01, 158-163 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2011-06-30
17:24:00
17:36:00
17:48:00
18:12:00
18:24:00

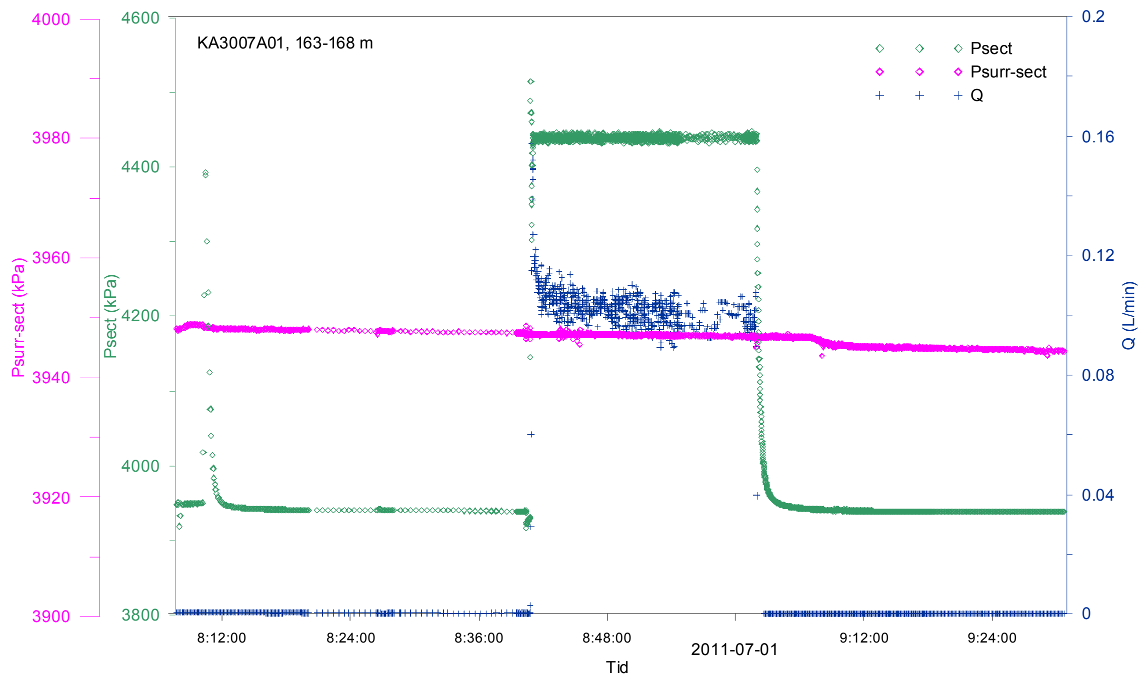


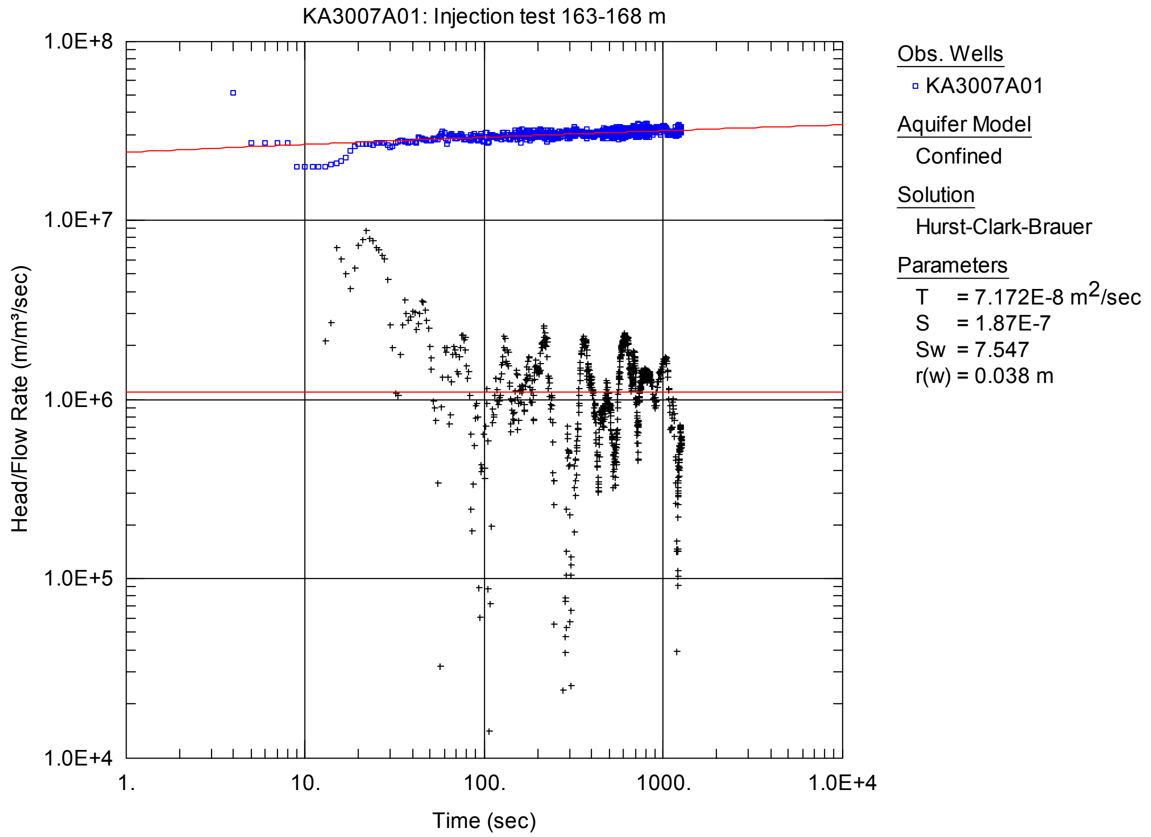
KA3007A01: Injection test 158-163 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 3.478E-8 m2/sec
S = 1.31E-7
r/B = 0.02286
r(w) = 0.3224 m

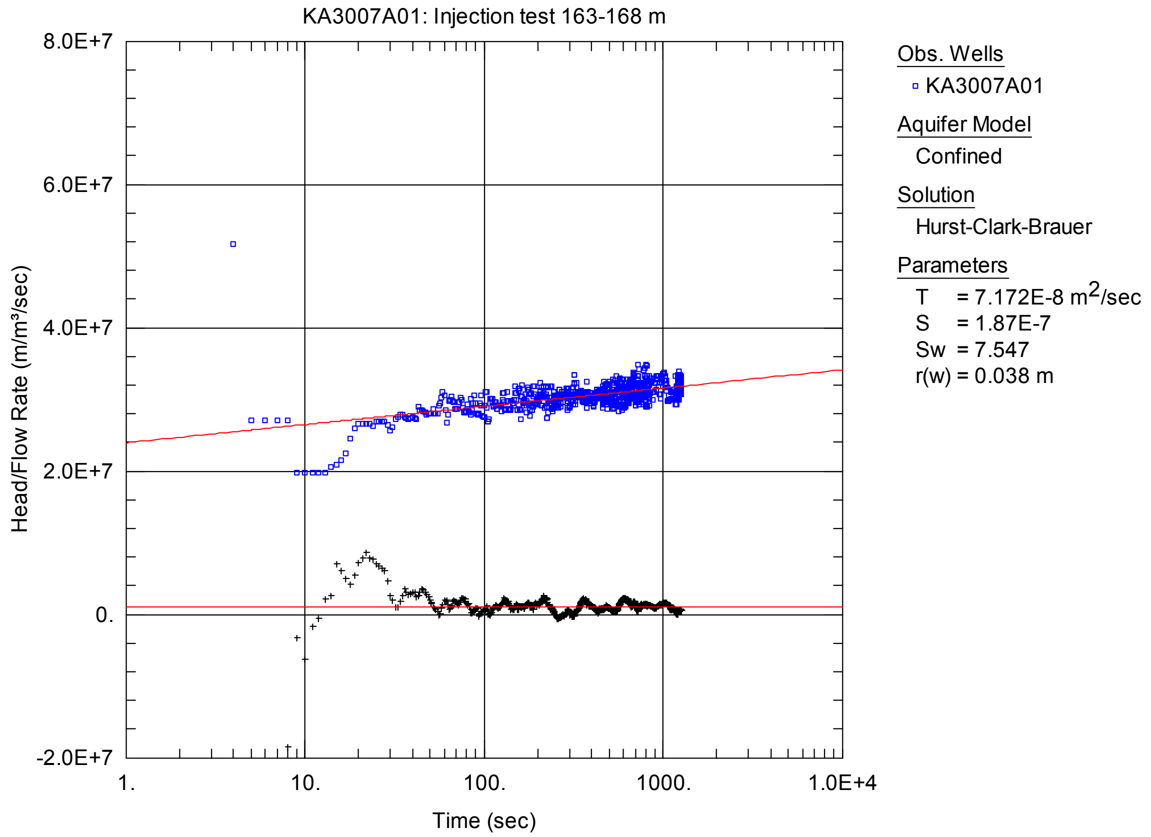

KA3007A01: Injection test 158-163 m
Head/Flow Rate (m/m³/sec)
2.4E+7
1.6E+7
8.0E+6
0.
-8.0E+6
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 3.478E-8 m2/sec
S = 1.31E-7
r/B = 0.02286
r(w) = 0.3224 m

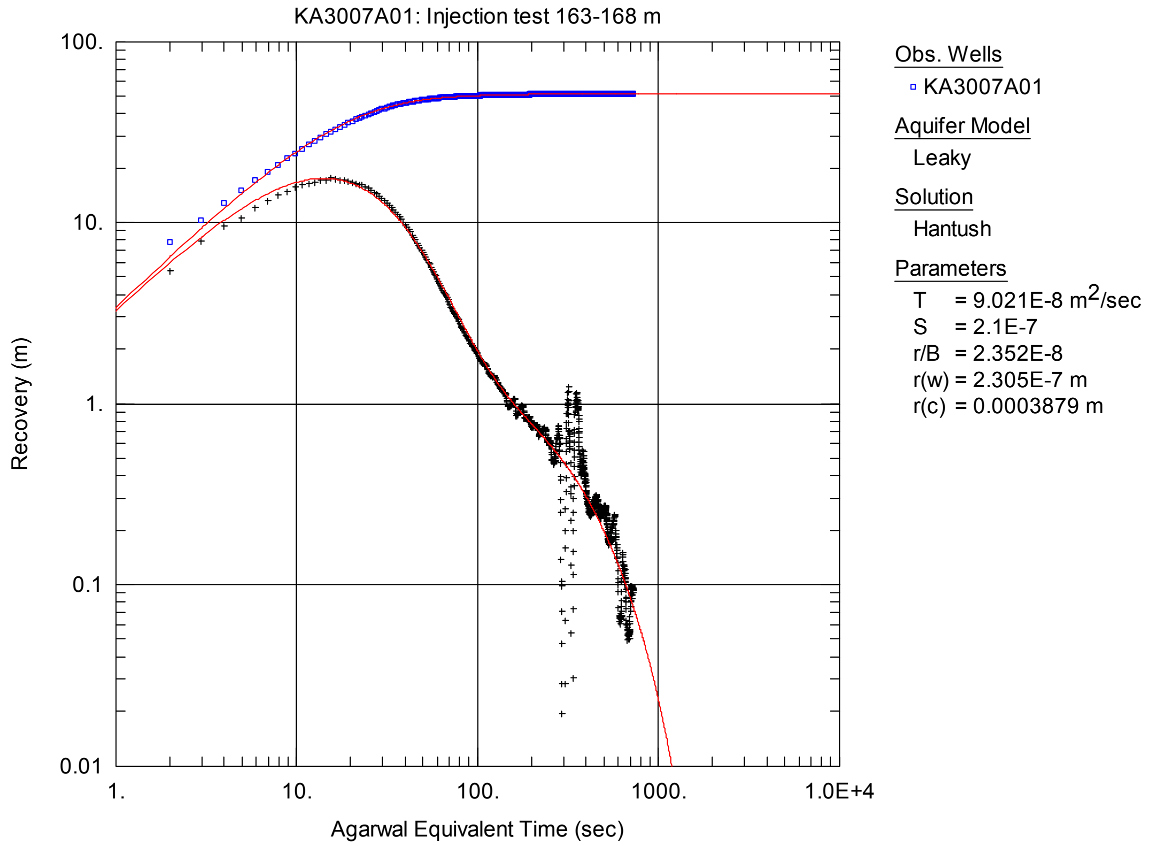

KA3007A01: Injection test 158-163 m
Recovery (m)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.537E-8 m2/sec
S = 8.68E-8
r/B = 0.2354
r(w) = 1.54 m
r(c) = 0.0005681 m

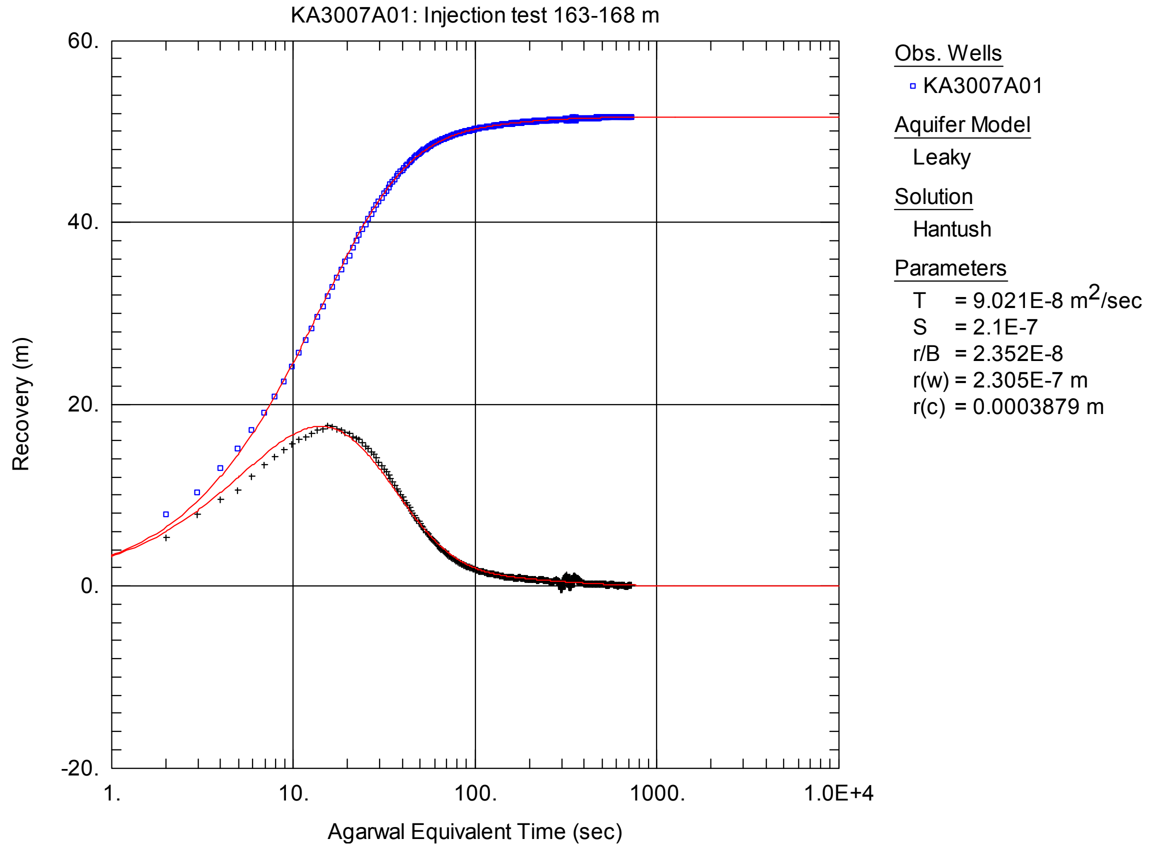

KA3007A01: Injection test 158-163 m
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.537E-8 m2/sec
S = 8.68E-8
r/B = 0.2354
r(w) = 1.54 m
r(c) = 0.0005681 m

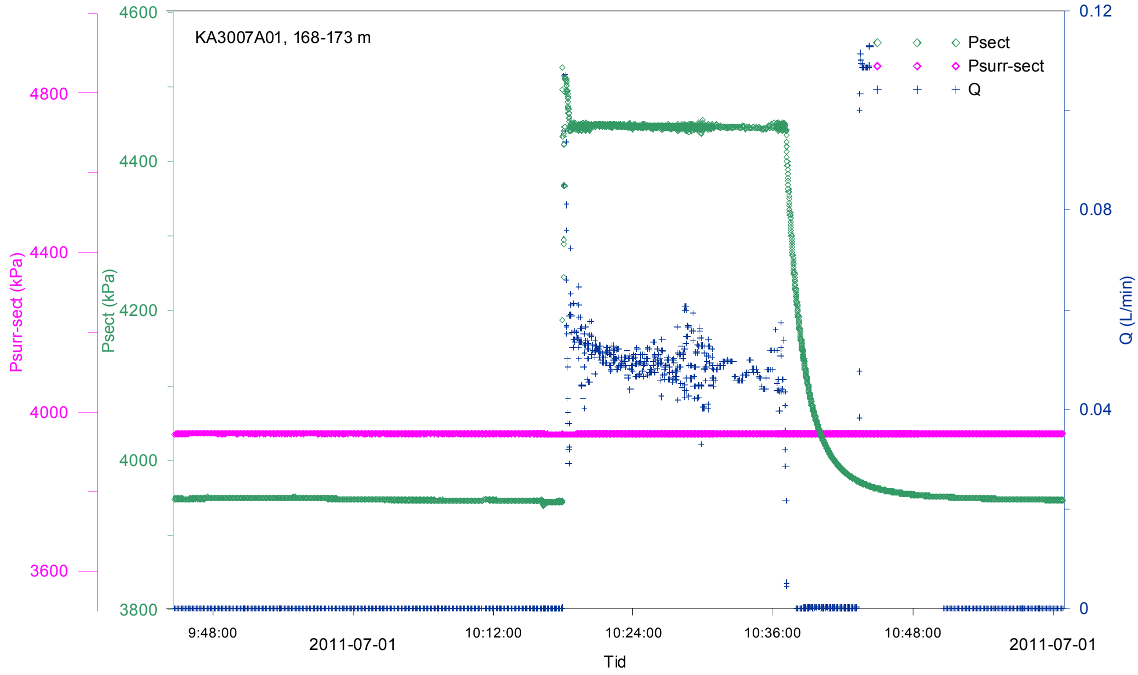

KA3007A01, 163-168 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
4000
3980
3960
3940
3920
3900
4600
4400
4200
4000
3800
0.2
0.16
0.12
0.08
0.04
0
8:12:00
8:24:00
8:36:00
8:48:00
2011-07-01
9:12:00
9:24:00
Tid

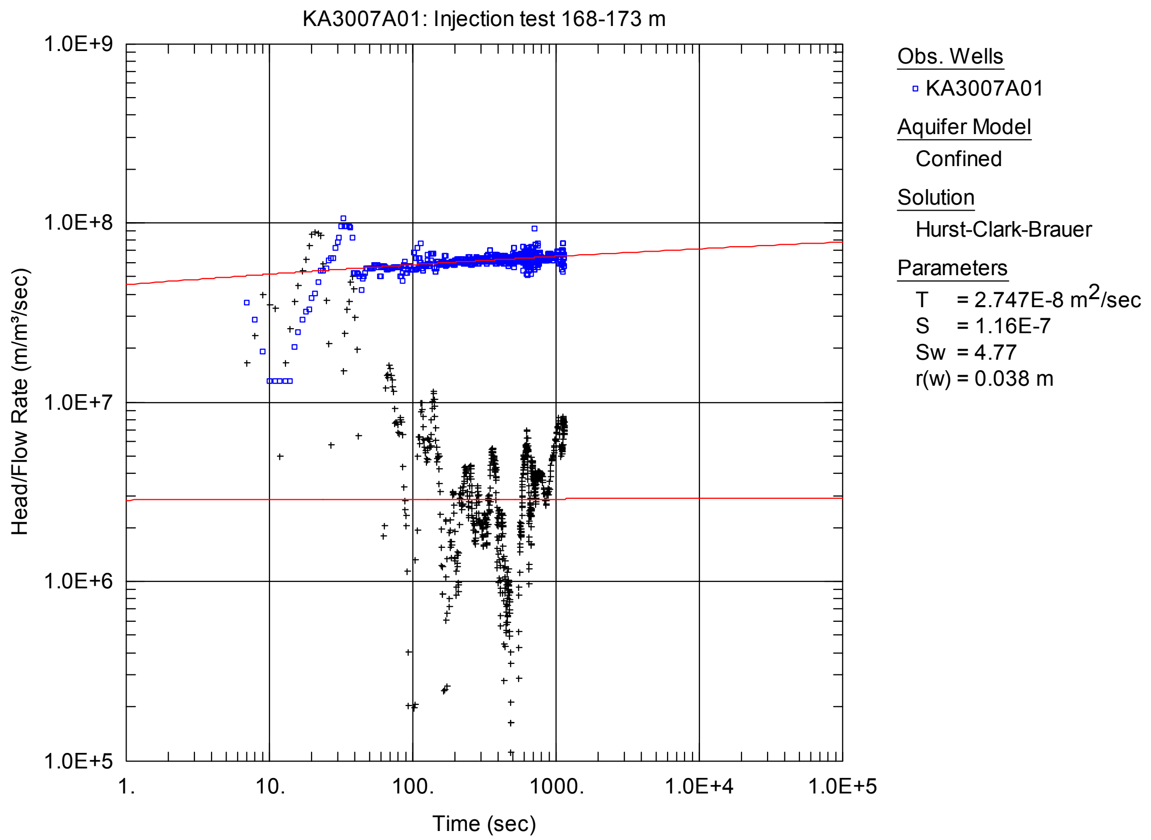

KA3007A01: Injection test 163-168 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 7.172E-8 m2/sec
S = 1.87E-7
Sw = 7.547
r(w) = 0.038 m

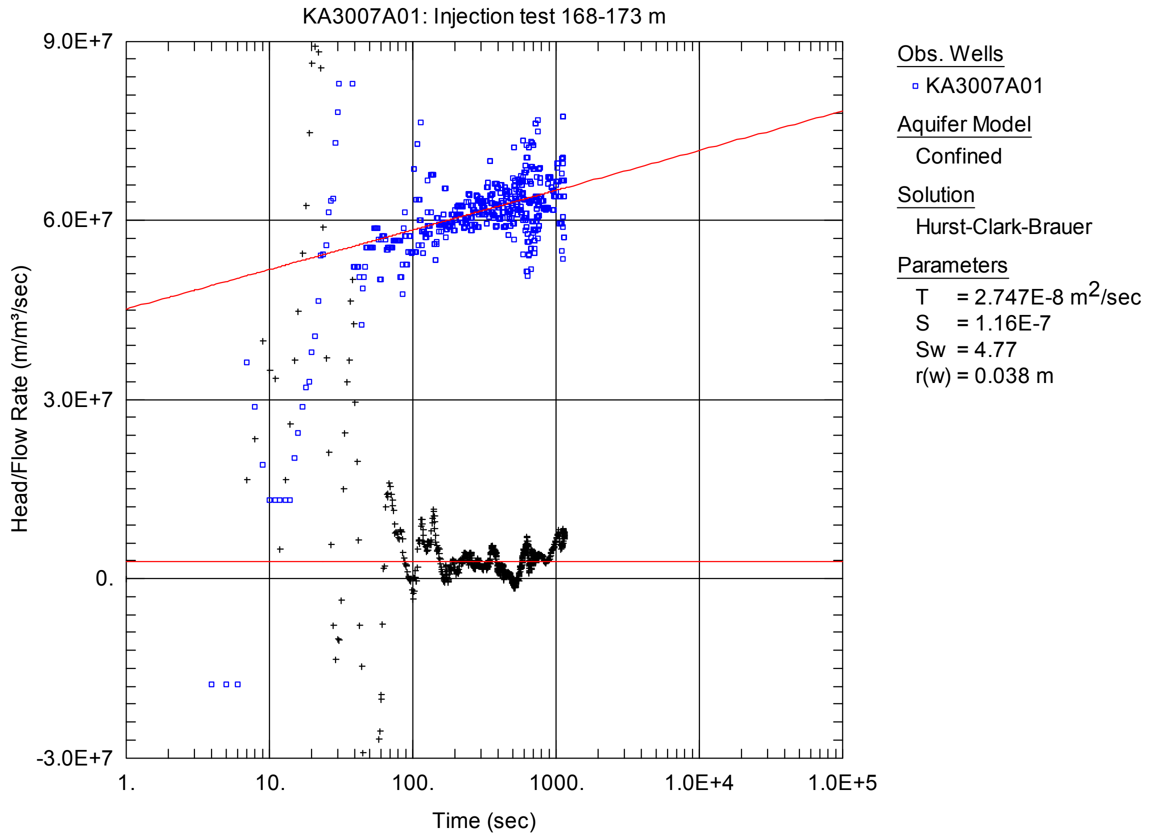

KA3007A01: Injection test 163-168 m
Head/Flow Rate (m/m³/sec)
Time (sec)
8.0E+7
6.0E+7
4.0E+7
2.0E+7
0.
-2.0E+7
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 7.172E-8 m2/sec
S = 1.87E-7
Sw = 7.547
r(w) = 0.038 m

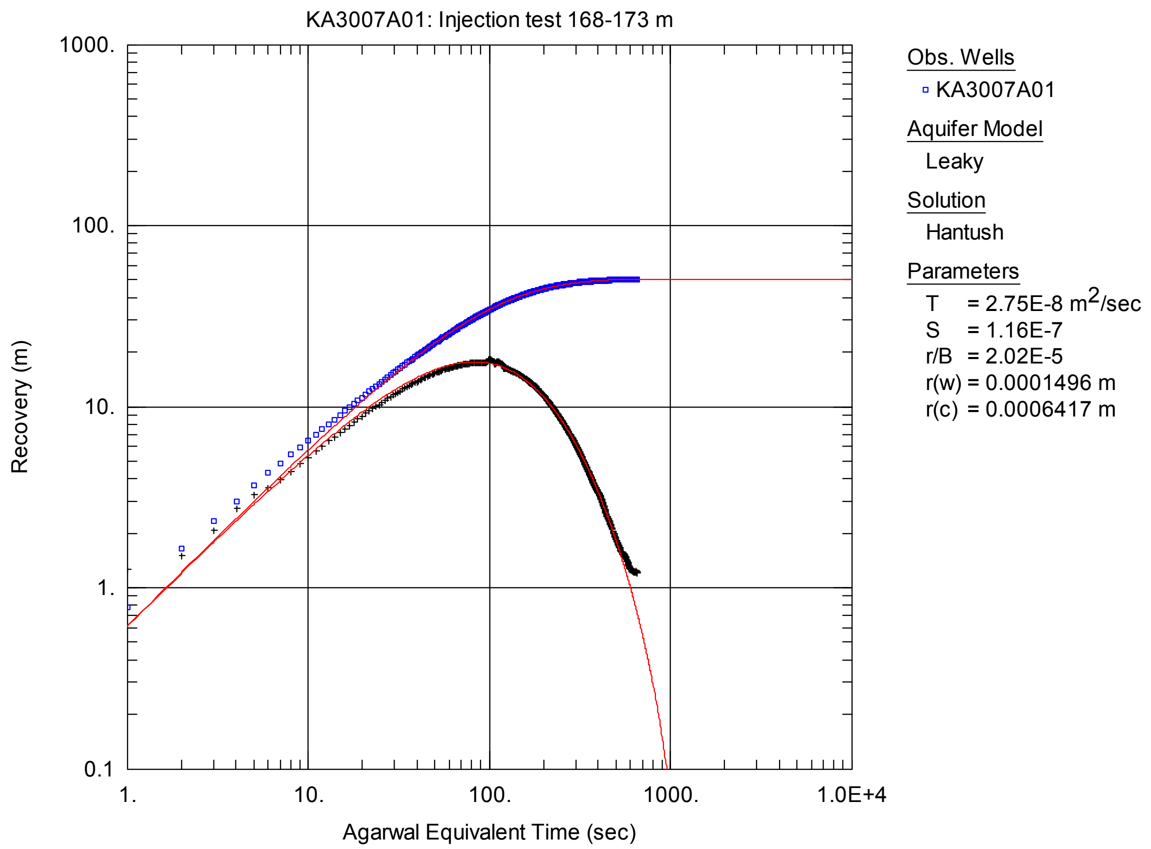

KA3007A01: Injection test 163-168 m
100.
10.
1.
0.1
0.01
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.021E-8 m2/sec
S = 2.1E-7
r/B = 2.352E-8
r(w) = 2.305E-7 m
r(c) = 0.0003879 m


KA3007A01: Injection test 163-168 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.021E-8 m2/sec
S = 2.1E-7
r/B = 2.352E-8
r(w) = 2.305E-7 m
r(c) = 0.0003879 m

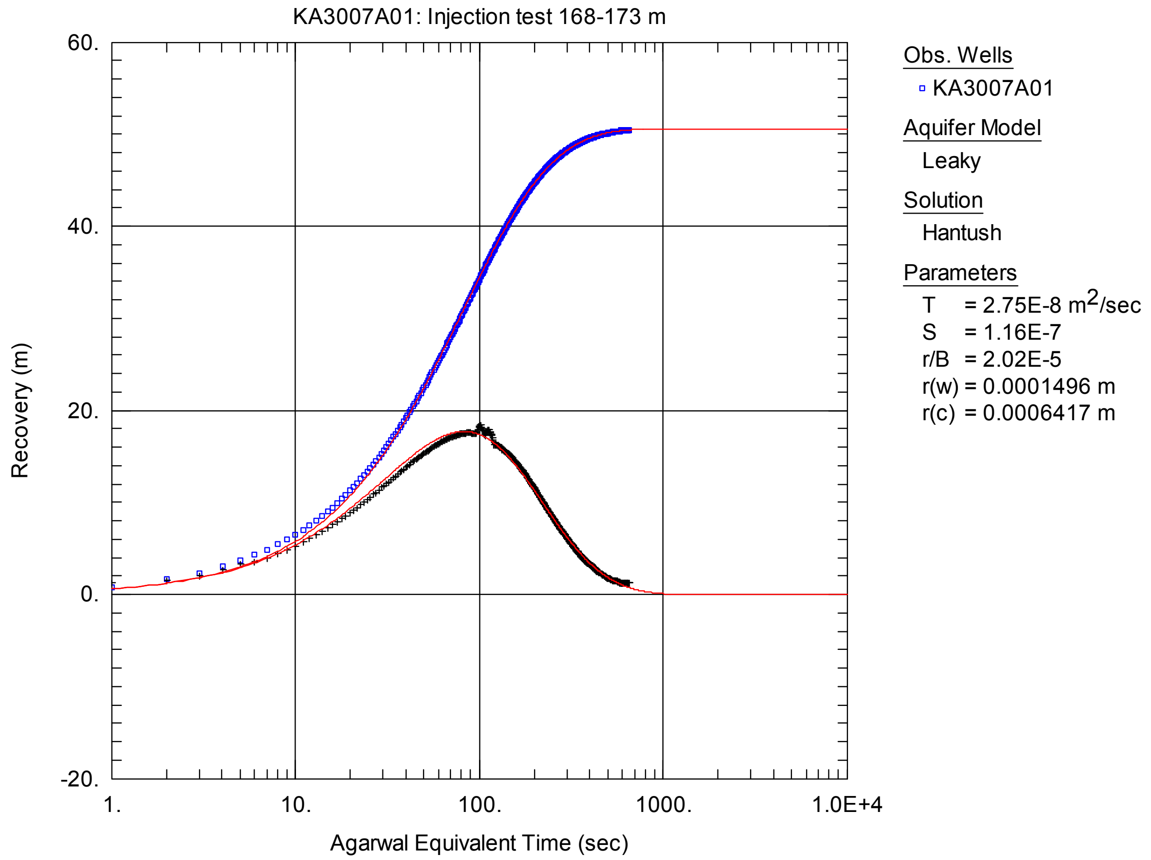

KA3007A01, 168-173 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2011-07-01
9:48:00
10:12:00
10:24:00
10:36:00
10:48:00


KA3007A01: Injection test 168-173 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.747E-8 m²/sec
S = 1.16E-7
Sw = 4.77
r(w) = 0.038 m

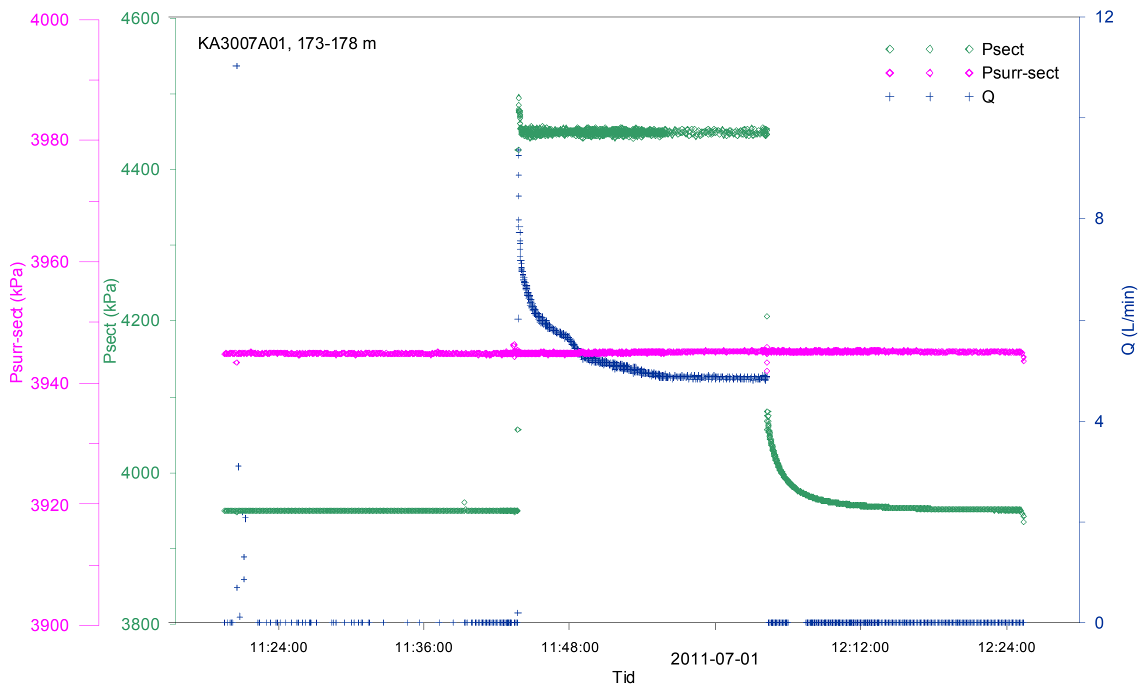


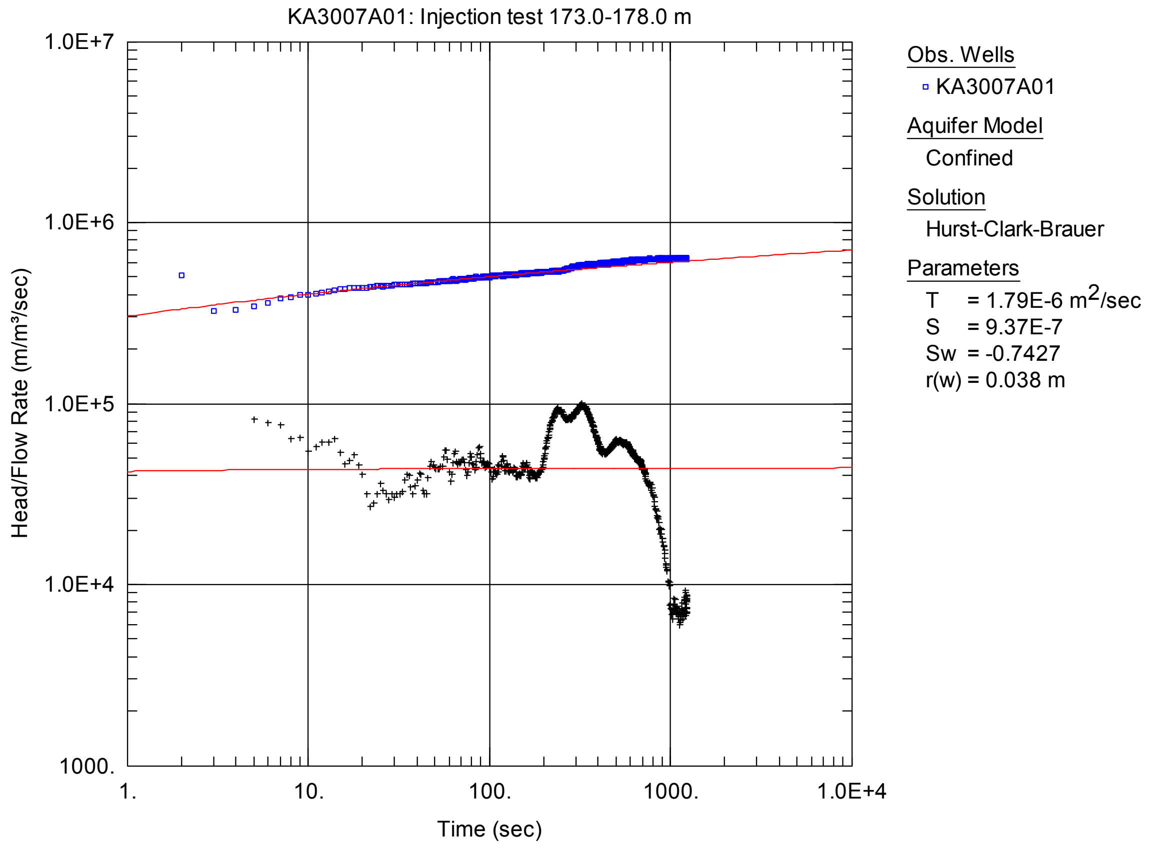


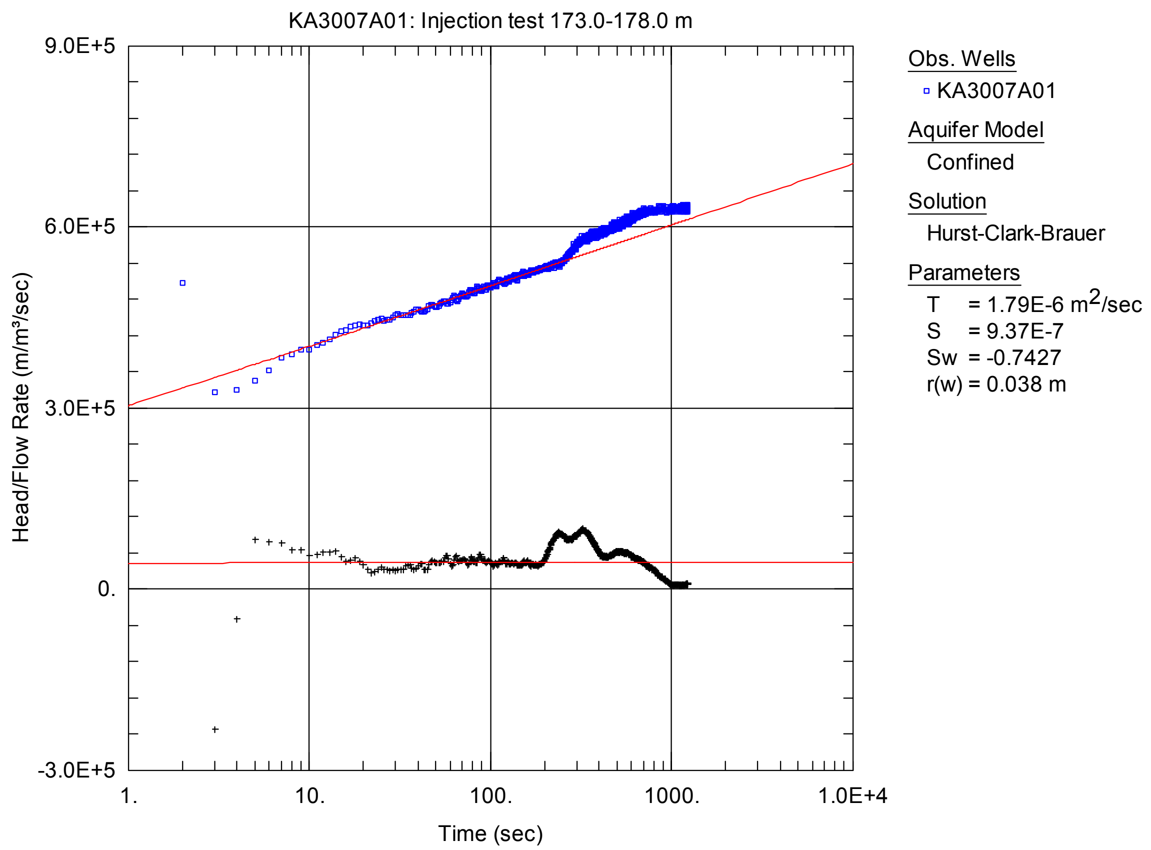
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

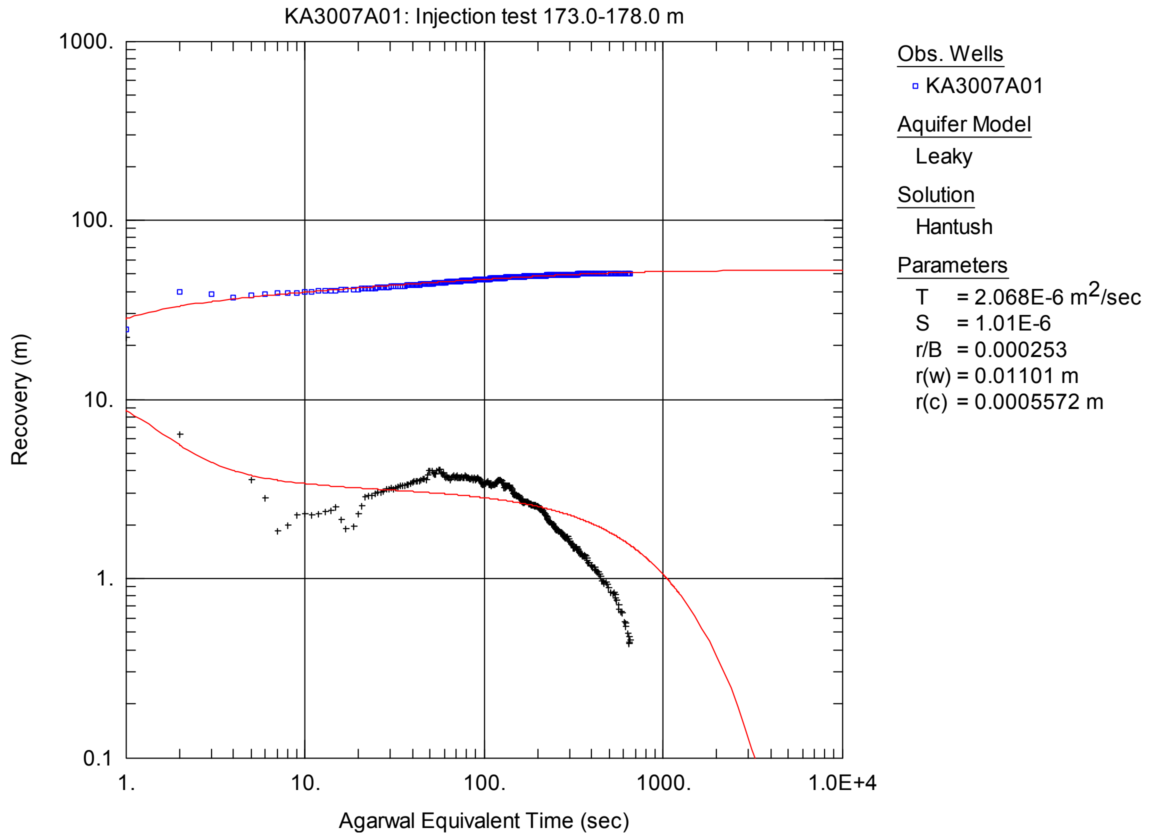


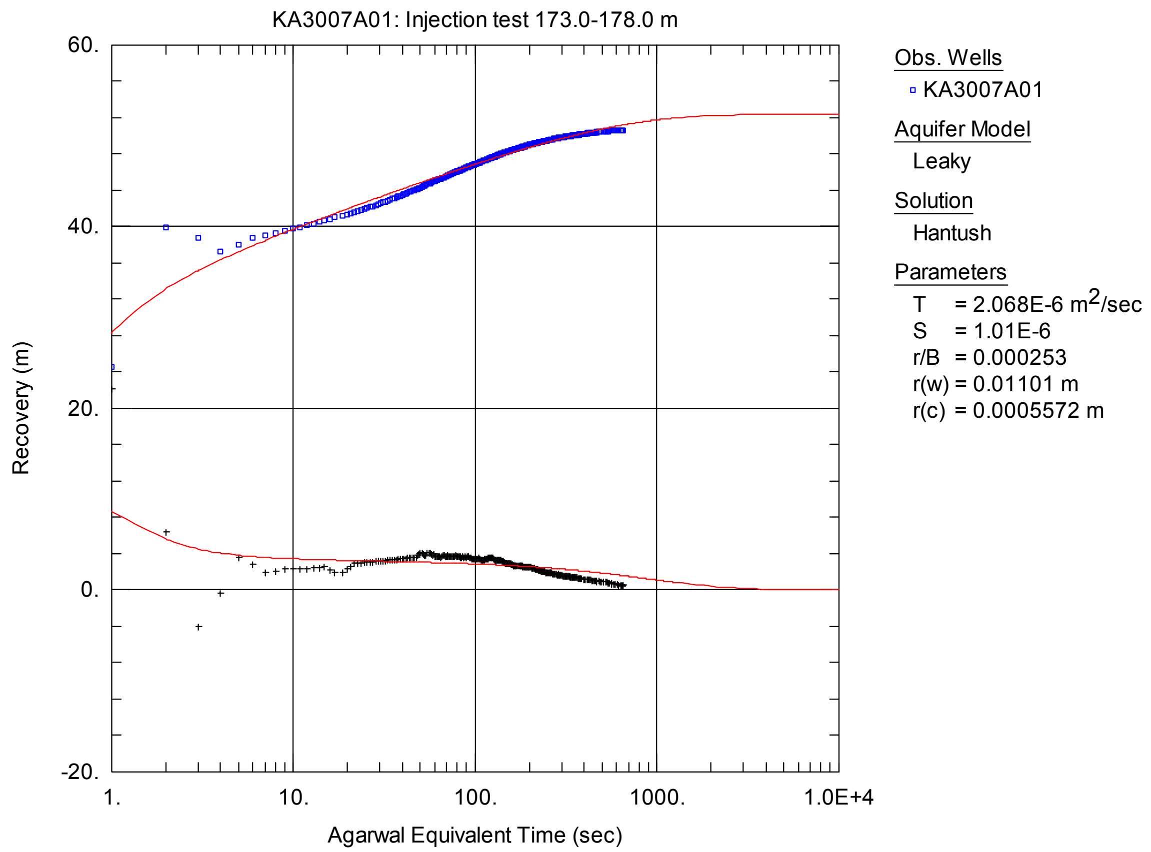
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

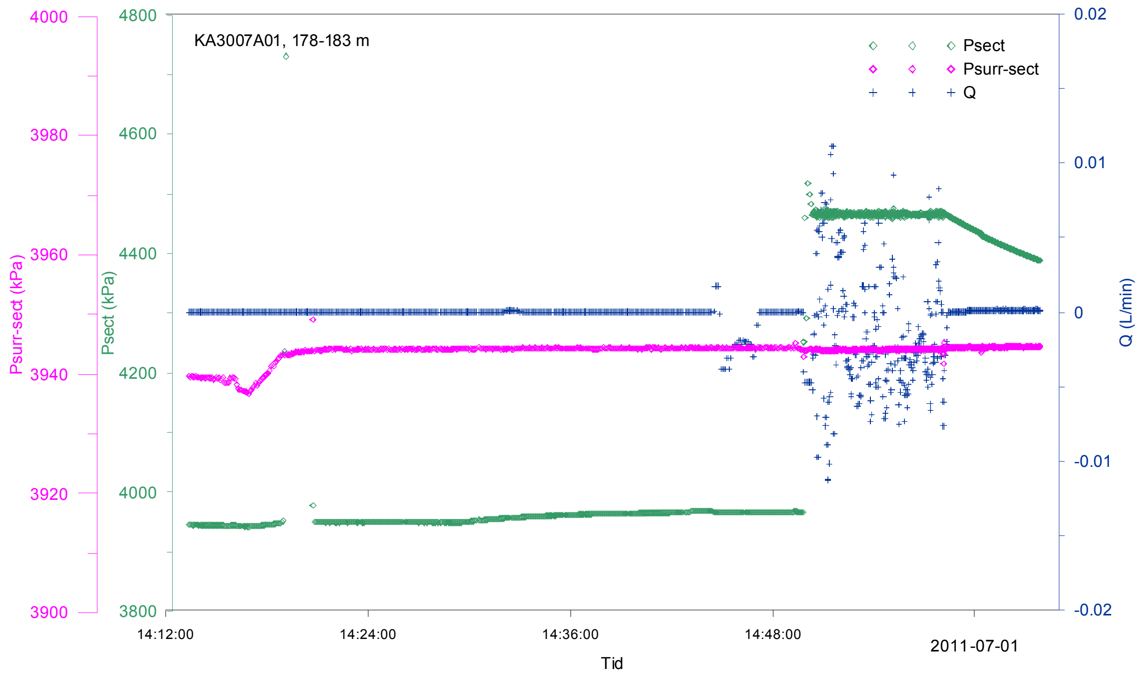


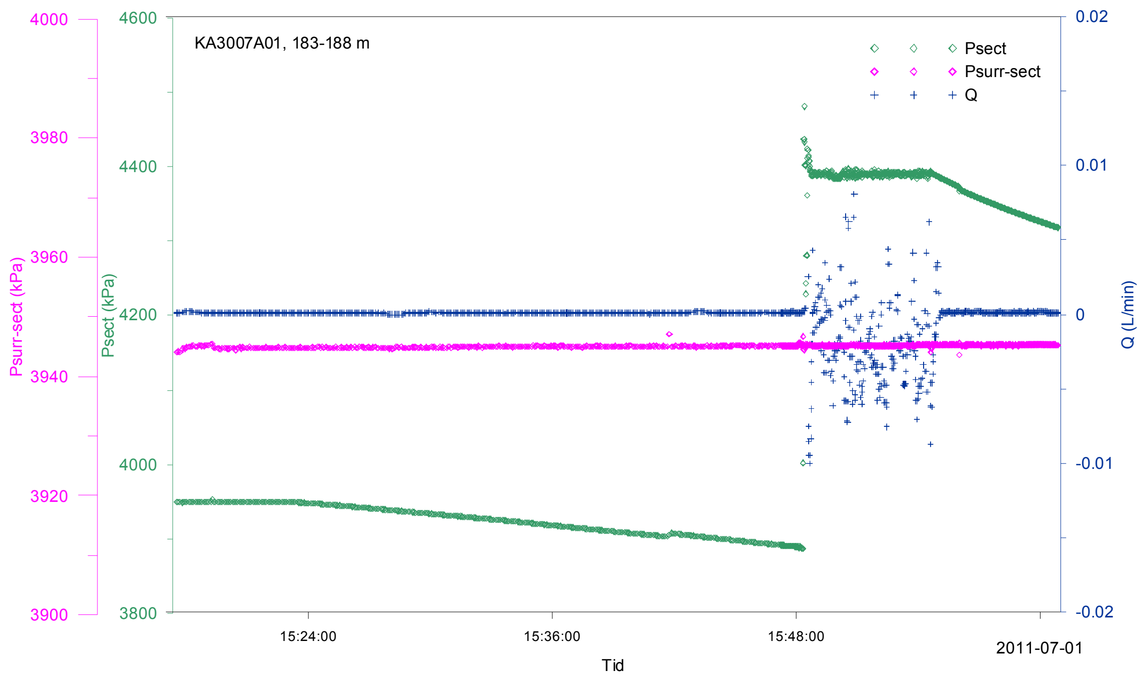

KA3007A01: Injection test 173.0-178.0 m
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.79E-6 m2/sec
S = 9.37E-7
Sw = -0.7427
r(w) = 0.038 m

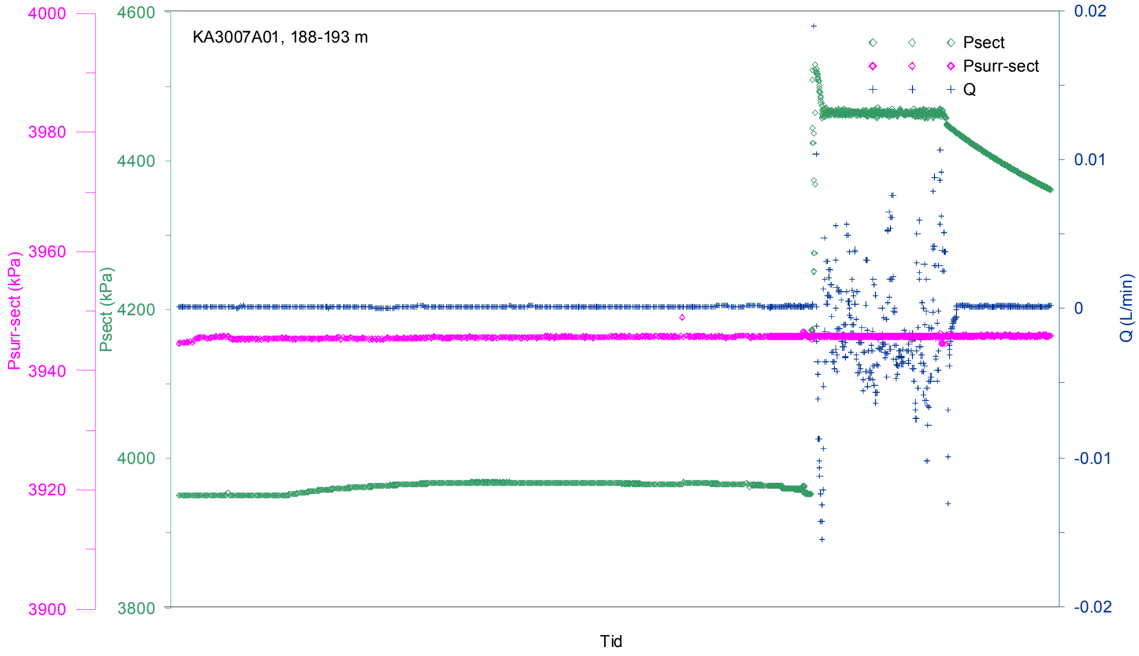

KA3007A01: Injection test 173.0-178.0 m
9.0E+5
6.0E+5
3.0E+5
0.
-3.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.79E-6 m2/sec
S = 9.37E-7
Sw = -0.7427
r(w) = 0.038 m


KA3007A01: Injection test 173.0-178.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.068E-6 m2/sec
S = 1.01E-6
r/B = 0.000253
r(w) = 0.01101 m
r(c) = 0.0005572 m

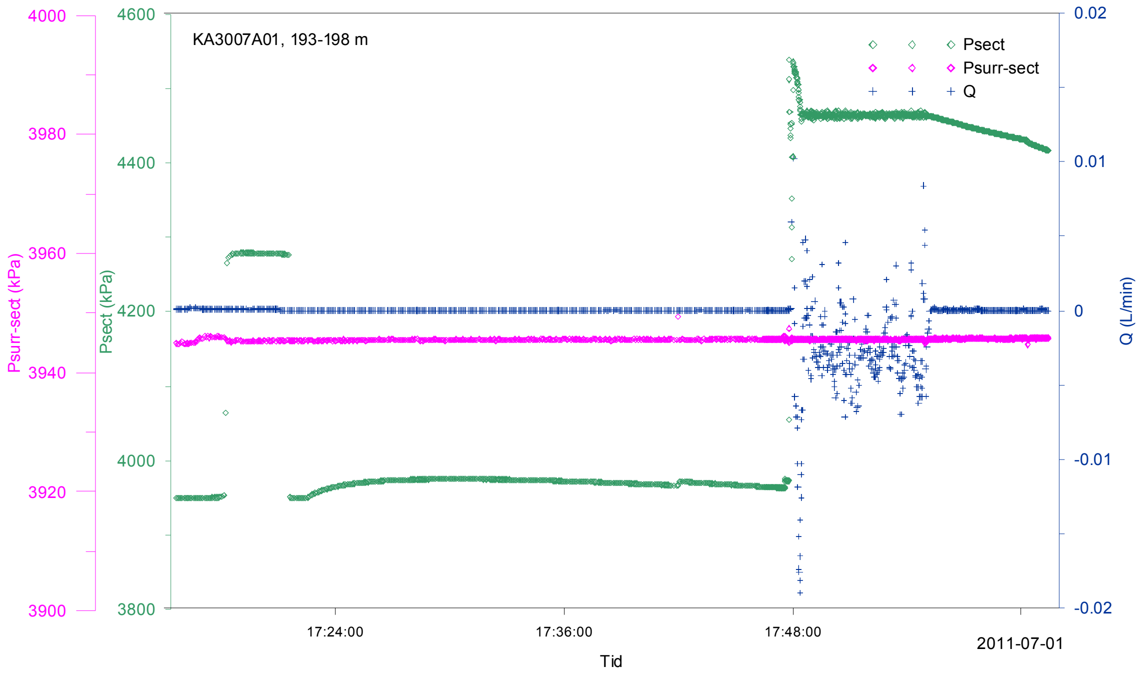

KA3007A01: Injection test 173.0-178.0 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.068E-6 m2/sec
S = 1.01E-6
r/B = 0.000253
r(w) = 0.01101 m
r(c) = 0.0005572 m


KA3007A01, 178-183 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2011-07-01
14:12:00
14:24:00
14:36:00
14:48:00

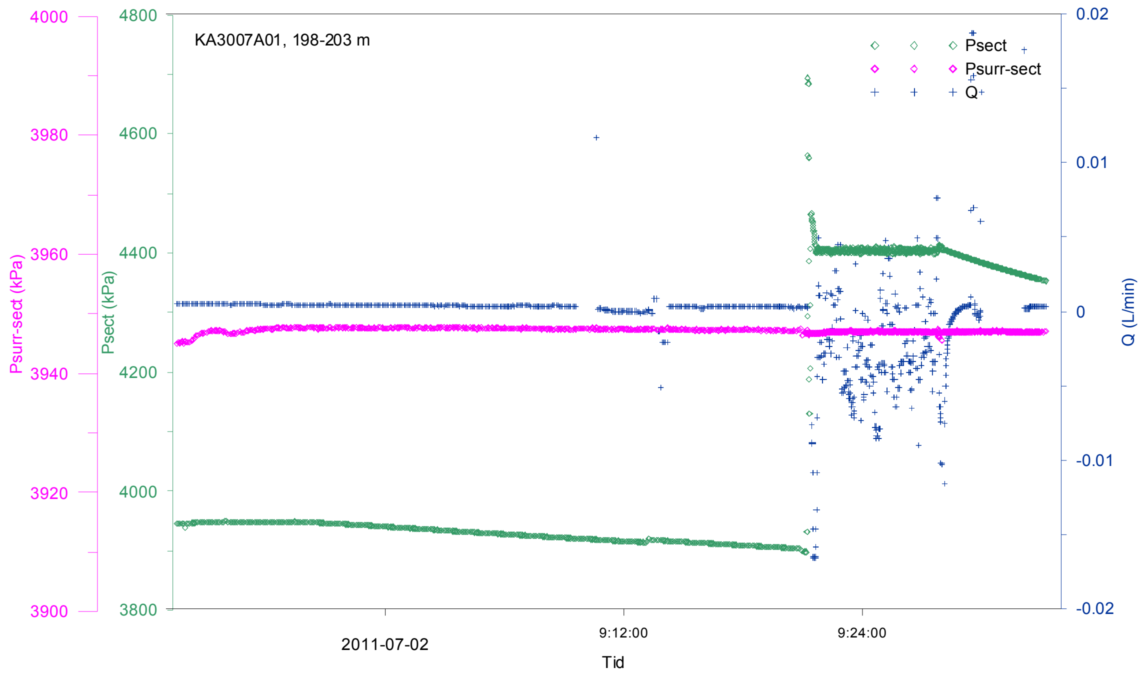

KA3007A01, 183-188 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2011-07-01
15:24:00
15:36:00
15:48:00

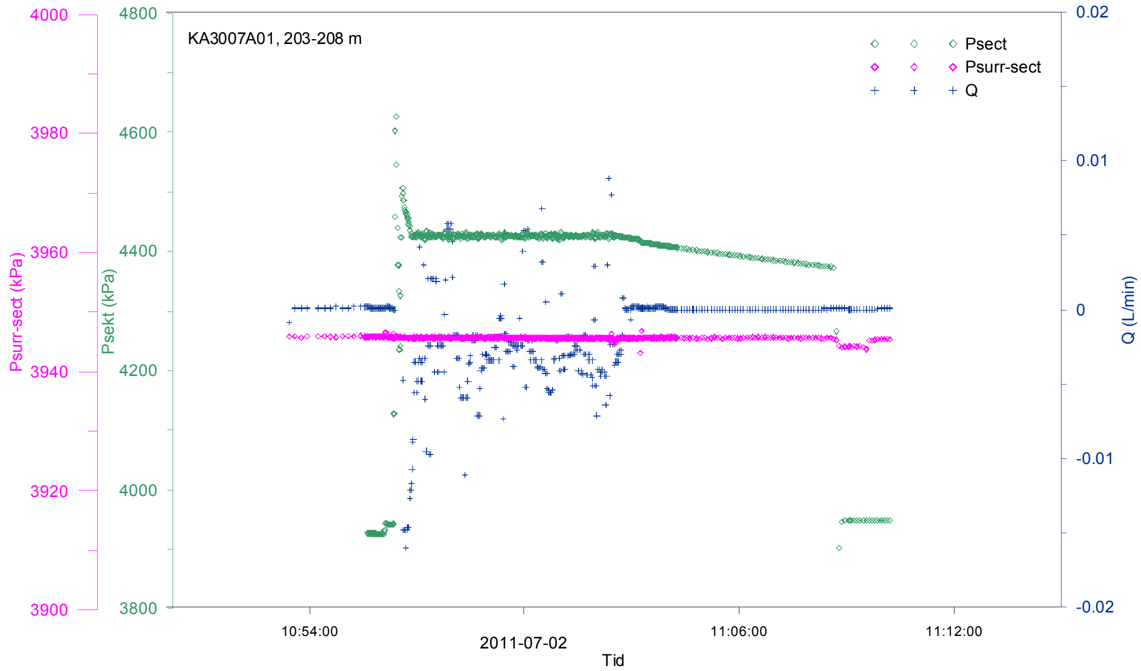


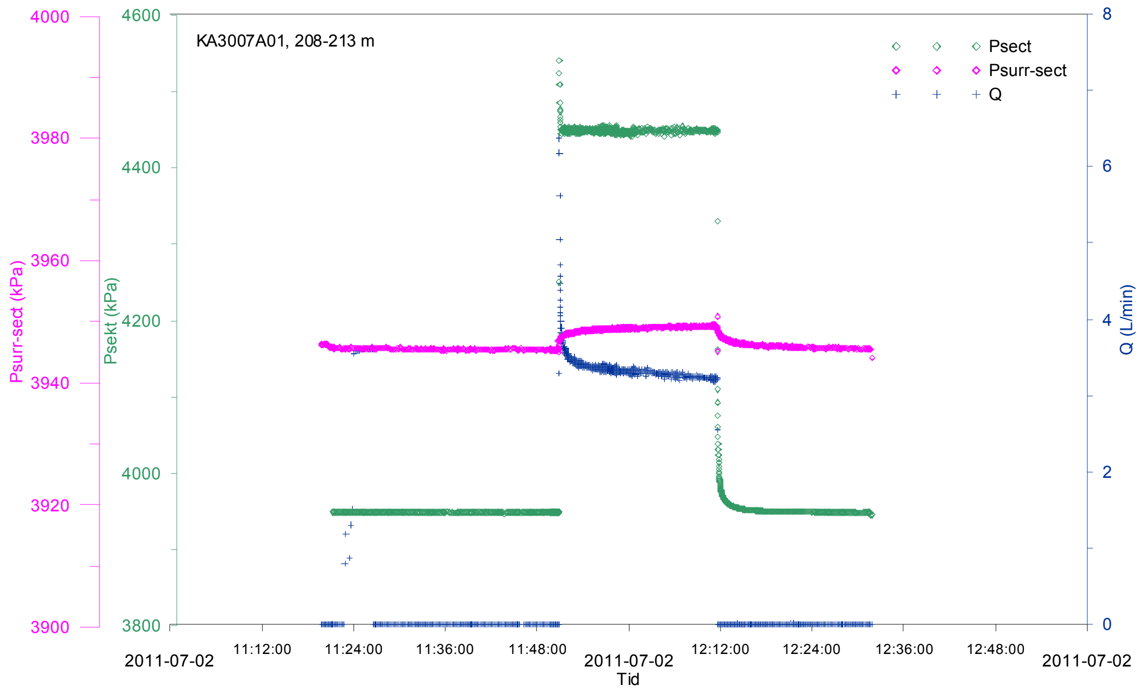
KA3007A01, 188-193 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
4000
3980
3960
3940
3920
3900
4600
4400
4200
4000
3800
0.02
0.01
0
-0.01
-0.02



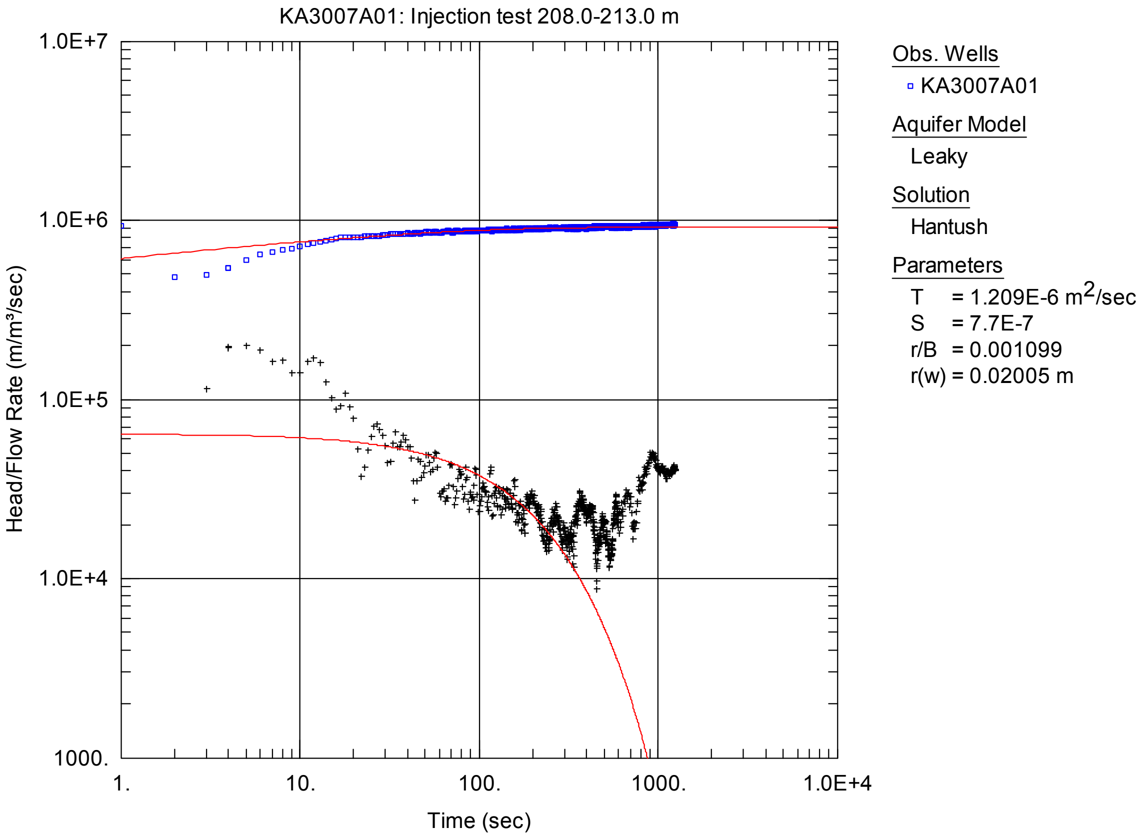
KA3007A01, 193-198 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
17:24:00
17:36:00
17:48:00
2011-07-01
Tid
4000
3980
3960
3940
3920
3900
4600
4400
4200
4000
3800
0.02
0.01
0
-0.01
-0.02


KA3007A01, 198-203 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2011-07-02
9:12:00
9:24:00
Tid

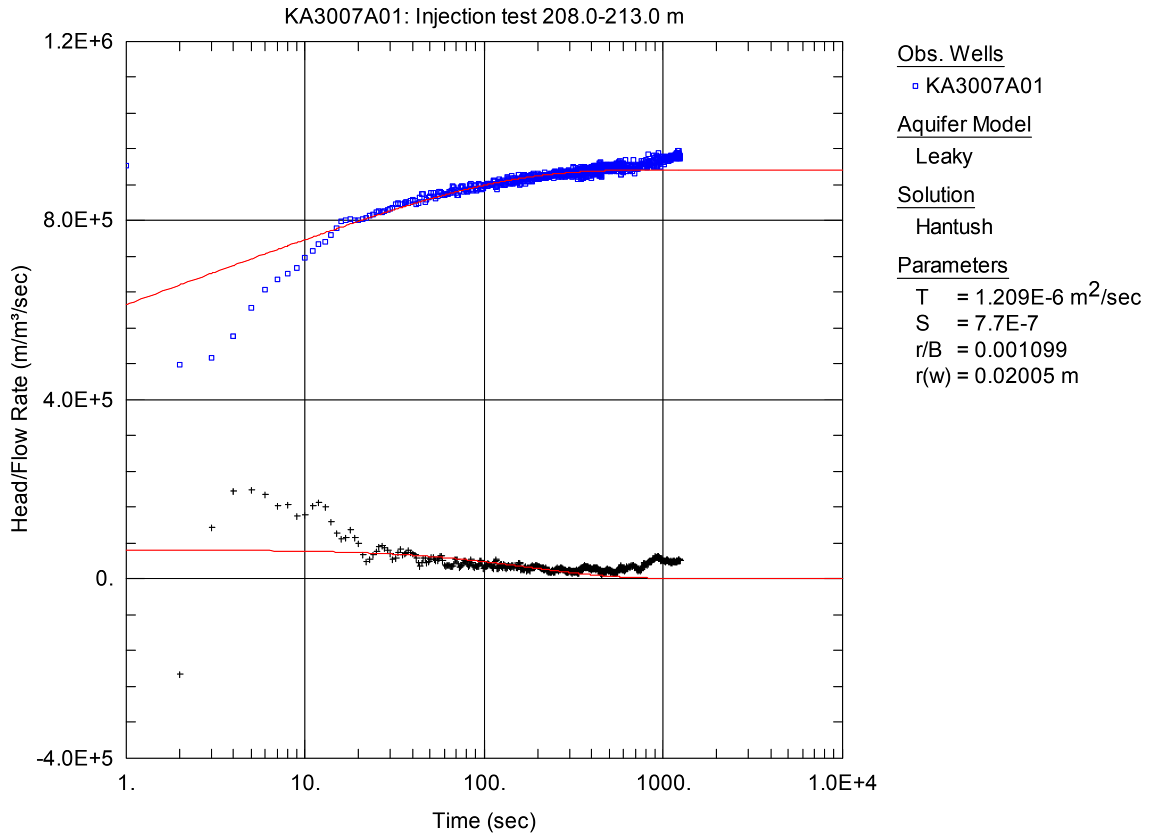

KA3007A01, 203-208 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
10:54:00
2011-07-02
11:06:00
11:12:00
Tid

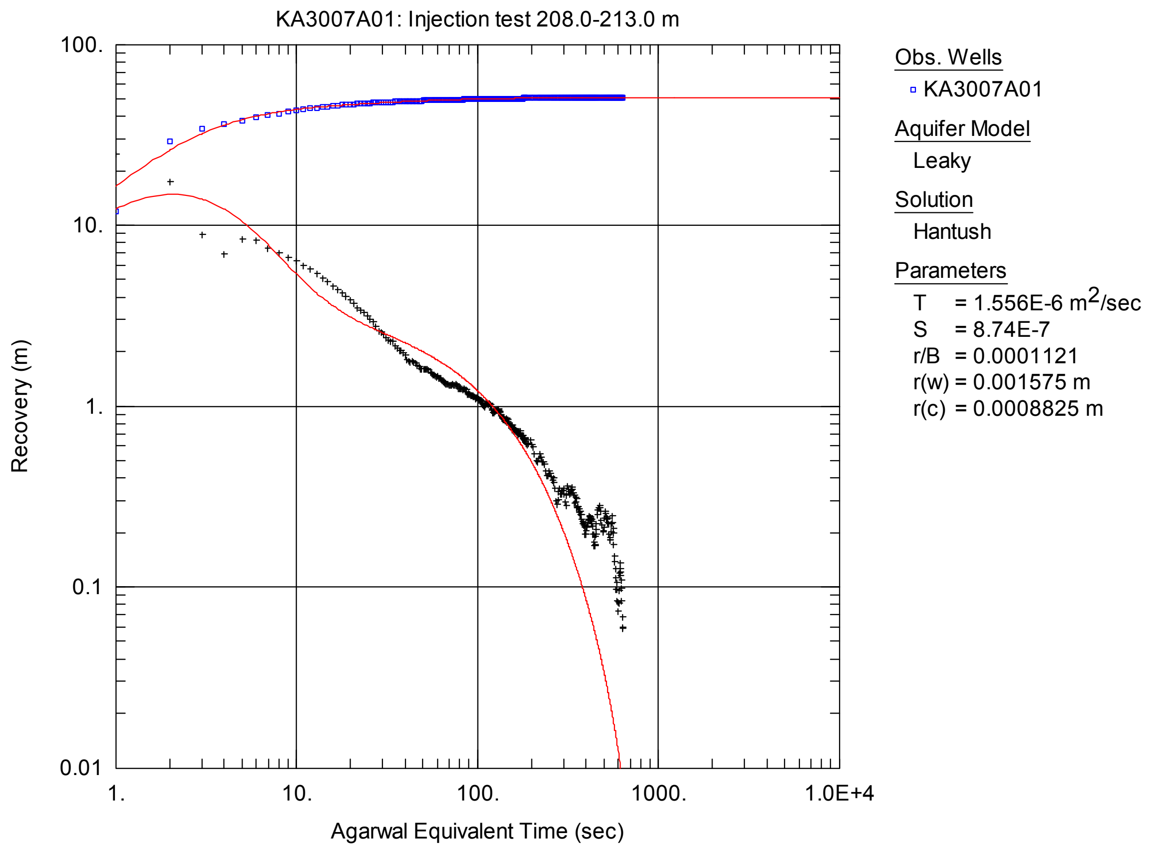


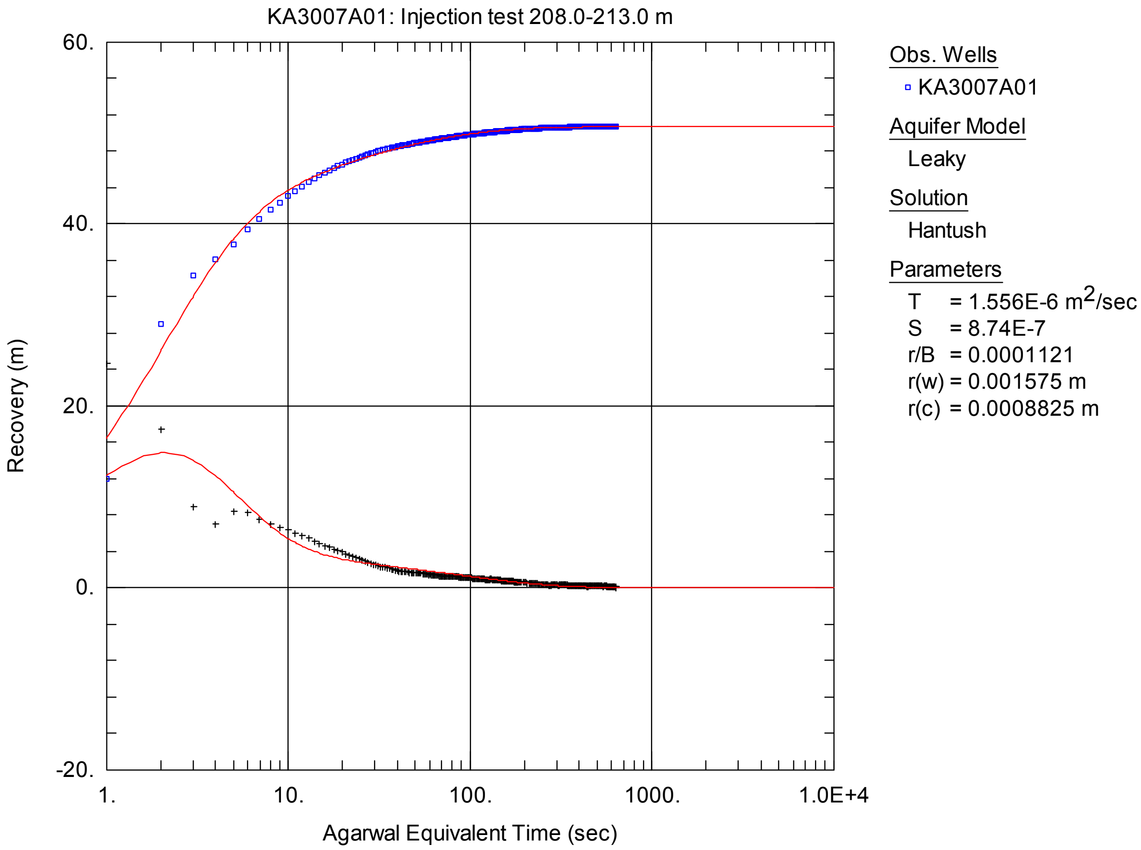
KA3007A01, 208-213 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-02
11:12:00
11:24:00
11:36:00
11:48:00
12:12:00
12:24:00
12:36:00
12:48:00



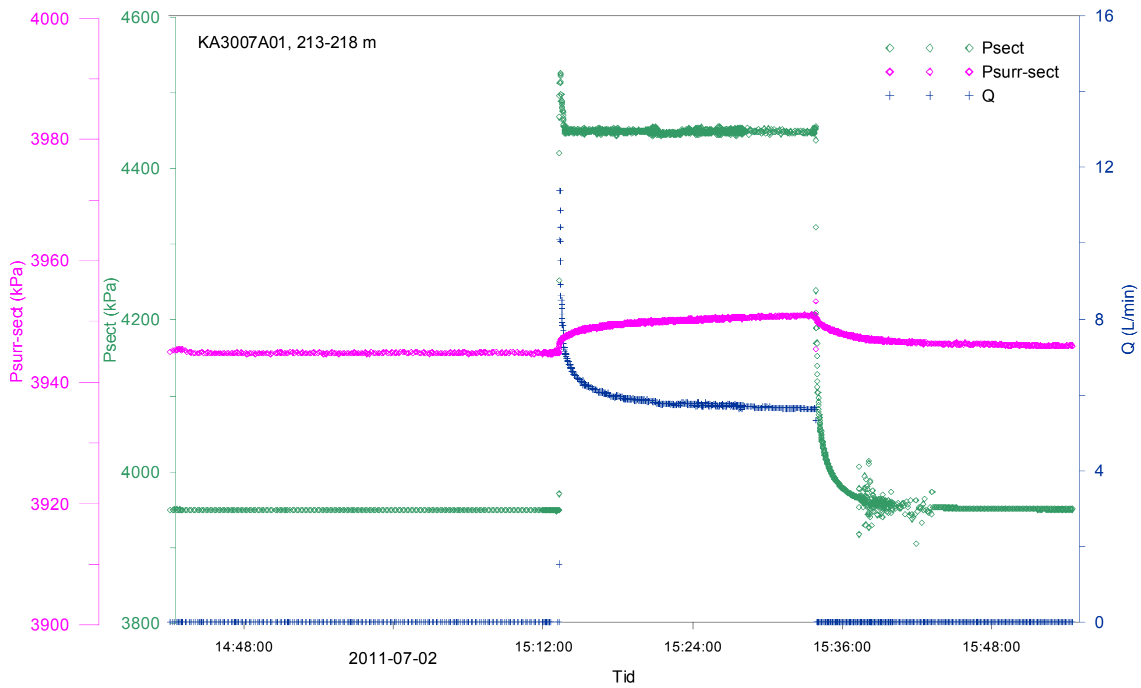
KA3007A01: Injection test 208.0-213.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.209E-6 m2/sec
S = 7.7E-7
r/B = 0.001099
r(w) = 0.02005 m


KA3007A01: Injection test 208.0-213.0 m
1.2E+6
8.0E+5
4.0E+5
0.
-4.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.209E-6 m2/sec
S = 7.7E-7
r/B = 0.001099
r(w) = 0.02005 m

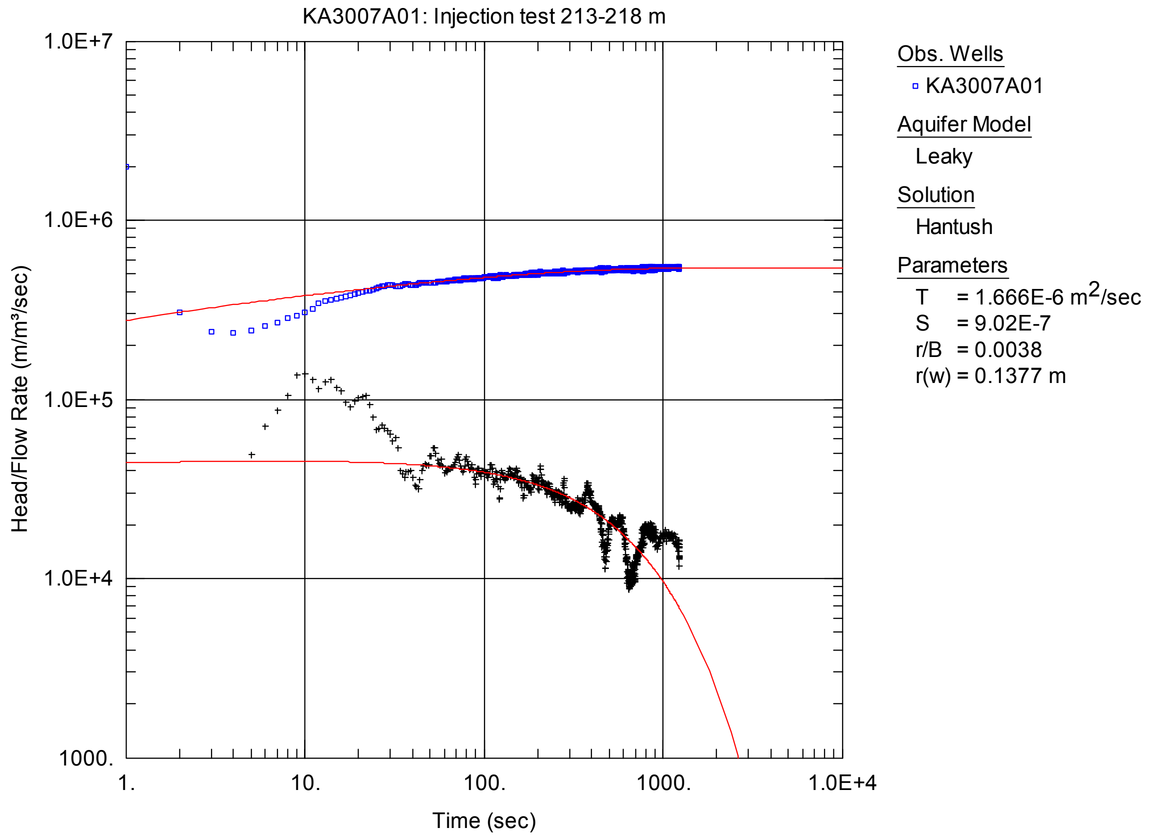

KA3007A01: Injection test 208.0-213.0 m
100.
10.
1.
0.1
0.01
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.556E-6 m2/sec
S = 8.74E-7
r/B = 0.0001121
r(w) = 0.001575 m
r(c) = 0.0008825 m

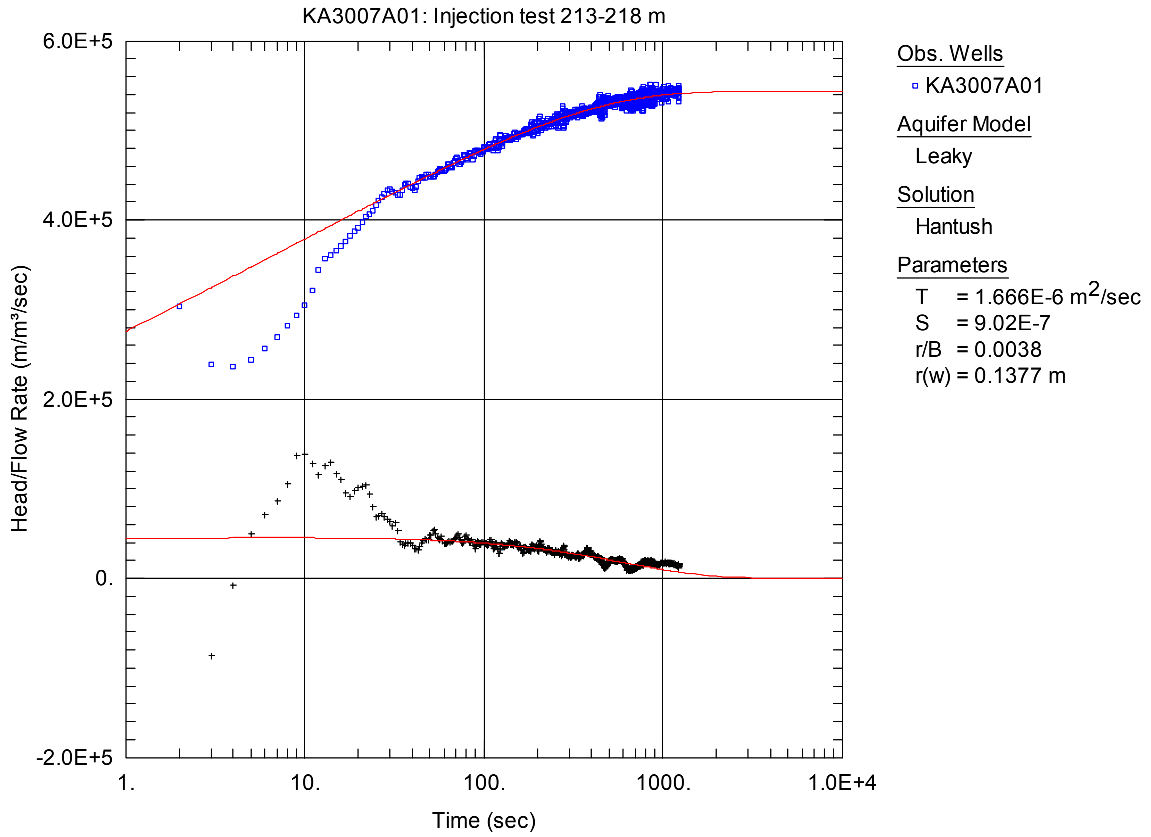


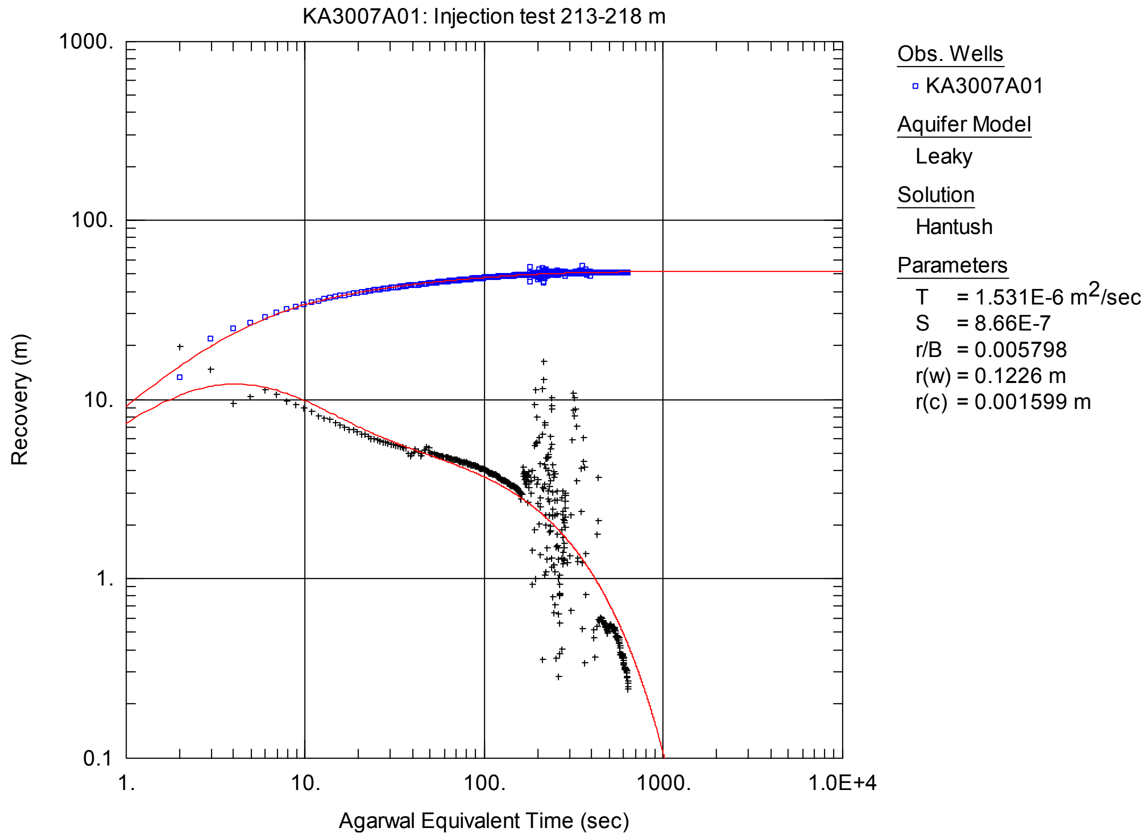
KA3007A01: Injection test 208.0-213.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.556E-6 m2/sec
S = 8.74E-7
r/B = 0.0001121
r(w) = 0.001575 m
r(c) = 0.0008825 m

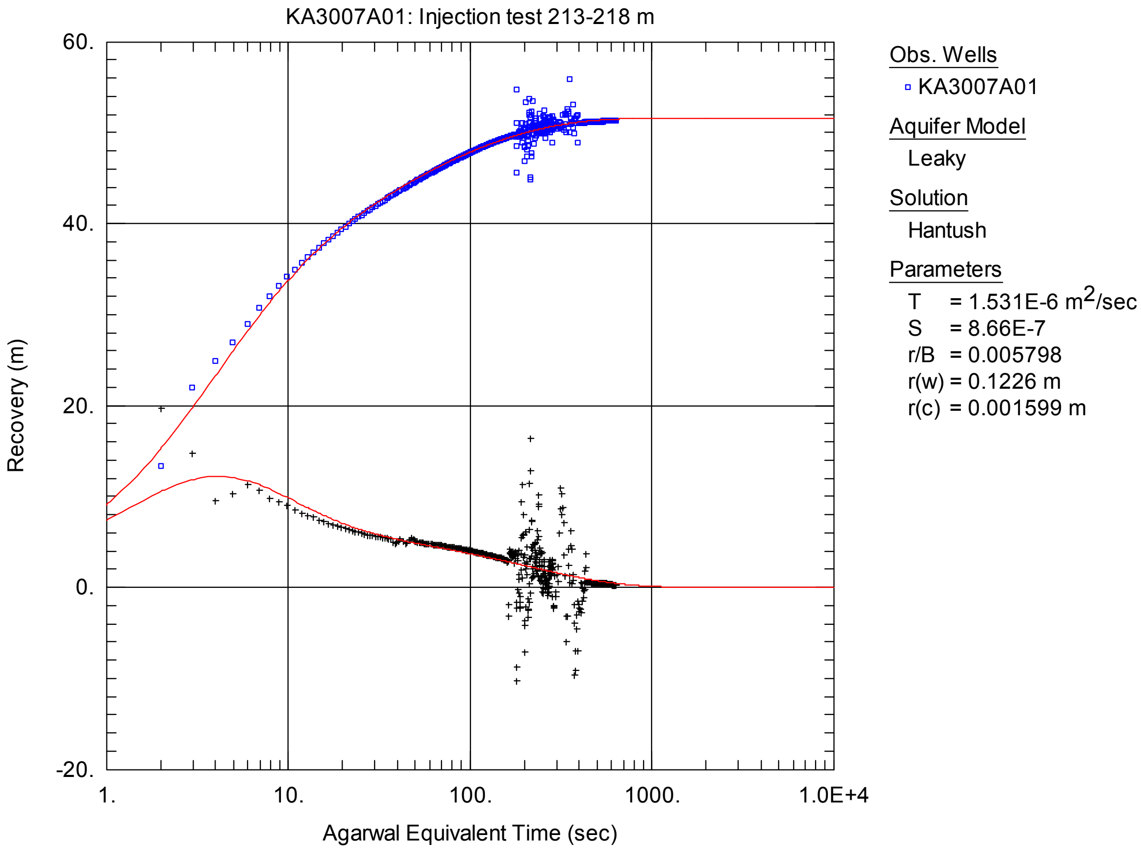


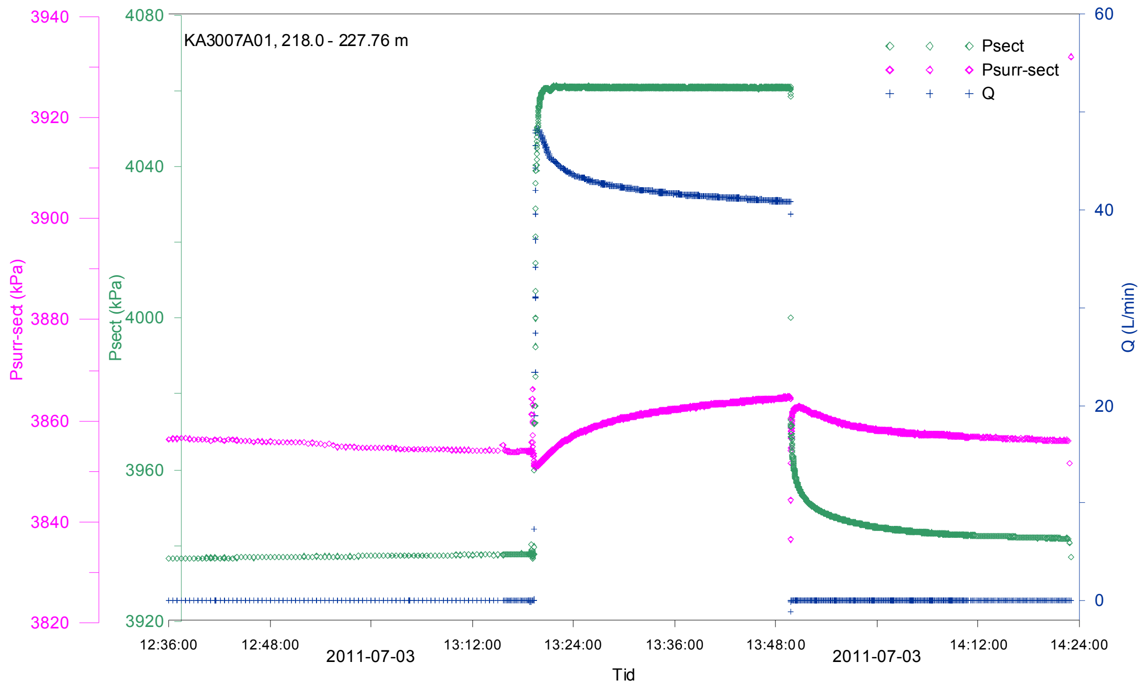
KA3007A01, 213-218 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
4000
3980
3960
3940
3920
3900
4600
4400
4200
4000
3800
16
12
8
4
0
14:48:00
15:12:00
15:24:00
15:36:00
15:48:00
2011-07-02
Tid

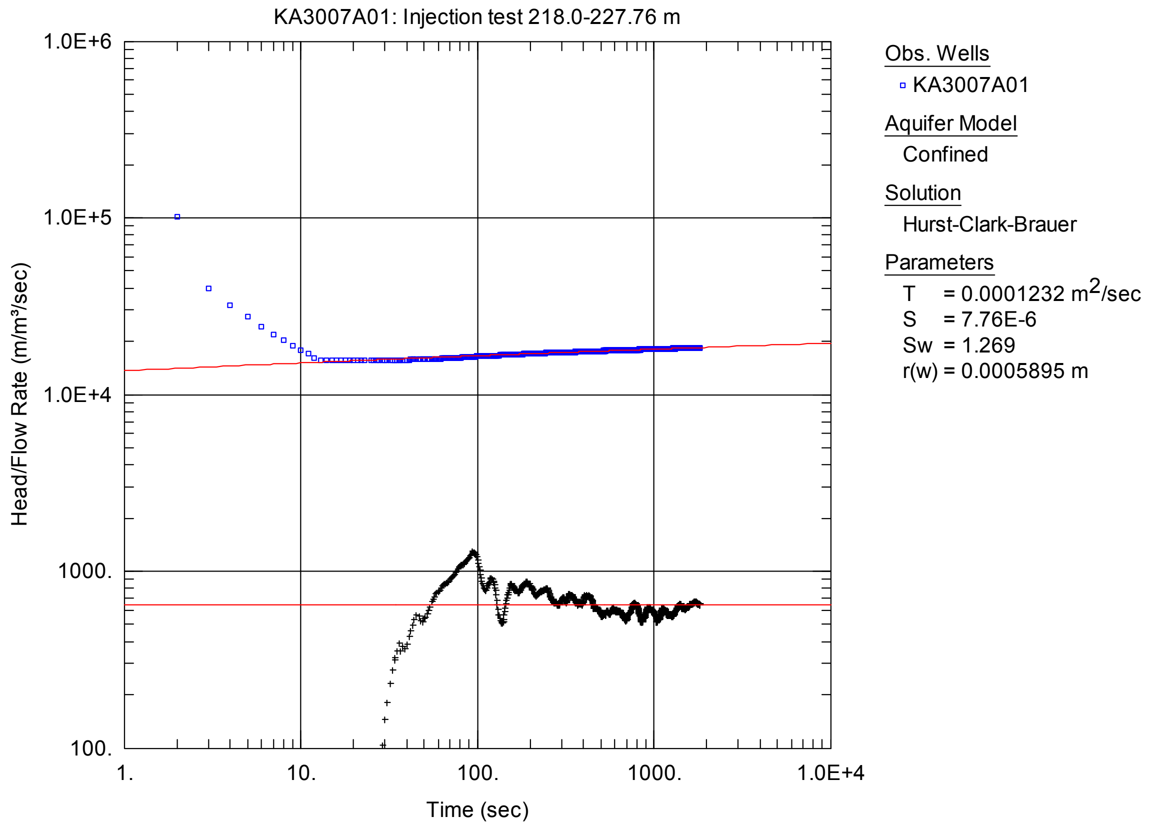

KA3007A01: Injection test 213-218 m
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.666E-6 m2/sec
S = 9.02E-7
r/B = 0.0038
r(w) = 0.1377 m

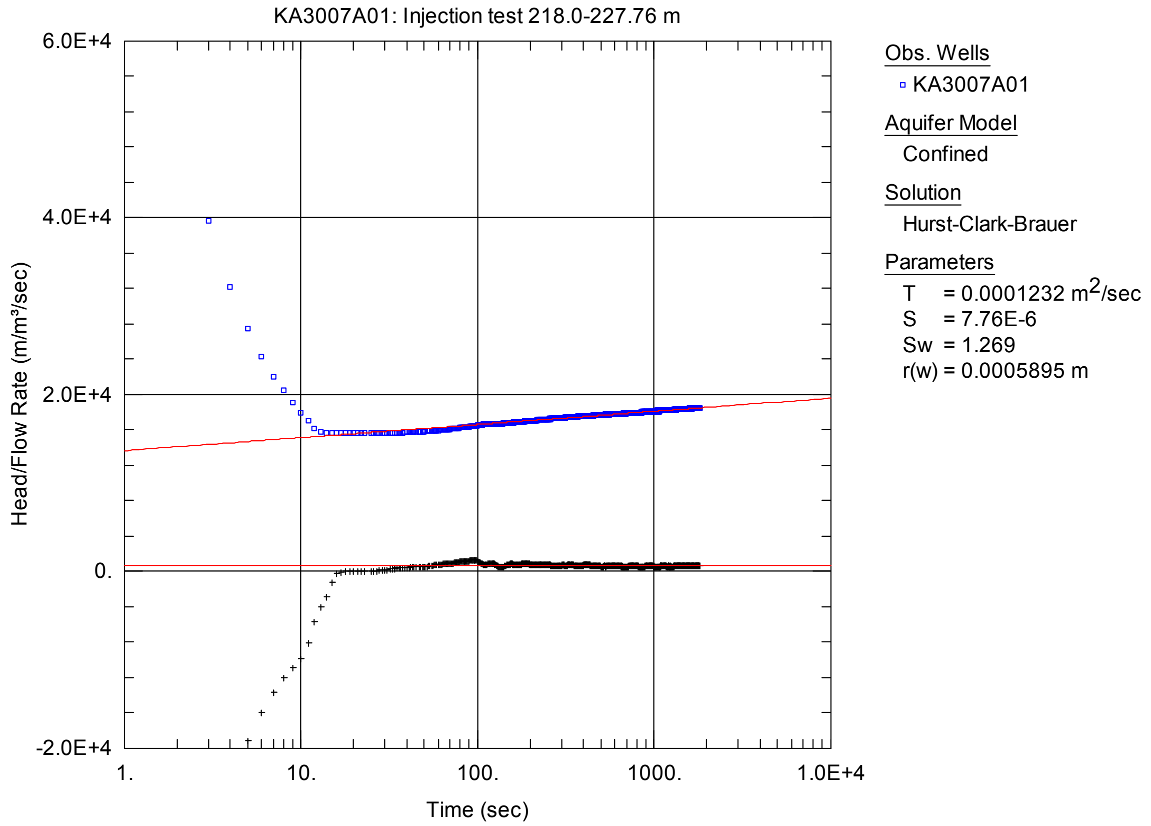

KA3007A01: Injection test 213-218 m
6.0E+5
4.0E+5
2.0E+5
0.
-2.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.666E-6 m2/sec
S = 9.02E-7
r/B = 0.0038
r(w) = 0.1377 m

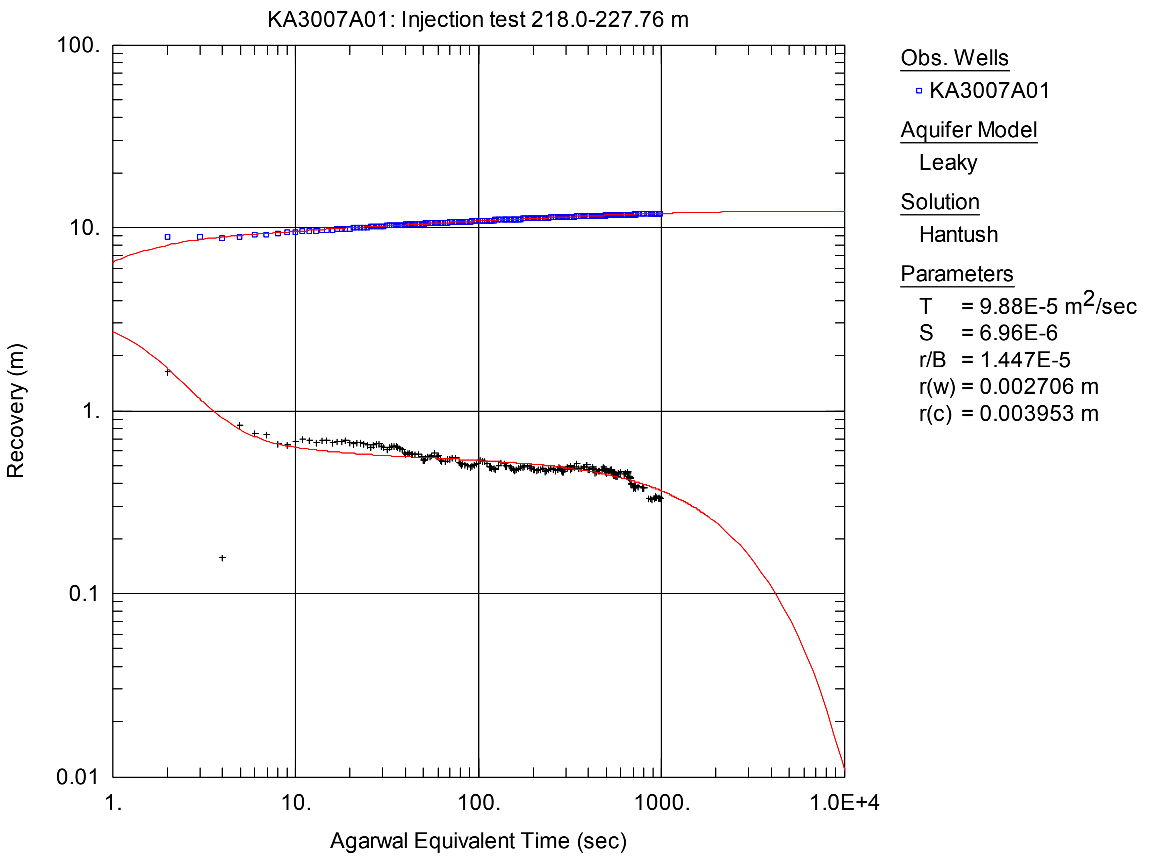

KA3007A01: Injection test 213-218 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.531E-6 m2/sec
S = 8.66E-7
r/B = 0.005798
r(w) = 0.1226 m
r(c) = 0.001599 m

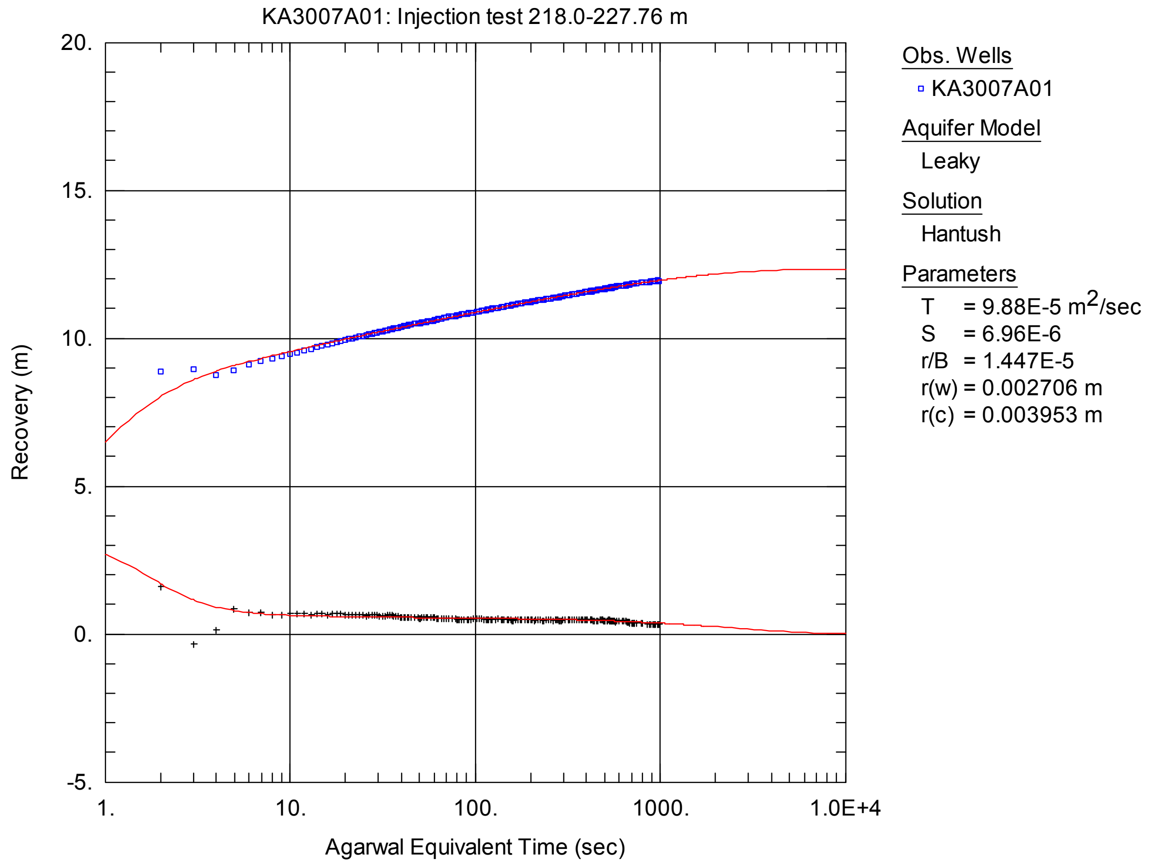

KA3007A01: Injection test 213-218 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.531E-6 m2/sec
S = 8.66E-7
r/B = 0.005798
r(w) = 0.1226 m
r(c) = 0.001599 m


KA3007A01, 218.0 - 227.76 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2011-07-03
2011-07-03
Tid


KA3007A01: Injection test 218.0-227.76 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 0.0001232 m2/sec
S = 7.76E-6
Sw = 1.269
r(w) = 0.0005895 m


KA3007A01: Injection test 218.0-227.76 m
6.0E+4
4.0E+4
2.0E+4
0.
-2.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 0.0001232 m2/sec
S = 7.76E-6
Sw = 1.269
r(w) = 0.0005895 m


KA3007A01: Injection test 218.0-227.76 m
100.
10.
1.
0.1
0.01
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.88E-5 m2/sec
S = 6.96E-6
r/B = 1.447E-5
r(w) = 0.002706 m
r(c) = 0.003953 m

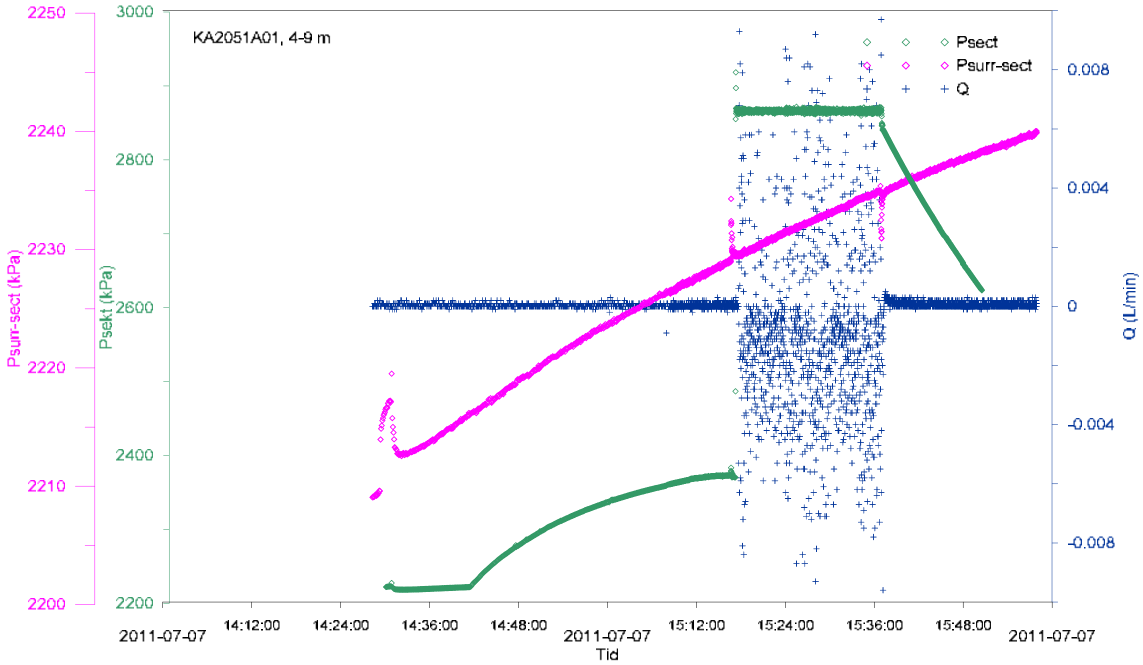


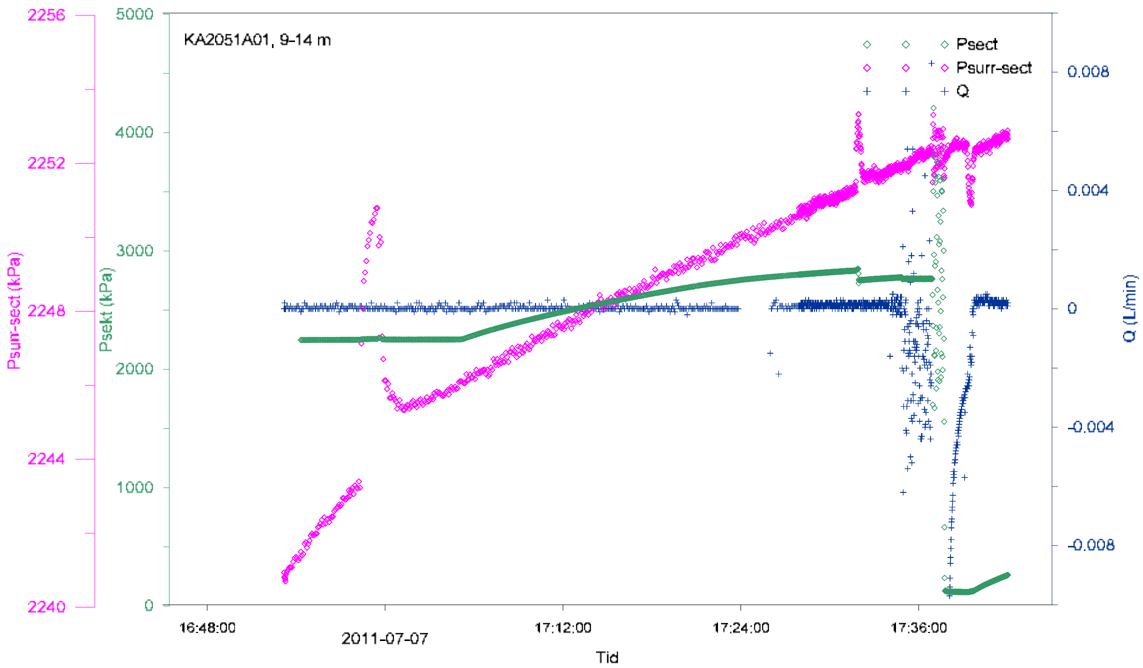
KA3007A01: Injection test 218.0-227.76 m
Recovery (m)
Agarwal Equivalent Time (sec)
20.
15.
10.
5.
0.
-5.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA3007A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.88E-5 m2/sec
S = 6.96E-6
r/B = 1.447E-5
r(w) = 0.002706 m
r(c) = 0.003953 m

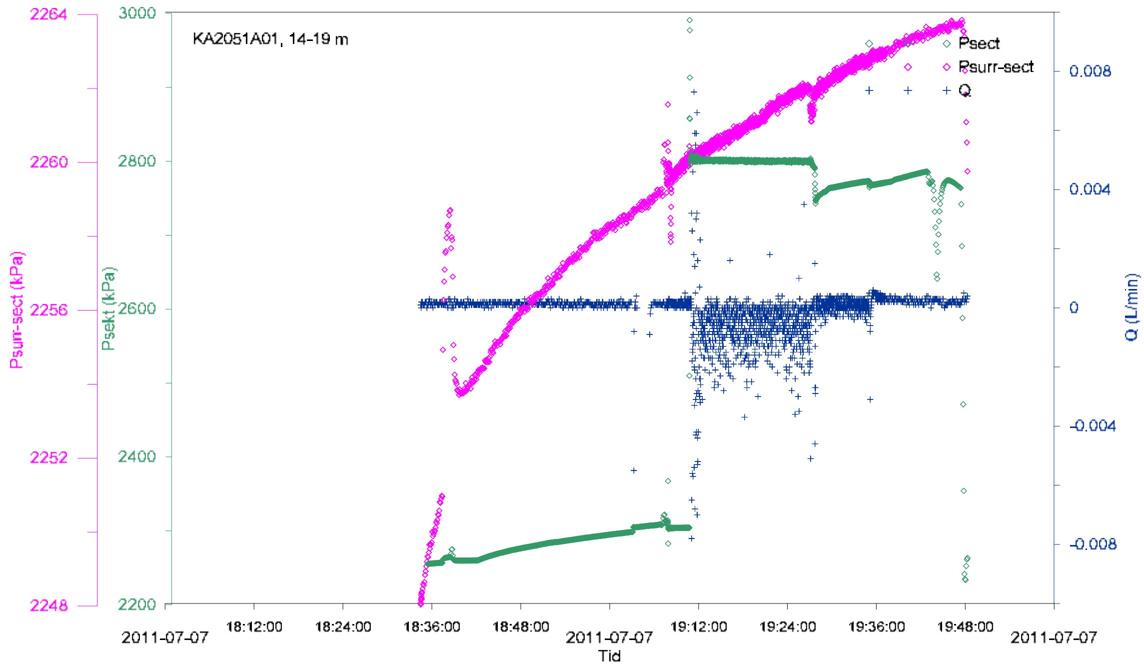
A3.2 Test diagrams – Injection tests KA2051A01

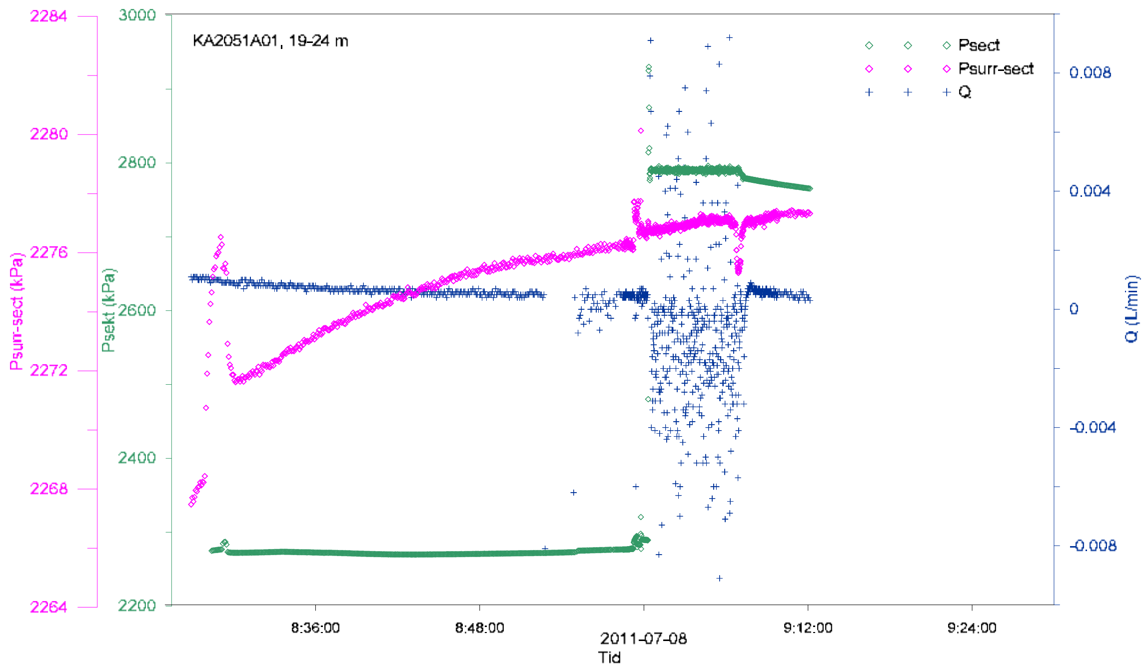
In general, one linear diagram showing the entire test sequence together with lin-log and log-log diagrams from the injection and recovery periods, respectively, are presented for the injection tests. From the injection period, the (reciprocal) flow rate versus time is plotted in log-log and lin-log diagrams together with the corresponding derivative. From the recovery period, the pressure is plotted versus Agarwal equivalent time in lin-log and log-log diagrams, respectively, together with the corresponding derivative.

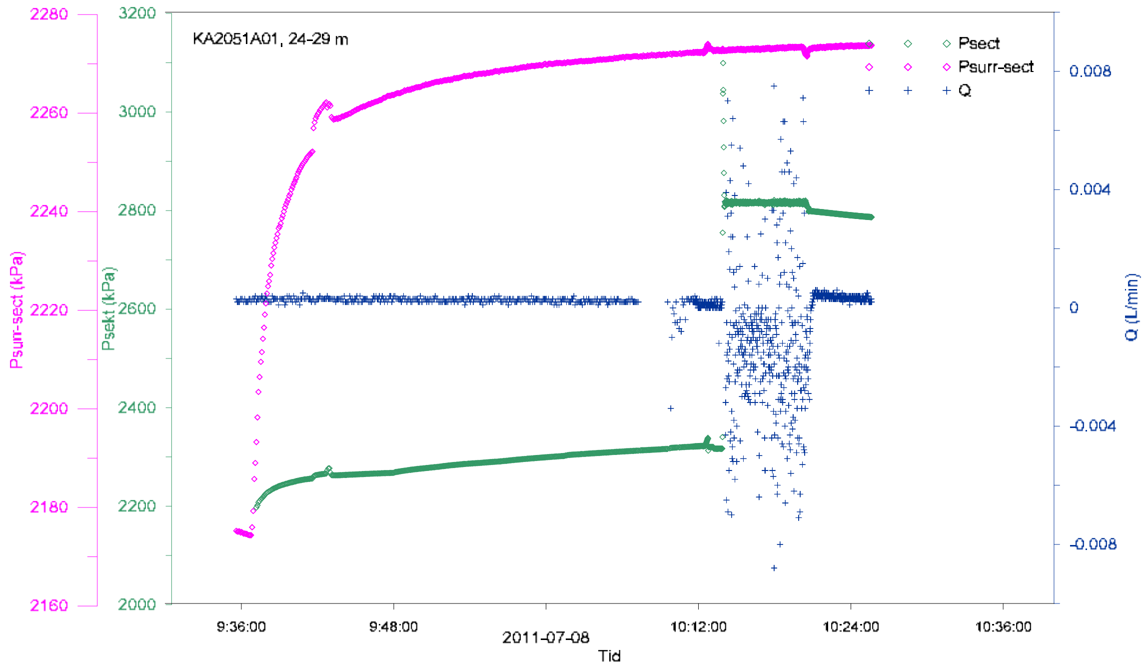
Diagrams are presented in borehole position order. Borehole, test section and test period are given by the headline in each figure. Special information is given for some figures in comments below the figure.

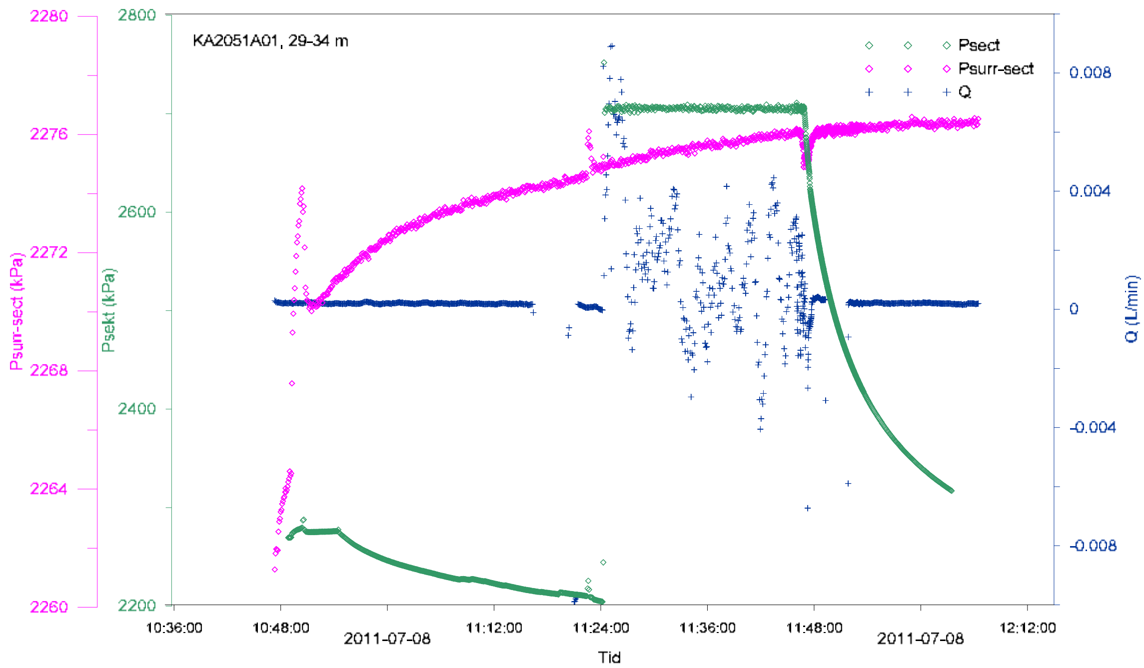


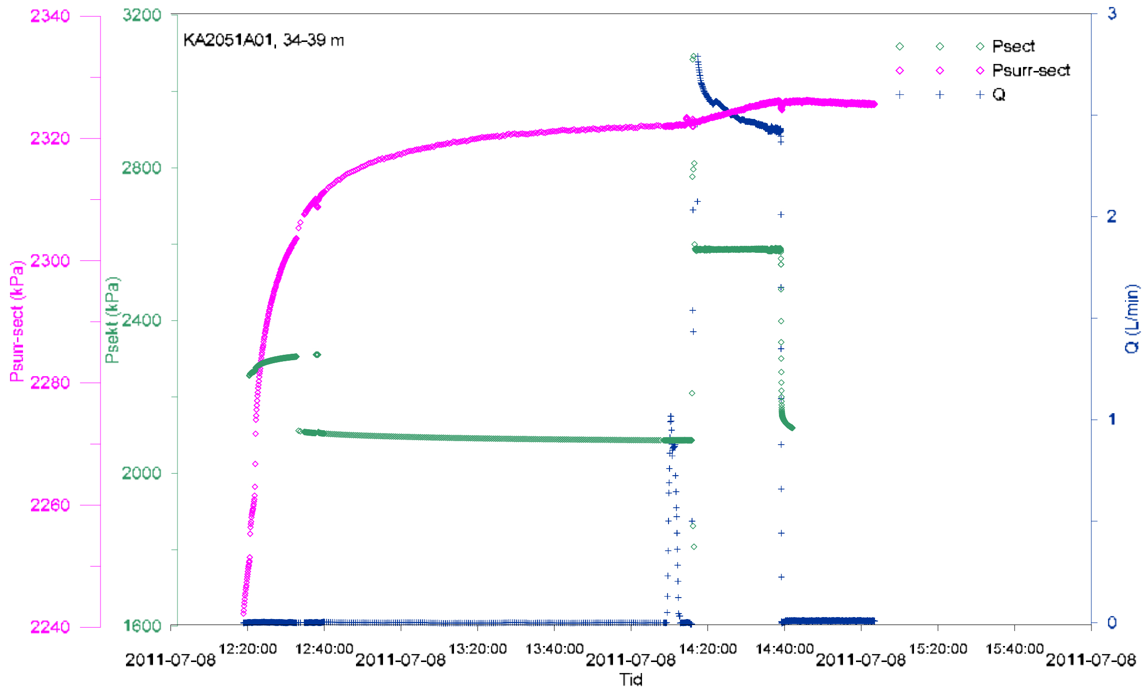


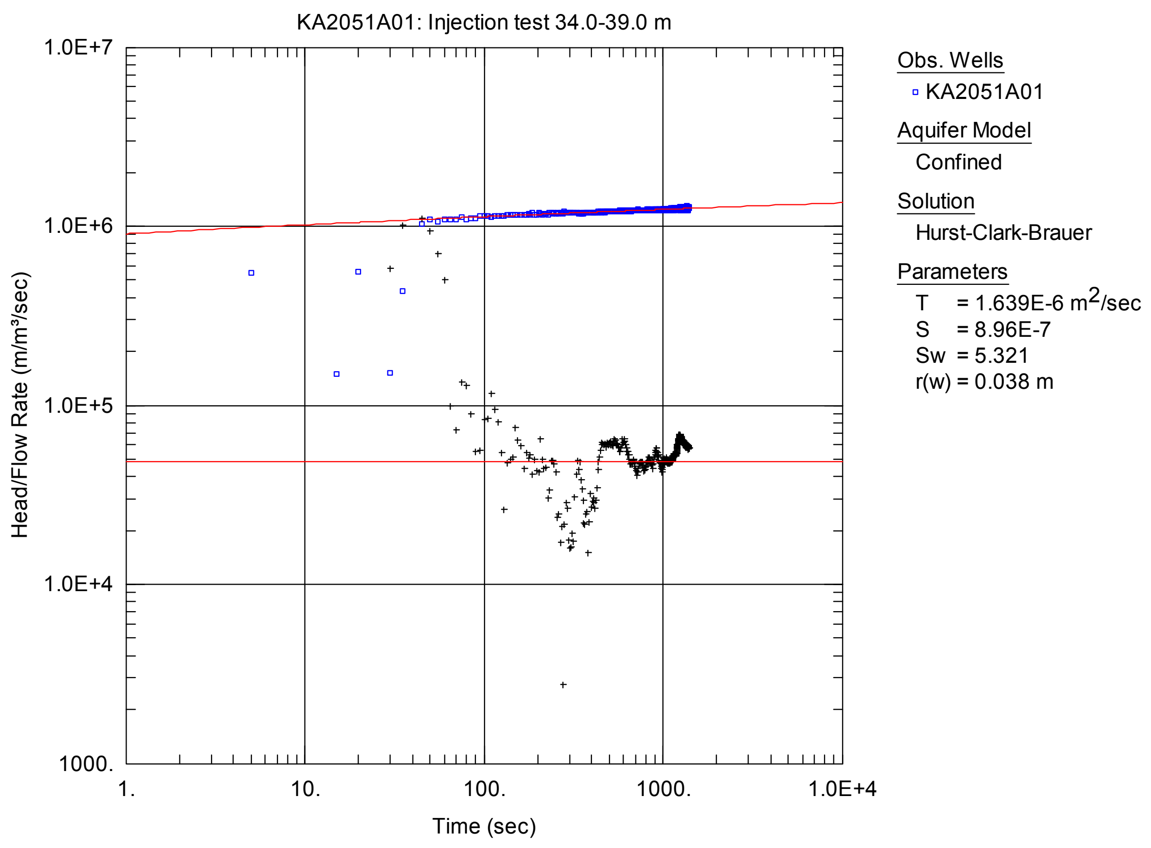

KA2051A01, 14-19 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-07
18:12:00
18:24:00
18:36:00
18:48:00
2011-07-07
19:12:00
19:24:00
19:36:00
19:48:00
2011-07-07

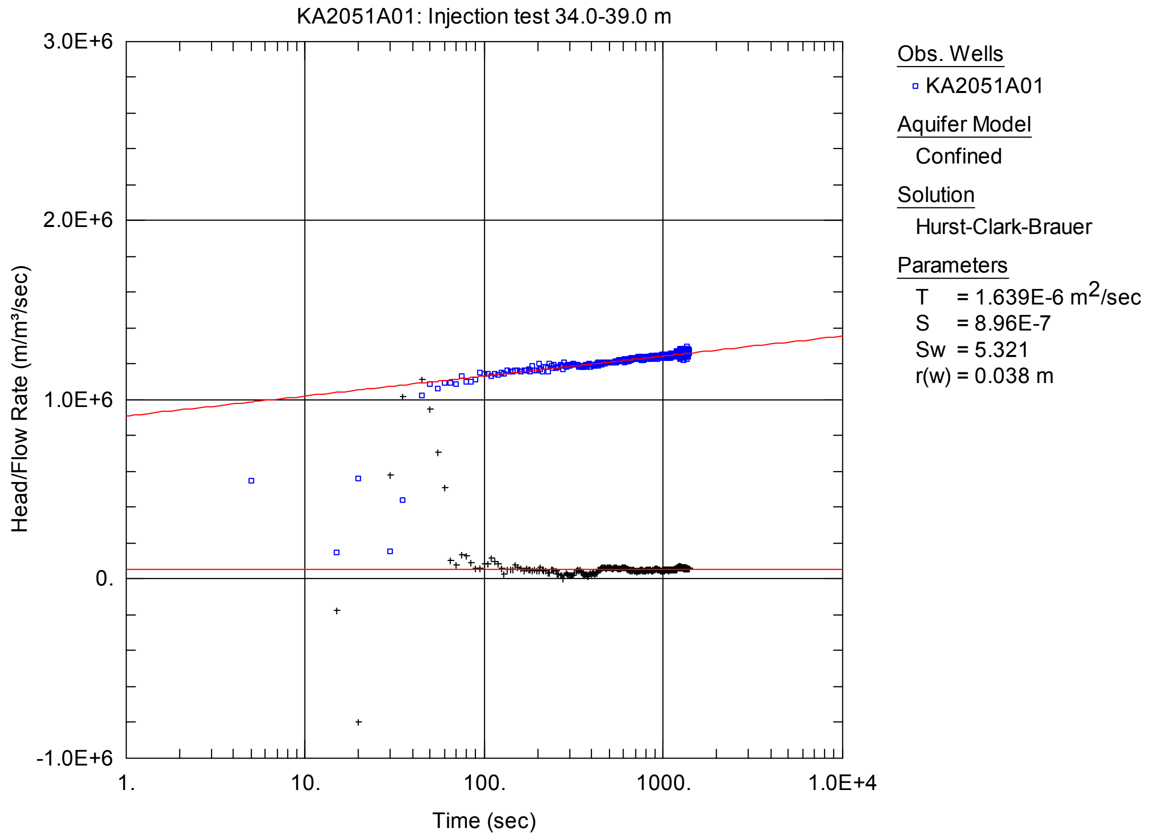

KA2051A01, 19-24 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
8:36:00
8:48:00
2011-07-08
9:12:00
9:24:00

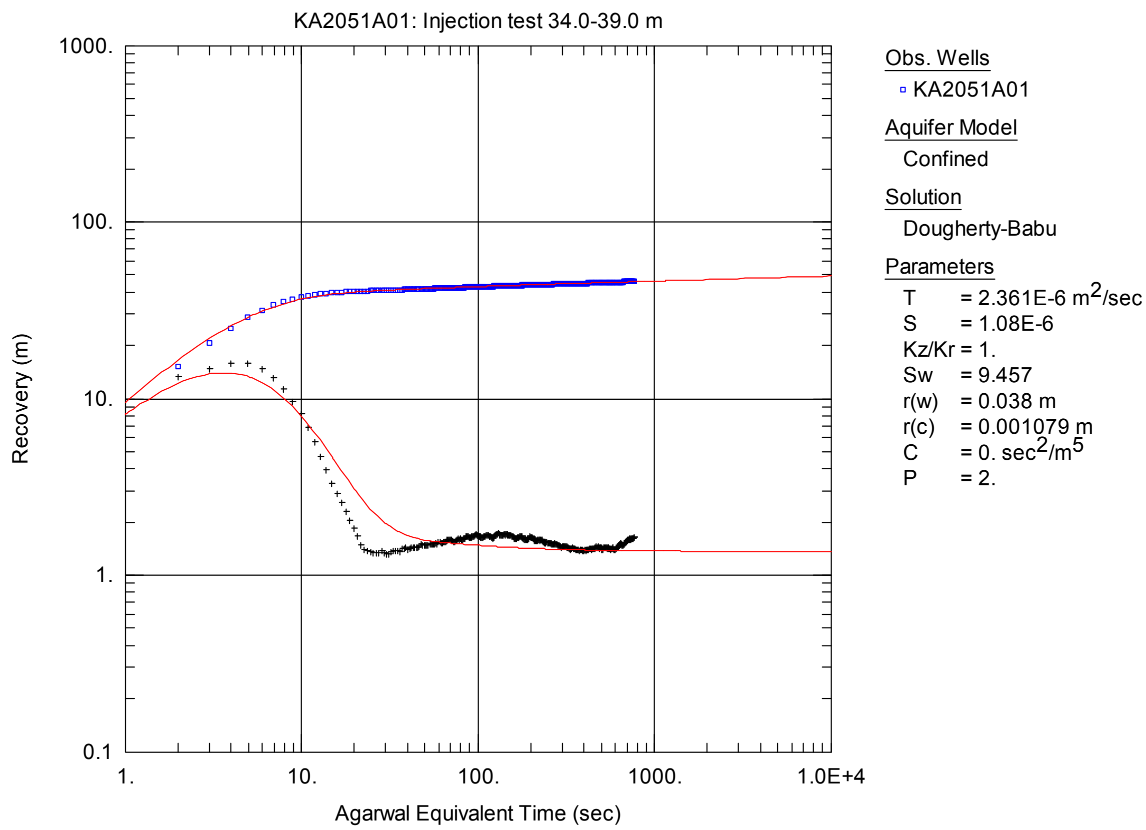

KA2051A01, 24-29 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2280
2260
2240
2220
2200
2180
2160
3200
3000
2800
2600
2400
2200
2000
0.008
0.004
0
-0.004
-0.008
9:36:00
9:48:00
2011-07-08
10:12:00
10:24:00
10:36:00
Tid

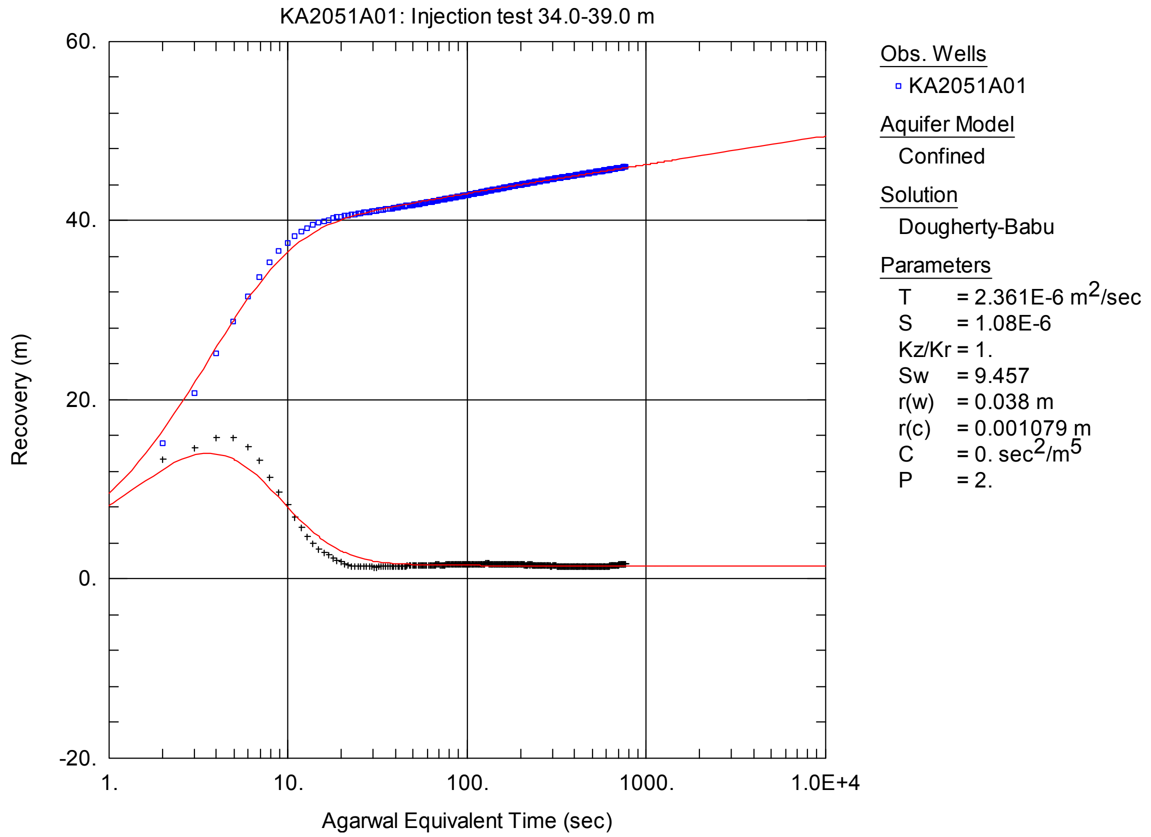

KA2051A01, 29-34 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2280
2276
2272
2268
2264
2260
2800
2600
2400
2200
0.008
0.004
0
-0.004
-0.008
10:36:00
10:48:00
2011-07-08
11:12:00
11:24:00
11:36:00
11:48:00
2011-07-08
12:12:00
Tid

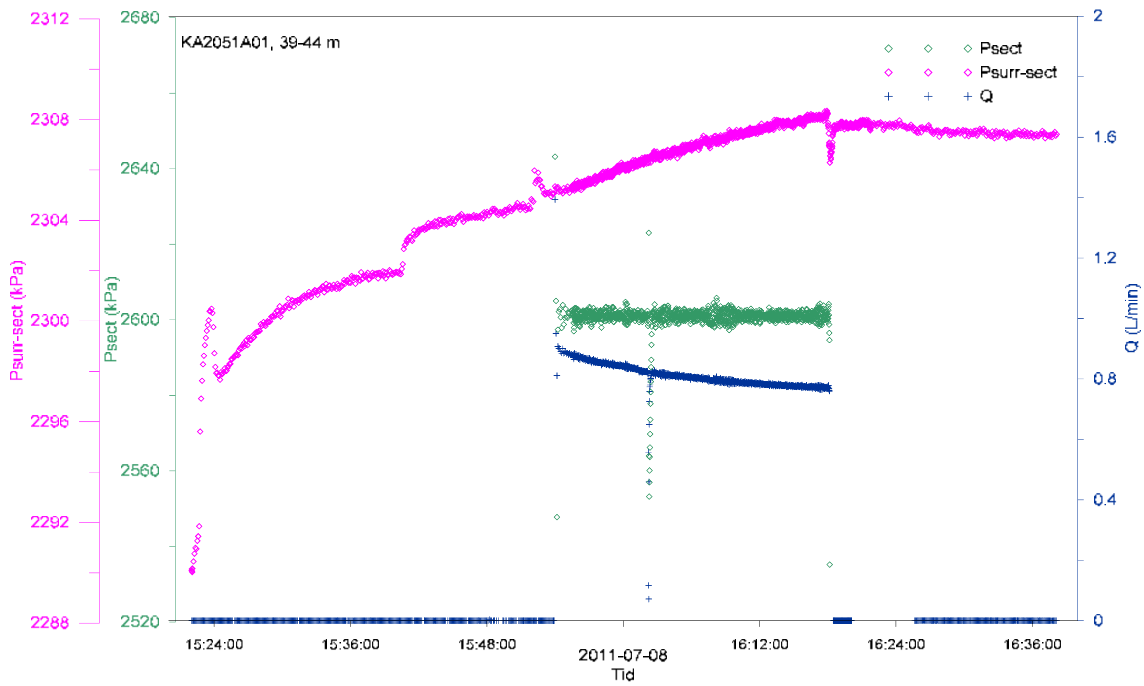

KA2051A01, 34-39 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2340
2320
2300
2280
2260
2240
3200
2800
2400
2000
1600
3
2
1
0
2011-07-08
12:20:00
12:40:00
13:20:00
13:40:00
14:20:00
14:40:00
15:20:00
15:40:00

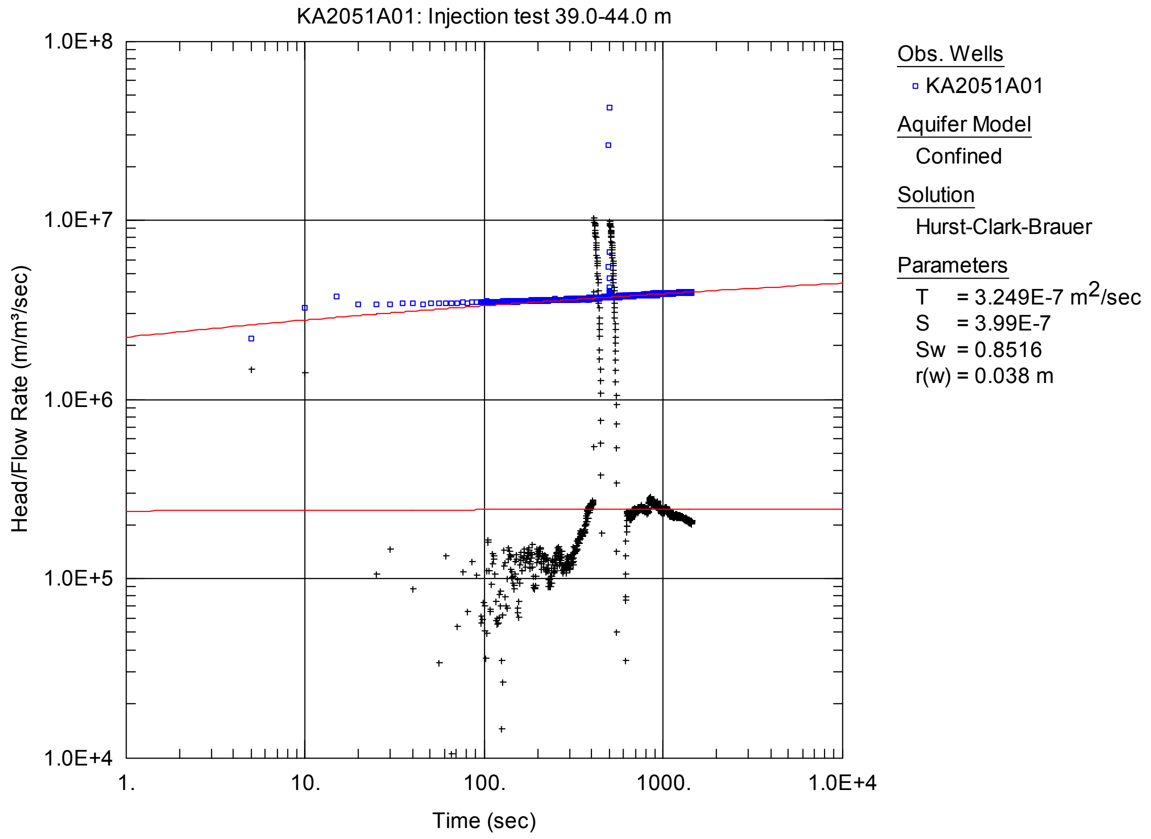

KA2051A01: Injection test 34.0-39.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.639E-6 m2/sec
S = 8.96E-7
Sw = 5.321
r(w) = 0.038 m

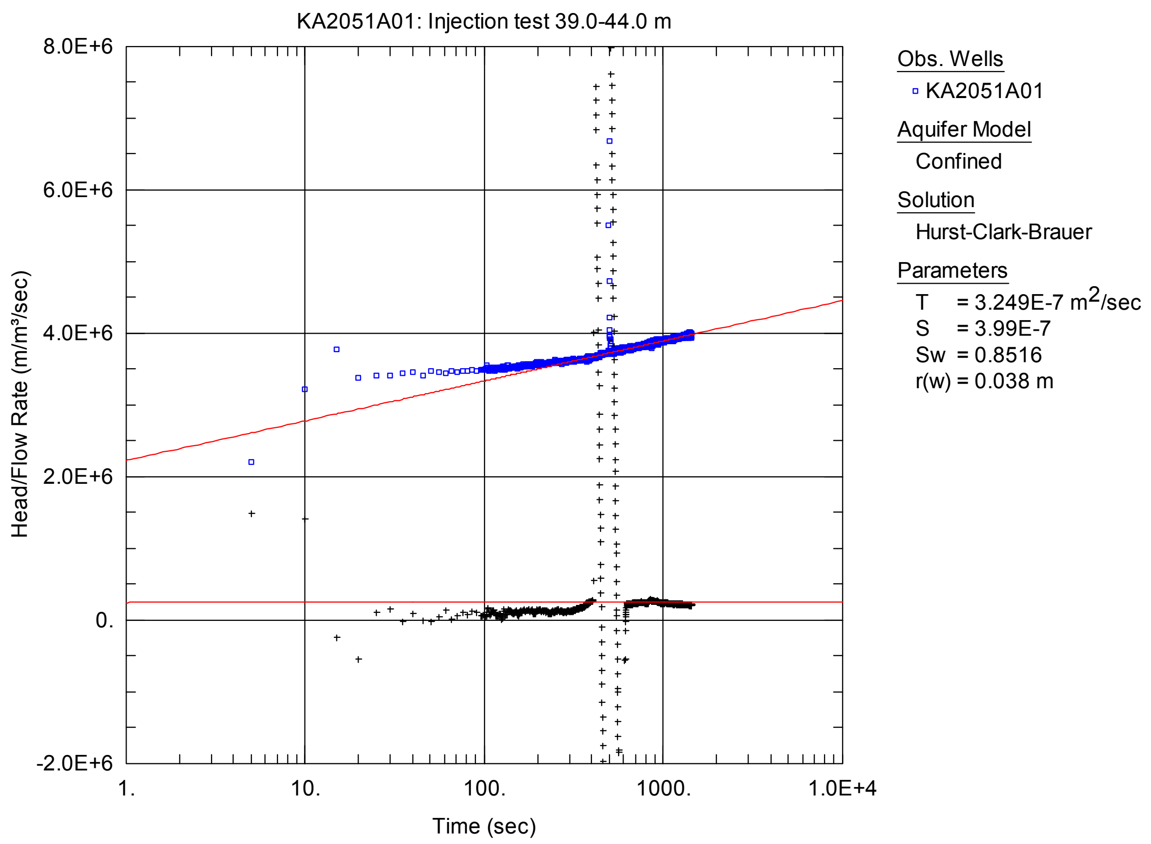

KA2051A01: Injection test 34.0-39.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
3.0E+6
2.0E+6
1.0E+6
0.
-1.0E+6
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.639E-6 m2/sec
S = 8.96E-7
Sw = 5.321
r(w) = 0.038 m

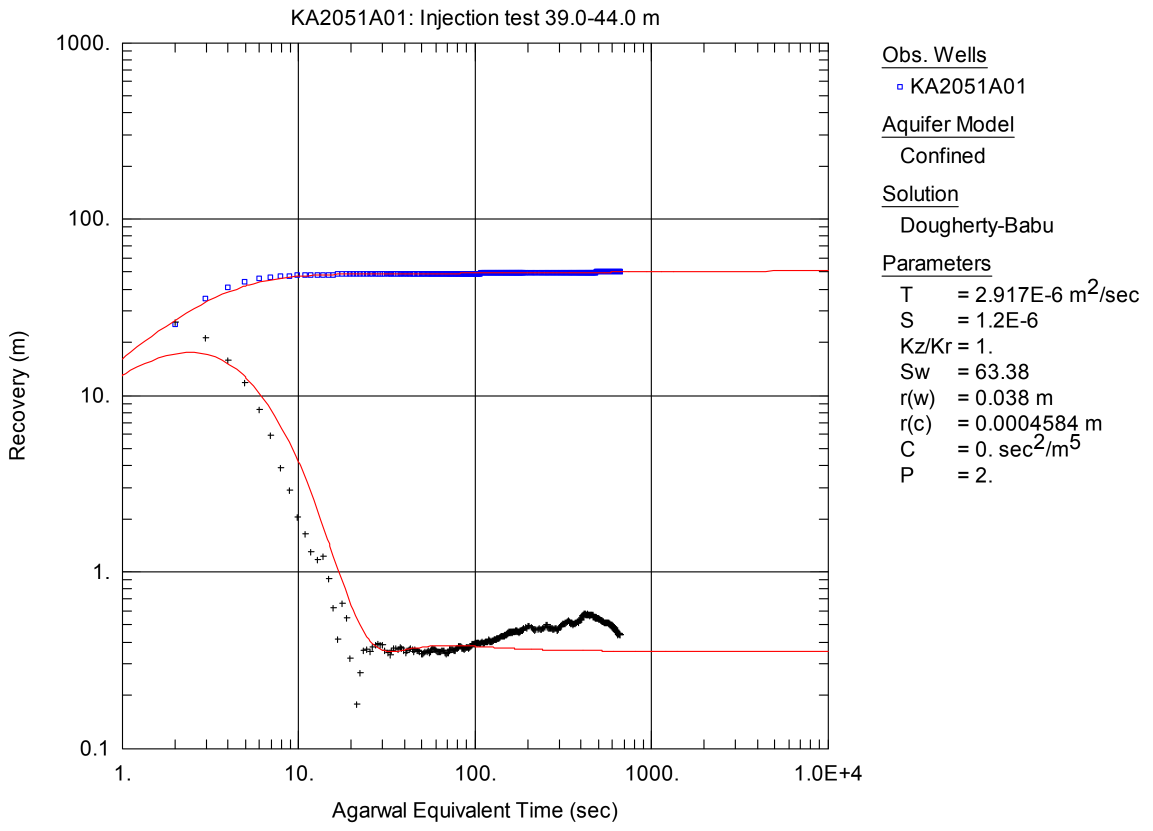

KA2051A01: Injection test 34.0-39.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.361E-6 m2/sec
S = 1.08E-6
Kz/Kr = 1.
Sw = 9.457
r(w) = 0.038 m
r(c) = 0.001079 m
C = 0. sec2/m5
P = 2.

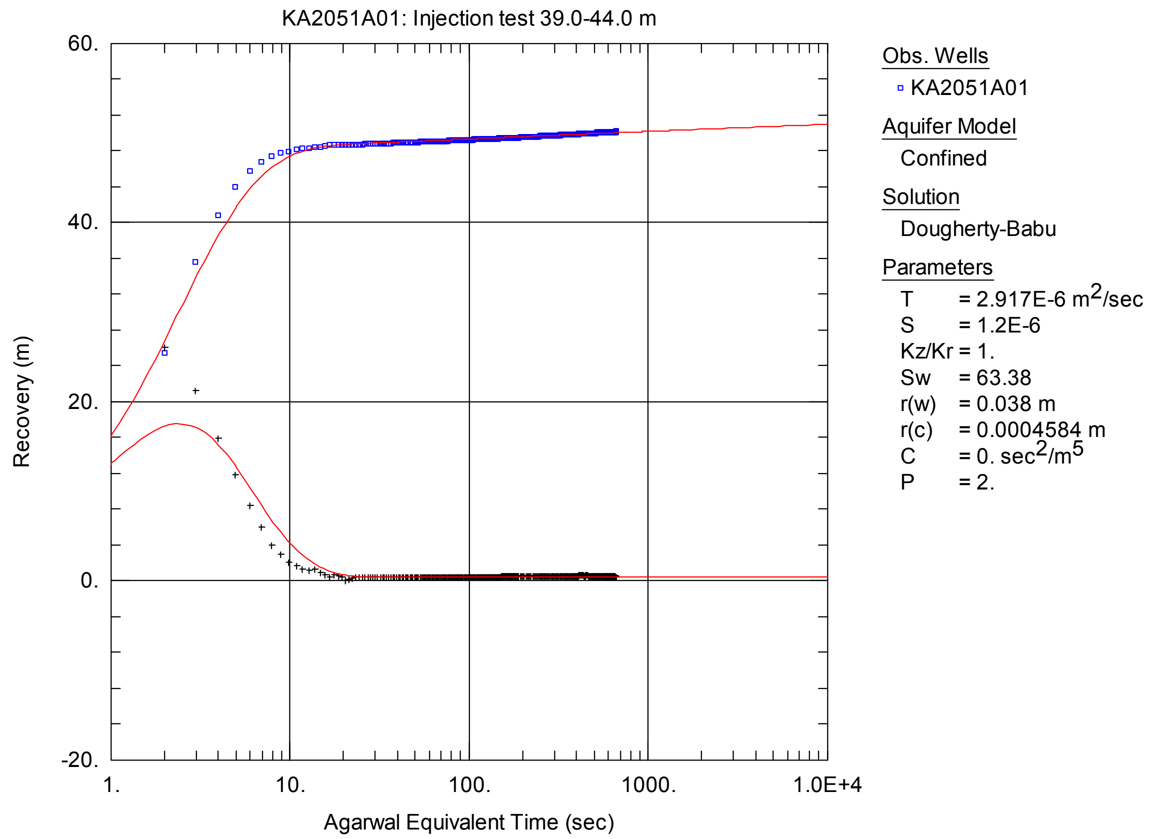

KA2051A01: Injection test 34.0-39.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.361E-6 m2/sec
S = 1.08E-6
Kz/Kr = 1.
Sw = 9.457
r(w) = 0.038 m
r(c) = 0.001079 m
C = 0. sec2/m5
P = 2.

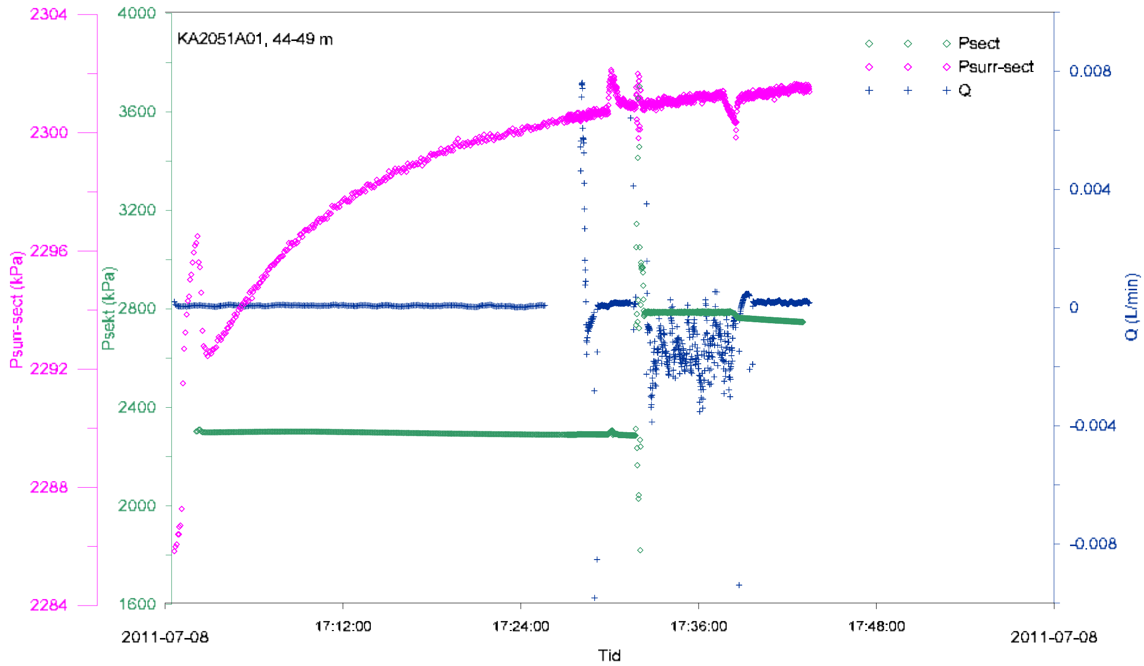

KA2051A01, 39-44 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2312
2308
2304
2300
2296
2292
2288
2680
2640
2600
2560
2520
2
1.6
1.2
0.8
0.4
0
15:24:00
15:36:00
15:48:00
2011-07-08
Tid
16:12:00
16:24:00
16:36:00


KA2051A01: Injection test 39.0-44.0 m
Head/Flow Rate (m/m³/sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.249E-7 m2/sec
S = 3.99E-7
Sw = 0.8516
r(w) = 0.038 m

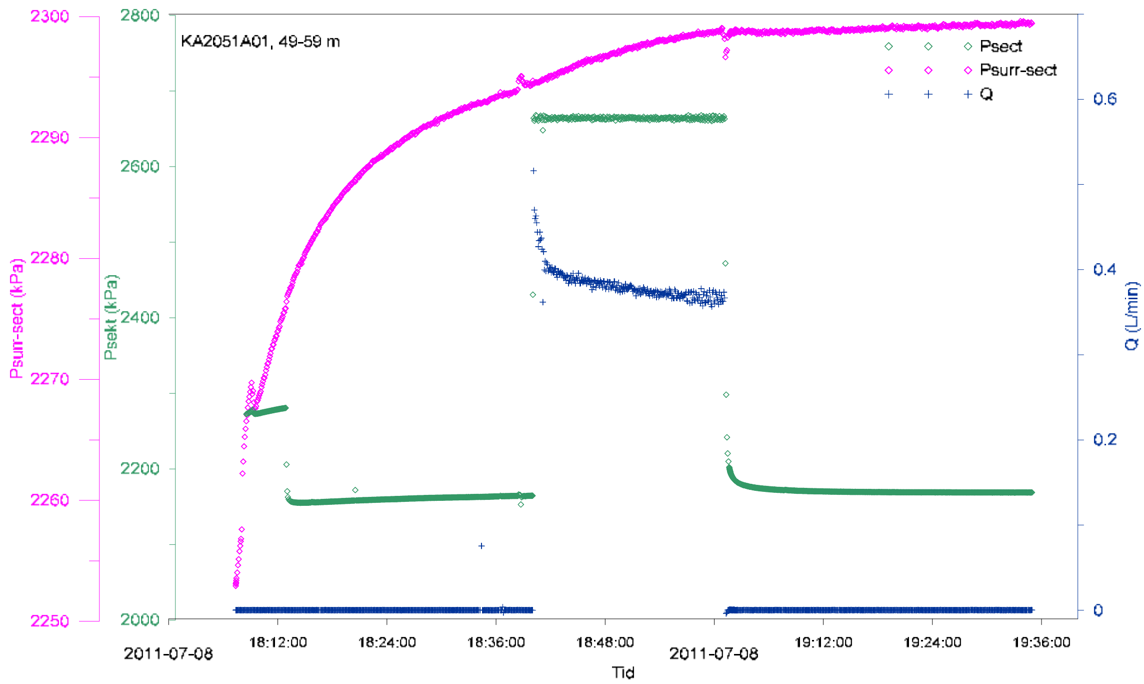

KA2051A01: Injection test 39.0-44.0 m
Head/Flow Rate (m/m³/sec)
8.0E+6
6.0E+6
4.0E+6
2.0E+6
0.
-2.0E+6
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.249E-7 m2/sec
S = 3.99E-7
Sw = 0.8516
r(w) = 0.038 m


KA2051A01: Injection test 39.0-44.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.917E-6 m2/sec
S = 1.2E-6
Kz/Kr = 1.
Sw = 63.38
r(w) = 0.038 m
r(c) = 0.0004584 m
C = 0. sec2/m5
P = 2.

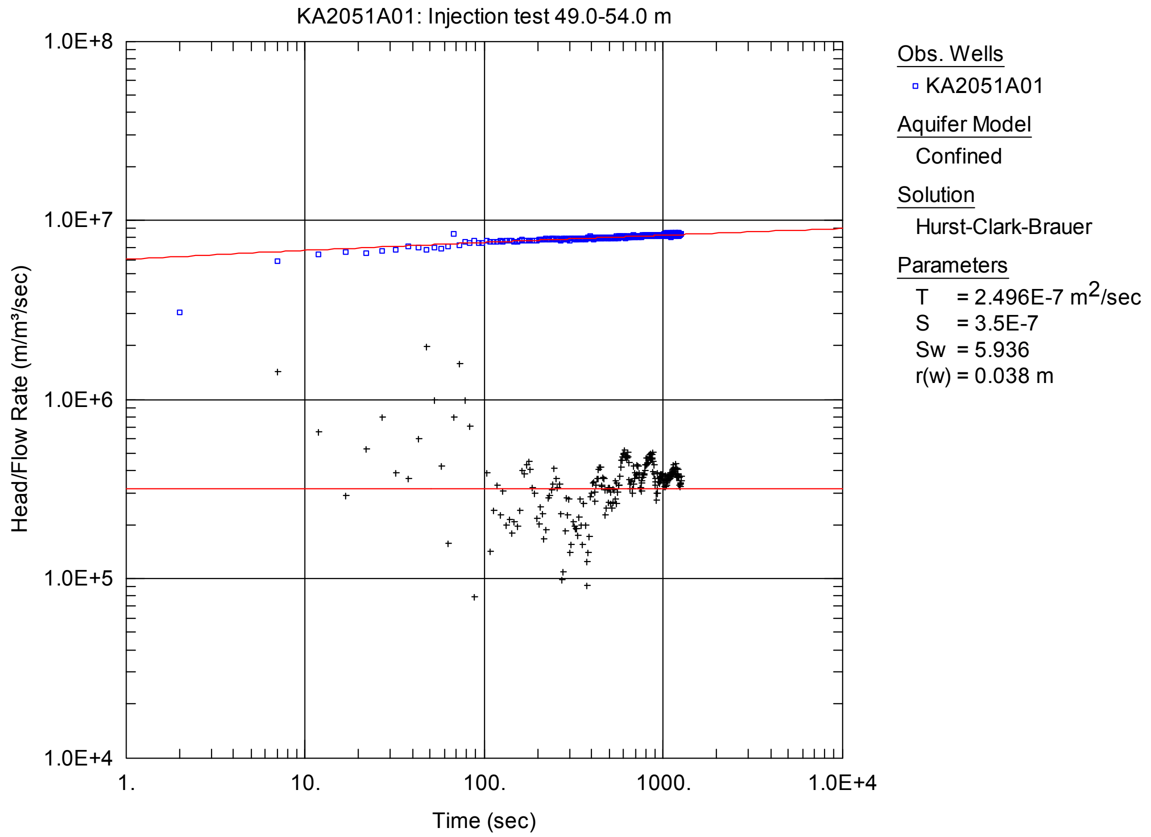

KA2051A01: Injection test 39.0-44.0 m
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.917E-6 m2/sec
S = 1.2E-6
Kz/Kr = 1.
Sw = 63.38
r(w) = 0.038 m
r(c) = 0.0004584 m
C = 0. sec2/m5
P = 2.

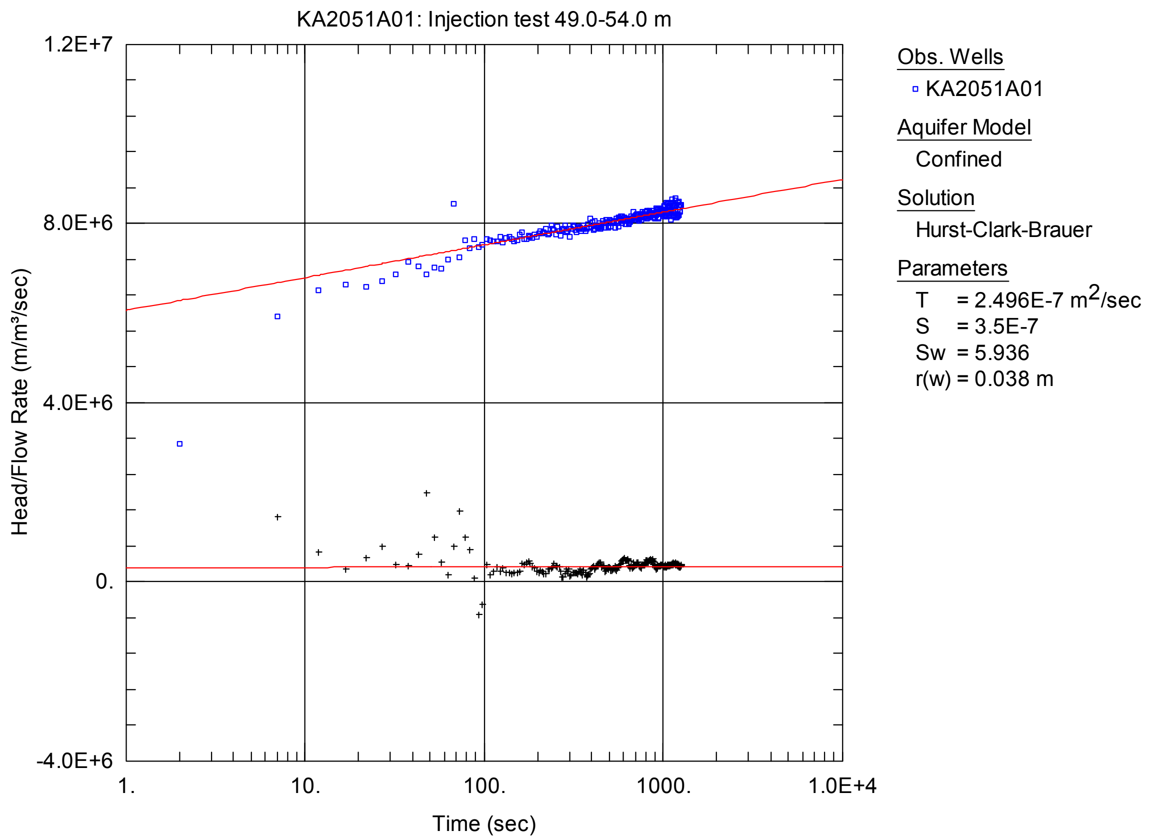


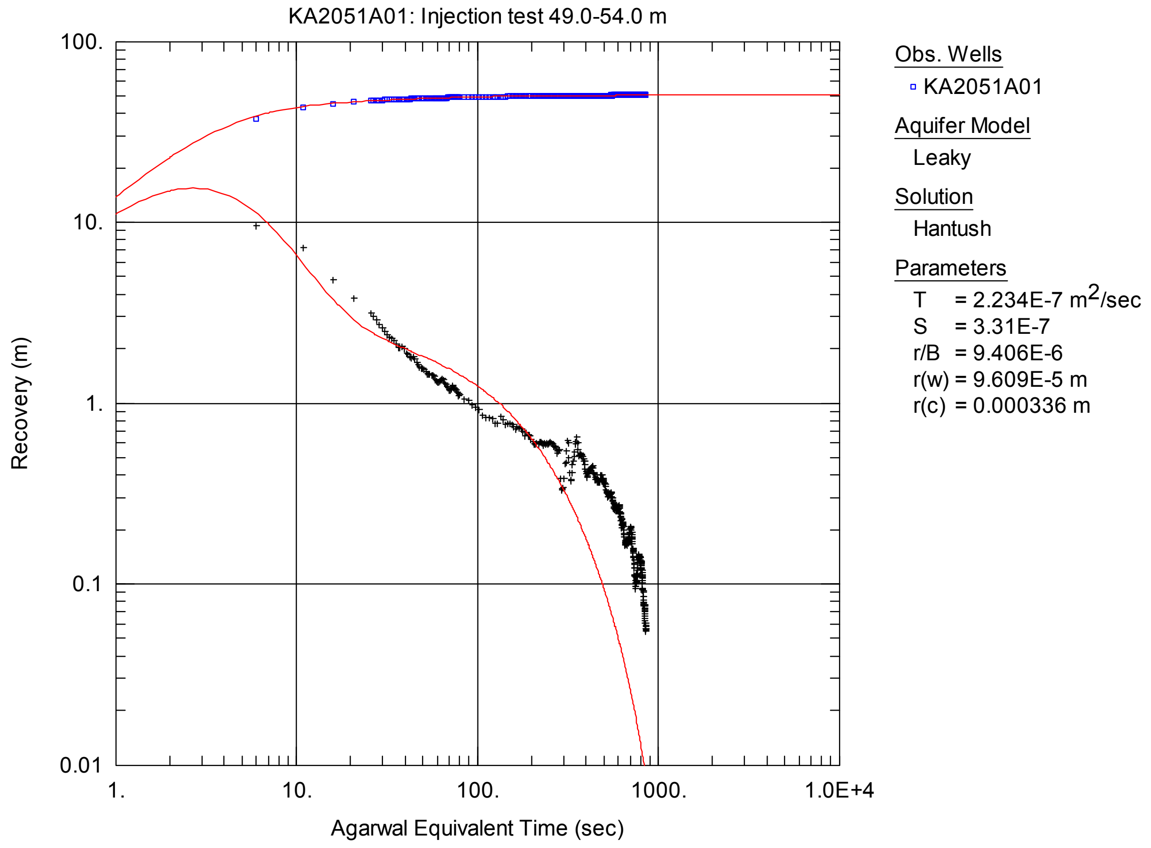
KA2051A01, 44-49 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-08
17:12:00
17:24:00
17:36:00
17:48:00
2011-07-08

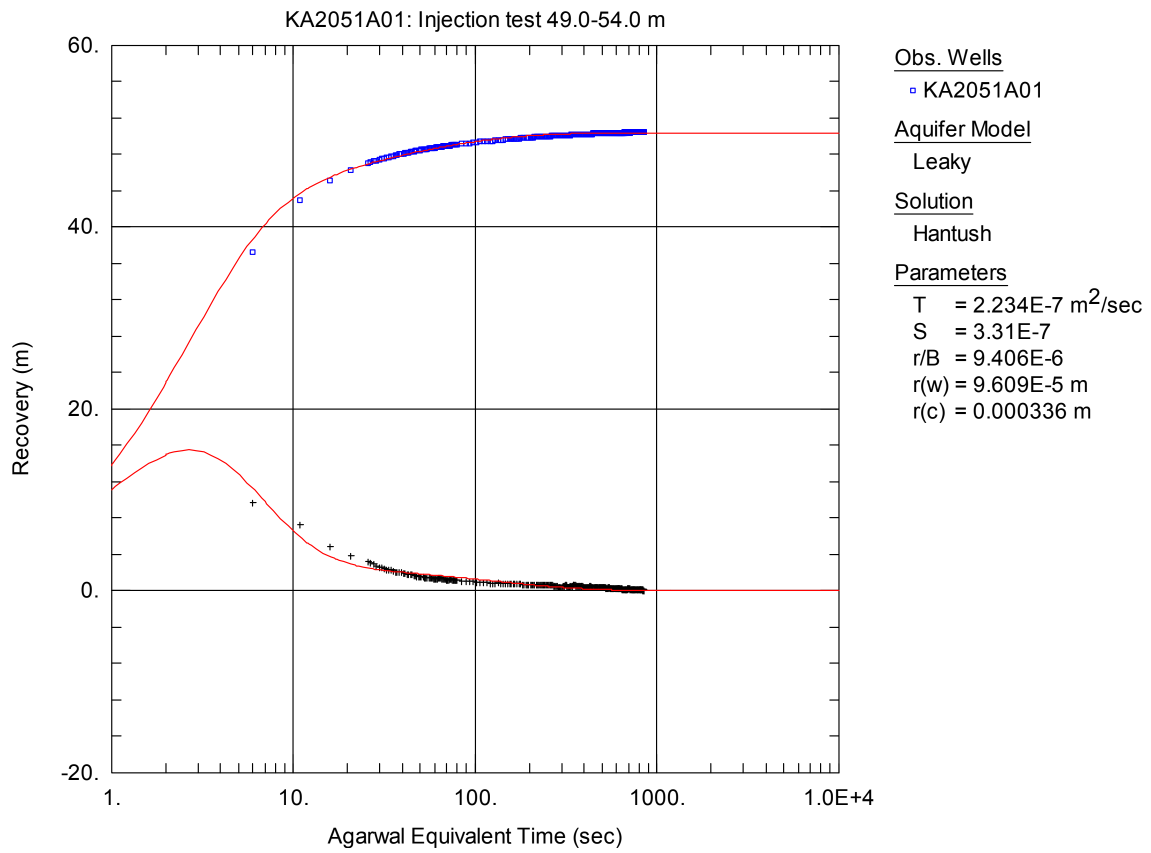


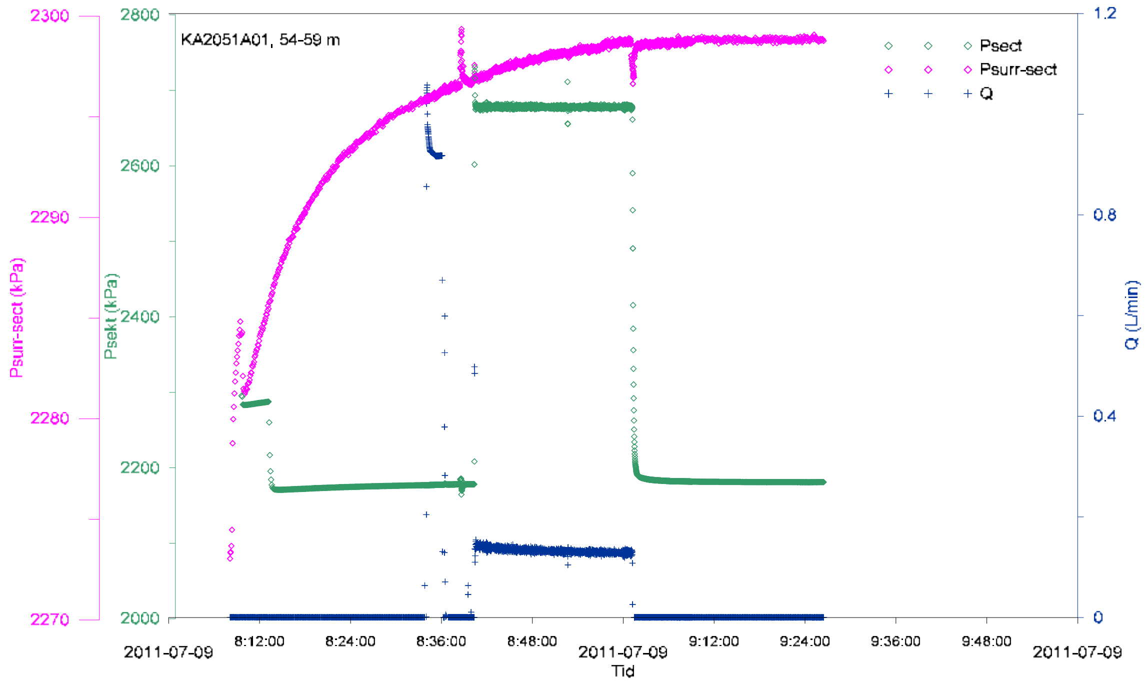
KA2051A01, 49-59 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-08
18:12:00
18:24:00
18:36:00
18:48:00
2011-07-08
19:12:00
19:24:00
19:36:00

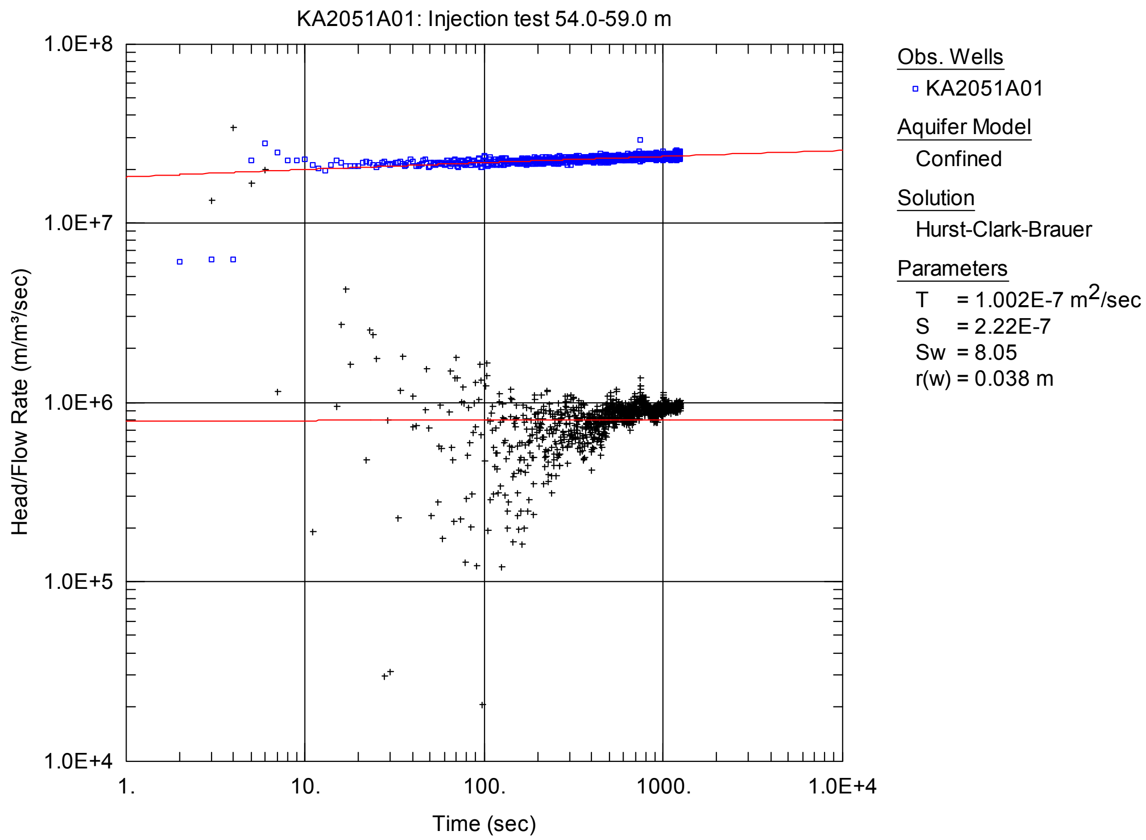

KA2051A01: Injection test 49.0-54.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.496E-7 m2/sec
S = 3.5E-7
Sw = 5.936
r(w) = 0.038 m

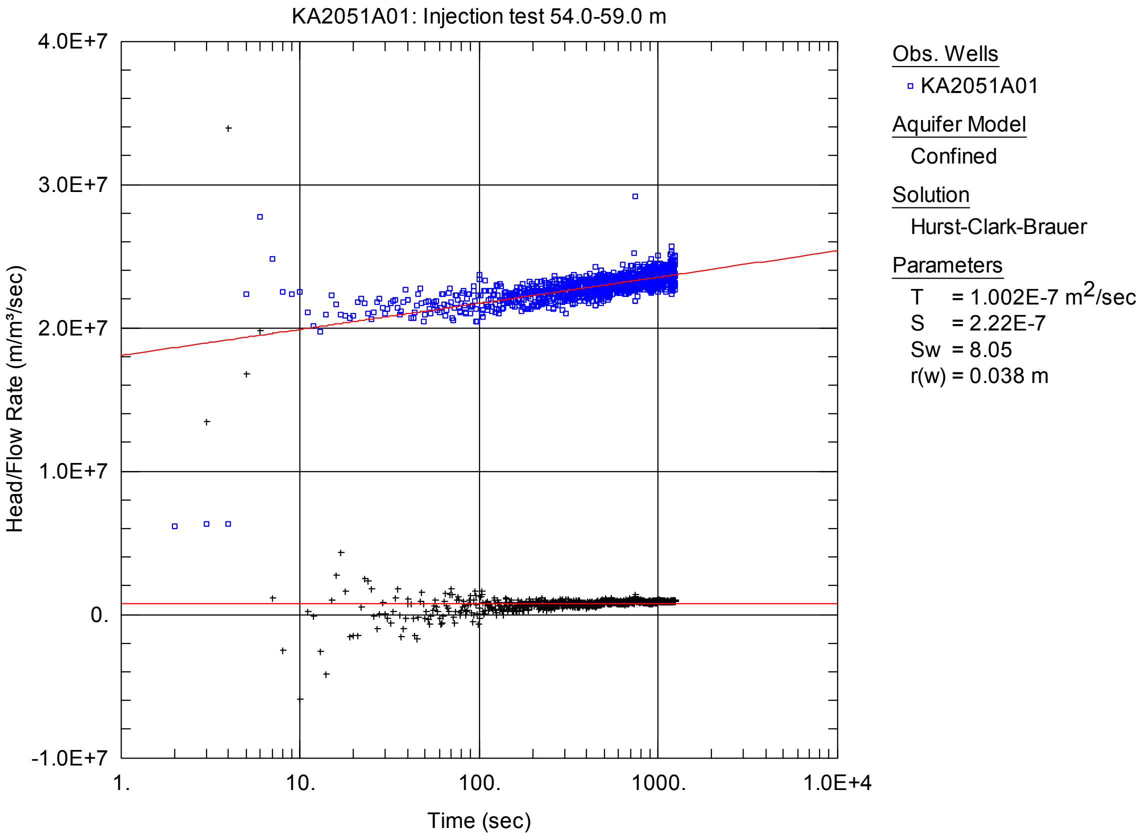

KA2051A01: Injection test 49.0-54.0 m
1.2E+7
8.0E+6
4.0E+6
0.
-4.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.496E-7 m2/sec
S = 3.5E-7
Sw = 5.936
r(w) = 0.038 m

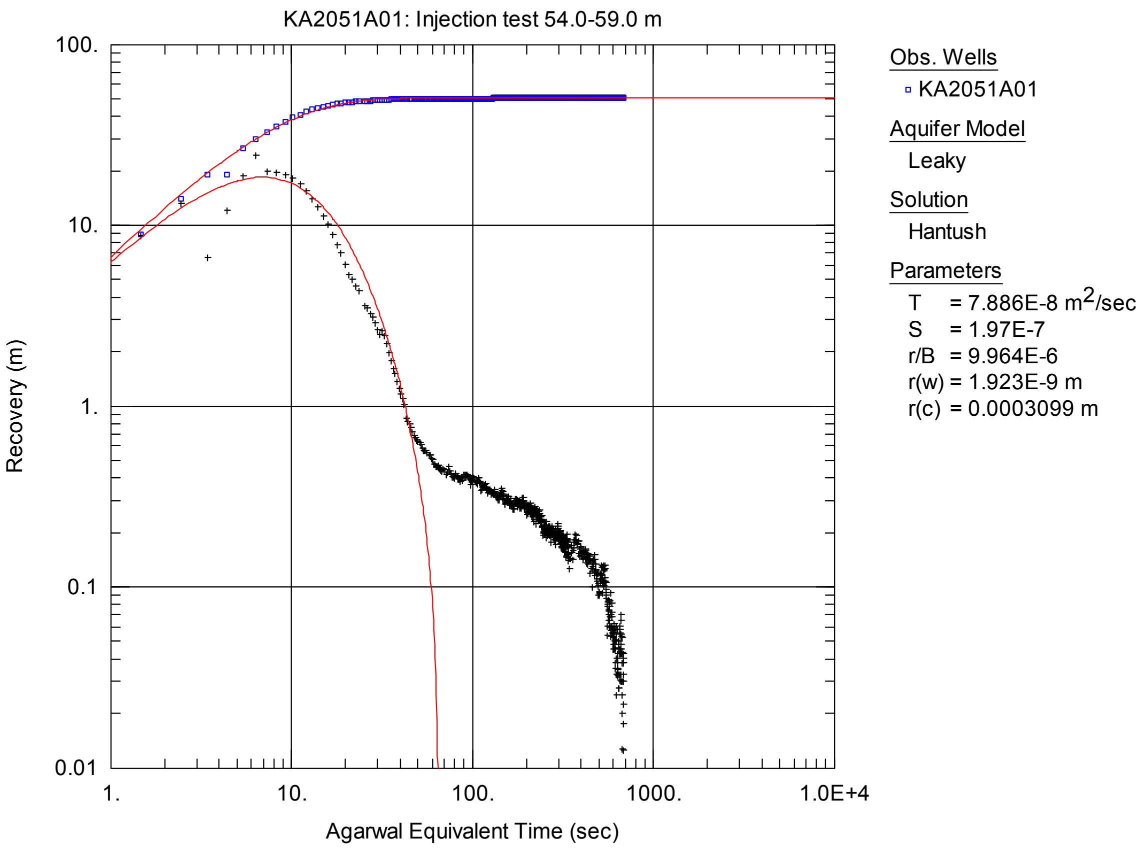

KA2051A01: Injection test 49.0-54.0 m
100.
10.
1.
0.1
0.01
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.234E-7 m2/sec
S = 3.31E-7
r/B = 9.406E-6
r(w) = 9.609E-5 m
r(c) = 0.000336 m


KA2051A01: Injection test 49.0-54.0 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.234E-7 m2/sec
S = 3.31E-7
r/B = 9.406E-6
r(w) = 9.609E-5 m
r(c) = 0.000336 m

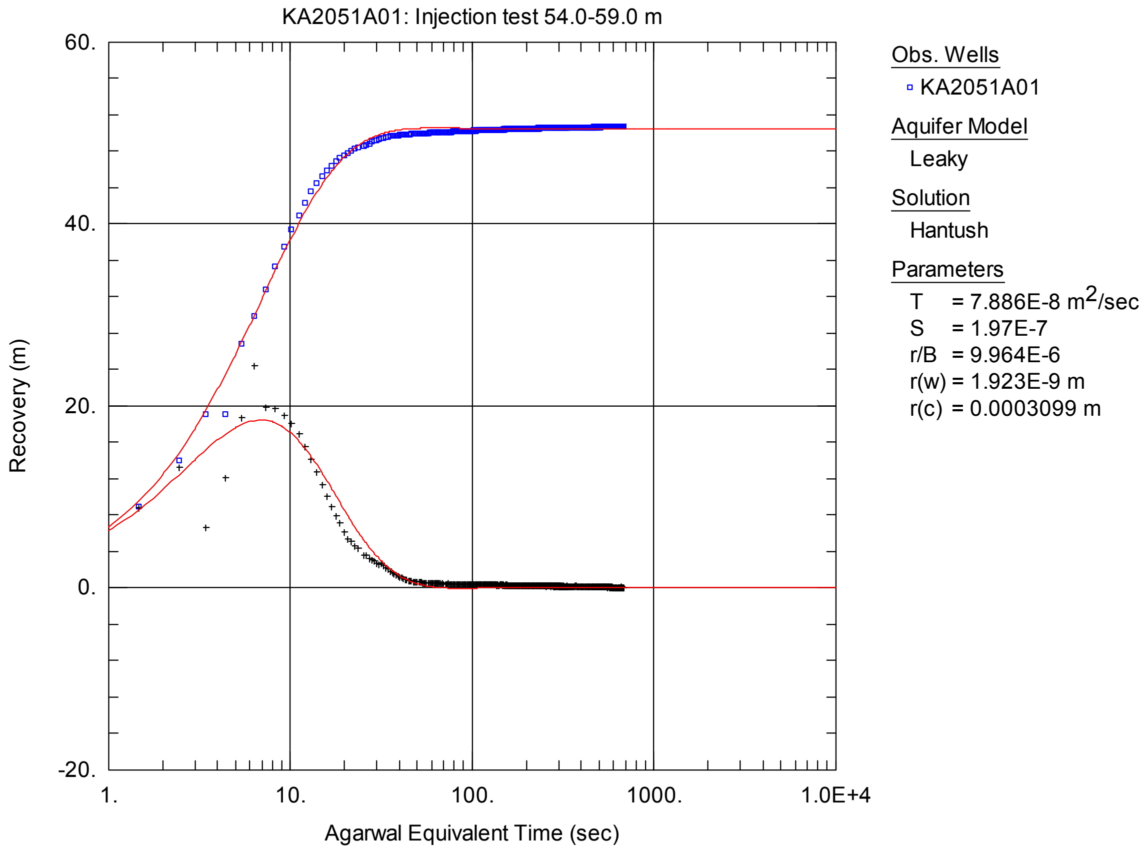

KA2051A01, 54-59 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2300
2290
2280
2270
2800
2600
2400
2200
2000
1.2
0.8
0.4
0
2011-07-09
8:12:00
8:24:00
8:36:00
8:48:00
2011-07-09
9:12:00
9:24:00
9:36:00
9:48:00
2011-07-09
Tid


KA2051A01: Injection test 54.0-59.0 m
Head/Flow Rate (m/m³/sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.002E-7 m2/sec
S = 2.22E-7
Sw = 8.05
r(w) = 0.038 m

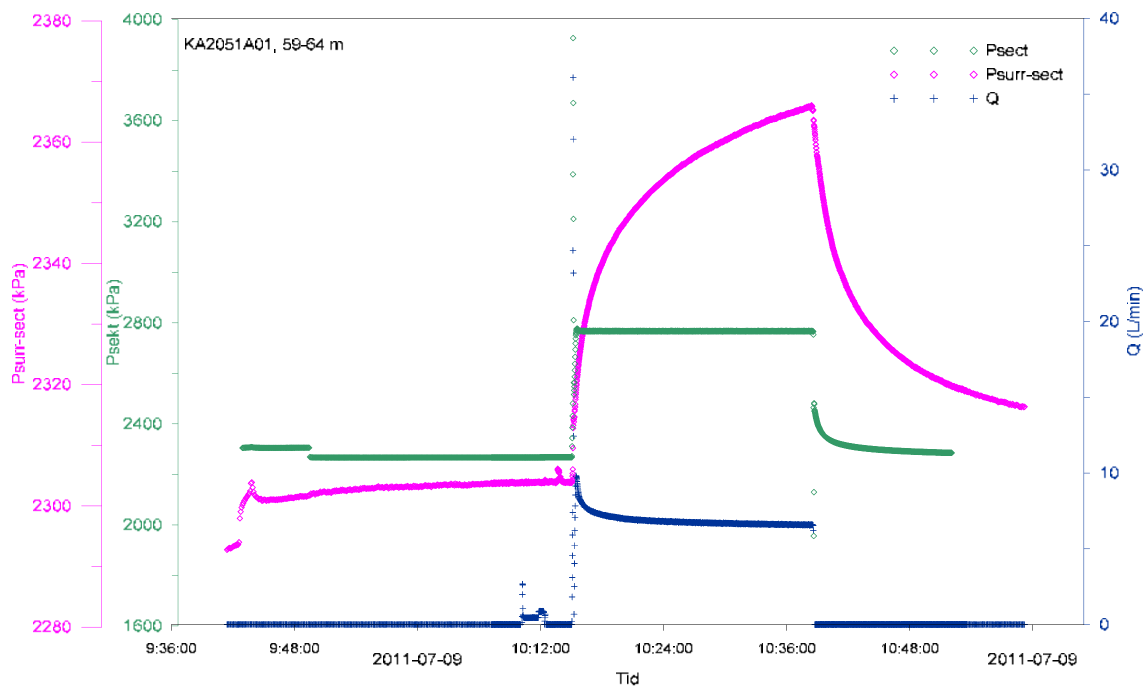


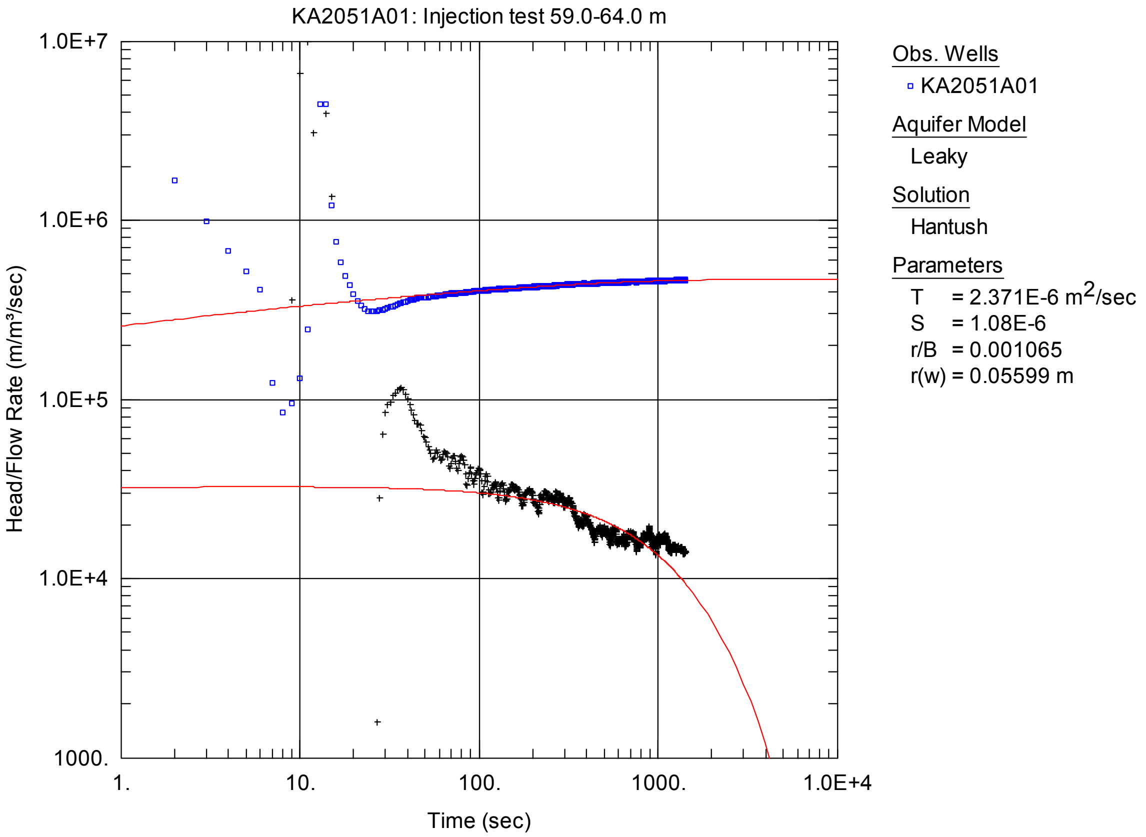


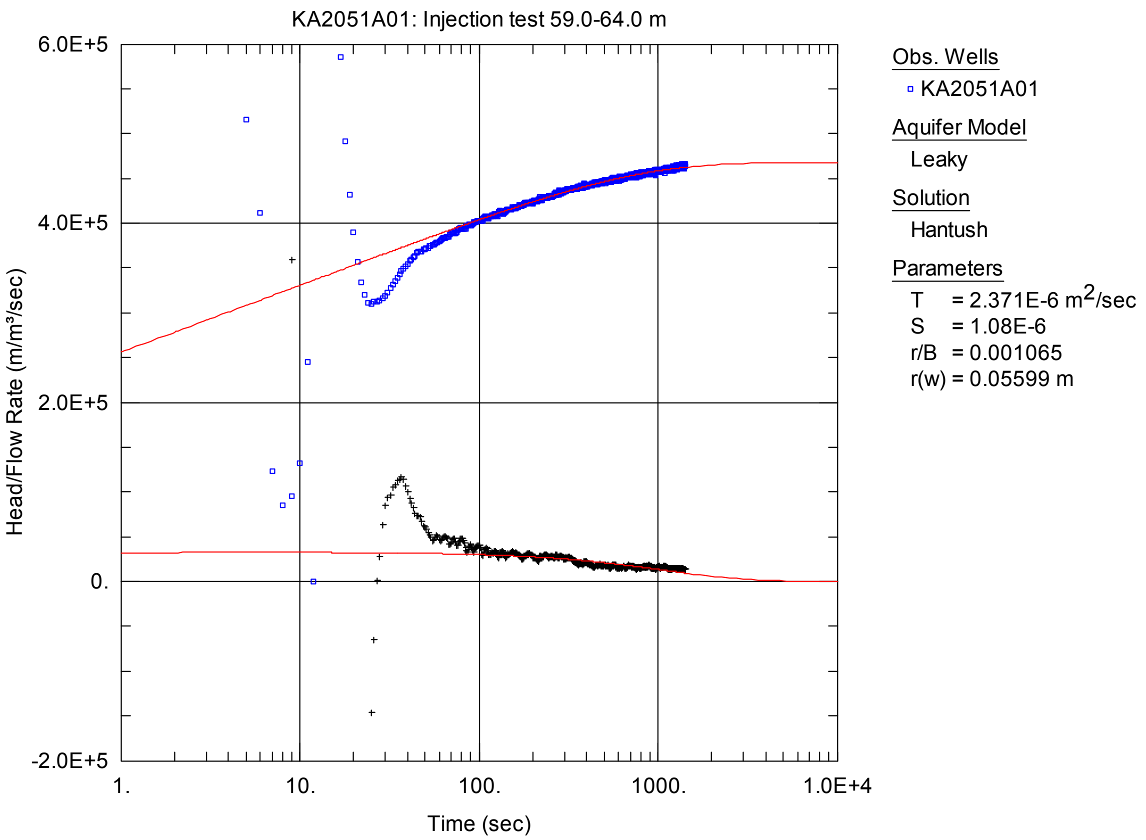
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

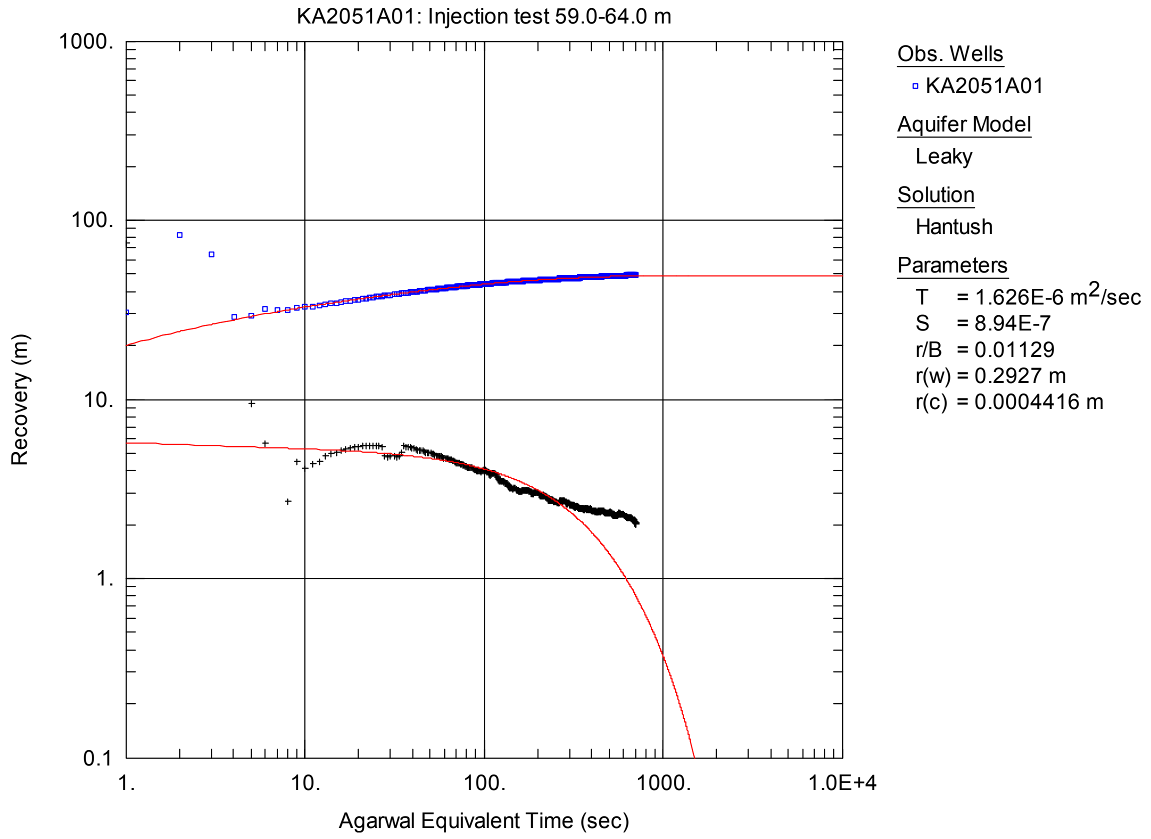


Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

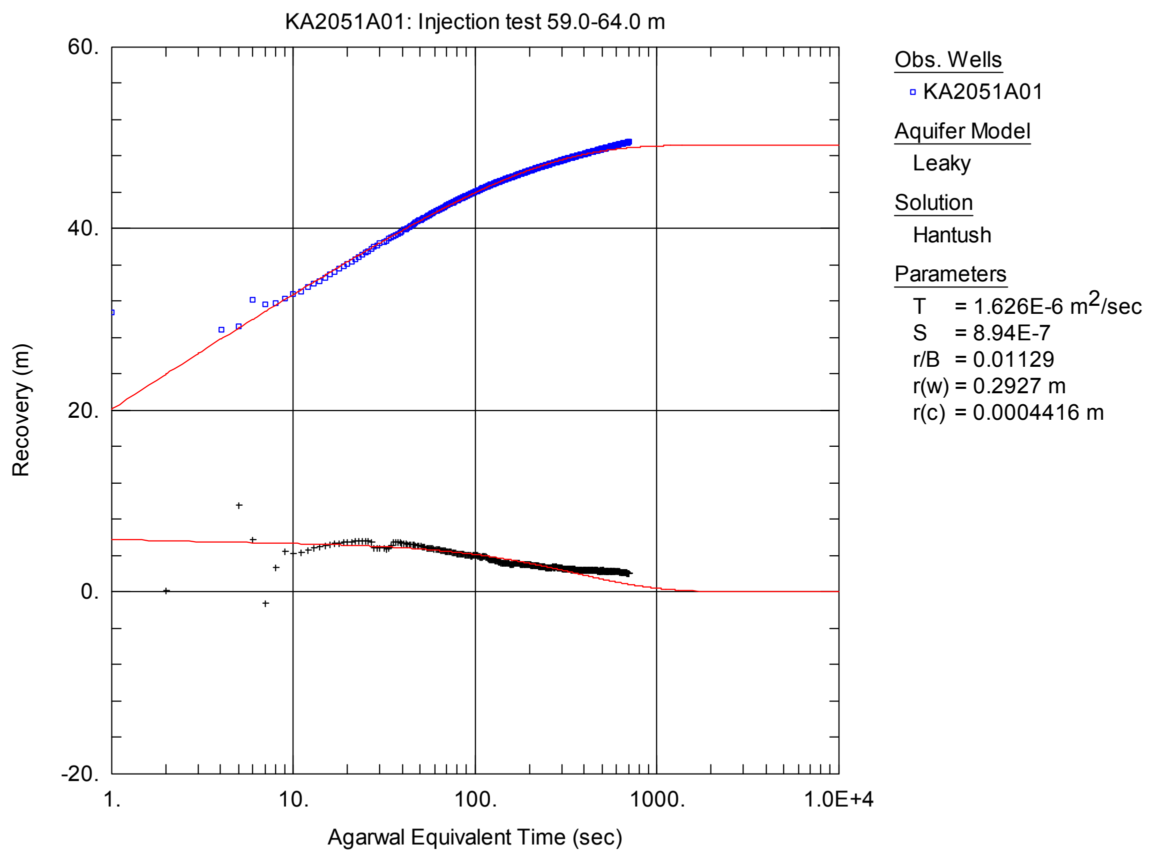



KA2051A01: Injection test 59.0-64.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.371E-6 m2/sec
S = 1.08E-6
r/B = 0.001065
r(w) = 0.05599 m

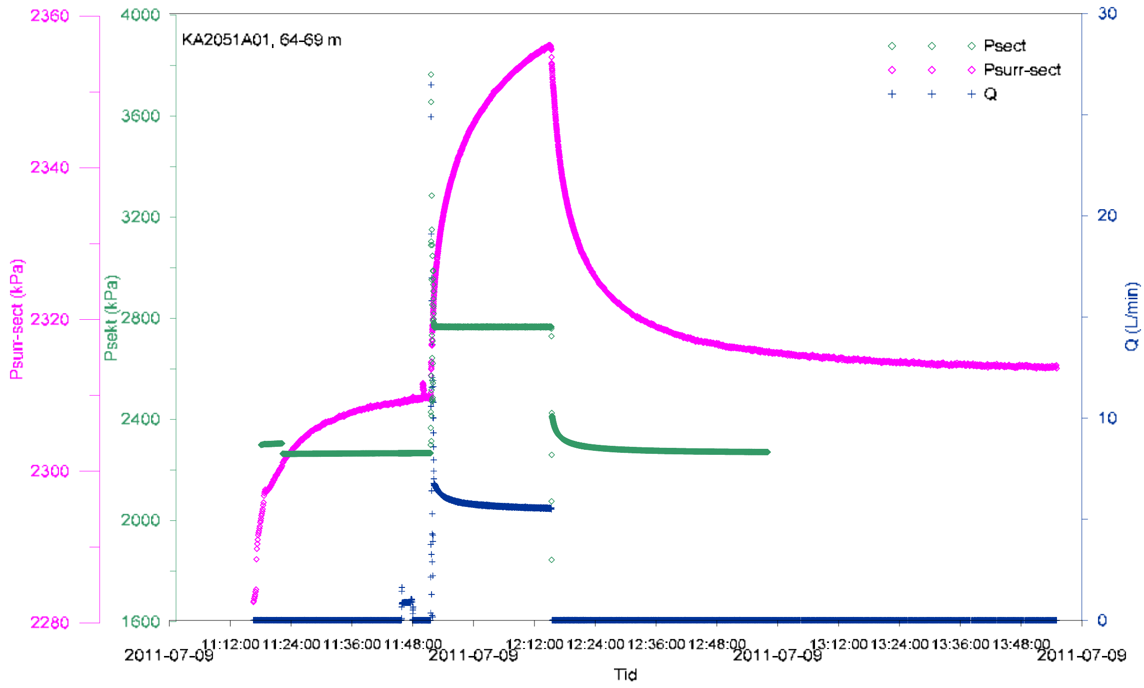

KA2051A01: Injection test 59.0-64.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
6.0E+5
4.0E+5
2.0E+5
0.
-2.0E+5
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.371E-6 m2/sec
S = 1.08E-6
r/B = 0.001065
r(w) = 0.05599 m

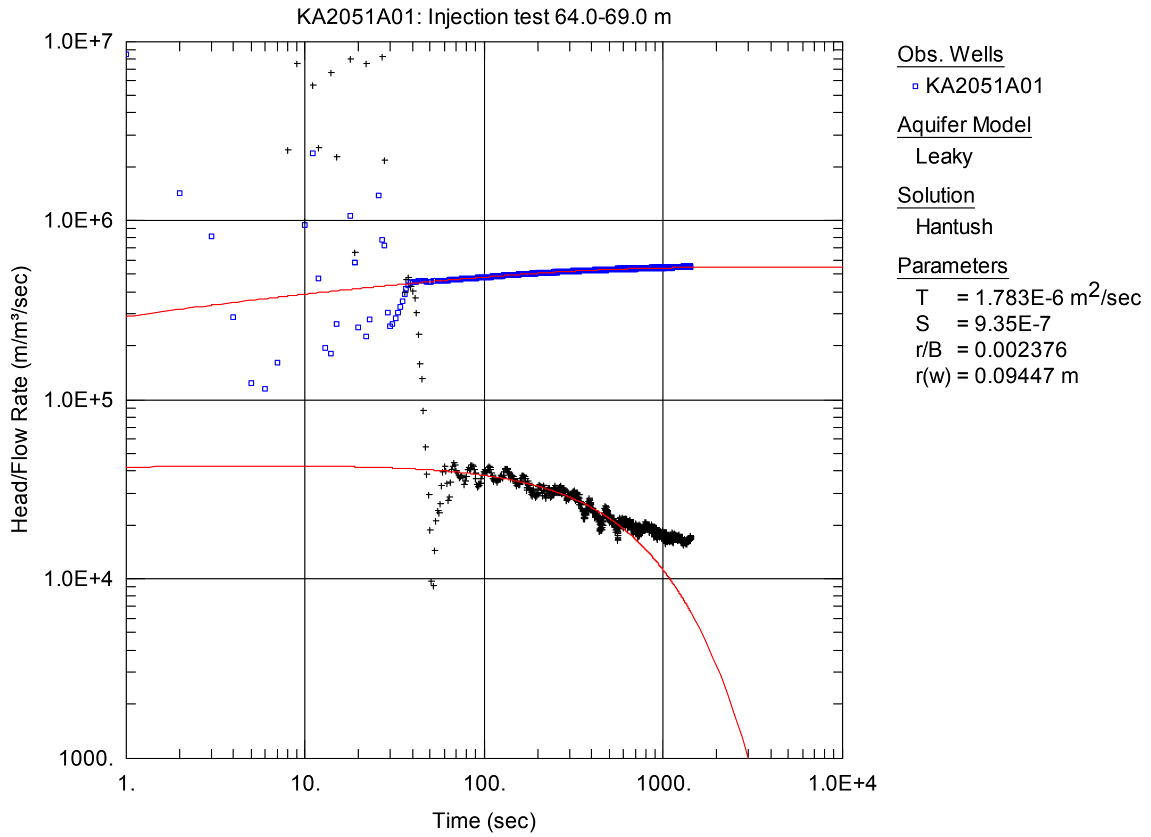


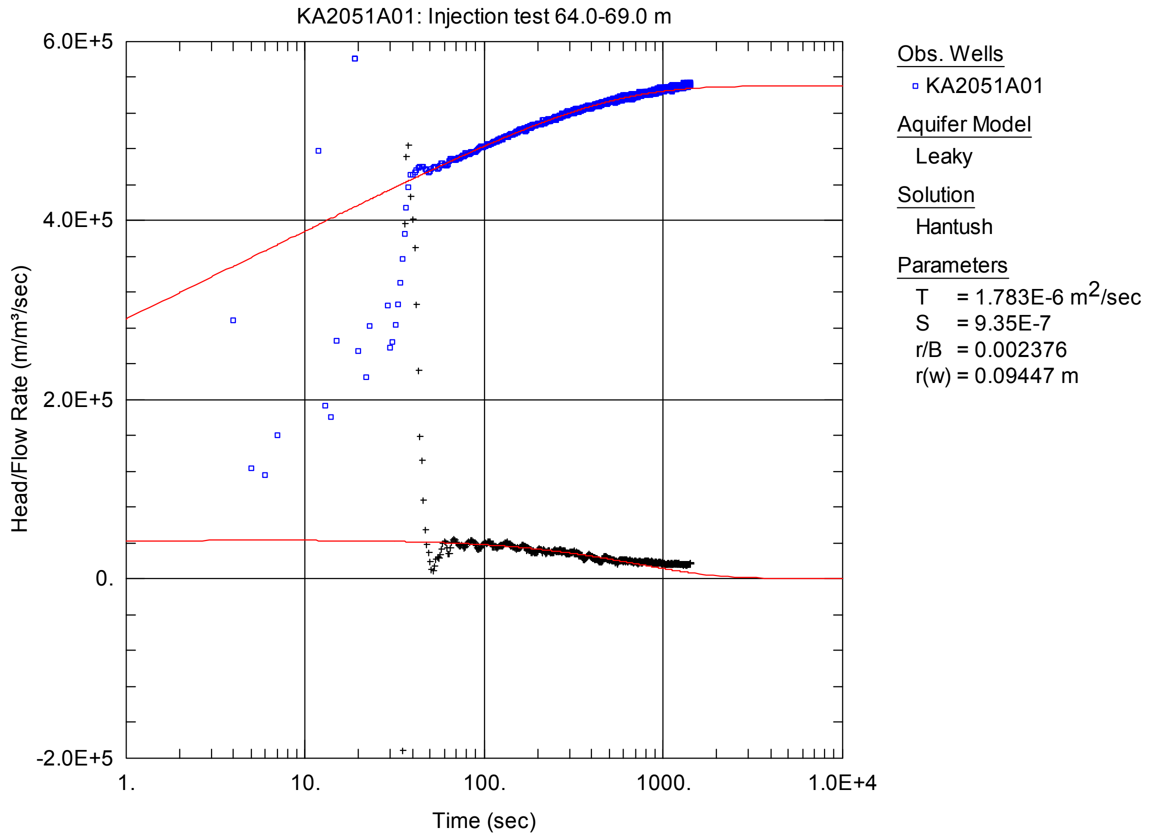
KA2051A01: Injection test 59.0-64.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.626E-6 m2/sec
S = 8.94E-7
r/B = 0.01129
r(w) = 0.2927 m
r(c) = 0.0004416 m

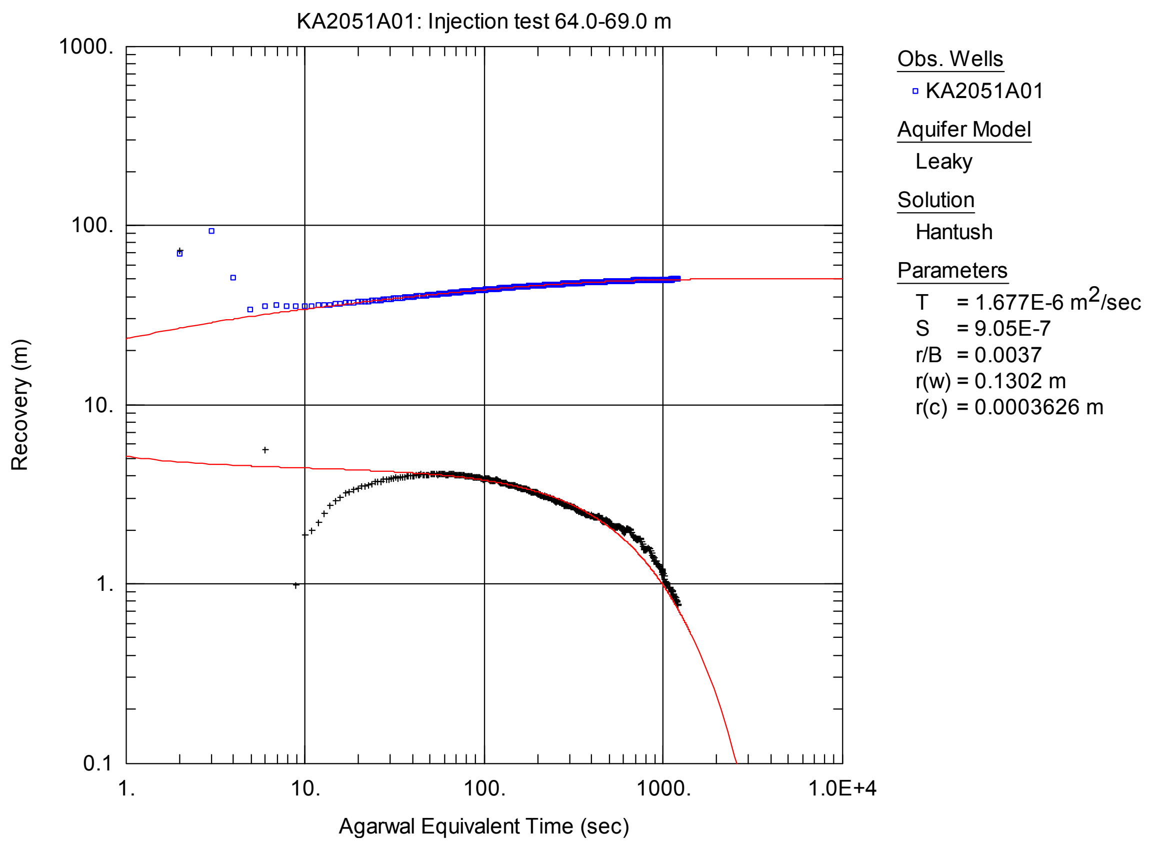


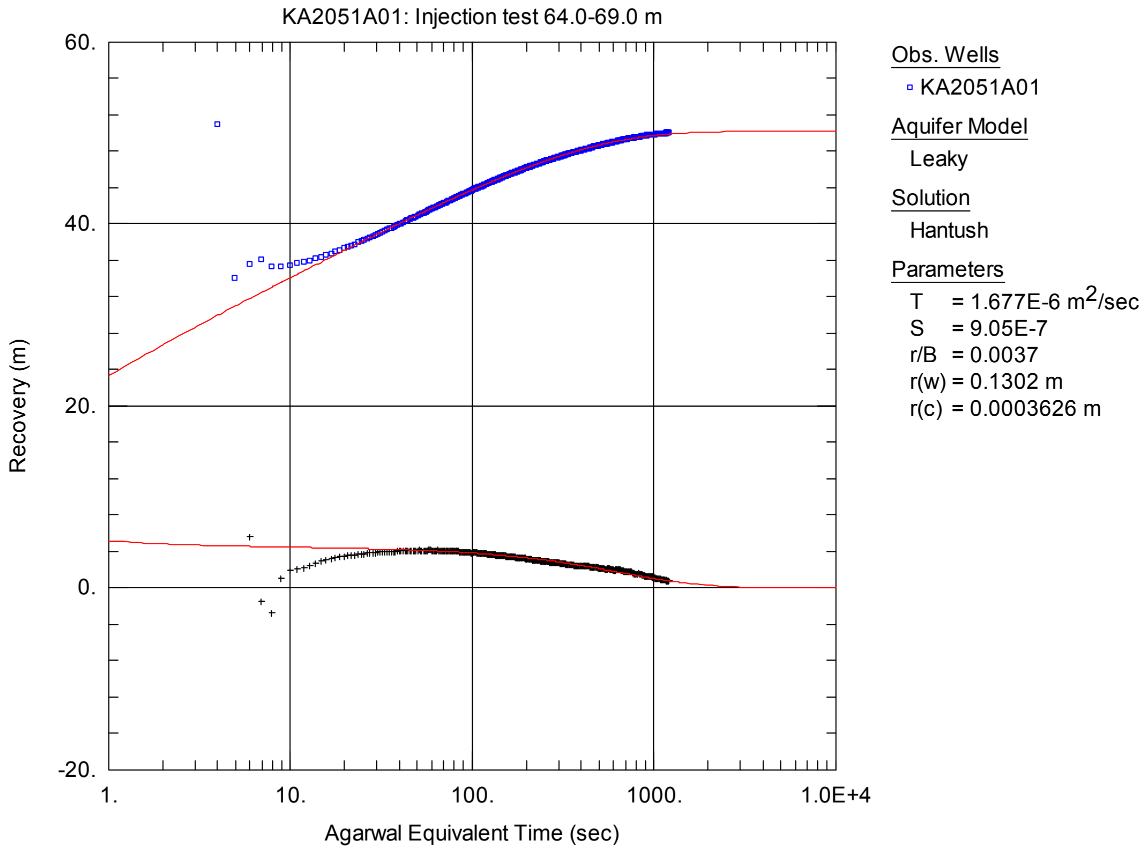
KA2051A01: Injection test 59.0-64.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.626E-6 m2/sec
S = 8.94E-7
r/B = 0.01129
r(w) = 0.2927 m
r(c) = 0.0004416 m

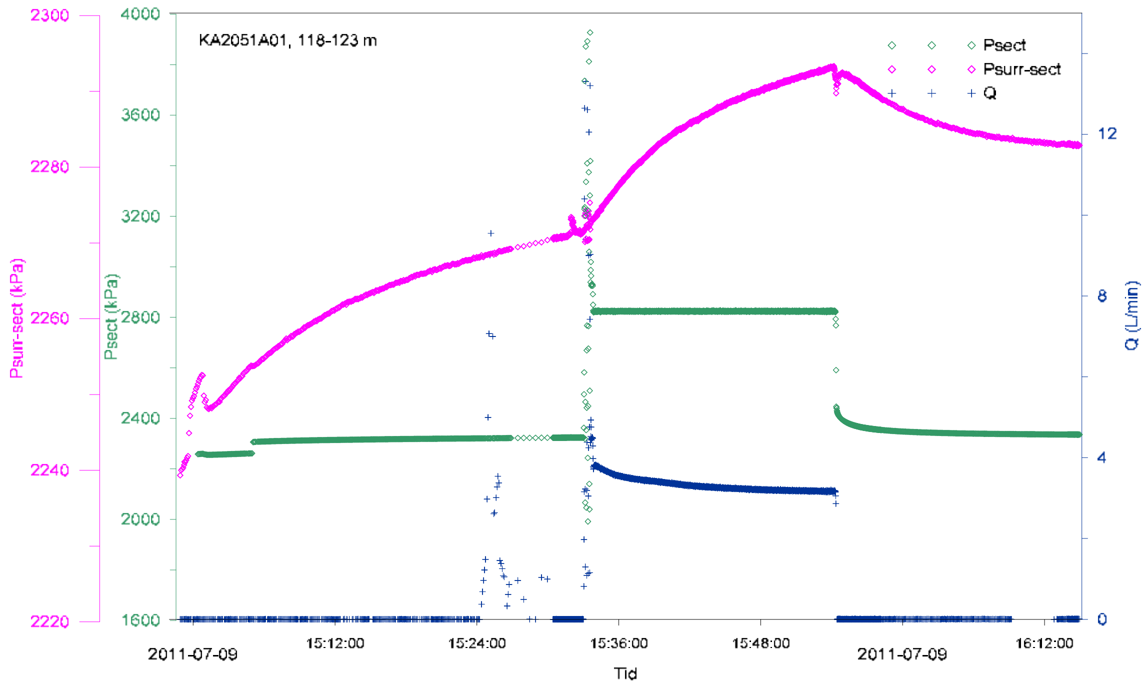

KA2051A01, 64-69 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-09
11:12:00 11:24:00 11:36:00 11:48:00
12:12:00 12:24:00 12:36:00 12:48:00
13:12:00 13:24:00 13:36:00 13:48:00

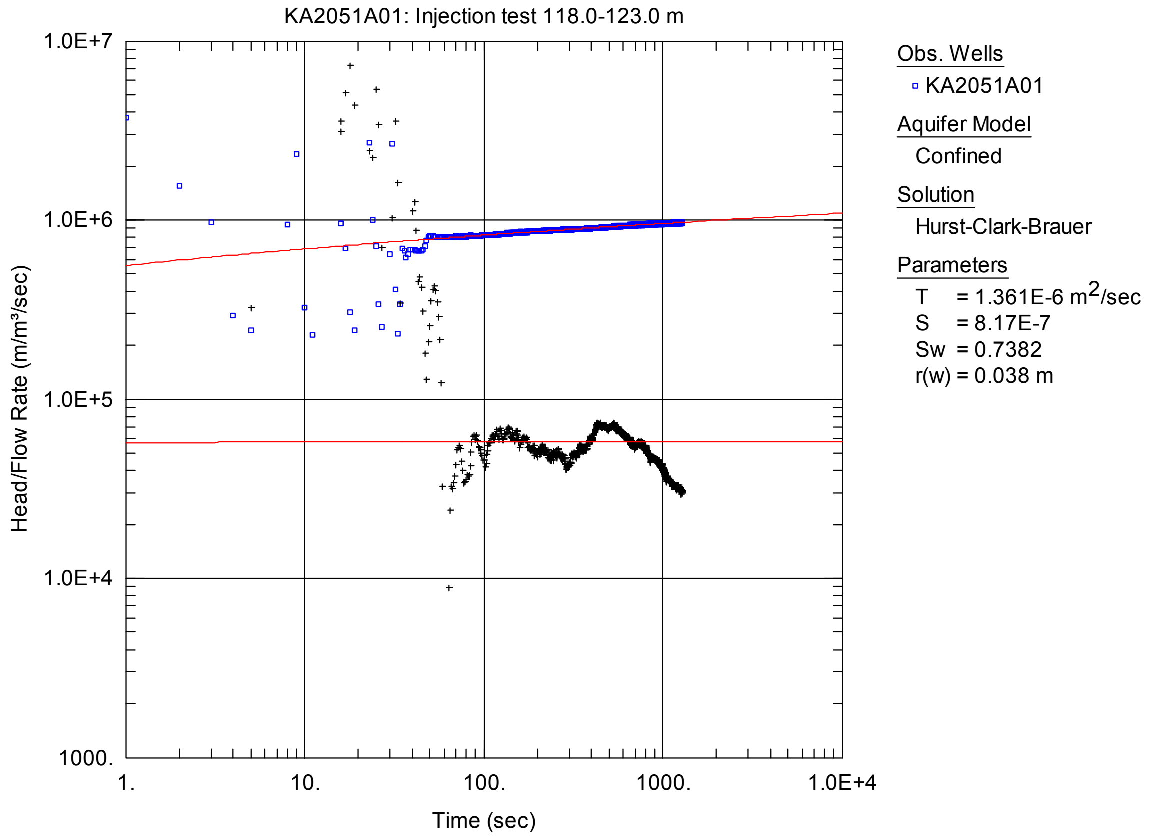

KA2051A01: Injection test 64.0-69.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.783E-6 m²/sec
S = 9.35E-7
r/B = 0.002376
r(w) = 0.09447 m

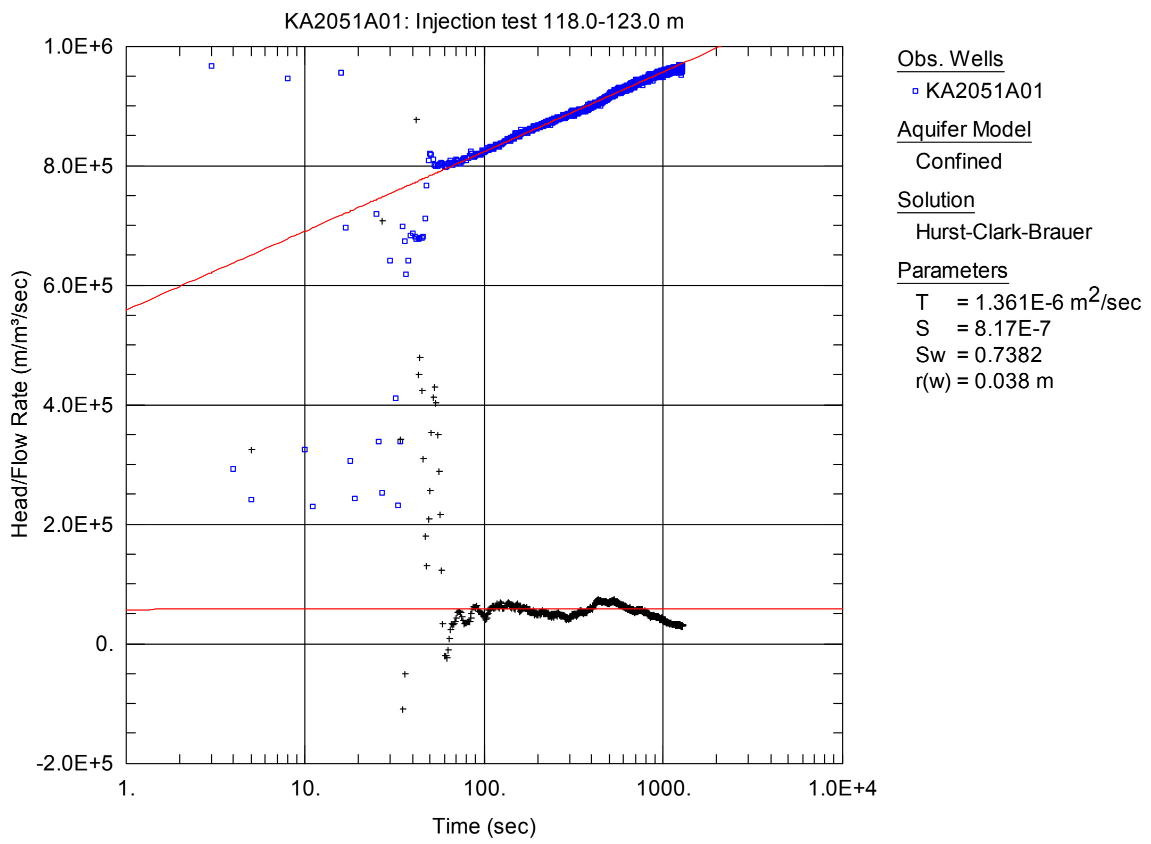

KA2051A01: Injection test 64.0-69.0 m
6.0E+5
4.0E+5
2.0E+5
0.
-2.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.783E-6 m2/sec
S = 9.35E-7
r/B = 0.002376
r(w) = 0.09447 m

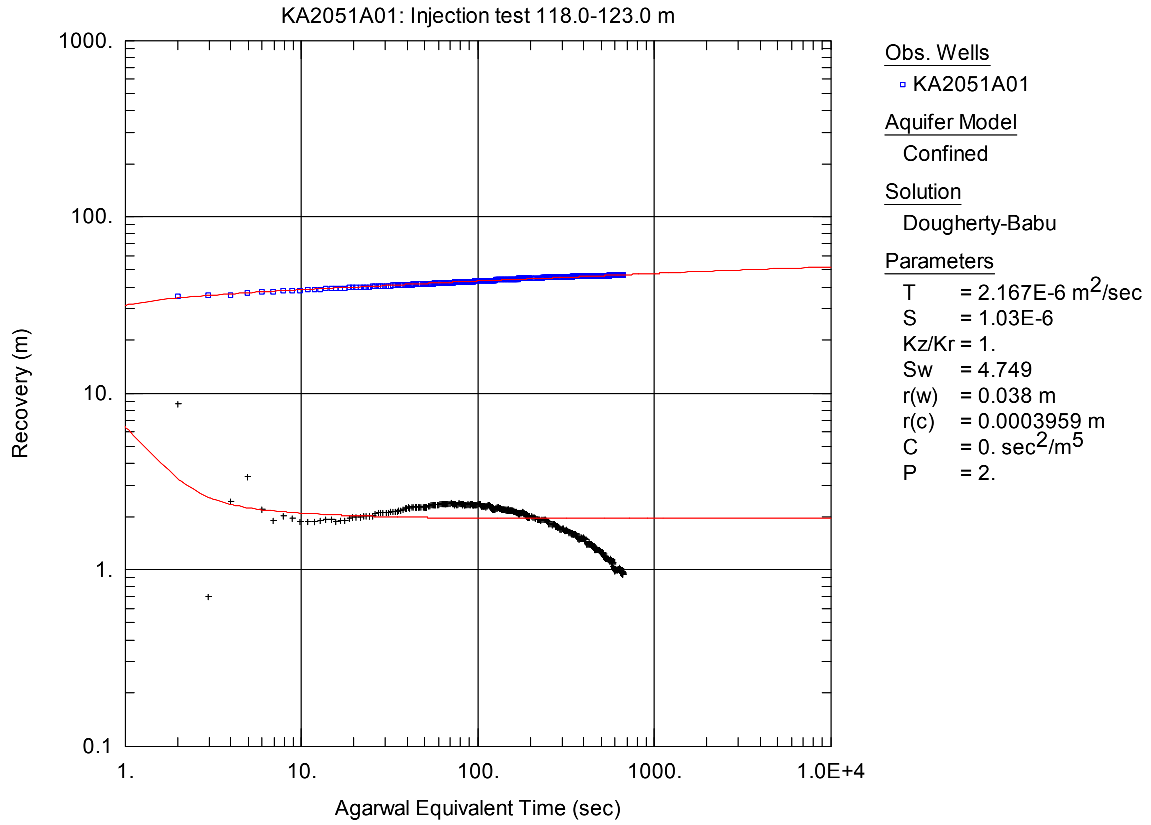

KA2051A01: Injection test 64.0-69.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.677E-6 m2/sec
S = 9.05E-7
r/B = 0.0037
r(w) = 0.1302 m
r(c) = 0.0003626 m

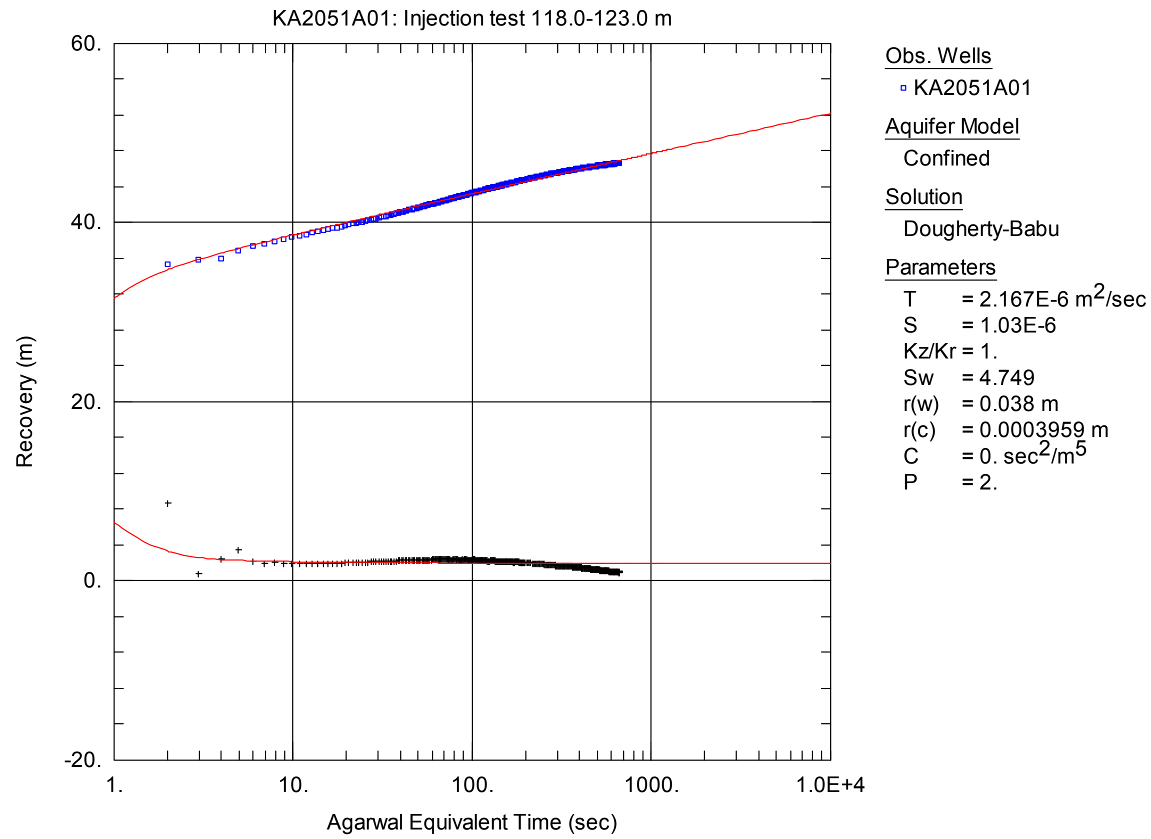

KA2051A01: Injection test 64.0-69.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.677E-6 m2/sec
S = 9.05E-7
r/B = 0.0037
r(w) = 0.1302 m
r(c) = 0.0003626 m

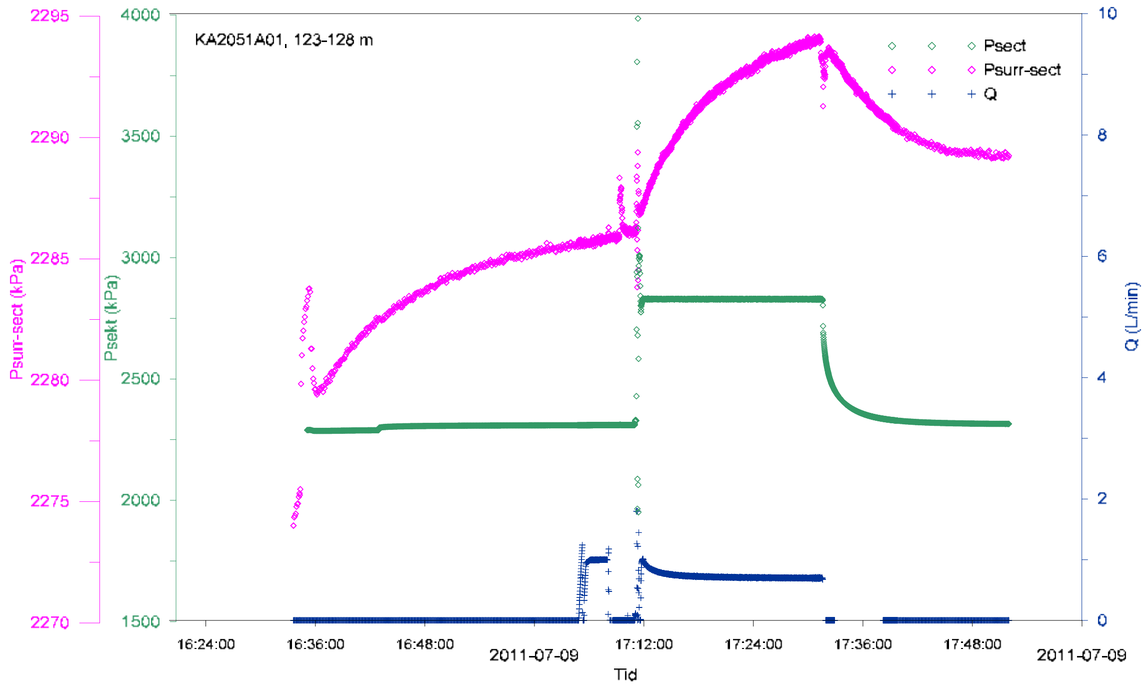

KA2051A01, 118-123 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2011-07-09
Tid


KA2051A01: Injection test 118.0-123.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.361E-6 m2/sec
S = 8.17E-7
Sw = 0.7382
r(w) = 0.038 m

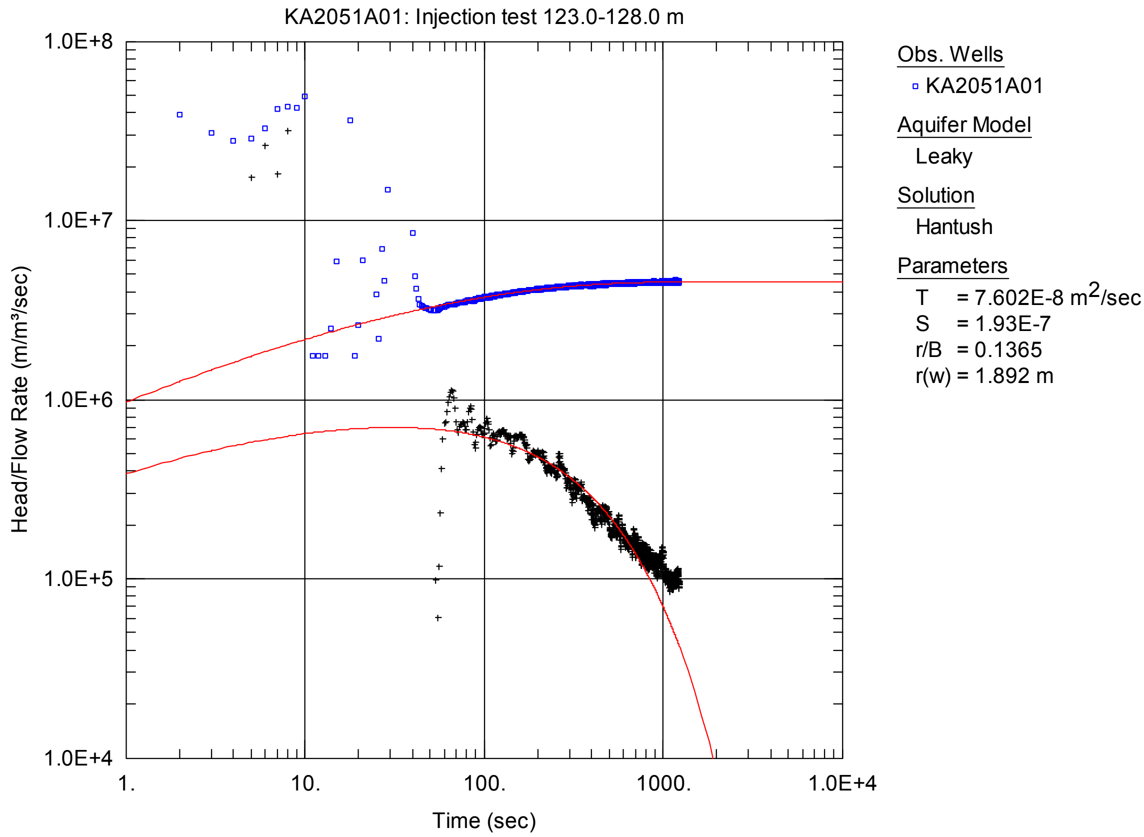

KA2051A01: Injection test 118.0-123.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.361E-6 m2/sec
S = 8.17E-7
Sw = 0.7382
r(w) = 0.038 m


KA2051A01: Injection test 118.0-123.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.167E-6 m2/sec
S = 1.03E-6
Kz/Kr = 1.
Sw = 4.749
r(w) = 0.038 m
r(c) = 0.0003959 m
C = 0. sec2/m5
P = 2.

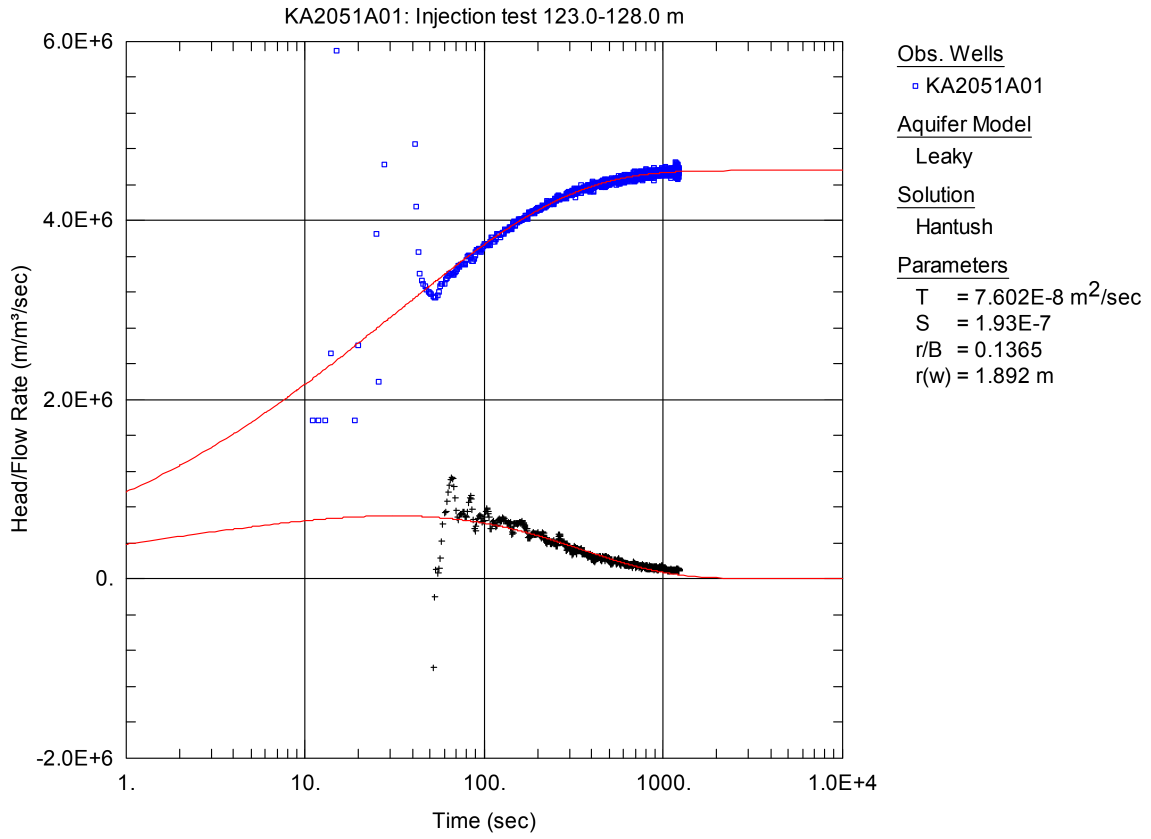

KA2051A01: Injection test 118.0-123.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.167E-6 m2/sec
S = 1.03E-6
Kz/Kr = 1.
Sw = 4.749
r(w) = 0.038 m
r(c) = 0.0003959 m
C = 0. sec2/m5
P = 2.

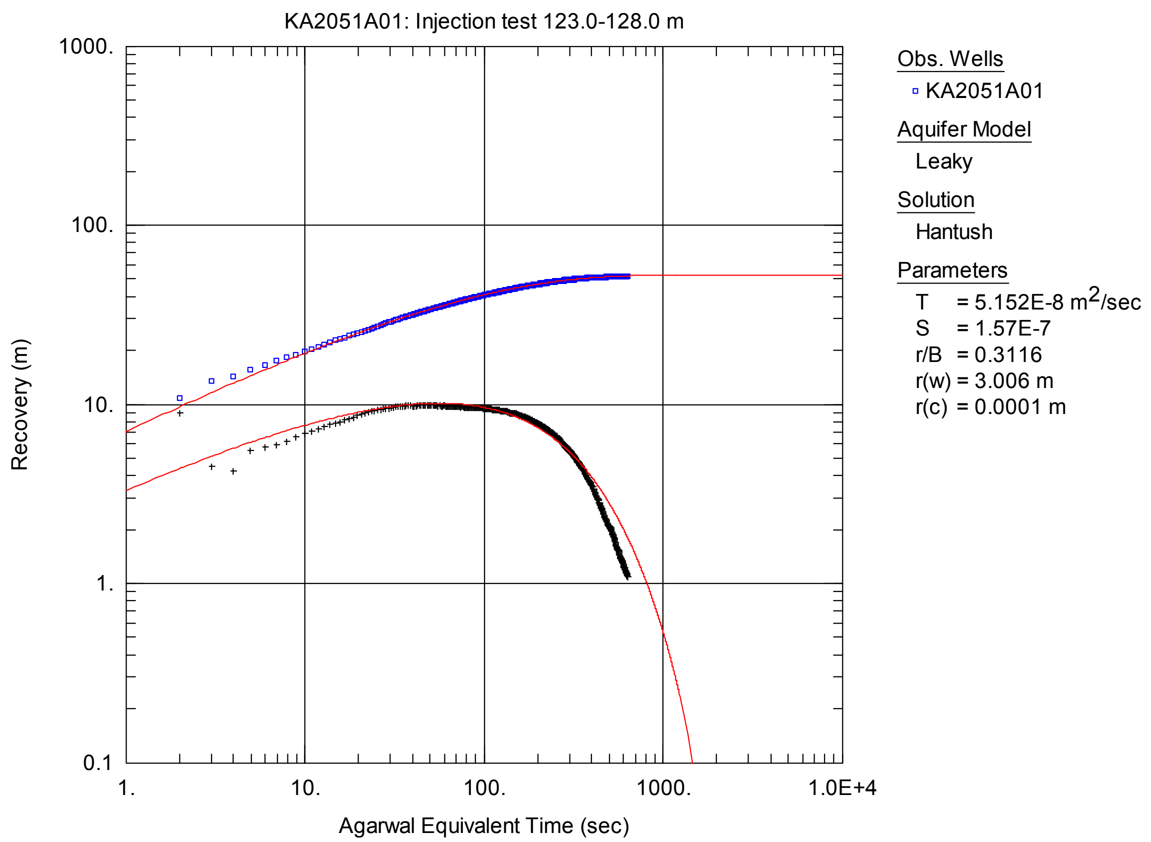


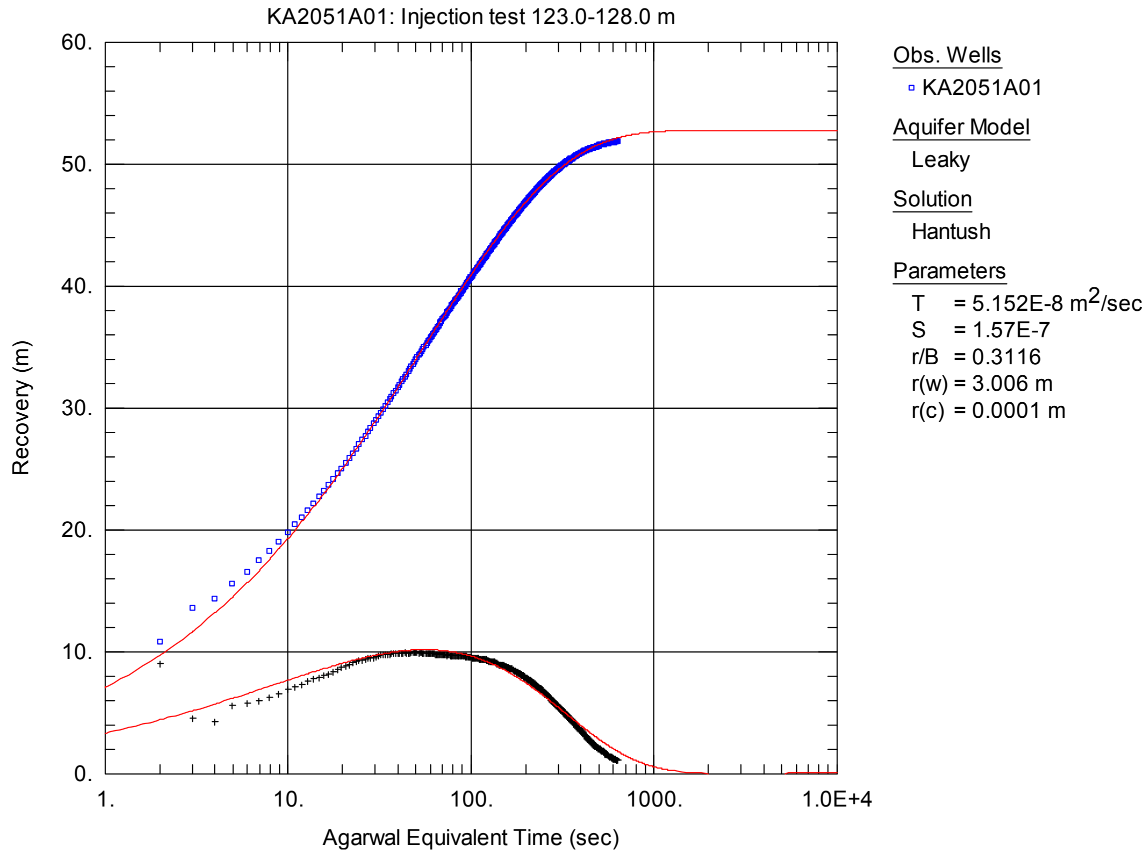
KA2051A01, 123-128 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-09
16:24:00
16:36:00
16:48:00
17:12:00
17:24:00
17:36:00
17:48:00

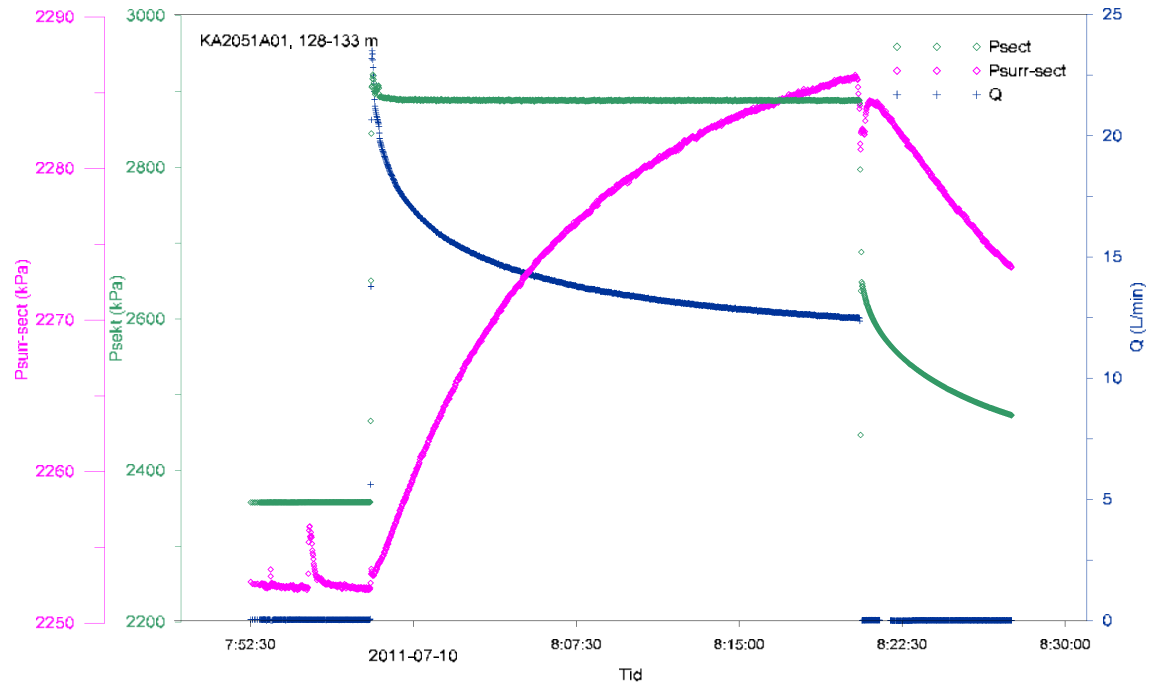


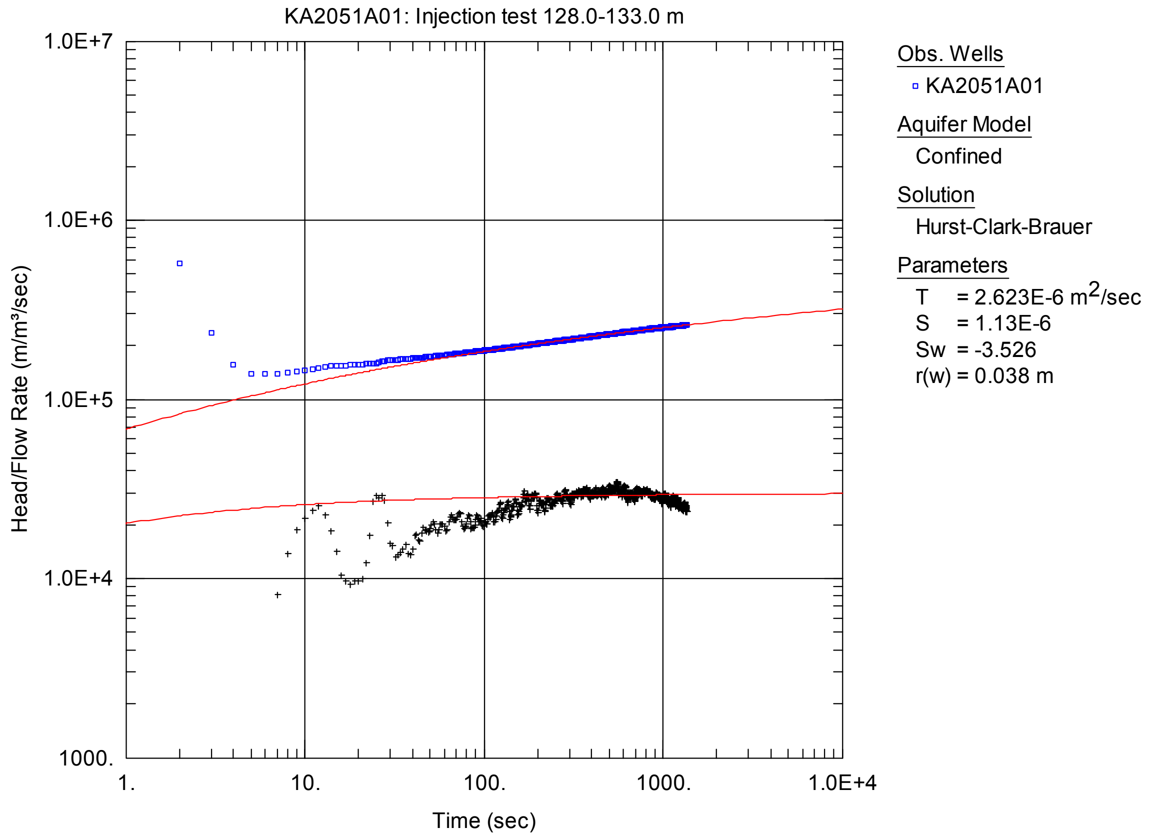
KA2051A01: Injection test 123.0-128.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 7.602E-8 m2/sec
S = 1.93E-7
r/B = 0.1365
r(w) = 1.892 m

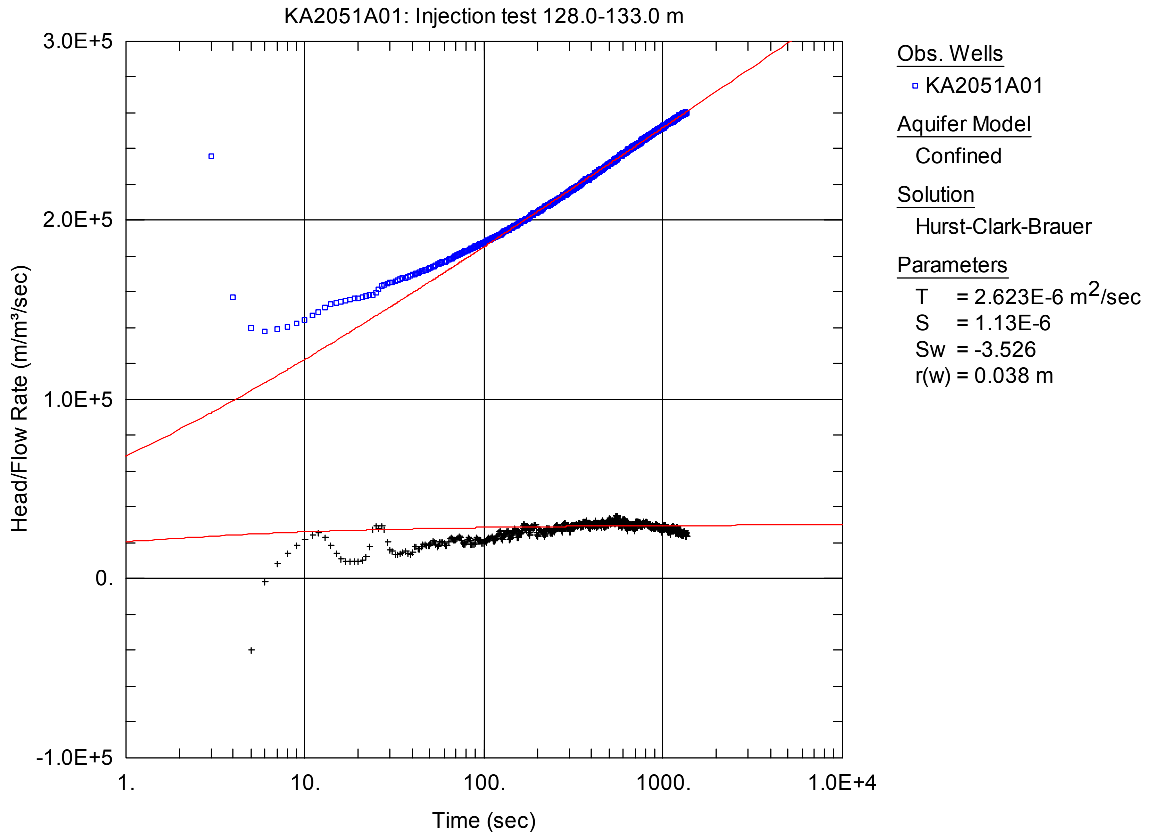

KA2051A01: Injection test 123.0-128.0 m
6.0E+6
4.0E+6
2.0E+6
0.
-2.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 7.602E-8 m2/sec
S = 1.93E-7
r/B = 0.1365
r(w) = 1.892 m

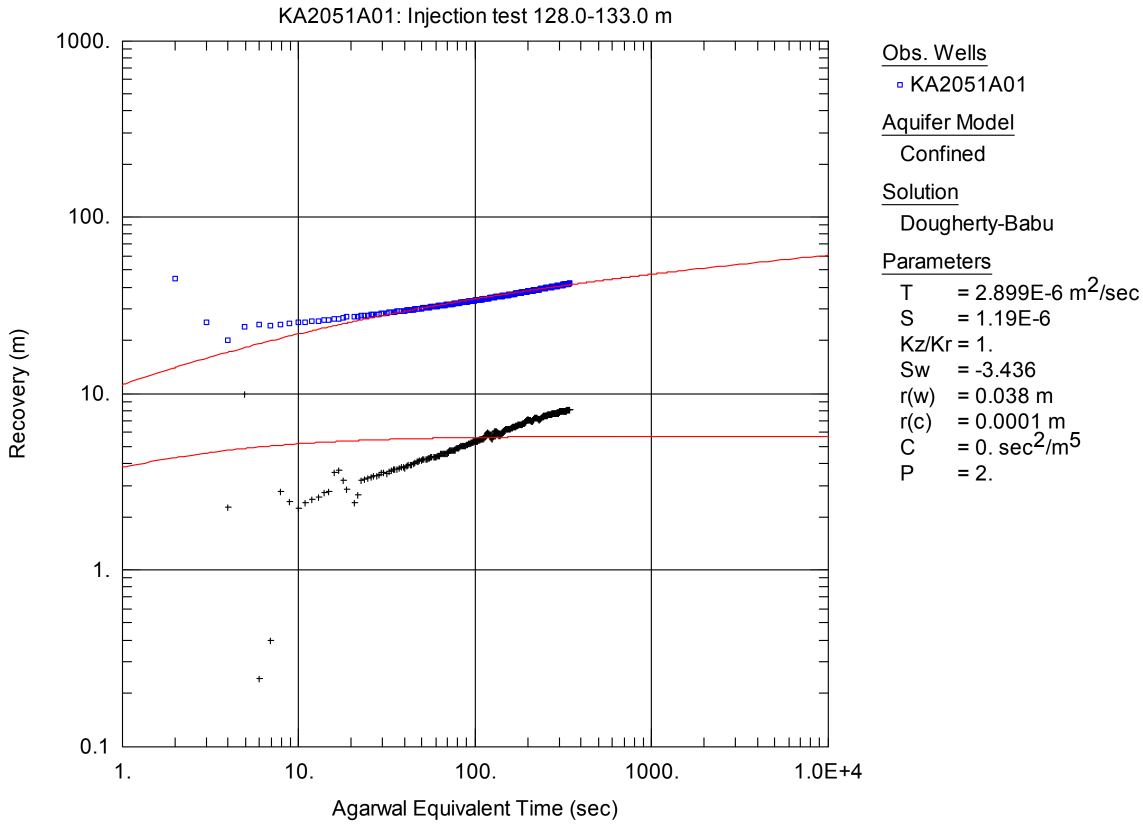

KA2051A01: Injection test 123.0-128.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 5.152E-8 m2/sec
S = 1.57E-7
r/B = 0.3116
r(w) = 3.006 m
r(c) = 0.0001 m


KA2051A01: Injection test 123.0-128.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 5.152E-8 m2/sec
S = 1.57E-7
r/B = 0.3116
r(w) = 3.006 m
r(c) = 0.0001 m

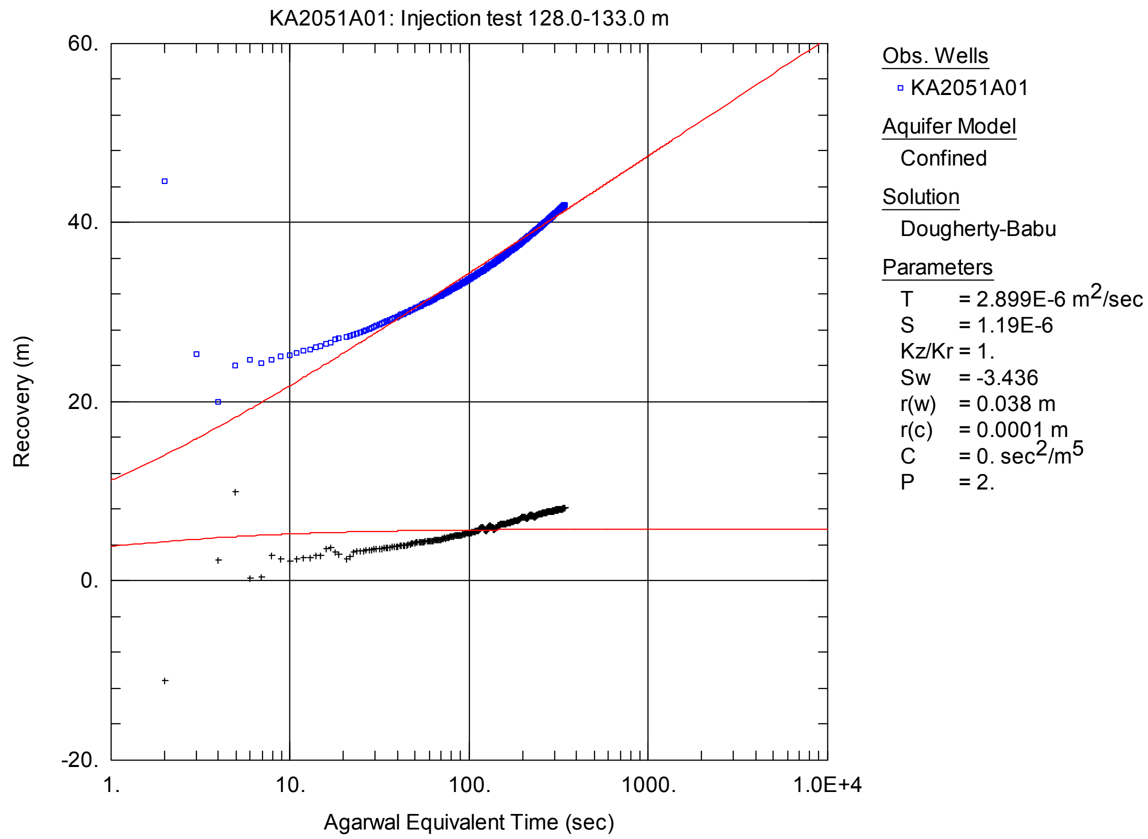

KA2051A01, 128-133 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2011-07-10
Tid


KA2051A01: Injection test 128.0-133.0 m
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
1.
10.
100.
1000.
1.0E+4
Time (sec)
Head/Flow Rate (m/m³/sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.623E-6 m2/sec
S = 1.13E-6
Sw = -3.526
r(w) = 0.038 m

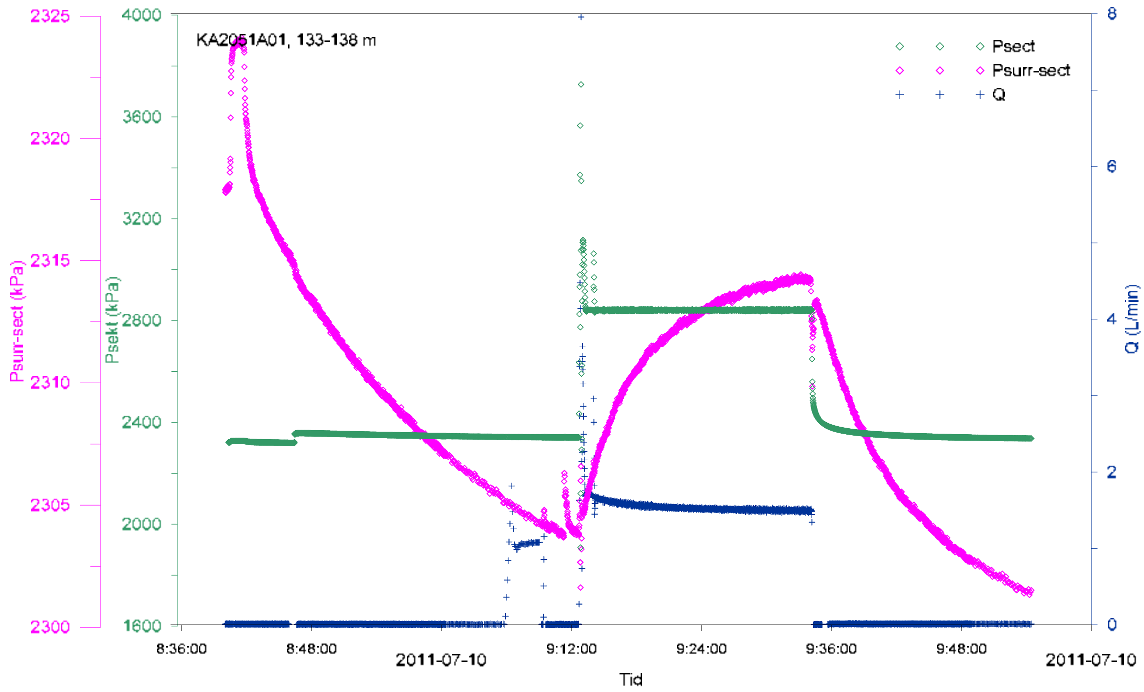

KA2051A01: Injection test 128.0-133.0 m
3.0E+5
2.0E+5
1.0E+5
0.
-1.0E+5
1.
10.
100.
1000.
1.0E+4
Time (sec)
Head/Flow Rate (m/m³/sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.623E-6 m2/sec
S = 1.13E-6
Sw = -3.526
r(w) = 0.038 m

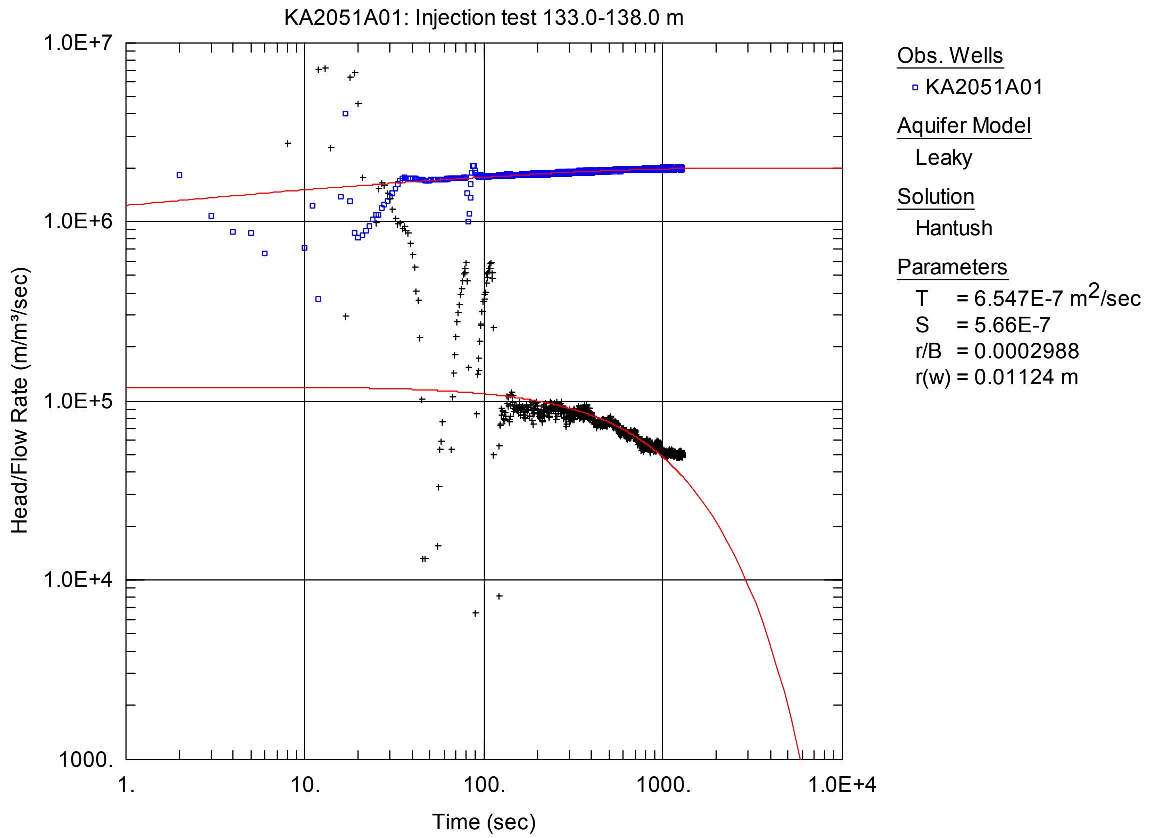


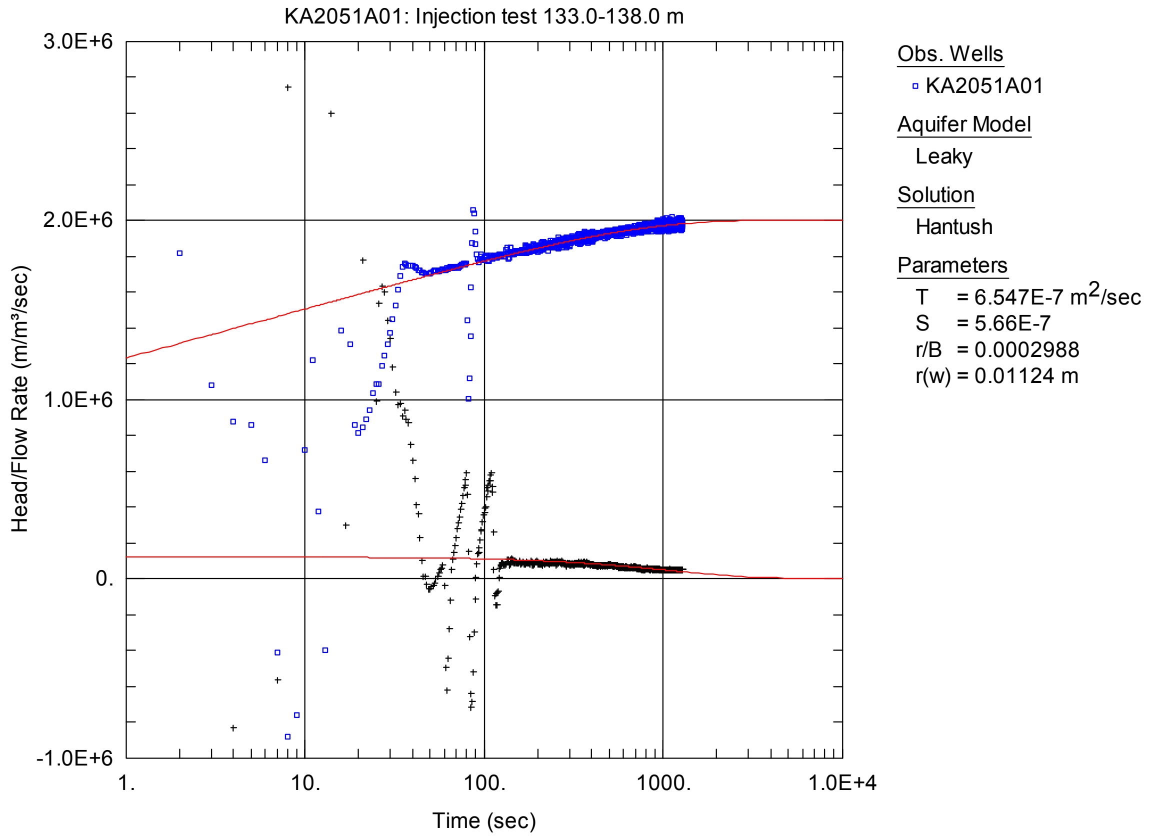
KA2051A01: Injection test 128.0-133.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.899E-6 m2/sec
S = 1.19E-6
Kz/Kr = 1.
Sw = -3.436
r(w) = 0.038 m
r(c) = 0.0001 m
C = 0. sec2/m5
P = 2.

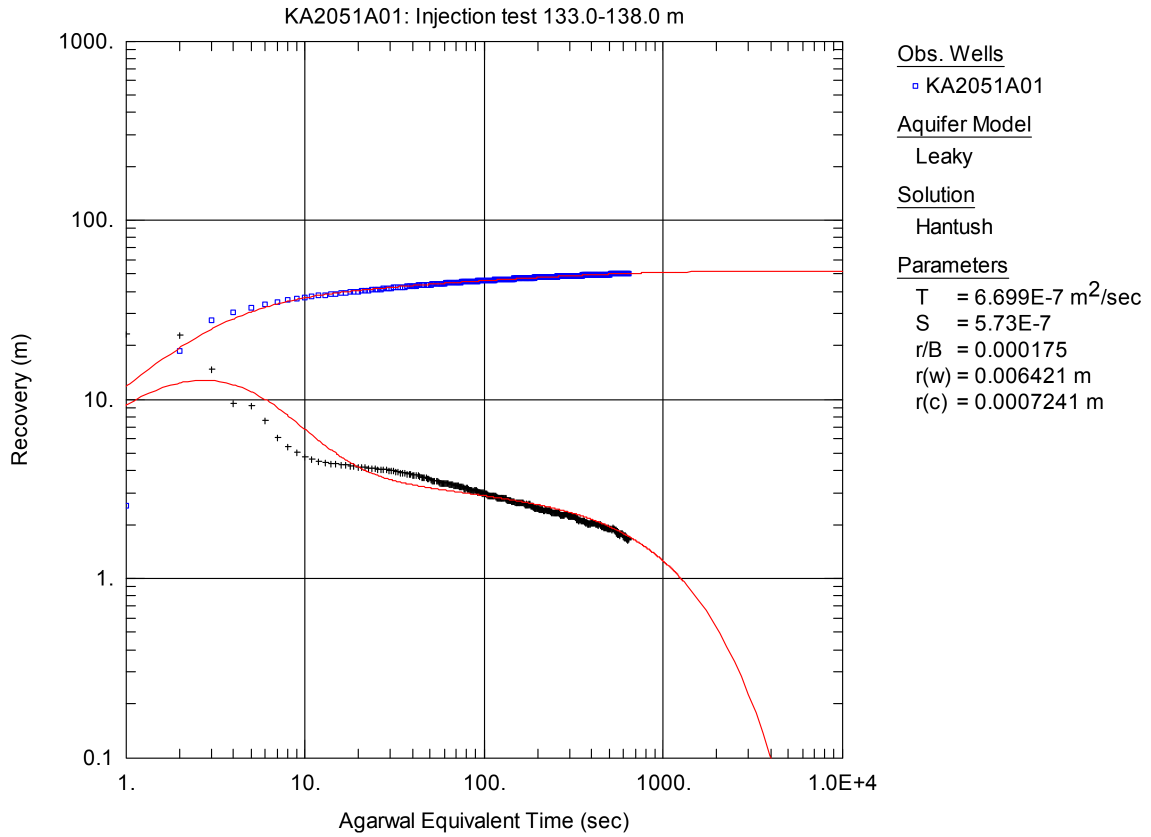


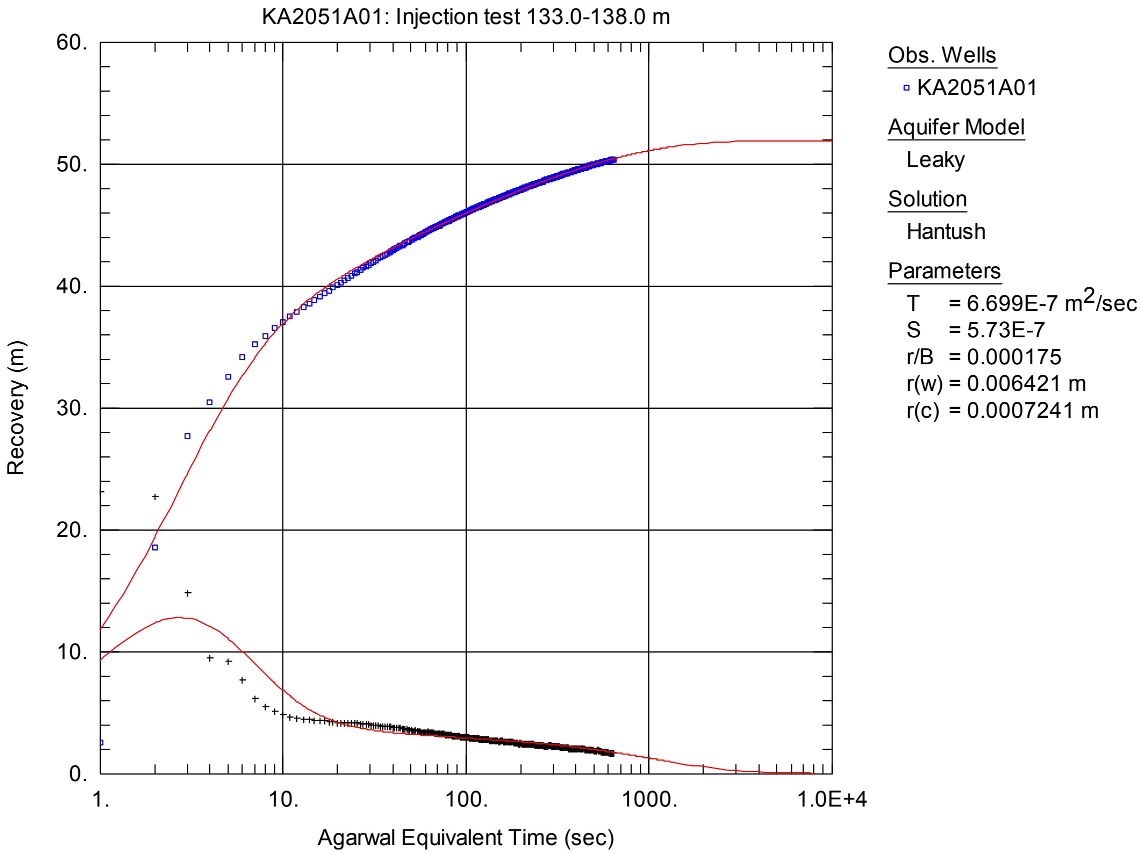
KA2051A01: Injection test 128.0-133.0 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.899E-6 m2/sec
S = 1.19E-6
Kz/Kr = 1.
Sw = -3.436
r(w) = 0.038 m
r(c) = 0.0001 m
C = 0. sec2/m5
P = 2.

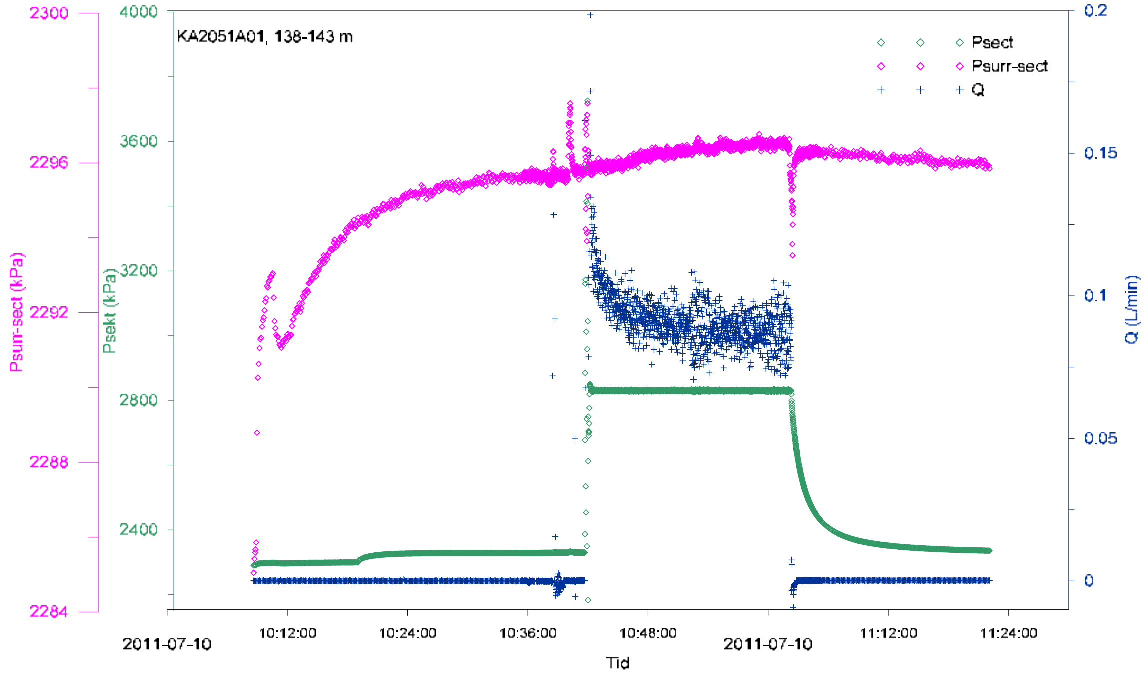

KA2051A01, 133-138 m
Psect
Psurr-sect
Q
2325
2320
2315
2310
2305
2300
Psurr-sect (kPa)
4000
3600
3200
2800
2400
2000
1600
Psekt (kPa)
8
6
4
2
0
Q (L/min)
8:36:00
8:48:00
2011-07-10
9:12:00
9:24:00
9:36:00
9:48:00
2011-07-10
Tid

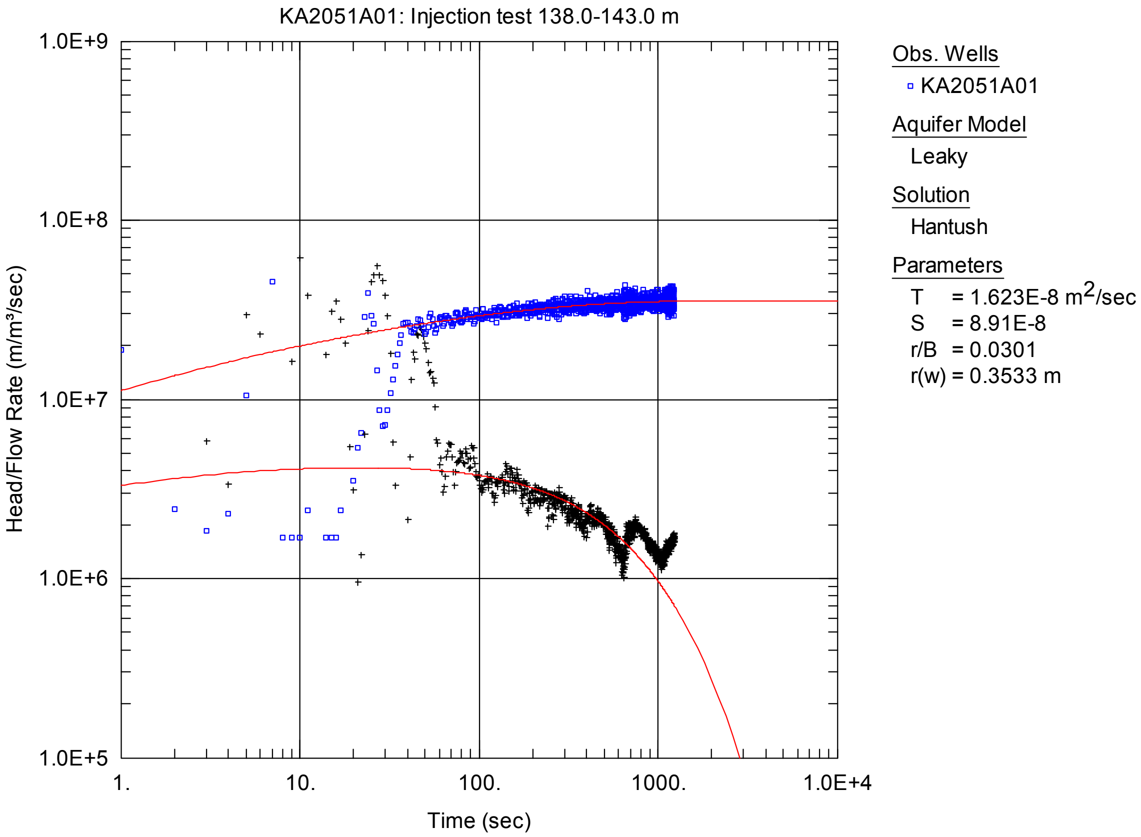

KA2051A01: Injection test 133.0-138.0 m
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1000.
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.547E-7 m2/sec
S = 5.66E-7
r/B = 0.0002988
r(w) = 0.01124 m

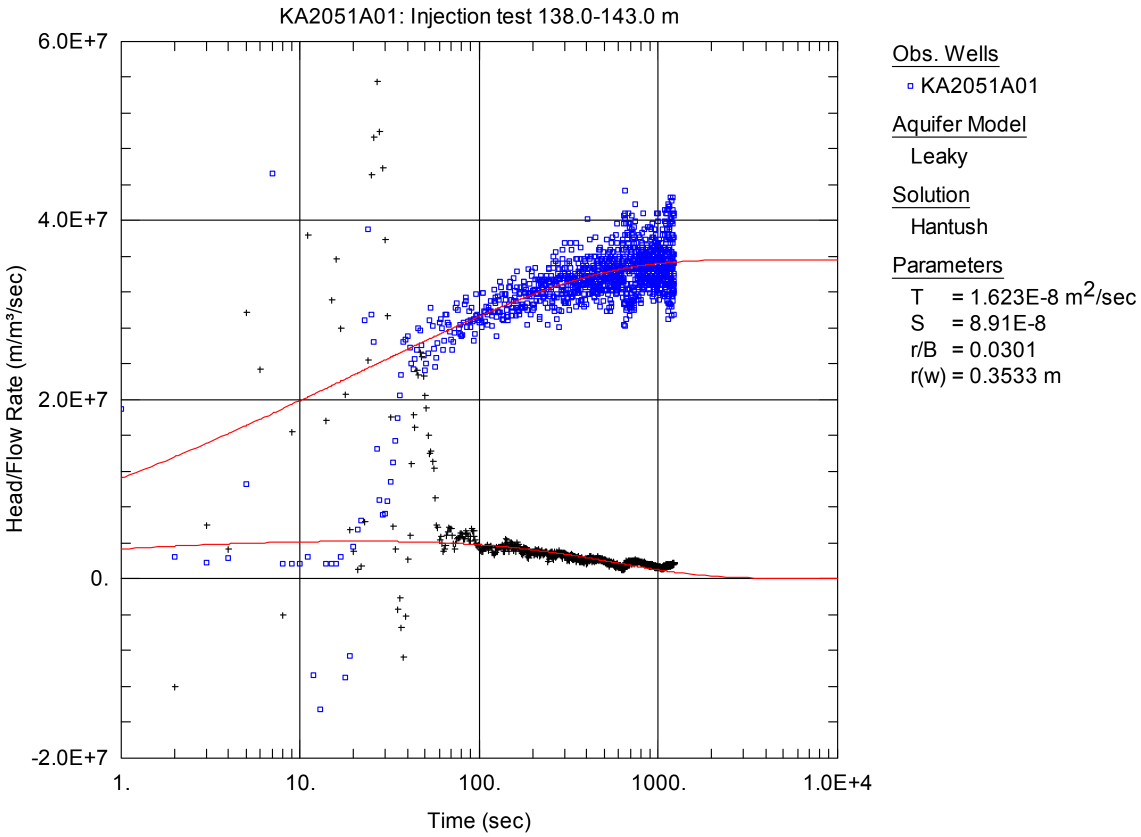

KA2051A01: Injection test 133.0-138.0 m
Head/Flow Rate (m/m³/sec)
3.0E+6
2.0E+6
1.0E+6
0.
-1.0E+6
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.547E-7 m2/sec
S = 5.66E-7
r/B = 0.0002988
r(w) = 0.01124 m

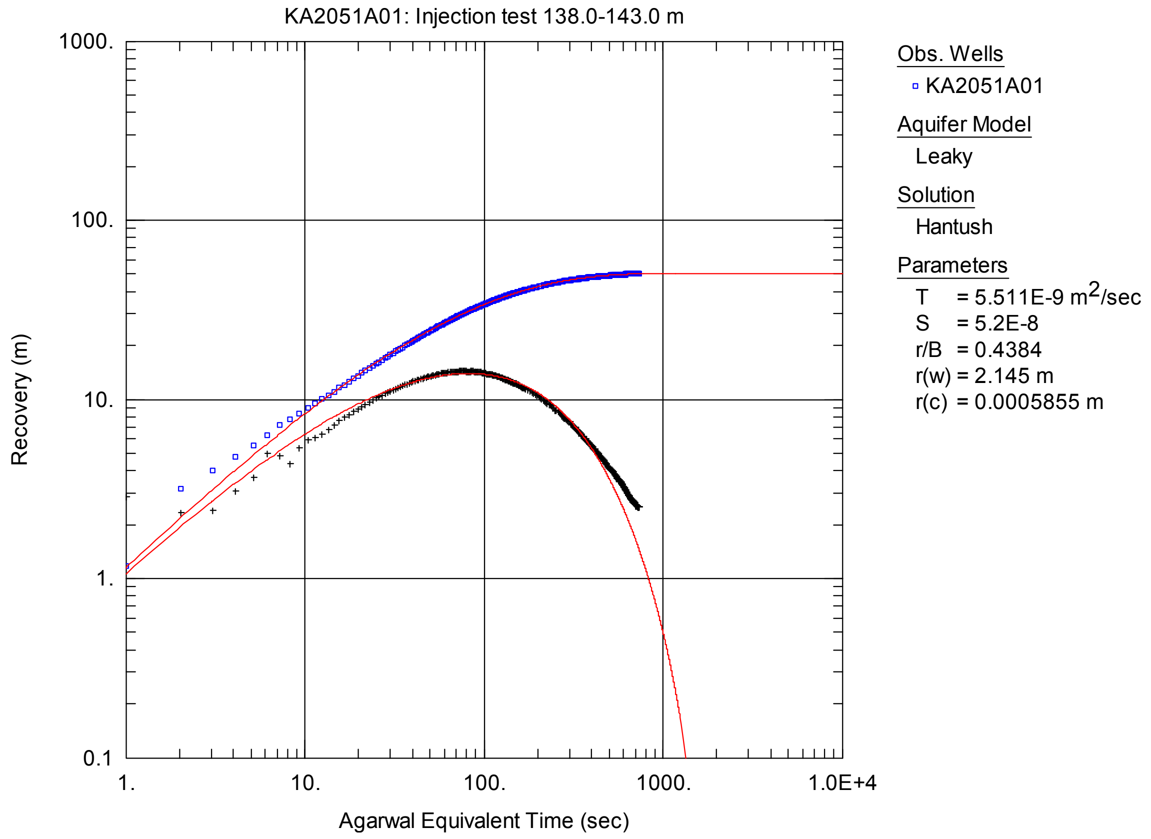

KA2051A01: Injection test 133.0-138.0 m
Recovery (m)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.699E-7 m2/sec
S = 5.73E-7
r/B = 0.000175
r(w) = 0.006421 m
r(c) = 0.0007241 m

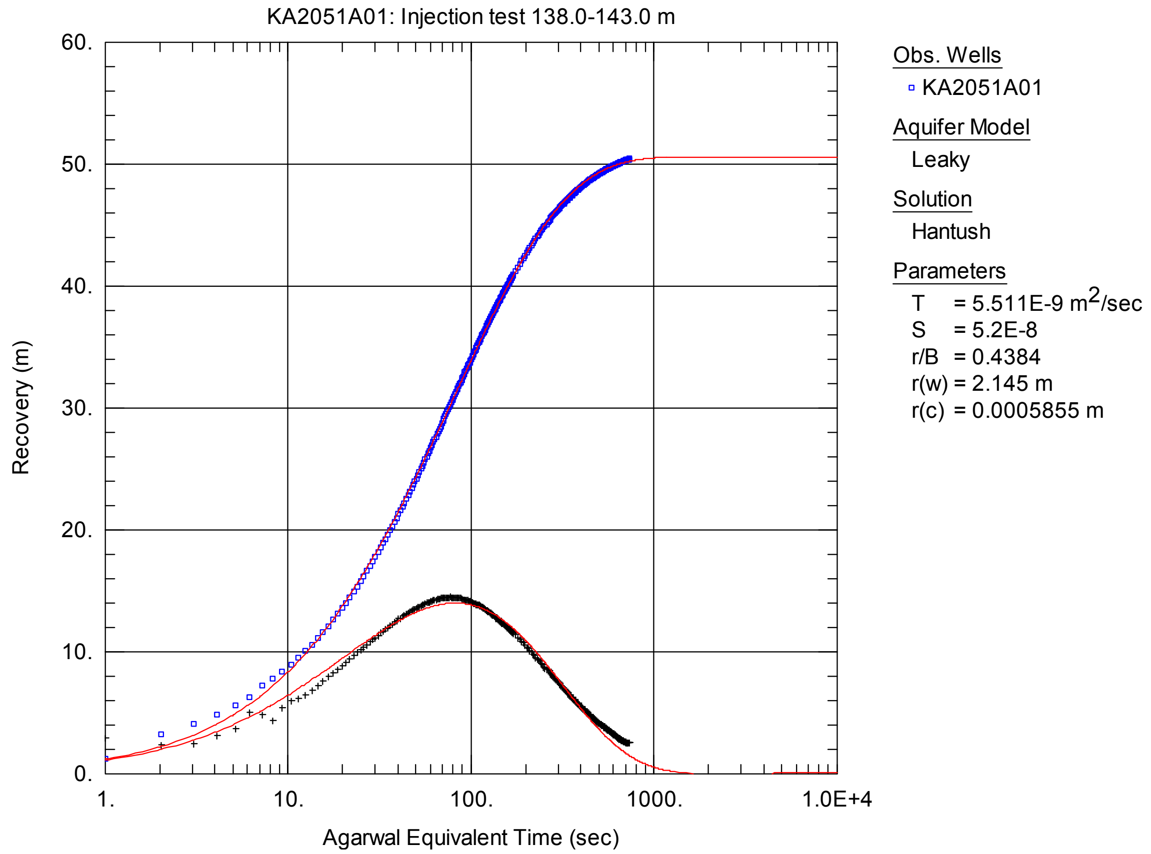

KA2051A01: Injection test 133.0-138.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.699E-7 m2/sec
S = 5.73E-7
r/B = 0.000175
r(w) = 0.006421 m
r(c) = 0.0007241 m

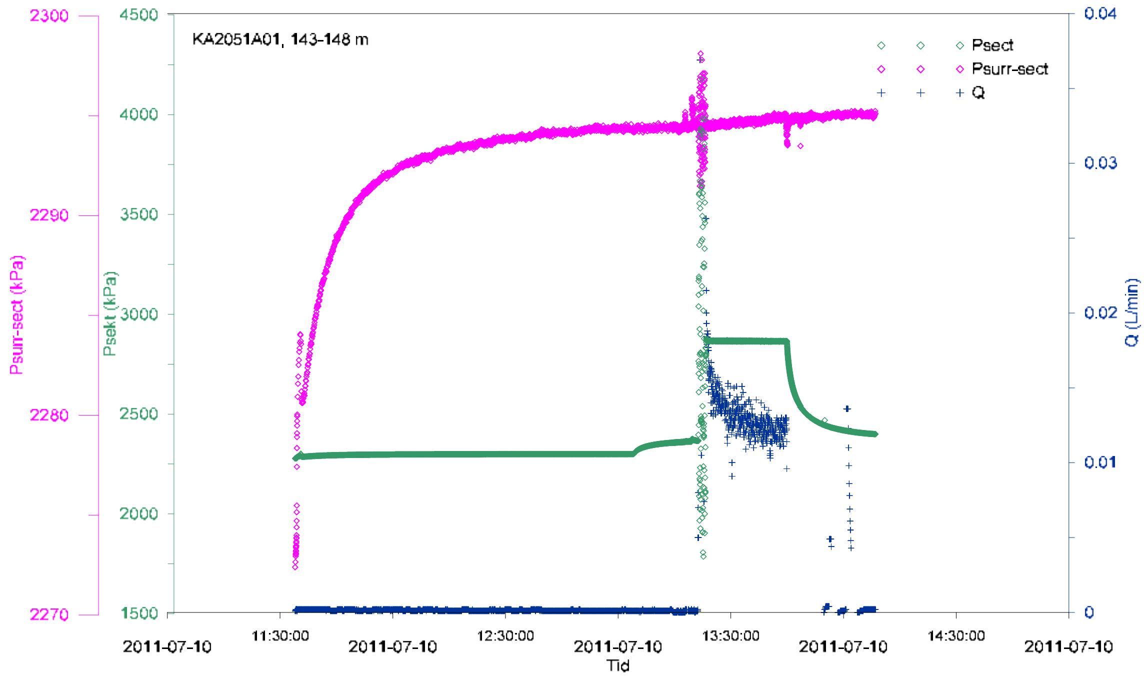

KA2051A01, 138-143 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2011-07-10
Tid


KA2051A01: Injection test 138.0-143.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.623E-8 m2/sec
S = 8.91E-8
r/B = 0.0301
r(w) = 0.3533 m

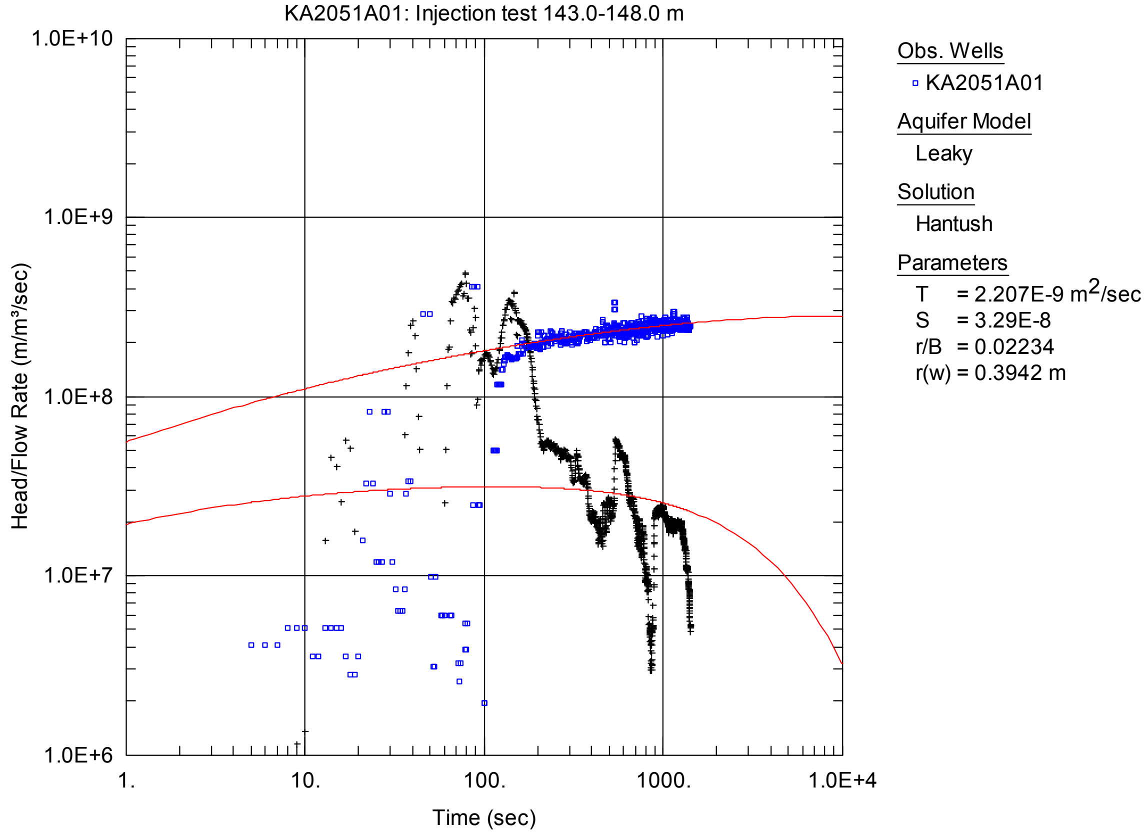

KA2051A01: Injection test 138.0-143.0 m
6.0E+7
4.0E+7
2.0E+7
0.
-2.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.623E-8 m2/sec
S = 8.91E-8
r/B = 0.0301
r(w) = 0.3533 m


KA2051A01: Injection test 138.0-143.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 5.511E-9 m2/sec
S = 5.2E-8
r/B = 0.4384
r(w) = 2.145 m
r(c) = 0.0005855 m

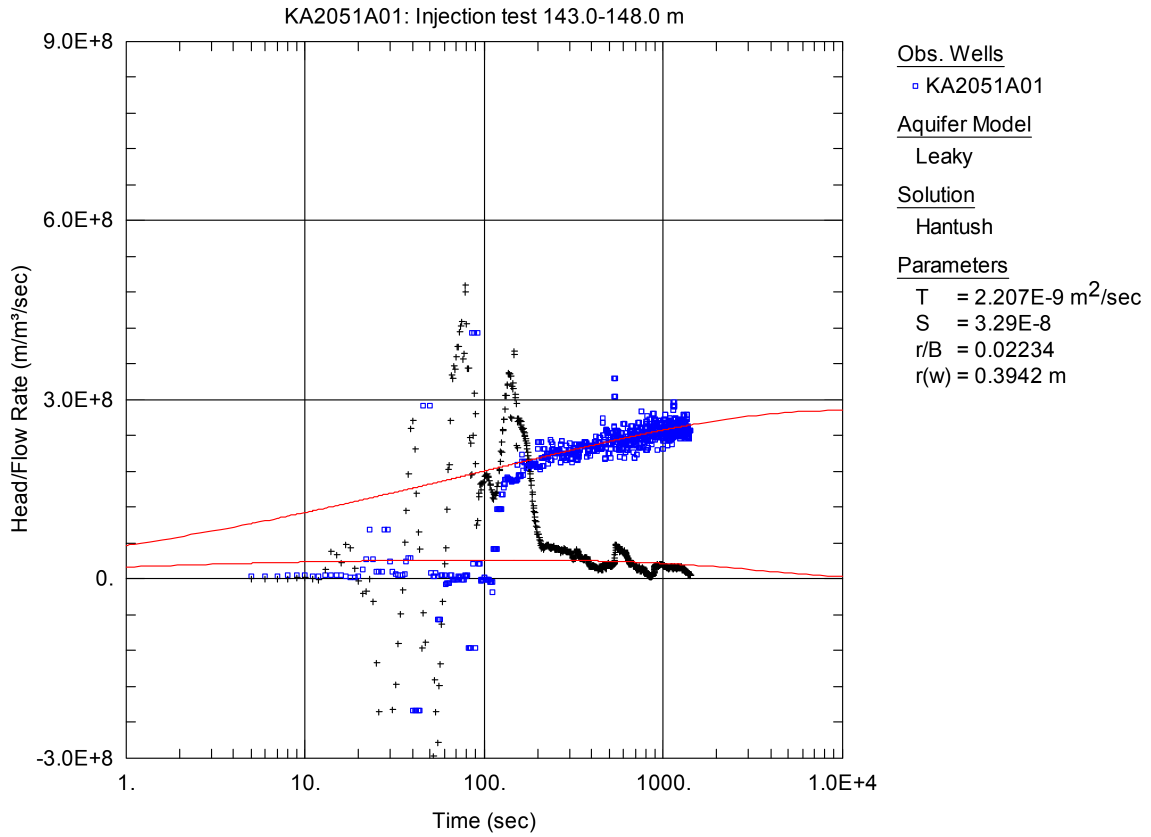

KA2051A01: Injection test 138.0-143.0 m
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 5.511E-9 m2/sec
S = 5.2E-8
r/B = 0.4384
r(w) = 2.145 m
r(c) = 0.0005855 m



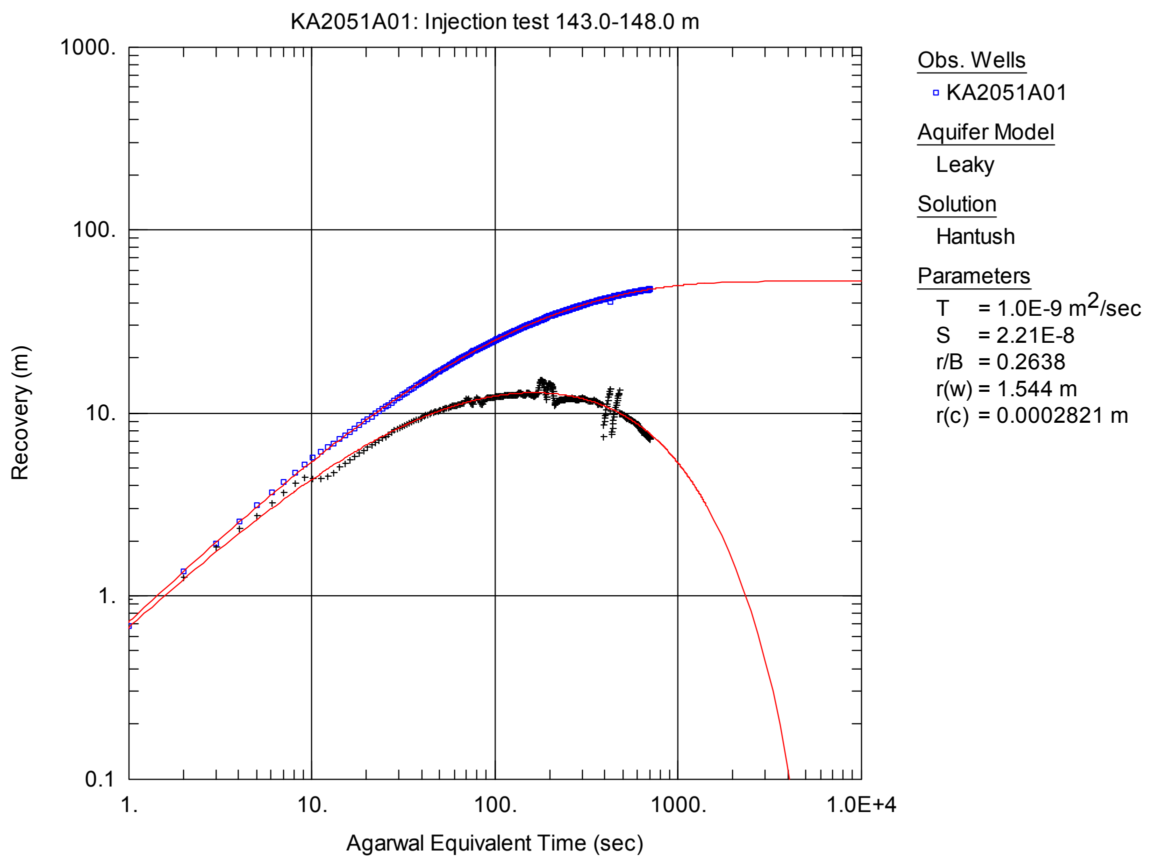
KA2051A01, 143-148 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-07-10
11:30:00
12:30:00
13:30:00
14:30:00



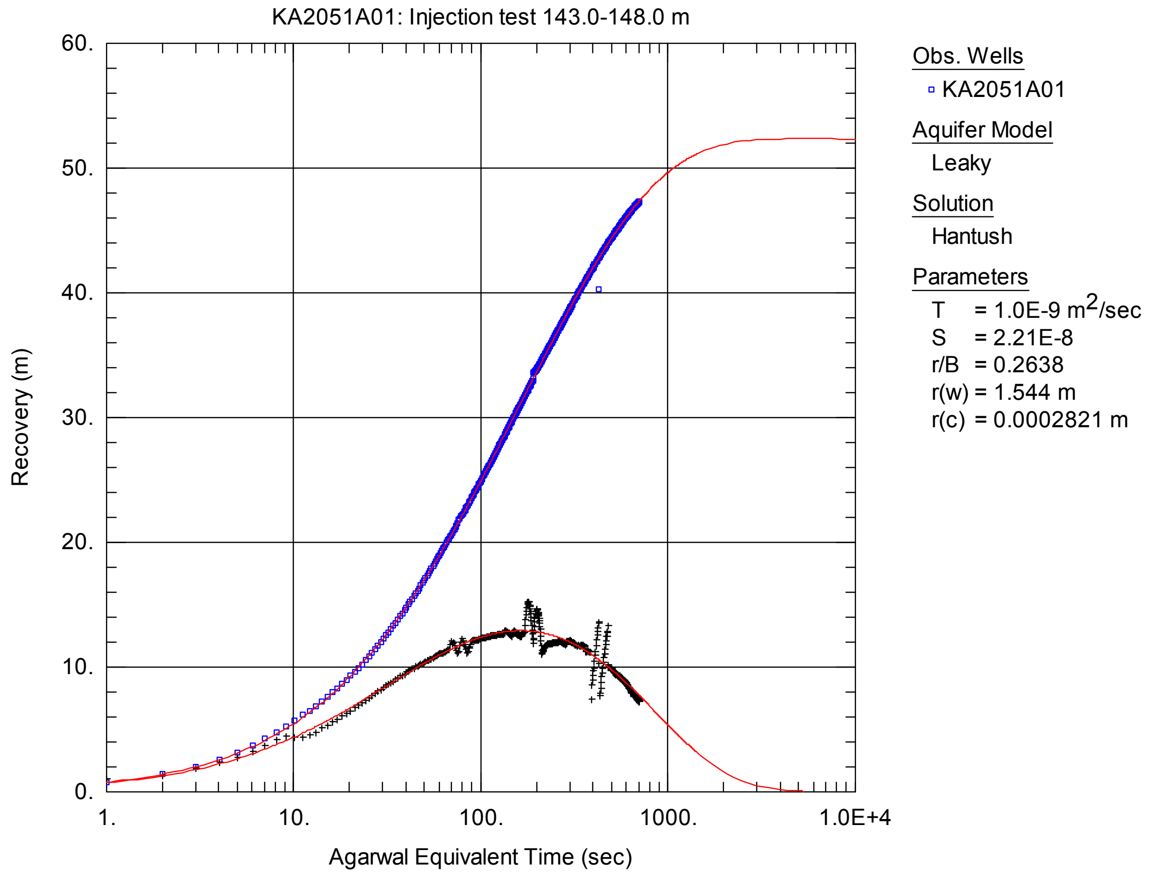
KA2051A01: Injection test 143.0-148.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.207E-9 m²/sec
S = 3.29E-8
r/B = 0.02234
r(w) = 0.3942 m

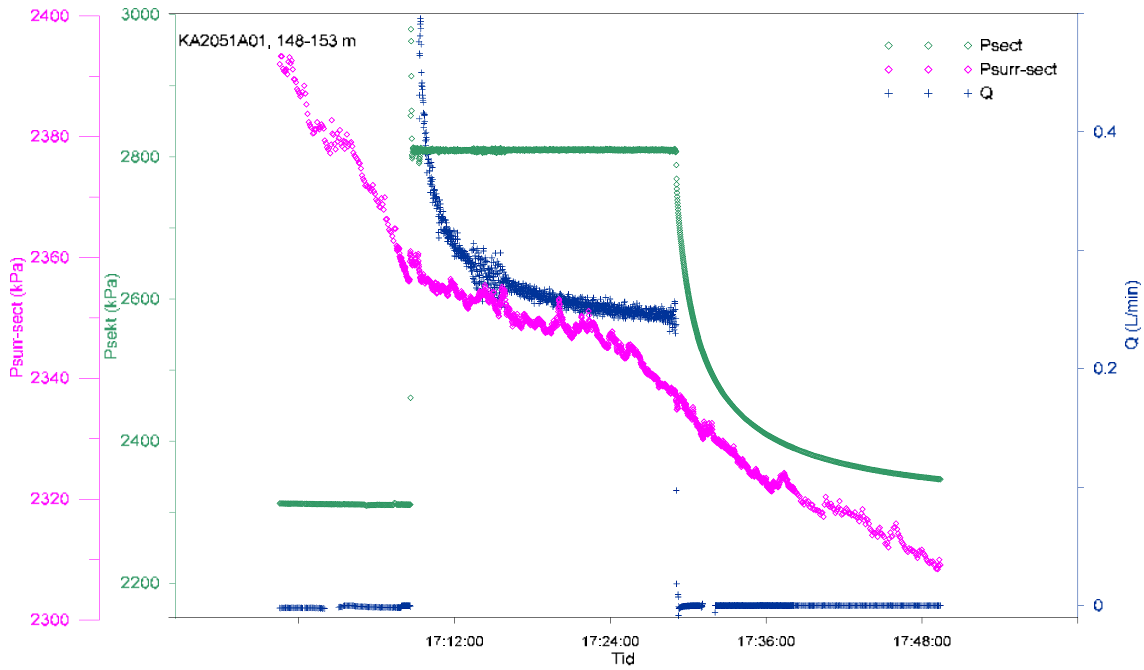


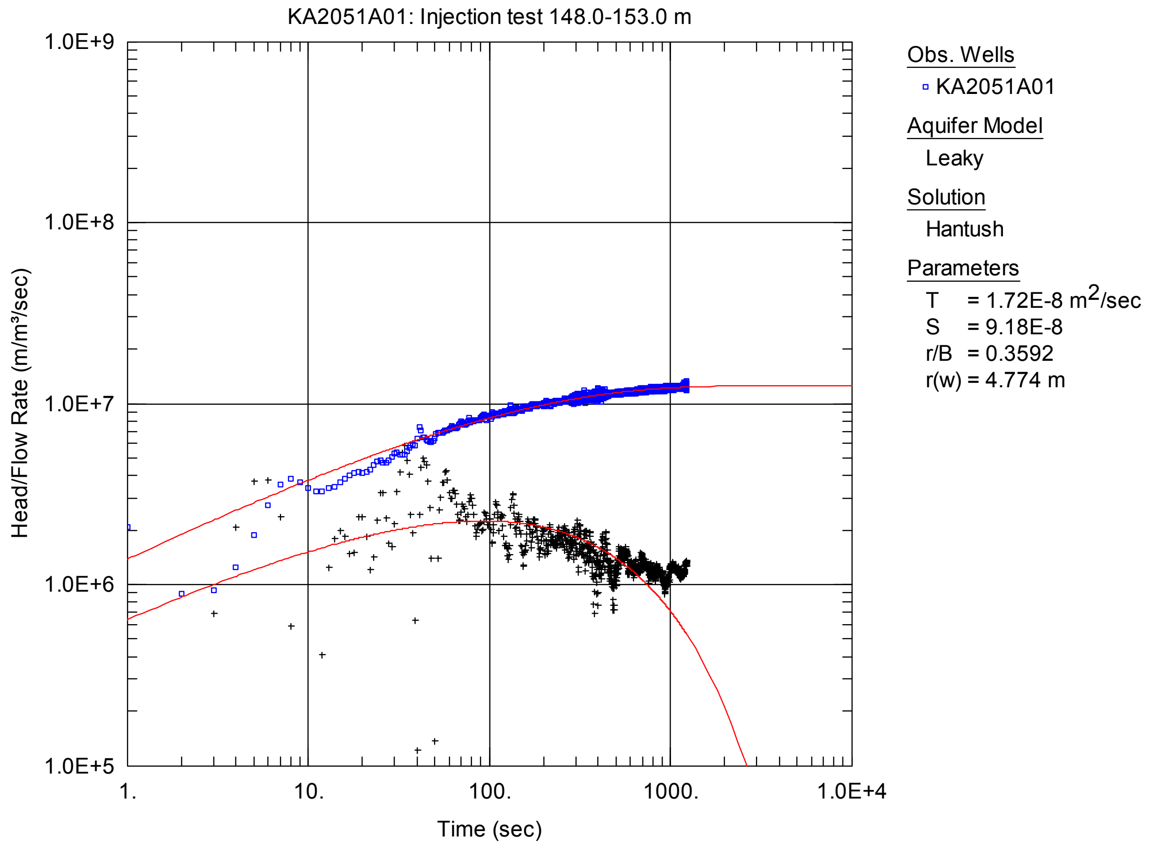
KA2051A01: Injection test 143.0-148.0 m
9.0E+8
6.0E+8
3.0E+8
0.
-3.0E+8
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.207E-9 m2/sec
S = 3.29E-8
r/B = 0.02234
r(w) = 0.3942 m



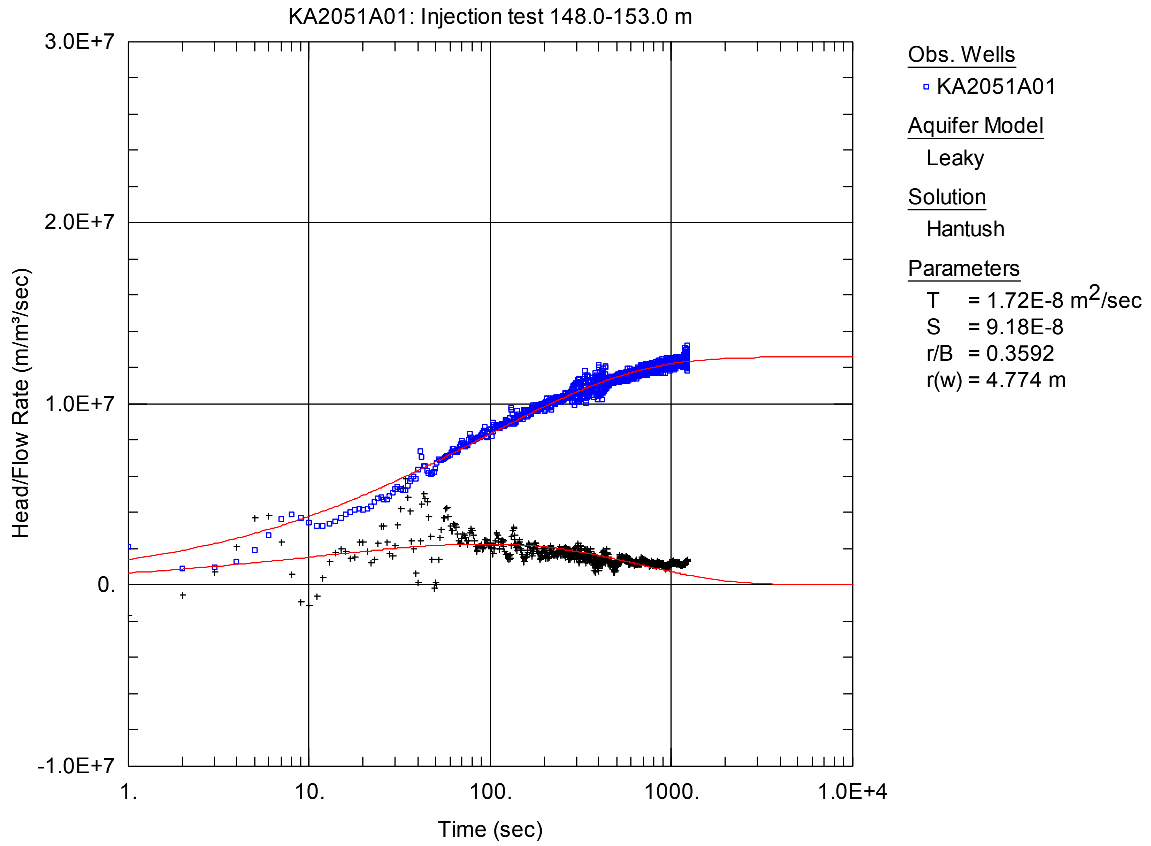
KA2051A01: Injection test 143.0-148.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.0E-9 m2/sec
S = 2.21E-8
r/B = 0.2638
r(w) = 1.544 m
r(c) = 0.0002821 m


KA2051A01: Injection test 143.0-148.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.0E-9 m2/sec
S = 2.21E-8
r/B = 0.2638
r(w) = 1.544 m
r(c) = 0.0002821 m

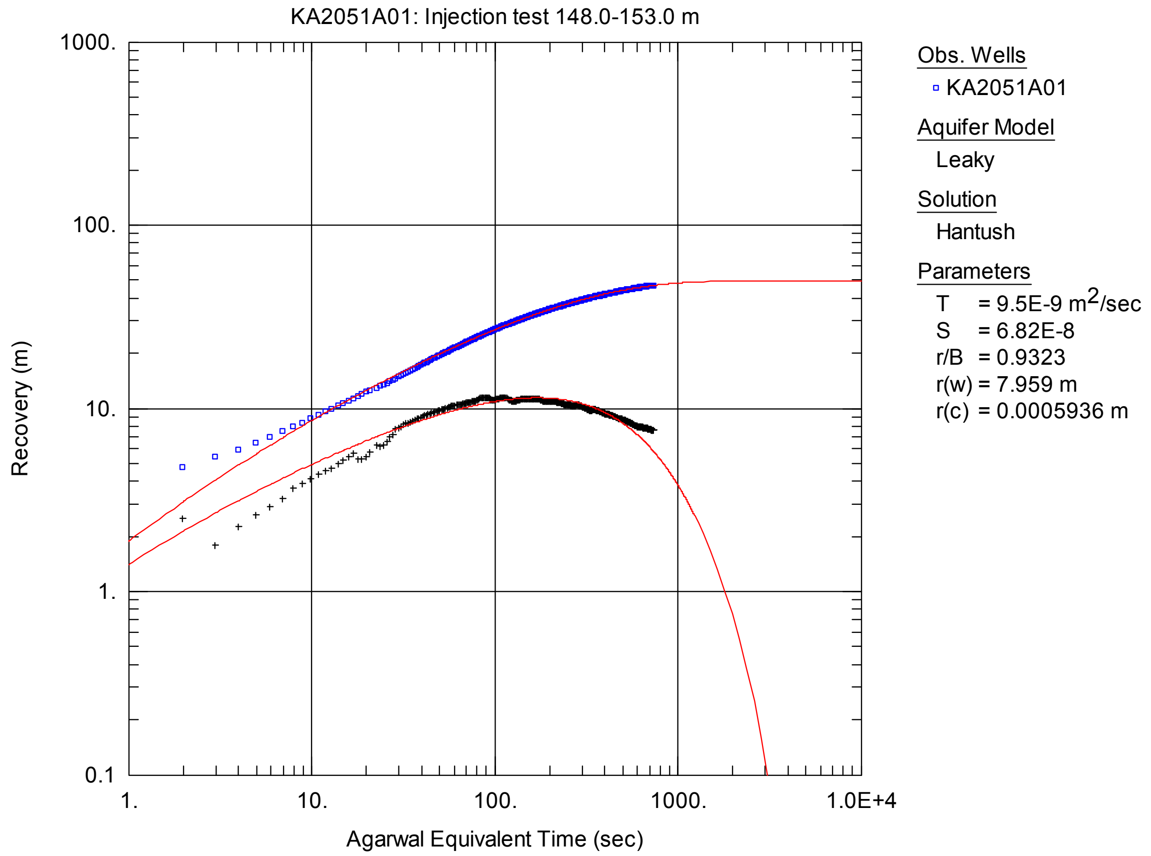

KA2051A01, 148-153 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid

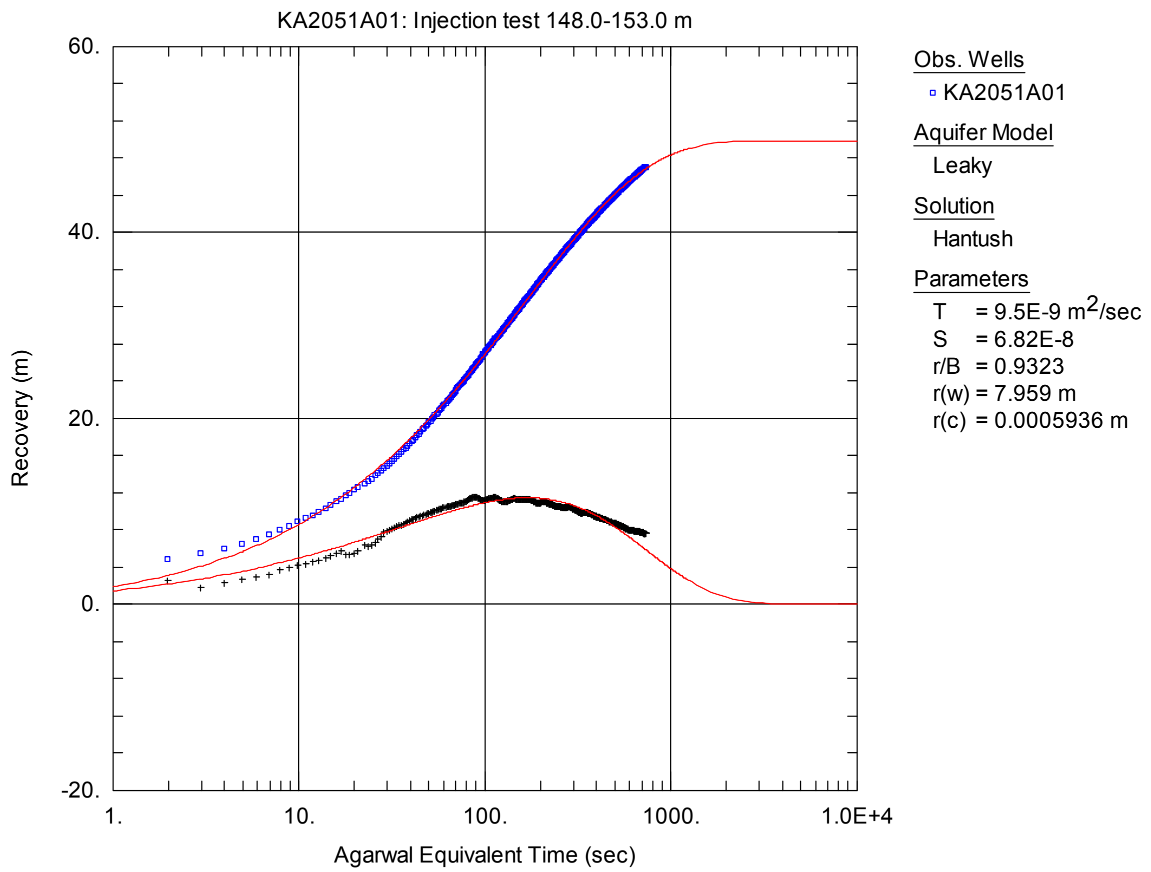


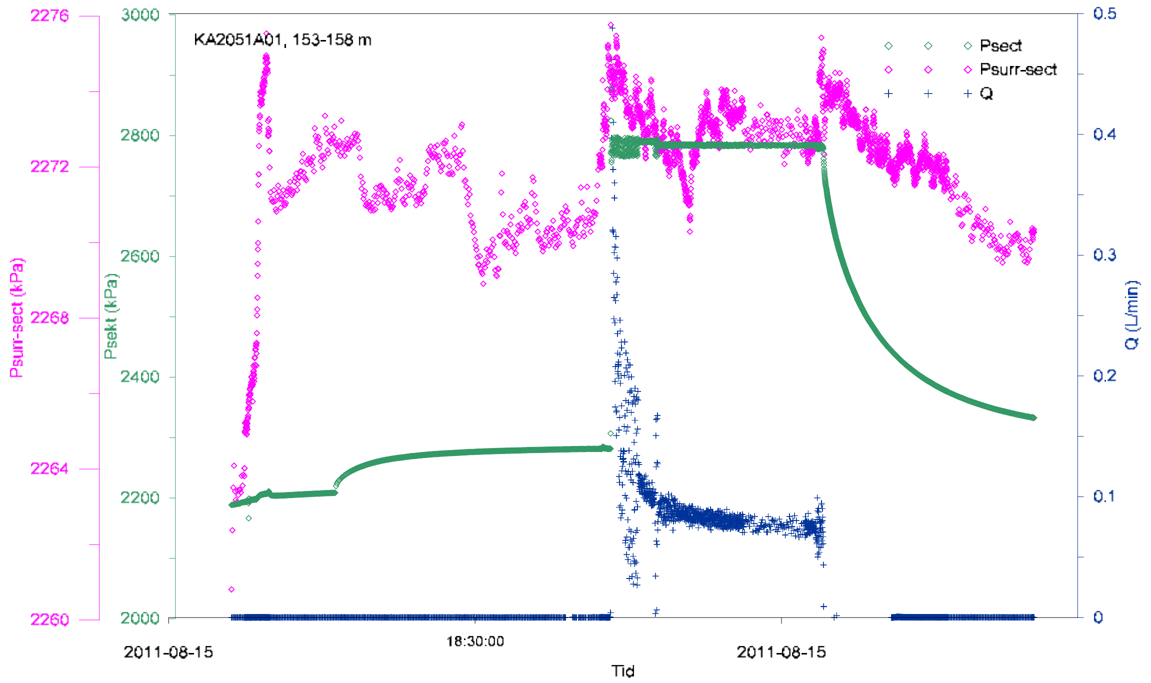
KA2051A01: Injection test 148.0-153.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.72E-8 m2/sec
S = 9.18E-8
r/B = 0.3592
r(w) = 4.774 m

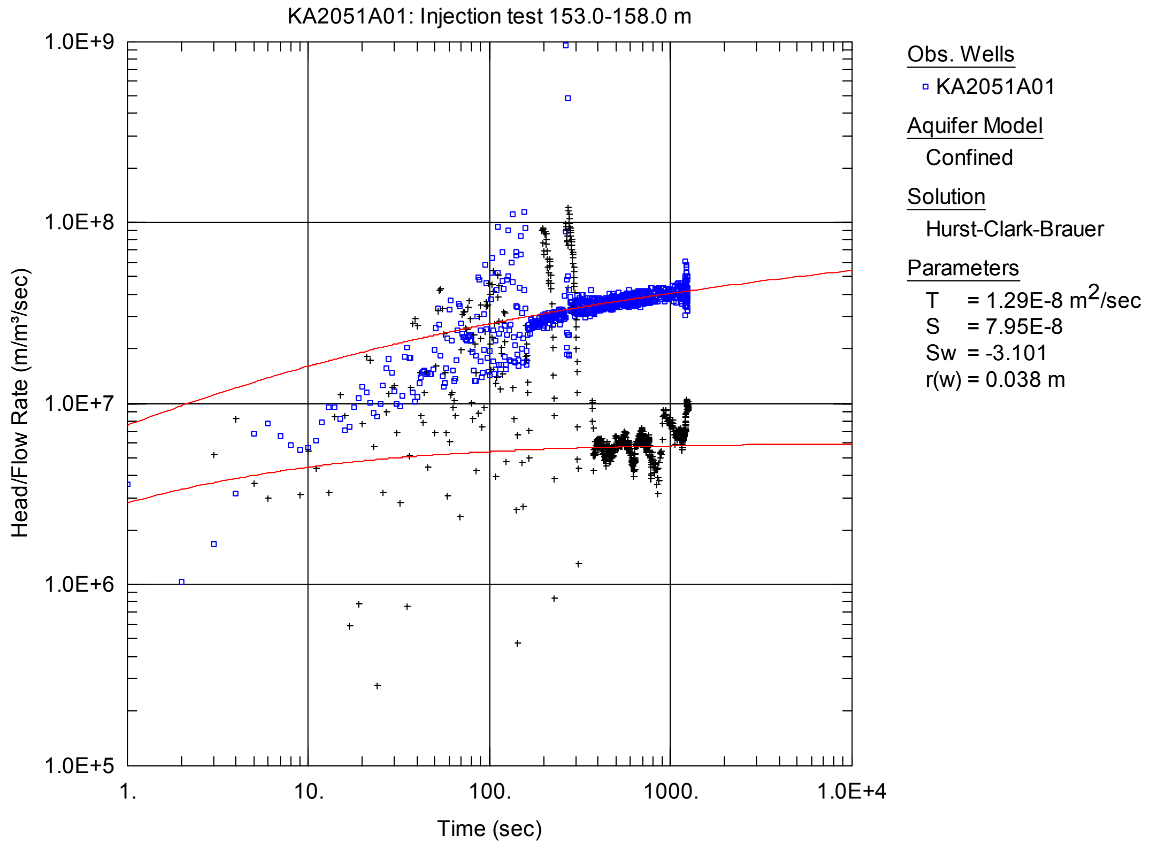


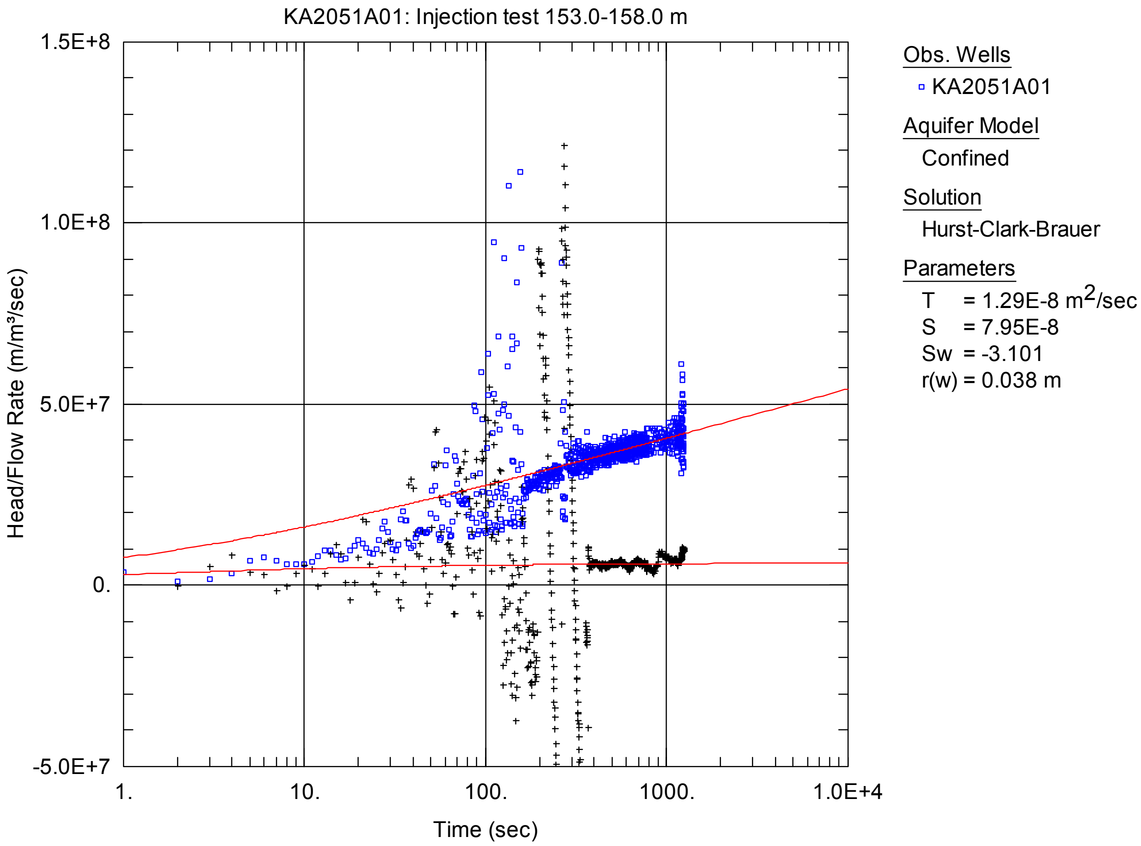
KA2051A01: Injection test 148.0-153.0 m
3.0E+7
2.0E+7
1.0E+7
0.
-1.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.72E-8 m2/sec
S = 9.18E-8
r/B = 0.3592
r(w) = 4.774 m

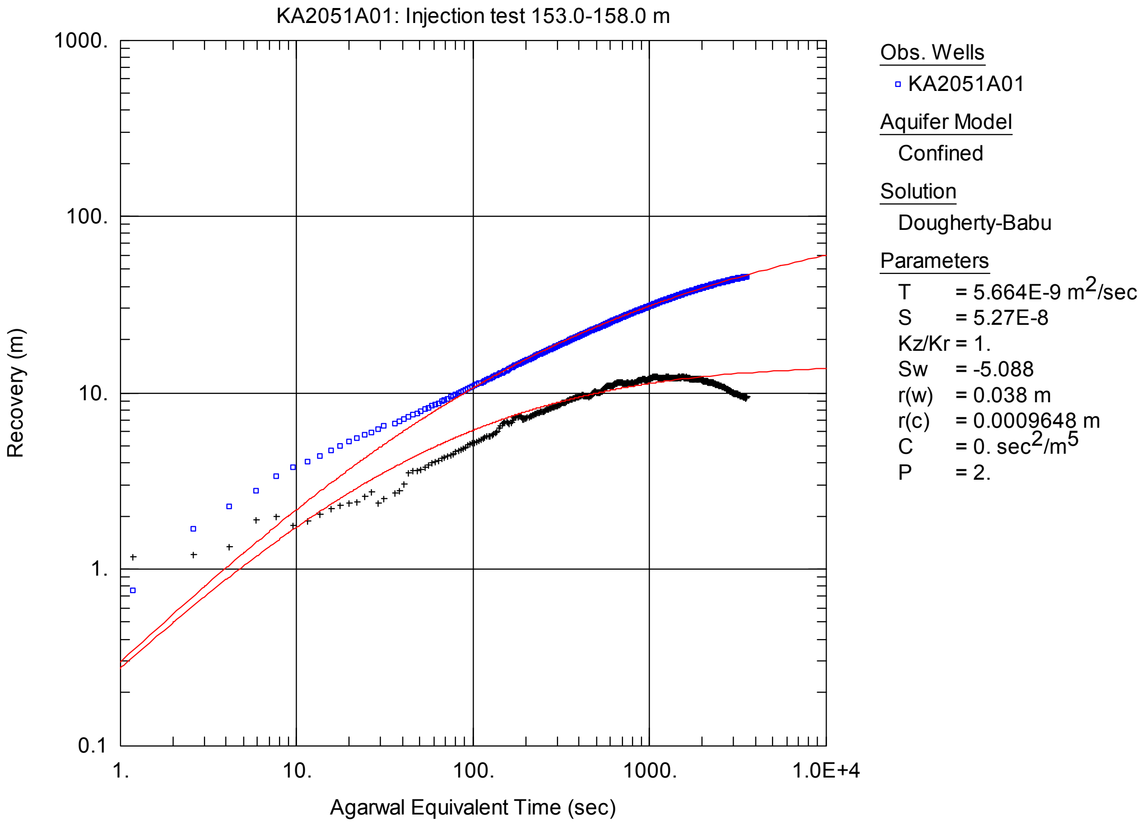

KA2051A01: Injection test 148.0-153.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.5E-9 m2/sec
S = 6.82E-8
r/B = 0.9323
r(w) = 7.959 m
r(c) = 0.0005936 m

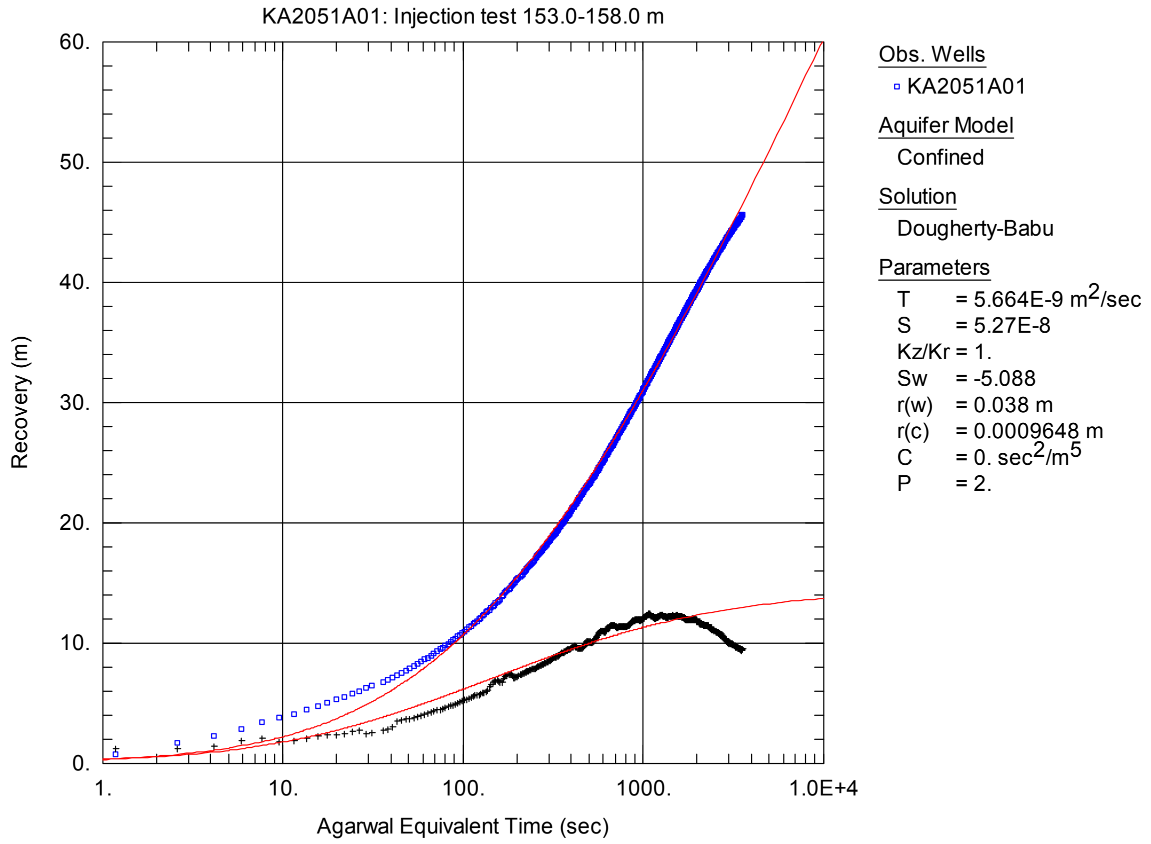

KA2051A01: Injection test 148.0-153.0 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.5E-9 m2/sec
S = 6.82E-8
r/B = 0.9323
r(w) = 7.959 m
r(c) = 0.0005936 m

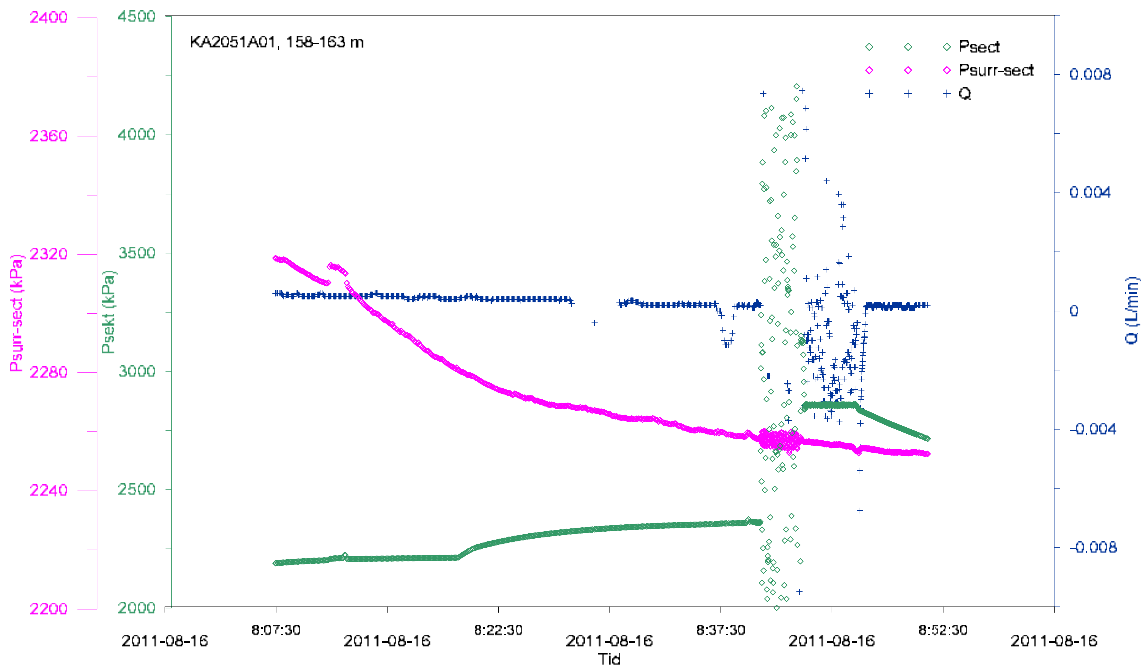

KA2051A01, 153-158 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2276
2272
2268
2264
2260
3000
2800
2600
2400
2200
2000
0.5
0.4
0.3
0.2
0.1
0
2011-08-15
18:30:00
2011-08-15
Tid

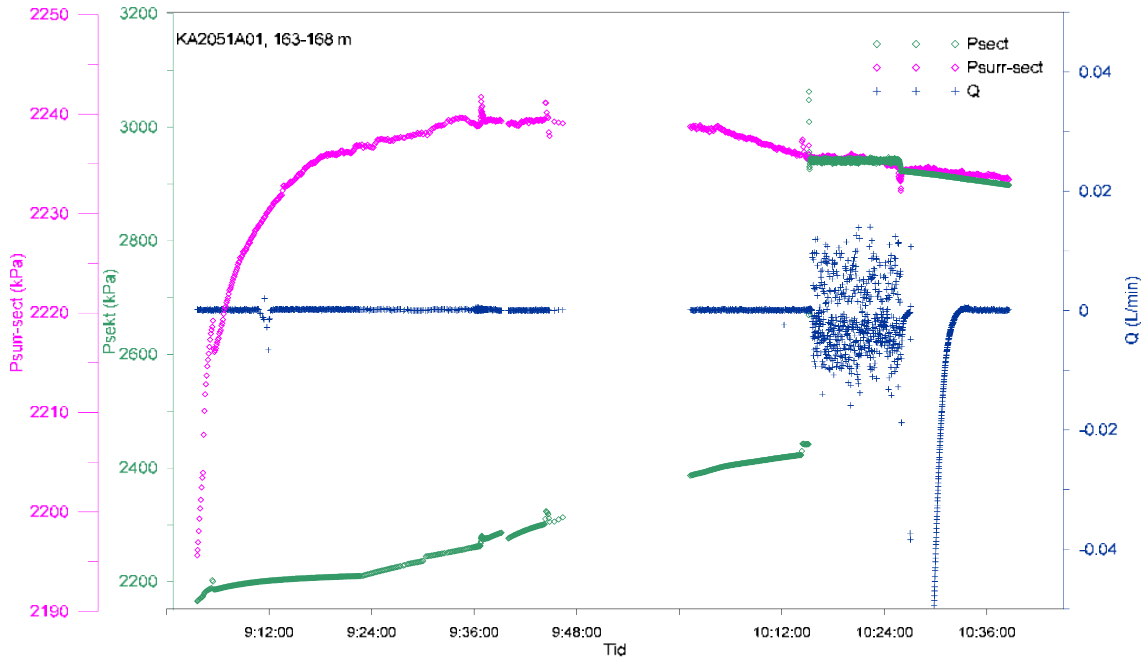

KA2051A01: Injection test 153.0-158.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.29E-8 m2/sec
S = 7.95E-8
Sw = -3.101
r(w) = 0.038 m

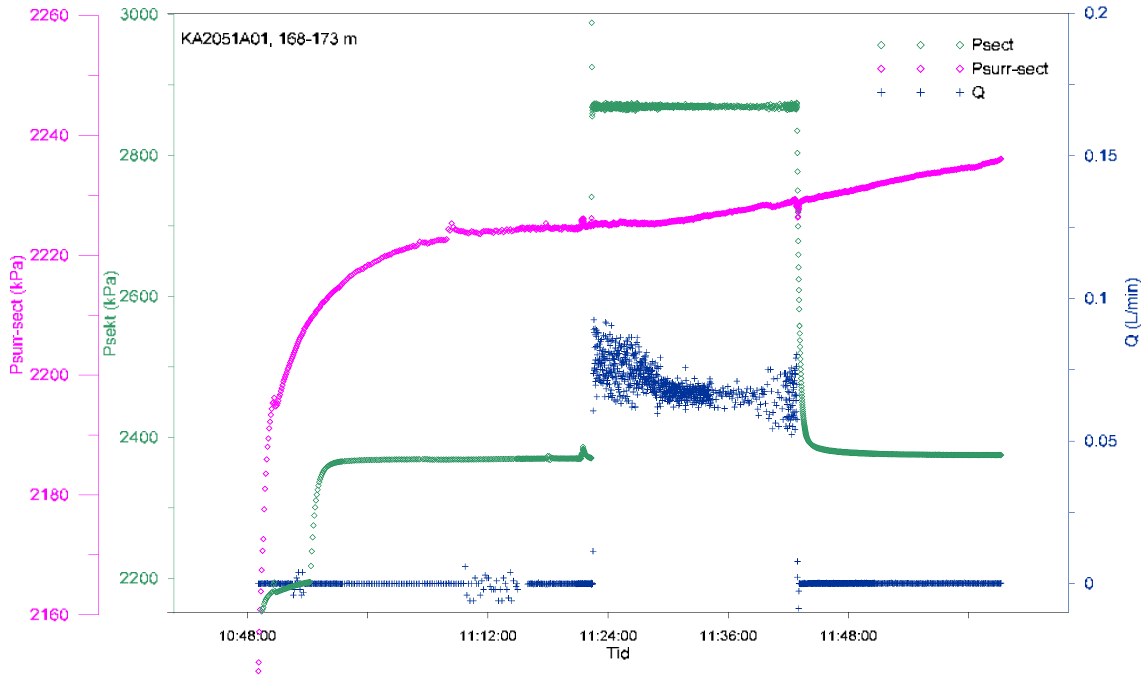

KA2051A01: Injection test 153.0-158.0 m
1.5E+8
1.0E+8
5.0E+7
0.
-5.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.29E-8 m2/sec
S = 7.95E-8
Sw = -3.101
r(w) = 0.038 m

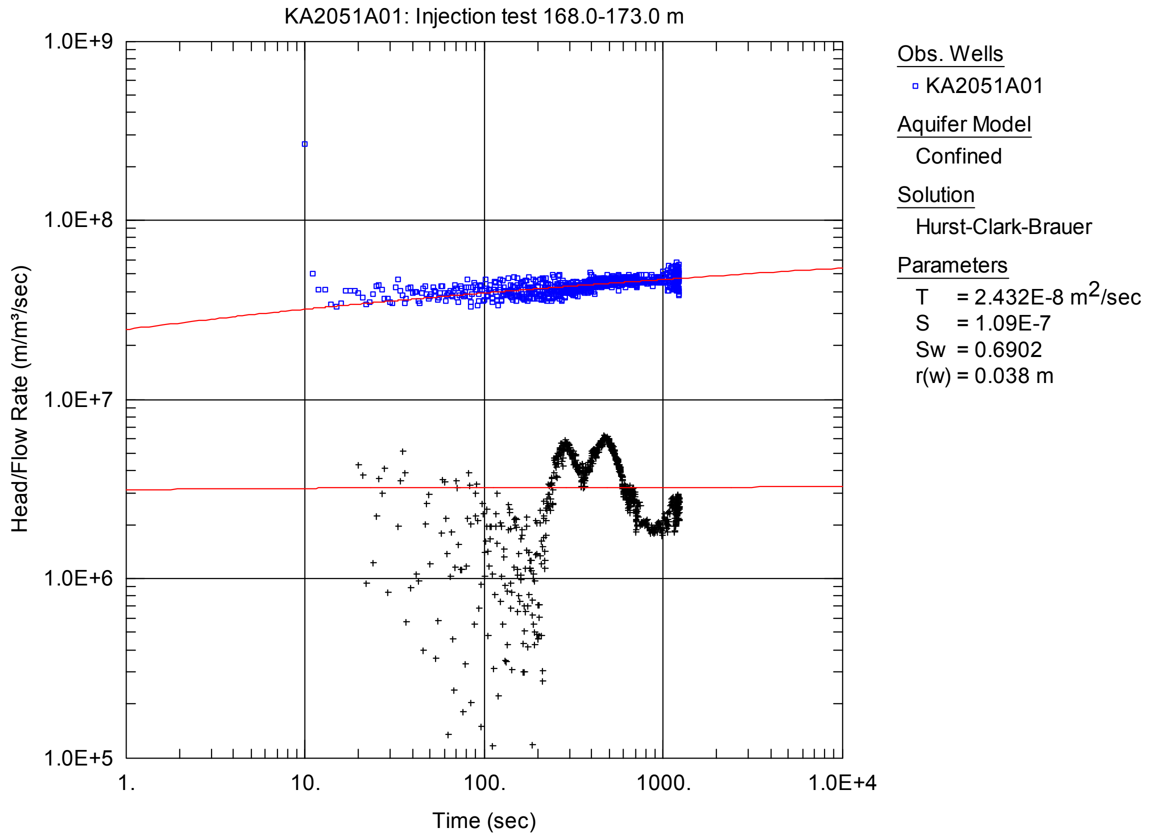

KA2051A01: Injection test 153.0-158.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 5.664E-9 m2/sec
S = 5.27E-8
Kz/Kr = 1.
Sw = -5.088
r(w) = 0.038 m
r(c) = 0.0009648 m
C = 0. sec2/m5
P = 2.

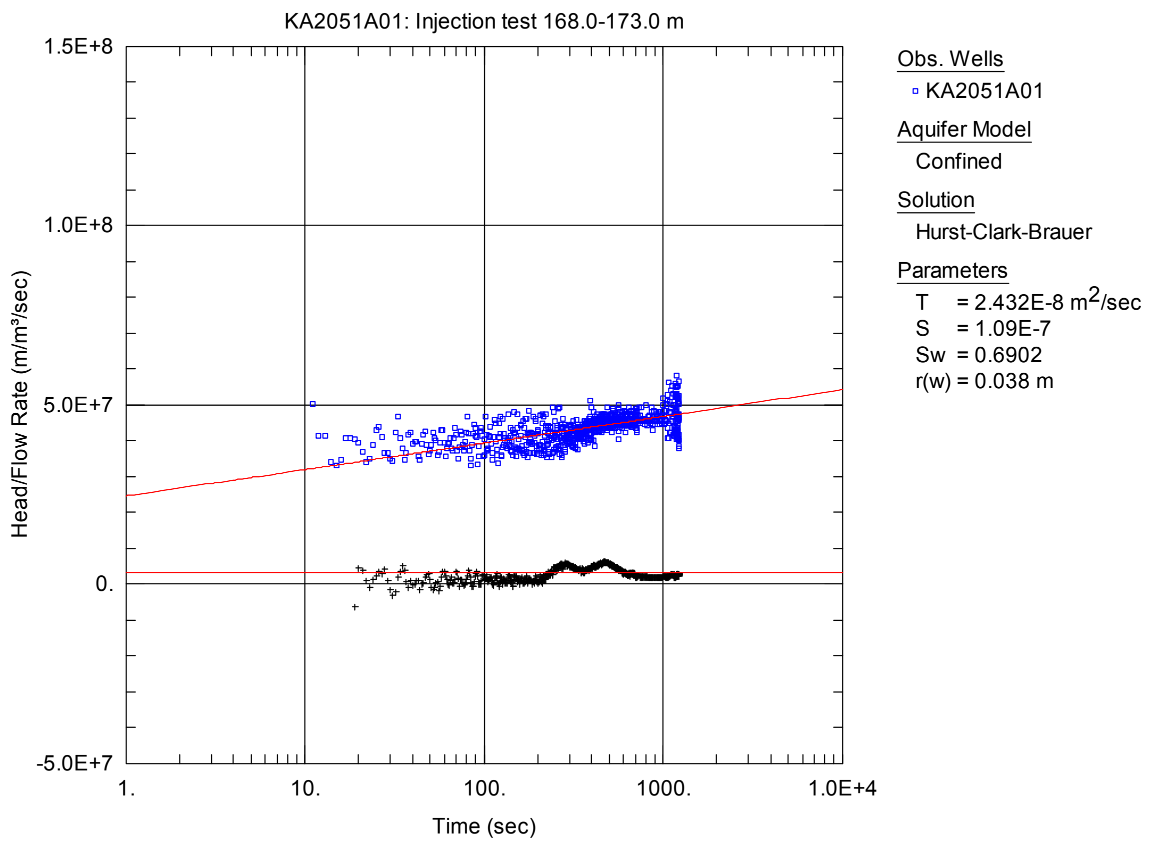

KA2051A01: Injection test 153.0-158.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 5.664E-9 m2/sec
S = 5.27E-8
Kz/Kr = 1.
Sw = -5.088
r(w) = 0.038 m
r(c) = 0.0009648 m
C = 0. sec2/m5
P = 2.

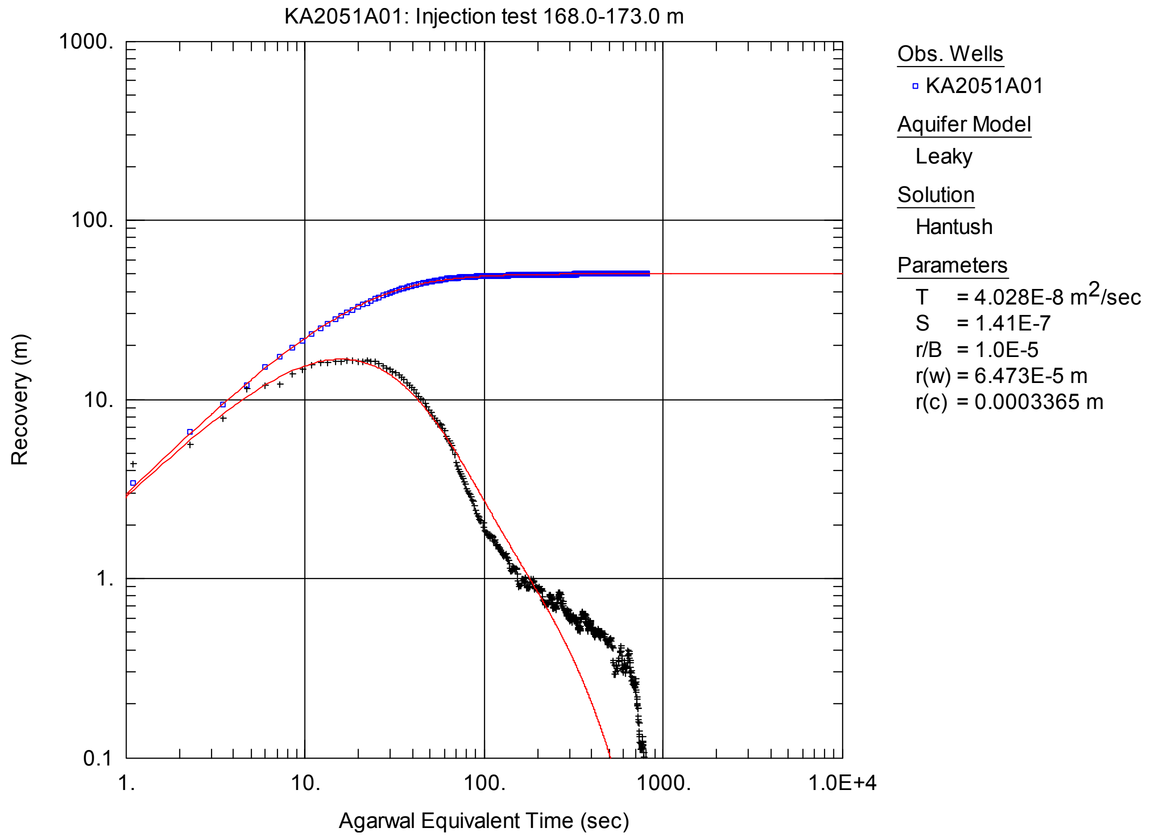

KA2051A01, 158-163 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2400
2360
2320
2280
2240
2200
4500
4000
3500
3000
2500
2000
0.008
0.004
0
-0.004
-0.008
2011-08-16
8:07:30
2011-08-16
8:22:30
2011-08-16
8:37:30
2011-08-16
8:52:30
2011-08-16
Tid

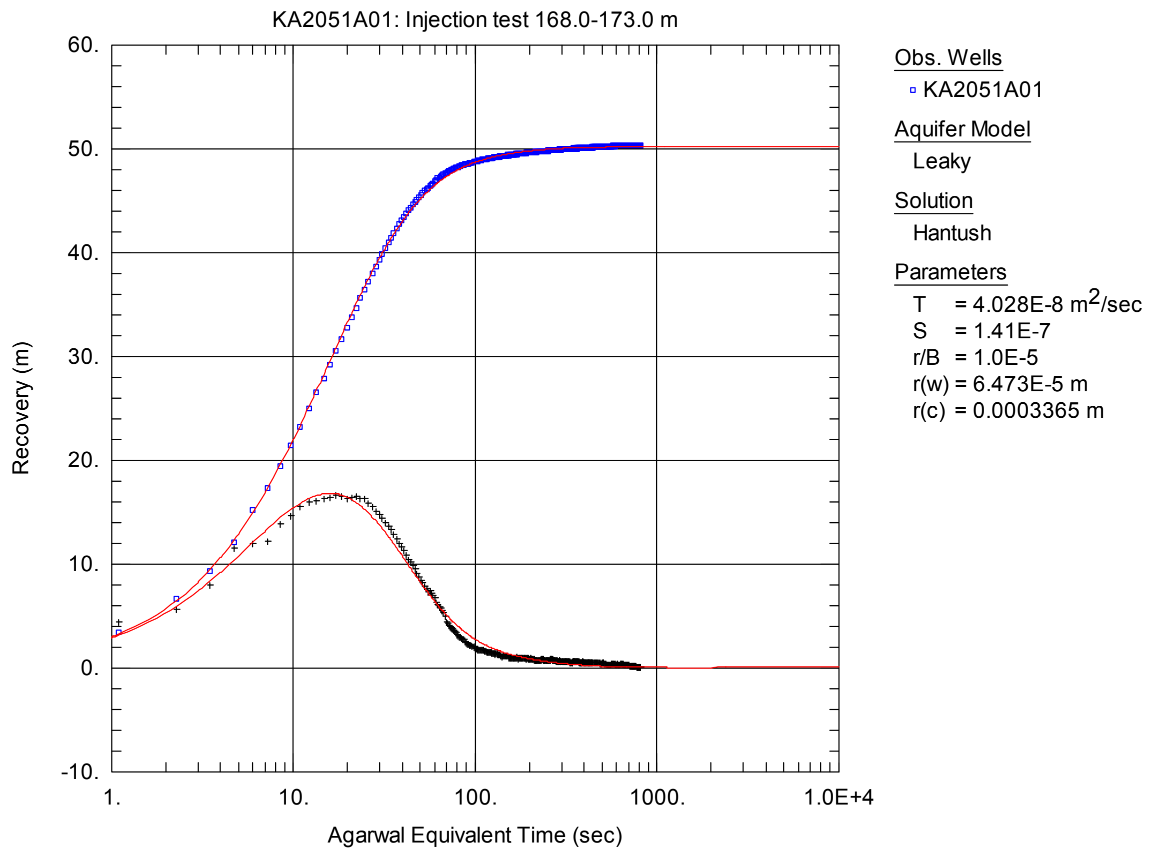

KA2051A01, 163-168 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2250
2240
2230
2220
2210
2200
2190
3200
3000
2800
2600
2400
2200
0.04
0.02
0
-0.02
-0.04
9:12:00
9:24:00
9:36:00
9:48:00
10:12:00
10:24:00
10:36:00

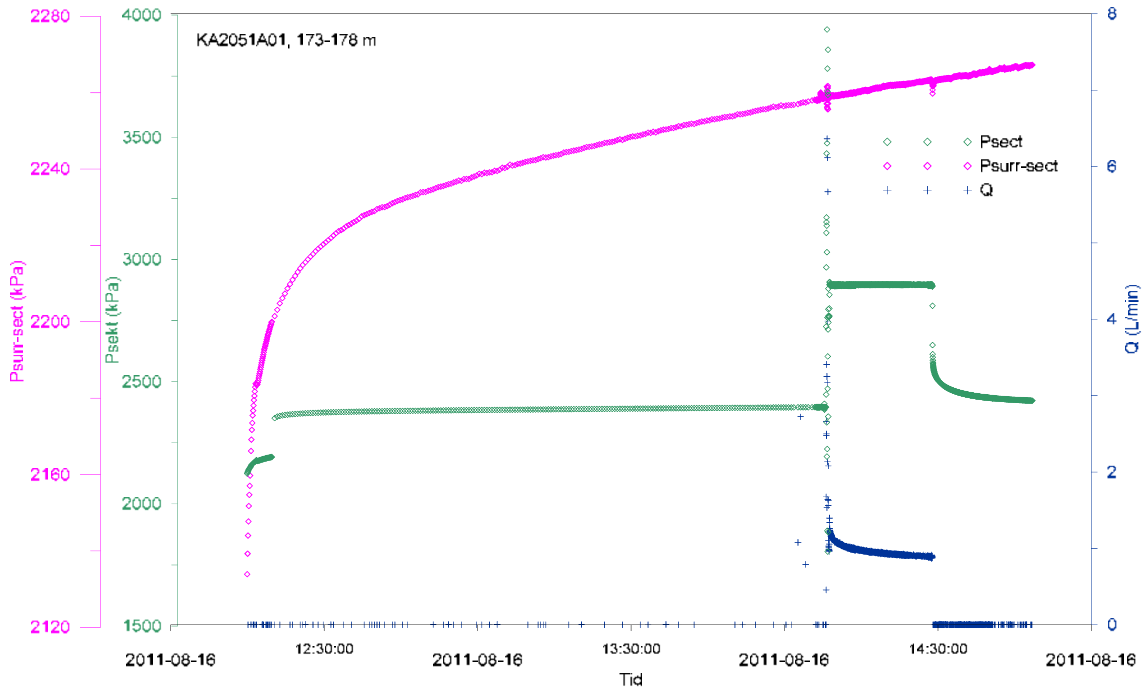

KA2051A01, 168-173 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2260
2240
2220
2200
2180
2160
3000
2800
2600
2400
2200
0.2
0.15
0.1
0.05
0
10:48:00
11:12:00
11:24:00
11:36:00
11:48:00

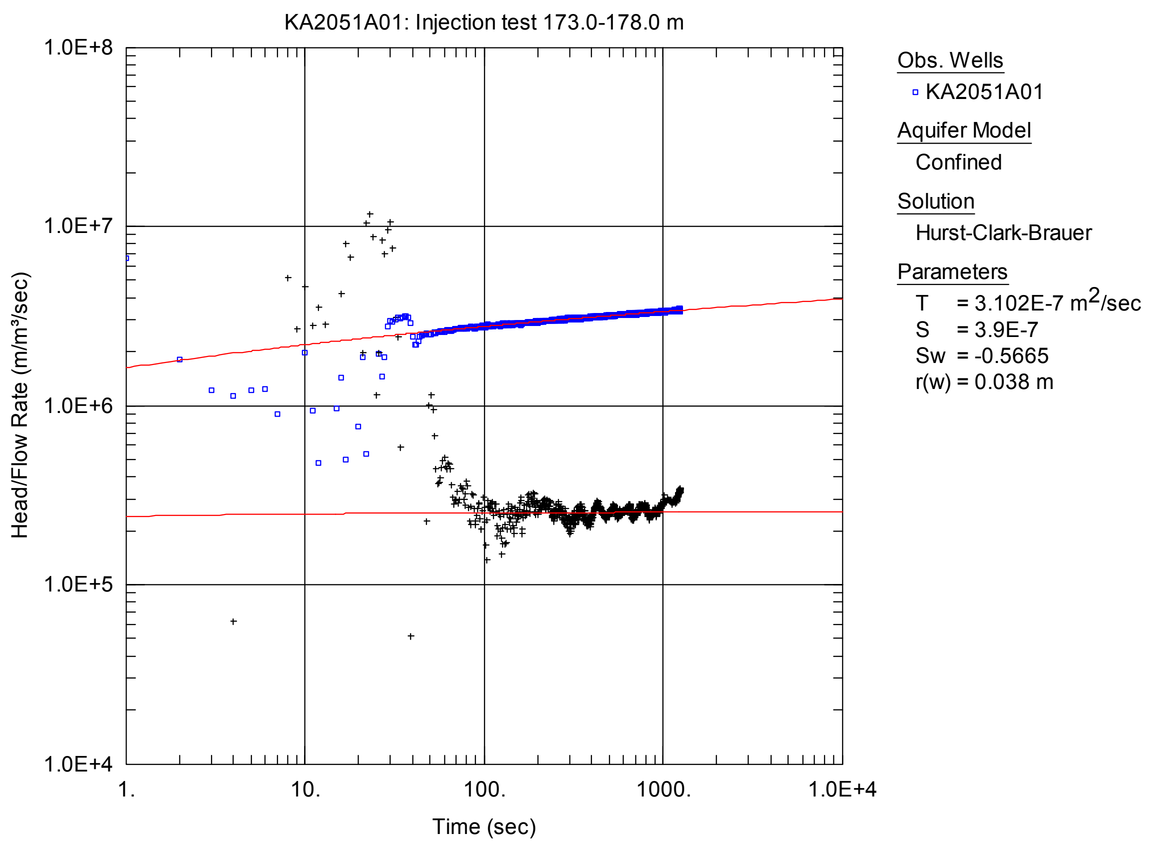

KA2051A01: Injection test 168.0-173.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.432E-8 m2/sec
S = 1.09E-7
Sw = 0.6902
r(w) = 0.038 m

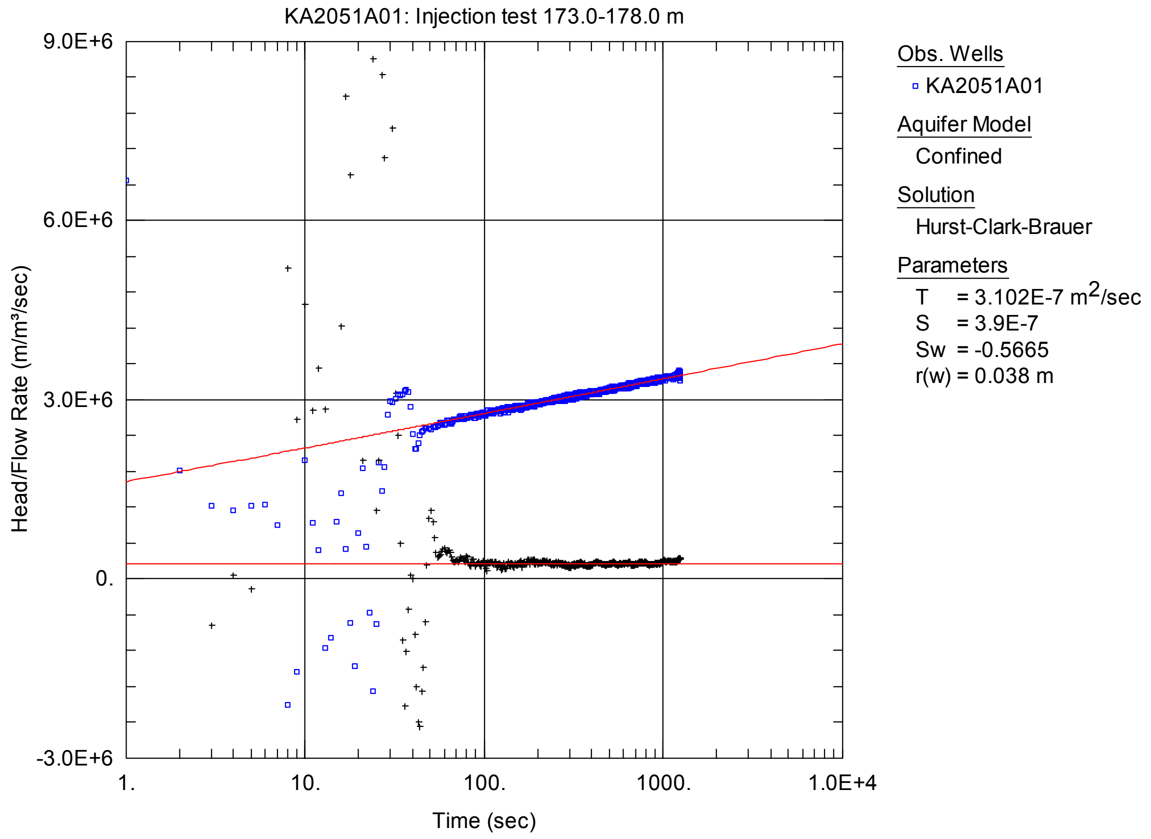

KA2051A01: Injection test 168.0-173.0 m
1.5E+8
1.0E+8
5.0E+7
0.
-5.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.432E-8 m2/sec
S = 1.09E-7
Sw = 0.6902
r(w) = 0.038 m


KA2051A01: Injection test 168.0-173.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.028E-8 m2/sec
S = 1.41E-7
r/B = 1.0E-5
r(w) = 6.473E-5 m
r(c) = 0.0003365 m

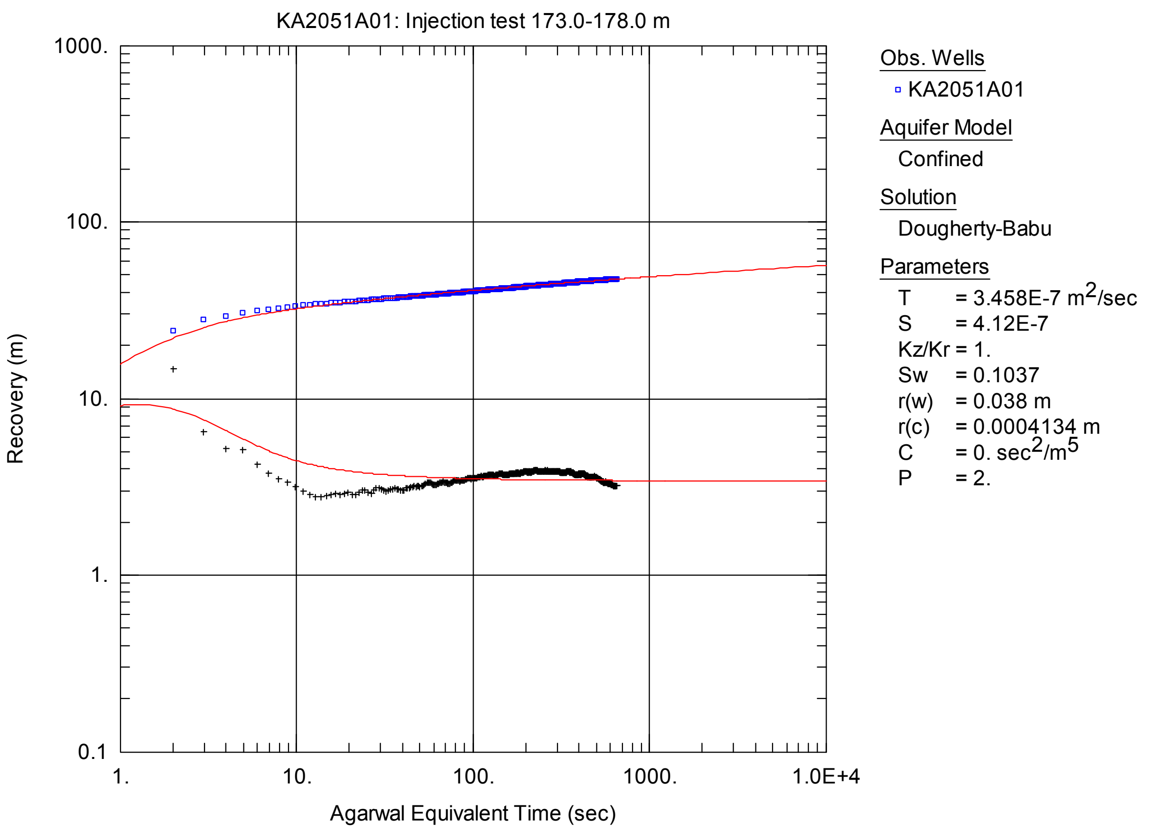

KA2051A01: Injection test 168.0-173.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
-10.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.028E-8 m2/sec
S = 1.41E-7
r/B = 1.0E-5
r(w) = 6.473E-5 m
r(c) = 0.0003365 m


KA2051A01, 173-178 m
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Psect
Psurr-sect
Q
2011-08-16
12:30:00
13:30:00
14:30:00
Tid

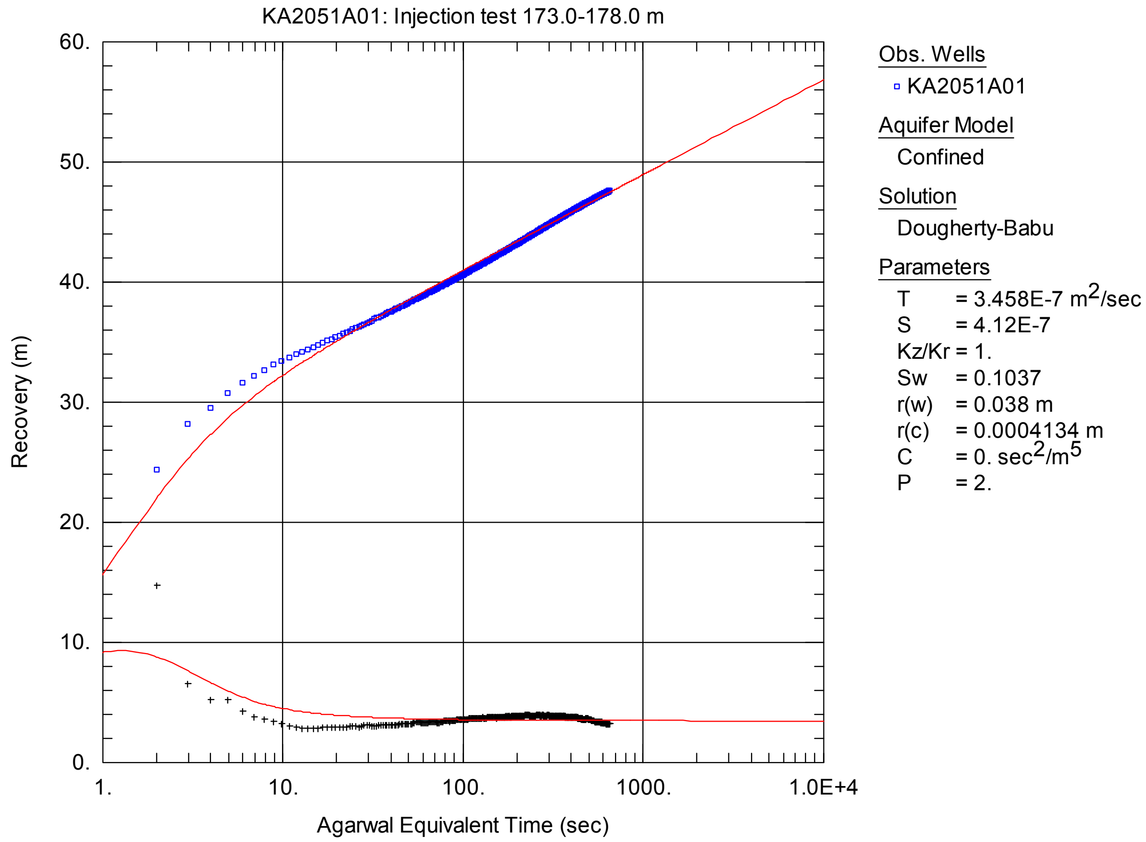

KA2051A01: Injection test 173.0-178.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.102E-7 m²/sec
S = 3.9E-7
Sw = -0.5665
r(w) = 0.038 m

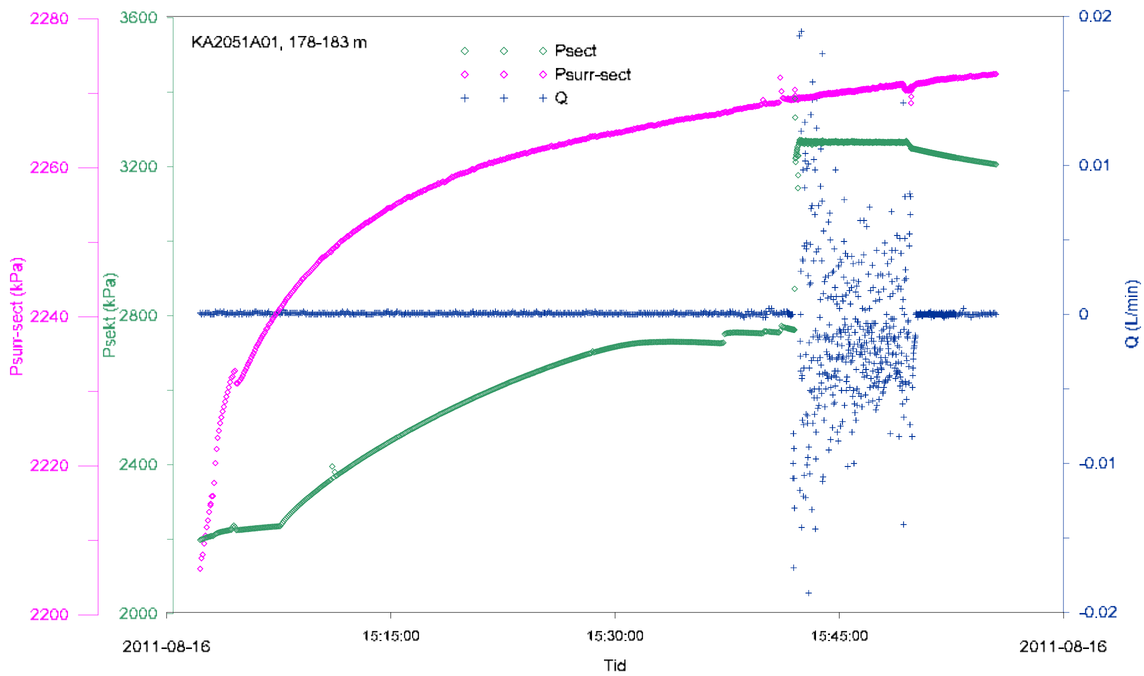


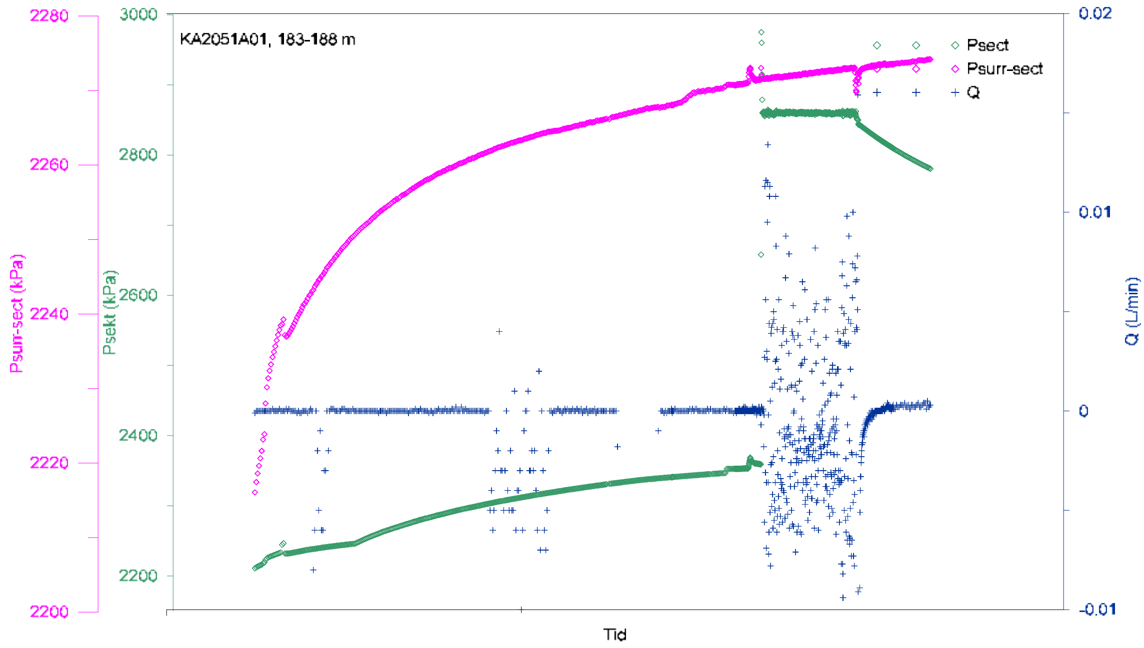
KA2051A01: Injection test 173.0-178.0 m
9.0E+6
6.0E+6
3.0E+6
0.
-3.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.102E-7 m²/sec
S = 3.9E-7
Sw = -0.5665
r(w) = 0.038 m

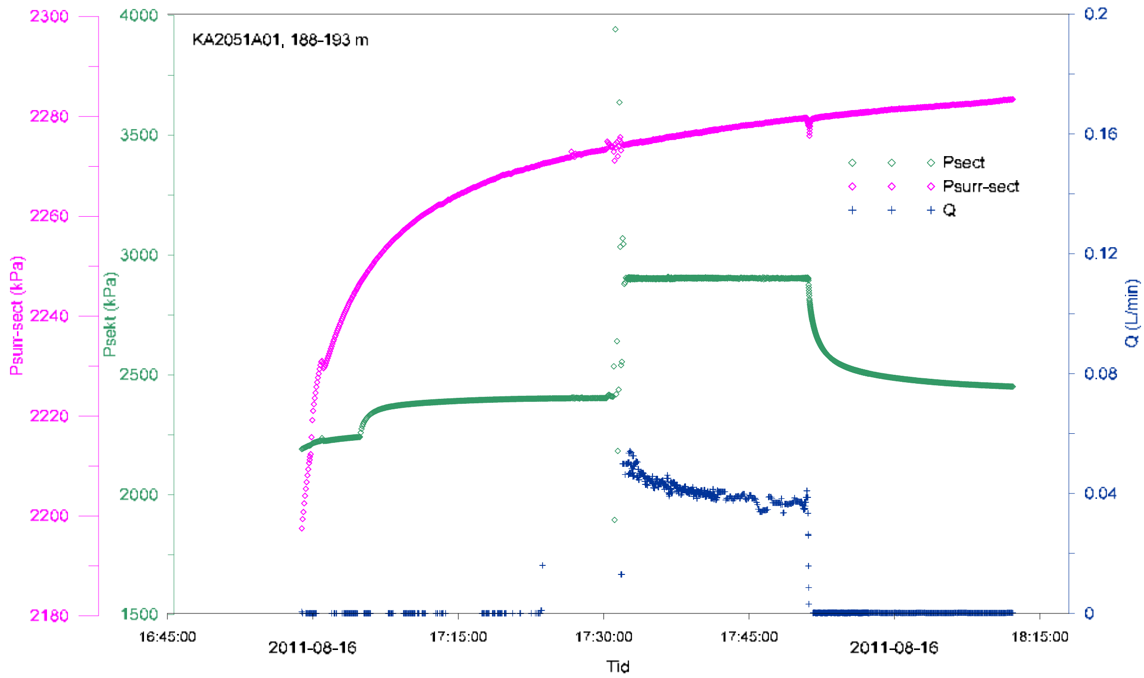


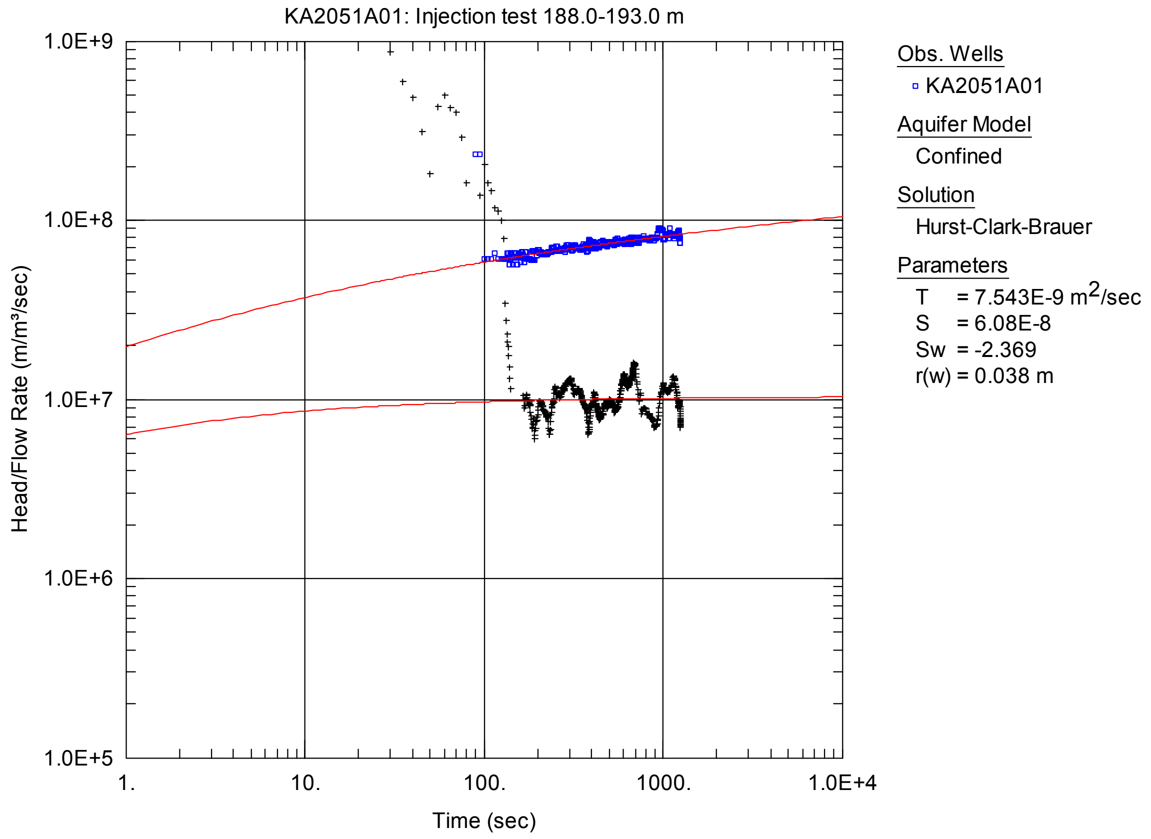
KA2051A01: Injection test 173.0-178.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.458E-7 m²/sec
S = 4.12E-7
Kz/Kr = 1.
Sw = 0.1037
r(w) = 0.038 m
r(c) = 0.0004134 m
C = 0. sec²/m⁵
P = 2.

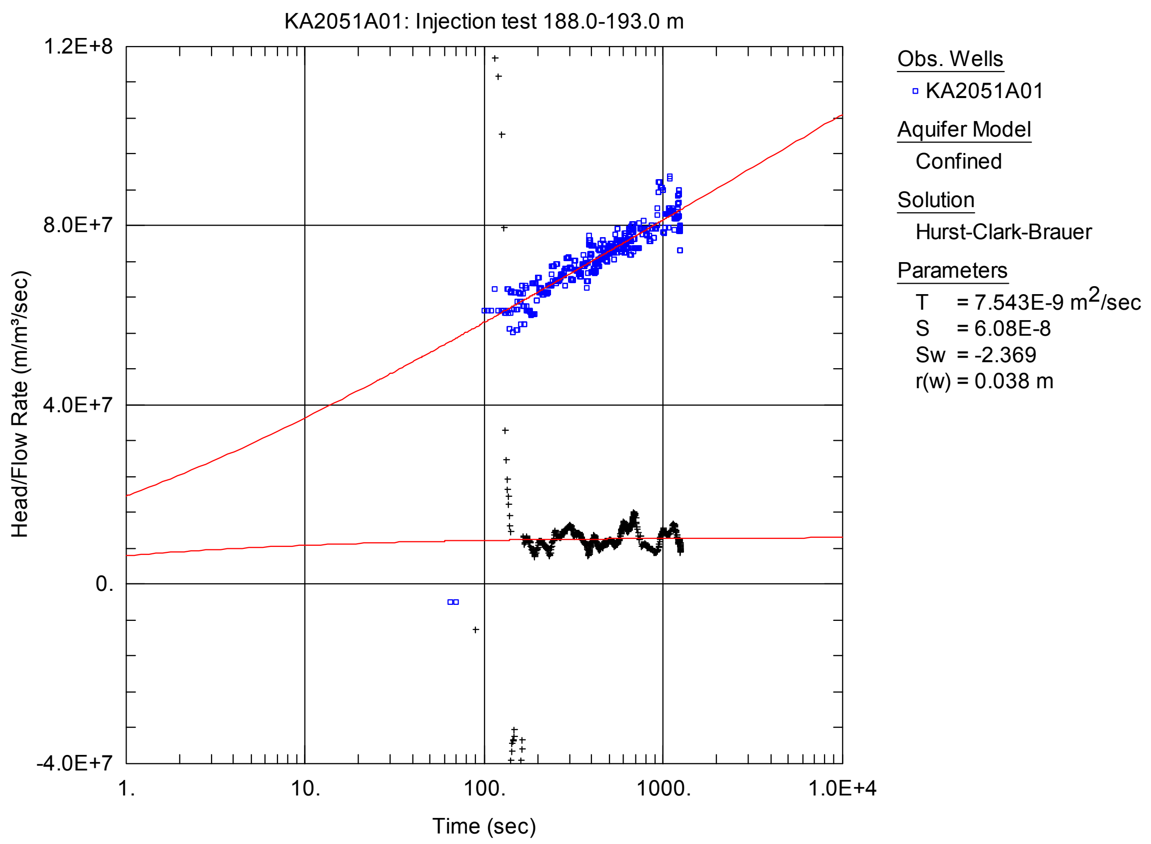

KA2051A01: Injection test 173.0-178.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.458E-7 m2/sec
S = 4.12E-7
Kz/Kr = 1.
Sw = 0.1037
r(w) = 0.038 m
r(c) = 0.0004134 m
C = 0. sec2/m5
P = 2.

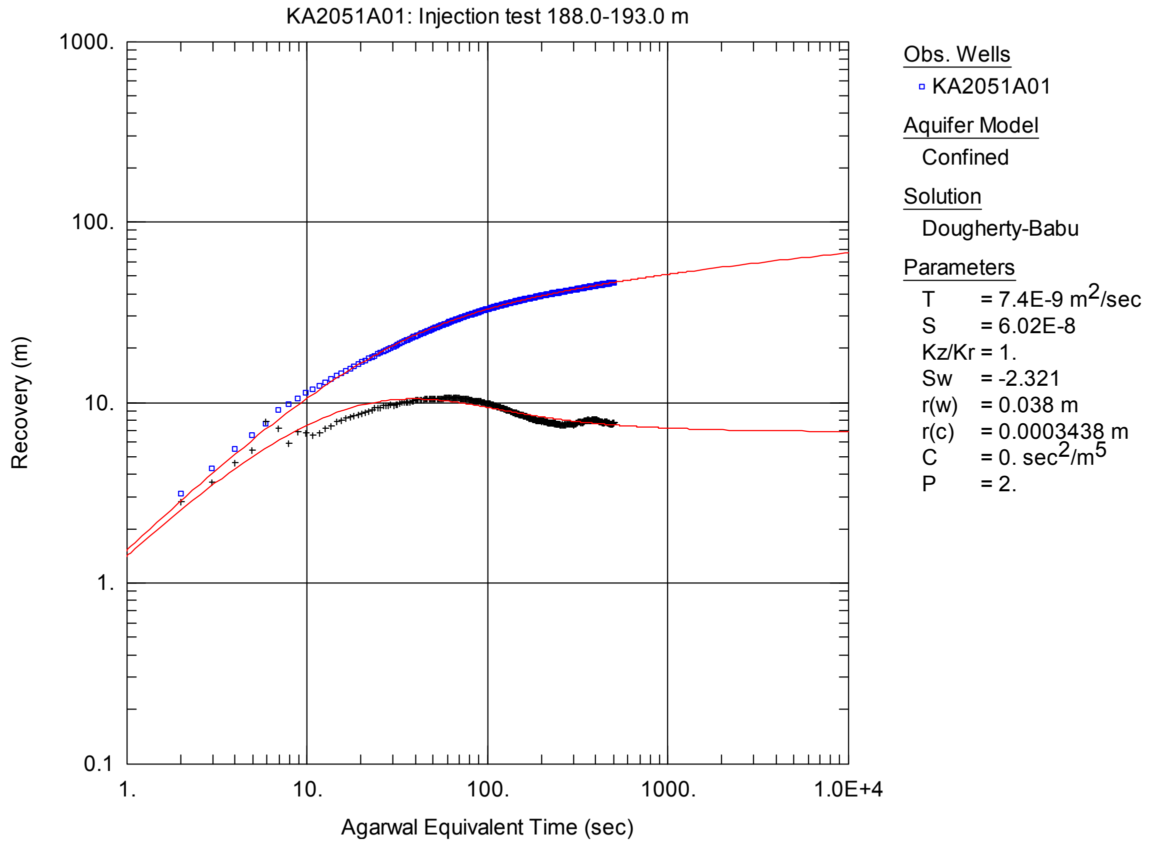

KA2051A01, 178-183 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2280
2260
2240
2220
2200
3600
3200
2800
2400
2000
0.02
0.01
0
-0.01
-0.02
2011-08-16
15:15:00
15:30:00
15:45:00
2011-08-16
Tid


KA2051A01, 183-188 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2280
2260
2240
2220
2200
3000
2800
2600
2400
2200
0.02
0.01
0
-0.01

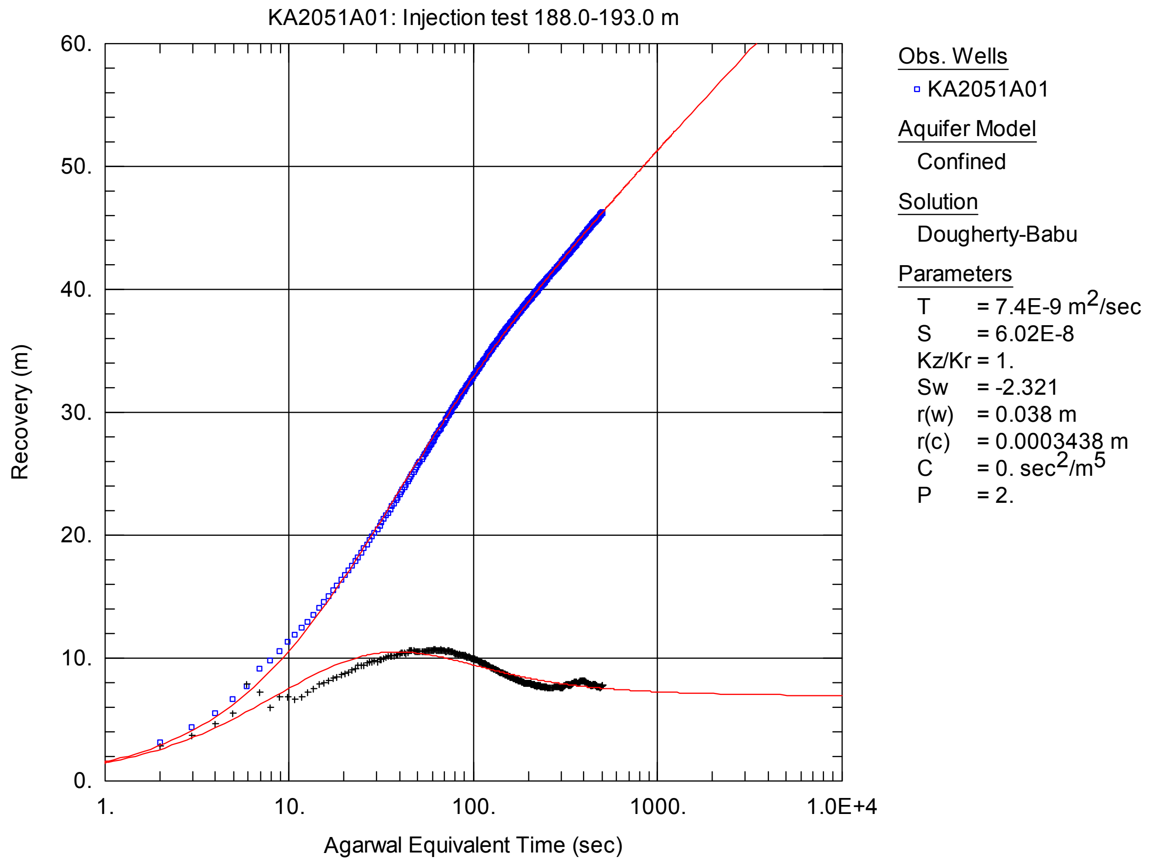

KA2051A01, 188-193 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2300
2280
2260
2240
2220
2200
2180
4000
3500
3000
2500
2000
1500
0.2
0.16
0.12
0.08
0.04
0
16:45:00
2011-08-16
17:15:00
17:30:00
17:45:00
2011-08-16
18:15:00


KA2051A01: Injection test 188.0-193.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 7.543E-9 m2/sec
S = 6.08E-8
Sw = -2.369
r(w) = 0.038 m

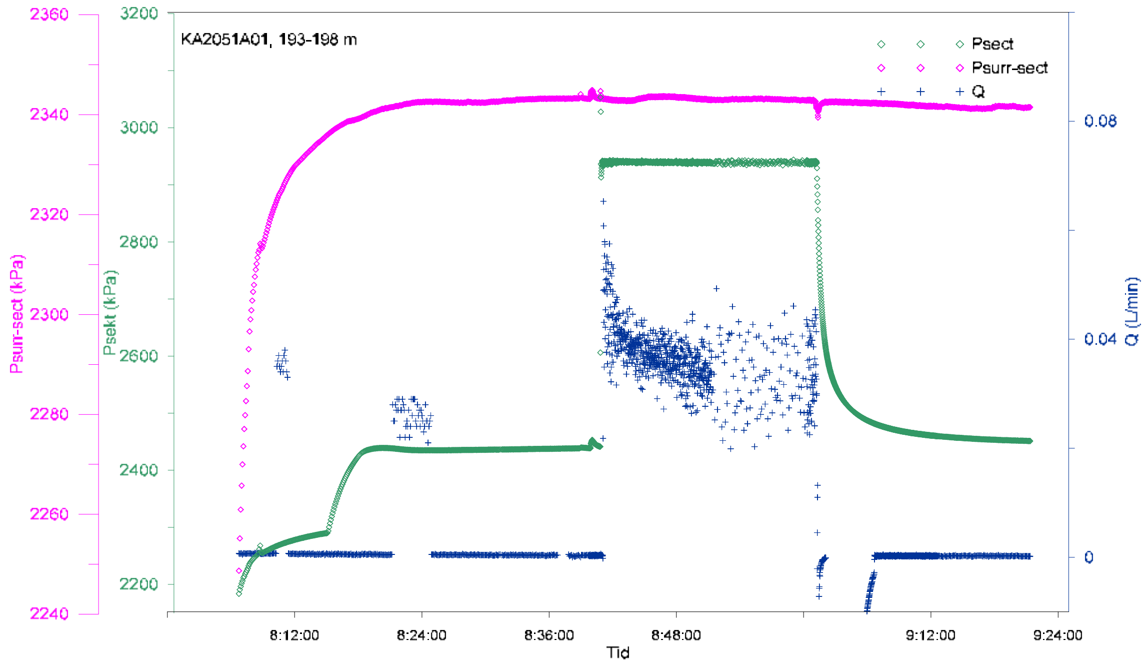

KA2051A01: Injection test 188.0-193.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.2E+8
8.0E+7
4.0E+7
0.
-4.0E+7
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 7.543E-9 m2/sec
S = 6.08E-8
Sw = -2.369
r(w) = 0.038 m



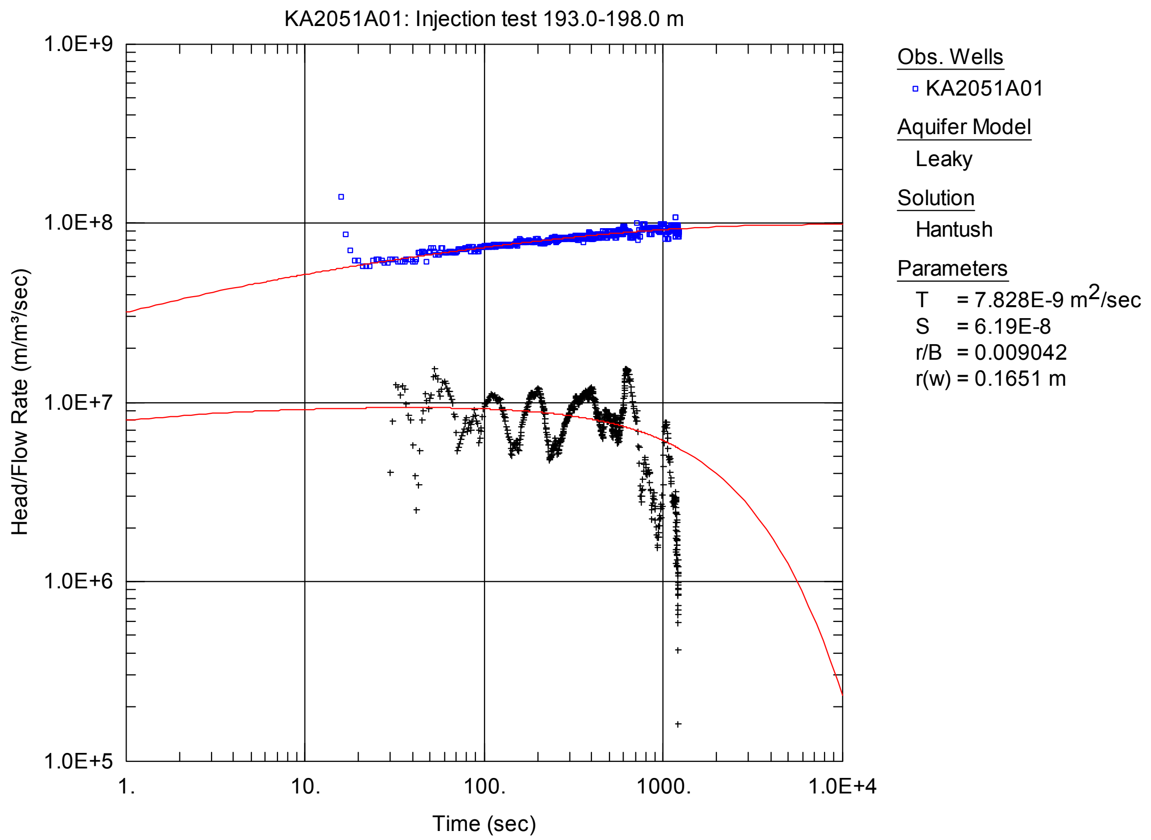
KA2051A01: Injection test 188.0-193.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 7.4E-9 m2/sec
S = 6.02E-8
Kz/Kr = 1.
Sw = -2.321
r(w) = 0.038 m
r(c) = 0.0003438 m
C = 0. sec2/m5
P = 2.



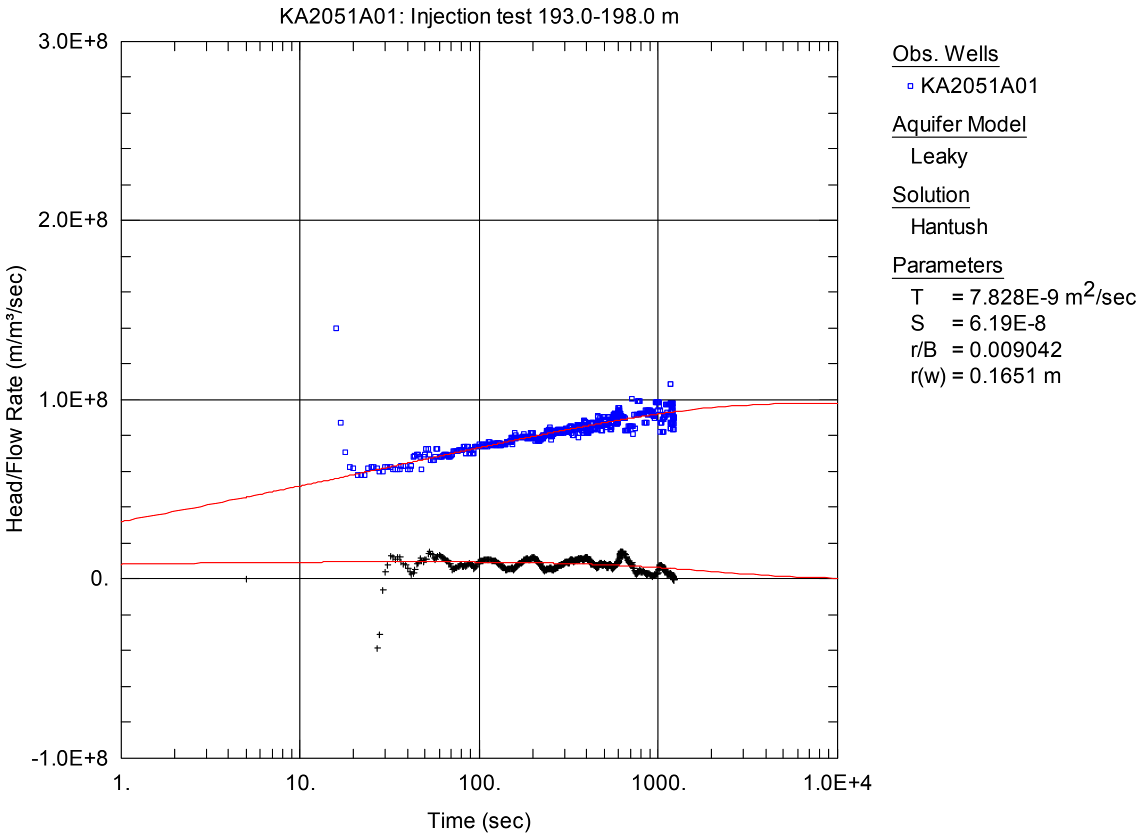
KA2051A01: Injection test 188.0-193.0 m
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 7.4E-9 m2/sec
S = 6.02E-8
Kz/Kr = 1.
Sw = -2.321
r(w) = 0.038 m
r(c) = 0.0003438 m
C = 0. sec2/m5
P = 2.

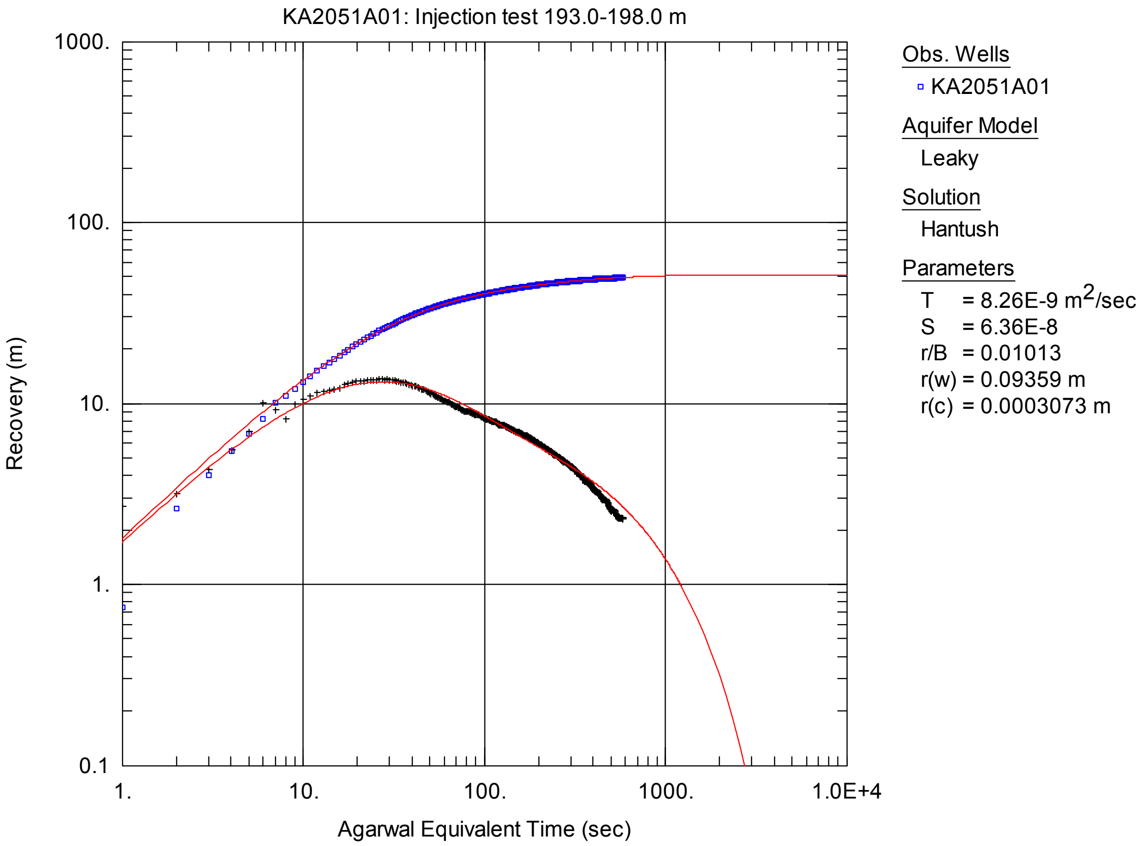


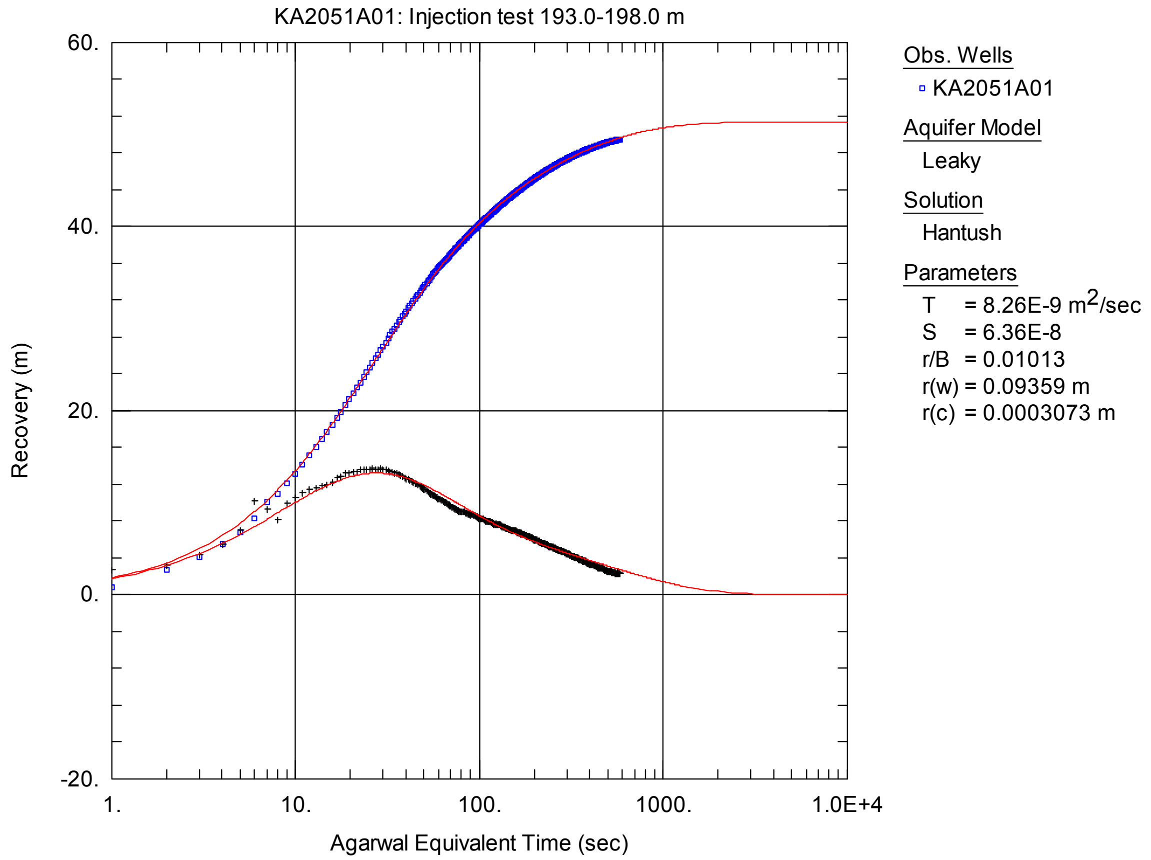
KA2051A01, 193-198 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2360
2340
2320
2300
2280
2260
2240
3200
3000
2800
2600
2400
2200
0.08
0.04
0
8:12:00
8:24:00
8:36:00
8:48:00
9:12:00
9:24:00

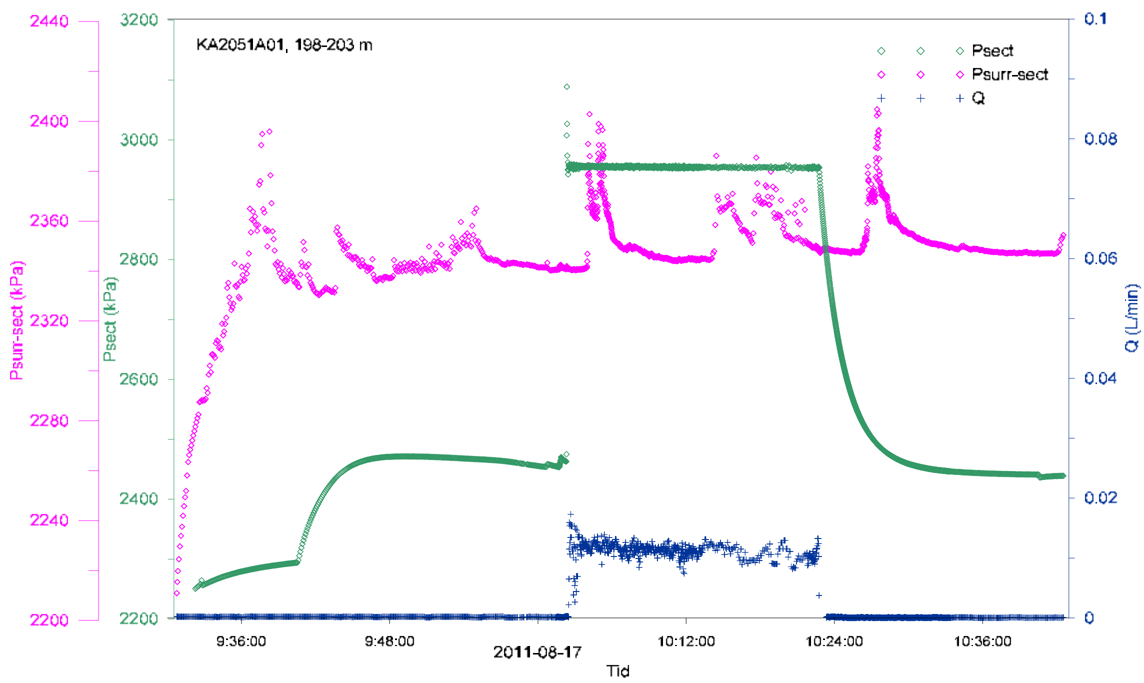


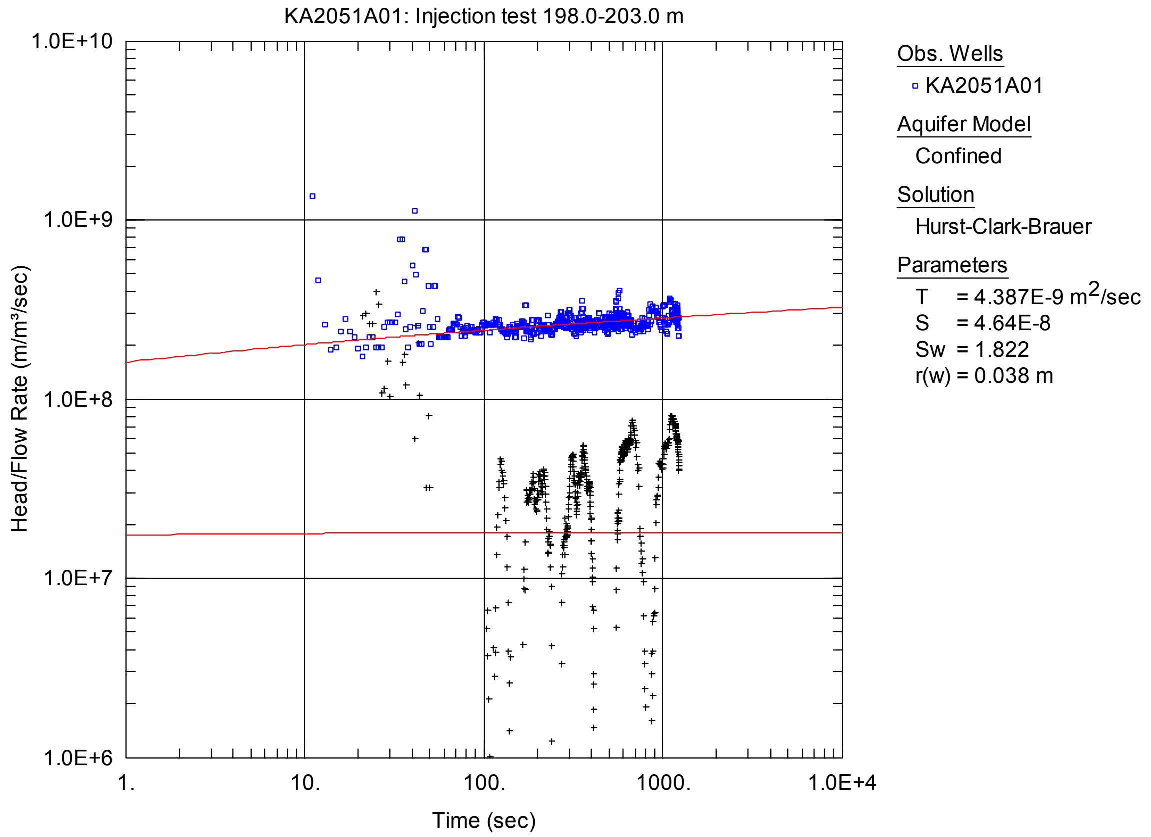
KA2051A01: Injection test 193.0-198.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 7.828E-9 m²/sec
S = 6.19E-8
r/B = 0.009042
r(w) = 0.1651 m

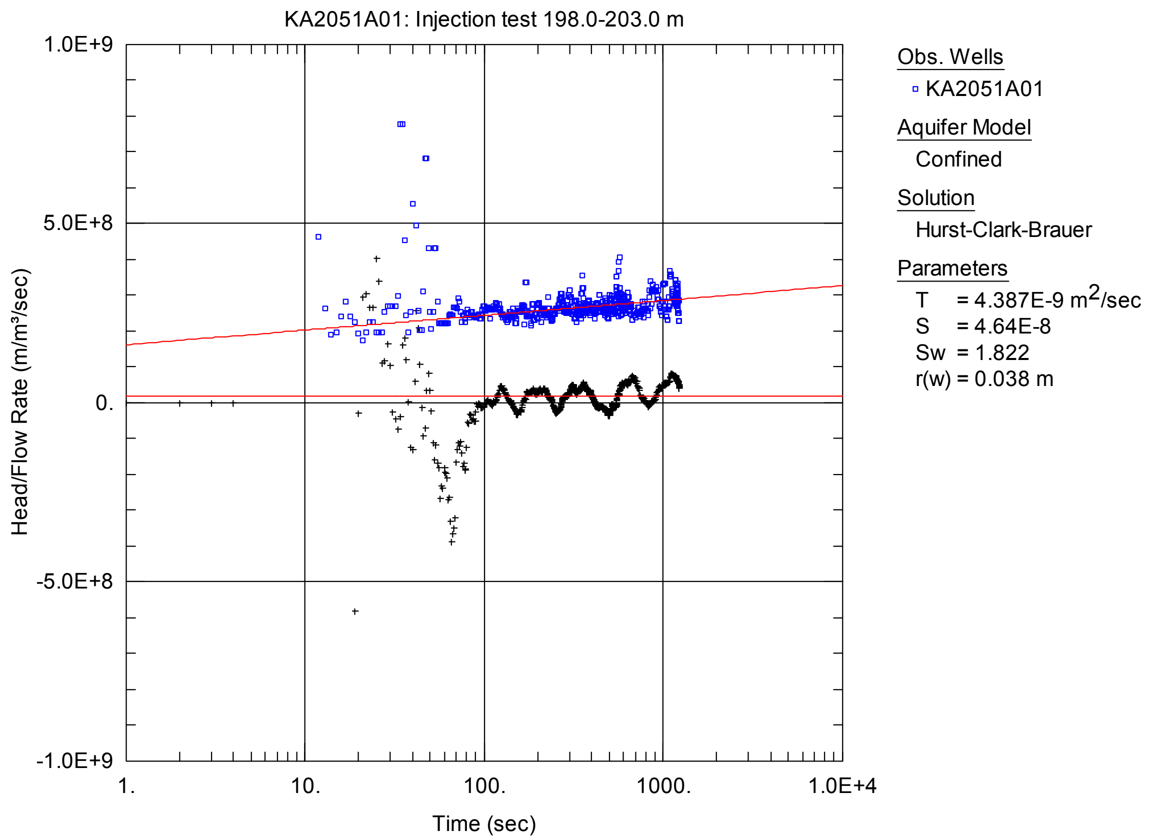

KA2051A01: Injection test 193.0-198.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
3.0E+8
2.0E+8
1.0E+8
0.
-1.0E+8
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 7.828E-9 m2/sec
S = 6.19E-8
r/B = 0.009042
r(w) = 0.1651 m

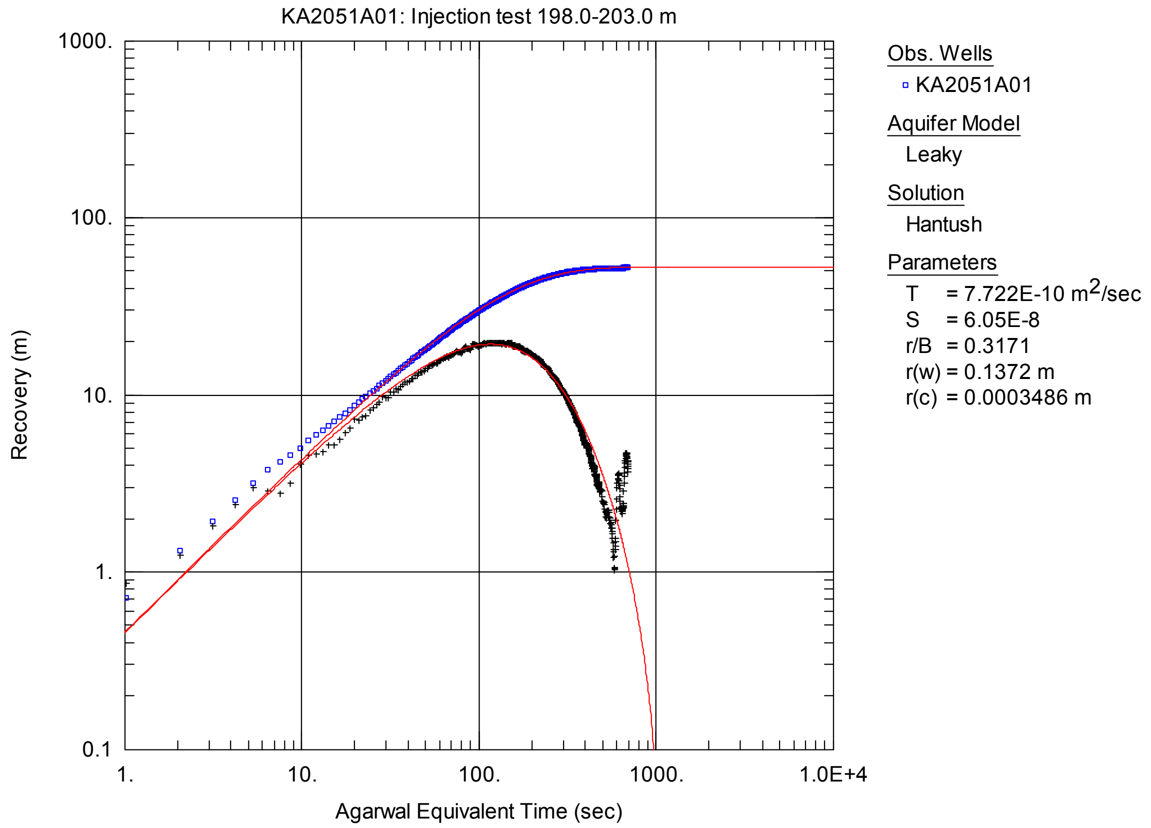

KA2051A01: Injection test 193.0-198.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 8.26E-9 m2/sec
S = 6.36E-8
r/B = 0.01013
r(w) = 0.09359 m
r(c) = 0.0003073 m


KA2051A01: Injection test 193.0-198.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 8.26E-9 m2/sec
S = 6.36E-8
r/B = 0.01013
r(w) = 0.09359 m
r(c) = 0.0003073 m

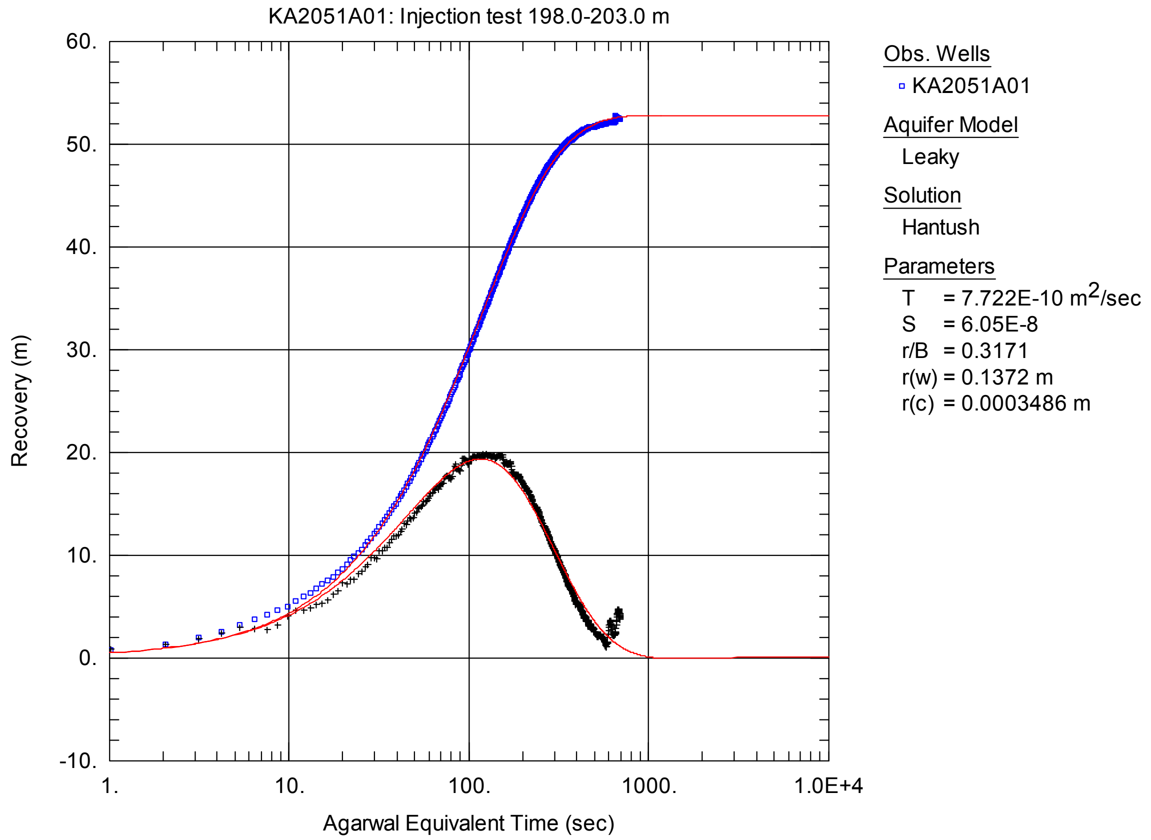

KA2051A01, 198-203 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2440
2400
2360
2320
2280
2240
2200
3200
3000
2800
2600
2400
2200
0.1
0.08
0.06
0.04
0.02
0
9:36:00
9:48:00
2011-08-17
10:12:00
10:24:00
10:36:00
Tid


KA2051A01: Injection test 198.0-203.0 m
1.0E+10
1.0E+9
1.0E+8
1.0E+7
1.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.387E-9 m2/sec
S = 4.64E-8
Sw = 1.822
r(w) = 0.038 m

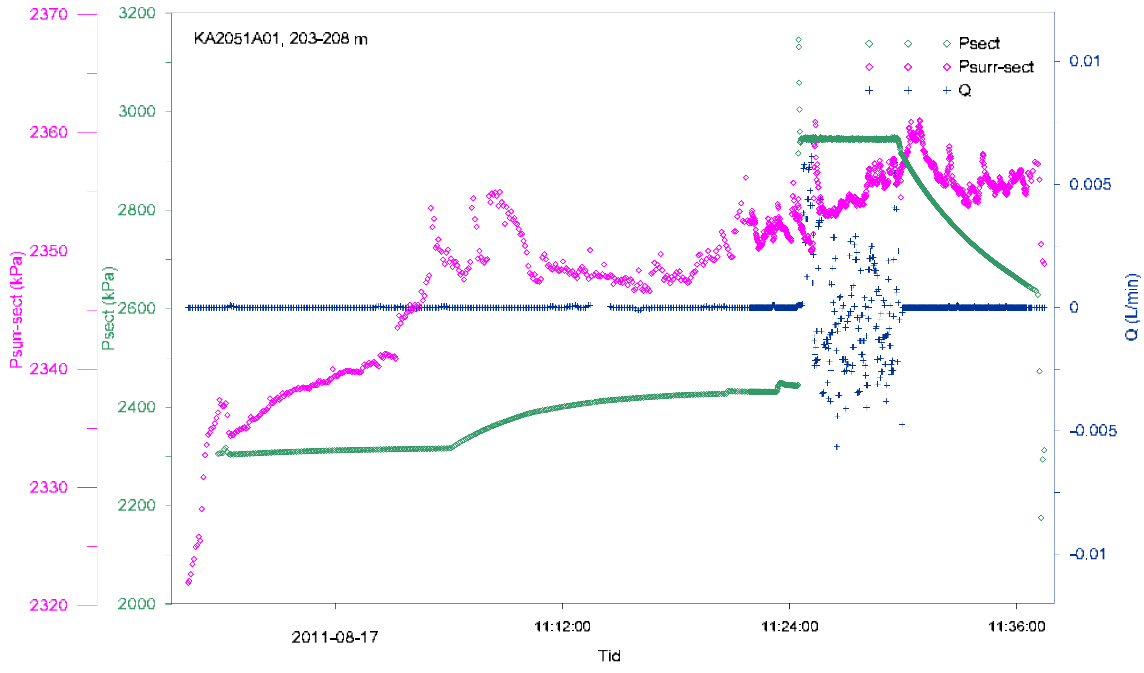

KA2051A01: Injection test 198.0-203.0 m
1.0E+9
5.0E+8
0.
-5.0E+8
-1.0E+9
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.387E-9 m2/sec
S = 4.64E-8
Sw = 1.822
r(w) = 0.038 m

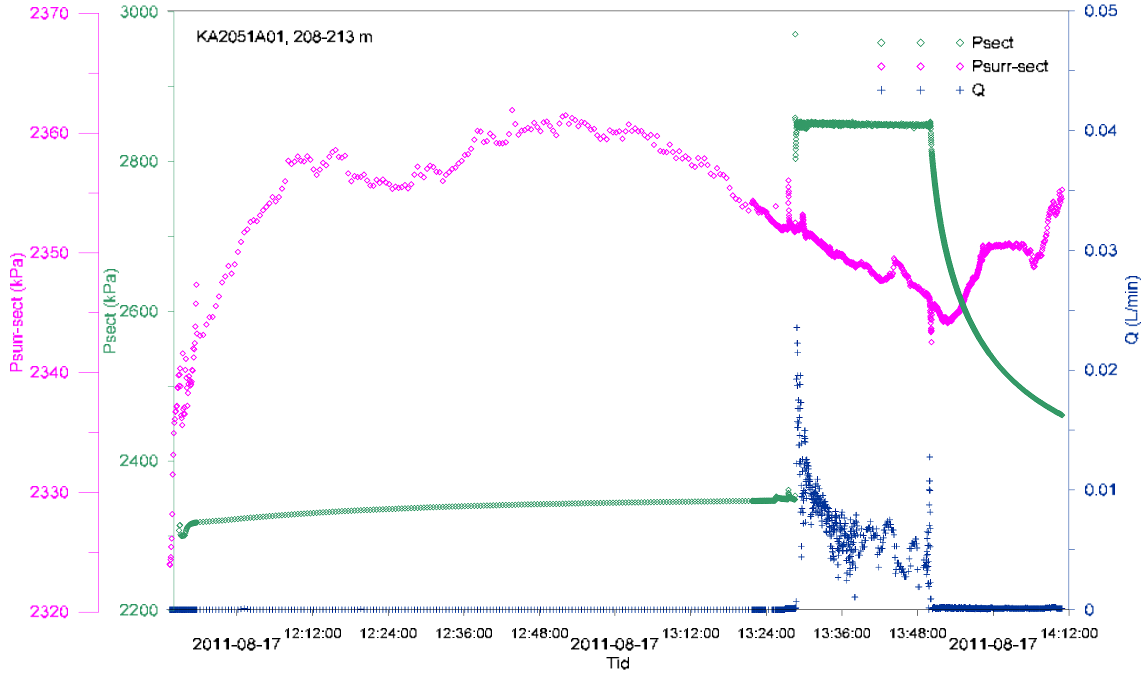


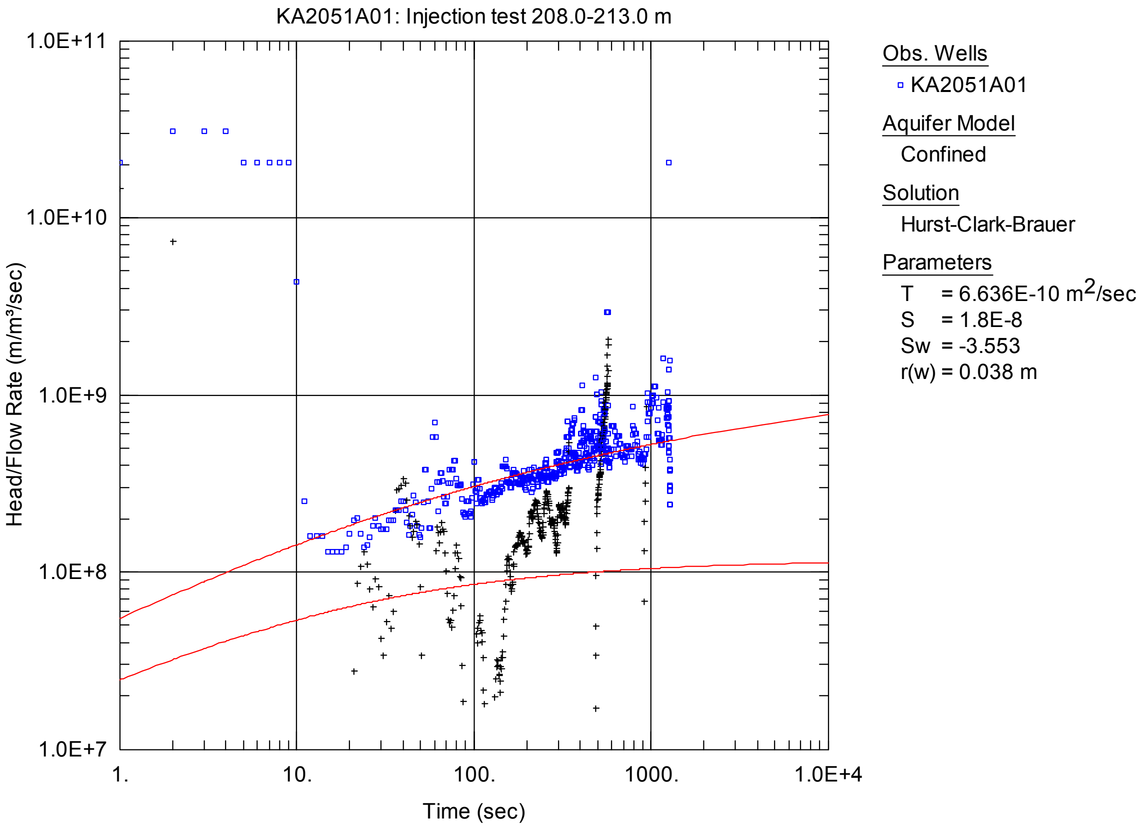
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

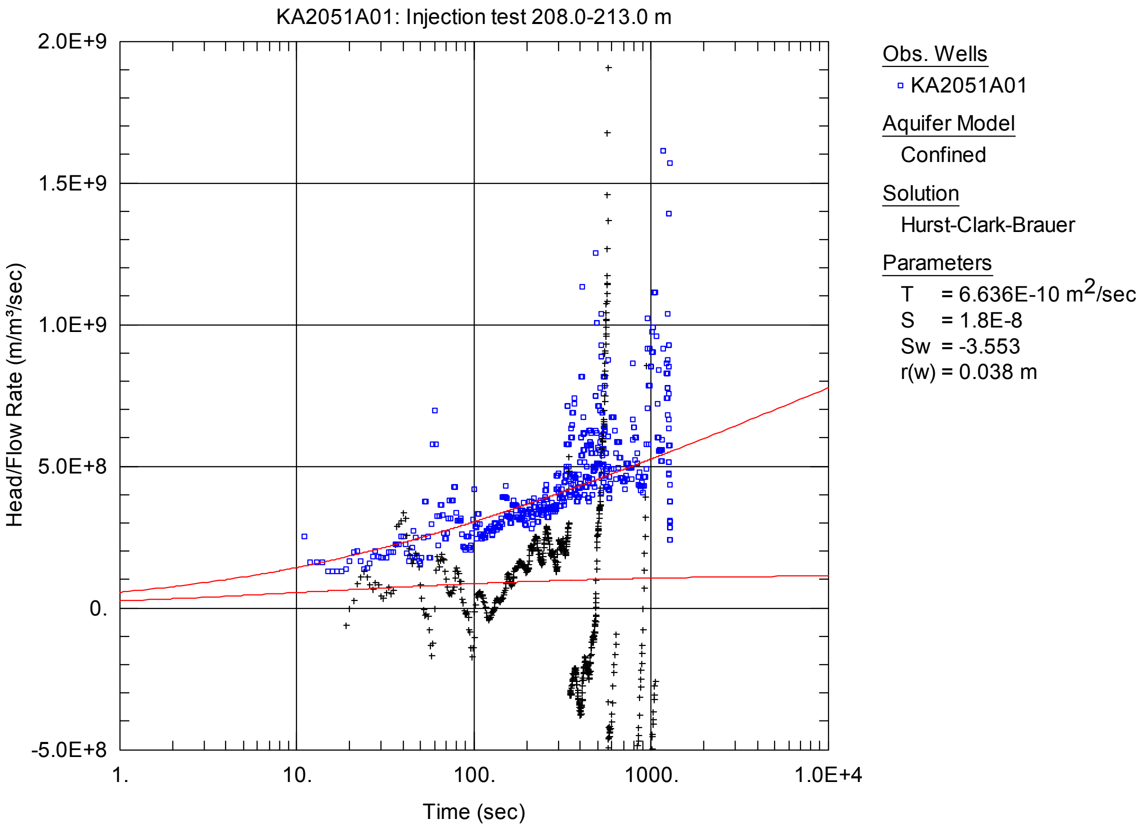


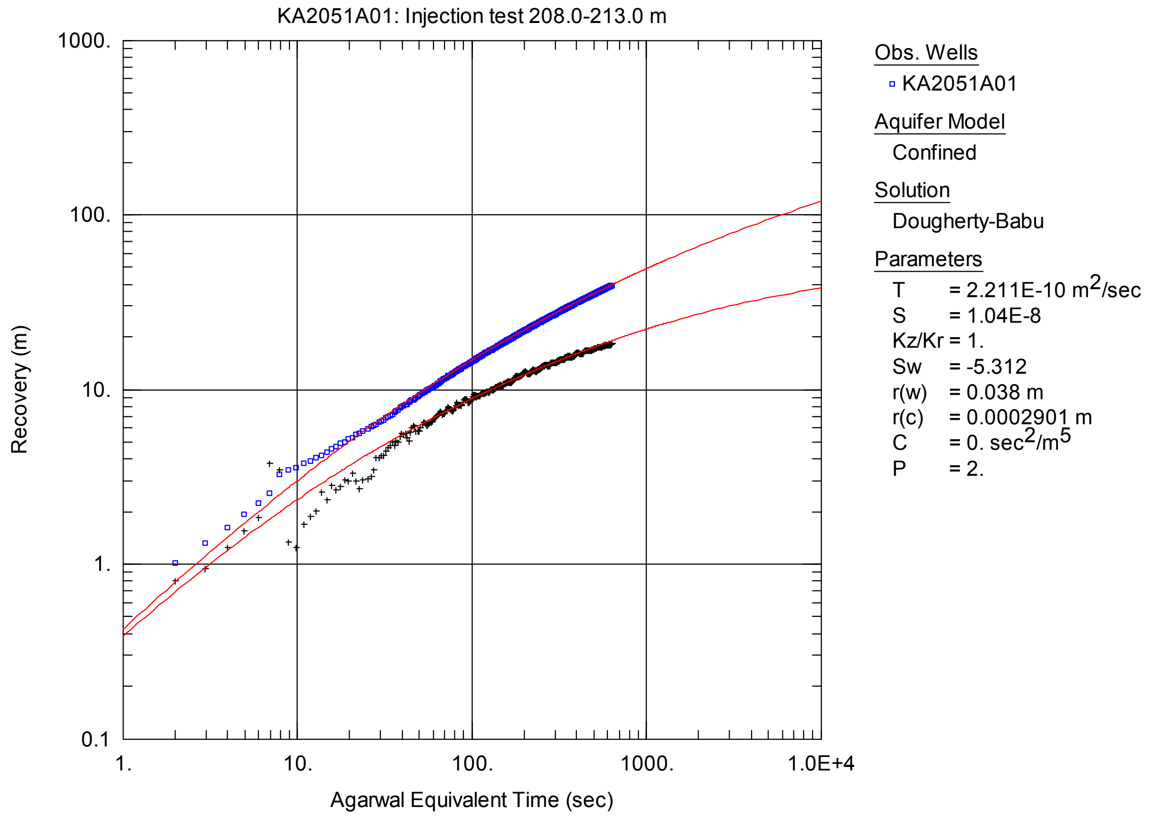
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

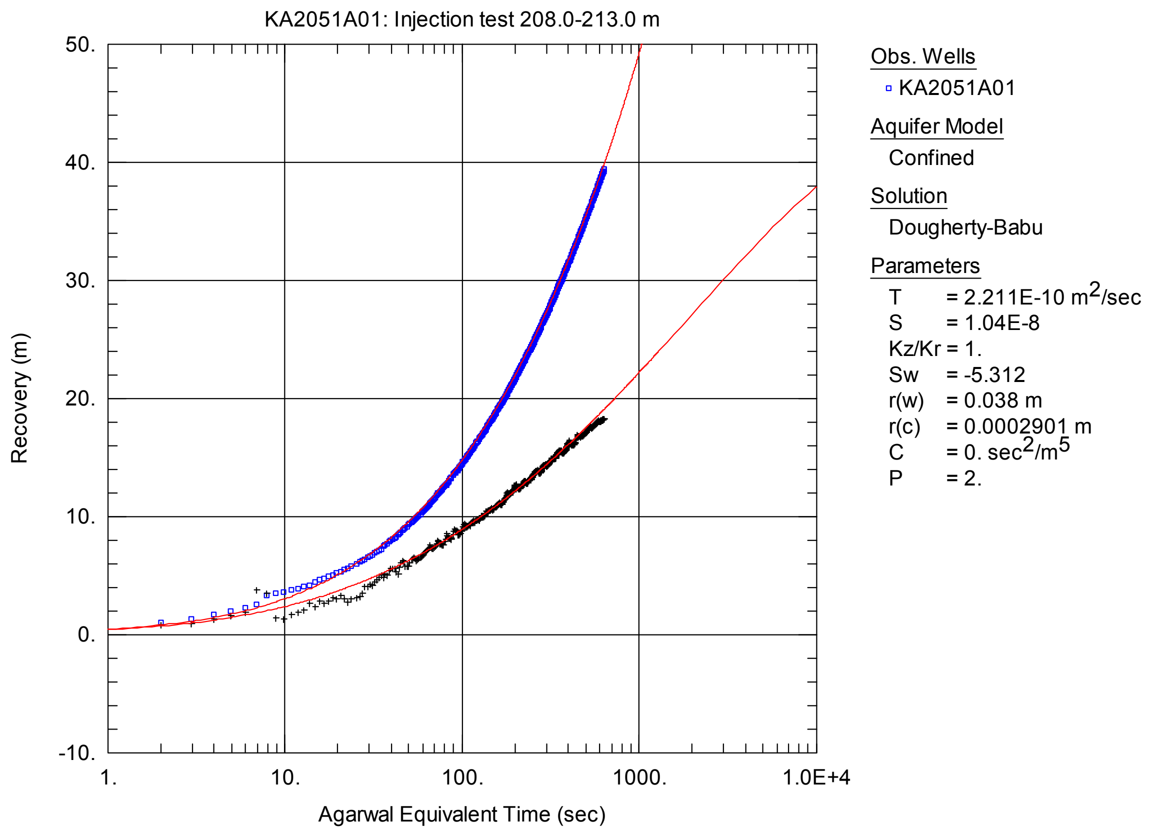

KA2051A01, 203-208 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2370
2360
2350
2340
2330
2320
3200
3000
2800
2600
2400
2200
2000
0.01
0.005
0
-0.005
-0.01
2011-08-17
11:12:00
11:24:00
11:36:00
Tid

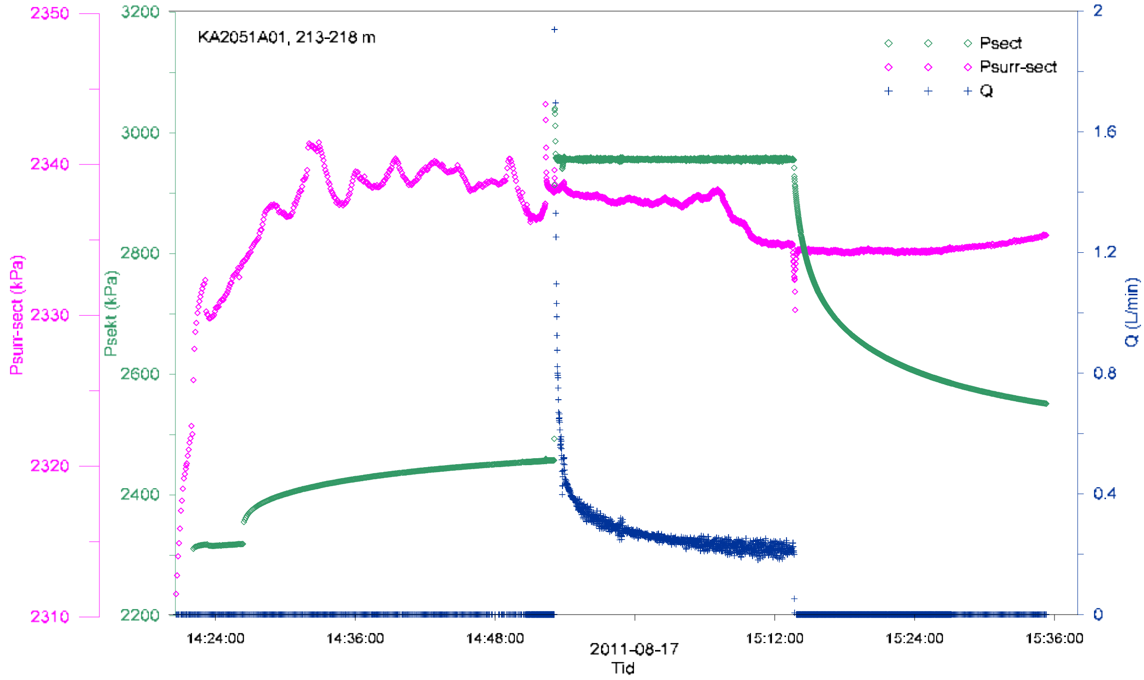

KA2051A01, 208-213 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2370
2360
2350
2340
2330
2320
3000
2800
2600
2400
2200
0.05
0.04
0.03
0.02
0.01
0
2011-08-17
12:12:00
12:24:00
12:36:00
12:48:00
2011-08-17
13:12:00
13:24:00
13:36:00
13:48:00
2011-08-17
14:12:00
Tid

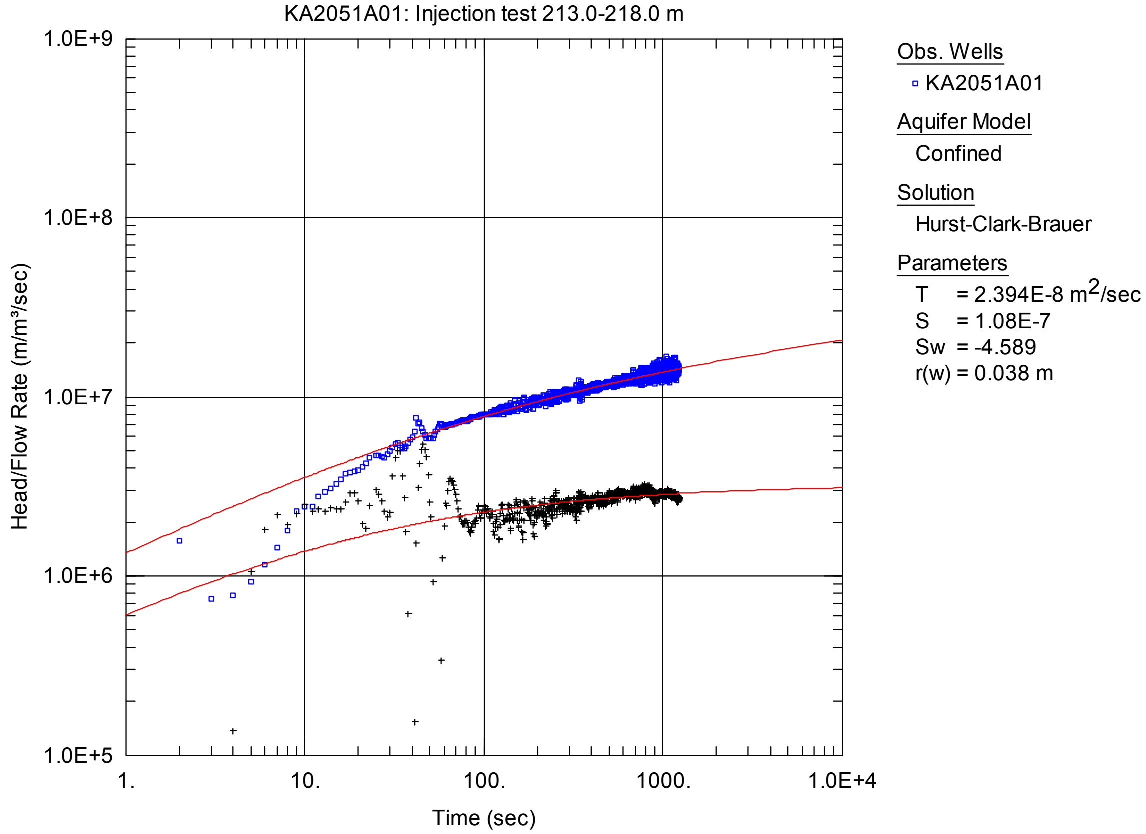

KA2051A01: Injection test 208.0-213.0 m
1.0E+11
1.0E+10
1.0E+9
1.0E+8
1.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 6.636E-10 m2/sec
S = 1.8E-8
Sw = -3.553
r(w) = 0.038 m

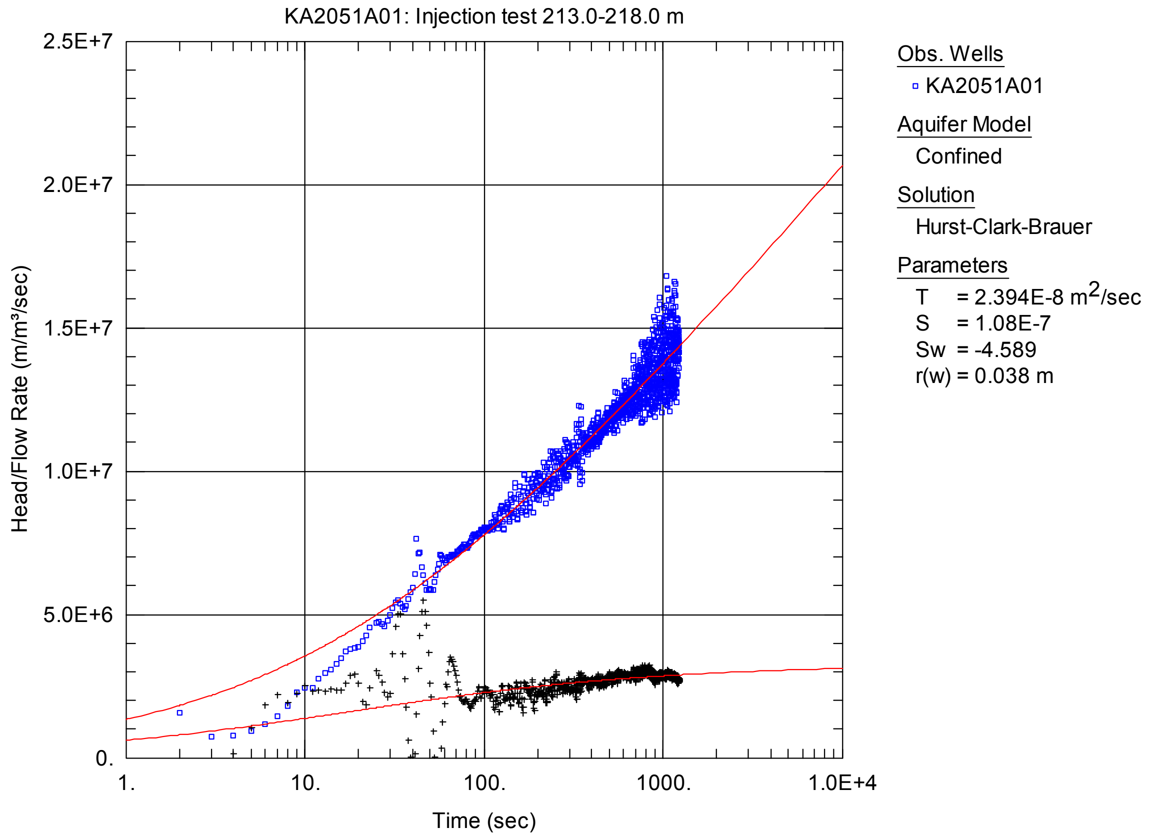

KA2051A01: Injection test 208.0-213.0 m
2.0E+9
1.5E+9
1.0E+9
5.0E+8
0.
-5.0E+8
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 6.636E-10 m2/sec
S = 1.8E-8
Sw = -3.553
r(w) = 0.038 m

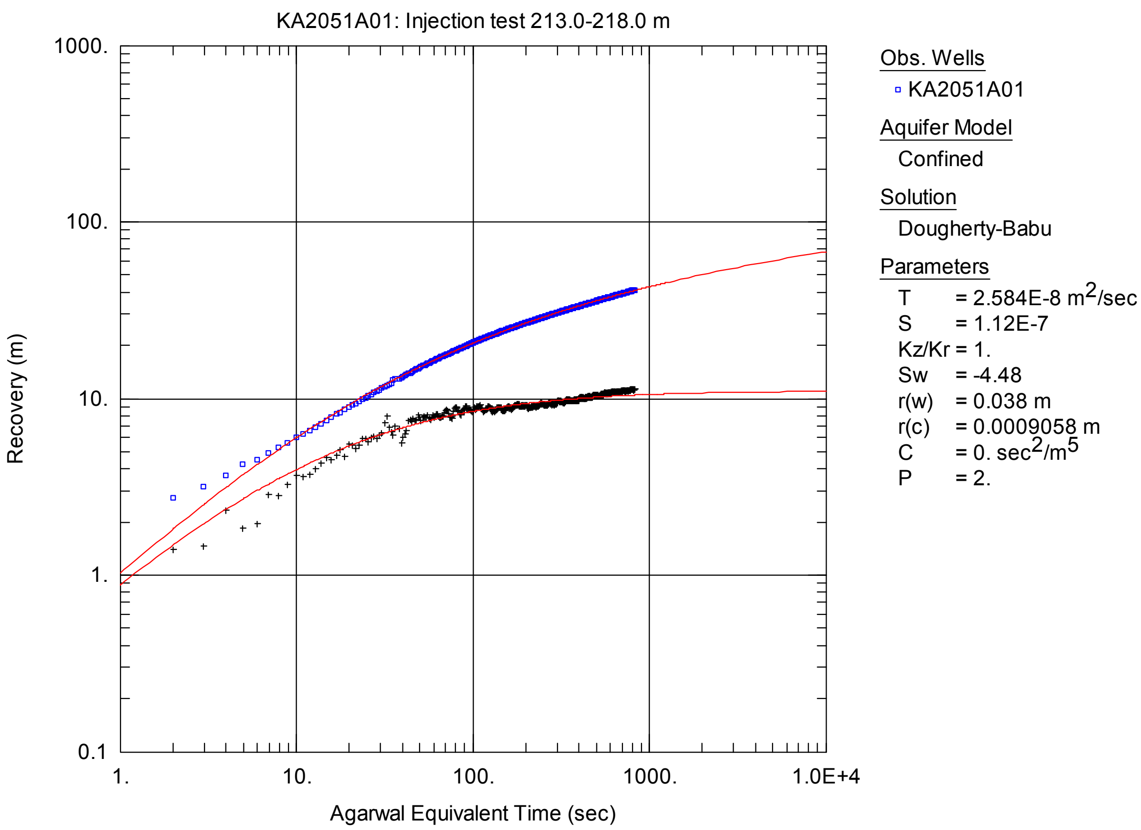

KA2051A01: Injection test 208.0-213.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.211E-10 m2/sec
S = 1.04E-8
Kz/Kr = 1.
Sw = -5.312
r(w) = 0.038 m
r(c) = 0.0002901 m
C = 0. sec2/m5
P = 2.

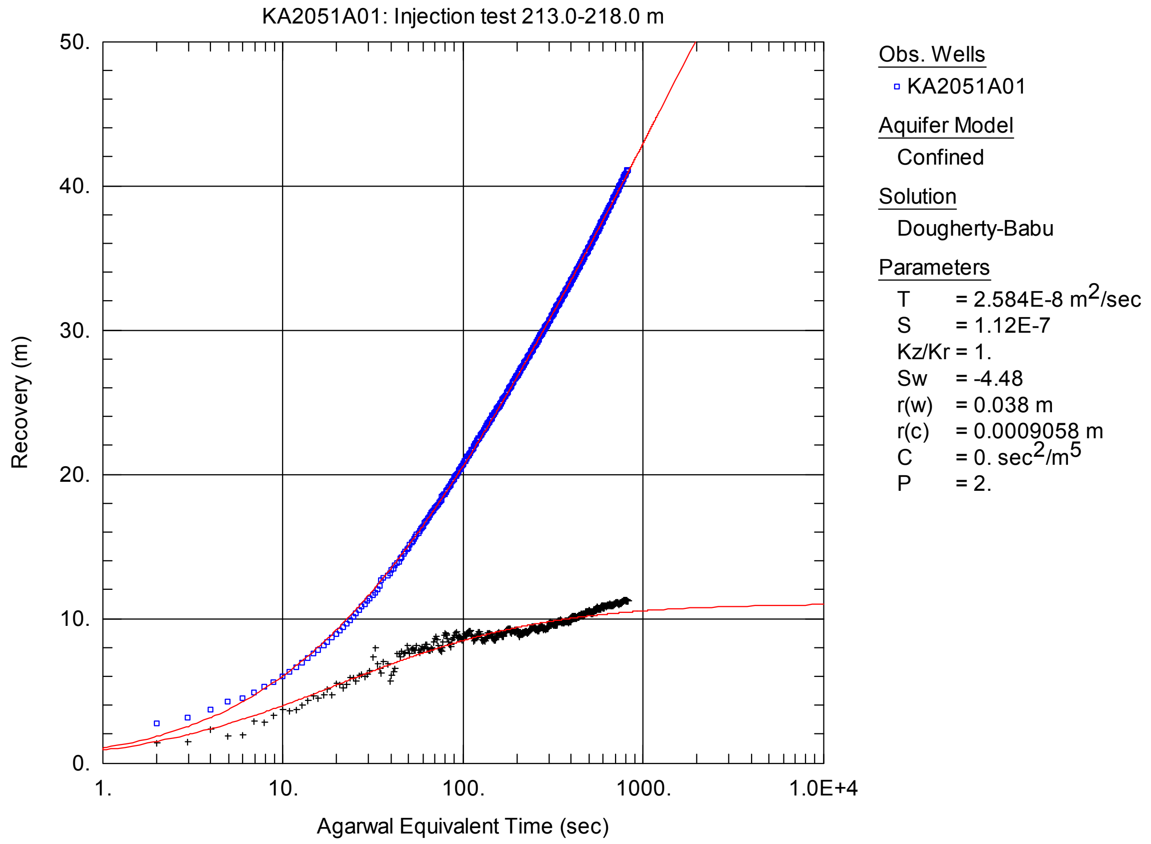

KA2051A01: Injection test 208.0-213.0 m
50.
40.
30.
20.
10.
0.
-10.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.211E-10 m2/sec
S = 1.04E-8
Kz/Kr = 1.
Sw = -5.312
r(w) = 0.038 m
r(c) = 0.0002901 m
C = 0. sec2/m5
P = 2.

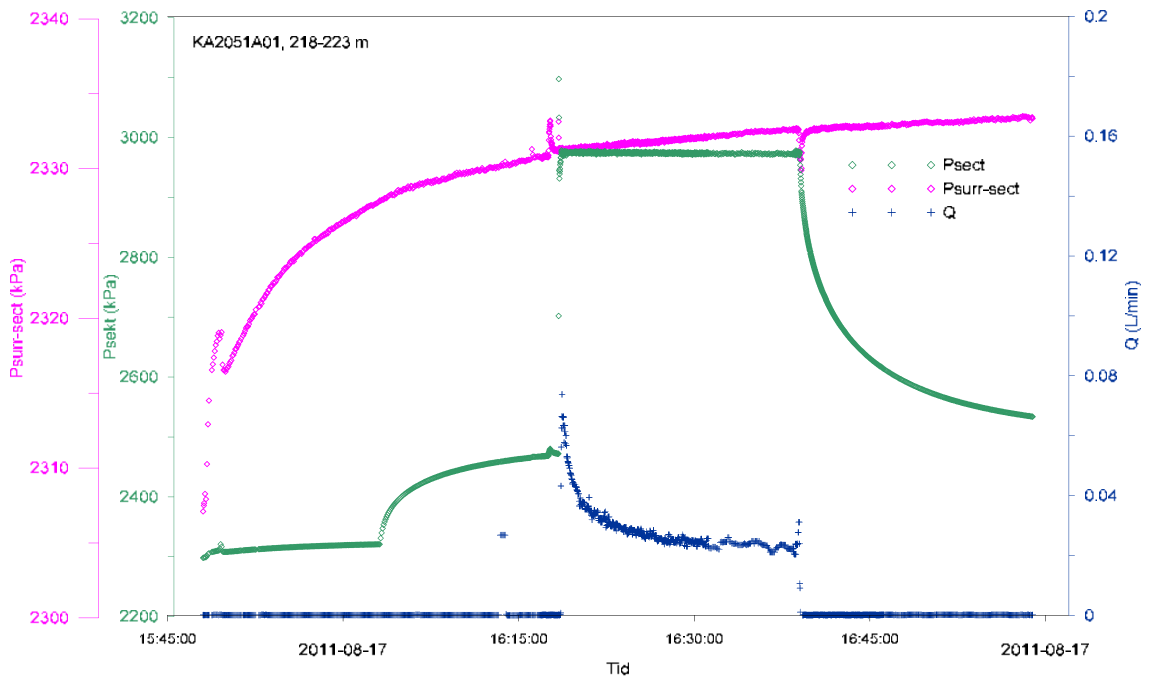

KA2051A01, 213-218 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2011-08-17
Tid
14:24:00
14:36:00
14:48:00
15:12:00
15:24:00
15:36:00

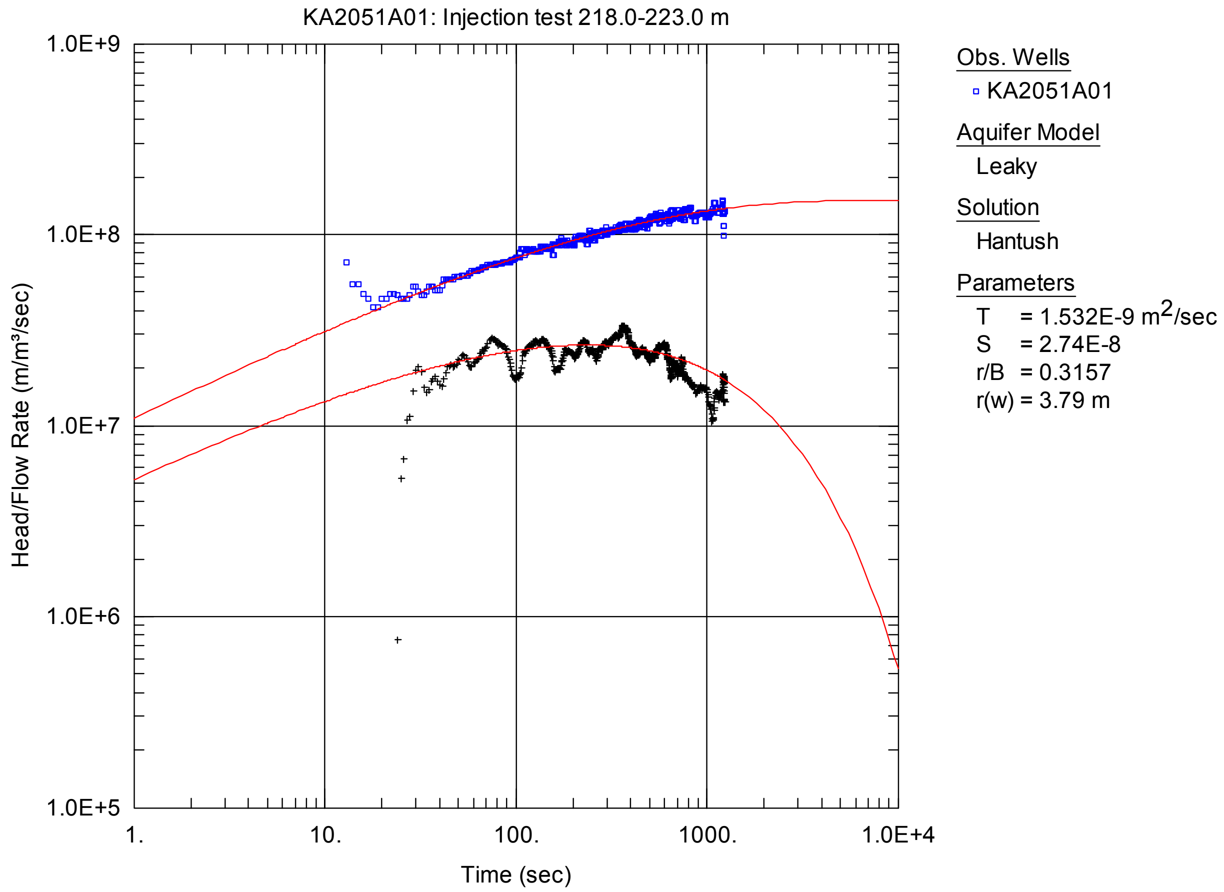

KA2051A01: Injection test 213.0-218.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.394E-8 m2/sec
S = 1.08E-7
Sw = -4.589
r(w) = 0.038 m

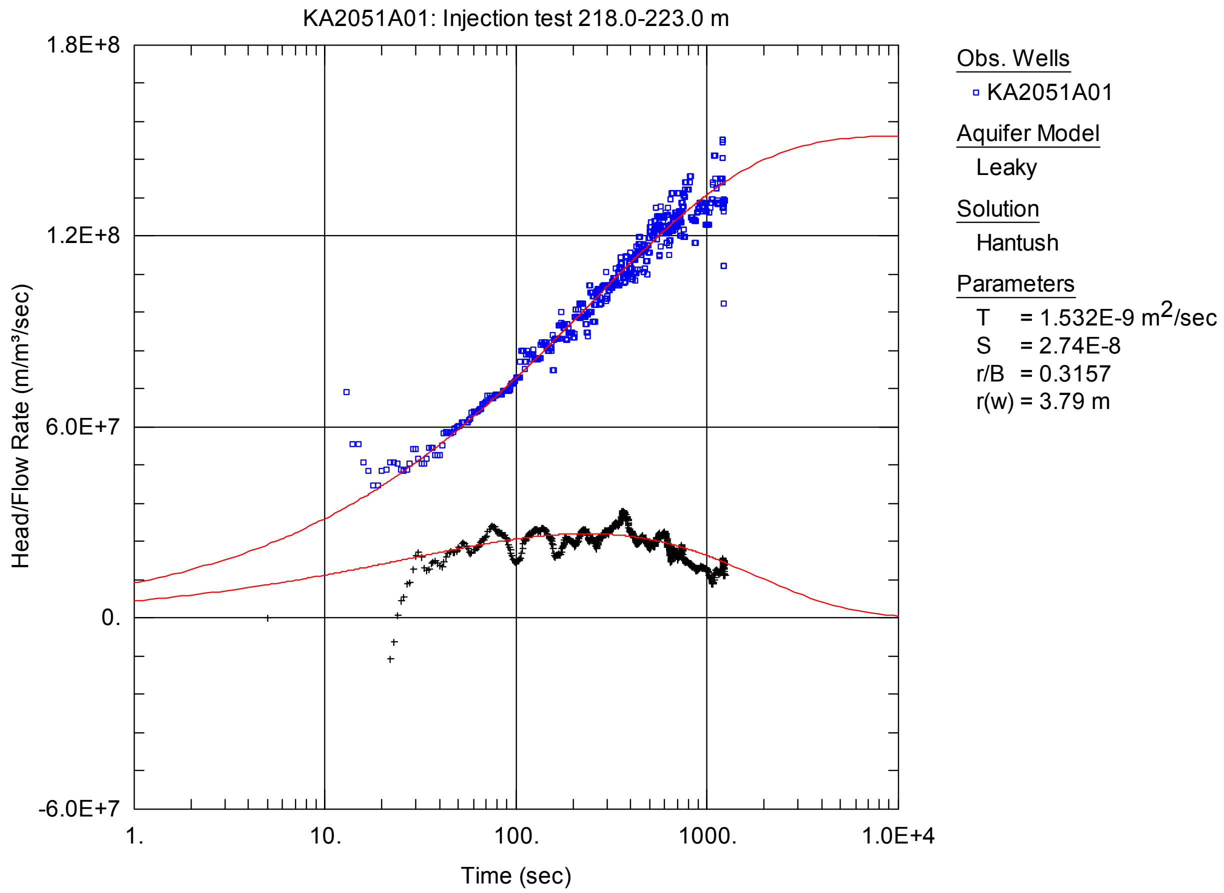

KA2051A01: Injection test 213.0-218.0 m
2.5E+7
2.0E+7
1.5E+7
1.0E+7
5.0E+6
0.
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.394E-8 m2/sec
S = 1.08E-7
Sw = -4.589
r(w) = 0.038 m

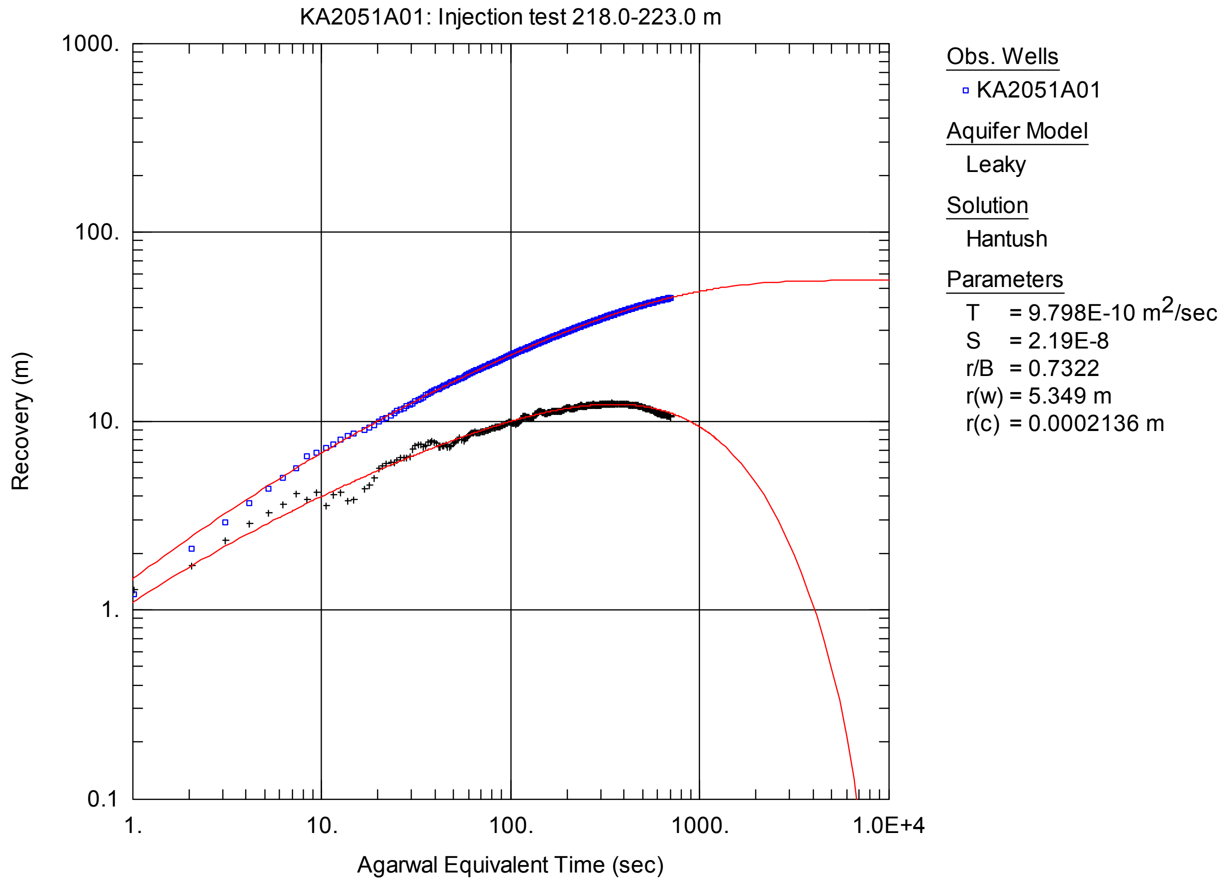

KA2051A01: Injection test 213.0-218.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.584E-8 m2/sec
S = 1.12E-7
Kz/Kr = 1.
Sw = -4.48
r(w) = 0.038 m
r(c) = 0.0009058 m
C = 0. sec2/m5
P = 2.

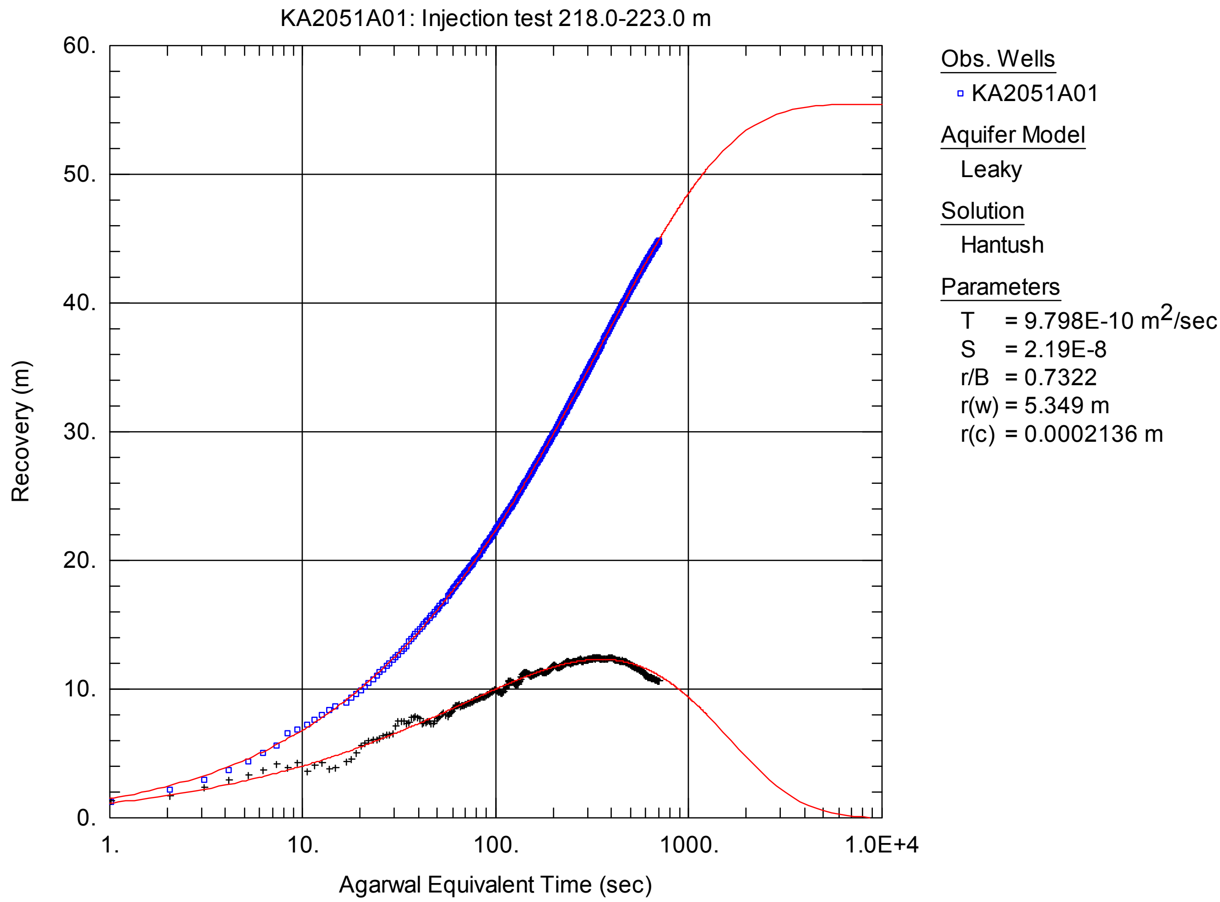

KA2051A01: Injection test 213.0-218.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 2.584E-8 m2/sec
S = 1.12E-7
Kz/Kr = 1.
Sw = -4.48
r(w) = 0.038 m
r(c) = 0.0009058 m
C = 0. sec2/m5
P = 2.

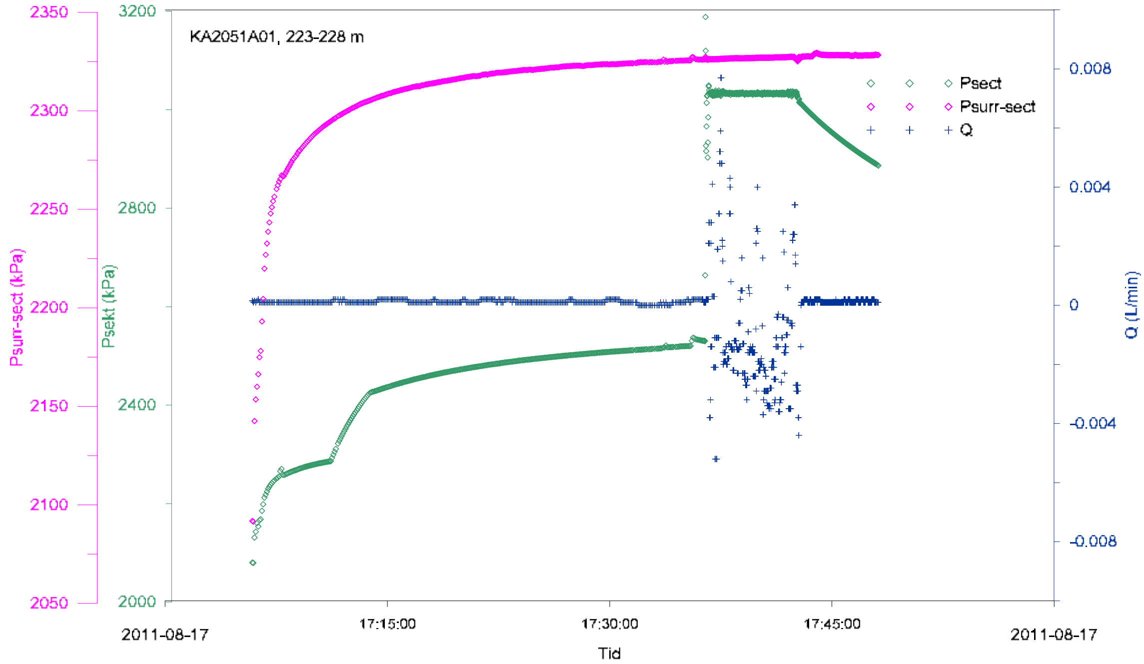

KA2051A01, 218-223 m
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
Psect
Psurr-sect
Q
2340
2330
2320
2310
2300
3200
3000
2800
2600
2400
2200
0.2
0.16
0.12
0.08
0.04
0
15:45:00
2011-08-17
16:15:00
16:30:00
16:45:00
2011-08-17

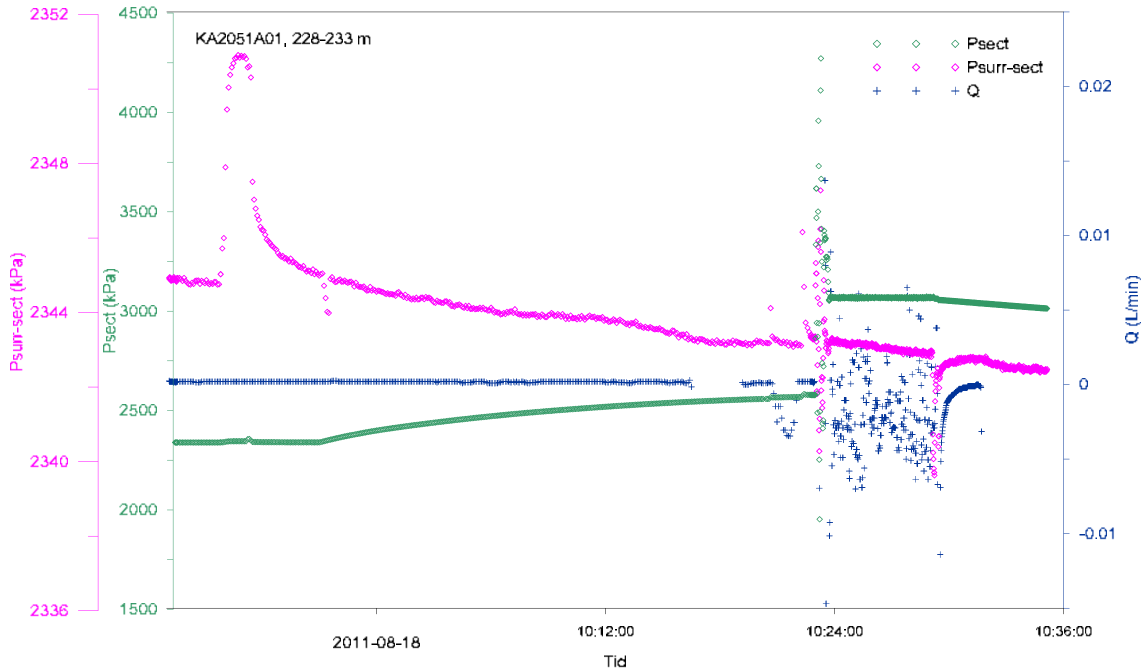

KA2051A01: Injection test 218.0-223.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.532E-9 m2/sec
S = 2.74E-8
r/B = 0.3157
r(w) = 3.79 m

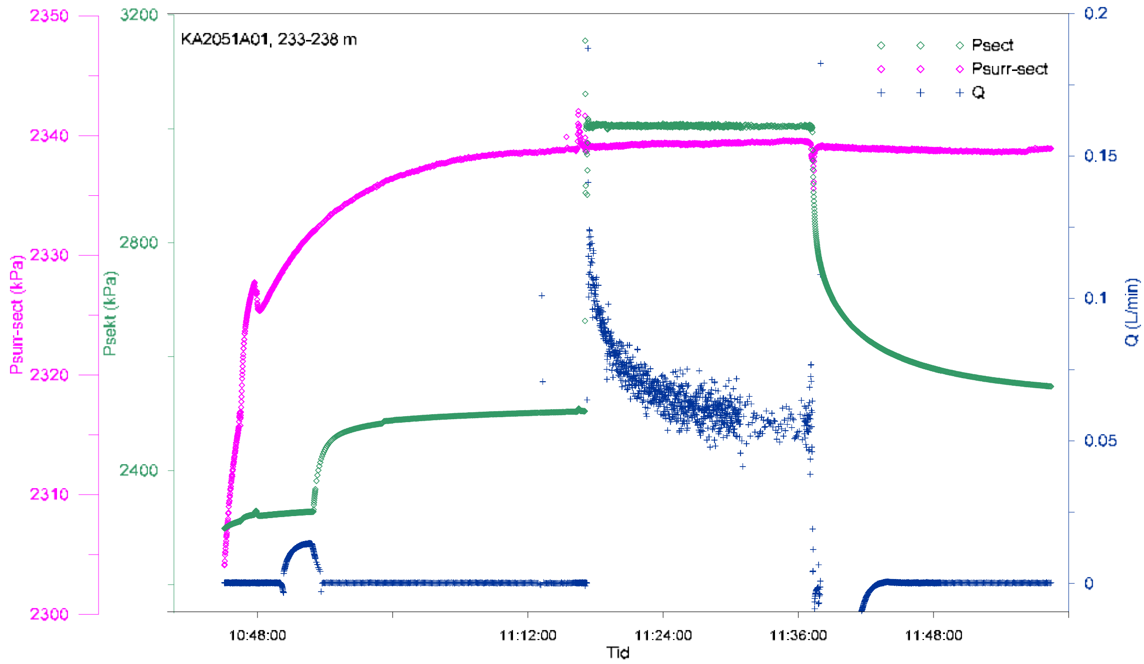

KA2051A01: Injection test 218.0-223.0 m
1.8E+8
1.2E+8
6.0E+7
0.
-6.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.532E-9 m2/sec
S = 2.74E-8
r/B = 0.3157
r(w) = 3.79 m

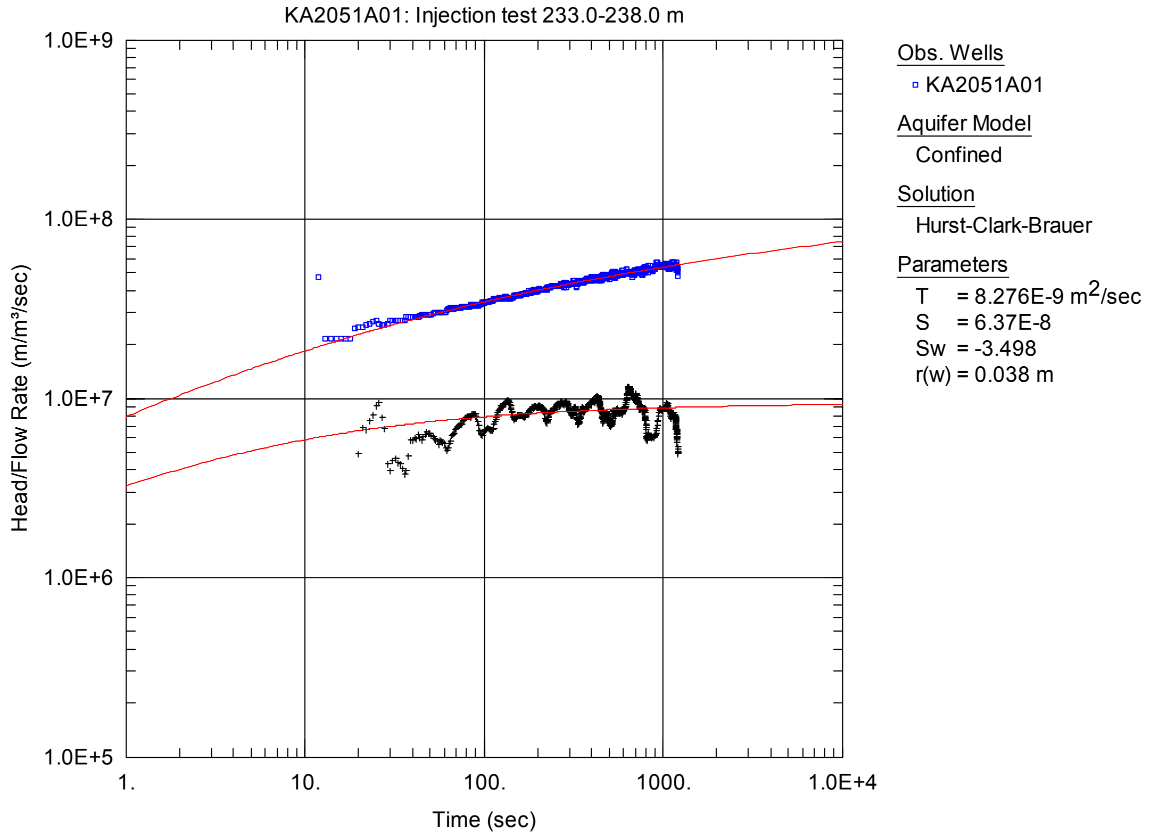

KA2051A01: Injection test 218.0-223.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.798E-10 m2/sec
S = 2.19E-8
r/B = 0.7322
r(w) = 5.349 m
r(c) = 0.0002136 m

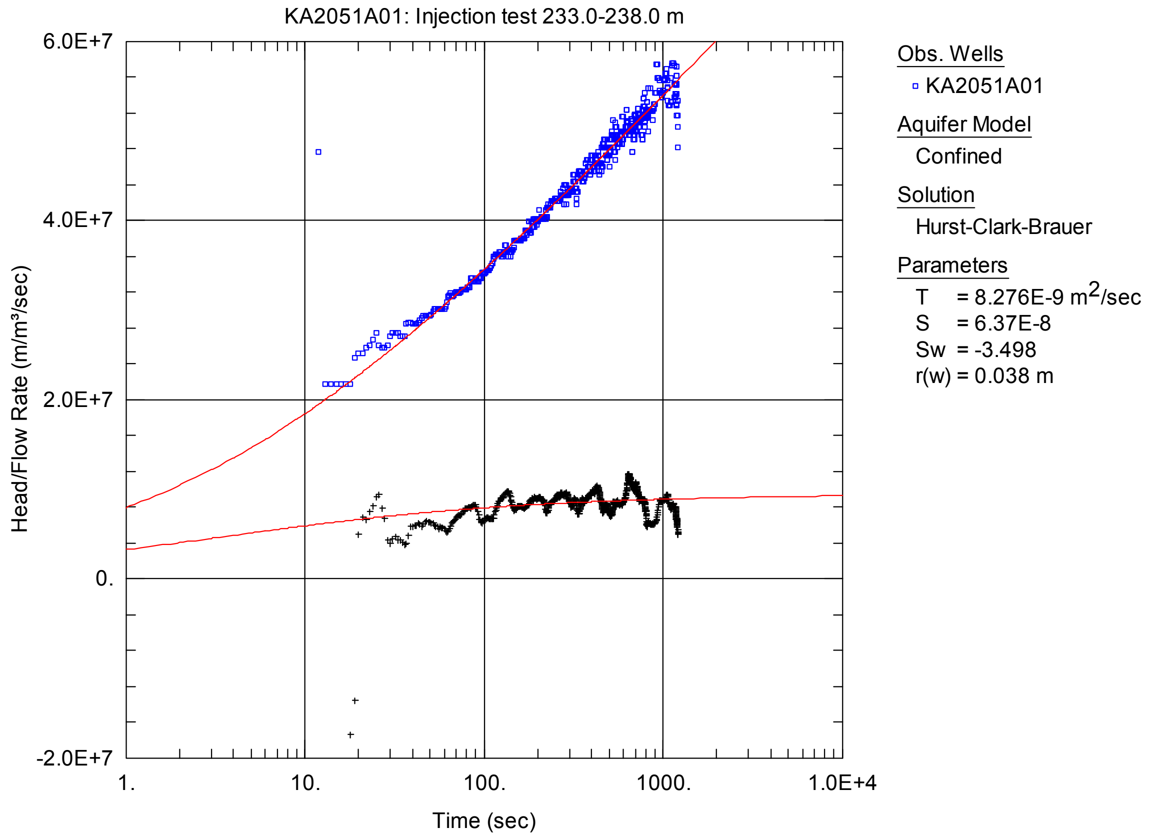

KA2051A01: Injection test 218.0-223.0 m
60.
50.
40.
30.
20.
10.
0.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.798E-10 m2/sec
S = 2.19E-8
r/B = 0.7322
r(w) = 5.349 m
r(c) = 0.0002136 m

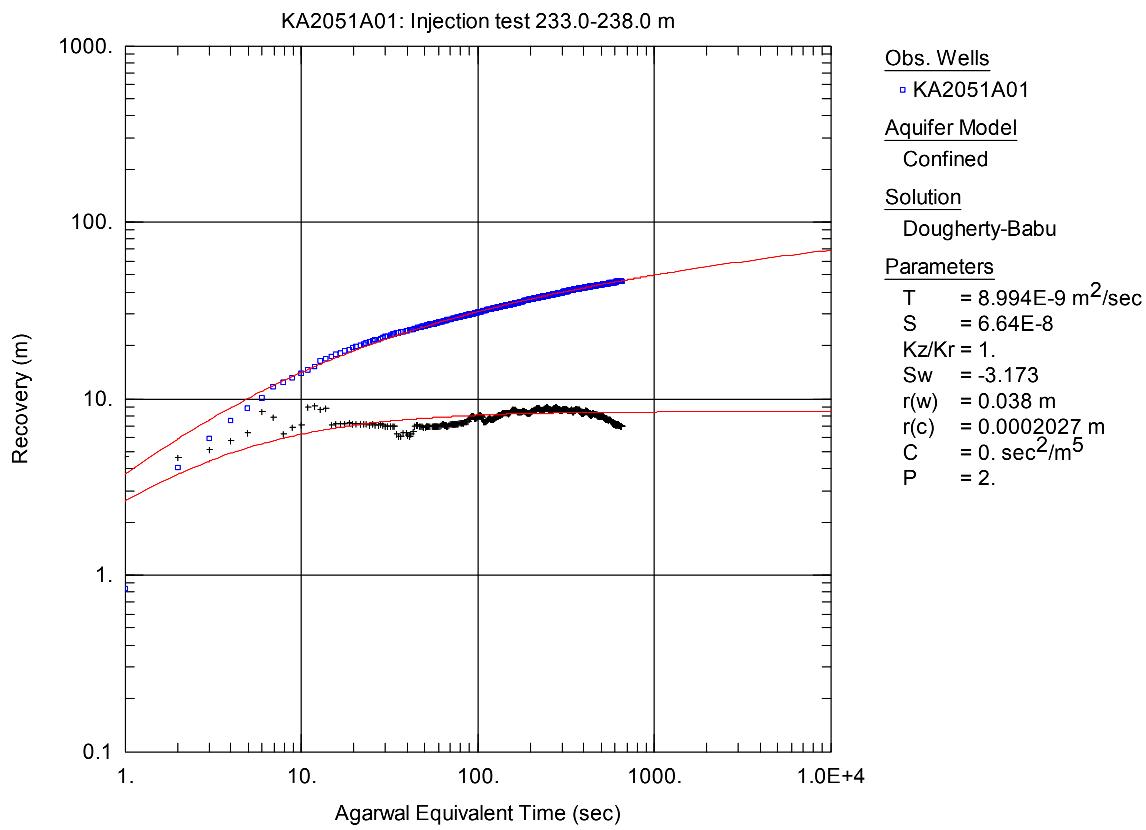

KA2051A01, 223-228 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2350
2300
2250
2200
2150
2100
2050
3200
2800
2400
2000
0.008
0.004
0
-0.004
-0.008
2011-08-17
17:15:00
17:30:00
17:45:00
2011-08-17
Tid

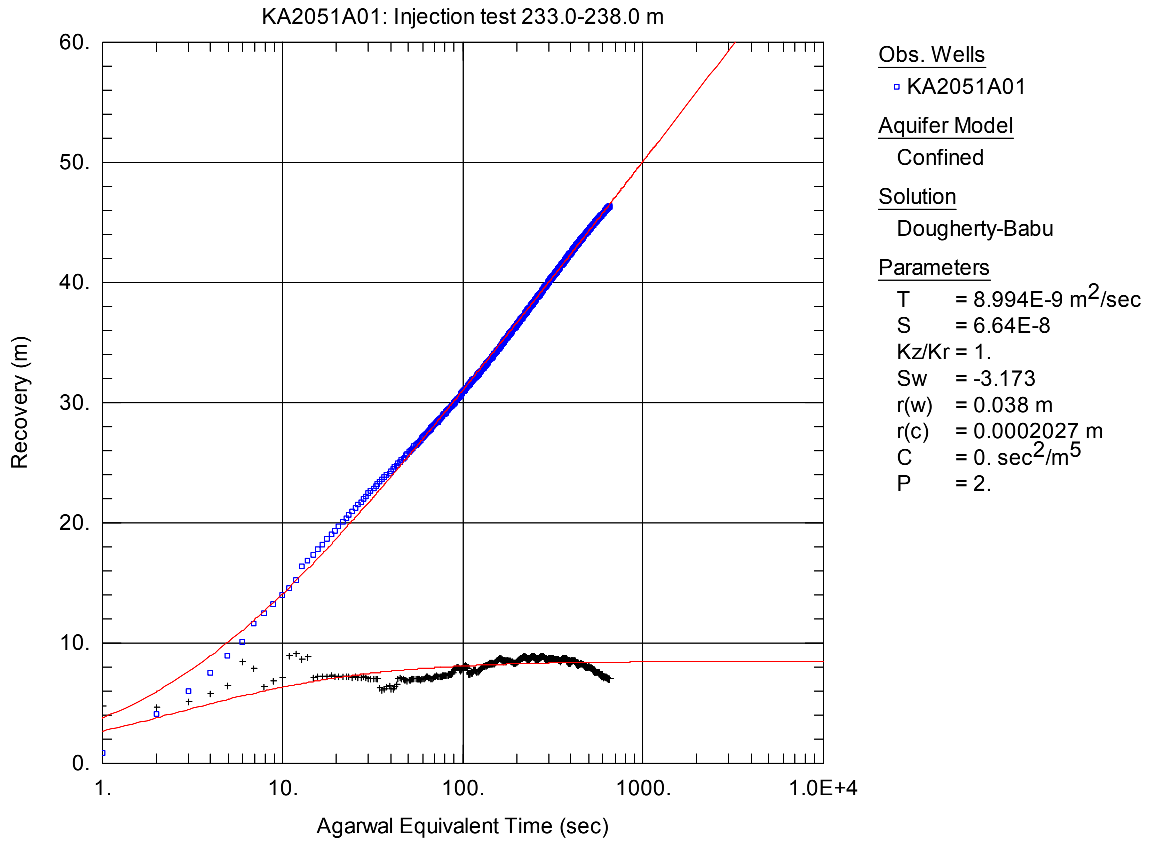

KA2051A01, 228-233 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2352
2348
2344
2340
2336
4500
4000
3500
3000
2500
2000
1500
0.02
0.01
0
-0.01
2011-08-18
10:12:00
10:24:00
10:36:00
Tid

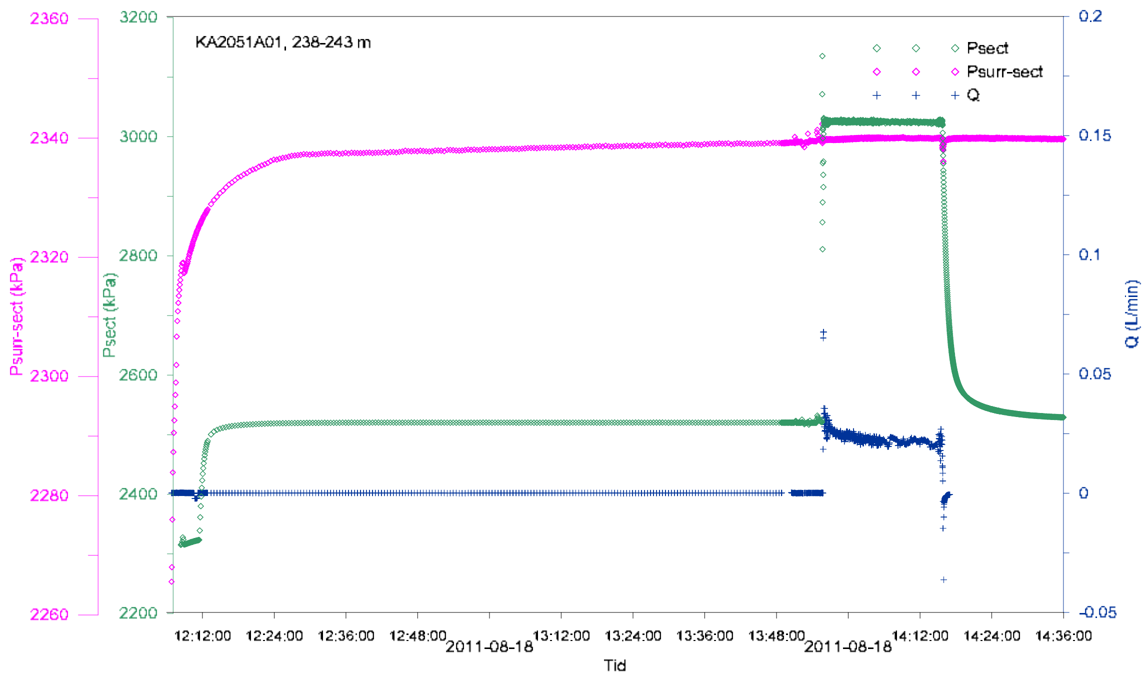

KA2051A01, 233-238 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
10:48:00
11:12:00
11:24:00
11:36:00
11:48:00
2350
2340
2330
2320
2310
2300
3200
2800
2400
0.2
0.15
0.1
0.05
0

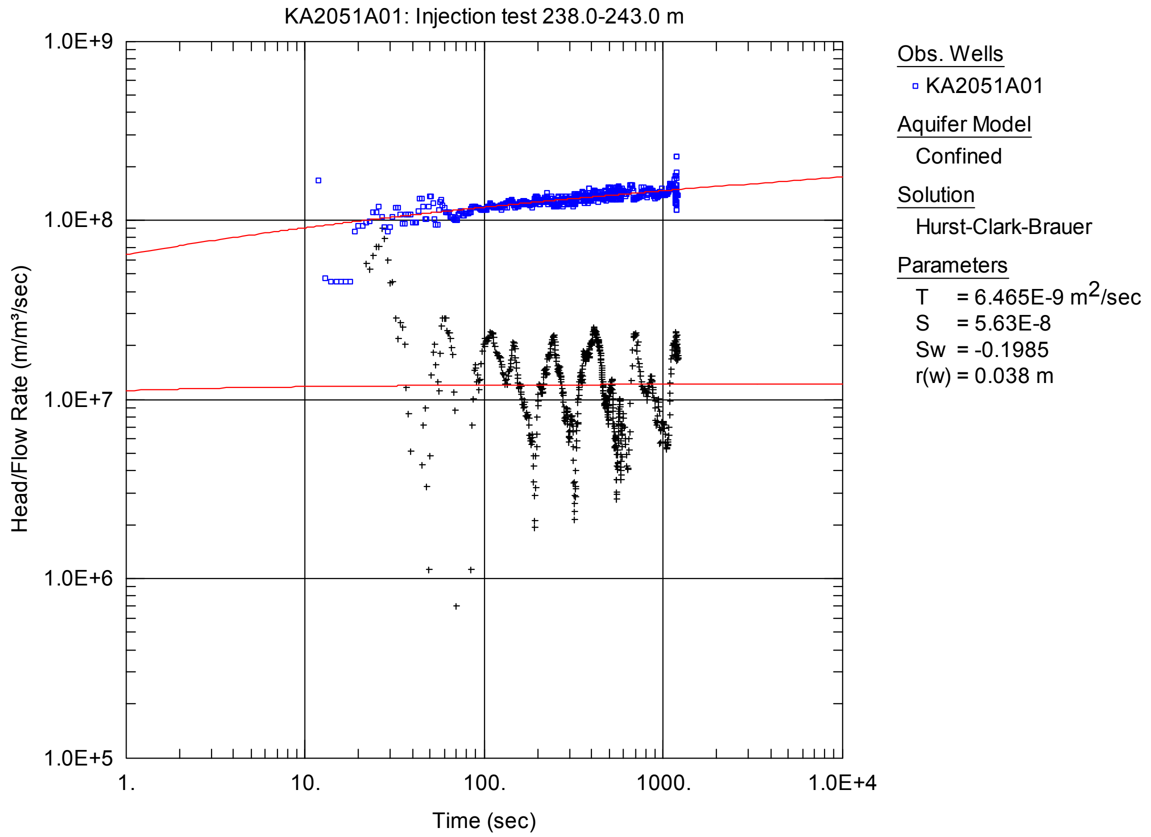

KA2051A01: Injection test 233.0-238.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 8.276E-9 m2/sec
S = 6.37E-8
Sw = -3.498
r(w) = 0.038 m

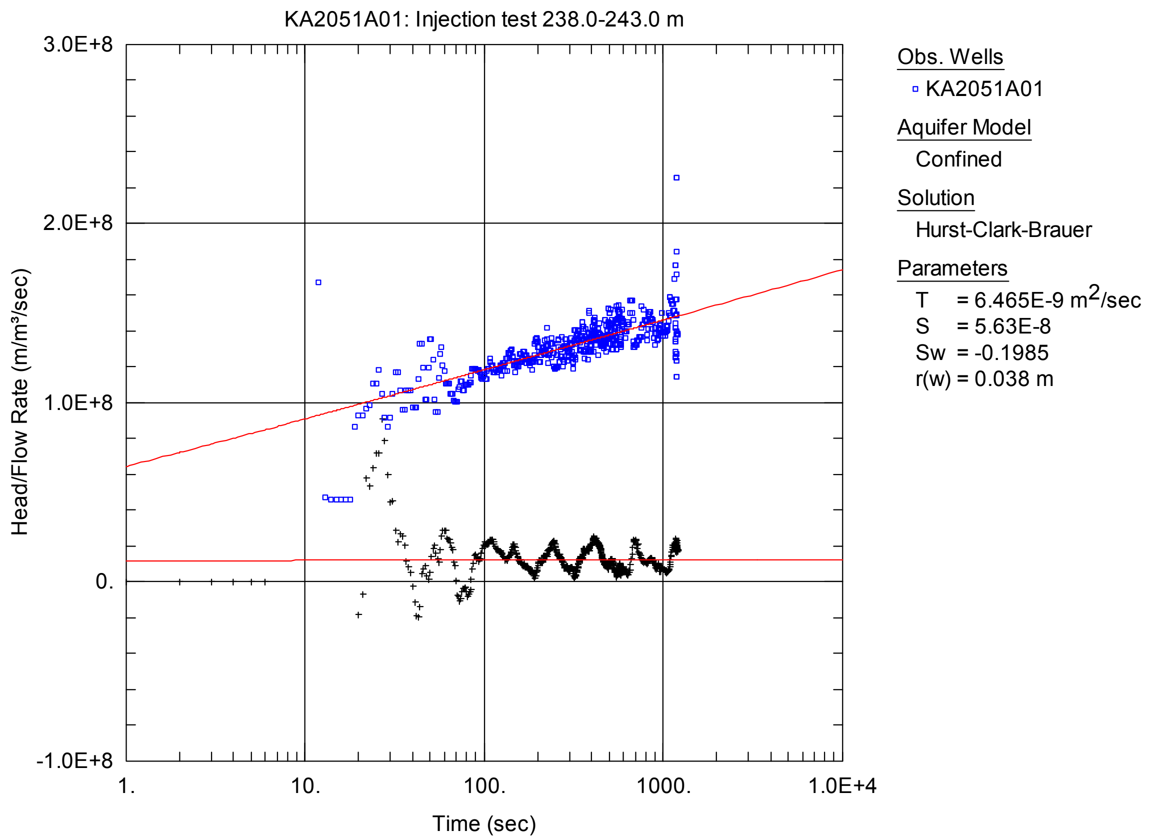

KA2051A01: Injection test 233.0-238.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
6.0E+7
4.0E+7
2.0E+7
0.
-2.0E+7
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 8.276E-9 m2/sec
S = 6.37E-8
Sw = -3.498
r(w) = 0.038 m

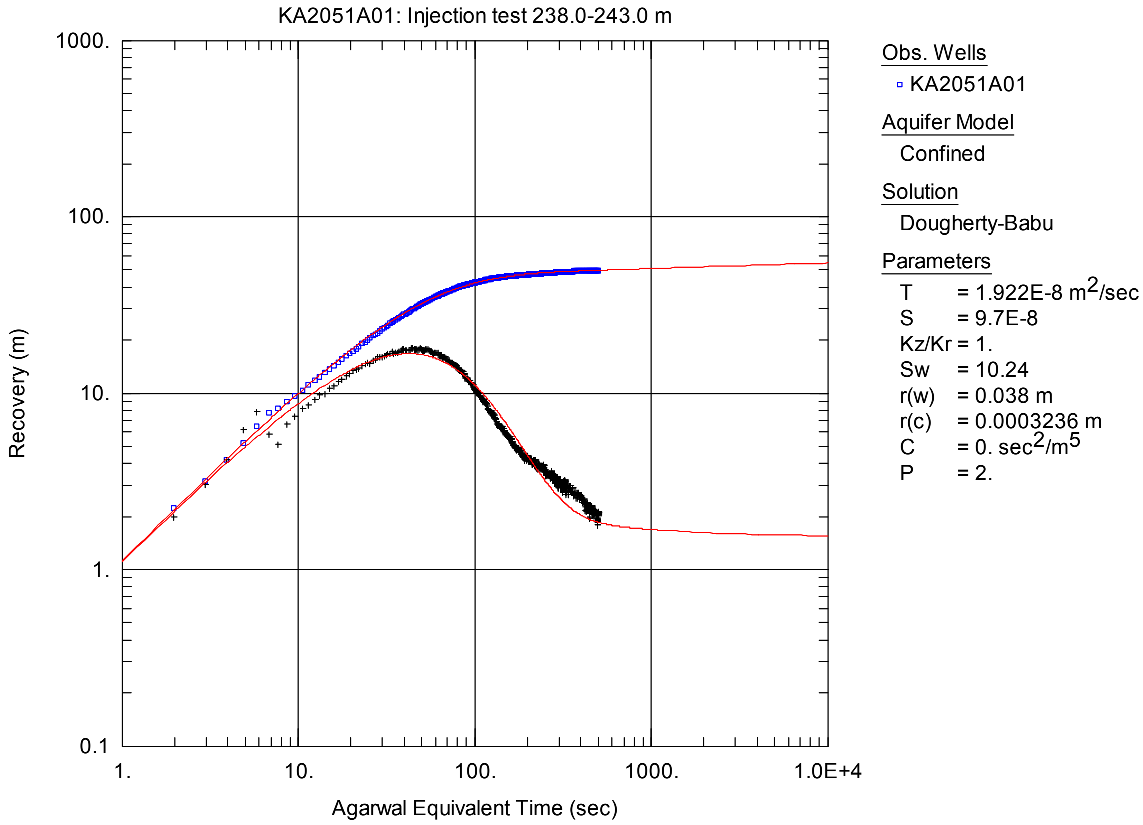

KA2051A01: Injection test 233.0-238.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 8.994E-9 m2/sec
S = 6.64E-8
Kz/Kr = 1.
Sw = -3.173
r(w) = 0.038 m
r(c) = 0.0002027 m
C = 0. sec2/m5
P = 2.

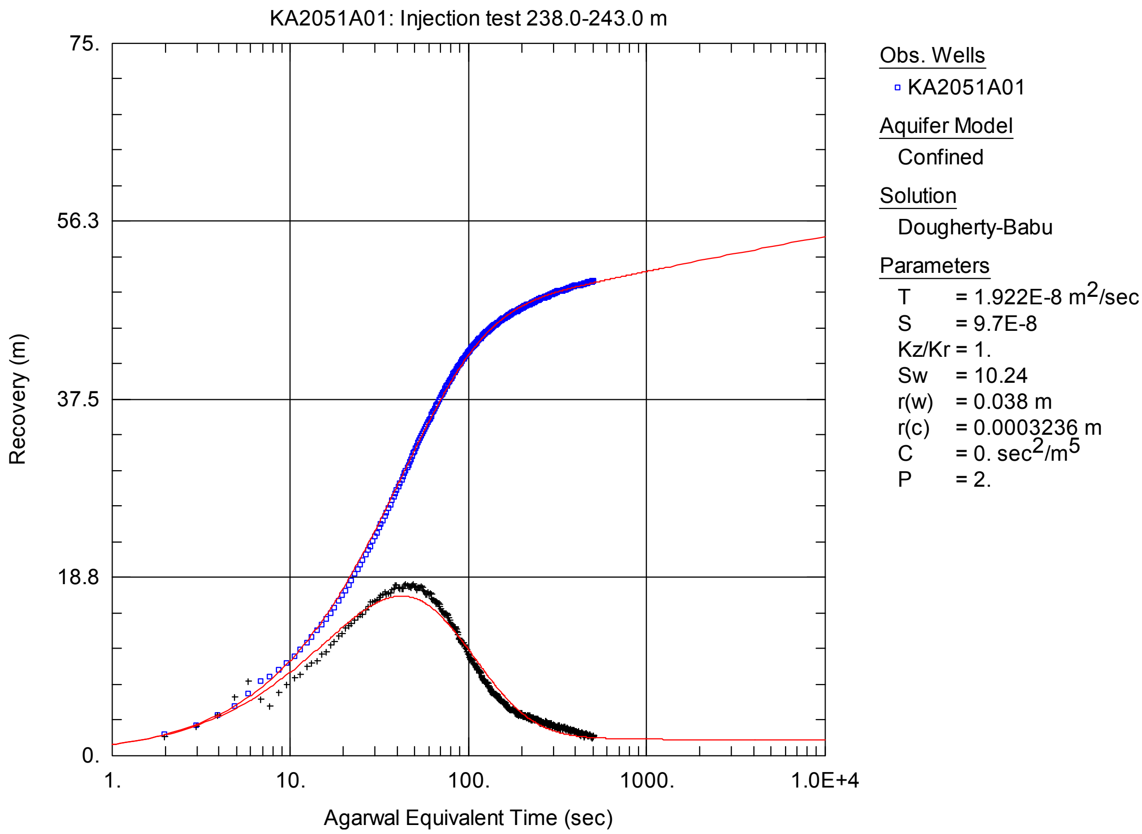

KA2051A01: Injection test 233.0-238.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 8.994E-9 m2/sec
S = 6.64E-8
Kz/Kr = 1.
Sw = -3.173
r(w) = 0.038 m
r(c) = 0.0002027 m
C = 0. sec2/m5
P = 2.

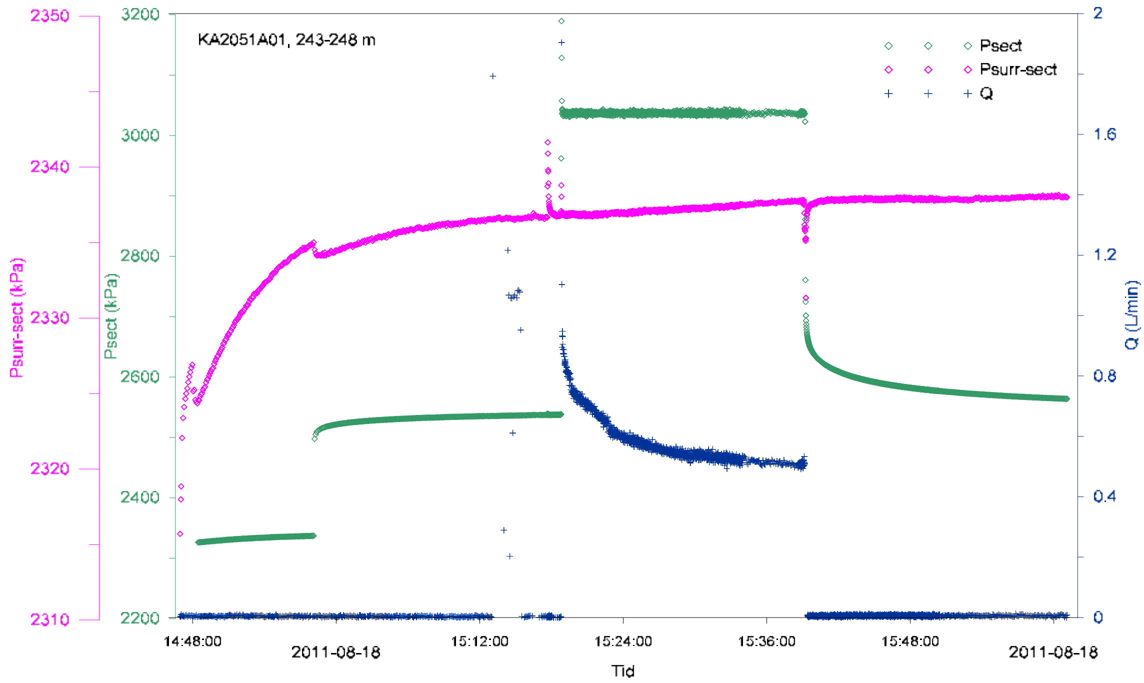

KA2051A01, 238-243 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2360
2340
2320
2300
2280
2260
3200
3000
2800
2600
2400
2200
0.2
0.15
0.1
0.05
0
-0.05
12:12:00
12:24:00
12:36:00
12:48:00
2011-08-18
13:12:00
13:24:00
13:36:00
13:48:00
2011-08-18
14:12:00
14:24:00
14:36:00

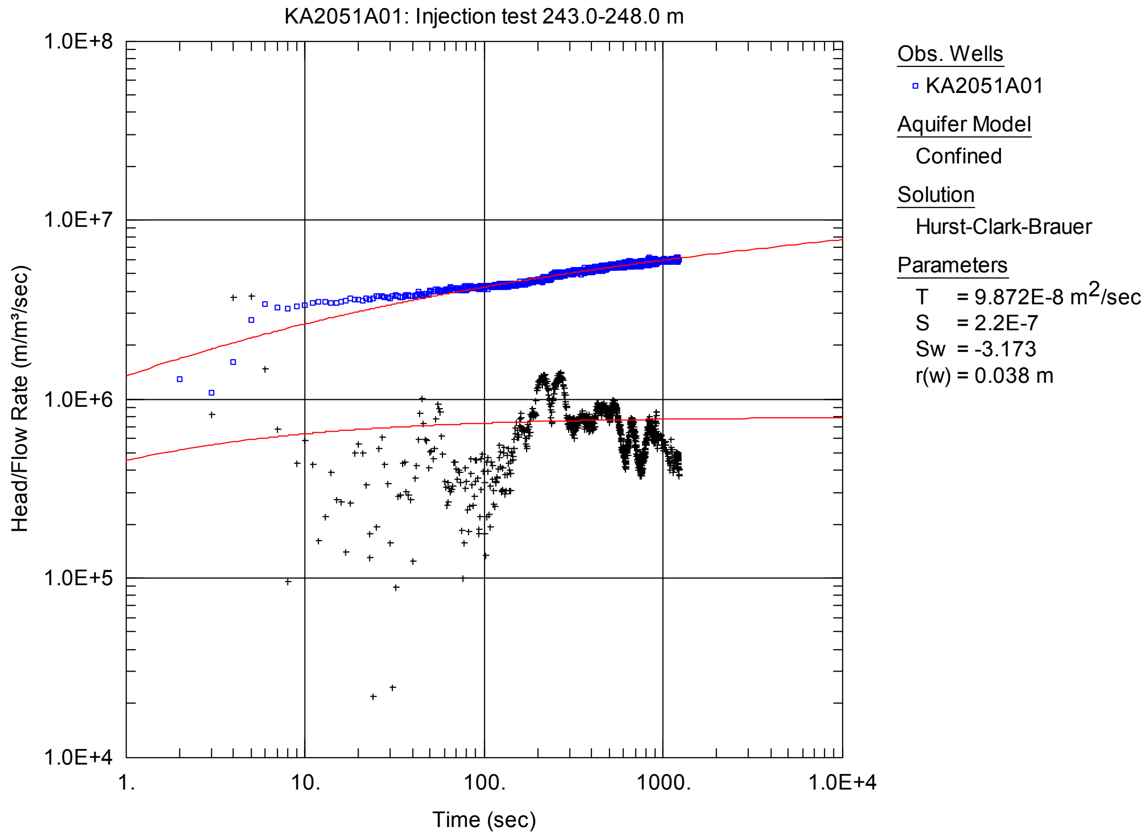

KA2051A01: Injection test 238.0-243.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 6.465E-9 m2/sec
S = 5.63E-8
Sw = -0.1985
r(w) = 0.038 m

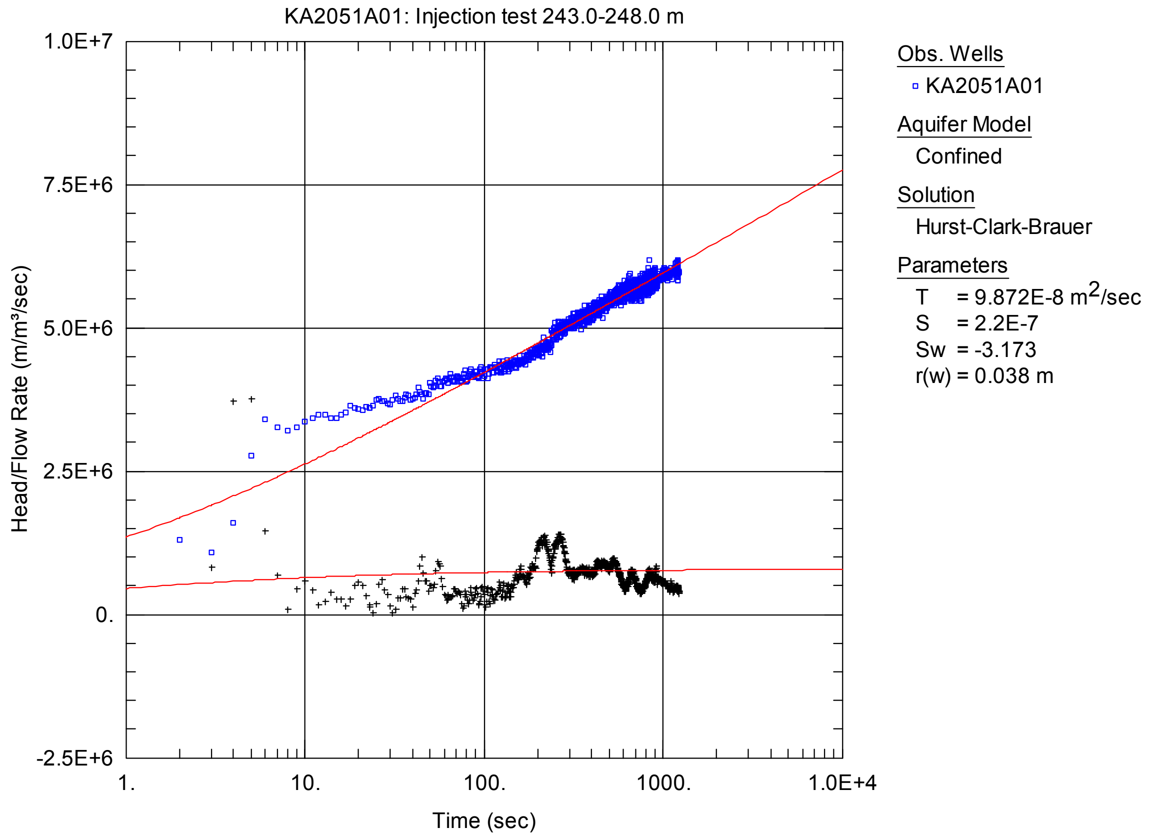

KA2051A01: Injection test 238.0-243.0 m
3.0E+8
2.0E+8
1.0E+8
0.
-1.0E+8
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 6.465E-9 m2/sec
S = 5.63E-8
Sw = -0.1985
r(w) = 0.038 m

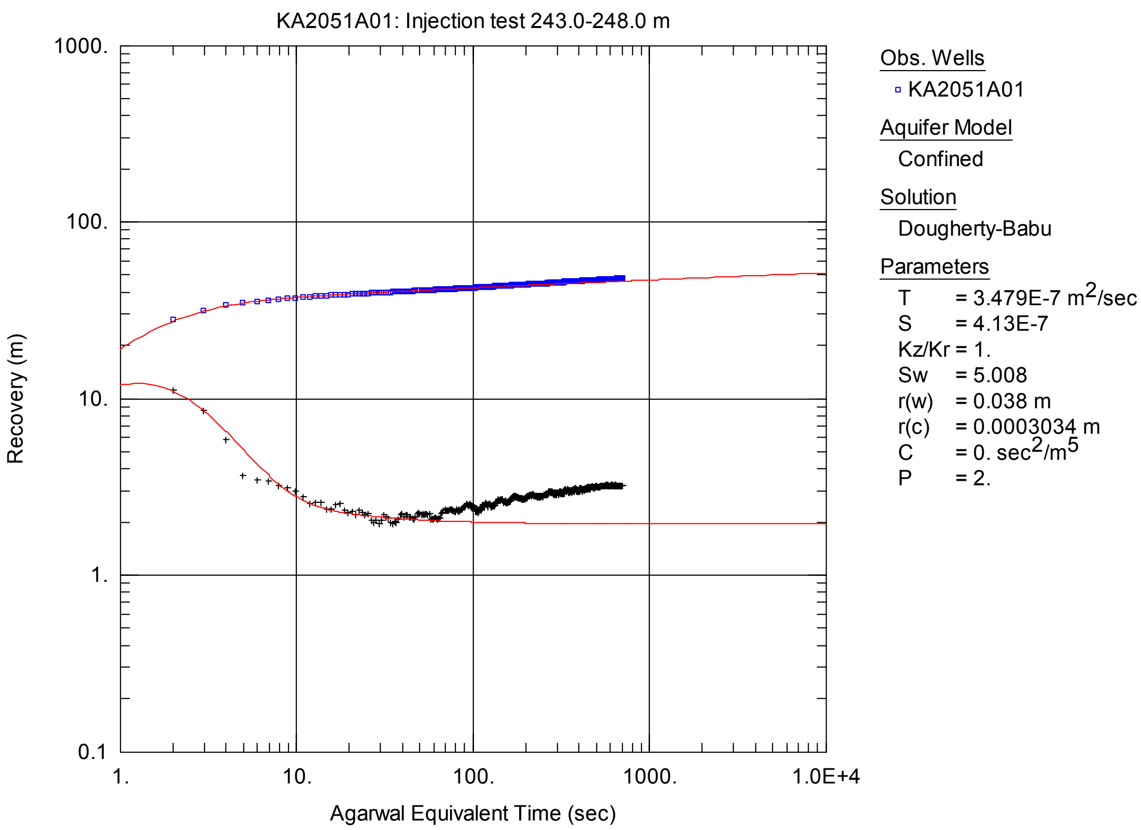

KA2051A01: Injection test 238.0-243.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 1.922E-8 m2/sec
S = 9.7E-8
Kz/Kr = 1.
Sw = 10.24
r(w) = 0.038 m
r(c) = 0.0003236 m
C = 0. sec2/m5
P = 2.

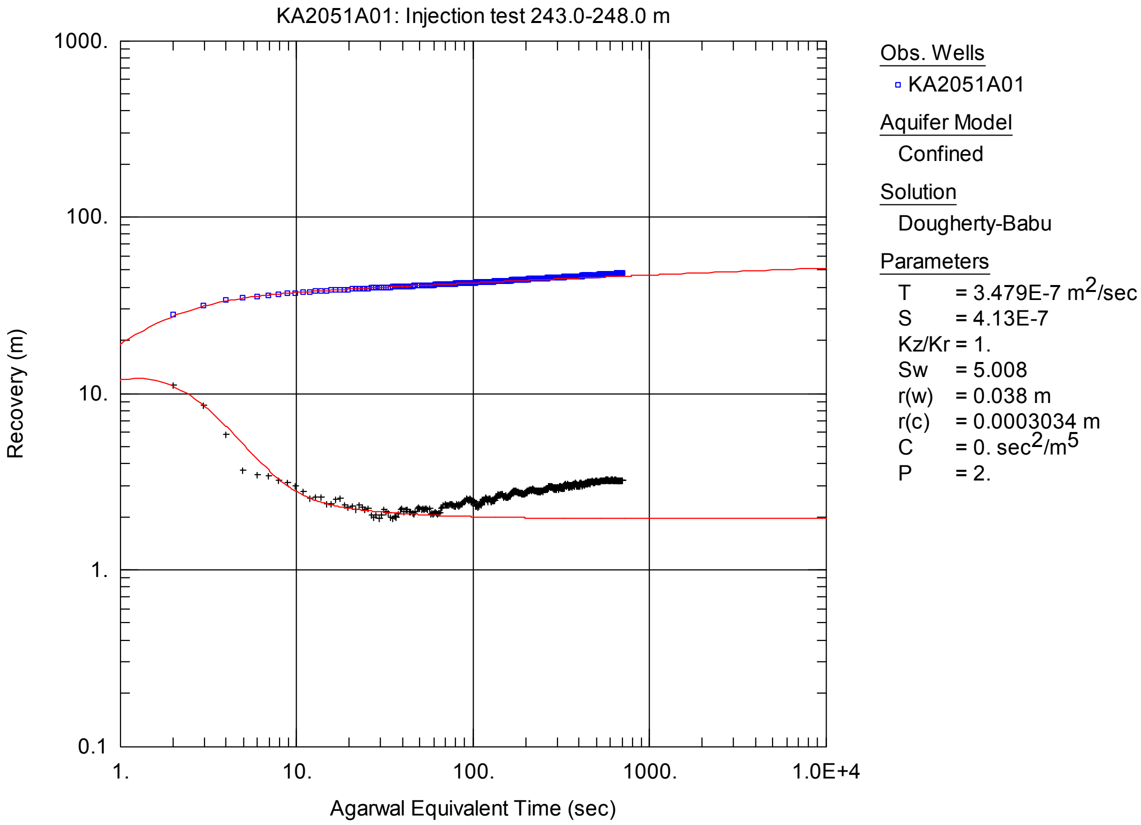

KA2051A01: Injection test 238.0-243.0 m
75.
56.3
37.5
18.8
0.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 1.922E-8 m2/sec
S = 9.7E-8
Kz/Kr = 1.
Sw = 10.24
r(w) = 0.038 m
r(c) = 0.0003236 m
C = 0. sec2/m5
P = 2.

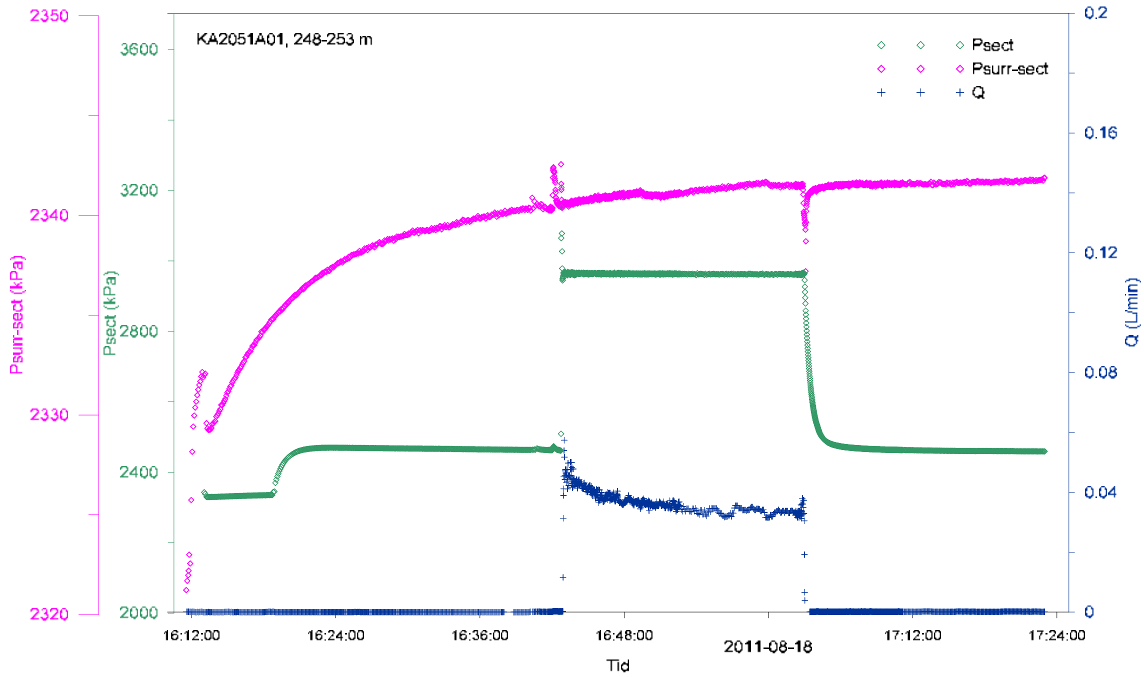

KA2051A01, 243-248 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
Tid
2011-08-18
14:48:00
15:12:00
15:24:00
15:36:00
15:48:00

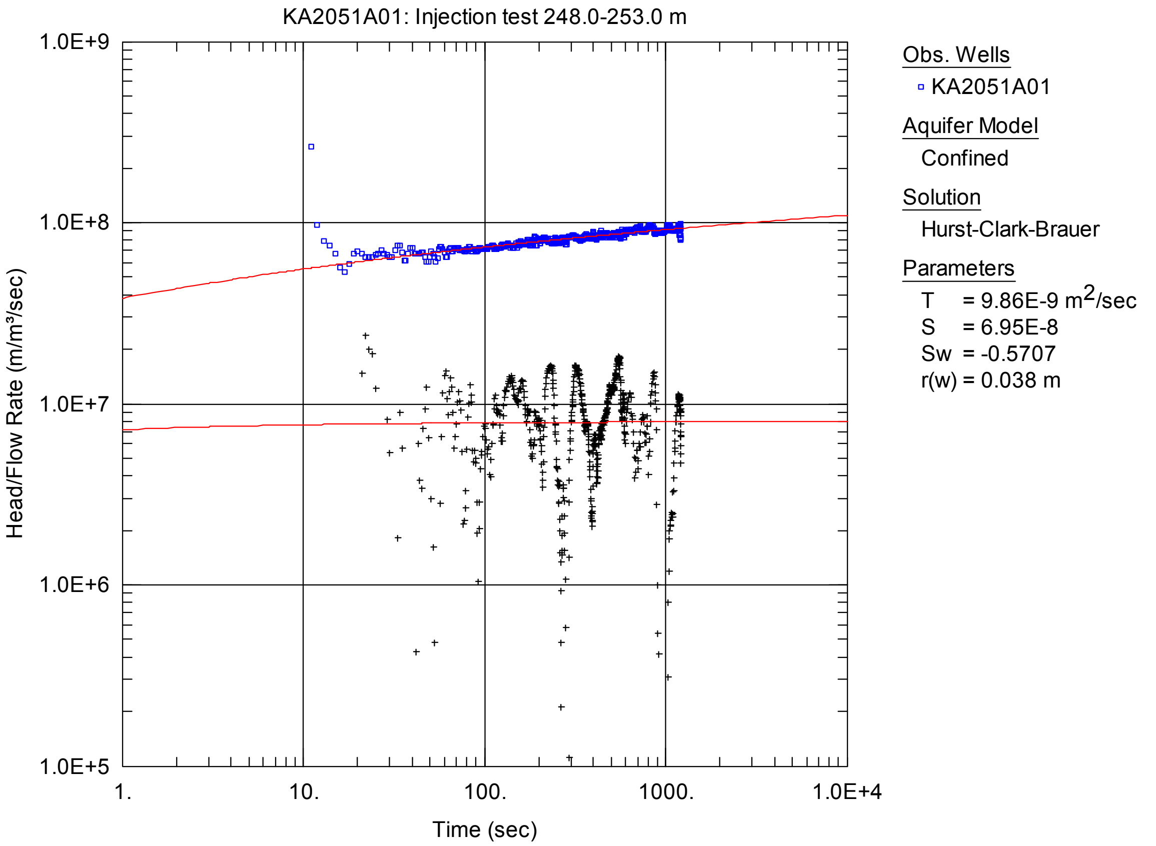

KA2051A01: Injection test 243.0-248.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 9.872E-8 m2/sec
S = 2.2E-7
Sw = -3.173
r(w) = 0.038 m

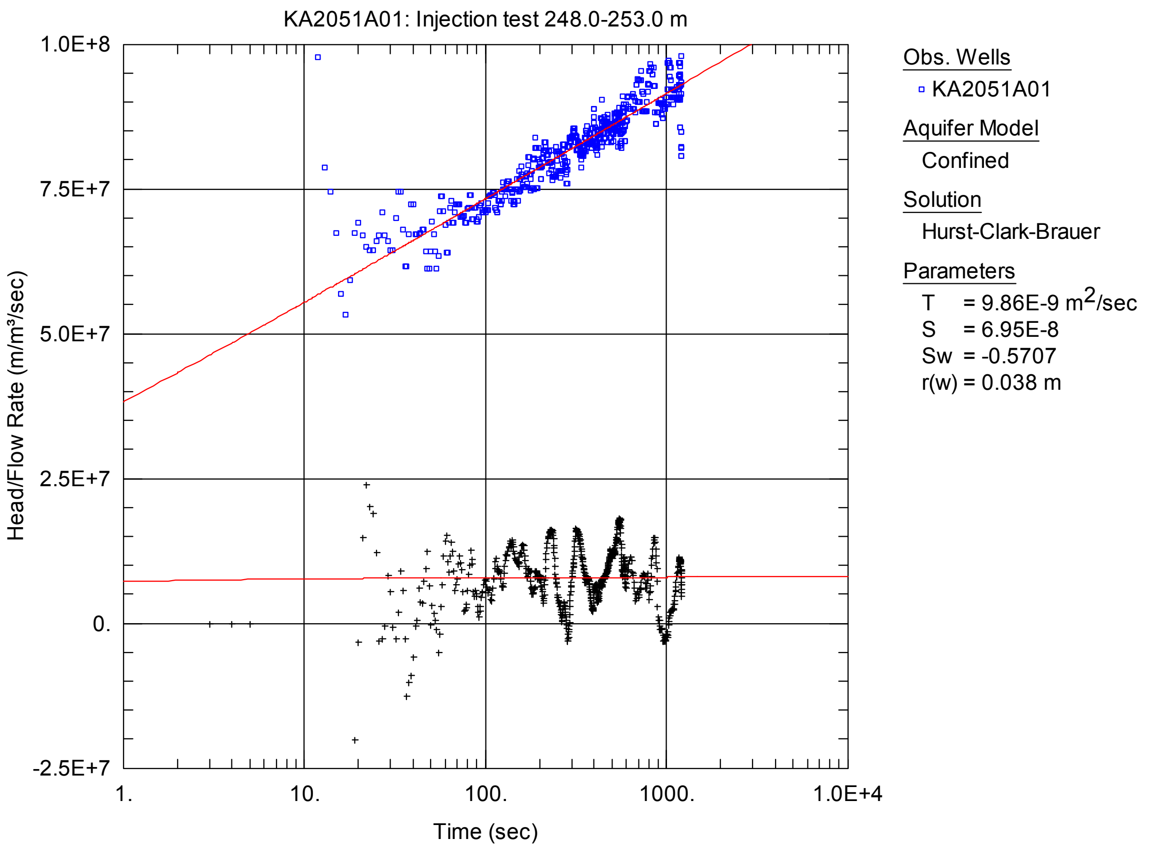

KA2051A01: Injection test 243.0-248.0 m
Head/Flow Rate (m/m³/sec)
1.0E+7
7.5E+6
5.0E+6
2.5E+6
0.
-2.5E+6
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 9.872E-8 m2/sec
S = 2.2E-7
Sw = -3.173
r(w) = 0.038 m

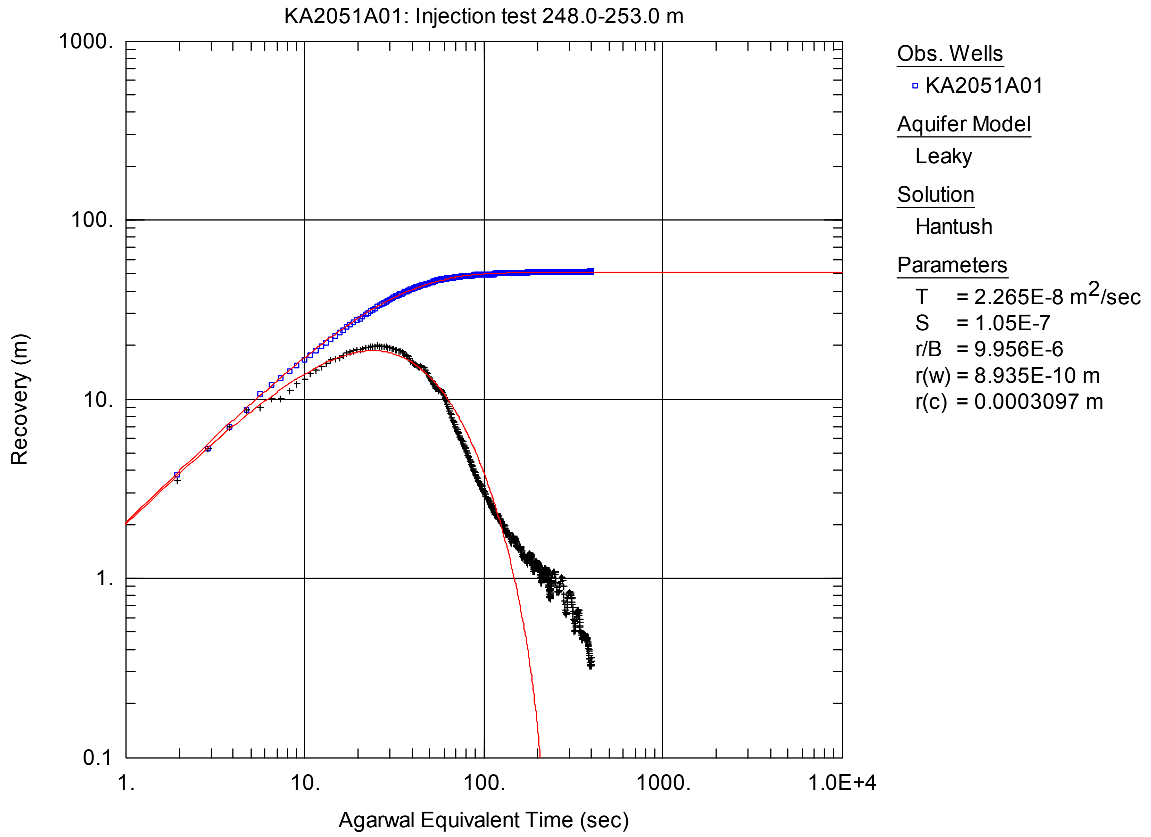

KA2051A01: Injection test 243.0-248.0 m
Recovery (m)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.479E-7 m2/sec
S = 4.13E-7
Kz/Kr = 1.
Sw = 5.008
r(w) = 0.038 m
r(c) = 0.0003034 m
C = 0. sec2/m5
P = 2.

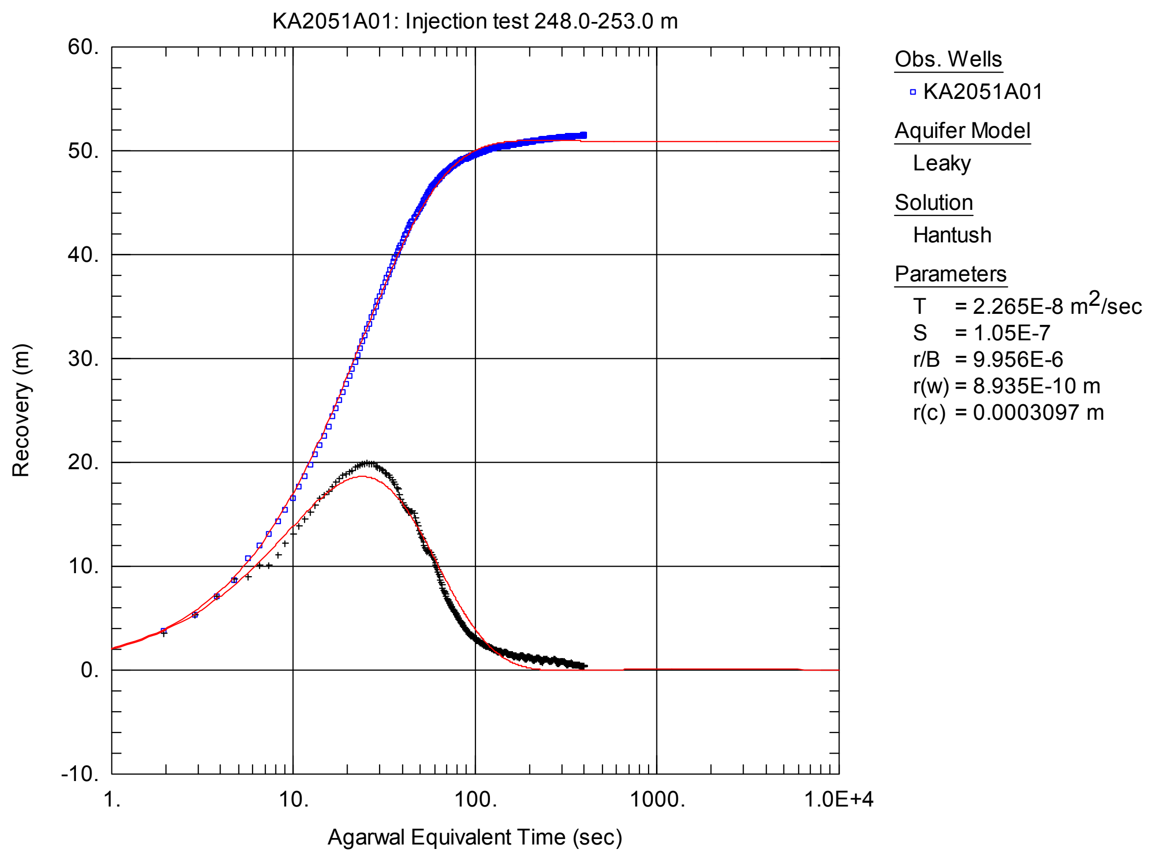

KA2051A01: Injection test 243.0-248.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.479E-7 m2/sec
S = 4.13E-7
Kz/Kr = 1.
Sw = 5.008
r(w) = 0.038 m
r(c) = 0.0003034 m
C = 0. sec2/m5
P = 2.

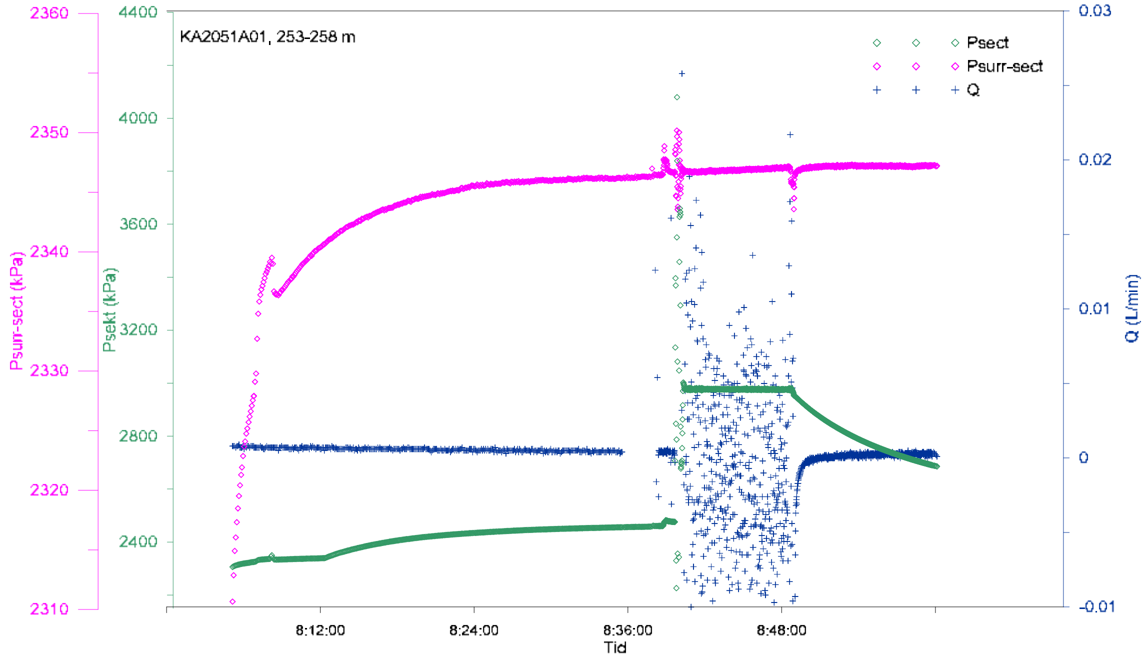

KA2051A01, 248-253 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2350
2340
2330
2320
3600
3200
2800
2400
2000
0.2
0.16
0.12
0.08
0.04
0
16:12:00
16:24:00
16:36:00
16:48:00
2011-08-18
17:12:00
17:24:00
Tid

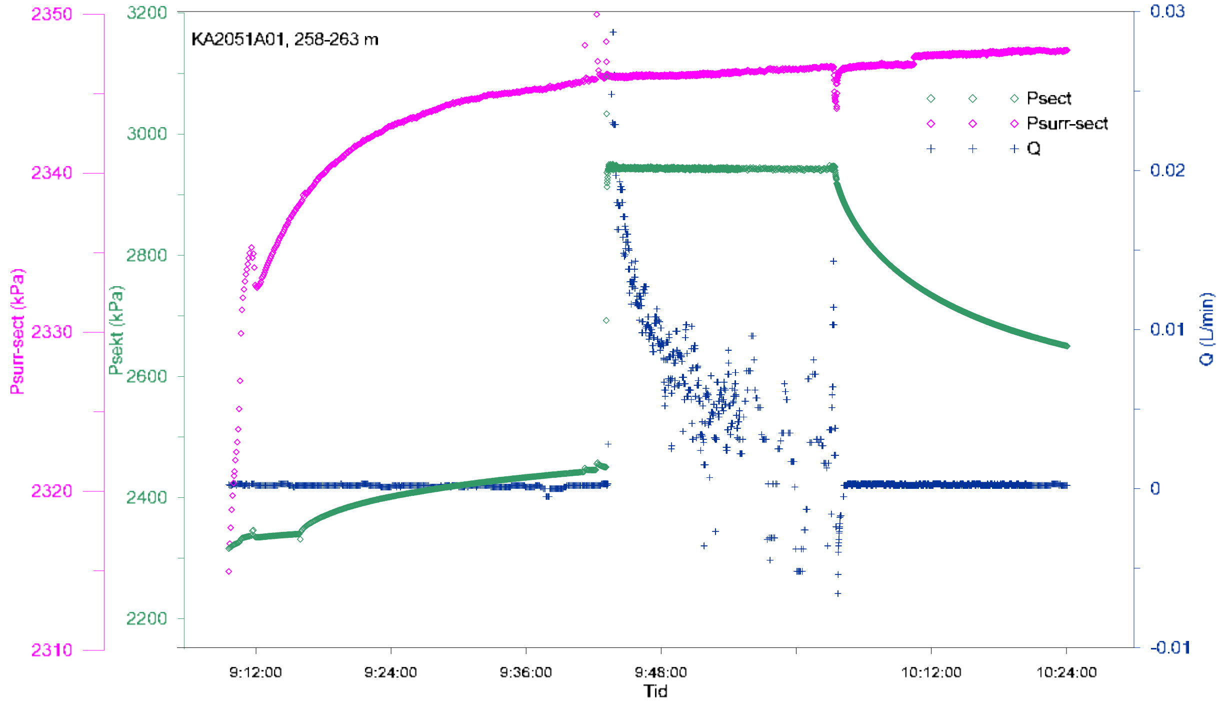

KA2051A01: Injection test 248.0-253.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 9.86E-9 m2/sec
S = 6.95E-8
Sw = -0.5707
r(w) = 0.038 m

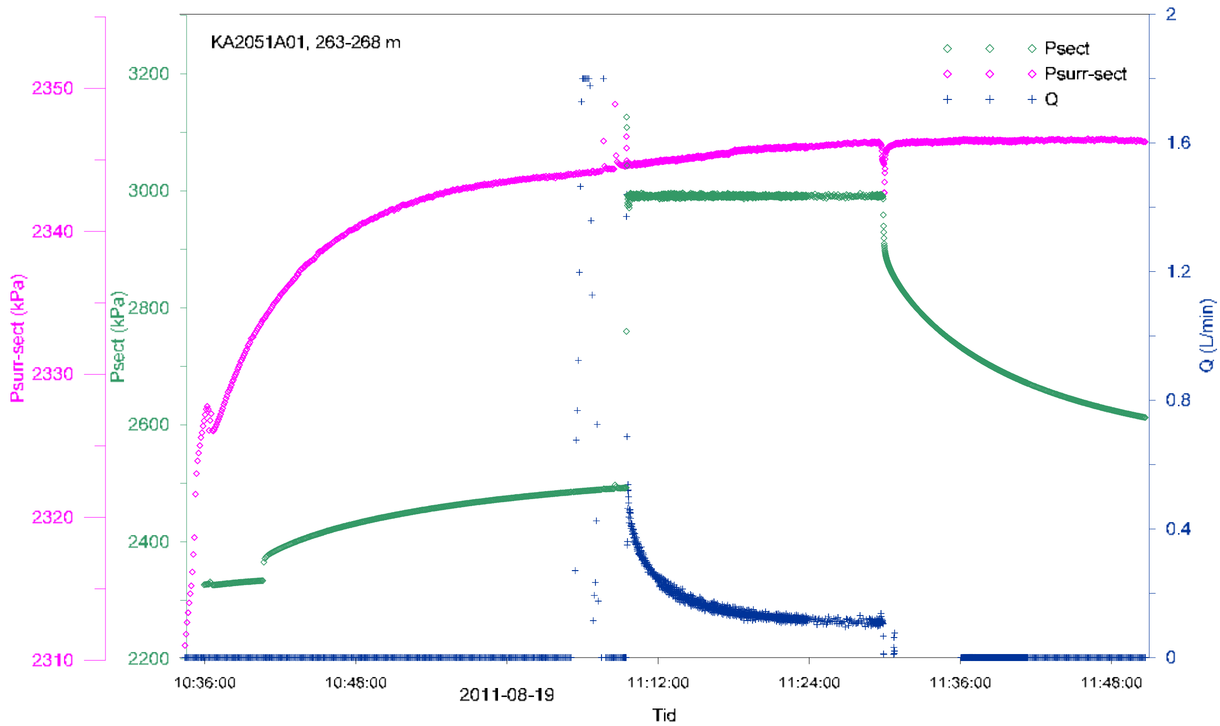

KA2051A01: Injection test 248.0-253.0 m
1.0E+8
7.5E+7
5.0E+7
2.5E+7
0.
-2.5E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 9.86E-9 m2/sec
S = 6.95E-8
Sw = -0.5707
r(w) = 0.038 m


KA2051A01: Injection test 248.0-253.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.265E-8 m2/sec
S = 1.05E-7
r/B = 9.956E-6
r(w) = 8.935E-10 m
r(c) = 0.0003097 m

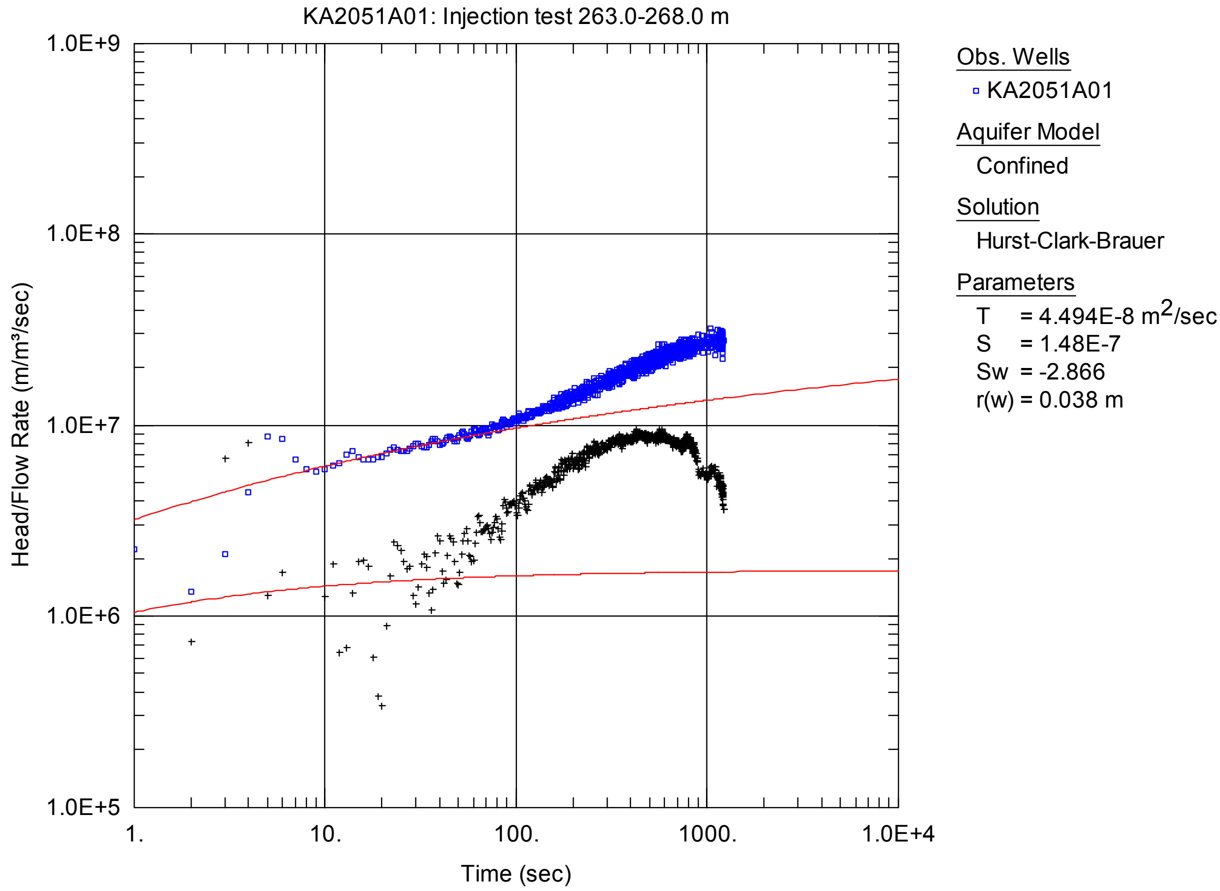

KA2051A01: Injection test 248.0-253.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
-10.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.265E-8 m2/sec
S = 1.05E-7
r/B = 9.956E-6
r(w) = 8.935E-10 m
r(c) = 0.0003097 m


KA2051A01, 253-258 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2360
2350
2340
2330
2320
2310
4400
4000
3600
3200
2800
2400
0.03
0.02
0.01
0
-0.01
8:12:00
8:24:00
8:36:00
8:48:00

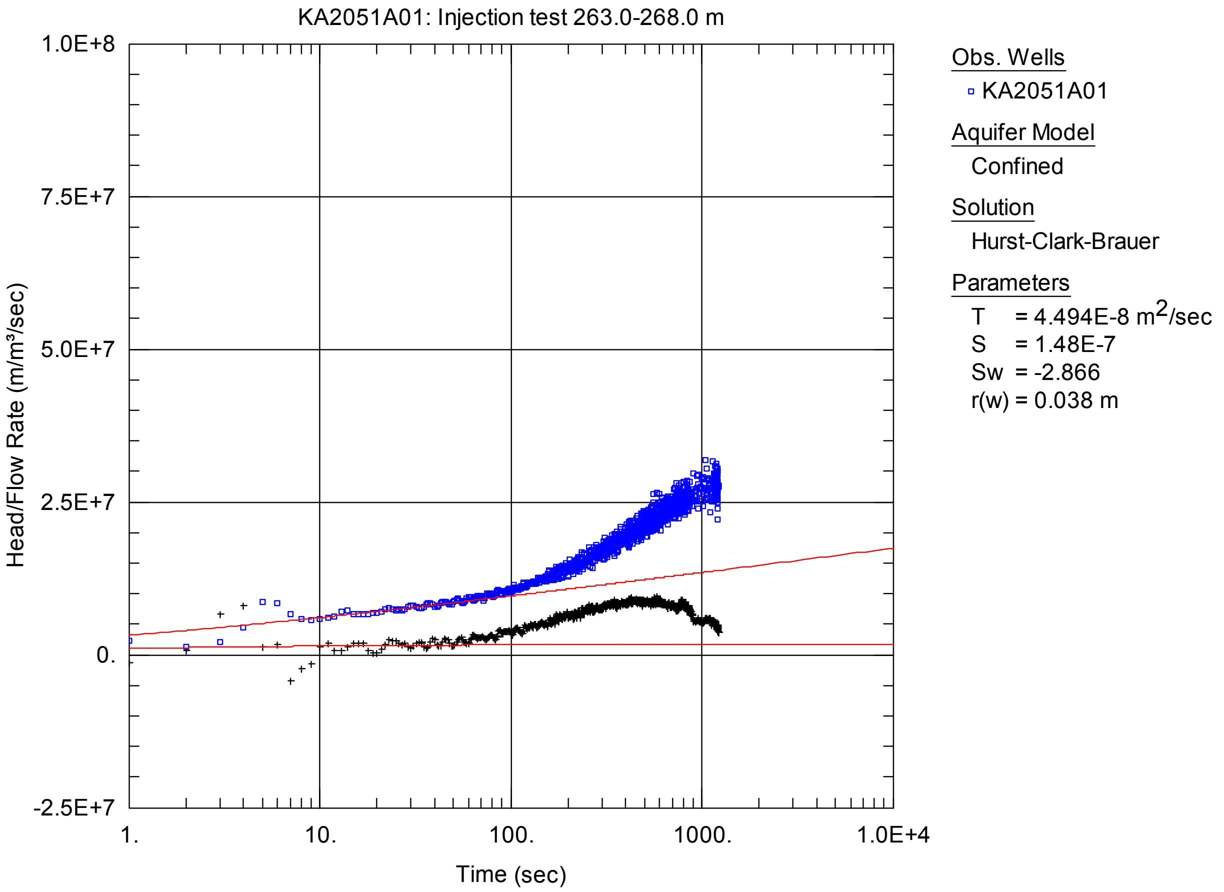

KA2051A01, 258-263 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2350
2340
2330
2320
2310
3200
3000
2800
2600
2400
2200
0.03
0.02
0.01
0
-0.01
9:12:00
9:24:00
9:36:00
9:48:00
10:12:00
10:24:00

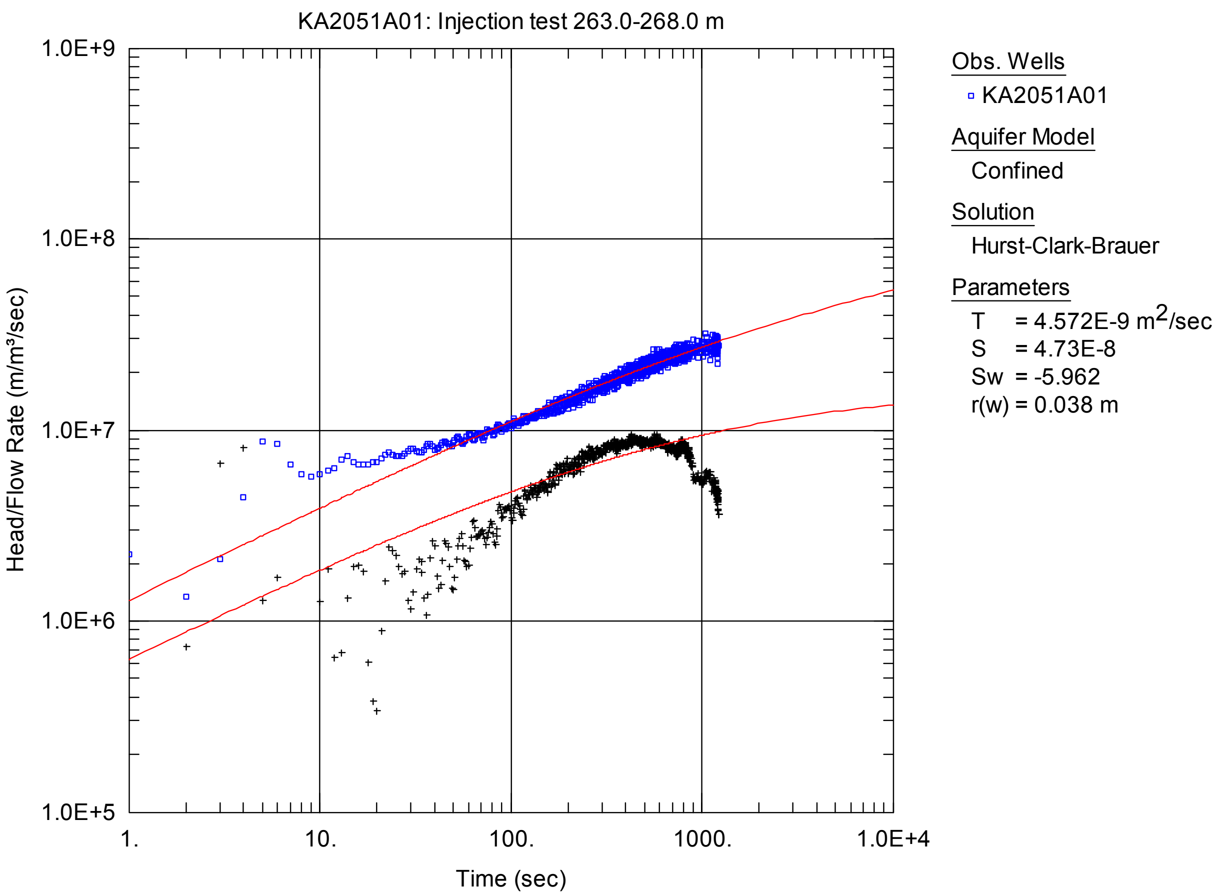


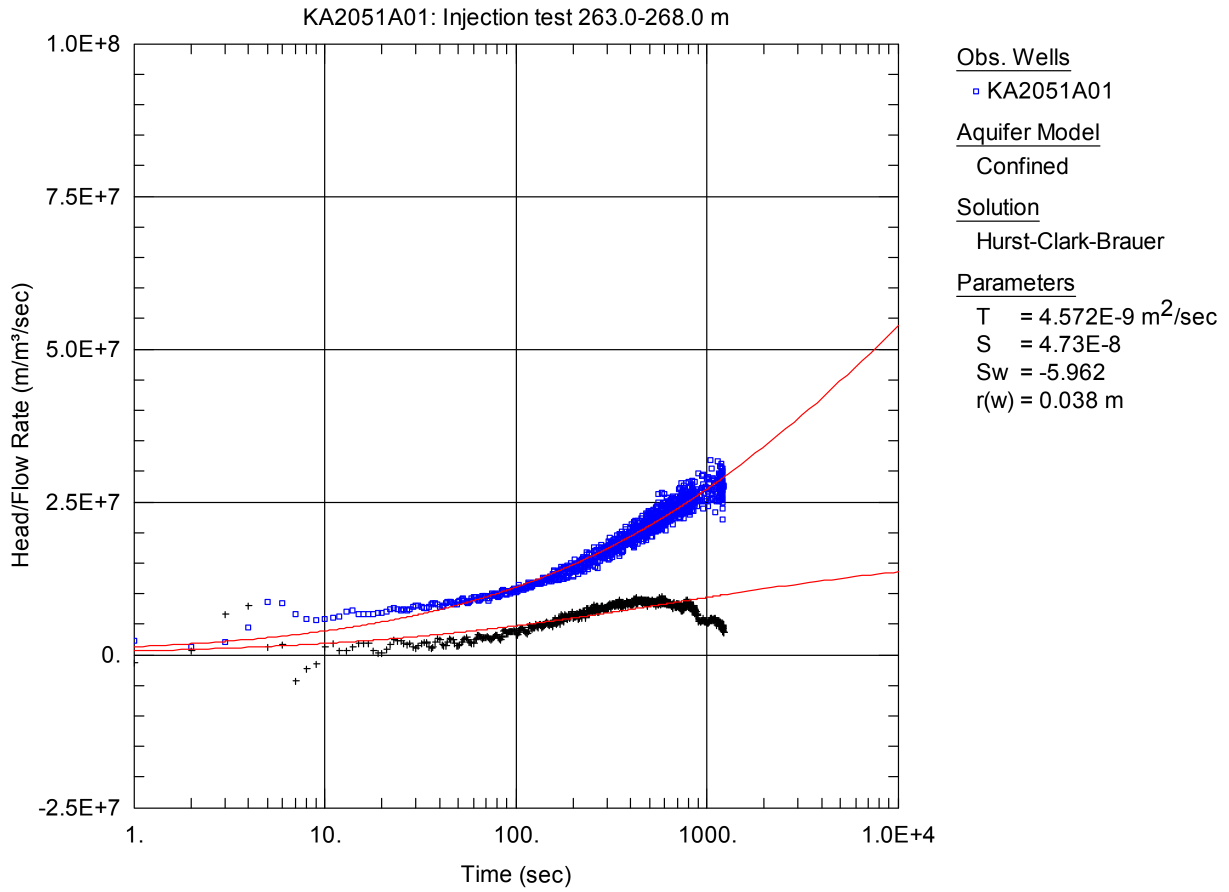
KA2051A01, 263-268 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2350
2340
2330
2320
2310
3200
3000
2800
2600
2400
2200
2
1.6
1.2
0.8
0.4
0
10:36:00
10:48:00
11:12:00
11:24:00
11:36:00
11:48:00
2011-08-19
Tid

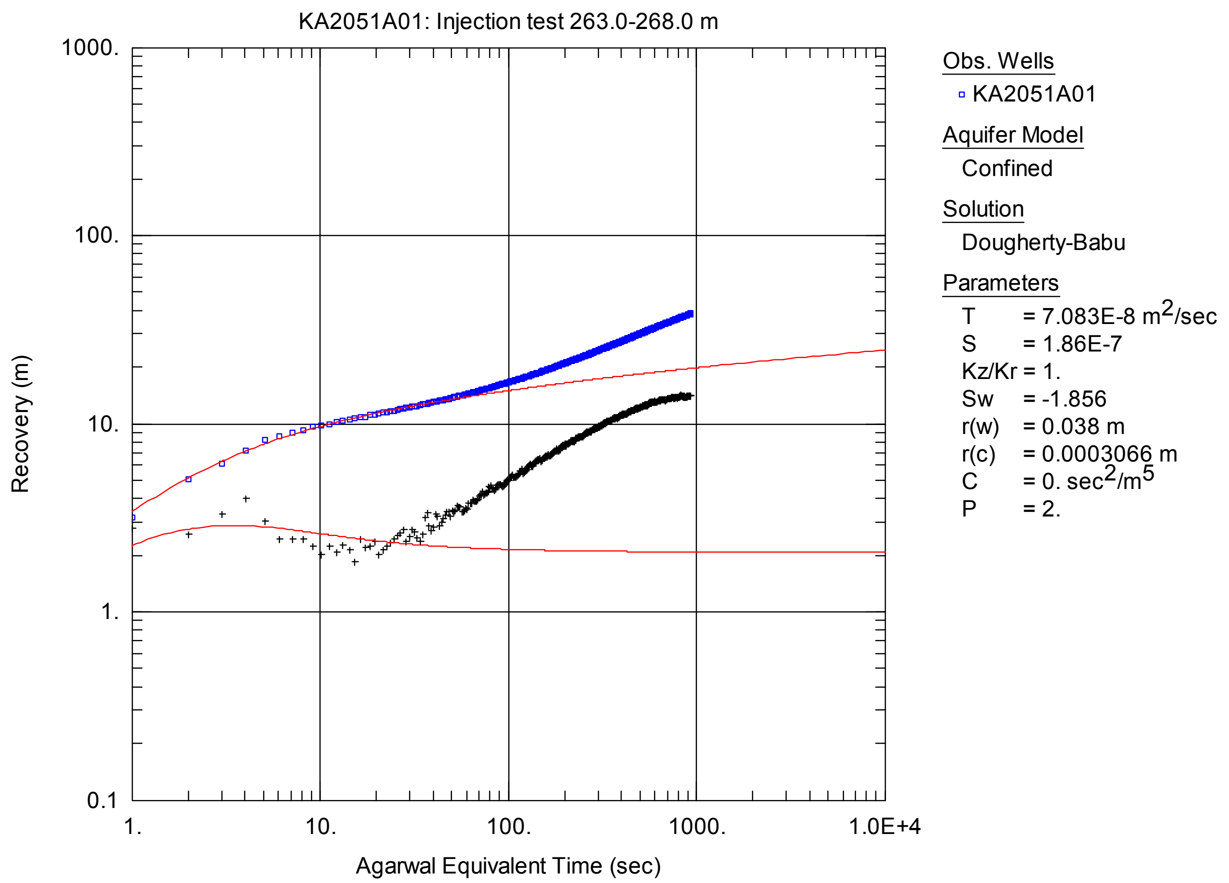


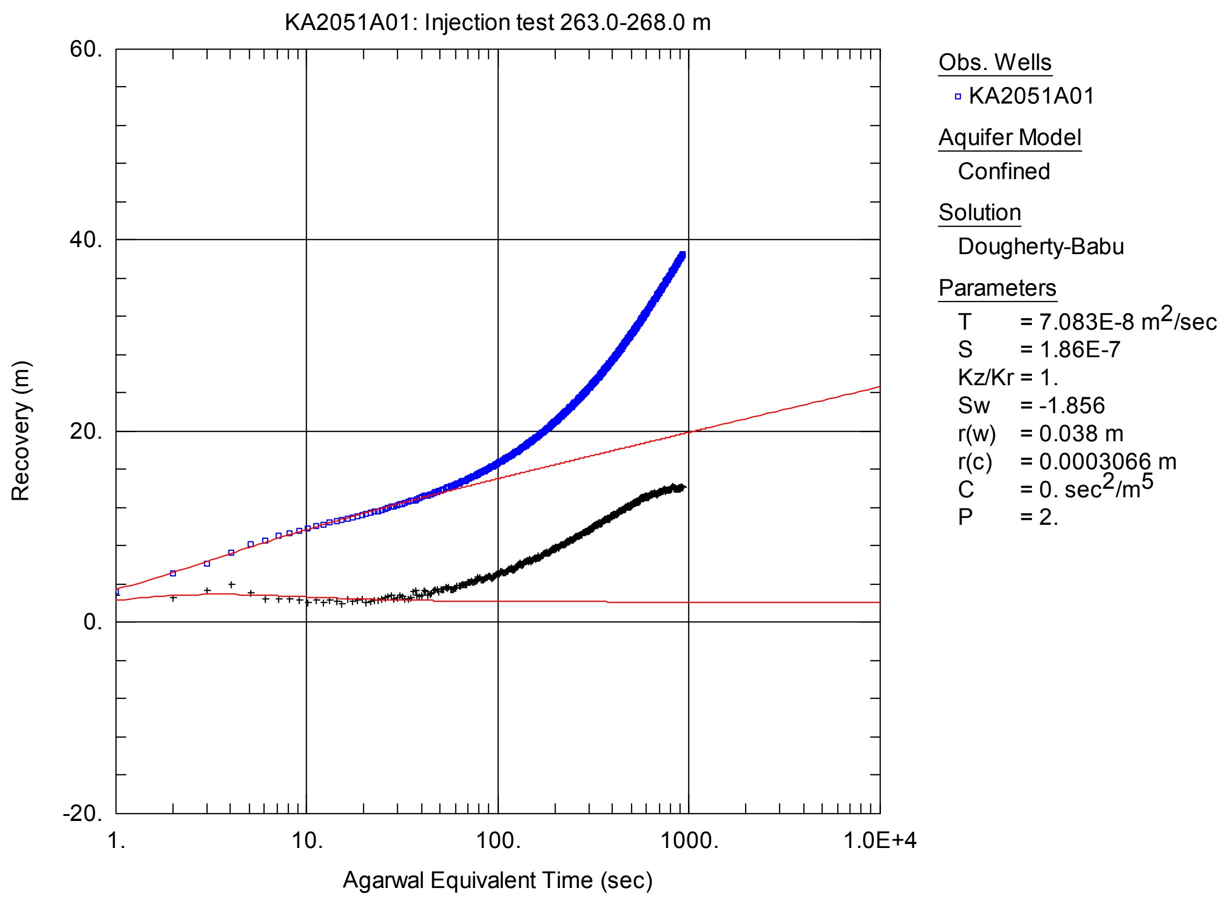
KA2051A01: Injection test 263.0-268.0 m
Head/Flow Rate (m/m³/sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.494E-8 m2/sec
S = 1.48E-7
Sw = -2.866
r(w) = 0.038 m

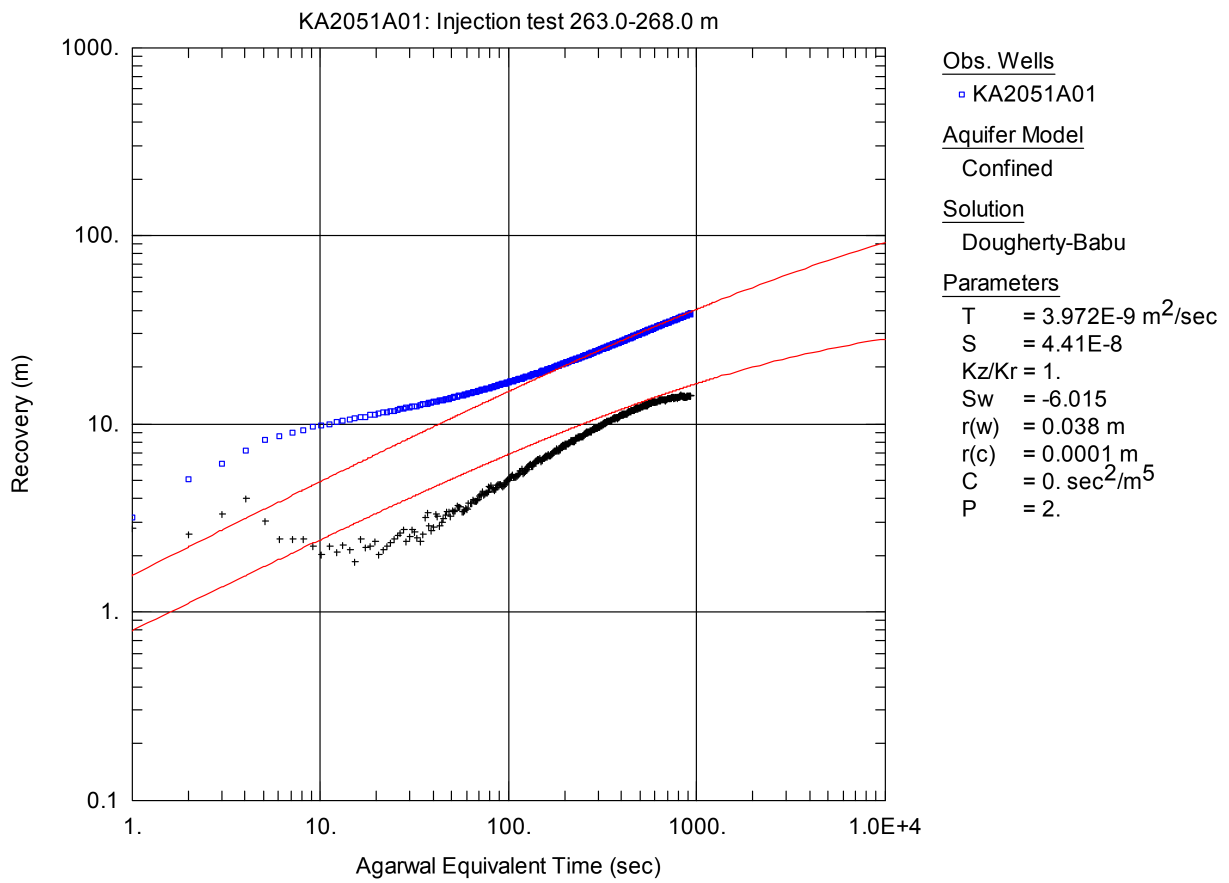

KA2051A01: Injection test 263.0-268.0 m
1.0E+8
7.5E+7
5.0E+7
2.5E+7
0.
-2.5E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.494E-8 m2/sec
S = 1.48E-7
Sw = -2.866
r(w) = 0.038 m

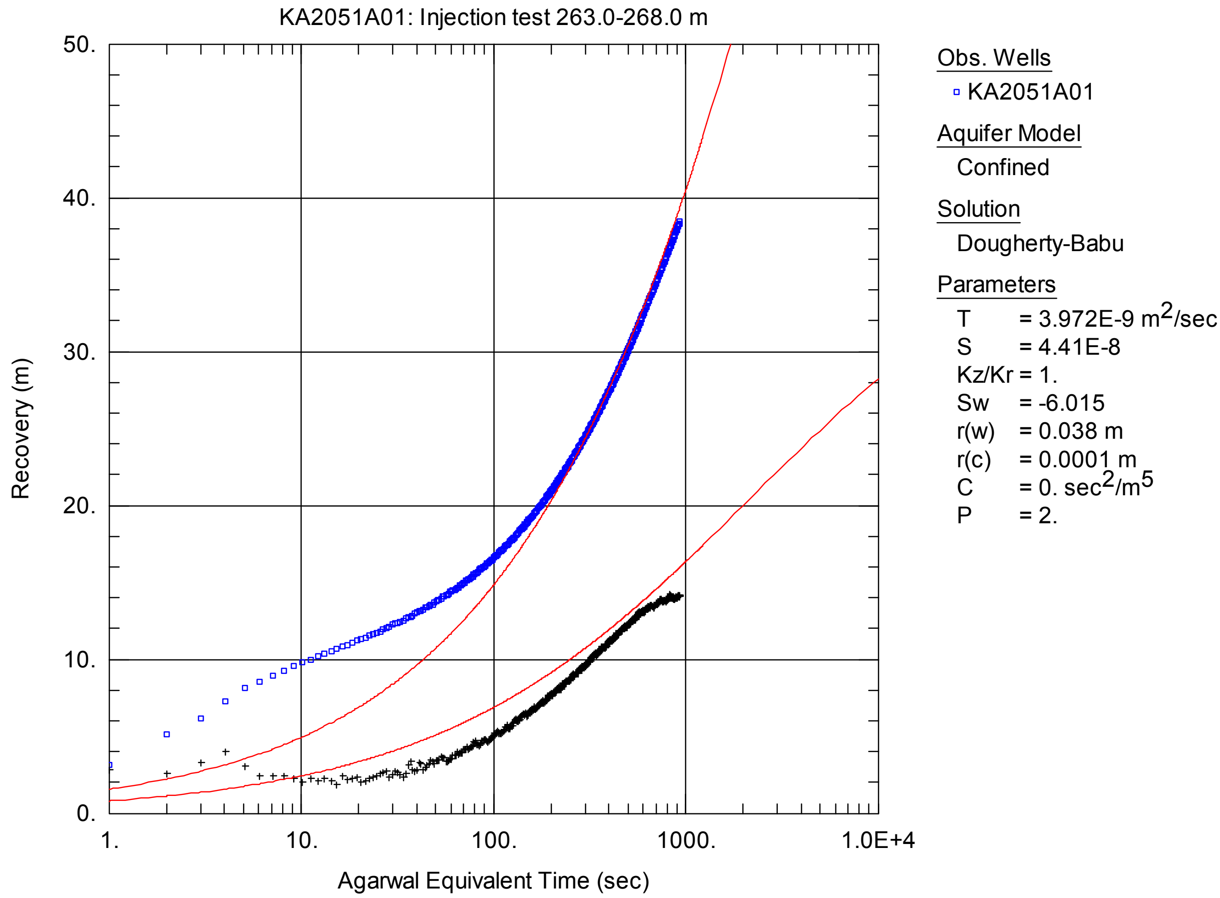

KA2051A01: Injection test 263.0-268.0 m
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.572E-9 m2/sec
S = 4.73E-8
Sw = -5.962
r(w) = 0.038 m

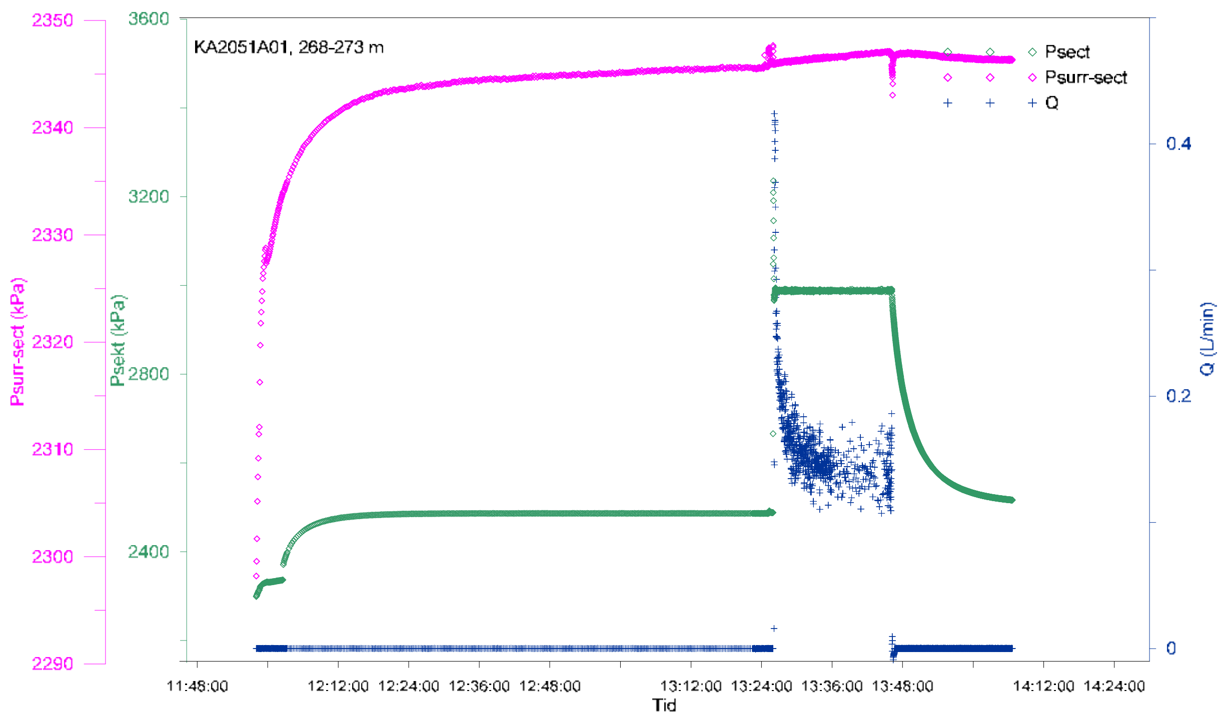

KA2051A01: Injection test 263.0-268.0 m
Head/Flow Rate (m/m³/sec)
1.0E+8
7.5E+7
5.0E+7
2.5E+7
0.
-2.5E+7
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.572E-9 m2/sec
S = 4.73E-8
Sw = -5.962
r(w) = 0.038 m

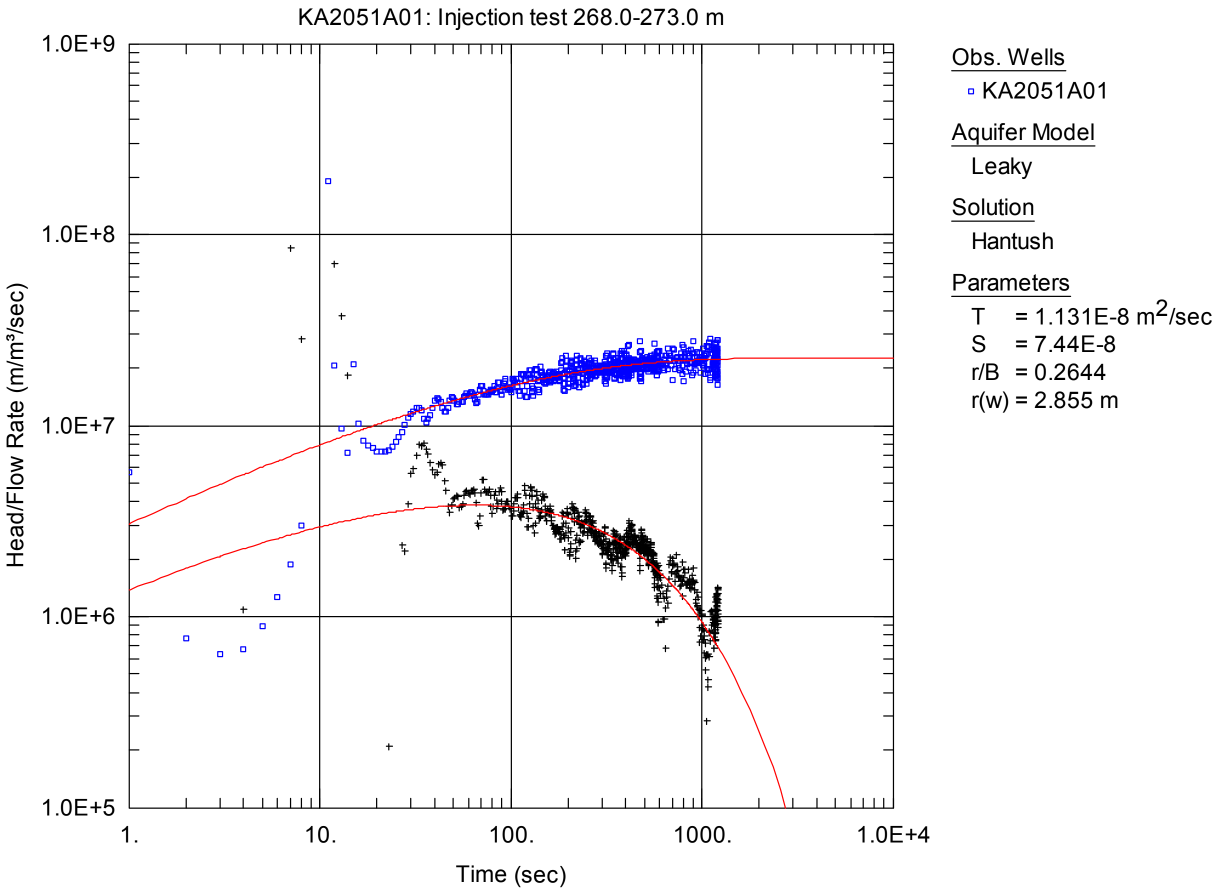

KA2051A01: Injection test 263.0-268.0 m
Recovery (m)
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 7.083E-8 m2/sec
S = 1.86E-7
Kz/Kr = 1.
Sw = -1.856
r(w) = 0.038 m
r(c) = 0.0003066 m
C = 0. sec2/m5
P = 2.

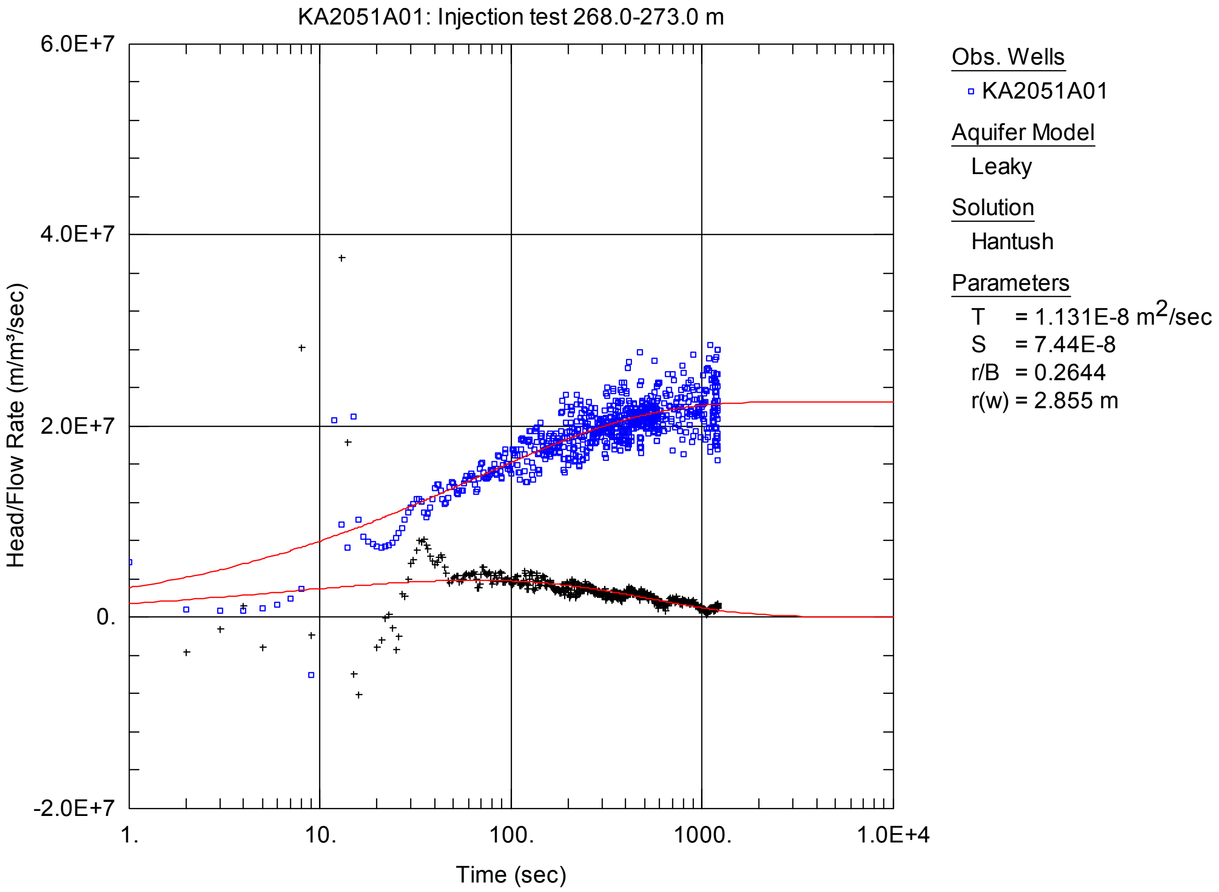

KA2051A01: Injection test 263.0-268.0 m
60.
40.
20.
0.
-20.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 7.083E-8 m2/sec
S = 1.86E-7
Kz/Kr = 1.
Sw = -1.856
r(w) = 0.038 m
r(c) = 0.0003066 m
C = 0. sec2/m5
P = 2.

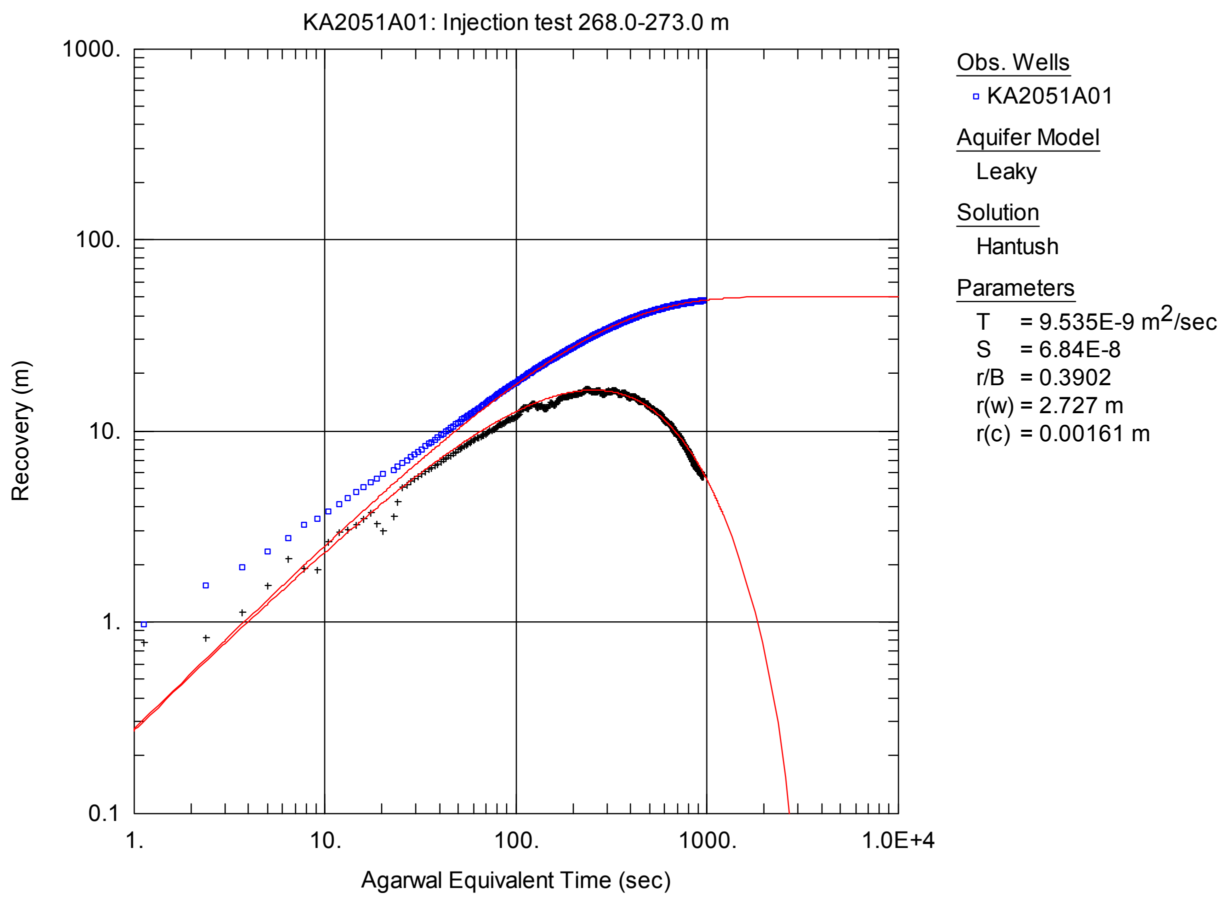

KA2051A01: Injection test 263.0-268.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.972E-9 m2/sec
S = 4.41E-8
Kz/Kr = 1.
Sw = -6.015
r(w) = 0.038 m
r(c) = 0.0001 m
C = 0. sec2/m5
P = 2.

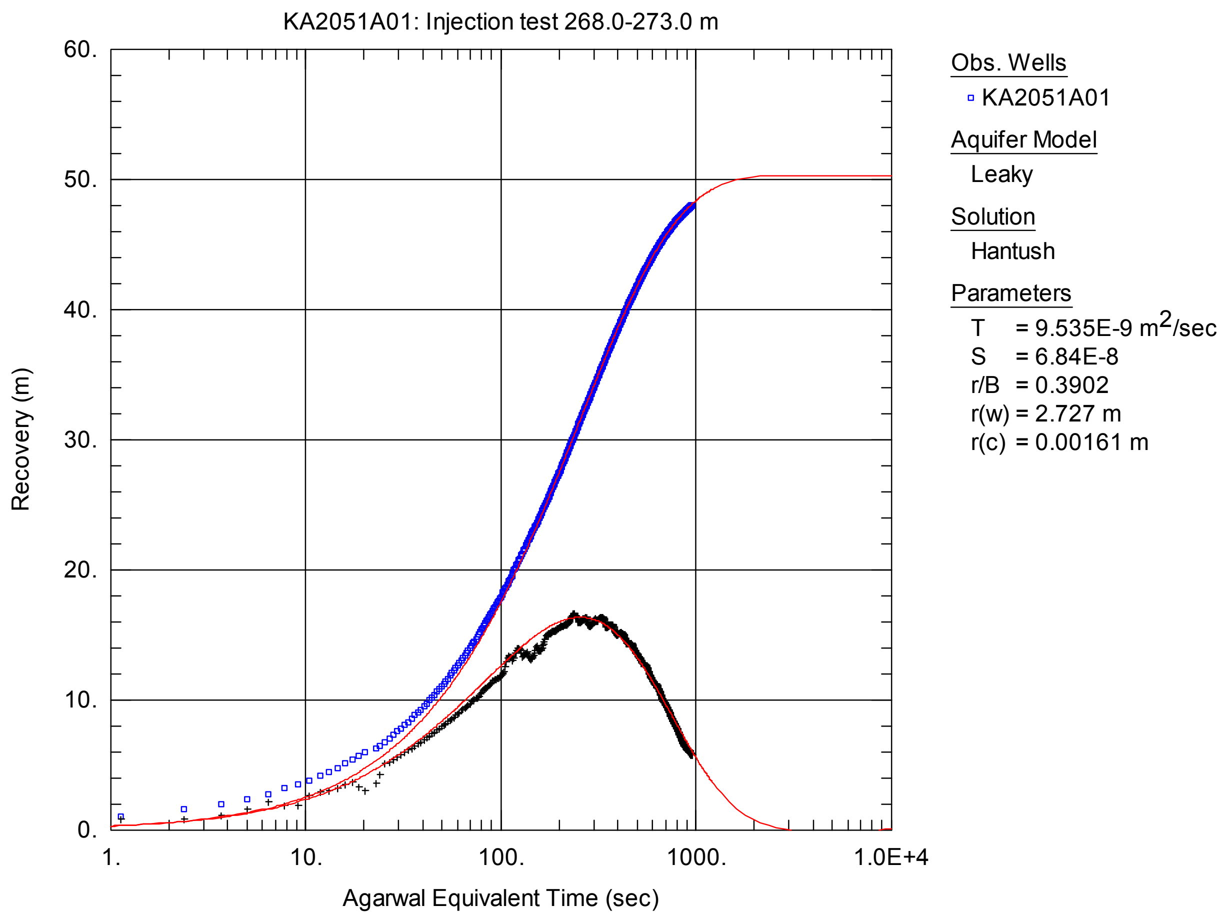

KA2051A01: Injection test 263.0-268.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 3.972E-9 m2/sec
S = 4.41E-8
Kz/Kr = 1.
Sw = -6.015
r(w) = 0.038 m
r(c) = 0.0001 m
C = 0. sec2/m5
P = 2.

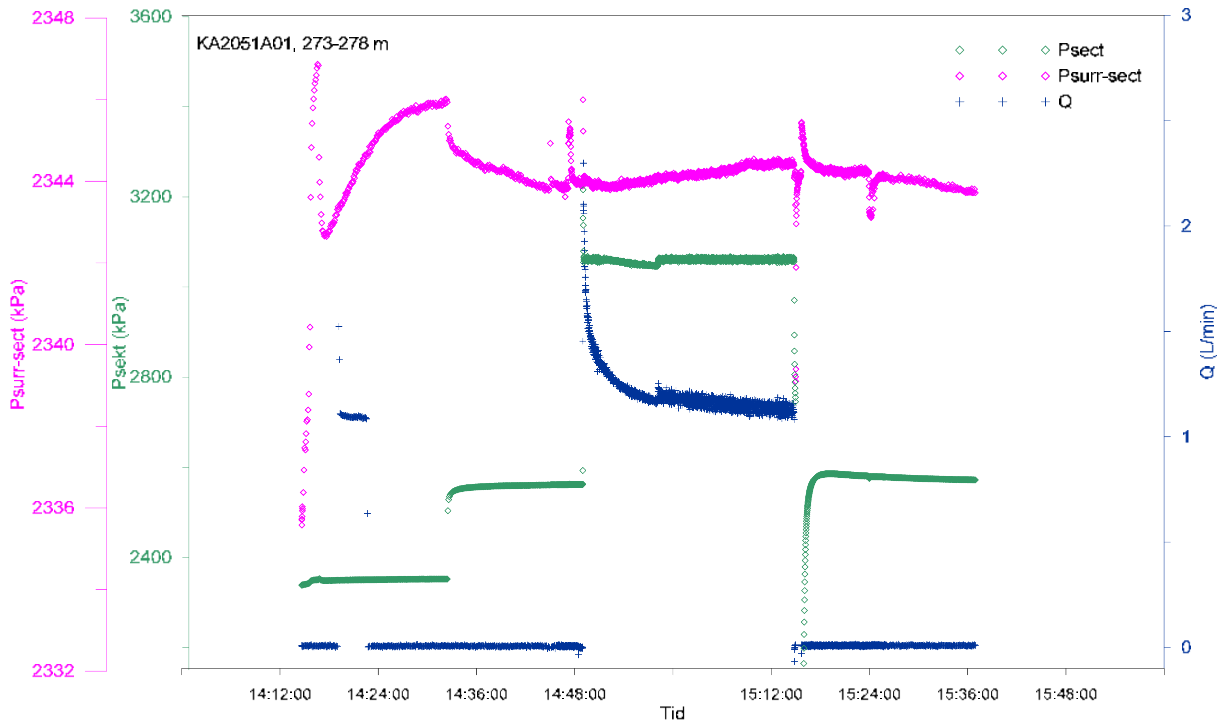

KA2051A01, 268-273 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2350
2340
2330
2320
2310
2300
2290
3600
3200
2800
2400
0.4
0.2
0
11:48:00
12:12:00
12:24:00
12:36:00
12:48:00
13:12:00
13:24:00
13:36:00
13:48:00
14:12:00
14:24:00
Tid

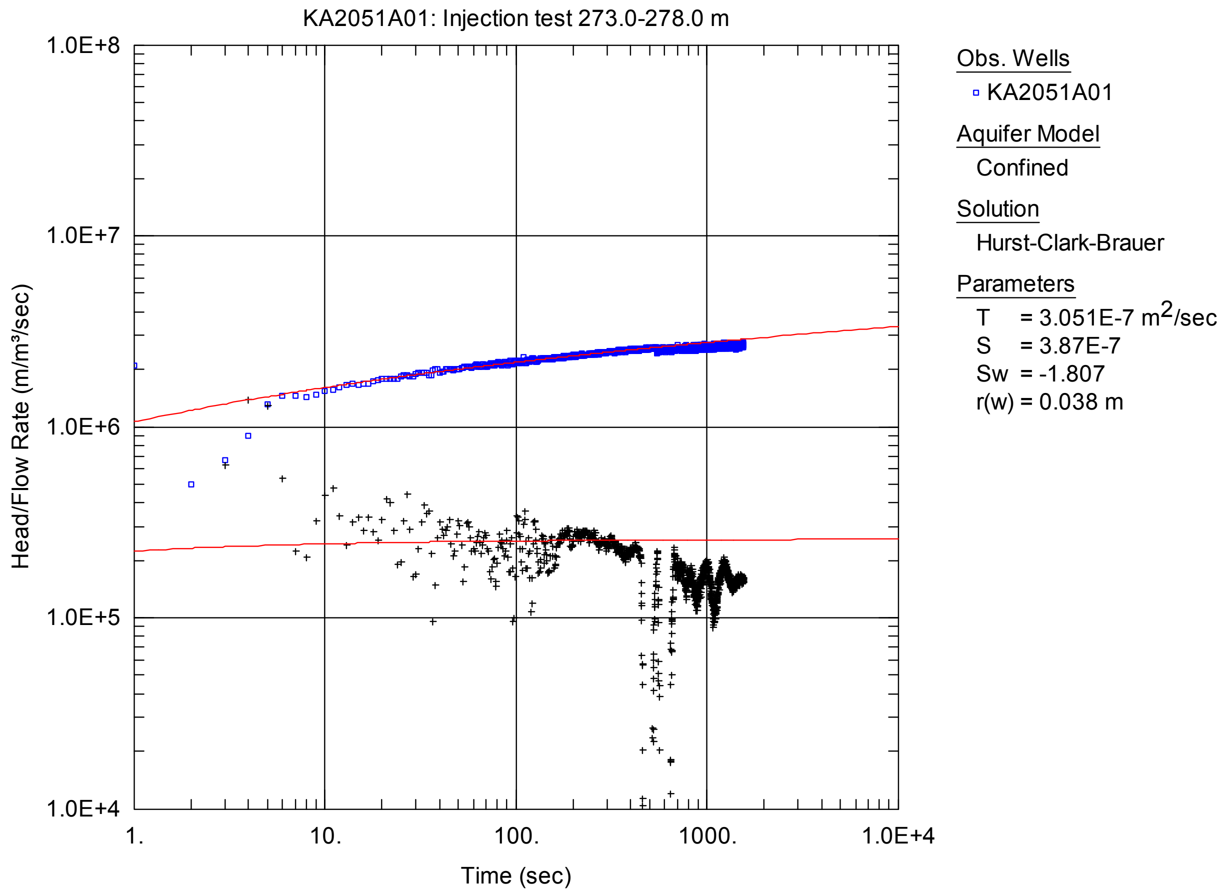

KA2051A01: Injection test 268.0-273.0 m
Head/Flow Rate (m/m³/sec)
1.0E+9
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.131E-8 m²/sec
S = 7.44E-8
r/B = 0.2644
r(w) = 2.855 m

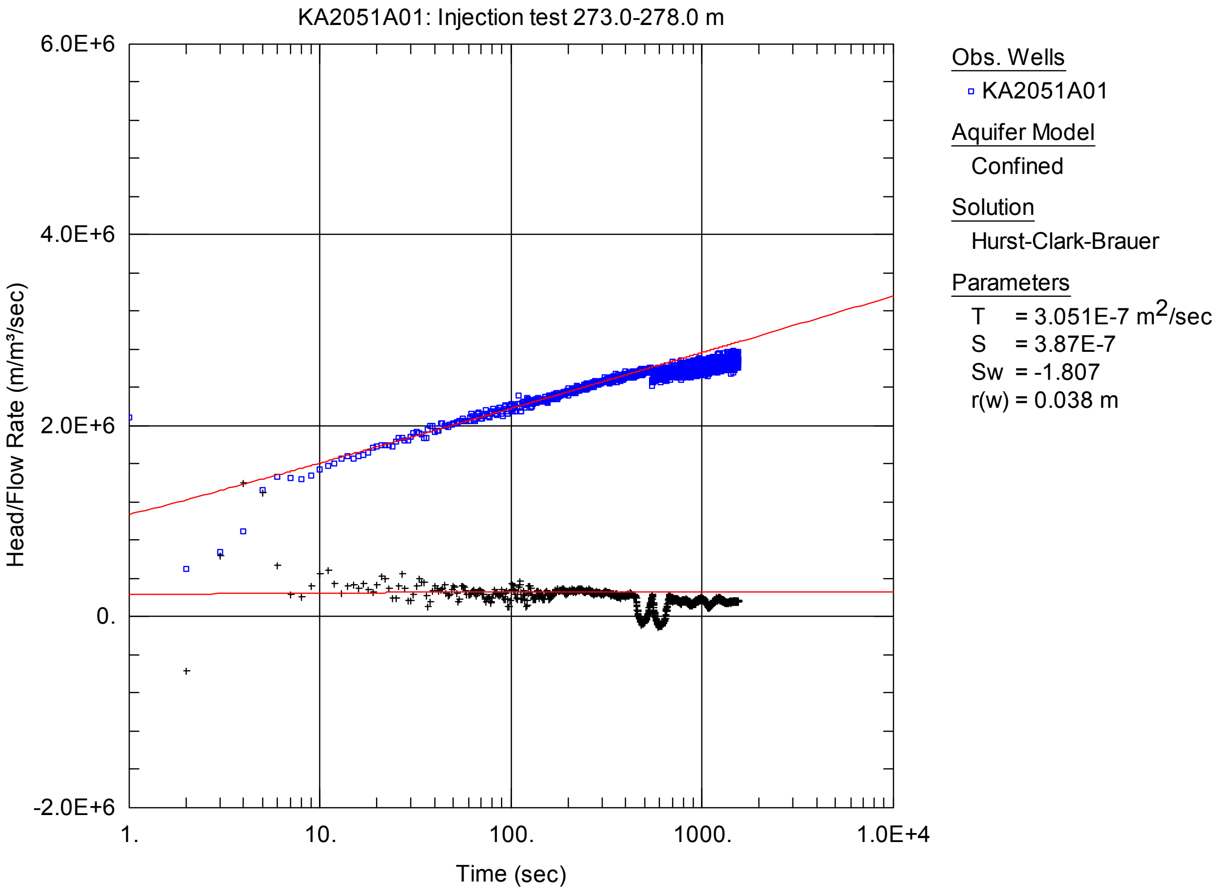

KA2051A01: Injection test 268.0-273.0 m
Head/Flow Rate (m/m³/sec)
6.0E+7
4.0E+7
2.0E+7
0.
-2.0E+7
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.131E-8 m²/sec
S = 7.44E-8
r/B = 0.2644
r(w) = 2.855 m

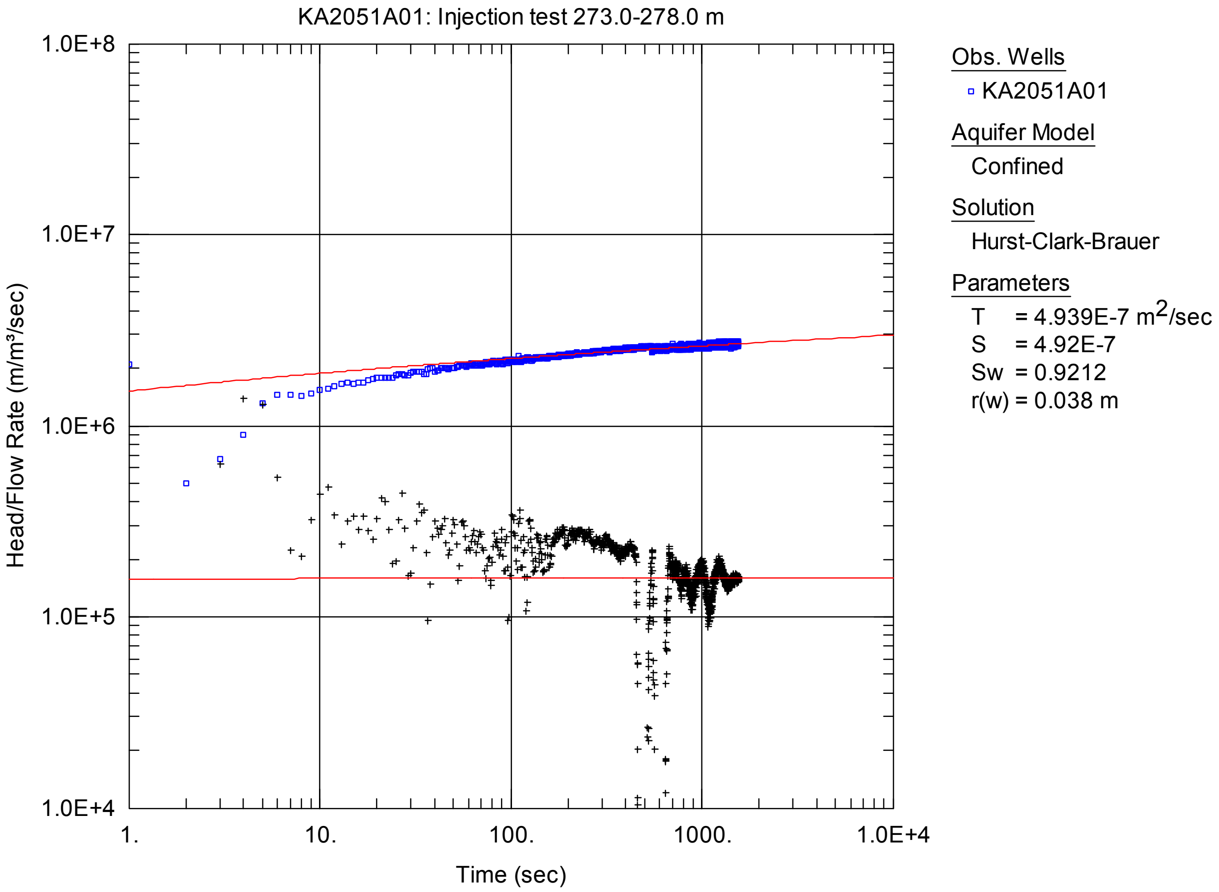

KA2051A01: Injection test 268.0-273.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.535E-9 m2/sec
S = 6.84E-8
r/B = 0.3902
r(w) = 2.727 m
r(c) = 0.00161 m

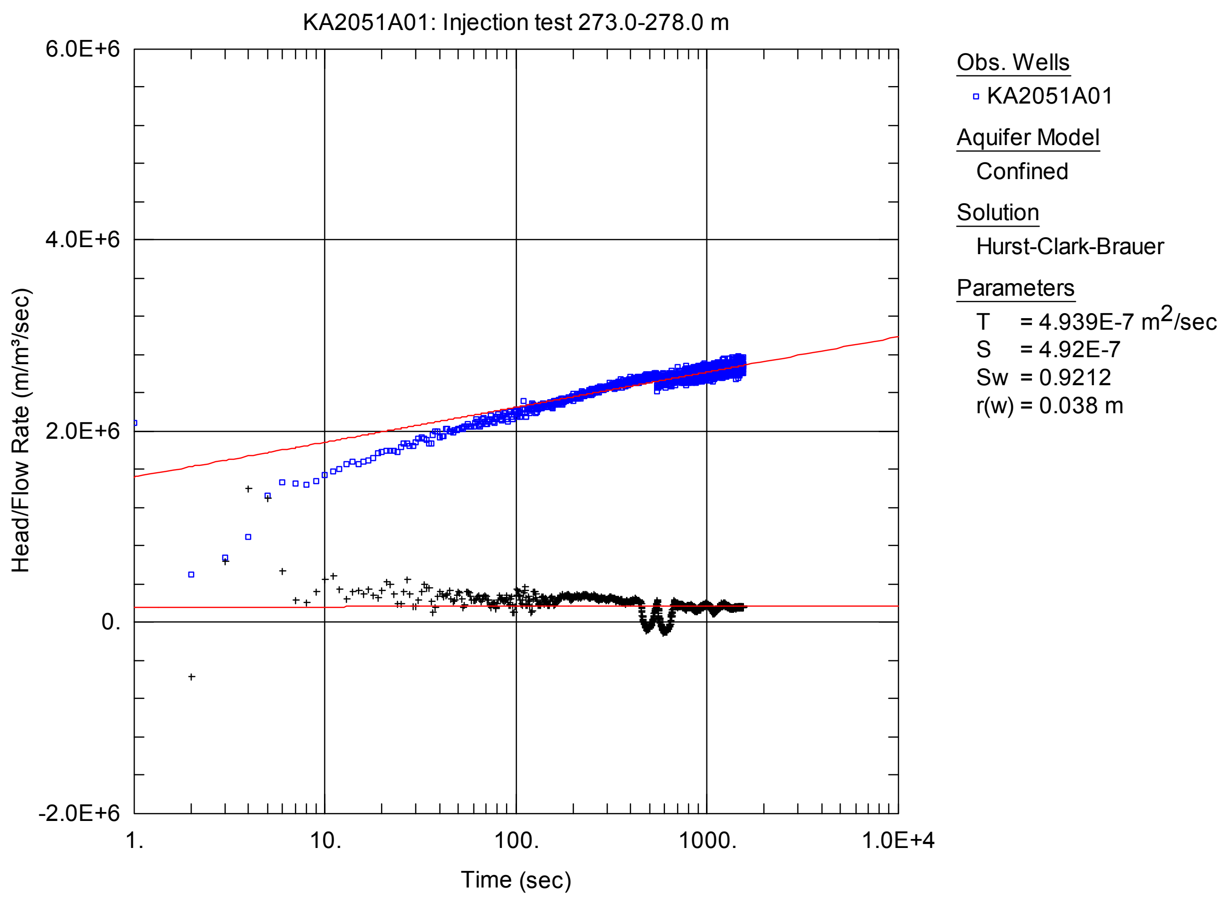

KA2051A01: Injection test 268.0-273.0 m
60.
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Recovery (m)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 9.535E-9 m2/sec
S = 6.84E-8
r/B = 0.3902
r(w) = 2.727 m
r(c) = 0.00161 m

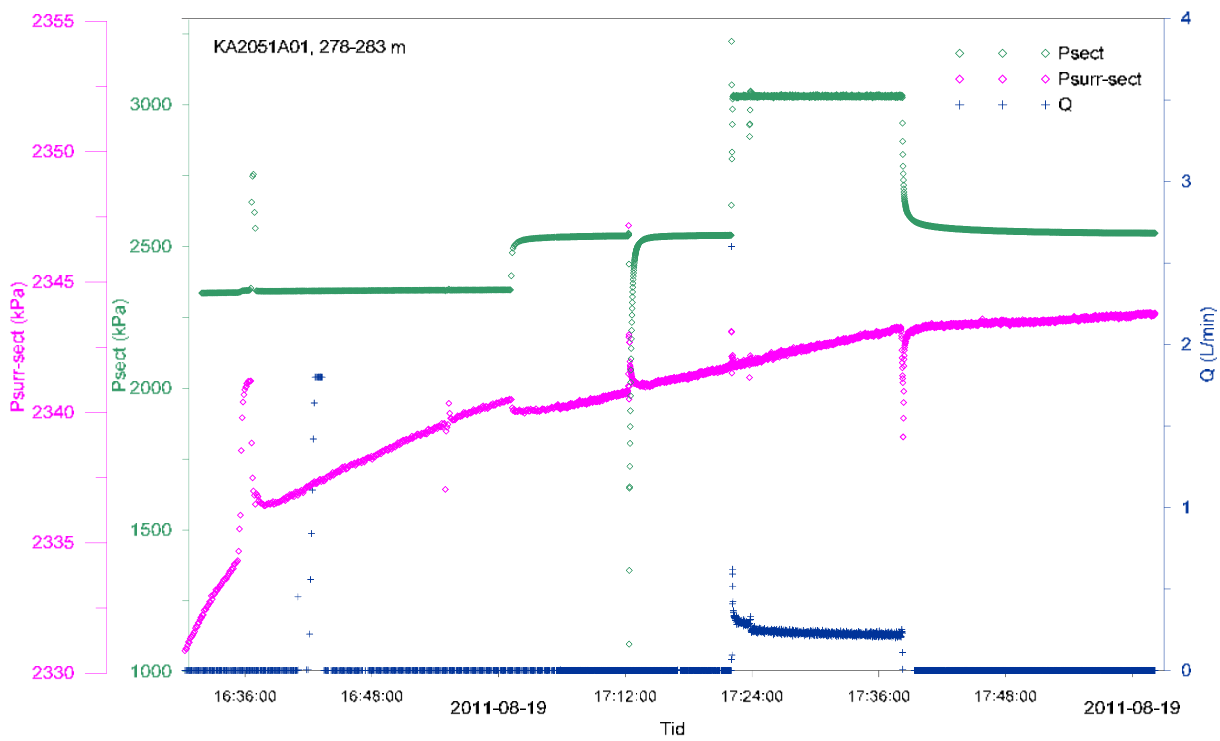

KA2051A01, 273-278 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2348
2344
2340
2336
2332
3600
3200
2800
2400
3
2
1
0
14:12:00
14:24:00
14:36:00
14:48:00
15:12:00
15:24:00
15:36:00
15:48:00

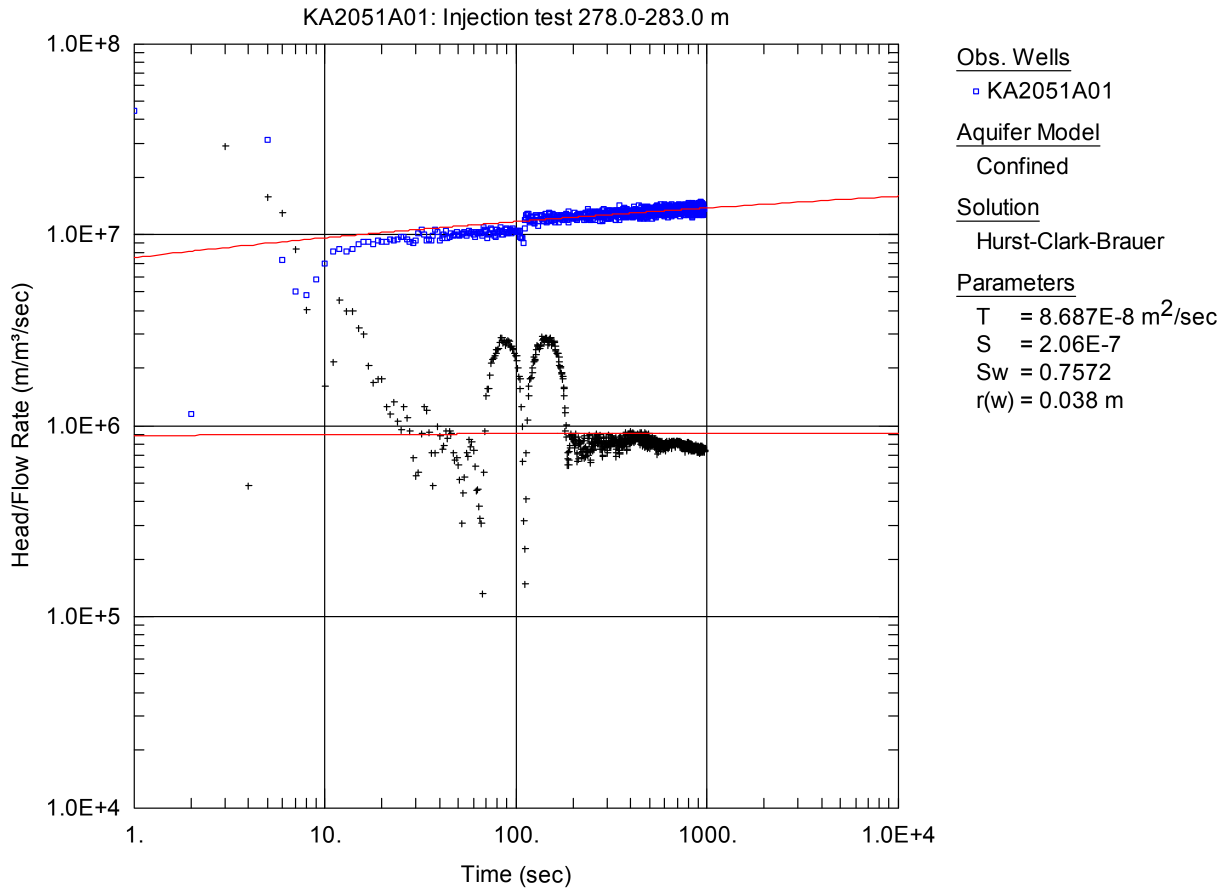

KA2051A01: Injection test 273.0-278.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.051E-7 m²/sec
S = 3.87E-7
Sw = -1.807
r(w) = 0.038 m


KA2051A01: Injection test 273.0-278.0 m
6.0E+6
4.0E+6
2.0E+6
0.
-2.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.051E-7 m2/sec
S = 3.87E-7
Sw = -1.807
r(w) = 0.038 m

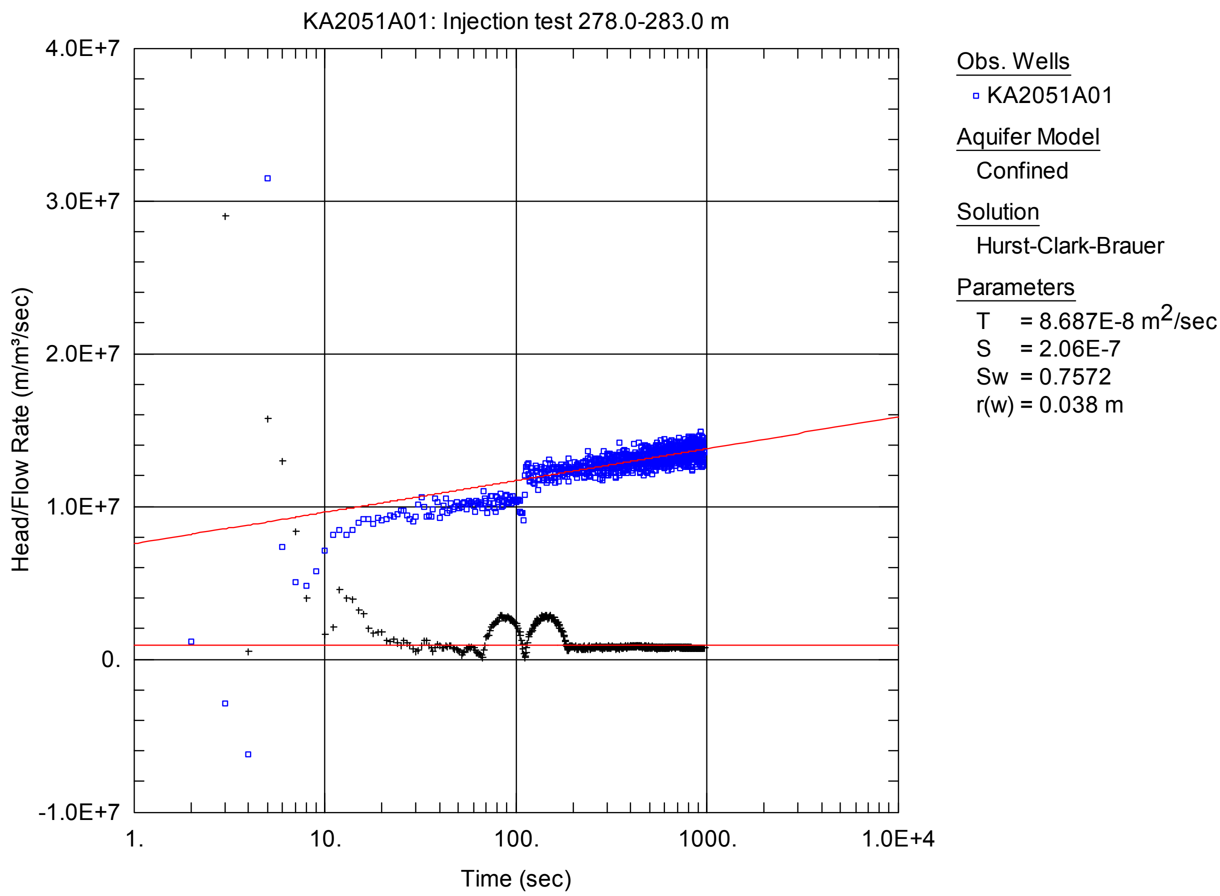

KA2051A01: Injection test 273.0-278.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.939E-7 m2/sec
S = 4.92E-7
Sw = 0.9212
r(w) = 0.038 m


KA2051A01: Injection test 273.0-278.0 m
6.0E+6
4.0E+6
2.0E+6
0.
-2.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.939E-7 m2/sec
S = 4.92E-7
Sw = 0.9212
r(w) = 0.038 m

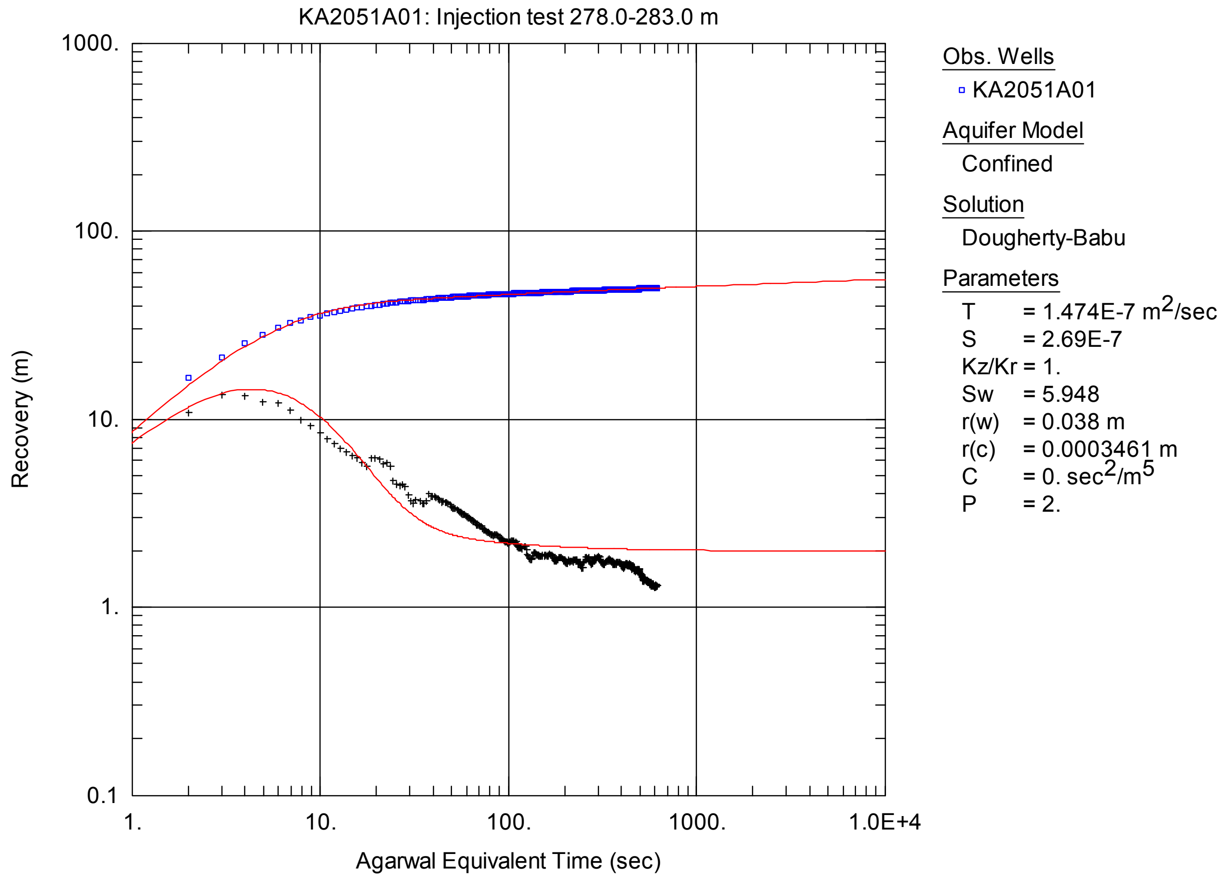

KA2051A01, 278-283 m
Psect
Psurr-sect
Q
2355
2350
2345
2340
2335
2330
Psurr-sect (kPa)
3000
2500
2000
1500
1000
Psect (kPa)
4
3
2
1
0
Q (L/min)
16:36:00
16:48:00
2011-08-19
17:12:00
17:24:00
17:36:00
17:48:00
2011-08-19
Tid



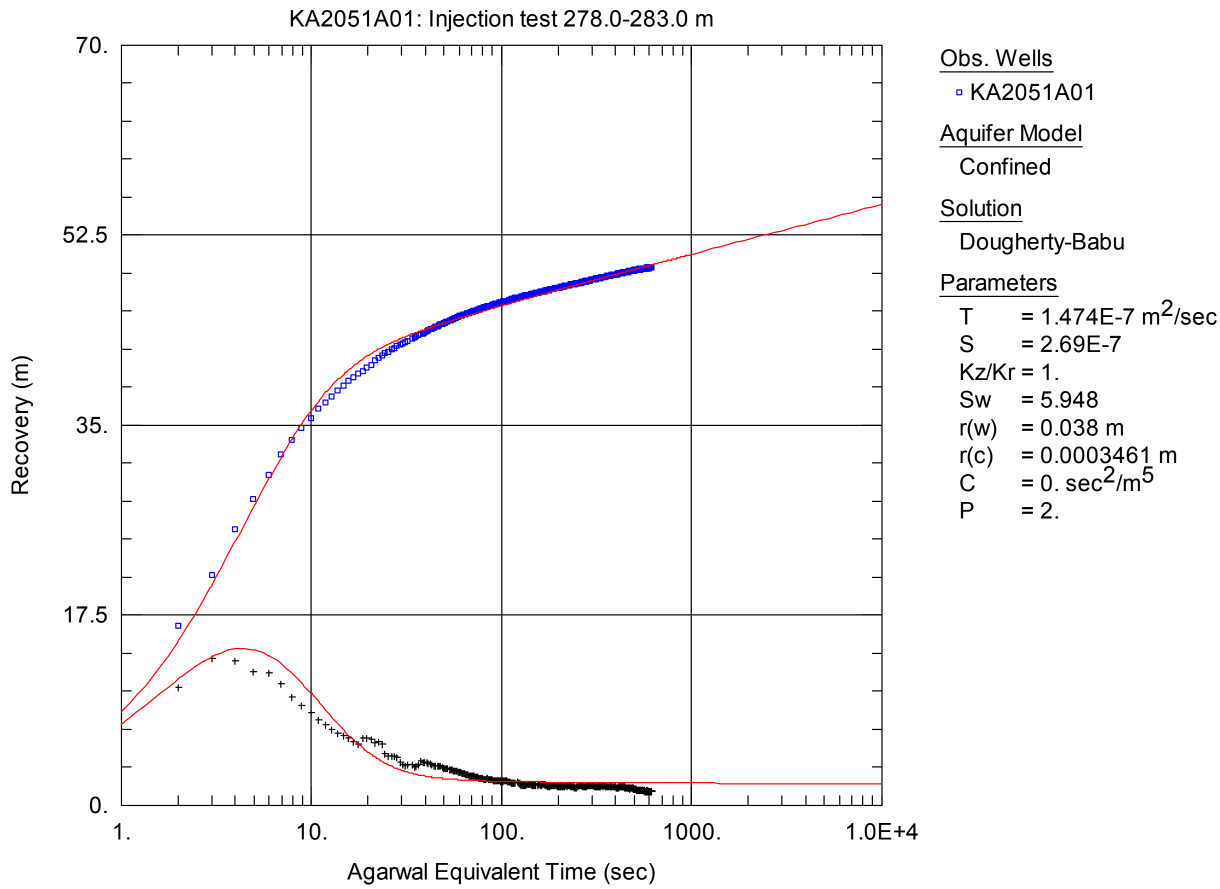
KA2051A01: Injection test 278.0-283.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 8.687E-8 m2/sec
S = 2.06E-7
Sw = 0.7572
r(w) = 0.038 m



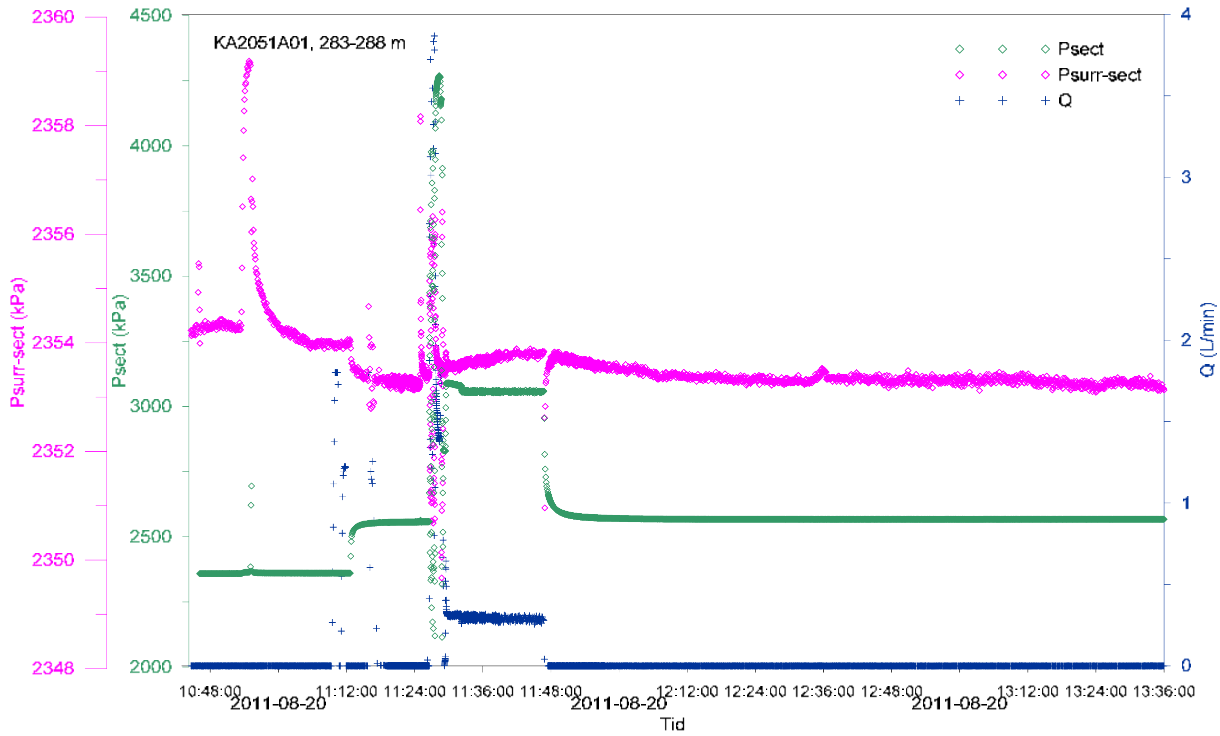
KA2051A01: Injection test 278.0-283.0 m
4.0E+7
3.0E+7
2.0E+7
1.0E+7
0.
-1.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 8.687E-8 m2/sec
S = 2.06E-7
Sw = 0.7572
r(w) = 0.038 m



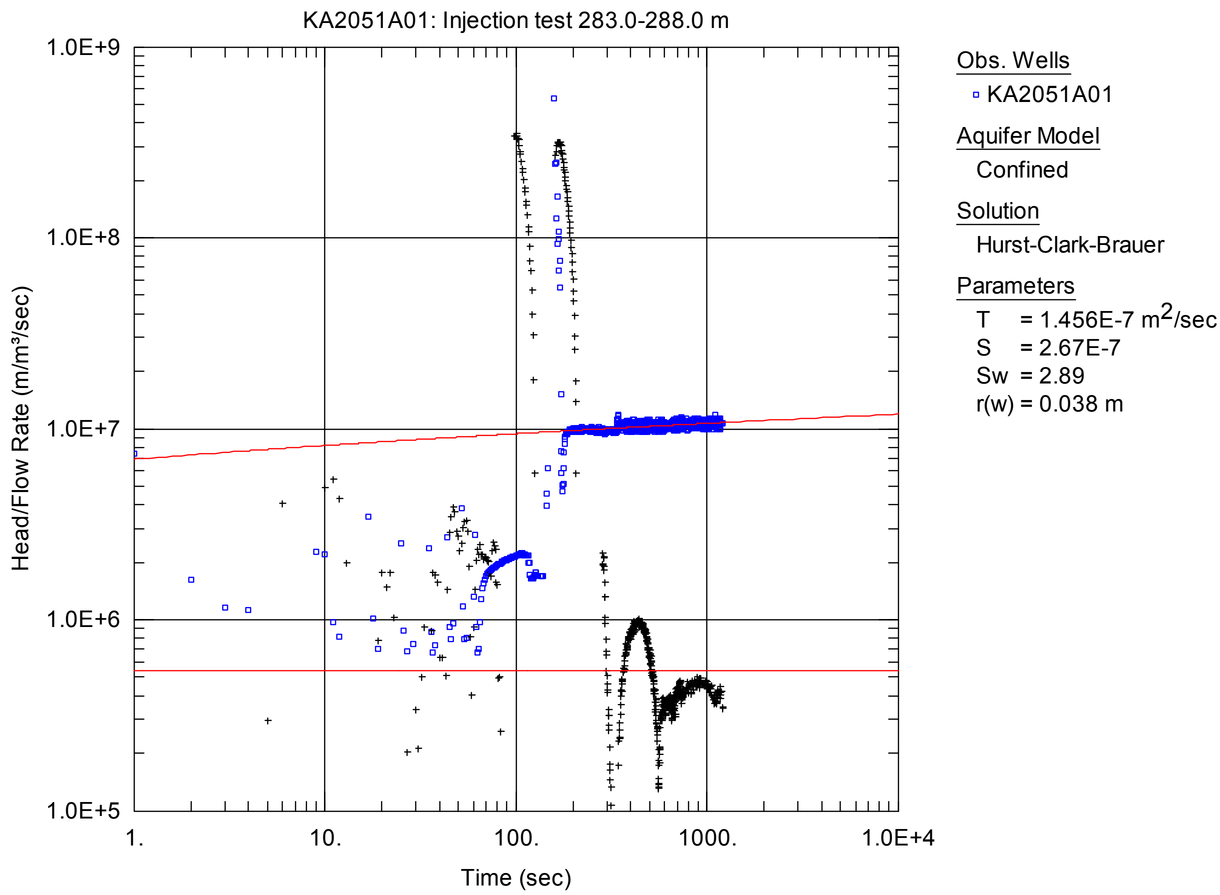
KA2051A01: Injection test 278.0-283.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
Kz/Kr = 1.
Sw = 5.948
r(w) = 0.038 m
r(c) = 0.0003461 m
C = 0. sec2/m5
P = 2.



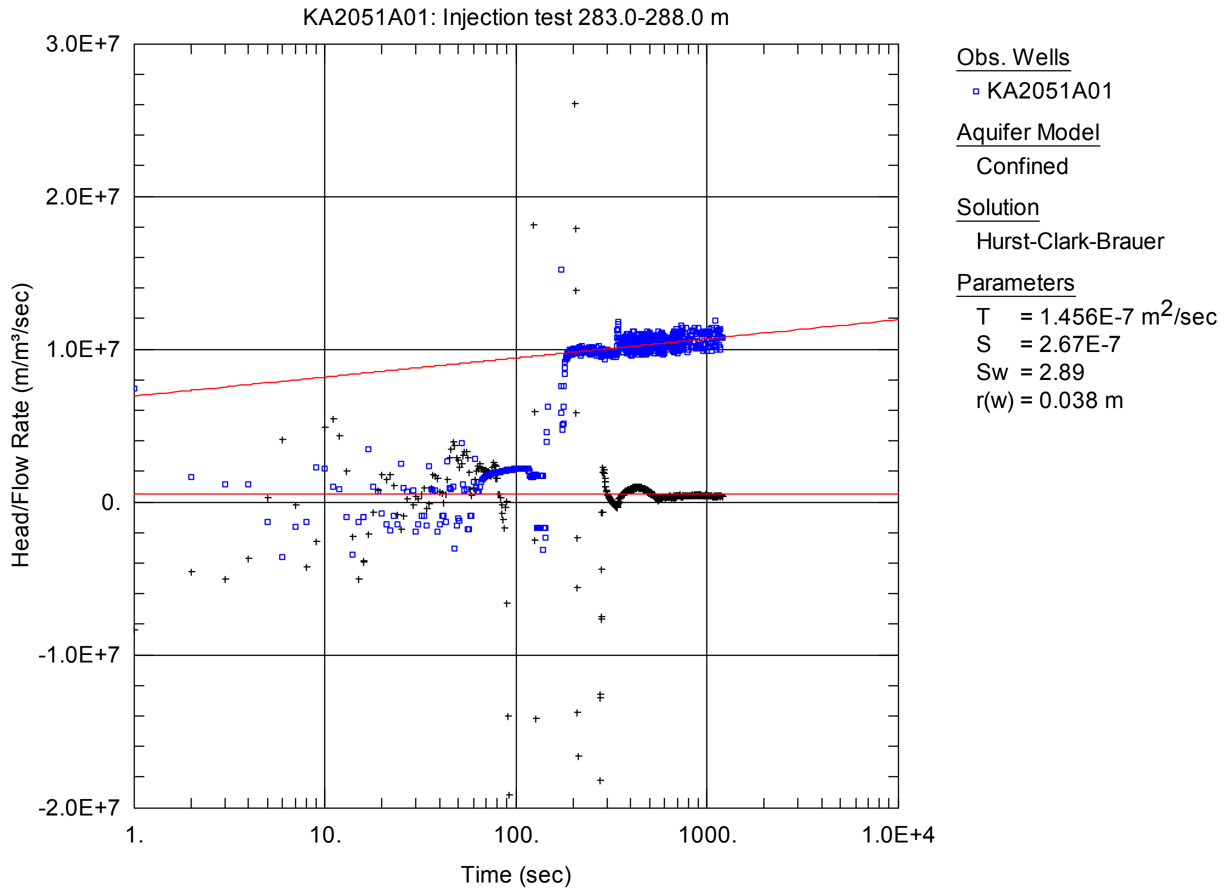
KA2051A01: Injection test 278.0-283.0 m
70.
52.5
35.
17.5
0.
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Dougherty-Babu
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
Kz/Kr = 1.
Sw = 5.948
r(w) = 0.038 m
r(c) = 0.0003461 m
C = 0. sec2/m5
P = 2.

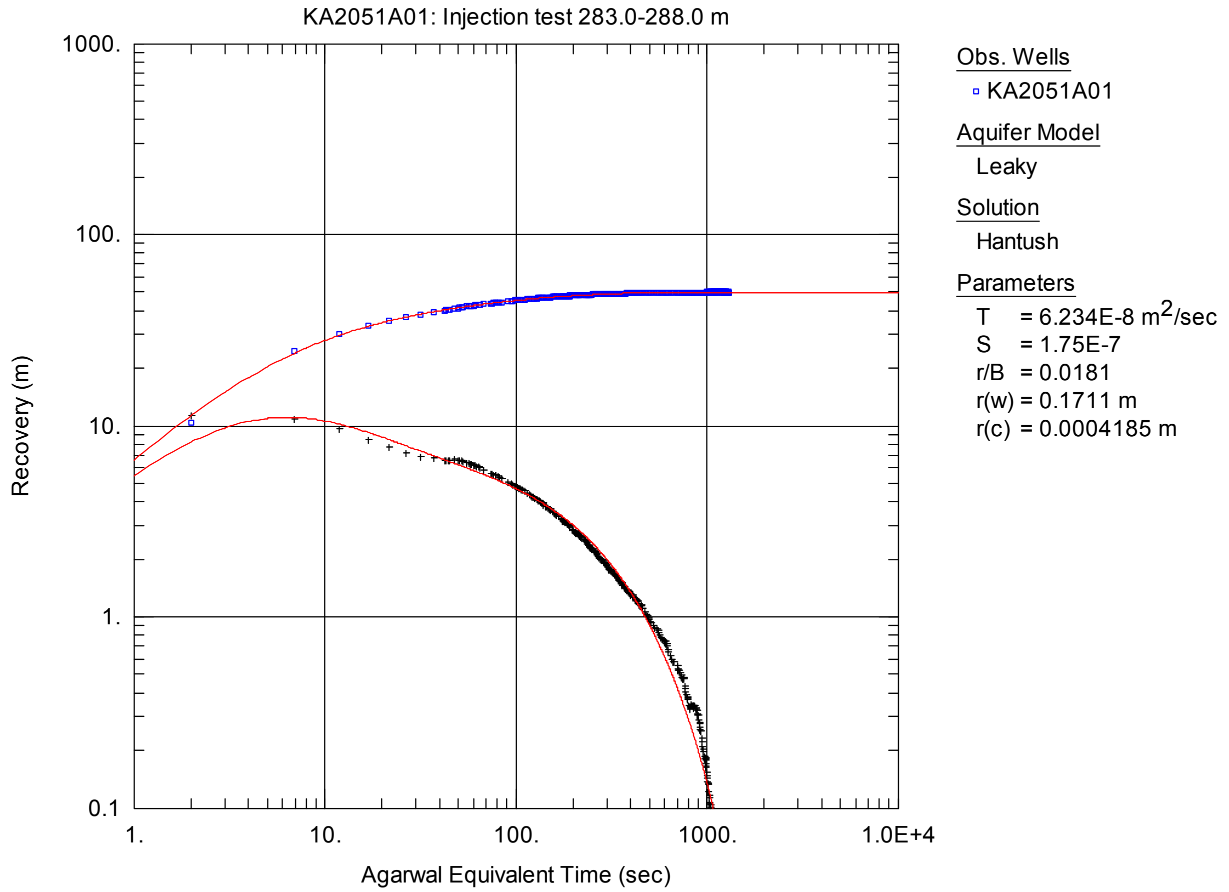


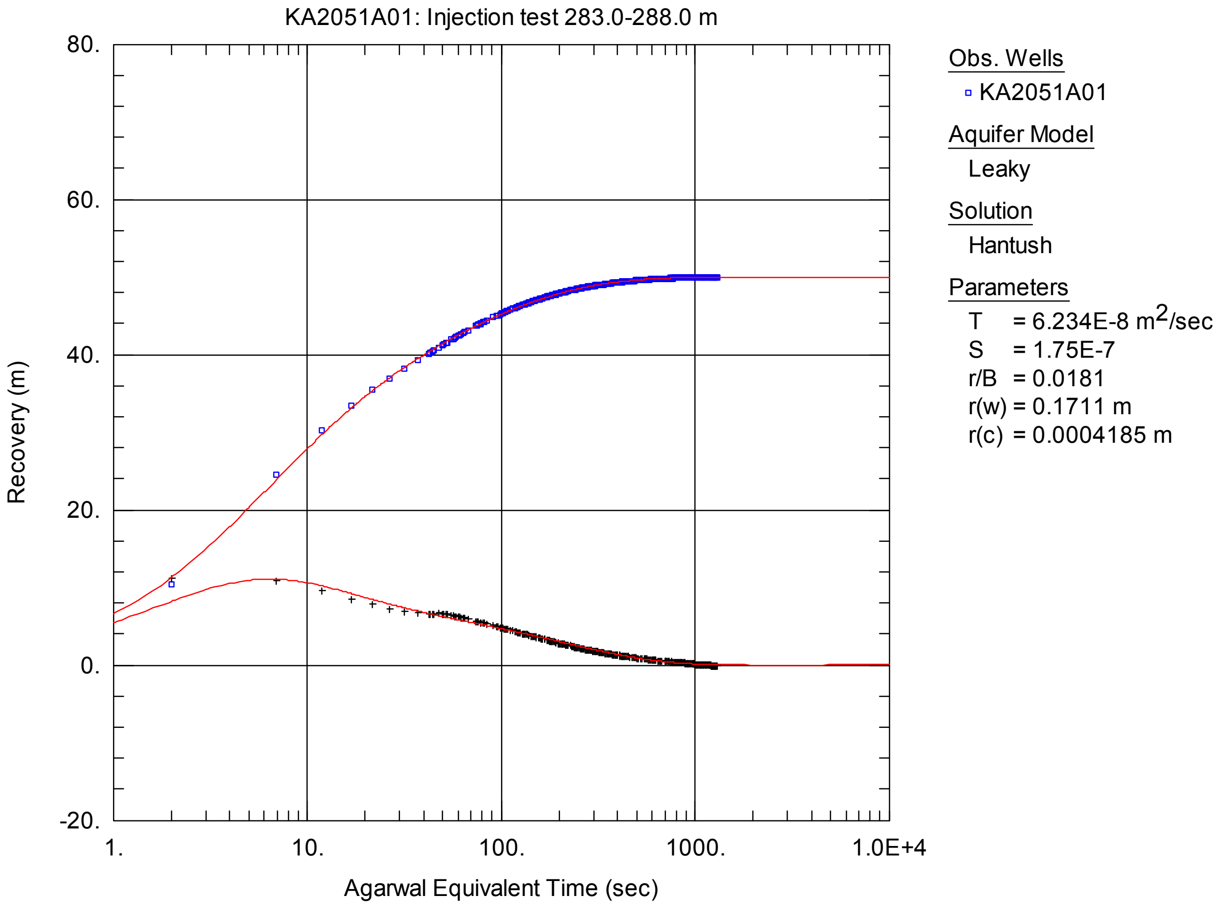
KA2051A01, 283-288 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2011-08-20
Tid



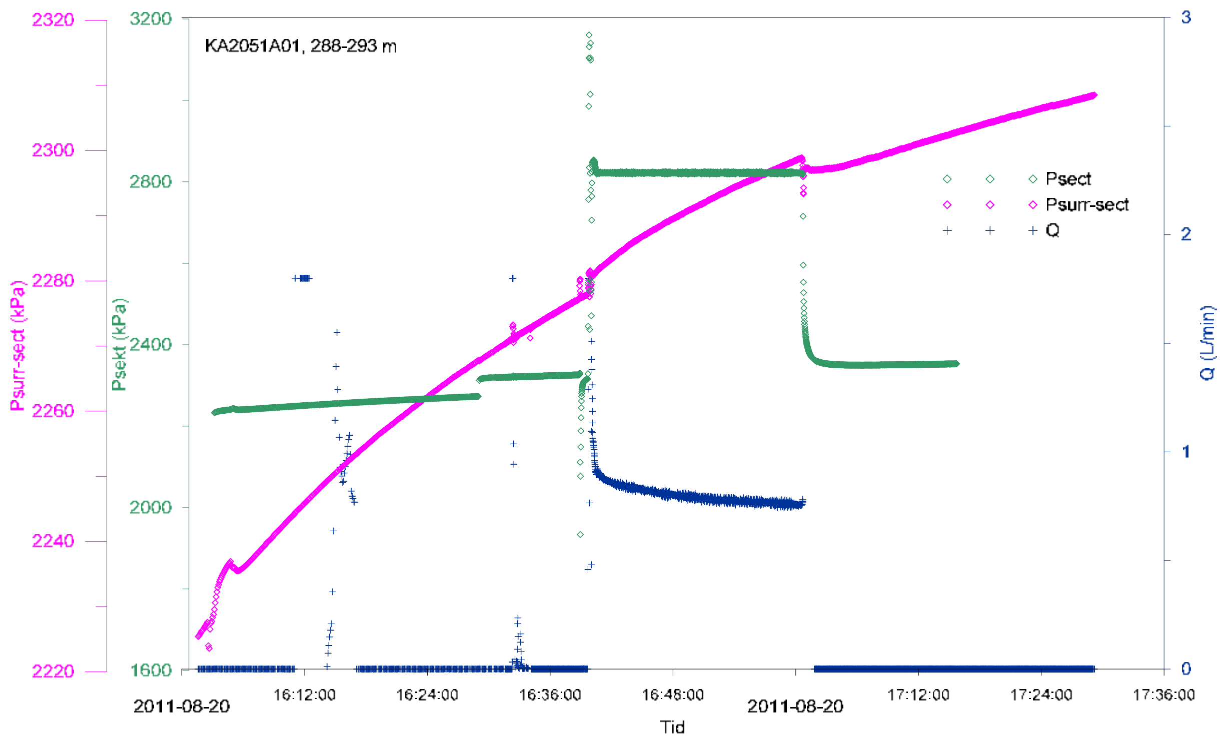
KA2051A01: Injection test 283.0-288.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.456E-7 m2/sec
S = 2.67E-7
Sw = 2.89
r(w) = 0.038 m


KA2051A01: Injection test 283.0-288.0 m
3.0E+7
2.0E+7
1.0E+7
0.
-1.0E+7
-2.0E+7
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.456E-7 m2/sec
S = 2.67E-7
Sw = 2.89
r(w) = 0.038 m

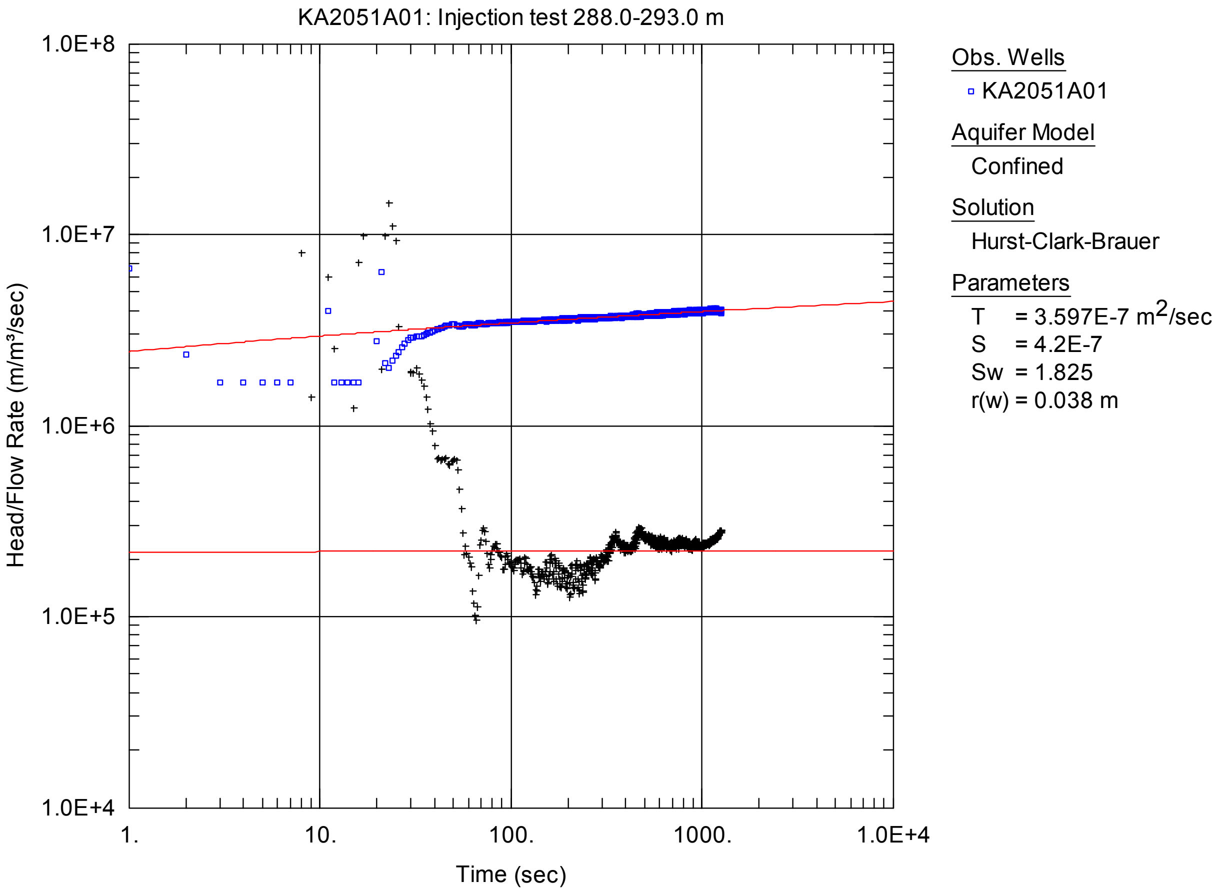

KA2051A01: Injection test 283.0-288.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.234E-8 m2/sec
S = 1.75E-7
r/B = 0.0181
r(w) = 0.1711 m
r(c) = 0.0004185 m

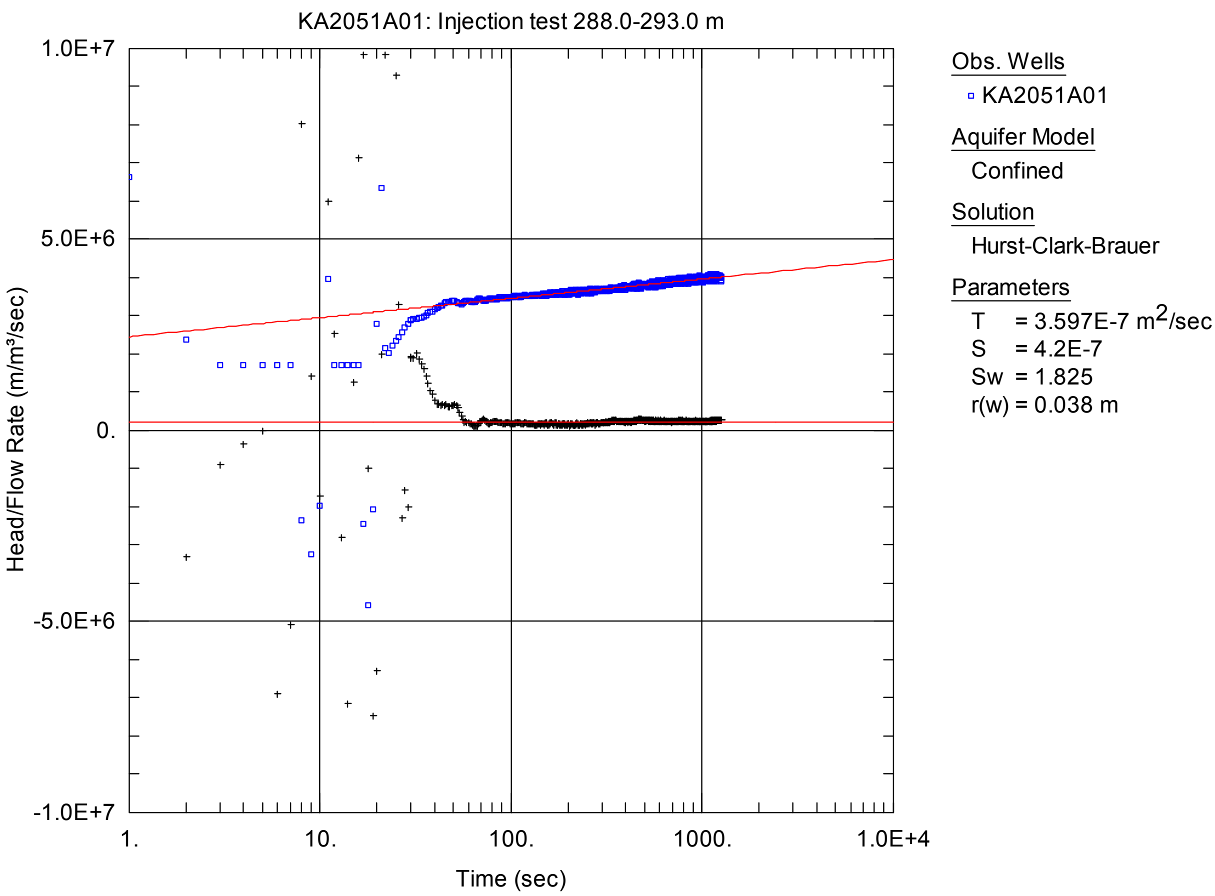


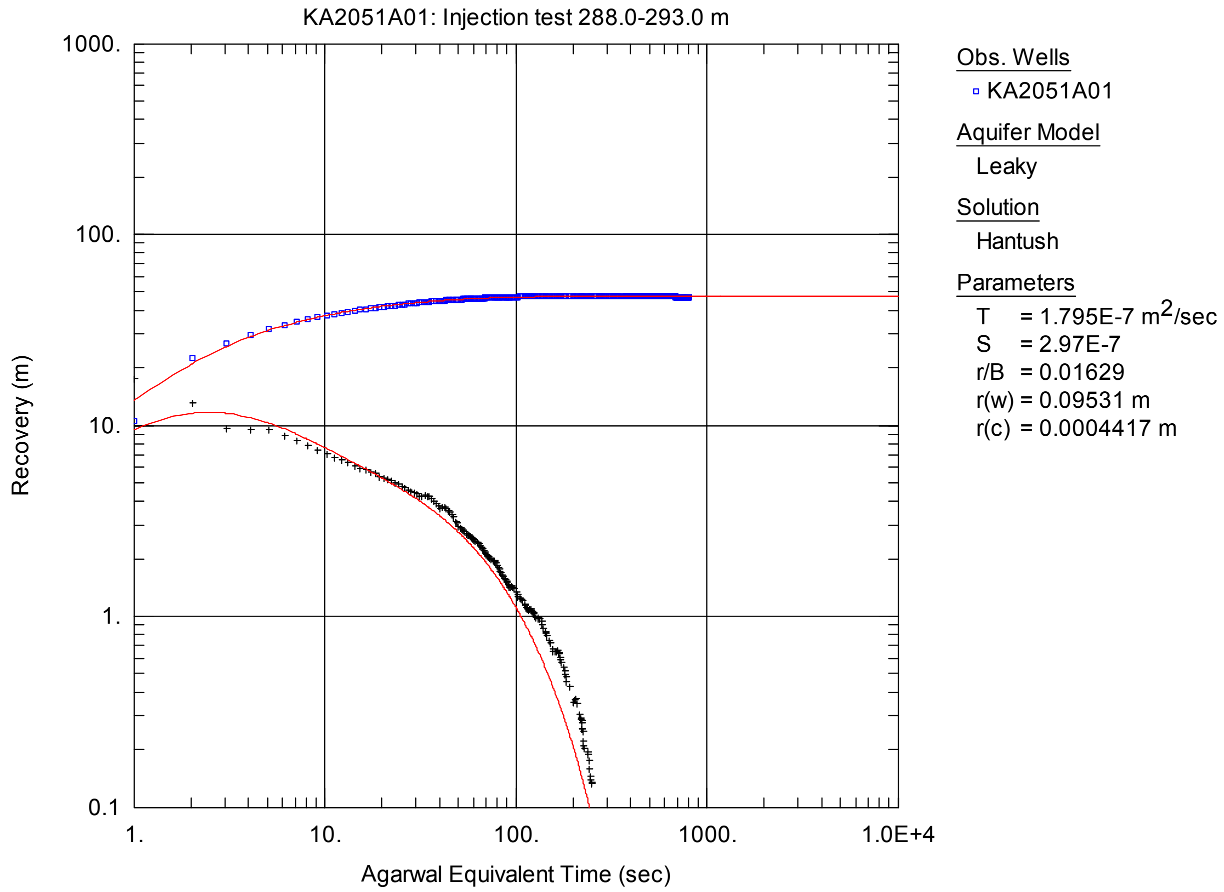
KA2051A01: Injection test 283.0-288.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
80.
60.
40.
20.
0.
-20.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 6.234E-8 m2/sec
S = 1.75E-7
r/B = 0.0181
r(w) = 0.1711 m
r(c) = 0.0004185 m

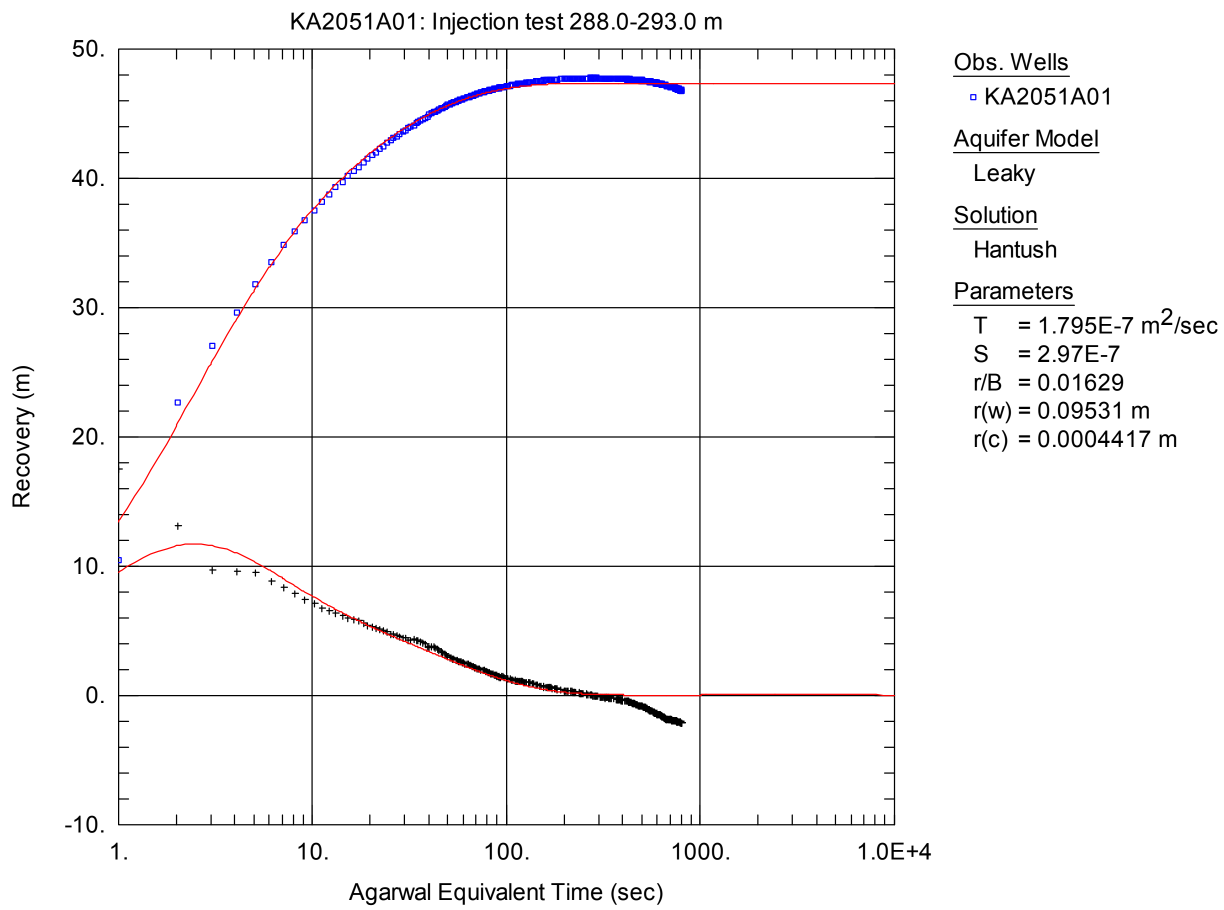


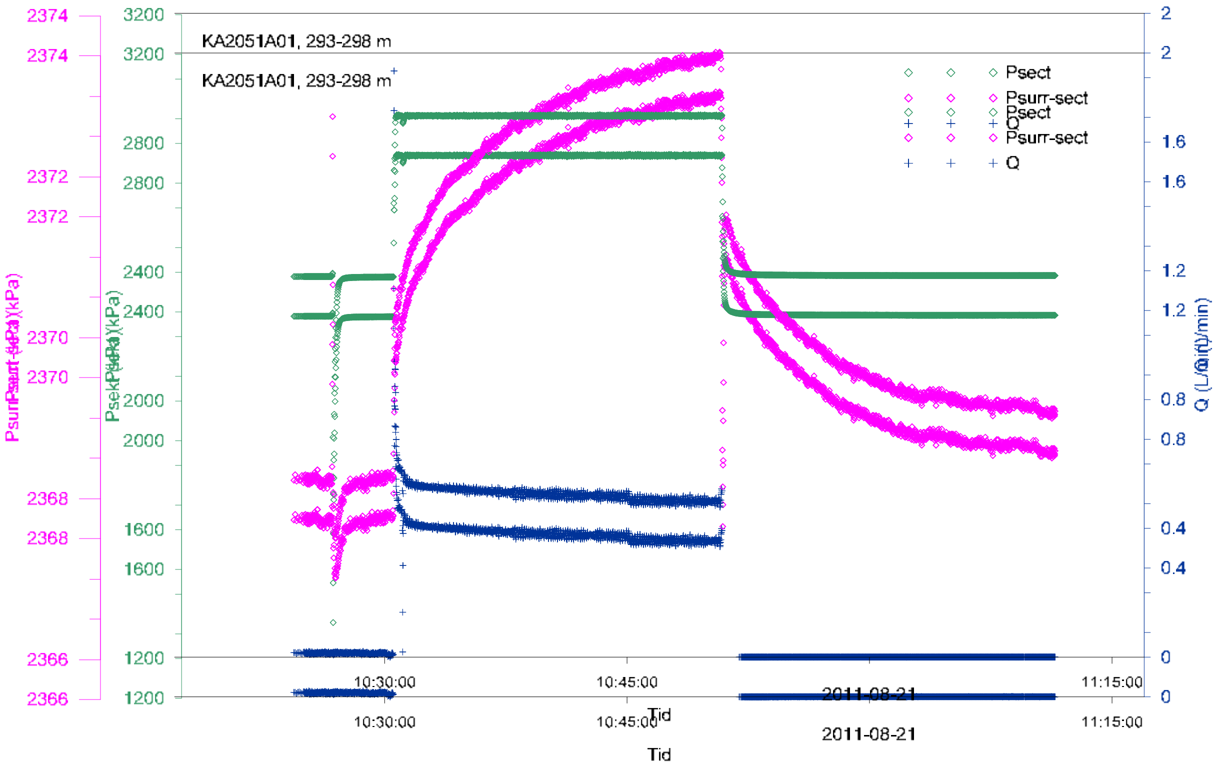
KA2051A01, 288-293 m
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
2320
2300
2280
2260
2240
2220
3200
2800
2400
2000
1600
3
2
1
0
Psect
Psurr-sect
Q
2011-08-20
16:12:00
16:24:00
16:36:00
16:48:00
2011-08-20
17:12:00
17:24:00
17:36:00
Tid

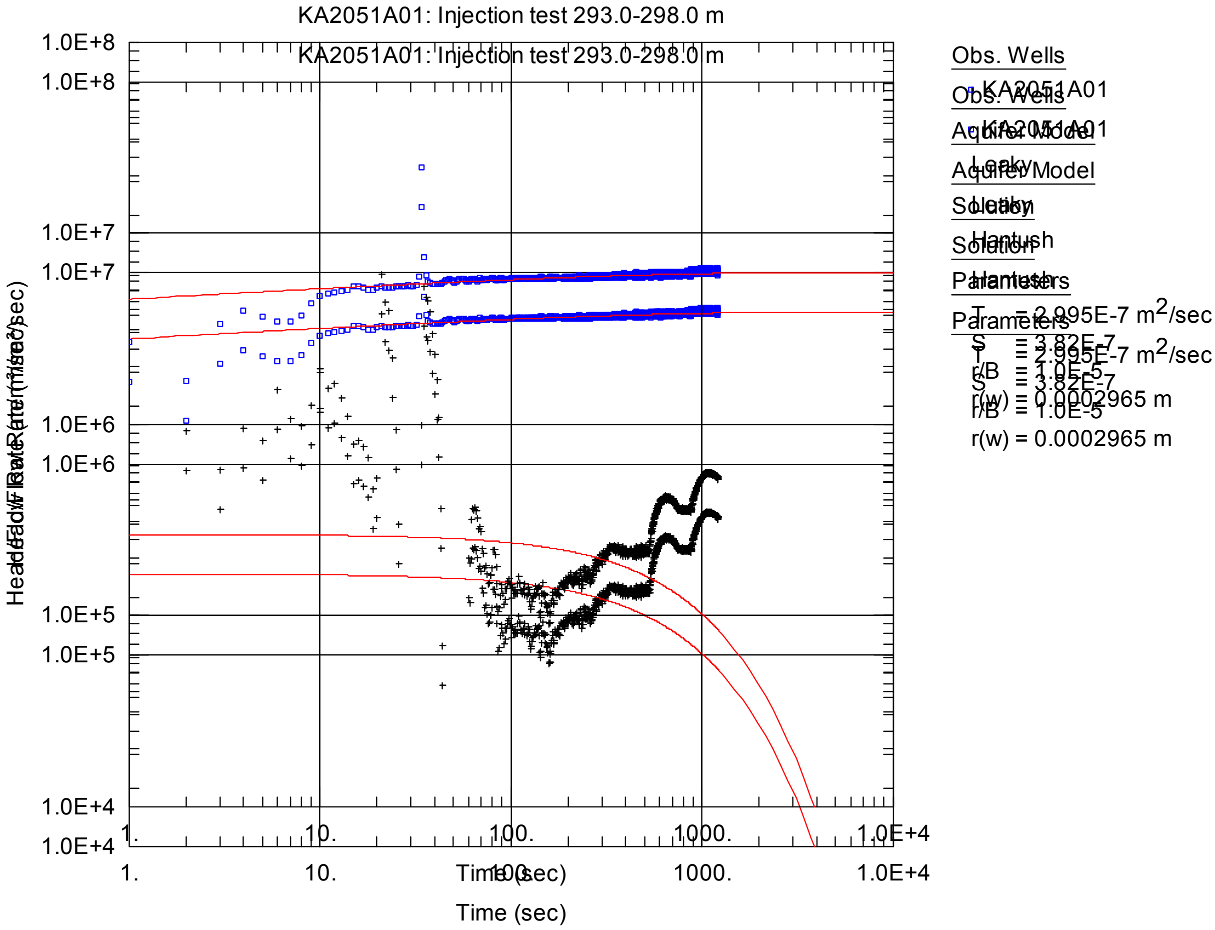

KA2051A01: Injection test 288.0-293.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.597E-7 m2/sec
S = 4.2E-7
Sw = 1.825
r(w) = 0.038 m

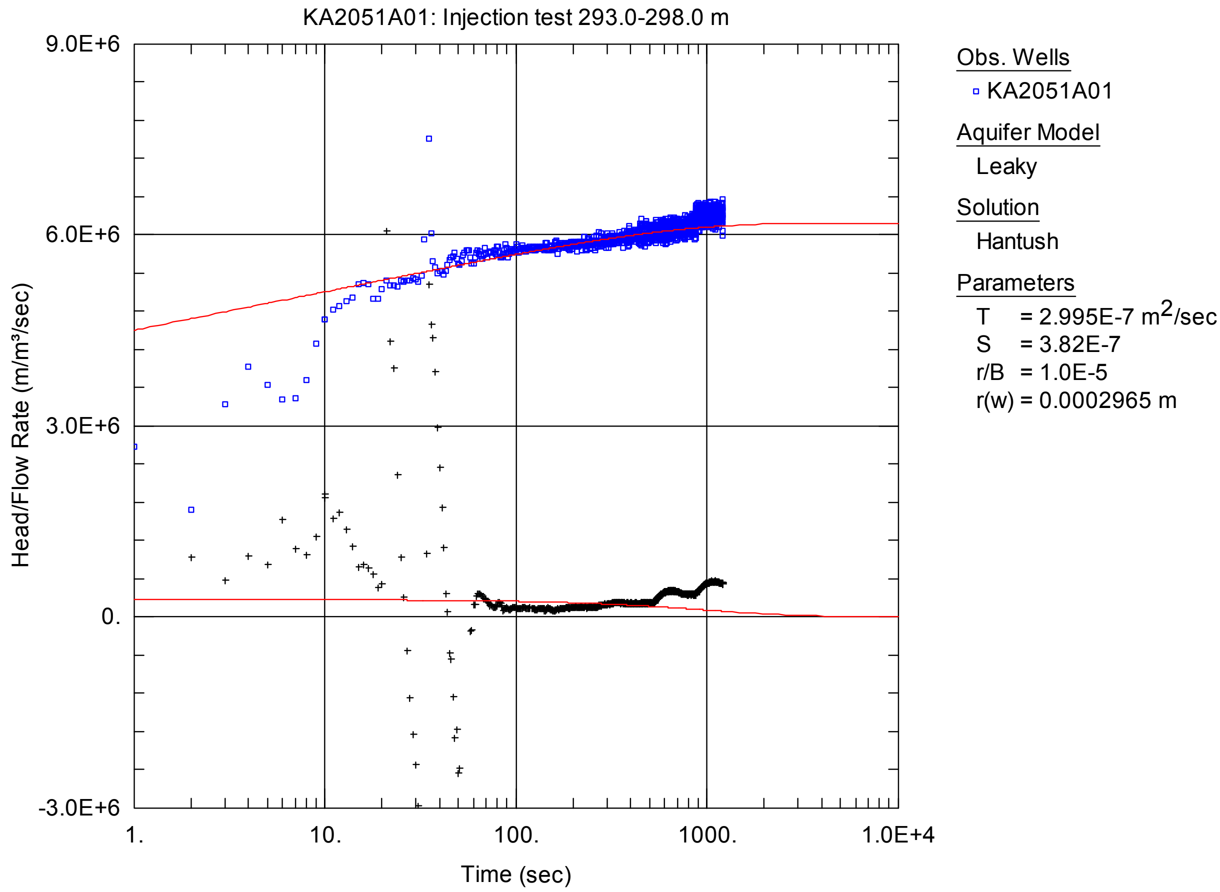

KA2051A01: Injection test 288.0-293.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+7
5.0E+6
0.
-5.0E+6
-1.0E+7
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 3.597E-7 m2/sec
S = 4.2E-7
Sw = 1.825
r(w) = 0.038 m

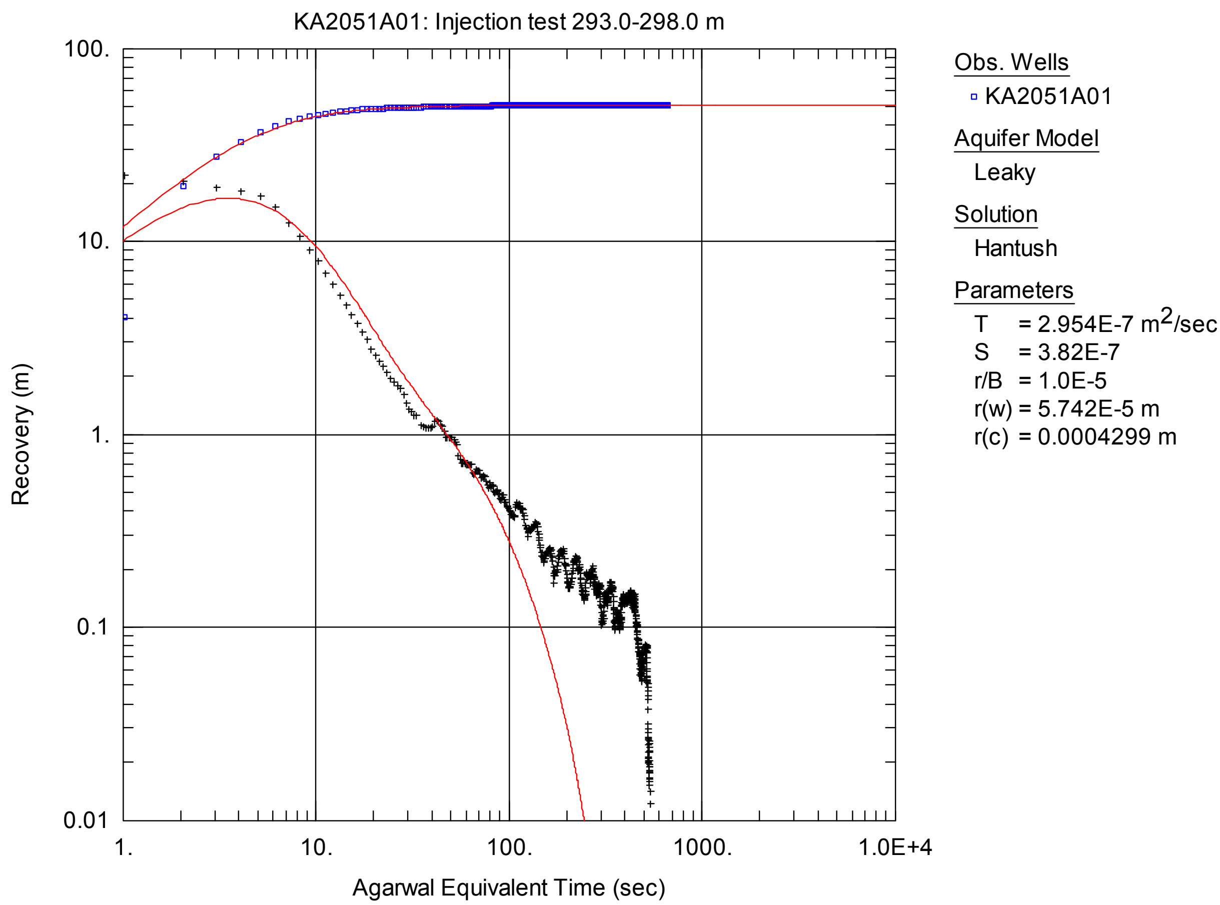

KA2051A01: Injection test 288.0-293.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.795E-7 m2/sec
S = 2.97E-7
r/B = 0.01629
r(w) = 0.09531 m
r(c) = 0.0004417 m

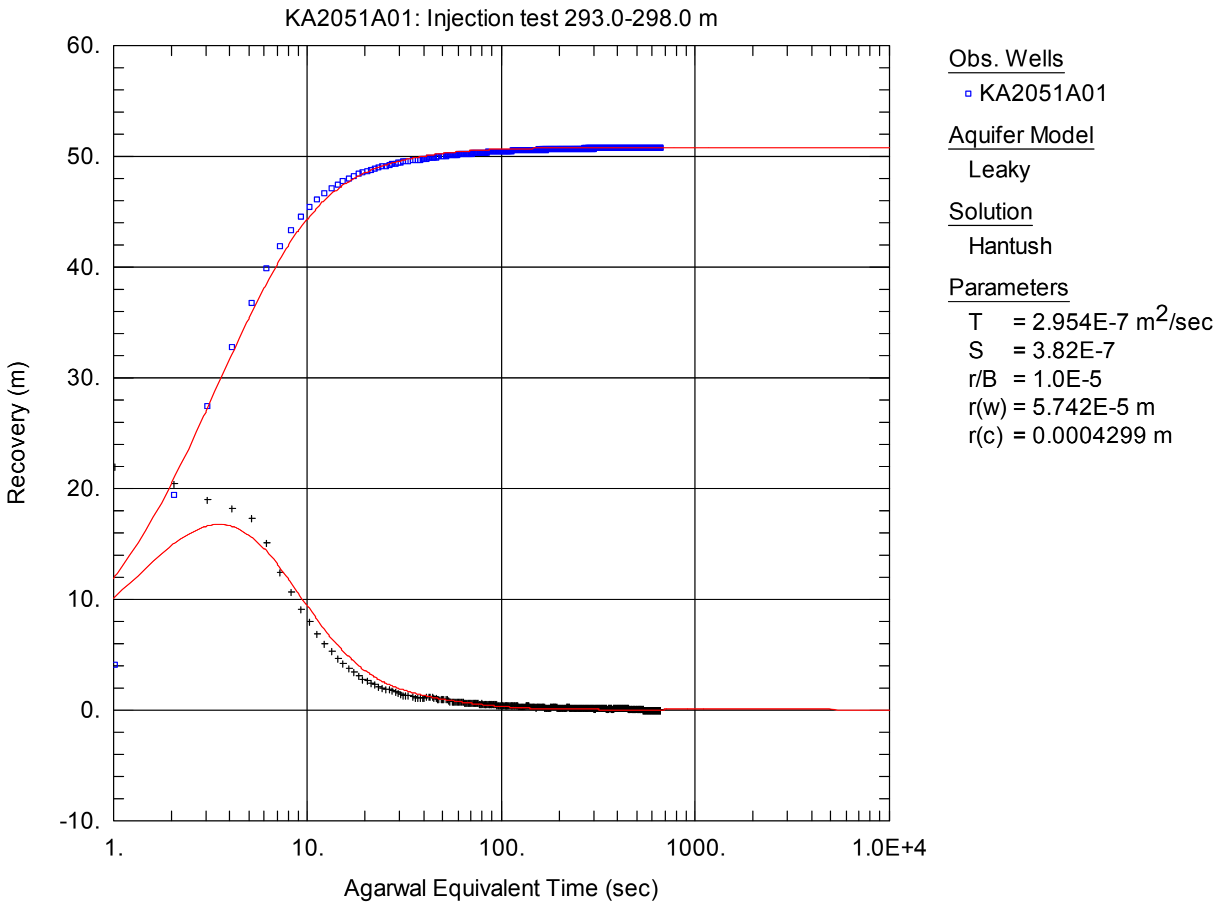

KA2051A01: Injection test 288.0-293.0 m
50.
40.
30.
20.
10.
0.
-10.
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 1.795E-7 m2/sec
S = 2.97E-7
r/B = 0.01629
r(w) = 0.09531 m
r(c) = 0.0004417 m


KA2051A01, 293-298 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2011-08-21
10:30:00
10:45:00
11:15:00

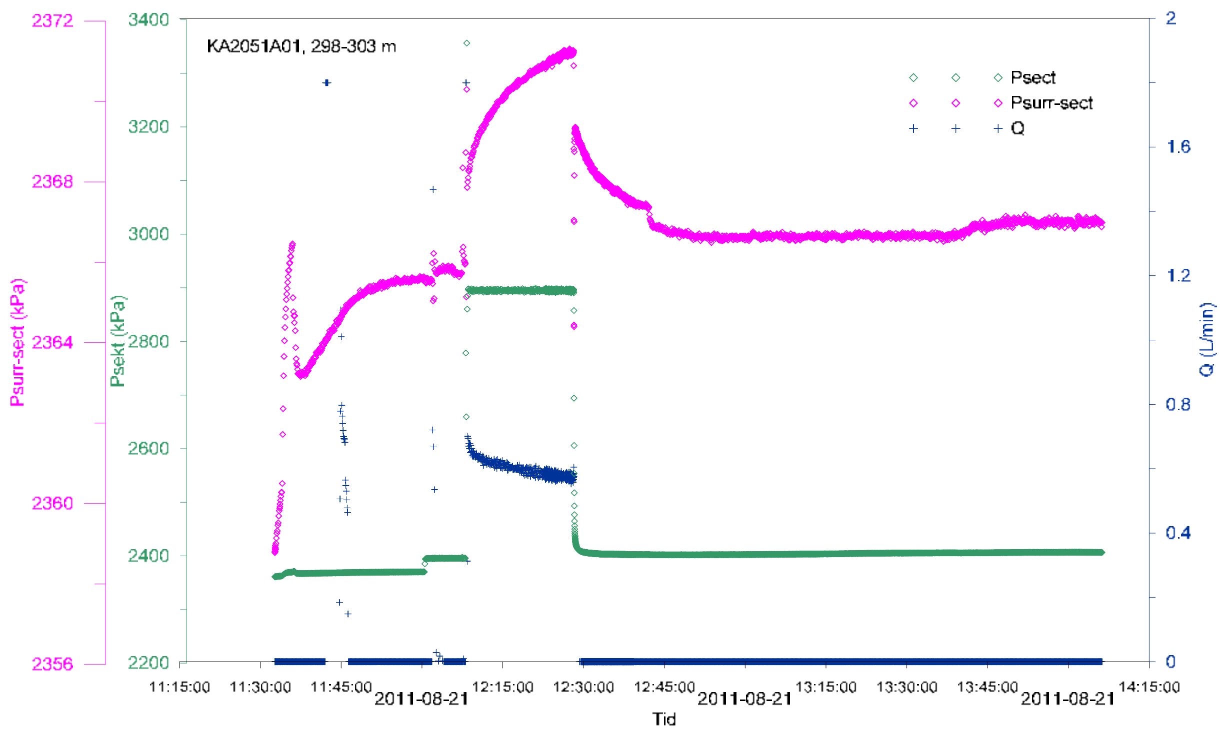

KA2051A01: Injection test 293.0-298.0 m
Head/Flow Rate (m/sec)
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.995E-7 m²/sec
S = 3.82E-7
r/B = 1.0E-5
r(w) = 0.0002965 m


KA2051A01: Injection test 293.0-298.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
9.0E+6
6.0E+6
3.0E+6
0.
-3.0E+6
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.995E-7 m2/sec
S = 3.82E-7
r/B = 1.0E-5
r(w) = 0.0002965 m

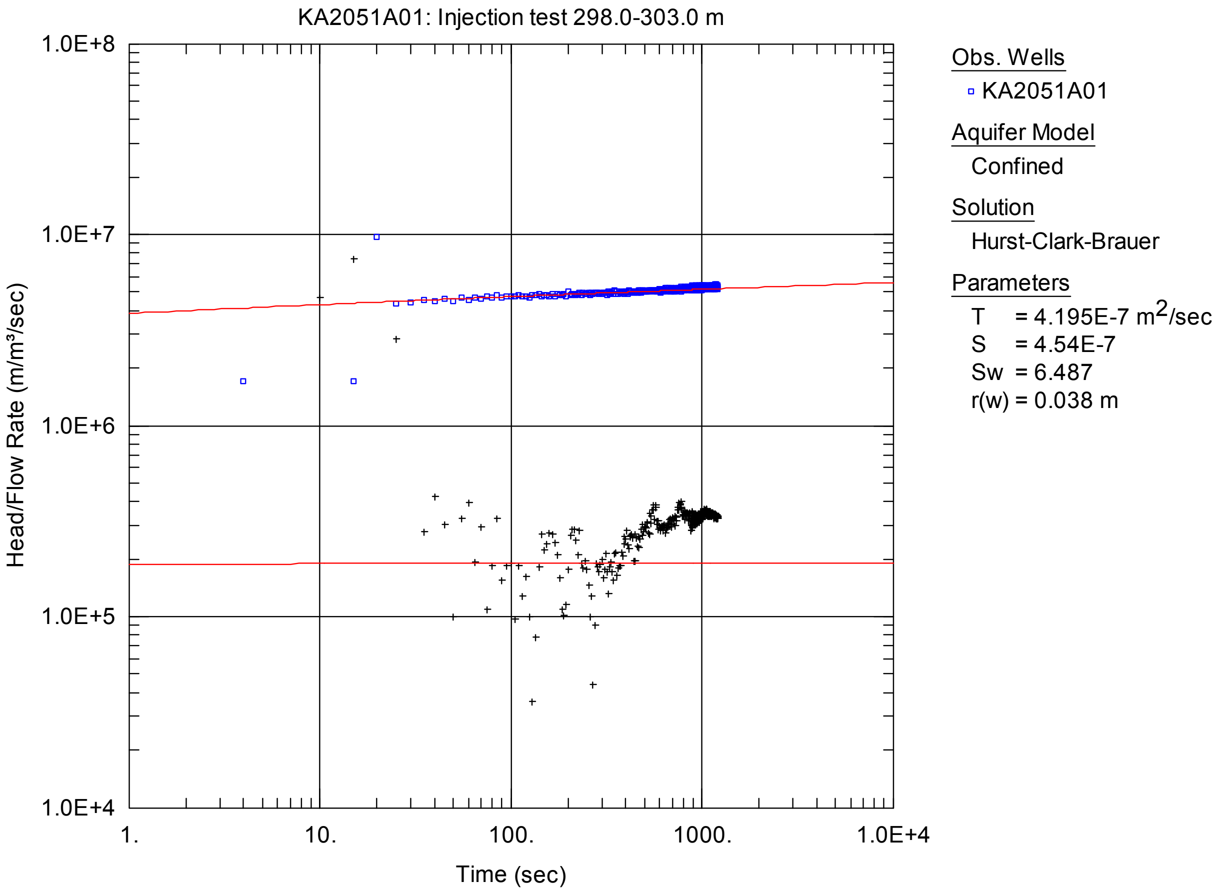

KA2051A01: Injection test 293.0-298.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
100.
10.
1.
0.1
0.01
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.954E-7 m2/sec
S = 3.82E-7
r/B = 1.0E-5
r(w) = 5.742E-5 m
r(c) = 0.0004299 m

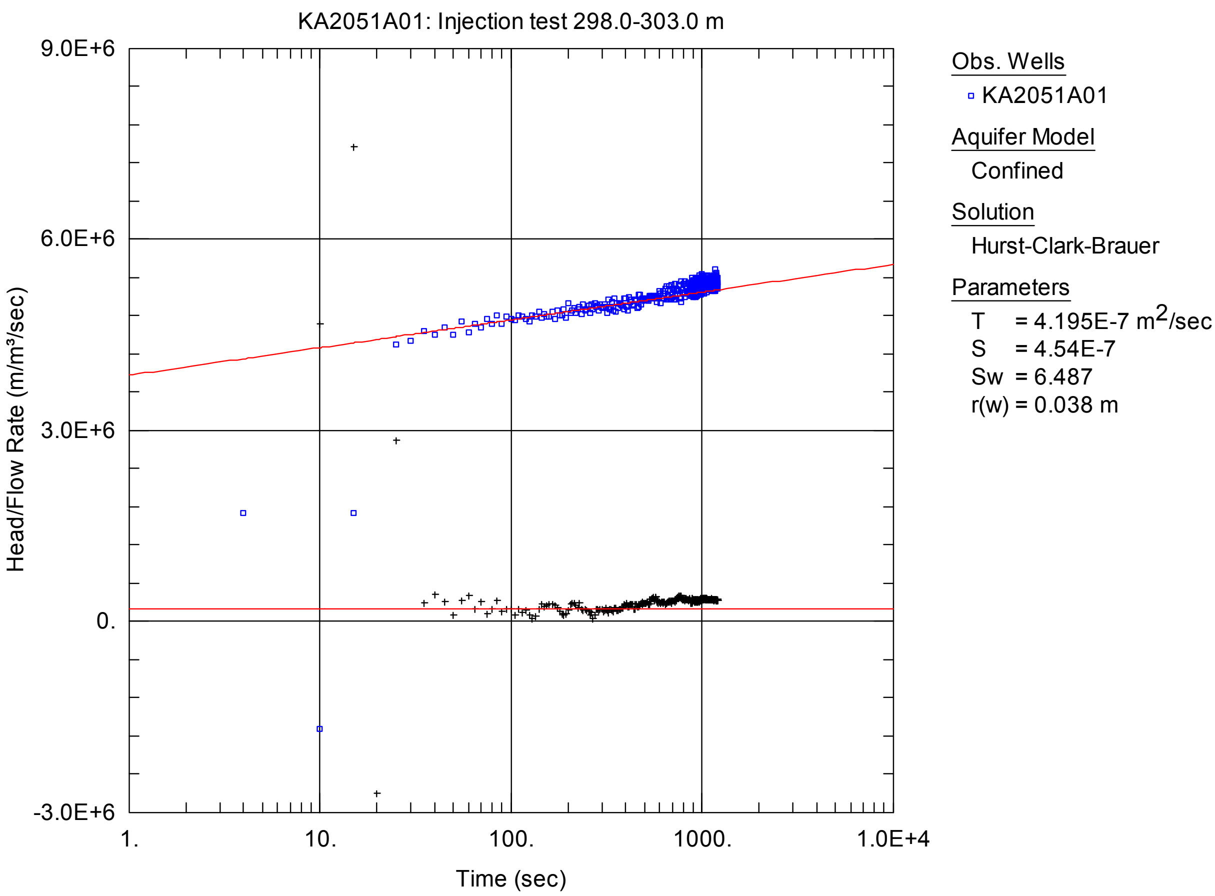


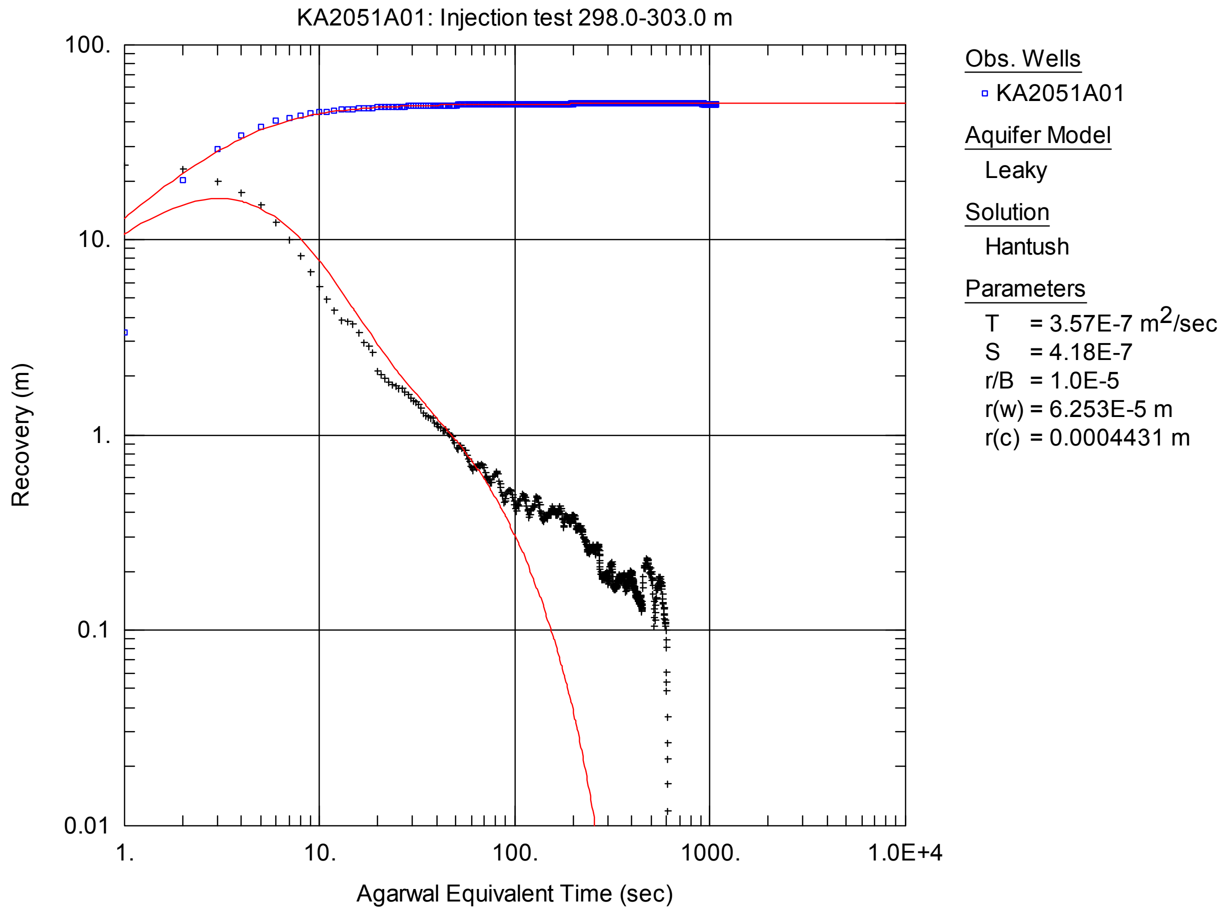
KA2051A01: Injection test 293.0-298.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
60.
50.
40.
30.
20.
10.
0.
-10.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 2.954E-7 m2/sec
S = 3.82E-7
r/B = 1.0E-5
r(w) = 5.742E-5 m
r(c) = 0.0004299 m

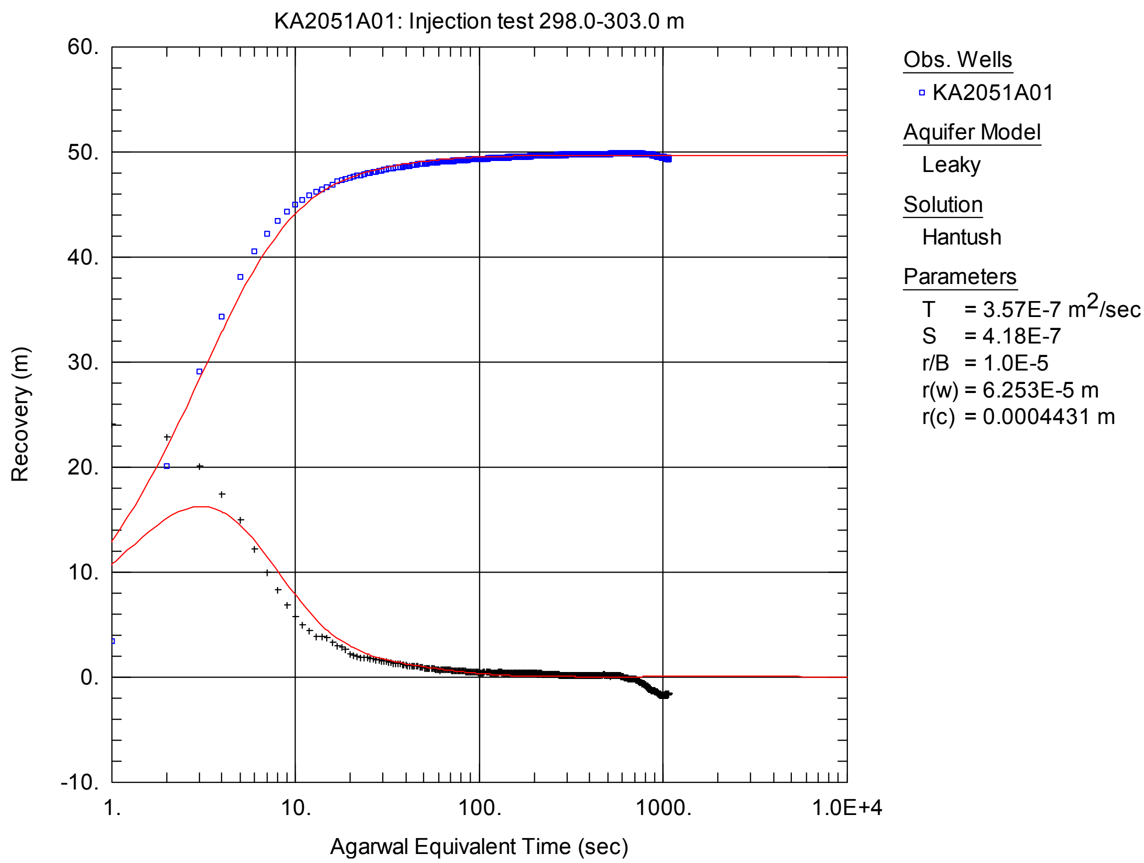


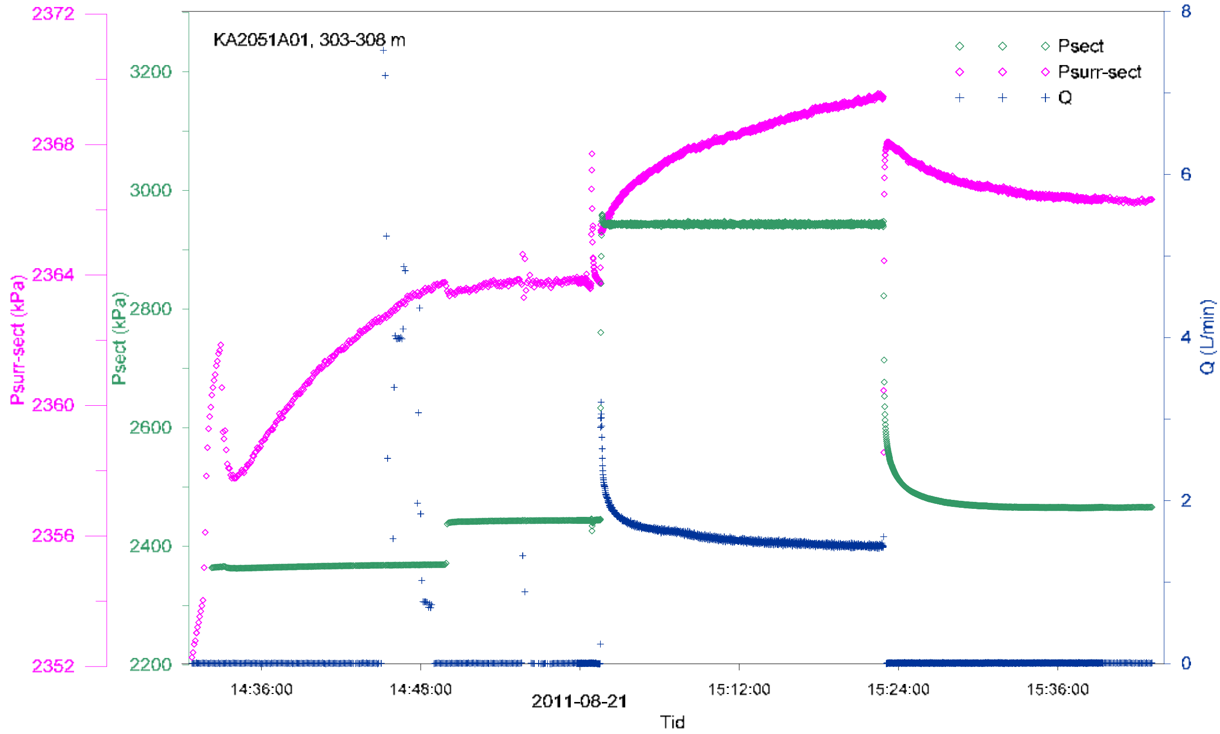
KA2051A01, 298-303 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psekt (kPa)
Q (L/min)
Tid
2372
2368
2364
2360
2356
3400
3200
3000
2800
2600
2400
2200
2
1.6
1.2
0.8
0.4
0
11:15:00
11:30:00
11:45:00
2011-08-21
12:15:00
12:30:00
12:45:00
2011-08-21
13:15:00
13:30:00
13:45:00
2011-08-21
14:15:00

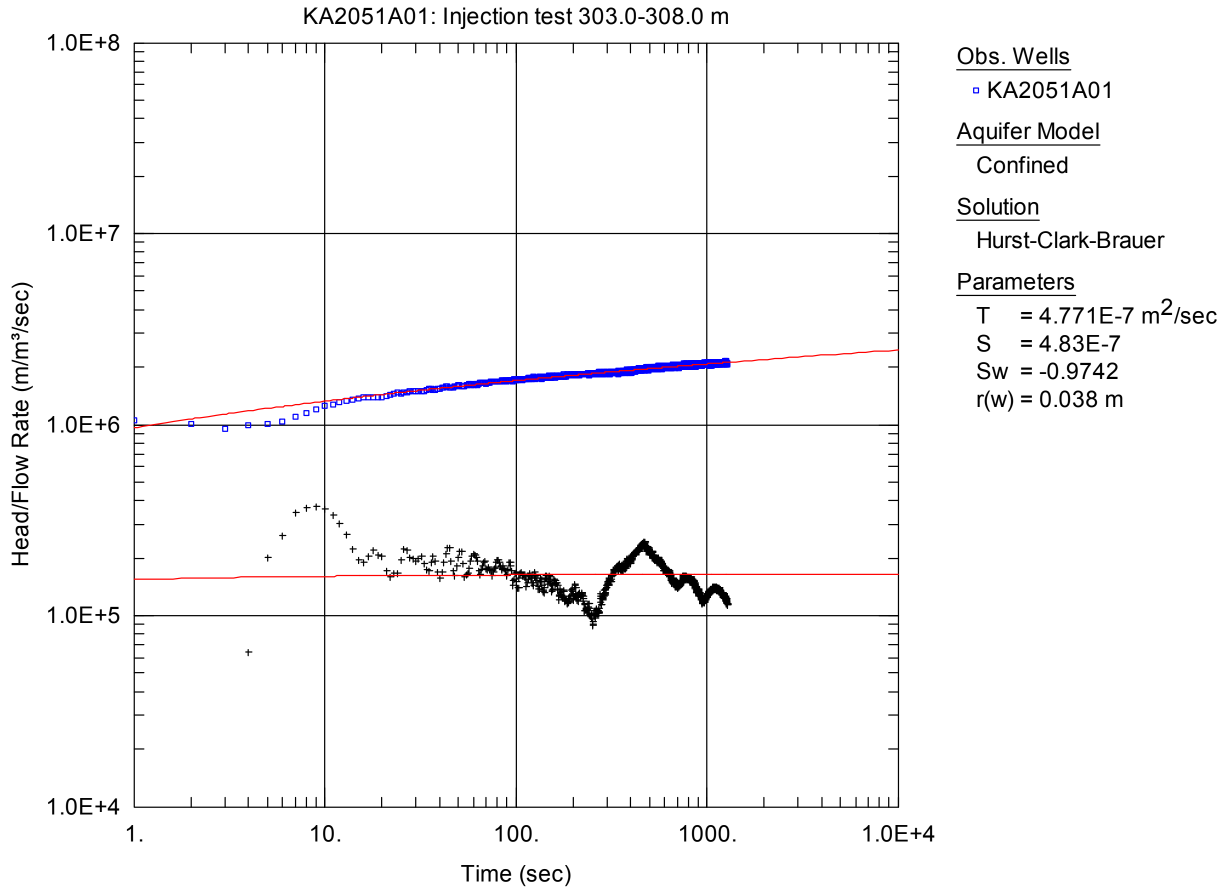

KA2051A01: Injection test 298.0-303.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.195E-7 m2/sec
S = 4.54E-7
Sw = 6.487
r(w) = 0.038 m

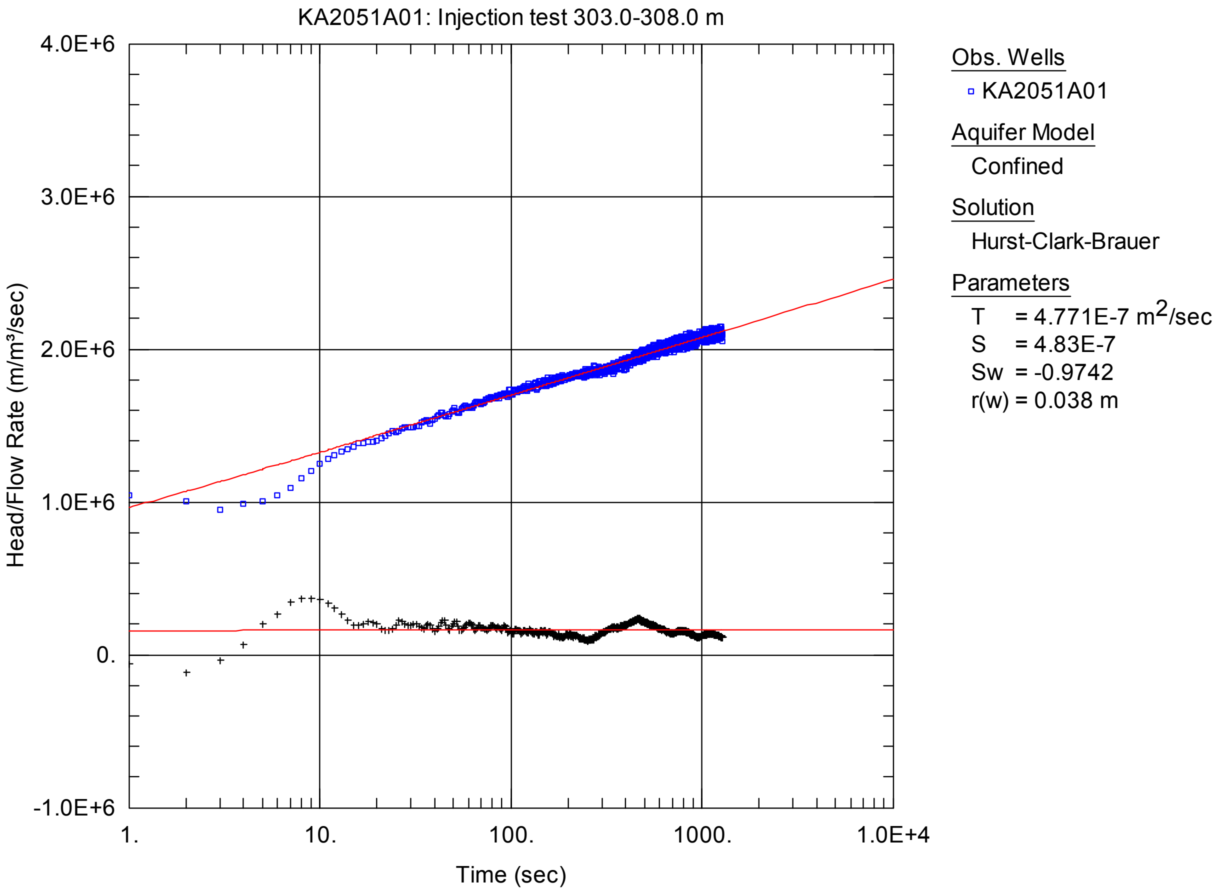

KA2051A01: Injection test 298.0-303.0 m
Head/Flow Rate (m/m³/sec)
Time (sec)
9.0E+6
6.0E+6
3.0E+6
0.
-3.0E+6
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.195E-7 m2/sec
S = 4.54E-7
Sw = 6.487
r(w) = 0.038 m


KA2051A01: Injection test 298.0-303.0 m
Recovery (m)
100.
10.
1.
0.1
0.01
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 3.57E-7 m2/sec
S = 4.18E-7
r/B = 1.0E-5
r(w) = 6.253E-5 m
r(c) = 0.0004431 m

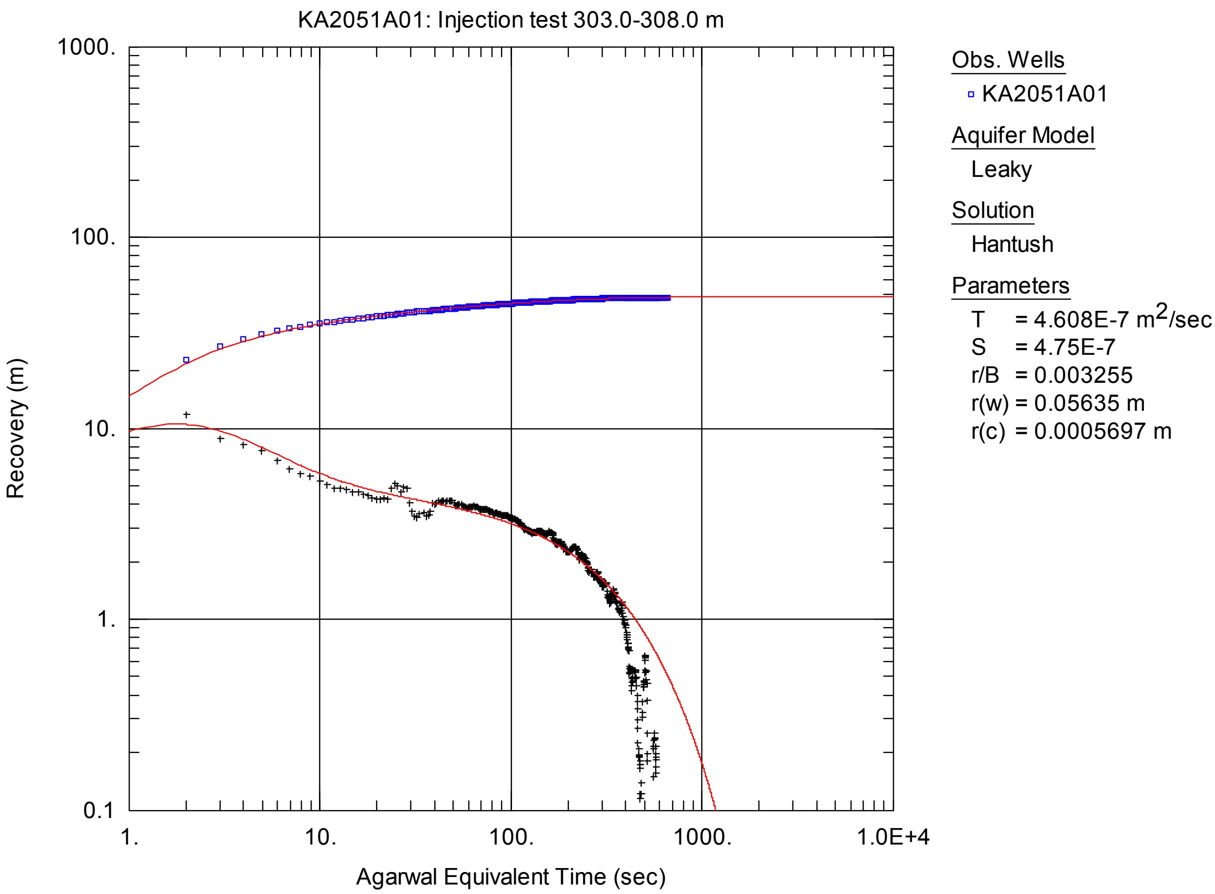

KA2051A01: Injection test 298.0-303.0 m
Recovery (m)
60.
50.
40.
30.
20.
10.
0.
-10.
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 3.57E-7 m2/sec
S = 4.18E-7
r/B = 1.0E-5
r(w) = 6.253E-5 m
r(c) = 0.0004431 m


KA2051A01, 303-308 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2372
2368
2364
2360
2356
2352
3200
3000
2800
2600
2400
2200
8
6
4
2
0
14:36:00
14:48:00
2011-08-21
15:12:00
15:24:00
15:36:00
Tid

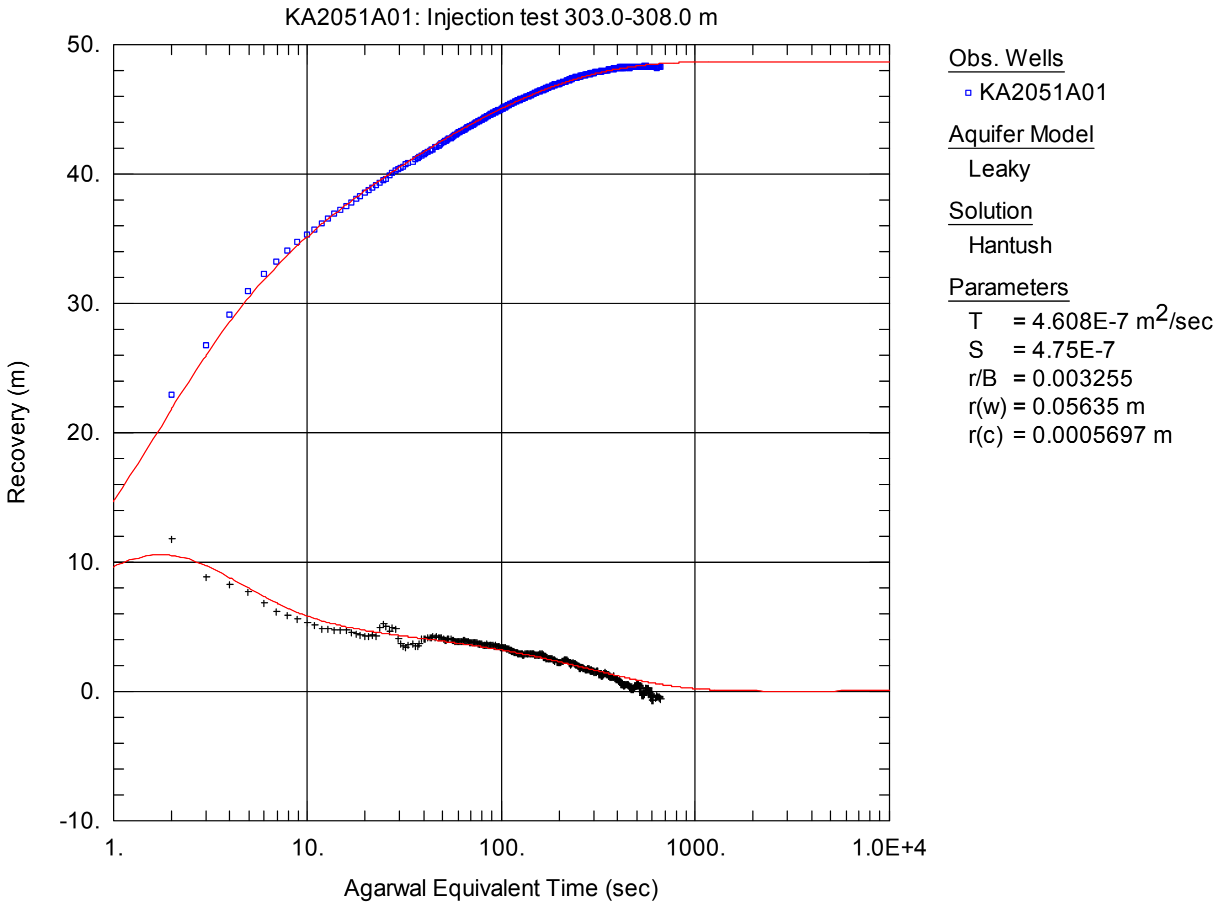

KA2051A01: Injection test 303.0-308.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.771E-7 m²/sec
S = 4.83E-7
Sw = -0.9742
r(w) = 0.038 m

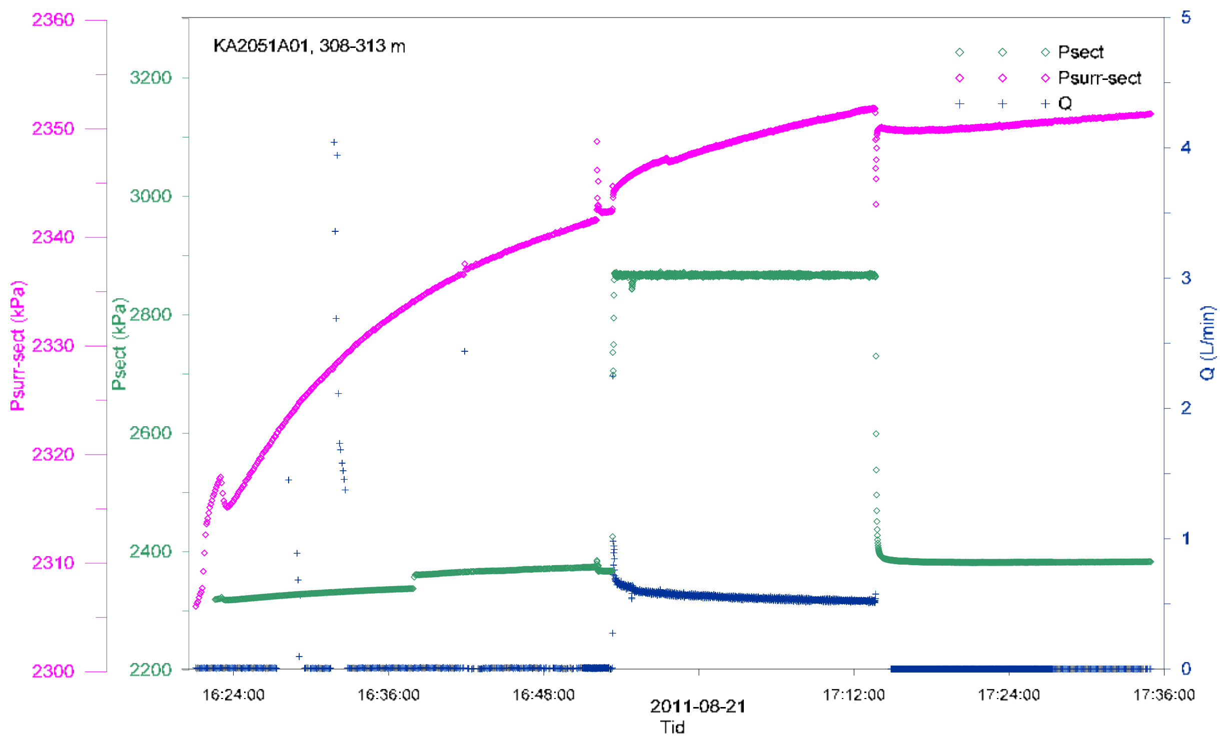


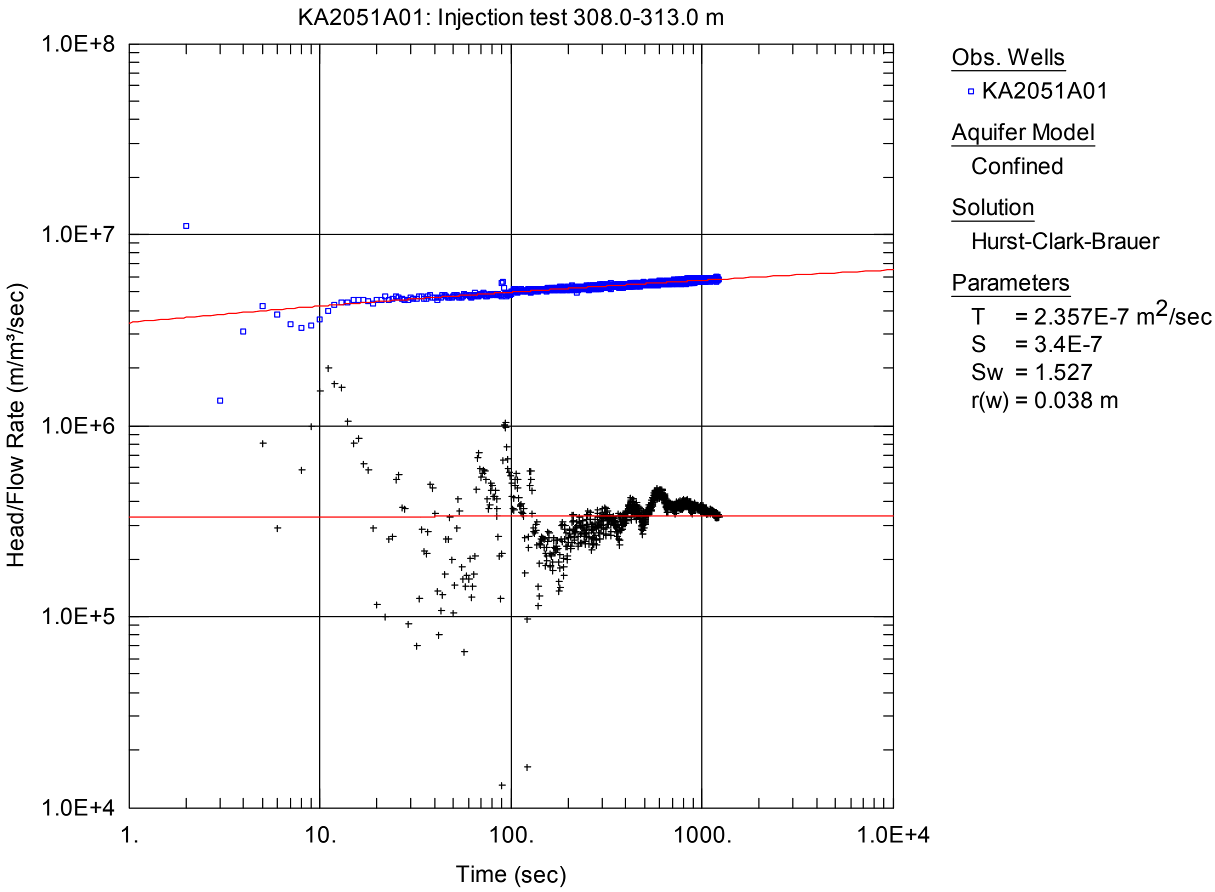
KA2051A01: Injection test 303.0-308.0 m
4.0E+6
3.0E+6
2.0E+6
1.0E+6
0.
-1.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 4.771E-7 m2/sec
S = 4.83E-7
Sw = -0.9742
r(w) = 0.038 m

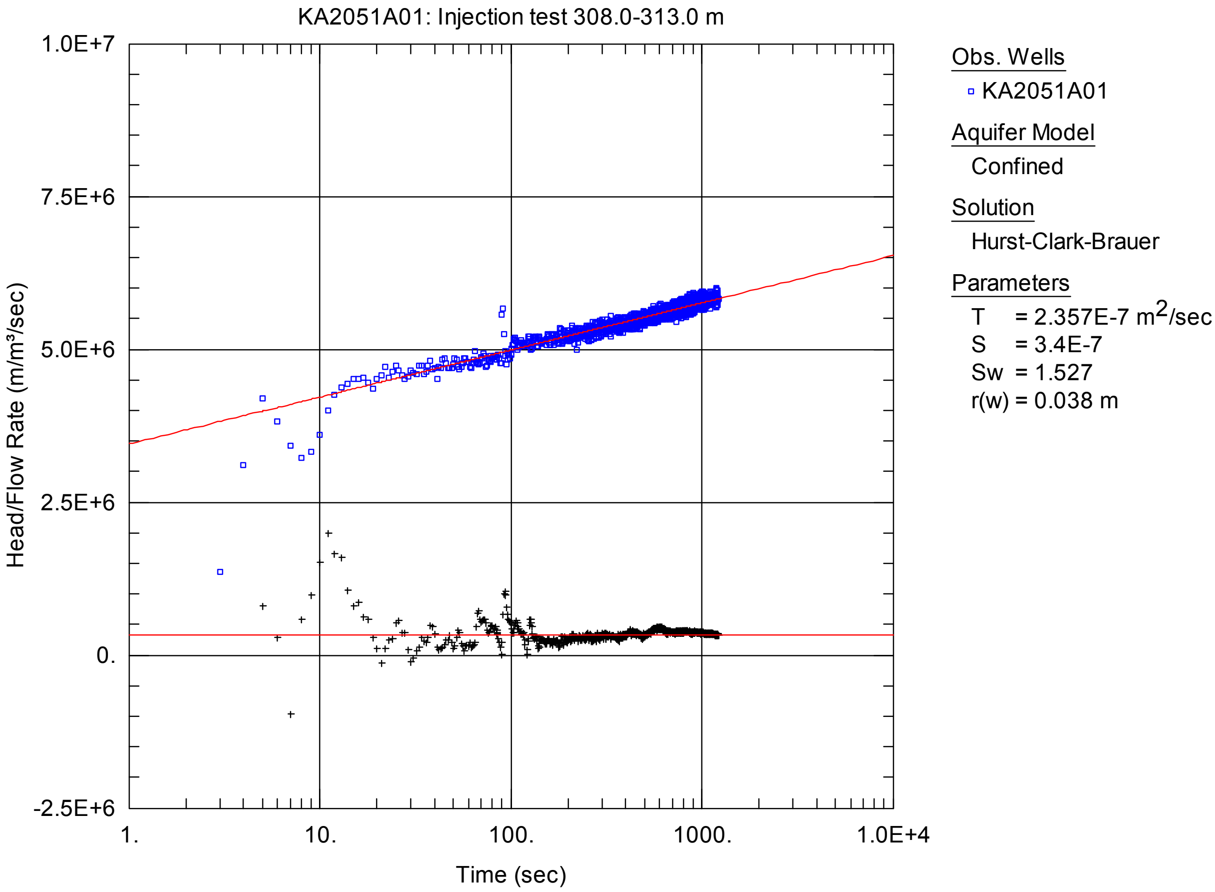


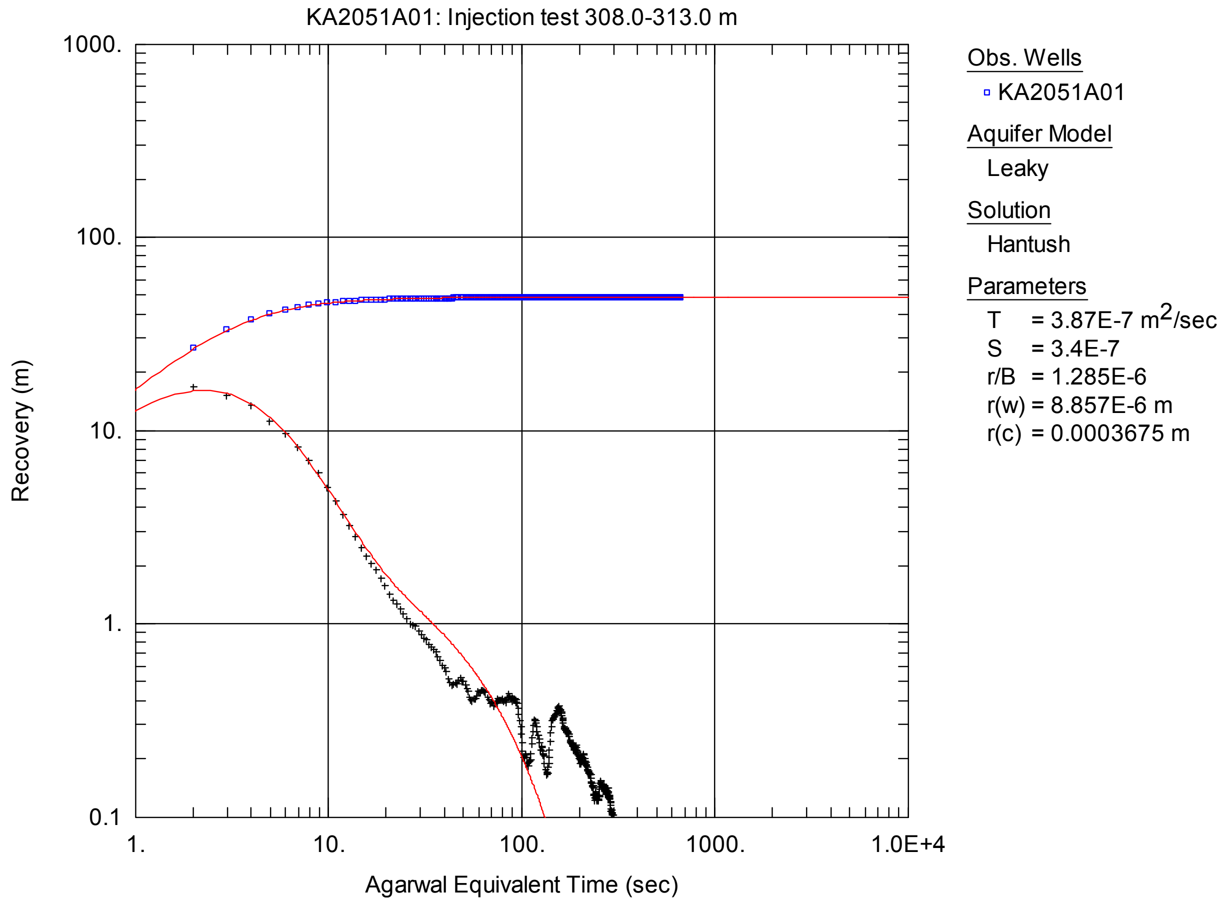
KA2051A01: Injection test 303.0-308.0 m
1000.
100.
10.
1.
0.1
Recovery (m)
1.
10.
100.
1000.
1.0E+4
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.608E-7 m2/sec
S = 4.75E-7
r/B = 0.003255
r(w) = 0.05635 m
r(c) = 0.0005697 m


KA2051A01: Injection test 303.0-308.0 m
Recovery (m)
Agarwal Equivalent Time (sec)
50.
40.
30.
20.
10.
0.
-10.
1.
10.
100.
1000.
1.0E+4
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.608E-7 m2/sec
S = 4.75E-7
r/B = 0.003255
r(w) = 0.05635 m
r(c) = 0.0005697 m

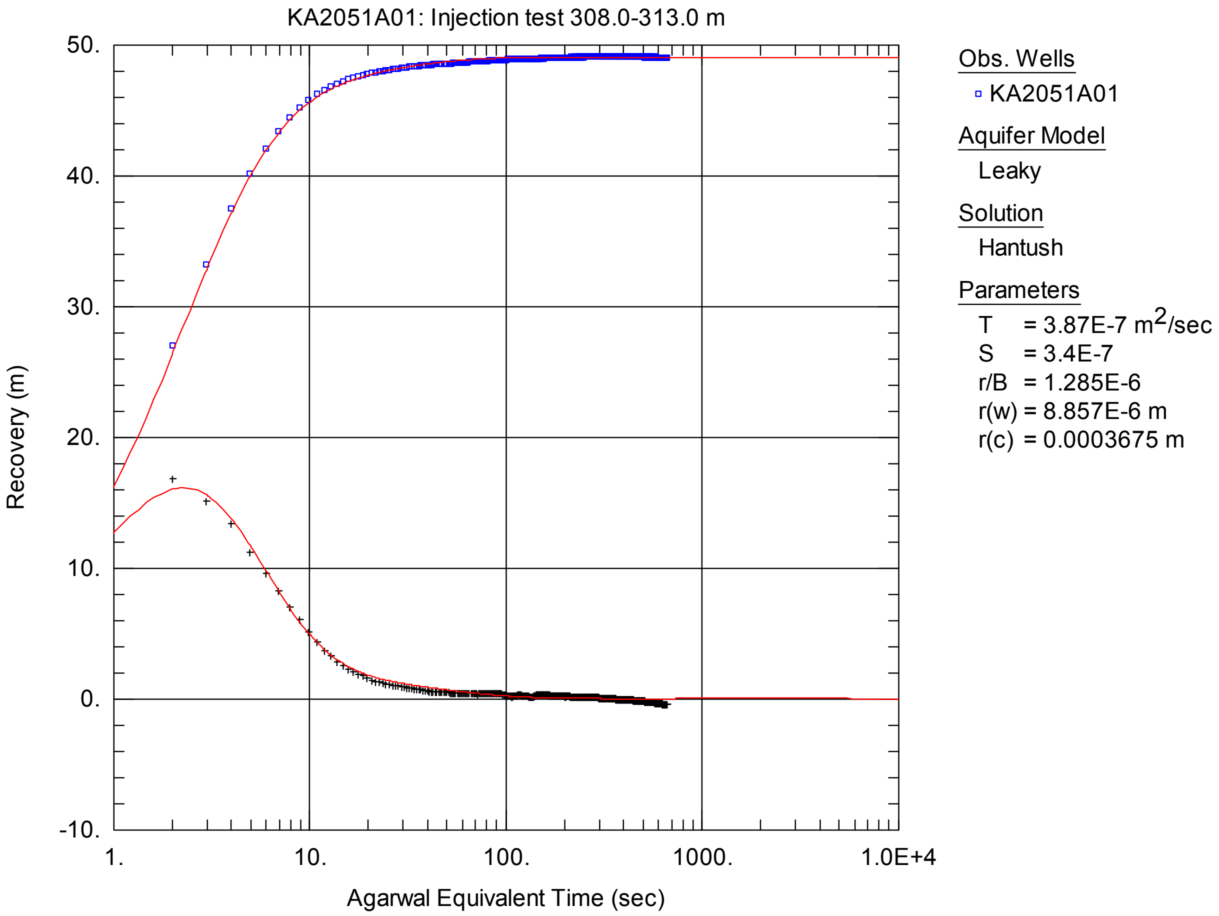

KA2051A01, 308-313 m
Psect
Psurr-sect
Q
Psurr-sect (kPa)
Psect (kPa)
Q (L/min)
2360
2350
2340
2330
2320
2310
2300
3200
3000
2800
2600
2400
2200
5
4
3
2
1
0
16:24:00
16:36:00
16:48:00
2011-08-21
Tid
17:12:00
17:24:00
17:36:00


KA2051A01: Injection test 308.0-313.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.357E-7 m2/sec
S = 3.4E-7
Sw = 1.527
r(w) = 0.038 m

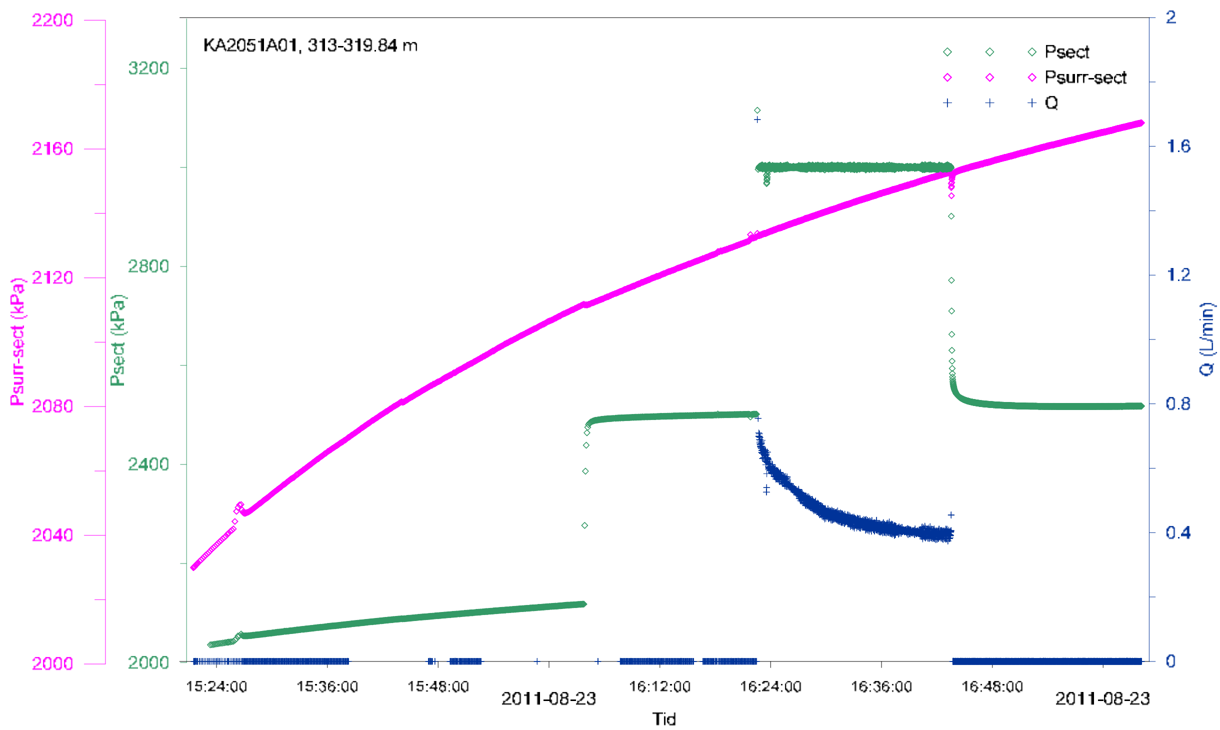

KA2051A01: Injection test 308.0-313.0 m
1.0E+7
7.5E+6
5.0E+6
2.5E+6
0.
-2.5E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 2.357E-7 m2/sec
S = 3.4E-7
Sw = 1.527
r(w) = 0.038 m

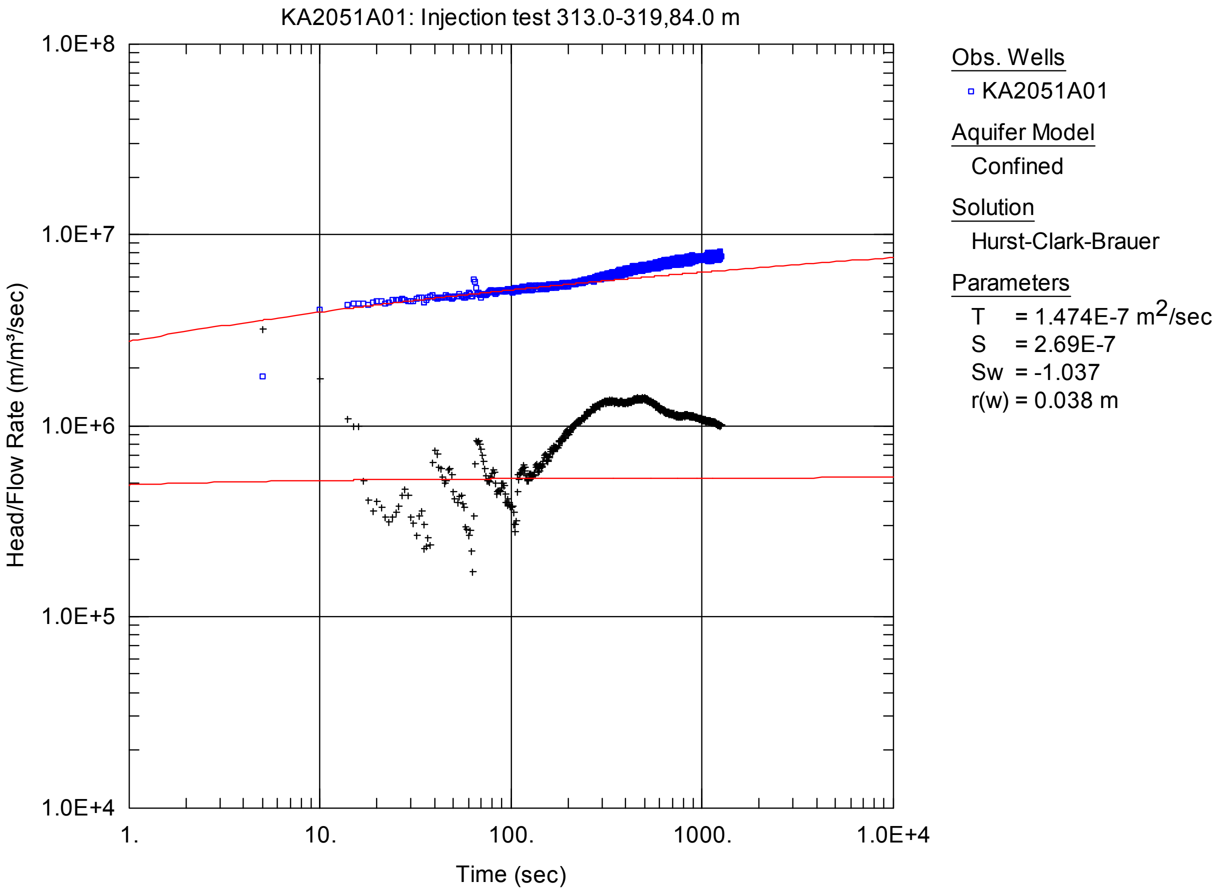


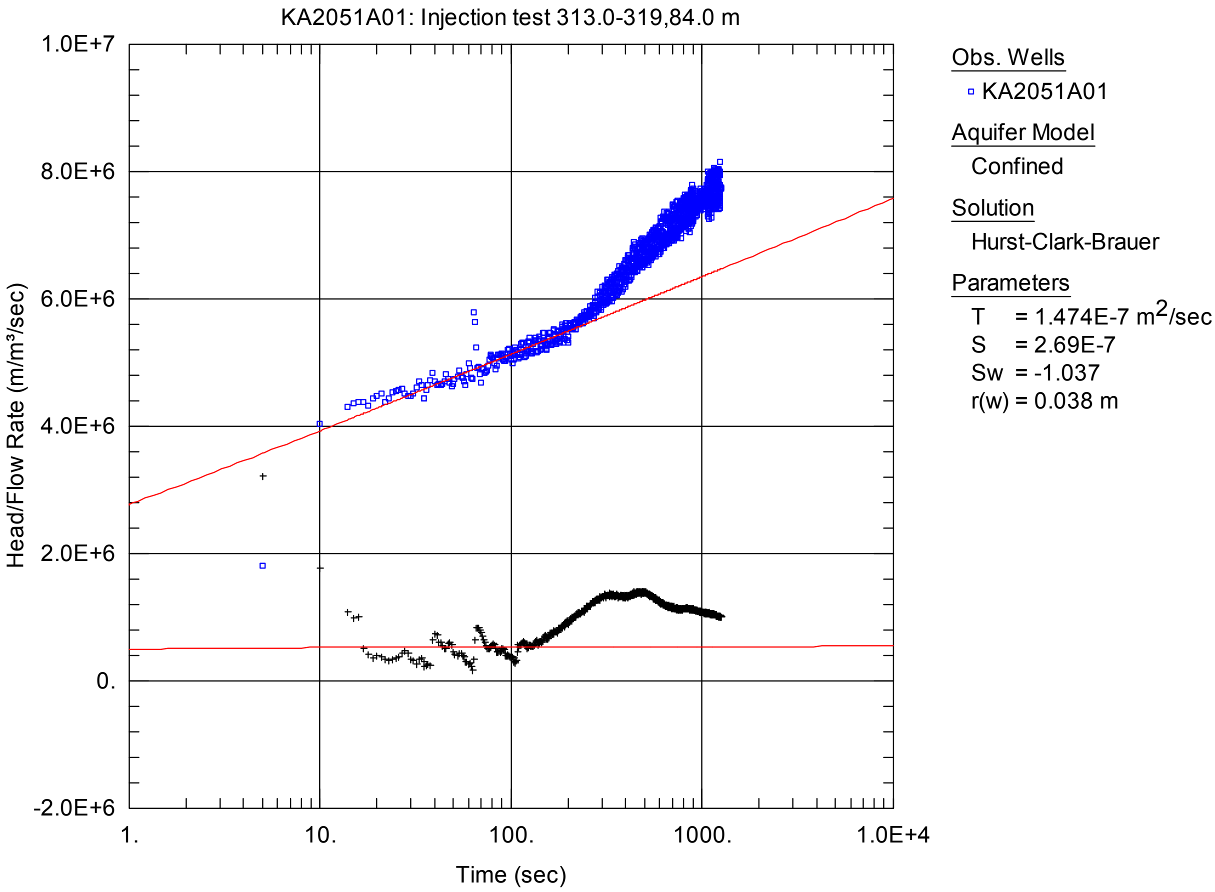
Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

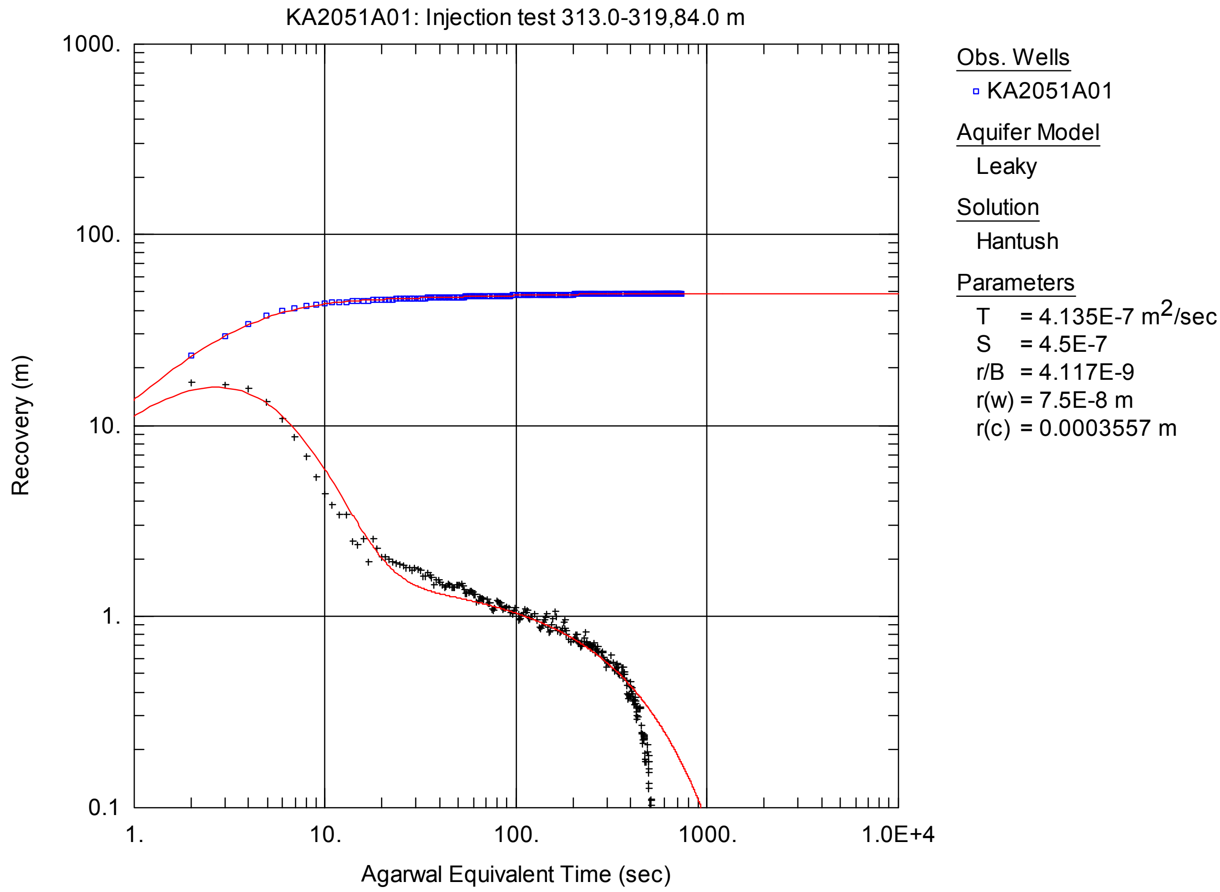


Comment: *The model fit shows a possible but not unambiguous transient evaluation.*

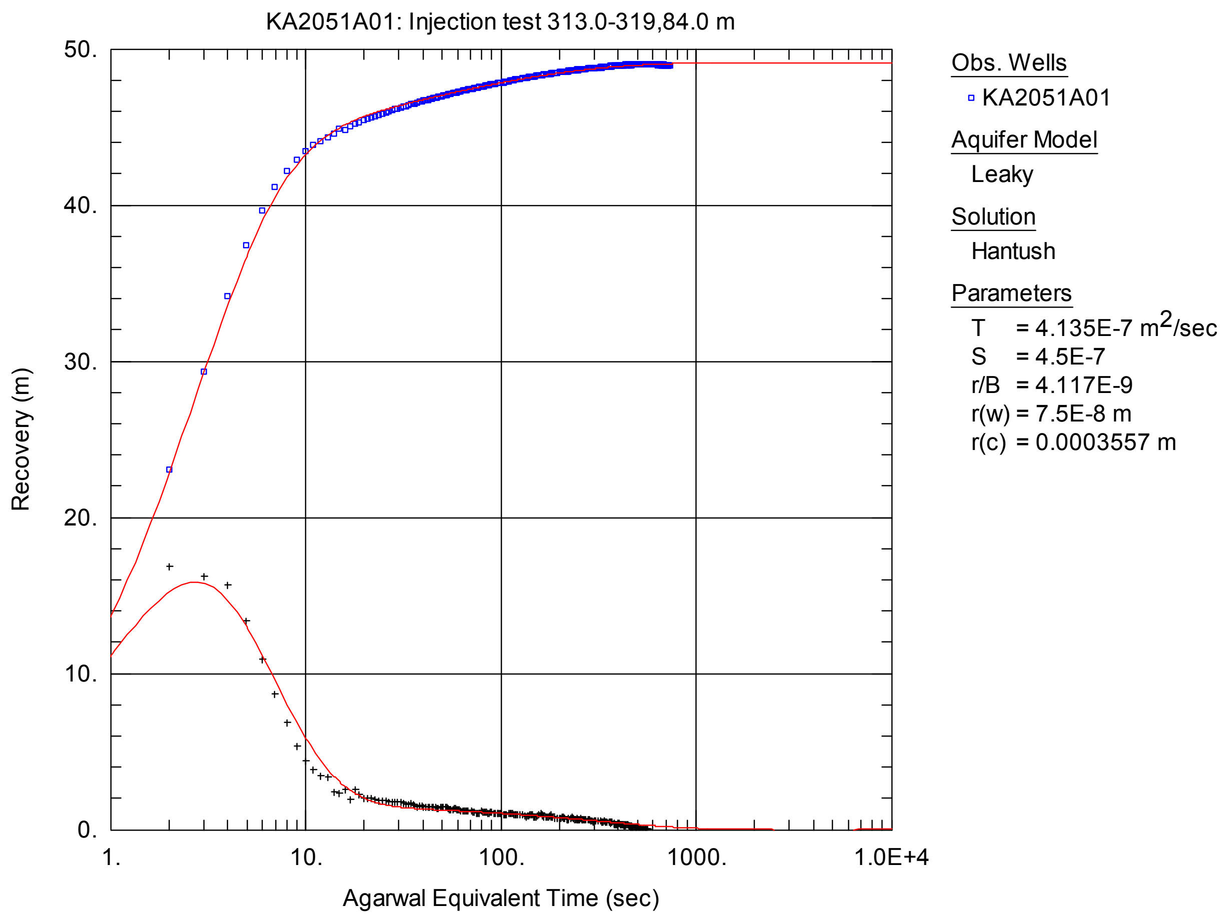



KA2051A01: Injection test 313.0-319,84.0 m
1.0E+8
1.0E+7
1.0E+6
1.0E+5
1.0E+4
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
Sw = -1.037
r(w) = 0.038 m


KA2051A01: Injection test 313.0-319,84.0 m
1.0E+7
8.0E+6
6.0E+6
4.0E+6
2.0E+6
0.
-2.0E+6
Head/Flow Rate (m/m³/sec)
1.
10.
100.
1000.
1.0E+4
Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Confined
Solution
Hurst-Clark-Brauer
Parameters
T = 1.474E-7 m2/sec
S = 2.69E-7
Sw = -1.037
r(w) = 0.038 m



KA2051A01: Injection test 313.0-319,84.0 m
1000.
100.
10.
1.
0.1
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.135E-7 m2/sec
S = 4.5E-7
r/B = 4.117E-9
r(w) = 7.5E-8 m
r(c) = 0.0003557 m



KA2051A01: Injection test 313.0-319,84.0 m
50.
40.
30.
20.
10.
0.
1.
10.
100.
1000.
1.0E+4
Recovery (m)
Agarwal Equivalent Time (sec)
Obs. Wells
KA2051A01
Aquifer Model
Leaky
Solution
Hantush
Parameters
T = 4.135E-7 m2/sec
S = 4.5E-7
r/B = 4.117E-9
r(w) = 7.5E-8 m
r(c) = 0.0003557 m

Appendix 4

Comments to the tests

A4.1 Comments on the tests in KA3007A01

Short comments on each test follow below. Tests were performed within the interval 148–227.8 m in KA3007A01. Flow regimes and hydraulic boundaries, as discussed in the main report, are in the text referred to as:

WBS = Wellbore storage

PRF = Pseudo-radial flow regime

PLF = Pseudo-linear flow regime

PSF = Pseudo-spherical flow regime

PSS = Pseudo-stationary flow regime

NFB = No-flow boundary

CHB = Constant-head boundary

148.0–153.0 m

The flow period is dominated by a clear PRF corresponding to a rather high positive skin factor. The recovery displays a PSF after an initial WBS. The flow regimes during the injection and recovery periods are not consistent. The transient evaluation from the flow period is considered as representative.

153.0–158.0 m

During the flow period the flow regime is interpreted as an intermediate between PRF and PSF. The recovery displays initial WBS followed by a PSF. The transient evaluation of the flow period is considered as representative.

158.0–163.0 m

Both the flow and recovery periods show clear PSF after initial WBS during the recovery period. The responses and transient evaluations are consistent. The transient evaluation of the flow period is considered as representative.

163.0–168.0 m

The flow rate is very scattered but the flow period is assumed to be dominated by a PRF corresponding to a rather high positive skin factor. The recovery period displays a PSF after initial WBS. The flow regimes during the injection and recovery periods are thus not consistent. The transient evaluation from the flow period is considered as representative.

168.0–173.0 m

Even though the flow rate is quite scattered, a PRF can be clearly identified during the flow period. The recovery period displays WBS followed by a PSF. However, no unambiguous transient evaluation is possibly of the recovery period. The transient evaluation from the flow period is considered as representative.

173.0–178.0 m

During the flow period a clear PRF is indicated after c. 30 s to c. 100 s. From c. 100 s there are indications of a possible PSF transitioning to a PSS by the end. After c. 200 s of the flow period a change in the flow rate can be seen but not in the pressure data. Therefore it is assumed to be due to a natural or pressure initiated change in the rock. The recovery period exhibits a PRF at intermediate times transitioning to a PSF by the end. Transient evaluations of the flow period and recovery period, respectively give consistent results. The transient evaluation of the flow period is regarded as the most representative.

178.0–183.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

183.0–188.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

188.0–193.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

193.0–198.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

198.0–203.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

203.0–208.0 m

TH eflow rate is below the measurement limit (5 mL/min). No transient evaluation is made.

208.0–213.0 m

The flow period displays a clear PSF in the beginning. During the late stage of the flow period a transition to some other flow regime, possibly an apparent NFB is indicated. After initial WBS during the recovery period a transition to PSF and PSS by the end occurs.

213.0–218.0 m

Both the flow as well as the recovery period indicate PSF as the dominating flow regime after initial WBS during the recovery period. The pressure increases c. 6 kPa in the surrounding sections during the flow period. The pressure in the test section is affected by some unknown effect between c. 200 s and 400 s during the recovery period. This disturbance is not considered to affect the final results of the evaluation. The transient evaluation of the flow period is considered as representative.

218.0–227.8 m

The last test of the borehole is performed as a single-packer test below a packer. Since the flow rate in the section was high, the injection head achieved was only c. 13 m compared to the target head at c. 50 m. An intermediate between a PRF and a PSF is indicated throughout the flow period. The recovery period indicates a first PRF with a transition to a PSF by the end. The transient evaluations of the flow and recovery period respectively provide consistent results. The transient evaluation of the flow period is regarded as representative. Pressure interference occurred in the borehole interval above the packer during the test.

A4.2 Comments on the tests in KA2051A01

Short comments on each test follow below. Tests were performed within the interval 4.0–319.8 m in KA2051A01. Flow regimes and hydraulic boundaries, as discussed in the main report, are in the text referred to as:

WBS = Wellbore storage

PRF = Pseudo-radial flow regime

PLF = Pseudo-linear flow regime

PSF = Pseudo-spherical flow regime

PSS = Pseudo-stationary flow regime

NFB = No-flow boundary

CHB = Constant-head boundary

4.0–9.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

9.0–14.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

14.0–19.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

19.0–24.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

24.0–29.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

29.0–34.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

34.0–39.0 m

A dominating PRF is indicated during the flow period, possibly transitioning to a short PSF by the end. After initial WBS during the recovery period a PRF followed by a possible PSF is indicated. The responses during the flow and recovery period are thus rather consistent but a higher skin factor is derived from the recovery period. The transient evaluation from the flow period is chosen as representative.

39.0–44.0 m

The change from the big flow meter to the small one caused a shift of the flow rate curve at intermediate times. The evaluation of the flow period is based on the later part of the curve with the small flow meter due to better accuracy and resolution at this range of flow. A rapid pressure recovery occurred with an apparent PRF corresponding to a very high positive skin factor is indicated by the end of this period. Thus, the responses during the flow and recovery period are not consistent. The transient evaluation of the flow period is chosen as representative.

44.0–49.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

49.0–54.0 m

Although the flow rate is scattered, a dominating PRF is assumed during the entire flow period. After initial wellbore storage during the recovery period a PSF transitioning to a PSS by the end is indicated. Thus, the responses during the flow and recovery period are not consistent but the estimated transmissivity is similar. The transient evaluation of the flow period is chosen as the most representative.

54.0–59.0 m

During the flow period an apparent PRF is assumed corresponding to a rather high skin factor. During the recovery period no unambiguous transient evaluation could be made. A possible evaluation is shown for comparison. The stationary transmissivity is selected as representative due to the uncertain transient evaluations.

59.0–64.0 m

During the flow period a PRF transitioning to PSF is indicated. During the recovery period a short initial PRF is assumed transitioning to a PSF. The first part of the recovery period is distorted. The transient evaluation from the flow period was selected as representative.

64.0–69.0 m

During the flow period a short PRF transitioning to PSF is indicated. During the recovery period a dominating PSF occurred. The first part of the recovery period is distorted. The transient evaluation from the flow period was selected as representative.

118.0–123.0 m

A dominating PRF is indicated during the flow period, possibly transitioning to a short PSF by the end. After initial WBS during the recovery period a PRF followed by a possible PSF is indicated. The responses during the flow and recovery period are thus rather consistent but a higher skin factor is derived from the recovery period. The transient evaluation from the flow period is chosen as representative.

123.0–128.0 m

During the flow period a dominating PSF is indicated. During the recovery period an initial PLF is transitioning to a PSF occurred. The responses and evaluations are consistent. The transient evaluation from the flow period was selected as representative.

128.0–133.0 m

During the flow period a dominating PSF occurred with a weak indication of a PSF by the end. During the recovery period a possible PLF is assumed. The transient evaluation from the flow period was selected as representative.

133.0–138.0 m

During the flow period a short PRF transitioning to a PSF is indicated. After initial WBS during the recovery period a possible short PRF transitioning to a PSF occurred. The responses and evaluations are consistent. The transient evaluation from the flow period was selected as representative.

138.0–143.0 m

The flow is dominated by a PSF. After initial wellbore storage the recovery period is also dominated by a PSF. The responses are thus consistent and give similar results. The transient evaluation of the flow period is chosen as the most representative.

143.0–148.0 m

During the flow period a dominating PSF is indicated. After initial WBS during the recovery period transition to a PSF occurred. The responses and evaluations are consistent. The transient evaluation from the flow period was selected as representative.

148.0–153.0 m

The flow period is dominated by a PSF. During the beginning of the recovery period a PLF is developed transitioning to a PSF by the end of the period. The flow and recovery period give similar results. The transient evaluation of the flow period is chosen as the most representative.

153.0–158.0 m

The flow rate was very scattered during the flow period. An approximate PRF is indicated at intermediate times. By the end weak indications of a possible NFB is indicated. The recovery period is dominated by PLF transitioning to PSF by the end. The transient evaluation from the flow period was selected as representative.

158.0–163.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

163.0–168.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

168.0–173.0 m

The flow rate was very scattered during the flow period but an approximate PRF is indicated after c. 100 s. After initial WBS during the recovery period a transition period to a PSF and PSS by the end occurred. The responses during the flow and recovery period were not consistent. The transient evaluation from the flow period was selected as representative.

173.0–178.0 m

During the flow period a dominating PRF occurred. By the end, weak effects of an apparent NFB are indicated. After initial WBS during the recovery period transition to a PRF occurred. The responses and evaluations are consistent. The transient evaluation from the flow period was selected as representative.

178.0–183.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

183.0–188.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

188.0–193.0 m

During the flow period a dominating PRF occurred. After initial WBS during the recovery period transition to a PRF occurred. The responses and evaluations are consistent. The transient evaluation from the flow period was selected as representative.

193.0–198.0 m

During the flow period a PRF transitioning to a PSF by the end is shown. After initial wellbore storage effects a transition to a PSF also occurred during the recovery period. Thus, the responses and transient evaluations are consistent during the flow and recovery period in this case. The transient evaluation from the flow period is chosen as representative.

198.0–203.0 m

A dominating PRF is indicated during the flow period. After initial WBS a PSF is indicated during the recovery period. No unique transient evaluation could be made on the recovery period. The transient evaluation from the flow period is chosen as representative.

203.0–208.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

208.0–213.0 m

Although the flow rate is scattered, pseudo-linear flow is indicated transitioning towards a possible PRF by the end of the flow period and during the recovery period. The transient evaluation of the recovery period is chosen as the most representative due to the high scatter in flow rate.

213.0–218.0 m

PLF transitioning towards approximate PRF is indicated during both the flow and recovery period. By the end of the recovery period a possible apparent NFB is weakly indicated. Consistent transient evaluations on the flow and recovery period. The transient evaluation from the recovery period is chosen as most representative.

218.0–223.0 m

During the flow period a short PRF transitioning to a PSF is indicated. After initial PLF during the recovery period a transition period to a possible PSF occurred. The transient evaluation from the flow period was selected as representative.

223.0–228.0 m

The flow rate was below the measurement limit (5 mL/min). No transient evaluation was made.

228.0–233.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

233.0–238.0 m

During the flow period a PRF was dominating during the entire period. After initial wellbore storage effects a transition to a PRF also occurred during the recovery period with a weak indication of a possible PSF by the end. Thus, the responses and transient evaluations are consistent during the flow and recovery period in this case. The transient evaluation from the flow period is chosen as representative.

238.0–243.0 m

Although the flow rate is scattered, a dominating PRF occurs during the flow period. The response during the recovery period is not consistent with the one during the flow period. After initial wellbore storage transition to a possible PSF is indicated corresponding to a high positive skin factor. The transient evaluation of the flow period is chosen as the most representative.

243.0–248.0 m

The flow rate curve indicates an early PRF transitioning to a late PRF followed by slightly leaky flow (PSF) during the flow period. The response during the recovery period is not consistent with the one during the flow period. After initial wellbore storage, a transition to an intermediate PRF which may trnsit to a possible, apparent NFB. The transient evaluation of the flow period is chosen as the most representative.

248.0–253.0 m

Although the flow rate is scattered, a dominating PRF occurs during the entire flow period. The response during the recovery period is not consistent with the one during the flow period. After initial wellbore storage transition to a possible PSF is indicated corresponding to a high positive skin factor. The transient evaluation of the flow period is chosen as the most representative.

253.0–258.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

258.0–263.0 m

The flow rate was below the measurement limit (5 mL/min) and no transient evaluation is made for this section.

263.0–268.0 m

The test section shows a complex response. The responses during both the flow and recovery period indicate a short initial period of possible PRF transitioning to an apparent NFB or another flow restriction. By the end of both periods a PSF is indicated. Transient evaluations are made on both the early and late responses of the data curves. The transient evaluation of the short period with possible PRF during the flow period is selected as representative.

268.0–273.0 m

During the flow period a PRF transitioning to a PSF occurred. After initial wellbore storage effects a transition to a PSF also occurred during the recovery period. The early part of the recovery curve is not quite consistent with the later part. Since the transient evaluation of the recovery is based on the later part the estimated wellbore storage coefficient is may not be representative in this case. The transient evaluation from the flow period is chosen as representative. During the flow period pressure interference was observed in the adjacent sections in the borehole.

273.0–278.0 m

During the flow period two PRF's are indicated, an early one and a late one with slightly higher apparent transmissivity. Alternatively, the later PRF may be interpreted as a PSF. No evaluation is made on the recovery due to technical problems with the test. The transient evaluation from the flow period is chosen as representative. During the flow period pressure interference was observed in the adjacent sections in the borehole.

278.0–283.0 m

Although the flow rate is scattered, a dominating PRF occurs during the entire flow period. After initial wellbore storage during the recovery period a PRF is also indicated corresponding to a higher skin than during the flow period. Alternatively, a PSF may also be considered during the recovery period but gives a similar transmissivity. The transient evaluation of the flow period is chosen as the most representative.

283.0–288.0 m

Although big pressure regulation problems in the beginning, an approximate PRF is assumed by the end of the flow period. During the recovery period a PSF developed after initial WBS. Thus, the responses during the flow and recovery periods are not consistent. Due to the problems with pressure regulation during the flow period, the transient evaluation of the recovery period is chosen as the most representative.

288.0–293.0 m

The flow rate during the flow period was scattered but indicates a dominating PRF throughout the period. After initial WBS the response during the recovery period shows a PSF transitioning to an apparent PSS. In the overview plot a first unsuccessful attempt to start injection is visible. The decreasing pressure before the test is assumed not to disturb the evaluation of the test. The flow rate values from the first 20 s are probably constrained by the small flow meter. For unknown reasons the pressure decreases slightly at the end of the recovery period. The pressure in the surrounding borehole sections is increasing during the entire test for other reasons than the test but a clear test-related pressure interference with surrounding sections is also seen. The Hurst-Clark-Brauer model for the flow period and the Hantush model for the recovery period provide consistent results. The transient evaluation from the flow period is chosen as the most representative.

293.0–298.0 m

During the flow period a PSF transitioning to an apparent NFB is indicated. After initial WBS during the recovery period a transition period to a PSF and PSS by the end occurred. The transient evaluation from the recovery period was selected as representative.

298.0–303.0 m

During the flow period a PRF is indicated in their beginning, possibly transitioning to an apparent NFB by the end. After initial WBS during the recovery period a transition period to a PSF and PSS by the end occurred. Since the transient evaluation of both the flow and recovery period are regarded as uncertain the stationary transmissivity was selected as representative.

303.0–308.0 m

Although the flow rate is scattered, a dominating PRF is assumed during the entire flow period. After initial wellbore storage during the recovery period a PSF transitioning to a PSS by the end is indicated. Thus, the responses during the flow and recovery period are not consistent but the estimated transmissivity is similar. The transient evaluation of the flow period is chosen as the most representative.

308.0–313.0 m

Although the flow rate is scattered, an approximate PRF is assumed during the flow period. After initial wellbore storage during the recovery period a PSF transitioning to a PSS by the end is indicated. Thus, the responses during the flow and recovery period are not consistent. No unambiguous transient evaluation could be made from the recovery period. The transient evaluation of the flow period is chosen as the most representative.

313.0–319.8 m

During the flow rate an early PRF is assumed transitioning to an apparent NFB or other kind of flow restriction. After initial wellbore storage during the recovery period a PSF transitioning to a PSS by the end is indicated. Thus, the responses during the flow and recovery period are not consistent but the estimated transmissivity is in the same order. The transient evaluation of the early part of the flow period is chosen as the most representative.

A4.3 Comments on the tests in KJ0050F01

Short comments on each test follow below. Tests were performed within the interval 3.5–46.8 m in KJ0050F01. Flow regimes and hydraulic boundaries, as discussed in the main report, are in the text referred to as:

WBS = Wellbore storage

PRF = Pseudo-radial flow regime

PLF = Pseudo-linear flow regime

PSF = Pseudo-spherical flow regime

PSS = Pseudo-stationary flow regime

NFB = No-flow boundary

CHB = Constant-head boundary

3.5–8.5 m

During the flow period a short PRF transitioning to a PSF occurred. During the recovery period initial WBS occurred followed by a PSF. The transient evaluation of the flow period is selected as representative.

8.5–13.5 m

During the flow period a clear PRF occurred after c. 50 s. The jump in the flow rate curve at this time depends on a change of flow exchanger. During the recovery period initial WBS occurred followed by a PRF. At the end there is a weak indication of a PSF. The transient evaluation of the flow period is selected as representative.

13.5–18.5 m

The flow rate was close to but still above the measurement limit (2 mL/min). However, the flow rate was rather scattered so no transient evaluation was possible for this test.

18.5–23.5 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.

23.5–28.5 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.

28.5–33.5 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.

33.5–38.5 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.

38.5–43.5 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.

43.5–46.8 m

The flow rate was below the measurement limit (2 mL/min) and no transient evaluation is made for this section.