THE BENEFICIAL USE OF BIOSOLIDS FROM THE CITY OF GRAND RAPIDS: A THIRD-YEAR ASSESSMENT OF ITS IMPACT ON SHALLOW SOIL WATER

by

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INTRODUCTION

This report, which presents the results of the third year of a three-year study, is part of a project sponsored by the City of Grand Rapids at the North Central Experiment Station (NCES) on the beneficial re-use of biosolids. The project was coordinated by the NCES, with technical assistance provided by the Natural Resources Research Institute (NRRI). The overall purpose of the project is to determine if biosolids can be used in a beneficial manner, alone, or in combination with wood ash, in reforestation practices in northern Minnesota. The purpose of this portion of the project is to evaluate the impact of applying biosolids, with and without wood ash, on shallow soil water in the unsaturated zone of a newly reforested area.

Biosolids from the City of Grand Rapids were applied by NCES staff on research plots planted with various tree seedlings in the summer of 1995. The biosolids were applied at two rates, 15 and 30 ton/acre, with and without wood ash applied at a single rate of 10 ton/acre. This report presents the results from the third year of the study of soil water monitoring during the summer/fall of 1997. Annual reports were prepared in 1996 (McCarthy and Monson Geerts 1996) and 1997 (McCarthy and Monson Geerts 1997) that summarized the data from the first two years of the project.

METHODS

The research site is located near the NCES. After the site was clear-cut, biosolids and wood ash were applied, tree seedlings were planted, and piezometers and lysimeters were installed in 1995.

Eighteen suction-cup lysimeters were installed in July 1995 to monitor subsurface water quality. A few lysimeters were replaced in 1996 and 1997. The lysimeters were fabricated at NRRI using porous ceramic cups, Schedule 20 PVC pipe, stoppers, tubing, and clamps. The lysimeters were installed on the six plots located in Replication 2, as shown in Figure 1. Three lysimeters were installed at the same depth on each plot.

The lysimeters were installed in boreholes using a 3 1/4-inch auger that terminated at a depth of 24 inches. A schematic of the lysimeters is shown in Figure 2. Approximately 4 inches of a silica flour slurry was placed in the bottom of each borehole, and the porous ceramic cup was embedded into the slurry. The borehole was backfilled with native soil, in lifts of 4-6 inches, and compacted using a small diameter rod. Each lysimeter terminated at a depth of 6 inches below the soil surface.

Two piezometers were installed on plot 3 and plot 5, in replication 2, as shown in Figure 1. Piezometers were used to determine depth to the water table when lysimeters were sampled in both 1995 and 1996. Piezometer 1 (P-1) was installed in a borehole 90 inches deep. The screened length is 24 inches, as shown in Figure 3. Piezometer 2 (P-2) was installed in a borehole 67 inches deep, with a screened length of 18 inches, as shown in Figure 4.

In 1997, water samples were collected from lysimeters during the months of June, July, September, and October, for a total of four sampling events. A peristaltic pump was used to remove water samples from each lysimeter. After evacuating water from each lysimeter, the samples were analyzed in the field for temperature and specific conductance. The samples were then submitted to the University of Minnesota, Research Analytical Laboratory (RAL), for analysis of chloride, nitrogen (NO_3+NO_2 and NH_3), and the total concentrations of the following elements: aluminum (Al), boron

(B), calcium (Ca), cadmium (Cd), chromium (Cr), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), phosphorus (P), lead (Pb), and zinc (Zn) using Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry.

RESULTS & DISCUSSION

PIEZOMETER/GROUNDWATER MEASUREMENTS

The soils at the study site are outwash sands with a seasonal water table fairly close to the existing surface. The soils are loamy sands to sands with the topsoil layer 2-6 inches thick. The coloration of the soil (mottling) indicated that the seasonal high water table is 20-25 inches below the existing soil surface at the locations evaluated in the study area.

The actual depth to groundwater during the warmer months in 1995-1997 is shown in Table 1. The measurements indicate that the suction-cup lysimeters were generally 2-3 feet above the seasonal high water table at the time of sample collection.

Groundwater levels during the three years of observation were typically 4-6 feet below the surface at the time of sample collection. The measurements verify that the suction-cup lysimeters were drawing soil water samples from the unsaturated zone at the time of sample collection

LYSIMETER ANALYSES

The analytical results for specific conductance, chloride, sodium, nitrate-nitrogen, and ammonia-nitrogen in 1995-1997 are presented in Figures 5-9. The results (mean values) are shown for each of the six treatments, including: 1) the control, 2) biosolids at 15 ton/acre, 3) biosolids at 30 ton/acre, 4) wood ash at 10 ton/acre, 5) biosolids at 15 ton/acre and wood at 10 ton/acre, and 6) biosolids at 30 ton/acre and wood ash at 10 ton/acre. The horizontal scales for Figures 5-9 are identical to graphically compare the treatments. The mean values for specific conductance, chloride, sodium, nitrate-nitrogen, and ammonium-nitrogen in soil water are shown: 1) before the application of biosolids/wood ash (background conditions) in July 1995, 2) the first year after the application of treatments in 1995 (July, August, September, October), 3) the second year in 1996 (May, June, October, November), and 4) the third year in 1997 (June, July, September, October).

Specific conductivity is a measure of the ability of a solution to carry an electrical current and depends upon the concentration of ions in solution (including calcium, magnesium, sodium, potassium, sulfate) and temperature of the solution. The specific conductivity was generally low (Figure 5) during all three years of the study. The mean conductivity was typically less than 0.4 mS/cm. Slightly higher conductivity's were associated with the application of wood ash alone and wood ash in combination with biosolids. Slightly elevated conductivity's occurred with the application of biosolids (30 ton/acre) and wood ash in 1995, but the conductivity decreased to background levels in 1996 and 1997. The application of biosolids alone, at either rate, did not increase soil water conductivity as compared to the control during the three years of the study.

Chloride levels measured in soil water are presented in Figure 6. The Maximum Contaminant Level (MCL) for chloride in drinking water is 250 mg/l (Minnesota Department of Health, 1991). Background chloride levels (July 1995) in soil water for five of the six treatments were typically

higher as compared to chloride levels after treatments were applied in 1995, 1996, and 1997. Only a slight increase in chloride levels (25-30 mg/L) were observed with the application of biosolids at 30 ton/acre and wood ash at 10 ton/acre after applying these amendments in 1995. Overall, chloride levels in shallow soil water were negligible in 1996 and 1997.

Sodium concentrations in soil water are shown in Figure 7. Sodium is a cation that is readily mobile in the soil. Very low sodium levels were measured on five of the six treatments during the three years of the study. Higher sodium levels were associated with the application of biosolids at 30 ton/acre and wood ash at 10 ton/acre during the first year, but decreased in 1996 and 1997 to background levels.

The mean concentrations of nitrite + nitrate-nitrogen in soil water are presented in Figure 8. The drinking water standard for nitrate is 10 mg/l. Nitrate-nitrogen levels for most of the treatments were comparable to nitrogen levels in the control, except using biosolids at 15 ton/acre and wood ash at 10 ton/acre, where slightly elevated nitrate levels were measured during the first growing season. The influence of clear-cutting on the release of nitrogen from both plant litter and soil organic matter may be of more significance than the contribution from biosolids applied at this location. Natural soil variability can account for differences in nitrate levels within the same field, depending upon organic matter content and environmental factors. By the third year of the study, nitrate-nitrogen decreased to negligible levels for all six treatments.

Ammonia-nitrogen levels in soil water are shown in Figure 9. The analysis for ammonia-nitrogen was added in 1996. The detection limit for ammonia-nitrogen was 0.02 mg/l. Ammonia-nitrogen levels were low for all treatments, generally less than the detection limit for ammonia-nitrogen during the three years of the study.

ICP ANALYSIS

The analytical data report for the remaining soil water constituents analyzed in the 1997 study (aluminum, boron, calcium, cadmium, chromium, copper, iron, potassium, magnesium, manganese, nickel, phosphorus, lead, and zinc via ICP analysis) is included in Appendix A.

Many of the other elements of concern in drinking water supplies (i.e., Cd, Cr, Cu, Pb, Ni, and Zn), related to land application of biosolids, were less than the detection limit, including cadmium (Cd), chromium (Cr), and lead (Pb). Both copper (Cu) and nickel (Ni) were generally less than their respective detection limits. Zinc (Zn) levels were low, generally below 0.1 mg/l. Boron (B) levels were typically less than the MCL/RAL for drinking water supplies of 0.3 mg/l for boron in 1997, with the exception of the plot amended with biosolids at 30 ton/acre and wood ash at 10 ton/acre, where boron was just above the limit at 0.4-0.5 mg/l.

CONCLUSIONS

The three-year assessment indicates that the land application of biosolids and wood ash, at the rates included in the study, had very minimal impact on soil water at ~2 feet below the surface. Biosolids applied at 15 ton/acre and at 30 ton/acre did not impact the quality of soil water at ~2 feet in either 1995, 1996, or 1997.

Shallow soil water in the unsaturated zone did have levels of boron that exceeded the MCL/RAL for drinking water on the plot amended with wood ash at 10 ton/acre and biosolids at 30 ton/acre. Overall, the plots that received wood ash generally had higher boron levels in shallow soil water as compared to the control or biosolids plots.

Overall, there were no negative impacts on soil water quality in the unsaturated zone from the land application of biosolids and wood ash used in a forest application.

LITERATURE CITED

McCarthy, B. and S. Monson Geerts. 1996. The Beneficial Use of Biosolids from the City of Grand Rapids: A Preliminary Assessment of its Impact on Shallow Soil Water. April 1996.

McCarthy, B. and S. Monson Geerts. 1997. The Beneficial Use of Biosolids from the City of Grand Rapids: A Second-Year Assessment of its Impact on Shallow Soil Water. NRRI Technical Report Number NRRI/TR-97/04.

Minnesota Department of Health. 1991. In Recommended Allowable Limits for Drinking Water Contaminants. Release No. 3. p. 1-19.

Table 1.--Depth to groundwater during the growing season in 1995-1997.

Date in 1995	Piezometer P-1 (inches)	Piezometer P-2 (inches)
July 10, 1995	57	41
July 19, 1995	57	43
August 21, 1995	64	54
September 21, 1995	71	66
October 31, 1995	61	51

Date in 1996	Piezometer P-1 (inches)	Piezometer P-2 (inches)
May 28, 1996	52	49
June 28, 1996	51	47
September 13, 1996	60	63
October 18, 1996	64	60
November 4, 1996	59	52

Date in 1997	Piezometer P-1 (inches)	Piezometer P-2 (inches)
June 26, 1997	53	49
July 21, 1997	49	49
September 22, 1997	59	63
October 28, 1997	60	60

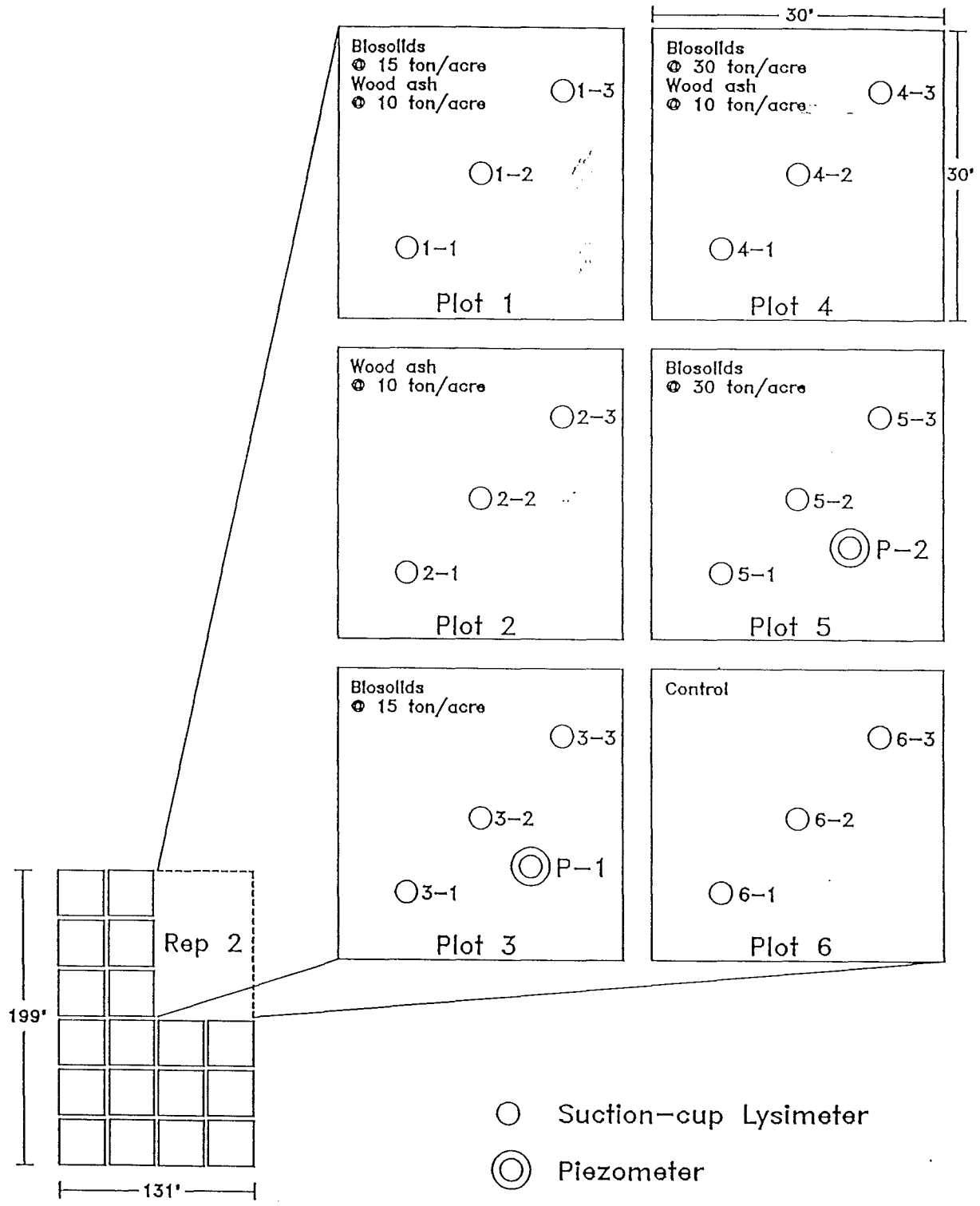

Figure 1. Plot plan for landspreading biosolids and wood ash on forest land.

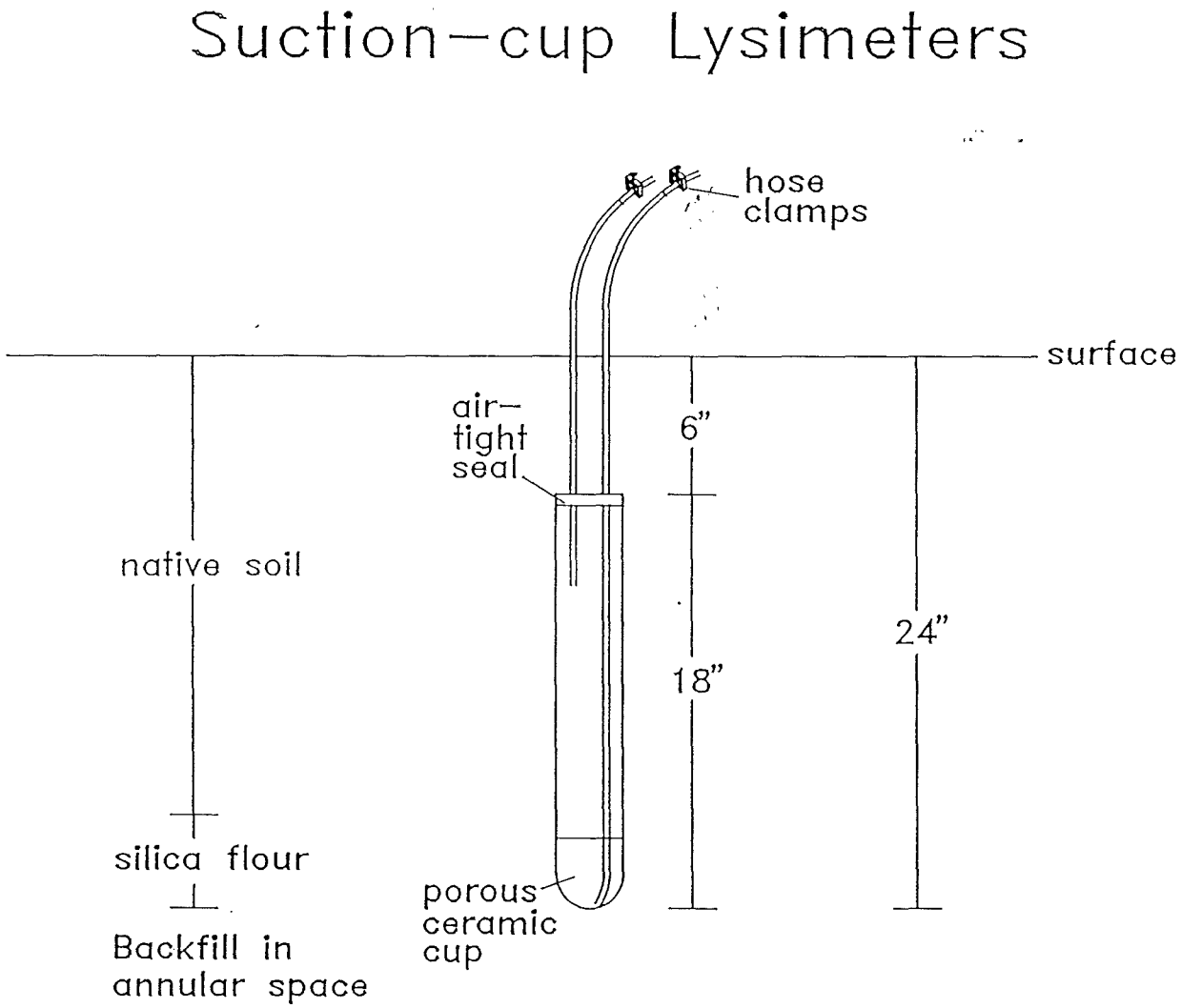

Figure 2. Lysimeter installation detail drawing for the Grand Rapids biosolids research project.

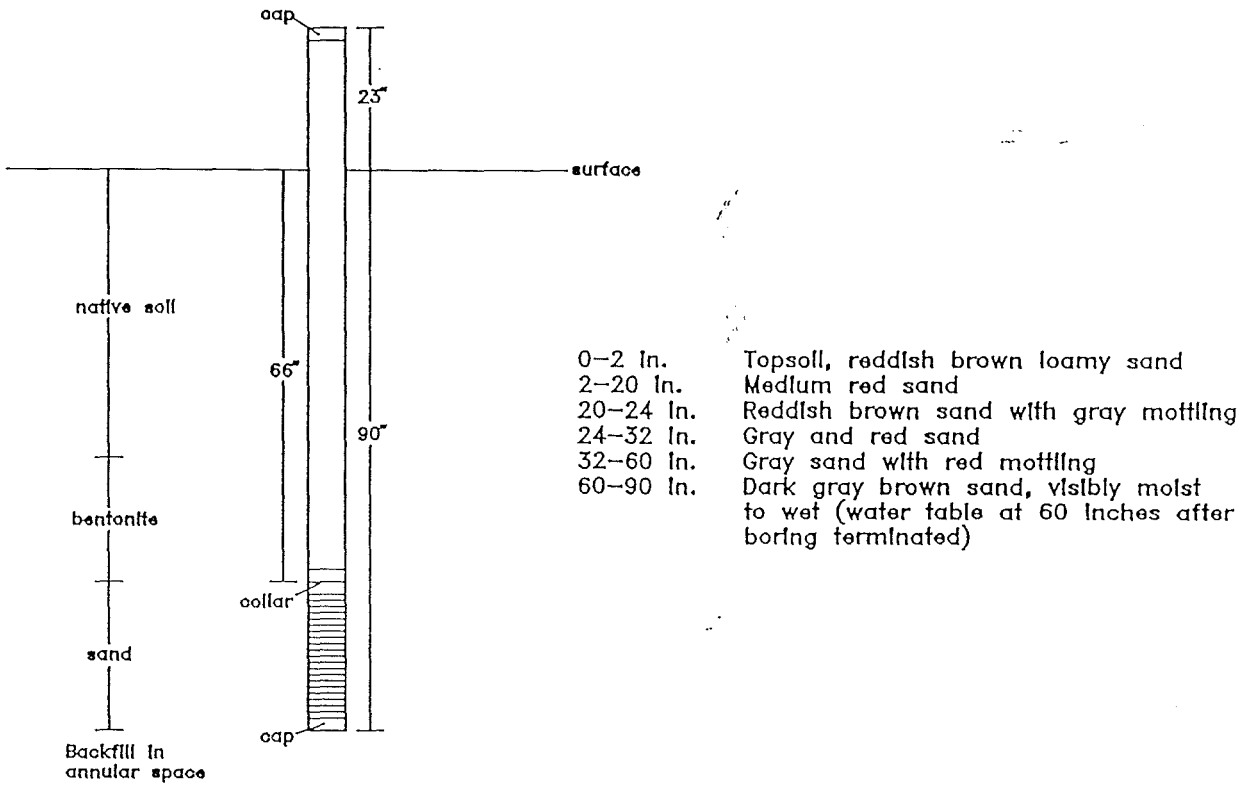

Figure 3. Piezometer 1 (P-1) construction details with associated soils information.

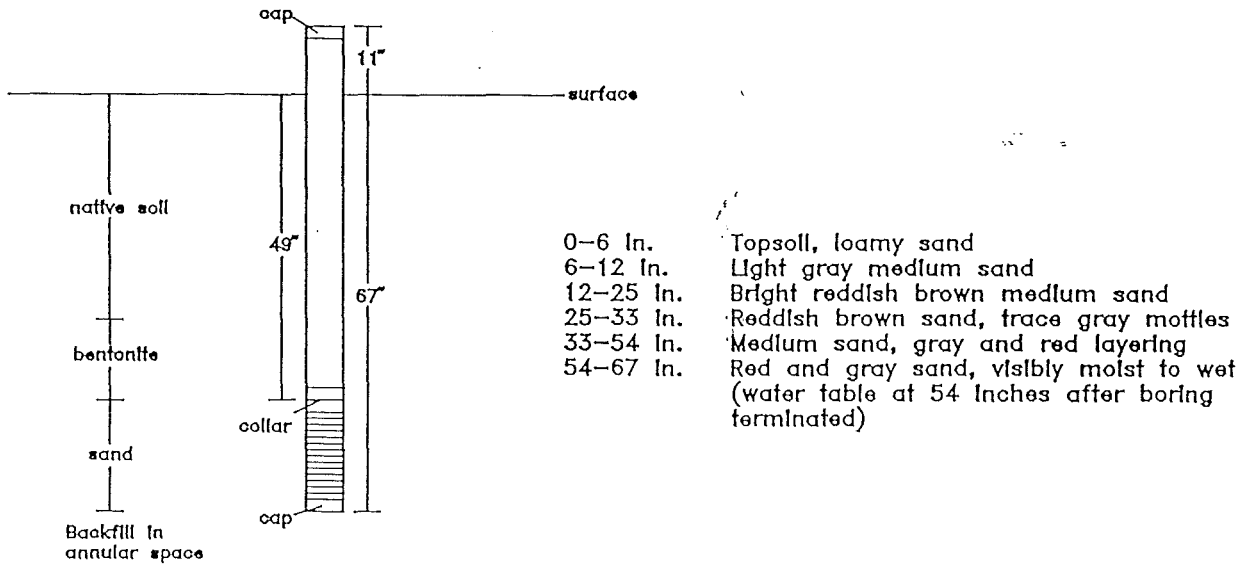

Figure 4. Piezometer 2 (P-2) construction details with associated soils information.

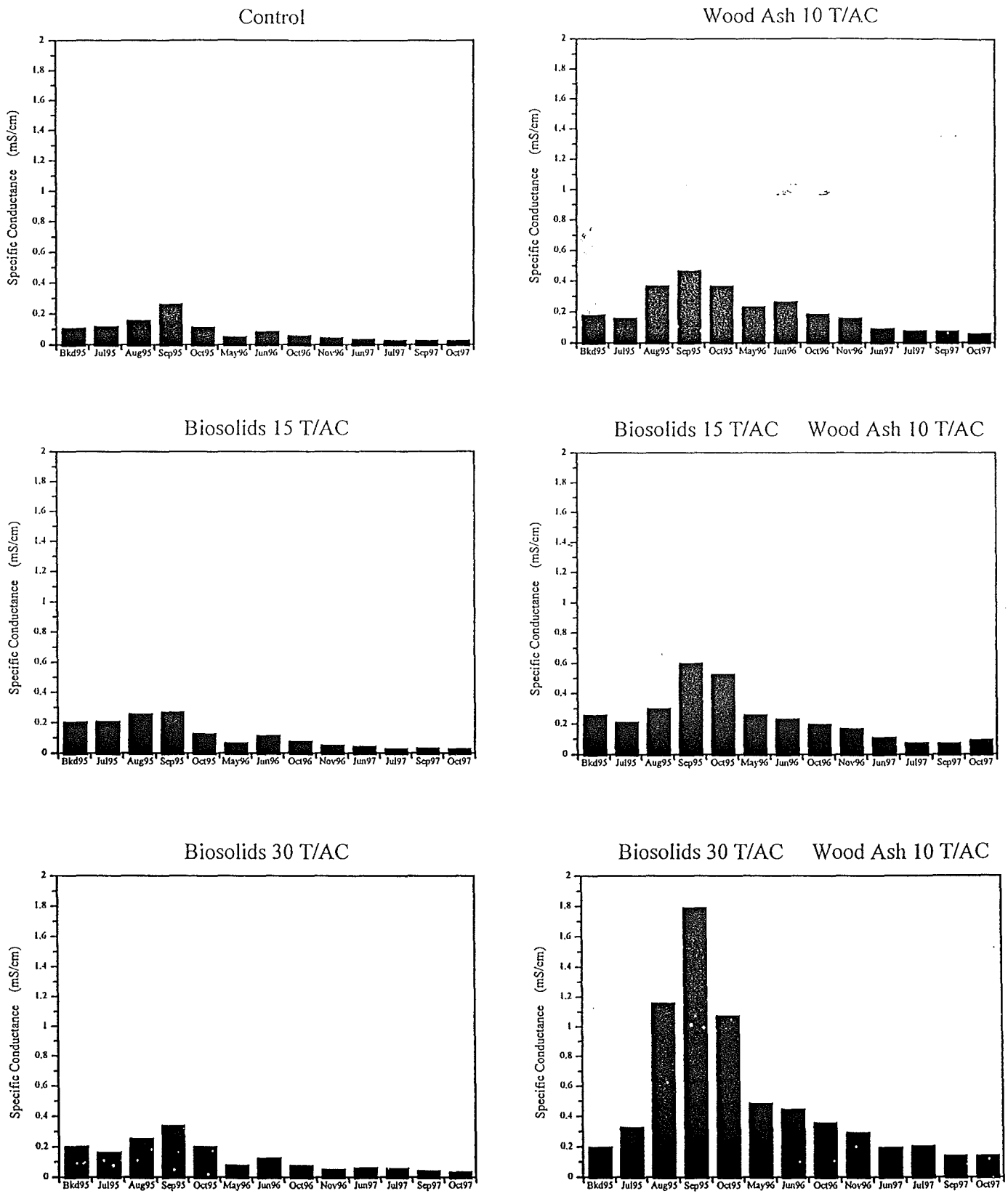

Figure 5. Mean specific conductance for treatments applied at the Grand Rapids biosolids/wood ash forestry project 1995-97.

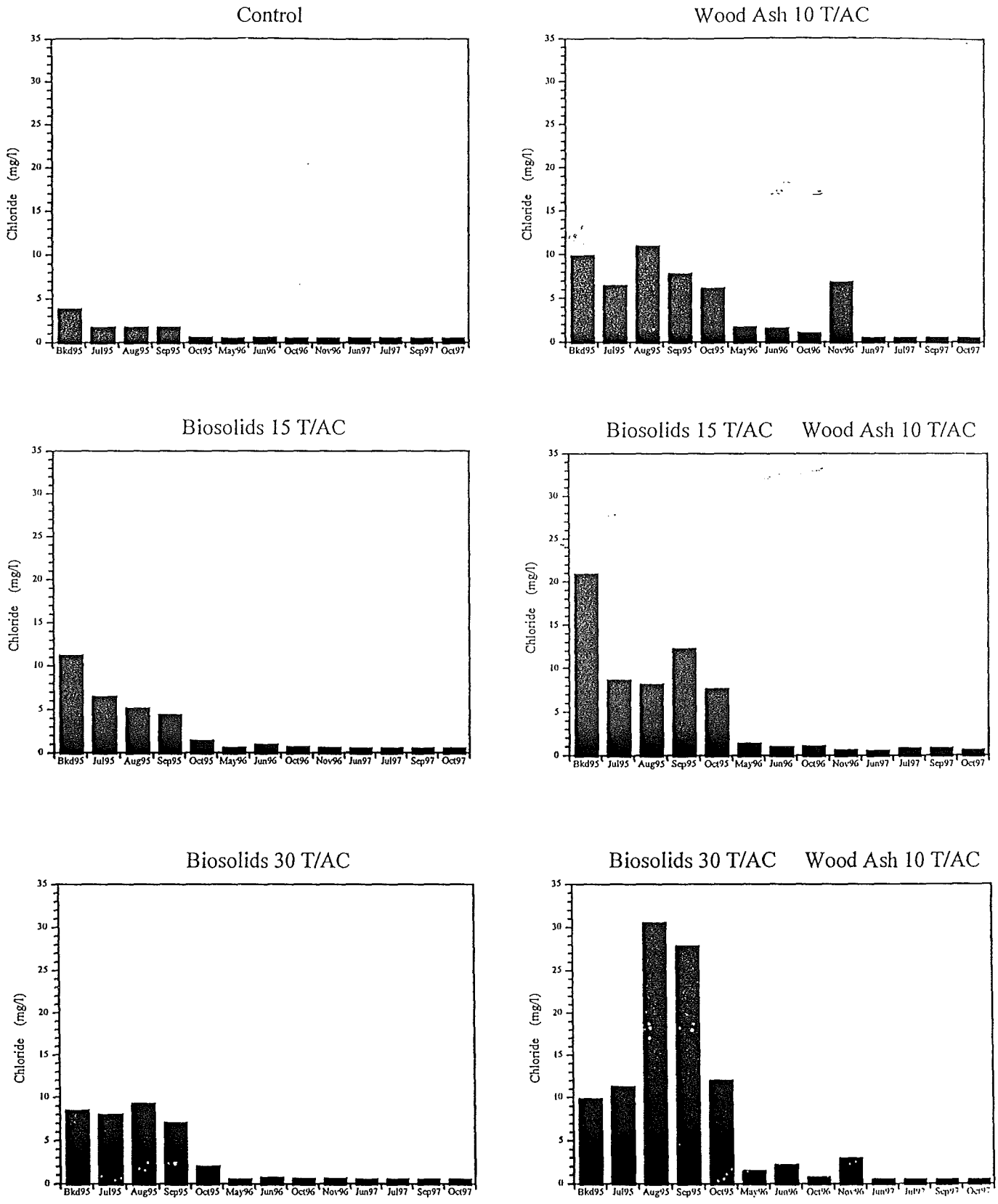

Figure 6. Mean chloride for treatments applied at the Grand Rapids biosolids/wood ash forestry project 1995-97. The maximum contaminant level (MCL) for chloride in drinking water is 250 mg/l.

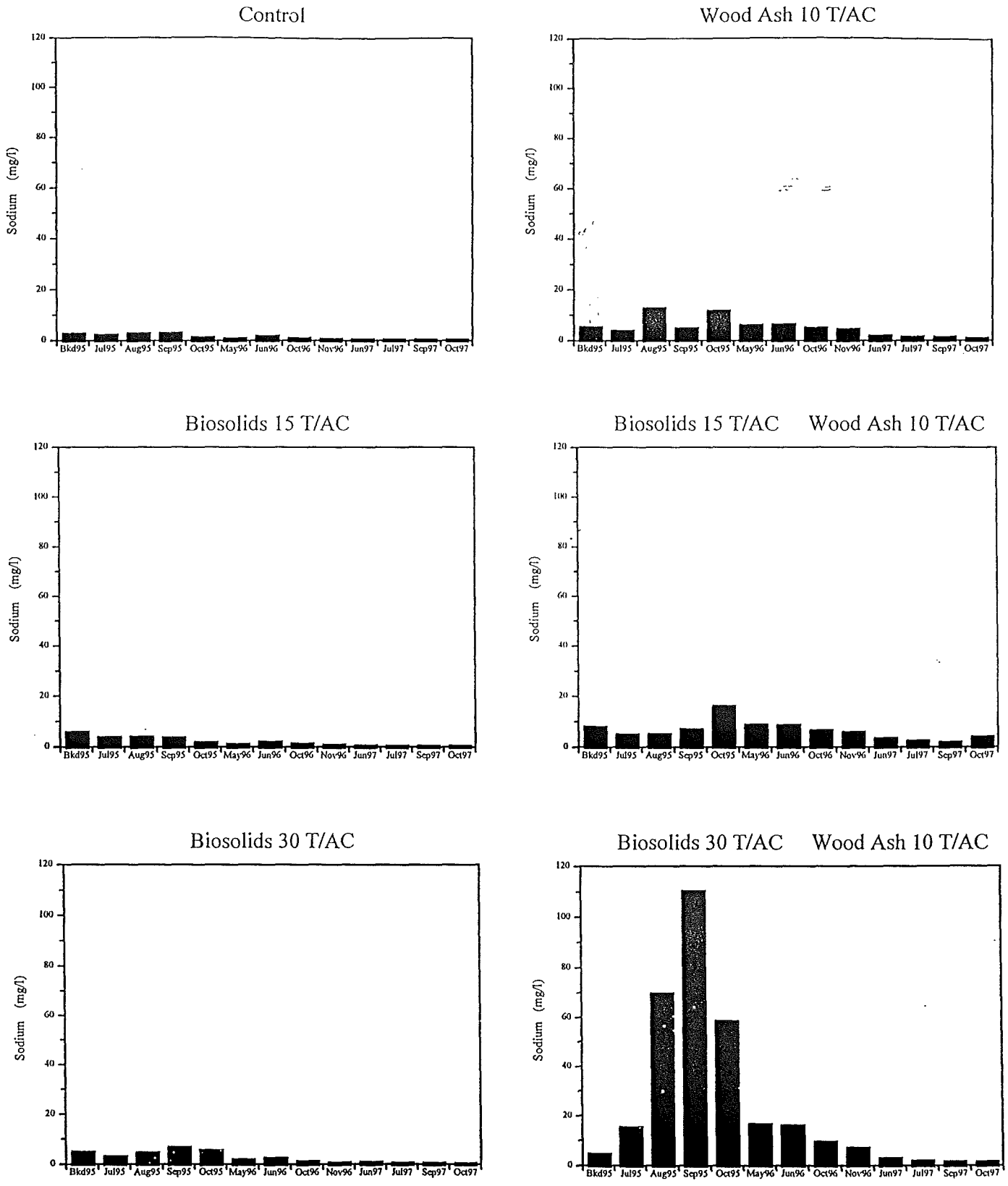

Figure 7. Mean sodium for treatments applied at the Grand Rapids biosolids/wood ash forestry project 1995-97.

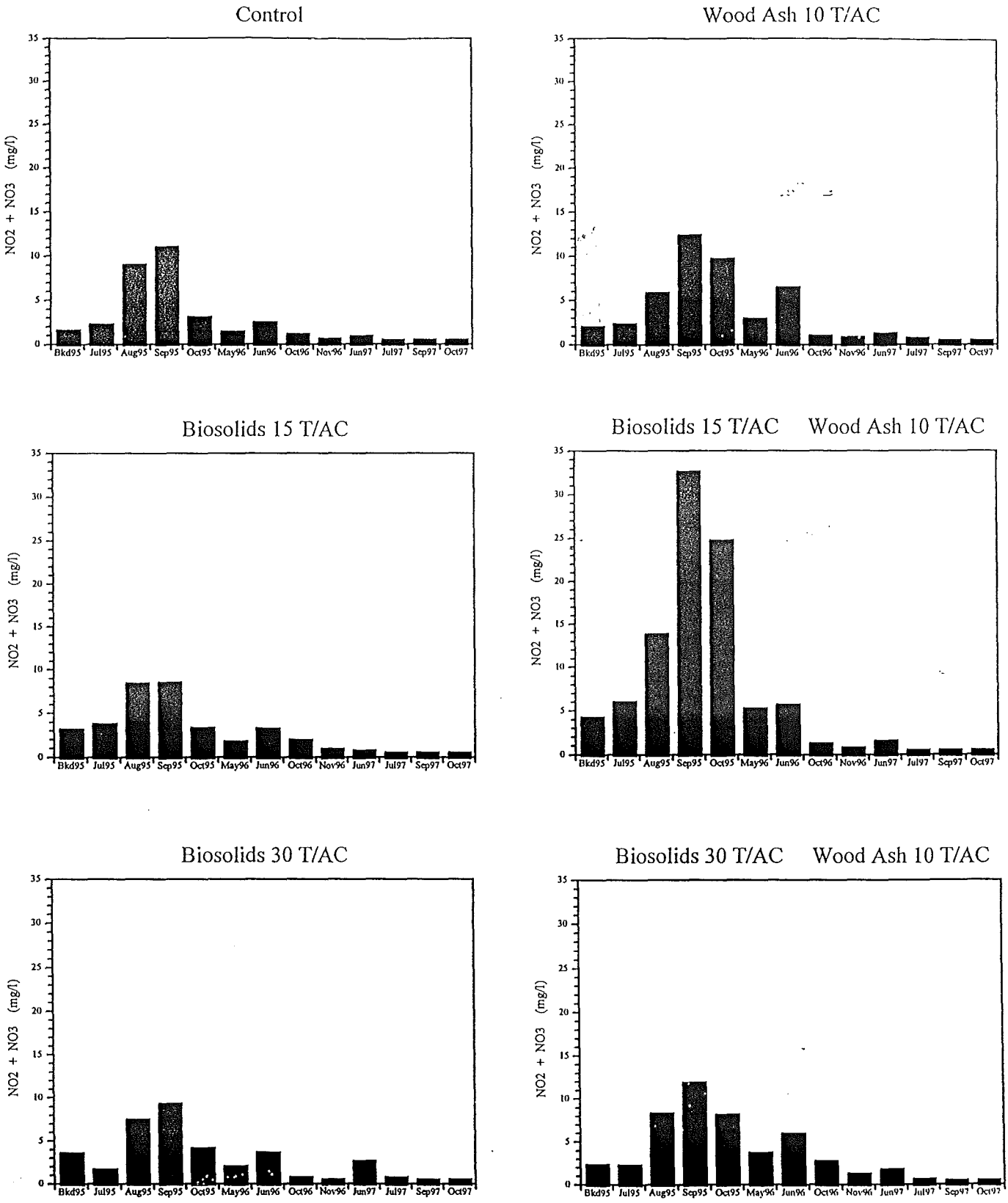

Figure 8. Mean $NO_2 + NO_3$ for treatments applied at the Grand Rapids biosolids/wood ash forestry project 1995-97.

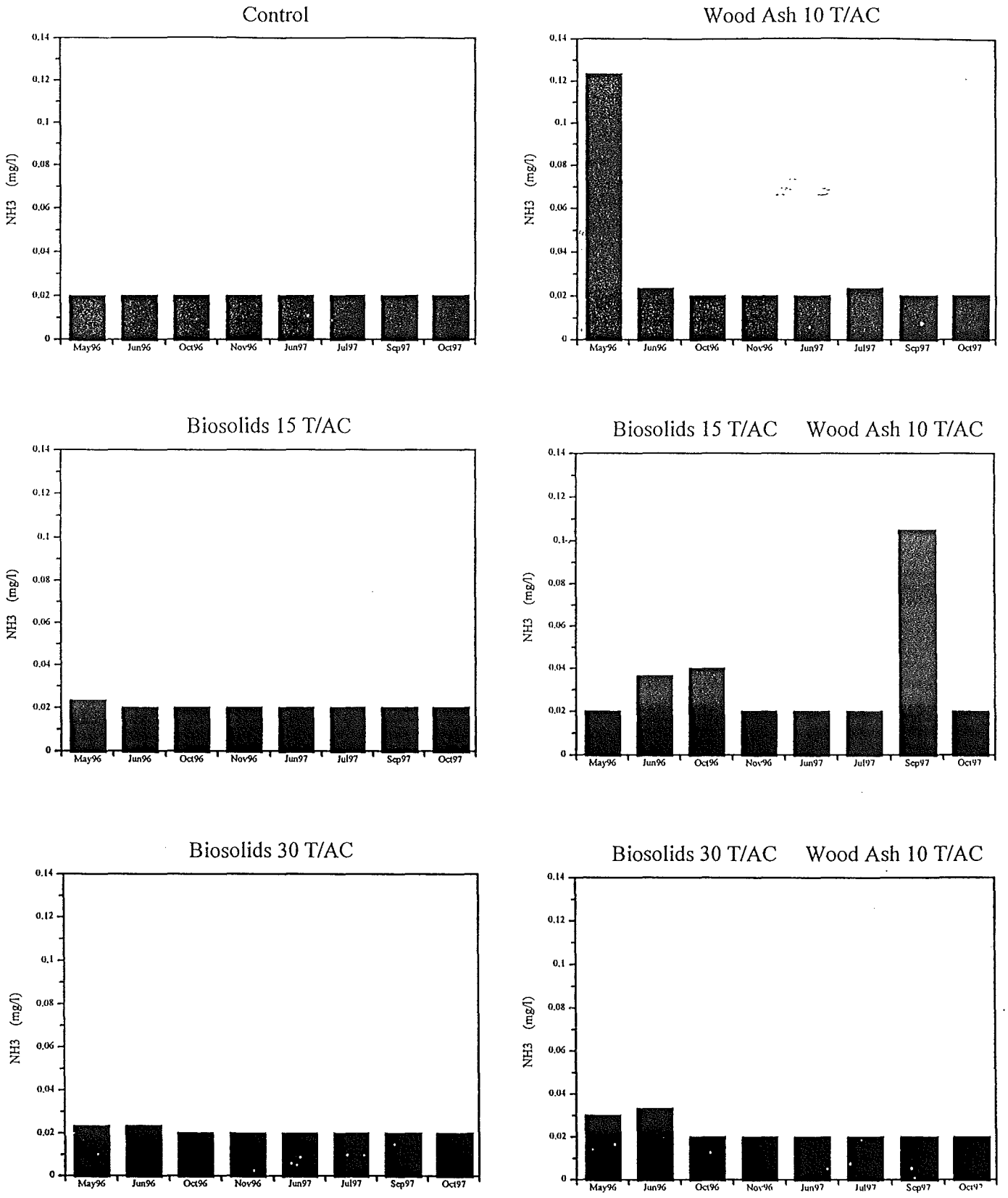

Figure 9. Mean NH_3 for treatments applied at the Grand Rapids biosolids/wood ash forestry project 1996-97. The detection limit for NH_3 is 0.02 mg/l.

Appendix A

Analytical Data Report 1995

Analytical Data Report 1996

Analytical Data Report 1997

Analytical Data Report

8/3/95

Prepared for:	Russ Mathison
Department:	North Central Expt. Sta.
Address:	5013 Miller Trunk Hwy.
	Grand Rapids, MN 55744
Phone:	218-327-4352
Name of Study:	Grand Rapids Sludge Project
Budget Number:	383-3500

Laboratory Group Number:	W4
Number of Samples:	36
Samples Received:	7/26/95
Samples Prepared:	7/27/95
Preparation:	1% HNO3
Samples Analyzed:	8/1/95
Instrumentation:	ARL 3560 ICP
Analyst:	RDA
Units Used in Report:	mg/l (ppm)

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Water Group #4, mg/l (ppm w/v) in the water

		P1	K	CA	MG	NA
1-1a		0.097	10.921	19.367	4.477	5.219
1-2a		0.111	8.107	44.597	9.763	14.896
1-3a		0.069	3.200	16.261	3.699	4.331
2-1a		0.045	3.335	15.726	3.837	5.196
2-2a		0.121	5.265	22.642	4.810	5.874
2-3a		0.050	2.642	19.817	4.226	5.129
3-1a		0.102	4.011	20.002	4.555	6.077
3-2a		0.157	3.656	20.764	4.483	5.014
3-3a		0.184	4.641	26.539	5.369	6.695
4-1a		0.095	4.020	20.779	5.176	4.566
1-1a	Dup	0.107	10.849	19.329	4.486	5.180
4-2a		0.105	3.525	22.755	6.013	5.095
4-3a		0.090	4.459	19.663	5.022	4.741
5-1a		0.088	2.098	22.816	5.874	5.314
5-2a		0.069	2.167	20.570	5.226	4.405
5-3a		0.065	3.127	20.476	5.448	4.939
6-1a		0.052	1.611	10.987	2.897	2.914
6-2a		0.061	1.827	14.238	3.123	2.937
6-3a		<0.035	1.828	6.488	1.991	2.857
1-1b		0.083	6.405	17.161	4.930	3.305
1-2b		0.065	4.696	29.065	7.867	8.846
4-2a	Dup	0.100	3.483	22.599	5.974	5.054
1-3b		0.052	2.880	13.254	3.864	2.810
2-1b		0.041	2.918	11.407	3.206	3.447
2-2b		0.082	3.736	19.198	5.148	3.736
2-3b		0.042	2.450	19.458	4.158	4.993
3-1b		0.060	4.349	15.336	4.714	4.605
3-2b		0.072	3.181	15.808	4.427	2.945
3-3b		0.086	5.168	27.546	8.566	4.243
4-1b		0.051	3.173	16.786	4.981	2.976
4-2b		<0.035	9.831	57.921	16.740	40.835
4-3b		<0.035	3.666	13.940	4.293	2.663
1-3b	Dup	<0.035	2.537	13.250	3.780	2.683
5-1b		0.047	1.909	17.950	5.581	3.548
5-2b		<0.035	3.790	16.865	5.253	2.889
5-3b		<0.035	2.917	15.915	4.987	3.014
6-1b		<0.035	1.079	9.043	2.463	2.138
6-2b		<0.035	1.170	13.022	3.229	2.161
6-3b		<0.035	1.261	5.801	1.579	2.898
5-1b	Dup	<0.035	1.715	17.963	5.556	3.512

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Water Group #4, mg/l (ppm w/v) in the water

		AL2	FE1	MN	ZN	CU
1-1a		<0.179	0.036	0.051	0.174	0.313
1-2a		<0.179	0.032	0.099	0.065	0.050
1-3a		<0.179	0.049	0.061	0.055	0.039
2-1a		<0.179	0.022	0.055	0.046	0.036
2-2a		0.215	0.039	0.069	0.084	0.092
2-3a		<0.179	0.019	0.023	0.081	0.069
3-1a		<0.179	0.087	0.128	0.101	0.048
3-2a		<0.179	0.025	0.049	0.038	0.048
3-3a		0.285	0.140	0.032	0.045	0.112
4-1a		<0.179	0.058	0.102	0.223	0.087
1-1a	Dup	<0.179	0.036	0.051	0.174	0.308
4-2a		<0.179	0.022	0.072	0.106	0.046
4-3a		0.221	0.055	0.091	0.074	0.046
5-1a		<0.179	0.025	0.055	0.113	0.049
5-2a		<0.179	0.165	0.143	0.164	0.074
5-3a		<0.179	0.873	0.417	0.146	<0.026
6-1a		<0.179	<0.017	0.024	0.065	0.074
6-2a		<0.179	0.020	0.029	0.040	<0.026
6-3a		0.188	0.069	0.043	0.037	0.028
1-1b		0.267	0.080	0.042	0.810	1.449
1-2b		<0.179	0.040	0.030	0.078	0.031
4-2a	Dup	<0.179	0.020	0.070	0.103	0.044
1-3b		0.228	0.056	0.029	0.079	<0.026
2-1b		<0.179	<0.017	0.028	0.051	<0.026
2-2b		0.233	0.034	0.041	0.076	0.035
2-3b		<0.179	<0.017	0.021	0.077	0.063
3-1b		<0.179	0.030	0.086	0.142	0.040
3-2b		0.280	0.047	0.014	0.110	0.065
3-3b		0.253	0.090	0.082	0.364	0.073
4-1b		0.193	0.041	0.050	0.163	0.038
4-2b		<0.179	<0.018	0.131	0.229	0.029
4-3b		<0.179	0.036	0.035	0.100	<0.026
1-3b	Dup	<0.179	0.046	0.029	0.075	<0.026
5-1b		<0.179	0.037	0.058	0.160	<0.026
5-2b		<0.179	0.042	0.106	0.168	0.056
5-3b		<0.179	0.555	0.352	0.130	<0.026
6-1b		<0.179	0.019	0.017	0.058	<0.026
6-2b		<0.179	0.052	0.021	0.079	<0.026
6-3b		<0.179	0.044	0.096	0.044	<0.026
5-1b	Dup	<0.179	0.036	0.056	0.158	<0.026

Date: 03-Aug-95 13:19:28 Page: 1.3

Water Group #4, mg/l (ppm w/v) in the water

		B	PB	NI	CR	CD
1-1a		0.046	<0.084	0.024	0.017	<0.006
1-2a		0.069	<0.084	0.036	0.016	<0.006
1-3a		0.049	<0.084	0.025	<0.014	<0.006
2-1a		0.044	<0.084	<0.022	<0.014	<0.006
2-2a		0.050	<0.084	<0.022	<0.014	<0.006
2-3a		0.052	<0.084	<0.023	<0.014	<0.006
3-1a		0.048	<0.084	0.028	<0.014	<0.006
3-2a		0.059	<0.084	0.026	<0.014	<0.006
3-3a		0.054	<0.084	0.024	<0.014	<0.006
4-1a		0.048	<0.084	<0.022	<0.014	<0.006
1-1a	Dup	0.045	<0.084	0.028	<0.014	<0.006
4-2a		0.050	<0.084	0.025	<0.014	<0.006
4-3a		0.058	<0.084	<0.022	<0.014	<0.006
5-1a		0.046	<0.084	0.025	<0.014	<0.006
5-2a		0.051	<0.084	0.036	<0.014	<0.006
5-3a		0.055	<0.084	0.047	<0.014	<0.006
6-1a		0.027	<0.084	<0.022	<0.014	<0.006
6-2a		0.032	<0.084	<0.022	<0.014	<0.006
6-3a		<0.023	<0.084	<0.022	<0.014	<0.006
1-1b		0.049	0.088	0.027	<0.014	<0.006
1-2b		0.055	<0.084	0.028	<0.014	<0.006
4-2a	Dup	0.048	<0.084	0.024	<0.014	<0.006
1-3b		0.043	<0.084	0.025	<0.014	<0.006
2-1b		0.043	<0.084	<0.022	<0.014	<0.006
2-2b		0.055	<0.084	0.023	<0.014	<0.006
2-3b		0.045	<0.084	<0.022	<0.014	<0.006
3-1b		0.060	<0.084	0.035	<0.014	<0.006
3-2b		0.056	<0.084	0.030	<0.014	<0.006
3-3b		0.075	<0.084	0.068	<0.014	<0.006
4-1b		0.049	<0.084	0.028	<0.014	<0.006
4-2b		0.050	<0.084	0.024	<0.014	<0.006
4-3b		0.043	<0.084	<0.022	<0.014	<0.006
1-3b	Dup	0.033	<0.084	<0.022	<0.014	<0.006
5-1b		0.041	<0.084	<0.022	<0.014	<0.006
5-2b		0.037	<0.084	<0.022	<0.014	<0.006
5-3b		0.027	<0.084	0.025	<0.014	<0.006
6-1b		<0.023	<0.084	<0.022	<0.014	<0.006
6-2b		<0.023	<0.084	<0.022	<0.014	<0.006
6-3b		<0.023	<0.084	<0.022	<0.014	<0.006
5-1b	Dup	0.028	<0.084	<0.022	<0.014	<0.006

Analytical Data Report

9/8/95

Prepared for:	Russ Mathison / Barb McCarthy
Department:	North Central Expt. Station
Address:	5013 Miller Trunk Highway
	Duluth, MN 55811
Phone:	218-327-4352
Name of Study:	Grand Rapids Sludge Project
Budget Number:	383-3500

Laboratory Group Number:	W18
Number of Samples:	18
Samples Received:	8/29/95
Samples Prepared:	9/1/95
Preparation:	1% HNO3
Samples Analyzed:	9/5/95
Instrumentation:	ARL 3560 ICP
Analyst:	RDA
Units Used in Report:	mg/l (ppm)

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Department of Soil, Water, and Climate

Research Analytical Laboratory
135 Crops Research Building
University of Minnesota
St. Paul, MN 55108

Phone; (612) 625-3101
Fax: (612) 624-3420

Date: 08-Sep-95 09:56:10 Page: 1.1

Water Group #18, mg/l (ppm w/v) in the water

		P1	K	CA	MG	NA
1-1		0.036	13.039	47.684	11.495	4.959
-2		<0.035	4.185	34.000	8.416	6.636
1-3		<0.035	5.309	25.921	6.846	3.858
2-1		0.075	5.510	29.914	7.383	4.956
-2		<0.035	4.513	36.344	8.834	3.748
-3		<0.035	4.013	35.471	8.261	29.878
3-1		0.054	3.726	17.394	4.958	4.539
-2		0.113	4.010	23.767	5.478	3.385
-3		0.048	5.861	33.422	9.123	4.294
4-1		0.036	4.597	53.466	14.238	22.876
1-1	Dup	<0.035	13.367	49.393	11.911	4.903
-2		0.089	155.621	205.121	57.272	179.596
4-3		<0.035	6.792	32.808	9.985	6.760
5-1		<0.035	2.615	22.948	6.402	4.728
-2		<0.035	2.670	21.191	6.047	3.529
-3		0.064	4.744	25.651	7.275	5.751
6-1		<0.035	1.562	14.675	3.774	2.619
-2		<0.035	1.586	17.407	3.372	2.514
-3		<0.035	1.595	11.993	3.418	3.714
4-2	Dup	0.090	156.922	208.642	58.289	180.934

Date: 08-Sep-95 09:56:10 Page: 1.2

Water Group #18, mg/l (ppm w/v) in the water

		AL2	FE1	MN	ZN	CU
1-1		0.515	0.094	0.123	0.639	0.494
-2		<0.179	0.022	0.043	0.354	0.033
-3		<0.179	<0.017	0.053	0.288	0.049
2-1		0.230	0.063	0.122	0.253	0.066
-2		<0.179	0.022	0.115	0.472	<0.026
-3		<0.179	0.027	0.089	0.401	0.061
3-1		<0.179	0.118	0.072	0.197	0.051
3-2		0.199	0.079	0.064	0.227	0.029
-3		0.405	0.107	0.168	0.624	0.103
4-1		0.207	0.018	0.092	0.498	0.047
1-1	Dup	0.466	0.090	0.126	0.656	0.498
-2		0.695	0.242	0.412	0.947	0.089
-3		0.401	0.032	0.108	0.643	0.062
5-1		<0.179	0.031	0.103	0.388	0.031
-2		<0.179	<0.017	0.135	0.294	0.056
-3		<0.179	0.062	0.430	0.227	<0.026
6-1		<0.179	0.061	0.033	0.077	<0.026
6-2		<0.179	0.045	0.056	0.228	<0.026
-3		<0.179	0.078	0.113	0.029	<0.026
4-2	Dup	0.750	0.179	0.414	0.958	0.094

Water Group #18, mg/l (ppm w/v) in the water

		B	PB	NI	CR	CD
1-1		0.055	<0.084	0.049	<0.014	<0.006
1-2		0.051	<0.084	0.036	<0.014	<0.006
1-3		0.052	<0.084	0.037	<0.014	<0.006
2-1		0.064	<0.084	0.038	<0.014	<0.006
2-2		0.060	<0.084	0.050	<0.014	<0.006
2-3		0.069	<0.084	0.053	<0.014	<0.006
3-1		0.053	<0.084	0.025	<0.014	<0.006
3-2		0.068	<0.084	0.032	<0.014	<0.006
3-3		0.068	<0.084	0.074	<0.014	<0.006
4-1		0.066	<0.084	0.057	<0.014	<0.006
1-1	Dup	0.049	<0.084	0.050	<0.014	<0.006
4-2		0.144	<0.084	0.080	<0.014	0.007
4-3		0.063	<0.084	0.052	<0.014	<0.006
5-1		0.048	<0.084	0.047	<0.014	<0.006
5-2		0.046	<0.084	0.052	<0.014	<0.006
5-3		0.050	<0.084	0.043	<0.014	<0.006
6-1		0.027	<0.084	<0.022	<0.014	<0.006
6-2		0.033	<0.084	0.026	<0.014	<0.006
6-3		0.026	<0.084	<0.022	<0.014	<0.006
4-2	Dup	0.153	<0.084	0.087	<0.014	0.009

Analytical Data Report

10/11/95

Prepared for:	Russ Mathison / Barb McCarthy
Department:	No. Cent. Expt. Station
Address:	5013 Miller Trunk Highway
	Duluth, MN 55811
Phone:	218-327-4352
Name of Study:	Grand Rapids Sludge Project
Budget Number:	383-3500

Laboratory Group Number:	W34
Number of Samples:	17
Samples Received:	10/3/95
Samples Prepared:	10/4/95
Preparation:	1% HNO3
Samples Analyzed:	10/11/95
Instrumentation:	ARL 3560 ICP
Analyst:	RDA
Units Used in Report:	mg/l (ppm)

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Date: 11-Oct-95 11:26:24 Page: 1.1

ater Group #34, mg/l (ppm w/v) in the water

		P1	K	CA	MG	NA
-1		0.039	18.827	72.726	16.782	6.824
-2		<0.035	4.960	69.305	15.268	6.981
1-3		<0.035	6.294	55.569	14.222	7.290
2-1		<0.035	6.372	48.444	11.701	5.890
-2		<0.035	5.425	54.767	11.988	4.169
-1		<0.035	4.722	33.478	8.739	5.319
3-2		<0.035	3.830	21.143	5.036	2.623
-3		<0.035	5.388	27.762	7.151	3.403
-1		<0.035	9.415	159.191	43.550	104.378
4-2		<0.035	369.697	154.101	33.895	164.656
-1	Dup	<0.035	18.876	72.692	16.719	6.776
-3		<0.035	10.884	79.236	26.345	62.067
5-1		<0.035	2.748	31.954	7.930	6.027
5-2		<0.035	4.104	36.504	9.797	5.006
-3		<0.035	3.741	35.452	9.906	9.301
-1		<0.035	2.300	35.053	8.446	3.577
6-2		<0.035	1.870	26.903	4.861	2.619
-3		<0.035	1.755	20.702	5.548	3.315
-3	Dup	<0.035	10.814	78.979	26.243	61.652

Date: 11-Oct-95 11:26:24 Page: 1.2

ater Group #34, mg/l (ppm w/v) in the water

		AL2	FE1	MN	ZN	CU
-1		1.394	0.139	0.240	0.804	0.501
-2		1.655	0.053	0.214	0.873	0.110
-3		1.071	0.030	0.246	0.670	0.071
2-1		1.116	0.061	0.260	0.590	0.081
-2		1.492	0.089	0.283	0.892	0.092
-1		0.725	0.171	0.221	0.628	0.104
3-2		<0.179	<0.017	0.069	0.368	0.036
-3		0.814	0.153	0.168	0.574	0.089
-1		1.582	0.092	0.385	1.027	0.094
4-2		1.722	0.229	0.435	1.072	0.091
1-1	Dup	1.403	0.118	0.238	0.792	0.474
-3		1.684	0.040	0.283	0.817	0.045
-1		0.488	0.029	0.174	1.063	0.056
5-2		0.760	<0.017	0.222	0.846	0.095
-3		0.487	0.030	0.669	0.520	0.038
-1		0.596	0.024	0.142	0.315	0.047
6-2		0.872	0.035	0.134	0.703	0.044
6-3		0.213	0.050	0.107	0.125	0.093
-3	Dup	1.681	0.033	0.282	0.813	0.045

Water Group #34, mg/l (ppm w/v) in the water

		B	PB	NI	CR	CD
?-1		0.037	<0.084	0.071	<0.014	<0.006
-2		0.037	<0.084	0.070	<0.014	<0.006
1-3		0.038	<0.084	0.055	<0.014	<0.006
2-1		0.043	<0.084	0.060	<0.014	<0.006
-2		0.043	<0.084	0.071	<0.014	<0.006
3-1		0.033	<0.084	0.083	<0.014	<0.006
3-2		0.040	<0.084	0.033	<0.014	<0.006
-3		0.034	<0.084	0.053	<0.014	<0.006
-1		0.178	<0.084	0.077	<0.014	<0.007
4-2		0.756	<0.084	0.077	<0.014	<0.006
?-1	Dup	0.037	<0.084	0.073	<0.014	<0.006
-3		0.059	<0.084	0.058	<0.014	<0.006
5-1		0.031	<0.084	0.092	<0.014	<0.006
5-2		0.037	<0.084	0.111	<0.014	<0.006
-3		0.043	<0.084	0.066	<0.014	<0.006
6-1		<0.023	<0.084	0.036	<0.014	<0.006
6-2		<0.023	<0.084	0.068	<0.014	<0.006
-3		<0.023	<0.084	0.036	<0.014	<0.006
-3	Dup	0.056	<0.084	0.058	<0.014	<0.006

Analytical Data Report

11/13/95

Prepared for:	Russ Mathison
Department:	No. Cent. Experiment Station
Address:	5013 Miller Trunk Hwy.
	Duluth, MN 55811
Phone:	218-327-4352
Name of Study:	Grand Rapids Sludge Project
Budget Number:	383-3500

Laboratory Group Number:	Water #47
Number of Samples:	17
Samples Received:	11/8/95
Samples Prepared:	11/9/95
Preparation:	1% HNO3
Samples Analyzed:	11/10/95
Instrumentation:	ARL 3560 ICP-AES
Analyst:	RDA
Units Used in Report:	mg/l (ppm)

University of Minnesota
Department of Soil, Water, and Climate

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Date: 10-Nov-95 14:24:01 Page: 1.1
Water Group #47, mg/l (ppm w/v) in the water

		P1	K	CA	MG	NA
.-1		<0.035	12.177	40.922	9.712	24.318
.-2		<0.035	4.472	69.105	14.959	7.528
1-3		<0.035	4.477	46.421	12.623	17.131
?-1		<0.035	3.957	26.936	6.760	17.640
:-2		<0.035	3.551	46.037	9.798	6.145
3-1		<0.035	2.295	14.286	3.554	2.564
3-2		<0.035	1.981	11.949	2.663	1.519
:-3		<0.035	2.331	10.153	2.565	1.639
4-1		<0.035	73.549	48.627	11.386	37.750
1-1	Dup	<0.035	12.170	41.121	9.775	24.354
:-2		<0.035	147.663	22.328	4.374	32.004
.-3		<0.035	16.873	145.571	52.940	106.047
5-1		<0.035	2.209	25.078	5.932	5.685
5-2		<0.035	2.041	20.946	5.435	4.937
:-3		<0.035	1.919	11.820	3.320	6.157
6-1		<0.035	0.973	15.133	3.564	1.839
6-2		<0.035	0.766	8.834	1.510	0.975
:-3		<0.035	0.914	11.790	3.006	1.310
.-2	Dup	<0.035	147.433	22.287	4.363	31.951

Date: 10-Nov-95 14:24:01 Page: 1.2
Water Group #47, mg/l (ppm w/v) in the water

		AL2	FE1	MN	ZN	CU
.-1		0.807	0.060	0.116	0.708	0.982
.-2		1.695	0.025	0.247	0.721	0.133
1-3		0.834	<0.017	0.105	0.404	0.052
?-1		0.589	0.025	0.148	0.315	0.078
:-2		1.512	0.024	0.200	0.678	0.083
3-1		0.478	<0.017	0.083	0.320	0.047
3-2		<0.179	<0.017	0.040	0.239	<0.026
:-3		0.347	0.115	0.062	0.238	0.094
4-1		0.686	0.030	0.109	0.453	0.076
1-1	Dup	0.796	0.049	0.115	0.708	0.967
:-2		0.311	0.053	0.082	0.257	0.037
.-3		2.183	0.063	0.397	0.696	0.070
5-1		1.320	0.025	0.138	0.997	0.092
5-2		0.502	0.023	0.111	0.488	0.058
:-3		0.247	0.028	0.199	0.635	0.866
6-1		0.333	<0.017	0.047	0.146	<0.026
6-2		0.494	<0.017	0.054	0.238	0.037
:-3		0.290	0.064	0.043	0.060	<0.026
.-2	Dup	0.309	0.044	0.081	0.254	0.037

ater Group #47, mg/l (ppm w/v) in the water

		B	PB	NI	CR	CD
-1		0.027	<0.084	0.040	<0.014	<0.006
-2		0.028	<0.084	0.055	<0.014	<0.006
1-3		0.041	<0.084	0.043	<0.014	<0.006
-1		0.039	<0.084	0.032	<0.014	<0.006
-2		0.036	<0.084	0.050	<0.014	<0.006
3-1		<0.023	<0.084	0.040	<0.014	<0.006
3-2		<0.023	<0.084	0.031	<0.014	<0.006
-3		<0.023	<0.084	0.032	<0.014	<0.006
-1		0.585	<0.084	0.046	<0.014	<0.006
1-1	Dup	0.029	<0.084	0.041	<0.014	<0.006
-2		0.991	<0.084	<0.022	<0.014	<0.006
-3		0.074	<0.084	0.048	<0.014	<0.006
5-1		0.025	<0.084	0.085	<0.014	<0.006
5-2		<0.023	<0.084	0.072	<0.014	<0.006
-3		<0.023	<0.084	0.040	<0.014	<0.006
6-1		<0.023	<0.084	<0.022	<0.014	<0.006
6-2		<0.023	<0.084	<0.022	<0.014	<0.006
-3		<0.023	<0.084	<0.022	<0.014	<0.006
-2	Dup	0.982	<0.084	<0.022	<0.014	<0.006

Analytical Data Report

11/25/96

Prepared for:	Barb McCarthy / Russ Mathison
Department:	North Central Exp. Station
Address:	5013 Miller Trunk Highway
	UMD-NRRI
	Duluth, MN 55811
Phone:	(218) 720-4322
Name of Study:	Grand Rapids Biosoloids
Budget Number:	383-3500

Laboratory Group Number:	Water 30
Number of Samples:	72
Samples Received:	11/12/96
Samples Prepared:	11/13/96
Preparation:	1% HNO3
Samples Analyzed:	11/24/96
Instrumentation:	ARL 3560 ICP-AES
Analyst:	MF / BN
Units Used in Report:	mg/kg (ppm) in the sample

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Department of Soil, Water,
and Climate

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Research Analytical Laboratory - ICP Analysis Report
Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
mg/kg (ppm) in the samples.

)	P1	K	CA	MG
5/28 1-1	< 0.035	8.068	18.893	4.588
/28 1-2	< 0.035	2.382	29.644	6.290
5/28 1-3	< 0.035	2.797	26.074	7.140
5/28 2-1	< 0.035	3.365	18.451	5.198
/28 2-2	< 0.035	3.570	20.639	4.585
5/28 2-3	< 0.035	23.000	18.516	4.614
5/28 3-1	< 0.035	1.478	6.224	1.492
/28 3-2	< 0.035	1.630	7.151	1.484
/28 3-3	< 0.035	1.503	4.963	1.200
5/28 4-1	< 0.035	46.226	12.393	8.135
5/28 1-1 Dup	< 0.035	8.171	18.963	4.628
/28 4-2	< 0.035	74.713	4.262	2.556
5/28 4-3	< 0.035	41.035	64.261	20.255
5/28 5-1	< 0.035	1.125	5.079	1.343
/28 5-2	< 0.035	1.431	7.611	2.084
/28 5-3	< 0.035	1.507	8.360	2.638
5/28 6-1	< 0.035	0.950	5.956	1.402
/28 6-2	< 0.035	0.910	5.323	0.912
/28 6-3	< 0.035	0.895	4.037	1.015
6/28 1-1	< 0.035	8.290	16.407	4.027
6/28 1-2	< 0.035	3.000	29.281	5.978
/28 4-2 Dup	< 0.035	74.287	4.262	2.590
5/28 1-3	< 0.035	3.657	27.899	7.385
6/28 2-1	< 0.035	3.522	19.779	5.541
/28 2-2	0.038	4.356	24.546	5.532
/28 2-3	< 0.035	38.620	19.857	4.615
6/28 3-1	< 0.035	2.649	10.819	2.583
/28 3-2	< 0.035	2.864	13.090	2.776
/28 3-3	0.038	2.455	8.236	2.044
6/28 4-1	0.076	51.014	12.748	7.512
6/28 4-2	< 0.035	78.673	6.598	4.303
/28 4-3	< 0.035	52.201	57.523	15.641
5/28 1-3 Dup	< 0.035	3.362	27.513	7.195
6/28 5-1	< 0.035	1.498	11.142	2.971
/28 5-2	< 0.035	1.846	10.777	2.870
/28 5-3	< 0.035	1.974	10.462	3.214
6/28 6-1	< 0.035	0.949	8.410	2.002
/28 6-2	< 0.035	1.057	8.302	1.477
/28 6-3	< 0.035	0.870	5.241	1.322
10/18 1-1	< 0.035	6.767	13.484	3.568
10/18 1-2	< 0.035	1.232	24.371	5.231
0/18 1-3	< 0.035	1.729	16.554	4.256
0/18 2-1	< 0.035	1.834	12.823	3.551
6/28 5-1 Dup	< 0.035	1.489	11.122	2.961
0/18 2-2	< 0.035	2.311	15.851	3.469
0/18 2-3	< 0.035	39.529	8.199	1.894
10/18 3-1	< 0.035	1.418	7.940	1.946
0/18 3-2	< 0.035	1.600	8.307	1.778
0/18 3-3	< 0.035	0.966	4.395	1.105

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
g/kg (ppm) in the samples.

ID	P1	K	CA	MG
0/18 4-1	< 0.035	31.951	7.718	4.657
10/18 4-2	< 0.035	46.126	5.017	3.379
10/18 4-3	< 0.035	58.195	38.375	9.643
0/18 5-1	< 0.035	0.898	6.236	1.653
0/18 5-2	< 0.035	1.260	6.848	1.780
10/18 2-2 Dup	< 0.035	2.376	15.881	3.491
0/18 5-3	< 0.035	1.451	6.695	2.057
0/18 6-1	< 0.035	0.714	7.090	1.765
10/18 6-2	< 0.035	< 0.707	4.820	0.889
0/18 6-3	< 0.035	0.860	4.508	1.132
1/4 1-1	< 0.035	5.038	10.061	2.499
11/4 1-2	0.059	1.507	21.440	4.614
11/4 1-3	< 0.035	1.629	14.589	3.979
1/4 2-1	< 0.035	1.992	9.994	2.928
1/4 2-2	< 0.035	17.183	14.561	3.253
11/4 2-3	< 0.035	32.791	7.347	1.615
0/18 5-3 Dup	< 0.035	1.475	6.664	2.053
1/4 3-1	< 0.035	1.071	4.780	1.208
11/4 3-2	< 0.035	1.034	4.927	1.060
11/4 3-3	< 0.035	0.763	3.116	0.768
1/4 4-1	< 0.035	25.220	6.255	3.945
11/4 4-2	< 0.035	32.710	3.855	2.606
11/4 4-3	< 0.035	55.919	32.966	8.361
1/4 5-1	< 0.035	0.725	4.351	1.166
1/4 5-2	< 0.035	0.997	4.166	1.104
11/4 5-3	< 0.035	1.309	4.575	1.424
11/4 6-1	< 0.035	< 0.707	4.719	1.211
1/4 3-1 Dup	< 0.035	1.106	4.784	1.222
11/4 6-2	< 0.035	< 0.707	3.930	0.731
11/4 6-3	< 0.035	0.766	4.466	1.128
1/4 6-2 Dup	< 0.035	< 0.707	3.944	0.731

ID	MN	AL2	FE1	NA
5/28 1-1	0.073	0.227	0.037	8.041
5/28 1-2	0.084	0.261	0.020	7.615
5/28 1-3	0.050	< 0.179	0.033	11.116
5/28 2-1	0.093	0.191	0.030	6.351
5/28 2-2	0.078	0.426	0.019	6.556
5/28 2-3	0.063	< 0.179	< 0.017	5.955
5/28 3-1	0.072	< 0.179	< 0.017	1.680
5/28 3-2	0.048	< 0.179	< 0.017	1.021
5/28 3-3	0.098	< 0.179	0.070	0.779
5/28 4-1	0.026	< 0.179	0.026	3.048
5/28 1-1 Dup	0.073	0.240	0.034	8.025
5/28 4-2	0.054	< 0.179	0.040	6.054
5/28 4-3	0.299	0.604	0.063	41.014
5/28 5-1	0.033	0.290	0.044	2.649

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
g/kg (ppm) in the samples.

ID	MN	AL2	FE1	NA
/28 5-2	0.040	0.229	0.042	1.615
6/28 5-3	0.078	< 0.179	0.023	1.418
6/28 6-1	0.048	< 0.179	0.025	1.589
/28 6-2	0.039	0.196	0.034	0.811
6/28 6-3	0.026	0.181	0.079	0.750
6/28 1-1	0.042	0.212	0.020	7.140
/28 1-2	0.188	1.038	0.138	8.610
/28 4-2 Dup	0.055	< 0.179	0.063	6.028
6/28 1-3	0.109	0.532	0.062	10.422
6/28 2-1	0.099	0.503	0.054	6.681
/28 2-2	0.133	1.241	0.082	7.247
6/28 2-3	0.090	1.034	0.042	5.856
6/28 3-1	0.090	0.483	0.076	3.094
/28 3-2	0.126	0.547	0.054	1.765
6/28 3-3	0.199	0.605	0.184	1.473
6/28 4-1	0.054	0.362	0.156	5.260
/28 4-2	0.029	< 0.179	0.055	6.947
/28 4-3	0.318	1.323	0.153	36.305
6/28 1-3 Dup	0.108	0.453	0.053	10.414
6/28 5-1	0.047	1.154	0.039	3.698
/28 5-2	0.043	0.442	0.025	2.113
6/28 5-3	0.101	0.362	0.043	1.967
6/28 6-1	0.033	0.269	0.032	2.050
/28 6-2	0.050	0.660	0.041	1.335
/28 6-3	0.047	0.186	0.055	1.164
10/18 1-1	0.074	0.329	0.073	5.191
10/18 1-2	0.112	< 0.179	0.018	9.442
0/18 1-3	0.060	< 0.179	0.021	5.439
10/18 2-1	0.129	0.232	0.067	4.105
6/28 5-1 Dup	0.047	1.127	0.036	3.714
0/18 2-2	0.105	0.261	< 0.017	5.975
10/18 2-3	0.047	< 0.179	< 0.017	5.553
10/18 3-1	0.100	< 0.179	< 0.017	2.277
0/18 3-2	0.077	0.215	< 0.017	1.056
0/18 3-3	0.081	< 0.179	0.023	0.748
10/18 4-1	0.038	< 0.179	0.051	3.115
10/18 4-2	0.070	< 0.179	0.022	3.265
0/18 4-3	0.173	0.916	0.086	22.542
10/18 5-1	0.076	0.930	0.063	1.304
10/18 5-2	0.032	< 0.179	< 0.017	1.159
0/18 2-2 Dup	0.105	0.262	< 0.017	5.980
10/18 5-3	0.063	0.214	0.026	1.272
10/18 6-1	0.057	0.221	0.109	1.616
0/18 6-2	0.066	< 0.179	0.032	0.805
0/18 6-3	0.045	< 0.179	0.041	0.870
11/4 1-1	0.044	0.265	0.051	3.673
11/4 1-2	0.095	0.353	0.094	9.385
1/4 1-3	0.036	0.201	0.045	4.656

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
g/kg (ppm) in the samples.

ID	MN	AL2	FE1	NA
1/4 2-1	0.065	0.181	0.041	2.905
11/4 2-2	0.081	0.471	0.081	5.698
11/4 2-3	0.031	0.204	0.081	5.039
0/18 5-3 Dup	0.063	0.217	0.027	1.248
1/4 3-1	0.052	< 0.179	0.029	1.557
11/4 3-2	0.057	0.193	< 0.017	0.647
1/4 3-3	0.041	0.250	0.059	0.481
1/4 4-1	0.054	< 0.179	0.104	1.884
11/4 4-2	0.019	< 0.179	0.189	2.019
1/4 4-3	0.136	0.649	0.040	17.602
1/4 5-1	0.069	0.771	0.036	0.884
11/4 5-2	0.035	0.196	0.033	0.577
11/4 5-3	0.059	0.227	0.038	0.692
1/4 6-1	0.048	0.293	0.115	1.058
1/4 3-1 Dup	0.053	< 0.179	0.037	1.562
11/4 6-2	0.063	0.267	0.023	0.533
1/4 6-3	0.035	< 0.179	0.027	0.780
1/4 6-2 Dup	0.065	0.274	0.025	0.513

D	ZN	CU	B	PB
5/28 1-1	0.264	0.757	0.100	< 0.084
/28 1-2	0.285	0.027	0.063	< 0.084
/28 1-3	0.211	0.050	0.217	< 0.084
5/28 2-1	0.189	0.034	0.160	< 0.084
/28 2-2	0.270	0.056	0.132	< 0.084
/28 2-3	0.149	0.046	0.215	< 0.084
5/28 3-1	0.176	0.051	< 0.023	< 0.084
5/28 3-2	0.185	0.028	< 0.023	< 0.084
/28 3-3	0.190	0.103	< 0.023	< 0.084
5/28 4-1	0.065	0.037	0.484	< 0.084
5/28 1-1 Dup	0.267	0.762	0.104	< 0.084
/28 4-2	0.096	0.053	0.632	< 0.084
/28 4-3	0.221	0.049	0.202	< 0.084
5/28 5-1	0.139	0.056	< 0.023	< 0.084
/28 5-2	0.182	0.146	< 0.023	< 0.084
/28 5-3	0.124	0.042	< 0.023	< 0.084
5/28 6-1	0.111	0.055	< 0.023	< 0.084
5/28 6-2	0.156	0.051	< 0.023	< 0.084
/28 6-3	0.122	0.053	< 0.023	< 0.084
6/28 1-1	0.196	0.365	0.125	< 0.084
6/28 1-2	0.464	0.175	0.091	< 0.084
/28 4-2 Dup	0.097	0.058	0.633	< 0.084
/28 1-3	0.324	0.167	0.282	< 0.084
6/28 2-1	0.254	0.084	0.194	< 0.084
/28 2-2	0.501	0.196	0.174	< 0.084
/28 2-3	0.285	0.063	0.329	< 0.084
6/28 3-1	0.314	0.132	0.039	< 0.084

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
g/kg (ppm) in the samples.

ID	ZN	CU	B	PB
/28 3-2	0.392	0.138	0.039	< 0.084
6/28 3-3	0.261	0.097	0.030	< 0.084
6/28 4-1	0.212	0.202	0.534	< 0.168
/28 4-2	0.158	0.085	0.693	< 0.084
6/28 4-3	0.359	0.207	0.237	< 0.084
6/28 1-3 Dup	0.318	0.157	0.269	< 0.084
/28 5-1	0.296	0.063	< 0.023	< 0.084
/28 5-2	0.230	0.093	< 0.023	< 0.084
6/28 5-3	0.181	0.042	< 0.023	< 0.084
/28 6-1	0.122	0.032	0.023	< 0.084
/28 6-2	0.237	0.040	0.023	< 0.084
6/28 6-3	0.071	0.031	0.024	< 0.084
10/18 1-1	0.726	0.624	0.086	< 0.084
0/18 1-2	0.251	< 0.026	0.124	< 0.084
10/18 1-3	0.134	< 0.026	0.281	< 0.084
10/18 2-1	0.220	0.129	0.148	< 0.084
/28 5-1 Dup	0.296	0.063	< 0.023	< 0.084
0/18 2-2	0.291	0.099	0.176	< 0.084
10/18 2-3	0.102	< 0.026	0.293	< 0.084
10/18 3-1	0.152	0.043	0.027	< 0.084
0/18 3-2	0.278	0.056	< 0.023	< 0.084
10/18 3-3	0.209	0.106	< 0.023	< 0.084
10/18 4-1	0.053	0.038	0.437	< 0.084
0/18 4-2	0.079	0.035	0.578	< 0.084
0/18 4-3	0.550	0.569	0.278	< 0.084
10/18 5-1	0.223	0.104	< 0.023	< 0.084
0/18 5-2	0.138	0.042	< 0.023	< 0.084
0/18 2-2 Dup	0.290	0.090	0.182	< 0.084
10/18 5-3	0.169	0.097	< 0.023	< 0.084
10/18 6-1	0.106	0.040	0.023	< 0.084
0/18 6-2	0.141	0.029	< 0.023	< 0.084
10/18 6-3	0.109	0.184	< 0.023	< 0.084
11/4 1-1	0.163	0.175	0.072	< 0.084
1/4 1-2	0.231	0.035	0.112	< 0.084
1/4 1-3	0.137	0.052	0.245	< 0.084
11/4 2-1	0.143	0.077	0.111	< 0.084
1/4 2-2	0.223	0.045	0.145	< 0.084
1/4 2-3	0.141	0.062	0.219	< 0.084
10/18 5-3 Dup	0.168	0.095	< 0.023	< 0.084
11/4 3-1	0.094	0.027	< 0.023	< 0.084
1/4 3-2	0.157	0.041	< 0.023	< 0.084
11/4 3-3	0.137	0.089	< 0.023	< 0.084
11/4 4-1	0.072	0.082	0.203	< 0.084
1/4 4-2	0.068	0.034	0.326	< 0.084
1/4 4-3	0.210	0.037	0.291	< 0.084
11/4 5-1	0.163	0.076	< 0.023	< 0.084
1/4 5-2	0.079	0.031	< 0.023	< 0.084
1/4 5-3	0.084	0.045	< 0.023	< 0.084

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
g/kg (ppm) in the samples.

ID	ZN	CU	B	PB
1/4 6-1	0.069	0.034	< 0.023	< 0.084
1/4 3-1 Dup	0.094	0.029	< 0.023	< 0.084
11/4 6-2	0.102	0.033	< 0.023	< 0.084
1/4 6-3	0.035	0.033	< 0.023	< 0.084
1/4 6-2 Dup	0.102	0.034	< 0.023	< 0.084

D	NI	CR	CD
5/28 1-1	< 0.022	< 0.014	< 0.006
/28 1-2	0.024	< 0.014	< 0.006
/28 1-3	< 0.022	< 0.014	< 0.006
5/28 2-1	0.033	< 0.014	< 0.006
/28 2-2	0.032	< 0.014	< 0.006
/28 2-3	< 0.022	< 0.014	< 0.006
5/28 3-1	< 0.022	< 0.014	< 0.006
/28 3-2	< 0.022	< 0.014	< 0.006
/28 3-3	0.051	< 0.014	< 0.006
5/28 4-1	< 0.022	< 0.014	< 0.006
5/28 1-1 Dup	< 0.022	< 0.014	< 0.006
/28 4-2	0.027	< 0.014	< 0.006
/28 4-3	0.029	< 0.014	< 0.006
5/28 5-1	< 0.022	< 0.014	< 0.006
/28 5-2	< 0.022	< 0.014	< 0.006
/28 5-3	0.030	< 0.014	< 0.006
5/28 6-1	< 0.022	< 0.014	< 0.006
/28 6-2	0.030	< 0.014	< 0.006
/28 6-3	< 0.022	< 0.014	< 0.006
6/28 1-1	< 0.022	< 0.014	< 0.006
6/28 1-2	0.069	< 0.014	< 0.006
/28 4-2 Dup	0.032	< 0.014	< 0.006
/28 1-3	0.030	< 0.014	< 0.006
6/28 2-1	0.037	< 0.014	< 0.006
/28 2-2	0.043	< 0.014	< 0.006
/28 2-3	0.044	< 0.014	< 0.006
6/28 3-1	0.050	< 0.014	< 0.006
/28 3-2	0.105	< 0.014	< 0.006
/28 3-3	0.113	< 0.014	< 0.006
6/28 4-1	0.060	< 0.028	< 0.012
6/28 4-2	< 0.022	< 0.014	< 0.006
/28 4-3	0.028	< 0.014	< 0.006
/28 1-3 Dup	0.023	< 0.014	< 0.006
6/28 5-1	0.033	< 0.014	< 0.006
/28 5-2	0.022	< 0.014	< 0.006
/28 5-3	< 0.022	< 0.014	< 0.006
6/28 6-1	< 0.022	< 0.014	< 0.006
6/28 6-2	< 0.022	< 0.014	< 0.006
/28 6-3	< 0.022	< 0.014	< 0.006
10/18 1-1	< 0.022	< 0.014	< 0.006

Report generated: 11/25/96 19:36:46 By: BN (bold)
RAL Job #: 1996 W030
ıg/kg (ppm) in the samples.

ID	NI	CR	CD
.0/18 1-2	0.038	< 0.014	< 0.006
ı0/18 1-3	< 0.022	< 0.014	< 0.006
10/18 2-1	< 0.022	< 0.014	< 0.006
;/28 5-1 Dup	0.032	< 0.014	< 0.006
.0/18 2-2	< 0.022	< 0.014	< 0.006
10/18 2-3	< 0.022	< 0.014	< 0.006
".0/18 3-1	0.029	< 0.014	< 0.006
.0/18 3-2	< 0.022	< 0.014	< 0.006
10/18 3-3	< 0.022	< 0.014	< 0.006
10/18 4-1	< 0.022	< 0.014	< 0.006
.0/18 4-2	< 0.022	< 0.014	< 0.006
ı0/18 4-3	0.053	< 0.014	< 0.006
10/18 5-1	0.041	< 0.014	< 0.006
.0/18 5-2	< 0.022	< 0.014	< 0.006
.0/18 2-2 Dup	< 0.022	< 0.014	< 0.006
10/18 5-3	< 0.022	< 0.014	< 0.006
".0/18 6-1	< 0.022	< 0.014	< 0.006
.0/18 6-2	< 0.022	< 0.014	< 0.006
ı0/18 6-3	< 0.022	< 0.014	< 0.006
11/4 1-1	< 0.022	< 0.014	< 0.006
.1/4 1-2	0.027	< 0.014	< 0.006
_1/4 1-3	< 0.022	< 0.014	< 0.006
11/4 2-1	< 0.022	< 0.014	< 0.006
.1/4 2-2	< 0.022	< 0.014	< 0.006
.1/4 2-3	< 0.022	< 0.014	< 0.006
10/18 5-3 Dup	< 0.022	< 0.014	< 0.006
"1/4 3-1	< 0.022	< 0.014	< 0.006
.1/4 3-2	< 0.022	< 0.014	< 0.006
ı1/4 3-3	< 0.022	< 0.014	< 0.006
11/4 4-1	< 0.022	< 0.014	< 0.006
.1/4 4-2	< 0.022	< 0.014	< 0.006
.1/4 4-3	< 0.022	< 0.014	< 0.006
11/4 5-1	0.041	< 0.014	< 0.006
"1/4 5-2	< 0.022	< 0.014	< 0.006
.1/4 5-3	0.035	< 0.014	< 0.006
11/4 6-1	< 0.022	< 0.014	< 0.006
"1/4 3-1 Dup	< 0.022	< 0.014	< 0.006
.1/4 6-2	0.036	< 0.014	< 0.006
ı1/4 6-3	< 0.022	< 0.014	< 0.006
11/4 6-2 Dup	0.037	< 0.014	< 0.006

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* Analytical Data Report *
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12/09/97

Prepared for: Stephen Monson Geerts / Russ Mathison

Department: North Central Experiment. Sta.

Address: 5013 Miller Trunk Highway
UMD-NRRI
Duluth, MN 55811
Phone: (218) 720-4202

Budget Number: 383-3500

Name of Study: Grand Rapids Biosolids
Sample Type: shallow soil water @ 22 in.

Laboratory Group: 1997 Water 70
Number of Samples: 69
Date Received: 12/02/97

Preparation: acidification to 1% HNO3 By: MF
Analyzed: 12/05/97 By: BN
Instrumentation: ARL 3560 ICP-AES

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Department of Soil, Water, and Climate

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Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
ample preparation: acidification to 1% HNO3
mg/kg (ppm) in the samples.

D	Sample Identification / Comments
1-1 6/26	1-1 6/26/97
-1 6/26 Dup	1-1 6/26/97

D	P1	K	CA	MG
1-1 6/26	< 0.035	5.226	6.248	1.378
1-1 6/26 Dup	< 0.035	5.278	6.240	1.400
-2 6/26	< 0.035	< 0.707	13.469	2.687
1-3 6/26	< 0.035	1.697	9.074	2.275
2-1 6/26	< 0.035	0.964	4.917	1.365
-2 6/26	< 0.035	1.592	7.154	1.507
2-3 6/26	< 0.035	27.834	3.235	0.599
3-1 6/26	< 0.035	0.738	3.594	0.722
-2 6/26	< 0.035	1.072	3.292	0.671
-3 6/26	< 0.035	0.990	3.699	0.763
4-1 6/26	< 0.035	16.287	11.529	5.817
4-2 6/26	< 0.035	19.405	6.767	4.165
-2 6/26 Dup	< 0.035	19.448	6.765	4.159
4-3 6/26	< 0.035	43.092	9.310	2.011
5-1 6/26	< 0.035	< 0.707	4.354	1.303
-3 6/26	< 0.035	1.620	6.454	2.168
6-1 6/26	< 0.035	< 0.707	3.249	0.800
6-2 6/26	< 0.035	< 0.707	2.829	0.497
6-3 6/26	< 0.035	< 0.707	2.669	0.583
-1 7/21	< 0.035	5.656	4.073	0.927
1-2 7/21	< 0.035	< 0.707	8.616	1.714
1-3 7/21	< 0.035	1.620	5.912	1.494
-1 7/21	< 0.035	0.950	3.768	1.093
2-1 7/21 Dup	< 0.035	0.942	3.786	1.108
2-2 7/21	< 0.035	1.313	4.526	0.999
-3 7/21	< 0.035	26.748	2.514	0.488
-1 7/21	< 0.035	< 0.707	2.485	0.553
3-2 7/21	< 0.035	1.074	2.244	0.463
3-3 7/21	< 0.035	0.790	1.751	0.389
-1 7/21	< 0.035	19.814	16.825	8.254
4-2 7/21	< 0.035	17.384	12.499	6.902
4-3 7/21	< 0.035	39.113	6.269	1.364
-1 7/21	< 0.035	< 0.707	3.258	0.996
5-2 7/21	< 0.035	1.310	7.707	2.283
5-2 7/21 Dup	< 0.035	1.337	7.656	2.284
-3 7/21	< 0.035	1.638	6.084	2.208
-1 7/21	< 0.035	< 0.707	2.548	0.635
6-2 7/21	< 0.035	< 0.707	2.414	0.443
6-3 7/21	< 0.035	< 0.707	2.233	0.512

Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
ample preparation: acidification to 1% HNO3
mg/kg (ppm) in the samples.

D	P1	K	CA	MG
1-1 9/15	0.140	5.971	5.806	1.308
.-3 9/15	< 0.035	1.417	5.425	1.374
2-1 9/15	< 0.035	< 0.707	5.164	1.443
2-2 9/15	< 0.035	0.990	4.700	1.054
:-3 9/15	< 0.035	21.726	1.628	0.354
3-1 9/15	< 0.035	< 0.707	2.621	0.586
3-1 9/15 Dup	< 0.035	< 0.707	2.682	0.593
3-2 9/15	< 0.035	1.025	2.387	0.529
3-3 9/15	0.055	< 0.707	2.760	0.588
4-1 9/15	< 0.035	13.722	9.387	4.313
4-2 9/15	< 0.035	11.066	7.954	3.343
4-3 9/15	< 0.035	35.469	4.824	1.038
5-1 9/15	< 0.035	< 0.707	2.878	0.834
5-3 9/15	< 0.035	1.349	4.836	1.569
6-1 9/15	< 0.035	< 0.707	2.126	0.539
6-2 9/15	< 0.035	< 0.707	2.475	0.479
6-3 9/15	< 0.035	< 0.707	2.044	0.449
6-3 9/15 Dup	< 0.035	< 0.707	2.029	0.444
.-1 10/28	< 0.035	4.233	4.075	0.978
1-2 10/28	< 0.035	1.526	12.945	2.167
1-3 10/28	< 0.035	1.135	4.884	1.234
2-1 10/28	< 0.035	< 0.707	3.665	1.043
2-2 10/28	< 0.035	0.757	3.537	0.809
2-3 10/28	< 0.035	17.983	1.355	0.301
3-1 10/28	< 0.035	< 0.707	2.464	0.544
3-2 10/28	< 0.035	0.789	2.307	0.523
3-3 10/28	< 0.035	< 0.707	1.955	0.472
4-1 10/28	< 0.035	13.247	11.579	5.443
4-1 10/28 Dup	< 0.035	13.215	11.627	5.449
4-2 10/28	< 0.035	9.120	8.845	3.551
4-3 10/28	< 0.035	30.853	4.414	0.980
5-1 10/28	< 0.035	< 0.707	2.595	0.834
5-2 10/28	< 0.035	< 0.707	3.539	1.052
5-3 10/28	< 0.035	1.053	4.365	1.622
6-1 10/28	< 0.035	< 0.707	1.778	0.478
6-2 10/28	< 0.035	< 0.707	2.465	0.485
6-3 10/28	< 0.035	< 0.707	1.792	0.438

Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
ample preparation: acidification to 1% HNO3
mg/kg (ppm) in the samples.

D	MN	AL2	FE1	NA
1-1 6/26	0.116	< 0.179	0.028	2.054
-1 6/26 Dup	0.115	< 0.179	0.030	2.056
1-2 6/26	0.067	< 0.179	< 0.017	5.684
1-3 6/26	0.064	< 0.179	0.024	2.558
-1 6/26	0.040	< 0.179	0.030	1.484
-2 6/26	0.056	< 0.179	< 0.017	2.479
2-3 6/26	0.030	< 0.179	0.022	1.877
3-1 6/26	0.058	< 0.179	0.024	0.961
-2 6/26	0.028	< 0.179	0.029	0.460
3-3 6/26	0.027	< 0.179	< 0.017	0.369
4-1 6/26	0.013	< 0.179	0.076	0.978
-2 6/26	0.054	< 0.179	0.029	1.205
4-2 6/26 Dup	0.053	< 0.179	0.026	1.192
4-3 6/26	0.040	< 0.179	0.028	6.629
-1 6/26	0.114	< 0.179	< 0.017	1.195
5-3 6/26	0.078	< 0.179	0.026	0.462
6-1 6/26	0.054	< 0.179	0.056	0.844
6-2 6/26	0.044	< 0.179	0.077	0.547
6-3 6/26	0.066	< 0.179	0.032	0.443
1-1 7/21	0.033	< 0.179	0.023	1.629
1-2 7/21	0.021	< 0.179	< 0.017	4.112
1-3 7/21	0.022	< 0.179	< 0.017	2.018
2-1 7/21	0.036	< 0.179	< 0.017	1.104
2-1 7/21 Dup	0.036	< 0.179	< 0.017	1.115
2-2 7/21	0.028	< 0.179	< 0.017	1.953
2-3 7/21	0.038	< 0.179	0.035	1.502
3-1 7/21	0.023	< 0.179	< 0.017	1.009
3-2 7/21	0.031	< 0.179	< 0.017	0.394
3-3 7/21	0.041	< 0.179	0.024	0.254
4-1 7/21	0.012	< 0.179	0.028	0.887
4-2 7/21	0.013	< 0.179	< 0.017	0.774
4-3 7/21	0.018	< 0.179	0.039	4.510
5-1 7/21	0.030	< 0.179	< 0.017	1.011
5-2 7/21	0.030	< 0.179	0.030	0.318
5-2 7/21 Dup	0.030	< 0.179	0.032	0.321
5-3 7/21	0.055	< 0.179	0.042	0.485
6-1 7/21	0.023	< 0.179	0.024	0.680
6-2 7/21	0.016	< 0.179	0.019	0.505
6-3 7/21	0.019	< 0.179	< 0.017	0.487
1-1 9/15	0.058	< 0.179	0.054	1.982
1-3 9/15	0.029	< 0.179	< 0.017	1.903
2-1 9/15	0.030	< 0.179	< 0.017	1.380
2-2 9/15	0.018	< 0.179	< 0.017	1.898

Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
ample preparation: acidification to 1% HNO3
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D	MN	AL2	FE1	NA
2-3 9/15	0.035	< 0.179	< 0.017	0.959
-1 9/15	0.018	< 0.179	0.031	1.016
-1 9/15 Dup	0.018	< 0.179	0.027	1.229
3-2 9/15	0.028	< 0.179	< 0.017	0.419
-3 9/15	0.027	< 0.179	< 0.017	0.300
-1 9/15	0.015	< 0.179	0.092	0.761
4-2 9/15	0.016	< 0.179	0.054	0.587
-3 9/15	0.055	< 0.179	0.023	3.675
-1 9/15	0.043	< 0.179	0.020	0.858
5-3 9/15	0.023	< 0.179	0.045	0.437
6-1 9/15	0.013	< 0.179	0.028	0.615
-2 9/15	0.022	< 0.179	< 0.017	0.545
-3 9/15	0.030	< 0.179	0.021	0.454
6-3 9/15 Dup	0.033	< 0.179	0.021	0.455
-1 10/28	0.018	< 0.179	0.044	1.492
-2 10/28	0.035	< 0.179	0.022	9.128
1-3 10/28	0.027	< 0.179	0.033	1.668
-1 10/28	0.028	< 0.179	< 0.017	0.894
-2 10/28	0.019	< 0.179	0.022	1.452
2-3 10/28	0.044	< 0.179	0.036	0.766
3-1 10/28	0.056	0.185	0.077	0.882
-2 10/28	0.021	< 0.179	< 0.017	0.358
-3 10/28	0.013	< 0.179	0.030	0.246
4-1 10/28	0.038	< 0.179	0.060	0.687
-1 10/28 Dup	0.038	< 0.179	0.062	0.683
-2 10/28	0.026	< 0.179	0.047	0.484
4-3 10/28	0.024	< 0.179	0.040	3.472
5-1 10/28	0.020	< 0.179	< 0.017	0.692
-2 10/28	0.026	< 0.179	0.030	0.269
-3 10/28	0.022	< 0.179	0.036	0.392
6-1 10/28	0.030	< 0.179	0.020	0.447
-2 10/28	0.031	< 0.179	< 0.017	0.519
-3 10/28	0.016	< 0.179	0.022	0.400

ID	ZN	CU	B	PB
-1 6/26	0.114	0.122	0.086	< 0.084
-1 6/26 Dup	0.115	0.123	0.087	< 0.084
1-2 6/26	0.100	< 0.026	0.102	< 0.084
-3 6/26	0.084	< 0.026	0.202	< 0.084
-1 6/26	0.053	< 0.026	0.100	< 0.084
2-2 6/26	0.103	< 0.026	0.108	< 0.084
2-3 6/26	0.073	< 0.026	0.147	< 0.084

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RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
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D	ZN	CU	B	PB
3-1 6/26	0.083	< 0.026	< 0.023	< 0.084
-2 6/26	0.089	< 0.026	< 0.023	< 0.084
-3 6/26	0.107	0.038	< 0.023	< 0.084
4-1 6/26	0.022	< 0.026	0.142	< 0.084
-2 6/26	0.026	< 0.026	0.226	< 0.084
-2 6/26 Dup	0.025	< 0.026	0.223	< 0.084
4-3 6/26	0.069	< 0.026	0.468	< 0.084
5-1 6/26	0.054	< 0.026	< 0.023	< 0.084
-3 6/26	0.058	< 0.026	< 0.023	< 0.084
6-1 6/26	0.049	< 0.026	< 0.023	< 0.084
6-2 6/26	0.063	< 0.026	< 0.023	< 0.084
-3 6/26	0.043	< 0.026	< 0.023	< 0.084
_-1 7/21	0.054	0.144	0.094	< 0.084
1-2 7/21	0.073	< 0.026	0.109	< 0.084
-3 7/21	0.049	< 0.026	0.196	< 0.084
-1 7/21	0.032	< 0.026	0.091	< 0.084
2-1 7/21 Dup	0.032	< 0.026	0.092	< 0.084
2-2 7/21	0.057	< 0.026	0.111	< 0.084
-3 7/21	0.040	< 0.026	0.159	< 0.084
3-1 7/21	0.043	< 0.026	< 0.023	< 0.084
3-2 7/21	0.047	< 0.026	< 0.023	< 0.084
-3 7/21	0.042	0.030	< 0.023	< 0.084
-1 7/21	0.017	< 0.026	0.180	< 0.084
4-2 7/21	0.016	< 0.026	0.191	< 0.084
-3 7/21	0.045	< 0.026	0.545	< 0.084
-1 7/21	0.041	< 0.026	< 0.023	< 0.084
5-2 7/21	0.033	< 0.026	< 0.023	< 0.084
5-2 7/21 Dup	0.034	< 0.026	< 0.023	< 0.084
-3 7/21	0.029	< 0.026	< 0.023	< 0.084
6-1 7/21	0.023	< 0.026	< 0.023	< 0.084
6-2 7/21	0.042	< 0.026	< 0.023	< 0.084
-3 7/21	0.023	< 0.026	< 0.023	< 0.084
-1 9/15	0.079	0.075	0.085	< 0.084
1-3 9/15	0.041	< 0.026	0.172	< 0.084
2-1 9/15	0.042	< 0.026	0.095	< 0.084
2-2 9/15	0.056	< 0.026	0.113	< 0.084
2-3 9/15	0.033	< 0.026	0.132	< 0.084
3-1 9/15	0.052	0.027	< 0.023	< 0.084
3-1 9/15 Dup	0.057	0.034	< 0.023	< 0.084
3-2 9/15	0.045	< 0.026	< 0.023	< 0.084
3-3 9/15	0.048	< 0.026	< 0.023	< 0.084
4-1 9/15	0.015	< 0.026	0.164	< 0.084
4-2 9/15	0.016	< 0.026	0.170	< 0.084

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RAL Job #: 1997 W070
tudy: Grand Rapids Biosolids / shallow soil water @ 22 in.
ample preparation: acidification to 1% HNO3
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D	ZN	CU	B	PB
4-3 9/15	0.038	< 0.026	0.536	< 0.084
-1 9/15	0.035	< 0.026	< 0.023	< 0.084
-3 9/15	0.034	0.030	< 0.023	< 0.084
6-1 9/15	0.021	< 0.026	< 0.023	< 0.084
-2 9/15	0.040	< 0.026	< 0.023	< 0.084
-3 9/15	0.016	< 0.026	< 0.023	< 0.084
6-3 9/15 Dup	0.015	< 0.026	< 0.023	< 0.084
-1 10/28	0.051	0.064	0.067	< 0.084
-2 10/28	0.083	< 0.026	0.077	< 0.084
-3 10/28	0.034	< 0.026	0.136	< 0.084
2-1 10/28	0.030	< 0.026	0.062	< 0.084
-2 10/28	0.039	< 0.026	0.080	< 0.084
-3 10/28	0.020	< 0.026	0.097	< 0.084
3-1 10/28	0.053	0.037	< 0.023	< 0.084
-2 10/28	0.048	< 0.026	< 0.023	< 0.084
-3 10/28	0.032	< 0.026	< 0.023	< 0.084
4-1 10/28	0.011	< 0.026	0.114	< 0.084
4-1 10/28 Dup	0.012	< 0.026	0.109	< 0.084
-2 10/28	0.012	< 0.026	0.112	< 0.084
4-3 10/28	0.034	< 0.026	0.410	< 0.084
5-1 10/28	0.031	< 0.026	< 0.023	< 0.084
-2 10/28	0.016	< 0.026	< 0.023	< 0.084
-3 10/28	0.021	< 0.026	< 0.023	< 0.084
6-1 10/28	0.015	< 0.026	< 0.023	< 0.084
-2 10/28	0.047	< 0.026	< 0.023	< 0.084
-3 10/28	0.059	0.101	< 0.023	< 0.084

D	NI	CR	CD
-1 6/26	0.028	< 0.014	< 0.006
-1 6/26 Dup	0.032	< 0.014	< 0.006
1-2 6/26	< 0.022	< 0.014	< 0.006
-3 6/26	0.033	< 0.014	< 0.006
-1 6/26	< 0.022	< 0.014	< 0.006
2-2 6/26	< 0.022	< 0.014	< 0.006
2-3 6/26	< 0.022	< 0.014	< 0.006
-1 6/26	0.025	< 0.014	< 0.006
-2 6/26	< 0.022	< 0.014	< 0.006
3-3 6/26	< 0.022	< 0.014	< 0.006
-1 6/26	< 0.022	< 0.014	< 0.006
-2 6/26	< 0.022	< 0.014	< 0.006
4-2 6/26 Dup	< 0.022	< 0.014	< 0.006
4-3 6/26	< 0.022	< 0.014	< 0.006

Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
Study: Grand Rapids Biosolids / shallow soil water @ 22 in.
Sample preparation: acidification to 1% HNO3
mg/kg (ppm) in the samples.

ID	NI	CR	CD
5-1 6/26	0.032	< 0.014	< 0.006
-3 6/26	< 0.022	< 0.014	< 0.006
-1 6/26	< 0.022	< 0.014	< 0.006
6-2 6/26	< 0.022	< 0.014	< 0.006
6-3 6/26	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
1-2 7/21	< 0.022	< 0.014	< 0.006
1-3 7/21	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
-1 7/21 Dup	< 0.022	< 0.014	< 0.006
2-2 7/21	< 0.022	< 0.014	< 0.006
-3 7/21	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
3-2 7/21	< 0.022	< 0.014	< 0.006
-3 7/21	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
4-2 7/21	< 0.022	< 0.014	< 0.006
4-3 7/21	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
-2 7/21	< 0.022	< 0.014	< 0.006
5-2 7/21 Dup	< 0.022	< 0.014	< 0.006
-3 7/21	< 0.022	< 0.014	< 0.006
-1 7/21	< 0.022	< 0.014	< 0.006
6-2 7/21	< 0.022	< 0.014	< 0.006
6-3 7/21	< 0.022	< 0.014	< 0.006
-1 9/15	0.026	< 0.014	< 0.006
1-3 9/15	< 0.022	< 0.014	< 0.006
2-1 9/15	< 0.022	< 0.014	< 0.006
-2 9/15	< 0.022	< 0.014	< 0.006
-3 9/15	< 0.022	< 0.014	< 0.006
3-1 9/15	< 0.022	< 0.014	< 0.006
-1 9/15 Dup	< 0.022	< 0.014	< 0.006
-2 9/15	< 0.022	< 0.014	< 0.006
-3 9/15	< 0.022	< 0.014	< 0.006
-1 9/15	< 0.022	< 0.014	< 0.006
-2 9/15	< 0.022	< 0.014	< 0.006
-3 9/15	< 0.022	< 0.014	< 0.006
-1 9/15	< 0.022	< 0.014	< 0.006
-3 9/15	< 0.022	< 0.014	< 0.006
-1 9/15	< 0.022	< 0.014	< 0.006
-2 9/15	< 0.022	< 0.014	< 0.006
-3 9/15	< 0.022	< 0.014	< 0.006
-3 9/15 Dup	< 0.022	< 0.014	< 0.006

Report generated: 12/09/97 08:54:33 By: BN (bold)
RAL Job #: 1997 W070
Study: Grand Rapids Biosolids / shallow soil water @ 22 in.
Sample preparation: acidification to 1% HNO3
mg/kg (ppm) in the samples.

ID	NI	CR	CD
1-1 10/28	< 0.022	< 0.014	< 0.006
1-2 10/28	< 0.022	< 0.014	< 0.006
1-3 10/28	< 0.022	< 0.014	< 0.006
2-1 10/28	< 0.022	< 0.014	< 0.006
2-2 10/28	< 0.022	< 0.014	< 0.006
2-3 10/28	< 0.022	< 0.014	< 0.006
3-1 10/28	< 0.022	< 0.014	< 0.006
3-2 10/28	< 0.022	< 0.014	< 0.006
3-3 10/28	< 0.022	< 0.014	< 0.006
4-1 10/28	< 0.022	< 0.014	< 0.006
4-1 10/28 Dup	< 0.022	< 0.014	< 0.006
4-2 10/28	< 0.022	< 0.014	< 0.006
4-3 10/28	< 0.022	< 0.014	< 0.006
5-1 10/28	< 0.022	< 0.014	< 0.006
5-2 10/28	< 0.022	< 0.014	< 0.006
5-3 10/28	< 0.022	< 0.014	< 0.006
6-1 10/28	< 0.022	< 0.014	< 0.006
6-2 10/28	< 0.022	< 0.014	< 0.006
6-3 10/28	< 0.022	< 0.014	< 0.006