APPENDIX B-3

PACKER TESTS

Golder Associates	Subject Piñon Ridge	Made by EF	Job No 073-81694
	Packer Test Data Reduction	Checked by	Date 1/14/2008
	Evaluation of Bedrock Permeability	Approved by	Sheet No 1 of 3

BACKGROUND:

Eight (8) packer tests were conducted at the Piñon Ridge site drilling investigation at various depths and intervals within drillholes GA-BH-24, GA-BH-26, GA-BH-33, GA-BH-36, GA-BH-38, and GA-BH-42. The drillholes were drilled using NX (2.98 inches diameter) core rods.

Packer testing was conducted using a single-packer set-up. The testing procedure involved pulling the core rods and inserting the packer down to the desired depth using 10-foot lengths of 1-inch diameter steel rods. Teflon tape was used at all rod connections to prevent leakage. Water was injected below the packer by pressurizing the 1-inch diameter steel rods.

OBJECTIVE:

Calculate the permeability of the foundation material based on the packer test results.

GIVEN:

- Geometry of the packer tests, including height of swivel above ground surface; and
- Stabilized readings of the flow rate and applied pressure (raw field data included in Attachment 1).

ASSUMPTIONS:

- Head losses due to flow through the packer setup were negligible;
- For the Thiem method, assumed a radius of influence of 10 feet; and
- The simplified methods used herein are adequate for the desired level of accuracy.

METHODS:

Earth Manual Method:

From Earth Manual (Bureau of Reclamation, 1974), the following equation for permeability, k, is obtained:

$$k = C_p\left(\frac{Q}{H}\right) \qquad (1)$$

Where:

k = Permeability in feet per year;
C_p = Constant that is a function of the length of the test interval and the diameter of the hole;
Q = Flow rate (gpm); and

H = Head in the tested section below the packer (in feet).

To derive C_p values, one of two equations are to be used dependent on the aspect ratio of the corehole (length of test interval to corehole diameter):

$$Cp = \left[\frac{1}{2\pi L}\log_e \frac{L}{r}\right] \times 70262; L \geq 10r \qquad (2)$$

$$Cp = \left[\frac{1}{2\pi L}\sinh^{-1} \frac{L}{2r}\right] \times 70262; 10r > L \geq 10r \qquad (3)$$

Where:

L = Length of the portion of the hole tested;
r = Radius of hole tested;
$\log_e$ = Natural logarithm; and
$\sinh^{-1}$ = Inverse hyperbolic sine.

The factor of 70262 is a conversion from gallons per minute (gpm) to cubic feet per year (ft^3/yr).

Thiem Method:

The following equation is the Thiem equation for evaluation of permeability, k, from packer test data:

$$k = \frac{Q \ln\left(\frac{R}{r_b}\right)}{2\pi P_i b} \qquad (4)$$

Where:

k = Permeability (ft/yr);
Q = Injection rate (ft^3/yr);
R = Radius of influence (ft);
r_b =Radius of borehole (ft);
P_i = Net injection pressure head (ft); and
b = Length of the sample (length of test interval) (ft).

The net injection pressure head, P_i, is calculated as follows:

$$P_i = P_g + h_g + h_s - h_f \qquad (5)$$

Where:

P_g = Gauge pressure (converted from pressure to elevation head);
h_g = Height of gauge above ground;
h_s = Depth to static water level; and
h_f = Friction loss.

RESULTS:

The calculated bedrock permeability values using both the Earth Manual and Thiem methods are summarized in Table 1, and presented at each time step in Tables 2 and 3 for the Earth Manual and Thiem methods, respectively. The permeability values obtained using the two methods compare well.

During the tests where no water was taken by the test interval, it is suspected that the water flow gauge may have been functioning improperly, and these results are therefore ignored. The second test in GA-BH-24 and the test in GA-BH-33 were performed with a new gauge, and both of these tests measured flow into the formation.

CONCLUSIONS:

The tested bedrock can be divided into three zones: sandstone, claystone, and gypsum. The permeability of the sandstone zone was approximately 4.3×10^{-4} cm/sec. The permeability of the claystone zone tested was approximately 2.4×10^{-5} cm/sec, and the gypsum permeability ranged from 2.0×10^{-7} cm/s to 1.9×10^{-5} cm/sec.

REFERENCES:

- U.S. Department of the Interior, Bureau of Reclamation. (1974). *Earth Manual*, Second Edition.
- Royle, M. (No date). "Standard Operating Procedures for Borehole Packer Testing", SRK Consulting, 23 pgs.
- Thiem, G. (1906). Hydrologische Methoden. Gebhardt, Leipzig, 56 pp

ATTACHMENT 1
RAW PACKER TEST DATA

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME EFR / Piñon Ridge
PROJECT NUMBER 073-81094
BORING NO. GA-BH-24
TESTED BY J. Elliott DATE 11/29/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 11/29/07 1313
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 15 min
CONTRACTOR Dakota Drilling
DRILLER Josh Gildon
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER SENSUS 5/8" SR II
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200 psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5.0'
TYPE OF PACKER SINGLE
DISTANCE TO TOP OF TEST ZONE 55'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 64.5'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 9.5'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	1318	53	473.9	—	
2	1323	53	473.9	0	
3	1328	53	473.9	0	No water taken

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME EPR/Dixon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-24
TESTED BY J. Ellrott DATE ~~11/28~~ 12/6/07
TEST NO. 2
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 12/6/07 0737
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST ≈ 1 hr
CONTRACTOR Dakota Drilling
DRILLER Josh Gildon
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Neptune 5/8" T-10 01 006 ~~Sensus 5/8" SR II~~
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200 psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER SINGLE
DISTANCE TO TOP OF TEST ZONE 60'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 99.5'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 39.5'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	0739	10	~~0.54~~ 65.4	—	
2	0744	10	70.8	1.08	
3	0749	10	76.15	1.07	
4	0753	20	81.8	—	
5	0758	20	88.1	1.26	
6	0803	20	94.8	1.34	
7	0808	20	101.4	1.32	
8	0811	30	105.8	—	
9	0816	30	113.3	1.50	
10	0821	30	120.8	1.50	
11	0823.5	10	122.9	—	
12	0828.5	10	128.1	1.04	
13	0833.5	10	133.3	1.04	

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME EFR/Piñon Ridge
PROJECT NUMBER 073-81664
BORING NO. GA-BH-26
TESTED BY J. Elliott DATE 11/12/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 11/12/07 0920
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 1 hr, 13 min
CONTRACTOR Dakota Drilling
DRILLER Josh G.
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN Pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Sensus 5/8" SR II
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200 psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER single
DISTANCE TO TOP OF TEST ZONE 75'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 85'
BEFORE TEST 164 psi
LENGTH OF TEST INTERVAL 10'
AFTER TEST 164 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	0925.30	10	136.218	—	
2	0930.30	10	138.40	~~0.22~~ 0.24	
3	0935.30	10	~~136~~ 139.75	0.47	
4	0940.30	10	142.15	0.48	10 psi, 0.48 gpm
5	0943.00	15	143.8	—	
6	0948.00	15	147.25	0.69	
7	0953.00	15	150.6	0.67	
8	0958.00	15	153.75	0.63	
9	1003.00	15	156.75	0.60	
10	1008.00	15	159.70	0.59	15 psi, 0.59 gpm
11	1010.00	20	161.2	—	
12	1015.00	20	164.75	0.71	
13	1020.00	20	168.3	0.71	20 psi, 0.71 gpm
14	1022.00	10	169.15	—	
15	1027.00	10	171.5	0.47	
16	1032.00	10	173.9	0.48	10 psi, 0.48 gpm

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME EFR/ Añon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-33
TESTED BY J. Elliott DATE 12/9/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 12/9/07 1030
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 1 hr
CONTRACTOR Dakota Drilling
DRILLER Josh Gilden
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Neptune 5/8" T-10 01 06
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200 psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER single
DISTANCE TO TOP OF TEST ZONE 70'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 100'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 30'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	1033	10	203.3	—	Gauge is only accurate to the tenth of a gallon, making flow readings on this order of magnitude very difficult.
2	1038	10	203.42	0.12/5	
3	1043	10	203.52	0.10/5=0.02	
4	1048	10	203.62	0.02	
5	1051	20	203.76	—	
6	1056	20	203.86	0.02	
7	1101	20	203.95	0.018	
8	1102	30	204.02	—	
9	1107	30	204.15	0.026	
10	1112	30	204.23	0.016	
11	1115	10	204.23	—	
12	1120	10	204.28	.01	
13	1125	10	204.21	N/A	Gage needle jumps slightly when tapped
14	1130	10	204.23	.004	
15	1135	10	204.27	.008	

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME Piñon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-36
TESTED BY J. Elliott DATE 11/15/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 11/15/07 1135
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 30 min.
CONTRACTOR Dakota Drilling
DRILLER Josh G.
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Sensus 5/8" SRII
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER single
DISTANCE TO TOP OF TEST ZONE 80'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 90'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 10'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	1135	10	206.6	—	
2	1140	10	206.7	—	
3	1145	20	206.85	—	
4	1150	20	206.9	0	
5	1155	20	206.9	0	
6	1200	50	207.2	—	
7	1205	50	207.2	0	formation did not take measurable water
8					
9					
10					
11					

Siltstone + claystone w/ evaporite veins

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME Piñon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-38
TESTED BY J. Elliott DATE 11/18/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 0810 11/18/07
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 20 min
CONTRACTOR Dakota Drilling
DRILLER Josh G.
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Sensus 5/8" SR II
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER Single
DISTANCE TO TOP OF TEST ZONE 80'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 90'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 10'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	0815	30	398.40	—	
2	0820	30	398.45	$\frac{.05}{5}$ = 0.01	
3	0825	30	398.50	0.01	
4	0830	30	398.50	0	Essentially no water taken by formation
5					
6					
7					
8					
9					
10					

Packer Test in CLAYSTONE

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME Piñon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-38
TESTED BY J. Elliott DATE 11/18/07
TEST NO. 2
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 11/18/07 1135
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 30 min.
CONTRACTOR Dakota Drilling
DRILLER Josh G.
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Sensus 5/8" SR II
DEPTH TO GROUNDWATER (BGS) n/a
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200 psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER Single
DISTANCE TO TOP OF TEST ZONE 90'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 100'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 10'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	1135	10		—	formation took no water
2	1137	30		—	"
3	1142:30	50	428.840	—	
4	1147:30	50	428.45	0.01	Pressure oscillating between 50 and 55 psi
5	1152:30	50	428.45	0	
6	1157:30	50	428.45	0	fm. took no water

Packer Test in CLAYSTONE and SHALE

FIELD PERMEABILITY TESTS IN BOREHOLES
PACKER TEST

PROJECT NAME Piñon Ridge
PROJECT NUMBER 073-81694
BORING NO. GA-BH-42
TESTED BY J. Elliott DATE 11/16/07
TEST NO. 1
CALCULATED BY _____ DATE _____
DATE / TIME TEST BEGUN 11/16/07
CHECKED BY _____ DATE _____
TOTAL TIME OF TEST 15 min
CONTRACTOR Dakota Drilling
DRILLER Josh G.
BORING RADIUS NX
TYPE AND NO. OF PUMP 1000 psi BEAN pump
GROUND SURFACE ELEVATION (AMSL) _____
TYPE AND NO. OF WATER METER Sensus 5/8" SRII
DEPTH TO GROUNDWATER (BGS) 93' ?
TYPE AND NO. OF PRESSURE GAUGE WIKA 10-200psi
DISTANCE FROM GROUND SURFACE TO SWIVEL 5'
TYPE OF PACKER Single
DISTANCE TO TOP OF TEST ZONE 80'
PACKER INFLATION :
DISTANCE TO BOTTOM OF TEST ZONE 100'
BEFORE TEST 165 psi
LENGTH OF TEST INTERVAL 20'
AFTER TEST 165 psi

STEP NO.	TIME (MIN.)	APPLIED PRESSURE (PSI)	VOLUME OF TEST FLOW OR METER READING (GAL OR CF)	FLOW RATE (GPM OR CFPM)	REMARKS
1	1753:30	10	270.0	—	
2	1755:30	10	297.5	$\frac{27.5}{2} = 13.75$	
3	1757:30	10	3245	$\frac{28}{2} = 14$	
4	1759:30	10	348.7	$\frac{24.2}{2} = 12.1$	stop Test to conserve water
5					
6					
7					
8					
9					
10					

ATTACHMENT 2
DATA REDUCTION

TABLE 1
SUMMARY OF PERMEABILITY RESULTS FROM PACKER TESTING

			Earth Manual Method		Thiem Method	
Test No.	**Interval Tested**	**Bedrock Type/Description**	**k (ft/yr)**	**k (cm/s)**	**k (ft/yr)**	**k (cm/s)**
Drillhole GA-BH-24						
Test #1	55 to 64.5 ft	Gypsum	flow not achieved (Note 4)			
Test #2	60 to 99.5 ft	Gypsum	19.2	1.9E-05	14.6	1.4E-05
Drillhole GA-BH-26						
Test #1	75 to 85 ft	Claystone	24.5	2.4E-05	24.6	2.4E-05
Drillhole GA-BH-33						
Test #1	70 to 100 ft	86% Gypsum, 14% Claystone	0.3	2.5E-07	0.2	2.0E-07
Drillhole GA-BH-36						
Test #1	80 to 90 ft	Sandstone	flow not achieved (Note 4)			
Drillhole GA-BH-38						
Test #1	80 to 90 ft	Claystone	flow not achieved (Note 4)			
Test #2	90 to 100 ft	Claystone	flow not achieved (Note 4)			
Drillhole GA-BH-42						
Test #1	80 to 100 ft	Sandstone	447.7	4.3E-04	392.4	3.8E-04

Notes:

1. Permeability calculations were completed without adding head losses due to pipe friction.
2. The pipe diameter was not available and the losses were considered negligible.
3. The radius of influence was considered to be 10ft for the Thiem Method. ("Standard Operating Procedures for Borehole Packer Testing", pg. 17)

Where test is indicated as failed, no pressure build-up was available for the test.

4. Tests likely failed as no flow was measured entering the formation. It is suspected that the water flow gauge was not functioning properly.

Table 2
Packer Test Permeability Calculations - Using the Earth Manual's Method

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-24-1	9.5	0	0	NX	5100	60.0	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-24-2	39.5	10	1.08	NX	1632	88.1	2.0E+01	1.9E-05
2	GA-BH-24-2	39.5	20	1.33	NX	1632	111.2	2.0E+01	1.9E-05
3	GA-BH-24-2	39.5	30	1.50	NX	1632	134.2	1.8E+01	1.8E-05
4	GA-BH-24-2	39.5	10	1.04	NX	1632	88.1	1.9E+01	1.9E-05
							average	**1.9E+01**	**1.9E-05**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-26-1	10	10	0.48	NX	4900	103.1	2.3E+01	2.2E-05
2	GA-BH-26-1	10	15	0.60	NX	4900	114.6	2.5E+01	2.5E-05
3	GA-BH-26-1	10	20	0.71	NX	4900	126.2	2.8E+01	2.7E-05
4	GA-BH-26-1	10	10	0.475	NX	4900	103.1	2.3E+01	2.2E-05
							average	**2.5E+01**	**2.4E-05**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-33-1	30	10	0.02	NX	2047	103.1	4.0E-01	3.8E-07
2	GA-BH-33-1	30	20	0.02	NX	2047	126.2	3.1E-01	3.0E-07
3	GA-BH-33-1	30	30	0.02	NX	2047	149.2	2.2E-01	2.1E-07
4	GA-BH-33-1	30	10	0.01	NX	2047	103.1	1.2E-01	1.2E-07
							average	**2.6E-01**	**2.5E-07**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-36-1	10	10	0.00	NX	4900	103.1	0.0E+00	0.0E+00
2	GA-BH-36-1	10	20	0.00	NX	4900	126.2	0.0E+00	0.0E+00
3	GA-BH-36-1	10	50	0.00	NX	4900	195.4	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-38-1	10	30	0.00	NX	4900	129.2	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-38-2	10	10	0.00	NX	4900	103.1	0.0E+00	0.0E+00
2	GA-BH-38-2	10	30	0.00	NX	4900	149.2	0.0E+00	0.0E+00
3	GA-BH-38-2	10	50	0.00	NX	4900	195.4	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Hole Dia.	C_p	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-42-1	20	10	13.28	NX	2800	83.1	4.5E+02	4.3E-04
							average	**4.5E+02**	**4.3E-04**

K = Cp * Q/H

Definitions:

L - Length of tested interval

P - Pressure measured at swivel

Q - Measured flow rate

C_p - constant that is a function of L, Hole Diameter, and unit conversion factors

H - Differential Head (gauge reading + height of swivel + height from ground to top of test interval)

K - permeability

*Reliability of test is suspect due to the flow gauge not working properly

Table 3
Packer Test Permeability Calculations - Thiem Method

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-24-1	9.5	0	0	10	0.124	60.0	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-24-2	39.5	10	1.08	10	0.124	88.1	1.5E+01	1.5E-05
2	GA-BH-24-2	39.5	20	1.33	10	0.124	111.2	1.5E+01	1.4E-05
3	GA-BH-24-2	39.5	30	1.50	10	0.124	134.2	1.4E+01	1.3E-05
4	GA-BH-24-2	39.5	10	1.04	10	0.124	88.1	1.5E+01	1.4E-05
							average	**1.5E+01**	**1.4E-05**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-26-1	10	10	0.48	10	0.124	103.1	2.3E+01	2.2E-05
2	GA-BH-26-1	10	15	0.60	10	0.124	114.6	2.5E+01	2.5E-05
3	GA-BH-26-1	10	20	0.71	10	0.124	126.2	2.8E+01	2.7E-05
4	GA-BH-26-1	10	10	0.48	10	0.124	103.1	2.3E+01	2.2E-05
							average	**2.5E+01**	**2.4E-05**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-33-1	30	10	0.02	10	0.124	103.1	3.2E-01	3.1E-07
2	GA-BH-33-1	30	20	0.02	10	0.124	126.2	2.5E-01	2.4E-07
3	GA-BH-33-1	30	30	0.02	10	0.124	149.2	1.8E-01	1.7E-07
4	GA-BH-33-1	30	10	0.01	10	0.124	103.1	9.5E-02	9.2E-08
							average	**2.1E-01**	**2.0E-07**

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-36-1	10	10	0.00	10	0.124	103.1	0.0E+00	0.0E+00
2	GA-BH-36-1	10	20	0.00	10	0.124	126.2	0.0E+00	0.0E+00
3	GA-BH-36-1	10	50	0.00	10	0.124	195.4	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-38-1	10	30	0.00	10	0.124	129.2	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-38-2	10	10	0.00	10	0.124	103.1	0.0E+00	0.0E+00
2	GA-BH-38-2	10	30	0.00	10	0.124	149.2	0.0E+00	0.0E+00
3	GA-BH-38-2	10	50	0.00	10	0.124	195.4	0.0E+00	0.0E+00

flow not achieved, unable to calculate permeability*

Step No.	Test No.	L (ft)	P (psi)	Q (GPM)	Rinf (ft)	Rb (ft)	H (ft)	K (ft/yr)	K (cm/s)
1	GA-BH-24-1	20	10	13.28	10	0.124	83.1	3.9E+02	3.8E-04
							average	**3.9E+02**	**3.8E-04**

K = Qln(Rb/Rinf)/2pi*Pi*b)

Definitions:

k = permeability (ft/day)

Q = Flow rate (gpm)

Rb = Radius of Borehole (ft)

Rinf = Radius of Influence (ft)

Pi = Net injection pressure (ft), i.e., the same as H in the Earth Manual method.

b = Saturated thickness (L in this case) (ft)