Groundwater Sampling Report and Statistical Analysis

Prepared for

Lenoir County Closed MSWLF and active C&D Landfill
LaGrange, North Carolina

January, 2007

Permit Number: 54-03
MESCO Project Number: G07015.0

Completed on April 30, 2007

Municipal Services Garner, NC
Engineering Company, P.A. Boone, NC

Municipal Engineering Services Company, P.A.
Garner, Boone and Morehead City, North Carolina

Detection Scan All Detections above SWSL and NCGW2L
Lenoir County Closed MSWLF and C&D Landfill

Well ID	Parameter Name [1]	Sample Date	Result	Unit	SWSL [2]	NCGW2L [3]	Exceedance
MW-1	**Iron**	**01/17/2007**	**659**	**ug/l**	**50**	**300**	**359**
MW-3	Zinc	01/17/2007	89	ug/l	10	1050	
MW-3	Manganese	01/17/2007	22	ug/l	10	50	
MW-3	**Iron**	**01/17/2007**	**5480**	**ug/l**	**50**	**300**	**5180**
MW-4	Sulfate	01/17/2007	21.2	ug/l	5		
MW-4	**Manganese**	**01/17/2007**	**56**	**ug/l**	**10**	**50**	**6**
MW-4	**Iron**	**01/17/2007**	**7005**	**ug/l**	**50**	**300**	**6705**
MW-6	Sulfate	01/17/2007	36	ug/l	5		
MW-6	Manganese	01/17/2007	46	ug/l	10	50	
MW-6	Zinc	01/17/2007	13	ug/l	10	1050	
MW-6	**Iron**	**01/17/2007**	**641**	**ug/l**	**50**	**300**	**341**
MW-9	**Iron**	**01/17/2007**	**1325**	**ug/l**	**50**	**300**	**1025**
MW-9	Sulfate	01/17/2007	13.7	ug/l	5		
MW-9	**Manganese**	**01/17/2007**	**287**	**ug/l**	**10**	**50**	**237**
MW-11	Sulfate	01/17/2007	5.6	ug/l	5		
MW-11	Manganese	01/17/2007	13	ug/l	10	50	
MW-11	**Iron**	**01/17/2007**	**1674**	**ug/l**	**50**	**300**	**1374**
MW-12	Mercury	01/17/2007	0.2	ug/l		1.1	
MW-12	**Iron**	**01/17/2007**	**830**	**ug/l**	**50**	**300**	**530**
SW-2	Chromium	01/17/2007	12	ug/l	10	50	
SW-2	Lead	01/17/2007	11	ug/l	10	15	
SW-2	Zinc	01/17/2007	18	ug/l	10	1050	

[1] Table only contains constituents detected above SWSL and NCGW2L Standard
[2] SWSL = Solid Waste Section Limit (Current as of sampling event)
[3] NCGW2L = North Carolina Ground Water 2L Standard

Detection Scan All Detections Reported by Laboratory
Lenoir County Closed MSWLF and C&D Landfill

Well ID	Parameter Name [1]	Sample Date	Result	Unit	SWSL [2]	NCGW2L [3]	Exceedance
MW-1	Chloride	01/17/2007	34	ug/l			
MW-1	**Iron**	**01/17/2007**	**659**	**ug/l**	**50**	**300**	**359**
MW-1	TDS	01/17/2007	52	ug/l			
MW-3	Chloride	01/17/2007	2	ug/l			
MW-3	**Iron**	**01/17/2007**	**5480**	**ug/l**	**50**	**300**	**5180**
MW-3	Manganese	01/17/2007	22	ug/l	10	50	
MW-3	TDS	01/17/2007	53	ug/l			
MW-3	Total Alkalinity	01/17/2007	11	ug/l			
MW-3	Zinc	01/17/2007	89	ug/l	10	1050	
MW-4	Chloride	01/17/2007	2	ug/l			
MW-4	**Iron**	**01/17/2007**	**7005**	**ug/l**	**50**	**300**	**6705**
MW-4	**Manganese**	**01/17/2007**	**56**	**ug/l**	**10**	**50**	**6**
MW-4	Sulfate	01/17/2007	21.2	ug/l	5		
MW-4	TDS	01/17/2007	81	ug/l			
MW-4	Total Alkalinity	01/17/2007	8	ug/l			
MW-6	Chloride	01/17/2007	4	ug/l			
MW-6	**Iron**	**01/17/2007**	**641**	**ug/l**	**50**	**300**	**341**
MW-6	Manganese	01/17/2007	46	ug/l	10	50	
MW-6	Sulfate	01/17/2007	36	ug/l	5		
MW-6	TDS	01/17/2007	76	ug/l			
MW-6	Zinc	01/17/2007	13	ug/l	10	1050	
MW-9	Chloride	01/17/2007	4	ug/l			
MW-9	**Iron**	**01/17/2007**	**1325**	**ug/l**	**50**	**300**	**1025**
MW-9	**Manganese**	**01/17/2007**	**287**	**ug/l**	**10**	**50**	**237**
MW-9	Sulfate	01/17/2007	13.7	ug/l	5		
MW-9	TDS	01/17/2007	77	ug/l			
MW-9	Total Alkalinity	01/17/2007	4	ug/l			
MW-11	Chloride	01/17/2007	5	ug/l			
MW-11	**Iron**	**01/17/2007**	**1674**	**ug/l**	**50**	**300**	**1374**
MW-11	Manganese	01/17/2007	13	ug/l	10	50	
MW-11	Sulfate	01/17/2007	5.6	ug/l	5		
MW-11	TDS	01/17/2007	54	ug/l			
MW-12	Chloride	01/17/2007	10	ug/l			
MW-12	**Iron**	**01/17/2007**	**830**	**ug/l**	**50**	**300**	**530**
MW-12	Mercury	01/17/2007	0.2	ug/l		1.1	
MW-12	TDS	01/17/2007	59	ug/l			
SW-2	Chromium	01/17/2007	12	ug/l	10	50	
SW-2	Lead	01/17/2007	11	ug/l	10	15	
SW-2	Zinc	01/17/2007	18	ug/l	10	1050	

[1] Table only contains constituents detected above SWSL and NCGW2L Standard
[2] SWSL = Solid Waste Section Limit (Current as of sampling event)
[3] NCGW2L = North Carolina Ground Water 2L Standard

Hydrologic Properties at Monitoring Well Locations
Lenoir County Closed MSWLF and C&D Landfill

Monitoring Well	Hydraulic Conductivity (cm/sec)	Effective Porosity (%)	Hydraulic Gradient	Flow Rate (ft/yr)	Flow Direction	Water Table Depth (ft)	Water Table Elev. (ft)
MW-1	4.30E-04	20%	0.01	25.6	N30E	13.56	84.78
MW-3	1.30E-04	20%	0.01	6.4	N35E	4.82	59.05
MW-4	5.40E-04	20%	0.01	32.9	N28E	4.78	63.25
MW-6	-	-	0.01	-	N2E	8.78	76.78
MW-9	3.80E-04	20%	0.01	16.6	N47E	4.95	57.45
MW-11	6.59E-04	20%	0.01	23.2	N35E	11.58	66.68
MW-12	2.10E-04	20%	0.008	9.0	N44E	14.53	62.93

NOTE: 1.Hydraulic conductivity (K), values for MW-1 through MW-10 were obtained from GAI Consultants (June 1996).

K values for MW-11 and MW-12 were based on slug test results conducted by MESCO in July 1999.

2.Water levels were measured prior to sampling by Environment 1, Inc. on January 17, 2007.

Flow rate (Q) is defined by the equation:

where

$$Q = -\frac{K}{n_e} \cdot \frac{dh}{dl}$$

K = hydraulic conductivity
ne = effective porosity
dh = head difference
dl = horizontal distance

Statistical Analysis Results Summary

Inter-Well Analysis Summary
Lenoir County Closed Sanitary Landfill

Background Well: MW-1

Mercury, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance limit	ND	2.5	ug/l

Well	Result	Significance
MW-12	0.2	no

Zinc, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	log-normal	Poisson tolerance limit	ND	8	log[ug/l]

Well	Result	Significance
MW-3	4.49	no
MW-6	2.56	no

NOTE: Bold-faced monitoring points indicate detected levels exceed North Carolina Groundwater Standard.

Summary of Pooled VOCs in Background Well (MW-1)
Lenoir County Closed Sanitary Landfill

Constituent	Samples	NDs	% NDs
1,1,1,2-Tetrachloroethane	28	28	100.00
1,1,1-Trichloroethane	28	28	100.00
1,1,2,2-Tetrachloroethane	28	28	100.00
1,1,2-Trichloroethane	28	28	100.00
1,1-Dichloroethane	28	28	100.00
1,1-Dichloroethene	28	28	100.00
1,2,3-Trichloropropane	28	28	100.00
1,2-Dibromo-3-chloropropane	28	28	100.00
1,2-Dibromoethane	28	28	100.00
1,2-Dichlorobenzene	28	28	100.00
1,2-Dichloroethane	28	28	100.00
1,2-Dichloropropane	28	28	100.00
1,4-Dichlorobenzene	28	28	100.00
2-Butanone	28	28	100.00
2-Hexanone	28	28	100.00
4-Methyl-2-Pentanone	28	28	100.00
Acetone	28	28	100.00
Acrylonitrile	28	28	100.00
Benzene	28	28	100.00
Bromochloromethane	28	28	100.00
Bromodichloromethane	28	28	100.00
Bromoform	28	28	100.00
Bromomethane	28	28	100.00
Carbon disulfide	28	28	100.00
Carbon tetrachloride	28	28	100.00
Chlorobenzene	28	28	100.00
Chloroethane	28	28	100.00
Chloroform	28	28	100.00
Chloromethane	28	28	100.00
cis-1,2-Dichloroethene	28	28	100.00
cis-1,3-Dichloropropene	28	28	100.00
Chlorodibromomethane	28	28	100.00
Dibromomethane	28	28	100.00
Ethylbenzene	28	28	100.00
Iodomethane	28	28	100.00
Dichloromethane	28	28	100.00
Styrene	28	28	100.00
Tetrachloroethylene	28	28	100.00
Toluene	28	28	100.00
trans-1,2-Dichloroethene	28	28	100.00
trans-1,3-Dichloropropene	28	28	100.00
trans-1,4-Dichloro-2-butene	28	28	100.00
Trichloroethylene	28	28	100.00
Trichlorofluoromethane	28	28	100.00
Vinyl acetate	28	28	100.00
Vinyl chloride	28	28	100.00
Xylene	28	28	100.00
Total	**1316**	**1316**	**100.00**

Poisson Prediction Interval Based upon Pooled Background VOCs
Lenoir County Closed Sanitary Landfill

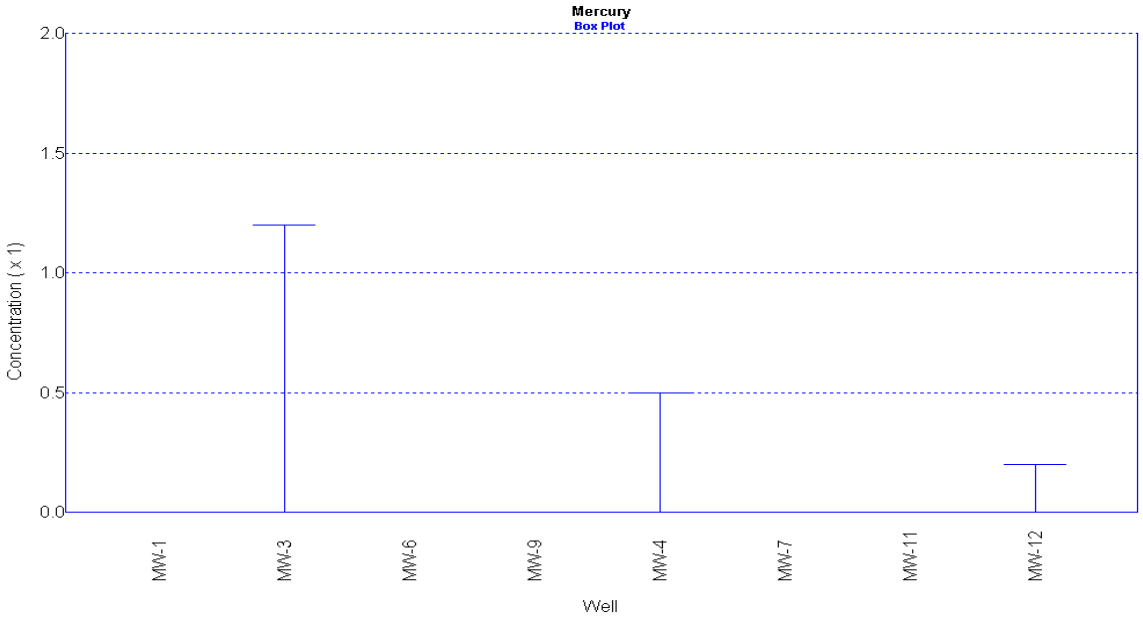
All detected VOCs (Background Well: MW-1)

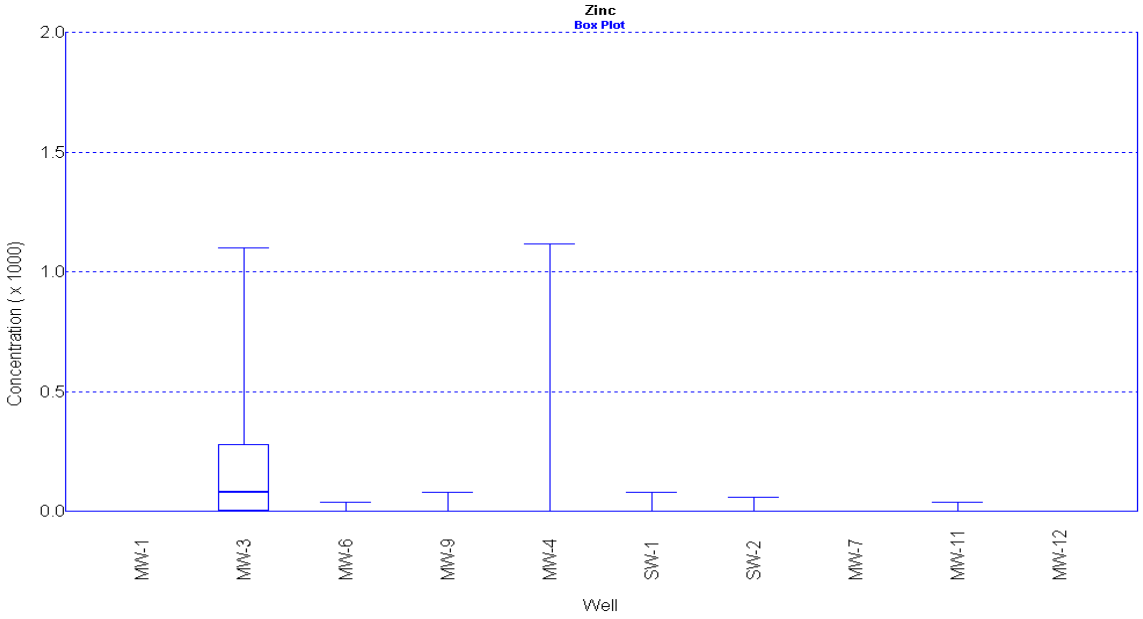
Constituent	
None	
Detection(s) per Scan	0.00

Total number of sampling events [n] =	28
Total number of detections in background wells [y] =	0
Number of comparisons (downgradient wells) [k] =	6
One-sided value of Student's t-statistic (95% confidence) [t] =	2.53
Expected number of detections in a single future sample [y*] =	**0.2286**

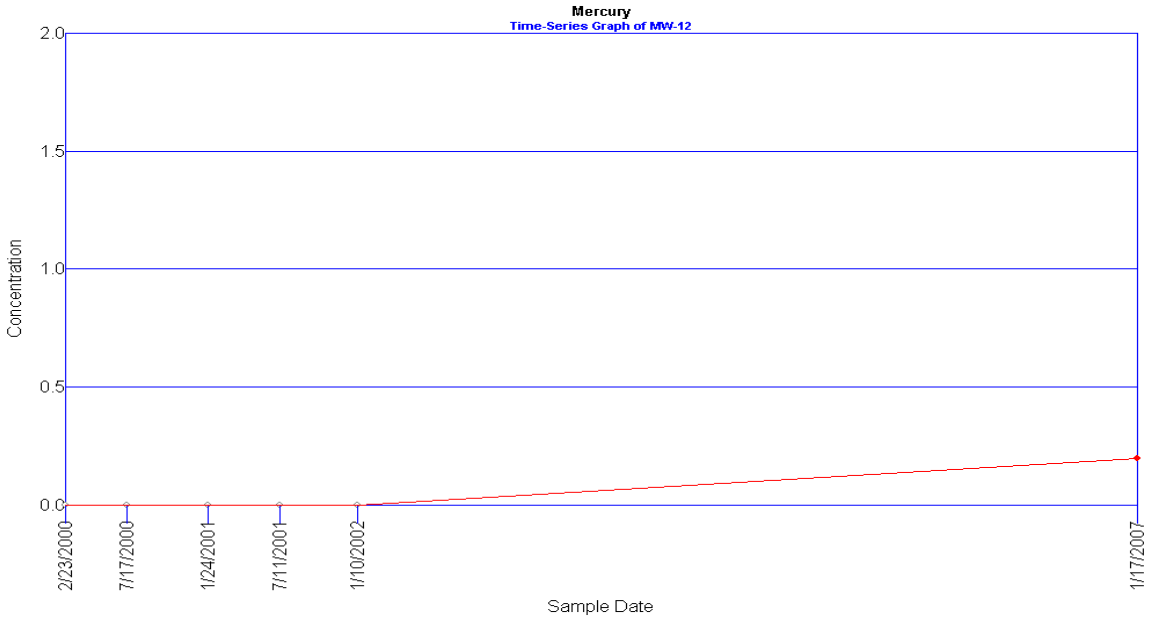
No Statistically Significant VOC Detections

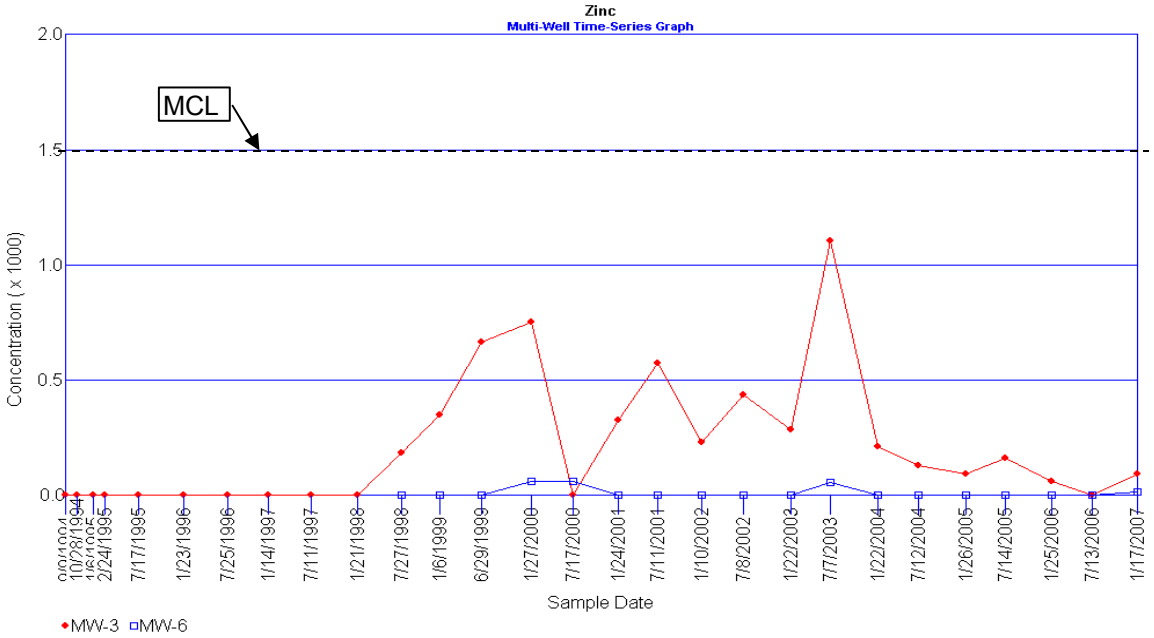
Box Plots for Select Constituents (Metals)
Lenoir County Closed Sanitary Landfill

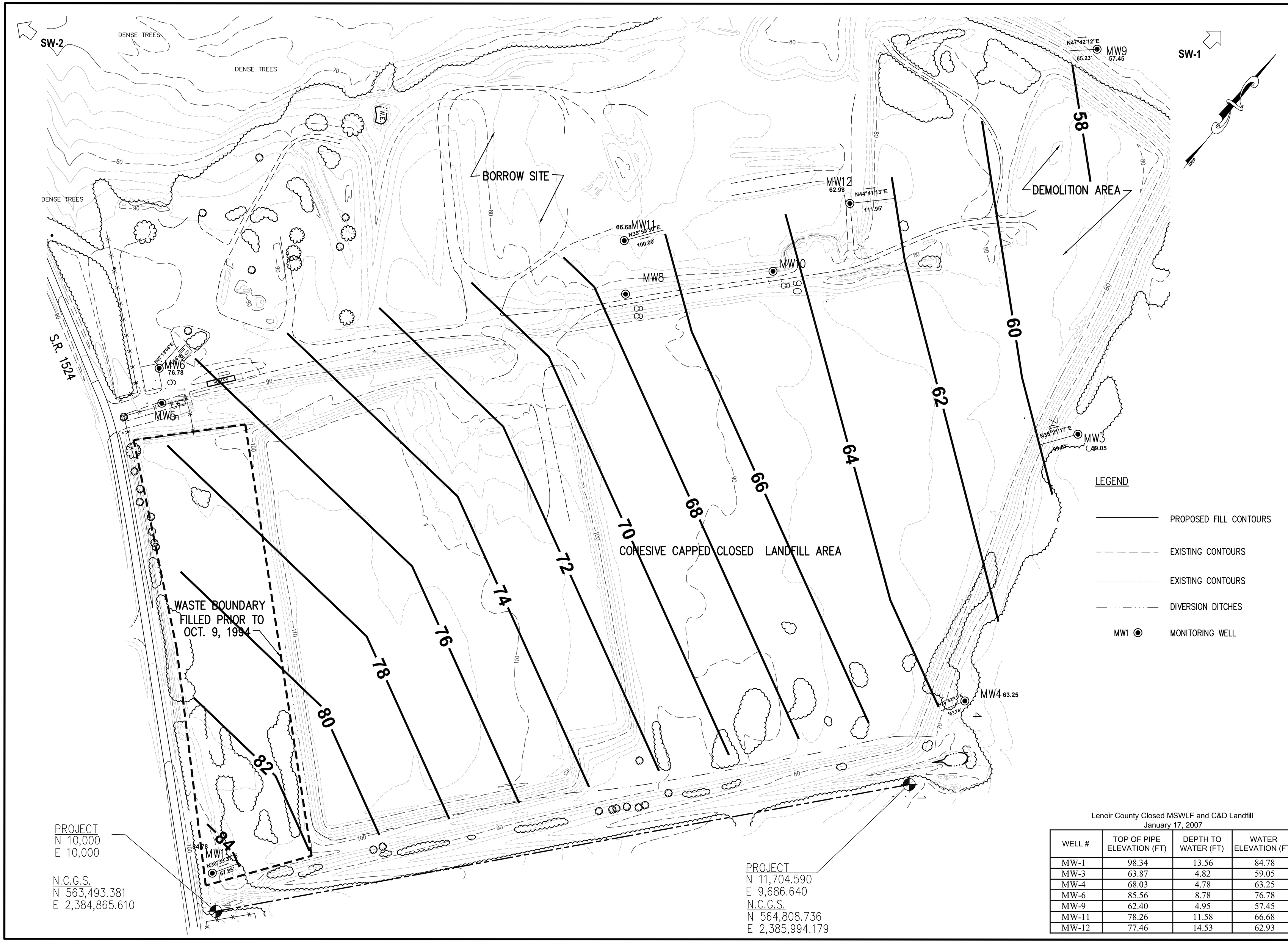




Time Series Plots for Select Constituents (Metals)
Lenoir County Closed Sanitary Landfill







Lenoir County Closed MSWLF and C&D Landfill
January 17, 2007

WELL #	TOP OF PIPE ELEVATION (FT)	DEPTH TO WATER (FT)	WATER ELEVATION (FT)
MW-1	98.34	13.56	84.78
MW-3	63.87	4.82	59.05
MW-4	68.03	4.78	63.25
MW-6	85.56	8.78	76.78
MW-9	62.40	4.95	57.45
MW-11	78.26	11.58	66.68
MW-12	77.46	14.53	62.93

Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 27529 (704) 262-1767

GROUNDWATER SAMPLING
MUNICIPAL SOLID WASTE LANDFILL
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

POTENTIOMETRIC MAP
SINGLE DAY

SCALE: 1"=100'
DATE: 3/8/02
DRWN. BY: L. HAMPTON
CHKD. BY: K. YOSHIDA
PROJECT NUMBER G99004
DRAWING NO. PM
SHEET NO. 1 of 1

Basic Statistics

Basic Statistics

Parameter: Mercury

Original Data (Not Transformed)

Non-Detects Replaced with 1/2 DL

	Total Observations
81	
Total Non-Detects	79
Pooled Mean	0.253704
Pooled Std Dev	0.123688
Background Mean	0.239286
Background Std Dev	0.0400892

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	14	14	100	3.35

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	0.239286	0.0400892	0	560	40

Compliance Wells

There are 6 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-3	18	17	94.4444	5.55
MW-4	14	13	92.8571	3.6
MW-9	13	13	100	3.1
MW-6	8	8	100	1.85
MW-11	7	7	100	1.6
MW-12	7	7	100	1.5

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-3	0.308333	0.233421	0.0690476	0.0443213	761	42.2778
MW-4	0.257143	0.0805203	0.0178571	0.0470099	600	42.8571
MW-9	0.238462	0.0416025	-0.000824176	0.0479054	520	40
MW-6	0.23125	0.053033	-0.00803571	0.055124	320	40
MW-11	0.228571	0.0566947	-0.0107143	0.0575751	280	40
MW-12	0.214286	0.0944911	-0.025	0.0575751	280	40

Analysis of Variance Statistics

SS Wells	0.0791464
SS Total	1.22389

Kruskal-Wallis Statistics

Non-Detect Rank	40
Background Rank Sum	560
Background Rank Mean	40
H Statistic	0.228861
H Adjusted for Ties	3.16687

Basic Statistics

Parameter: Manganese, total
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
7	
Total Non-Detects	2
Pooled Mean	62
Pooled Std Dev	101.173
Background Mean	5
Background Std Dev	0

Background Wells
There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	1	1	100	5

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	5	0	0	1.5	1.5

Compliance Wells
There are 6 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-6	1	0	0	46
MW-12	1	1	100	5
MW-3	1	0	0	22
MW-9	1	0	0	287
MW-11	1	0	0	13
MW-4	1	0	0	56

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-6	46	0	41	0	5	5
MW-12	5	0	0	0	1.5	1.5
MW-3	22	0	17	0	4	4
MW-9	287	0	282	0	7	7
MW-11	13	0	8	0	3	3
MW-4	56	0	51	0	6	6

Analysis of Variance Statistics

SS Wells	61416
SS Total	61416

Kruskal-Wallis Statistics

Non-Detect Rank	1.5
Background Rank Sum	1.5
Background Rank Mean	1.5
H Statistic	5.89286
H Adjusted for Ties	6

Basic Statistics

Parameter: Iron, total

Original Data (Not Transformed)

Non-Detects Replaced with 1/2 DL

	Total Observations
7	
Total Non-Detects	0
Pooled Mean	2516.29
Pooled Std Dev	2609.93
Background Mean	659
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	1	0	0	659

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	659	0	0	2	2

Compliance Wells

There are 6 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-4	1	0	0	7005
MW-6	1	0	0	641
MW-11	1	0	0	1674
MW-3	1	0	0	5480
MW-12	1	0	0	830
MW-9	1	0	0	1325

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-4	7005	0	6346	0	7	7
MW-6	641	0	-18	0	1	1
MW-11	1674	0	1015	0	5	5
MW-3	5480	0	4821	0	6	6
MW-12	830	0	171	0	3	3
MW-9	1325	0	666	0	4	4

Analysis of Variance Statistics

SS Wells	4.08705e+007
SS Total	4.08705e+007

Kruskal-Wallis Statistics

Non-Detect Rank	0
Background Rank Sum	2
Background Rank Mean	2
H Statistic	6
H Adjusted for Ties	6

Basic Statistics

Parameter: Zinc

Original Data (Not Transformed)

Non-Detects Replaced with 1/2 DL

	Total Observations
213	
Total Non-Detects	175
Pooled Mean	57.7183
Pooled Std Dev	136.826
Background Mean	24.2857
Background Std Dev	3.77964

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	28	28	100	680

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	24.2857	3.77964	0	2464	88

Compliance Wells

There are 8 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-3	28	12	42.8571	5897
MW-4	28	21	75	2107
MW-9	28	23	82.1429	896
SW-1	26	25	96.1538	695
SW-2	25	21	84	701
MW-6	18	14	77.7778	529
MW-11	16	15	93.75	409
MW-12	16	16	100	380

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-3	210.607	270.873	186.321	33.2609	4309	153.893
MW-4	75.25	206.934	50.9643	33.2609	3201	114.321
MW-9	32	18.3162	7.71429	33.2609	2966	105.929
SW-1	26.7308	13.4865	2.44505	33.8945	2397	92.1923
SW-2	28.04	13.1196	3.75429	34.2442	2586	103.44
MW-6	29.3889	12.3438	5.10317	37.5977	1958	108.778
MW-11	25.5625	9.07722	1.27679	39.0018	1502	93.875
MW-12	23.75	5	-0.535714	39.0018	1408	88

Analysis of Variance Statistics

SS Wells	809360
SS Total	3.96892e+006

Kruskal-Wallis Statistics

Non-Detect Rank	88
Background Rank Sum	2464
Background Rank Mean	88
H Statistic	23.1192
H Adjusted for Ties	51.9053

Interwell Analyses for Metals

Poisson Tolerance Limit

Parameter: Mercury

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Poisson Count of 14 background Samples = 6.7
Degrees of Freedom = 15

95% Confidence Values

Chi-Squared Value (95% Confidence) = 24.9958
Lambda (from Zack's formula) = 0.892707
Smallest Degrees of Freedom = 7
Upper Tolerance Limit (95%) = 2.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 30.578
Lambda (from Zack's formula) = 1.09207
Smallest Degrees of Freedom = 10
Upper Tolerance Limit (99%) = 4

	Date	Result	Impacted 95%	Impacted 99%
MW-12	2/23/2000	ND<0.5	FALSE	FALSE
	2/23/2000	ND<0.5	FALSE	FALSE
	7/17/2000	ND<0.5	FALSE	FALSE
	1/24/2001	ND<0.5	FALSE	FALSE
	7/11/2001	ND<0.5	FALSE	FALSE
	1/10/2002	ND<0.5	FALSE	FALSE
	1/17/2007	0.2	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Zinc

Natural Logarithm Transformation
Non-Detects Replaced with Detection Limit

Poisson Count of 28 background Samples = 107.927
Degrees of Freedom = 217

95% Confidence Values

Chi-Squared Value (95% Confidence) = 252.366
Lambda (from Zack's formula) = 4.50653
Smallest Degrees of Freedom = 18
Upper Tolerance Limit (95%) = 8

99% Confidence Values

Chi-Squared Value (99% Confidence) = 268.383
Lambda (from Zack's formula) = 4.79255
Smallest Degrees of Freedom = 23
Upper Tolerance Limit (99%) = 10.5

	Date	Result	Impacted 95%	Impacted 99%
MW-3	9/9/1994	ND<3.91202	FALSE	FALSE
	10/28/1994	ND<3.91202	FALSE	FALSE
	1/6/1995	ND<3.91202	FALSE	FALSE
	2/24/1995	ND<3.91202	FALSE	FALSE
	7/17/1995	ND<3.91202	FALSE	FALSE
	1/23/1996	ND<3.91202	FALSE	FALSE
	7/25/1996	ND<3.91202	FALSE	FALSE
	1/14/1997	ND<3.91202	FALSE	FALSE
	7/11/1997	ND<3.91202	FALSE	FALSE
	1/21/1998	ND<3.91202	FALSE	FALSE
	7/27/1998	5.18739	FALSE	FALSE
	1/6/1999	5.84932	FALSE	FALSE
	6/29/1999	6.49527	FALSE	FALSE
	1/27/2000	6.62007	FALSE	FALSE
	7/17/2000	ND<3.91202	FALSE	FALSE
	1/24/2001	5.78074	FALSE	FALSE
	7/11/2001	6.34914	FALSE	FALSE
	1/10/2002	5.4161	FALSE	FALSE
	7/8/2002	6.06611	FALSE	FALSE
	1/22/2003	5.63479	FALSE	FALSE
	7/7/2003	7.00397	FALSE	FALSE
	1/22/2004	5.33754	FALSE	FALSE
	7/12/2004	4.83628	FALSE	FALSE
	1/26/2005	4.46591	FALSE	FALSE
	7/14/2005	5.0689	FALSE	FALSE
	1/25/2006	4.04305	FALSE	FALSE
	7/13/2006	ND<3.91202	FALSE	FALSE
	1/17/2007	4.48864	FALSE	FALSE
MW-6	7/27/1998	ND<3.91202	FALSE	FALSE
	1/6/1999	ND<3.91202	FALSE	FALSE
	6/29/1999	ND<3.91202	FALSE	FALSE
	1/27/2000	4.07754	FALSE	FALSE
	7/17/2000	4.02535	FALSE	FALSE
	1/24/2001	ND<3.91202	FALSE	FALSE
	7/11/2001	ND<3.91202	FALSE	FALSE
	1/10/2002	ND<3.91202	FALSE	FALSE
	7/8/2002	ND<3.91202	FALSE	FALSE
	1/22/2003	ND<3.91202	FALSE	FALSE
	7/7/2003	3.93183	FALSE	FALSE

1/22/2004	ND<3.91202	FALSE	FALSE
7/12/2004	ND<3.91202	FALSE	FALSE
1/26/2005	ND<3.91202	FALSE	FALSE
7/14/2005	ND<3.91202	FALSE	FALSE
1/25/2006	ND<3.91202	FALSE	FALSE
7/13/2006	ND<3.91202	FALSE	FALSE
1/17/2007	2.56495	FALSE	FALSE