

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Pr	oject:	Oco	nee Nucl	ear Sta	tion									B	oring	g No.	GM	-9
L	Location: Seneca, SC Number:								: 1264-	-07-234					Sheet	No. 1	of 2	
В	oring D	Depth (ft):		43.3	Elevation (ft):	780.6	Driller:	Jay Litt B1575	le, SC C	ert No.	Date	e Drill	ed: 10/	8/07			
L	ogged l	By: Julie	Peterser	1		Water Le	evel: Sta	bilized W	ater Level	at 33.32	ft bls	Dril	ling M	lethod:	Mud	Rota	ry	
E (1	Elev. Feet)	Depth (Feet)	Lith- ology		Materi	al Desci	ription			W Const	ell ruction	0	Pene	tration	Resist 51	ance (0	Blows	/Foot) 10
	780	-		ASPI	HALT				/_							_		
F		-		GRA	VEL			-	/				ŀ					
		_		FILL	(F): Tan, B	rown, and	Reddish-B	rown, Mic	aceous,									
F		_		to Fir	Medium to I	rine SAP	ND, Wiin ck Fragmer	white, Me	aium									
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	765	-		FILL	(F): Brown	and Orang	ge, Micaceo	ous, Silty, l	Medium									
E		_		to Fir	ie SAND	with Roc	k Fragment	S										
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Ē				FILL	(F): BIO	TITE GNI	EISS Boul	ders		🕅								
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; -;	750			FILL Rock	(r): Brow Fragments	m, rine Sa	indy, Silty, I Wood	CLAY	with									
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S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

I	Project: Oconee Nuclear Station										Boring No. GM-9											
	Location	Sene	ca, SC					Number:	1264-	07-23	34				Sheet No. 2 of 2							
1	Boring D	epth (ft):		43.3	Elevation	(ft):	780.6	Driller: J B	ay Litt 1575	le, SC	Cert N	0.	Date	Drille	led: 10/8/07							
	Logged H	3y: Julie	Petersen	l		Water Lev	vel: Stal	bilized Water	r Level	at 33	.32 ft bl	S	Drilli	ng M	ethod	l: Mud	Rot	ary				
	Elev. (Feet)	Depth (Feet)	Lith- ology		Mater	ial Descri	iption			Coi	Well struct	ion	Penetration Resistance (Blows/Foot) 0 50 100									
DG WITH WELL RECOVERED ONS LOG.GPJ LAGWGN01.GDT 7/23/08	.745 .740	40		FILL FILL FILL CLA	Mater (F): Brov he Sandy, G (F): Red ar (F): Orang Y blogic Descr ring Termin	ial Descri	iption , Micaceor ty, High Pl Red, Coars ained Fron 30 ft bls	asticity CLA asticity CLA ast to Fine San m GM-9R	ium Y dy,	Con		ion										
BORING																						

COMPLETIC

DN	REPORT	OF WELL	No. GM-9	

PROJECT: Oconee Nuclear Station WATER LEVEL: Stabilized Water Level at PROJECT NO: 1264-07-234 PROJECT LOCATION: Seneca, SC 33.32 ft bls LATITUDE: 34°47'40.524" LONGITUDE: 82°53'48.389" DRILLING CONTRACTOR: S&ME, Inc. TOP OF CASING ELEVATION: 780.36 DRILLING METHOD: Mud Rotary DATUM: MSL DATE DRILLED: 10/8/07 LOGGED BY: Julie Petersen STRATA LEVATION (ft.) WELL LEGEND DEPTH (ft.) SYMBOI DEPTH (ft.) DETAILS WELL CONSTRUCTION DETAILS DESCRIPTION Щ **PROTECTIVE CASING** 0.00 GS 780.60 Diameter: 0 ASPHALT Type: GRAVEL Interval: FILL (F): Tan, Brown, and Reddish-Brown, Micaceous, Silty, **RISER CASING** Medium to Fine Diameter: 2" SAND, With White, Type: Sch. 40 PVC Medium to Fine Sand Lenses and Rock Interval: 0 to 28 ft bls Fragments GROUT FILL (F): BIOTITE GNEISS Boulders Type: Neat Cement Interval: 0 to 24 ft bis SEAL Type: Bentonite Interval: 24 to 26 ft bls FILL (F): Brown and Orange, Micaceous, FILTERPACK Silty, Medium to Fine SAND With Rock Type: #1 Silica Sand Interval: 26 to 43.3 ft bls Fragments SCREEN Diameter: 2" FILL (F): BIOTITE Type: 0.010 Slotted PVC **GNEISS** Boulders 24.00 756.60 Interval: 28 to 43 ft bls 25 26.00 754.60 GOT LEGEND S&ME. FILTER PACK TOC TOP OF CASING 30 GS GROUND SURFACE FILL (F): Brown, g BENTONITE BENTONITE SEAL BS Fine Sandy, Silty, FILTER PACK FP ONS CLAY With Rock CEMENT GROUT TOP OF SCREEN BOTTOM OF SCREEN Fragments, Roots, and TSC **CUTTINGS / BACKFILL** BSC Wood /ERED TOTAL DEPTH TD ▼ STATIC WATER LEVEL CEMENT GROUT CG **COMPLETION REPORT OF** 9751 Southern Pine Boulevard WELL No. GM-9 Charlotte, North Carolina 28273 Sheet 1 of 2 ENGINEERING • TESTING ENVIRONMENTAL SERVICES

Sheet 1 of 2

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234

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GROUND SURFACE ELEVATION: LOGGED BY: 780.6

PROJECT LOUP	TION.						
STRATA	\		WELL	-	Δ	z	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGEN	ELEVATI (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		0.5					
		- 35		•			
and Gray, Micaceous, Silty, Medium to Fine							
FILL (F): Red and		-					
Plasticity CLAY		-40					
ILL (F): Orange, an, and Red, Coarse		*		42.50		738.10	
o Fine Sandy, CLAY	Æ			43.00		737.60	
				43.30		101.00	
							· · · · ·
							· · · · · ·
							LEGEND
							BENTONITE BS BENTONITE SEAL
							CEMENT GROUT FF FILTER FACE TSC TOP OF SCREEN
							▼ STATIC WATER LEVEL CG CEMENT GROUT
	4		1	I		I	
							COMPLETION REPORT OF
S8		E	9751 Southerr	n Pine I	Boule	vard	WELL No. GM-9
ENGINEERING		IG ES	Shanolle, NOI	ui care	/iiid 2	.0213	Sheet 2 of 2
		-					

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	10/15/2007
Well Label:	GM-9
Aquifer Thickness:	14.68 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	2. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.378 Inches
Static Water Level:	33.32 feet
Water Table to Screen Bottom:	9.68 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0 There are 86 time and drawdown measurements Maximum head is 4.362 feet Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Ho is 4.362 feet at 0. Seconds

PERMEABILITY 1.79 x 10⁻⁴ cm/sec

\$S&ME



1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO

Project:	Осог	nee Nucl	ear Station		<u>DRIVE 1.4 IN. 1.1</u>	J. SAIVI		Bori	ng No	0. GM	-9R			
Location	n: Sene	ca, SC		Number: 1264-	07-234		-	Sh	eet No	lof	3			
Boring	Depth (ft):		80.3 Elevation (ft): 780.4	Driller: Jay Littl	le, SC Cert No.	Date	Drilled	: 10/2/	07	01				
Logged	By: Cour	tnev Wit	thers/David Klemm Water Level: Sto	B1575	at 30 /3 ft ble	, D=:11;	• ~ Mat	had M	ud De					
508800			Water Level. Sta		Wall	Drini	lig Met	metration Resistance (Blows/Foot)						
(Feet)	Depth (Feet)	Lith- ology	Material Description		Construction	0	enetra		50	.e (Blov	10(
- 780			ASPHALT	/r										
E	-		GRAVEL FILL (F): Tan Brown and Reddish-F	rown Micaceous										
\vdash			Silty, Medium to Fine SAND, With	White, Medium										
F			to Fine Sand Lenses and Rock Fragme	nts										
F	_					10								
- 775	5-							1						
F ·									\prec					
										\square				
F						50,					\square			
	_		FILL (F): BIOTITE GNEISS Bould	lers		× ×					>>			
F 770	10-		Auger Refusal at 9.80 ft bls			n⊢								
F	_		C											
F														
–	_					50								
	_										>>			
E	15													
765			FILL (F): Brown and Orange, Micace	ous, Silty, Medium										
_	-		to Fine SAND With Rock Fragmer	its										
-	_		Roller Cone Refusal at 22.20 ft bls											
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F														
760	20-			•		50,								
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* - ; -		×	FILL (F): BIOTITE CNEISS Bould	lers										
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	-									1				
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750			Rock Fragments, Roots, and Wood	CLAY With					Λ					
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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Осог	iee Nucl	ear Sta	ation]	Bori	ng I	No.	GM-	9R	
Location	: Sene	ca, SC				Number	1264-	-07-234					SI	neet l	No. 2	2 of 3		
Boring D	Depth (ft):		80.3	Elevation (ft):	780.4	Driller:	Jay Litt B1575	le, SC C	ert No.	D	ate Dr	illed:	10/2/	07				
Logged	By: Cour	tney Wit	thers/E	David Klemm Water Lev	vel: Stal	bilized W	ater Level	at 30.43	ft bls	D	rilling	Metho	od: N	1ud	Rotai	ry		·
Elev.	Depth (Feet)	Lith-		Material Descri	ption			W	/ell	Penetration Resistance (Blows/Foot)								
745									K K	()			 	<u> </u>		1	00
F ⁷⁴³			FILL	L (F): Brown and Gray, I	Micaceous	, Silty, Me	dium to				7							
F .			гше	Sandy, CLAY					\otimes	Δ								
			EIL I	(F) D 1 - 1 (Corrected)			T 4 37			Π	Ι. Ι							
–	_			L (F): Red and Gray, Silt	y, High Pl	asticity C				M	15							
	40			(F): Orange, Tan, and I XY	Red, Coars	se to Fine :	sandy,											
- 740																		ļ
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F	_	XXXX	501		an and Wh	ita Miana												
			Sligh	htly Clayey, Silty, Coarse	an and wh to Fine §	SAND	eous,			Π								
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-730	50										·	V						
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E			SOIL	L/SAPROLITE (M1): B	rown, Ver	y Micaceo	us, Fine		Ň	Δ		•	\mathbb{N}					
	55		SOU	IY, SILI	ark Grav a	nd White	/					_		\rightarrow	+	!		_
3-725			Coar	rse to Fine SAND	aik Olay a	ina winte,	Sifty,								\uparrow	$ \downarrow \mid$		
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											50/							$ \lor$
	-		- 5011	I SAPROLITE (M1) D	ark Grav a	nd Brown				М	3						>>	┥
		KKII	Mica	aceous, Silty, Fine SAN	D	JIUWII	, lt	1 🕅	₿									
720	60	<u>IGDI</u>	SOII	L/SAPROLITE (M1): G	ray, Silty,	Fine SAN	D		. 📓							+		_
		بمرجم كم	WEA	ATHERED ROCK (M2):	When Sa	umpled Be	comes											
	-	بر جرجز	Tan,	, Silty, Fine SAND	0 ft ble		lr lr	1 🕅										
5		برجم تم	PAR	TIALLY WEATHERE)/FRACTI	IRED RO	СК											
		المرجم كم	(WF): Medium-Grained GI	RANITIC	GNEISS	With											
	65-	بمرجم بمرج	Inter	mittent Medium-Grained	BIOTIT	ГЕ	.											
715		برتم تمز	Angl	KINBLEINDE GNEISS le Joints With No Stainin	intensely	ractured	, LOW							ſ				
-		م تمر مرام	SOU	JND ROCK (D): Mediu	n-Grained	GRANI	ГІС											
F	_	المرجم الم	GNE	EISS With Intermittent	BIOTIT	`E			•					1				
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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO

DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Ocor	nee Nucl	ear Sta	ition									Bo	ring	No.	GM	-9R	
Location		Number	: 1264-	-07-23	34			Sheet No. 3 of 3										
Boring	Depth (ft):		80.3	Elevation (ft):	780.4	Driller:	Jay Litt B1575	le, SC	C Cert N	0.	Date Drilled: 10/2/07							
Logged	By: Cour	tney Wi	thers/D	David Klemm Water	Level: Stal	bilized Wa	ater Level	at 30).43 ft bl	s	Drilli	ng Mo	ethod:	Mud	Rota	ıry		
Elev. (Feet)	Depth (Feet)	Lith- ology		Material Des	cription			Cor	Well	ion	0	Peneti	ation I	Resist	ance 0	(Blow	s/Foo	t) 100
BORING LOG WITH WELL RECOVERED ONS LOG.GPJ LAGWGN01.GDT 7/23/08			PAR (WF) Intern Inten With SOU GNE PAR (WF) GNE Angl PAR (WF) Intern Inten Borit	TIALLY WEATHER i: Medium-Grained mittent BIOTITE H sely Fractured, Low A No Staining ND ROCK (D): Mec NBLENDE GNEIS zontal and High Angl ND ROCK (D): Mec ISS ; Unfractured TIALLY WEATHER i: Medium-Grained MISS; Intensely Frad- e Joints With No Stai TIALLY WEATHER i: Medium-Grained mittent BIOTITE H sely Fractured, Low A ng Terminated at 80	ED/FRACTU GRANITIC IORNBLEN Angle and Hi dium-Grained S Slightly e Joints With dium-Grained ED/FRACTU BIOTITE H ctured Low A ning ED/FRACTU GRANITIC IORNBLEN Angle Joints V 0.30 ft bls	JRED RO GNEISS DE GNEI gh Angle J BIOTIT Fractured, No Stainin GRANI JRED RO ORNBLE ngle and F JRED RO GNEISS DE GNEI With No S	CK With SS foints E TIC CK CK E TIC CK With SS taining											

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234





Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234

Core Location: GM-9R







EXPLANATION

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234

Core Location: GM-9R





Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-9R



COMPLETION REPORT OF WELL No. GM-9R

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 PROJECT LOCATION: Seneca, SC

WATER LEVEL: Stabilized Water Level at 30.43 ft bls

LATITUDE: 34°47'40.463"

LONGITUDE: 82°53'48.364"

TOP OF CASING ELEVATION: 780.19

DATUM: MSL

LOGGED BY: Courtney Withers/David Klemm

	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
ASPHALT GRAVEL FILL (F): Tan, Brown, and Reddish-Brown, Micaceous, Silty, Medium to Fine SAND, With White, Medium to Fine Sand Lenses and Rock Fragments FILL (F): BIOTITE GNEISS Boulders Auger Refusal at 9.80 ft bls FILL (F): Brown and Orange, Micaceous, Silty, Medium to Fine SAND With Rock Fragments Roller Cone Refusal at 22.20 ft bls FILL (F): BIOTITE GNEISS Boulders 800		0 5		0.00	GS	780.42	PROTECTIVE CASING Diameter: Type: Interval: RISER CASING Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 68.7 ft bls GROUT Type: Neat Cement Interval: 0 to 66 ft bls SEAL Type: K-packer Interval: 67.9 to 68.1 ft bls FILTERPACK Type: Interval: SCREEN Diameter: 2" Type: 0.010 Slotted PVC Interval: 68.7 to 73.7 ft bls
FILL (F): Brown, Fine Sandy, Silty, CLAY With Rock Fragments, Roots, and Wood		30	Ţ				FILTER PACKTOCTOP OF CASINGBENTONITEGSGROUND SURFACEBENTONITEBSBENTONITE SEALCEMENT GROUTFPFILTER PACKCUTTINGS / BACKFILLBSCBOTTOM OF SCREENCUTTINGS / BACKFILLBSCBOTTOM OF SCREENTDTOTAL DEPTHCGCEMENT GROUT
		NG IS	9751 Souther Charlotte, Nor	n Pine I th Card	Boulev olina 2	vard 8273	COMPLETION REPORT OF WELL No. GM-9R Sheet 1 of 3

DRILLING CONTRACTOR: S&ME, Inc. DRILLING METHOD: Mud Rotary DATE DRILLED: 10/2/07 PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 GROUND SURFACE ELEVATION: LOGGED BY: 780.4

DGGED BY: 100.4 FCKED BY: Courtney Withers/[

STRATA	_		WELL	-	Δ	NO	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGEN	ELEVATI (ft.)	WELL CONSTRUCTION DETAILS
			-				(See Page 1)
FILL (F): Brown and Gray, Micaceous, Silty, Medium to Fine Sandy, CLAY FILL (F): Red and Gray, Silty, High Plasticity CLAY FILL (F): Orange, Tan, and Red, Coarse to Fine Sandy, CLAY		- 35 - 40					
SOIL/SAPROLITE (M1): Tan and White, Micaceous, Slightly Clayey, Silty, Coarse to Fine SAND		- 45 50					
SOIL/SAPROLITE M1): Brown, Very Micaceous, Fine Sandy, SILT SOIL/SAPROLITE M1): Dark Gray and White, Silty, Coarse to Fine SAND SOIL/SAPROLITE M1): Dark Gray and		- 55					·
Silty, Fine SAND SOIL/SAPROLITE (M1): Gray, Silty, Fine SAND WEATHERED ROCK (M2): When Sampled Becomes Tan, Silty,	لر کر کر ار کر کر ار کر کر	-65		66.00		714.42	
Fine SAND PARTIALLY WEATHERED/FRACTU ROCK (WF): Medium-Grained GRANITIC GNEISS	ת ת הת אין הת אין הת הק	- - - 70		67.90 68.10 68.70		712.52 712.32 711.72	
With Intermittent Medium-Grained BIOTITE HORNBLENDE GNEISS, Intensely Fractured, Low Angle Joints With No Staining SOUND ROCK (D): Medium-Grained		-75		73.20 73.70 75.00		707.22 706.72 705.42	LEGEND FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN STATIC WATER LEVEL CG CEMENT GROUT
\$ 88			9751 Southerr Charlotte, Nor	n Pine f	Boulev Solina 2	/ard 28273	COMPLETION REPORT OF WELL No. GM-9R

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234

GROUND SURFACE ELEVATION: LOGGED BY: 780.4

rs/[

PROJECT LOCA	TION	: Sei	neca, SC			•	CHECKED BY: Courtney Wit
STRATA			WELL			Z	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)		ELEVATIC (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
GRANITIC GNEISS	م. م.	+					
	ز جر جر <u>ز</u> جر ج	- 80		80.30		700.12	
Fractured, Low Angle							
With Moderate to No			1				
PARTIALLY							
VEATHERED/FRACTUR ROCK (WF):	IRED		•				
/ledium-Grained SRANITIC GNEISS					· ·		
Vith Intermittent							
IORNBLENDE SNEISS: Intenselv							
ractured, Low Angle							
With No Staining							
Medium-Grained							
IORNBLENDE							
SNEISS; Slightly ractured, Horizontal							
nd High Angle Joints Vith No Staining			•				
SOUND ROCK (D):			•			•	
GRANITIC GNEISS							
PARTIALLY							
VEATHERED/FRACTU ROCK (WF):	IRED						
Medium-Grained							
IORNBLENDE							•
ractured Low Angle			;				
Vith No Staining		1					
VEATHERED/FRACT	RED						
ROCK (WF): Medium-Grained							
GRANITIC GNEISS							
BIOTITE IORNBLENDE							LEGEND
GNEISS; Intensely ractured, Low Angle							
oints With No						,	BENTONITE GS GROUND SUFACE
							CEMENT GROUT FP FILTER PACK
							TSC TOP OF SCREEN
							STATIC WATER LEVEL TD TOTAL DEPTH
1	·		I	4			l
		_					
12 SRN		5	751 Southern	Pine E	Boule	vard	WELL No. GM-9R
ENGINEERING •	TESTIN	1G (Charlotte, Nor	th Caro	olina 2	28273	Sheet 3 of 3
ENVIRONMENTAL	SERVIC	ES					

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234



SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Number:	GM-9R
Sample No: 7 Depth (ft-bls): 42.7 - 44.2 Blow Count: 7 * 7 * 9	GM-9R 42.71-44.2
Sample No: 8 Depth (ft-bls): 47.7 - 49.2 Blow Count: 4 * 4 * 8	Sm-9R 417:44.2
Sample No: 9 Depth (ft-bls): 52.7 - 54.2 Blow Count: 12 * 12 * 18	DD1 2 3 3 4 5 5 6 7 8 9 C
Sample No: 10 Depth (ft-bls): 57.7 - 59.2 Blow Count: 10 * 23 * 50/3	201 2 3 3 1 cs 5 6 7 8 9 0 3

ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-9R







ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-9R



CLASSIFICATION:

9.80' to 47.00': FILL - Granitic Gneiss Boulders and Soil60.60' to 80.30': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO.:	ONS - GWPP
LOCATION:	Seneca, SC
TEST DATE:	10/4/2007
TESTED BY:	Jay Little/David Klemm
GROUND ELEV (ft MSL):	780.4

BOREHOLE NO.:	GM-9R			
TEST INTERVAL:	66.9	to	71.9	bgs
TEST INTERVAL:	713.5	to	708.5	EL

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Flow (Q)	Pressure (psi	mud	Lugeons	Permeability	Permeability
	(gpm)	Gauge	Effective		(ft/sec)	(cm/sec)
1	0.29	30	45	2	7.84E-07	2.4E-05
2	0.32	40	55	2	7.1E-07	2.2E-05
3	0.86	50	65	5	1.6E-06	4.9E-05
4	0.8	40	55	5	1.8E-06	5.4E-05
5	0.58	30	45	5	1.6E-06	4.8E-05
	in an an indiana an an an an an ing an in	1	VERAGE	4	1.3E-06	3.9E-05
		SELECTEI	VALUES			

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION







PERMEABILITY CALCULATIONS FOR EACH STEP OF TEST



CALCULATED PERMEABILITY FOR STEP T	• •		
Gauge Pressure, h2	30	psi	69.3 feet of water
30	0.29	gpm	0.001 ft ³ /sec
30	0.0	psi	(per tables)
30	0.0	psi	0.0 feet of water
30	33.7	feet	
30	33.7	feet	
. 30	103.0	feet	44.6 psi
30	_	-	
Select Zone 1, 2, or 3	3	-	Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U - D + H	61.1	feet	0.29
X = (H/Tu)*100	168.7	%	
Tu/A	12.2		
40 .			
40	-		Value for Zone 1 analysis
40	-		Value for Zone 1 analysis
40	40		Value for Zone 2 and 3 analysis
. 40			Cu for Zone 1
40	. 64		Cs for Zones 2 and 3
40		ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- 0.32
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	7.84E-07	ft/sec	2.39E-05 cm/sec
50			
50 50 Coloridate of the total energy of the t			2.0 6
Su Calculate a the total open area of the t	est section:		3.9 square teet
$50 \ln O(s + (set) + set) > 1000$			T T
50 Is Q/a * (estimated porosity) > 10??			True, Test Valid
50 Is Q/a * (estimated porosity) > 10??			True, Test Valid
50 Is Q/a * (estimated porosity) > 10??			True, Test Valid
50 Is Q/a * (estimated porosity) > 10?? 50 50	40	nsi	True, Test Valid
50 Catedrate 4, site of all of point it is of all of 50 is Q/a * (estimated porosity) > 10?? 50 50 50	40	psi	92.4 feet of water
50 Is Q/a * (estimated porosity) > 10?? 50 50 50 50 50 50 50 50	40 0.32	psi gpm	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec
50 Is Q/a * (estimated porosity) > 10?? 50 50 50 50 50 50 50 50 50 50	40 0.32 0.0	psi gpm psi	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86
50 Is Q/a * (estimated porosity) > 10?? 50 50 50 50 50 50 50 50 50 50	40 0.32 0.0 0.0	psi gpm psi psi	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water
50 Is Q/a * (estimated porosity) > 10?? 50 50 50 50 50 50 50 50 50 50	40 0.32 0.0 0.0 33.7	psi gpm psi psi feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40	40 0.32 0.0 0.0 33.7 33.7	psi gpm psi psi feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40	40 0.32 0.0 0.0 33.7 33.7 126.1	psi gpm psi feet feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, \mathbf{h}_1 : 40 40 40	40 0.32 0.0 0.0 33.7 33.7 126.1	psi gpm psi psi feet feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40	40 0.32 0.0 0.0 33.7 33.7 126.1 3	psi gpm psi feet feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, \mathbf{h}_1 : 40 40 40 40 Tu = U-D+H	40 0.32 0.0 0.0 33.7 33.7 126.1 <u>3</u> 84.1	psi gpm psi feet feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, \mathbf{h}_1 : 40 40 40 40 40 40 40 40 40 40	40 0.32 0.0 33.7 33.7 126.1 <u>3</u> 84.1 149.9 16.8	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 40 40 40 20 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30	40 0.32 0.0 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone I analysis
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss, L: Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8 Value for Zone 1 analysis Value for Zone 1 analysis
Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30 30	40 0.32 0.0 0.0 33.7 126.1 3 84.1 149.9 16.8 40	psi gpm psi feet feet feet feet	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone I analysis Value for Zone I analysis Value for Zone I analysis Value for Zone 2 and 3 analysis
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 40 40 40 40 40 40	40 0.32 0.0 0.0 33.7 126.1 3 84.1 149.9 16.8 - 40	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone I analysis Value for Zone I analysis Value for Zone 2 and 3 analysis Cu for Zone I
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, \mathbf{h}_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30 30 30 Cs for Zone 2 and 3 tests:	40 0.32 0.0 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 - 40 64	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30 30 30 Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 40 64	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8 Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Cs for Zones 2 and 3 - 0.58
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, \mathbf{h}_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30 30 30 30 Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single packer (Method 1)	40 0.32 0.0 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 40 64	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone I analysis Value for Zone I analysis Value for Zone I analysis Value for Zone I analysis Cu for Zone I Cone
Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h_1 : 40 40 40 40 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient 30 30 30 Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single packer (Method 1) Calculate K if Zone 2 and using single packer (Method 2)	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 40 64	psi gpm psi feet feet % fl/sec fl/sec fl/sec	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones 1 and 2 are unsaturated, 3 is saturated 0.8 Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3 - 0.58 - cm/sec - cm/sec
$50 \text{ Is } Q/a * (\text{estimated porosity}) > 10??$ $50 \text{ Is } Q/a * (\text{estimated porosity}) > 10??$ $50 \frac{50}{50}$ Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h ₁ : 40 + 40 + 40 + 40 + 40 + 40 + 40 + 40 +	40 0.32 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 - 40 64	psi gpm psi feet feet - feet %	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone I analysis Value for Zone I analysis Value for Zone I analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Cs for Zones 2 and 3 - 0.58 - cm/sec - cm/sec - cm/sec
$50 \text{ Is } Q/a * (\text{estimated porosity}) > 10??$ $50 \text{ Is } Q/a * (\text{estimated porosity}) > 10??$ $50 \frac{50}{50}$ Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h ₁ : 40 + 40 + 40 + 40 + 40 + 40 + 40 + 40 +	40 0.32 0.0 0.0 33.7 33.7 126.1 3 84.1 149.9 16.8 - 40 64 - - 7.07E-07	psi gpm psi feet feet feet % fl/sec fl/sec fl/sec fl/sec fl/sec	True, Test Valid 92.4 feet of water 0.001 ft ³ /sec 0.86 0.0 feet of water 54.6 psi Zones I and 2 are unsaturated, 3 is saturated 0.8 Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3 - 0.58 - cm/sec - cm/sec - cm/sec 2.15E-05 cm/sec

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If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3					
Gauge Pressure, h2:	50	psi		115.5 feet of water	
Flow Rate, Q:	0.86	gpm		0.002 ft ³ /sec	
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)	
Head Loss, L:	0.0	psi		0.0 feet of water	
Distance from pressure gauge to bottom of test section, \mathbf{h}_1 :	33.7	feet			
Value of h _i :	33.7	feet			
Effective Head, H where $H = h1 + h2 - L$:	149.2	feet		64.6 psi	
Determine Saturation Zone:		-			
Select Zone 1, 2, or 3	3		Zones 1 and	2 are unsaturated, 3 is saturated	
Tu = U-D+H	107.2	feet			•
$\mathbf{X} = (\mathbf{H}/\mathbf{T}\mathbf{u})^* 100$	139.1	%			
Tu/A	21.4				
Determine Conductivity Coefficient				• • • • • • • • •	
H/r	-		Value for Zo	ne 1 analysis	
A/H	-		Value for Zo	ne 1 analysis	
A/r	40		Value for Zo	ne 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone	1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones	2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec	
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec	
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec	
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec	
Calculate K if Zone 3 and using double packer (Method 2)	1.61E-06	ft/sec	4	.89E-05 cm/sec	
Is this step valid?					
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be val	id due to turbulen	t flow			
Calculate a, the total open area of the test section:				3.9 square feet	

Is Q/a * (estimated porosity) > 10??

True, Test Valid

CALCULATED PERMEABILITY FOR STEP 4				
Gauge Pressure, h2	40	psi		92.4 feet of water
Flow Rate, Q:	0.80	gpm	(0.002 ft ³ /sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, L:	0.0	psi		0.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	33.7	feet		
Value of h ₁ :	33.7	feet		
Effective Head, H where $H = h1 + h2 - L$:	126.1	feet		54.6 psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 and	re unsaturated, 3 is saturated
Tu = U-D+H	84.1	feet		
X = (H/Tu)*100	149.9	%		
Tu/A	16.8			
Determine Conductivity Coefficient				
H/r	-		Value for Zone	1 analysis
A/H	-		Value for Zone	1 analysis
A/r	40		Value for Zone	2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 a	and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.77E-06	ft/sec	5.39	E-05 cm/sec
Is this step valid?				
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid	id due to turbulen	t flow		
Calculate a, the total open area of t	he test section:			3.9 square feet

Is Q/a * (estimated porosity) > 10??

True, Test Valid

Packer Test GM-9R Test 2 Redo Permeability Calculations Page 3 of 4

CALCULATED PERMEABILITY FOR STEP 5			
Gauge Pressure, h2	30	psi	69.3 feet of water
Flow Rate, Q:	0.58	gpm	$0.001 \text{ ft}^3/\text{sec}$
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)
Head Loss, L:	0.0	psi	0.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	33.7	feet	
Value of h ₁ :	33.7	feet	
Effective Head, H where $H = h1 + h2 - L$:	103.0	feet	44.6 psi
Determine Saturation Zone:		-	· · · · ·
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	61.1	feet	
X = (H/Tu)*100	168.7	%	
Tu/A	12.2		
Determine Conductivity Coefficient			
Н/т	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	40		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.57E-06	ft/sec	4.78E-05 cm/sec
Is this step valid?			
If (Ω/a) *(actimated porosity) > 10 the calculations may not be valid	due to turbules	+ flow	

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

> Packer Test GM-9R Test 2 Redo Permeability Calculations Page 4 of 4

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO.:	ONS - GWPP
LOCATION:	Seneca, SC
TEST DATE:	10/4/2007
TESTED BY:	Jay Little/David Klemm
GROUND ELEV (ft MSL):	780.4

BOREHOLE NO.:	GM-9R			
TEST INTERVAL:	71.9	to	76.9	bgs
TEST INTERVAL:	708.5	to	703.5	EL

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Flow (Q)	Pressure (psi)		Lugeons	Permeability	Permeability
	(gpm)	Gauge	Effective		(ft/sec)	(cm/sec)
1	0.03	40	55	0	6.63E-08	2.0E-06
2	0.04	50	65	0	7.5E-08	2.3E-06
3	0.05	60	75	0	8.1E-08	2.5E-06
4	0	50	65	0	0.0E+00	0.0E+00
5	0.02	40	55	0	4.4E-08	1.3E-06
			AVERAGE	0	5.3E-08	1.6E-06
		SELECTE	D VALUES			

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION





Packer Test GM-9R Test 1 Redo Permeability Calculations Page 1 of 4

PERMEABILITY CALCULATIONS FOR				17		LCO	
EACH STEP OF TEST	t.					50	
CALCULATED PERMEABILITY FOR STEP 1							•
Gauge Pressure h 2	40	nsi		92.4 feet	of water		
Flow Rate O	0.03	anm		0.000 ft ³ /s			
Head loss per TFN foot section of nine:	0.05	nsi		0.000 It /s	tables)		
Head Loss, L :	0.0	psi		0.0 feet	of water		
Distance from pressure gauge to bottom of test section. h.:	33.7	feet		010 1000			
Value of h ₁ :	33.7	feet					
Effective Head, H where $H = h1 + h2 - L$:	126.0	feet		54.6 psi			
Determine Saturation Zone:		-					
Select Zone 1, 2, or 3	3		Zones 1 and 2	2 are unsatura	ated, 3 is satur	ated	
Tu = U-D+H	79.1	feet			0.03		
X = (H/Tu)*100	159.4	%					
Tu/A	15.8						
Determine Conductivity Coefficient							
H/r	-		Value for Zor	ne 1 analysis			
A/H	-		Value for Zor	ne 1 analysis			
A/r	40		Value for Zor	ne 2 and 3 an	alysis		
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone	1			
Cs for Zone 2 and 3 tests:	64		Cs for Zones	2 and 3			
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/s	sec		
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/s	sec		
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-		0.04		
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	· -	cm/s	sec		
Calculate K if Zone 3 and using double packer (Method 2)	6.63E-08	ft/sec	2	02E-06 cm/s	sec		
Is this step valid?							
If (Q/a)*(estimated porosity) > 10 the calculations may not be value.	alid due to turbuler	nt flow					

Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

50	psi	115.5 feet of water
0.04	gpm	0.000 ft ³ /sec
0.0	psi	0.05
0.0	psi	0.0 feet of water
33.7	feet	
33.7	feet	
149.1	feet	64.6 psi
	-	
3	_	Zones 1 and 2 are unsaturated, 3 is saturated
102.2	feet	
145.9	%	0
20.4		
-		Value for Zone 1 analysis
-		Value for Zone 1 analysis
40		Value for Zone 2 and 3 analysis
		Cu for Zone 1
64		Cs for Zones 2 and 3
-	ft/sec	- 0.02
-	ft/sec	- cm/sec
-	ft/sec	- cm/sec
-	ft/sec	- cm/sec
7.47E-08	ft/sec	2.28E-06 cm/sec
	50 0.04 0.0 0.0 33.7 33.7 149.1 3 102.2 145.9 20.4 - - - - - - - - - - - - - - - - - - -	50 psi 0.04 gpm 0.0 psi 0.0 psi 0.0 psi 0.1 feet 33.7 feet 149.1 feet - - 102.2 feet 145.9 % 20.4 - - - 40 - 64 - - ft/sec - ft/sec - ft/sec - ft/sec - ft/sec

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3							
Gauge Pressure, h2	60	psi		138.6 feet of water			
Flow Rate, O :	0.05	gpm		0.000 ft ³ /sec			
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)			
Head Loss, L :	0.0	psi		0.0 feet of water			
Distance from pressure gauge to bottom of test section, h ₁ :	33.7	feet					
Value of h ₁ :	33.7	feet					
Effective Head, H where $H = h1 + h2 - L$:	172.2	feet	74.6 psi				
Determine Saturation Zone:		-					
Select Zone 1, 2, or 3	3		Zones 1 and 2	are unsaturated, 3 is saturated			
Tu = U-D+H	125.3	feet					
X = (H/Tu)*100	137.5	%					
Tu/A	25.1						
Determine Conductivity Coefficient							
H/r	-	e 1 analysis					
A/H	-		Value for Zone 1 analysis				
A/r	40		Value for Zone 2 and 3 analysis				
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1				
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2	2 and 3			
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec			
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec			
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec			
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec			
Calculate K if Zone 3 and using double packer (Method 2)	ft/sec	2.4	46E-06 cm/sec				
Is this step valid?							
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid	l due to turbulen	t flow					
Calculate a, the total open area of the			3.9 square feet				
Is Q/a * (estimated porosity) > 10??			True, Test Valid				

CALCULATED PERMEABILITY FOR STEP 4							
Gauge Pressure, h2	50	psi	115.5 feet of water				
Flow Rate, Q:	0.00	gpm	0.000 ft ³ /sec				
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)				
Head Loss, L:	0.0	psi	0.0 feet of water				
Distance from pressure gauge to bottom of test section, h ₁ :	33.7	feet					
Value of h ₁ :	33.7	feet					
Effective Head, H where $H = h1 + h2 - L$:	149.1	feet	64.6 psi				
Determine Saturation Zone:		-					
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated				
Tu = U-D+H	102.2	feet					
X = (H/Tu)*100	145.9	%					
Tu/A	20.4						
Determine Conductivity Coefficient							
H/r	-		Value for Zone 1 analysis				
A/H	-		Value for Zone 1 analysis				
A/r	40		Value for Zone 2 and 3 analysis				
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1				
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3				
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec				
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec				
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec				
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec				
Calculate K if Zone 3 and using double packer (Method 2)	0.00E+00	ft/sec	0.00E+00 cm/sec				
Is this step valid?							
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow							
Calculate a, the total open area of the te	3.9 square feet						
Is Q/a * (estimated porosity) > 10??	True, Test Valid						

			· · ·			
CALCULATED PERMEABILITY FOR STEP 5						
Gauge Pressure, h2	40	psi	92.4 feet of water			
Flow Rate, Q:	0.02	gpm	$0.000 \ ft^3/sec$			
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)			
Head Loss, L:	0.0	psi	0.0 feet of water			
Distance from pressure gauge to bottom of test section, h ₁ :	33.7	feet				
Value of h ₁ :	33.7	feet				
Effective Head, H where $H = h1 + h2 - L$:	126.0	feet	54.6 psi			
Determine Saturation Zone:		-				
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated			
Tu = U-D+H	79.1	feet				
X = (H/Tu)*100	159.4	%				
Tu/A	15.8					
Determine Conductivity Coefficient						
H/r	-		Value for Zone 1 analysis			
A/H	-		Value for Zone 1 analysis			
A/r	40		Value for Zone 2 and 3 analysis			
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1			
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3			
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec			
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec			
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec			
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec			
Calculate K if Zone 3 and using double packer (Method 2)	4.42E-08	ft/sec	1.35E-06 cm/sec			
Is this step valid?						

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

> Packer Test GM-9R Test 1 Redo Permeability Calculations Page 4 of 4

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP					
Test Date:	10/15/2007					
Well Label:	GM-9R					
Aquifer Thickness:	48.27 feet					
Screen Length:	5. feet					
Casing Radius:	1. Inches					
Effective Radius:	1.5 Inches					
Static Water Level:	30.43 feet					
Water Table to Screen Bottom:	43.27 feet					
Anisotropy Ratio:	1					
Time Adjustment:	0. Seconds					
Test starts with trial 0						
There are 90 time and drawdown m	easurements					

Maximum head is 2.053 feet Minimum head is 0. feet



Analysis by Julie Petersen of S&ME, Inc.

Ho is 2.053 feet at 0. Seconds

PERMEABILITY 6.86 x 10⁻⁵ cm/sec



Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II. Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project: Oconee Nuclear Station - GWPP

S&ME Project No.:

1264-07-234



FETTER AND BEAR DIAGRAMS

3*&*.ME







S&ME Project No.:

1264-07-234

FETTER AND BEAR DIAGRAMS

S&ME

S&ME PROJECT: Oconee Nuclear Station - GWPP S&ME PROJECT NO.: 1264-07-234





FETTER AND BEAR DIAGRAMS

\$S&ME

S&ME PROJECT: Oconee Nuclear Station - GWPP S&ME PROJECT NO.: 1264-07-234





1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: Oconee Nuclear Station Boring No. GI							GM	-10										
Location	Location: Seneca, SC Number: 1264					-07-234				Sheet No. 1 of 1								
Boring	Depth (ft):		30.0 Elevation (ft): 735.3 Dri			Driller:	Driller: Jay Little, SC Cert No. Date 1			ite Dri	e Drilled: 10/25/07							
Logged	By: Scott Dacus Water Level: Stabilized Water Level at 6.00 ft bls Drilling Method: 4¼" H								H.S.A	۸.								
Elev.	Depth	Lith-	Material Description Well						Penetration Resistance (Blows/Foot)						t)			
-735			PRE	-DUG HOLE	FOR UT	TILITY CLE	ARANCE	:							50			100
E			FILI	L														
F																		
E																		
-730	5															_		
Ē			FILI	(F): Brown	, Micaceo	ous, Clayey,	Silty, Med	lium to		₽								
- 			SOII	SAND JSAPROLIT	Ъ. (M1):	Red, Tan, a	nd Brown,											
			Mica	iceous, Medii	um to Fin	e Sandy, SI	LT											
															+			_
-																		
F																		
-720	15-		SOIL/SAPROLITE (M1): Reddish-Orange, Micaceous, Clayey, SILT				iceous,							+	_			
		\mathcal{M}																
<u> </u>		M																
- 715	20-													┢┼┤			_	
//23/08		XX																
			SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey, SILT With Manganese Nodules			layey,												
¶ 	25											_	+			_		
SNO ONS																		
			SOIL/SAPROLITE (M1): White, Brown, and Gray, Micaceous, Silty, Medium to Fine SAND						8-0									
L REC	30-	<u> </u>	SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey,							+								
TH WEL			Fine Sand Seam at 29.90 ft bls Lithologic Information Obtained From GM-10R															
10 0 M			Boring Terminated at 30.00 ft bls															
DRING																		
ă	1										1							

COMPLETION REPORT OF WELL No. GM-10

PROJECT: PROJECT NO: PROJECT LOCATION:	Oconee Nuclea 1264-07-234 Seneca, SC	r Station	WATER LEVEL: Stabilized Water Level at 6.00 ft bls				
			LATITUDE: 34°47'38.220"				
DRILLING CONTRACTOR	S&ME. Inc.		LONGITUDE: 82°53'40.225"				
	4¼" H.S.A.		TOP OF CASING ELEVATION: 737.89				
DATE DRILLED	10/25/07		DATUM: MSL				
_		·	LOGGED BY: Scott Dacus				
DESCRIPTION		DEPTH (ft.) LEGEND ELEVATION (ft.)	WELL CONSTRUCTION DETAILS				
PRE-DUG HOLE FOR UTILITY CLEARANCE: FILL		0.00 GS 735.27	PROTECTIVE CASING Diameter: Type: Interval: RISER CASING Diameter: 2 "				
FILL (F): Brown, Micaceous, Clayey, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): Red, Tan, and Brown, Micaceous, Medium to Fine Sandy, SILT	- 10 - 10	9.80 725.47	Type: Sch. 40 PVC Interval: 0 to 13.8 ft bls GROUT Type: Neat Cement Interval: 0 to 9.8 ft bls SEAL Type: Bentonite				
SOIL/SAPROLITE (M1): Reddish-Orange, Micaceous, Clayey, SILT	-15		Interval: 9.8 to 11.8 ft bis FILTERPACK Type: #1 Silica Sand Interval: 11.8 to 28.8 ft bis				
SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey, SILT With Manganese Nodules	-25		Diameter: 2" Type: 0.010 Slotted PVC Interval: 13.8 to 28.8 ft bls				
SOIL/SAPROLITE (M1): White, Brown, and Gray, Micaceous, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey, SILT With	30	28.30 706.97 28.80 706.47 30.00 705.27	FILTER PACK FILTER PACK BENTONITE BENTONITE CEMENT GROUT CUTTINGS / BACKFILL STATIC WATER LEVEL CG CEMENT GROUT CG CEMENT GROUT CG CEMENT GROUT CG CEMENT GROUT CG CEMENT GROUT CG CEMENT GROUT				
Ŭ	· · · · · · · · · · · · · · · · · · ·	-fe I I	-				
	9751 Souther Charlotte, Nor	n Pine Boulevard rth Carolina 28273	COMPLETION REPORT OF WELL No. GM-10				
	ES		Sheet 1 01 2				
PRO PROJEC PROJECT LOCA	DJECT: (CT NO: 1 ATION: 5	Dconee Nuclea 264-07-234 Seneca, SC	r Stati	GROUND SURFACE ELEVATION: LOGGED BY: 735.3 CHECKED BY: Scott Dacus			
---	--	---	----------------	--	--------------------	---	---
DESCRIPTION	SYMBOL	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTR	UCTION DETAILS
						(See	Page 1)
Manganese Staining and White, Medium to Fine Sand Seam at 29.90 ft bls							
	2						
							· .
S&ME.CDT 7/23/08						LEGEND	
COVERED ONS LOG. OPJ						FILTER PACK BENTONITE CEMENT GROUT CUTTINGS / BACKFILL STATIC WATER LEVEL	TOCTOP OF CASINGGSGROUND SURFACEBSBENTONITE SEALFPFILTER PACKTSCTOP OF SCREENBSCBOTTOM OF SCREENTDTOTAL DEPTHCGCEMENT GROUT
Sand well REC	ME	9751 Souther	n Pine E	Boulev	ard	CON	IPLETION REPORT (L No. GM-10
ENGINEERING ENVIRONMENTA	TESTING SERVICES	Griariotte, Noi	th Card	onna 2	0213		Sheet 2

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/8/2007
Well Label:	GM-10
Aquifer Thickness:	27.8 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	6. feet
Water Table to Screen Bottom:	22.8 feet
Anisotropy Ratio:	1
Time Adjustment	0 Seconds

Test starts with trial 0 There are 53 time and drawdown measurements Maximum head is 3.068 feet Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



SONE

Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY 1.83 x 10⁻³ cm/sec



1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project:	Oconee Nuc	lear Stat	tion									B	lorin	g No). GI	A-10	0R
Location	: Seneca, SC					Number	1264-	-07-234					She	et No	o. 1 c	of 3	
Boring [Depth (ft):	88.0	Elevation (ft):	735.3	Driller:	Jay Litt B1575	le, SC Ce	rt No.	D	ate D	Drilled: 10/22/07					
Logged	By: Scott Dacus		Water Level: Stabilized Water Level at 7.59 ft bls Drillin									g Method: 4¼" H.S.A.					
Elev. (Feet)	Depth Lith- (Feet) ology		Materi	al Descri	ption			W Constr	ell	(Pe	netrati	on Res	sistan	ce (Bl	ows/l	Foot)
-735		PRE-I	OUG HOLE	UG HOLE FOR UTILITY CLEARANCE:FILL										1			
-																	
				!													
730						•											_
		FILL Fine	(F): Brown, SAND	Micaceou	s, Clayey,	Silty, Med	ium to										
 -		SOIL/	SAPROLIT	E (M1): R	ed, Tan, ar Sandy, SI	nd Brown, LT			¥.	_							
										X	7						
- 725																1	
 -																	
Ē		SOIL	SAPROLIT	E (M1): R	eddish-Ora	ange, Mica	ceous,			X	12						
- 720		Claye	y, SILT														
E																	
										Π							
-	20									X	\$						
– –		SOIL	/SAPROLIT	E (M1): O	range, Mic	caceous, C	layey,										
-		SILT	With Man	ganese No	dules					\overline{M}							
- 710	25									Ň	₿						
			,														
- -		SOIL	SAPROLIT	E (M1): W Medium to	/hite, Brov Fine SA	vn, and Gr ND	ay, 1	1		М							
- 705	30		SAPROLIT	E (M1): O	range, Mic	caceous, C	layey,			Ň	- 1			+		-+	
		Fine S	Sand Seam at	29.90 ft b	ls												
		SOIL/ Silty,	SAPROLIT Medium to I	E(MI): T Fine SAN	an and Wh D	nte, Micac	eous,										
-																	
i E		•							\otimes								



1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1:4 IN. I.D. SAMPLER 1 FT.

Floject.	Oconee Nuclear Station												Boring No. GM-10R						
Location	n: Senec	a, SC					Number	1264	-07-234				1	5	Sheet	No.	2 of 3	3	1
Boring	Depth (ft):		88.0	Elevation (f	t):	735.3	Driller:	Jay Litt B1575	le, SC Cer	rt No.	D	Date Drilled: 10/22/07							
Logged	Logged By: Scott DacusWater Level: Stabilized Water Level at 7.59 ft blsDrilli									rilling	g Method: 4¼" H.S.A.								
Elev. (Feet)	Depth (Feet)	Lith-		Materia	al Desc	ription			We	ell		Pe	Penetration Resistance (Blows/Foot)						
-700												, M	TT		5				00
-											М								
											M	18							
⊨ ⊨.											M	24							
695	40										Ш		-				_		
			SOIL	/SAPROLITI	E (M1):	Black and C	Drange, Sil	ty,			M	17							
690	45		Wieur		SAND	with Manga		mg										╉╌╋	-
 -														X					
- -			SOIL	/SAPROLITI	E (M1):	Tan and WI	nite, Micao	eous,			N	47							
685	50		Silty,	Medium to F	ine SA	ND	,								\top				-
F																			
										Ø									
			SOIL	/SAPROLIT	E (M1):	Black and T	`an, Micac	eous,		Ň	X	38							
680			Silty,	Medium to F	ine SAI	ND)									
-																			
-			Auge	er Refusal at	61.20 ft	bls				×.									
675	60		Resu	me Auger Di	rilling at	t 61.40 ft bl	5												
		5111		K LENSE: M	ledium-(Grained GI	RANITIC	[
 -			WEA	THERED RO	DCK (M	2): When Silty Madi	ampled Be	comes											
		5111	SAN	D	caceous,	, only, wear	an w rif	-		\mathbb{N}									
- 670 -																			
		BIII								×									
										X									
		SI	Auge	er Refusal at	70.00 ft	bls				Ň									



1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: Ocone	e Nuclea	ar Station		Boring No. GM-10R								
Location: Seneca	a, SC			Number: 1264-	07-234		Sheet No. 3 of 3					
Boring Depth (ft):	1	88.0 Elevation ((ft): 735.3	Driller: Jay Litt B1575	le, SC Cert No.	Date Dr	Date Drilled: 10/22/07					
Logged By: Scott D	acus		Water Level: Sta	bilized Water Level	at 7.59 ft bls	Drilling	Drilling Method: 4¼" H.S.A.					
Elev. Depth (Feet) (Feet)	Lith- ology	Materi	ial Description		Well	Per	netration	Resistanc	e (Blows	s/Foot)		
(reet)		WEATHERED R Black and Tan, M SAND; Mostly WEATHERED R Medium-Grained Mostly Core Loss PARTIALLY WE (WF): Medium-C Intensely Fracture Horizontal Joints	OCK (M2): When Sa icaceous, Silty, Medi Core Loss OCK (M2): Few Sm GRANITIC GNEI due to Soil Seams Aue to Soil Seams CATHERED/FRACT Grained GRANITIC d, Low Angle, High With Slight to No Sta	ampled Becomes um to Fine all Pieces of SS Recovered; URED ROCK GNEISS Angle and ining				50				
RING LOG WITH WELL RECOVERED ONS LOG. GPJ LAGWGN01.GDT 7/23/08		Boring Terminat	ted at 88.00 ft bls									

FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234



COMPLETION REPORT OF WELL No. GM-10R

PROJECT: PROJECT NO: PROJECT LOCATION:	Oconee Nuclear Station 1264-07-234 Seneca, SC		WATER LEVEL: Stabilized Water Level at 7.59 ft bls
DRILLING CONTRACTOR: DRILLING METHOD: DATE DRILLED:	S&ME, Inc. 4¼" H.S.A. 10/22/07		LATITUDE: 34°47'38.229" LONGITUDE: 82°53'40.175" TOP OF CASING ELEVATION: 737.91 DATUM: MSL LOGGED BY: Scott Dacus
STRATA			
		ELEVAT (ft.)	WELL CONSTRUCTION DETAILS
PRE-DUG HOLE FOR UTILITY CLEARANCE: FILL	0 0 5	<u>S 735.29</u>	PROTECTIVE CASING Diameter: Type: Interval: RISER CASING Diameter: 2"
FILL (F): Brown, Micaceous, Clayey, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): Red, Tan, and Brown, Micaceous, Medium to Fine Sandy, SILT	⊥ 10		Type: Sch. 40 PVC Interval: 0 to 83 ft bls GROUT Type: Neat Cement Interval: 0 to 80 ft bls SEAL Type: K-packer
SOIL/SAPROLITE (M1): Reddish-Orange, Micaceous, Clayey, SILT	-15		FILTERPACK Type: Interval: SCREEN
SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey, SILT With Manganese Nodules	-25		Diameter: 2" Type: 0.010 Slotted PVC Interval: 83 to 88 ft bls LEGEND
SOIL/SAPROLITE (M1): White, Brown, and Gray, Micaceous, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): Orange, Micaceous, Clayey, SILT With			FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK TSC TOP OF SCREEN CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TD TOTAL DEPTH STATIC WATER LEVEL CG CEMENT GROUT
	9751 Southern Pine Bou Charlotte, North Carolin	ulevard a 28273	COMPLETION REPORT OF WELL No. GM-10R Sheet 1 of 3

PROJECT:	Oconee	Nuclear	Station
	4064 07	224	

PROJECT NO: 1264-07-234

FROJECT LOOP	PROJECT LOCATION: Seneca, SC CHECKED BY: SCOTT Dacus								
STRATA			\//ELL			Z			
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGENI	ELEVATIO (ft.)	WELL CONSTRUCTION DETAILS		
							(See Page 1)		
Manganese Staining and White, Medium to Fine Sand Seam at 29.90 ft bls SOIL/SAPROLITE (M1): Tan and White, Micaceous, Silty, Medium to Fine SAND (continued)		- 35 							
SOIL/SAPROLITÉ (M1): Black and Orange, Silty, Medium to Fine SAND With Manganese Staining		-45							
SOIL/SAPROLITE (M1): Tan and White, Micaceous, Silty, Medium to Fine SAND		+ - 50					· · · · · · · · · · · · · · · · · · ·		
SOIL/SAPROLITE (M1): Black and Tan, Micaceous, Silty, Medium to Fine SAND		- 55							
ROCK LENSE: Medium-Grained GRANITIC GNEISS WEATHERED ROCK (M2): When Sampled Becomes Black and Tan, Micaceous, Silty, Medium to Fine SAND	1999 B	65							
WEATHERED ROCK (M2): When Sampled Becomes Black and Tan, Micaceous, Silty, Medium to Fine SAND, Mostly Core Loss		70					LEGEND FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK TSC TOP OF SCREEN CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TD TOTAL DEPTH STATIC WATER LEVEL CG CEMENT GROUT		
			9751 Southern Charlotte, Nor	n Pine I th Carc	Boulev plina 2	vard 8273	COMPLETION REPORT OF WELL No. GM-10R		
	L SERVI	CES					Sneet 2 of 3		

PROJE PROJECT I PROJECT LOCATIO	CT: OC NO: 12 ON: Se	onee Nuclea 64-07-234 neca, SC	r Stati	GROUND SURFACE ELEVATION: LOGGED BY: 735.3 CHECKED BY: Scott Dacus			
STRATA DESCRIPTION	SYMBOL DEPTH (ft.)	WELL	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS	
						(See Page 1)	
	तात		80.00		655.20		
(M2): Few Small Pieces of Medium-Grained	80 - الابلار - بر بر - بر بر		80.00		055.29		
GRANITIC GNEISS Recovered; Mostly Core Loss due to Soil	۲. ۲. ۲. ۲. ۲. ۲.		82.43 82.63 83.00		652.86 652.66 652.29		
Seams (continued)	- 7 - 85 - 85					-	
ROCK (WF): Medium-Grained			87.50 88.00		647.79 647.29		
Intensely Fractured, Low Angle, High Angle and Horizontal Joints							
With Slight to No Staining							
				``			
			•		•		
• •						LEGEND	
						FILTER PACK TOC TOP OF CASING GS GROUND SURFACE	
						CEMENT GROUT FP FILTER PACK TSC TOP OF SCREEN	
						TD TOTAL DEPTH STATIC WATER LEVEL TO TOTAL DEPTH CG CEMENT GROUT	
	E	9751 Southern Charlotte Nor	Pine I	Boule	vard 28273	COMPLETION REPORT OF WELL No. GM-10R	
	STING					Sheet 3 of	

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Numl	ber:	GM-10R
Sample No: Depth (ft-bls): Blow Count:	1 8.5 - 10 1 * 3 * 4	2 19 2 1919 2 3 Milling 4 Luthi 5 mear 26 27 98 Martin 9 11 1F
Sample No: Depth (ft-bls): Blow Count:	2 13.5 - 15 1 * 5 * 7	
Sample No: Depth (ft-bls): Blow Count:	3 18.5 - 20 1 * 2 * 2	2 101HS & 3 100THS #
Sample No: Depth (ft-bls): Blow Count:	4 23.5 - 25 2 * 2 * 2	2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -
Sample No: Depth (ft-bls): Blow Count:	5 28,5 - 30 2 * 3 * 4	2 PETA 3 NOHES 4 5 Lattin 5 graw 7
Sample No: Depth (ft-bls): Blow Count:	6 36.5 - 38 7 * 8 * 10	

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Number:		GM-10R
Sample No: Depth (ft-bls): 38. Blow Count: 9 * 1	7 .5 - 40 11 * 13	2 10 2 10 10 10 10 11 14 2 10 10 2 10 10 10 10 11 14 2 10 10 2 10 10 10 10 10 10 10 10 10 10 10 10 10
Sample No: Depth (ft-bls): 43. Blow Count: 5 *	8 .5 - 45 7 * 10	10 2 PEETS 3 NG
Sample No: Depth (ft-bls): 48. Blow Count: 9 * 1	9 .5 - 50 14 * 33	2 '10 2 'regra 3 wickes 4 15 Laffeld 5 wream ; 6 . 7 . 8. 9 2 regra 3 wickes 4 15 Laffeld 6 wream ; 6 . 7 . 9 . 9
Sample No: Depth (ft-bls): 53. Blow Count: 12 *	10 .5 - 55 16 * 22	2 reers 3 Notes 4 5 Lutht 5 reer 7 8

ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-10R



CLASSIFICATION:

70.00' to 75.00': Soil75.00' to 80.00': Medium-Grained Granitic Gneiss With Soil Seams80.00' to 88.00': Medium-Grained Granitic Gneiss

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name:	ONS - GWPP	
Date:	10/24/2007	
Boring I.D.	GM-10R	
Test Interval:	70' to 75'	(Weather
Total Depth of Hole:	75 ft	
Length of Open Hole:	5 ft	
Transformation Ratio m=	1	
Performed by:	Scott Dacus	

thered Rock) 2286.59 cm 152.44 cm

<u>Time (sec)</u>	Head (cm)	Permeability (cm/sec)		<u>Calculations</u>
0	984.09			(2 I)
60	975.88	2.45E-05	d^2	$\ln\left(\frac{2mL}{mL}\right)$ $\int mL$
120	971.13	1.43E-05	ч	H_{1} D H_{2} H_{3} H_{4}
180	967.59	1.07E-05	$K_{k} =$	$\frac{(D)}{(D)} \cdot \ln \frac{(D)}{(D)}$
240	964.79	8.50E-06	∥ ″ 8·.	$L \cdot (t_2 - t_1) \qquad H_2$
300	962.38	7.32E-06		
360	960.30	6.31E-06	Where:	
420	958.48	5.58E-06	K _h	is the Horizontal Coefficient of Permeability (cm/sec)
480	956.80	5.13E-06	H ₁	is the Piezometric Head for time; $t = t_1$ (cm)
540	955.24	4.76E-06	H ₂	is the Piezometric Head for time; $t = t_2$ (cm)
600	953.81	4.39E-06	D	is the Diameter of the Standpipe (cm)
900	947.50	3.89E-06	d	is the diameter of the Open Length (cm),
1200	941.98	3.42E-06	m	is the Transformation Ratio, Where
1500	936.89	3.17E-06		$m = \sqrt{K/K}$ K _h is the Horizontal Permeability
1800	932.10	3.00E-06		K_{v} is the Vertical Permeability
2400	923.72	2.65E-06	L	is the Open Length of Hole (cm)
3000	916.80	2.20E-06		
3600	911.22	1.79E-06	Spreadsheet as	ssumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

6.56E-06



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name:	ONS - GWPP		
Date:	10/23/2007		
Boring I.D.	GM-10R		
Test Interval:	33.5' to 36.5'	(Soil Saprolite)	
Total Depth of Hole:	36.5 ft	1112.8 cm	
Length of Open Hole:	3 ft	91.46 cm	
Transformation Ratio m=	1		
Performed by:	Scott Dacus		

<u>Time (sec)</u>	<u>Head (cm)</u>	<u>Permeability (cm/sec)</u>		<u>Calculations</u>	
0	486.40			$(2 \dots I)$	
60	482.87	3.07E-05	d^2 .	$\ln\left(\frac{2mL}{mL}\right)$ mL	
120	480.73	1.86E-05	u	H_{1} D H_{2} H_{1} H_{2} H_{1} H_{2}	
180	478.84	1.66E-05	$\ K_{\mu} =$	$\frac{1}{2} \cdot \ln \frac{1}{2}$	
240	477.16	1.47E-05	∥″8· <i>1</i>	$L \cdot (t_2 - t_1) \qquad H_2$	
300	475.58	1.40E-05	L		
360	474.18	1.24E-05	Where:		
420	472.87	1.16E-05	K _h	is the Horizontal Coefficient of Permeability (cm/sec	:)
480	471.65	1.09E-05	H ₁	is the Piezometric Head for time; $t = t_1$ (cm)	
540	470.49	1.03E-05	H ₂	is the Piezometric Head for time; $t = t_2$ (cm)	
600	469.42	9.54E-06	D	is the Diameter of the Standpipe (cm)	
900	464.73	8.45E-06	d	is the diameter of the Open Length (cm),	
1200	460.79	7.15E-06	m	is the Transformation Ratio, Where	Ì
1500	457.38	6.25E-06		$m = \sqrt{K/K}$ K _h is the Horizontal Permeab	ility
1800	454.27	5.74E-06		K_v is the Vertical Permeab	oility
2400	448.81	5.08E-06	L	is the Open Length of Hole (cm)	
3000	444.02	4.51E-06			
3600	439.76	4.06E-06	Spreadsheet as	ssumes 3" ID Pipe; NQ Hole, OD = 3"	

MEAN PERMEABILITY (cm/sec)

1.12E-05



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)



Site Name:	ONS - GWPP			
Date:	10/24/2007			
Boring I.D.	GM-10R			
Test Interval:	70' to 80'	(Weathered Rock)		
Total Depth of Hole:	80 ft	2439.02 cm		
Length of Open Hole:	10 ft	304.88 cm		
Transformation Ratio m=	1 -			
Performed by:	Scott Dacus			

<u>Time (sec)</u>	<u>Head (cm)</u>	<u>Permeability (cm/sec)</u>		Calculations	
0	1132.38			$(2, \mathbf{J})$	
15	1094.97	2.34E-04	d^2 .	$\ln\left(\frac{2mL}{2mL}\right)$	mL
30	1072.93	1.41E-04		D H	for $\frac{1}{D}$ 4
45	1059.42	8.81E-05	$\ K_{h} =$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	D
60	1050.18	6.09E-05	∥ ″ 8· <i>L</i>	$L \cdot (t_2 - t_1) = H_2$	
75	1043.48	4.46E-05	L		
90	1038.45	3.36E-05	Where:		
			K _b	is the Horizontal Coefficie	nt of Permeability (cm/sec)
			H ₁	is the Piezometric Head fo	r time; $t = t_1$ (cm)
			H ₂	is the Piezometric Head fo	r time; $t = t_2$ (cm)
		, ,	D	is the Diameter of the Stan	dpipe (cm)
			d	is the diameter of the Oper	Length (cm),
		•	m	is the Transformation Rati	o, Where
				$m = \sqrt{K/K}$ K _h	is the Horizontal Permeability
				$m = \sqrt{K_h/K_v}$	K, is the Vertical Permeability
			L	is the Open Length of Hole	e (cm)
			Spreadsheet ass	sumes 3" ID Pipe; NQ Hole, (DD = 3"

MEAN PERMEABILITY (cm/sec)

1.00E-04



Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/8/2007
Well Label:	GM-10R
Aquifer Thickness:	85.41 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	7.59 feet
Water Table to Screen Bottom:	80.41 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds Test starts with trial 0 There are 68 time and drawdown measurements Maximum head is 1.961 feet Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY 1.55 x 10⁻³ cm/sec



S&ME Project:

Oconee Nuclear Station - GWPP

S&ME Project No.:

1264-07-234



FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Oconee Nuclear Station - GWPP **S&ME PROJECT NO.:** 1264-07-234







S&ME Project: Oconee Nuclear Station - GWPP S&ME Project No.: 1264-07-234



FETTER AND BEAR DIAGRAMS





\$S&ME



1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

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Project:	Ocor	iee Nucle	ear Sta	ation								Boring No. GM-11						
Location	n: Sene	ca, SC					Number: 1264	-07-234		Sheet No. 1 of 2								
Boring I	Boring Depth (ft):40.0Elevation (ft):720.4Driller:JaBl								ttle, SC Cert No. Date Drilled: 9/25/07									
Logged	By: Scott	Dacus			Water Leve	el: Sta	bilized Water Leve	l at 30.19	ft bls	Dr	illing	g Method: 4¼" H.S.A.						
Elev. (Feet)	Depth (Feet)	Lith- ology		Materi	al Descrip	otion		We Constr	ell	Penetration Resistance (Blows/Foot)								
-720	(/		- GRA	SS and TO	PSOIL With	GRAVI	EL		N N	Ηĭ				<u> </u>			100	
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F	_													1				
	_								\mathbb{N}									
- .	-		,															
	-		FILI	(F): Light F	Brown, Micad	ceous. M	edium to Fine	┨ / [8]	\mathbb{N}									
-	5-		Sand	v. SILT	With Roots							_		_				
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	30-	 ∷ ∶[∷]	SOII	JSAPROLII	E (MI): Lig	ght Brow	n and White, Silty,	:E	<u>∔</u> ∷ ¥			+		+	┝──┼		+	
≥ 090	_		Med	ium to Fine	SAND													
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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project:	Oconee Nuc		Boring No. GM-11										
Location	n: Seneca, SC	. *	,	Number: 1264	-07-234		Sheet No. 2 of 2						
Boring I	Depth (ft):	40.0 Elevation	(ft): 720.4	Driller: Jay Litt B1575	le, SC Cert No.	Date Dr	ate Drilled: 9/25/07						
Logged	By: Scott Dacus		Water Level: St	abilized Water Level	at 30.19 ft bls	Drilling Method: 4¼" H.S.A.							
Elev.	Depth Lith-	Mater	ial Description		Well	Penetration Resistance (Blows/Foot							
- - - - - - - - - - - - - - - -	35	SOIL/SAPROLIT Micaceous, Silty, Brown, Very Mic bls	TE (M1): Light Brow Medium to Fine SA faceous, SILT at 4	vn and White, ND. Layers of 0.42 ft and 40.48 ft									
		Lithologic Descr		om GM-11R									
OG WITH WELL RECOVERED ONS LOG.GPJ_LAGWGN01.GDT_7/23/08		Lithologic Descr Boring Termina	iption Obtained Fr ted at 40.00 ft bls	om GM-11R									
BORIN													

COMPLETION REPORT OF WELL No. GM-11

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 WATER LEVEL: Stabilized Water Level at PROJECT LOCATION: Seneca, SC 30.19 ft bls LATITUDE: 34°47'35.017" LONGITUDE: 82°53'30.619" DRILLING CONTRACTOR: S&ME, Inc. TOP OF CASING ELEVATION: 723.31

DRILLING METHOD: 41/4" H.S.A. DATE DRILLED: 9/25/07

.

DATUM: MSL LOGGED BY: Scott Dacus

STRATA	<u>א</u> ל		WELL	HL T	END	ATION	
DESCRIPTION	SYMB	DEPTI (ft.)	DETAILS	DEI (f	LEG	ELEV,	WELL CONSTRUCTION DETAILS
		- 0		0.00	GS	720.37	PROTECTIVE CASING Diameter:
GRASS and TOPSOIL With GRAVEL							Type: Interval:
FILL (F): Reddish-Brown, Clayey, SILT	_	x x x x x x x x x x x x x x x x x x x					RISER CASING
FILL (F): Light Brown, Micaceous, Medium to Fine Sandy SILT With		- 5					Type: Sch. 40 PVC Interval: 0 to 28.5 ft bls
Roots							GROUT Type: Neat Cement Interval: 0 to 23 ft bls
							SEAL Type: Bentonite Interval: 23 to 26.5 ft bls
FILL (F): Reddish-Brown, Micaceous, Medium to Fine Sandy, SILT		- 15					FILTERPACK Type: #1 Silica Sand Interval: 26.5 to 40 ft bls
FILL (F): Light Brown, Micaceous, Silty, Medium to Fine SAND		- 20		23.00		697.37	SCREEN Diameter: 2" Type: 0.010 Slotted PVC Interval: 28.5 to 38.5 ft bls
FILL (F): Weddish-Brown, Silty, Medium to Fine SAND With		-25		26.50		693.87	LEGEND
SOIL/SAPROLITE (M1): Light Brown and White, Silty, Medium to Fine SAND		- 30					BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TD TOTAL DEPTH STATIC WATER LEVEL CG CEMENT GROUT
			······································				
			9751 Southern Charlotte, Nor	Pine E	Boulev olina 2	/ard 8273	COMPLETION REPORT OF WELL No. GM-11
	• TESTIN	4G ES					Sheet 1 of 2

PROJECT NO: PROJECT LOCATION:	1264-07-234 Seneca, SC				LOGGED BY: 720.4 CHECKED BY: Scott Dacus
STRATA		ſ		z	
		DEPTH (ft.)	LEGEND	ELEVATIO (ft.)	WELL CONSTRUCTION DETAILS
	· · · · · · · · · · · · · · · · · · ·				(See Page 1)
SOIL/SAPROLITE (M1): Light Brown and White, Micaceous, Silty, Medium to Fine SAND. Layers of Brown, Very Micaceous, SILT at 40.42 ft and 40.48 ft bls	40	38.00 38.50 40.00		682.37 681.87 680.37	
		· .			
23908					
J SAME.GUT /					
					■ BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK TSC TOP OF SCREEN CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TD TOTAL DEPTH CG CEMENT GROUT
					COMPLETION REPORT OF
Source Source House Hous	9751 Southern Charlotte, Nor	Pine B th Caro	ina 2	ard 8273	WELL No. GM-11 Sheet 2 of 2

GROUND SURFACE ELEVATION:

PROJECT: Oconee Nuclear Station

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/15/2007
Well Label:	GM-11
Aquifer Thickness:	13.31 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	30.19 feet
Water Table to Screen Bottom:	8.31 feet
Anisotropy Ratio:	1

Time Adjustment:0. SecondsTest starts with trial 0There are 41 time and drawdown measurementsMaximum head is 2.402 feetMinimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Adjusted Time (minutes) Ho is 2.402 feet at 0. Seconds

PERMEABILITY 3.76 x 10⁻³ cm/sec





1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project:	Ocon	ee Nucle	ear Sta	tion						Boring No. GM-11R									
Location	: Sene	ca, SC					Number:	1264-	07-234		Sheet No. 1 of 2								
Boring D	Depth (ft):		70.2	Elevation (ft):	720.5	Driller: Ja	y Littl 575	e, SC Ce	rt No.	0. Date Drilled: 9/20/07								
Logged	bilized Water Level at 28.97 ft bls Drilling Method: 4¼" H.S.A.																		
Elev.	Depth (Feet)	Lith-		Materi	al Descr	iption			We	ell		P	eneti	ration	Resist	ance	(Blov	ws/Fc	oot)
720	(1 001)		GRA	SS and TOF	SOIL Wi	th GRAVE	EL			M						ÎT			$\frac{100}{1}$
- 720			FILL	(F): Reddis	h-Brown, (Clayey, SI	LT												
F										×.									
										K									
E	·																		
E	5		FILL	(F): Light E	Brown, Mic	caceous, M	edium to Fine			\mathbb{X}	M	6							
-715	 		Sandy	, SILI V	with Roots)				Ø	M		_						
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F			FILL	(F): Reddis	h-Brown,	Micaceous,	Medium to Fin	ne			$ \Lambda $	14	Γ						
-705	- 15		Sandy	, SILI						\mathbb{X}	$ \square $		T						
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F	20-		FILI	(F) Light F	Rown Mid	caceous Sil	ty Medium to				Х	6					_	<u> </u>	
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695	25-		FILL	(F): Reddis	h-Brown,	Silty, Medi	um to Fine			\bigotimes	$ \square $		•						+ - 1
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	30-		SOIL	/SAPROLIT	<u>те (М1): Т</u>	.ight Brown	n and White, Si	ilty,		\boxtimes	X	13	┥		-	┞┤	+		
2) — 690 2 —			Medi	um to Fine	SAND					\bowtie									
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<u>-</u> 685	35-		SOIL	SAPROLIT	E (M1): 1 Medium te	Light Brown	n and White,	of		\mathbb{N}	$ \mathbb{M} $		•			 			+1
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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF

BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Ocon	ee Nucl	ear Sta	ation					,			Bo	ring]	No. G	M-1 1	IR
Location	n: Seneo	ca, SC					Number	1264-	07-234			,	Sheet	No. 2	of 2	
Boring I	Depth (ft):	: 70.2 Elevation (ft): 720.5 Driller: Jay Little, SC Cert No. Date B1575					ate Dr	Drilled: 9/20/07								
Logged By: Scott Dacus Water Level: Stabilized Water Level at 28.97 ft bls Drilling Method:						: 4¼"	H.S.A.		ı							
Elev. (Feet)	Depth (Feet)	Lith- ology		Mater	ial Descr	iption			Well		Per	netration	Resist	ance (E	Blows/F	Foot)
			Brow bls	vn, Very Mic	aceous, S	ILT at 40	0.42 ft and	40.48 ft								
										M	11					
- 680 																
- -			5011		E (M1): 1	White Vell	ony and Pr	,				\mathbb{N}				
675	45		Mica	iceous, Silty,	Medium to	o Fine SA	ND	Jwn,		X	32		\mathbf{k}			
															\mathbb{N}	
670	50-	IS III	WEA Whit	ATHERED R e, Yellow, ar	OCK (M2) nd Brown,): When Sa Micaceous	ampled Be , Silty, Me	comes, lium to			50/ 3		_			~~
		مر جم م مرجم م مرجم م مرجم م	Augo SOU GNE	er Refusal at ND ROCK (CISS With I	t 50.60 ft b D): Mediu ntermitten	ols 1m-Grained t Medium-(I GRANI Grained									
	55	م مر مر م مر مر مر مر مر مر	BIO Fract Mod	TITE HORN tured, Low A erate to No S	NBLENDE ngle and H taining	C GNEISS ligh Angle	_ Moderat Joints With	ely 1								
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	70-	ת ת ת ת ת ת ת ת ה	Bori	ng Termina	ted at 70.2	0 ft bls										
<u> </u>																

FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



S&ME 110ject No. 1204-07-23-



FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-11R



EXPLANATION



End of Run
Contact
Healed Joint

COMPLETION REPORT OF WELL No. GM-11R

PROJ PROJECT PROJECT LOCAT	ECT: NO: NO:	Oco 126 Ser	onee Nuclea 4-07-234 neca, SC	r Stati	on		WATER LEVEL: Stabilized Water Level at 28.97 ft bls
							LATITUDE: 34°47'35.052''
DRILLING CONTRAC	TOR:	S&I	ME, Inc.				LONGITUDE: 82°53'30.574"
DRILLING METH	HOD:	4¼'	" H.S.A.				TOP OF CASING ELEVATION: 723.48
DATE DRIL	LED:	9/20	0/07				DATUM: MSL
							LOGGED BY: Scott Dacus
STRATA			WELL	₋	₽	NO	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPT (ft.)	LEGEN	ELEVAT (ft.)	WELL CONSTRUCTION DETAILS
GRASS and TOPSOIL With		0		0.00	GS	720.49	PROTECTIVE CASING Diameter: Type: Interval:
GRAVEL FILL (F): Reddish-Brown, Clayey, SILT FILL (F): Light Brown, Micaceous, Medium to Fine Sandy, SILT With		5					RISER CASING Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 61.5 ft bls
		10					GROUT Type: Neat Cement Interval: 0 to 58 ft bis SEAL Type: K-packer
FILL (F): Reddish-Brown, Micaceous, Medium to Fine Sandy, SILT		20					Interval: 60.8 to 61 ft bls FILTERPACK Type: Interval:
FILL (F): Light Brown, Micaceous, Silty, Medium to Fine SAND		25					SCREEN Diameter: 2" Type: 0.010 Slotted PVC Interval: 61.5 to 66.5 ft bls
Reddish-Brown, Silty, Medium to Fine SAND With Manganese Staining		20	Ţ				LEGEND
SOIL/SAPROLITE		30					FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TOTAL DEPTH TOTAL DEPTH CG CEMENT GROUT
S8N	TESTING	9 0	0751 Southerr Charlotte, Nor	n Pine I th Carc	3oulev olina 2	/ard 8273	COMPLETION REPORT OF WELL No. GM-11R Sheet 1 of 2

PROJECT:	Oconee Nuclear Station
OJECT NO	1264-07-234

PROJECT NO: 1264-07-234 PROJECT LOCATION: Seneca, SC GROUND SURFACE ELEVATION: LOGGED BY: 720.5 CHECKED BY: Scott Dacus

STRATA				~	Z		
	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGEND	ELEVATIC (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Light Brown and White, Micaceous, Silty, Medium to Fine SAND. Layers of Brown, Very Micaceous, SILT at 40.42 ft and 40.48 ft bls (continued) SOIL/SAPROLITE (M1): White, Yellow, and Brown, Micaceous, Silty, Medium to Fine SAND WEATHERED ROCK (M2): When Sampled Becomes, White, Yellow, and Brown, Micaceous, Silty, Medium to Fine SAND Auger Refusal at 50.60 ft bls SOUND ROCK (D): Medium-Grained GRANITIC GNEISS With Intermittent Medium-Grained BIOTITE HORNBLENDE GNEISS; Moderately Fractured, Low Angle and High Angle Joints With Moderate to No Staining				58.00 60.80 61.00 61.50 66.00 66.50 68.20 70.20		662.49 659.69 659.49 658.99 653.99 652.29 650.29	
							BENTONITE BS BENTONITE SEAL SERITORITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK TSC TOP OF SCREEN CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TOTAL DEPTH TOTAL DEPTH STATIC WATER LEVEL CG CEMENT GROUT
	TESTIN		9751 Southerr Charlotte, Nor	Pine I th Care	Boulev Dina 2	vard 28273	COMPLETION REPORT OF WELL No. GM-11R
	• TESTIN L SERVIC	IG ES					Sheet 2 of 2

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Number:		GM-11R
Sample No: Depth (ft-bls): Blow Count:	1 4 - 5.5 3 * 3 * 3	2
Sample No: Depth (ft-bls): Blow Count:	2 9 -10.5 2 * 2 * 3	B ¹ ⁹ 2 ⁻² T ²
Sample No: Depth (ft-bls): Blow Count:	3 14 - 15.5 3 * 6 * 8	1 2 ² 2 ² 2 ³ 2
Sample No: Depth (ft-bls): Blow Count:	4 19 - 20.5 4 * 3 * 3	2
Sample No: Depth (ft-bls): Blow Count:	5 24 - 25.5 5 * 6 * 8	231' 2 :2 IOTHS AT 3 IOTHS FT. 4 5 INTRO 5 INTRO 6
Sample No: Depth (ft-bls): Blow Count:	6 29 - 30.5 4 * 5 * 8	

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Number:	GM-11R
Sample No: 7 Depth (ft-bls): 34 - 35.5 Blow Count: 4 * 6 * 9	
Sample No: 8 Depth (ft-bls): 39 - 40.5 Blow Count: 6 * 5 * 6	2 PEET & 3 INCHES 4 120FEI & 4 Lafkin 5 INVELSE 7 8 2 PEET & 3 INCHES 4 120FEI & 5 Lafkin 5 INVELSE 7 8 3 INCHES 4 120FEI & 5 INVELSE 7 8 5 INVELSE 1 0 10 10 10 10 10 10 10 10 10 10 10 10
Sample No: 9 Depth (ft-bls): 44 - 45.5 Blow Count: 7 * 15 * 17	2 PERTA 3 NOTHS EL. *4 2 PERTA 3 NOTHS EL. *4 5 Luftis 5 ***********************************
Sample No: 10 Depth (ft-bls): 49 - 50.5 Blow Count: 20 * 39 * 50/3	2 12 10THS & N 3 100THS EF. 4 2 FEET 3 INCHES 4 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-11R



CLASSIFICATION:

50.60' to 70.20': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name: ONS - GWPP 9/21/2007 Date: Boring I.D. GM-11R **Test Interval:** 50.6' to 55.6' 55.6 ft Total Depth of Hole: Length of Open Hole: 5 ft Transformation Ratio m= t Performed by: Scott Dacus

(Weathered/Sound Rock) 1695.12 cm 152.44 cm

Time (sec)	Head (cm)	Permeability (cm/sec)	,	Calculation	IS
0	615.03			(2 - 1)	
60	588.32	1.30E-04	d^2	$\ln\left(\frac{2mL}{m}\right)$	mL
120	578.90	4.73E-05	u	$\begin{bmatrix} \mathbf{m} \\ \mathbf{D} \end{bmatrix} = H_{\mathbf{i}}$	for $\left \frac{1}{D}\right>4$
180	571.22	3.91E-05	$K_{h} = -$	$\frac{\sqrt{D}}{\sqrt{1-1}} \cdot \ln \frac{1-1}{1-1}$	
240	563.84	3.81E-05	·″ 8·⊿	$L \cdot (t_2 - t_1) = H_2$	
300	557.23	3.46E-05			
360	551.01	3.29E-05	Where:		
420	544.79	3.32E-05	K _h	is the Horizontal Coeffi	cient of Permeability (cm/sec)
480	541.19	1.94E-05	H ₁	is the Piezometric Head	for time; $t = t_1$ (cm)
540	537.04	2.25E-05	H ₂	is the Piezometric Head	for time; $t = t_2$ (cm)
600	531.92	2.81E-05	D	is the Diameter of the S	tandpipe (cm)
900	503.48	3.22E-05	d	is the diameter of the O	pen Length (cm),
1200	474.30	3.50E-05	m	is the Transformation R	atio, Where
1500	451.31	2.91E-05		$m - \sqrt{K/K}$	K _h is the Horizontal Permeability
				$m = \sqrt{K_h/K_v}$	K_v is the Vertical Permeability
			L	is the Open Length of H	lole (cm)
			C		
			j Spreadsneet as	ssumes 5" ID Pipe; NQ Hold	$e_{1}, UU = 3^{\circ}$

MEAN PERMEABILITY (cm/sec) 4.01E-05



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name:	ONS - GWPP
Date:	9/20/2007
Boring I.D.	GM-11R
Test Interval:	35' to 38'
Total Depth of Hole:	38 ft
Length of Open Hole:	3 ft
Transformation Ratio m=	1
Performed by:	Scott Dacus

(Soil/Sa lite)

rmation katio	m=	I
ed by:		Scott Dacus

n/saprome)	
1158.54	cm
91.46	cm

<u>Head (cm)</u>	Permeability (cm/sec)		Calculations
490.46			(2mI)
455.82	3.08E-04	d^2 .	$\ln\left(\frac{2mL}{mL}\right)$ for mL
427.35	2.71E-04		H_1 H_1 H_2 H_3 H_4 H_1 H_2 H_3 H_4 H_2 H_3 H_3 H_4 H_3 H_3 H_4 H_3 H_3 H_4 H_3 H_4 H_3 H_4
402.80	2.49E-04	$ K_{h} =$	$\frac{1}{1} \frac{D}{1} \frac{D}{1}$
381.13	2.33E-04	∥ ["] 8 · I	$L \cdot (t_2 - t_1) = H_2$
361.74	2.19E-04	 	
344.15	2.10E-04	Where:	
328.14	2.00E-04	K _h	is the Horizontal Coefficient of Permeability (cm/sec)
313.57	1.91E-04	H ₁	is the Piezometric Head for time; $t = t_1$ (cm)
300.00	1.86E-04	H ₂	is the Piezometric Head for time; $t = t_2$ (cm)
287.41	1.80E-04	D	is the Diameter of the Standpipe (cm)
236.59	1.64E-04	d	is the diameter of the Open Length (cm),
200.15	1.41E-04	m	is the Transformation Ratio, Where
173.05	1.22E-04		$m = \sqrt{K/K}$ K _h is the Horizontal Permeability
152.53	1.06E-04		K_{v} is the Vertical Permeability
		L	is the Open Length of Hole (cm)
		Spreadsheet as	sumes 3" ID Pipe; NO Hole, OD = 3"

MEAN PERMEABILITY (cm/sec) 1.99E-04


Site Name:	ONS - GWPP
Date:	9/21/2007
Boring I.D.	GM-11R
Test Interval:	50.6' to 60.6'
Total Depth of Hole:	60.6 ft
Length of Open Hole:	10 ft
Transformation Ratio m=	1
Performed by:	Scott Dacus

-

(Weathered/Sound Rock) 1847.56 cm 304.88 cm

Time (sec)	<u>Head (cm)</u>	Permeability (cm/sec)		Calculation	<u>s</u>
0	680.82			(2 I)	
60	653.32	7.17E-05	d^2	$\cdot \ln\left(\frac{2mL}{2mL}\right)$	mL
120	641.83	3.09E-05	u u	$D H_{1}$	for $\left \frac{m^2}{D}\right $
180	630.79	3.02E-05	$ K_{h} =$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	
240	620.18	2.95E-05	″ 8·1	$L \cdot (t_2 - t_1) = H_2$	
300	610.03	2.87E-05	[<u> </u>		
360	600.18	2.83E-05	Where:		
420	590.73	2.76E-05	K _h	is the Horizontal Coeffic	eient of Permeability (cm/sec)
480	581.52	2.73E-05	H ₁	is the Piezometric Head	for time; $t = t_1$ (cm)
540	572.50	2.72E-05	H ₂	is the Piezometric Head	for time; $t = t_2$ (cm)
600	563.84	2.65E-05	D	is the Diameter of the St	andpipe (cm)
900	523.90	2.55E-05	d	is the diameter of the Op	en Length (cm),
1200	489.27	2.38E-05	m	is the Transformation Ra	tio, Where
1500	458.99	2.22E-05		$m = \sqrt{K/K}$	K _h is the Horizontal Permeability
1800	432.41	2.07E-05	1	$m = \sqrt{m_h/m_v}$	K _v is the Vertical Permeability
2400	391.31	1.74E-05	L	is the Open Length of H	ole (cm)
3000	358.05	1.54E-05		. –	
			Spreadsheet as	sumes 3" ID Pipe: NO Hole	OD = 3"

MEAN PERMEABILITY (cm/sec) 2.83E-05



BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO .:	ONS - GWPP				
LOCATION:	Seneca, SC				
TEST DATE:	9/24/2007				
TESTED BY:	Adam Jennings/Scott Dacus				
GROUND ELEV (ft MSL):	720.5				

BOREHOLE NO.:	GM-11R			
TEST INTERVAL:	61.0	to	67.0	bgs
TEST INTERVAL:	659.5	to	653.5	EL

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Step Flow (Q)			Lugeons	Permeability	Permeability	
	(gpm)	Gauge	Effective		(ft/sec)	(cm/sec)	
1	5.46	30	43	38	1.35E-05	4.1E-04	
2	5.83	40	53	33	1.2E-05	3.6E-04	
3	6.77	50	63	32	1.1E-05	3.5E-04	
4	5.65	40	53	32	1.1E-05	3.5E-04	
5	4.47	30	43	31	1.1E-05	3.4E-04	
			AVERAGE	33	1.2E-05	3.6E-04	
		SELECTE	D VALUES				

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION





Packer Test GM-11R Redo Permeability Calculations Page 1 of 4

PERMEABILITY CALCULATIONS FOR				-
EACH STEP OF TEST		-		
CALCULATED PERMEABILITY FOR STEP 1				
Gauge Pressure, h2	30	psi	69.3 feet of water	
Flow Rate, O:	5.46	gpm	$0.012 \text{ ft}^3/\text{sec}$	
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)	
Head Loss, L:	0.7	psi	1.5 feet of water	
Distance from pressure gauge to bottom of test section, h_1 :	32.2	feet		
Value of h ₁ :	32.2	feet		
Effective Head, H where $H = h1 + h2 - L$:	. 99.9	feet	43.3 psi	
Determine Saturation Zone:		-	·	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	ed
Tu = U-D+H	62.2	feet		
X = (H/Tu) * 100	160.8	%		
Tu/A	10.3			
Determine Conductivity Coefficient	<i>i</i>			
H/r	-		Value for Zone 1 analysis	
A/H	-	,	Value for Zone 1 analysis	
A/r	48		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	. 72		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec	
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec	
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec	
Calculate K if Zone 3 and using single packer (Method 1)		ft/sec	cm/sec	
Calculate K if Zone 3 and using double packer (Method 2)	1.35E-05	ft/sec	4.12E-04 cm/sec	
ls this step valid?				

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

7

CALCULATED PERMEABILITY FOR STEP 2			
Gauge Pressure, h2	40	psi	92.4 feet of water
Flow Rate, Q:	5.83	gpm	0.013 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.7	· psi	1.5 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	32.2	feet	
Value of h_1 :	32.2	feet	
Effective Head, H where $H = h1 + h2 - L$:	123.0	feet	53.3 psi
Determine Saturation Zone:		-	L .
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	85.3	feet	· ,
X = (H/Tu)*100	144.3	%	
Tu/A	14.2		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)		ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.17E-05	ft/sec	3.58E-04 cm/sec
Is this step valid?			

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3				
Gauge Pressure, h2	50	psi	115.5 feet of water	
Flow Rate, O:	6.77	gom	$0.015 \text{ ft}^3/\text{sec}$	
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)	
Head Loss, L:	0.7	, psi	1.5 feet of water	
Distance from pressure gauge to bottom of test section, h1:	32.2	feet		
Value of h ₁ :	32.2	feet		
Effective Head, H where $H = h1 + h2 - L$:	146.1	feet	63.3 psi	
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	108.3	feet		
X = (H/Tu)*100	134.9	%		
Tu/A	18.0			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	48		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			. Cu for Zone 1	
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec	
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec	
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec	
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec	
Calculate K if Zone 3 and using double packer (Method 2)	1.15E-05	ft/sec	3.50E-04 cm/sec	
		~		
Is this step value: If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid Colorated with the barrier of the state	id due to turbulen	it flow		
Is this step value: If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the Calculate a step to the total open area of the total open area of the Calculate a step to the total open area of total	id due to turbulen the test section:	it flow	4.7 square feet	
If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10?	id due to turbulen the test section: ??	it flow	4.7 square feet True, Test Valid	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10?	id due to turbulen the test section: ??	it flow	4.7 square feet True, Test Valid	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABLE ITY FOR STEP 4	id due to turbulen the test section: ?	it flow	4.7 square feet True, Test Valid	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure b2	id due to turbulen the test section: ?	nsi	4.7 square feet True, Test Valid	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Poet O	id due to turbulen the test section: ? 40	nt flow	4.7 square feet True, Test Valid 92.4 feet of water	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Hard here of Elifect estimated for the state of the s	id due to turbulen the test section: ? 40 5.65	psi gpm	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per L	id due to turbulen the test section: ? 40 5.65 0.1	psi gpm psi	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables)	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L :	id due to turbulen the test section: ? 40 5.65 0.1 0.7	psi gpm psi psi	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water	
If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h ₁ : Value of the section of test section, h ₁ :	40 5.65 0.1 0.7 32.2	psi gpm psi feet	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective liked H where H=h1h2 L.	40 5.65 0.1 0.7 32.2 32.2	psi gpm psi feet feet	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, H where $H = h1 + h2 - L$:	40 5.65 0.1 0.7 32.2 32.2 123.0	psi gpm psi feet feet feet	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi	
If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone:	40 5.65 0.1 0.7 32.2 32.2 123.0	psi gpm psi feet feet feet	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Ten UD (1)	40 5.65 0.1 0.7 32.2 32.2 123.0 <u>3</u>	psi gpm psi feet feet feet -	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be vali Calculate a, the total open area of t Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H V = (UTT, v1100)	40 5.65 0.1 0.7 32.2 32.2 123.0 <u>3</u> 85.3	psi gpm psi feet feet feet feet	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value? If $(Q/a)^*(estimated porosity) > 10$ the calculations may not be valid Calculate a, the total open area of the structure of the structu	40 5.65 0.1 0.7 32.2 123.0 <u>3</u> 85.3 144.3	psi gpm psi feet feet feet - feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value: If $(Q/a)^*(estimated porosity) > 10$ the calculations may not be valid Calculate a, the total open area of the Is Q/a^* (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2	psi gpm psi feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the calculate a the total open area of the calculate a, the total open area of total open are	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2	psi gpm psi feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the calculate a the total open area of the calculate a, the total open area of the table. CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, the calculate a, the total open area of the table. Head Loss, L: Distance from pressure gauge to bottom of test section, the table. Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2	psi gpm psi feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the calculate a, the total open area of total open area of the total open area of the total open area of total open area of the total open area of total open area of the total open area of	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2	psi gpm psi feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the calculate a, the total open area of total open area of the total open area of total open a	40 5.65 0.1 0.7 32.2 32.2 123.0 3 85.3 144.3 14.2 - - 48	psi gpm psi feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3 analysis	
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Is this step value: If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer	40 5.65 0.1 0.7 32.2 32.2 123.0 3 85.3 144.3 14.2 48 72	psi gpm psi feet feet feet feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 1 analysis Calue for Zone 2 and 3 analysis Cu for Zone 1 Cs for Zone 2 and 3	
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Is this step value: If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the Is Q/a * (estimated porosity) > 10? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using single packer (Method 1) Calculate K if Zone 2 and using single packer (Method 2)	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2 - 48 72	psi gpm psi feet feet - feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 3 analysis Cu for Zone 1 Cs for Zone 2 and 3 - cm/sec - cm/sec - cm/sec	
Is this step value? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid Calculate a, the total open area of the structure	40 5.65 0.1 0.7 32.2 123.0 3 85.3 144.3 14.2 - 48 72 -	psi gpm psi feet feet feet - feet %	4.7 square feet True, Test Valid 92.4 feet of water 0.013 ft ³ /sec (per tables) 1.5 feet of water 53.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 3 analysis Cu for Zone 4 analysis Value for Zone 5 and 3 c cm/sec c cm/sec c cm/sec	
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Is this step valid? If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

Packer Test GM-11R Redo **Permeability Calculations** Page 3 of 4

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CALCULATED PERMEABILITY FOR STEP 5					
Gauge Pressure, h2	30	psi	69.3 feet of water		
Flow Rate, Q:	4.47	gpm	0.010 ft ³ /sec		
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)		
Head Loss, L:	. 0.7	psi	1.5 feet of water		
Distance from pressure gauge to bottom of test section, h ₁ :	32.2	feet			
Value of h ₁ :	32.2	feet			
Effective Head, H where $H = h1 + h2 - L$:	99.9	feet	43.3 psi		
Determine Saturation Zone:		-	•		
Select Zone 1, 2, or 3	. 3		Zones 1 and 2 are unsaturated, 3 is saturated		
Tu = U-D+H	62.2	feet			
X = (H/Tu)*100	160.8	%			
Tu/A	10.3				
Determine Conductivity Coefficient					
H/r	-		Value for Zone 1 analysis		
A/H	-		Value for Zone 1 analysis		
A/r	48		Value for Zone 2 and 3 analysis		
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1		
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3		
Calculate K if Zone 1 and using single or double packer		ft/sec	- cm/sec		
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec		
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec		
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec		
Calculate K if Zone 3 and using double packer (Method 2)	1.11E-05	ft/sec	/sec 3.37E-04 cm/sec		
Is this step valid?					
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be value	d due to turbulen	t flow			

Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

Packer Test GM-11R Redo Permeability Calculations Page 4 of 4

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	9/27/2007
Well Label:	GM-11R
Aquifer Thickness:	42.56 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	28.94 feet
Water Table to Screen Bottom:	37.56 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0

There are 60 time and drawdown measurements Maximum head is 4.36 feet Minimum head is 0. feet



Analysis by Julie Petersen of S&ME, Inc.

Ho is 4.36 feet at 0. Seconds

PERMEABILITY 1.07 x 10⁻³ cm/sec



Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II. Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:

Oconee Nuclear Station - GWPP

S&ME Project No.:

1264-07-234



FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Oconee Nuclear Station - GWPP S&ME PROJECT NO.: 1264-07-234







S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Ocon	iee Nucli	ear Sta	ation			•								Bori	ing	No. (GM-	12	
Location	n: Seneo	ca, SC					Number	1264	-07-2	234	.,,				Sł	neet 1	No. 1	of 1		
Boring I	Depth (ft):		23.0 Elevation (ft): 695.1 Driller: Jay Little, SC Cert No. Date B1575					ate Drilled: 9/26/07												
Logged	By: David	l Klemm	h		Water Level:	Sta	bilized Wa	ater Level	l at 7	.91 ft bls		Dri	lling l	Meth	od: 4	¼" H	[.S.A.	,		
Elev. (Feet)	Depth (Feet)	Lith- ology		Materi	al Descriptio	n			Co	Well onstruct	ion	0	Pen	etrati	on Re	sista 50	nce (l	Blows	/Foo ⁻ 1	t) 100
	-		FILL	(F): Orange D	and Brown, Silt	ty, M	edium to F	ìine								T				
-																		ŀ		
F																				
- 	5-																			
E .																				
Ē	-		FILL	(F): Gray, S	Silty, Coarse to F	ine	SAND W	/ith	1		T									
					E (M1): Proum	S:1+	. Fine SA	ND	_		-				· .					
685	10-		With	Tan, Silty, F	ine SAND Fr	om l	0.10 ft to 1	0.40 ft						-		+				_
			Fron	n 19.00 ft to 1	9.20 ft bls	at		s and												
–																				
E																				
- 680 -	15														$\left \right\rangle$					-
Ē	-																			
675	20			/SAPROLIT	E (M1): Brown	, Mic	caceous, Si	lty, /				-								
			SOII	L/SAPROLIT	E (M1): White,	Silty	, Medium	to Fine												
			SAN	D wiin Qu	artz Kock Fragir	ients														
			Lith Bo	ologic Descr ring Termin	iptions Obtaine ated at 23.00 ft	d Fro bls	om GM-12	R												
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COMPLETION REPORT OF WELL No. GM-12

PROJECT: PROJECT NO: PROJECT LOCATION:	Oconee Nuclear 1264-07-234 Seneca, SC	Station		WATER LEVEL: Stabilized Water Level at 7.91 ft bls
				LATITUDE: 34°47'30.943"
DRILLING CONTRACTOR:	S&ME, Inc.			LONGITUDE: 82°53'33.023"
DRILLING METHOD:	4¼" H.S.A.			TOP OF CASING ELEVATION: 698.02
DATE DRILLED:	9/26/07			DATUM: MSL
				LOGGED BY: David Klemm
DESCRIPTION		DEPTH (ft.) LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
FILL (F): Orange and Brown, Silty, Medium to Fine SAND	0	0.00 GS 2.00	<u>695.09</u> 693.09	PROTECTIVE CASING Diameter: Type: Interval:
	5	4.00	691.09	RISER CASING Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 5 ft bls
FILL (F): Gray, Silty, Coarse to Fine SAND With Quartz Gravel SOIL/SAPROLITE (M1): Brown, Silty, Fine SAND With	10			GROUT Type: Neat Cement Interval: 0 to 2 ft bls
Tan, Silty, Fine SAND From 10.10 ft to 10.40 ft bls, and White, Silty, Fine SAND at 13.70 ft bls and From 19.00 ft to	15			SEAL Type: Bentonite Interval: 2 to 4 ft bls
		19.50	675.59	Type: #1 Silica Sand Interval: 4 to 20 ft bls
(M1): Brown,		20.00	675.09	
Micaceous, Silty,				SCREEN
SAND SOIL/SAPROLITE (M1): White, Silty, Medium to Fine SAND With Quartz Rock Fragments		23.00	672.09	Type: 0.010 Slotted PVC Interval: 5 to 20 ft bls
				LEGEND
				FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN STATIC WATER LEVEL TD TOTAL DEPTH CEMENT GROUT FD CEMENT GROUT
	9751 Southern	Pine Boulev	/ard	COMPLETION REPORT OF
ENGINEERING • TESTING ENVIRONMENTAL SERVICES	Charlotte, Norti	h Carolina 2	8273	Sheet 1 of 1

Sheet 1 of 1

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	9/27/2007
Well Label:	GM-12
Aquifer Thickness:	17.09 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	7.91 feet
Water Table to Screen Bottom:	12.09 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds Test starts with trial 0 There are 43 time and drawdown measurements Maximum head is 4.041 feet Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY 4.25 x 10⁻³ cm/sec



S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

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Project:	Project: Oconee Nuclear Station									Boring No. GM-12R								
Location	n: Seneca	, SC					Number	1264-	1264-07-234 Sheet No. 1 of 2									
Boring I	Depth (ft):		54.3	Elevation (ft):	695.2	Driller:	Jay Litt B1575	le, SC Ce	ert No.	D	ate D	rille	d: 9/2	4/07			
Logged	By: David	Klemm			Water L	Level: Sta	bilized Wa	ater Level	at 7.49 f	t bls	Drilling Method: 4¼" H.S.A.							
Elev. (Feet)	Depth (Feet)	Lith- ology		Material Description						ell uction	(Pe	eneti	ation 1	Resist	ance (Blows	/Foot) 100
- 695			FILL	(F): Orange	and Bro	wn, Silty, M	edium to F	ine				Í						
			DH															
											M	15	•					
- 690 -								·										
			FILL	(F): Grav. 9	Silty, Coa	rse to Fine	SAND V	Vith										
E			Quart	z Gravel	, eou													
Ē			SOIL	SAPROLIT	E (M1):	Brown, Silty	y, Fine SA	ND			X	74						
685 			bls, a	nd White, Si	Ity, Fine	SAND at	13.70 ft bl	s and										
 -			110111	17.00 It to 1	9.20 It 01	15												
-											Π							
-											Ň	•						
- 080																		
_																		
F											М							
675	20		SOIL Medi	/SAPROLIT	`Е (М1): SAND	Brown, Mic	aceous, Si	lty,			Ŋ	12		.				
23/08			SOIL	SAPROLIT	E (M1): artz Rock	White, Silty	, Medium	to Fine										
			57 H V	5 () (iii Qu		(i ruginentis								\setminus				
VGN01.											$\overline{\mathbb{N}}$	29		\mathbb{N}				
670	25										Δ							
			4.1100	* Defused of	27 20 64	bla												
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		کم کم کم امر کم کم امر کم ک	(WF) Intens	: Medium-C sely Weather	irained (red and Fi	GRANITIC ractured, Lo	GNEISS, w Angle Jo	oints Wițh										
0 2 2 2 665		کمر جمر ج امر جمر جم	No Si	aining								$\left - \right $						
		م بر بر . م بر بر م بر بر	SOUT	ND ROCK (D): Med	ium-Grained	GRANI	TIC										
		تم بم ربم بم ربم بم	GNE	ISS; Unfr	actured	Gramou	GIVIN											
		م بر بر بر بر بر بر بر بر	PAR (WF)	FIALLLY W	EATHE	RED/FRAC	FURED R	ОСК										
<u>م</u>		1.1	<u> </u>						4 DN	K/	LIL.				1		l	



S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project:	Ocor	nee Nucl	ear Sta	ition										I	Bori	ng]	No.	GN	1-12	R
Location	n: Sene	ca, SC					Number	: 1264-	07-2	34		Sheet No. 2 of 2								
Boring	Depth (ft):		54.3	Elevation (ft):	695.2	Driller:	Jay Littl B1575	le, SC	C Cert N	lo.	Da	te Dr	rilled: 9/24/07						
Logged	By: David	l Klemm	1		Water Leve	l: Sta	bilized W	ater Level	at 7.	.49 ft bls	5	Dr	illing	Meth	od: 4	1/4"	H.S.	A.		
Elev. (Feet)	Depth (Feet)	Lith- ology		Material Description						Well	ion		Per	etrati	on R	esist	ance	(Blo	ws/F	00t)
660		بر تر بر بر تر بر	Inten	sely Weather	ed and Fract	ured, Lo	w Angle J	oints With				H								
E	-	کم جم کم کم کم کم کم کم کر کم کم	SOU	ND ROCK (D): Medium	-Grained	GRANI	TIC												
E		م مرجز م ربر مرجز	SOU	ND ROCK (D): Medium	-Grained	GRANI	тіс												
	40	ا مرجم م مرجم مرجم م مرجم مرجم	GNE BIO	ISS With I FITE HORN	ntermittent S BLENDE G	eams of SNEISS	Medium-C Modera	Grained tely												
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F			SOU HOF	ND ROCK (RNBLENDE	D): Medium GNEISS W	-Grained /ith Inter	BIOTIT mittent	E												
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FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Contact

Core Location: GM-12R



FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234

Core Location: GM-12R



EXPLANATION



Fracture End of Run Contact Healed Joint



COMPLETION REPORT OF WELL No. GM-12R

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PROJECT: PROJECT NO: PROJECT LOCATION:	Oconee Nuclear S 1264-07-234 Seneca, SC	Station	WATER LEVEL: Stabilized Water Level at 7.49 ft bls
			LATITUDE: 34°47'30.895''
DRILLING CONTRACTOR:	S&ME, Inc.		LONGITUDE: 82°53'33.004"
DRILLING METHOD:	4¼" H.S.A.		TOP OF CASING ELEVATION: 698.18
DATE DRILLED:	9/24/07		DATUM: MSL
		<u> </u>	LOGGED BY: David Klemm
	WELL HE DETAILS	LEGEND (ft.) (ft.) (ft.)	WELL CONSTRUCTION DETAILS
FILL (F): Orange and Brown, Silty, Medium to Fine SAND FILL (F): Gray, Silty, Coarse to Fine SAND With Quartz Gravel SOIL/SAPROLITE (M1): Brown, Silty, Fine SAND With Quartz Gravel SOIL/SAPROLITE (M1): Brown, Silty, Fine SAND From 10.10 ft to 10.40 ft bls, and White, Silty, Fine SAND at 13.70 ft bls and From 19.00 ft to 19.20 ft bls SOIL/SAPROLITE (M1): Brown, Micaceous, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): White, Silty, Medium-Grained GRANITIC GNEISS Intensely Weathered and Fractured, Low Angle logists With No.		.00 GS 695.22	PROTECTIVE CASING Diameter: Type: Interval: PISER CASING Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 37 ft bls GROUT Type: Neat Cement Interval: 0 to 35 ft bls SEAL Type: Neat Cement Interval: 36.2 to 36.5 ft bls FILTERPACK Type: Interval: SCREEN Diameter: 2" Type: 0.010 Slotted PVC Interval: 37 to 42 ft bls EEGEND FILTER PACK TOC TOP OF CASING GROUND SURFACE BENTONITE BS BENTONITE B
Staining SOUND ROCK (D):	35	5.00 660.22	Image: Static Water Level Static Water Level Static Water Level Static Water Level
		• • • • • • • • • • • • • • • • • • •	
SSENER ENGINEERING - TESTIN ENVIRONMENTAL SERVICE	9751 Southern Pi Charlotte, North (ine Boulevard Carolina 28273	COMPLETION REPORT OF WELL No. GM-12R Sheet 1 of 2

PROJECT:	Oconee Nuclear Static	n
O FOT NO	4064 07 004	

PROJECT NO: 1264-07-234 PROJECT LOCATION: Seneca. SC GROUND SURFACE ELEVATION: LOGGED BY: 695.2 CHECKED BY: David Klemm

		00.	1000, 00				SHEGKED DI: Duvid Kichini
STRATA						z	
DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATIO (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
Medium-Grained GRANITIC GNEISS Unfractured PARTIALLLY	جر جر بر جر جر بر جر جر	- 35		36.20 36.40 37.00		659.02 658.82 658.22	
WEATHERED/FRACT ROCK (WF): Medium-Grained GRANITIC GNEISS Intensely Weathered and Fracturad Low	R D 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	-40		41.50		653.72	
Angle Joints With No Staining SOUND ROCK (D): Medium-Grained		- 45		44.50		650.72	
Unfractured (continued) SOUND ROCK (D): Medium-Grained							,
GRANIFIC GNEISS With Intermittent Seams of Medium-Grained BIOTITE	لر جمر م لر جمر م لر جمر م	- 50					
GNELENDE GNEISS; Moderately Fractured, Low Angle Joints With No Staining	ر بر بر . ر بر بر			54.30		640.92	
SOUND ROCK (D): Medium-Grained BIOTITE HORNBLENDE GNEISS With Intermittent							
Medium-Grained GRANITIC GNEISS Moderately Fractured, Low Angle Joints With No Staining							
SOUND ROCK (D): Medium-Grained GRANITIC GNEISS Moderately Fractured, Low Angle Joints With							
No Staining							
							FILTER PACK TOC TOP OF CASING GS GROUND SURFACE BENTONITE BS BENTONITE SEAL
							CEMENT GROUT CUTTINGS / BACKFILL STATIC WATER LEVEL CUTTINGS / BACKFILL CUTTINGS / BACKFILL
A C2			9751 Southern	Pine E	Boulev	vard	COMPLETION REPORT OF
	TESTIN L SERVIC	4G ES	Charlotte, Nor	th Carc	olina 2	28273	Sheet 2 of 2

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234



ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-12R







CLASSIFICATION:

27.30' to 37.60': Medium-Grained Granitic Gneiss

37.60' to 47.60': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss 47.60' to 54.30': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss



(Partially Weathered/Fractured Rock) 923.78 cm 91.46 cm

Time (sec)	Head (cm)	Permeability (cm/sec)		Calculation	<u>15</u>
0	366.46			$(2\dots I)$	
3	349.70	3.94E-03	d^2	$\ln\left(\frac{2mL}{mL}\right)$	mL
6	330.21	4.82E-03	· · ·	H_{L}	$1 \text{ for } \left \frac{1}{D} \right ^{4}$
9	316.46	3.58E-03	$\ K_{h} = -$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	
12	306.89	2.58E-03	∥ ″ 8∙	$L \cdot (t_2 - t_1) = H_2$	
15	300.24	1.84E-03	L		J
18	295.64	1.30E-03	Where:		
21	292.53	8.89E-04	K _h	is the Horizontal Coeffi	cient of Permeability (cm/sec)
24	290.27	6.51E-04	Нι	is the Piezometric Head	I for time; $t = t_1$ (cm)
27	288.63	4.78E-04	H ₂	is the Piezometric Head	I for time; $t = t_2$ (cm)
30	287.29	3.92E-04	D	is the Diameter of the S	tandpipe (cm)
			d	is the diameter of the O	pen Length (cm),
			m	is the Transformation R	atio, Where
				$m = \sqrt{K/K}$	K _h is the Horizontal Permeability
				$m = \sqrt{K_h/K_v}$	K_{y} is the Vertical Permeability
			L	is the Open Length of H	lole (cm)
			Spreadsheet a	ssumes 3" ID Pipe; NQ Hol	e, OD = 3"

MEAN PERMEABILITY (cm/sec) 2.05E-03



Site Name: ONS - GWPP Date: 9/20/2007 Boring I.D. GM-12R **Test Interval:** 15' to 18' **Total Depth of Hole:** 18 ft Length of Open Hole: 3 ft Transformation Ratio m= 1 Performed by: David Klemm

<u>Time (sec)</u>

(Soil/Saprolite) - 548.78 cm 91.46 cm

<u>Head (cm)</u>	Permeability (cm/sec)		Calculations
211.28			(2mI)
178.48	7.09E-04	$d^2 \cdot l^2$	$n \left[\frac{2mL}{m} \right]$ for mL_{1}
158.99	4.86E-04	- u 1	H_{1} D H_{1} H_{2} H_{1} H_{2}
145.67	3.68E-04	$K_{k} =$	$\frac{\langle D \rangle}{\langle D \rangle} \cdot \ln \frac{\langle D \rangle}{\langle D \rangle}$
136.19	2.83E-04		$(t_2 - t_1) = H_2$
129.24	2.20E-04		
124.05	1.72E-04	Where:	
		K _h	is the Horizontal Coefficient of Permeability (cm/sec)
		H_1	is the Piezometric Head for time; $t = t_1$ (cm)
		H ₂	is the Piezometric Head for time; $t = t_2$ (cm)
		D	is the Diameter of the Standpipe (cm)
		d '	is the diameter of the Open Length (cm),
		m	is the Transformation Ratio, Where
			$m = \sqrt{K/K}$ K _h is the Horizontal Permeability
			$\frac{m - \sqrt{K_h/K_v}}{K_v}$ K _v is the Vertical Permeability
		L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec) 3.73E-04



1-S&M

Site Name:	ONS - GWPP
Date:	9/21/2007
Boring I.D.	GM-12R
Test Interval:	27.3' to 35.3'
Total Depth of Hole:	35.3 ft
Length of Open Hole:	8 ft
Transformation Ratio m=	1
Performed by:	David Klemm

(Partially Weathered/Fractured and Sound Rock)) 1076.22 cm 243.9 cm

Time (sec)	Head (cm)	Permeability (cm/sec)		Calculation	<u>15</u>
0	396.19			$(2 \dots I)$	
3	391.59	4.82E-04	d^2	$\ln\left(\frac{2mL}{m}\right)$	mL
6	378.84	1.36E-03	и и	$D \to H_1$	$\left \frac{10r}{D} \right = \frac{1}{2} $
9	375.18	4.00E-04	$K_{h} = -$	$\frac{\sqrt{2}}{\sqrt{2}} \cdot \ln \frac{2}{\sqrt{2}}$	
12	371.04	4.58E-04	<i>"</i> 8∙⊿	$L \cdot (t_2 - t_1) = H_2$	
15	367.99	3.40E-04	·		J
18	365.49	2.81E-04	Where:		
21	- 363.38	2.38E-04	K _h	is the Horizontal Coeffi	cient of Permeability (cm/sec)
24	361.52	2.12E-04	H ₁	is the Piezometric Head	for time; $t = t_1$ (cm)
27	359.94	1.81E-04	H ₂	is the Piezometric Head	for time; $t = t_2$ (cm)
30	358.51	1.65E-04	D	is the Diameter of the S	tandpipe (cm)
45	353.35	1.19E-04	d	is the diameter of the O	pen Length (cm),
			m	is the Transformation R	atio, Where
				$m - \frac{K}{K}$	K _h is the Horizontal Permeability
				$m = \sqrt{K_h/K_v}$	K _v is the Vertical Permeability
			L	is the Open Length of H	lole (cm)
			Spreadsheet as	ssumes 3" ID Pipe: NO Hol	e, OD = 3"

MEAN PERMEABILITY (cm/sec)

3.86E-04



BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO .:	ONS - GWPP
LOCATION:	Seneca, SC
TEST DATE:	9/25/2007
TESTED BY:	Jay Little/Julie Petersen
GROUND ELEV (ft MSL):	695.2

BOREHOLE NO.:	GM-12R			
TEST INTERVAL:	37.0	to	42.0	bgs
TEST INTERVAL:	658.2	to	653.2	EL

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Flow (Q)	Q) Pressure (psi)			Permeability	Permeability	
	(gpm)	Gauge	Effective		(ft/sec)	(cm/sec)	
1	2.53	30	36	25	8.41E-06	2.6E-04	
2	3.45	40	46	27	9.0E-06	2.7E-04	
3	4.34	50	56	28	9.4E-06	2.9E-04	
4	3.45	40	46	27	9.0E-06	2.7E-04	
5	2.78	30	36	28	9.2E-06	2.8E-04	
			AVERAGE	27	9.0E-06	2.7E-04	
		SELECTE	DVALUES				

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION





PERMEABILITY CALCULATIONS FOR

EACH STEP OF TEST





CALCULATED PERMEABILITY FOR STEP 1

Gauge Pressure, h2	30	psi	69.3 feet of water
Flow Rate, Q:	2.53	gpm	0.006 ft ³ /sec
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)
Head Loss, L:	0.0	psi	0.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	14.5	feet	
Value of h ₁ :	14.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	83.8	feet	36.3 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	52.8	feet	
X = (H/Tu)*100	158.7	%	
Tu/A	10.6		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	40		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	8.41E-06	ft/sec	2.56E-04 cm/sec
Is this step valid?			

2.934

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 2			
Gauge Pressure, h2	40	psi	92.4 feet of water
Flow Rate, Q:	3.45	gpm	0.008 ft ³ /sec
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)
Head Loss, L:	0.0	psi	0.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	14.5	feet	
Value of h_1 :	14.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	106.9	feet	46.3 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	75.9	feet	
X = (H/Tu)*100	140.8	%	
Tu/A	15.2		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	40		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	8.99E-06	ft/sec	2.74E-04 cm/sec
Is this step valid?			

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

3.9 square feet True, Test Valid

CALCULATED PERMEADLE ITY FOR STER 3	_		
CALCULATED FERMEADILITY FOR STEP 3	50		
Gauge Flessure, uz	50	psi	115.5 feet of water
Flow Rate, Q:	4.34	gpm	0.010 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.4	psi	1.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	14.5	feet	
Value of h ₁ :	14.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	129.0	feet	55.9 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3	_	Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	98.0	feet	
$X = (H/Tu)^*100$	131.6	%	
Tu/A	19.6		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	40		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3
Calculate K if Zone I and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	it/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	9.37E-06	ft/sec	2.86E-04 cm/sec
is this step value: $I_{\alpha}(O(x)) = I_{\alpha}(O(x)) = I_{\alpha}(O(x))$			
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due Coloriations (Q/a)*	e to turbulen	t flow	,
Calculate a, the total open area of the te	st section:		3.9 square feet
1 - O(1 + (1 + 1) + 1) + 1000			
Is $Q/a * (estimated porosity) > 10??$			True, Test Valid
Is Q/a * (estimated porosity) > 10??			True, Test Valid
Is Q/a * (estimated porosity) > 10??			True, Test Valid
Is Q/a * (estimated porosity) > 10??			True, Test Valid
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2	40	psi	True, Test Valid 92.4 feet of water
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q:	40 3.45	psi gpm	92.4 feet of water 0.008 ft ³ /sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q: Head loss per TEN foot section of pipe:	40 3.45 0.0	psi gpm psi	True, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables)
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L :	40 3.45 0.0 0.0	psi gpm psi psi	True, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h ₁ :	40 3.45 0.0 0.0 14.5	psi gpm psi psi feet	True, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2. Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ :	40 3.45 0.0 0.0 14.5 14.5	psi gpm psi psi feet feet	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 : Flow Rate, Q : Head loss, p : TEN foot section of pipe: Head Loss, <i>L</i> : Distance from pressure gauge to bottom of test section, h ₁ : Value of h_1 : Effective Head, <i>H</i> where $H = h1+h2-L$:	40 3.45 0.0 0.0 14.5 14.5 106.9	psi gpm psi feet feet feet	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 : Flow Rate, Q : Head loss per TEN foot section of pipe: Head Loss, <i>L</i> : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, <i>H</i> where $H = h1+h2-L$: Determine Saturation Zone:	40 3.45 0.0 0.0 14.5 14.5 106.9	psi gpm psi feet feet feet	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : Value of h_1 : Effective Head, H where $H = h1+h2-L$: Determine Saturation Zone: Select Zone 1, 2, or 3	40 3.45 0.0 0.0 14.5 14.5 106.9 3	psi gpm psi feet feet feet	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones I and 2 are unsaturated, 3 is saturated
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q; Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : Value of h_1 : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H	40 3.45 0.0 0.0 14.5 14.5 106.9 <u>3</u> 75.9	psi gpm psi feet feet - feet	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : Value of h_1 : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100	40 3.45 0.0 0.0 14.5 14.5 106.9 <u>3</u> 75.9 140.8	psi gpm psi feet feet - feet %	Truc, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : Value of h_1 : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A	40 3.45 0.0 14.5 14.5 106.9 <u>3</u> 75.9 140.8 15.2	psi gpm psi feet feet feet %	True, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2	psi gpm psi feet feet feet %	Truc, Test Valid 92.4 feet of water 0.008 fl ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h_1 : Value of h_1 : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r	40 3.45 0.0 0.0 14.5 14.5 106.9 <u>3</u> 75.9 140.8 15.2	psi gpm psi feet feet feet feet %	True, Test Valid 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 : Flow Rate, Q : Head loss, p : TEN foot section of pipe: Head Loss, <i>L</i> : Distance from pressure gauge to bottom of test section, h ₁ : Value of h_1 : Effective Head, <i>H</i> where $H = h1+h2-L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2	psi gpm psi feet feet feet feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 1 analysis
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2 : Flow Rate, Q : Head loss per TEN foot section of pipe: Head Loss, <i>L</i> : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, <i>H</i> where $H = h1+h2-L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 - 40	psi gpm psi feet feet feet feet %	Year 92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h ₁ : Value of h ₁ : Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests:	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 40	psi gpm psi feet feet feet feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests:	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 - 40 64	psi gpm psi feet feet feet feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Cu for Zone 2 and 3
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 40 64	psi gpm psi feet feet - feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Cs for Zones 2 and 3 - cm/sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using single packer (Method 1)	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 - 40 64 -	psi gpm psi feet feet feet - feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3 - cm/sec - cm/sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss per TEN foot section of pipe: Head Loss, L: Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using double packer (Method 1) Calculate K if Zone 2 and using double packer (Method 2)	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 40 64	psi gpm psi feet feet feet - feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Cone 1 Cone 1 Case 2 and 3 - cm/sec - cm/sec - cm/sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q; Head loss per TEN foot section of pipe: Head Loss, L : Distance from pressure gauge to bottom of test section, h1; Value of h1; Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using single packer (Method 1) Calculate K if Zone 3 and using single packer (Method 1)	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 40 64	psi gpm psi feet feet feet % ft/sec ft/sec ft/sec	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones I and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Core 2 and 3 - cm/sec - cm/sec - cm/sec - cm/sec - cm/sec - cm/sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2: Flow Rate, Q: Head loss, per TEN foot section of pipe: Head loss, L: Distance from pressure gauge to bottom of test section, h1: Value of h1: Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using double packer (Method 1) Calculate K if Zone 3 and using single packer (Method 2) Calculate K if Zone 3 and using single packer (Method 2)	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 - 40 64 - - 8.99E-06	psi gpm psi feet feet feet - feet %	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 2 and 3 - cm/sec - cm/sec
Is Q/a * (estimated porosity) > 10?? CALCULATED PERMEABILITY FOR STEP 4 Gauge Pressure, h2; Flow Rate, Q: Head loss per TEN foot section of pipe: Head loss, L : Distance from pressure gauge to bottom of test section, h1; Value of h1; Effective Head, H where $H = h1 + h2 - L$: Determine Saturation Zone: Select Zone 1, 2, or 3 Tu = U-D+H X = (H/Tu)*100 Tu/A Determine Conductivity Coefficient H/r A/H A/r Select Cu from Fig 10-7 for Zone 1 tests: Cs for Zone 2 and 3 tests: Calculate K if Zone 1 and using single or double packer Calculate K if Zone 2 and using double packer (Method 1) Calculate K if Zone 3 and using single packer (Method 2) Calculate K if Zone 3 and using single packer (Method 2) Calculate K if Zone 3 and using single packer (Method 2) Calculate K if Zone 3 and using single packer (Method 1) Calculate K if Zone 3 and using single packer (Method 2) Is this step valid?	40 3.45 0.0 0.0 14.5 14.5 106.9 3 75.9 140.8 15.2 - 40 64 - - - 8.99E-06	psi gpm psi feet feet feet % fl/sec fl/sec fl/sec fl/sec	92.4 feet of water 0.008 ft ³ /sec (per tables) 0.0 feet of water 46.3 psi Zones 1 and 2 are unsaturated, 3 is saturated Value for Zone 1 analysis Value for Zone 1 analysis Value for Zone 2 and 3 analysis Cu for Zone 1 Core 2 and 3 - cm/sec

Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10?? 3.9 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 5			
Gauge Pressure, h2	30	psi	69.3 feet of water
Flow Rate, Q:	2.78	gpm	0.006 ft ³ /sec
Head loss per TEN foot section of pipe:	0.0	psi	(per tables)
Head Loss, L:	0.0	psi	0.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	14.5	feet	
Value of h ₁ :	14.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	83.8	feet	36.3 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	52.8	feet	,
X = (H/Tu)*100	158.7	%	
Tu/A	10.6		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	40		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	· -	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	9.24E-06	ft/sec	2.82E-04 cm/sec
Is this step valid?			
and the second		-	

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a^* (estimated porosity) > 10??

3.9 square feet True, Test Valid

> Packer Test GM-12R Test 2 Redo Permeability Calculations Page 4 of 4

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	9/27/2007
Well Label:	GM-12R
Aquifer Thickness:	39.51 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	7.49 feet
Water Table to Screen Bottom:	34.51 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds
Test starts with trial 0	
There are 69 time and drawdown m	easurements

Maximum head is 5.95 feet Minimum head is -1.6e-002 feet





Analysis by Julie Petersen of S&ME, Inc.

Ho is 5.95 feet at 0 Seconds

PERMEABILITY 8.30 x 10⁻⁴ cm/sec S&ME



S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project:	Oconee Nuclear Station											ĺ	Be	oring	No	. GN	А-13	3		
Location	ocation: Seneca, SC Number: 1264-0												Sheet No. 1 of 2							
Boring [Depth (ft):		46.2	Elevation (ft):	736.3	Driller:	Jay Litt B1575	le, SC Ce	ert No.	Date Drilled: 11/5/07									
Logged	By: Scott	Dacus			Water L	Water Level: Stabilized Water Level at 37.16 ft bls Drilling						ling N	1ethod:	4¼"	H.S./	A .				
Elev.	Depth (Feet)	Lith-		Materi	al Desc	ription			W	ell	_	Pene	tration	Resist	ance	(Blo	ws/Fo	oot)		
	(Peer)	XXXXX	PRF-	DUG HOLF	FOR LIT		ARANCE	·FILL		K K	0			5	0 			100		
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- 135																				
F																				
-	_		FILI	(F): Red an	d Brown	Micaceous	Silty CI	AV	$ \otimes $	\bigotimes										
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-	10-															-				
-725			FILL	(F): Brown	, Micaceo	us, Clayey,	SILT V	Vith												
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E	-	\bigotimes	501	SADDOL 17	E (M1)	Orange 117	vita and D													
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S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Location: Search, SC Number: 1264-07-234 Sheet No. 2 of 2 Boring Depth (fi): 46.2 Elevation (fi): 736.3 Driller: Aya, Little, SC Cert No. B1577 Date Datilizi: 11/507 Logged By: Scott Datest Water Level: Subbilized Water Level at 37.16 fib Drilling Method: 4/4" H.S.A. Elevation (fib: 0 abg/) Material Description Owner Construction 0 50 100 100	Project	Project: Oconee Nuclear Station Boring No. GM-13														
Boring Depth (II): 46.2 Elevation (II): 73.6 Driller Jay Lutits, SC Cert No. BHS73 Date Drilleg Method: 41/5/07 Leged By: Sort Dates Water Lavel: Stabilized Water Level at 37.16 A bis Derilling Method: 4/4" H.S.A. Liber, Depth Librology Material Description Weil Penetration Resistance (Blows/Foc) Construction 9 50 100 -700	Locati	on: Senec	a, SC				Number: 1264	-07-234	Sheet No. 2 of 2							
Lingged By: Sext Dacus Water Level: Stabilized Water Level at 37.16 ft bis Drilling Method: 4/4" H.S.A. Else, Opph Ling Material Description Veli Penetration Resistance (Blower/Bont) -700 -	Boring	g Depth (ft):		46.2	Elevation	(ft): 736.3	Driller: Jay Litt B1575	tle, SC Cert No.	Date Dr	Drilled: 11/5/07						
Lithologic Description Well Construction Penetration Resistance (Blowyllow) Construction Penetration Resistance (Blowyllow) Construction -700 -	Logge	d By: Scott l	Dacus			Water Level: St	abilized Water Leve	l at 37.16 ft bls	Drilling	Method	: 4¼" I	H.S.A.				
-700 -700 -695 -700 40 -700 415 -700 42 -700 43 -700 445 -700 45 -700 45 -700 45 -700 45 -700 45 -700 45 -700 45 -700 45 -700 45 -700 46 -700 45 <t< td=""><td>Elev. (Feet)</td><td>Depth (Feet)</td><td>Lith- ology</td><td></td><td>Mater</td><td>ial Description</td><td></td><td>Well Construction</td><td colspan="8">Penetration Resistance (Blows/Fc</td></t<>	Elev. (Feet)	Depth (Feet)	Lith- ology		Mater	ial Description		Well Construction	Penetration Resistance (Blows/Fc							
	DRING LOG WITH WELL RECOVERED ONS LOG. GPJ LAGWGN01.GDT 7/23/08			Litho Rol	logic Descr ler Cone Ro	iption Obtained Fre efusal at 46.20 ft bls	om GM-13R									

COMPLETION REPORT OF WELL No. GM-13

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 WATER LEVEL: Stabilized Water Level at 37.16 ft bls PROJECT LOCATION: Seneca, SC LATITUDE: 34°47'32.366" LONGITUDE: 82°53'36.494" DRILLING CONTRACTOR: S&ME, Inc. TOP OF CASING ELEVATION: 739.10 DRILLING METHOD: 41/4" H.S.A. DATUM: MSL DATE DRILLED: 11/5/07 LOGGED BY: Scott Dacus STRATA LEVATION (ft.) WELL LEGEND DEPTH (ft.) SYMBOL DEPTH (ft.) WELL CONSTRUCTION DETAILS DETAILS DESCRIPTION Щ **PROTECTIVE CASING** 0.00 736.25 Diameter: GS 0 PRE-DUG HOLE Type: FOR UTILITY Interval: CLEARANCE: FILL **RISER CASING** FILL (F): Red and Brown, Micaceous, Silty, CLAY Diameter: 2" Type: Sch. 40 PVC interval: 0 to 30.8 ft bls GROUT Type: Neat Cement Interval: 0 to 26.8 ft bls FILL (F): Brown, Micaceous, Clayey, SEAL SILT With Rock Type: Bentonite Fragments Interval: 26.8 to 28.8 ft bls FILTERPACK Type: #1 Silica Sand Interval: 28.8 to 45.8 ft bls SCREEN Diameter: 2" FILL (F): Gray and Type: 0.010 Slotted PVC Brown, Micaceous, Silty, CLAY With Interval: 30.8 to 45.8 ft bls Roots 123/08 25 26.80 709.45 GDT SOIL/SAPROLITE LEGEND S&ME. (M1): Orange, White, 28.80 707.45 and Brown, FILTER PACK GPJ Micaceous, Silty, TOC TOP OF CASING 30 GS GROUND SURFACE SAND 00 BENTONITE BS BENTONITE SEAL ONSL FP FILTER PACK CEMENT GROUT TOP OF SCREEN BOTTOM OF SCREEN TSC **CUTTINGS / BACKFILL** BSC RECOVERED ΤD TOTAL DEPTH ▼ STATIC WATER LEVEL CG CEMENT GROUT **COMPLETION REPORT OF** CORING 9751 Southern Pine Boulevard WELL No. GM-13 Charlotte, North Carolina 28273 Sheet 1 of 2 ENGINEERING • TESTING ENVIRONMENTAL SERVICES

Sheet 1 of 2

PROJECT: Oconee Nuclear Station GROUND SURFACE ELEVATION: PROJECT NO: 1264-07-234 LOGGED BY: 736.3 PROJECT LOCATION: Seneca, SC CHECKED BY: Scott Dacus STRATA ELEVATION (ft.) WELL LEGEND DEPTH (ft.) SYMBOL DEPTH (ft.) WELL CONSTRUCTION DETAILS DETAILS DESCRIPTION (See Page 1) 35 SOIL/SAPROLITE (M1): White, Tan, and Brown, Micaceous, Silty, SAND (continued) 40 45.30 690.95 45 45.80 690.45 46.20 690.05 7/23/08 RECOVERED ONS LOG.GPJ S&ME.GDT LEGEND FILTER PACK тос TOP OF CASING GS GROUND SURFACE BENTONITE BS BENTONITE SEAL FILTER PACK TOP OF SCREEN FP \otimes CEMENT GROUT TSC CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TD TOTAL DEPTH ▼ STATIC WATER LEVEL CG CEMENT GROUT NFI I **COMPLETION REPORT OF** MONITORING WELL No. GM-13



9751 Southern Pine Boulevard Charlotte, North Carolina 28273

Sheet 2 of 2

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPF
Test Date:	11/15/2007
Well Label:	GM-13
Aquifer Thickness:	13.64 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	37.16 feet
Water Table to Screen Bottom:	8.64 feet
Anisotropy Ratio:	1

Time Adjustment:0. SecondsTest starts with trial 0There are 46 time and drawdown measurementsMaximum head is 1.768 feetMinimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Adjusted Time (minutes) Ho is 1 768 feet at 0. Seconds

PERMEABILITY 5.05 x 10⁻³ cm/sec **\$S&ME**



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Project:	Ocor	iee Nucle	ear Sta	ar Station									Boring No. GM-								
Location	: Sene	ca, SC	<u></u>				Number	1264	-07-234				Sheet No. 1 of 2								
Boring D	Depth (ft):		68.2	Elevation (ft):	736.3	Driller:	Jay Litt B1575	le, SC Ce	ert No.	Da	ate Di	Drilled: 10/30/07								
Logged	By: Scott	Dacus			Water L	evel: Sta	abilized Water Level at 33.56 ft bls						Drilling Method: 4¼" H.S.A.								
Elev. (Feet)	Depth (Feet)	Lith- ology		Materi	al Desc	ription			W Constr	ell uction	(Pe	netration Resistance (Blows/Foot)								
-			PRE-	DUG HOLE	FOR UT	ILITY CLE	ARANCE	: FILL							Ť	Τ					
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-	、			(7) 5 1	1.12		<u></u>				,										
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- 730																					
E	-																				
											\mathbb{N}	10		<u> </u>							
- 725	-		FILL	(F): Brown	Micaceo	us Clavey	SILT V	Vith													
			Rock	Fragments		uo, chujej,	, in the second se														
E								×			Μ										
-											Å	10				_		<u> </u>			
720			. ,																		
F											Μ	16									
	20-										Δ		•		+			\rightarrow			
715	-			·																	
	-		FILL With	(F): Gray ar Roots	nd Brown	, Micaceous	, Silty, C	LAY	1 🕅					•							
	-										M	14				:					
	25-										Ш				+						
710																					
			SOIL Mica	/SAPROLIT ceous, Silty,	E (M1): SAND	Orange, Wh	ite, and B	rown,													
	· _										\mathbf{N}	20									
	30-										Ш		\top					+			
705	_		0.017	(0 A PR C 1 17			10														
			SOIL Mica	/SAPROLIT ceous, Silty,	E (M1): SAND	white, Tan,	and Brow	n,		×											
	-										X	15									
	35-					·															



S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. 1.D. SAMPLER 1 FT.

Project: Oconee Nuclear Station												Boring No. GM-13R						
Location	: Sene	ca, SC					Number: 1264	-07-234			Sheet No. 2 of 2							
Boring I	Depth (ft):	24	68.2	Elevation (Driller: Jay Litt B1575	Little, SC Cert No. Date Drilled: 10/30/07												
Logged	By: Scott	Dacus			l at 33.56 ft bls Drilling Method: 4¼" H.S.A.						•							
Elev. (Feet)	Depth (Feet)	Lith- ology		Mater	al Descri		Well		Penetration Resistance (Blows/Foot)									
Elev. (Feet) 700 695 695 695 690 690 690 690 685 685 685 685 685 685 685 685	Depth (Feet)	$ = \underbrace{ = } \\ = \underbrace{ - } \\ + \underbrace{ - }$	SOU GNE Stain Rolld SOU GNE BIO Fract Mod	Materi ND ROCK (CISS; Slight ing er Cone Refu Er Cone Refu Er Cone Refu Er Cone Refu	D): Mediu Iy Fracture D): Mediu Ity Fracture D): Mediu Itermittent NBLENDE Ingle and L Itaining	m-Grained d Low An 0 ft bls m-Grainec Medium-U GNEISS ow Angle	GRANITIC gle Joints With No Grained Moderately Joints With	Well Construction										
670		م تمر م م تمر م مر تمر م																
		<u>}</u>	Bori	ng Termina	ted at 68.15	5 ft bls												

FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-13R



FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-13R





EXPLANATION

End of Run
Contact
Healed Joint
COMPL

	COMPLETION REPORT OF WELL No. GM-13R	
PROJECT:	Oconee Nuclear Station	

PROJECT NO: 1264-07-234 WATER LEVEL: Stabilized Water Level at 33.56 ft bls PROJECT LOCATION: Seneca, SC LATITUDE: 34°47'32.417" LONGITUDE: 82°53'36.511" DRILLING CONTRACTOR: S&ME, Inc. TOP OF CASING ELEVATION: 739.18 DRILLING METHOD: 41/4" H.S.A. DATUM: MSL DATE DRILLED: 10/30/07 LOGGED BY: Scott Dacus STRATA LEVATION (ft.) WELL LEGEND DEPTH (ft.) SYMBOL DEPTH (ft.) WELL CONSTRUCTION DETAILS DETAILS DESCRIPTION Щ **PROTECTIVE CASING** 0.00 736.33 Diameter: GS 0 PRE-DUG HOLE Type: FOR UTILITY Interval: CLEARANCE: FILL **RISER CASING** FILL (F): Red and Brown, Micaceous, Diameter: 2" 5 Silty, CLAY Type: Sch. 40 PVC Interval: 0 to 58.15 ft bis GROUT Type: Neat Cement Interval: 0 to 55 ft bis FILL (F): Brown, Micaceous, Clayey, SILT With Rock SEAL Fragments Type: K-packer Interval: 57.58 to 57.78 ft bls FILTERPACK Type: Interval: 20 SCREEN FILL (F): Gray and Brown, Micaceous, Diameter: 2" Type: 0.010 Slotted PVC Silty, CLAY With Interval: 58,15 to 68.15 ft bis Roots 25 7/23/08 GDT SOIL/SAPROLITE (M1): Orange, White, LEGEND and Brown, Micaceous, Silty, SAND FILTER PACK TOC TOP OF CASING GPJ GS GROUND SURFACE BENTONITE 00 BS BENTONITE SEAL SOIL/SAPROLITE FILTER PACK FP ONS CEMENT GROUT (M1): White, Tan, and Brown, TOP OF SCREEN BOTTOM OF SCREEN TSC **CUTTINGS / BACKFILL** BSC RECOVERED Micaceous, Silty, TD TOTAL DEPTH ▼ STATIC WATER LEVEL SAND CEMENT GROUT CG **COMPLETION REPORT OF** NITORING 9751 Southern Pine Boulevard WELL No. GM-13R Charlotte, North Carolina 28273 Sheet 1 of 2 ENGINEERING • TESTING ENVIRONMENTAL SERVICES ĝ

E N I

Sheet 1 of 2

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234

GROUND SURFACE ELEVATION: LOGGED BY: 736.3

PROJECT LOCA	PROJECT LOCATION: Seneca, SC CHECKED BY: Scott Dacus						
STRATA						z	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGEND	ELEVATIO (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
					1		(See Page T)
		-	N///				
(M1): White, Tan,		-					
and Brown, Micaceous, Silty,		-		1			
SAND (continued)		40			·		
		ŀ					
SOUND ROCK (D): Medium-Grained	بر تر مر	-					
GRANITIC GNEISS Slightly Fractured Low	بربر بربر	-					
Angle Joints With No Staining	برجر جمر جم	-45					
Ŭ	بمرجم	F					
	بم تم مرجم	┢					
	ر بر بر . ر بر بر ا	-50					
	بم بم بر بر	+					
	ر ر بر بر بر ر	1					
	بم بم بر بر	[
	بربم	-55		55.00		681.33	
SOUND ROCK (D):	ج ج کم کو ج کم ک			57 50		670.75	
Medium-Grained	بربر	ŀ		57.58		678.55	
With Intermittent	بر بر بر	-		58.15		678.18	
	بربم بر						
GNEISS;	برتر	-					
High Angle and Low	بمرجم ا						
Angle Joints With Moderate to No	بر مربم	-65					
Staining	بر بر بر						
	ر کر کم	F		67.65		668.68 668.18	
3/08							
27							
ME.GC							LEGEND
19:0¢							BENTONITE GS GROUND SURFACE
							CEMENT GROUT FP FILTER PACK
							TSC TOP OF SCREEN BSC BOTTOM OF SCREEN
							TD TOTAL DEPTH CG CEMENT GROUT
	•	•		-		A	•
			• » <u>.</u>				COMPLETION REPORT OF
SXI	9751 Southern Pine Boulevard WELL No. GM-13R						
ENGINEERING	ENGINEERING - TESTING ENGINEERING - TESTING Sheet 2 of 2						
	L SERVIC	52					

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project

,



S&ME Project No: 1264-07-234

Boring Numl	ber:	GM-13R
Sample No: Depth (ft-bls): Blow Count:	1 8.5 - 10 3 * 4 * 6	CONTROL 2 10THS 8 = 3 100THS EL 4 FEET 6 3 NOHES 4 2014 5 Latiti 5 aven
Sample No: Depth (ft-bls): Blow Count:	2 13.5 - 15 4 * 4 * 6	2 PET A 3 INCHES & 3 INCHES A 4 INCHES 5 INCHES 6
Sample No: Depth (ft-bls): Blow Count:	3 18.5 - 20 4 * 7 * 9	
Sample No: Depth (ft-bls): Blow Count:	4 23.5 - 25 4 * 6 * 8	B ^{1/2} 2 ⁻²² maxi ³ matt ^{1,4} a litht ⁵ a ^{1/2} b ^{1/2} b ^{1/2} b ^{1/2} b ^{1/2} b ^{1/2} b ^{1/2} c ^{1/}
Sample No: Depth (ft-bls): Blow Count:	5 28.5 - 30 5 * 8 * 12	5 ¹ 2 ² und L-3 ² und L-3 ³ Lable ³ 5
Sample No: Depth (ft-bls): Blow Count:	6 33.5 - 35 7 * 9 * 6	3319 2 10THS & 3 10THS & 4

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



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Boring Numb	ber:	GM-13R
Sample No: Depth (ft-bls): Blow Count:	7 38.5 - 40 2 * 6 * 12	
Sample No: Depth (ft-bls): Blow Count:	8 43.5 - 45 10 * 14 * 8	B ² 9 2 ² 10 10 10 10 10 1 1 1 1 1 1 1 1 1 1

ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-13R



CLASSIFICATION:

46.10' to 56.60': Medium-Grained Granitic Gneiss56.60' to 68.15': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name: **ONS - GWPP** Date: 10/31/2007 Boring I.D. GM-13R **Test Interval:** 46.1' to 51.1' **Total Depth of Hole:** 51.1 ft Length of Open Hole: 5 ft Transformation Ratio m= 1 Performed by: Scott Dacus

(Sound Rock) 1557.93 cm 152.44 cm

Time (sec)	Head (cm)	Permeability (cm/sec)		Calculations
0	685.46		[$(2 \dots I)$
60	627.26	2.60E-04	d^2	$\ln\left(\frac{2mL}{mL}\right)$ for mL
120	609.97	8.18E-05	u	H_1 D H_1 $\frac{10}{D}^{4}$
180	603.23	3.25E-05	$\ K_{h} = -$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$
240	597.13	2.97E-05	8.	$L \cdot (t_2 - t_1) = H_2$
300	591.55	2.75E-05	ļ	
360	586.16	2.68E-05	Where:	
420	581.07	2.55E-05	K _h	is the Horizontal Coefficient of Permeability (cm/sec)
480	576.25	2.44E-05	H ₁	is the Piezometric Head for time; $t = t_1$ (cm)
540	571.68	2.33E-05	H ₂	is the Piezometric Head for time; $t = t_2$ (cm)
600	567.41	2.19E-05	D	is the Diameter of the Standpipe (cm)
900	549.42	1.89E-05	d	is the diameter of the Open Length (cm),
1200	532.74	1.80E-05	m	is the Transformation Ratio, Where
1500	515.00	1.98E-05		$m = \sqrt{K/K}$ K _h is the Horizontal Permeability
1800	500.34	1.69E-05		K_{v} is the Vertical Permeability
2400	477.80	1.35E-05	L	is the Open Length of Hole (cm)
3000	454.05	1.49E-05		
3600	431.62	1.48E-05	Spreadsheet as	ssumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec) 3.94E-05



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

S&ME

K_v is the Vertical Permeability

is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

Site Name: Date: Boring I.D. Test Interval: Total Depth of Length of Oper Transformation Performed by:	Hole: 1 Hole: n Ratio m=	ONS - GWPP 11/5/2007 GM-13R 43.5' to 46.2' 46.2 ft 2.7 ft 1 Scott Dacus	(Soil/Saprolite) 1408.54 cm 82.32 cm
Time (sec)	Head (cm)	Permeability (cm/sec)	Calculations
0	632.07		
60	623.45	6.21E-05	$d^2 \cdot \ln\left(\frac{2mL}{mL}\right)$
120	617.96	3.99E-05	$H_{1} = \frac{u + m}{D} H_{1} = \frac{tor}{D} 4$
180	613.57	3.22E-05	$\ K_{\mu} = \frac{\langle D \rangle}{\langle D \rangle} \cdot \ln \frac{\Pi_{1}}{\langle D \rangle}$
240	610.00	2.63E-05	$\ " 8 \cdot L \cdot (t_2 - t_1) H_2 \ $
300	606.52	2.58E-05	
360	603.08	2.57E-05	Where:
420	599.70	2.54E-05	K _h is the Horizontal Coefficient of Permeability (cm/sec)
480	596.43	2.46E-05	H_1 is the Piezometric Head for time; $t = t_1$ (cm)
540	593.26	2.41E-05	H ₂ is the Piezometric Head for time; $t = t_2$ (cm)
600	590.12	2.40E-05	D is the Diameter of the Standpipe (cm)
900	576.07	2.18E-05	d is the diameter of the Open Length (cm),
1200	563.54	1.99E-05	m is the Transformation Ratio, Where
1500	552.04	1.86E-05	$K_{\rm h}$ is the Horizontal Permeability
1000	F 41 24	1 775 05	$ m = \sqrt{\Lambda_h / \Lambda_v} \qquad "v + 1 + v + 1 + v + 1 + v$

L

MEAN PERMEABILITY (cm/sec) 2.54E-05

1.77E-05

1.70E-05

1.54E-05

1.12E-05



1800

2400

3000

3600

541.34

521.34

503.84 491.46



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material) and the family with the



Site Name:	ONS - GWPP
Date:	10/31/2007
Boring I.D.	GM-13R
Test Interval:	46.1' to 56.1'
Total Depth of Hole:	56.1 ft
Length of Open Hole:	10 ft
Transformation Ratio m=	1
Performed by:	Scott Dacus

<u>Time (sec)</u>

(Sound Rock) 1710.37 cm 304.88 cm

	Soon Duous			
Head (cm)	Permeability (cm/sec)		<u>Calculati</u>	ons
732.47			(2,I)	-
679.33	1.31E-04	d^2	$\ln\left(\frac{2mL}{2mL}\right)$	mL
668.05	2.91E-05	<u>и</u> и	(D) H .	10r $\frac{1}{D}$ 4
660.43	2.00E-05	$\ K_{h} = -$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	
652.77	2.03E-05	∥ ″ 8∙⊿	$L \cdot (t_2 - t_1) = H_2$	
645.79	1.87E-05	L		
640.40	1.46E-05	Where:	·.	
636.31	1.11E-05	K _h	is the Horizontal Coef	ficient of Permeability (cm/sec)
632.77	9.69E-06	H ₁	is the Piezometric Hea	ad for time; $t = t_1$ (cm)
629.15	1.00E-05	H ₂	is the Piezometric Hea	ad for time; $t = t_2$ (cm)
625.82	9.21E-06	D	is the Diameter of the	Standpipe (cm)
607.29	1.05E-05	d	is the diameter of the	Open Length (cm),
586.49	1.21E-05	m	is the Transformation	Ratio, Where
569.09	1.05E-05		$m = \sqrt{K/K}$	K _h is the Horizontal Permeability
556.83	7.57E-06		$m = \sqrt{m_h/m_v}$	K_v is the Vertical Permeability
530.79	8.33E-06		is the Open Length of	Hole (cm)
501.49	9.87E-06		-	
475.61	9.21E-06	Spreadsheet as	sumes 3" ID Pipe; NQ Ho	ole, OD = 3"

MEAN PERMEABILITY (cm/sec) 2.01E-05



BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO.:	ONS - GWPP
LOCATION:	Seneca, SC
TEST DATE:	11/1/2007
TESTED BY:	Adam Jennings/Scott Dacus
GROUND ELEV (ft MSL):	736.3

BOREHOLE NO.:	GM-13R				
TEST INTERVAL:	51.9	to	57.9	bgs	
TEST INTERVAL:	684.4	to	678.4	EL	

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Flow (Q)	Pressure (psi)		Lugeons	Permeability	Permeability
	(gpm)	Gauge	Effective	U.S.	(ft/sec)	(cm/sec)
1	6.33	30	45	42	1.50E-05	4.6E-04
2	6.43	40	55	35	1.2E-05	3.8E-04
3	7.97	50	65	37	1.3E-05	4.0E-04
4	7.25	40	55	39	1.4E-05	4.3E-04
5	6.38	30	45	42	1.5E-05	4.6E-04
			AVERAGE	39	1.4E-05	4.3E-04
		SELECTE	DVALUES			

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION





Packer Test GM-13R Test 2 Redo Permeability Calculations Page 1 of 4 PERMEABILITY CALCULATIONS FOR

CALCULATED PERMEABILITY FOR STEP 1				
Gauge Pressure, h2	30	psi	69	.3 feet of water
Flow Rate, Q:	6.33	gpm	0.0	4 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi		(per tables)
Head Loss, L:	0.6	psi	1	.3 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet		
Value of h ₁ :	36.5	feet		
Effective Head, H where $H = h1 + h2 - L$:	104.4	feet	45	.2 psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are u	nsaturated, 3 is saturated
Tu = U-D+H	80.4	feet		
$\mathbf{X} = (\mathbf{H}/\mathbf{T}\mathbf{u})^*100$	130.0	%		
Tu/A	13.3			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 ar	nalysis
A/H	-		Value for Zone 1 and	nalysis
A/r	48		Value for Zone 2 and	nd 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	•
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and	3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.50E-05	ft/sec	4.57E-()4 cm/sec
Is this step valid?				
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be vali	id due to turbulen	t flow		
Calculate a, the total open area of t	the test section:			4.7 square fe

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 2			
Gauge Pressure, h2	40	psi	92.4 feet of water
Flow Rate, Q:	6.43	gpm	0.014 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.6	psi	1.3 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = hI + h2 - L$:	127.5	feet	55.2 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	103.5	feet	
X = (H/Tu)*100	123.3	%	
Tu/A	17.2		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.25E-05	ft/sec	3.80E-04 cm/sec
Is this step valid?			

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

> Packer Test GM-13R Test 2 Redo Permeability Calculations Page 2 of 4

CALCULATED PERMEABILITY FOR STEP 3			
Gauge Pressure, h2	50	psi	115.5 feet of water
Flow Rate, Q:	7.97	gpm	0.018 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.6	psi	1.3 feet of water
Distance from pressure gauge to bottom of test section, \mathbf{h}_1 :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	150.6	feet	65.2 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3	_	Zones 1 and 2 are unsaturated, 3 is saturated
$T_{ll} = U - D + H$	126.6	feet	
X = (H/Tu)*100	119.0	%	
Τι/A	21.0		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.31E-05	ft/sec	3.99E-04 cm/sec
Is this sten valid?			

Is this step valid? If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

,

4.7 square feet True, Test Valid

CALCULATED PERMEABILITY FOR STEP 4					
Gauge Pressure, h2:	40	psi		92.4 feet of water	
Flow Rate, Q:	7.25	gpm		0.016 ft ³ /sec	
Head loss per TEN foot section of pipe:	0.1	psi		(per tables)	
Head Loss, L:	0.6	psi		1.3 feet of water	
Distance from pressure gauge to bottom of test section, h1:	36.5	feet			
Value of h ₁ :	36.5	feet			
Effective Head, H where $H = h1 + h2 - L$:	127.5	feet		55.2 psi	
Determine Saturation Zone:		-			
Select Zone 1, 2, or 3	3		Zones 1 and 2 a	re unsaturated, 3 is sa	iturated
Tu = U-D+H	103.5	feet			
X = (H/Tu)*100	123.3	%			
Τυ/Α	17.2				
Determine Conductivity Coefficient					
H/r	-		Value for Zone	1 analysis	
A/H	-		Value for Zone	1 analysis	
A/r	48		Value for Zone	2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1		
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2	and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec	
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec	
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec	
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec	
Calculate K if Zone 3 and using double packer (Method 2)	1.41E-05	ft/sec	4.2	9E-04 cm/sec	
Is this step valid?					
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid	due to turbulen	t flow			
Calculate a, the total open area of th	e test section:			4.7 sq	uare feet

Is Q/a * (estimated porosity) > 10??

True, Test Valid

Packer Test GM-13R Test 2 Redo Permeability Calculations Page 3 of 4

CALCULATED PERMEABILITY FOR STEP 5	4			
Gauge Pressure, h2	30	psi	69	.3 feet of water
Flow Rate, Q:	6.38	gpm	0.01	4 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi		(per tables)
Head Loss, L:	0.6	psi	1	.3 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet		
Value of h ₁ :	36.5	feet		
Effective Head, H where $H = h1 + h2 - L$:	104.4	feet	45	.2 psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3	-	Zones 1 and 2 are u	insaturated, 3 is saturated
Tu = U-D+H	80.4	feet		
X = (H/Tu)*100	130.0	%		
Tu/A	13.3			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 ar	nalysis
A/H	-		Value for Zone 1 at	nalysis
A/r	48		Value for Zone 2 and	nd 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	_
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and	3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	1.51E-05	ft/sec	4.61E-	04 cm/sec
Is this step valid?				

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a^* (estimated porosity) > 10??

.

.

4.7 square feet True, Test Valid

,

Packer Test GM-13R Test 2 Redo Permeability Calculations Page 4 of 4

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS



PROJECT NAME AND NO.:	ONS - GWPP	
LOCATION:	Seneca, SC	
TEST DATE:	11/1/2007	
TESTED BY:	Adam Jennings/Scott Dacus	
GROUND ELEV (ft MSL):	736.3	

BOREHOLE NO.:	GM-13R				
TEST INTERVAL:	58.9	to	64.9	bgs	
TEST INTERVAL:	677.4	to	671.4	EL	

TEST METHOD: Double Packer Method using Multiple Pressure Tests METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

RESULTS OF PERMEABILITY CALCULATIONS MULTIPLE STEP TEST

Step	Flow (Q)	Pressure (psi)		Lugeons	Permeability	Permeability
	(gpm)	Gauge	Effective	-	(ft/sec)	(cm/sec)
1	12.23	30	45	82	2.95E-05	9.0E-04
2	11.47	40	55	62	2.2E-05	6.8E-04
3	12.69	50	65	59	2.1E-05	6.4E-04
4	11.19	40	55	61	2.2E-05	6.6E-04
5	10.15	30	45	67	2.4E-05	7.3E-04
			AVERAGE	66	2.4E-05	7.2E-04
		SELECTE	DVALUES			1

Rock Description of Tested Interval:

Moderately Fractured Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

TEST INTERPRETATION



Packer Test GM-13R Test 1 Redo Permeability Calculations Page 1 of 4

PERMEABLETY CALCULATIONS FOR		ti aligi di	
EACH STEP OF TEST			S&ME
	hadan an de Ballan in an	<u></u>	i sellen en en del de ser del de la construction de la construcción de la construcción de la construcción de la La construcción de la construcción d
CALCULATED PERMEABILITY FOR STEP 1			
Gauge Pressure, h2	30	psi	69.3 feet of water
Flow Rate, Q:	12.23	gpm	0.027 ft ³ /sec
Head loss per TEN foot section of pipe:	0.2	psi	(per tables)
Head Loss, L:	1.3	psi	3.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet	
Value of \mathbf{h}_1 :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	102.8	feet	44.5 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3	_	Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	71.7	feet	
$\mathbf{X} = (\mathbf{H}/\mathbf{T}\mathbf{u})^*100$	143.3	%	
Tu/A	11.9		
Determine Conductivity Coefficient			
H/r ·	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	• •	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.95E-05	ft/sec	8.98E-04 cm/sec
Is this step valid?			
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid	d due to turbulen	t flow	
Calculate a, the total open area of the	he test section:		4.7 square feet
Is Q/a * (estimated porosity) > 10?	?		True, Test Valid
CALCULATED PERMEABILITY FOR STEP 2			· · · ·
Gauge Pressure, h2	40	psi	92.4 feet of water
Flow Rate, Q:	11.47	gpm	0.026 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.6	psi	1.5 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	127.4	feet	55.2 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	96.3	feet	
X = (H/Tu)*100	132.3	%	
Tu/A	16.0	-	

-

48

72

Determine Conductivity Coefficient

Cs for Zone 2 and 3 tests:

Select Cu from Fig 10-7 for Zone 1 tests:

H/r

A/H

A/r

 Calculate K if Zone 1 and using single or double packer
 ft/sec

 Calculate K if Zone 2 and using single packer (Method 1)
 ft/sec

 Calculate K if Zone 2 and using double packer (Method 2)
 ft/sec

 Calculate K if Zone 3 and using single packer (Method 1)
 ft/sec

 Calculate K if Zone 3 and using single packer (Method 1)
 ft/sec

 Calculate K if Zone 3 and using double packer (Method 2)
 2.23E-05
 ft/sec

 Is this step valid?
 If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent llow
 Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

Value for Zone 1 analysis

Value for Zone 1 analysis

Cu for Zone 1

-

-

-

Cs for Zones 2 and 3

Value for Zone 2 and 3 analysis

cm/sec

cm/sec

cm/sec

cm/sec 6.80E-04 cm/sec

> Packer Test GM-13R Test 1 Redo Permeability Calculations Page 2 of 4

CALCIULATED DEDMEADILITY FOD STED 2			· · · · · · · · · · · · · · · · · · ·
CALCULATED PERMIEABILITY FURSTERS	50		115 5 5
Gauge Pressure, n2;	50	psı	115.5 leet of water
Flow Rate, Q:	12.69	gpm	0.028 ft ³ /sec
Head loss per TEN foot section of pipe:	0.2	psi	(per tables)
Head Loss, L:	1.3	psi	3.0 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	149.0	feet	64.5 psi
Determine Saturation Zone:		-	
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	117.9	feet	
X = (H/Tu)*100	126.4	%	
Tu/A	19.6		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)		ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.11E-05	ft/sec	6.43E-04 cm/sec
Is this step valid?			,
If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be value	id due to turbuler	t flow	
Calculate a, the total open area of t	the test section:		4.7 square feet
Is Q/a * (estimated porosity) > 10?	??		True, Test Valid
		•	
CALCULATED PERMEABILITY FOR STEP 4			
Gauge Pressure, h2	40	psi	92.4 feet of water
			2

Flow Rate, O:	11.19	gom	0.025 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.6	psi	1.5 feet of water
Distance from pressure gauge to bottom of test section, \mathbf{h}_1 :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	127.4	feet	55.2 psi
Determine Saturation Zone:		-	·
Select-Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	96.3	feet	
X = (H/Tu)*100	132.3	%	
Tu/A	16.0		
Determine Conductivity Coefficient			
H/r -	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	. 72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.17E-05	ft/sec	6.63E-04 cm/sec
Is this step valid?			
If $(O/a)^*$ (estimated porosity) > 10 the calculations may not be vali	d due to turbulen	t flow	

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow Calculate a, the total open area of the test section: Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

> Packer Test GM-13R Test 1 Redo Permeability Calculations Page 3 of 4

CALCULATED PERMEABILITY FOR STEP 5			
Gauge Pressure, h2	30	psi	69.3 feet of water
Flow Rate, Q:	10.15	gpm	0.023 ft ³ /sec
Head loss per TEN foot section of pipe:	0.1	psi	(per tables)
Head Loss, L:	0.6	psi	1.5 feet of water
Distance from pressure gauge to bottom of test section, h ₁ :	36.5	feet	
Value of h ₁ :	36.5	feet	
Effective Head, H where $H = h1 + h2 - L$:	104.3	feet	45.2 psi
Determine Saturation Zone:		-	·
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated
Tu = U-D+H	73.2	feet	
X = (H/Tu)*100	142.4	%	
Tu/A	12.2		
Determine Conductivity Coefficient			
H/r	-		Value for Zone 1 analysis
A/H	-		Value for Zone 1 analysis
A/r	48		Value for Zone 2 and 3 analysis
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1
Cs for Zone 2 and 3 tests:	72		Cs for Zones 2 and 3
Calculate K if Zone 1 and using single or double packer	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	- cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.41E-05	ft/sec	7.34E-04 cm/sec
Is this step valid?			

If $(Q/a)^*$ (estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section:

Is Q/a * (estimated porosity) > 10??

4.7 square feet True, Test Valid

> Packer Test GM-13R Test 1 Redo Permeability Calculations Page 4 of 4

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/15/2007
Well Label:	GM-13R
Aquifer Thickness:	39.59 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	33.56 feet
Water Table to Screen Bottom:	34.59 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds
Test starts with trial 0	
There are 72 time and drawdown m	easurements
Maximum head is 1.738 feet	

Minimum head is 0. feet





Analysis by Julie Petersen of S&ME, Inc.

Ho is 1 738 feet at 0 Seconds

PERMEABILITY

1.64 x 10⁻⁴ cm/sec





FETTER AND BEAR DIAGRAMS

5&ME

S&ME PROJECT: Oconee Nuclear Station - GWPP **S&ME PROJECT NO.:** 1264-07-234





1264-07-234

FETTER AND BEAR DIAGRAMS

& ME

S&ME PROJECT: Oconee Nuclear Station - GWPP S&ME PROJECT NO.: 1264-07-234





Estimated Porosity: 42.5%





S&ME, Inc. 9751 Southern Pine Boulevard Charlotte, North Carolina 28273 Telephone: 704-523-4726 Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Ocor	iee Nucl	ear Sta	tion									Bo	ring	No. G	M-1	4
Location	n: Sene	ca, SC					Number	1264-	07-234					Sheet	No. 1	of 1	
Boring I	Depth (ft):		29.0	Elevation (ft):	719.6	Driller:	Jay Littl B1575	le, SC Ce	ert No.	Da	te Dril	led: 11/	13/07			
Logged	By: Scott	Dacus			Water Level: Stabilized Water Level at 18.50 ft bl					ft bls	Dri	illing N	ling Method: 4¼" H.S.A.				
Elev. (Feet)	Depth (Feet)	Lith- ology		Materi	al Descri	iption			W Consti	ell	0	Pene	tration	Resista 50	ance (B	lows/F	⁷ oot) 100
		×××××	GRA	VEL						X	Ť			ΤĨ			
E	_		FILL	(F): Reddis	h-Brown, S	ilty, CLA	Y			Ø					•		
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700	20-		FILL	(F): Orange	and Brown	n, Clayey,	SILT										
	_							,									
	_		SOIL	/SAPROLIT	E (M1): T	an, White.	and Brown	n,									
	_		Micad	ceous, Silty,	Medium to	Fine SA!	ND										
695 5	25-									13			<u> </u>]
3-	–									THE SECTION							
	_																
			SOIL	/SAPROLIT	E (M1): B	lack, Whit	e, and Gra	у,									
	-	1.1.		ceous, Silty,	Medium to	Fine SAI	ND With	Rock		1643	┼─╂	_		+		\vdash	
			\Fragn	nents	ntion Obt	ained From	n CM-141	<u> </u>									
			Bor	ing Termin	ated at 29.	00 ft bls	in ():41-141	`									
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COMPLETION REPORT OF WELL No. GM-14

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 WATER LEVEL: Stabilized Water Level at 18.50 ft bls PROJECT LOCATION: Seneca, SC LATITUDE: 34°47'41.305" LONGITUDE: 82°53'30.305" DRILLING CONTRACTOR: S&ME, Inc. TOP OF CASING ELEVATION: 722.62 DRILLING METHOD: 41/4" H.S.A. DATUM: MSL DATE DRILLED: 11/13/07 LOGGED BY: Scott Dacus STRATA EVATION (ft.) WELL LEGEND DEPTH (ft.) SYMBOL DEPTH (ft.) DETAILS WELL CONSTRUCTION DETAILS DESCRIPTION Щ **PROTECTIVE CASING** 0.00 719.56 Diameter: GS 0 GRAVEL Type: FILL (F): Interval¹ Reddish-Brown, Silty, CLAY **RISER CASING** Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 13.43 ft bis GROUT 710.13 9.43 Type: Neat Cement 10 Interval: 0 to 9.43 ft bls 11.43 708.13 SEAL Type: Bentonite Interval: 9.43 to 11.43 ft bis FILL (F): Brown, 15 Micaceous, Silty, SAND FILTERPACK Type: #1 Silica Sand Interval: 11.43 to 28.43 ft bis FILL (F): Orange and 20 Brown, Clayey, SCREEN SILT Diameter: 2" Type: 0.010 Slotted PVC SOIL/SAPROLITE Interval: 13.43 to 28.43 ft bls (M1): Tan, White, and Brown, 25 Micaceous, Silty, Medium to Fine SAND 27.93 691.63 LEGEND SOIL/SAPROLITE 28.43 691.13 WAR A (M1): Black, White, 29.00 690.56 FILTER PACK TOC TOP OF CASING and Gray, Micaceous, GS GROUND SURFACE Silty, Medium to Fine BENTONITE BENTONITE SEAL BS SAND With Rock FP FILTER PACK CEMENT GROUT Fragments TSC TOP OF SCREEN **CUTTINGS / BACKFILL** BSC BOTTOM OF SCREEN TOTAL DEPTH TD ▼ STATIC WATER LEVEL CEMENT GROUT CG **COMPLETION REPORT OF** 9751 Southern Pine Boulevard WELL No. GM-14 Charlotte, North Carolina 28273 Sheet 1 of 1 ENGINEERING • TESTING ENVIRONMENTAL SERVICES

501

S&ME

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RECOVERED

PONITORING

Sheet 1 of 1

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/14/2007
Well Label:	GM-14
Aquifer Thickness:	14.93 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	18.5 feet
Water Table to Screen Bottom:	9.93 feet
Anisotropy Ratio:	1

Time Adjustment:0. SecondsTest starts with trial 0There are 74 time and drawdown measurementsMaximum head is 2.223 feetMinimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Ho is 2.223 feet at 0 Seconds

PERMEABILITY 1.49 x 10⁻³ cm/sec



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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586. 2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project:	Ocor	nee Nucl	ear Sta	ition										Bori	ng I	No. (GM-	14R	Ł
Location	n: Sene	ca, SC	SC Number: 1264-07-234									1	S	heet	No.	l of 2	2		
Boring I	Depth (ft):		68.0 Elevation (ft): 719.6 Driller: Jay Little, SC Cert No. Date Dril B1575							rilled	: 11/7	/07							
Logged	By: Scott	Dacus	Water Level: Stabilized Water Level at 4.80 ft bls Drilling Method: 41/4" H.S.A.								,								
Elev.	Depth (Feet)	Lith-		Materi	al Descrip	otion			W	ell		Penetration Resistance (Blows/Foot)							ot)
	(1 cet)	××××××	GRA	VEL) [!			50	, 			100
F			FILL	(F): Reddis	h-Brown, Sil	ty, CLA	Y												
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			SOIL	./SAPROLIT	E (M1): Tar	n, White,	and Brown	n,											
695	-		Mica	ceous, Silty,	Medium to F	Fine SAI	ND			Ň	X	13						l	
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	_		Mica	ceous, Silty,	Medium to F	ine SA	ND			₿	:								
Ď–	-												X						
685	-										X	15	4						



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Project:	Ocen	ee Nucl	ear Sta	tion								F	Boring	g No.	. GM	-14R	
Location: Seneca, SC Number: 1264-07-234								1	She	et No.	2 of	2					
Boring I	Depth (ft):		68.0	Elevation ([ft):	719.6	Driller: Jay Litt B1575	le, SC Cert	No.	D	ate D	rilled:	11/7/01	7			
Logged By: Scott Dacus Water Level: Stabilized Water Level at 4.80 ft bls Drilling						g Method: 4¼" H.S.A.											
Elev. (Feet)	Depth (Feet)	Lith- ology		Mater	al Descrip	tion		Well	tion	Penetration Resistance (Blows/Foot)							
Elev. (Feet)	Depth (Feet)		WEA Tan, Fine Roll d SOU HOI Stair WEA Whit SAN SOU GNE HOI HOI Stair	Materi ATHERED R White, and E SAND er Cone Refu ND ROCK (RNBLENDE erately Fractu- ting ATHERED R te and Brown D; (Core Lo ND ROCK (EISS With J RNBLENDE zontal, Low A ting	OCK (M2): ' Brown, Micace Isal at 39.80 D): Medium- GNEISS S Ured, Low An OCK (M2): ' , Micaceous, ss) D): Medium- ntermittent Sc GNEISS S Angle, and Hi	tion When Sa eous, Sil ft bls -Grained Slightly gle Join When Sa Silty, M -Grained eams of Moderat igh Angl	ampled Becomes Ity, Medium to BIOTITE Weathered, ts With Moderate ampled Becomes edium to Fine I GRANITIC BIOTITE ely Fractured, e Joints With No	Well			Pee)					s/Foo	
655	65	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~							4								
			Bori	ng Termina	ted at 68.00 f	t bls						,					

FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-14R



FIELD ROCK CORE LOG

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-14R



COMPLETION REPORT OF WELL No. GM-14R

PROJ PROJECT PROJECT LOCAT	IECT: T NO: TION:	Oco 1264 Sen	nee Nuclea 4-07-234 eca, SC	r Stati	on		WATER LEVEL: Stabilized Water Level at 4.80 ft bls
DRILLING CONTRAC DRILLING MET DATE DRIL	TOR: HOD: _LED:	S&N 4¼" 11/7	1E, Inc. H.S.A. /07				LATITUDE: 34°47'41.293" LONGITUDE: 82°53'30.362" TOP OF CASING ELEVATION: 722.59 DATUM: MSL LOGGED BY: Scott Dacus
DESCRIPTION	SYMBOL	иегін (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
GRAVEL FILL (F): Reddish-Brown, Silty, CLAY		0	Y	0.00	GS	719.63	PROTECTIVE CASING Diameter: Type: Interval: RISER CASING Diameter: 2" Type: Sch. 40 PVC Interval: 0 to 57.5 ft bls GROUT Type: Neat Cement Interval: 0 to 54 ft bls SEAL
FILL (F): Brown, Micaceous, Silty, SAND FILL (F): Orange and Brown, Clayey, SILT		15 20					FILTERPACK Type: Interval: SCREEN
SOIL/SAPROLITE (M1): Tan, White, and Brown, Micaceous, Silty, Medium to Fine SAND SOIL/SAPROLITE (M1): Black, White, and Gray, Micaceous, Silty, Medium to Fine SAND With Rock Fragments		25 X// X// X// X// X// X// X// X// X// X/					Diameter: 2 Type: 0.010 Slotted PVC Interval: 57.5 to 67.5 ft bls LEGEND FILTER PACK TOC BENTONITE GS BENTONITE BS CEMENT GROUT FP FILTER PACK TOC CEMENT GROUT FP FILTER PACK TOC CUTTINGS / BACKFILL BSC STATIC WATER LEVEL TD TOTAL DEPTH CEMENT GROUT
MONITORING WELL REC SS&A ENGINEERING ALL ENGINEERING A	TESTING	97 C	751 Southerr harlotte, Nor	Pine E th Carc	Boulev blina 2	vard 18273	COMPLETION REPORT OF WELL No. GM-14R Sheet 1 of 2

PROJECT: Oconee Nuclear Station PROJECT NO: 1264-07-234 PROJECT LOCATION: Seneca, SC GROUND SURFACE ELEVATION: LOGGED BY: 719.6 CHECKED BY: Scott Dacus

STRATA						z	
DESCRIPTION	SYMBOL	DEPTH (ft.)	DETAILS	DEPTH (ft.)	LEGEND	ELEVATIO (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Tan, White, and Brown, Micaceous, Silty, Medium to Fine SAND (continued) WEATHERED ROCK (M2): When Sampled Becomes Tan, White, and Brown, Micaceous, Silty, Medium to Fine SAND Roller Cone Refusal at 39.80 ft bls SOUND ROCK (D): Medium-Grained BIOTITE HORNBLENDE GNEISS; Slightly Weathered, Moderately Fractured, Low Angle Joints With Moderate Staining WEATHERED ROCK (M2): When Sampled Becomes White and Brown, Micaceous, Silty, Medium to Fine SAND; (Core Loss) SOUND ROCK (D): Medium-Grained GRANITIC GNEISS With Intermittent Seams of BIOTITE HORNBLENDE GNEISS; Moderately Fractured, Horizontal, Low Angle, and High Angle Joints With No Staining		- 35		54.00 56.93 57.13 57.50 67.00 67.50 68.00		665.63 662.70 662.50 662.13 652.63 652.13 651.63	
COVERED ONS LOG.GPJ S&ME.GDT							LEGEND FILTER PACK TOC TOP OF CASING BENTONITE GS GROUND SURFACE BENTONITE BS BENTONITE SEAL CEMENT GROUT FP FILTER PACK CUTTINGS / BACKFILL BSC BOTTOM OF SCREEN TOTAL DEPTH TOTAL DEPTH CG CEMENT GROUT
S8			9751 Southerr Charlotte, Nor	n Pine E th Card	3oulev blina 2	vard 28273	COMPLETION REPORT OF WELL No. GM-14R
	• TESTIN L SERVIC	ig Es					Sheet 2 of 2

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Num	ber:	GM-14R
Sample No: Depth (ft-bls): Blow Count:	1 8.5 - 10 4 * 4 * 6	B : 1 2 10 HB 3 B 100 HB FT. • 4 Lufth: 5 • • • • • • • • • • • • • • • • • • •
Sample No: Depth (ft-bls): Blow Count:	2 13.5 - 15 6 * 6 * 8	B: 1 2 10THS & 3 100THB ET #4 2 FEET & 3 HOLES 4 HILL REF. 6
Sample No: Depth (ft-bls): Blow Count:	3 18.5 - 20 3 * 2 * 1	Bite 2 fortis a 3 100 HS EL . 4 FEET A 3 INCHES 4 FEET 4 Luikin 5 From 6 8 10 10 10 10 10 10 10 10 10 10
Sample No: Depth (ft-bls): Blow Count:	4 23.5 - 25 8 * 7 * 6	Process of a state of
Sample No: Depth (ft-bls): Blow Count:	5 28.5 - 30 10 * 26 * 14	1° 2 UTHE & 9 JUTHE FT. 2 PEET 8 3 NOLES 4
Sample No: Depth (ft-bls): Blow Count:	6 33.5 - 35 8 * 7 * 8	10 2 11 2 11 14 14 5 141 5 000 7 8 9 17 18 19 11 1F 1 12 3 3 4 1

SPLIT SPOON SAMPLE PICTURES

Oconee Nuclear Station - Groundwater Protection Project



S&ME Project No: 1264-07-234

Boring Number: GM-14R

Sample No: Depth (ft-bls): 38. Blow Count: 5

7 38.5 - 40 50/1

No Recovery

Page 2 of 2

ROCK CORE PICTURES

Oconee Nuclear Station - Groundwater Protection Project S&ME Project No: 1264-07-234



Core Location: GM-14R



CLASSIFICATION:

39.80' to 41.10': Medium-Grained Biotite Hornblende Gneiss
41.10' to 44.10': Soil
44.10' to 68.00': Medium-Grained Granitic Gneiss With Intermittent Biotite Hornblende Gneiss

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

Site Name:	ONS - GWPP
Date:	11/8/2007
Boring I.D.	GM-14R
Test Interval:	39.8' to 44.8'
Total Depth of Hole:	44.8 ft
Length of Open Hole:	5 ft
Transformation Ratio m=	1
Performed by:	Scott Dacus

(Weathered/Sound Rock) 1365.85 cm 152.44 cm

Time (sec)	Head (cm)	Permeability (cm/sec)		Calculation	ns
0	579.02			$(2 \dots I)$	
60	523.66	2.94E-04	d^2	$\ln\left[\frac{2mL}{2mL}\right]$	mL
120	515.09	4.83E-05	u u	$D \to H_{\rm c}$	10r $\frac{1}{D}$ 4
180	506.52	4.91E-05	$K_h = -$	$\frac{\sqrt{2}}{\sqrt{2}} \cdot \ln \frac{1}{2}$	
240	498.60	4.62E-05	∥ " 8∙⊿	$L \cdot (t_2 - t_1) = H_2$	
300	493.11	3.24E-05]
360	488.75	2.60E-05	Where:		
420	484.09	2.81E-05	K _h	is the Horizontal Coeff	icient of Permeability (cm/sec)
480	480.18	2.37E-05	H ₁	is the Piezometric Head	I for time; $t = t_1$ (cm)
540	477.04	1.92E-05	H ₂	is the Piezometric Head	I for time; $t = t_2$ (cm)
600	473.38	2.25E-05	D	is the Diameter of the S	standpipe (cm)
900	458.05	1.93E-05	d	is the diameter of the O	pen Length (cm),
1200	448.02	1.30E-05	m	is the Transformation R	tatio, Where
1500	442.04	7.86E-06		$m = \sqrt{K/K}$	K _h is the Horizontal Permeability
1800	436.13	7.89E-06		$m = \sqrt{m_h/m_v}$	K_v is the Vertical Permeability
2400	419.70	1.12E-05	L	is the Open Length of I	lole (cm)
3000	406.65	9.25E-06			
3600	395.85	7.87E-06	Spreadsheet as	sumes 3" ID Pipe; NQ Hol	e, OD = 3"

MEAN PERMEABILITY (cm/sec) 3.92E-05

Graph of Field Data



S&ME

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CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

ONS - GWPP Site Name: Date: 11/7/2007 Boring I.D. GM-14R **Test Interval:** 28.5' to 31.5' Total Depth of Hole: 31.5 ft 3 ft Length of Open Hole: Transformation Ratio m= 1 Performed by: Scott Dacus

(Soil/Saprolite) 960.37 cm 91.46 cm

Time (sec)	<u>Head (cm)</u>	Permeability (cm/sec)		Calculations	
0	416.86			(2 - I)	
60	404.15	1.30E-04	d^2	$\ln\left(\frac{2mL}{m}\right)$ for	mL
120	394.09	1.06E-04		H_{1}	$\left \frac{1}{D}\right\rangle 4$
180	385.95	8.77E-05	$\ K_{h} =$	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	
240	378.96	7.67E-05	∥ ″ 8∙⊿	$L \cdot (t_2 - t_1) = H_2$	
300	372.93	6.75E-05	·		
360	367.47	6.20E-05	Where:		
420	361.01	7.46E-05	K _h	is the Horizontal Coefficient of Perr	neability (cm/sec)
480	356.25	5.57E-05	H ₁	is the Piezometric Head for time; t =	t _l (cm)
540	352.62	4.30E-05	H ₂	is the Piezometric Head for time; t =	• t ₂ (cm)
600	348.08	5.45E-05	D	is the Diameter of the Standpipe (cn	1)
900	326.86	5.29E-05	d	is the diameter of the Open Length (cm),
1200	313.57	3.49E-05	m	is the Transformation Ratio, Where	
1500	303.48	2.75E-05		$m = \sqrt{K/K}$ K _h is the Hol	rizontal Permeability
1800	292.68	3.04E-05		$\frac{m - \sqrt{K_h / K_v}}{K_v \text{ is the } V}$	/ertical Permeability
2400	277.62	2.22E-05	L	is the Open Length of Hole (cm)	
3000	268.35	1.43E-05			
3600	255.09	2.13E-05	Spreadsheet as	sumes 3" ID Pipe; NQ Hole, OD = 3"	

MEAN PERMEABILITY (cm/sec) 5.66E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (Open Hole in Uniform Material)

ONS - GWPP Site Name: 11/8/2007 Date: Boring I.D. GM-14R 39.8' to 49.8' **Test Interval:** 49.8 ft **Total Depth of Hole:** Length of Open Hole: 10 ft Transformation Ratio m= 1 Performed by: Scott Dacus

(Weathered/Sound Rock) 1518.29 cm 304.88 cm

<u>Time (sec)</u>	Head (cm)	Permeability (cm/sec)		Calculation	<u>S</u>
0	634.39	×		$(2 \dots I)$	
60	577.96	1.62E-04	d^2 .	$\ln\left(\frac{2mL}{m}\right)$	mL_{1}
120	573.23	1.43E-05	а 1	$\begin{bmatrix} D \\ D \end{bmatrix} = H_1$	$\frac{10}{D}$
180	569.24	1.22E-05	$\ K_{h} = -$	$\frac{\sqrt{2}}{\sqrt{2}} \cdot \ln \frac{1}{1}$	
240	565.73	1.07E-05	∥ ″ 8 <i>·1</i>	$L \cdot (t_2 - t_1) = H_2$	
300	562.90	8.74E-06			
360	560.55	7.27E-06	Where:		
420	558.48	6.44E-06	K _h	is the Horizontal Coeffic	eient of Permeability (cm/sec)
480	556.40	6.47E-06	H ₁	is the Piezometric Head	for time; $t = t_1$ (cm)
540	554.70	5.34E-06	H ₂	is the Piezometric Head	for time; $t = t_2$ (cm)
600	552.84	5.84E-06	D	is the Diameter of the Sta	andpipe (cm)
900	542.38	6.64E-06	d	is the diameter of the Op	en Length (cm),
1200	532.26	6.55E-06	m	is the Transformation Ra	itio, Where
1500	523.81	5.56E-06		$m = \sqrt{K/K}$ K	K_h is the Horizontal Permeability
1800	515.98	5.24E-06		$m = \sqrt{\frac{1}{h}} \frac{1}{k_v}$	K_v is the Vertical Permeability
2400	506.13	3.35E-06	L ·	is the Open Length of He	ole (cm)
3000	497.01	3.16E-06			
3600	483.60	4.76E-06	Spreadsheet as	sumes 3" ID Pipe; NQ Hole	, OD = 3"

MEAN PERMEABILITY (cm/sec)

1.61E-05




Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	ONS-GWPP
Test Date:	11/14/2007
Well Label:	GM-14R
Aquifer Thickness:	67.7 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	4.8 feet
Water Table to Screen Bottom:	62.7 feet
Anisotropy Ratio:	1
Time Adjustment:	12. Seconds
Test starts with trial 2	
There are 148 time and drawdown	measurements

Maximum head is 0.334 feet Minimum head is 0. feet



Analysis by Julie Petersen of S&ME, Inc.

Adjusted Time (Hours) Ho is 0.334 feet at 12 Seconds

SSAME

PERMEABILITY 1.89 x 10⁻⁵ cm/sec



FETTER AND BEAR DIAGRAMS

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