

Tables

Table 1-1: Data Collection Locations

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

CDM Control Code	Installed By	Installed As	CDM		URS		MACTEC	
			September 2009 Sample Code	October 2009 Sample Code	September 2009 Sample Code	October 2009 Sample Code	May 2009 Sample Code	June 2009 Sample Code
MW-1A	URS	MW-1A			MW-1A	MW-1A		
MW-1C	URS	MW-1C			MW-1C	MW-1C		
MW-2A	URS	MW-2A			MW-2A	MW-2A		
MW-2C	URS	MW-2C			MW-2C	MW-2C		
MW-3A	MACTEC	MW-6A	MW-6A	MW-6A				MW-6A
MW-3B	MACTEC	MW-6B	MW-6B	MW-6B				MW-6B
MW-3C	URS	MW-3C			MW-3C	MW-3C		
MW-4A	URS	MW-4A			MW-4A	MW-4A		
MW-4B	URS	MW-2			MW-2	MW-2		
MW-4C	URS	MW-1			MW-1	MW-1		
MW-5A	Kimley-Horn	MW-4			MW-4	MW-4		
MW-5C	URS	MW-5C			MW-5C	MW-5C		
MW-6A	URS	MW-6A			MW-6A	MW-6A		
MW-6C	URS	MW-6C			MW-6C	MW-6C		
MW-7A	MACTEC	MW-7A	MW-7A	MW-7A				MW-7A
MW-7B	MACTEC	MW-7B	MW-7B	MW-7B				MW-7B
MW-8A	MACTEC	MW-8A	MW-8A	MW-8A				MW-8A
MW-8B	MACTEC	MW-8B	MW-8B	MW-8B				MW-8B
MW-9A	MACTEC	MW-9A	MW-9A	MW-9A				MW-9A
MW-9B	MACTEC	MW-9B	MW-9B	MW-9B				MW-9B
MW-10A	MACTEC	MW-10A	MW-10A	MW-10A				MW-10A
MW-10B	MACTEC	MW-10B	MW-10B	MW-10B				MW-10B
MW-11A	MACTEC	MW-11A	MW-11A	MW-11A				MW-11A
MW-11B	MACTEC	MW-11B	MW-11B	MW-11B				MW-11B
MW-12A	MACTEC	MW-12A	MW-12A	MW-12A				MW-12A
MW-12B	MACTEC	MW-12B	MW-12B	MW-12B				MW-12B
MW-13A	MACTEC	MW-13	MW-13A	MW-13A				MW-13
MW-14A	MACTEC	MW-14	MW-14A	MW-14A				MW-14
MW-15A	MACTEC	MW-15	MW-15A	MW-15A				MW-15
MW-16A	MACTEC	MW-5A	MW-5A					MW-5A
MW-16B	MACTEC	MW-5B	MW-5B					MW-5B
MW-17A	Kimley-Horn	MW-1	MW-1	MW-1				
MW-18A	Kimley-Horn	MW-2	MW-2	MW-2				
MW-19A	Kimley-Horn	MW-3	MW-3	MW-3				
MW-20A	URS	URS-MW-2					URS-MW2	URS-MW2
TW-1	CDM	TW-1						
PZ-1	CDM	PZ-1						
PZ-2	CDM	PZ-2						
LW-1	CDM	LW-A						
LW-2	CDM	LW-B						
LW-3	CDM	LW-C						

MW - Monitoring well

TW - Test Well

PZ - Piezometer

A - Upper surficial aquifer well

B - Lower surficial aquifer well

C - Upper Yorktown aquifer well

Table 1-1: Data Collection Locations

Hydrogeologic Investigation and Groundwater Modeling Report
 Battlefield Golf Club
 Chesapeake, Virginia

CDM Control Code	Installed By	Installed As	CDM		URS		MACTEC	
			September 2009 Sample Code	October 2009 Sample Code	September 2009 Sample Code	October 2009 Sample Code	May 2009 Sample Code	June 2009 Sample Code
SG-1	unknown	SG-1	SW-1					
SG-2A	unknown	SG-2A	SW-2A				SG-10	
SG-2B	unknown	SG-2B						
SG-3	unknown	SG-3	SW-3				SG11	
SG-4	unknown	SG-4	SW-4					
SG-5	unknown	SG-5	SW-5					
SG-6	unknown	SG-6	SW-6					
SG-7	unknown	SG-7	SW-7					
SG-8	unknown	SG-8	SW-8					
SG-9	unknown	SG-9	SW-9					
SG-10	URS	SG-10	SW-10		SG-10			
SG-11	URS	SG-11			SG-11			
SG-12	URS	SG-12			SG-12			
SG-13	URS	SG-13			SG-13			
SG-14	URS	SG-14			SG-14			
SG-15	URS	SG-15			SG-15			
SG-16	URS	SG-16			SG-16			
SG-17	MACTEC	SG-BGC-1						
SG-18	MACTEC	SG-BGC-2						
SG-19	MACTEC	SG-BGC-3						
SG-20	MACTEC	SG-BGC-4						
SG-21	MACTEC	SG-BGC-5						
SG-22	MACTEC	SG-BGC-6						
SG-23	MACTEC	SG-BGC-7						
SG-24	MACTEC	SG-BGC-8						
SG-25	MACTEC	SG-BGC-9						
SG-26	MACTEC	SG-BGC-10						
SG-27	MACTEC	SG-BGC-11						
SG-28	MACTEC	SG-BGC-12						
SG-29	MACTEC	SG-BGC-13						
SG-30	MACTEC	SG-BGC-14						
SG-31	MACTEC	SG-BGC-15						
SG-32	MACTEC	SG-BGC-16						
SG-33	MACTEC	SG-BGC-17						
SG-34	MACTEC	SG-BGC-18						
SG-35	MACTEC	SG-BGC-19						

SG - Staff gauge

Table 2-1: Fly Ash Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code / Depth	LW-1						LW-2						LW-3					
	2 - 4 ft		4 - 8 ft		8 - 10.5 ft		1.5 - 4 ft		4 - 8 ft		8 - 10.8 ft		1.5 - 4 ft		4 - 8 ft		8 - 12 ft	
Boron	52.3		39.6		37.8		29.2	B	19.2	B	31.8		34.1		44		39.2	
Molybdenum	5.5	B,J	7.4	J	8.3	J	4	B,J	3.4	B,J	4.4	B,J	6.1	J	6.6	J	6.1	B,J
Silver	0.13	B	0.1	B	0.097	B	BDL		BDL		BDL		BDL		0.097	B	BDL	
Aluminum	15,200	J	12,900	J	14,000	J	10,900	J	9,340	J	9,810	J	10,600	J	11,700	J	12,200	J
Arsenic	89.5		83.7		90.1		48.4		25.7		41.1		61.2		74.4		83.8	
Barium	605		535		683		405		313		361		570		565		462	
Beryllium	5.6	J	4.6	J	4.8	J	3.6	J	2.3	J	3.1	J	3.8	J	4.6	J	3.9	J
Cadmium	0.33	B	0.27	B	0.3	B	0.18	B	0.12	B	0.15	B	0.18	B	0.21	B	0.21	B
Cobalt	16.1		12.7		13.8		9.8		6.4	B	9.3		9.8		11.9		9.6	
Chromium	28.1		29.6		31.3		20		15.9		17.3		17.9		21.6		20.6	
Copper	59.8		48.8		51.8		38.9		25.8		34.3		39.8		45.1		41.2	
Iron	13,800	J	12,600	J	14,000	J	10,000	J	8,080	J	8,580	J	8,680	J	9,640	J	12,600	J
Magnesium	1,980		1,690		1,750		1,360		1,360		1,510		1,260		1,370		1,440	
Manganese	109		96.3		97.6		62.2		49.7		62.8		60.2		66.5		72.2	
Nickel	27		22.7		24.2		18.9		13.2		17.3		19.3		22.8		19	
Lead	23		19		20.3		15.2		10.1		13.3		15.4		18.1		14.9	
Selenium	17.2		15		15.5		12.4		7.2		12.3		13.8		16.9		11.5	
Thallium	2.9		1.9		1.9		0.97	B	1.2	B	1.2	B	1.4	B	1.6		1.7	
Antimony	1.5	B	1.4		1	B	0.84	B	0.65	B	1	B	1.5		1.6		1.4	B
Vanadium	79.5		65.9		70.7		53.3		32.5		45.6		54.1		64.2		59.4	
Zinc	36.1		30.3	J	33.2	J	26.1	J	17.6	J	29.6	J	26.3	J	29.3	J	27.1	J
Mercury	0.36		0.35		0.36		0.29		0.13		0.3		0.3		0.32		0.35	
Ammonia Nitrogen	7.3	B,J	5.1	B,J	10.1	J	11.3	J	14.3	J	15	J	10.3	J	11.2	J	11.1	J
Nitrate (N)	ND		ND		ND		ND		ND		ND		1.3		0.71	B	ND	
Nitrite (N)	0.39	B	0.25	B	0.11	B	0.21	B	0.18	B	0.13	B	0.27	B	0.25	B	0.21	B
Percent Moisture	37.2		26.6		37.4		34.9		32.1		38.8		34.7		32.3		32.4	

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination (2.4 mg/kg). The associated Method Blank contains the target analyte at a reportable level.

ND - Not detected

Table 2-2: Surface Water Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code	MCL	SG-1	SG-2A	SG-3	SG-4	SG-5	SG-6	SG-7	SG-8	SG-9	SG-10
Aluminum	37,000 ^b	433 J	496 J	885 J	800 J	736 J	12,600 J	2,580 J	3,700 J	1,450 J	233 J
Ammonia Nitrogen		0.96	0.23	0.49	0.52	0.45	0.66	0.87	0.54	0.37	0.14
Antimony	6	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	10	< 10	< 10	< 10	< 10	< 10	7 B	5 B	< 10	< 10	< 10
Barium	200	70.1 B	41.4 B	42.9 B	73.6 B	27.9 B	79.9 B	44 B	32.1 B	19.3 B	59.7 B
Beryllium	4	< 4	< 4	< 4	0.35 B	< 4	< 4	< 4	< 4	< 4	< 4
Boron	7,300 ^b	72.6 B	65.9 B	65.2 B	62.6 B	48.8 B	540	55.3 B	55.8 B	73.9 B	64 B
Cadmium	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Chromium	100	0.63 B	0.68 B	1.3 B	0.6 B	1.2 B	16.7	3.7 B	4.6 B	2.1 B	0.92 B
Cobalt	11 ^b	< 50	< 50	0.87 B	8.5 B	< 50	1.3 B	< 50	< 50	< 50	< 50
Copper	1,300	< 25	< 25	< 25	< 25	< 25	4.6 B	< 25	< 25	< 25	< 25
Iron	26,000 ^b	626	486	1,100	1,370	433	6,470	1,750	2,120	1,030	521
Lead	15	< 3	< 3	1 B	1 B	< 3	10	1 B	1 B	2 B	< 3
Magnesium		5,190	4,540 B	3,580 B	7,310	3,480 B	2,750 B	4,470 B	1,620 B	989 B	4,480 B
Manganese	880 ^b	56.9	13 B	97.2	224	7.1 B	71.3	24.8	13.3 B	10.3 B	31
Mercury	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	180 ^b	1.4 B	2.1 B	1.6 B	< 40	< 40	6.9 B	5.1 B	< 40	1.8 B	< 40
Nickel	730 ^b	< 40	< 40	1.8 B	8.9 B	3.9 B	6.2 B	< 40	2.2 B	< 40	< 40
Nitrate as Nitrogen	10,000	32 B	< 50	240	26 B	33 B	280	< 50	< 50	< 50	46 B
Nitrite as Nitrogen	1,000	87 J	120 J	60 J	28 B J	< 50	< 50	< 50	< 50	< 50	130 J
Selenium	50	< 5	< 5	< 5	< 5	< 5	4.6 B	4.5 B	< 5	< 5	< 5
Silver	180 ^b	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	2	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	180 ^b	2.5 B	< 50	< 50	< 50	2.5 B	20.3 B	5.8 B	6.2 B	3.1 B	< 50
Zinc	50 ^a	7.5 B	5.1 B	13.1 B	16.1 B	10.6 B	27.9	7.3 B	9.8 B	8.2 B	< 20

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.

MCL - Federal Maximum Contaminant Level, EPA National Primary Drinking Water Standards.

a - Virginia Department of Environmental Quality Groundwater Quality Standard.

b - EPA Regional Screening Level for tap water.



Table 2-3: Groundwater Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code / Date		MW-3A		MW-3B		MW-7A		MW-7B		MW-8A		MW-8B
Parameter, ug/L	MCL	9/11/09	10/13/09	9/11/09	10/13/09	9/11/09	10/13/09	9/11/09	10/13/09	9/10/09	10/14/09	9/10/09
Aluminum	37,000 ^b	527	135 B	2,620	338	1,360	1,080	1,040	84.5 B	786	487 J	354
Ammonia Nitrogen		0.12 J	0.98 J	0.32 J	0.085 B J	0.27 J	0.52 J	0.4 J	0.98 J	0.43 J	0.92 J	0.23 J
Antimony	6	< 10	< 10	1.4 B	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	10	3.1 B	6.1 B	< 10	6.8 B	9.3 B	15	< 10	< 10	< 10	4.8 B	< 10
Barium	200	90.6 B	40.5 B	34.3 B	87 B	82.2 B	84.6 B	17.4 B	13.2 B	63.9 B	65.4 B	17.5 B
Beryllium	4	0.57 B	< 4	< 4	0.56 B	< 4	0.32 B	< 4	< 4	0.58 B	0.6 B	< 4
Boron	7,300 ^b	35 B J	51.1 B	38.1 B J	32.7 B	42.1 B J	43.6 B	32.1 B J	31.6 B	42.8 B J	47.7 B	70.8 B J
Cadmium	5	< 5	< 5	< 5	< 5	0.24 B	< 5	< 5	< 5	< 5	< 5	< 5
Chromium	100	0.71 B	0.61 B	2.9 B	< 5	2.1 B	1.9 B	1.8 B	< 5	0.88 B	< 5	1 B
Cobalt	11 ^b	5.7 B	< 50	< 50	5.5 B	4.3 B	3.7 B	< 50	< 50	8 B	7.4 B	< 50
Copper	1,300	< 25	3.2 B	7.6 B	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Iron	26,000 ^b	4,350	1,310	761	4,380	5,230	5,440	6,590	6,390	10,100	7,550 J	8,170
Lead	15	< 3	< 3	1.7 B	< 3	< 3	< 3	< 3	1.3 B	< 3	< 3	< 3
Magnesium		3,720 B	7,450 J	3,460 B	3,830 B J	2,780 B	2,890 B J	2,920 B	3,060 B J	4,290 B	3,790 B J	9,160
Manganese	880 ^b	134	196	33.7	128	30.9	33.8	152	143	290	206	281
Mercury	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	180 ^b	2.4 B J	1.7 B	3.5 B J	< 40	2.9 B J	2.6 B	2.4 B J	< 40	< 40	< 40	< 40
Nickel	730 ^b	7.9 B	< 40	2.7 B	6.8 B	4.6 B	3.2 B	< 40	< 40	5.7 B	6 B	< 40
Nitrate as Nitrogen	10,000	< 50	530	140	< 100	25 B	< 100	100	< 100	< 50	< 100	< 50
Nitrite as Nitrogen	1,000	< 50		< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Selenium	50	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	180 ^b	< 5	0.69 B	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	2	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	180 ^b	3.3 B	< 50	4.5 B	2.2 B	3.8 B	4.5 B	< 50	< 50	< 50	< 50	< 50
Zinc	50 ^a	21.6	126	128	20.8	7.9 B	16.9 B	4.3 B	< 20	8.3 B	9 B J	84.1

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.

MCL - Federal Maximum Contaminant Level, EPA National Primary Drinking Water Standards.

a - Virginia Department of Environmental Quality Groundwater Quality Standard.

b - EPA Regional Screening Level for tap water.



Table 2-3: Groundwater Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code / Date	MCL	MW-8B 10/14/09	MW-9A		MW-9B		MW-10A		MW-10B		MW-11A	
Parameter, ug/L			9/10/09	10/14/09	9/10/09	10/14/09	9/10/09	10/14/09	9/10/09	10/14/09	9/16/09	10/14/09
Aluminum	37,000 ^b	37 B	75.5 B	22.9 B	117 B	34.7 B	166 B	53.6 B	179 B	27 B	34.3 B	26 B
Ammonia Nitrogen		1.4 J	0.52 J	1.4 J	0.66 J	1.4 J	0.72 J	0.48 J	0.42 J	1.5 J	1.3 J	0.29 J
Antimony	6	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	10	3.1 B	< 10	< 10	< 10	< 10	< 10	3.8 B	< 10	< 10	< 10	5.6 B
Barium	200	14.1 B	39.8 B	28.1 B	15.5 B	14.2 B	9.3 B	6.7 B	8.2 B	5.7 B	10.6 B	8.3 B
Beryllium	4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Boron	7,300 ^b	79.5 B	79.4 B J	107 B	142 B J	126 B	51.3 B J	54.9 B	151 B J	167 B	46.6 B	44.7 B
Cadmium	5	< 5	0.2 B	< 5	< 5	< 5	0.2 B	< 5	< 5	< 5	0.15 B	< 5
Chromium	100	< 5	1 B	< 5	< 5	< 5	0.63 B	< 5	0.7 B	< 5	0.57 B	< 5
Cobalt	11 ^b	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Copper	1,300	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	3.2 B	< 25	< 25
Iron	26,000 ^b	4,550	7,890	2,490	394	74.4 B	9,490	7,420	627	192	4,380	3,660
Lead	15	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	1.8 B	< 3	1.3 B
Magnesium		9,910 J	14,700	13,600 J	13,800	12,900 J	13,000	12,400 J	20,000	18,200 J	21,300	21,900 J
Manganese	880 ^b	211	196	146	77.4	58.1	182	157	78.5	54	84.3	52.6
Mercury	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	180 ^b	< 40	3.6 B J	< 40	< 40	< 40	< 40	< 40	< 40	< 40	4.4 B	< 40
Nickel	730 ^b	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40
Nitrate as Nitrogen	10,000	< 100	32 B	< 100	< 50	230	< 50	< 100	< 50	13 B	< 50	< 100
Nitrite as Nitrogen	1,000		< 50		< 50		< 50		< 50		< 50	
Selenium	50	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	180 ^b	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	2	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	180 ^b	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Zinc	50 ^a	285	< 20	< 20	< 20	3.7 B	8.5 B	< 20	< 20	< 20	< 20	9.9 B

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.

MCL - Federal Maximum Contaminant Level, EPA National Primary Drinking Water Standards.

a - Virginia Department of Environmental Quality Groundwater Quality Standard.

b - EPA Regional Screening Level for tap water.



Table 2-3: Groundwater Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code / Date Parameter, ug/L	MCL	MW-11B		MW-12A		MW-12B		MW-13A		MW-14A		MW-15A
		9/16/09	10/14/09	9/16/09	10/14/09	9/16/09	10/14/09	9/16/09	10/14/09	9/16/09	10/14/09	9/16/09
Aluminum	37,000 ^b	62.9 B	37 B	60 B	102 B J	57.1 B	165 B J	802	1,550 J	93 B	45.8 B J	3,330
Ammonia Nitrogen		0.65 J	0.68 J	0.25 J	0.69 J	0.75 J	1.2 J	0.44 J	0.65 J	0.29 J	0.69 J	2.9 J
Antimony	6	< 10	< 10	< 10	1.8 B	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	10	< 10	< 10	3.6 B	5.8 B	< 10	3.5 B	< 10	4.6 B	< 10	5.5 B	15.4
Barium	200	25.2 B	21.4 B	28.4 B	23.4 B	25.9 B	24.6 B	34.6 B	34.4 B	39.8 B	37.2 B	68.8 B
Beryllium	4	< 4	< 4	< 4	< 4	< 4	< 4	11.7	16.6	< 4	< 4	1.2 B
Boron	7,300 ^b	105 B	71.1 B	36.9 B	37.2 B	112 B	99.6 B	38.8 B	40.3 B	39.2 B	41.8 B	157 B
Cadmium	5	< 5	< 5	< 5	< 5	< 5	< 5	0.61 B	< 5	0.19 B	< 5	1.1 B
Chromium	100	< 5	< 5	0.67 B	< 5	< 5	< 5	2.2 B	3.1 B	0.84 B	< 5	2.3 B
Cobalt	11 ^b	< 50	< 50	1.4 B	1.4 B	< 50	< 50	28.2 B	34.5 B	< 50	< 50	2.6 B
Copper	1,300	< 25	< 25	< 25	< 25	< 25	< 25	< 25	5.2 B J	< 25	< 25	< 25
Iron	26,000 ^b	3,580	4,580	4,940	4,980 J	5,930	7,390 J	40,800	49,700 J	8,500	8,650 J	64,000
Lead	15	< 3	< 3	< 3	1.3 B	< 3	2 B	< 3	3.4	< 3	< 3	< 3
Magnesium		20,100	18,600 J	19,000	17,500 J	21,100	20,800 J	27,100	26,800 J	4,480 B	4,720 B J	27,700
Manganese	880 ^b	226	215	115	101	149	138	498	585	213	211	286
Mercury	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	180 ^b	4.6 B	< 40	< 40	< 40	< 40	< 40	< 40	< 40	1.8 B	< 40	< 40
Nickel	730 ^b	< 40	< 40	9.3 B	6.7 B	< 40	< 40	52.3	66.9	< 40	< 40	4.9 B
Nitrate as Nitrogen	10,000	< 50	< 100	< 2,500 G	< 100	< 50	130	< 50	< 100	< 500 G	< 100	< 500 G
Nitrite as Nitrogen	1,000	230		< 2,500 G		79		60		< 500 G		600
Selenium	50	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	180 ^b	< 5	0.86 B	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	2	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	180 ^b	< 50	< 50	< 50	< 50	< 50	< 50	4.5 B	3.3 B	< 50	< 50	7.6 B
Zinc	50 ^a	< 20	< 20	12.3 B	12.9 B J	< 20	< 20	107	156 J	< 20	< 20	58.3

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.



G - Matrix interference

MCL - Federal Maximum Contaminant Level, EPA National Primary Drinking Water Standards.

a - Virginia Department of Environmental Quality Groundwater Quality Standard.

b - EPA Regional Screening Level for tap water.

Table 2-3: Groundwater Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code / Date	MCL	MW-15A 10/15/09	MW-16A 9/16/09	MW-16B 9/16/09	MW-17A		MW-18A		MW-19A	
Parameter, ug/L					9/10/09	10/14/09	9/10/09	10/15/09	9/10/09	10/14/09
Aluminum	37,000 ^b	2,060 J	51.8 B	58.3 B	367 J	376 J	5,740 J	1,660 J	851 J	1,690 J
Ammonia Nitrogen		2.3 J	0.83 J	1.5 J	0.46	0.22 J	0.43	0.58 J	0.44 J	1.3 J
Antimony	6	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	10	15.8	< 10	< 10	3.1 B	7.8 B	< 10	12.3	< 10	5.4 B
Barium	200	73.4 B	33 B	13.5 B	22 B	19.8 B	61.5 B	23.5 B	17.9 B	17 B
Beryllium	4	0.93 B	< 4	< 4	0.44 B	0.52 B	< 4	< 4	< 4	< 4
Boron	7,300 ^b	157 B	100 B	94 B	35.7 B	36.3 B	188 B	70 B	50.1 B	47.4 B
Cadmium	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Chromium	100	2 B	< 5	< 5	0.9 B	0.74 B	7.2	3.4 B	6.1	2.9 B
Cobalt	11 ^b	0.73 B	< 50	< 50	15.9 B	20.8 B	2.2 B	< 50	0.86 B	0.59 B
Copper	1,300	4.4 B J	< 25	< 25	< 25	3.8 B J	< 25	3.4 B J	< 25	3.6 B J
Iron	26,000 ^b	44,700 J	7,980	573	9,840	8,600 J	3,510	10,700 J	8,090	7,110 J
Lead	15	1.4 B	< 3	< 3	< 3	2.1 B	3.3	2.3 B	< 3	2.3 B
Magnesium		20,300 J	17,900	10,500	21,300	23,100 J	7,890	17,900 J	20,200	17,700 J
Manganese	880 ^b	201	300	51.7	187	200	79.7	136	168	143
Mercury	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	180 ^b	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40
Nickel	730 ^b	3.6 B	2 B	< 40	29.8 B	36.6 B	8.9 B	2.5 B	3.7 B	< 40
Nitrate as Nitrogen	10,000	< 100	< 50	< 50	< 50	< 100	< 50	< 100	< 50	< 100
Nitrite as Nitrogen	1,000		< 50	66	< 50		< 50		< 50	
Selenium	50	< 5	< 5	< 5	< 5	< 5	3.3 B	< 5	< 5	< 5
Silver	180 ^b	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	2	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	180 ^b	13.1 B	< 50	< 50	2.2 B	< 50	9.6 B	4.1 B	3.7 B	3.4 B
Zinc	50 ^a	29.6 J	< 20	157	78.2	91.6 J	448	101 J	20.5	10 B J

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.

MCL - Federal Maximum Contaminant Level, EPA National Primary Drinking Water Standards.

a - Virginia Department of Environmental Quality Groundwater Quality Standard.

b - EPA Regional Screening Level for tap water.



Table 2-4: Duplicate Sample Data Summary

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Code Parameter, ug/L	SG-10 (9-9-09)		MW-3A (9-11-09)		MW-12B (9-16-09)	
	Sample	Duplicate	Sample	Duplicate	Sample	Duplicate
Aluminum	233 J	216 J	527	3,030	57.1 B	58.6 B
Ammonia Nitrogen	0.14	0.54	0.12 J	0.74 J	0.75 J	0.19 J
Antimony	< 10	< 10	< 10	< 10	< 10	< 10
Arsenic	< 10	< 10	3.1 B	3.3 B	< 10	3.4 B
Barium	59.7 B	61.2 B	90.6 B	34.9 B	25.9 B	27.8 B
Beryllium	< 4	< 4	0.57 B	< 4	< 4	< 4
Boron	64 B	67.6 B	35 B J	39.4 B J	112 B	37 B
Cadmium	< 5	< 5	< 5	0.18 B	< 5	< 5
Chromium	0.92 B	0.61 B	0.71 B	3.3 B	< 5	0.83 B
Cobalt	< 50	< 50	5.7 B	< 50	< 50	2.1 B
Copper	< 25	< 25	< 25	7.5 B	< 25	< 25
Iron	521	529	4,350	884	5,930	4,900
Lead	< 3	< 3	< 3	1.3 B	< 3	< 3
Magnesium	4,480 B	4,620 B	3,720 B	3,430 B	21,100	18,700
Manganese	31	27.9	134	32.8	149	113
Mercury	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Molybdenum	< 40	< 40	2.4 B J	7.7 B J	< 40	< 40
Nickel	< 40	< 40	7.9 B	2.7 B	< 40	9.7 B
Nitrate as Nitrogen	46 B	53	< 50	140	< 50	< 2,500 G
Nitrite as Nitrogen	130 J	130 J	< 50	< 50	79	< 2,500 G
Selenium	< 5	< 5	< 5	< 5	< 5	< 5
Silver	< 5	< 5	< 5	< 5	< 5	< 5
Thallium	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	< 50	< 50	3.3 B	4.8 B	< 50	< 50
Zinc	< 20	3 B	21.6	124	< 20	12 B

B - Estimated Result. Result is less than the Reporting Limit.

J - Method Blank contamination. The associated Method Blank contains the target analyte at a reportable level.

< - Not detected, value listed is the detection limit.

G - Matrix interference

Table 2-5: General Water Quality Parameters

Hydrogeologic Investigation and Groundwater Modeling Report
 Battlefield Golf Club
 Chesapeake, Virginia

Code	MW-3A		MW-3B		MW-7A		MW-7B		MW-8A		MW-8B		MW-9A	
Parameter	9/11/2009	10/13/2009	9/11/2009	10/13/2009	9/11/2009	10/13/2009	9/11/2009	10/13/2009	9/10/2009	10/14/2009	9/10/2009	10/14/2009	9/10/2009	10/14/2009
Ferrous Iron, mg/L	0.35	0.97	2.81	2.8	2.03	2.58	4.33	2.36	2.36	5.18	1.75	1.95	2.06	1.15
Total Iron, mg/L	0.44	1.52	2.84	5.45	3.87	3.47	5.11	4.14	4.14	6.48	5.98	4.85	4.44	3.38
Sulfate, mg/L	0.13	54		119	37	39	37	69	69	46	15	16	69	52
Sulfide, mg/L	0.18	55	31	112	14	10	41			9	11		9	34
Code	MW-9B		MW-10A		MW-10B		MW-11A	MW-11B	MW-12A	MW-12B	MW-13A	MW-14A	MW-15A	MW-17A
Parameter	9/10/2009	10/14/2009	9/10/2009	10/14/2009	9/10/2009	10/14/2009	10/14/2009	10/14/2009	10/14/2009	10/14/2009	10/14/2009	10/14/2009	10/15/2009	9/10/2009
Ferrous Iron, mg/L	1.15	0.04	1.02	2.13	0.47	0.22	2.6	3.32	2.7	2.93	2.5	5.9	5.9	0.1
Total Iron, mg/L	3.38	0.06	5.44	6.51	0.55	0.21	3.2	4.79	4.6	5.56	6.27	6.43	6.43	2.55
Sulfate, mg/L	52	28	93	102	59	45	65	93	92	3.92		49	49	46
Sulfide, mg/L	34	7			0.01		12		8	10	0	14	14	55
Code	MW-17A	MW-18A		MW-19A	SG-1	SG-2A	SG-3	SG-4	SG-5	SG-6	SG-7	SG-8	SG-9	SG-10
Parameter	10/14/2009	9/10/2009	10/15/2009	10/14/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009	9/9/2009
Ferrous Iron, mg/L	2.64	0.35	3.39	2.52	0.07	0.09	0.09	0.63	0.06	0.38	0.18	0.08	0.18	0.07
Total Iron, mg/L	6.72	1.25	5.36	5.5	0.56	0.3	0.3	1.33	0.17	0.97	0.41	0.63	0.44	0.45
Sulfate, mg/L	119	50		110	29	21	21	73	43	71	71	60	25	19
Sulfide, mg/L	14	96		76	21	16	16	0	18	46	59	82	40	72

Table 3-1: Water Level Data

Hydrogeologic Investigation and Groundwater Modeling Report
 Battlefield Golf Club
 Chesapeake, Virginia

Well Code	Hydrogeologic Unit	Date	Depth to Water feet	Measuring Point Elevation feet	Potentiometric Surface Elevation feet	Remarks
MW-1A	Surficial Aquifer	9/15/2009	6.25	20.13	13.88	
MW-2A	Surficial Aquifer	9/15/2009	2.96	9.69	6.73	
MW-3A	Surficial Aquifer	9/15/2009	2.15	15.55	13.40	
MW-4A	Surficial Aquifer	9/15/2009	4.60	8.34	3.74	
MW-6A	Surficial Aquifer	9/15/2009	4.55	11.41	6.86	
MW-7A	Surficial Aquifer	9/15/2009	2.75	14.36	11.61	
MW-8A	Surficial Aquifer	9/15/2009	9.31	16.49	7.18	
MW-9A	Surficial Aquifer	9/15/2009	7.87	14.06	6.19	
MW-10A	Surficial Aquifer	9/15/2009	8.55	13.71	5.16	
MW-11A	Surficial Aquifer	9/15/2009	8.88	12.87	3.99	
MW-12A	Surficial Aquifer	9/15/2009	8.90	12.47	3.57	
MW-13A	Surficial Aquifer	9/15/2009	8.10	14.91	6.81	
MW-14A	Surficial Aquifer	9/15/2009	9.09	17.26	8.17	
MW-15A	Surficial Aquifer	9/15/2009	5.15	12.30	7.15	
MW-18A	Surficial Aquifer	9/15/2009	4.43	9.89	5.46	
MW-19A	Surficial Aquifer	9/15/2009	3.00	9.22	6.22	
MW-20A	Surficial Aquifer	9/15/2009	1.50	7.81	6.31	
SG-17	Surface Water	-	1.44	11.17	9.73	Average values from 12/3/2008, 12/10/2008, and 7/15/2009 (MACTEC, 2009)
SG-18	Surface Water	-	1.43	10.87	9.44	
SG-19	Surface Water	-	1.47	7.53	6.06	
SG-20	Surface Water	-	1.35	4.73	3.38	
SG-21	Surface Water	-	1.21	5.45	4.24	
SG-22	Surface Water	-	0.90	9.48	8.58	
SG-23	Surface Water	-	0.99	10.28	9.29	
SG-24	Surface Water	-	1.51	10.00	8.49	
SG-25	Surface Water	-	0.84	10.93	10.09	
SG-26	Surface Water	-	1.23	10.55	9.32	
SG-27	Surface Water	-	2.00	7.96	5.96	
SG-28	Surface Water	-	2.10	7.85	5.75	
SG-29	Surface Water	-	1.41	8.22	6.81	
SG-30	Surface Water	-	0.70	12.76	12.07	
SG-31	Surface Water	-	1.45	13.36	11.91	
SG-32	Surface Water	-	1.55	13.33	11.78	
SG-33	Surface Water	-	1.57	13.74	12.17	
SG-34	Surface Water	-	1.42	5.97	4.55	
SG-35	Surface Water	-	1.06	13.29	12.23	
MW-1C	Yorktown Aquifer	9/15/2009	19.30	20.36	1.06	
MW-2C	Yorktown Aquifer	9/15/2009	13.35	9.70	-3.65	
MW-3C	Yorktown Aquifer	9/15/2009	3.60	13.22	9.62	
MW-4C	Yorktown Aquifer	9/15/2009	4.45	8.81	4.36	
MW-5C	Yorktown Aquifer	9/15/2009	11.10	18.62	7.52	
MW-6C	Yorktown Aquifer	9/15/2009	6.80	11.44	4.64	

Vertical Datum: NAVD88

Table 3-2: Water Quality Data Summary Statistics

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Parameter (ug/L) Appendix E Figure No.	All Data - Initial Screen					Quantile Plot Data Analysis	
	Count	Detects	Detects	Average ug/L	Max ug/L	Conclusions	Recommendation
Aluminum, E-1	182	172	95%	1,832	109,000	High concentration outliers (MW-8A)	Remove outliers for further analysis
Ammonia Nitrogen, E-2	86	86	100%	666	2,900	Approximates log distribution	Further analysis
Antimony, none	141	24	17%	8.5	42.8	Low Percentage of detections	No further analysis
Arsenic, E-3	173	75	43%	8.8	109	High concentration outlier (MW-3C) Low concentration outliers (J values)	Remove outliers for further analysis
Barium, E-4	242	239	99%	44	663	High concentration outliers (PW-25 and MW-3A)	Remove outliers for further analysis
Beryllium, none	150	39	26%	3.4	16.6	Low Percentage of detections	No further analysis
Boron, E-5	295	280	95%	100	1,100	Approximates log distribution	Further analysis
Cadmium, none	151	27	18%	2.9	2	Low Percentage of detections	No further analysis
Chromium, E-6	165	93	56%	4.1	85	Approximates log distribution	Further analysis
Cobalt, none	161	63	39%	32	790	Low Percentage of detections	No further analysis
Copper, none	149	26	17%	15.4	24	Low Percentage of detections	No further analysis
Iron, E-7	193	192	99%	7,677	169,000	Approximates log distribution	Further analysis
Lead, E-8	211	121	57%	5.2	100	Approximates log distribution	Further analysis
Magnesium, E-9	191	191	100%	12,552	96,700	Approximates log distribution	Further analysis
Manganese, E-10	216	214	99%	160	2,260	Approximates log distribution	Further analysis
Mercury, none	138	23	17%	0.2	0.2	Low Percentage of detections	No further analysis
Molybdenum, none	139	28	20%	4.5	9.7	Low Percentage of detections	No further analysis
Nickel, E-11	164	84	51%	31	825	High concentration outliers (MW-5A and MW-8A)	Remove outliers for further analysis
Nitrate, E-12	118	37	31%	416	2,500	Approximates log distribution	Further analysis
Nitrite, E-13	66	29	44%	209	2,500	Approximates log distribution	Further analysis
Selenium, none	142	11	8%	4.9	9	Low Percentage of detections	No further analysis
Silver, none	141	10	7%	0.7	1.9	Low Percentage of detections	No further analysis
Sulfate, E-14	83	74	89%	112,367	1,050,000	Approximates log distribution	Further analysis
Sulfide, none	55	1	2%	3,200	3,200	Low Percentage of detections	No further analysis
Thallium, none	139	4	3%	10	25	Low Percentage of detections	No further analysis
Vanadium, none	153	60	39%	9.6	203	Low Percentage of detections	No further analysis
Zinc, E-15	193	135	70%	61	1,030	Approximates log distribution	Further analysis

Table 3-3: Water Quality Data Analysis

Hydrogeologic Investigation and Groundwater Modeling Report
 Battlefield Golf Club
 Chesapeake, Virginia

Parameter (ug/L) Appendix E Figure No.	Baseline Data		Onsite Data				95% Confidence Interval (CI) of the Mean
	Mean	95% CI	Ponds		"A" Wells		
			Mean	95% CI	Mean	95% CI	
Aluminum, E-16	824	378	1,811	911	1,023	476	
Ammonia Nitrogen, E-17	628	131	566	151	805	283	
Arsenic, E-18	6.9	1.9	5.2	1.9	7.9	2.2	
Barium, E-19	39	5.7	53	6.9	39	6.1	
Boron, E-20	121	23	76	41	49	12	
Chromium, E-21	2.9	1.3	4.3	2.4	5.5	4.5	
Iron, E-22	4200	1536	1,324	466	17,301	6,929	
Lead, E-23	6.2	3.2	3.4	1.7	8	3.1	
Magnesium, E-24	12,658	2,874	4,549	752	16,714	1,986	
Manganese, E-25	140	27	68	32	248	79	
Nickel, E-26	6.9	2.5	10	7.9	19	7.1	
Nitrate, E-27	466	266	113	57	883	450	
Nitrite, E-28	382	252	74	38	915	1061	
Sulfate, E-29	80,832	25,129	52,248	25,482	291,123	182,834	
Zinc, E-30	48	23	19	12	87	45	

Baseline Data - All data excluding outliers, onsite ponds, and onsite "A" wells.

All concentrations are micrograms per liter. Non detect results not included in analysis.

Bold Values - The onsite data mean exceeds the baseline data 95% upper confidence interval of the mean.

Table 4-1: APT Well Construction

Hydrogeologic Investigation and Groundwater Modeling Report

Battlefield Golf Club

Chesapeake, Virginia

Well ID	Type/Zone	X	Y	Ground Surface (ft NAVD88)	Top of Casing* (ft NAVD88)	Total Depth (ft)	Screen Length (ft)
TW-1	B - Lower Surficial	1,293,848.89	13,325,429.21	NA	15.00	40	30
PZ-1	B - Lower Surficial	1,293,878.89	13,325,429.21	NA	15.00	40	10
PZ-2	B - Lower Surficial	1,293,908.89	13,325,429.21	NA	15.00	40	10
MW-3A	A - Upper Surficial	1,293,611.13	13,325,449.18	15.77	15.55	15	10
MW-3B	B - Lower Surficial	1,293,608.99	13,325,444.53	15.66	15.48	42	10
MW-3C	C - Yorktown Aquifer	1,293,937.64	13,325,484.36	13.67	13.22	101	10
MW-5A	A - Upper Surficial	1,291,534.59	13,322,311.48	NA	18.62	25	20
MW-5C	C - Yorktown Aquifer	1,291,524.23	13,322,301.86	18.90	18.62	107	10

*Top of casing elevation was estimated for TW-1, PZ-1, PZ-2, and MW-5A

Table 4-2: AQTESOLV Results

Hydrogeologic Investigation and Groundwater Modeling Report
Battlefield Golf Club
Chesapeake, Virginia

Input	MW-3A	MW-3B	PZ-1	PZ-2
Distance from TW-1 (ft)	238	240	30	60
Aquifer Thickness (ft)	55	55	55	55
AQTESOLV Analysis Results: $K_h/K_z^1 = 0.1$				
Transmissivity (ft ² /d)	2,795	4,150	4,258	2,835
Hydraulic Conductivity ² (ft/d)	51	75	77	52
Storage	1.74E-02	6.10E-04	1.14E-06	1.36E-04
AQTESOLV Analysis Results: $K_h/K_z^1 = 0.01$				
Transmissivity (ft ² /d)	2,843	4,024	4,258	2,825
Hydraulic Conductivity ² (ft/d)	52	73	77	51
Storage	2.07E-02	6.78E-04	2.65E-06	2.49E-04

1 Ratio of horizontal hydraulic conductivity (Kh) to vertical hydraulic conductivity (Kz)

2 Based on a saturated thickness of 55 feet

**Table 5.1 Summary of HELP Model Simulations
and Calculated Leachate Production Rates**
Hydrogeologic Investigation and Groundwater Modeling Report
Battlefield Golf Club
Chesapeake, Virginia

Soil Cover (Layer 1) Thickness (in)	Evaporative Zone Depth (in)	Hydraulic Conductivity (cm/s)			Infiltration (in/yr)
		Layer 1	Layer 2	Layer 3	
6	6	6.4 E-5	5.0 E-5	8.2 E-7	18.8
6	6	6.4 E-5	5.0 E-5	N/A	18.8
6	6	6.4 E-5	5.0 E-5	6.4 E-6	20.3
18	6	6.4 E-5	5.0 E-5	6.4 E-6	19.9
18	10	6.4 E-5	5.0 E-5	6.4 E-6	15.8
18	18	6.4 E-5	5.0 E-5	6.4 E-6	12.7
18	18	8.2 E-7	5.0 E-5	6.4 E-6	7.15
18	18	1.8 E-5	5.0 E-5	6.4 E-6	7.55

Table 6-1: Groundwater Model Layers

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Chesapeake, Virginia

Layers(s)	Description	Approximate Layer Thickness in Site Area (ft)
7	Surficial silt-clay in the vicinity of the site where identified in boring logs, surficial aquifer elsewhere	20
3 to 6	Surficial aquifer	40 ft total, 10 ft each layer
2	Yorktown confining zone	42
1	Yorktown aquifer	84

Table 6-2: Assigned Model Hydraulic Properties

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Chesapeake, Virginia

Stratigraphic Unit	DYN Model Layer	Kh (feet/day)	Kv (feet/day)	Ss (1/feet)	Sy
Surficial silt-clay	7	2	0.005	0.000001	0.16
Surficial aquifer (upper)	6 - 5	30-100	0.3 - 4	0.000032	0.16
Surficial aquifer (lower)	4 - 3	70-100	0.3 - 4	0.000032	0.16
Yorktown confining zone	2	10 - 25	0.0013	0.000001	0.16
Yorktown aquifer	1	50-100	0.5 - 4	0.000001	0.16

Kh - Horizontal hydraulic conductivity

Kv - Vertical hydraulic conductivity

Ss - Storativity

Sy - Specific yield

Table 6-3: Steady State Model Calibration Results:**Aquifer Performance Test Model**

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Battlefield Golf Club

Chesapeake, Virginia

Well	Aquifer	Average Observed Head (ft)	Simulated Head (ft)	Residual (ft)
MW-1A	Surficial aquifer (upper)	14.055	9.887	-4.168
MW-2A	Surficial aquifer (upper)	7.145	8.346	1.201
MW-3A	Surficial aquifer (upper)	13.259	9.659	-3.600
MW-4A	Surficial aquifer (upper)	4.015	5.795	1.780
MW-6A	Surficial aquifer (upper)	8.260	6.656	-1.604
MW-7A	Surficial aquifer (upper)	11.413	9.541	-1.872
MW-8A	Surficial aquifer (upper)	6.946	7.686	0.740
MW-9A	Surficial aquifer (upper)	5.631	6.599	0.968
MW-10A	Surficial aquifer (upper)	4.806	5.480	0.674
MW-11A	Surficial aquifer (upper)	3.930	4.922	0.992
MW-12A	Surficial aquifer (upper)	4.001	5.007	1.006
MW-13A	Surficial aquifer (upper)	6.677	7.259	0.582
MW-14A	Surficial aquifer (upper)	8.047	8.300	0.253
MW-15A	Surficial aquifer (upper)	6.973	8.453	1.480
MW-16A	Surficial aquifer (upper)	7.911	8.381	0.470
MW-17A	Surficial aquifer (upper)	5.332	5.740	0.408
MW-18A	Surficial aquifer (upper)	6.014	6.162	0.148
MW-19A	Surficial aquifer (upper)	5.864	6.245	0.381
MW-20A	Surficial aquifer (upper)	7.122	6.634	-0.488
Mean Difference - Surficial aquifer (upper)				-0.034
Standard Deviation – Surficial aquifer (upper)				1.638
MW-3B	Surficial aquifer (lower)	13.187	9.612	-3.575
MW-7B	Surficial aquifer (lower)	11.660	9.515	-2.145
MW-8B	Surficial aquifer (lower)	7.137	8.376	1.239
MW-9B	Surficial aquifer (lower)	6.140	7.161	1.021
MW-10B	Surficial aquifer (lower)	5.073	5.970	0.897
MW-11B	Surficial aquifer (lower)	3.856	5.282	1.426
MW-12B	Surficial aquifer (lower)	3.883	5.397	1.514
MW-16B	Surficial aquifer (lower)	6.837	8.325	1.488
Mean Difference – Surficial aquifer (lower)				0.233
Standard Deviation – Surficial aquifer (lower)				1.959
MW-1C	Yorktown-Eastover aquifer	6.840	6.478	-0.362
MW-2C	Yorktown-Eastover aquifer	7.185	5.860	-1.325
MW-3C	Yorktown-Eastover aquifer	9.260	6.590	-2.670
MW-4C	Yorktown-Eastover aquifer	3.480	6.387	2.907
MW-5C	Yorktown-Eastover aquifer	6.810	7.629	0.819
MW-6C	Yorktown-Eastover aquifer	5.020	6.032	1.012
Mean Difference - Yorktown-Eastover aquifer				0.063
Standard Deviation - Yorktown-Eastover aquifer				1.956
Mean Difference – All Layers				0.048
Standard Deviation – All Layers				1.721

**Table 6-4: Steady State Model Calibration Results:
High Flow Model**

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Chesapeake, Virginia

Well	Aquifer	Average Observed Head (ft)	Simulated Head (ft)	Residual (ft)
MW-1A	Surficial aquifer (upper)	14.055	13.279	-0.776
MW-2A	Surficial aquifer (upper)	7.145	8.800	1.655
MW-3A	Surficial aquifer (upper)	13.259	11.582	-1.677
MW-4A	Surficial aquifer (upper)	4.015	5.214	1.199
MW-6A	Surficial aquifer (upper)	8.260	6.671	-1.589
MW-7A	Surficial aquifer (upper)	11.413	10.816	-0.597
MW-8A	Surficial aquifer (upper)	6.946	7.535	0.589
MW-9A	Surficial aquifer (upper)	5.631	6.147	0.516
MW-10A	Surficial aquifer (upper)	4.806	4.980	0.174
MW-11A	Surficial aquifer (upper)	3.930	4.293	0.363
MW-12A	Surficial aquifer (upper)	4.001	4.568	0.567
MW-13A	Surficial aquifer (upper)	6.677	6.871	0.194
MW-14A	Surficial aquifer (upper)	8.047	8.436	0.389
MW-15A	Surficial aquifer (upper)	6.973	8.623	1.650
MW-16A	Surficial aquifer (upper)	7.911	8.743	0.832
MW-17A	Surficial aquifer (upper)	5.332	5.361	0.029
MW-18A	Surficial aquifer (upper)	6.014	5.839	-0.175
MW-19A	Surficial aquifer (upper)	5.864	6.044	0.180
MW-20A	Surficial aquifer (upper)	7.122	6.611	-0.511
Mean Difference - Surficial aquifer (upper)				0.159
Standard Deviation – Surficial aquifer (upper)				0.913
MW-3B	Surficial aquifer (lower)	13.187	11.433	-1.754
MW-7B	Surficial aquifer (lower)	11.660	10.801	-0.859
MW-8B	Surficial aquifer (lower)	7.137	7.889	0.752
MW-9B	Surficial aquifer (lower)	6.140	6.340	0.200
MW-10B	Surficial aquifer (lower)	5.073	5.107	0.034
MW-11B	Surficial aquifer (lower)	3.856	4.351	0.495
MW-12B	Surficial aquifer (lower)	3.883	4.660	0.777
MW-16B	Surficial aquifer (lower)	6.837	8.742	1.905
Mean Difference – Surficial aquifer (lower)				0.194
Standard Deviation – Surficial aquifer (lower)				1.108
MW-1C	Yorktown-Eastover aquifer	6.840	6.439	-0.401
MW-2C	Yorktown-Eastover aquifer	7.185	5.828	-1.357
MW-3C	Yorktown-Eastover aquifer	9.260	6.507	-2.753
MW-4C	Yorktown-Eastover aquifer	3.480	6.326	2.846
MW-5C	Yorktown-Eastover aquifer	6.810	7.470	0.660
MW-6C	Yorktown-Eastover aquifer	5.020	6.048	1.028
Mean Difference - Yorktown-Eastover aquifer				0.004
Standard Deviation - Yorktown-Eastover aquifer				1.958
Mean Difference – All Layers				0.139
Standard Deviation – All Layers				1.158

**Table 6-5: Water Budget for Steady State Calibration
Aquifer Performance Test Model and High Flow Model**

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Battlefield Golf Club
Chesapeake, Virginia

	High Flow Model (MGD)	Aquifer Performance Test Model (MGD)
Flow Into Model from Perimeter	1.62	0.91
Flow Out of Model at Perimeter	-6.64	-2.44
Discharge to Surface Water	-31.3	-7.73
Pumping	-0.25	-0.25
Recharge	58	17.68
Evapotranspiration	-21.43	-8.17

MGD - million gallons per day

Table 7-1: Transport Analysis Constituents

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 Chesapeake, Virginia

Measurements for Fly Ash				Regulatory Standards/Criteria			Mobility	
Constituent	Average Total in	Constituent	Average Leaching	Regulatory		Constituent	Relative	
	Fly Ash ¹		from Fly Ash ²	Criteria	Standard			Mobility
	mg/kg		mg/L	mg/L	Type			
Aluminum	11,500	Sulfate	162.5	<u>Arsenic</u>	0.01	MCL	Ammonia	High
Iron	10,500	Aluminum	9.14	Nitrite	1	MCL	Nitrate	High
Magnesium	1,330	Magnesium	2.82	Nitrate	10	MCL	Nitrite	High
Sulfate	780	Iron	0.0994	Zinc	0.05	VDEQ Stnd	Sulfate	High
Manganese	66.2	<u>Arsenic</u>	<u>0.0931</u>	Manganese	0.05	VDEQ Crit	Aluminum	Moderate
<u>Arsenic</u>	<u>59.1</u>	Manganese	0.0715	Iron	0.3	VDEQ Crit	<u>Arsenic</u>	<u>Low</u>
Zinc	25.9	Zinc	0.0423	Sulfate	50	VDEQ Crit	Iron	Low
Nickel	18.2	Nickel	0.0129	Nickel	1.8	Tap	Manganese	Low
Ammonia	10.6	<u>Nitrate</u>	<u>No Data</u>	Aluminum	37	Tap	Nickel	Low
<u>Nitrate</u>	<u>1.4</u>	Ammonia	No Data	Ammonia	None Established		Zinc	Low
Nitrite	0.222	Nitrite	No Data	Magnesium	None Established		Magnesium	Undetermined

1 - Data sources: CDM 2011 and MACTEC 2009.

2 - Data sources: CDM 2011; MACTEC 2009, URS 2001b, and Kimley-Horn and Associates 2008.

VDEQ Stnd - Virginia DEQ Groundwater Quality Standards 9 VAC 25-280-40, effective February 12, 2004.

VDEQ Crit - Virginia DEQ Groundwater Criteria of the Coastal Plain 9 VAC 25-280-70, effective February 12, 2004. These criteria apply to naturally occurring constituents and enforceable standards were not adopted.

MCL - EPA Maximum Contaminant Level.

Tap - EPA , Tap Water Regional Screening Level, November 2010.

Table 7-2: Summary of Initial Source Loading Rates and Source Decay Parameters

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Battlefield Golf Club

Chesapeake, Virginia

Soil/Water Partition Coefficient L/Kg	Source Half-life	Infiltration in/yr	Initial Leachable Mass in Fill mg/Kg Ash	Initial Leachate Concentration mg/L	Initial Source Loading Rate to Leachate ¹ grams/day
Arsenic Method #1, TCLP					
20	125 yrs	15.8	4.65	0.233	95.6
20	265 yrs	7.5	4.65	0.233	45.4
30	188 yrs	15.8	4.65	0.155	63.7
30	397 yrs	7.5	4.65	0.155	30.3
Arsenic Method #2, Solids Concentration					
20	125 yrs	15.8	43	2.14	878
20	265 yrs	7.5	43	2.14	417
30	188 yrs	15.8	43	1.42	585
30	397 yrs	7.5	43	1.42	278
Nitrate ² Method #1, R = 1.1					
0.023	108 days	15.8	14.5	627	258 kg/day
0.023	50 days	7.5	14.5	627	122 kg/day
Nitrate ² Method #2, Pore Volume					
N/A	N/A	15.8	14.5	62.7	25.8 kg/day (767 days)
N/A	N/A	7.5	14.5	62.7	12.2 kg/day (1615 days)

1 - With the exception of Nitrate Method #2, the source loading rates to leachate decrease according to the source half-life values.

2 - The values presented are nitrate derived from the conversion of "nitrate as nitrogen" laboratory results.

Table 7-3: Transport Parameters

Hydrogeologic Investigation and Groundwater Modeling Report

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Chesapeake, Virginia

Transport Parameter	Simulated Value (Range)
Effective porosity, n_{eff} (dimensionless)	0.2
Soil/water partition coefficient, K_d (L/Kg)	20 – 30 (arsenic), 0.023 (nitrate)
Retardation factor, R (dimensionless)	84.7 – 131 (arsenic), 1.1 (nitrate)
Dispersivity, Longitudinal (ft^{-1})	30
Dispersivity, Transverse (ft^{-1})	3
Dispersivity, Vertical (ft^{-1})	0.3
Half Life	125 – 382 years (arsenic), 50 – 108 days (nitrate)