Groundwater Sampling Report and Statistical Analysis

Prepared for

Wayne County Closed MSWLF and C&D Landfill
Dudley, North Carolina

February, 2006

Permit Number: 96-01
MESCO Project Number: G06016.0

Completed on August 30, 2006

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

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

OPERATION/CONSTRUCTION MANAGERS

Municipal Services

CIVIL/SANITARY ENGINEERS

Engineering Company, P.A.

August 30, 2006

Mr. Ethan Brown
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Groundwater Sampling and Statistical Analysis
Wayne County Closed MSW and active C&D Landfill, Dudley
Permit # : 96-01
MESCO Project No. G06016.0

Dear Mr. Brown:

Municipal Engineering Services Company, P.A. (MESCO) completed the sampling report and statistical analyses for the Wayne County Closed and active C&D Landfills, located in Dudley, NC. Environment 1 Inc. of Greenville, NC, sampled and analyzed the water samples obtained from the monitoring wells on February 23, 2006. Downgradient wells MW-2 and MW-8 were analyzed for the Appendix II list of constituents and the remaining monitoring locations (MW-1, MW-3, MW-4, MW-5, MW-6, MW-7) were tested for only the Appendix I metal and VOC parameters as part of the assessment monitoring program. All three surface water sites SW-1, SW-2, and SW-3 were reported to be dry therefore not sampled during this event. The laboratory results and statistical analysis are included herein.

All detected constituents were compared with North Carolina Groundwater Standards for regulatory exceedance. The results are shown in the enclosed table titled "Exceedance Scan". The following table (Table 1) summarizes those constituents that exceed the Standard.

Table 1. Exceedance Summary

Monitoring Location	Cadmium	Lead	1,4-Dichlorobenzene
MW-6	x		
MW-7		x	
MW-8			x

x = concentration greater than NCGW2L standard

Lead was detected within MW-7 above the Standard for the fourth consecutive event. The intermediate chlorinated hydrocarbon 1,4-dichlorobenzene was found in a concentration above the MCL within MW-8. A sample obtained from MW-6 was found to contain levels of cadmium above the Standard. Low levels of chlorobenzene were also found within compliance well MW-2 for the 18th consecutive event.

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MESCO also completed the statistical analysis as required by the Solid Waste Section. The purpose of these analyses is to determine, in comparison to background levels, statistical significance of constituents detected during the February 2006 event.

Statistical Analysis Methodology

Metals

MESCO conducted an interwell statistical analysis on all of the detected metals. Monitoring well MW-1 was defined as the background well, and an upper tolerance limit (UTL) with 95% coverage was computed for each detected constituent from the background data at a 95% level of confidence. For each tested constituent, an appropriate statistical analysis method was selected based on the percentages of non-detects (%ND) in the historical background data. The following table (Table 2) summarizes the methods used for four different %ND ranges.

Table 2. Statistical Analysis Methods for Various %ND Ranges

%ND	Analysis Method	ND Substitution
%ND<15%	Parametric tolerance limit	1/2 ND
15%<%ND<50%	Parametric tolerance limit	Cohen or 1/2 ND
50%<%ND<90%	Non-parametric tolerance limit	1/2 ND
90%<%ND	Poisson tolerance limit	-

NOTE: For parametric tolerance interval, normality of the background data was checked by the Shapiro-Wilks normality test, as the method requires that the data be normally distributed.

A total of 5 metals were tested for statistical significance. For arsenic, cadmium, lead, and vanadium the Poisson tolerance limit was used on the original data or the log of the original data with no ND substitution since the constituents had never been detected within the background well. For chromium the non-parametric tolerance limit with ½ NDs was used on the original data as its %ND was not normally distributed and the ND rate was 84%.

VOCs

All historical VOC detections in the background well MW-1 were pooled in order to determine the total number of detections, from which the expected number of detections in a single down gradient monitoring point (y^*) was derived by utilizing the Poisson prediction interval. The parameter y^* is defined by the following equation:

$$y^* = cy + \frac{t^2 c}{2} + tc\sqrt{y\left(1+\frac{1}{c}\right)+\frac{t^2}{4}}$$

where

c = 1/ n (n =number of background samples)
t = one-sided value of students t -Statistic at 95% confidence [a]
y = number of events observed in n previous samples
y^* = expected number of events in a single future sample

[a] Gibbons, R.D., 1994, Statistical methods for groundwater monitoring: John Wiley & Sons, Inc., p.12.

For each monitoring location showing any VOC detections, the number of detected VOCs was counted with each detection being considered a "hit". The number was then compared with the expected number of detections derived from the background VOC data. The value of Student's t -Statistic was derived from tabulated values included in Gibbons (1994).

Intrawell Analyses

Intrawell Analyses were conducted only upon those constituents that were initially found to be statistically significant by interwell analysis. In general, intrawell analysis is conducted in order to differentiate true contamination from spatial variability. Baseline levels in this context are defined as the background level derived from the data in a given downgradient well. Intrawell analyses through Shewhart-CUSUM control charts require a minimum of eight independent historical sampling events and a detection rate greater than 25% (%ND≤75%). Due to the detection rate criteria arsenic within MW-7 could not be analyzed via Shewhart-CUSUM charts.

Results

Historical data compiled for monitoring well MW-1 was used as the baseline. Data distributions were reviewed using time series and box and whiskers plots (enclosed charts). Table 3 summarizes those metals that were found statistically significant by interwell comparison analysis.

Table 3. Interwell Analyses Summary

Well	Arsenic	Chromium	Lead
MW-7	x	x	x

x=level significantly higher than the background level

The numbers of metal detections continue to be consistent with historical results and all concentrations were found within the historically identified range with the exception of arsenic within MW-7. Concentrations of arsenic, chromium, and lead were found to have increased over the background levels within MW-7 according to interwell analyses. However, according to further intrawell analysis through formulation of Shewhart-CUSUM charts none of the metals have increased over their own background levels.

The Poisson Tolerance Interval at a 95% confidance level was completed for all of the detected VOCs. The wells that were found to be impacted statistically by VOCs are summarized in the following table 4.

Table 4. Poisson Tolerance Interval Analyses Summary

Well	Chlorobenzene	1,4-Dichlorobenzene
MW-2	x	
MW-8		x

x=detection exceeded those expected from the background

Low levels of the chlorinated solvent 1,4-dichlorobenzene continues to be detected within MW-8 but the concentrations have decreased each of the last 5 events. Chlorobenzene also continues to be detected in low concentrations within MW-2. Chlorobenzene has consistently been detected within both MW-2 and MW-8 since groundwater monitoring was initiated in 1994 but current levels are within the historical range. After further analyses through both Mann-Kendall Trend Analysis and Sen's Slope Analysis the detected VOCs were found to not be exhibiting an upward trend. However due to the historical absence of VOCs detected within the background well both MW-2 and MW-8 are considered to be impacted according to the Poisson Prediction Interval Analysis at a 95% confidence level.

Conclusion

The statistical analysis results conducted on metals indicate that no metals have increased within any of the compliance wells. The detected metals are likely naturally inherent in the groundwater as indicated by elevated concentrations found within the background wells for both the closed and adjacent Subtitle D Landfills. Metal concentrations have historically exhibited large fluctuations and none of the constituents are exhibiting an upward trend. Compliance wells MW-2 and MW-8 continue to be the only wells containing VOCs. The decrease in concentrations within the intermediate VOC 1,4-Dichlorobenzene within MW-8 may indicate that natural attenuation is progressing. Further it is very unlikely that any VOC would be detected along the compliance boundary in this region based upon the flow direction and the specific gravity of 1,4-dichlorobenzene. MW-2 also is installed in very close proximity to the waste boundary and it is also unlikely that VOCs have migrated to or beyond the compliance boundary in the western region of the facility.

MESCO completed the groundwater report including a potentiometric map with groundwater flow rates and direction for the sampling event. The flow directions and gradients are very consistent with historical observations, showing no changes that would result in a different interpretation of the groundwater system. The facility is scheduled to be sampled again in August 2006 and a report and statistical analysis will be forwarded upon completion. If you have any questions or comments regarding this report, please contact me by phone at (919) 772-5393 or by email at jpfohl@mesco.com.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Jonathan Pfohl
Environmental Specialist

Enclosures

cc: Mr. Lloyd Cook
Wayne County

Exceedance Scan
Wayne County Closed Landfill (Dudley)

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-2	Arsenic	02/23/2006	0.012	mg/l	0.01	0.05	
MW-5	Cadmium	02/23/2006	0.001	mg/l	0.001	0.0018	
MW-6	**Cadmium**	**02/23/2006**	**0.002**	**mg/l**	**0.001**	**0.0018**	**0.0003**
MW-7	**Lead**	**02/23/2006**	**0.042**	**mg/l**	**0.01**	**0.015**	**0.027**
MW-7	Vanadium	02/23/2006	0.12	mg/l	0.04		
MW-7	Chromium	02/23/2006	0.026	mg/l	0.01	0.05	
MW-7	Arsenic	02/23/2006	0.048	mg/l	0.01	0.05	
MW-8	Chromium	02/23/2006	0.013	mg/l	0.01	0.05	
MW-8	Arsenic	02/23/2006	0.01	mg/l	0.01	0.05	
MW-8	Lead	02/23/2006	0.012	mg/l	0.01	0.015	
MW-2	Chlorobenzene	02/23/2006	10.8	ug/l	5	50	
MW-8	**1,4-Dichlorobenzene**	**02/23/2006**	**14.4**	**ug/l**	**5**	**1.4**	**13**

[1] Table only contains detected constituents.
[2] PQL = Practical Quantitation Limit
[3] NCGW2L = North Carolina Ground Water 2L Standard

Hydrologic Properties at Monitoring Well Locations
Wayne County Closed Landfill (Dudley)

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	5.40E-04	20.0	0.00654	18.26	N57W	15.42	147.84
MW-2	3.00E-04	20.0	0.00997	15.47	N60W	4.72	129.80
MW-3	6.40E-03	20.0	0.02004	663.46	N45W	0.50	134.31
MW-4	9.90E-04	20.0	0.00653	33.46	N57W	6.72	143.48
MW-5	3.10E-05	20.0	0.01852	2.97	N50W	2.53	122.25
MW-6	1.60E-04	20.0	0.00654	5.41	N69W	5.40	140.13
MW-7	7.30E-05	20.0	0.00898	3.39	N56W	6.73	136.86
MW-8	3.40E-04	20.0	0.00565	9.94	N53W	19.21	142.67

NOTE: Data for conductivities and effective porosity obtained from GAI Consultants' Water Sampling Report (January, 1995).
Hydrologic Gradient taken from the February 23, 2006 sampling event from water levels reported by Environment I.
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 Analyses Summary
Wayne County Closed Sanitary Landfill (Dudley)

Background Well: MW-1

Arsenic, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	16.5	ug/l

Well	Result	Significance
MW-2	12	No
MW-7	48	yes
MW-8	10	No

Cadmium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	3.5	ug/l

Well	Result	Significance
MW-5	1	No
MW-6	2	No

Chromium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
84	-	Non-Parametric tolerance interval	1/2 ND	13	ug/l

Well	Result	Significance
MW-7	26	yes
MW-8	13	No

Lead, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	16.5	ug/l

Well	Result	Significance
MW-7	42	yes
MW-8	12	No

Vanadium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	log normal	Poisson tolerance interval	1/2 ND	8	log[ug/l]

Well	Result	Significance
MW-7	4.79	No

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

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

Constituent	Samples	NDs	% NDs
1,1,1,2-Tetrachloroethane	27	27	100.00
1,1,1-Trichloroethane	27	27	100.00
1,1,2,2-Tetrachloroethane	27	27	100.00
1,1,2-Trichloroethane	27	27	100.00
1,1-Dichloroethane	27	27	100.00
1,1-Dichloroethene	27	27	100.00
1,2,3-Trichloropropane	27	27	100.00
1,2-Dibromo-3-chloropropane	27	27	100.00
1,2-Dibromoethane	27	27	100.00
1,2-Dichlorobenzene	27	27	100.00
1,2-Dichloroethane	27	27	100.00
1,2-Dichloropropane	27	27	100.00
1,4-Dichlorobenzene	27	27	100.00
2-Butanone	27	27	100.00
2-Hexanone	27	27	100.00
4-Methyl-2-Pentanone	27	27	100.00
Acetone	27	27	100.00
Acrylonitrile	27	27	100.00
Benzene	27	27	100.00
Bromochloromethane	27	27	100.00
Bromodichloromethane	27	27	100.00
Bromoform	27	27	100.00
Bromomethane	27	27	100.00
Carbon disulfide	27	27	100.00
Carbon tetrachloride	27	27	100.00
Chlorobenzene	26	26	100.00
Chloroethane	27	27	100.00
Chloroform	27	27	100.00
Chloromethane	27	27	100.00
cis-1,2-Dichloroethene	27	27	100.00
cis-1,3-Dichloropropene	27	27	100.00
Chlorodibromomethane	27	27	100.00
Dibromomethane	27	27	100.00
Ethylbenzene	27	27	100.00
Iodomethane	27	27	100.00
Dichloromethane	27	27	100.00
Styrene	27	27	100.00
Tetrachloroethylene	27	27	100.00
Toluene	27	27	100.00
trans-1,2-Dichloroethene	27	27	100.00
trans-1,3-Dichloropropene	27	27	100.00
trans-1,4-Dichloro-2-butene	27	27	100.00
Trichloroethylene	27	27	100.00
Trichlorofluoromethane	27	27	100.00
Vinyl acetate	27	27	100.00
Vinyl chloride	27	27	100.00
Xylene	27	27	100.00
Total	**1268**	**1268**	**100.00**

Poisson Prediction Interval Based upon Pooled Background VOCs
Wayne County Closed Sanitary Landfill (Dudley)

All detected VOCs (Background Well: MW-1)

Constituent	MW-2	MW-8
1,4-Dichlorobenzene		x
Chlorobenzene	x	
Detection(s) per Scan	1.00	1.00

Total number of sampling events [n] =	26.98
Total number of detections in background wells [y] =	0
Number of comparisons (downgradient wells) [k] =	7
One-sided value of Student's t-statistic (95% confidence) [t] =	2.599
Expected number of detections in a single future sample [y*] =	**0.2503**

Statistically significant VOC detections at 95% confidence level within MW-2 & MW-8

Intra-Well Analysis Summary (Metals)
Wayne County Closed Sanitary Landfill (Dudley)

Well	Arsenic	Chromium	Lead
MW-7	n/a	no	no

EXPLANATION

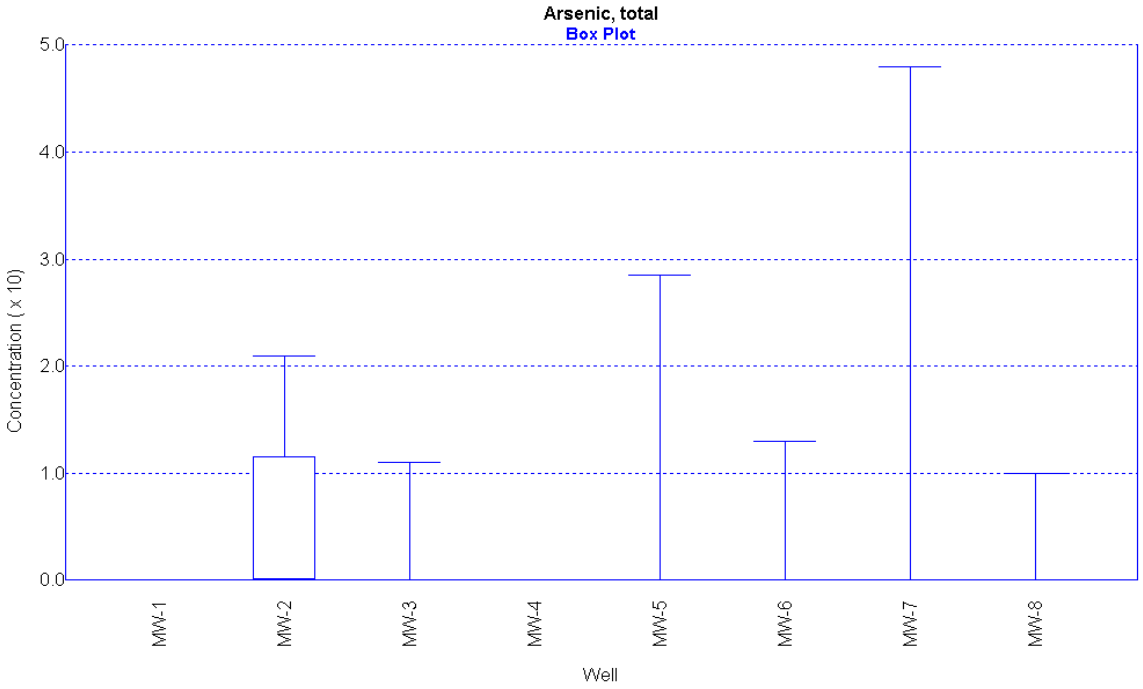
yes=detection statistically significant by intrawell analysis

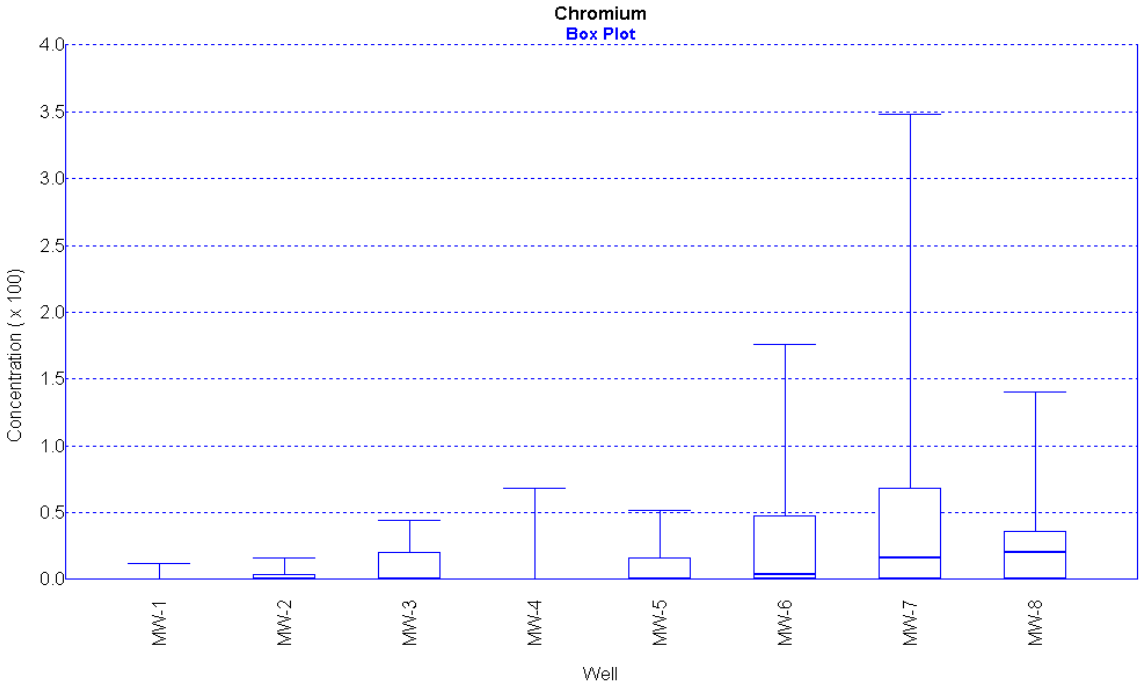
no=detection not statistically significant by intrawell analysis

n/a=not available, intrawell not possible via Shewhart CUSUM chart due to detection rate requirement

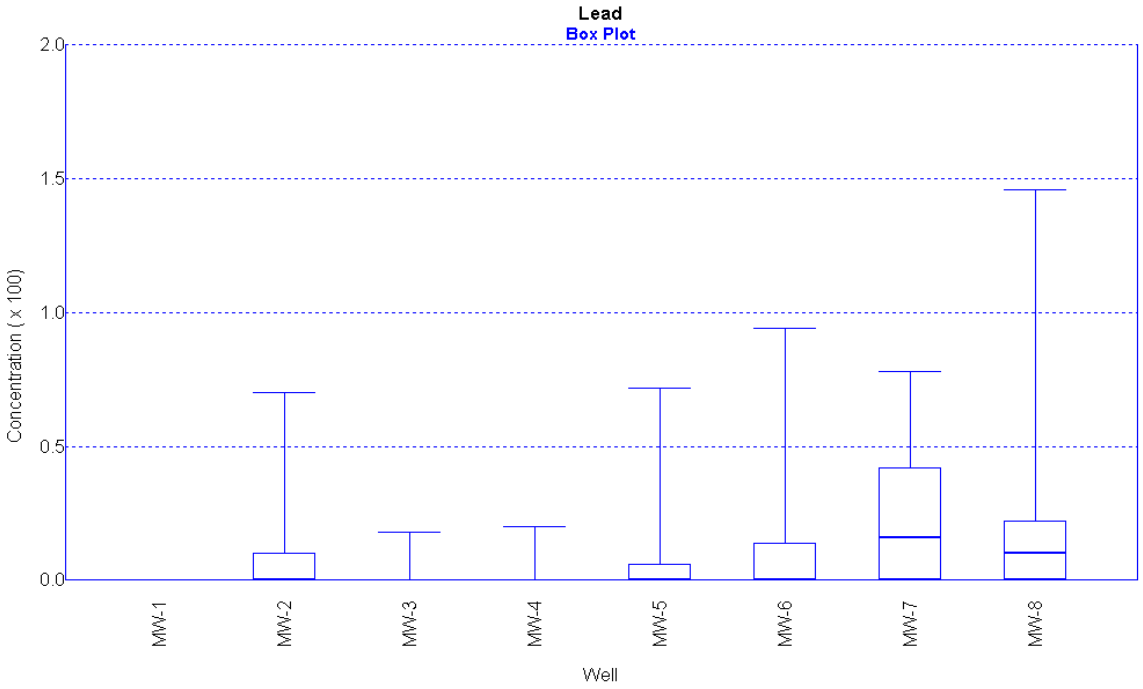
No Metals have increased according to Intrawell Analysis

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

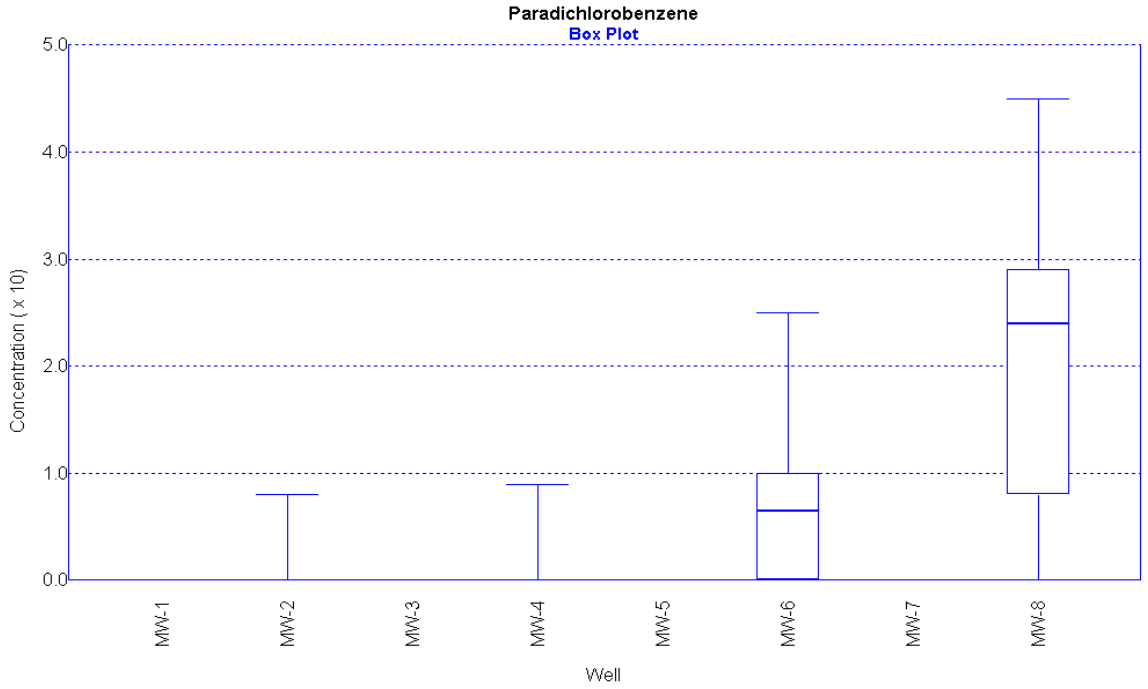


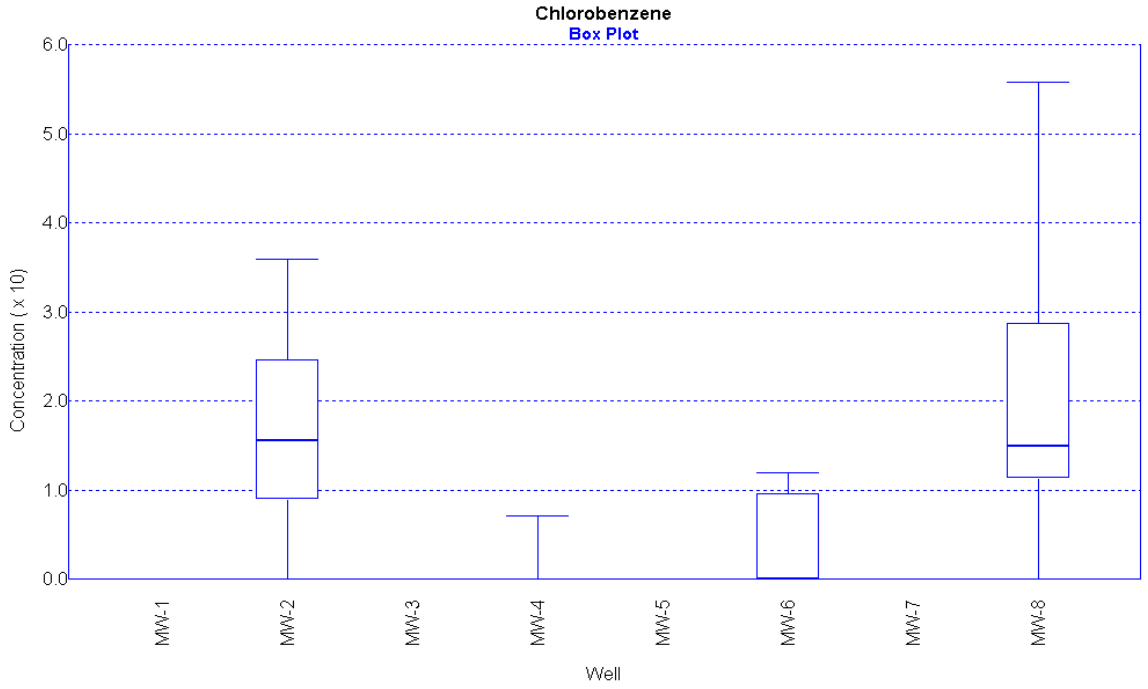


Box Plots for Select Constituents (Metals)
Wayne County Closed Sanitary Landfill (Dudley)

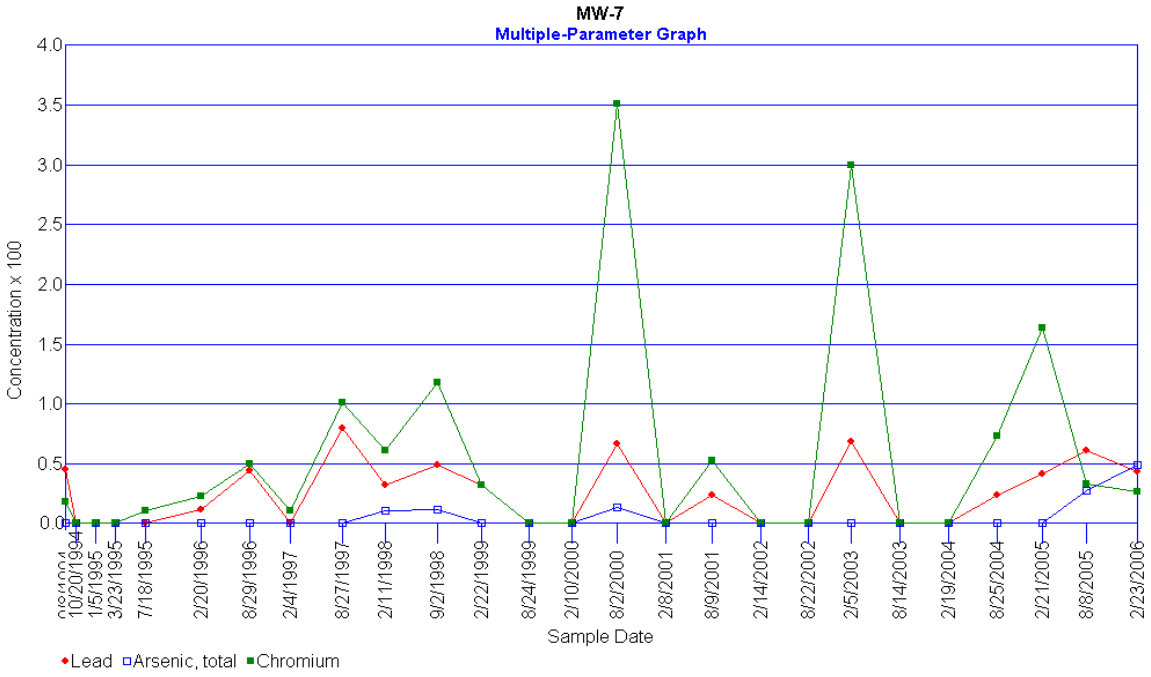


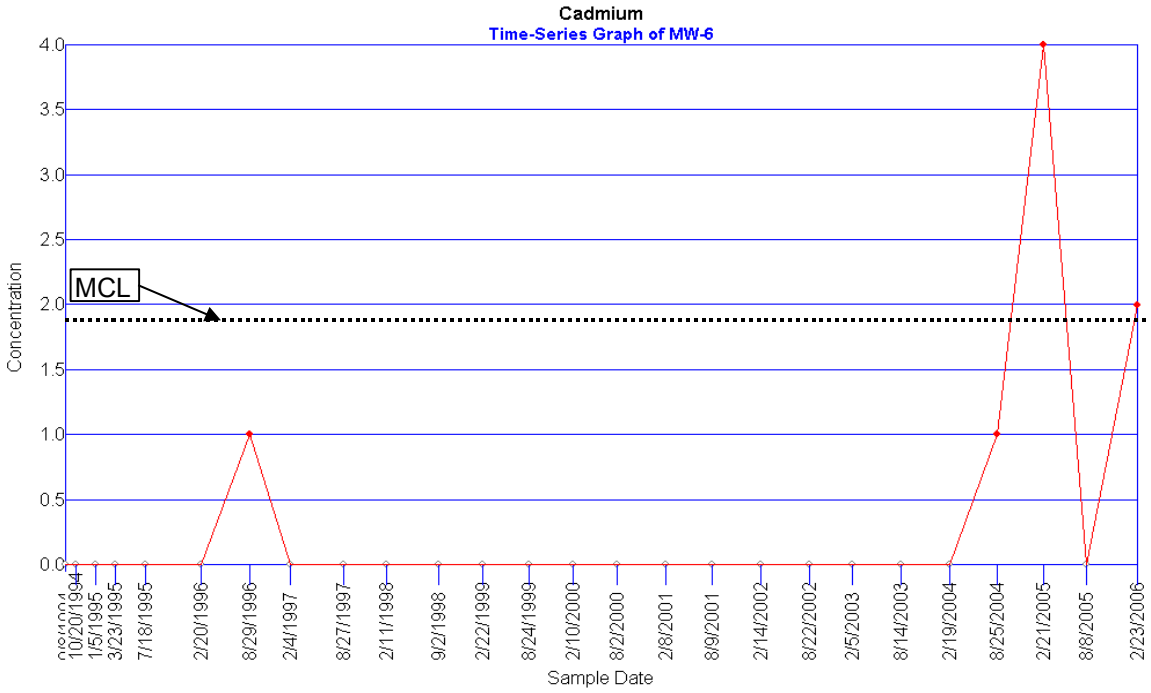
Box Plots for Select Constituents (VOCs)
Wayne County Closed Sanitary Landfill (Dudley)



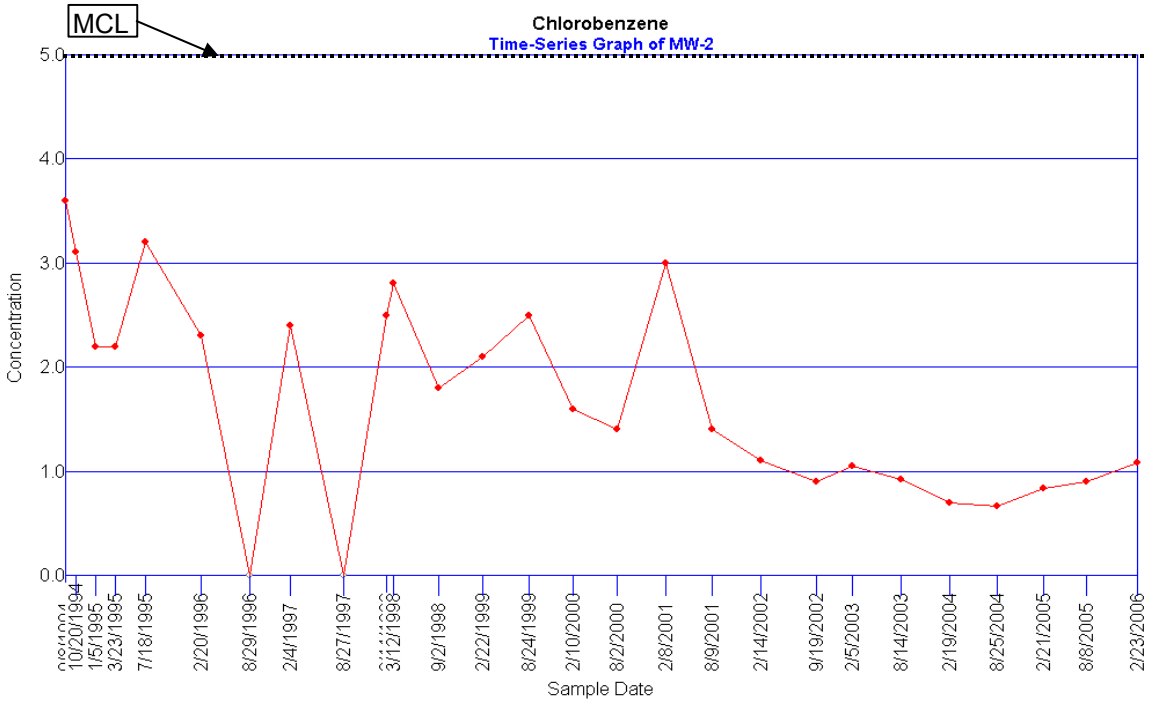


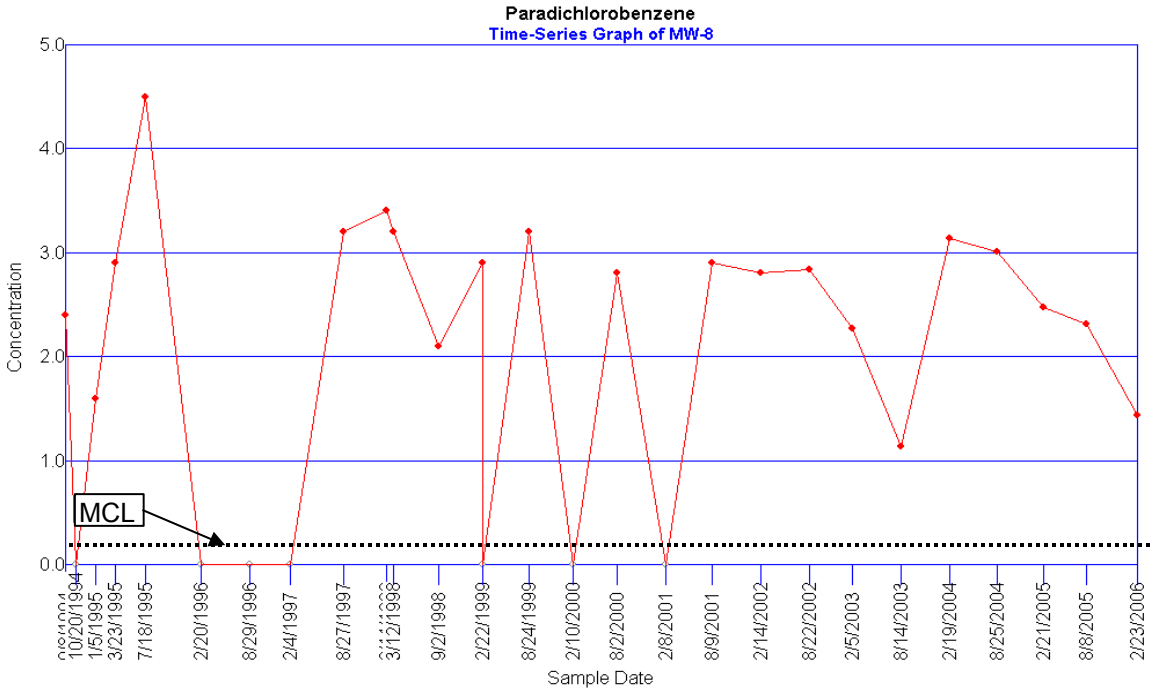
Time Series Plots for Select Constituents (Metals)
Wayne County Closed Sanitary Landfill (Dudley)



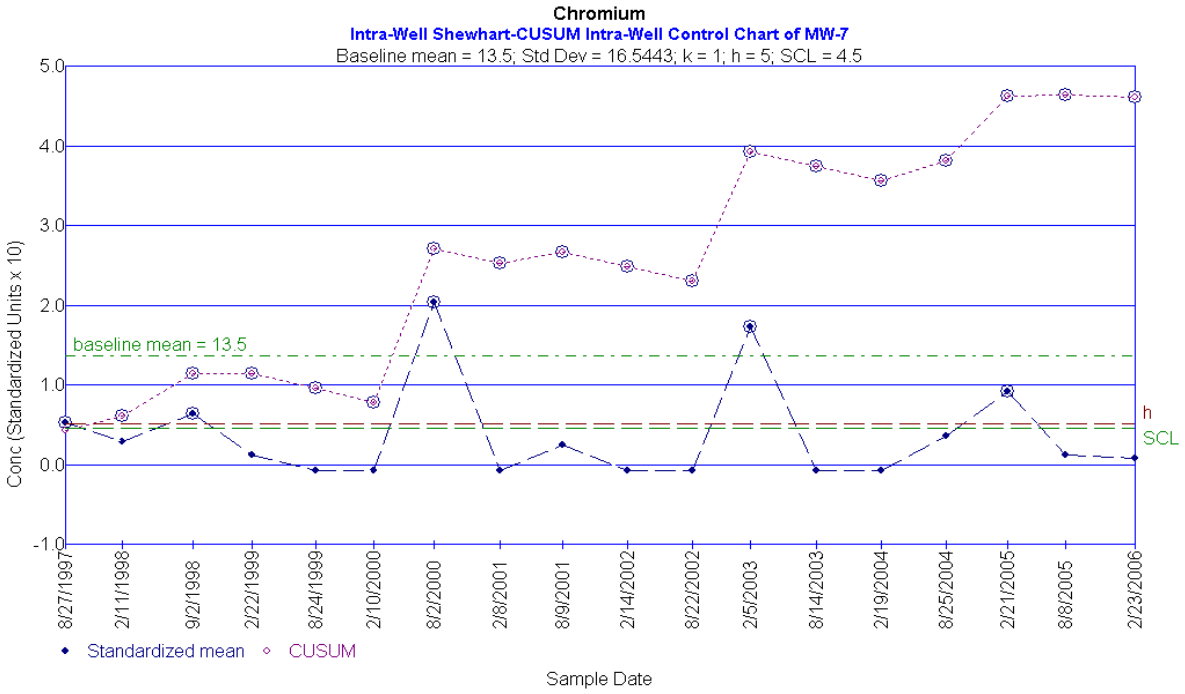


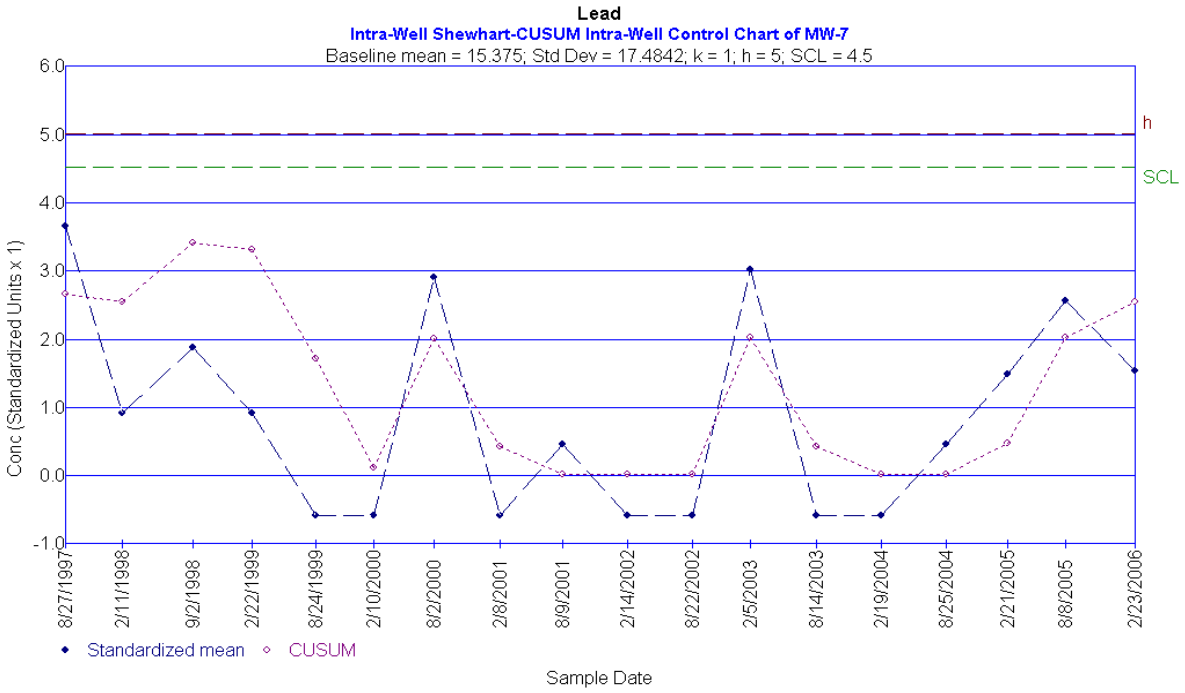
Time Series Plots for Select Constituents (VOCs)
Wayne County Closed Sanitary Landfill (Dudley)





Shewhart-CUSUM charts for selected constituents
Wayne County Closed Sanitary Landfill (Dudley)





Basic Statistics

Basic Statistics

Parameter: Lead

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
207	
Total Non-Detects	153
Pooled Mean	11.814
Pooled Std Dev	17.5414
Background Mean	4.9
Background Std Dev	0.5

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	25	25	100	122.5

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	4.9	0.5	0	1925	77

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	26	19	73.0769	256
MW-3	26	24	92.3077	149
MW-4	26	24	92.3077	151
MW-5	26	20	76.9231	257
MW-6	26	18	69.2308	370
MW-7	26	12	46.1538	670
MW-8	26	11	42.3077	470

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	9.84615	13.5017	4.94615	4.60817	2661	102.346
MW-3	5.73077	2.76489	0.830769	4.60817	2183	83.9615
MW-4	5.80769	3.24985	0.907692	4.60817	2181	83.8846
MW-5	9.88462	14.1204	4.98462	4.60817	2589	99.5769
MW-6	14.2308	20.0166	9.33077	4.60817	2866	110.231
MW-7	25.7692	24.0754	20.8692	4.60817	3614	139
MW-8	18.0769	27.8193	13.1769	4.60817	3509	134.962

Analysis of Variance Statistics

SS Wells	9527.82
SS Total	63386.1

Kruskal-Wallis Statistics

Non-Detect Rank	77
Background Rank Sum	1925
Background Rank Mean	77
H Statistic	27.1875
H Adjusted for Ties	45.6004

Basic Statistics

Parameter: Cadmium

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
207	
Total Non-Detects	185
Pooled Mean	0.770048
Pooled Std Dev	1.30851
Background Mean	0.5
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	25	25	100	12.5

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	0.5	0	0	2325	93

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	26	26	100	13
MW-3	26	23	88.4615	20
MW-4	26	25	96.1538	13.5
MW-5	26	12	46.1538	55.4
MW-6	26	22	84.6154	19
MW-7	26	26	100	13
MW-8	26	26	100	13

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	0.5	0	0	0.341269	2418	93
MW-3	0.769231	0.862911	0.269231	0.341269	2733	105.115
MW-4	0.519231	0.0980581	0.0192308	0.341269	2511	96.5769
MW-5	2.13077	3.24293	1.63077	0.341269	3874	149
MW-6	0.730769	0.737981	0.230769	0.341269	2831	108.885
MW-7	0.5	0	0	0.341269	2418	93
MW-8	0.5	0	0	0.341269	2418	93

Analysis of Variance Statistics

SS Wells	57.3278
SS Total	352.714

Kruskal-Wallis Statistics

Non-Detect Rank	93
Background Rank Sum	2325
Background Rank Mean	93
H Statistic	18.7286
H Adjusted for Ties	65.4484

Basic Statistics

Parameter: Chromium

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
207	
Total Non-Detects	126
Pooled Mean	21.3043
Pooled Std Dev	41.5043
Background Mean	6.24
Background Std Dev	2.90517

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	25	21	84	156

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	6.24	2.90517	0	1887.5	75.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	26	20	76.9231	176
MW-3	26	15	57.6923	323
MW-4	26	21	80.7692	245
MW-5	26	17	65.3846	312
MW-6	26	13	50	891
MW-7	26	10	38.4615	1460
MW-8	26	9	34.6154	847

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	6.76923	3.55874	0.529231	10.8116	2095	80.5769
MW-3	12.4231	10.9879	6.18308	10.8116	2694.5	103.635
MW-4	9.42308	13.3841	3.18308	10.8116	2128.5	81.8654
MW-5	12	12.8125	5.76	10.8116	2512.5	96.6346
MW-6	34.2692	45.5786	28.0292	10.8116	3179.5	122.288
MW-7	56.1538	88.9826	49.9138	10.8116	3498	134.538
MW-8	32.5769	37.1302	26.3369	10.8116	3532.5	135.865

Analysis of Variance Statistics

SS Wells	58389.1
SS Total	354858

Kruskal-Wallis Statistics

Non-Detect Rank	63.5
Background Rank Sum	1887.5
Background Rank Mean	75.5
H Statistic	30.1191
H Adjusted for Ties	38.8895

Basic Statistics

Parameter: Arsenic, total

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
207	
Total Non-Detects	188
Pooled Mean	6.14734
Pooled Std Dev	4.63406
Background Mean	4.9
Background Std Dev	0.5

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	25	25	100	122.5

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	4.9	0.5	0	2362.5	94.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	26	18	69.2308	207
MW-3	26	25	96.1538	136
MW-4	26	26	100	130
MW-5	26	23	88.4615	190
MW-6	26	25	96.1538	138
MW-7	26	21	80.7692	214
MW-8	26	25	96.1538	135

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	7.96154	4.91919	3.06154	1.26417	3278	126.077
MW-3	5.23077	1.1767	0.330769	1.26417	2555.5	98.2885
MW-4	5	0	0.1	1.26417	2457	94.5
MW-5	7.30769	6.73955	2.40769	1.26417	2786.5	107.173
MW-6	5.30769	1.56893	0.407692	1.26417	2558.5	98.4038
MW-7	8.23077	9.35225	3.33077	1.26417	2976.5	114.481
MW-8	5.19231	0.980581	0.292308	1.26417	2553.5	98.2115

Analysis of Variance Statistics

SS Wells	370.448
SS Total	4423.76

Kruskal-Wallis Statistics

Non-Detect Rank	94.5
Background Rank Sum	2362.5
Background Rank Mean	94.5
H Statistic	6.3897
H Adjusted for Ties	25.4707

Basic Statistics

Parameter: Vanadium

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
207	
Total Non-Detects	158
Pooled Mean	54.058
Pooled Std Dev	123.387
Background Mean	20
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	25	25	100	500

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	20	0	0	1987.5	79.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	26	25	96.1538	553
MW-3	26	19	73.0769	1149
MW-4	26	25	96.1538	568
MW-5	26	15	57.6923	1319
MW-6	26	18	69.2308	1491
MW-7	26	12	46.1538	4511
MW-8	26	19	73.0769	1099

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	21.2692	6.47183	1.26923	32.4741	2155.5	82.9038
MW-3	44.1923	47.8289	24.1923	32.4741	2794.5	107.481
MW-4	21.8462	9.41357	1.84615	32.4741	2160.5	83.0962
MW-5	50.7308	57.5003	30.7308	32.4741	3128.5	120.327
MW-6	57.3462	88.3678	37.3462	32.4741	2907	111.808
MW-7	173.5	302.476	153.5	32.4741	3612	138.923
MW-8	42.2692	44.2959	22.2692	32.4741	2782.5	107.019

Analysis of Variance Statistics

SS Wells	461568
SS Total	3.13624e+006

Kruskal-Wallis Statistics

Non-Detect Rank	79.5
Background Rank Sum	1987.5
Background Rank Mean	79.5
H Statistic	21.9389
H Adjusted for Ties	39.5071

Basic Statistics

Parameter: Paradichlorobenzene

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
223	
Total Non-Detects	182
Pooled Mean	5.54395
Pooled Std Dev	7.66134
Background Mean	2.59259
Background Std Dev	0.481125

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	27	27	100	70

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	2.59259	0.481125	0	2470.5	91.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	28	26	92.8571	82.5
MW-3	28	28	100	72.5
MW-4	28	27	96.4286	79
MW-5	28	28	100	72.5
MW-6	28	11	39.2857	202.2
MW-7	28	28	100	72.5
MW-8	28	7	25	585.1

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	2.94643	1.37665	0.353836	1.29907	2754	98.3571
MW-3	2.58929	0.472456	-0.00330688	1.29907	2562	91.5
MW-4	2.82143	1.29967	0.228836	1.29907	2663.5	95.125
MW-5	2.58929	0.472456	-0.00330688	1.29907	2562	91.5
MW-6	7.22143	5.1668	4.62884	1.29907	4299.5	153.554
MW-7	2.58929	0.472456	-0.00330688	1.29907	2562	91.5
MW-8	20.8964	12.3911	18.3038	1.29907	5102.5	182.232

Analysis of Variance Statistics

SS Wells	8043.32
SS Total	13030.5

Kruskal-Wallis Statistics

Non-Detect Rank	91.5
Background Rank Sum	2470.5
Background Rank Mean	91.5
H Statistic	59.1668
H Adjusted for Ties	129.644

Basic Statistics

Parameter: Chlorobenzene

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

	Total Observations
215	
Total Non-Detects	152
Pooled Mean	6.93395
Pooled Std Dev	8.93597
Background Mean	2.5
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	26	26	100	65

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	2.5	0	0	1989	76.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-2	27	2	7.40741	467.5
MW-3	27	27	100	67.5
MW-4	27	26	96.2963	72.3
MW-5	27	27	100	67.5
MW-6	27	14	51.8519	148
MW-7	27	27	100	67.5
MW-8	27	3	11.1111	535.5

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-2	17.3148	9.56048	14.8148	1.60198	4813	178.259
MW-3	2.5	0	0	1.60198	2065.5	76.5
MW-4	2.67778	0.92376	0.177778	1.60198	2148	79.5556
MW-5	2.5	0	0	1.60198	2065.5	76.5
MW-6	5.48148	3.4795	2.98148	1.60198	3221	119.296
MW-7	2.5	0	0	1.60198	2065.5	76.5
MW-8	19.8333	12.8944	17.3333	1.60198	4852.5	179.722

Analysis of Variance Statistics

SS Wells	10051.9
SS Total	17088.2

Kruskal-Wallis Statistics

Non-Detect Rank	76.5
Background Rank Sum	1989
Background Rank Mean	76.5
H Statistic	104.298
H Adjusted for Ties	161.29

Non-Parametric Tolerance Interval

Parameter: Chromium

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

Total Percent Non-Detects = 51.9481%
Background Samples (n) = 25
Maximum Background Concentration = 13
Minimum Coverage = 88.7%
Average Coverage = 96.1538%

Well	Sample	Result	Impacted
MW-7	9/8/1994	17	TRUE
MW-7	10/20/1994	ND<5	FALSE
MW-7	1/5/1995	ND<5	FALSE
MW-7	3/23/1995	ND<5	FALSE
MW-7	7/18/1995	10	FALSE
MW-7	2/20/1996	22	TRUE
MW-7	8/29/1996	49	TRUE
MW-7	2/4/1997	10	FALSE
MW-7	8/27/1997	100	TRUE
MW-7	2/11/1998	60	TRUE
MW-7	9/2/1998	117	TRUE
MW-7	2/22/1999	31	TRUE
MW-7	8/24/1999	ND<5	FALSE
MW-7	2/10/2000	ND<5	FALSE
MW-7	8/2/2000	350	TRUE
MW-7	2/8/2001	ND<5	FALSE
MW-7	8/9/2001	52	TRUE
MW-7	2/14/2002	ND<5	FALSE
MW-7	8/22/2002	ND<5	FALSE
MW-7	2/5/2003	299	TRUE
MW-7	8/14/2003	ND<5	FALSE
MW-7	2/19/2004	ND<5	FALSE
MW-7	8/25/2004	72	TRUE
MW-7	2/21/2005	163	TRUE
MW-7	8/8/2005	32	TRUE
MW-7	2/23/2006	26	TRUE
MW-8	9/8/1994	15	TRUE
MW-8	10/20/1994	ND<5	FALSE
MW-8	1/5/1995	ND<5	FALSE
MW-8	3/23/1995	ND<5	FALSE
MW-8	7/18/1995	17	TRUE
MW-8	2/20/1996	25	TRUE
MW-8	8/29/1996	72	TRUE
MW-8	2/4/1997	ND<5	FALSE
MW-8	8/27/1997	38	TRUE
MW-8	2/11/1998	33	TRUE
MW-8	9/2/1998	38	TRUE
MW-8	2/22/1999	ND<5	FALSE
MW-8	8/24/1999	101	TRUE
MW-8	2/10/2000	ND<5	FALSE
MW-8	8/2/2000	140	TRUE
MW-8	2/8/2001	ND<5	FALSE
MW-8	8/9/2001	ND<5	FALSE
MW-8	2/14/2002	ND<5	FALSE
MW-8	8/22/2002	66	TRUE
MW-8	2/5/2003	117	TRUE

MW-8	8/14/2003	24	TRUE
MW-8	2/19/2004	27	TRUE
MW-8	8/25/2004	26	TRUE
MW-8	2/21/2005	37	TRUE
MW-8	8/8/2005	13	FALSE
MW-8	2/23/2006	13	FALSE

Interwell Analyses for Metals

Poisson Tolerance Limit

Parameter: Cadmium

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

Poisson Count of 25 background Samples = 25
Degrees of Freedom = 52

95% Confidence Values

Chi-Squared Value (95% Confidence) = 69.8322
Lambda (from Zack's formula) = 1.39664
Smallest Degrees of Freedom = 9
Upper Tolerance Limit (95%) = 3.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 78.6156
Lambda (from Zack's formula) = 1.57231
Smallest Degrees of Freedom = 12
Upper Tolerance Limit (99%) = 5

	Date	Result	Impacted 95%	Impacted 99%
MW-5	9/8/1994	7	TRUE	TRUE
	10/20/1994	4	TRUE	FALSE
	1/5/1995	ND<1	FALSE	FALSE
	3/23/1995	1	FALSE	FALSE
	7/18/1995	16	TRUE	TRUE
	2/20/1996	2	FALSE	FALSE
	8/29/1996	ND<1	FALSE	FALSE
	2/4/1997	1	FALSE	FALSE
	8/27/1997	3	FALSE	FALSE
	2/11/1998	1.4	FALSE	FALSE
	9/2/1998	ND<1	FALSE	FALSE
	2/22/1999	ND<1	FALSE	FALSE
	8/24/1999	ND<1	FALSE	FALSE
	2/10/2000	ND<1	FALSE	FALSE
	8/2/2000	ND<1	FALSE	FALSE
	2/8/2001	ND<1	FALSE	FALSE
	8/9/2001	ND<1	FALSE	FALSE
	2/14/2002	1	FALSE	FALSE
	8/22/2002	ND<1	FALSE	FALSE
	2/5/2003	4	TRUE	FALSE
	8/14/2003	2	FALSE	FALSE
	2/19/2004	ND<1	FALSE	FALSE
	8/25/2004	3	FALSE	FALSE
	2/21/2005	ND<1	FALSE	FALSE
	8/8/2005	3	FALSE	FALSE
	2/23/2006	1	FALSE	FALSE
MW-6	9/8/1994	ND<1	FALSE	FALSE
	10/20/1994	ND<1	FALSE	FALSE
	1/5/1995	ND<1	FALSE	FALSE
	3/23/1995	ND<1	FALSE	FALSE
	7/18/1995	ND<1	FALSE	FALSE
	2/20/1996	ND<1	FALSE	FALSE
	8/29/1996	1	FALSE	FALSE
	2/4/1997	ND<1	FALSE	FALSE
	8/27/1997	ND<1	FALSE	FALSE
	2/11/1998	ND<1	FALSE	FALSE
	9/2/1998	ND<1	FALSE	FALSE
	2/22/1999	ND<1	FALSE	FALSE

8/24/1999	ND<1	FALSE	FALSE
2/10/2000	ND<1	FALSE	FALSE
8/2/2000	ND<1	FALSE	FALSE
2/8/2001	ND<1	FALSE	FALSE
8/9/2001	ND<1	FALSE	FALSE
2/14/2002	ND<1	FALSE	FALSE
8/22/2002	ND<1	FALSE	FALSE
2/5/2003	ND<1	FALSE	FALSE
8/14/2003	ND<1	FALSE	FALSE
2/19/2004	ND<1	FALSE	FALSE
8/25/2004	1	FALSE	FALSE
2/21/2005	4	TRUE	FALSE
8/8/2005	ND<1	FALSE	FALSE
2/23/2006	2	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Arsenic, total

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

Poisson Count of 25 background Samples = 245
Degrees of Freedom = 492

95% Confidence Values

Chi-Squared Value (95% Confidence) = 544.709
Lambda (from Zack's formula) = 10.8942
Smallest Degrees of Freedom = 35
Upper Tolerance Limit (95%) = 16.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 567.901
Lambda (from Zack's formula) = 11.358
Smallest Degrees of Freedom = 41
Upper Tolerance Limit (99%) = 19.5

	Date	Result	Impacted 95%	Impacted 99%
MW-2	9/8/1994	ND<10	FALSE	FALSE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	ND<10	FALSE	FALSE
	2/20/1996	ND<10	FALSE	FALSE
	8/29/1996	ND<10	FALSE	FALSE
	2/4/1997	ND<10	FALSE	FALSE
	8/27/1997	ND<10	FALSE	FALSE
	2/11/1998	11	FALSE	FALSE
	9/2/1998	14	FALSE	FALSE
	2/22/1999	ND<10	FALSE	FALSE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	10	FALSE	FALSE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	ND<10	FALSE	FALSE
	2/14/2002	ND<10	FALSE	FALSE
	8/22/2002	21	TRUE	TRUE
	2/5/2003	17	TRUE	FALSE
	8/14/2003	ND<10	FALSE	FALSE
	2/19/2004	ND<10	FALSE	FALSE
	8/25/2004	16	FALSE	FALSE
	2/21/2005	ND<10	FALSE	FALSE
	8/8/2005	16	FALSE	FALSE
	2/23/2006	12	FALSE	FALSE
MW-7	9/8/1994	ND<10	FALSE	FALSE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	ND<10	FALSE	FALSE
	2/20/1996	ND<10	FALSE	FALSE
	8/29/1996	ND<10	FALSE	FALSE
	2/4/1997	ND<10	FALSE	FALSE
	8/27/1997	ND<10	FALSE	FALSE
	2/11/1998	10	FALSE	FALSE
	9/2/1998	11	FALSE	FALSE
	2/22/1999	ND<10	FALSE	FALSE

	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	13	FALSE	FALSE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	ND<10	FALSE	FALSE
	2/14/2002	ND<10	FALSE	FALSE
	8/22/2002	ND<10	FALSE	FALSE
	2/5/2003	ND<10	FALSE	FALSE
	8/14/2003	ND<10	FALSE	FALSE
	2/19/2004	ND<10	FALSE	FALSE
	8/25/2004	ND<10	FALSE	FALSE
	2/21/2005	ND<10	FALSE	FALSE
	8/8/2005	27	TRUE	TRUE
	2/23/2006	48	TRUE	TRUE
MW-8	9/8/1994	ND<10	FALSE	FALSE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	ND<10	FALSE	FALSE
	2/20/1996	ND<10	FALSE	FALSE
	8/29/1996	ND<10	FALSE	FALSE
	2/4/1997	ND<10	FALSE	FALSE
	8/27/1997	ND<10	FALSE	FALSE
	2/11/1998	ND<10	FALSE	FALSE
	9/2/1998	ND<10	FALSE	FALSE
	2/22/1999	ND<10	FALSE	FALSE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	ND<10	FALSE	FALSE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	ND<10	FALSE	FALSE
	2/14/2002	ND<10	FALSE	FALSE
	8/22/2002	ND<10	FALSE	FALSE
	2/5/2003	ND<10	FALSE	FALSE
	8/14/2003	ND<10	FALSE	FALSE
	2/19/2004	ND<10	FALSE	FALSE
	8/25/2004	ND<10	FALSE	FALSE
	2/21/2005	ND<10	FALSE	FALSE
	8/8/2005	ND<10	FALSE	FALSE
	2/23/2006	10	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Lead

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

Poisson Count of 25 background Samples = 245
Degrees of Freedom = 492

95% Confidence Values

Chi-Squared Value (95% Confidence) = 544.709
Lambda (from Zack's formula) = 10.8942
Smallest Degrees of Freedom = 35
Upper Tolerance Limit (95%) = 16.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 567.901
Lambda (from Zack's formula) = 11.358
Smallest Degrees of Freedom = 41
Upper Tolerance Limit (99%) = 19.5

	Date	Result	Impacted 95%	Impacted 99%
MW-7	9/8/1994	44	TRUE	TRUE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	ND<10	FALSE	FALSE
	2/20/1996	11	FALSE	FALSE
	8/29/1996	43	TRUE	TRUE
	2/4/1997	ND<10	FALSE	FALSE
	8/27/1997	79	TRUE	TRUE
	2/11/1998	31	TRUE	TRUE
	9/2/1998	48	TRUE	TRUE
	2/22/1999	31	TRUE	TRUE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	66	TRUE	TRUE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	23	TRUE	TRUE
	2/14/2002	ND<10	FALSE	FALSE
	8/22/2002	ND<10	FALSE	FALSE
	2/5/2003	68	TRUE	TRUE
	8/14/2003	ND<10	FALSE	FALSE
	2/19/2004	ND<10	FALSE	FALSE
	8/25/2004	23	TRUE	TRUE
	2/21/2005	41	TRUE	TRUE
	8/8/2005	60	TRUE	TRUE
	2/23/2006	42	TRUE	TRUE
MW-8	9/8/1994	147	TRUE	TRUE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	12	FALSE	FALSE
	2/20/1996	12	FALSE	FALSE
	8/29/1996	29	TRUE	TRUE
	2/4/1997	ND<10	FALSE	FALSE
	8/27/1997	25	TRUE	TRUE
	2/11/1998	14	FALSE	FALSE
	9/2/1998	11	FALSE	FALSE
	2/22/1999	ND<10	FALSE	FALSE

8/24/1999	19	TRUE	FALSE
2/10/2000	ND<10	FALSE	FALSE
8/2/2000	31	TRUE	TRUE
2/8/2001	ND<10	FALSE	FALSE
8/9/2001	21	TRUE	TRUE
2/14/2002	ND<10	FALSE	FALSE
8/22/2002	24	TRUE	TRUE
2/5/2003	33	TRUE	TRUE
8/14/2003	ND<10	FALSE	FALSE
2/19/2004	ND<10	FALSE	FALSE
8/25/2004	11	FALSE	FALSE
2/21/2005	14	FALSE	FALSE
8/8/2005	ND<10	FALSE	FALSE
2/23/2006	12	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Vanadium

Natural Logarithm Transformation
Non-Detects Replaced with Detection Limit

Poisson Count of 25 background Samples = 92.222
Degrees of Freedom = 186

95% Confidence Values

Chi-Squared Value (95% Confidence) = 218.82
Lambda (from Zack's formula) = 4.37641
Smallest Degrees of Freedom = 18
Upper Tolerance Limit (95%) = 8

99% Confidence Values

Chi-Squared Value (99% Confidence) = 233.786
Lambda (from Zack's formula) = 4.67572
Smallest Degrees of Freedom = 22
Upper Tolerance Limit (99%) = 10

	Date	Result	Impacted 95%	Impacted 99%
MW-7	9/8/1994	4.04305	FALSE	FALSE
	10/20/1994	ND<3.68888	FALSE	FALSE
	1/5/1995	ND<3.68888	FALSE	FALSE
	3/23/1995	ND<3.68888	FALSE	FALSE
	7/18/1995	ND<3.68888	FALSE	FALSE
	2/20/1996	3.68888	FALSE	FALSE
	8/29/1996	5.05625	FALSE	FALSE
	2/4/1997	ND<3.68888	FALSE	FALSE
	8/27/1997	5.03695	FALSE	FALSE
	2/11/1998	5.0876	FALSE	FALSE
	9/2/1998	5.50533	FALSE	FALSE
	2/22/1999	3.73767	FALSE	FALSE
	8/24/1999	ND<3.68888	FALSE	FALSE
	2/10/2000	ND<3.68888	FALSE	FALSE
	8/2/2000	6.95368	FALSE	FALSE
	2/8/2001	ND<3.68888	FALSE	FALSE
	8/9/2001	4.64439	FALSE	FALSE
	2/14/2002	ND<3.68888	FALSE	FALSE
	8/22/2002	ND<3.68888	FALSE	FALSE
	2/5/2003	7.05962	FALSE	FALSE
	8/14/2003	ND<3.68888	FALSE	FALSE
	2/19/2004	ND<3.68888	FALSE	FALSE
	8/25/2004	5.55683	FALSE	FALSE
	2/21/2005	6.40688	FALSE	FALSE
	8/8/2005	4.72739	FALSE	FALSE
	2/23/2006	4.78749	FALSE	FALSE