KINGSTON FOSSIL PLANT MONITORING WELLS NSTALLATION JAN 2005

Hensley, Christopher W.

From: Petty, Harold L.

Sent: Friday, February 04, 2005 8:26 AM

To: Hensley, Christopher W.

Subject: FW: Analyses cross section in Cad

Chris:

Please print out a half size of each of these. Print this e-mail and put all in the notebook/

Thanks, Lynn

-----Original Message----- **From:** TElkady@GeoSyntec.com [mailto:TElkady@GeoSyntec.com] **Sent:** Thursday, February 03, 2005 7:01 PM **To:** Petty, Harold L.; Daniel.R.Smith@worleyparsons.com; Smith, Amos L; Boggs, J. Markus; Bowers, Larry C; eGreg.McNulty@parsons.com **Cc:** GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES; TElkady@GeoSyntec.com **Subject:** Analyses cross section in Cad

Dear All:

I hope this email finds you all well.

I am attaching a total of 6 CAD files that define the limits of the analysis cross section and the boundaries of subsurface stratigraphy along the agreed analysis cross sections for different analyses cases.

As we discussed, Case 1 represents the current conditions at the site (for calibration purposes); Case 2 represents conditions that occurred during failure; and Case 3 represents assumed future condition.

For future conditions, it is assumed that wet disposal of fly ash will continue by raising the dikes in stages until the disposal life of a certain stage is significantly reduced. At this point, it is anticipated that operations at in the dredge cells will switch to dry disposal. Approximate calculations (assuming fly ash disposal rate to be 398,000 cy/year as reported in the Dregde Cells Operation plans) estimated the disposal life to be about 8 to 9 months with top of dike at elevation 902 ft. Given the short disposal life at this stage, it is anticipated that operations in the dredge cells will switch to dry disposal. Therefore, Case 3 (future conditions) cross section assumes wet disposal of fly ash up to elevation 902 ft with water level 2 feet below top of the dike (i.e., 900 ft).

A brief description of the contents of Cad File is as follows:

- File titled "Cell I-case 1&2" defines the boundaries of the subsurface layers along the Cell I cross section drawn with vertical exaggeration.
- File titled "Cell I-case 1&2 to scale" defines the boundaries of subsurface layers along the Cell I cross section drawn with no vertical exaggeration.
- File titled "Cell I-case3" defines the boundaries of the subsurface layers along the Cell I cross section for assumed future conditions.
- File titled " Cell III-Case 1&2" defines the boundaries of the subsurface layers along the Cell III cross section drawn with vertical exaggeration.
- File titled " Cell III-Case 1&2 to scale" defines the boundaries of subsurface layers along the Cell III cross section drawn with no vertical exaggeration.
- File titled "Cell III-case3" defines the boundaries of the subsurface layers along the Cell III cross section for assumed future conditions.

If you have any questions/comments, please let me know.

Tamer

Tamer Y. Elkady, Ph.D. Senior Staff Engineer GeoSyntec Consultants 1255 Roberts Blvd NW Suite 200 kennesaw, GA, 30144-3694 (678)202-9500



Petty, Harold L.

From:Rick Pope [rpope.conetec@verizon.net]Sent:Wednesday, December 08, 2004 1:53 PMTo:Petty, Harold L.Subject:Ch values

Len,

Here's the table of values you requested.

If you should have any questions, give Bruce a call.

Thanks

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TABLE 1 - SUMMARY OF CPTU SUMMARY OF



Job No.:	04-717
Location:	TVA Fossil Fuel Power Plant – Kingston, Tennessee
Client:	MACTEC Engineering and Consulting Inc.
Date:	March 22, 23, 24, 2004

Comments	ran out of rods, having more shipped in.			redue of CPT-1																					2nd attempt - 1st attempt refusal at 2.6 feet					
T-50 (sec)	8.1	35.8	3.1	0.9	8.8	7.4	2.8	3.7	82.3	16.8	3.3	4.1	4.1	4.7	8.2	5.9	2.9	3.3	4.2	240.8		3.2	6.2	3.4		4.3	4.3	7.3	85.1	
U-max	120.00	79.07	76.82	58.75	100.24	110.28	58.61	92.12	185.18	110.05	110.33	182.18	172.93	175.75	89.26	104.18	63.92	106.81	153.18	217.80		55.24	116.15	90.10		55.24	58.71	85.55	67.01	
Est. Water Table Depth (ft)	27.60	2.70	10.02	28.22	28.22	28.22	28.22	28.22	28.22	36.85	36.85	36.85	36.85	36.85	25.35	25.35	25.35	25.35	25.35	25.35	23.42	6.74	6.74	6.74	20.28	11.04	9.40	9.40	9.40	
C _h (cm^2/min)	88.564	19.980	229.583	118.641	81.812	96.486	255.305	193.953	119.160	42.706	218.692	174.721	175.375	153.321	86.870	121.524	246.170	214.634	172.003	2.974		226.680	114.745	210.577		166.052	165.432	97.874	8.412	
Jissipation depth (ft)	50.03	31.66	52.00	32.32	51.35	52.00	68.41	71.69	81.36	48.39	64.80	71.36	74.64	77.92	61.84	65.12	71.69	74.97	78.25	80.38		22.47	25.75	29.04		35.43	35.43	38.71	62.09	
Pore Water Pressure Dissipation Tests (sec)	1,000	400	475	1,625						490					2,304						0	145			200	145	605			7,389
Total Depth (ft)	50.03	47.41	71.69	95.14						87.93					95.14						63.98	49.38			61.52	69.06	60.79			758.4
File Name	71 7cp001.cor	71 7cp01 0.cor	717cp008.cor	717cp01a.cor						71 7cp006.cor					717cp004.cor						717cp011.cor	717cp009.cor			717cp12a.cor	71 7cp00n.cor	717cp00s.cor			11
CPTU Sounding	CPT-1	CPT-10	CPT-8	CPT-1A						CPT-6					CPT-4						CPT-11	CPT-9			CPT-12A	DIKE N	DIKE S			
Date	22-Mar-04	23-Mar-04	23-Mar-04	23-Mar-04						23-Mar-04					24-Mar-04						24-Mar-04	24-Mar-04			24-Mar-04	24-Mar04	24-Mar-04			Totals:

22 Marie 28FER 28 FER 10 MAR IZ MAY 30 SCP IS APR NULIO O/JUN 5 Amendory-JT DESIN RTO - DRIVER CEL SWPPP TO TOEL FR DRAIN STUDY PROT RAVION MID 1070 REVIEW 50% DCN RENEW 100% DON RAVIEN STRET CONST Essue DCN

S. S. at rey 28FER 28 FER 10 MAR 30 SCP IZ MAV O J JUN O(JUN IS APR 51 Annadory -JT DESIGN RTO - DREVOSE CELL SWPPP TO TIDEL FR DRAIN STUDY PROT RAVION MID 1070 REVIEW 50% DON RENEW 10070 DON RAVIEN STRET CONST Essue DON

KIF Dredge Cell Dike Summary of Slug/Pump Test Results

	Screen Ir	nterval (ft)			K (c	m/s)	
Well	from	to	Media	BR	CBP	Hvorslev	Mean
MW-1	9.6	19.6	ash	1.7E-05	2.4E-05	2.5E-05	2.2E-05
MW-3A	29.6	39.6	ash	3.5E-05	2.4E-05	5.3E-05	3.7E-05
MW-4A	4.0	9.0	FA	5.1E-06	5.0E-06	8.6E-06	6.2E-06
MW-4B	19.0	24.0	BA	1.2E-05	2.4E-06	1.6E-05	1.0E-05
MW-5A	42.5	47.5	FA	3.7E-05	1.3E-05	4.7E-05	3.2E-05
MW-6A	50.0	55.0	BA-FA	1.6E-04	7.3E-05	2.1E-04	1.5E-04
MW-7A	40.0	45.0	BA-FA	2.3E-05	8.5E-06	3.8E-05	2.3E-05
MW-7B	60.0	65.0	BA	1.5E-04	5.1E-05	2.0E-04	1.3E-04
MW-8A	20.0	25.0	BA-FA	6.0E-05	2.2E-05	8.8E-05	5.7E-05
MW-8B	35.0	40.0	FA	1.0E-05	1.0E-05	9.9E-06	1.0E-05
MW-9A	10.0	15.0	FA-fill	1.1E-06	2.9E-05	1.4E-06	1.0E-05
MW-9B	20.0	25.0	BA-FA	1.3E-03	3.2E-04	1.8E-03	1.1E-03

Slug Test Results Assuming Bedrock as Lower Aquifer Boundary (Original)

Slug Test Results Assuming Ash-Alluvium Interface as Lower Aquifer Boundary (New)

	Screen Ir	nterval (ft)			K (c	m/s)		Diff. in
Well	from	to	Media	BR	CBP	Hvorslev	Mean	Means
MW-1	9.6	19.6	ash	1.7E-05	3.5E-05	2.5E-05	2.6E-05	17%
MW-3A	29.6	39.6	ash	3.5E-05	2.4E-05	5.3E-05	3.7E-05	0%
MW-4A	4.0	9.0	FA	5.2E-06	9.9E-06	8.6E-06	7.9E-06	27%
MW-4B	19.0	24.0	BA	1.3E-05	5.3E-06	1.6E-05	1.1E-05	11%
MW-5A	42.5	47.5	FA	3.7E-05	1.3E-05	4.7E-05	3.2E-05	1%
MW-6A	50.0	55.0	BA-FA	1.6E-04	9.9E-05	2.1E-04	1.6E-04	6%
MW-7A	40.0	45.0	BA-FA	2.3E-05	1.2E-05	3.8E-05	2.4E-05	5%
MW-7B	60.0	65.0	BA	1.6E-04	7.2E-05	2.0E-04	1.4E-04	6%
MW-8A	20.0	25.0	BA-FA	6.1E-05	3.6E-05	8.8E-05	6.2E-05	9%
MW-8B	35.0	40.0	FA	1.0E-05	1.7E-05	9.9E-06	1.2E-05	24%
MW-9A	10.0	15.0	FA-fill	1.2E-06	7.8E-05	1.4E-06	2.7E-05	159%
MW-9B	20.0	25.0	BA-FA	1.5E-03	9.4E-04	1.8E-03	1.4E-03	22%

Pump Test Results Assuming Ash-Alluvium Interface as Lower Aquifer Boundary

	Screen Ir	nterval (ft)			K (cm/s)	
Well	from	to	Media	CJ	Theis	Mean
MW-3B	29.6	39.6	alluvium	1.3E-04	7.2E-05	1.0E-04
MW-5B	4.0	9.0	BA	3.5E-04	5.4E-05	2.0E-04
MW-6B	19.0	24.0	BA-FA	1.7E-04	1.8E-05	9.6E-05

01/28/2005

Correlation of Kavg and Media Type



	Screen Ir	nterval (ft)		
Well	from	to	Media	K _{avg} (cm/s)
MW-4A	4.0	9.0	FA	7.9E-06
MW-4B	19.0	24.0	BA	1.1E-05
MW-8B	35.0	40.0	FA	1.2E-05
MW-7A	40.0	45.0	BA-FA	2.4E-05
MW-1	9.6	19.6	ash	2.6E-05
MW-9A	10.0	15.0	FA-fill	2.7E-05
MW-5A	42.5	47.5	FA	3.2E-05
MW-3A	29.6	39.6	ash	3.7E-05
MW-8A	20.0	25.0	BA-FA	6.2E-05
MW-6B	70.0	75.0	BA-FA	9.6E-05
MW-3B	95.0	100.0	alluvium	1.0E-04
MW-7B	60.0	65.0	BA	1.4E-04
MW-6A	50.0	55.0	BA-FA	1.6E-04
MW-5B	62.5	67.5	BA	2.0E-04
MW-9B	20.0	25.0	BA-FA	1.4E-03

FA - fly ash

BA - bottom ash

KIF_test_summary_2.xls

01/28/2005

Saturated thickness -	WT to bedrock (ft)	74.7	69.69	73.0	65.7	41.8	38.2	75.6	78.5	67.8	67.4	73.8	71.9	64.3	62.6	53.8	52.0
Saturated thickness - WT to top	alluvium (ft)	45.0	44.6	53.5	AN	32.8	29.2	62.4	65.3	47.0	46.6	47.6	45.7	40.5	38.8	23.8	22.0
	WT to BOS (ft)	12.1	16.7	9.1	62.2	7.8	19.2	29.9	52.8	19.8	39.4	7.6	25.7	10.8	24.1	10.8	19.0
Depth BGS	to bedrock (ft)	82.2	87.5	103.5	103.5	43.0	43.0	93.2	93.2	103.0	103.0	111.2	111.2	78.5	78.5	58.0	58.0
Depth BGS	to alluvium (ft)	52.5	62.5	84.0	84.0	34.0	34.0	80.0	80.0	82.2	82.2	85.0	85.0	54.7	54.7	28.0	28.0
1/21/05 WT	Elevation (ft-msl)	774.1	177.1	780.6	772.9	765.6	761.8	786.5	789.7	773.0	772.3	774.3	772.6	770.6	769.8	760.5	759.1
	WT depth BGS (ft)	7.5	17.9	30.5	37.8	1.3	4.8	17.6	14.8	35.2	35.6	37.4	39.3	14.2	15.9	4.2	6.0
	WT depth BTOC (ft)	7.8	18.4	30.9	38.7	2.7	6.7	18.6	17.3	37.7	36.6	40.0	40.0	15.7	17.4	4.2	6.6
	BOS depth (ft)	19.6	34.6	39.6	100.0	0.6	24.0	47.5	67.5	55.0	75.0	45.0	65.0	25.0	40.0	15.0	25.0
	TOS depth (ft)	9.6	24.6	29.6	95.0	4.0	19.0	42.5	62.5	50.0	70.0	40.0	60.09	20.0	35.0	10.0	20.0
Estimated	fill up in screen (ft)	1.6	10.2	1.9	-2.1	1.1	2.2	-2.5	0.4	0.0	0.0	0.1	0.0	1.4	-1.9	-0.1	0.5
MACTEC Reported	Well Depth BGS (ft)	20.2	35.2	40.2	100.6	9.6	24.6	48.1	68.1	55.6	75.6	45.6	65.6	25.6	40.6	15.6	25.6
TVA Measured	Well Depth BGS (ft)	18.0	24.4	37.7	102.1	2.9	21.8	50.0	67.1	55.0	75.0	44.9	65.0	23.6	41.9	15.1	24.5
TVA Measured	Well Depth BTOC(ft)	18.3	24.9	38.1	103.0	9.3	23.7	51.0	69.69	57.5	76.0	47.5	65.7	25.1	43.4	15.1	25.1
	Stick-up (ft)	0.3	0.5	0.4	0.9	1.4	1.9	1.0	2.5	2.5	1.0	2.6	0.7	1.5	1.5	0.0	0.6
Grade	Elevation (ft-msl)	781.6	795.0	811.1	810.7	766.8	766.6	804.1	804.4	808.3	807.9	811.7	811.9	784.8	785.7	764.7	765.1
TOC	(ft-msl)	781.87	795.50	811.45	811.56	768.21	768.49	805.08	806.92	810.76	808.89	814.30	812.56	786.26	787.19	764.70	765.68
	Well	1-WW	MW-2	MW-3A	MW-3B	MW-4A	MW-4B	MW-5A	MW-5B	MW-6A	MW-6B	MW-7A	MW-7B	MW-8A	MW-8B	MW-9A	MW-9B

KIF Dredge Cell - Piezometer Information Summary

Abbreviations: TOC - top of casing BTOC - below top of casing BGS - below ground surface TOS - top of screen BOS - bottom of screen WT - water table

KIF_piezometer_info.xls

01/28/2005



KIF_well_profiles_r0.xls

2006 2008				X		\square	•	•	7									W B F B				
Actual Mhrs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0.00	0.00										
Frest / Mhrs		0.00	60.00	0.00	00.00	0.00	0.00	0.00	0.00	24.00	0.00	0.00	9									
Bdgt Mhrs		0.00	60.00 2	0.00	00.00	0.00	0.00	0.00	0.00	24.00	0.00	0.00	2									
Res			s2PC, 2		DCE 3				DCE	s2RU 3												
Э.		đ	CPP 13	ЧÜ	DP	dCl	P	đ	H H	Ц ПР	ЧQ	PD										
Prin F Engr		НГР	HLPR	НГР	НГР В	НГР	НСР В	НГР	НГР	DLLR	нгр R	нгр R										
Resp Engr		HMS	SMH							DLL		HWS										
Total Float		0	0	148	0	148	σ	0	6	7	6	0								72		
Finish Target											-		1000	فك وار	10 27					Sheet 142 of 1		
Forecast Finish		06FEB06	120CT08	14FEB06	29JUN08	02FEB08	29JUN08	29JUN08	21SEP08	23SEP08	23SEP08	120CT08	3.5	ي دير	150.						e valler AU Layout 70	
Forecast Start		06FEB06	06FEB06	14FEB06	14FEB06	15MAR06			01JUL08	22SEP08			Cri Jun		XOX							
P S Activity S E -ID T C	Implementation (Phase 3)	D 30 LDKCK530PA KIF530 Receive Phase 3 FPEP Approval	D 30 LDKCK530PS KIF530 Phase 3 - Project Support Mhrs (Hammock)	D 35 LDKCK530X1 KIF530 Issue Partner PA	D 99 LDKCK530NS KIF530 Implementation Field Support	D 35 LDKCK530PO Implementation And Construction Period	D 35 LDKCK530NO KIF530 DCN KIF-0X-XXX RTO	D 35 LDKCK530PT KIF530 Project Turnover	D 35 LDKCK530ND KIF530 Closure Process of DCN KIF-0X-XXX	D T2 LDKCK530RU ERU ASSEMBLE AND DISTRIBUTE KIF-0X-XXX	D 35 LDKCK530NC KIF530 DCN KIF-0X-XXX Closed	D 30 LDKCK530PC KIF530 Verify Benefits & Close Project	The DRAM CIVIL Says	pravel PRAN- RD	chil per XY M					Start Date 01JAN89 Early Bar FHEN Early Bar Prinish Date 02AUG13	Data Date 14JAN05 15:40 Critical Activity	© Primavera Systems, Inc.

TVA-00013543

P S Activity	and the second se	1						ć				2000
} 	Description	Start	Finish	rınısn Target	Float Eng	25	빌	S C	Mhrs	Mhrs	Actual Mhrs	2002 - 2002
- ×											4	
KIF530 DEVEL	OP FLY ASH/BOTTOM ASH CAP /	CITY										
Preliminary Engg	(Phase 1)											
A 30 LDKAK530PA KI	F530 Phase 1 - Prelim Engr Approved	22SEP04A	010CT04A		SM	NS H	H SMF		00.0	0.00	0.00	
A 30 LDKAK530PS KI	F530 Ph 1 - Project Support Mhrs Hammock	22SEP04A	31MAR05		-55 SM	NS T	H SMF	I FDPE,	260.00	120.00	80.00	
A 35 LDKAK530X1 KI	F530 Conduct Study (French Drains)	08OCT04A	20 January 05		-55 MSI	보	P RDF	FDCEA	120.00	187.00	187.00	
A 15 LDKAK530X4 KI	F530 Estimators Prep Total Pkg Est (Matrix)	08DEC04A	20DEC04A	7	CT.		H RDF	TS2CE	40.00	94.00	94.00	×-
A 30 LDKAK530X3 KI	F530 Prepare Ph 2 FPEP Pkg (French Drain)	24MAR05*	31MAR05		-55 SM	г Т	P RDF		0.00	0.00	0.00	M
A 30 LDKAK530R0 KI	F530 Prelim Engr Proj Review Mtg (French Drn)	23 30MAROS	2 POMAROS	. (-54 SMI	보	P RDF		0.00	0.00	0.00	<u>×</u>
A 30 LDKAK530PC Pr	eliminary Engr Complete (French Drain)	n	8 (JIMMEROS (04FEB05	-95 SMI	<u> </u>	P RDF		0.00	0.00	0.00	٠
A 30 LDKAK530X5 KI	F530 Submit Ph 2 Pkg for Appr'l (French Drain)		31MAR05			<u>_</u>	P RDF		0.00	0.00	0.00	٠
Final Engineering	(Phase 2)											-
A 35 LDKBK530A2 KII	F530 Response To TDEC NODs	08OCT04A	010CT05		0 MSI	Η	P RDP	FDCE	240.00	240.00	0.00	
A 35 LDKBK530A1 KII	F530 Develop Decision Matrix	01NOV04A	01FEB05		109 MSI	Ŧ	P RDP	FDCE	80.00	80.00	0.00	
A 35 LDKBK530DR KII	F530 10% DCN Design Review (FR Drain)		Variation 1		0 MSI	Ē	P RDP		0.00	0.00	0.00	•
A 30 LDKBK530PA KII	F530 Receive Phase 2 FPEP Approval (Fr Drain)	01APR05*	01APR05		0 SMI	Ŧ	P RDP		0.00	0.00	0.00	
A 30 LDKBK530PS KII	F530 Ph 2 - Project Support Mhrs (Hammock)	01APR05	09AUG05		0 SMI		P RDP	FDPE,	272.00	272.00	0.00	
A 35 LDKBK530AP KII	F530 Prepare DCN KIF-0X-XXX	02APR05	11JUL05		0 MSI	F	P RDP	FDCE	100.00	100.00	0.00	
A 35 LDKBK530R5 KII	F530 50% DCN Design Review		21MAY05		0 HLF	Ŧ	P RDP		0.00	0.00	0.00	٠
A 35 LDKBK530R9 KII	F530 100% DCN Design Review		10JUL05		0	Ŧ	P RDP		0.00	0.00	0.00	٠
A 35 LDKBK530M4 KII	F530 Award Contract For Long Lead Material		11JUL05		0	Ē	P RDP		0.00	0.00	0.00	٠
A T2 LDKBK530RU KII	F530 ERU ASSEMBLE AND DISTRIBUTE KIF-0X-XXX	18JUL05	19JUL05		0 DFI	Б	L RDP	TS2RU	16.00	16.00	0.00	
A 35 LDKBK530NN KI	F530 DCN KIF-0X-XXX Issued		19JUL05		0	Ŧ	P RDP		0.00	0.00	0.00	
A 15 LDKBK530X2 Re	eview Const Estimate & Prepare Total Proj Estim	2010105	22JUL05		0 JLF	1	H RDP	TS2CE	24.00	24.00	0.00	
A 30 LDKBK530X3 KII	F530 Prepare Ph 3 FPEP Pkg	30JUL05	08AUG05		0 SMI	Ē	P RDP		0.00	0.00	0.00	
A 30 LDKBK530PC KII	F530 Final Engineering Complete		09AUG05		0 SMI	Ē	P ROP		0.00	0.00	0.00	٠
A 35 LDKBK530M7 KII	F530 LL Matl Delivery		07JAN06		184	Ŧ	P RDP		0.00	0.00	0.00	٠
	5 to FA DRAW DII - Run	2	15 1402									
Start Date 5 Finish Date 0	01JAN89			Sheet 141 of 1	72							
Data Date 14JAN	16JAN05	TENNESSE	E VALLEY AUTH Lavout 70	ORITY								
© Primavera Systems,	luc.											
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Saturate	WT to		42.9	73.0	65.7	41.8	38.2	75.6	78.5	67.8	67.4	73.8	71.9	64.3	62.6	53.8	52.0
Saturated thickness - WT to top	alluvium	45.01	44.6	53.5	AN	32.8	29.2	62.4	65.3	47.0	46.6	47.6	45.7	40.5	38.8	23.8	22.0
	WT to	10 10 10 10 10 10 10 10 10 10 10 10 10 1	16.7	9.1	62.2	7.8	19.2	29.9	52.8	19.8	39.4	7.6	25.7	10.8	24.1	10.8	19.0
Depth BGS	to Bedrock	(II) 82.2	87.5	103.5	103.5	43.0	43.0	93.2	93.2	103.0	103.0	111.2	111.2	78.5	78.5	58.0	58.0
Depth BGS	to alluvium	11/ 52.5	62.5	84.0	84.0	34.0	34.0	80.0	80.0	82.2	82.2	85.0	85.0	54.7	54.7	28.0	28.0
1/21/05 WT	Elevation	(IL-IIISI) 774.1	777.1	780.6	772.9	765.6	761.8	786.5	789.7	773.0	772.3	774.3	772.6	770.6	769.8	760.5	759.1
	WT depth		17.9	30.5	37.8	1.3	4.8	17.6	14.8	35.2	35.6	37.4	39.3	14.2	15.9	4.2	6.0
	WT depth	7.8	18.4	30.9	38.7	2.7	6.7	18.6	17.3	37.7	36.6	40.0	40.0	15.7	17.4	4.2	6.6
	BOS depth	19.6	34.6	39.6	100.0	0.6	24.0	47.5	67.5	55.0	75.0	45.0	65.0	25.0	40.0	15.0	25.0
	S depth	9.6	24.6	29.6	95.0	4.0	19.0	42.5	62.5	50.0	70.0	40.0	60.0	20.0	35.0	10.0	20.0
	6																
Estimated sediment	fill up in TO	301001 (II) 1.6	-102	1.9	-2.1	1.1	2.2	-2.5	0.4	0.0	0.0	0.1	0.0	1.4	-1.9	-0.1	0.5
MACTEC Estimated Reported sediment	Well Depth fill up in TO	20.2 1.6	35.2 -10.2	40.2 1.9	100.6 +2.1	9.6 1.1	24.6 2.2	48.1 -2.5	68.1 0.4	55.6 0.0	75.6 0.0	45.6 0.1	65.6 0.0	25.6 1.4	40.6 -1.9	15.6 -0.1	25.6 0.5
TVA MACTEC Estimated Measured Reported sediment	Well Depth Well Depth fill up in TO	18.01 20.2 1.6	24.4 35.2 -10.2	37.7 40.2 1.9	102.1 100.6 +2.1	7.9 9.6 1.1	21.8 24.6 2.2	50.0 48.1 -2.5	67.1 68.1 0.4	55.0 55.6 0.0	75.0 75.6 0.0	44.9 45.6 0.1	65.0 65.6 0.0	23.6 25.6 1.4	41.9 40.6 -1.9	15.1 15.6 -0.1	24.5 25.6 0.5
TVA TVA MACTEC Estimated Measured Measured Reported sediment	Well Depth Well Depth Well Depth fill up in TO BTOC(#) BCS (#) BCS (#)		24.9 24.4 35.2 -10.2	38.1 37.7 40.2 1.9	103.0 102.1 100.6 -2.1	9.3 7.9 9.6 1.1	23.7 21.8 24.6 2.2	51.0 50.0 48.1 -2.5	69.6 67.1 68.1 0.4	57.5 55.0 55.6 0.0	76.0 75.0 75.6 0.0	47.5 44.9 45.6 0.1	65.7 65.0 65.6 0.0	25.1 23.6 25.6 1.4	43.4 41.9 40.6 -1.9	15.1 15.1 15.6 -0.1	25.1 24.5 25.6 0.5
TVA TVA MACTEC Estimated Measured Measured Reported sediment	Stick-up Well Depth Well Depth Well Depth fill up in TO (#) BTCC(#) BTCS (#) BTCS (#) BTCS (#)	0.3 18.3 18.0 20.2 1.6	0.5 24.9 24.4 35.2 +10.2	0.4 38.1 37.7 40.2 1.9	0.9 103.0 102.1 100.6 -2.1	1.4 9.3 7.9 9.6 1.1	1.9 23.7 21.8 24.6 2.2	1.0 51.0 50.0 48.1 -2.5	2.5 69.6 67.1 68.1 0.4	2.5 57.5 55.0 55.6 0.0	1.0 76.0 75.0 75.6 0.0	2.6 47.5 44.9 45.6 0.1	0.7 65.7 65.0 65.6 0.0	1.5 25.1 23.6 25.6 1.4	1.5 43.4 41.9 40.6 -1.9	0.0 15.1 15.1 15.6 -0.1	0.6 25.1 24.5 25.6 0.5
TVA TVA MACTEC Estimated Measured Measured Reported sediment	Elevation Stick-up Well Depth Well Depth Well Depth fill up in TO	781.6 0.3 18.3 18.0 20.2 1.6	795.0 0.5 24.9 24.4 35.2 -10.2	811.1 0.4 38.1 37.7 40.2 1.9	810.7 0.9 103.0 102.1 100.6 2.1	766.8 1.4 9.3 7.9 9.6 1.1	766.6 1.9 23.7 21.8 24.6 2.2	804.1 1.0 51.0 50.0 48.1 2.5	804.4 2.5 69.6 67.1 68.1 0.4	808.3 2.5 57.5 55.0 55.6 0.0	807.9 1.0 76.0 75.0 75.6 0.0	811.7 2.6 47.5 44.9 45.6 0.1	811.9 0.7 65.7 65.0 65.6 0.0	784.8 1.5 25.1 23.6 25.6 1.4	785.7 1.5 43.4 41.9 40.6 -1.9	764.7 0.0 15.1 15.1 15.6 -0.1	765.1 0.6 25.1 24.5 25.6 0.5
TOC Grade Measured Measured Reported Sediment	Elevation Elevation Stick-up Well Depth Well Depth Well Depth fill up in TO	781.87 781.6 0.3 18.3 18.0 20.2 1.6	795.50 795.0 0.5 24.9 24.4 35.2 -10.2	811.45 811.1 0.4 38.1 37.7 40.2 1.9	811.56 810.7 0.9 103.0 102.1 100.6 -2.1	768.21 766.8 1.4 9.3 7.9 9.6 1.1	768.49 766.6 1.9 23.7 21.8 24.6 2.2	805.08 804.1 1.0 51.0 50.0 48.1 -2.5	806.92 804.4 2.5 69.6 67.1 68.1 0.4	810.76 808.3 2.5 57.5 55.0 55.6 0.0	808.89 807.9 1.0 76.0 75.0 75.6 0.0	814.30 811.7 2.6 47.5 44.9 45.6 0.1	812.56 811.9 0.7 65.7 65.0 65.6 0.0	786.26 784.8 1.5 25.1 23.6 25.6 1.4	787.19 785.7 1.5 43.4 41.9 40.6 -1.9	764.70 764.7 0.0 15.1 15.1 15.6 -0.1	765.68 765.1 0.6 25.1 24.5 25.6 0.5

KIF Dredge Cell - Piezometer Information Summary

Abbreviations: TOC - top of casing BTOC - below top of casing BGS - below ground surface TOS - top of screen BOS - bottorn of screen WT - water table

Petty, Harold L.

From: Petty, Harold L.

Sent: Thursday, January 06, 2005 11:53 AM

To: GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES

Subject: RE: Questions on Kingston Operations

Yes we got it.

Thanks, Lynn

> -----Original Message----- **From:** GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES **Sent:** Thursday, January 06, 2005 11:33 AM **To:** Petty, Harold L. **Subject:** RE: Questions on Kingston Operations

Lynn:

Thank you very much – these are very comprehensive answers and help a lot. We have a SEEP model up and running, but are adding additional layers and refinements based on the boring logs and this information.

On a separate note, I did send back a revised outline of the seepage class to Ron yesterday right after our call. Would you mind asking if he got it. I will email it again to you (separate email) to see if we can get it through electronically.

Thanks Neil

From: Petty, Harold L. [mailto:hlpetty@tva.gov]
Sent: Thursday, January 06, 2005 11:22 AM
To: Neil Davies
Cc: McNulty, Greg; Robert Bachus; Tamer Elkady; Smith, Daniel R.; Purkey, Ronald E.
Subject: Questions on Kingston Operations

Greetings Neil:

To facilitate answering your questions I have copied your previous e-mail and added my answers in **Bold blue Italics**:

Lynn:

I hope this email finds you fine. We have some questions that would be helpful in effectively constructing and, later on, calibrating the model to be used for the seepage analysis within the Dredge cell. These questions are as follows:

During operations in the Dredge cell, was water allowed to pond freely on top of the Fly ash?. If yes, what is typically the height of the ponding water?. Does ponding extend to the outer dike or is it confined in a mid area within the dredge cell?. Water ponds freely to the outer dike (no inner dikes) of each cell. The height of the water above the deposited ash is managed by use of the boards in the outlet structure. Viewed in section from the outlet structure to the dredge discharge point the water is a

triangle above the ash; approximately three foot deep at the outlet structure to zero feet deep at the discharge point from the dredge line. As ash is dredged into the cell, the bottom of the cell rises with the deposited ash and boards are added periodically to raise the water elevation.

Are the outer dikes constructed around the perimeter of the dredge cells considered a zone of high permeability?. Review of recent design drawings indicate that the outer dikes are supplemented with underdrains most probably to facilitate the drainage of water accumulated behind the dike. Furthermore, previous site investigations have revealed that the hydraulic conductivity is in the 10-6 range. Given all that, it can be inferred that the outer dikes act as a containment dike rather than a zone of high permeability when compared to the disposed fly ash. *Not exactly.....The underdrains were added to assist the slip circle analysis that was being done. The underdrains were added to lower the phreatic surface in the model for global stability. Also remember that there were no underdrains in the bottom two lifts of the dredge cell for cells I, and III. The outer dikes were constructed by placing alternating layers of bottom and fly ash. The intent during construction was to "blade back" the two layers as they were placed, to obtain a uniform mixture. The CPT data (not from the dissipation tests, but the "relative test results) indicate that there is layering (stratification) of bottom and fly ash, that could create zones of higher hydraulic conductivity within the outer dike itself, as discussed in our meeting.*

In addition, in anticipation for the upcoming seepage workshop, we would like to know what version of SEEP/W does TVA have? as well as if TVA has another program named SLIDE?. In addition, what drafting program does TVA use; AutoCAD or Microstation? *The version of Seep/w TVA has in hand is 5.12. For drafting we use AutoCAD 2004. We do not have SLIDE. We do have PCSTABL5M, UTEXAS3.*

Thanks, Lynn

Petty, Harold L.

From:	GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES
	Tuesday, January 04, 2005 12:57 PM
10:	Pelly, Harold L.
Cc:	RBachus@GeoSyntec.com; TElkady@GeoSyntec.com
Subject:	Questions on Kingston Operations
Follow Up Flag:	Follow up

Flagged

Lynn:

Flag Status:

I hope this email finds you fine. We have some questions that would be helpful in effectively constructing and, later on, calibrating the model to be used for the seepage analysis within the Dredge cell. These questions are as follows:

During operations in the Dredge cell, was water allowed to pond freely on top of the Fly ash?. If yes, what is typically the height of the ponding water?. Does ponding extend to the outer dike or is it confined in a mid area within the dredge cell?.

Are the outer dikes constructed around the perimeter of the dredge cells considered a zone of high permeability?. Review of recent design drawings indicate that the outer dikes are supplemented with underdrains nost probabaly to facilitate the drainage of water accumulated behind he dike. Furthermore, previous site investigations have revealed that the hydraulic conductivity is in the 10-6 range. Given all that, it can be inferred that the outer dikes act as a containment dike rather than a zone of high permeability when compared to the disposed fly ash.

In addition, in anticipation for the upcoming seepage workshop, we would like to know what version of SEEP/W does TVA have? as well as if TVA has another program named SLIDE?. In addition, what drafting program does TVA use; Autocad or Microstation?

We would like to discuss these questions with you during our conference call today @ 1:00 pm.

	ConeTec Inc. Geotechnical and Environmental Site Investigation Contractors
436 Comm 800	ierce Lane, Unit C, West Berlin, NJ, 08091 • Tel: 856-767-8600 • Fax: 856-767-4008)-504-1116 • E-mail newjersey@conetec.com • Website www.conetec.com
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Geotechnical Parameters

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Hydraulic conductivity (k)

An approximate cstimate of soil hydraulic conductivity or coefficient of permeability, k, can be made form an estimate of soil behaviour type using the CPT classification charts. Table 4 provides estimates based on the non-normalized chart shown in Figure 2 (Robertson et al., 1986), while Table 5 provides estimates based on the normalized chart shown in Figure 3 (Robertson, 1990). These estimates are approximate at best, but can provide a guide to variations of possible permeability.

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Table 4. Estimation of soil permeability (k) from the non-normalized CPT soil behaviour chart by Robertson et al. (1986) shown in Figure 2.

Zone	Soil Behaviour Type (SBT)	Range of permeability k (m/s)
1	Sensitive fine grained	3x10 ⁻⁹ to 3x10 ⁻⁸
2	Organic soils	1x10* to 1x10**
3	Clay	-1x10 ⁴⁰ to 1x10 ⁻⁹
4	Silty clay to clay	1x10 ⁻⁹ to 1x10 ⁻⁸
5	Clayey silt to silty clay	1x10 ⁻⁸ to 1x10 ⁻⁷
6	Sandy silt to clayey silt	1x10 ¹⁷ to 1x10 ¹⁰
7	Silty sand to sandy silt	1x10 ⁻⁵ to 1x10 ⁻⁶
8	Sand to silty sand	1x10 ⁻⁵ to 1x10 ⁻⁴
9	Sand	1x10 ⁻⁴ to 1x10 ⁻³
10	Gravelly sand to dense sand	1x10 ⁻³ to 1
11	Very still fine-grained soil	1x10 ⁻⁹ to 1x10 ⁻⁷
12	Very stiff sand to clayey sand	3x10 ⁻⁶ to 3x10 ⁻⁶

Baligh and Levadoux (1980) recommended that the horizontal coefficient of permeability can be estimated from the expression:

$$k_{h} = \left(\frac{\gamma_{w}}{2.3 \,\sigma'_{vo}}\right) RR \, c_{h}$$

where RR is the re-compression ratio in the overconsolidated range. It represents the strain per log cycle of effective stress during recompression and can be determined from laboratory consolidation tests. Baligh and Levadoux recommended that RR should range from 0.5×10^{-2} to 2×10^{-2} .

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Table 5. Estimation of soil permeability (k) from the normalized CPT soil behaviour chart by Robertson (1990) shown in Figure 3.

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Zone	Soil Bchaviour Type (SBT)	Range of permeability k (m/s)
		a
1	Sensitive fine grained	3X10 10 3X10
2	Organic soils	1x10 ⁻³ to 1x10 ⁻⁶
3	Clay	1x10 ⁻¹⁰ to 1x10 ⁻⁹
4	Silt mixtures	3x10 ⁻⁹ to 1x10 ⁻⁷
5	Sand mixtures	1x10 ⁻⁷ to 1x10 ⁻⁵
6	Sands	1×10^{-5} to 1×10^{-3}
7	Gravelly sands to dense sands	1×10 ⁻³ to 1
8	Very stiff sand to clayey sand	1x10 ⁻⁸ to 1x10 ⁻⁶
9	Very stiff fine-grained soil	1x10" to 1x10"



Figure 7. Summary of data for estimating horizontal coefficient of permeability from dissipation tests (after Robertson et al., 1992).

P.K. Robertson

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Person : Conetec New Jersey

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Robertson et al. (1992) presented a summary of available data to estimate the horizontal coefficient of permeability from dissipation tests. This summary is shown in Figure 7. Since the relationship is also a function of the recompression ration (RR) there is a wide variation of + or - one order of magnitude.

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Jamiolkowski et al. (1985) suggested a range of possible values of k_{μ}/k_{ν} for soft clays.

Table 6. Range of possible field values of k_h/k_c for soft clays (after Jamiolkowski et al., 1985)

Nature of clay	k,/k,
No macrofabric, or only slightly developed macrofabric, essentially homogeneous deposits	1 to 1.5
From fairly well- to well-developed macrofabric, e.g. sedimentary clays with discontinuous lenses and layers of more permeable material	2 10 4
Varved clays and other deposits containing embedded and more or less continuous permeable layers	3 to 15

References

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Baligh, M.M. and Levadoux, J.N. 1986. Consolidation after undrained piezocone penetration, II: Interpretation, J. of Geotech. Engineering, ASCE, 112(7): 727-745.

Jamiolkowski, M., Ladd, C.C., Germaine, J.T. and Lancellotta, R. 1985. New developments in field and laboratory testing of soils, State-of-the-art report, Proceedings of the 11th International Conference on Soil Mechanics and Foundation Engineering, San Francisco, 1, 57-153, Balkema.

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Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G. 1992. Estimating coefficient of consolidation from piezocone tests, Canadian Geotechnical J., 29(4): 551-557. Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J. 1986. Use of piezometer cone data. Proceedings of the ASCE Specialty Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, 1263-80.

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Geotechnical Parameters

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Consolidation Characteristics

Flow and consolidation characteristics of a soil are normally expressed in terms of the coefficient of consolidation, c, and hydraulic conductivity, k. They are inter-linked through the formula;

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$$c = \frac{k M}{\gamma_{x}}$$

where M is the constrained modulus relevant to the problem (i.e. unloading, reloading, virgin loading).

The parameters c and k vary over many orders of magnitude and are some of the most difficult parameters to measure in geotechnical engineering. It is often considered that an accuracy within one order of magnitude is acceptable. Due to soil anisotropy, both c and k have different values in the horizontal (c_h, k_h) and vertical (c_v, k_v) direction. The relevant design values depend on drainage and loading direction.

Details on how to estimate k from CPT soil classification charts are given in another section.

The coefficient of consolidation can be estimated by measuring the dissipation or rate of decay of pore pressure with time after a stop in CPT penetration. Many theoretical solutions have been developed for deriving the coefficient of consolidation from CPT pore pressure dissipation data. These are summarized by Lunne et al. (1997). Torstensson (1977) suggested that the coefficient of consolidation should be interpreted at 50% dissipation, using the following formula:

 $c = \left(\frac{T_{so}}{t_{so}}\right) r_o^2$

where: T_{50} = theoretical time factor t_{50} = measured time for 50% dissipation r_{0} = penetrometer radius (PPD)

It is clear from this formula that the dissipation time is inversely proportional to the radius of the probe. Hence, in soils of very low permeability, the time for dissipation can be decreased by using smaller probes.

Robertson et al. (1992) reviewed dissipation data from around the world and compared the results with the leading theoretical solution by Teh and Houlsby (1991), as shown in Figure 8.

– (x 1.5 for a 15-cm² cone)



Figure 8. Average laboratory ck values and CPTU results (after Robertson et al., 1992).

P.K. Robertson

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The review showed that the theoretical solution provided reasonable estimates of c_h . The solution shown in Figure 8 applies to pore pressure sensors located just behind the cone tip (i.e. u_2).

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The ability to estimate c_h from CPT dissipation results is controlled by soil stress history, sensitivity, anisotropy, rigidity index (relative stiffness), fabric and structure. In overconsolidated soils, the pore pressure behind the cone tip can be low or negative, resulting in dissipation data that can initially rise before a decay to the equilibrium value. In these cases, the pore pressure sensor can be moved to the face of the cone or the t_{50} time can be estimated using the maximum pore pressure as the initial value. Care is required to ensure that the dissipation is continued to the correct equilibrium and not stopped prematurely after the initial rise.

Based on available experience, the CPT dissipation method should provide estimates of c_h to within + or - half an order of magnitude. However, the technique is repeatable and provides an accurate measure of changes in consolidation characteristics within a given soil profile.

An approximate estimate of the coefficient of consolidation in the vertical direction can be obtained using the ratios of permeability in the horizontal and vertical direction given in the section on hydraulic conductivity, since:

 $c_{v} = c_{h} \left(\frac{k_{v}}{k_{v}} \right)$

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.
- Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie,
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- Torstensson, B.A. 1977. The pore pressure probe, Norsk jord- og fjellteknisk forbund. Fjellsprengningsteknikk – bergmekanikk – geoteknikk, Oslo, Foredrag, 34.1-34.15, Trondheim, Norway, Tapir.
- Teh, C.I. and Houlsby, G.T. 1991. An analytical study of the cone penetration test in clay, Geotechnique, 41(1): 17-34.

P.K. Robertson DEC: 08 2004 02:02 02

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FROM : ConeTec New Jersey

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INTERPRETATION OF CPT/PIEZOCONE DATA

stress history (OCR). Then, using Figure 5.35, estimate E_{ν} for the relevant shear stress level appropriate to the particular problem. A knowledge of the plasticity index (l_{P}) would significantly improve the estimate.

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5.4.3.3 Small strain shear modulus

The shear modulus is largest at very low strains and decreases with increasing shear strain. It has generally been found that the initial maximum shear modulus is constant for shear strains less than about 10^{-3} %. This initial, small strain modulus is often denoted G_{o} .

Mayne and Rix (1993) showed that the small strain shear modulus varied with void ratio (e) and cone penetration resistance (q_i) for a wide range of clays and can be expressed

$$G_o = 99.5 (p_u)^{0.305} \frac{(q_i)^{0.695}}{(q_o)^{1.130}}$$
(5.30)

where:

25:

$p_o = \text{atmospheric reference stress in the}$ same units as G_o and q_t .

The strong dependence of G_o upon void ratio (e) requires that CPT q_c is only successful as a profiler of G_o if comparison profiles of e_o are known. This is not usually the case. However, elastic theory relates the maximum shear modulus, G_o , to soil density, p, and shear wave velocity, V_r , as follows:

 $G_{\mu} = \rho \cdot V_s^2 \tag{5.31}$

where:

$\rho = \text{mass density of the soil} = \gamma/g$

and this supports the recommendation of making direct measurements of *in situ* shear wave velocity using the seismic CPT (see section 7.4).

Based on these observations, Robertson *et al.* (1995) suggested a chart to identify soil type using scismic CPT data, as shown in Figure 5.10. This chart can also be used to estimate G_o based on an estimate of soil type from the basic CPT soil classification charts.

However, care must always be taken when using any of these charts or correlations as it should be remembered that G_o is not independent of the direction of shear (Powell and Butcher, 1991). Butcher and Powell (1995a) showed that the shear wave velocity in clays, and therefore the G_o value deduced, was dependent on the stresses in the directions of propagation and polarization of the shear waves and can vary by up to 300% in heavily overconsolidated clays.

5.4.4 Flow and consolidation characteristics

Flow and consolidation characteristics of soil are normally expressed in terms of the coefficient of consolidation, c, and hydraulic conductivity or permeability, k. They are interlinked through the formula:

$$c = k \cdot \frac{M}{\gamma_{w}} \tag{5.32}$$

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where M is the constrained modulus relevant to the problem modelled (that is, unloading, reloading, virgin loading).

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The parameters c and k vary over many orders of magnitude and are some of the most difficult parameters to measure in geotechnical engineering. It is often considered that an accuracy within one order of magnitude is acceptable. Nevertheless, c and k are parameters that are often essential input in some geotechnical calculations.

Due to soil anisotropy both c and k have different values

in the horizontal (c_h, k_h) and vertical (c_v, k_v) direction. The relevant design values depend on drainage and loading direction.

5.4.4.1 Coefficient of consolidation

Rate of consolidation parameters may be assessed from the piczocone test by measuring the dissipation or decay of pore pressure with time after a stop in penetration.



Figure 5.35 Stiffness ratio, E/s_{μ} , as function of I_p (adapted from Ladd et al., 1977).

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Figure 5.36 Stiffness ratio, E/s_{μ} , as function of OCR (after Duncan and Buchignani, 1976).

Figure 5.37a shows typical dissipation curves for a soft clay (Bothkennar clay) plotted on a logarithmic time scale. The results vary with the filter position. For interpretation it is best to normalize the pore pressure relative to the initial pore pressure at the beginning of dissipation, u_i , and the equilibrium in situ pore pressure u_o . The normalized excess pore pressure, U, at time t, is thus expressed as:



Figure 5.37a Dissipation test results from Bothkennar.

$$U = \frac{u_{t} - u_{o}}{u_{t} - u_{o}}$$
(5.33)

where:

 u_i = the pore pressure at time t

 u_i = initial pore pressure at i = 0

 $u_o = in situ$ pore pressure before penetration.

The results of Figure 5.37a are replotted in normalized form in Figure 5.37b.

Over the last 10 to 15 years, theoretical and semiempirical solutions have been developed for deriving the coefficient of consolidation from pore pressure dissipation data.

Table 5.9 presents an overview of the main solutions available to calculate the coefficient of consolidation from piezocone dissipation data.

Torstensson (1975, 1977) developed an interpretation model based on cavity expansion theories. Initial pore pressures were computed assuming an elasto-plastic soil model and spherical or cylindrical cavity expansion theory, as shown in Table 5.9. Torstensson then used linear uncoupled one-dimensional consolidation to compute the dissipation of pore pressures.

Torstensson suggested that the coefficient of consolidation should be interpreted at 50% dissipation from the following formula:

$$c = \frac{T_{50}}{t_{50}} \cdot r_o^2 \tag{5.34}$$

where the time factor T_{50} is found from the theoretical solutions, t_{50} is the measured time for 50% dissipation and r_o = penetrometer radius (cylindrical model) or equivalent penetrometer radius for spherical model.



Figure 5.37b Normalized dissipation test data from Bothkennar.

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Author	Cavity type	Soil model	Initial por c pressure, Δu ₁	Consolidation	Remarks
Søderberg (1962)	Cylindrical, radius R	Elastoplastic	$\frac{\Delta u}{\Delta u} = \frac{R}{2}$	1-D	Not in use
Torstensson (1975, 1977)	Cylindrical/spherical	Elastoplastic	$\Delta u_1 = r$ $\Delta u_1 = 2s_{\mu} \ln(r_{\mu}/r)$ $\Delta u_1 = 4s_{\mu} \ln(r_{\mu}/r)$	1-D	
Randolph & Wroth (1979)	Cylindrical	Elastoplastic	As Torstensson's	1-D	= Equiv. to
Battaglio <i>et al.</i> (1981)	Cylindrical/spherical	Elastoplastic	Same as Torstensson	1-D	Fits entire curve
Sennesct et al, (1982)	Cylindrical	Elastoplastic	Same as Torstensson	1-D	= Equiv. to
Levadoux & Baligh (1985)	Piezocone model	Non-linear $I_{e} = 500$	From strain path method	2-D	Most comprehensive
Gupta & Davidson (1986)	Piezocone model	Elastoplastic	Modified cavity expansion, some dissipation	Lincar axisymmetric	
Soarès <i>er al</i> . (1987)	Piezocone model	Non-linear	Corrected by visual examination and regression analysis	2-D	
Houlsby and Tch (1988)	Piczocone model	Non-linear I, varies	Predicted by large strain finite element analysis and strain path method	2-D	Extension of Levadoux and Baligh (1985)

Table 5.9 Available solutions to calculate the coefficient of consolidation from piezocone dissipation tests

 $u = \text{pore pressure; } s_v = \text{undrained shear strength; } r = \text{radial distance; } r_p = \text{radius of plastic zone; } l_r = O/s_u = \text{rigidity index.}$

The selection of the appropriate model depends on the location of the porous element. The spherical solution may be most applicable if the filter element is located somewhere on the conical part. If the filter is located somewhere on the cylindrical shaft some distance away from the cone the cylindrical solution will be the most applicable.

A comprehensive study on pore pressure dissipation has been performed by Levadoux and Baligh (1980, 1986) and Baligh and Levadoux (1980, 1986) who proposed an interpretation method after evaluating predictions of dissipation tests in Boston Blue Clay (BBC).

Levadoux and Baligh used the strain path method (Baligh, 1985) to predict the initial pore pressure distribution for normally consolidated Boston Blue Clay with rigidity index, $l_r = 500$. A finite element method was used for the subsequent coupled and uncoupled linear isotropic consolidation analysis.

Some important conclusions from the study of Baligh and Levadoux (1986) were:

- 1. The simple uncoupled solutions provide reasonably accurate predictions of the dissipation process.
- 2. Consolidation is taking place predominantly in the recompression mode for dissipation less than 50%.
- 3. Initial distribution of excess pore pressures around the probe has a significant influence on the dissipation process.
- 4. Dissipation is predominantly in the horizontal direction.

Houlsby and Teh (1988) proposed an interpretation based on the results of large strain finite element analyses of the penetration pore pressures, and a finite difference analysis of the dissipation pore pressure. They used an approach similar to the Levadoux-Baligh theory but included the effect of varying the rigidity index, I_{x} (= G/s_{u}). Houlsby and Teh suggested using a modified dimensionless time factor, T^* given in Table 5.10, defined as follows:

$$T^* = \frac{c_h \cdot I}{r^2 \sqrt{I_r}} \tag{5.35}$$

Table 5.10 Modified time factors T^* from consolidation analysis (from Houlsby and Teh, 1988)

	Location				
Degree of consolidation	Conc (u ₁)	Cylindrical cxtension above cone base (u ₂)	Five radii above cone base	Ten radii abovc cone basc	
20%	0.014	0.038	0.294	0.378	
30%	0.032	0.078	0.503	0.662	
40%	0.063	0.142	0.756	0.995	
50%	0.118	0.245	1.11	1.458	
60%	0.226	0.439	1.65	2.139	
70%	0.463	0.804	2.43	3.238	
80%	1.04	1.60	4.10	5.24	

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where:

 c_h = coefficient of consolidation in direction perpendicular to cone axis, typically horizontal

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- r = radius of cone, typically 35.7 mm
- $I_r = rigidity index, G/s_{\mu}$.

These solutions are based on clastic plastic soil models and hence the rigidity index represents an equivalent clastic normalized stiffness.

Figure 5.38 shows the values of T^* derived by Houlsby and Teh (1988) and compares them with values by Torstensson (1977) for element locations immediately behind the cone (u_2) and on the face of the cone (u_1) . It is interesting to note that the simplified solutions by Torstensson (1977) provide essentially the same values as the more recent and comprehensive solutions by Houlsby and Tch (1988).

Figure 5.39 shows a simplified diagram that can be used to estimate c_{μ} using the Houlsby and Teh (1988) solution.

Robertson *et al.* (1992b) reviewed dissipation data from piezocone tests to predict coefficient of consolidation using Houlsby and Teh's (1988) solutions with reference values from laboratory tests and field observations. The review showed that the Tch and Houlsby solution provided reasonable estimates of c_A . Results were evaluated for pore pressure data from different filter locations and the least scatter was obtained with the pore pressure element location immediately above the cone (u_2). Figure 5.40 shows some of the results presented by Robertson *et al.* (1992b).

Powell and Quatermann (1997) showed that in a soft clay the normalized dissipation curves from different filter positions were very close in shape to those of Teh and Houlsby but displaced relative to each other. Values of c_h deduced using Teh and Houlsby were very similar for filter positions u_1 and u_2 but somewhat lower for u_3 .

Teh (1987) also proposed the interpretation of the consolidation data on a root time scale, as the initial section of the plot approximates closely to a straight line.

If the pore pressure dissipation is plotted on a square-root time scale, the gradient of this linear section is m, as shown



Figure 5.38 Theoretical solution of normalized pore pressure dissipation vs T (after Teh and Houlsby, 1991).



Figure 5.39 Chart for finding c₆ from 1₅₀ (after Robertson et al., 1992b).

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on Figure 5.39. Then ch can be evaluated from the equation:

$$c_{h} = (m/M)^{2} \cdot \sqrt{l_{r} \cdot r^{2}}$$
 (5.36)

where:

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M = gradient corresponding to the theoretical curve for a given probe geometry and porous element location m = measured gradient of the initial linear dissipation (d(time) units).

Values for M arc given in Table 5.11.

The square-root time method is useful for short dissipa-



Figure 5.40 Average laboratory c* values and CPTU results (after Robertson et al., 1992b).

Table 5.11 Gradient of dissipation curve (M), root time plot (from Tch. 1987)

Filter position	Conc (21)	Cylindrical extension above cone base (u ₂)	Five radii above cone base
Gradient of dissipation curve (M)	1.63	1.15	0.62

tion tests and/or where initial excess pore pressure (u_i) is uncertain.

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As summarized by several authors (for example, Soares et al., 1987; Sandven, 1990; Robertson et al., 1992) the Computer by Eq. 5.34 or 5.35 meaning and use of theoretical solutions are complicated by several phenomena including:

1. Estimation of initial pore pressure distribution.

Experience has shown that the initial pore pressures around a penetrating cone vary from the cone and along the shaft as illustrated in Figure 5.41. In stiff, heavily overconsolidated clays there is a very large gradient in pore pressure going from the cone to the shaft - where negative pore pressures may be observed. Before pore pressure dissipation starts a local redistribution occurs which may result in an initial increase in pore pressure behind the cone before radial dissipation starts (see Figure 9.26).

Comparison of theoretical analysis with laboratory and field test results shows that to improve the reliability of the prediction of coefficient of consolidation from piezocone tests, it is necessary to define the initial pore water pressure at time t = 0.

To better define the correct initial porc pressure value, it is essential to record pore pressures at frequent time intervals, which will be a function of soil type (section 2.3.8), at the beginning of the dissipation test. A linear projection of the square-root time plot can provide a reasonable estimate of Uj.

Powell and Quatermann (1997) showed that in soft clays the use of u, derived from a square-root time plot significantly improved the repeatability of the normalized dissipation curves.

2. Effects of soil disturbance due to penetration.

This effect can create a zone of disturbed soil around the piezocone during penetration which may have lower permeability than the undisturbed soil.

3. Importance of vertical as well as horizontal dissipation.

Although it is believed that dissipation is mainly governed by the radial coefficient of consolidation, (e.g. Levadoux and Baligh, 1986) there will be some uncertainties related to the relative importance of c_{ν} and c_{h} . The importance of this will also depend on soil anisotropy, as discussed below.

4. Soil anisotropy.

For most soils the permeability and coefficient of consolidation is higher in the horizontal direction, but this may vary from one soil to another (see below).

Based on the above discussion, the recommended procedure to estimate the coefficient of consolidation is to use dissipation data from the filter location behind the cone (u_2) ; however, other filter locations may be used even though the data may be somewhat less consistent.

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Figure 5.41 Pore pressure distribution in saturated clays (after Sully et al., 1988).

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The recommended procedure is as follows:

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- (a) Plot the early part of the dissipation (less than 10% dissipation) at an enlarged scale, either log or square root time, and evaluate the initial pore pressure, u_i .
- (b) Define u_o from available data on ground water level, piezometric readings or data from piezocone tests in adjacent sand layers.
 - Plot normalized excess pore pressure

$$U = \frac{u_c - u_o}{u_1 - u_o} \tag{5.37}$$

versus time (t) on log and/or \sqrt{t} scale.

(d) Define time for 50% dissipation (t_{50}) .

- (e) Use t_{50} and curves in Figure 5.39 to predict c_h . If no other data are available use an average I_r between the range in Figure 5.39.
- (f) If dissipation has not proceeded sufficiently long to define t₅₀, then the slope of the straight line from the first part of u vs √t plot (m) may be used in Figure 5.39 to predict c_v.

Based on available experience, this recommended procedure should provide estimates of c_h to within \pm half an order of magnitude. However, the technique is repeatable and provides an accurate measure of the changes in the consolidation characteristics within a given soil profile.

A rough estimate of the coefficient of consolidation in the vertical direction can be obtained using the ratios of permeability in horizontal and vertical direction given in Table 5.12 since:

$$c_{n} = k_{c} \cdot \frac{M}{\gamma_{w}}$$

$$c_{h} = k_{h} \cdot \frac{M}{\gamma_{w}}$$
(5.38)
(5.39)

If the soil compressibility is assumed isotropic (that is, $m_k = m_\nu$):

$$c_v = c_h \cdot \frac{k_v}{k_h} \tag{5.40}$$

Due to the uncertainties associated with interpretation of coefficient of consolidation from dissipation test data, the predicted value of c_0 can currently only be considered to be representative within one order of magnitude.

5.4.4.2 Coefficient of permeability (hydraulic conductivity)

Baligh and Levadoux (1980) recommended that the horizontal coefficient of permeability can be estimated from the expression:

$$k_h = \frac{\gamma_{co}}{2.3 \cdot \sigma'_{co}} \cdot RR \cdot c_h \tag{5.41}$$

where RR is the compression ratio in the overconsolidated range. It represents the strain per log cycle of effective stress during recompression and can be determined from laboratory consolidation tests $(0.5 \times 10^{-2} < RR < 2 \times 10^{-2})$ was recommended by Baligh and Levadoux).

Robertson *et al.* (1992a) presented a summary of available data from dissipation tests and laboratory determined k_h values (Figure 5.42). A preliminary relationship proposed by Schmertmann (1974) is also included.

Table 5.12 Range of possible field values of k_{t}/k_{v} for soft clays (from Jamiołkowski *et al.*, 1985)

Nature of clay	k _n ∕k.
 No macrofabric, or only slightly developed macrofabric, essentially homogeneous deposits 	1 to 1.5
• From fairly well- to well-developed macrofabric, c.g. sedimentary clays with discontinuous lenses and layers of more permeable material	2 to 4
 Varved clays and other deposits containing embedded and more or less continuous permeable layers 	3 to 15

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Figure 5.42 Proposed chart for evaluating K_{k} from r_{50} for 10 cm² piezocones (after Robertson *et al.*, 1992a).

Figure 5.42 can be used as a rough guide to estimate k_h from I_{50} . Jamiolkowski *et al.* (1985) presented Table 5.12 which can be used to estimate k_v from k_h .

oil permeability can also be estimated as a function of types from the CPT classification charts as shown in Tables 5.13a and b.

Estimation of soil permeability from CPT and dissipation data is subject to much uncertainty and should be used as a guide only.

5.5 INTERPRETATION IN COARSE-GRAINED SOILS

Cone penetration testing in coarse-grained soils, such as sandy soils, is generally drained. Under drained conditions there should be no excess pore pressures generated as a result of cone penetration, that is, the *in situ* static pore pressure is measured. An example of a CPTU in sand (McDonalds Farm, BC.) is shown in Figure 5.43.

However, sometimes equipment-related pore pressures may be generated on the cone (u_1) due to high compressive stresses (for example, Bruzzi and Battaglio, 1987; Gillespic, 1990). In very dense fine or silty sands negative pore pressures may be recorded behind the cone (u_2) due to dilatancy effects (Figure 5.44).

In the following sections, fully drained cone penetration is considered, then only measured cone resistance and sleeve friction are used in the interpretation. However, it is important to review the recorded pore pressures to check if the comption of fully drained conditions is valid.

Most of the interpretation methods described in this section are based on results from large laboratory calibration chamber tests (for instance, Schmertmann, 1975; Veismanis, 1975; Bellotti *et al.*, 1982; Parkin and Lunne, 1982; Baldi *et al.*, 1986; Ghionna and Jamiolkowski, 1992). For completeness, a summary of calibration chamber testing techniques and results is included in Appendix C.

5.5.1 State characteristics

The following sections detail the interpretations related to the parameters that describe soil state and stress history.

5.5.1.1 Relative density (density index)

For cohesionless soils, the density, or more commonly, the relative density or density index, is often used as an intermediate soil parameter.

Table 5.13(a) Estimation of soil permeability (k) from CPT soil behaviour charts. Based on a CPT chart by Robertson *et al.*, 1986 (Figure 5.7)

Zone	Soil behaviour type (SBT)	Range of soil permeability k (m/s)
1	Sensitive fine grained	3×10^{-9} to 3×10^{-3}
2	Organic soils	1×10^{-8} to 1×10^{-6}
3	Clay	1×10^{-10} to 1×10^{-9}
4	Silty clay to clay	1×10^{-9} to 1×10^{-5}
5	Clayey silt to silty clay	1×10^{-8} to 1×10^{-7}
6	Sandy silt to clayey silt	1×10^{-7} to 1×10^{-6}
7	Silty sand to sandy silt	1×10^{-5} to 1×10^{-5}
8	Sand to silty sand	1×10^{-5} to 1×10^{-5}
ĝ.	Sand	1×10^{-4} to 1×10^{-3}
10	Gravelly sand to sand	1×10^{-3} to 1
11	*Very stiff fine-grained soil	1×10^{-9} to 1×10^{-7}
12	"Very stiff sand to claycy sand	1×10^{-5} to 1×10^{-6}

*Overconsolidated or cemented

Table 5.13(b) Estimation of soil permeability (k) from CPT soil behaviour charts. Based on normalized CPT chart by Robertson, 1990 (Figure 5.8)

Zone	Soil bchaviour type (SBT)	Range of soil permeability k (m/s)
	Sensitive fine grained	3×10^{-9} to 3×10^{-8}
2	Organic soils	1×10^{-8} to 1×10^{-6}
3	Clay	1×10^{-10} to 1×10^{-9}
4	Silt mixtures	3×10^{-9} to 1×10^{-7}
Ś	Sand mixtures	1×10^{-7} to 1×10^{-5}
6	Sands	1×10^{-5} to 1×10^{-3}
7	Gravelly sand to sand	1×10^{-3} to 1
8	*Very stiff sand to clavey sand	1×10^{-5} to 1×10^{-5}
9	*Very stiff fine-grained soil	1×10^{-9} to 1×10^{-7}

*Overconsolidated or ocmented



January 18, 2005

Mr. Ron Purkey Tennessee Valley Authority 1101 Market Street, LP-2G Chattanooga, TN 37402 Phone: (423) 751-4820 Fax: (423) 751-7094

Subject: Modification to Task Order Proposal for Monitoring Wells Installation TVA Kingston Fossil Plant Ash Disposal Area Kingston, Tennessee MACTEC Proposal Prop04Knox/399, Revision 1

Dear Mr. Purkey:

MACTEC Engineering and Consulting, Inc., (MACTEC) is pleased to submit this proposal for modification of our original task order proposal for providing geotechnical engineering support for the ash disposal area at the Tennessee Valley Authority (TVA) Kingston Fossil Plant in Kingston, Tennessee. Included in this proposal are the proposed additional services and our cost estimate.

Project Information

We understand that TVA would like MACTEC to provide additional drilling and monitoring well installation at the subject site. The scope of additional work was assigned by Parsons E&C and Geosyntec during a teleconference on January 13, 2005.

Proposed Scope of Additional Services

Based on our understanding of your needs, we will provide the following additional services:

• Drill boring B-3 to refusal including standard penetration test (SPT) at 5-foot depth intervals and at major changes of material type when detectable. The SPT sampling will start at a depth of about 70 feet.

MACTEC Engineering and Consulting, Inc. 1725 Louisville Drive • Knoxville, TN 37921-5904 865-588-8544 • Fax: 865-588-8026

- Install and develop one 2-inch monitoring well at a total depth of 100 feet near the location of boring B-3. The well will be 2-inch I.D., Schedule 40 PVC with double-density, slotted, 0.010-inch screen with a 5-foot screen length.
- Drill boring B-4 at the originally staked location after TVA prepares a working pad at that location.
- Backfill all test borings with a cement-bentonite grout.
- Include the additional field data in our final report for this project.

Assumptions

MACTEC assumes the following:

- All boring/monitoring well locations will be selected and located in the field by TVA or their designees. After completion of drilling, all boring locations will be staked by MACTEC and surveyed by TVA using land surveying techniques. A base map and coordinates of all boring locations will be provided to MACTEC for use in their final report to TVA.
- TVA will furnish a dozer and any necessary stone to provide access for MACTEC's drilling equipment to all boring/monitoring well locations as needed.
- Underground utilities, if any, will be located by others.
- Mitigation of environmental concerns (if any are encountered) is not part of this work.

Cost Estimate

We have estimated the cost to perform the additional services to be approximately \$8,120. This projected cost was based on manpower estimates and quantities of work as presented in the attached cost estimate. The actual cost will be based on the units of work performed. Our total cost estimate for this project, including the originally approved \$61,000 and the additional cost given above, is \$69,120. We request that TAO MAC-0710-00068 be modified to this amount.

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The additional field services will be performed in conjunction with the original field work. We expect the additional field exploration to last approximately two working days. Preliminary boring logs can be provided at the completion of each boring.

Authorization

We propose to perform the requested services in accordance with the terms and conditions of our existing contract 21705. We understand that, if this proposal is acceptable to you, TVA will authorize this work by issuance of a modified TAO.



Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Hussein A. Benkhayal

Senior Professional

HAB/CDT:sjm

Attachment

cc: Mr. Lynn Petty TVA Chattanooga

n Julm Carl D. Tockstein, P.E.

Carl D. Tockstein, P.E. Chief Engineer - Tennessee Operations





COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399, Revision 1

Manpower

\$2,876.89

Drilling

\$5,242.50

Total \$8,119.39





SCHEDULE OF FEES PERSONNEL CHARGES TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399, Revision 1

PROFESSIONAL SERVICES					
DESCRIPTION	HOURS	RATE	BURDEN	BILLING RATE	соѕт
Project Administration					
Chief Engineer	0	\$48.00	\$20.00	\$138.72	\$0.00
Senior Engineer	0	\$25.00	\$6.00	\$72.25	\$0.00
Drilling/Field Coordination					
Senior Engineer	2	\$25.00	\$47.25	\$72.25	\$144.50
Project Engineer	0	\$23.00	\$43.47	\$66.47	\$0.00
Field Engineering					
Project Engineer	16	\$23.00	\$43.47	\$66.47	\$1,063.52
Senior Engineer	0	\$25.00	\$47.25	\$72.25	\$0.00
Senior Geologist	16	\$29.41	\$55.58	\$84.99	\$1,359.92
Project Geologist	0	\$22.50	\$42.53	\$65.03	\$0.00
Data Analysis / Lab Coordination	1				
Chief Engineer	0	\$48.00	\$90.72	\$138.72	\$0.00
Senior Engineer	1	\$25.00	\$47.25	\$72.25	\$72.25
Project Engineer	0	\$23.00	\$43.47	\$66.47	\$0.00
Senior Geologist	0	\$29.41	\$55.58	\$84.99	\$0.00
Report Preparation					
Project Engineer	0	\$23.00	\$43.47	\$66.47	\$0.00
Senior Engineer	0	\$25.00	\$47.25	\$72.25	\$0.00
Chief Engineer	0	\$48.00	\$90.72	\$138.72	\$0.00
Drafter/CADD	2	\$15.00	\$28.35	\$43.35	\$86.70
Word Processor	0	\$14.00	\$26.46	\$40.46	\$0.00
SUBTOTAL LABOR	37	Hours			\$2,726.89
Travel Expenses (Professional)					
	Unit Rate		Quantity	Estimated Cost	
Expenses (includes transportation	\$150.00 Each		1	\$150.00	
to and from site, per diem in					
accordance with TVA allowances,					
etc.)					
SUBTOTAL TRAVEL EXPENSES	· · · · · · · · · · · · · · · · · · ·				\$150.00
					\$2 876 89
SUBTUTAL SUBCONTRACT					ψ2,010.03
SCHEDULE OF FEES COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399, Revision 1

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			Description	Quantity	Unit	Unit Rate	Subtotal
γ Α.	Mol	bili	zation and demobilization of drilling, sampling, or support equipment:				
	1.	#]			
	L	6	Truck-mounted drill rig	0	each	\$200.00	\$0.00
		b.	ATV-mounted drill rig	0	each	\$250.00	\$0.00
		c.	Water truck	0	each	\$100.00	\$0.00
		d.	Geoprobe	0	each	\$200.00	\$0.00
		e.	Workover rig	0	each	\$100.00	\$0.00
		f.	Support truck	0	each	\$50.00	\$0.00
	2.	Be	eyond 25 miles from originating location, add per mile one-way				
	•	a.	Truck-mounted drill rig	0	mile	\$4.00	\$0.00
		b.	ATV-mounted drill rig	0	mile	\$5.00	\$0.00
		c.	Water truck, workover rig, or Geoprobe	0	mile	\$2.00	\$0.00
		d.	Support truck	0	mile	\$1.00	\$0.00
В.	Wa	ash	Boring in overburden soil, per linear foot				
		a.	4 - inch diameter	285	feet	\$6.50	\$1,852.50
		Ь	6 - inch diameter	0	feet	\$7.50	\$0.00
~	64-					LL	
υ.	514		< 50	22	each	\$20.00	\$440.00
	2	N	> 50	2	each	\$25.00	\$50.00
_	<u> </u>					<u></u>	· · · · · · · · · · · · · · · · · · ·
F.	Gro	Sut	ing (cement) borehole without well, per linear foot:	60	feet	\$5.50	\$330.00
	2	6	to 9-inch diameter, per linear foot		feet	\$11.00	\$0.00
	2.	0	to 12 inch diameter, per linear foot	0	feet	\$22.00	\$0.00
	3.	9	have rates are based on peat line borehole volume, if grout losses occur	0	1661	422.00	
	4.		ditional grouting will be charged at time rate drilling cost plus actual				
	L	1					
G.	Ty	pe	I PVC well construction in pre-drilled borehole, including time and mate	rials, per linear	foot:	\$10.00	00 D\$
	1.	1.		400	foot	\$10.00	\$1.300.00
	2.	2.	inch	100	leet	\$13.00	\$1,300.00
I.	Tir	me	rate for drill crew and equipment including steam cleaning, packer testi	ng with drill cro	ew, difficult m	noving, clearing	, well
	de	ve ck	lopment, nauling water, nandling iDw, diπicuit drilling through collapsin drilling using a roller cone bit in partially weathered rock only, drilling t	g or nowing ma rouah boulder	s or debris, r	eaming out	entent,
	pa	rtia	ally weathered rock corehole, standby, safety orientation, site restoration	n, packer testin	ng, off-truck d	rilling, inside w	ork, or
	tin	ne-	rate drilling, per hour.				
				0	hours	\$150.00	\$0.00
J.	Eq	iui	pment charges, per day:			T	
	1.4	1			مدينية ا	1 COEC 001	EU 00

Page 3 of 4

SCHEDULE OF FEES COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399, Revision 1

	Description	Quantity	Unit	Unit Rate	Subtotal
11. Supp	port truck	2	days	\$35.00	\$70.00
17 Cellu	lar Telephone	2	days	\$50.00	\$100.00

L

V. Overtime charges for drilling at TVA's request during other than 40-hour week or on weekends or holidays, multiply rates by 1.3.

W. Crew daily trip charge, to and from site

	2	days	\$75.00	\$150.00
--	---	------	---------	----------

X. Per diem and lodging in accordance with TVA allowances

2 day \$125.00 \$250.0				
	2	day	\$125.00	\$250.00

TOTAL COST ESTIMATE

\$5,242.50

Page 4 of 4

om:	Smith, Daniel R on behalf of Smith, Daniel R.
Bent:	wednesday, January 12, 2005 3:15 PM
To:	Boggs, J. Markus; GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES; Smith, Amos L; egreg.mcnulty@parsons.com; Benkhayal, Hussein
Cc:	Julian, Hank; Petty, Harold L.
Subject:	Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

We need to meet TOMORROW Thursday January 13, 2004 at 11 am. Mactec has completed holes 8&9, and will have completed hole 4 by early tomorrow morning at the latest. They will be ready to drill the wells for these holes starting tomorrow. Please be prepared to discuss basically the same items for these holes as we did yesterday for 5,6 & 7.

We will therefore cancel Friday's meeting. We will set a time for the followup meetings tomorrow.

Mactec needed to move hole # 4 up the slope about 20 ft, due to inaccessibility. From what they described, it will be placed on the existing bench that is at about El 775. Hole 9 went in at the location staked.

Here is the phone no and Meeting ID. call 423-751-2428 or . Enter Mtg ID 6704 when prompted.

If you have a conflict let me know. Lynn is on the road and this is the best time we could schedule - given an allowance for receiving the faxed information from hole #4. I'm out of the office and can be reached by cell phone.

Daniel R. (Dan) Smith, P.E.Parsons E & CPhone: (423) 757-808833 Chestnut St, Suite 400Fax: (423) 266-0922Chattanooga, TN 37932Cell: (423) 364-1679Please note my new email address: Daniel.R.Smith@parsonsec.com

GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES tom: Sent: Tuesday, January 11, 2005 2:17 PM To: Smith, Daniel R.; Boggs, J. Markus; Julian, Hank; Smith, Amos L; egreg.mcnulty@parsons.com; HABENKHAYAL@mactec.com Cc: Petty, Harold L. **RE: Borings at KIF - Piezometer Locations** Subject: Borina ;_Jan1105.pdf (149 Gentlemen: The attached pdf file provides a summary of the borings completed to date and also indicates the agreed upon elevations for piezometers at the locations MW-5, -6, and -7. The proposed depths are as follows: MW-5 Location - 42.5 to 47.5 ft BGS - 62.5 to 67.5 ft BGS MW-6 Location - 70 to 75 ft BGS - observe water level during drilling; determine depth of upper piezometer based on field observations W-7 Location - 60 to 65 ft BGS Next conference call scheduled for 11am on Friday Jan 14. Hussein, Dan and Mark - could you please confirm that you have received this email and that the pdf file opens OK. Thanks Neil ----Original Message-----From: Smith, Daniel R [mailto:Daniel.R.Smith@parsonsec.com] Sent: Monday, January 10, 2005 12:08 PM To: Boggs, J Marcus; Neil Davies; Julian, Hank; Smith, Amos; egreg.mcnulty@parsons.com Cc: Petty, H. L. Subject: Borings at KIF <html> *** WorleyParsons Group Notice *** "This email is confidential. If you are not the intended recipient, you must not disclose or use the information contained in it. If you have received this email in error, please notify us immediately by return email and delete the email and any attachments. Any personal views/ opinions expressed by the writer may not necessarily reflect the views/ opinions of the company." /html>

Legend

Screen location (agreed during TeleConf on 11Jan 2005)





MW-5

Ground Elevation = 806 ft (estimated from the drawing showing proposed locations of additional borings and peizometers 10W425-26A)

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in the second se

MW-6 Ground Elevation = 805 ft (estimated from the drawing showing proposed locations of additional borings and peizometers 10W425-26A) Legend

Screen location (agreed during Tele Conf 11 Jan 2005)

Elevation (ft)	Depth (ft)		
805	°	Soft gray dry to slight moist sendy silt (Fly/Bottom Ash)	
800	5 -	Firm gray dry to slight moist sandy silt (Fly/Bottom Ash)	No • Scree
795	10	Soft gray very moist to wet saudy silt (Fly/Bottom Ash)	born
790	15	Firm gray very moist to wet sendy silt (Fly/Bottom Ash)	dete obse
785	20	Firm gray slight moist silty send (Bottom Ash)	leu of
780	25	Very soft gray wet sandy clayey silt (Fly Ash)	(r.
775	30	Vary soft wet candy clayey sik (Fly Ash)	FLY ASH
770	35	From 35 ft to 36 ft: Very soft gray wet sandy clayey slit (Fly Ash) From 36 to 36.5 ft: Loose gray wet slity sand (bottom Ash)	
765	40	Dense gray slightly moist silty sand (Bottom Ash)	
760	45 j	Very firm gray wet silty sand (Bottom Ash interbedded with Fly Ash)	
755	5 Ó	Very soft gray wet sandy silt (Fly Ash interbedded with Bottom Ash)	
 750		Loose gray wet silty sand (Bottom Ash)	
745	60	From 60 to 60.5 ft and 61.3 to 61.5: Soft gray wet sany clayey silt (Fly Ash) From 60.5 to 61.3 ft: very loose gray wet silty sand (Bottom Ash)	
740	65	From 65 to 65.5 ft: Very soft gray wet clayey silt (Fly ash) From 65.5 to 66.1 ft: Soft to firm yellow brown very mois: silty slay (Clay fill with Fly Ash)	FLYASH + Battom
735		From 70 to 71.3 ft: very coarse gray wet silty sand (Bottom Ash) . From 71.3 to 71.5 ft: Soft gray wet clayey silt (Fly Ash)	Ash
730	4	4 Very soft gray wet slightly sandy claycy silt (Fly Ash)	
 725	80		v santiv ulavev siliri Piv Aslin
720	85	From 82.2 to 82.7 ft. Siff dark gray slightly (Alluvium) From 82.7 to 83.5 ft: Stiff gray to light gray Stiff light gray to gray moist tilty sandy clay (Alluvium)	moist to moist silty clay with few roots
715	90	From 90 to 91 ft: Very stiff light gray and yellow brown slightly moist to moist sandy sifty clay with few roots (Alluvium)	ALLUVIUM.
710	95	room 91 to 91.5 tr. Same & above except "saady silt" Firm gray moist silty send with a few roots (Alluvium)	
705	100	Dense olive brown wet silty sand with gravel (Alluvium)	

Note: Screen location for the upper 55 ft of the boring logic will be determined based on observation of water level during inshill hon of the lower Screen (r.c.; 70 to 75 ft bgs)



а. г. М.

From: Boggs, J. Markus

Sent: Wednesday, January 12, 2005 4:39 PM

To: 'Hussein Benkhayal (hbenkhayal@mactec.com)'

Cc: Petty, Harold L.

Subject: Kingston - well development

Contacts: Hussein Benkhayal

Hussein,

Please let me know when the field crew is ready to begin development of completed piezometers in the dredge cell area. I would like to be present for initial development work in case there are questions or unexpected conditions.

Thanks.

Mark

J. Mark Boggs, Hydrologist Environmental Engineering Services - East

Tennessee Valley Authority 400 W. Summit Hill Drive WT 9C-K Knoxville, TN 37802-1401

Phone: 865-632-6941 Fax: 865-632-8375



From: GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES

Sent: Thursday, January 13, 2005 11:13 AM

To: Smith, Daniel R.; Boggs, J. Markus; Smith, Amos L; egreg.mcnulty@parsons.com; habenkhayal@mactec.com

Cc: Julian, Hank; Petty, Harold L.

Subject: RE: Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

Boring Logs

<<0376_001.pdf>>

From: Smith, Daniel R [mailto:Daniel.R.Smith@parsonsec.com]
Sent: Wednesday, January 12, 2005 3:15 PM
To: Boggs, J Marcus; Neil Davies; Smith, Amos; egreg.mcnulty@parsons.com; Benkhayal, Hussein
Cc: Julian, Hank; Petty, H. L.
Subject: Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

We need to meet TOMORROW Thursday January 13, 2004 at 11 am. Mactec has completed holes 8&9, and will have completed hole 4 by early tomorrow morning at the latest. They will be ready to drill the wells for these holes starting tomorrow. Please be prepared to discuss basically the same items for these holes as we did yesterday for 5,6 & 7.

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call 423-751-2428 or . Enter Mtg ID 6704 when prompted.

If you have a conflict let me know. Lynn is on the road and this is the best time we could schedule - given an allowance for receiving the faxed information from hole #4. I'm out of the office and can be reached by cell phone.

Daniel R. (Dan) Smith, P.E.

Parsons E & C Phone: (423) 757-8088

633 Chestnut St, Suite 400 Fax: (423) 266-0922

Chattanooga, TN 37932 Cell: (423) 364-1679 Email: Daniel.R.Smith@parsonsec.com

Please note my new email address: Daniel.R.Smith@parsonsec.com

From: Bartley, Gregory L.

Sent: Thursday, January 13, 2005 1:55 PM

To: Anderson, Cynthia M; Thacker, Denice R.; Houston, Donald P.; Bowers, Larry C; Johnson, Lindy P.; Hastings, D. Mark; Petty, Harold L.; Purkey, Ronald E.

Cc: Evans, H. Gary; Shattuck, Clinton L.

Subject: RE: Non EDTA Boiler Cleaning Draft Guidance

All, I have only one comment of the draft, and it is that we cannot use frac tanks on the once thru units. Each frac tank holds 20,000 gallons, and we need from 500,000 to 800,000 gallons to collect all the wastes from our once thru units. Some other tank would have to be employed. Sorry I missed the conf call.

-----Original Message----- **From:** Anderson, Cynthia M **Sent:** Thursday, January 13, 2005 8:42 AM **To:** Thacker, Denice R.; Houston, Donald P.; Bowers, Larry C; Johnson, Lindy P.; Hastings, D. Mark; Bartley, Gregory L.; Petty, Harold L.; Purkey, Ronald E. **Subject:** Non EDTA Boiler Cleaning Draft Guidance

Attached is the draft of the Non-EDTA Boiler Cleaning Waste developed by Environmental Affairs. We will be discussing this guidance along with other issues during our 2:00 PM meeting today.

Thanks,

Cynthia M. Anderson Hazardous Waste Specialist

TVA

1101 Market Street, LP 5D Chattanooga, TN 37402-2801 Phone: (423) 751-4878 Fax: (423)751-7011 cmanderson@tva.gov

TVA-00013577

From:GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIESSent:Thursday, January 13, 2005 1:03 PMTo:Smith, Daniel R.; Boggs, J. Markus; Smith, Amos L; egreg.mcnulty@parsons.com;
habenkhayal@mactec.comCc:Julian, Hank; Petty, Harold L.; TElkady@GeoSyntec.comSubject:RE: Revised meeting for KIF Seepage - Summary of Decisions From Jan 13 Call

Based on today's conference call, the following target well elevations were established:

MW-3

- drill down to 70 ft. depth; commence sampling
- drill to refusal or bedrock
- decision to be made on well screen elevation after review of logs

MW-4

- move to location originally established; needs some surface preparation prior to drilling
- drill/sample to bedrock or refusal
- we will probably establish 2 wells at this new location (TBD based on drill logs)

MW-6

- additional well to be established with screen at 50-55 ft BGS

MW-7

additional well to be established with screen at 40-45 ft BGS

MW-8

- well to be established with screen at 20-25 ft BGS
- well to be established with screen at 35-40 ft BGS

MW-9

- well to be established with screen at 10-15 ft BGS
- well to be established with screen at 20-25 ft BGS

Note Nomenclature:

At each physical location, the pilot boring should be referred to as Bx; well should be labeled as MW-xA and MWxB where x is the location number.

Thanks

Neil

From: Smith, Daniel R [mailto:Daniel.R.Smith@parsonsec.com]
Sent: Wednesday, January 12, 2005 3:15 PM
To: Boggs, J Marcus; Neil Davies; Smith, Amos; egreg.mcnulty@parsons.com; Benkhayal, Hussein
Cc: Julian, Hank; Petty, H. L.
Subject: Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

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Daniel R. (Dan) Smith, P.E.

Parsons E & C Phone: (423) 757-8088

633 Chestnut St, Suite 400 Fax: (423) 266-0922

Chattanooga, TN 37932 Cell: (423) 364-1679 Email: Daniel.R.Smith@parsonsec.com

Please note my new email address: Daniel.R.Smith@parsonsec.com

om: ent: To: Cc: Subject:

Smith, Daniel R. Thursday, January 13, 2005 5:58 PM Benkhayal, Hussein; Justice, Todd Petty, Harold L. KIF Seepage Well Drilling



KIF Seepage Well Drilling

<html>

<fort face="Arial" style="font-size: 8pt;">*** WorleyParsons Group Notice *** "This email is confidential. If you are not the intended recipient, you must not disclose or use the information contained in it. If you have received this email in error, please notify us immediately by return email and delete the email and any attachments. Any personal views/ opinions expressed by the writer may not necessarily reflect the views/ opinions of the company."

om: cent: To: Cc: Subject: Smith, Daniel R on behalf of Smith, Daniel R. Thursday, January 13, 2005 5:58 PM Benkhayal, Hussein; Justice, Todd Petty, Harold L. KIF Seepage Well Drilling

TVA is off Monday, January 17, 2005. IF you have boring logs that need to be sent out on that day ONLY, please fax to me at the number below and I'll take care of distributing to the team. I assume Mactec is working Monday, as we are. If not, then I guess you can disregard this message. We apparently have a 3 pm phone call.

Please call me tomorrow to confirm you got this message. I left Todd an voicemail on his cell phone.

Thanks

Please note new email address: Daniel.R.Smith@parsonsec.com Daniel R. (Dan) Smith, P.E. Parsons E & C Phone: (423) 757-8088 633 Chestnut St, Suite 400 Fax: (423) 266-0922 Chattanooga, TN 37450 Cell: (423) 364-1679 Email: I

Email: Daniel.R.Smith@parsonsec.com



December 16, 2004

Mr. Ron Purkey Tennessee Valley Authority 1101 Market Street, LP-2G Chattanooga, TN 37402 Phone: (423) 751-4820 Fax: (423) 751-7094

Subject:

Task Order Proposal for Monitoring Wells Installation TVA Kingston Fossil Plant Ash Disposal Area Kingston, Tennessee MACTEC Proposal Prop04Knox/399

Dear Mr. Purkey:

MACTEC Engineering and Consulting, Inc., (MACTEC) is pleased to submit this proposal for providing geotechnical engineering support for the ash disposal area at the Tennessee Valley Authority (TVA) Kingston Fossil Plant in Kingston, Tennessee. Included in this proposal are our understanding of the project requirements, our proposed scope of services, our cost estimate, and our schedule.

Project Information

We understand that TVA would like MACTEC to provide drilling, monitoring well installation, laboratory testing, and geotechnical engineering services for evaluations and engineering activities associated with the existing ash disposal area. Our scope of work, cost estimate, and schedule are based on discussions during a teleconference on December 14, 2004, and a revised Scope of Work provided by TVA on December 15, 2004.

Proposed Scope of Services

Based on our understanding of your needs, we will provide the following services:

• Mobilize one All Terrain (ATV) Mounted drill rig and possibly an additional truck-mounted drill rig.

MACTEC Engineering and Consulting, Inc. 1725 Louisville Drive • Knoxville, TN 37921-5904 865-588-8544 • Fax: 865-588-8026

- Drill six test borings including standard penetration test (SPT) at 5-foot depth intervals and at major changes of material type when detectable. The borings will be drilled to refusal (approximate depths range from 70 to 110 feet).
- Backfill all test borings with a cement-bentonite grout.
- Install and develop 12 two-inch monitoring wells at depths ranging from 30 to 60 feet as specified by TVA or their designee. The wells will be 2-inch I.D., Schedule 40 PVC with double-density, slotted, 0.010-inch screen with a 5-foot screen length.
- Perform in situ hydraulic conductivity test at 12 monitoring well locations.
- Obtain one complete set of groundwater readings from the newly installed monitoring wells.
- Perform laboratory tests on ash and soil samples consisting of natural moisture content, Atterberg limits, grain size analyses, and specific gravity.
- Prepare a brief report that presents the field and laboratory data.

Assumptions

MACTEC assumes the following:

- All boring/monitoring well locations will be selected and located in the field by TVA or their designees. After completion of drilling, all boring locations will be staked by MACTEC and surveyed by TVA using land surveying techniques. A base map and coordinates of all boring locations will be provided to MACTEC for use in their final report to TVA.
- TVA will furnish a dozer and any necessary stone to provide access for MACTEC's drilling equipment to all boring/monitoring well locations as needed.
- Underground utilities, if any, will be located by others.
- Mitigation of environmental concerns (if any are encountered) is not part of this work.

Cost Estimate

We have estimated the cost to perform the geotechnical exploration services to be approximately \$72,440.53. This projected cost was based on manpower estimates and quantities of work as presented in the attached cost estimate. The actual cost will be based on the units of work performed. Our cost estimate includes performing 12 field hydraulic conductivity tests. If these tests are not to be performed by MACTEC, the total estimated cost should be reduced by \$11,900, assuming no use or involvement of MACTEC equipment and personnel.

Schedule

Based on our current work load, we can mobilize drilling equipment to the site within a week after receiving your authorization, but not sooner than January 3, 2005. We expect the field exploration to last approximately 10 to 15 working days. Preliminary boring logs can be provided at the completion of each boring. We anticipate laboratory testing to be completed in about two weeks after completion of the field work and the report to be issued approximately one week after completion of the laboratory testing.

Authorization

We propose to perform the requested services in accordance with the terms and conditions of our existing contract 21705. We understand that, if this proposal is acceptable to you, TVA will authorize this work by issuance of a TAO.

3

TVA Kingston Fossil Plant Ash Disposal Area MACTEC Proposal Prop04Knox/399



Mr. Purkey, we appreciate this opportunity to provide these services to TVA. If you have any questions regarding this proposal, please contact Hussein Benkhayal or Carl Tockstein at (865) 588-8544.

Samuel D. Stone

Samuel D. Stone, P.E.

Senior Principal Engineer

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Hussein A. Benkhaval

Hussein A. Benkhayal Senior Professional

HAB/SDS:sjm

Attachment

cc: Mr. Lynn Petty TVA Chattanooga

4



MACTEC



COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399

Manpower	\$33,750.53
Drilling	\$35,440.00
Lab	\$3,250.00
Total	\$72,440.53



SCHEDULE OF FEES PERSONNEL CHARGES TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399

DESCRIPTION	HOURS	RATE	BURDEN	BILLING RATE	COST
Project Administration	LI		LI		
Chief Engineer	8	\$48.00	\$20.00	\$138.72	\$1,109.76
Senior Engineer	12	\$25.00	\$6.00	\$72.25	\$867.00
Drilling/Field Coordination					
Senior Engineer	16	\$25.00	\$47.25	\$72.25	\$1,156.00
Project Engineer	8	\$23.00	\$43.47	\$66.47	\$531.76
Field Engineering					
Project Engineer	150	\$23.00	\$43.47	\$66.47	\$9,970.50
Senior Engineer	16	\$25.00	\$47.25	\$72.25	\$1,156.00
Senior Geologist	60	\$29.41	\$55.58	\$84.9 9	\$5,099.69
Project Geologist	60	\$22.50	\$42.53	\$65.03	\$3,901.50
Data Analysis / Lab Coordination	1				
Chief Engineer	4	\$48.00	\$90.72	\$138.72	\$554.88
Senior Engineer	24	\$25.00	\$47.25	\$72.25	\$1,734.00
Project Engineer	8	\$23.00	\$43.47	\$66.47	\$531.76
Senior Geologist	16	\$29.41	\$55.58	\$84.99	\$1,359.92
Report Preparation					
Project Engineer	8	\$23.00	\$43.47	\$66.47	\$531.76
Senior Engineer	32	\$25.00	\$47.25	\$72.25	\$2,312.00
Chief Engineer	4	\$48.00	\$90.72	\$138.72	\$554.88
Drafter/CADD	16	\$15.00	\$28.35	\$43.35	\$693.60
Word Processor	12	\$1 4.00	\$26.46	\$40.46	\$485.52
SUBTOTAL LABOR	454	Hours			\$32,550.53
Travel Expenses (Professional)					
		Uni	t Rate	Quantity	Estimated Cos
Expenses (includes transportation		\$1,200.00	Each	1	\$1,200.0
to and from site, per diem in					
accordance with TVA allowances, etc.)					
SUBTOTAL TRAVEL EXPENSES					\$1,200.00
					000 750 50
SUBTOTAL SUBCONTRACT					\$33,750.53

SCHEDULE OF FEES COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399

	Description		Quantity	Unit	Unit Rate	Subtotal	
Α.	Mol	oili	zation and demobilization of drilling, sampling, or support equipment:				
	1.	#	and an and a second a se]			
		6	Truck-mounted drill rig	1	each	\$200.00	\$200.00
		b.	ATV-mounted drill rig	1	each	\$250.00	\$250.00
		c.	Water truck	0	each	\$100.00	\$0.00
		d.	Geoprobe	0	each	\$200.00	\$0.00
		e.	Workover rig	0	each	\$100.00	\$0.00
		f.	Support truck	1	each	\$50.00	\$50.00
	2.	Be	eyond 25 miles from originating location, add per mile one-way				
		a.	Truck-mounted drill rig	15	mile	\$4.00	\$60.00
		b.	ATV-mounted drill rig	15	mile	\$5.00	\$75.00
		c.	Water truck, workover rig, or Geoprobe	0	mile	\$2.00	\$0.00
		d.	Support truck	15	mile	\$1.00	\$15.00
в.	Wa	sh	Boring in overburden soil, per linear foot				
		a.	4 - inch diameter	1095	feet	\$6.50	\$7,117.50
		b.	6 - inch diameter	0	feet	\$7.50	\$0.00
C.	Sta	nda	ard penetration test in conjunction with boring, per sample				
	1.	N <	< 50	80	each	\$20.00	\$1,600.00
	2.	N۶	> 50	13	each	\$25.00	\$325.00
F	Gro	uti	ing (cement) horehole without well, per linear foot:				
••	1.	6-	inch diameter or less, per linear foot	555	feet	\$5.50	\$3,052.50
	2.	6-	to 9-inch diameter, per linear foot	0	feet	\$11.00	\$0.00
	3.	9-	to 12-inch diameter, per linear foot	0	feet	\$22.00	\$0.00
	4.	Ał	pove rates are based on neat line borehole volume, if grout losses occur,		· · · · ·	L	
		ac	ditional grouting will be charged at time rate drilling cost plus actual				
		m	aterial cost times 1.10.				
G.	Tv	be	I PVC well construction in pre-drilled borehole, including time and mate	rials, per linear	foot:		
•.	1.	1-	inch		feet	\$10.00	\$0.00
	2.	2-	inch	540	feet	\$13.00	\$7,020.00
I.	Tir de roc pa tim	ne vel ck (rtia ne-l	rate for drill crew and equipment including steam cleaning, packer testin opment, hauling water, handling IDW, difficult drilling through collapsing drilling using a roller cone bit in partially weathered rock only, drilling th ally weathered rock corehole, standby, safety orientation, site restoratior rate drilling, per hour.	ng with drill cro g or flowing ma rough boulder n, packer testin	ew, difficult m aterials, drillin s or debris, re g, off-truck dr	oving, clearing g through pav aming out illing, inside w	ı, weli ement, /ork, or
				36	hours	\$150.00	\$5,400.00

I. E	quipment charges, per day:		-		
1	. Water truck to support drill rig	0	days	\$250.00	\$0.00
2	. Steam cleaner		days	\$75.00	\$0.00
3	. Generator		days	\$50.00	\$0,00
9	. Grout plant	18	days	\$250.00	\$4,500.00
1	0. ATV drill	15	days	\$100.00	\$1,500.00

Page 3 of 5

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SCHEDULE OF FEES COST ESTIMATE TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399

Description	Quantity	Unit	Unit Rate	Subtotal
11. Support truck	15	days	\$35.00	\$525.00
17 Cellular Telephone	15	days	\$50.00	\$750.00

V. Overtime charges for drilling at TVA's request during other than 40-hour week or on weekends or holidays, multiply rates by 1.3.

W. Crew daily trip charge, to and from site

15	days	\$75.00	\$1,125.00

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X. Per diem and lodging in accordance with TVA allowances

15	day	\$125.00	\$1,875.00

TOTAL COST ESTIMATE \$35,440.00

Page 4 of 5

SCHEDULE OF FEES LABORATORY TESTING SERVICES TVA KINGSTON FP MONITORING WELL INSTALLATION MACTEC Proposal Prop04Knox/399

Description	ASTM	Quantity	Unit	Rate	Subtotal
Natural (Jar) Moisture Content	D-2216	80	per test	\$8.00	\$640.00
Atterberg Limits	D-4318	8	per test	\$65.00	\$520.00
Sieve Analysis (wash wo/hydrometer - assumed Spec. Grav.)	D-422	20	per test	\$50.00	\$1,000.00
Sieve Analysis w/hydrometer (assumed Spec. Grav.)	D-422	8	per test	\$110.00	\$880.00
Specific Gravity	D-854	6	per test	\$35.00	\$210.00

TOTAL COST ESTIMATE

\$3,250.00

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Neil Davies GeoSyntec Fax number: 678-202-9501

Dan Smith Parsons Fax number: 423-266-0922

Mark Boggs & Hank Julian TVA Fax number: 865-632-8375 Greg McNulty Parsons Fax number: 513-554-6572

From

Lynn Petty Phone: 423-751-6704 Fax: 423-751-7094 Email: hlpetty@tva.gov

KINGSTON WELL INSTALLATION-2005-DAILY LOGS

Date sent: 1/5/05

Number of pages including cover page: <u>4</u>

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B-4 (ORIG LOCATION)

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865 717 2042 P.02/02 BURING NU. 12 - 7 ____ PG. ____ OF ___ KINGSTON YARD OPERATIONS JAN-18-2005 12:14 MALLEC SOIL TEST BORING FIELD REPORT RIG TYPE ATV HAMMER TYPE MANUAL GROUND SURFACE ELEV. JOB NO. 3043041063 DRILLER R. BANKS HOURS DRILLING DATE: 17/05WEATHER: COLP 1 20'5 JOB NAME THA KINGSTON LOGGED BY J.J. J. Stick HOURS MOVING 1/10/05 From O to 2, SFT ENCOUNTERED REPRAP NOTE: Drill FLUID AND CRUSHED STONE BASE AGOREGATE. LOSS AT 2 FT. INSTANION BEGANS SPOON SAMPLING @ 4.0 FT. PVC CASING. STIFF GRAY SI moist Clayey Sandy silt with a faw roaf Fragmento - 7/4, ASH 1.4. Soff Gray WET SANdy Clayey Silt with a few root layers - 714 AsH 2 I.Y VerySTIFF RED-Blown Sightly moist Siltycing with chest fragmate 1.0 LOOSE GRAY WET clayay Suty SAND - BOTTOM ASH 10 Firm Graz wet Silty SAND with coal frequeto - Botton ASH 1.4 Firm Gray wet Sandy clagay SICT - Fly Ash 52 \$ 29-30.5 S DEILLER NOTED HARD DRILING 32 HARD CRAYISH BROWN to Olive Brown 7 34-35.5 12 22 13 Slightly moist WEATHERED SHALE - RESIDUUM NOTE: ENGUNTERED GRAVEL WITH SAND FIM. 34 to 34.1 FT. Possible Allaviel internal located in between Fig ASH AND ROSIDUUM 8 39-405 20 25 .44 VeryHARD CORAYISH BROWN SLIGHTLY MOIST WEATHERED SHALE - RESIDUUM BORING TERMINATED: 43.01 METHOD OF ADVANCING BORING DEPTH BORING REFUSAL: 43.01 POWER AUGER TO WATER TOO DEPTH @ time of drilling 2 6.5 Fr HAND SHOP: W/MUD: W/WATER TO WATER 24 HR.: DEPTH _TO 43.01 ROTARY DRILL: WIMUD: WIWATED 4 "9 WATER LOSSES _ SEE NOTE DIAMOND CORE TO CAVE-IN DEPTHS CORE SIZE TO LENGTH O TO 8 FT UNDISTURBED SAMPLES NO _____ SIZE ____ STANDBY TIME BORING LAYOUT **BAG SAMPLES** NO TOTAL P.02 P.02 98% JAN-18-2005 12:01 865 717 2042

TVA-00013598

865 717 2042 BURING NU. 12 - 7 ____ PG. ___ P.02/02 KINGSTON YARD OPERATIONS JAN-18-2005 12:14 IVIALLEL SOIL TEST BORING FIELD REPORT RIG TYPE ATV HAMMER TYPE MANUA L JOB NO. 304304.1063 DRILLER R. BANKS HOURS DRILLING GROUND SURFACE ELEV. DATE: 17/05WEATHER: COLP 1 20'5 JOB NAME THA KINGSTON LOGGED BY J.J. WATICE HOURS MOVING 1/10/05 From 0 to 2, SFT ENCOUNTERED REPRAD NOTE: Drill PLUD AND CRUSHED STONE BASE AGOREMPTE. LOSS AT 2 FT INSTANTON BEGAN SPED SAMPLING @ 4.0FT PVC CASIKIU. 6 0.8 STIFF GRAY SI moist clayey Sandy silt with a faw front S 0.8 -5.5 3 Fragments - 7/4, HSH 1.7 Soff Gray WET SANdy clayey sut with a few root layers - Fly AsH 29-10,5312 2. I.Y Very STIFF RED-Blown Stightly moist Siltyclay with chest fragments 1.0 Loose Gray WET chargey Sulty SAND - BOTTOM ASH 1.0 Firm Gray wet Silty SAND with coal frequento - Botton ASH . المحاد المحدة البيار في المنافعة الحد 2 1.4 Firm Gray wet SAndy Clayer SILT - FIL ASH 2-305 S DEILLER NOTED HARS DRILLING 32.0F HARD CRAYISH BROWN to Olive Brown 7 39-25.5 12 22 :13 1.2 Suguely moist WEATHERED SHALE - RESIDUAN NOTE: ENCOUNTERED CRATEL WITH SAND FIM 34 to 34. LET. Possible Allowial interval locatal in between Fly Ast AMP Rosiouum 3 39-405 20 25 Very HARD CORANISH BROWN SLIGHTly .44 MOIST WEATHERED SHALE - RESOLUM BORING TERMINATED: 43.04 METHOD OF ADVANCING BORING DEPTI BORING REFUSAL: __ 43.01 POWER AUGER TO WATER TOO DEPTH @ time of drilling 2 6.5 FT HAND SHOP: W/MUD: W/WATER TO WATER 24 HR .: DEPTH HOTARY DRILL WIMUD: WWATED 4 "0 TO 43.0 WATER LOSSES _ SEE NOTE DIAMOND CORE TO CAVE-IN DEPTHS CORE SIZE TO CASING: SIZE 344 LENGTH 0 TO 8 UNDISTURBED SAMPLES NO _____ SIZE ____ STANDBY TIME BORING LAYOUT BAG SAMPLES NO TOTAL P.02 P.02 865 717 2042 98% JAN-18-2005 12:01

From:	Smith, Daniel R on behalf of Smith, Daniel R.
Sent:	Monday, January 17, 2005 1:12 PM
To	GEOSÝNTEC CONSULTANTS INC Attn: R NEIL DAVIES; Boggs, J. Markus; Petty, Harold
10.	L.: Smith. Amos L: egreg.mcnulty@parsons.com
Subject:	Latest sketches for MW installation - TVA KIF Seepage study

Subject:

Attached are the latest sketches. The pilot borings are not shown, only one well is currently shown for each location. This will be updated later. Neil had previously suggested a numbering approach (see attached email) - this can be incorporated next if everyone agrees.









F (548 KB)

SK10W425-26A.PD SK10W425-73A.PD SK10W425-73B.PD RE: Revised F (464 KB) neeting for KIF Se... F (925 KB)

Please note new email address: Daniel.R.Smith@parsonsec.com Daniel R. (Dan) Smith, P.E.

Phone: (423) 757-8088 Parsons E & C Fax: (423) 266-0922 633 Chestnut St, Suite 400 Cell: (423) 364-1679 Chattanooga, TN 37450

Email: Daniel.R.Smith@parsonsec.com

203 EA HOLE

865 717 2042 P.02/02 JAN-18-2005 12:14 KINGSTON YARD OPERATIONS SOIL TEST BORING FIELD REPORT MACIEC RIG TYPE ATV HAMMER TYPE MANUA L JOB NO. 3043041063 **GROUND SURFACE ELEV.** DRILLER R. BANKS HOURS DRILLING DATE: YIT / SWEATHER: COLP 1 20'S JOB NAME TOA KINGSTON LOGGED BY J. Justice HOURS MOVING From O to 2, SFT ENCOUNTERED REPRAP Note: Drill Pluso AND CRUSHED STONE BASE AGOREMPTE LOSS A 12 FT. INStATION BEGAN SPOON SAMPLING @ 4.0FT PVC CASINU. STIFF GRAY SCIMOIST CLAYE Sandy silt with a faw forf fragmente - 7/4/ASH 1.4. Soft Gray wer SANDY clayey silt with a few root layers. Thy Ash 1.4 Very STIFF RED-BROWN Stishely moist Sittyciay with chest fragmate 4-15.5 3 FOR 5 30 DOSE GIAY WET CHAPTY Sector S SAND - BOTTOM ASH Firm Gray wet Silty SAND With Coal frequento - Bottom ASH 1.0 1.4 Firm Gray wet sandy clance SILT - FIL ASH SDEILER NOTED HARD DRILLING 32.0FT 7 39-35.5 12 22 :13 HARD GRAYISH BROWN to Blive Brown Slightly Moist WEATHERED SHALE - REGIDUUM E NOTE: ENCOUNTERED GRATEL WICH SAND From 34 to 34. 1 FT. Passible Allavial interval locatal in batwar Fly ASH AND Rossouum Very HARD CORAYISH BROWN SLIGHTLY 25 44 8 39-408 MOIST WEATHERED SHALE - RESIDUUM BORING TERMINATED: 43.0 METHOD OF ADVANCING BORING DEPTH 43.01 BORING REFUSAL: **POWER AUGER** ΤÖ WATER TOO DEPTH @ time of drilling 6.5 FT HAND SHOP: W/MUD: W/WATER то WATER 24 HR .: DEPTH HOTARY DRILL-WIMUD: WWATER 4 "\$ <u>0 to 43.01</u> WATER LOSSES SEE NOTE DIAMOND CORE TO . **CAVE-IN DEPTHS** CORE SIZE TO CASING: SIZE 244 LENGTH O TO 8 FT UNDISTURBED SAMPLES NO ____ SIZE ___ STANDBY TIME BORING LAYOUT BAG SAMPLES NO 1024 A/03 TOTAL P.02 98% P.02 865 717 2042 JAN-18-2005 12:01

From: Sent: To:

Subject:

Smith, Daniel R. Monday, January 17, 2005 1:12 PM GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES; Boggs, J. Markus; Petty, Harold L.; Smith, Amos L; egreg.mcnulty@parsons.com Latest sketches for MW installation - TVA KIF Seepage study

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Latest sketches for MW install...

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From:	GEOSYNTEC CONSULTANTS INC Attn: R NEIL DAVIES
Sent:	Thursday, January 13, 2005 1:03 PM
То:	Smith, Daniel R.; Boggs, J. Markus; Smith, Amos L; egreg.mcnulty@parsons.com; habenkhaval@mactec.com
Cc:	Julian, Hank; Petty, Harold L.; TElkady@GeoSyntec.com
Subject:	RE: Revised meeting for KIF Seepage - Summary of Decisions From Jan 13 Call

Based on today's conference call, the following target well elevations were established:

MW-3

- drill down to 70 ft. depth; commence sampling
- drill to refusal or bedrock
- decision to be made on well screen elevation after review of logs

MW-4

- move to location originally established; needs some surface preparation prior to drilling
- drill/sample to bedrock or refusal
- we will probably establish 2 wells at this new location (TBD based on drill logs)

MW-6

- additional well to be established with screen at 50-55 ft BGS

MW-7

- additional well to be established with screen at 40-45 ft BGS

MW-8

- well to be established with screen at 20-25 ft BGS
- well to be established with screen at 35-40 ft BGS

MW-9

- well to be established with screen at 10-15 ft BGS
- well to be established with screen at 20-25 ft BGS

Note Nomenclature:

At each physical location, the pilot boring should be referred to as Bx; well should be labeled as MW-xA and MW-xB where x is the location number.

Thanks Neil

From: Smith, Daniel R [mailto:Daniel.R.Smith@parsonsec.com]
Sent: Wednesday, January 12, 2005 3:15 PM
To: Boggs, J Marcus; Neil Davies; Smith, Amos; egreg.mcnulty@parsons.com; Benkhayal, Hussein
Cc: Julian, Hank; Petty, H. L.
Subject: Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

We need to meet TOMORROW Thursday January 13, 2004 at 11 am. Mactec has completed holes 8&9, and will have completed hole 4 by early tomorrow morning at the latest. They will be ready to drill the wells for these holes starting tomorrow. Please be prepared to discuss basically the same items for these holes as we did yesterday for 5,6 & 7.

We will therefore cancel Friday's meeting. We will set a time for the followup meetings tomorrow.

Mactec needed to move hole # 4 up the slope about 20 ft, due to inaccessibility. From what they described, it will be placed on the existing bench that is at about El 775. Hole 9 went in at the location staked.
Here is the phone no and Meeting ID. call 423-751-2428 or . Enter Mtg ID 6704 when prompted.

If you have a conflict let me know. Lynn is on the road and this is the best time we could schedule - given an allowance for receiving the faxed information from hole #4. I'm out of the office and can be reached by cell phone.

Daniel R. (Dan) Smith, P.E.Parsons E & CPhone: (423) 757-8088633 Chestnut St, Suite 400Fax: (423) 266-0922Chattanooga, TN 37932Cell: (423) 364-1679Please note my new email address: Daniel.R.Smith@parsonsec.com





TVA-00013606



To:

Neil Davies GeoSyntec Fax number: 678-202-9501 Dan Smith Parsons Fax number: 423-266-0922 74 29

Mark Boggs & Hank Julian TVA Fax number: 865-632-8375 Greg McNulty Parsons Fax number: 513-554-6572

From

Lynn Petty Phone: 423-751-6704 Fax: 423-751-7094 Email: hlpetty@tva.gov

KINGSTON WELL INSTALLATION-2005-DAILY LOGS

Date sent:______/ ~__/8-05

Number of pages including cover page: _____

Notes:

B-4 (ORIG LOCATION)



To:

Neil Davies GeoSyntec Fax number: 678-202-9501 Dan Smith Parsons Fax number: 423-266-0922 میتر منت

Mark Boggs & Hank Julian TVA Fax number: 865-632-8375 Greg McNulty Parsons Fax number: 513-554-6572

From

Lynn Petty Phone: 423-751-6704 Fax: 423-751-7094 Email: hlpetty@tva.gov

KINGSTON WELL INSTALLATION-2005-DAILY LOGS

Date sent: 1-18-05

Number of pages including cover page: _____

Notes:

B-4 (ORIG LOCATION)

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PARSONS

2443 Crowne Point Drive Cincinnati, OH 45241 (513) 554-4455 (Phone) (513) 554-6572 (Fax)

facsimile transmittal

W770 H.L. Petty To: Fax: 423-751-7094 Date: 1-13-09 From: MCNUL Fai Re: erday Pages: 2 CC: J. Marcys Amos Smith Hark Bo 995 Urgent G For Review Please Comment D Please Reply Please Recycle 770)-475-4985 MIKE MARSON

01/13/2005 10:37 513-554-6572

Revised meeting for KIF Seepage - discussion of Holes 8,9, & 4

McNulty, Greg

From:	McNuity, Greg
Sent:	Wednesday, January 12, 2005 5:02 PM
To:	Benkhayal, Hussein
Cc:	Julian, Hank; Petty, H. L.; Boggs, J Marcus; Davies, Neil; Smith, Amos; 'Smith, Daniel R'
Subject	: Confirmation of D-422 Sieve Analyses with Hydrometer at each Location with 5' Well Screen Interval.

PARSONS

Benkhayal,

Hello, as discussed yesterday in our 1 pm teleconference, this email confirms the use of the ASTM D-422 sieve analyses with hydrometer tests on soil samples taken from from each location interval where we plan to installed six 5-foot well screens. These six tests will leave two ASTM D422 sieve analyses with hydrometer tests to be performed at other locations. The group could probably discuss the location for these and other tests in tomorrow's 11:00 am conference call.

Greg McNulty PhD, PE, PG

PARSONS

2443 Crowne Point Drive Cincinnati, Ohio 45241-5407 Cinci Office 513 552-7052 Fax 513 554-6572 Cell Personal 513 304-9099 egreg.mcnulty@parsons.com

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P.02



To:

Neil Davies GeoSyntec Fax number: 678-202-9501 Dan Smith Parsons Fax number: 423-266-0922

Mark Boggs & Hank Julian TVA Fax number: 865-632-8375 Greg McNulty Parsons Fax number: 513-554-6572

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Date sent:_____

Number of pages including cover page:_____

MW-4

Ground Elevation = 765 ft (estimated from the drawing showing proposed locations of additional borings and peizometers 10W425-26A)



MW-8

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Ground Elevation = 785.5 ft (estimated from the drawing showing proposed locations of additional borings and peizometers 10W425-26A)



MW-9

Ground Elevation = 766 ft (estimated from the drawing showing proposed locations of additional borings and peizometers 10W425-26A)



Saturated thickness -	WT to	bedrock	(¥)	74.7	42.9	73.0	65.7	41.8	38.2	75.6	78.5	67.8	67.4	73.8	71.9	64.3	62.6	53.8	52.0
Saturated thickness -	WT to top	alluvium	(¥)	45.0	44.6	53.5	NA	32.8	29.2	62.4	65.3	47.0	46.6	47.6	45.7	40.5	38.8	23.8	22.0
		WT to	BOS (ft)	12.1	16.7	9.1	62.2	7.8	19.2	29.9	52.8	19.8	39.4	7.6	25.7	10.8	24.1	10.8	19.0
	Depth BGS	to Bedrock	(ft)	82.2	87.5	103.5	103.5	43.0	43.0	93.2	93.2	103.0	103.0	111.2	111.2	78.5	78.5	58.0	58.0
	Depth BGS	to alluvium	(tt)	52.5	62.5	84.0	84.0	34.0	34.0	80.0	80.0	82.2	82.2	85.0	85.0	54.7	54.7	28.0	28.0
1/21/05	ΨT	Elevation	(ft-msl)	774.1	777.1	780.6	772.9	765.6	761.8	786.5	789.7	773.0	772.3	774.3	772.6	770.6	769.8	760.5	759.1
		WT depth	BGS (ft)	7.5	17.9	30.5	37.8	1.3	4.8	17.6	14.8	35.2	35.6	37.4	39.3	14.2	15.9	4.2	6.0
		WT depth	BTOC (ft)	7.8	18.4	30.9	38.7	2.7	6.7	18.6	17.3	37.7	36.6	40.0	40.0	15.7	17.4	4.2	6.6
		BOS depth	(ft)	19.6	34.6	39.6	100.0	9.0	24.0	47.5	67.5	55.0	75.0	45.0	65.0	25.0	40.0	15.0	25.0
		TOS depth	(ft) (ft)	9.6	24.6	29.6	95.0	4.0	19.0	42.5	62.5	50.0	70.0	40.0	60.09	20.0	35.0	10.0	20.0
Estimated	sediment	fill up in	screen (ft)	1.6	-10.2	1.9	-2.1	1.1	2.2	-2.5	0.4	0.0	0.0	0.1	0.0	1.4	-1.9	-0.1	0.5
MACTEC	Reported	Well Depth	BGS (ft)	20.2	35.2	40.2	100.6	9.6	24.6	48.1	68.1	55.6	75.6	45.6	65.6	25.6	40.6	15.6	25.6
TVA	Measured	Well Depth	BGS (ft)	18.0	24.4	37.7	102.1	7.9	21.8	50.0	67.1	55.0	75.0	44.9	65.0	23.6	41.9	15.1	24.5
TVA	Measured	Well Depth	BTOC(ft)	18.3	24.9	38.1	103.0	9.3	23.7	51.0	69.6	57.5	76.0	47.5	65.7	25.1	43.4	15.1	25.1
		Stick-up	(#)	0.3	0.5	0.4	0.9	1.4	1.9	1.0	2.5	2.5	1.0	2.6	0.7	1.5	1.5	0.0	0.6
	Grade	Elevation	(ft-msl)	781.6	795.0	811.1	810.7	766.8	766.6	804.1	804.4	808.3	807.9	811.7	811.9	784.8	785.7	764.7	765.1
	TOC	Elevation	(ft-msl)	781.87	795.50	811.45	811.56	768.21	768.49	805.08	806.92	810.76	808.89	814.30	812.56	786.26	787.19	764.70	765.68
		:	Well	MW-1	MW-2	MW-3A	MW-3B	MW-4A	MW-4B	MW-5A	MW-5B	MW-6A	MW-6B	MW-7A	MW-7B	MW-8A	MW-8B	MW-9A	MW-9B

KIF Dredge Cell - Piezometer Information Summary

Abbreviations: TOC - top of casing BTOC - below top of casing BGS - below ground surface TOS - top of screen BOS - bottom of screen WT - water table



TVA-00013626



TVA-00013627

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SECTION A73 - CELL III

Base Material



SECTION A73 - CELL III

TVA-00013629