STUDY OF THE EFFECTS OF STORM WATER INJECTION BY CLASS V WELLS ON A POTABLE GROUND WATER SYSTEM

Final Report

UC6001

Prepared for

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Lee,

Here is a copy of Woessner's storm water study for your records.

Take Care,
Richard

ABSTRACT

The City of Missoula, Montana, disposes of urban storm runoff through 2,669 Class V Wells. These storm water drains inject water directly into a 20 to 70 ft thick (6 to 21 m) sand, gravel, cobble and boulder vadose zone and the underlying unconfined aquifer which is used as the principal water supply. This research attempts to quantify the effects of injected water on the quality of the potable supply.

Class V Wells were inventoried and runoff samples and discharge measurements were taken at two storm sewer outfall sites that integrate drains from residential and commercial land uses. Samples were analyzed for gross chemistry, trace elements, and EPA priority organic pollutants. Pollutant loadings were computed using precipitation, impervious drainage areas, runoff coefficients, and EMC data. Two injection well sites were instrumented with nested lysimeters and single monitoring wells to determine the role of the vadose zone in attenuating or contributing pollutants in runoff recharge, and to monitor water quality changes at the water table. Water quality impacts to a portion of the aquifer in the vicinity of a large parking area containing over 100 Class V Wells were also evaluated.

Inventory results show 82% of the sumps are located in residential areas; commercial and industrial areas contain 16% and 2% respectively. We estimate that 119 million gallons (4.5×10^8 L) of storm water are injected annually through sumps. Runoff quality is highly variable. Runoff is a calcium bicarbonate type and contains measurable quantities of iron, manganese and zinc. Total annual loading of TDS is estimated to be over 4,400 tons (1.8×10^6 kg). Lysimeter data indicate that the vadose zone is a

source of gross ionic constituents, and reduces the concentrations of metals. Spring snow melt was dominated by sodium chloride which was partially attenuated in the vadose zone. The vadose zone increased the concentrations of major anions and cations in the runoff by several hundred to s_veral thousand percent. Ground water concentrations of bicarbonate, calcium, magnesium, sodium, chloride and iron increased in response to runoff recharge. Impacts to the ground water from runoff injected in the vicinity of a 3,000,000 ft^2 (279,000 m^2) parking lot showed TDS and chloride concentrations increased down gradient. Iron, copper and zinc were found more frequently in the ground water at this site than in other areas studied.

ACKNOWLEDGEMENTS

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INTRODUCTION

Activities associated with populated centers produce large volumes of waste materials which are contained in discrete waste streams and collection stations, discharged to the atmosphere, and/or dispersed on or below land surface. The waste dispersed on land surface and atmospheric dustfall generate pollutants in urban storm water (Overton and Meadows, 1976). Runoff is often disposed of in municipal storm sewers or sent to the sewage treatment plant. However, in arid regions with thick vadose zones runoff is disposed of by street corner sumps, dry wells or French drains as an alternative to higher cost sewers. Such disposal mechanisms are classified by the EPA as Class V Injection Wells. The impact of urban runoff on underlying unconfined aquifer systems has not been well documented. This paper quantifies the chemical loading to a coarse alluvial unconfined aquifer which is the sole source of water to more than 50,000 residents.

In recent years, there has been increasing concern over urban runoff as a source of receiving water quality problems. In 1978, the Nationwide Urban Runoff Program (NURP) was established to obtain information on the significance of urban runoff as a contributor to these problems (EPA, 1983). Researchers found that inorganic pollutants occurred more frequently and at higher concentrations than organic pollutants. The trace metals most often detected were copper, lead, and zinc. Other trace inorganics detected were arsenic, chromium, cadmium, and nickel. Two NURP study sites, Long Island, NY, (Koppelman, 1984), and Fresno, CA, (Brown and Caldwell, 1984) were situated over unconfined sole source aquifers. Both studies reported that soil processes were efficient in retaining urban runoff pollutants. Schmidt (1985) studied dry well injection of urban runoff into an unconfined-ground water system in Phoenix AZ, and found that the water quality from one monitoring well had concentrations of inorganic constituents which were lower than background, and injected water "improved" receiving ground water quality. He also reported that lead, iron and manganese were potential ground water pollutants but trace metals found in the runoff were not at detectable concentrations in the ground water. In Spokane, WA, where Class V Injection Wells are used for runoff disposal, the County Engineers (1983) conducted a study to identify sources of impacts to ground water quality. They concluded that storm drain injection could account for up to 30% of contaminant loading to the aquifer. Ground water monitoring revealed a "stratification" of contaminant levels which was attributed to polluted surface water recharging the aquifer.

This study examines the effects of recharging storm water runoff, via Class V Injection Wells, on the quality and quantity of water in the Missoula Aquifer. Specific objectives include:

1) an inventory of storm drain locations, land use, and impervious area,
3) determination of urban runoff quantity, ratios, quality and loading,
4) determination of the effect of the vadose zone on injected water and the resulting impact to the aquifer.

STUDY SETTING

The Missoula Valley is located in a fault-bounded basin typical of Northwestern Montana (Figure 1) and contains approximately 2,500 ft (760 m)

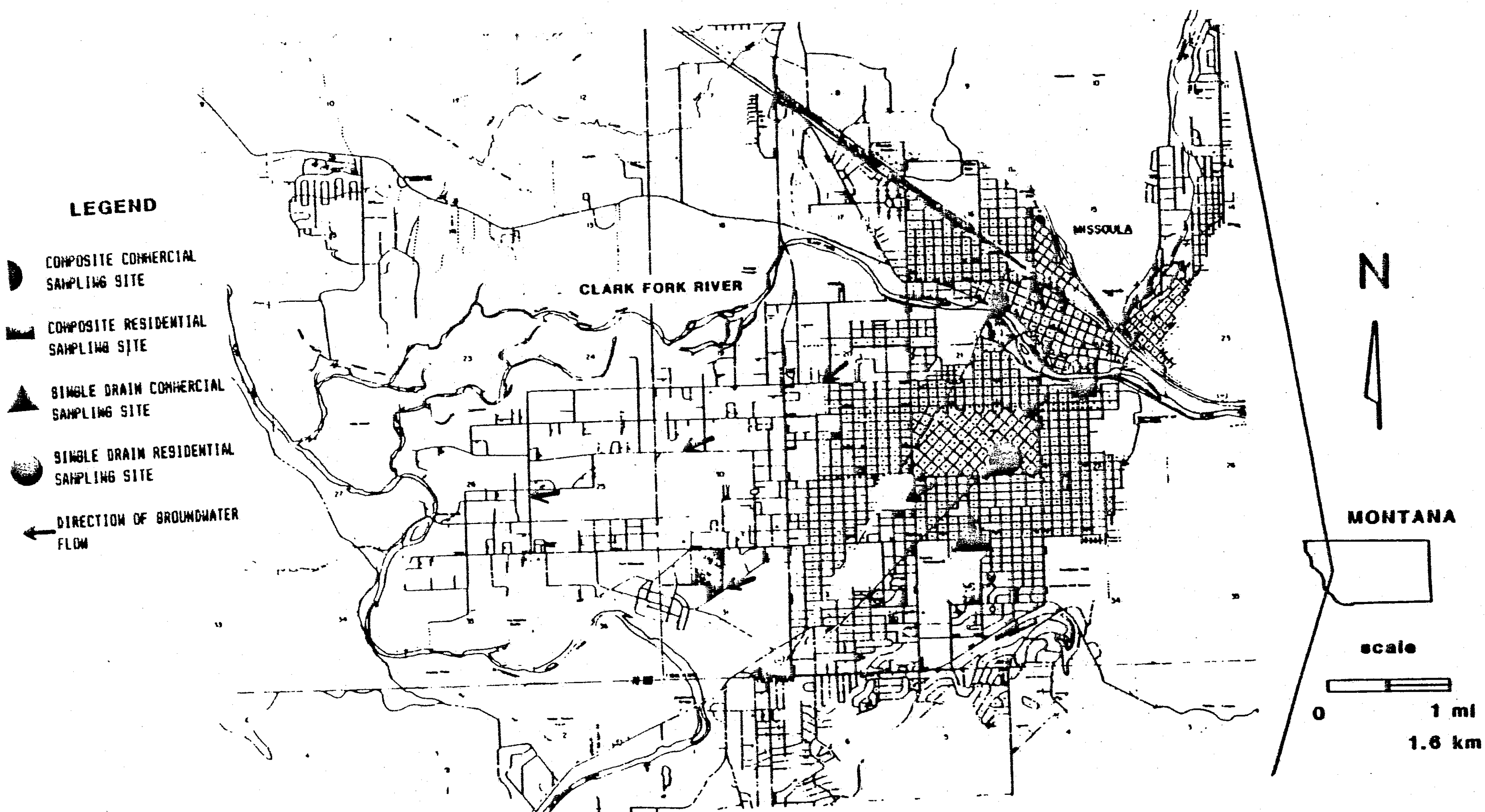

Figure 1: Location map.

of continental clastic basin fill deposits (McMurtrey et al., 1965). These deposits range in size from clay to coarse gravel which unconformably overlie pre-basin Precambrian Belt Supergroup metasediments. The Missoula Aquifer forms the valley bottom, is unconfined and extends from 100 to 200 ft (30 to 60 m) below land surface. Stratigraphically, it is composed of: a top layer exposed at land surface 10 to 30 ft (3 to 9 m) thick of interbedded boulders, cobbles, gravel, sand and silt; an intermediate layer with an average thickness of 40 ft (12 m) dominated by silty sandy clay, with local layers of coarse sand and gravel; and a basal layer that varies from 50 to 100 feet (15 to 30 m) dominated by interbedded gravel, sand, silt and clay. The vadose zone varies from 20 to 70 ft (6 to 21 m) thick, and is composed of both the coarse grained surficial unit and the finer intermediate unit. The aquifer is prolific with hydraulic conductivities of about 3,400 ft/d (1,040 m/d) and transmissivities of about 1,700,000 gpd/ft (21,125 m^2/d). The Clark Fork River, which flows westward through the Missoula Valley, is influent for about the first three miles (5 km), and recharges the unconfined Missoula Aquifer at an average rate of approximately 36 million gallons (136 million liters) of water a day (Clark, 1986). The water table rises from April to June in response to increased river recharge during spring snowmelt. The water table declines from July through February. Ground water flow is generally away from the Clark Fork River (Figure 1). The aquifer is the sole source of drinking water for Missoula and annually yields in excess of 9.7 billion gallons (36.7 billion L).

The climate in the valley is semiarid. The long-term average annual precipitation is 13.29 in (33.76 cm). Peak precipitation occurs in May and June.

METHODOLOGY

We inventoried the storm drains in Missoula through field examination and by using city records. City maps were used to make a land use map and to estimate the impervious area. Land uses were categorized as residential, commercial or industrial. Precipitation was measured near sampling sites by two continuously recording gages. To categorize runoff quality and quantity entering the Class V Injection Wells, we selected two sampling sites which integrated several drains connected by a storm sewer (one in a commercial land use, the other in a residential land use) (Figure 1). At the outfalls of these two storm sewer systems, discharge was measured and water quality data were collected several times during a storm. Samples were filtered through a .45um filter, refrigerated and analyzed for major cations and anions. Samples collected for metal analyses were filtered and preserved with nitric acid. A few selected samples were analyzed for oil and grease, dissolved and total Kjeldahl nitrogen, nitrate and nitrite, and total metals. Grab samples of runoff and ground water were also analyzed for EPA priority pollutants. All sampling and laboratory procedures used EPA approved techniques (Appendix A).

Characterization of storm runoff quality was accomplished by calculating the Event Mean Concentration (EMC) (EPA, 1983).

$$EMC = \frac{(t_{n+1}-t_n)(1/2)(c_n q_n + c_{n+1} q_{n+1})}{(t_{n+1}-t_n)(1/2)(q_n + q_{n+1})}$$

where:

t = time, min
c = concentration, mg/l
q = discharge, l/min

Runoff ratios (ROR) were estimated for residential and commercial land use areas by dividing the runoff volume by the precipitation volume. Contaminant loadings (lbs/yr) for each land use were calculated using the equation;

$$\text{load} = \text{ppt} \times \text{area} \times \text{ROR} \times \text{EMC}$$

and added together to yield the total annual loading to the Missoula Aquifer sediments.

Two sampling sites (commercial and residential) were selected to determine the role of the vadose zone in contributing or attenuating contaminants of recharging runoff, and to monitor the effect of Class V Injection Well recharge on the underlying ground water system (Figure 1). Each site was instrumented with a runoff collection device, variable depth suction lysimeters, a monitoring well, and a neutron access tube. The runoff collection device consisted of a plastic garbage can top strapped under the drain grate. Suction lysimeters were Soilmoisture one bar high flow ceramic cups. The monitoring well was constructed using PVC casing, completed at the water table with ten feet of 60 slot screen capped at the bottom, and equipped with a Stevens Type F continuous water level recorder (Figure 2). The neutron access tube was constructed using two inch (5.1 cm) diameter aluminum pipe. The neutron probe was a Troxler model 3222. A sampling program was designed to collect samples of runoff, the wetting front in the vadose zone and ground water as the wetting front reached the water table. It included sampling runoff and calculating the EMC, sampling the lysimeters after a storm, and sampling ground water daily during the observed water table rise associated with the storm water recharge event. A soil moisture profile was measured after a storm with the neutron probe to follow the wetting front to the ground water system. Aquifer background water quality

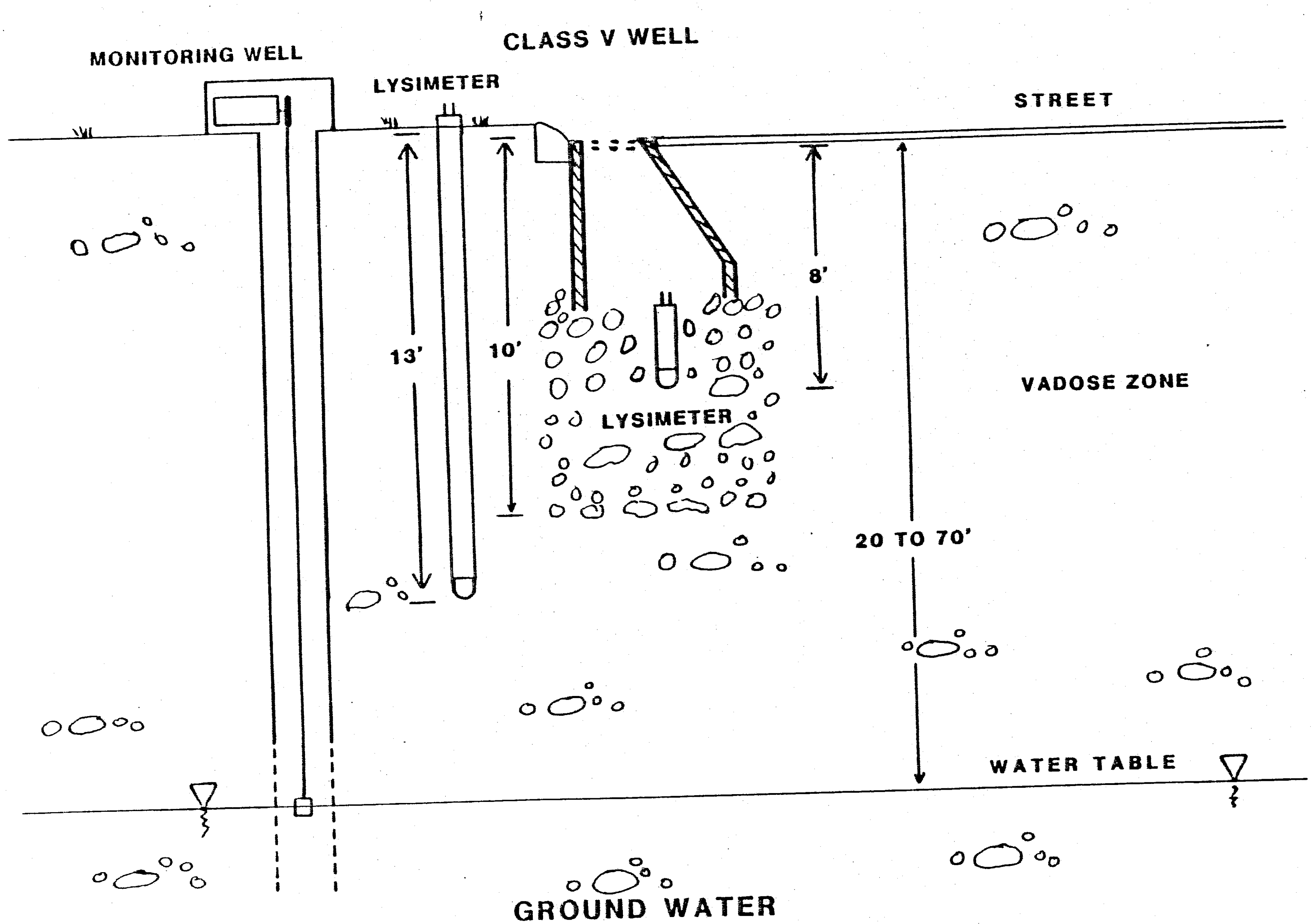

Figure 2: Schematic cross section of single drain site instrumentation.

was established by sampling wells at the single drain sites and up hydraulic gradient of these instrumented sites weekly from February to June.

As an expansion of our single drain commercial site impact analysis, we studied effects of urban runoff from a 3,000,000 ft^2 (279,000 m^2) parking area containing over 100 drains. Grab samples of storm runoff were collected at three large parking areas to characterize runoff. A ground water monitoring network was set up in the vicinity of one parking area in an attempt to monitor the effect of runoff injection from a large number of drains on the ground water quality. We sampled four existing wells bimonthly that were located around Southgate Mall (Plate 1). We measured water levels at additional wells in this area and tied them into a larger valley wide network to determine ground water flow direction. Impacts were accessed by comparing the change in water quality in the vicinity of the mall site with changes observed where there is no impact due to urban runoff recharge.

RESULTS AND INTERPRETATION

Storm water runoff recharges the Missoula Aquifer over an area of approximately nine square miles (23 km) through 2,669 storm drains (Plate 1). 82% of the storm drains are located in residential areas, 16% are found in commercial areas and 2% in industrial areas. Because the industrial area composed a small percentage of the total land use, we did not separate it out for study. Instead, we assumed that it had similar properties as the commercial area.

The location of precipitation gages are shown in Plate 1. Table 1 presents precipitation, impervious areas, quantity of runoff measured, and the runoff ratios estimated for the two composite sites for five storms. Runoff ratios were variable. Generally, commercial land has higher runoff ratios than residential land. We believe this is due in part to the lack of canopy interception. Complete precipitation and related data used to calculate runoff ratios can be found in Appendix B and C.

Table 1: Runoff Ratio Calculations.

storm	ppt (in)	ppt (cm)	area (ft^2)	area (m^2)	RO vol (gal)	RO vol (l)	ROR
COMMERCIAL SITE							
1986							
June 28	.77	1.96	59200	4760	19700	86880	.69
Nov 5	.03	.13	59200	4760	900	3410	.82
RESIDENTIAL SITE							
1986							
June 4	.15	.38	351600	32680	6800	25670	.21
June 7	.37	.94	351600	32680	46600	176400	.57
Nov 6	.02	.05	351600	32680	2000	7670	.45

Using an average annual precipitation of 13.29 in/yr (33.76 cm/yr), average runoff ratios and impervious areas from Table 3, approximately 119 million gallons (4.5×10^8 L) of water recharge the vadose zone annually. Residential runoff makes up 58% of the calculated value and commercial runoff comprises 42%.

Data used for the EMC calculation are found in Appendix C and D. Table 2 lists the EMC's for the storms monitored at the composite sampling sites and illustrates the highly variable nature of runoff quality. Several factors contribute to this variability. A comparison of the 6-4-86 and 6-7-86 storms at the Missoulian site (MO) demonstrates the effect of the length of time without rain on runoff quality. Runoff was higher in constituents during the June 4th storm which was proceeded by 12 days without rain as compared to the June 7th event which was proceeded by only one day without rain.

Table 2: EMC's of Composite Sites.*

	MISSOULIAN (MO) RESIDENTIAL				BLANCHE (BO) COMMERCIAL		
	1986			1987	1986		1987
	04-Jun	07-Jun	06-Nov	snowmelt	28-Jun	05-Nov	snowmelt
EMC HCO_3	55.5	19.7	47.5	37.4	7.6	34.0	40.6
EMC Cl	5.64	1.64	19.26	166.20	1.13	10.02	819.13
EMC SO_4	15.1	4.1	15.0	14.2	1.8	12.8	28.6
EMC NO_3-N	0.68	0.09	0.08	0.67	0.22	0.75	1.12
EMC Ca	19.8	6.7	24.5	15.5	3.5	17.8	48.7
EMC Mg	4.0	1.1	6.2	3.0	0.4	3.2	9.6
EMC Na	7.3	2.2	5.0	109.0	1.6	8.9	507.9
EMC K	11.4	2.9	26.0	8.5	1.2	6.8	18.6
EMC TDS	121	38	143	356	18	98	1436
EMC As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
EMC Cd	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
EMC Cr	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
EMC Cu	0.01	0.01	0.03	0.01	<0.01	0.02	0.02
EMC Fe	0.29	0.09	0.30	0.16	0.11	1.04	0.13
EMC Pb	0.02	0.01	<0.01	<0.01	<0.01	0.08	<0.01
EMC Mn	0.21	0.05	0.43	0.16	0.04	0.35	0.39
EMC Ni	<.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
EMC Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<.001
EMC Zn	0.05	0.04	0.26	0.05	0.05	0.27	0.08

* concentrations are in mg/l

Snowmelt data collected simultaneously at the two land use sites indicate that commercial land uses have higher contaminant concentrations. These data also show a substantial seasonal increase in sodium and chloride due to the salting of gravel used on roads in the winter. The metals commonly found in urban runoff include iron, manganese, and zinc with the occasional occurrence of copper and lead. Concentrations in runoff are variable and range from <.03-.1.51, <.02-.74, <.01-.52, <.01-.05, and <.01-.11 mg/l for iron, manganese, zinc, copper and lead, respectively. Cadmium, chromium and nickel rarely occur; no arsenic or mercury were found. Runoff was sampled for EPA priority organic pollutants once at the composite residential and commercial sites and a parking lot. At each site all compounds were below standard detection limits. Appendix D contains all water quality data and Appendix G holds the Quality Control data.

Results of the samples that were analyzed for dissolved and total load data show that for iron, copper, lead, and zinc the dissolved fraction of these metals makes up only a small portion of the total (greater than .45 um) load. The concentrations of manganese were approximately the same in the dissolved load and total load. Oil and grease was detected in 100% of the runoff samples and concentrations ranged from 3 to 14 mg/l. Kjeldahl nitrogen concentrations ranged between 0.9 and 6.3 mg/l in runoff. Concentrations of nitrate-nitrite ranged from .48 to 3.12 mg/l in runoff. EMC's were not calculated because only a few samples were analyzed for these constituents (Appendix E).

Annual runoff loading rates for various chemical constituents were calculated using average EMC's, ROR and impervious area for residential and commercial land (Table 3). When concentrations for trace metals were below detection, one half the detection limit of the parameter was used to calculate loadings. Annual constituent loading by land use and also for the total area served by Class V Injection Wells are presented in Table 4. Commercial areas contributed the largest load of TDS, sodium, chloride, iron and lead. Loading of calcium, nitrate and copper was about the same as in residential areas. Residential areas contributed larger loads of the remaining constituents.

Table 3: Variables Used in Loading Calculations.*

	RESIDENTIAL SITE	COMMERCIAL SITE
ppt	13.29 in (33.76 cm)	13.29 in (33.76 cm)
imp area	20,424,000 ft ($1.9x10^6$ m)	7,877,000 ft ($7.3x10^5$ m)
ROR	.41	.76
EMC HCO_3	40.02	27.38
EMC Cl	48.19	276.76
EMC SO_4	12.11	14.37
EMC NO_3-N	0.38	0.70
EMC Ca	16.61	23.34
EMC Mg	3.61	4.38
EMC Na	30.90	172.79
EMC K	12.22	8.88
EMC TDS	165.12	517.07
EMC Cu	0.01	0.02
EMC Fe	0.21	0.42
EMC Pb	0.01	0.03
EMC Mn	0.21	0.26
EMC Zn	0.10	0.13

* concentrations in mg/l

EMC calculations for runoff events monitored at the single drain commercial site, South (SW), and the residential site, Blaine (BW), are presented in Appendix F. Trends were similar to those found at the composite sites. Selected EMC data used to examine the impact to the vadose zone on the recharging water is found in Table 5.

The effect of the vadose zone on the percolating runoff was generalized by comparing water quality samples of runoff, samples taken from the eight and thirteen feet (2.4 and 4.0 m) lysimeters and ground water. The stiff diagrams (Figure 3) represent water quality results for major anions and cations at the commercial and residential land use sites for summer and snowmelt. At both sites the vadose zone is a source of major cations and anions. However, the concentrations of chloride and sodium ions appear to be

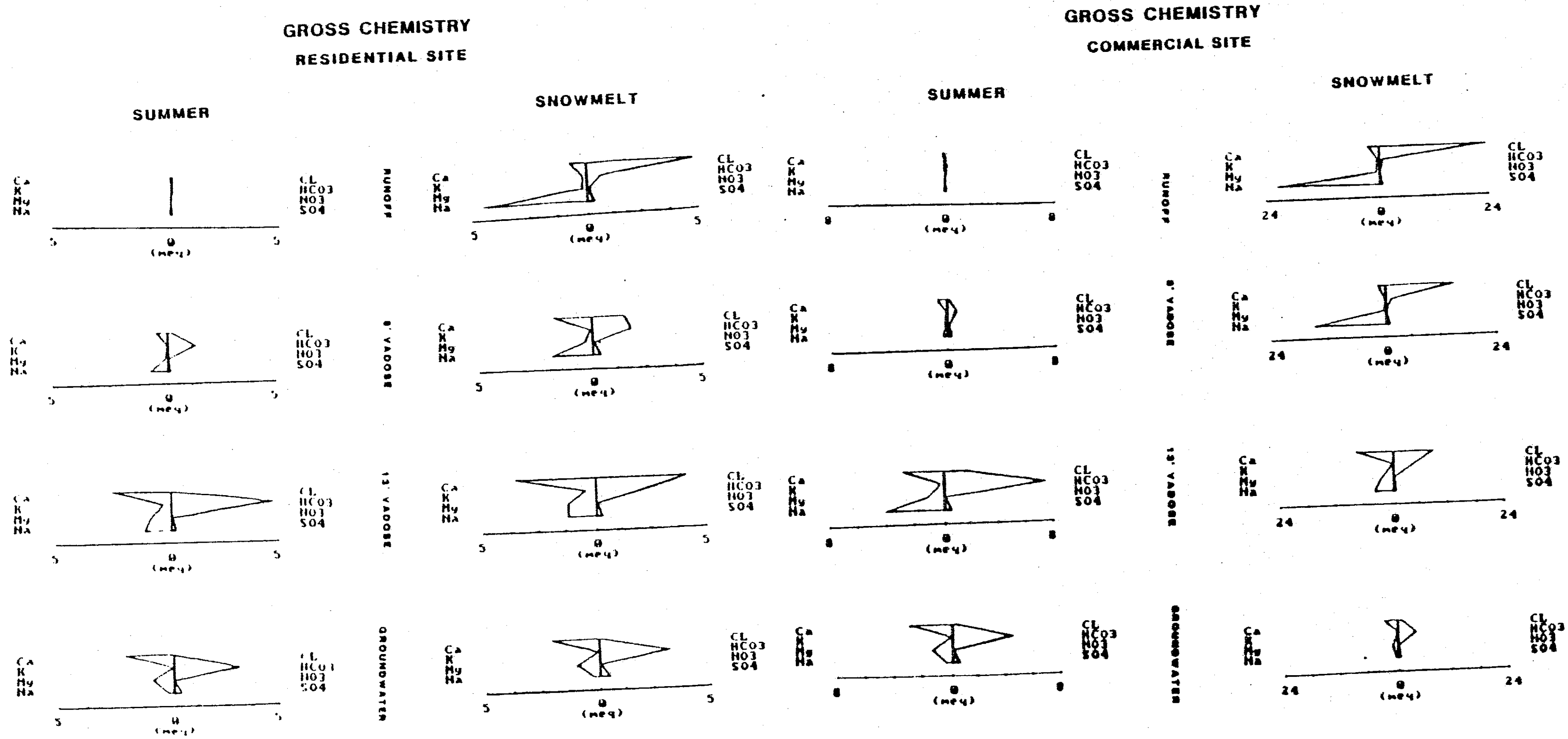

Figure 3: Stiff diagrams for commercial and residential sites.

partially attenuated in the vadose zone during snowmelt recharge.

Table 4: Annual Loading from Runoff.

	COMM (lb/yr)	COMM (kg/yr)	RES (lb/yr)	RES (kg/yr)	TOT (lb/yr)	TOT (kg/yr)
HCO_3	11330	5140	23170	10510	34500	15650
Cl	114550	51960	27900	12650	142450	64610
SO_4	5950	2700	7010	3180	12950	5880
NO_3-N	290	130	220	100	510	230
Ca	9660	4380	9620	4360	19270	8740
Mg	1810	820	2090	950	3900	1770
Na	71520	32440	17890	8110	89410	40550
K	3670	1670	7070	3210	10750	4880
TDS	214010	97070	95590	43360	309600	140430
Cu	6.3	2.8	7.0	3.2	13.2	6.0
Fe	175.1	79.4	121.5	55.1	296.6	134.5
Pb	13.1	5.9	7.1	3.2	20.2	9.2
Mn	107.5	48.8	124.1	56.3	231.6	105.1
Zn	55.0	25.0	57.0	25.8	112.0	50.8

The trace elements most frequently found in runoff and lysimeter samples were iron, copper, manganese and zinc. Copper and zinc generally increased in concentration from runoff to the eight feet (2.4 m) lysimeter, and then decreased at the thirteen feet (4.0 m) lysimeter (Figure 4). At the residential site manganese showed trends similar to copper and zinc. However, at the commercial site, manganese concentrations decreased with depth. Iron concentrations decreased with depth at the commercial site and during snowmelt at the residential site. At both sites snowmelt recharge had higher concentrations of copper, iron, and manganese than summer recharge. Vadose zone water beneath commercial land uses had higher concentrations of iron, zinc, and copper during summer runoff and snowmelt.

Oil and grease was detected in the 13 ft (4.0 m) lysimeter at the residential site 4 out of 6 times; concentrations ranged from 1 to 3 mg/l. Kjeldahl nitrogen concentrations ranged from 1.6 and .20 mg/l in the vadose

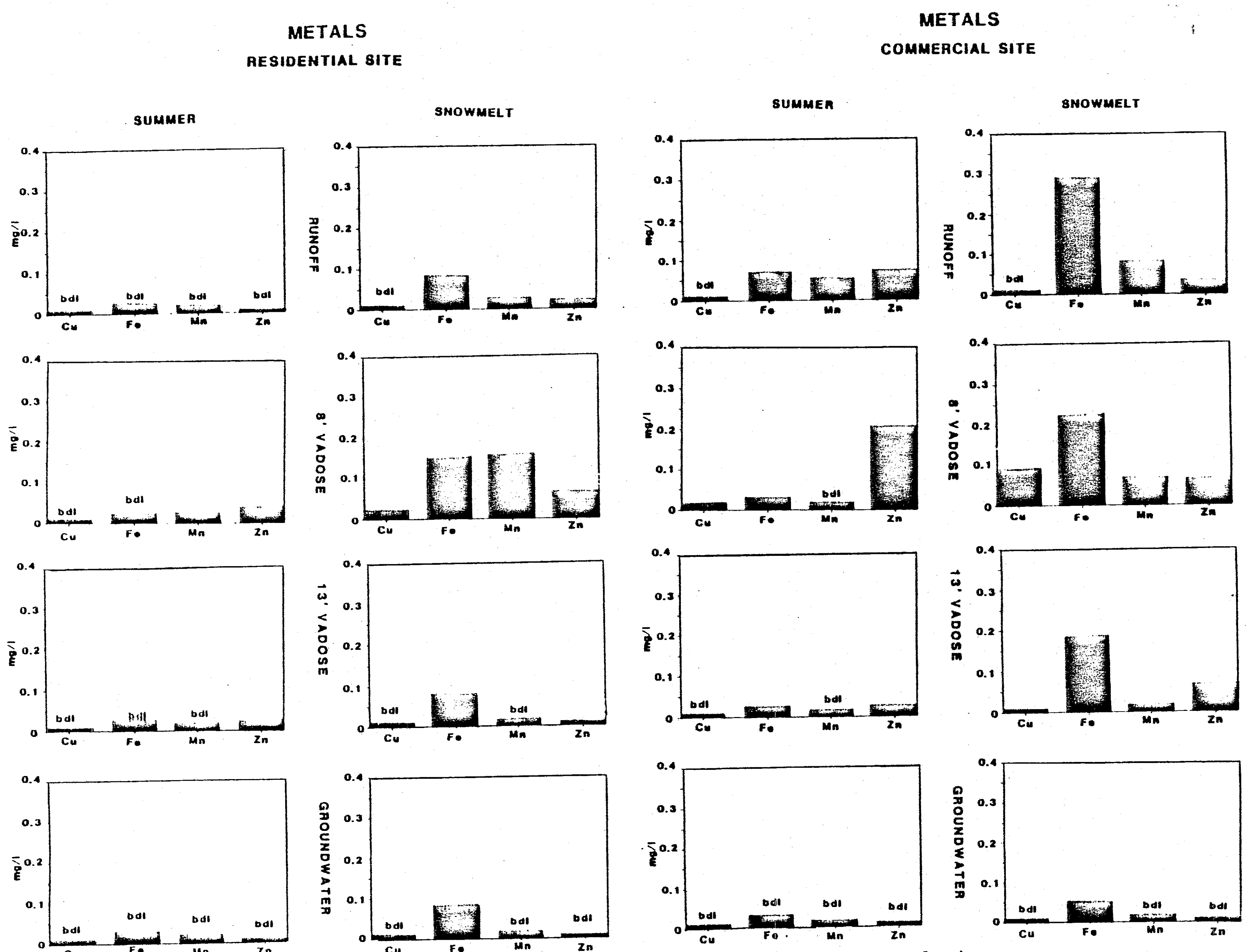

Figure 4: Metal concentrations for commercial and residential sites.

zone. Concentrations of nitrate-nitrite ranged from 1.28 to 2.52 mg/l.

Table 5 lists the percent change in major ion concentrations after recharge passed through the vadose zone. The percent change was determined by comparing the runoff EMC's for a summer or fall event to concentrations found at the 13 ft (4.0 m) lysimeter. The data used does not account for additional loading during spring snowmelt. Consequently, it represents a conservative estimate of annual loading. All parameters increased with depth on the order of several hundred to several thousand percent. The highly variable nature of the metal data made it extremely difficult to generalize vadose zone concentrations. As a result the effect of the vadose zone on each metal was not quantified.

Table 5: Effect of the Vadose Zone on Percolating Runoff.*

	RESIDENTIAL SITE**					COMMERCIAL SITE***				
	storm EMC	8ft lys	%	13ft lys	%	storm EMC	8ft lys	%	13ft lys	%
HCO_3	4.5	87.4	+1842	280.2	+6127	12.0	104.4	+770	367.2	+2960
Cl	1.01	6.13	+507	1.43	+41	1.37	9.76	+612	95.20	+6849
SO_4	1.8	6.8	+278	9.1	+405	1.9	10.3	+442	20.0	+953
NO_3-N	0.15	1.11	+640	2.6	+1633	0.07	0.4	+471	0.6	+757
Ca	1.5	16.8	+1020	53.5	+3467	3.8	28.1	+639	76.9	+1924
Mg	.26	2.8	+977	11.6	+4362	0.42	3.2	+662	16.0	+3710
Na	.6	16.6	+2667	28.5	+4650	2.0	13.1	+555	48.3	+2315
K	.3	1.8	+500	15.3	+5000	0.8	4.1	+413	7.8	+875
TDS	10.6	143	+1249	407.8	+3747	22.6	175	+674	542	+2300

* concentrations in mg/l
** October 3 & 16, 1986
*** June 6 & 19, 1987

Table 6 presents the estimated annual loading to the aquifer. These estimates assume that no additional increase or decrease in concentrations occurred below 13 feet (4.0 m) and that all recharging water reaches the water table.

Table 6: Annual Loading to the Aquifer

	COMM (lb/yr)	COMM (kg/yr)	RES (lb/yr)	RES (kg/yr)	TOT (lb/yr)	TOT (kg/yr)
HCO_3	346800	157310	1442770	654430	1789580	665760
Cl	7960070	3610620	39330	17840	7999400	132390
SO_4	62620	28400	35390	16050	98010	22000
NO_3-N	2470	1120	3820	1730	6280	2020
Ca	195480	88670	343030	155590	538510	165250
Mg	69130	31360	93140	42250	162280	44060
Na	1727090	783400	849760	385450	2576860	456960
K	35820	16250	360800	163650	396620	167330
TDS	5136300	2329780	3677440	1668060	8813740	1882070

Precipitation, water level fluctuations and water quality data were used to determine the effect of recharge derived from Class V Injection Wells on water quality. At both sites percolating storm runoff passed through about a 50 to 60 ft (15 to 18 m) thick gravel, boulders and sand vadose zone. Since water level fluctuations and water quality changes were more pronounced at the commercial site, it is the focus of this report.

We were unable to detect the wetting front as it percolates through the vadose zone with the Troxler neutron probe. We feel that the very coarse grained nature of the vadose zone, the eight inch (20.3 cm) diameter disturbed zone we created during access tube installation, the location of the access tube, and the small sphere of influence of the probe have prevented us from observing changes in moisture content through the vadose zone.

Precipitation and water level fluctuations at the commercial site are shown in Figure 5. General water table trends are principally controlled by

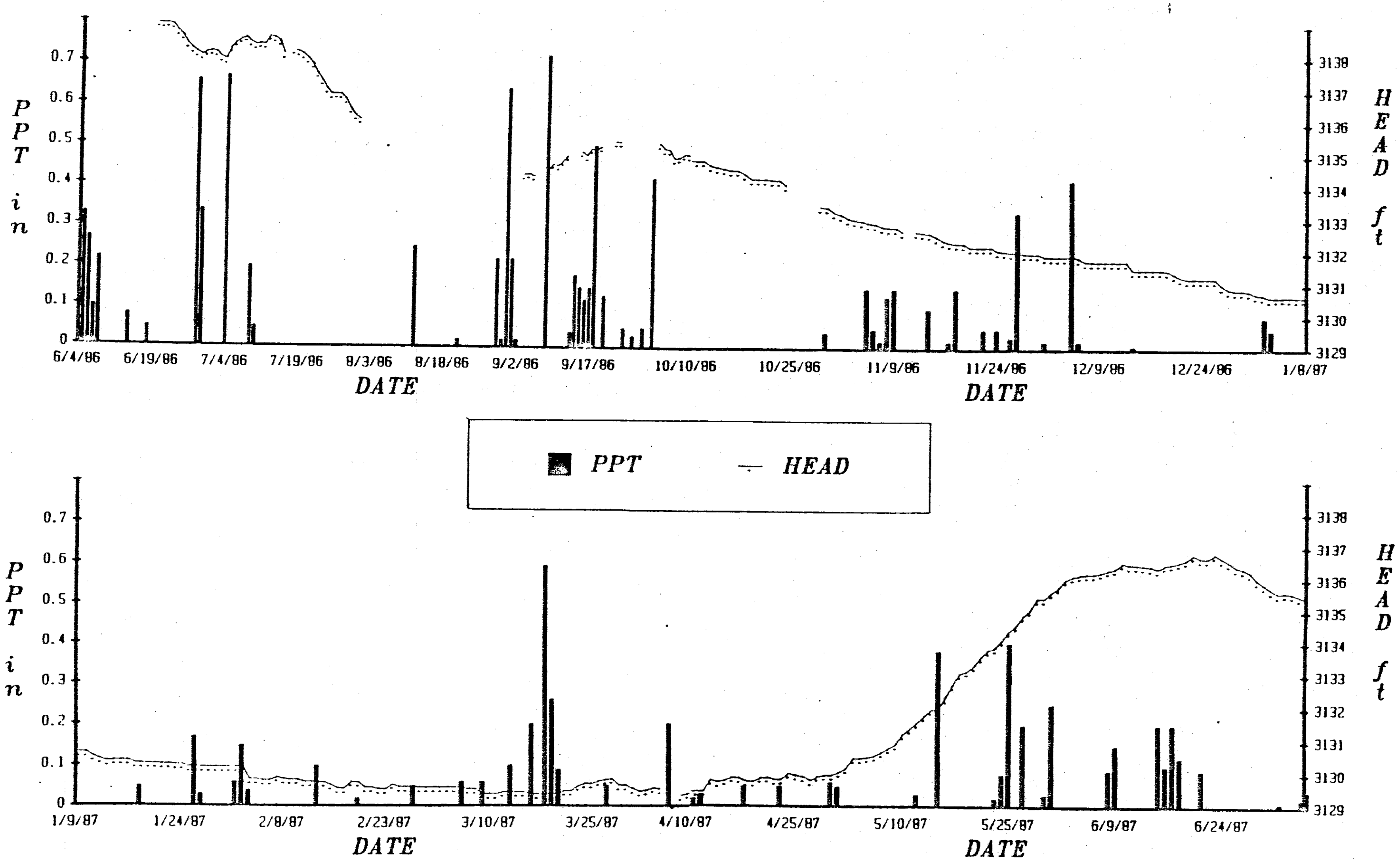

Figure 5: Precipitation and water table fluctuation vs. time at the commercial site.

the rate of Clark Fork River leakage to the aquifer. Precipitation data appears to correlate with small rises in the water table in June, 1986 through early October, 1986 and then again from late February through June, 1987. Water level rises are between 0.47 ft (0.14 m) and 1.06 ft (0.32 m). Winter precipitation was in the form of snow which did not melt until late February, hence the lack of a correlation of winter time precipitation data with water level change. Figures 3 and 4 document the transport of dissolved constituents through the vadose zone and also show the concentrations found in the ground water adjacent to each site. However, the impact of recharging water is difficult to detect without accounting for background ground water quality prior to a recharge event. Figure 6 shows background concentrations of TDS and concentrations related to recharging vadose water. Concentrations in ground water during September, 1986, and late February - March, 1987, show a measurable increase during water level rise. The behavior of TDS is similar to that of bicarbonate, calcium, magnesium, and sodium. Chloride concentrations increase during the spring when recharging water contains up to 800 mg/l of chloride (Figure 7). Iron concentrations remained below detection, < 0.03 mg/l, until late February - March, 1987, when they rose to 0.35 mg/l (Figure 7). These peaks in concentration are associated with water level fluctuations attributed to injected snowmelt water reaching the aquifer. Sulfate and potassium concentrations show no measurable increase related to storm water injection.

Ground water was sampled for organic EPA Priority Pollutants twice at both the residential and commercial site. All parameters were below detection with the following exceptions: at the residential site tetrachloroethene was detected on September 15, 1986 (6 ug/l) and June 24, 1987

1987 (11 g/l), and bis (2-ethylhexl) phthalate was detected on June 24, 1987

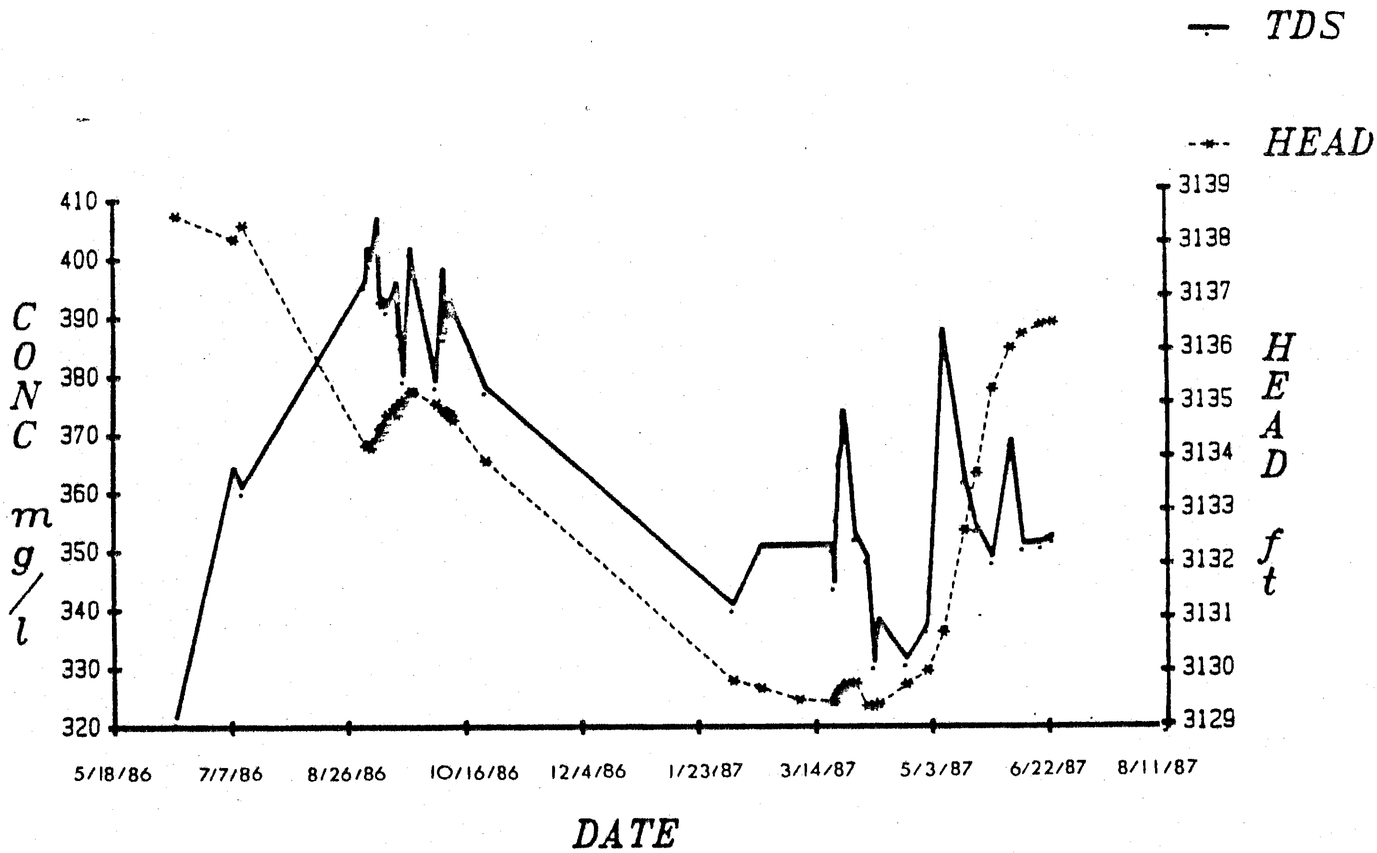

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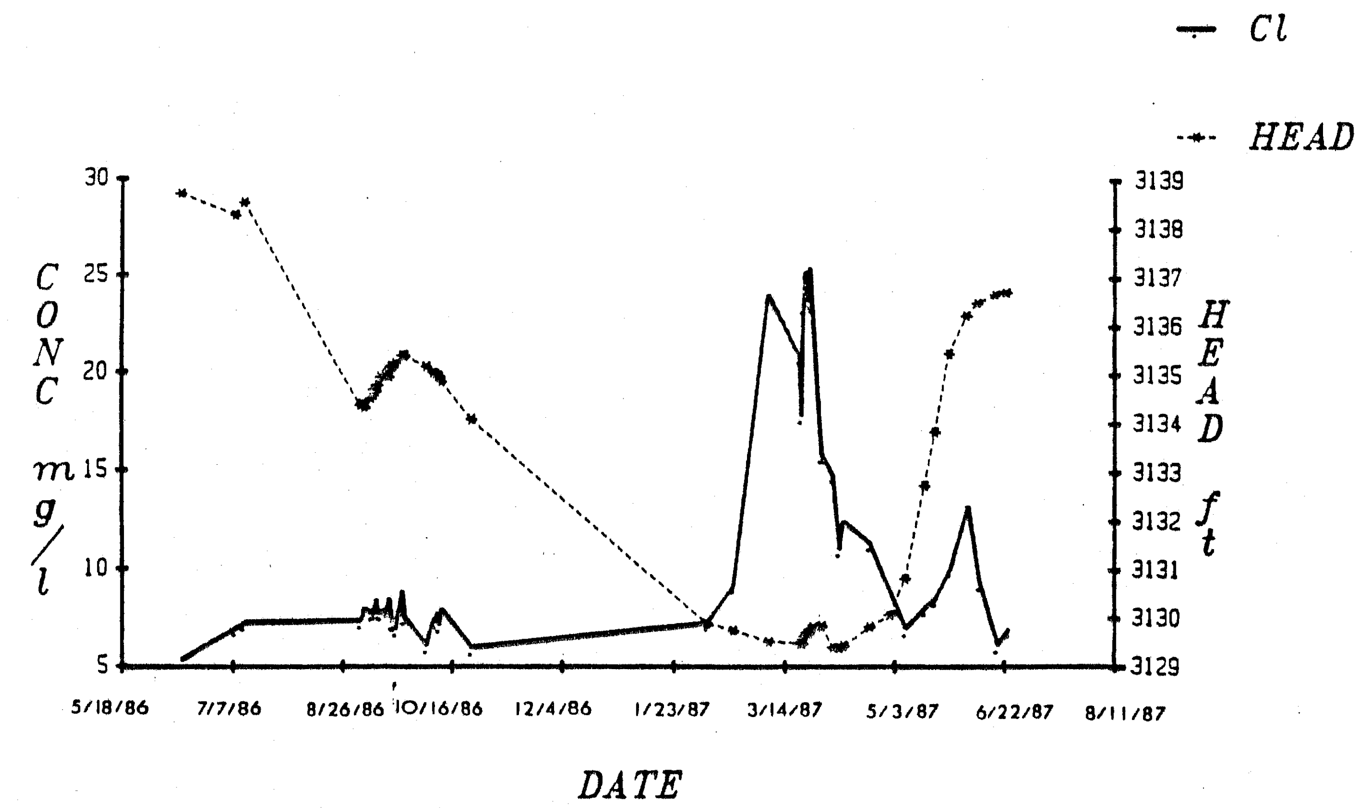
Figure 6: TDS and water table fluctuation vs. time

(40 µg/l); and at the commercial site bis (2-ethylhexl) phthalate was detected on June 24, 1987 (80 g/l). We do not believe these concentrations represent storm water contamination because they were not detected in runoff samples.

The last phase of our research effort focused on documenting the effects of urban runoff injected from large parking areas on the underlying ground water quality. Runoff samples were collected at the K-mart (KM), University of Montana (UM), Buttrey (BP), and Southgate Mall (SMD & MD) parking lots (Plate 1). Our ground water sampling efforts concentrated around the



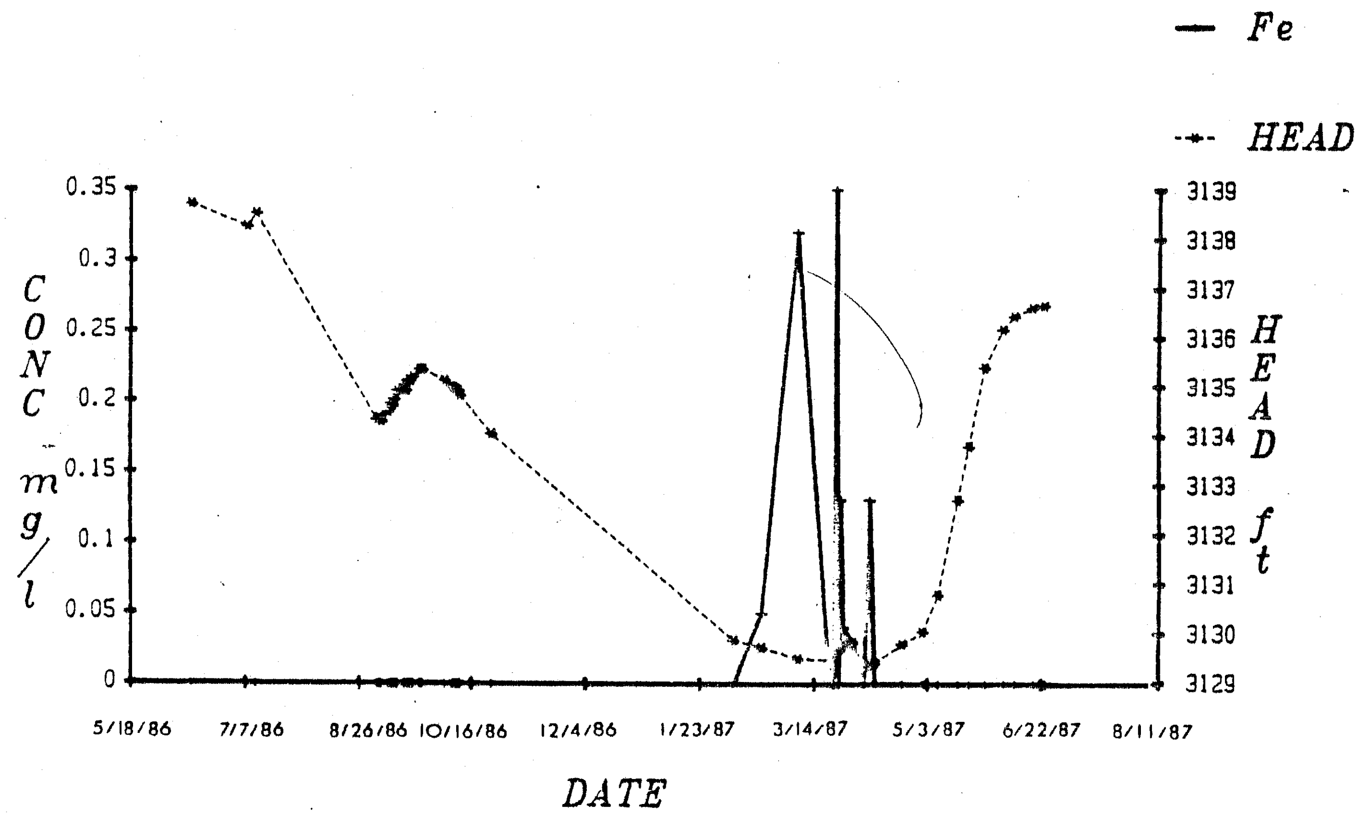


Figure 7: Chloride, iron and water table fluctuation vs. time.

Southgate Mall parking lot where storm water is injected through over 100 drains in a concentrated area. To isolate the effects from injected water we analyzed ground water flow data, natural seasonal variations in ground water quality, the change in TDS concentration in the direction of ground water flow, and the relationship between metal occurrence in storm water runoff and in ground water.

Water level data from the valley and wells around Southgate Mall indicate that ground water flows to the southeast (Plate 1). Wells sampled for water chemistry were Southgate Office well (SO), Dearborn well (DW), Engine Rebuilders well (EW), and Checker well (CW). Checker well is located down gradient of the Southgate Mall parking area and the other wells are up gradient (Plate 1). In order to evaluate the impact of the parking area on local ground water quality, we recognized that existing wells were not ideally located or constructed. The down gradient Checker well is not centered in the flow path passing through the parking area. All wells are steel cased and open only at the bottom.

Another important factor influencing impact analysis is that the chemistry of the recharge water from the Clark Fork River varies seasonally. To evaluate the impact on aquifer water quality from recharge from the river, we collected samples from the steel cased Madison Bridge well (MB) which is located adjacent to the river (Plate 1). Results show that total dissolved solids decreases due to dilution during May - June, a period of increased recharge. Metals data show that 3 of 14 samples contained iron and 2 of 14 samples contained zinc. No other metals were detected. These occurrences do not appear to related to increased river recharge. We feel the detection of metals is possibly related to the steel casing of the well. We do not believe there is an source of metals to the aquifer from the river because only isolated detections of metals are found in the Madison Bridge well and other monitored wells along the river. In addition, the Blaine (BW) and South (SW) monitoring wells, which are constructed properly for metal sampling, only show the occurrence of metals during periods of storm water runoff recharge. We defined seasonal changes by looking at the range in TDS concentrations at selected wells in the valley (Table 7). Wells near the river show a 20% change in TDS (MB), however, as the distance from the river increases, as seen at MV28, only a 3% change was measured. MV28 was selected for analysis because it represents ground water passing through a large section of the aquifer which is not impacted by Class V Wells and it is about the same distance from the river as the mall study site. Therefore, we infer that at Southgate Mall, there is should be no measurable seasonal change in ground water chemistry.

?

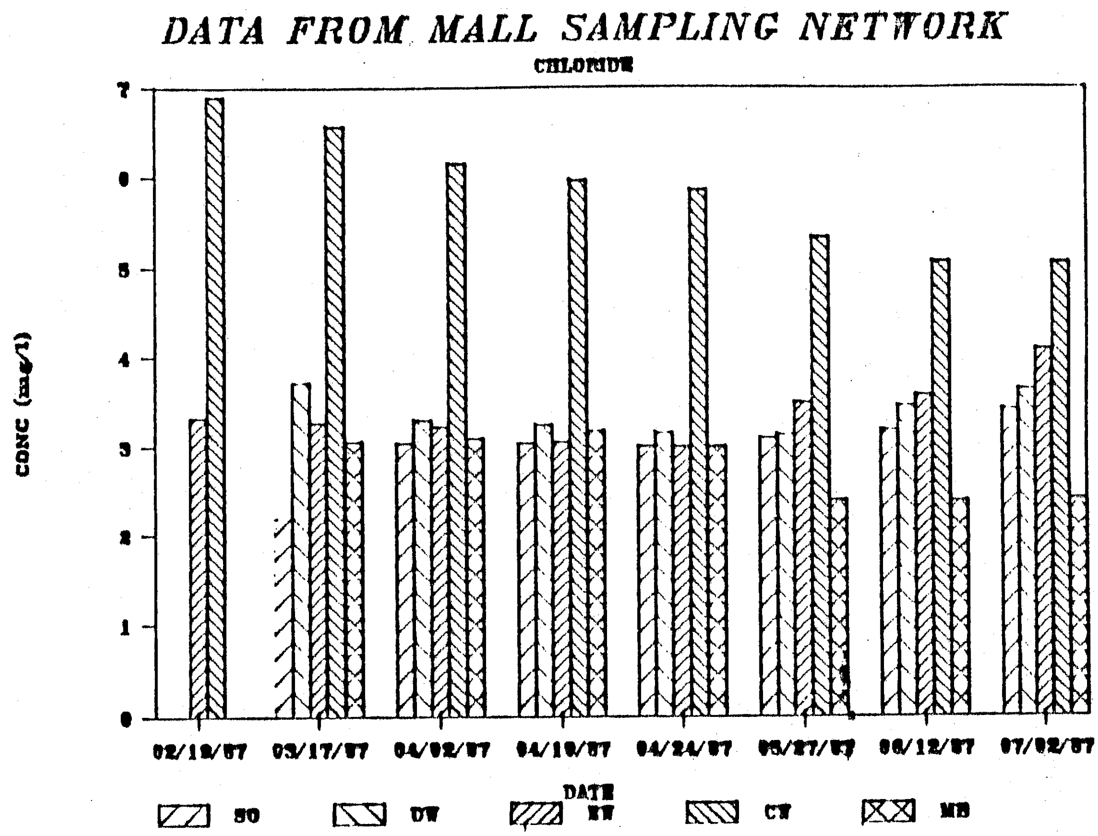
Table 7: Range in Well Concentrations of TDS (mg/l).

Well	Mean TDS	TDS Range	n	Date Sampled
MB	265.5	54.2	14	Mar-Jun
MV3	255.9	30.5	4	Feb-Feb
BW	267.4	43.3	43	Jul-Jun
SW	371.5	85.3	49	Jun-Jun
MV28	289.0	9.1	4	Feb-Feb
SO	289.0	11.7	7	Mar-Jul
DW	297.8	16.8	7	Mar-Jul
EW	290.3	9.8	8	Feb-Jul
CW	332.6	20.5	8	Feb-Jul

We identified loading impacts by comparing changes in total dissolved solids between down gradient wells located in areas where minimal storm water recharge occurred and in the vicinity of Southgate Mall parking area. The variation in average TDS concentrations from MB to MV3, over a distance of 1,990 ft (607 m), shows that the natural system picked up 3.7 mg/l, a one percent change. The aquifer is not receiving urban runoff because runoff is collected by a storm water sewer system and discharged to the Clark Fork River. The change in concentration of TDS between MV3 and BW, a distance of 3,000 ft (915 m) is 9.0 mg/l, a four percent change. Here the aquifer underlies a residential land use area served by Class V Wells. Based on this information, we would not expect natural aquifer dissolution to measurably effect our impact analysis at the mall site.

Average TDS data indicate that ground water in the vicinity of Southgate Mall is being impacted. At the mall site, we see an increase in TDS and chloride, and the consistent occurrence of a number of trace metals in well CW located down gradient from the parking area (Figure 8, 10 and 11). An increase of TDS concentration between SO and CW, a distance of 2,700 ft (823 m) is 43.5 mg/l, a 14 % change. We believe that this impact is the result of Class V Well injection. It was brought to our attention that the mall area was once an industrial site (Anderson, personal communication, 1987). However, the presence of copper, iron, and zinc in both up gradient and down gradient wells and storm water runoff supports a runoff source of TDS.

Copper, iron, manganese, and zinc are detected frequently in runoff from parking lots in the valley (Figure 9). Our previous discussion demonstrates that the metal concentrations of unimpacted ground water are usually below detection. Wells around the mall area show the presence of metals (Figure 10 and 11). At well CW, iron concentrations are typically higher and zinc concentrations typically lower than up gradient wells and it is the only well that consistently contains copper. The two possibly sources of metals are



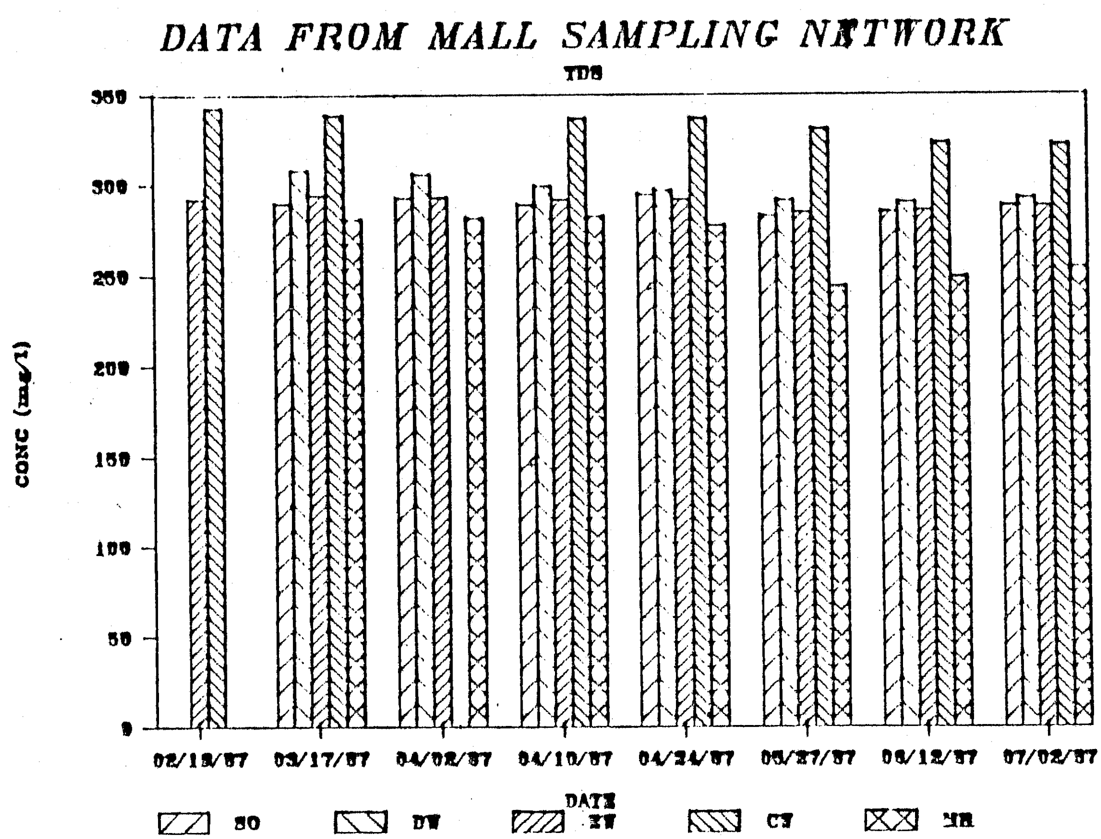


Figure 8: Chloride and TDS ground water concentrations at the Mall.

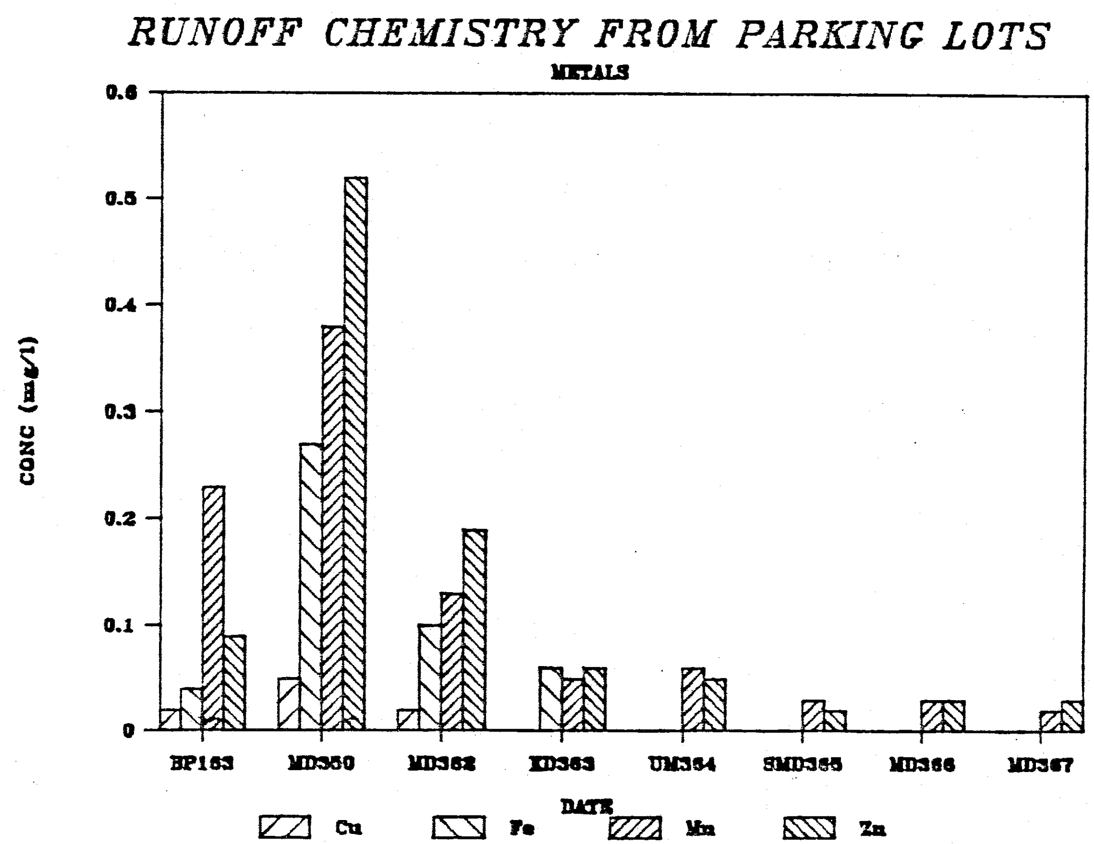
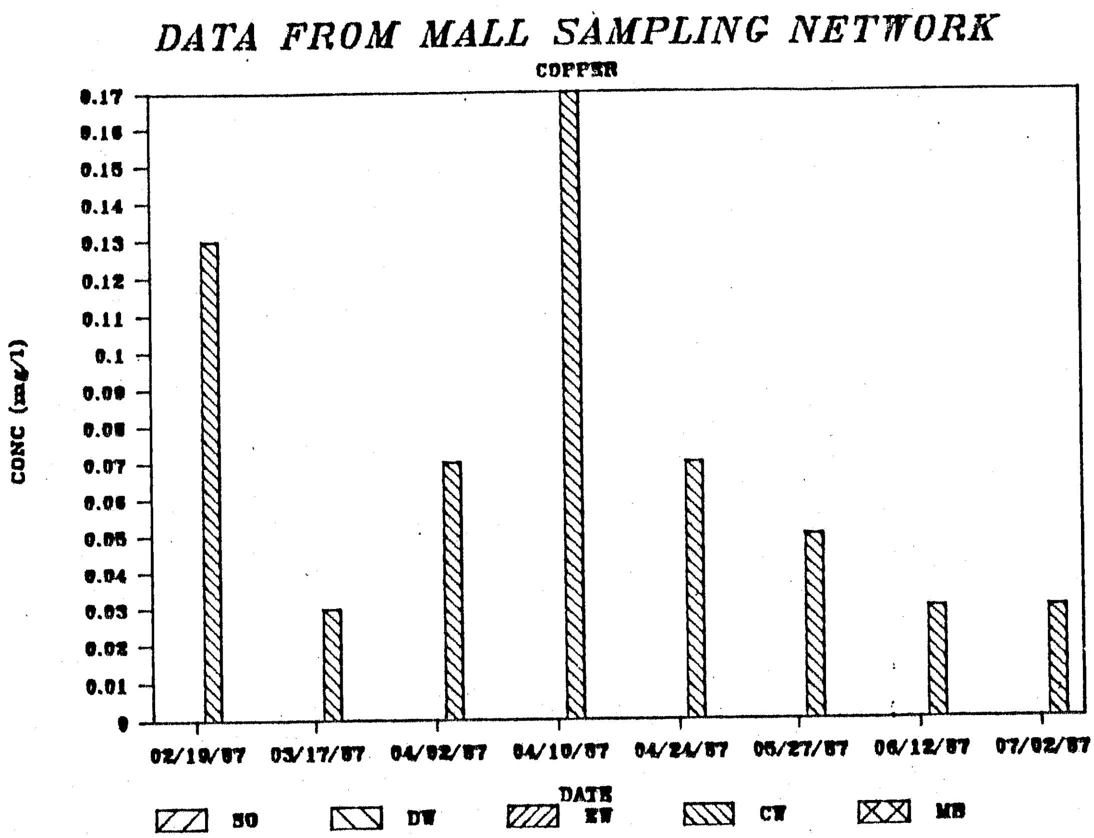


Figure 9: Metal concentrations in runoff from parking areas.



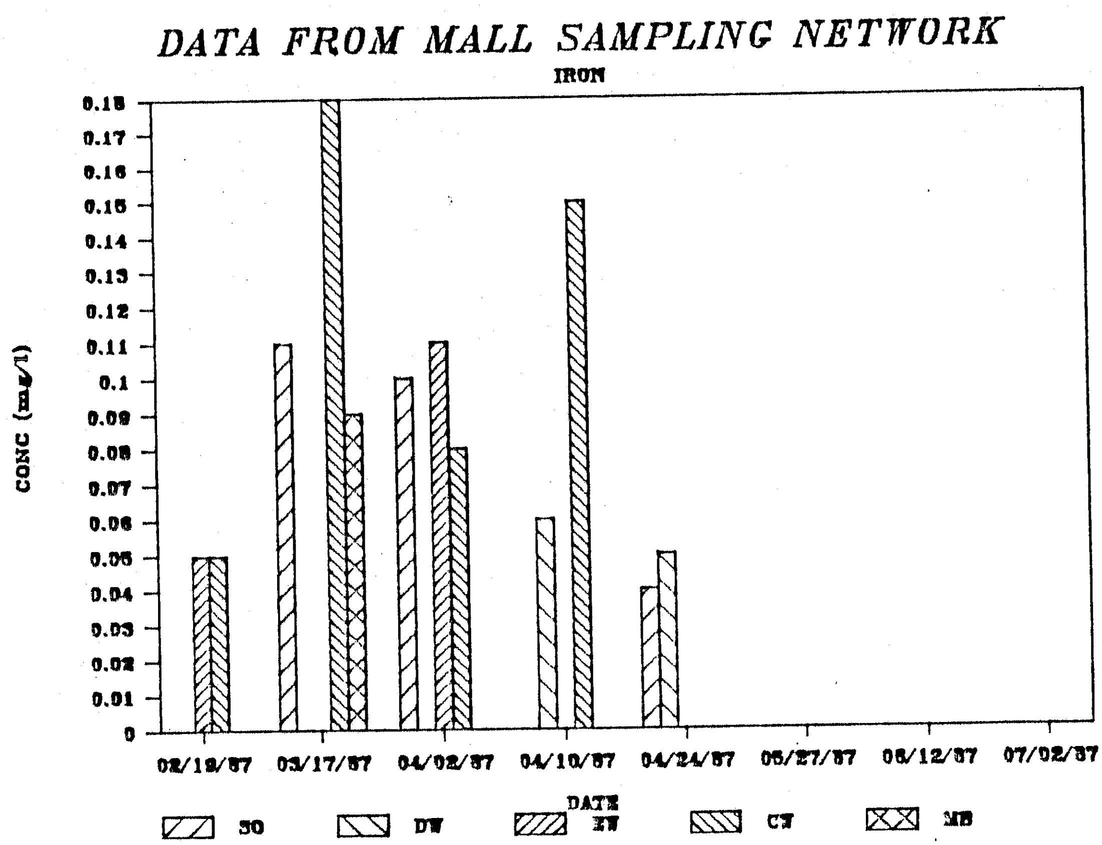


Figure 10: Copper and iron concentrations in ground water at the Mall sampling site.

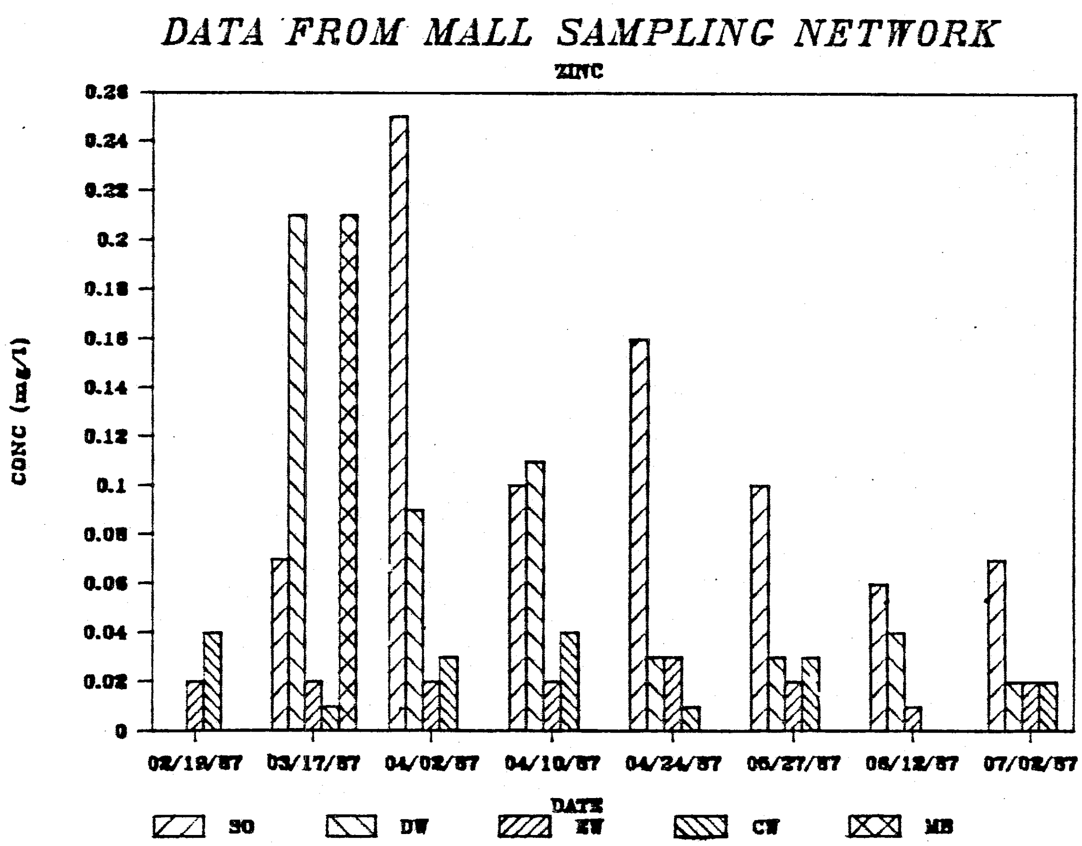


Figure 11: Zinc concentrations in ground water at the Mall sampling site.

urban runoff or metal casing and pipes. The absence of any iron detected past April (Figure 10) indicates that background concentrations are less than detection limits and that iron is not coming from the casing. This occurrence of metals during the spring and absence during part of the year is also consistent with what we found at the commercial single drain sampling site. The source of the metals detected in the ground water in this portion of the aquifer may either be from the mall parking lot or adjacent commercial land uses because metals were detected in both upgradient and downgradient wells around the mall.

We feel that the increase in TDS and chloride concentrations found in the mall area are due to Class V Well injection. This implies that parking areas in the valley associated with city, county, university, federal, and private facilities are contributing to degradation of the aquifer.

SUMMARY AND CONCLUSIONS

Class V Injection Wells are used to dispose of surface runoff at 2,669 sites in the Missoula Valley. Over 119 million gallons (4.5×10^8 L) of storm water enter the drains annually. Fifty eight percent of the water is derived from residential areas and forty-two percent from commercial areas. The quality of the runoff is variable, depending on the antecedent conditions, land use, and the season. Runoff injected from commercial sites contributes the largest load of TDS, sodium, chloride, iron and lead to underlying sediments. Loading from residential areas exceeded loading from commercial areas for bicarbonate, magnesium, potassium, sulfate, manganese, and zinc. Both land use areas contributed about equal loads of calcium, nitrate and copper.

The percolation of runoff through the vadose zone results in the dissolution of major cations and anions. Concentrations of major cations and anions typically increase by several hundred to several thousand percent above runoff concentrations. Chloride and sodium seem to be partially attenuated in the vadose zone during snowmelt runoff when concentrations are high. Metals are attenuated in the vadose zone. The metals most frequently occurring in runoff and the vadose zone are copper, iron, manganese and zinc. Copper, zinc and iron usually show an increase in concentration during the first few feet of transport through the vadose zone and then are attenuated. Generally, manganese is attenuated.

Ground water sampling typically showed measurable increases in bicarbonate, calcium, magnesium, sodium, and TDS concentrations during water table rises attributed to storm water recharge. Ground water chloride concentrations in the vicinity of Class V Wells injecting street runoff increased by 400% due to spring snowmelt runoff recharge. Iron concentrations in the underlying aquifer also increased in response to snowmelt recharge.

Impacts to the ground water from runoff injected in the vicinity of a 3,000,000 ft^2 (279,000 m^2) parking lot showed an increase in TDS and chloride concentrations down gradient. Iron, copper and zinc occurred more frequently in this area than at other locations evaluated as part of this study.

In conclusion, the effect of Class V Injection Wells on the potable unconfined aquifer is directly related to the quality of storm runoff, the composition of the vadose zone and the dilution ability of the aquifer. Although ground water was measurably impacted by injected storm water, only iron exceeded drinking water standards, and then only during the period of spring snowmelt recharge. This is not because poorer quality recharge water is not reaching the aquifer, instead it is due to the slow rate of flux across the water table and the immediate dispersion of the contaminate load in the lower TDS ground water. Class V Injection Wells contribute over 4,400 tons/yr (1.8×10^6 kg/yr) of dissolved constituents to the aquifer. ?

Our research indicates expansion of Class V Injection Wells in the Missoula valley will further degrade the water quality for down-gradient users. Further quantification of impacts requires additional research. Our characterization of the loading from the vadose zone was limited to data collected at our 13 ft (4.0 m) lysimeters. Deeper lysimeters would better characterize the total effect of the vadose zone on percolating runoff. Characterization of the impacts to ground water from large parking areas would be better accessed by construction of specifically designed monitoring networks. Specific studies of Class V Wells in industrial areas are also needed. Further sampling and modeling of the ability of the aquifer to dilute contaminants found in the vicinity of Class V injection sites is necessary to be able to predict impacts.

Finally, we conclude that, if warranted, efforts to mitigate impacts from Class V Wells, should be concentrated in commercial land use areas. Because the majority of loading occurs from vadose zone reactions, efforts should be made to reduce the quantity of water entering the drains. Adverse effects from spring snowmelt may be reduced by using alternative means of treating the streets during the winter.

would surface percolation of rainfall have the same effect?

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APPENDIX A

QUALITY ASSURANCE PLAN

Quality Assurance Plan

Study of the Effects of Storm Water Injection by

Class V Wells on a potable Ground Water System

UC6001

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Missoula, Montana 59812

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Quality Assurance Officer:______________________________Date:______

William W. Woessner 406-243-2341

Section	Table of Contents	Page

1) Project Organization and Responsibility

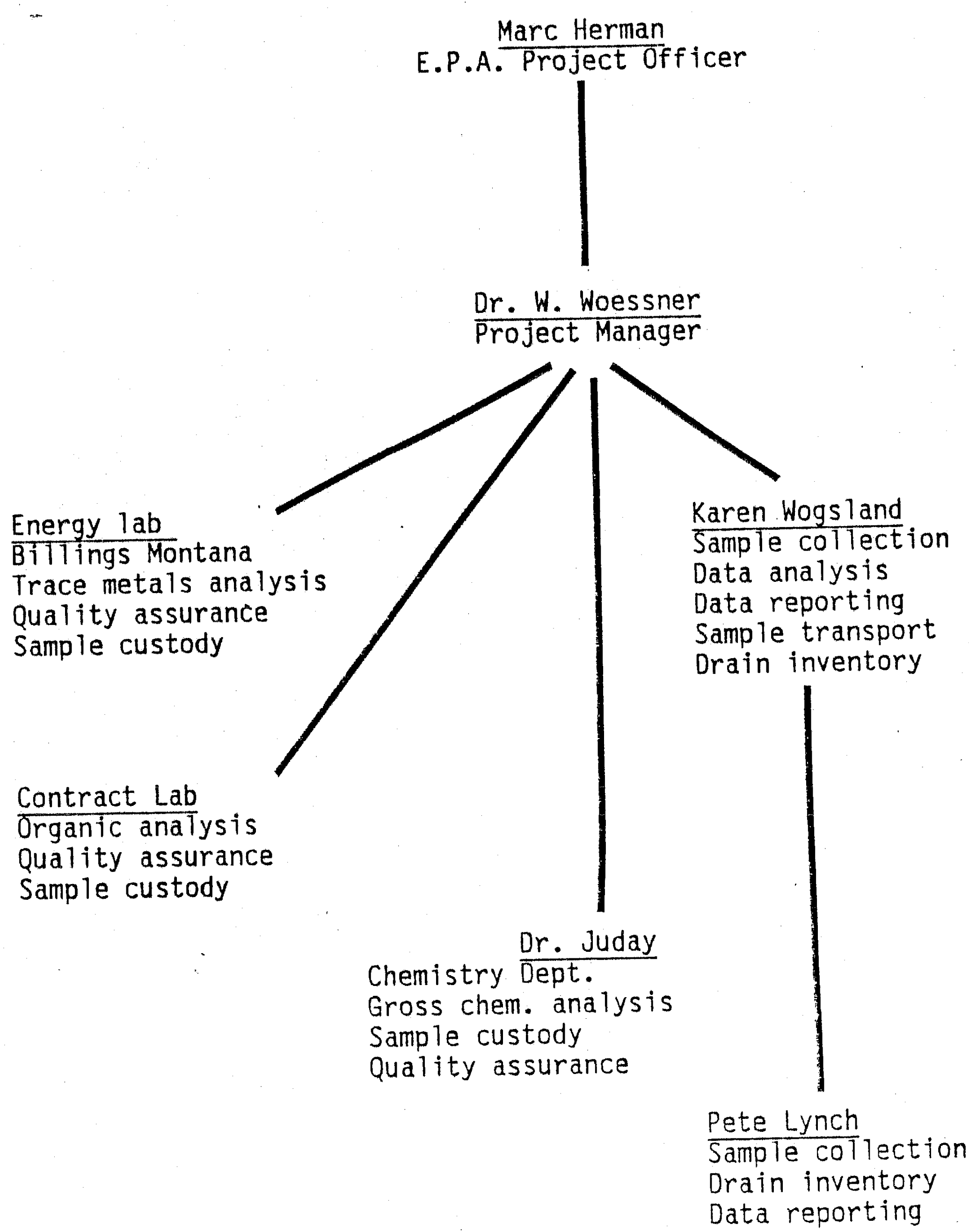
The project organization is summarized in Figure 1. Dr. William Woessner will act as project manager and will report to Marc Herman, the project officer from U.S.E.P.A. Dr. Woessner will direct all aspects of the study which will include monitoring well construction, lysimeter installation, water level monitoring, water sample collection, and discharge measurements. In addition, Dr. Woessner will oversee water quality results from Dr. Juday, the Energy Laboratory, and the contracted lab for organic analyses. Karen Wogsland will be responsible for sample collection and processing, field measurements, storm drain inventory, data processing, and sample storage. Pete Lynch will assist Karen Wogsland in these tasks (Figure 1).

Dr. Juday, of the Department of Chemistry, University of Montana, will be responsible for gross chemistry analyses, which will include calcium, magnesium, sodium, potassium, sulfate, chloride, bicarbonate, specific conductance, total dissolved solids, and pH. He will also be in charge of quality assurance and sample custody.

Energy Lab of Billings, Montana, will perform trace metal analysis for mercury, lead, iron, cadmium, chromium, nickel, arsenic, copper, zinc, and manganese. The quality assurance officer at Energy Lab will be in charge of quality assurance and sample custody.

A contract lab will be selected using the state bidding process to complete analysis for organic EPA priority pollutants. Acceptable quality assurance and quality control documentation must be provided by the lab before a contract will be awarded.

Figure 1: Project Organization and Responsibility



2) Project Description

a) The E.P.A. Nationwide Urban Runoff Program has shown that certain pollutants found in urban runoff exceed E.P.A. drinking water standards. The shallow water table and the coarse unsaturated zone provide potential for these pollutants to travel unattenuated to the water table. This study will examine the effect of approximately 3,000 Class V Injection wells on the quality and quantity of recharge to the sole source aquifer. Objectives include; 1) inventory the storm drains in the Missoula Valley and categorize land uses; 2) characterize the quality of storm runoff; 3) characterize the effect of storm water recharge on the regional shallow water table aquifer.

To accomplish these objectives, the following activities will be completed: 1) an inventory of the number and location of Class V Injection wells; 2) land used will be categorized as residential, commercial of industrial; 3) the quality and quantity of runoff and recharge will be characterized by sampling and data analysis.

b) Schedule of Tasks and Milestones.

The attainment of these objectives will follow the schedule described in Table 1.

c) Data Usage

Water quality data will be used for developing a data base to characterize the quality of storm runoff from two land uses on the resulting groundwater recharge. Measurements taken from outfalls will also be used as a data base for model calibration and verification and to determine quantity

Table 1: Schedule of Tasks and Milestones

Milestones	Activity
June 28, 1986	Inventory wells
July 3, 1986	Categorize land uses
June-August, 1986	Monitor runoff events Sample wells and lysimeters Sample analysis Data review and validation
August 31,1986	Final report preparation

of runoff and mass discharge calculations. The results will be interpreted in terms of best managements practices.

d) Monitoring Network, Sampling and Analysis Design and Rationale.

The location of specific sampling sites are shown in Figures 2, 3, and 4. Criteria for site selection are discussed in the paragraph below. The drainage area of the outfall sites must first represent two land use areas that are characteristic of the Missoula Valley. The sites must represent a residential watershed (Figure 2), and a commercial watershed (Figure 3). The sites will be sampled in such a manner as to compare the relative effects of the different land use areas. Outfall sites of an integrated storm sewer system to be monitored must be free of dry flow, which consists of flow from groundwater or flow from unauthorized connections to the system. The sites must also be accessible to field personnel for monitoring. The number of samples collected per runoff event will depend on the amount of rainfall and number of runoff events. Approximately three to six samples will be taken per runoff event plus 5% splits, duplicates and blanks. The frequency of sample collection will account for variations in flow and quantity of pollutants. Sampling frequency will be high at the beginning of the runoff event because of the "first flush" effect. Discharge measurements will be taken approximately every three minutes because of the highly variable flows that are characteristic of runoff.

The monitoring well sites are located to determine the cause/effect relationship of storm water recharge on the groundwater system (Figure 4). The monitoring wells are located downstream from groundwater flow and as close as possible to an intake drain, and each site must be representative of the specified land use. Practical considerations to the location of these

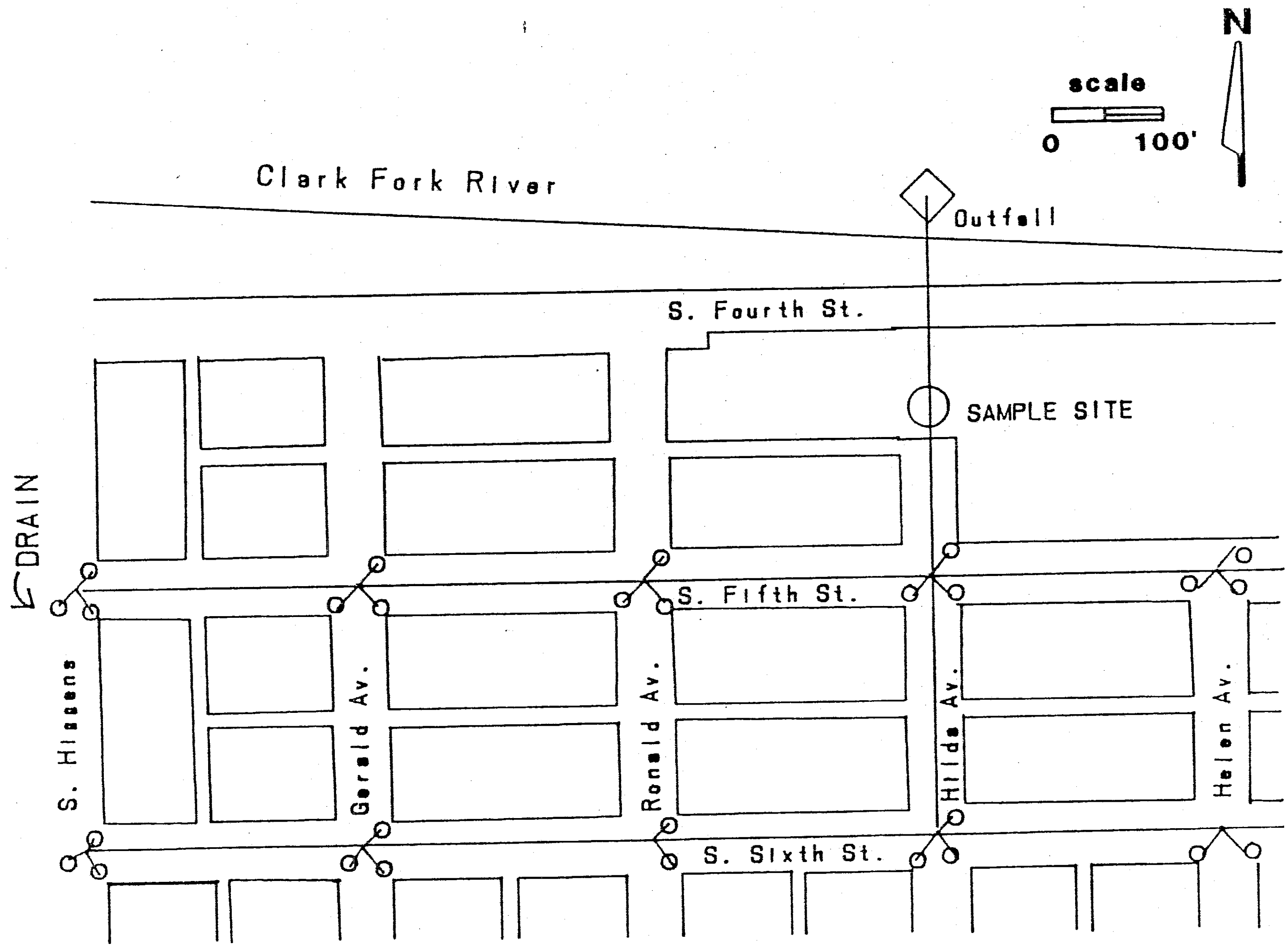


Figure 2: Residential area storm drain system

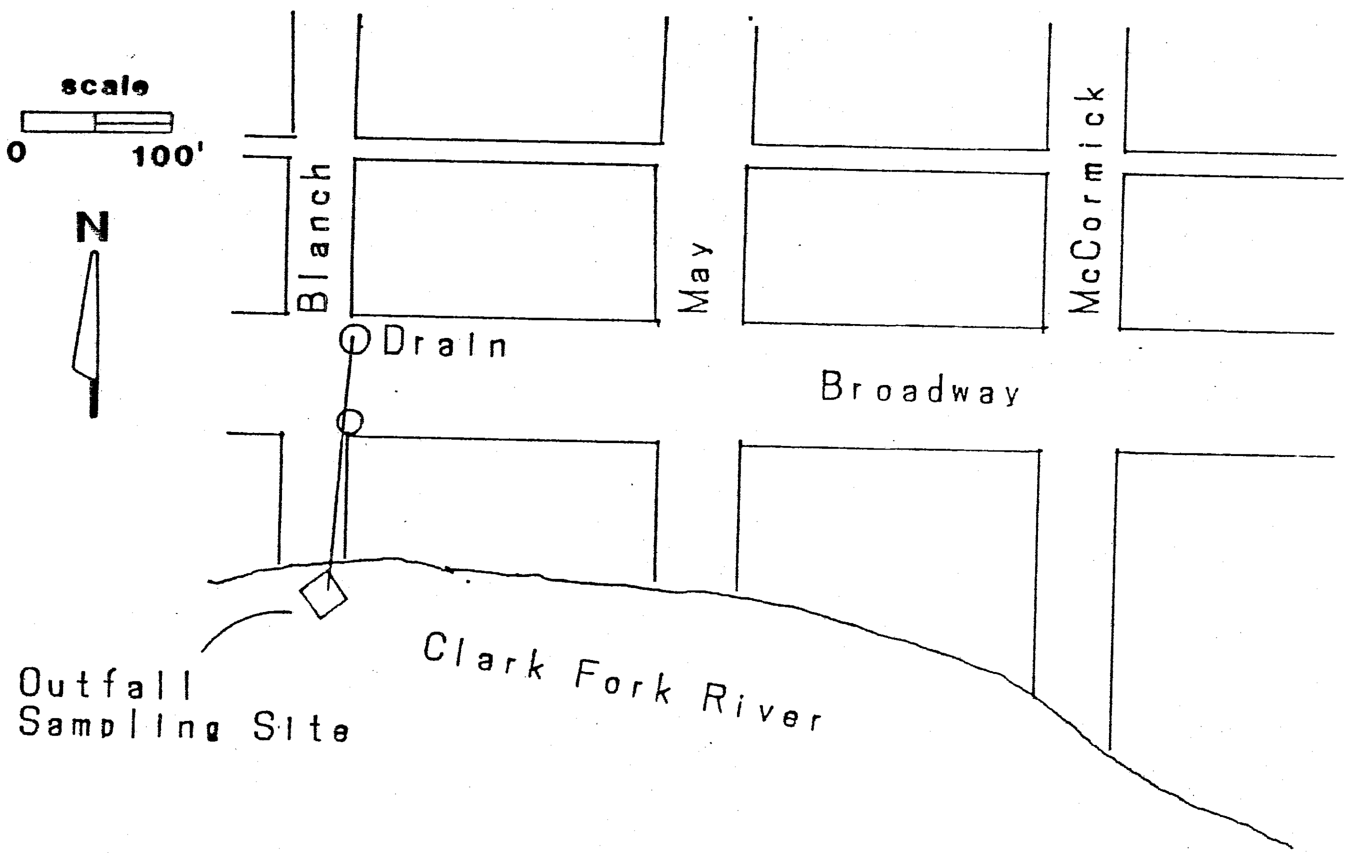


Figure 3: Commercial area storm drain system

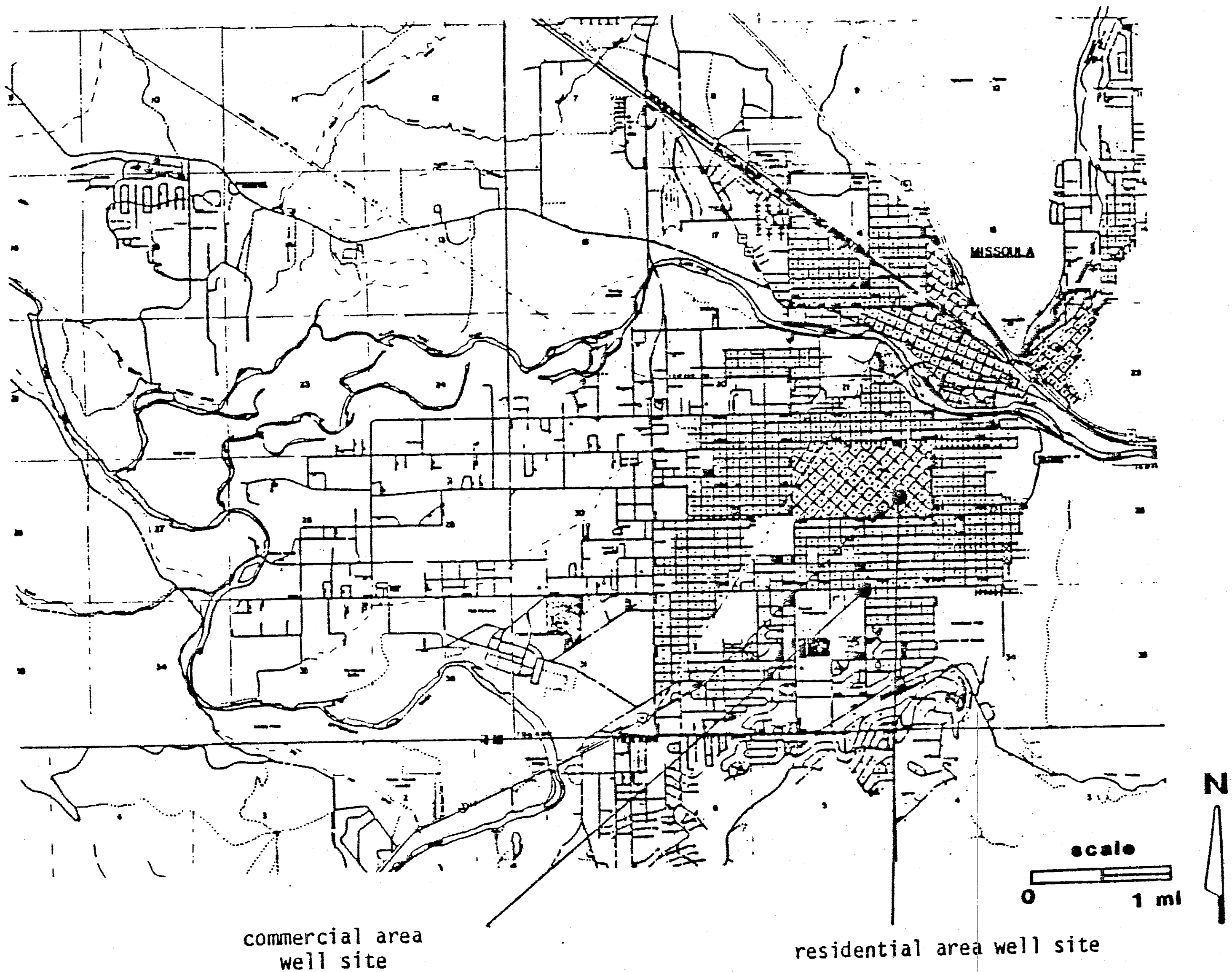


Figure 4: Monitoring well sites.

sites include permission to drill, underground cables, and above ground telephone and power lines. To obtain samples that are representative of storm water recharge, a Stevens F type continuous recorder will be installed on the wells, and the data charts will be interpreted to determine water level rises associated with storm water recharge. Sampling times will correspond with this water level rise. The frequency of well sample collection will be determined by the frequency and number of runoff events monitored.

Lysimeters will be installed as close as possible to the two storm drains to be monitored. Storm frequency will dictate the number and frequency of samples taken. Sampling of lysimeters will be performed while the wetting front approaches the water table. Nitrogen gas will be used to extract the sample rather than oxygen because it is an inert gas and will not alter the chemistry of the sample. Figure 5 illustrates the installation of the lysimeters.

The organic parameters selected for screening include the E.P.A. priority pollutants most frequently found in urban storm runoff (E.P.A., 1983). These parameters include Bis(2-ethylhexyl) phthalate, Hexachlorocyclohexane, Endosulfan, Pentachlorophenol, Chlodane, Hexachlorocyclohexane, Pyrene, Phenol, Phenanthrene, Dichloromethane, 4-Nitrophenol, Chrysene, and Fluoranthene. Table 2 describes the sampling protocol.

Inorganic parameters selected for analysis are shown on Table 2, including, sample preservation and holding time. The trace metals selected for analysis were limited to those most frequently detected on the Nationwide Urban Runoff Program (E.P.A., 1983).

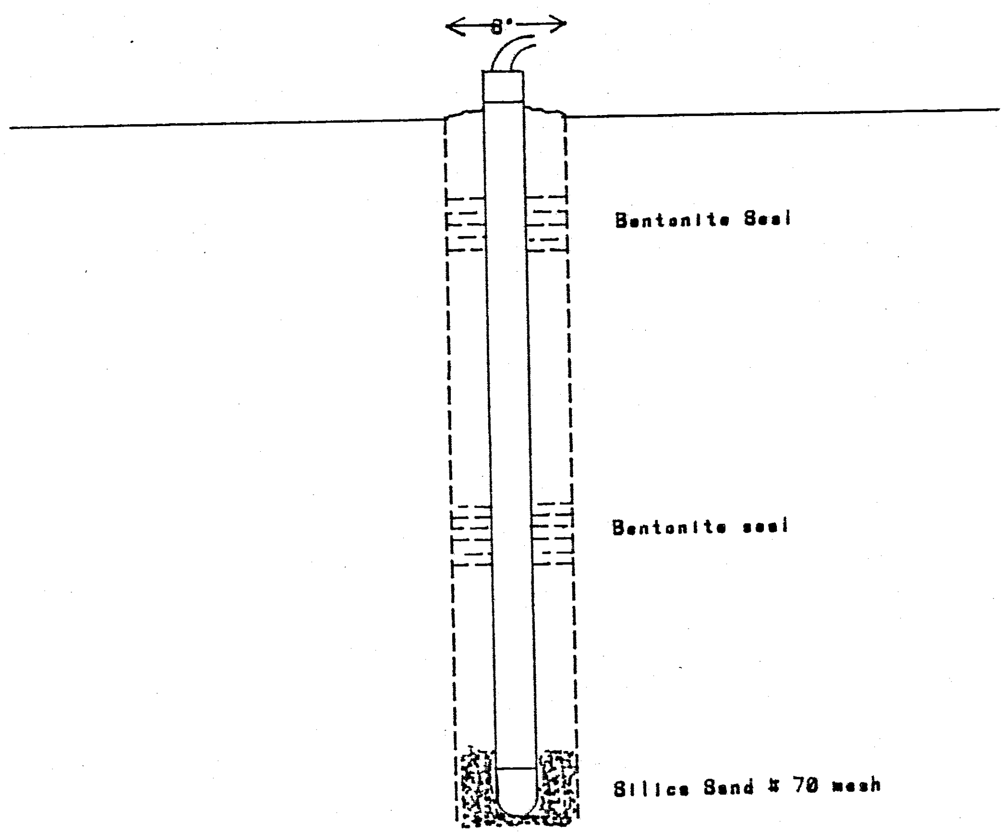


Figure 5: Lysimeter Installation

Due to the variability of runoff during an event, the objective of the sampling protocol is to obtain discrete samples collected at a certain time and discharge, and retained separately for analysis. Discrete samples are desired for storm water flows to characterize variations in constituent load with time and discharge (Shelly, 1979).

3) Data Quality Objectives

a) Precision and Accuracy Protocols/Limits

Table 2 describes acceptance criteria for the data to be collected. Accuracy will be monitored with field blanks, duplicates and National Bureau of Standards' reference materials. Precision will be monitored with splits and internal laboratory quality control. Accuracy of gross chemistry analysis will be tested by anion-cation balance. Accuracy and precision of field equipment is covered in the calibration procedures and preventative maintenance section.

b) Data Representativeness

Representativeness will be insured by taking replicate samples and following proper sampling procedures.

c) Data Comparability

To compare data from different sites and previous studies, storm water quality data will be calculated as an event mean concentration to deal with the variability of constituent load collected will by expressed in comparable units.

d) Data Completeness

The amount of valid data needed to meet the projects goals will be determined as results from runoff events are received and the data is analyzed.

Table 2: Analytical parameters.

Parameter	Reference	Preservation	Holding time	Exp. conditions	Precision	Accuracy
pH	Beckman Manual			Field	±.02pH	±0.05pH
Specific Conductance	YSI operation manual			Field	10umho/cm	10umhos/cm
Ca	EPA-600/4-79020	4C	28 days	Lab	±0.6STD	1%
Mg	"	"	"	"	±0.2STD	1%
Na	"	"	"	"	±0.8STD	1%
K	"	"	"	"	±0.5STD	3%
Cl	"	"	"	"	±0.3STD	4%
SO_4	Std. Methods	"	"	"	9.1%	1.2%
HCO_3	USGS, 1972	"	"	"	1.17mg/l	3%
pH	EPA 600/4-	"	"	"	0.15	±0.01
TDS	79020 "	"	"	"	See Energy Laboratories Analytical Quality Control Manual.	
Hg		3ml HNO_3	6 mo	"		
Fe		"	"	"		
Pb		"	"	"		
Cd		"	"	"		
As		"	"	"		
Cu		"	"	"		
Zn		"	"	"		
Mn		"	"	"		
Organics		4C	7 days	"		
Rainfall	Belfort instr. bk.					

4) Sample Procedures

Water level measurements

Water levels in two monitoring wells constructed near french drains will be determined continuously by a Stevens Type F recorder and calibrated with a steel tape. Standard recorder charts will be interpreted to establish a recharge hydrograph. Points of measurement will be surveyed using standard surveying techniques. Sites for monitoring wells were chosen according to the criteria discussed in section 1d.

Field water sampling

Gross and trace metal chemistry will be performed on water samples from wells, runoff samples going into single drains, runoff samples flowing from outfalls, and water samples drawn from suction lysimeters. See Table 2 for analytical methods, preservation, and holding times. Sampling strategy has been discussed in section 1d. Sample containers will be acid washed with 50% hydrochloric acid which remains in the container for at least three hours, rinsed three times with deionized water and air dried. Specific conductance, temperature and pH will be measured in the field and the sample will be filtered through a Geofilter 0.45 micron filter apparatus. The first 100ml of sample will rinse the polyethylene cubic one quart containers, and two containers will be filled. One container will be stored at 4C for gross chemistry analysis and the other container will be preserved by acidifying it with 3ml of Ultrapure Baker analyzed concentrated nitric acid which has been premeasured into a glass ampule. Sample cubitainers will be labeled in the field as shown in Figure 6, and field information will be recorded on field sheets shown in Figure 7. Immediately after field samples are taken, the Geofilter will be rinsed with deionized water, the old filter discarded and

Figure 6: Sample label.

PROJECT
University of Montana
Department of Geology

Sample #:______________________

Well___ Surface Water___ Other___

____
Location:______________________
Sampled by:____________________
Date:_____________Time:________

Type: Grab___ Pump___ Tap___
Other______________________
Preservation: Filtered________
Acidified____ Unfiltered________
Refridgerated________

Sample #	Well # or Location	Date	Sampling Method			Treatment			Stable SPC (umhos)					pH	Meter #
			Tap	Bailer	Sub. Pump	Filtered	Acid	Unfilt.	Field Temp.	umhos	Time	Meter #	25°C		

Figure 7: Field data sheet.

a new filter inserted. Organic samples collected unfiltered in glass containers will stored at 4C and sent to the laboratory within twenty-four hours for analysis. They will be stored in glass bottles with teflon caps that have been washed with acetone and rinsed with deinonized water. Groundwater samples will be taken with a Johnson-Keck submersible pump. To insure a sample that is representative of the aquifer, the well will be pumped until temperature and specific conductance stabilizes. Outfall samples will be taken using a plastic bucket that has been rinsed three times with the sample. All samples will be kept cool in the field and brought back to the University of Montana refrigerator as soon as possible. Samples to be analyzed for trace metals will be transferred to 120ml acid washed polyethylene sample bottles and sent via UPS to Energy lab. Organic samples will be refrigerated and sent via UPS over night to the contracted lab. Samples to be analyzed for gross chemistry will be transported to Dr. Juday's laboratory at the University of Montana Chemistry Department. All holding times will be observed. To document proper sampling procedures field procedures, field blanks will by taken by passing deionized water through the Geofilter and pump that have been field cleaned, by a rinse with deionized water.

Monitoring well construction

Two monitoring well sites were selected to observe the effect of recharge due to storm runoff. Wells were drilled by the forward rotary method. Water or air was used as a drilling fluid. A daily drilling record was kept. Six inch steel casing was driven ten feet below the water table and four inch PVC flush couple casing was set inside the six inch steel casing, and the steel casing was pulled out. PVC casing was selected because it would not contaminate samples that will be analyzed for trace metals. A study by Curran and Tomson (1983) indicates that rigid flush coupled PVC is acceptable for monitoring wells where sampling will be done for trace organics if it is washed and rinsed before installation. The PVC casing was washed with Anapox laboratory detergent and rinsed with tap water. Wells were flushed after completion of the drilling by pumping for thirty minutes with a Johnson-Keck submersible pump.

Lysimeter installation and construction

Holes for lysimeters were drilled with a six inch hollow stem auger. Lysimeters have been installed at different depths to observe the effect of the vadose zone on the attenuation of pollutants. If possible, lysimeters were installed in fine grained layers which were pinpointed with the drillers logs. The porous ceramic cups were imbedded in 70 mesh silica sand that was wetted with deionized water, and the hole was backfilled with the original unsaturated zone material. Bentonite pellets were installed within ten feet of the surface to prevent water from flowing down the outside of the lysimeter (Figure 5). Lysimeters were constructed of two inch PVC pipe that was acid washed and rinsed. Inert nalgene tubing was used for the pressure and discharge tubing. The ceramic porous cups were acid washed and rinsed with deionized water. Lysimeters purchased from Soil Moisture were also acid washed and rinsed.

5) Sample Custody Procedures

Karen Wogsland will be responsible for the custody of all water samples from the time of collection to delivery to contracted labs, and to Dr. Juday's laboratory in the Chemistry Department. A chain of custody log will be kept of each sample (Figure 8). Samples will be collected by either Karen

Wogsland of Pete Lynch. The samples will be stored in the Geology Department analytical laboratory refrigerator which has limited access. Contracted labs will receive the samples to be tested for trace metals and organics respectively, and will also be responsible for their custody. Samples will be returned to Karen Wogsland, where they will be stored in the Geology Department storage room that is kept locked. Upon delivery of samples to the appropriate laboratory, a chain-of-custody form is signed and dated to acknowledge receipt or relinquishment.

6) Calibration Procedures and Preventative Maintenance

Instruments will be calibrated as shown in Table 3.

The instrumentation Lab 252 AA used for Ca, Mg, Na, and K analyses is calibrated by standard procedure with knowns and blanks (EPA 600/4-79020). All volumetric glassware has been calibrated and solutions are made by weight. Analytical balances are serviced by the manufacturer annually. The Beckman Acta (-III) Spectrophotometer is calibrated with standards at each use and with manufacturer filters annually. The Beckman Model 350 pH meter is calibrated using pH buffers 4 and 7 at each use.

Trace metal and organic analysis instrument calibration is described in the attached document.

7) Analytical Methodology

Analysis for calcium, magnesium, and potassium are performed using AA methods as described in EPA 600/4-79020. Samples are field filtered and cooled to 4C. Samples are acidified in the lab to a pH of less than two using "instra-analyzed nitric acid. This procedure will be used because ion concentrations are at levels at which precipitation will not occur prior to analysis (Woessner and Popoff, 1982). Specific methods are as follows: Ca,

Sample #	Collected by/ Date	Received by/ Date	Transported to Lab: Chem.	Transported to Lab: GEVST	Relinquished by/ Date	Received by/ Date	Post Lab Analysis Relinquished by/ Date	Post Lab Analysis Received by/ Date	Storage Location

Figure 8: Chain of custody log.

Table 3: Calibration proceedures.

Equipment	Procedure	Frequency	Standard Source
Universal Recording rain gage	Belfort Instr. Instruction Bk.	yearly	Calibration weights
Feild pH	Beckman operating manual	Every reading	Buffers
Field specific Conductance	Operanting manual	Every reading	KCl standard solution
Temperature	Calibration against lab thermometer	Every 6 mo.	
Stevens F type water level recorder	Independent water level readings	Monthly	

p. 215.1; Mg, p. 242.1; Na, p. 273.1 and K, p. 258.1 (EPA, 1979). Chloride will be determined by colorimetric techniques as described on the same EPA reference on page 325.1. Sulfate analysis will be determined using Standard Methods Procedures, p496. Bicarbonate is determined by titration to pH 4.5 (USGS, 1972, p. 43). Lab pH is by Beckman Model 350 meter and TDS is calculated.

8) Documentation, Data reduction and Reporting

a) Documentation

All data collected will be recorded on the appropriate data sheet, and filed for data reduction and storage.

b) Data Reduction, Validation and Reporting

Precipitation data will be collected from two continuous recording rain gages every week, and data will be reduced as daily readings. During rainfall events, precipitation will be compiled so the data may be compared with runoff. Discharge from outfall pipes will be calculated by using water depth measurements and discharge charts (Bethleham Steel, 1959). Discharge measurements will be plotted as hydrographs. Event Mean Concentrations will be calculated according to the equation

$$EMC = \frac{(t_{n+1}-t_n)(1/2)(c_n q_n + c_{n+1} q_{n+1})}{(t_{n+1}-t_n)(1/2)(q_n + q_{n+1})}$$

where:

t = time, min
c = concentration, mg/l
q = discharge, l/min

Drainage area will be calculated using a city maps. Mass pollutant loading will be calculated using land use data, quantity of runoff, event mean concentrations of pollutants, and drainage areas. Data will be validated by comparing results on field blanks, duplicates and spikes, and comparing them with correct values.

9) Data Assessment

Gross chemistry and trace metals are checked be sending 10% splits and duplicates, 5% blanks and knowns to the lab for precision and accuracy. Dr. Juday's lab uses ionic balance as its principal means of an internal check, and will undergo an E.P.A. standard (for gross chemistry) check during the project.

10) Performance and System Audits

Field procedures will be reviewed during the project. Contract labs will be responsible for internal audits.

11) Corrective Action

Field procedures will be corrected by retraining and modifications of sampling procedures. Split and standard analysis will fall within stated error tolerance. When the results fall outside of appropriate values, samples will be reanalyzed by the lab involved.

12) Quality Assurance Reports to Management

Quality Assurance reports will be reported to management.

13) Safety

Standard safety procedures will be used in field construction, sampling and sample handling.

REFERENCES

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U.S. Environmental Protection Agency, 1983, Results of the Nationwide Urban Runoff Program, Vol. 1, Final Report. National Technical Information Service, PB84-185552.

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APPENDIX B

PRECIPITATION AND HEAD

SITE LOCATIONS KEY
MSL=MISSOULIAN SITE CENT=CENTINEL SITE B=BLAINE S=SOUTH

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
17-May-86	0		0				
18-May-86	0		T				
19-May-86	0		T				
20-May-86	0		T				
21-May-86	0.28		0.48				
22-May-86	0		0				
23-May-86	0		0				
24-May-86	0		0				
25-May-86	0		0				
26-May-86	0		0				
27-May-86	0		T				
28-May-86	0		0				
29-May-86	0		0				
30-May-86	0		0				
31-May-86	0		T				
01-Jun-86	0		T				
02-Jun-86	0		0				
03-Jun-86	0.03		0.04				
04-Jun-86	0.15	0.15	0.21	53.94	3136.37		
05-Jun-86	0.33	0.33	0.39				
06-Jun-86	0.3	0.27	0.34	53	3137.31	60.05	3140.74
07-Jun-86	0.17	0.1	0.48			59.8	3140.99
08-Jun-86	0.2	0.22	0.13			59.5	3141.29
09-Jun-86	0	0	T			59.3	3141.49
10-Jun-86	0	0	0			59.1	3141.69
11-Jun-86	0	0	0			59	3141.79
12-Jun-86	0	0	0			59	3141.79
13-Jun-86	0	0	0	51.6	3138.71	58.99	3141.8
14-Jun-86	0.1	0.08	0.07			59	3141.79
15-Jun-86	0	0	0			59.01	3141.78
16-Jun-86		0	0			59	3141.79
17-Jun-86		0	0			59	3141.79
18-Jun-86		0.05	T			59.08	3141.71
19-Jun-86		0	0	51.4	3138.91	59.1	3141.69
20-Jun-86		0	0.05	51.42	3138.89	59.23	3141.56
21-Jun-86		0	0	51.4	3138.91	59.27	3141.52
22-Jun-86		0	0	51.45	3138.86	59.38	3141.41
23-Jun-86		0	0	51.65	3138.66	59.51	3141.28
24-Jun-86	0	0	0	51.78	3138.53	59.61	3141.18
25-Jun-86	0	0	0	52.03	3138.28	58.87	3141.92
26-Jun-86	0	0	0	52.18	3138.13	60.02	3140.77
27-Jun-86	0	0	0	52.28	3138.03	60.11	3140.68
28-Jun-86	0.77	0.66	0.87	52.37	3137.94	60.11	3140.68
29-Jun-86	0.3	0.34	0.08	52.26	3138.05	60.11	3140.68
30-Jun-86	0	0	0	52.23	3138.08	60.11	3140.68
01-Jul-86	0	0	0	52.27	3138.04	60.28	3140.51

DATE	MBL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
02-Jul-86	0	0	0	52.42	3137.89	60.25	3140.54
03-Jul-86		0	T	52.47	3137.84	60.38	3140.41
04-Jul-86		0.67	0.63	52.15	3138.16	60.4	3140.39
05-Jul-86		0	T	51.97	3138.34	60.35	3140.44
06-Jul-86		0	0	51.87	3138.44	60.25	3140.54
07-Jul-86		0	0	51.81	3138.5	60.25	3140.54
08-Jul-86	0	0	T	51.96	3138.35	60.25	3140.54
09-Jul-86	0.2	0.2	0.1	52.04	3138.27	60.21	3140.58
10-Jul-86	0.05	0.05	0.06	52	3138.31	60.25	3140.54
11-Jul-86	0	0	0.04	52.03	3138.28	60.26	3140.53
12-Jul-86	0	0	0	51.78	3138.53	60.23	3140.56
13-Jul-86	0	0	0	51.83	3138.48	60.2	3140.59
14-Jul-86	0	0	0	51.93	3138.38	60.23	3140.56
15-Jul-86	0	0	0	52.32	3137.99	60.35	3140.44
16-Jul-86	0	0	0.01			60.43	3140.36
17-Jul-86	0	0	0	52.2	3138.11	60.5	3140.29
18-Jul-86	0	0	0	52.25	3138.06	60.6	3140.19
19-Jul-86	0	0	0	52.33	3137.98	60.68	3140.11
20-Jul-86	0	0	0	52.44	3137.87	60.73	3140.06
21-Jul-86	0	0	0	52.6	3137.71	60.98	3139.81
22-Jul-86	0	0	0	52.89	3137.42	61.08	3139.71
23-Jul-86	0	0	0	53.12	3137.19	61.21	3139.58
24-Jul-86	0	0	0	53.36	3136.95	61.39	3139.4
25-Jul-86	0	0	0	53.52	3136.79	61.46	3139.33
26-Jul-86	0	0	0	53.51	3136.8	61.46	3139.33
27-Jul-86	0	0	0	53.52	3136.79	61.78	3139.01
28-Jul-86	0	0	0	53.68	3136.63	61.9	3138.89
29-Jul-86	0	0	0	53.97	3136.34	61.98	3138.81
30-Jul-86	0	0	0	54.18	3136.13	61.98	3138.81
31-Jul-86	0	0	0	54.29	3136.02	62.22	3138.57
01-Aug-86	0	0	0			62.38	3138.41
02-Aug-86	0	0	0			62.48	3138.31
03-Aug-86	0	0	0.1			62.45	3138.34
04-Aug-86	0	0	0			62.45	3138.34
05-Aug-86	0	0	0			62.45	3138.34
06-Aug-86	0	0	0	55	3135.31	63	3137.79
07-Aug-86	0	0	0			63.07	3137.72
08-Aug-86	0	0	0			63.2	3137.59
09-Aug-86	0	0	0			63.31	3137.48
10-Aug-86		0	0.04			63.35	3137.44
11-Aug-86		0	0.05			63.48	3137.31
12-Aug-86		0.25	0.28			63.48	3137.31
13-Aug-86	0	0	T			63.48	3137.31
14-Aug-86	0	0	0			63.48	3137.31
15-Aug-86	0	0	0			63.64	3137.15
16-Aug-86	0	0	0			63.72	3137.07
17-Aug-86	0	0	T			63.81	3136.98
18-Aug-86	0	0	0			63.92	3136.87
19-Aug-86	0	0	0			64	3136.79
20-Aug-86	0	0	0			64.14	3136.65

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
21-Aug-86	0.02	0.02	0.03			64.24	3136.55
22-Aug-86	0	0	0			64.27	3136.52
23-Aug-86	0	0	0				
24-Aug-86	0	0	0				
25-Aug-86	0	0	0				
26-Aug-86	0	0	0				
27-Aug-86	0	0	0				
28-Aug-86	0	0	0				
29-Aug-86	0.22	0.22	0.32				
30-Aug-86	0.02	0.02	0.12				
31-Aug-86	0.64	0.64	0.74				
01-Sep-86	0.22	0.22	0.32			64.77	3136.02
02-Sep-86	0.02	0.02	0.02			64.67	3136.12
03-Sep-86	0	0	0	55.97	3134.34	64.57	3136.22
04-Sep-86		0	0	55.94	3134.37	64.39	3136.4
05-Sep-86		0	0	56.01	3134.3	64.39	3136.4
06-Sep-86		0	0			64.39	3136.4
07-Sep-86		0	t			64.39	3136.4
08-Sep-86		0.72	1.05	55.82	3134.49	64.39	3136.4
09-Sep-86		0	0	55.64	3134.67	63.38	3137.41
10-Sep-86		0	t	55.69	3134.62	64.37	3136.42
11-Sep-86		0	t	55.55	3134.76	64.32	3136.47
12-Sep-86		0	0.02	55.38	3134.93	64.3	3136.49
13-Sep-86		0.04	0.07			64.3	3136.49
14-Sep-86		0.18	0.14			64.3	3136.49
15-Sep-86		0.15	0.2	55.26	3135.05	64.32	3136.47
16-Sep-86		0.12	0.11	55.38	3134.93	64.32	3136.47
17-Sep-86		0.15	0.45	55.16	3135.15	64.32	3136.47
18-Sep-86	0.05	0.5	0.47	55.18	3135.13	64.32	3136.47
19-Sep-86	0	0	0	55.1	3135.21	64.32	3136.47
20-Sep-86	0.13	0.13	0.28			64.32	3136.47
21-Sep-86	0	0	0			64.32	3136.47
22-Sep-86	0	0	0	54.94	3135.37	64.32	3136.47
23-Sep-86	0	0	0	54.95	3135.36	64.32	3136.47
24-Sep-86	0.05	0.05	0.03			64.32	3136.47
25-Sep-86	0	0	0.07			64.32	3136.47
26-Sep-86	0.03	0.03	0.01				
27-Sep-86	0	0	t				
28-Sep-86	0.07	0.05	0.04				
29-Sep-86	0	0	0.04				
30-Sep-86	0.27	0.42	0.22				
01-Oct-86	0	0	T	54.99	3135.32	64.08	3136.71
02-Oct-86	0	0	0	55.15	3135.16	64.08	3136.71
03-Oct-86	0	0	0	55.17	3135.14	64.18	3136.61
04-Oct-86	0	0	0	55.44	3134.87	64.21	3136.58
05-Oct-86	0	0	0	55.4	3134.91	64.2	3136.59
06-Oct-86	0	0	0	55.3	3135.01	64.38	3136.41
07-Oct-86	0	0	0	55.33	3134.98	64.38	3136.41
08-Oct-86	0	0	0	55.37	3134.94	64.38	3136.41
09-Oct-86		0	0	55.38	3134.93	64.4	3136.39

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
10-Oct-86		0.12	0.36	55.48	3134.83	64.4	3136.39
11-Oct-86		0	0	55.51	3134.8	64.51	3136.28
12-Oct-86		0	0	55.51	3134.8	64.59	3136.2
13-Oct-86	0	0	0	55.65	3134.66	64.85	3135.94
14-Oct-86	0	0	0	55.71	3134.6	64.9	3135.89
15-Oct-86	0	0	0	55.75	3134.56	65	3135.79
16-Oct-86	0	0	0	55.8	3134.51	65.06	3135.73
17-Oct-86	0	0	0	55.8	3134.51	65.09	3135.7
18-Oct-86	0	0	0	55.92	3134.39	65.16	3135.63
19-Oct-86	0	0	0	56.07	3134.24	65.25	3135.54
20-Oct-86	0	0	0	56.07	3134.24	65.33	3135.46
21-Oct-86	0	0	0	56.07	3134.24	65.35	3135.44
22-Oct-86	0	0	0	56.1	3134.21	65.4	3135.39
23-Oct-86	0	0	0	56.1	3134.21	65.49	3135.3
24-Oct-86	0	0	0	56.26	3134.05	65.55	3135.24
25-Oct-86	0	0	0			65.64	3135.15
26-Oct-86	0	0	0			65.71	3135.08
27-Oct-86	0	0	0.03			65.8	3134.99
28-Oct-86	0	0	0			65.81	3134.98
29-Oct-86	0	0	T	56.91	3133.4	65.88	3134.91
30-Oct-86	0.04	0.04	0.04	56.93	3133.38	65.99	3134.8
31-Oct-86	0	0	0.01	57.08	3133.23	66	3134.79
01-Nov-86	0	0	0	57.15	3133.16	66.1	3134.69
02-Nov-86	0	0	0	57.26	3133.05	66.15	3134.64
03-Nov-86	0	0	0	57.31	3133	66.28	3134.51
04-Nov-86	0	0	0	57.34	3132.97	66.28	3134.51
05-Nov-86	0.13	0.15	0.07	57.4	3132.91	66.3	3134.49
06-Nov-86	0.1	0.05	0.06	57.42	3132.89	66.32	3134.47
07-Nov-86	0.1	0.02	0.01	57.5	3132.81	66.39	3134.4
08-Nov-86	0.05	0.13	0.04	57.53	3132.78	66.39	3134.4
09-Nov-86	0.1	0.15	0.06	57.53	3132.78	66.5	3134.29
10-Nov-86	0	0	0	57.65	3132.66	66.54	3134.25
11-Nov-86	0.15		0.15			66.63	3134.16
12-Nov-86	0	0	0	57.64	3132.67	66.63	3134.16
13-Nov-86	0	0	T	57.67	3132.64	66.63	3134.16
14-Nov-86	0.15	0.1	0.07	57.7	3132.61	66.63	3134.16
15-Nov-86	0	0	T	57.8	3132.51	66.63	3134.16
16-Nov-86	0	0	0	57.92	3132.39	66.63	3134.16
17-Nov-86	0	0.02	0.03	57.98	3132.33	66.63	3134.16
18-Nov-86	0.2	0.15	0.16	58	3132.31	66.63	3134.16
19-Nov-86	0	0	T	58.02	3132.29	66.63	3134.16
20-Nov-86	0	0	T	58.12	3132.19	66.63	3134.16
21-Nov-86	0	0	T	58.12	3132.19	66.63	3134.16
22-Nov-86	0.03	0.05	0.03	58.12	3132.19	66.74	3134.05
23-Nov-86	0	0	T	58.12	3132.19	66.74	3134.05
24-Nov-86	0	0.05	0.02	58.23	3132.08	66.75	3134.04
25-Nov-86	0	0	0	58.25	3132.06	66.78	3134.01
26-Nov-86	0.04	0.03	0.03	58.28	3132.03	66.79	3134
27-Nov-86	0.4	0.34	0.34	58.27	3132.04	66.8	3133.99
28-Nov-86	0	0	T	58.32	3131.99	66.8	3133.99

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
29-Nov-86	0	0	T	58.32	3131.99	66.8	3133.99
30-Nov-86	0	0	0	58.32	3131.99	66.8	3133.99
01-Dec-86	0.02	0.02	0.01	58.4	3131.91	66.8	3133.99
02-Dec-86	0	0	0	58.41	3131.9	66.8	3133.99
03-Dec-86	0	0	0	58.41	3131.9	66.8	3133.99
04-Dec-86	0	0	0	58.41	3131.9	66.8	3133.99
05-Dec-86	0.33	0.42	0.43	58.36	3131.95	66.8	3133.99
06-Dec-86	0.04	0.02	0.03	58.45	3131.86	66.8	3133.99
07-Dec-86	0	0	0	58.55	3131.76	66.98	3133.81
08-Dec-86	0	0	0	58.56	3131.75	66.98	3133.81
09-Dec-86	0	0	T	58.56	3131.75	66.98	3133.81
10-Dec-86	0	0	0	58.56	3131.75	66.98	3133.81
11-Dec-86	0	0	T	58.56	3131.75	66.98	3133.81
12-Dec-86	0	0	0	58.56	3131.75	67.2	3133.59
13-Dec-86	0	0	T	58.56	3131.75	67.5	3133.29
14-Dec-86	0	0.01	0.02	58.82	3131.49	68.04	3132.75
15-Dec-86	0	0	0	58.82	3131.49	68.03	3132.76
16-Dec-86	0	0	T	58.82	3131.49	68.03	3132.76
17-Dec-86	0	0	0	58.82	3131.49	68.07	3132.72
18-Dec-86	0	0	T	58.82	3131.49	68.11	3132.68
19-Dec-86	0	0	T	58.84	3131.47	68.14	3132.65
20-Dec-86	0	0	0	58.95	3131.36	68.16	3132.63
21-Dec-86	0	0	0	59.05	3131.26	68.23	3132.56
22-Dec-86	0	0	0	59.1	3131.21	68.29	3132.5
23-Dec-86	0	0	0	59.1	3131.21	68.3	3132.49
24-Dec-86	0	0	0	59.1	3131.21	68.31	3132.48
25-Dec-86	0	0	0	59.1	3131.21	68.34	3132.45
26-Dec-86	0	0	0	59.1	3131.21	68.38	3132.41
27-Dec-86	0	0	0	59.3	3131.01	68.42	3132.37
28-Dec-86	0	0	0.01	59.42	3130.89	68.44	3132.35
29-Dec-86	0	0	0.01	59.46	3130.85	68.51	3132.28
30-Dec-86	0	0	T	59.46	3130.85	68.54	3132.25
31-Dec-86	0	0	0	59.48	3130.83	68.56	3132.23
01-Jan-87	0	0	T	59.57	3130.74	68.6	3132.19
02-Jan-87	0.15	0.08	0.1	59.6	3130.71	68.64	3132.15
03-Jan-87	0.05	0.05	0.02	59.67	3130.64	68.65	3132.14
04-Jan-87	0	0	T	59.66	3130.65	68.65	3132.14
05-Jan-87	0	0	T	59.65	3130.66	68.66	3132.13
06-Jan-87	0	0	T	59.66	3130.65	68.66	3132.13
07-Jan-87	0	0	0	59.67	3130.64	68.75	3132.04
08-Jan-87	0	0	0	59.67	3130.64	68.79	3132
09-Jan-87	0	0	T	59.67	3130.64	68.81	3131.98
10-Jan-87	0	0	0	59.67	3130.64	68.85	3131.94
11-Jan-87	0	0	0	59.8	3130.51	68.88	3131.91
12-Jan-87	0	0	0	59.88	3130.43	68.92	3131.87
13-Jan-87	0	0	0.01	59.95	3130.36	68.93	3131.86
14-Jan-87	.05	.05	0.01	59.91	3130.4	68.93	3131.86
15-Jan-87	0	0	0	59.92	3130.39	68.95	3131.84
16-Jan-87	0	0	0	59.92	3130.39	68.96	3131.83
17-Jan-87	0	0	T	60	3130.31		

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
18-Jan-87	0.05	0.05	T	60.01	3130.3		
19-Jan-87	0	0	0.01	60.02	3130.29		
20-Jan-87	0	0	0	60.02	3130.29		
21-Jan-87	0	0	0	60.03	3130.28		
22-Jan-87	0	0	0	60.03	3130.28		
23-Jan-87	0	0	0	60.05	3130.26		
24-Jan-87	0	0	T	60.05	3130.26		
25-Jan-87	0	0	T	60.12	3130.19		
26-Jan-87	0.17	0.17	0.12	60.12	3130.19		
27-Jan-87	0.03	0.03	T	60.12	3130.19		
28-Jan-87	0	0	T	60.12	3130.19		
29-Jan-87	0	0	0.01	60.12	3130.19		
30-Jan-87	0	0	0	60.12	3130.19		
31-Jan-87	0	0	T	60.12	3130.19		
01-Feb-87	0.1	0.06	0.11	60.12	3130.19		
02-Feb-87	0.15	0.15	0.07	60.12	3130.19		
03-Feb-87	0	0.04	T	60.49	3129.82	70.7	3130.09
04-Feb-87	0	0	T	60.49	3129.82		
05-Feb-87	0	0	0	60.53	3129.78		
06-Feb-87	0	0	0	60.53	3129.78		
07-Feb-87	0	0	0	60.43	3129.88		
08-Feb-87	0	0	0	60.49	3129.82	69.39	3131.4
09-Feb-87	0	0	0	60.51	3129.8		
10-Feb-87	0	0	0	60.51	3129.8	69.62	3131.17
11-Feb-87	0	0	0	60.58	3129.73	69.65	3131.14
12-Feb-87	0	0	0	60.57	3129.74	69.68	3131.11
13-Feb-87	0.14	0.1	0.12	60.59	3129.72	69.7	3131.09
14-Feb-87	0	0	T	60.59	3129.72	69.71	3131.08
15-Feb-87	0	0	0	60.67	3129.64	69.79	3131
16-Feb-87	0	0	0.02	60.78	3129.53	69.79	3131
17-Feb-87	0	0	T	60.78	3129.53		
18-Feb-87	0	0	T	60.58	3129.73		
19-Feb-87	0.05	0.02	0.03	60.58	3129.73	71	3129.79
20-Feb-87	0	0	0.01	60.75	3129.56		
21-Feb-87	0	0	0	60.75	3129.56		
22-Feb-87	0	0	T	60.8	3129.51		
23-Feb-87	0	0	0	60.8	3129.51	70.64	3130.15
24-Feb-87	0	0	0	60.65	3129.66		
25-Feb-87	0	0	0	60.73	3129.58		
26-Feb-87	0	0	0	60.73	3129.58		
27-Feb-87		0.05	T	60.73	3129.58		
28-Feb-87	0	0	0.01	60.75	3129.56		
01-Mar-87	0	0	T	60.75	3129.56		
02-Mar-87	0	0	0	60.75	3129.56	69.95	3130.84
03-Mar-87	0	0	T	60.75	3129.56	69.95	3130.84
04-Mar-87	0	0	0	60.75	3129.56	69.95	3130.84
05-Mar-87	0	0	0	60.75	3129.56	69.95	3130.84
06-Mar-87		0.06	0.12	60.75	3129.56	69.95	3130.84
07-Mar-87	0	0	0	60.8	3129.51	70	3130.79
08-Mar-87	0	0	0	60.8	3129.51	70	3130.79

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
09-Mar-87		0.06	0.07	60.95	3129.36	70	3130.79
10-Mar-87	0	0	0.02	60.95	3129.36	70	3130.79
11-Mar-87	0	0	0.01	60.95	3129.36	70	3130.79
12-Mar-87	0	0	0	60.88	3129.43	70	3130.79
13-Mar-87	0.15	0.1	0.11	60.88	3129.43	70	3130.79
14-Mar-87	0	0	0	60.88	3129.43	70	3130.79
15-Mar-87	0	0	0	60.88	3129.43	70	3130.79
16-Mar-87		0.2	0.08	60.95	3129.36	70	3130.79
17-Mar-87		0	T	60.95	3129.36	70	3130.79
18-Mar-87		0.59	0.34	60.95	3129.36	70	3130.79
19-Mar-87		0.26	0.23	60.95	3129.36	70	3130.79
20-Mar-87		0.09	0.07	60.95	3129.36	70	3130.79
21-Mar-87		0	0	60.84	3129.47	69.8	3130.99
22-Mar-87		0	0	60.84	3129.47	69.87	3130.92
23-Mar-87		0	0	60.69	3129.62	69.87	3130.92
24-Mar-87		0	0	60.62	3129.69	69.8	3130.99
25-Mar-87		0	0	60.62	3129.69	69.8	3130.99
26-Mar-87		0	0.03	60.55	3129.76	69.8	3130.99
27-Mar-87		0.05	0.15	60.5	3129.81	69.86	3130.93
28-Mar-87		0	T	60.48	3129.83	69.86	3130.93
29-Mar-87		0	0	60.68	3129.63	69.86	3130.93
30-Mar-87		0	0	60.68	3129.63	69.86	3130.93
31-Mar-87		0	0	60.78	3129.53	69.8	3130.99
01-Apr-87		0	0	60.87	3129.44	69.86	3130.93
02-Apr-87		0	0	60.83	3129.48	69.85	3130.94
03-Apr-87		0	0	60.76	3129.55	69.85	3130.94
04-Apr-87		0	0	60.8	3129.51	69.85	3130.94
05-Apr-87		0.2	0.1			69.85	3130.94
06-Apr-87		0	0.01			69.93	3130.86
07-Apr-87		0	T	61	3129.31	69.95	3130.84
08-Apr-87		0	0.05	60.93	3129.38	69.92	3130.87
09-Apr-87		0	0	60.95	3129.36	69.9	3130.89
10-Apr-87		0	0.01	60.88	3129.43	69.9	3130.89
11-Apr-87		0.02	0.03	60.85	3129.46	69.87	3130.92
12-Apr-87		0.03	0.04	60.85	3129.46	69.8	3130.99
13-Apr-87		0	0	60.51	3129.8	69.7	3131.09
14-Apr-87		0	0	60.58	3129.73	69.7	3131.09
15-Apr-87		0	0	60.52	3129.79	69.68	3131.11
16-Apr-87		0	0	60.43	3129.88	69.65	3131.14
17-Apr-87		0	0.02	60.45	3129.86	69.61	3131.18
18-Apr-87		0.05	0.06	60.55	3129.76	69.6	3131.19
19-Apr-87		0	T	60.56	3129.75	69.58	3131.21
20-Apr-87		0	0	60.44	3129.87	69.52	3131.27
21-Apr-87		0	0	60.43	3129.88	69.4	3131.39
22-Apr-87		0	0	60.5	3129.81	69.3	3131.49
23-Apr-87		0.05	0.04	60.48	3129.83	69.3	3131.49
24-Apr-87		0	0	60.3	3130.01	69.3	3131.49
25-Apr-87		0	0	60.36	3129.95	69.25	3131.54
26-Apr-87		0	0	60.4	3129.91	69.2	3131.59
27-Apr-87		0	0	60.52	3129.79	69.15	3131.64

DATE	MSL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT B (ft)	BLAINE WL (ft)	STAT B (ft)
28-Apr-87	0	0	T	60.39	3129.92	69.15	3131.64
29-Apr-87	0	0	T	60.35	3129.96	69.07	3131.72
30-Apr-87	0.06	0.06	0.05	60.34	3129.97	69	3131.79
01-May-87	0.05	0.05	0.11	60.25	3130.06	68.98	3131.81
02-May-87	0	0	T	60.13	3130.18	68.8	3131.99
03-May-87	0	0	T	59.83	3130.48	68.58	3132.21
04-May-87	0	0	0	59.83	3130.48	68.34	3132.45
05-May-87	0	0	0	59.8	3130.51	68.3	3132.49
06-May-87	0	0	0	59.75	3130.56	68.2	3132.59
07-May-87	0	0	0	59.64	3130.67	68	3132.79
08-May-87	0	0	T	59.51	3130.8	67.54	3133.25
09-May-87	0	0	0	59.41	3130.9	67.5	3133.29
10-May-87	0	0	0	59.1	3131.21	67.2	3133.59
11-May-87	0	0	0	58.93	3131.38	66.8	3133.99
12-May-87	0.03	0.03	0.01	58.75	3131.56	66.65	3134.14
13-May-87	0	0	T	58.55	3131.76	66.4	3134.39
14-May-87	0	0	0	58.35	3131.96	66.4	3134.39
15-May-87	0.4	0.38	0.26	58.33	3131.98	66.4	3134.39
16-May-87	0	0	0.01	58	3132.31	66	3134.79
17-May-87	0	0	0	57.6	3132.71	65.35	3135.44
18-May-87	0	0	T	57.25	3133.06	65.15	3135.64
19-May-87	0	0	T	57.17	3133.14	65.08	3135.71
20-May-87	0	0	T	56.99	3133.32	64.99	3135.8
21-May-87	0	0	0.01	56.72	3133.59	64.75	3136.04
22-May-87	0	0	T	56.51	3133.8	64.6	3136.19
23-May-87	0.07	0.02	0.01	56.44	3133.87	64.5	3136.29
24-May-87	0.08	0.08	0.02	56.2	3134.11	64.4	3136.39
25-May-87	0.4	0.4	0.32	55.92	3134.39	64.22	3136.57
26-May-87	0	0	0.01	55.75	3134.56	64	3136.79
27-May-87	0.25	0.2	0.14	55.45	3134.86	63.93	3136.86
28-May-87	0	0	0.04	55.26	3135.05	63.7	3137.09
29-May-87	0	0	0	54.9	3135.41	63.16	3137.63
30-May-87	0.03	0.03	0.01	54.9	3135.41	63	3137.79
31-May-87	0.32	0.25	0.36	54.7	3135.61	62.88	3137.91
01-Jun-87	0	0	0	54.55	3135.76	62.67	3138.12
02-Jun-87	0	0	0	54.29	3136.02	62.5	3138.29
03-Jun-87	0	0	0	54.2	3136.11	62.3	3138.49
04-Jun-87	0	0	T	54.15	3136.16	62.25	3138.54
05-Jun-87	0	0	T	54.12	3136.19	62.22	3138.57
06-Jun-87	0	0	0	54.12	3136.19	62.22	3138.57
07-Jun-87	0	0	0.03	54.07	3136.24	62.18	3138.61
08-Jun-87	0.09	0.09	0.1	54	3136.31	62.14	3138.65
09-Jun-87	0.13	0.15	0.03	53.95	3136.36	62.14	3138.65
10-Jun-87	0	0	0	53.78	3136.53	62.05	3138.74
11-Jun-87	0	0	0	53.85	3136.46	61.93	3138.86
12-Jun-87	0	0	0	53.85	3136.46	61.93	3138.86
13-Jun-87	0	0	0	53.87	3136.44	61.99	3138.8
14-Jun-87	0	0	0	53.9	3136.41	62	3138.79
15-Jun-87	0.2	0.2	0.71	53.96	3136.35	62.1	3138.69
16-Jun-87	0.2	0.1	0.14	53.84	3136.47	62.1	3138.69

DATE	MBL PPT (in)	CENT PPT (in)	AIR PPT (in)	SOUTH WL (ft)	STAT S (ft)	BLAINE WL (ft)	STAT B (ft)
17-Jun-87	0.2	0.2	0.12	53.8	3136.51	62.1	3138.69
18-Jun-87	0.15	0.12	0.17	53.75	3136.56	62.1	3138.69
19-Jun-87	0	0	0	53.68	3136.63	61.98	3138.81
20-Jun-87	0	0	0.11	53.52	3136.79	61.98	3138.81
21-Jun-87	0.09	0.09	0.12	53.63	3136.68	61.94	3138.85
22-Jun-87	0	0	0	53.64	3136.67	61.94	3138.85
23-Jun-87	0	0	0	53.5	3136.81	61.94	3138.85
24-Jun-87	0	0	0	53.64	3136.67	61.94	3138.85
25-Jun-87	0	0	0	53.75	3136.56	62	3138.79
26-Jun-87	0	0	0	53.9	3136.41	62.1	3138.69
27-Jun-87	0	0	0	53.95	3136.36	62.2	3138.59
28-Jun-87	0	0	0	54.06	3136.25	62.3	3138.49
29-Jun-87	0	0	0	54.3	3136.01	62.59	3138.2
30-Jun-87	0	0	0	54.45	3135.86	62.7	3138.09
01-Jul-87	0	0		54.6	3135.71	62.82	3137.97
02-Jul-87	0	0.01		54.71	3135.6	63	3137.79
03-Jul-87	0	0		54.68	3135.63	63.02	3137.77
04-Jul-87	0	0		54.72	3135.59	63.08	3137.71
05-Jul-87	0	0.02		54.8	3135.51	63.11	3137.68
06-Jul-87	0	0.04		54.9	3135.41	63.2	3137.59

BLAINE WELL - CORNER OF BLAINE AND CROSBY
ELEVATION TOP OF PVC CASING - 3200.79 ft
DEPTH OF WELL - 76.33 ft

SOUTH WELL - CORNER OF SOUTH AND S. BANCROFT
ELEVATION OF PVC CASING - 3190.31 ft
DEPTH OF WELL - 70.83 ft

MADISON BRIDGE WELL (MB) - UNDER MADISON BRIDGE
ELEVATION OF CASING - 3107.00 ft

DATE	WL(ft)	HEAD(ft)
21-Mar-87	44.27	3062.73
31-Mar-87	45.40	3061.60
05-Apr-87	44.34	3062.66
10-Apr-87	43.94	3063.06
23-Apr-87	42.07	3064.93
01-May-87	43.40	3063.60
08-May-87	40.00	3067.00
17-May-87	35.27	3071.73
22-May-87	35.50	3071.50
29-May-87	36.34	3070.66
06-Jun-87	34.34	3072.66
11-Jun-87	34.25	3072.75
19-Jun-87	34.58	3072.42
24-Jun-87	34.85	3072.15

SOUTHGATE OFFICE WELL (SO) - 1719 DEARBORN
ELEVATION OF CASING - 3178.34 ft
DEPTH OF WELL - 73.10 ft

DATE	WL(ft)	HEAD(ft)
03/17/87	50.82	3127.52
04/02/87	50.72	3127.62
04/10/87	50.61	3127.73
04/24/87	50.11	3128.23
05/27/87	45.15	3133.19
06/12/87	43.49	3134.85
07/02/87	44.51	3133.83

DEARBORN WELL (DW)- 2100 DEARBORN WELL
ELEVATION OF CASING - 3167.55 ft
DEPTH OF WELL - 43.21 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-87	41.16	3126.39
06-Apr-87	40.98	3126.57
11-Apr-87	40.72	3126.83
27-May-87	34.55	3133.00
12-Jun-87	33.57	3133.98
02-Jul-87	34.24	3133.31

CHECKER AUTO WELL (CW) - CORNER OF BROOKS AND PAXSON
ELEVATION OF CASING - 3173.22 ft
DEPTH OF CASING - 79 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-87	48.82	3124.40
02-Apr-87	48.87	3124.35
11-Apr-87	48.81	3124.41
24-Apr-87	48.35	3124.87
27-May-87	42.88	3130.34
12-Jun-87	41.92	3131.30
02-Jul-87	43.34	3131.53

2141 SOUTH AVE. W. BEHIND BARBER SHOP
ELEVATION OF CASING - 3165.53 ft

DATE	WL(ft)	HEAD(ft)
27-May-87	32.56	3132.97
02-Jul-87	32.07	3133.46

GARDNER RESIDENCE - 1626 PITMAN DR.
ELEVATION OF CASING - 3171.20 ft

DATE	WL(ft)	HEAD(ft)
03-Apr-87	45.69	3125.51
11-Apr-87	45.92	3125.28
24-Apr-87	45.20	3126.00
15-May-87	43.88	3127.32
27-May-87	41.64	3129.56
12-Jun-87	39.95	3131.25
02-Jul-87	40.50	3130.70

SKIPPERS WELL - CORNER OF BROOKS AND HAVRE
ELEVATION OF CASING - 3174.87 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-87	49.00	3125.87
04-Apr-87	49.03	3125.84
10-Apr-87	49.59	3125.28
24-Apr-87	48.38	3126.49
15-May-87	46.11	3128.76
27-May-87	44.05	3130.82
12-Jun-87	42.46	3132.41
02-Jul-87	43.45	3133.43

AMERICAN DENTAL MANUFACTURING WELL - 2800 RESERVE
ELEVATION OF CASING - 3166.16 ft
DEPTH OF WELL - 106 ft

DATE	WL(ft)	HEAD(ft)
27-May-87	37.48	3128.68
02-Jul-87	36.94	3129.22

2115 38TH IN BACK OF HOUSE
ELEVATION OF CASING - 3160.48 ft

DATE	WL(ft)	HEAD(ft)
11-Apr-87	36.67	3123.81
24-Apr-87	36.09	3124.39
15-May-87	34.40	3126.08
27-May-87	32.56	3127.92
12-Jun-87	31.00	3129.48
02-Jul-87	31.65	3128.83

FIRST BANK SOUTHSIDE - 2801 BROOKS
ELEVATION OF CASING - 3176.88 ft
DEPTH OF WELL - 87 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-87	49.66	3127.22
02-Apr-87	49.57	3127.31
10-Apr-87	49.69	3127.19
24-Apr-87	48.97	3127.91
15-May-87	46.32	3130.56
27-May-87	44.18	3132.70
12-Jun-87	44.45	3132.43
02-Jul-87	43.45	3133.43

GRIZZLY MINIGOLF - SHACK SOUTH OF MINI-GOLF
ELEVATION OF CASING - 3171.15 ft
DEPTH OF WELL - 106 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-87	46.05	3125.10
06-Apr-87	46.10	3125.05
24-Apr-87	46.73	3124.42
15-May-87	42.19	3128.96
27-May-87	40.14	3131.01
12-Jun-87	38.66	3132.49
02-Jul-87	39.41	3131.74

DUELING DALTON'S SALOON - 2006 ERNEST AVE.
ELEVATION OF CASING - 3173.36 ft
DEPTH OF WELL - 80.4 ft

DATE	WL(ft)	HEAD(ft)
17-Mar-76	47.86	3125.50
03-Apr-87	48.86	3124.50
10-Apr-87	48.95	3124.41
24-Apr-87	47.22	3126.14
15-May-87	45.00	3128.36
27-May-87	43.00	3130.36
12-Jun-87	41.52	3131.84
02-Jul-87	42.08	3131.28

APPENDIX C

DATA FOR EMC AND ROR CALCULATIONS

MISSOULIAN OUTFALL
IMPERVIOUS AREA: 351600 sq ft
LAND USE: RESIDENTIAL
POPULATION DENSITY: 8,150 PERSONS/sq mi
DWELLING UNITS PER ACRE: 5.41

04-Jun-86
SITE: MISSOULIAN OUTFALL
PRECIPITATION: .15 in
DURATION: 5.5 hrs
RUNOFF VOLUME: 6800 gal

TIME	Q gpm	VOL gal	WQ #
16:50			
16:54	16.6	33.2	MO1
16:58	16.6	66.4	
17:00	21.9	38.5	
17:06	31	158.7	
17:10	73.16	208.32	
17:14	87.8	321.9	
17:21	87.8	351.1	
17:25	102.4	380.3	
17:32	31	466.9	MO2
17:37	21.9	132.3	
17:40	16.6	57.8	
17:50	16.6	166	MO3
17:58	14.63	124.9	
18:04	11	76.8	
18:09	11	54.9	
18:18	11	98.7	
18:26	7.3	73.1	
18:38	3.7	65.8	
18:51	3.7	47.6	
18:56	11	36.6	MO4
19:05	14.6	115.2	
19:10	46	151.6	
19:14	46	184	
19:18	87.8	267.5	
19:23	146.3	585.15	
19:25	146.3	292.6	MO5
19:30	43.9	475.5	
19:36	31	224.67	
19:42	31	186	

TIME	Q gpm	VOL gal	WQ #
19:47	31	155	
19:49	31	62	
19:52	21.9	79.4	
20:00	14.6	146.1	
20:10	11	128	
20:23	11	142.6	
20:26	11	32.9	
20:28	11	21.9	
20:32	11	43.9	
20:45	11	142.6	MO6
20:52	11	76.8	
21:04	7.3	109.7	
21:11	3.7	38.4	
21:14	1.83	16.6	
21:20	1.83	11	
21:31	1.83	20.1	
21:35	1.83	7.3	
21:43	1.83	14.6	
21:48	1.83	9.1	
21:52	1.83	7.32	
23:13		74.1	

07-Jun-86
SITE: MISSOULIAN OUTFALL
PRECIPITATION: .37 in
DURATION: 10.5 hrs
RUNOFF VOLUME: 46,600 gal

TIME	Q gpm	VOL gal	WQ #
22:14			
22:16	1.8	1.8	
22:21	11	32	
22:24	14.6	51.2	M010
22:30	234.1	746.1	
22:34	249.8	967.8	
22:36	249.8	499.6	
22:39	285.3	802.6	
22:43	314.5	1199.6	
22:46	314.5	943.6	
22:49	314.5	943.6	M011
22:55	314.5	1887.2	
23:02	314.5	2201.7	
23:05	314.5	943.6	
23:10	314.5	1572.7	
23:17	249.8	1975.2	
23:21	190.2	880	
23:30	87.8	1250.8	
23:33	87.8	263.3	M012
23:39	146.3	702.2	
23:43	249.8	792.2	
23:50	285.3	1872.8	
23:55	347.4	1581.8	
23:59	512	1718.9	
00:01	512	1024	
00:05	438.9	1901.8	
00:09	347.4	1572.6	
00:16	249.8	2090.4	
00:20	249.8	999.2	

TIME	Q gpm	VOL gal	WQ #
00:33	131.7	2479.6	M013
00:41	73.2	819.28	
00:48	46	417	
00:55	31	269.5	
00:57	21.9	52.9	
01:02	16.6	96.3	
01:09	16.6	116.2	
01:15	16.6	99.6	
01:23	16.6	132.8	
01:33	14.6	156.2	
01:41	16.6	124.9	
01:51	14.6	156.2	
02:05	16.6	218.6	
02:23	16.6	298.8	
02:42	16.6	315.4	
03:05	14.6	359.2	M014
03:22	14.6	248.7	
03:30	11	102.4	
03:50	11	219.4	
04:15	21.9	410.9	
04:52	73.2	1758.6	
05:23	73.2	2268	
06:07	31	2291.5	
07:07	7.3	1149.3	
07:16	7.3	65.8	
07:35	7.3	138.9	
07:05		438.6	
09:35			

06-Nov-86
SITE: MISSOULIAN OUTFALL
PRECIPITATION: .02 in
DURATION: 1 hr
VOLUME: 2,000 gal

TIME	Q gpm	VOL gal	WQ #
16:45			
17:15	16.6	249	
18:24	14.6	1077.4	M0130
18:38	14.6	204.8	
18:49	14.6	160.9	
18:53	11	51.2	
19:01	7.3	73.1	M0131
19:12	3.7	60.3	
19:18	3.7	22	
19:28	3.7	36.6	M0132
19:38	2.7	32	
19:48	1.8	23	M0133
20:28		36.6	

06-Nov-87
SITE: BLANCHE OUTFALL
PRECIPITATION: .03 in
DURATION: .5 hr
VOLUME: 900 gal

TIME	Q gpm	VOL gal	WQ #
10:45			
11:00	1.66	12.5	
11:27	5.2	92.88	B0124
11:45	7.8	117	B0125
12:08	7.8	178.9	B0126
12:33	5.2	162.5	
12:42	5.2	47	
12:53	4.8	55.2	B0127
13:20	3.2	131.8	
13:35	2	38.6	
13:53	1.7	32.7	B0128
14:33		33.2	

28-Jun-86
SITE: BLANCHE OUTFALL
PRECIPITATION: .77 in
DURATION: 2.5 hrs
VOLUME: 86880 gal

TIME	Q gpm	VOL gal	WQ #
19:40			
20:32	98.5	837.6	B018
20:46	871.7	6791.7	
21:00	197.1	7481.6	B019
21:14	40	1659.7	
21:22	14.13	216.52	B020
21:31	10.9	112.4	
21:46	7.8	139.7	
21:53	14.1	76.7	
21:58	28.1	105.6	
22:04	33.7	185.3	
22:10	33.7	201.9	
22:20	69.8	517.5	B021
22:44	14.1	1007.64	
22:50	14.1	84.8	
22:55	14.1	70.6	
23:00	10.8	62.5	
23:05	5.2	40.2	
23:08	5.2	15.6	
23:23	0.78	45	
23:31	1.66	9.7	

BLANCHE OUTFALL
IMPERVIOUS AREA: 59,200 sq ft
LAND USE: COMMERCIAL
POPULATION DENSITY: 4,680 PERSONS/sq mi
DWELLING UNITS PER ACRE: 5.38

APPENDIX D

WATER QUALITY DATA

RUNOFF CHEMISTRY GROSS CHEMISTRY (mg/l)

DATE	TIME	SAMPLE #	pH	TEMP	COND 25	HCO3	CL	SO4	NO3-N	Ca	Mg	Na	K	TDS
04-Jun-86	16:45	M01*	6.9	25.0	223	127.7	11.10	19.7	3.02	45.0	7.5	17.9	16.1	258.4
	17:32	M02	6.5	22.0	171	52.6	7.10	18.1	0.99	21.6	4.4	8.8	12.5	129.5
	17:50	M03	6.4	22.5	182	55.6	6.50	15.6	0.81	22.2	4.7	8.0	15.0	131.2
	18:56	M04	6.7	24.0	190	71.5	7.10	17.6	0.49	24.6	5.5	8.5	18.0	155.0
	19:25	M05	6.6	22.2	157	51.4	5.10	14.5	0.59	18.1	3.7	6.7	10.5	112.6
	20:45	M06	6.7	21.5	160	64.7	5.50	14	0.06	19.8	4.2	6.8	10.2	125.5
07-Jun-86	22:24	M010	6.5	25.0		36.4	3.69	5.2	0.11	11.7	2.0	2.4	6.1	68.0
	22:49	M011	6.5	22.5		22.4	2.50	6.2	0.08	8.3	1.5	3.0	3.4	47.7
	23:30	M012	6.6	21.0		18.2	1.86	5	0.02	8.0	1.4	2.5	3.7	40.7
08-Jun-86	00:33	M013	6.8	22.0		17.4	0.88	2.3	0.12	4.9	0.8	1.6	2.4	30.8
	03:05	M014	6.7	24.0		25.9	1.65	2.8	0.06	6.6	1.1	2.1	2.6	43.0
06-Nov-86	18:24	M0130		7.0	152									
	19:01	M0131	7.5	6.2	227	44.7	17.60	14.5	0.08	23.1	5.8	4.9	23.9	134.9
	19:28	M0132	7.4	7.0	236	49.5	20.80	15.6	0.08	25.5	6.5	5.0	27.7	151.0
	19:38	M0133	7.5	6.5	257	52.9	21.00	14.7	0.07	27.2	6.8	5.1	29.2	157.2
26-Jan-87	13:50	M0160	7.7			56.8	1104.00	69.4	2.25	65.5	29.1	715.0	20.1	2070.0
29-Jan-87	14:07	M0164	6.6			25.4	682.00	31	1.09	63.2	7.4	415.0	18.4	1247.0
01-Feb-87	13:25	M0167	6.8	2.2	603	37.2	170.00	11.9	0.51	15.7	2.8	109.0	9.6	358.5
05-Feb-87	15:50	M0174	7.5	2.2	710	47.9	183.00	10.9	0.35	15.2	2.6	125.0	7.8	346.6
13-Feb-87	14:26	M0181	7.2	1.1	277	36	61.30	14.9	0.95	9.2	1.4	47.9	4.4	179.3
05-Jun-86	21:09	B09	6.5	20.0	7	14.8	3.00	3.3	0.37	5.7	0.8	3.2	1.9	34.3
28-Jun-86		B018	6.7			7.8	1.18	3	0.29	4.8	0.6	2.0	1.4	22.1
	21:00	B019	7.0	21.0	32	7.2	1.48	1.7	0.23	3.2	0.4	1.8	1.2	17.9
	21:22	B020	6.4	22.0	36	10.6	1.43	2.2	0.24	4.4	0.5	1.8	1.5	23.5
	22:20	B021	6.3	21.5	26	7.7	0.16	1.3	0.16	3.0	0.3	0.8	0.9	14.9
05-Nov-86	11:27	B0124	7.4	6.2	374	35.04	11.20	15.4	0.74	18.6	3.3	9.2	7.8	103.9
	11:45	B0125	7.5	7.7	372	33.94	9.90	16.5	0.74	18.6	3.2	8.9	6.8	101.3
	12:08	B0126	7.5	7.8	371	32.04	9.46	11.1	0.79	16.4	3.0	8.5	6.2	90.4
	12:53	B0127	7.5	8.2	393	35.6	10.30	11.2	0.75	18.0	3.2	8.9	7.0	97.9
	13:53	B0128	7.5			34.14	10.60	15.6	0.57	20.2	3.6	9.5	7.8	112.3
26-Jan-87	14:10	B0161	7.5			43.2	1589.00	62.2	2.84	127.0	31.8	953.0	47.3	2070.0
27-Jan-87	12:50	B0162	7.5			57.2	1208.00	48.5	2.01	74.2	26.8	767.0	33.4	2218.0
29-Jan-87	14:35	B0165	7.1			35.7	1291.00	35.8	1.45	66.6	7.5	787.0	21.6	2252.0
01-Feb-87	14:35	B0170	7.1	1.0	799	35.9	203.00	10.3	0.28	15.8	2.0	132.0	7.4	407.6
05-Feb-87	15:05	B0172	7.5	0.7	511	45	158.00	12	0.32	11.4	1.3	112.0	5.5	346.6
13-Feb-87	15:20	B0183	7.0	1.1	259	38.5	53.40	9	0.47	7.8	1.0	42.5	4.0	158.3
30-Sep-86	17:08	BD91	6.4			5.8	1.27	2.2	0.2	2.2	0.4	0.7	0.6	14.0
	17:39	BD92	6.2			4.7	0.74	1.1	0.14	1.5	0.2	0.5	0.3	9.7
	18:22	BD93	6.2			4.9	1.18	2.3	0.16	1.5	0.3	0.8	0.3	12.0
	18:48	BD94	6.2			3.4	1.21	2	0.13	1.1	0.3	0.5	0.3	9.2
	19:11	BD95	6.3			2.7	0.56	0.9	0.11	1.0	0.2	0.3	0.2	6.4
13-Feb-87	16:15	BD185	7.2			28.5	20.20	5.2	0.3	6.4	1.1	17.0	0.8	80.5
18-Mar-87	09:30	BD209	7.0			19.5	1.91	2.2	0.14	4.2	0.7	3.5	0.9	33.5
	10:04	BD210	7.0			8.7	0.99	1.1	0.11	2.5	0.2	1.9	0.6	16.5
	10:38	BD211	6.6			6.3	0.50	1.1	0.09	1.5	0.2	1.2	0.4	13.9
	11:32	BD212	7.0			8.2	0.67	0.9	0.07	2.0	0.2	1.2	0.4	13.9
15-May-87	17:10	BD305	6.5	21.0		5	0.48	1.3	0.14	1.9	0.3	1.0	1.3	11.9

CONT' RUNOFF CHEMISTRY GROSS CHEMISTRY (mg/l)

DATE	TIME	SAMPLE #	pH	TEMP	COND 25	HCO3	CL	SO4	NO3-N	Ca	Mg	Na	K	TDS
	17:20	BD306	6.5	18.0		5.5	0.61	1.1	0.12	2.0	0.3	0.9	1.2	12.1
	17:59	BD307	6.6	19.0		4.6	0.36	1.4	0.08	1.8	0.2	0.5	0.8	9.7
25-May-87	09:30	BD329	6.8	14.0	56	5.9	0.27	1.1	0.07	1.6	0.3	0.7	0.7	10.9
	09:51	BD330	6.7	15.0	14	3.9	0.24	0.8	0.04	1.0	0.2	0.6	0.6	7.5
	10:11	BD331	6.4	15.0	11	3.7	0.20	0.5	0.03	1.0	0.2	0.6	0.6	6.8
09-Jul-86	22:30	SD34	3.7	22.0	18	-	18.50	1.7	0.39	6.9	0.9	2.8	1.2	
13-Mar-87	11:30	SD199	7.2			55	72.70	18.2	0.43	12.4	1.8	57.6	4.7	224.3
16-Mar-87	09:50	SD200	7.6			35.6	22.70	7.5	0.38	7.8	1.1	22.0	2.5	100.9
	10:30	SD201	7.3			41.4	26.30	8	0.57	9.0	1.1	25.9	2.9	117.1
	10:52	SD202	7.0	7.8	166	41.7	24.70	8.1	0.35	8.1	1.0	24.3	2.6	112.1
	11:43	SD203	7.3	9.6	207	51.4	30.00	9.4	0.41	11.6	1.4	29.2	3.2	138.0
15-May-87	17:15	SD308	7.1			22.7	8.63	7.8	0.37	8.5	1.0	6.9	2.5	59.7
	17:55	SD309	7.0	21.0	6	14.8	4.03	4.7	0.2	5.3	0.6	4.2	1.5	36.0
25-May-87	09:50	SD326	7.1			10.5	1.20	1.4	0.08	3.3	0.4	1.8	0.9	19.9
	10:10	SD327	7.1	15.0	44	11.1	1.22	1.7	0.06	3.5	0.4	1.8	0.8	20.8
	10:55	SD328	7.1	17.0	42	13.1	1.54	2.1	0.08	4.2	0.5	2.2	0.8	24.7
27-Jan-87	12:15	BP163				37.5	398.20	19.8	0.75	33.0	3.3	262.0	7.6	767.4
07-Jun-87	21:10	MD350	6.7			63	15.90	31	1.71	48.9	3.3	7.2	6.0	182.9
15-Jun-87	17:43	MD362	6.6			28.8	7.08	7.6	0.58	16.4	0.6	1.4	1.1	65.6
15-Jun-87	18:03	KD363	6.3			5.2	1.12	1.6	0.29	3.4	0.4	1.1	0.6	14.7
15-Jun-87	18:27	UM364	6.6			10.7	1.07	2.5	0.25	5.5	0.6	0.8	1.3	23.6
16-Jun-87	08:04	SMD365	7.2	15.0	6	24.9	31.10	3	0.45	10.8	0.6	0.7	0.7	43.9
16-Jun-87	08:32	MD366	7.0	15.0	4	13.4	0.92	2	0.24	5.7	0.4	0.9	0.7	25.0
16-Jun-87	09:00	MD367	7.1	15.0	4	14.3	0.51	2.2	0.2	5.5	0.3	0.5	0.6	24.8

* SITE LOCATIONS KEY

MO=MISSOULIAN OUTFALL BO=BLANCHE OUTFALL BD=BLAINE SD=SOUTH MD=MALL

SMD=SOUTH MALL BP=BUTTREY PARKING LOT UM=UNIVERSITY OF MT KD=K-MART PARKING LOT

RUNOFF CHEMISTRY METALS (mg/l)

DATE	TIME	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
04-Jun-86	16:45	M01	<.005	<.001	<.02	0.03	0.38	<.01	0.22	<.03	<.001	0.09
	17:32	M02	<.005	<.001	<.02	0.02	0.28	<.01	0.22	<.03	<.001	0.09
	17:50	M03	<.005	<.001	<.02	0.02	0.28	0.02	0.24	<.03	<.001	0.08
	18:56	M04	<.005	<.001	<.02	0.02	0.33	0.1	0.33	<.03	<.001	0.08
	19:25	M05	<.005	<.001	<.02	0.01	0.29	0.02	0.2	<.03	<.001	0.04
	20:45	M06	<.005	<.001	<.02	<.01	0.18	<.01	0.2	<.03	<.001	0.04
07-Jun-86	22:24	M010	<.005	<.001	<.02	0.01	0.88	0.04	0.11	<.03	<.001	0.12
	22:49	M011	<.005	<.001	<.02	<.01	0.09	<.01	0.06	<.03	<.001	0.05
	23:30	M012	<.005	0.001	<.02	<.01	0.12	<.01	0.06	<.03	<.001	0.04
08-Jun-86	00:33	M013	<.005	<.001	<.02	<.01	0.07	<.01	0.04	<.03	<.001	0.03
	03:05	M014	<.005	0.001	<.02	<.01	0.09	<.01	0.04	<.03	<.001	0.04
06-Nov-86	18:24	M0130	<.005	<.001	<.02	0.03	0.46	<.01	0.33	<.03	<.001	0.41
	19:01	M0131	<.005	<.001	<.02	0.03	0.17	<.01	0.48	<.03	<.001	0.13
	19:28	M0132	<.005	<.001	<.02	<.01	0.17	<.01	0.59	<.03	<.001	0.14
	19:38	M0133	<.005	<.001	<.02	<.01	0.16	<.01	0.62	<.03	<.001	0.12
26-Jan-87	13:50	M0160	<.005	<.001	<.02	0.01	0.05	<.01	0.38	<.03	<.001	0.09
29-Jan-87	14:07	M0164	<.005	<.001	<.02	0.02	0.2	<.01	0.46	<.03	<.001	0.09
01-Feb-87	13:25	M0167	<.005	<.001	<.02	0.03	0.12	<.01	0.19	<.03	<.001	0.05
05-Feb-87	15:50	M0174	<.005	<.001	<.02	<.01	0.2	<.01	0.14	<.03	<.001	0.05
13-Feb-87	14:26	M0181	<.005	<.001	<.02	<.01	0.27	<.01	0.07	<.03	<.001	0.04
05-Jun-86	21:09	B09	<.005	<.001	<.02	<.01	0.09	<.01	0.04	<.03	<.001	0.07
28-Jun-86		B018	<.005	<.001	<.02	<.01	0.09	<.01	0.06	<.03	<.001	0.11
	21:00	B019	<.005	<.001	<.02	<.01	0.14	<.01	0.03	<.03	<.001	0.04
	21:22	B020	<.005	<.001	<.02	<.01	0.09	<.01	0.04	<.03	<.001	0.09
	22:20	B021	<.005	<.001	<.02	<.01	0.04	<.01	0.03	<.03	<.001	0.03
05-Nov-86	11:27	B0124	<.005	<.001	<.02	0.04	1.11	0.08	0.37	<.03	<.001	0.32
	11:45	B0125	<.005	<.001	<.02	0.03	1.51	0.11	0.44	<.03	<.001	0.38
	12:08	B0126	<.005	<.001	<.02	0.03	1.06	0.09	0.35	<.03	<.001	0.26
	12:53	B0127	<.005	<.001	<.02	<.01	0.87	0.07	0.32	<.03	<.001	0.23
	13:53	B0128	<.005	<.001	<.02	<.01	0.35	<.01	0.27	<.03	<.001	0.15
26-Jan-87	14:10	B0161	<.005	<.001	<.02	0.01	0.03	<.01	0.74	<.03	<.001	0.09
27-Jan-87	12:50	B0162	<.005	<.001	<.02	0.01	0.07	<.01	0.60	<.03	<.001	0.17
29-Jan-87	14:35	B0165	<.005	<.001	<.02	0.02	<.03	<.01	0.57	<.03	<.001	0.08
01-Feb-87	14:35	B0170	<.005	<.001	<.02	0.03	0.31	<.01	0.14	<.03	<.001	0.04
05-Feb-87	15:05	B0172	<.005	<.001	<.02	<.01	<.03	<.01	0.05	<.03	<.001	0.03
13-Feb-87	15:20	B0183	<.005	<.001	<.02	<.01	0.21	<.01	0.05	<.03	<.001	0.02
30-Sep-86	17:08	BD91	<.005	<.001	<.02	<.01	0.05	<.01	<.02	<.03	<.001	0.03
	17:39	BD92	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.03
	18:22	BD93	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
	18:48	BD94	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
	19:11	BD95	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
13-Feb-87	16:15	BD185	<.005	<.001	<.02	0.02	0.14	<.01	0.04	<.03	<.001	0.03
18-Mar-87	09:30	BD209	<.005	<.001	<.02	<.01	0.12	<.01	0.07	<.03	<.001	0.02
	10:04	BD210	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.01
	10:38	BD211	<.005	<.001	<.02	<.01	0.07	<.01	<.02	<.03	<.001	0.01
	11:32	BD212	<.005	<.001	<.02	<.01	0.21	0.01	<.02	<.03	<.001	0.07
15-May-87	17:10	BD305	<.005	<.001	<.02	0.01	0.08	<.01	0.07	<.03	<.001	0.06

CONT' RUNOFF CHEMISTRY METALS (mg/l)

DATE	TIME	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
	17:20	BD306	<.005	<.001	<.02	<.01	0.07	<.01	0.03	<.03	<.001	0.03
	17:59	BD307	<.005	<.001	<.02	<.01	0.05	<.01	0.03	<.03	<.001	0.02
25-May-87	09:30	BD329	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
	09:51	BD330	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
	10:11	BD331	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
09-Jul-86	22:30	SD34	<.005	<.001	<.02	<.01	0.26	<.01	0.11	<.03	<.001	0.21
13-Mar-87	11:30	SD199	<.005	<.001	0.11	0.02	1.12	<.01	0.16	0.06	<.001	0.06
16-Mar-87	09:50	SD200	<.005	<.001	<.02	<.01	0.08	<.01	0.06	<.03	<.001	0.02
	10:30	SD201	<.005	<.001	0.04	<.01	0.18	<.01	0.08	<.03	<.001	0.03
	10:52	SD202	<.005	<.001	0.05	<.01	0.23	<.01	0.07	<.03	<.001	0.03
	11:43	SD203	<.005	<.001	<.02	<.01	0.04	<.01	0.08	<.03	<.001	0.02
15-May-87	17:15	SD308	<.005	<.001	<.02	<.01	0.14	0.01	0.11	<.03	<.001	0.06
	17:55	SD309	<.005	<.001	<.02	<.01	0.25	<.01	0.09	<.03	<.001	0.06
25-May-87	09:50	SD326	<.005	<.001	<.02	<.01	<.03	<.01	0.03	<.03	<.001	0.02
	10:10	SD327	<.005	<.001	<.02	<.01	<.03	<.01	0.03	<.03	<.001	0.02
	10:55	SD328	<.005	<.001	<.02	<.01	<.03	<.01	0.04	<.03	<.001	0.03
27-Jan-87	12:15	BP163	<.005	<.001	<.02	0.02	0.04	<.01	0.23	<.03	<.001	0.09
07-Jun-87	21:10	MD350	<.005	<.001	<.02	0.05	0.27	<.01	0.38	0.04	<.001	0.52
15-Jun-87	17:43	MD362	<.005	<.001	<.02	0.02	0.1	<.01	0.13	<.03	<.001	0.19
15-Jun-87	18:03	KD363	<.005	<.001	<.02	<.01	0.06	<.01	0.05	<.03	<.001	0.06
15-Jun-87	18:27	UM364	<.005	<.001	<.02	<.01	<.03	<.01	0.06	<.03	<.001	0.05
16-Jun-87	08:04	SMD365	<.005	<.001	<.02	<.01	<.03	<.01	0.03	<.03	<.001	0.02
16-Jun-87	08:32	MD366	<.005	<.001	<.02	<.01	<.03	<.01	0.03	<.03	<.001	0.03
16-Jun-87	09:00	MD367	<.005	<.001	<.02	<.01	<.03	<.01	0.02	<.03	<.001	0.03

SITE LOCATIONS KEY

MD=MISSOULIAN OUTFALL BD=BLANCHE OUTFALL BD=BLAINE SD=SOUTH MD=MALL

SMD=SOUTH MALL BP=BUTTREY PARKING LOT UM=UNIVERSITY OF MT KD=K-MART PARKING LOT

LYSIMETER CHEMISTRY GROSS CHEMISTRY (mg/l)
RESIDENTIAL SINGLE DRAIN SITE - BLAINE (BW)

3 FT LYSIMETER

DATE	SAMPLE #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K	TDS
03-Sep-86	44	7.9	185.0	8.37	71.7	3.16	43.6	7.1	97.5	6.5	434.1
03-Oct-86	97	7.7	76.3	8.10	5.7	0.66	11.2	2.1	20.1	1.5	127.9
16-Oct-86	118	7.5	98.4	4.16	7.8	1.55	22.4	3.4	13.1	2.2	158.3
07-Feb-87	178	7.9	104.0	50.00	17.5	3.56	35.2	5.0	44.1	4.1	276.3
15-Feb-87	186	7.5	53.9	25.30	4.5	0.34	9.5	1.7	24.2	1.3	121.9
21-Mar-87	214	7.4	13.8	1.46	0.8	0.21	1.9	0.3	3.8	0.6	23.6
31-Mar-87	241	7.3	16.6	4.96	3.0	0.32	5.8	0.7	4.8	1.1	38.4
08-Apr-87	258	7.2	19.1	4.48	3.6	0.53	6.9	0.9	4.9	1.5	44.0
19-Jun-87	372	7.0	13.1	2.15	1.9	0.82	4.1	0.9	1.6	1.8	29.2
06-Jul-87	385	7.3	37.1	2.21	6.6	1.16	14.8	2.7	2.6	2.8	74.0

13 FT LYSIMETER

DATE	SAMPLE #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K	TDS
03-Sep-86	43	7.8	270.1	2.23	7.4	5.10	42.8	10.7	37.0	18.4	411.8
05-Sep-86	52	8.1	291.5	2.10	10.0	6.00	53.2	12.7	36.2	18.9	451.2
08-Sep-86	58	8.0	288.5	1.92	11.7	5.68	54.6	12.6	36.5	17.8	448.8
10-Sep-86	67	8.0	292.2	1.94	12.0	6.05	55.0	13.0	37.1	18.2	456.2
12-Sep-86	74	8.2	289.6	1.81	10.8	5.67	54.6	12.4	35.3	18.1	447.7
18-Sep-86	83	7.8	287.7	1.49	9.3	4.46	53.2	12.0	34.3	17.1	434.9
03-Oct-86	101	8.0	282.5	1.43	9.1	2.62	54.5	11.6	28.5	15.3	407.8
16-Oct-86	119	7.8	277.9	1.43	9.1	2.59	52.5	11.6	28.5	15.3	407.8
07-Feb-87	179	7.7	313.8	15.10	13.5	(.01	65.3	14.0	30.8	16.2	468.7
15-Feb-87	187	8.1	137.1	141.00	11.4	2.34	73.6	16.0	30.1	19.8	439.4
19-Feb-87	189	7.8	138.1	155.00	12.6	2.48	88.7	15.2	29.3	17.7	467.6
16-Mar-87	204	8.1	181.1	51.50	12.7	2.68	54.2	10.6	25.9	13.2	361.1
21-Mar-87	215	8.1	189.6	47.30	11.5	2.64	53.7	11.0	25.4	12.1	416.0
21-Mar-87	218	8.3	200.1	39.90	10.7	2.83	51.3	10.4	26.8	12.8	364.5
22-Mar-87	222	8.0	190.5	45.20	10.3	2.19	53.0	10.8	25.5	12.1	357.1
23-Mar-87	226	8.3	189.6	42.10	10.3	0.71	53.5	10.3	23.9	11.8	344.7
24-Mar-87	229	8.3	191.5	40.00	10.4	1.05	53.7	10.0	23.9	11.6	345.7
25-Mar-87	232	8.3	190.1	37.90	10.5	2.18	52.2	10.1	23.8	11.9	346.2
26-Mar-87	235	8.2	189.7	37.00	10.1	2.16	51.6	10.1	23.8	11.5	279.9
27-Mar-87	238	8.2	193.0	36.40	10.1	2.24	52.2	10.1	24.2	11.9	347.8
31-Mar-87	242	8.1	195.1	34.40	10.3	2.35	52.2	9.6	23.9	11.9	347.8
05-Apr-87	251	8.1	198.0	31.70	9.8	2.71	51.1	9.6	24.5	11.4	348.1
08-Apr-87	259	8.4	199.1	29.20	10.6	2.82	49.2	9.7	25.0	11.7	347.0
10-Apr-87	265	8.3	203.0	27.70	11.2	2.89	48.8	9.8	24.2	11.3	348.8
22-Apr-87	277	8.1	213.4	24.00	11.1	2.65	47.4	9.7	25.8	12.0	355.1
01-May-87	289	8.2	227.3	18.60	12.0	2.75	49.1	9.8	26.7	11.4	367.1
08-May-87	296	8.3	235.3	15.40	10.0	2.73	49.3	9.8	26.7	11.4	370.0
17-May-87	315	8.1	242.4	13.80	10.3	2.53	52.0	9.7	27.3	12.1	378.8
22-May-87	318	8.1	248.5	12.30	11.1	2.87	50.2	10.3	29.5	12.8	387.4
29-May-87	337	8.1	253.5	12.00	10.6	2.64	53.9	10.1	29.2	12.3	393.3
06-Jun-87	344	8.1	266.4	9.93	10.7	2.47	54.5	10.4	30.8	13.0	406.7
11-Jun-87	354	8.2	281.9	7.30	10.5	2.60	53.7	10.7	34.4	13.2	423.2
19-Jun-87	373	8.0	281.0	5.90	10.5	2.47	53.9	10.1	32.7	12.9	418.4
06-Jul-87	386	7.8	293.3	4.78	10.1	1.74	52.4	10.5	34.3	13.1	426.2

LYSIMETER CHEMISTRY METALS (mg/l)
RESIDENTIAL SINGLE DRAIN SITE - BLAINE (BW)
8 FT LYSIMETER

DATE	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
05-Sep-86	53	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
08-Sep-86	59	0.006	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.02
10-Sep-86	68	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.03
12-Sep-86	75	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.05
03-Oct-86	97	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
16-Oct-86	118	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
07-Feb-87	178	<.005	<.005	<.02	0.03	<.05	<.02	<.02	<.03	<.001	0.11
07-Mar-87	194	<.005	<.001	0.06	0.06	0.37	<.01	<.02	0.04	<.001	0.06
21-Mar-87	214	<.005	<.001		0.03	<.02	<.01	<.02		<.001	0.02
22-Apr-87	276	<.005	<.001	0.07	0.03	0.33	<.01	0.34	0.03	<.001	0.08
01-May-87	288	<.005	<.001	<.02	0.04	0.22	<.01	0.07	<.03	<.001	0.09
08-May-87	295	<.005	<.001	<.02	0.03	0.15	<.01	0.81	<.03	<.001	0.11
22-May-87	317	<.005	<.001	<.02	0.03	0.06	<.01	0.04	<.03	<.001	0.02
29-May-87	a336	<.005	<.001	<.02	0.01	0.06	<.01	<.02	<.03	0.001	0.03
11-Jun-87	353	<.005	<.001	<.02	0.01	<.03	<.01	0.09	<.03	<.001	0.08
19-Jun-87	372	<.005	<.001	<.02	0.01	<.03	<.01	0.02	<.03	<.001	0.06
06-Jul-87	385	<.005	<.001	<.02	0.02	0.04	<.01	0.16	<.03	<.001	0.17

13 FT LYSIMETER

DATE	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
03-Sep-86	43	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.12
05-Sep-86	52	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.05
08-Sep-86	58	0.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
10-Sep-86	67	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
12-Sep-86	74	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
18-Sep-86	83	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
22-Sep-86	88	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
03-Oct-86	101	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.03
16-Oct-86	119	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.02
07-Feb-87	179	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.06
15-Feb-87	187	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.04
19-Feb-87	189	<.005	<.001	<.02	<.01	0.11	<.01	<.02	<.03	<.001	0.02
07-Mar-87	195	<.005	<.001	0.03	<.01	0.12	<.01	<.02	<.03	<.001	0.02
16-Mar-87	204	<.005	<.001	<.02	<.01	0.04	<.01	<.02	<.03	<.001	0.01
21-Mar-87	215	<.005	<.001		<.01	0.05	<.01	<.02		<.001	<.01
21-Mar-87	218	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
22-Mar-87	222	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
23-Mar-87	226	<.005	<.001		<.01	0.05	<.01	<.02		<.001	<.01
24-Mar-87	229	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
25-Mar-87	232	<.005	<.001		<.01	0.05	<.01	<.02		<.001	<.01
26-Mar-87	235	<.005	<.001		<.01	1.00	<.01	0.05		<.001	<.01
31-Mar-87	242	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
05-Apr-87	251	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
08-Apr-87	259	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
10-Apr-87	265	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
22-Apr-87	277	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
01-May-87	289	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
08-May-87	296	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01

CONT' 13 FT LYSIMETER

DATE	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
17-May-87	315	<.005	<.001	<.02	<.01	0.09	<.01	<.02	<.03	<.001	<.01
22-May-87	318	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
29-May-87	337	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
06-Jun-87	344	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
11-Jun-87	354	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
19-Jun-87	373	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.01
06-Jul-87	386	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.01

LYSIMETER CHEMISTRY   GROSS CHEMISTRY (mg/l)
COMMERCIAL SINGLE DRAIN SITE - SOUTH (SW)
8 FT LYSIMETER

DATE	SAMPLE #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K	TDS
07-Jul-86	26	5.1	0.5	13.20	6.8	0.26	3.3	0.7	7.3	1.0	36.1
11-Jul-86	35	7.5	38.3	22.50	10.5	1.57	11.7	3.6	19.6	1.8	115.0
03-Sep-86	47	7.9	125.4	15.60	42.9	1.01	29.9	5.9	41.2	5.7	271.1
03-Oct-86	102	7.6	42.0	4.32	11.4	0.19	14.1	2.0	5.2	2.1	81.9
15-Feb-87	188	8.1	78.6	506.00	29.4	0.54	33.8	4.5	356.0	5.6	1016.0
07-Mar-87	197			438.00	85.0		45.0	5.0	326.0	8.0	
21-Mar-87	216	8.0	67.2	23.40	6.8	0.17	15.9	1.9	19.4	2.5	137.9
06-Jun-87	346	8.0	99.4	9.41	9.6	0.41	25.4	2.9	12.7	3.6	164.8
19-Jun-87	374	7.8	109.5	10.10	11.1	0.44	30.7	3.4	13.4	4.6	184.8
06-Jul-87	387	7.9	136.3	8.36	31.6	1.62	51.2	6.0	16.4	6.3	263.3

13 FT LYSIMETER

DATE	SAMPLE #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K	TDS
03-Sep-86	46	8.6	424.2	76.20	27.4	0.28	58.0	16.3	120.0	12.3	735.6
03-Oct-86	103	8.4	441.7	41.60	22.9	0.01	61.6	14.3	99.0	13.4	694.5
21-Mar-87	217	8.2	260.3	298.00	24.3	0.86	165.0	32.0	100.0	14.0	895.4
31-Mar-87	245	8.3	244.2	224.00	26.9	0.61	114.0	21.1	78.5	11.7	723.1
29-May-87	340	8.3	370.4	158.00	27.5	0.78	106.4	20.6	98.0	13.3	797.7
06-Jun-87	347	8.2	326.3	104.00	19.7	0.60	71.4	16.4	10.5	2.6	369.0
19-Jun-87	375	8.1	408.0	86.80	20.4	0.54	82.4	15.7	86.1	12.9	714.7
06-Jul-87	388	8.0	415.5	85.30	22.3	0.18	78.1	16.3	96.1	11.4	725.8

30 FT LYSIMETER

DATE	SAMPLE #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K	TDS
22-Mar-87	224	8.5	229.6	233.00	24.7	0.69	135.0	25.5	90.5	11.0	754.4
06-Jul-87	389	8.2	372.5	386.50	49.9	1.69	158.5	34.0	167.6	12.2	1188.7

LYSIMETER CHEMISTRY METALS (mg/l)
COMMERCIAL SINGLE DRAIN SITE - SOUTH (SW)
8 FT LYSIMETER

DATE	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
07-Jul-86	26	<.005	0.002	<.02	0.07	0.04	<.02	0.04	0.05	<.001	0.5
11-Jul-86	35	<.005	<.005	<.02	0.04	<.05	<.02	0.05	<.03	<.001	0.77
03-Sep-86	47	<.005	<.005	<.02	0.03	<.05	<.02	<.02	<.03	<.001	0.06
08-Sep-86	56	<.005	<.005	<.02	<.02	0.09	<.02	<.02	<.03	<.001	0.05
10-Sep-86	65	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.05
07-Mar-87	197	<.005	<.001	<.02	0.02	<.03	<.01	0.05	<.03	<.001	0.02
21-Mar-87	216	<.005	<.001		0.05	0.2	<.01	0.05		<.001	0.06
31-Mar-87	244	<.005	<.001		0.29	0.3	<.01	0.07		<.001	0.14
08-Apr-87	262	<.005	<.001	<.02	0.22	0.24	<.01	0.04	<.03	<.001	0.09
22-Apr-87	279	<.005	<.001	<.02	0.08	0.05	<.01	0.02	<.03	<.001	0.04
01-May-87	291	<.005	<.001	0.09	0.07	0.44	<.01	0.03	0.06	<.001	0.03
08-May-87	298	<.005	<.001	0.09	0.04	0.5	<.01	0.09	0.08	<.001	0.04
17-May-87	311	<.005	<.001	<.02	0.03	0.31	0.02	0.23	0.04	<.001	0.06
29-May-87	339	<.005	<.001	<.02	0.02	<.03	<.01	0.03	<.03	<.001	0.04
19-Jun-87	374	<.005	<.001	<.02	0.01	<.03	<.01	<.02	<.03	<.001	0.03
06-Jul-87	387	<.005	<.001	<.02	0.02	<.03	<.01	<.02	<.03	<.001	0.03

13 FT LYSIMETER

DATE	SAMPLE #	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
10-Sep-86	64	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.04
05-Apr-87	253	<.005	<.001		0.01	0.07	<.01	<.02		<.001	0.08
08-Apr-87	261	<.005	<.001	0.07	0.01	0.26	<.01	<.02	<.03	<.001	0.07
10-Apr-87	267	<.005	<.001	<.02	0.02	0.1	<.01	<.02	<.03	<.001	0.07
23-Apr-87	280	<.005	<.001	<.02	<.02	<.03	<.01	<.02	<.03	0.002	0.07
01-May-87	292	<.005	<.001	0.18	0.02	0.86	<.01	0.04	0.09	0.001	0.07
08-May-87	299	<.005	<.001	0.29	0.02	1.67	0.01	0.08	0.19	0.002	0.08
17-May-87	312	<.005	<.001	<.02	<.02	<.03	<.01	<.02	<.03	0.001	0.05
22-May-87	321	<.005	<.001	<.02	<.02	<.03	<.01	<.02	<.03	<.001	0.03
06-Jun-87	347	<.005	<.001	<.02	<.02	0.06	<.01	<.02	<.03	0.001	0.03
19-Jun-87	375	<.005	<.001	<.02	<.02	<.03	<.01	<.02	<.03	<.001	0.02
06-Jul-87	388	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02

BLAINE WELL GROUND WATER CHEMISTRY GROSS CHEMISTRY (mg/l)

DATE	SAMPLE#	pH	TEMP	COND @25	HCO3	CL	SO4	NO3-N	Ca	Mg	Na	K	TDS
6-Jul-85	BW23	8.1	11.0	402	184.8	3.50	16.8	0.64	44.4	12.1	6.9	1.6	272.4
3-Jul-86	BW28	8.1	12.5	534	184.8	3.58	16.5	0.71	44.5	12.0	6.8	1.6	272.8
6-Jul-86	BW39	7.6	14.0		176.4	4.60	16.9	0.66	43.2	11.2	6.4	1.3	262.9
3-Sep-86	BW45	8.2	10.1		181.7	3.03	15.0	0.57	43.2	11.7	6.4	1.6	265.1
4-Sep-86	BW50	8.2	10.0		186.7	3.08	15.6	0.59	42.7	11.8	6.1	1.6	264.2
5-Sep-86	BW54	8.0	9.9		180.9	3.06	14.2	0.59	42.6	11.4	6.3	1.6	262.7
8-Sep-86	BW60	8.0	10.1		180.9	3.10	15.6	0.60	42.5	11.9	6.1	1.7	264.5
9-Sep-86	BW63	8.1	10.1		185.9	3.10	14.9	0.60	43.2	12.1	6.4	1.6	265.4
0-Sep-86	BW69	8.1	9.9		182.0	3.08	14.8	0.60	43.0	12.0	6.2	1.7	265.2
1-Sep-86	BW71	8.0	9.8		182.0	3.13	16.3	0.59	43.0	11.9	6.2	1.6	266.5
2-Sep-86	BW76	8.0	9.8		183.2	3.08	15.6	0.60	43.0	11.9	6.3	1.8	267.3
5-Sep-86	BW78	8.0	10.0		181.7	3.08	15.7	0.60	44.0	11.6	6.0	1.6	266.4
17-Sep-86	BW81	8.0	9.6		182.9	3.14	15.6	0.60	43.0	11.8	6.0	1.6	267.0
18-Sep-86	BW84	7.9	9.5		183.5	3.11	15.3	0.60	43.7	11.8	6.1	1.7	267.9
19-Sep-86	BW86	7.9			164.4	3.10	14.4	0.61	36.2	11.7	6.0	1.7	240.1
22-Sep-86	BW89	7.9	9.6		184.3	3.07	14.8	0.61	44.0	11.6	6.1	1.7	288.3
03-Oct-86	BW98	8.2	8.4	286	184.6	3.19	15.5	0.57	43.5	12.0	6.5	1.5	269.3
07-Oct-86	BW109	8.0	9.0	295	185.8	3.10	15.7	0.59	44.0	12.0	6.4	1.6	271.3
08-Oct-86	BW111	8.1	9.2	292	182.9	3.08	15.7	0.59	42.5	12.0	6.4	1.6	266.8
09-Oct-86	BW113	8.2	8.6	297	184.7	3.10	15.2	0.59	43.0	12.0	6.4	1.6	268.7
07-Feb-87	BW176	8.0	9.0	221	184.3	2.84	20.9	0.44	44.5	12.4	6.4	1.6	274.8
19-Feb-87	BW190	8.1	8.0	345	189.0	3.08	21.1	0.47	44.5	12.7	6.6	1.7	280.8
07-Mar-87	BW196		10.0	328		7.00	24.0		47.0	12.0	4.0	(1	
21-Mar-87	BW219	8.1	8.0		186.9	2.85	21.4	0.49	45.0	12.7	6.8	1.7	279.5
22-Mar-87	BW223	8.2	9.8		188.7	2.85	21.3	0.47	45.0	12.7	6.9	1.7	281.2
23-Mar-87	BW227	8.2	10.3		187.2	2.76	21.4	0.47	45.6	12.3	6.9	1.5	279.7
24-Mar-87	BW230	8.2	8.9		187.5	2.76	21.2	0.46	45.3	12.1	7.0	1.5	279.4
25-Mar-87	BW233	8.2	11.1		187.2	2.73	21.9	0.46	45.6	12.1	6.8	1.5	279.9
26-Mar-87	BW236	8.2	8.6		186.9	2.75	21.1	0.46	45.0	12.1	6.8	1.7	278.4
27-Mar-87	BW239	8.1	8.8		188.2	2.76	21.5	0.44	45.0	12.1	6.9	1.6	280.0
31-Mar-87	BW243	8.1	10.0		187.2	2.90	20.1	0.31	46.0	12.4	6.4	1.6	278.0
05-Apr-87	BW252	8.2	16.0		187.6	2.83	22.7	0.45	45.5	12.5	6.6	1.6	281.5
08-Apr-87	BW260	8.3	9.0	355	188.7	2.78	22.1	0.44	46.3	12.5	6.4	1.8	282.5
10-Apr-87	BW266	8.3	8.0	409	188.0	2.78	21.5	0.46	46.0	12.5	6.5	1.6	280.9
22-Apr-87	BW278	8.2	13.5	323	186.9	2.72	21.6	0.45	45.5	12.0	6.5	1.9	279.1
01-May-87	BW290	8.3			188.1	2.74	21.4	0.46	45.0	12.4	7.8	1.7	281.2
08-May-87	BW297	8.2	12.0	272	187.2	2.92	20.7	0.46	45.5	12.2	6.4	1.9	278.8
17-May-87	BW316	8	11.3	297	188.3	3.13	21.2	0.50	49.0	11.6	6.1	1.8	283.4
22-May-87	BW319	8.2	11.0	335	187.2	3.06	21.0	0.52	44.9	12.2	6.6	1.6	278.9
29-May-87	BW338	8	12.0	300	188.3	3.02	21.4	0.55	46.9	11.3	6.7	1.9	282.0
06-Jun-87	BW345	8.1	11.0	292	187.6	3.34	21.4	0.56	44.5	12.3	6.8	2.0	280.4
11-Jun-87	BW355	8.1	11.0	314	188.7	3.32	20.8	0.55	47.2	12.8	6.4	1.7	283.4
19-Jun-87	BW371	8	10.9	315	188.3	3.35	20.4	0.48	45.3	12.7	6.6	1.7	280.5
24-Jun-87	BW378	8.2	10.0	332	187.2	3.77	21.3	0.54	44.7	12.3	6.8	2.0	280.0

BLAINE WELL GROUND WATER CHEMISTRY METALS (mg/l)

DATE	SAMPLE#	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
06-Jul-86	BW23	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
08-Jul-86	BW28	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
16-Jul-86	BW39	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
03-Sep-86	BW45	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
04-Sep-86	BW50	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
05-Sep-86	BW54	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
08-Sep-86	BW60	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
09-Sep-86	BW63	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
10-Sep-86	BW69	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
11-Sep-86	BW71	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
12-Sep-86	BW76	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
15-Sep-86	BW78	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
17-Sep-86	BW81	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
18-Sep-86	BW84	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
19-Sep-86	BW86	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
22-Sep-86	BW89	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
03-Oct-86	BW98	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
07-Oct-86	BW109	<.005	<.005	<.02	<.02	0.05	<.02	<.02	<.03	<.001	<.02
08-Oct-86	BW111	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
09-Oct-86	BW113	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
07-Feb-87	BW176	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
19-Feb-87	BW190	<.005	<.001	<.02	<.01	0.05	<.01	<.02	<.03	<.001	<.01
07-Mar-87	BW196	<.005	<.001	<.02	<.01	0.09	<.01	<.02	<.03	<.001	<.01
21-Mar-87	BW219	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
22-Mar-87	BW223	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
23-Mar-87	BW227	<.005	<.001		<.01	0.16	<.01	<.02		<.001	<.01
24-Mar-87	BW230	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
25-Mar-87	BW233	<.005	<.001		<.01	0.39	<.01	<.02		<.001	<.01
26-Mar-87	BW236	<.005	<.001		<.01	0.03	<.01	<.02		<.001	<.01
27-Mar-87	BW239	<.005	<.001		<.01	0.16	<.01	<.02		<.001	<.01
31-Mar-87	BW243	<.005	<.001		<.01	0.04	<.01	<.02		<.001	<.01
05-Apr-87	BW252	<.005	<.001		<.01	0.15	<.01	<.02		<.001	<.01
08-Apr-87	BW260	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
10-Apr-87	BW266	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
22-Apr-87	BW278	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
01-May-87	BW290	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
08-May-87	BW297	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
17-May-87	BW316	<.005	<.001	<.02	<.01	0.04	<.01	<.02	<.03	<.001	<.01
22-May-87	BW319	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
29-May-87	BW338	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
06-Jun-87	BW345	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
11-Jun-87	BW355	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
19-Jun-87	BW371	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
24-Jun-87	BW378	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01

SOUTH WELL GROUND WATER CHEMISTRY GROSS CHEMISTRY (mg/l)

DATE	SAMPLE#	pH	TEMP	COND @25	HCO3	CL	SO4	NO3-N	Ca	Mg	Na	K	TDS
13-Jun-86	SW17	7.9	13	326	216.1	5.30	19.7	1.44	53.3	15.3	3.9	1.7	321.7
08-Jul-86	SW31	7.9	15.0	503	238.4	6.92	21.2	2.45	59.4	16.5	9.1	2.0	364.4
12-Jul-86	SW36	8.1	11.5	545	236.0	7.20	21.8	2.42	58.5	16.5	8.3	2.0	361.0
03-Sep-86	SW48	7.9	11.5		261.5	7.31	20.7	3.04	63.0	17.4	10.4	2.4	396.2
04-Sep-86	SW51	8.1	12.0		264.5	7.76	20.6	3.24	64.2	17.4	10.5	2.6	402.0
05-Sep-86	SW55	8.1	11.0		263.6	7.92	20.0	2.90	64.2	17.1	10.9	2.3	399.8
08-Sep-86	SW57	7.8	11.3		267.1	7.67	22.7	2.88	66.0	17.4	11.0	2.4	407.1
09-Sep-86	SW62	7.9	11.0		260.4	7.76	20.6	2.81	61.9	17.4	10.8	2.4	393.8
10-Sep-86	SW66	7.9	10.5		260.0	8.38	20.8	2.57	61.8	17.4	10.8	2.4	393.0
11-Sep-86	SW70	7.9	11.0		260.4	7.76	21.2	2.54	61.8	17.4	10.8	2.4	393.1
12-Sep-86	SW73	8.0	10.3		259.6	7.68	22.0	2.38	61.6	17.4	10.8	2.4	392.0
15-Sep-86	SW77	7.8	10.9		263.5	7.89	21.3	1.98	63.5	17.4	10.7	2.4	394.6
16-Sep-86	SW79	7.9	10.4		263.3	8.44	20.8	1.97	63.2	17.2	11.0	2.2	396.0
17-Sep-86	SW80	7.8	11.0		259.2	7.22	21.1	1.96	63.0	16.8	10.0	2.2	388.2
18-Sep-86	SW82	7.7	10.5		257.0	7.17	21.1	1.99	62.4	16.8	10.2	2.4	385.9
19-Sep-86	SW85	7.8	10.2		254.0	6.90	20.0	2.11	60.2	17.1	10.2	2.3	380.1
22-Sep-86	SW87	7.8	10.2		270.3	8.81	19.6	1.76	64.2	17.7	11.2	2.3	401.9
23-Sep-86	SW90	7.8	10.3		269.7	7.48	19.9	1.72	63.6	17.1	11.0	2.2	398.6
03-Oct-86	SW104	8.1	10.0		256.6	6.04	19.1	1.77	60.2	16.8	10.5	2.1	379.1
06-Oct-86	SW105	8.3	10.0	462	268.6	7.40	19.5	1.68	62.8	17.4	11.9	2.3	398.3
07-Oct-86	SW110	7.8	9.1	445	265.2	7.30	19.5	1.63	61.6	17.4	11.8	2.3	387.3
08-Oct-86	SW112	7.9	9.2	466	265.2	7.70	19.0	1.68	61.6	17.4	11.8	2.3	392.4
09-Oct-86	SW114	7.8	10.1	533	266.7	7.10	19.7	1.69	61.6	17.4	11.8	2.3	392.6
10-Oct-86	SW116	8.3	9.5	444	264.9	7.90	18.6	1.63	61.6	17.5	12.0	2.1	391.6
24-Oct-86	SW120	8.0	9.9	468	256.6	5.92	20.1	1.49	59.4	16.5	10.6	2.5	378.2
07-Feb-87	SW180	7.9	8.0	415	228.3	7.20	18.3	0.88	56.0	16.5	8.5	2.2	340.9
19-Feb-87	SW191	8.0	8.0	444	237.8	9.12	17.5	0.86	55.8	15.8	9.2	1.9	350.9
07-Mar-87	SW198		13.0	480		24.00	20.0		60.0	16.0	8.0	1.9	
21-Mar-87	SW220	8	8.0		222.4	20.80	18.4	0.79	58.2	15.6	10.3	1.9	351.1
22-Mar-87	SW225	8.1	9.6		220.2	17.80	19.6	1.02	56.5	15.1	9.2	1.7	344.6
23-Mar-87	SW228	8.1	10.9		223.1	23.40	19.0	0.75	59.8	15.6	10.2	1.9	356.3
24-Mar-87	SW231	8.2	10.1		231.0	25.20	17.1	0.73	60.9	16.0	10.6	1.9	365.9
25-Mar-87	SW234	8.1	11.0		232.0	23.70	18.8	0.80	60.6	16.1	10.8	1.9	367.4
26-Mar-87	SW237	8.1	8.3		236.0	25.40	17.6	0.85	61.6	16.4	11.3	1.9	374.0
27-Mar-87	SW240	8.0	9.3		235.3	23.50	18.8	0.82	61.4	16.3	10.8	1.9	371.6
31-Mar-87	SW246	8.3	12.3		229.2	15.80	18.6	0.86	58.8	15.4	10.0	2.0	353.0
05-Apr-87	SW254	8.0	16.0		226.0	14.80	19.8	0.82	57.4	15.5	9.6	2.0	349.3
08-Apr-87	SW263	8.1			219.8	11.00	18.6	0.79	53.0	14.7	8.7	1.8	331.1
10-Apr-87	SW268	8.3	14.0	423	223.1	12.40	17.9	0.81	55.6	14.6	9.4	1.9	338.5
22-Apr-87	SW281	8.2	12.1	392	219.8	11.30	18.3	0.78	53.0	14.1	9.4	2.2	331.6
01-May-87	SW293	8.3	11.0	311	217.2	*19.5	19.0	0.79	53.1	14.3	9.0	1.8	337.4
08-May-87	SW300	8	13.0	364	264.5	6.88	17.7	1.35	61.6	16.9	12.0	2.3	387.9
17-May-87	SW313	8	12.5	373	241.7	8.00	20.0	1.81	56.9	15.9	10.0	2.3	362.7
22-May-87	SW322	7.9	12.0	417	237.1	8.48	19.0	1.39	56.0	15.6	10.1	2.0	354.4
29-May-87	SW341	8.0	13.0	396	231.7	10.00	19.1	1.23	54.5	15.9	10.0	2.2	348.9
06-Jun-87	SW348	8.2	12.0	380	241.0	13.20	20.3	1.21	59.6	16.4	10.5	2.6	369.0
11-Jun-87	SW356	8.2	12.0	370	233.1	9.25	20.0	1.21	56.2	16.0	9.2	2.1	351.2
19-Jun-87	SW376	7.9	11.3	384	234.9	6.05	20.4	1.63	55.7	15.7	9.1	2.4	351.5
24-Jun-87	SW379	8	11.0	394	234.2	6.86	21.2	1.60	56.1	15.4	9.5	2.2	352.6

SOUTH WELL GROUND WATER CHEMISTRY METALS (mg/l)

DATE	SAMPLE#	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
13-Jun-86	SW17	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	0.02
08-Jul-86	SW31	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
12-Jul-86	SW36	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
03-Sep-86	SW48	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
04-Sep-86	SW51	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
05-Sep-86	SW55	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
08-Sep-86	SW57	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
09-Sep-86	SW62	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
10-Sep-86	SW66	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
11-Sep-86	SW70	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
12-Sep-86	SW73	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
15-Sep-86	SW77	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
16-Sep-86	SW79	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
17-Sep-86	SW80	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
18-Sep-86	SW82	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
19-Sep-86	SW85	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
22-Sep-86	SW87	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
23-Sep-86	SW90	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
03-Oct-86	SW104	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
06-Oct-86	SW105	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
07-Oct-86	SW110	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
08-Oct-86	SW112	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
09-Oct-86	SW114	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
10-Oct-86	SW116	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
24-Oct-86	SW120	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
07-Feb-87	SW180	<.005	<.005	<.02	<.02	<.05	<.02	<.02	<.03	<.001	<.02
19-Feb-87	SW191	<.005	<.001	<.02	<.01	0.05	<.01	<.02	<.03	<.001	<.01
07-Mar-87	SW198	<.005	<.001	<.02	<.01	0.32	<.01	<.02	<.03	<.001	0.01
21-Mar-87	SW220	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
22-Mar-87	SW225	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
23-Mar-87	SW228	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
24-Mar-87	SW231	<.005	<.001		<.01	0.35	<.01	<.02		<.001	<.01
25-Mar-87	SW234	<.005	0.001		<.01	<.03	<.01	<.02		<.001	<.01
26-Mar-87	SW237	<.005	<.001		<.01	0.13	<.01	<.02		<.001	<.01
27-Mar-87	SW240	<.005	<.001		<.01	0.04	<.01	<.02		<.001	<.01
31-Mar-87	SW246	<.005	<.001		<.01	0.03	<.01	<.02		<.001	<.01
05-Apr-87	SW254	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
08-Apr-87	SW263	<.005	<.001	0.04	<.01	0.13	<.01	<.02	<.03	<.001	<.01
10-Apr-87	SW268	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
22-Apr-87	SW281	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
01-May-87	SW293	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
08-May-87	SW300	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
17-May-87	SW313	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
22-May-87	SW322	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
29-May-87	SW341	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
06-Jun-87	SW348	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
11-Jun-87	SW356	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
19-Jun-87	SW376	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
24-Jun-87	SW379	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01

GROUND WATER CHEMISTRY GROSS CHEMISTRY (mg/l)

DATE	SAMPLE#	pH	TEMP	COND @25	HCO3	CL	SO4	NO3-N	Ca	Mg	Na	K	TDS
1-Mar-87	MB221	8.0	8.0		186.9	3.06	21.9	0.50	45.1	12.7	6.8	1.6	281.0
1-Mar-87	MB247	8.2	10.9		186.2	3.18	22.2	0.48	45.5	12.6	6.7	1.7	280.2
5-Apr-87	MB255	8.0	13.0		186.5	3.09	23.6	0.48	45.5	12.5	6.6	1.6	281.5
10-Apr-87	MB269	8.2	10.0	362	187.2	3.18	22.8	0.50	46.3	12.6	6.7	1.5	282.5
23-Apr-87	MB282	8.1	12.1	321	185.1	3.00	21.8	0.50	44.5	12.3	6.8	1.7	277.4
01-May-87	MB294	8.1	9.3	313	193.7	5.91	24.8	0.75	48.2	13.4	7.1	1.7	298.1
08-May-87	MB301	8.1	11.6	269	173.0	3.68	24.0	0.61	43.3	11.7	7.0	1.5	266.9
17-May-87	MB314	7.6	10.0	289	168.2	3.11	17.6	0.52	39.7	11.4	6.8	1.8	251.7
22-May-87	MB323	7.7	11.0	309	167.9	2.84	18.7	0.54	39.7	10.8	6.5	1.5	250.3
29-May-87	MB342	7.8	11.0	314	162.5	2.39	18.9	0.45	39.1	10.8	6.5	1.7	243.9
06-Jun-87	MB343	7.8	10.0	271	165.0	2.46	19.1	0.43	39.7	11.0	6.3	1.9	247.4
11-Jun-87	MB352	7.9	10.0	271	167.5	2.38	18.5	0.38	40.1	11.3	6.0	1.5	249.0
19-Jun-87	MB370	7.6	10.3	292	170.7	2.48	19.7	0.41	39.6	11.2	6.5	1.7	252.5
24-Jun-87	MB377	7.8	9.0	298	171.5	2.42	18.7	0.41	40.3	11.2	6.6	1.7	254.2
03/17/87	SO205	8.1	9.3	376	199.1	2.19	18.8	0.52	47.0	12.4	6.6	1.7	290.1
04/02/87	SO248	8.1	10.1	402	202.3	3.04	19.2	0.52	48.6	12.8	6.8	1.8	293.2
04/10/87	SO264	8.4	9.3	357	196.2	3.04	19.6	0.50	46.7	12.9	6.7	1.7	289.0
04/24/87	SO284	8.2	14.0	338	200.0	3.00	20.1	0.51	47.5	12.7	6.9	1.9	294.5
05/27/87	SO336	8.3	10.8	26	192.2	3.10	19.1	0.66	46.6	12.9	5.0	1.4	282.8
06/12/87	SO358	8.1	10.0	330	192.6	3.19	19.7	0.56	46.4	12.7	6.4	1.8	285.3
07/02/87	SO380	8	10.0	322	194.1	3.42	20.4	0.64	45.9	13.0	7.1	1.6	288.4
17-Mar-87	DW208	8.3			208.9	3.72	19.8	0.71	50.5	13.2	7.1	1.0	308.3
06-Apr-87	DW257	8.1	9.8	412	209.4	3.30	18.5	0.66	49.8	13.3	6.9	1.8	305.9
11-Apr-87	DW270	8.4	9.2	378	204.4	3.25	18.2	0.68	48.6	13.1	7.0	1.7	299.3
24-Apr-87	DW287	8.2	10.8	370	202.6	3.15	19.3	0.64	47.0	13.0	7.1	1.7	296.7
27-May-87	DW332	8.2	10.1	430	198.3	3.14	18.3	0.67	46.6	13.2	7.3	1.7	291.5
12-Jun-87	DW361	8.3	10.0	328	196.9	3.46	19.3	0.59	46.4	13.1	6.7	1.7	290.2
02-Jul-87	DW384	8	10.0	174	198.7	3.64	18.9	0.60	46.0	13.3	7.4	1.8	292.4
19-Feb-87	EW193	8.2	9.9	377	200.1	3.33	17.9	0.67	45.6	13.5	7.3	1.5	292.2
17-Mar-87	EW207	8.2	11.2	366	199.8	3.27	19.0	0.64	48.0	13.0	6.9	1.8	294.6
06-Apr-87	EW256	8.1	10.4	388	199.4	3.23	18.6	0.61	47.5	13.0	6.9	1.9	293.2
11-Apr-87	EW271	8.3	10.5	374	199.1	3.06	18.7	0.59	47.1	12.7	6.9	1.6	291.8
24-Apr-87	EW286	8.2	10.5	363	198.7	3.00	18.9	0.59	47.5	12.5	6.9	1.7	291.8
27-May-87	EW334	8.3	10.5	441	193.3	3.50	18.4	0.59	45.1	13.1	7.0	1.8	284.8
12-Jun-87	EW360	8.2	10.2	327	193.2	3.58	19.2	0.54	46.3	12.9	6.7	1.4	285.7
02-Jul-87	EW382	8	10.1	326	194.8	4.09	19.3	0.54	45.6	13.0	7.4	1.6	288.2
19-Feb-87	CW192	8.2			232.4	6.90	18.7	0.89	55.1	15.0	8.9	1.7	342.6
17-Mar-87	CW206	8.1	9.2	437	231.0	6.57	17.6	0.91	54.5	14.4	8.6	1.8	338.5
02-Apr-87	CW249	8.2	10.8	471	231.0	6.15	17.8	0.86	55.2	14.4	8.6	1.8	230.3
11-Apr-87	CW272	8.4	10.5	449	229.9	5.97	18.5	0.67	54.6	14.3	8.6	1.8	336.6
24-Apr-87	CW285	8.1	11.2	416	228.8	5.86	18.7	0.88	54.6	14.2	8.4	2.1	336.6
27-May-87	CW335	8.3	12.0	480	227.7	5.34	17.3	0.76	52.2	14.3	8.6	1.9	330.7
12-Jun-87	CW359	8.2	10.5	371	221.3	5.07	17.4	0.68	52.2	14.2	8.1	1.7	323.0
02-Jul-87	CW381	8	11.2	352	220.6	5.06	18.0	0.66	50.8	14.0	8.8	1.9	322.1

MB=MADISON WELL SO=SOUTHGATE OFFICE WELL DW=DEARBORN WELL EW=ENGINE REBUILDERS WELL CW=CHECKER AUTO WELL

GROUND WATER CHEMISTRY METALS (mg/l)

DATE	SAMPLE#	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn
21-Mar-87	MB221	<.005	<.001		<.01	0.09	<.01	<.02		<.001	0.21
31-Mar-87	MB247	<.005	<.001		<.01	0.12	<.01	<.02		<.001	<.01
05-Apr-87	MB255	<.005	<.001		<.01	<.03	<.01	<.02		<.001	<.01
10-Apr-87	MB269	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
23-Apr-87	MB282	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
01-May-87	MB294	<.005	<.001	<.02	<.01	0.11	<.01	<.02	<.03	<.001	<.01
08-May-87	MB301	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
17-May-87	MB314	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
22-May-87	MB323	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
29-May-87	MB342	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
06-Jun-87	MB343	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
11-Jun-87	MB352	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
19-Jun-87	MB370	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.03
24-Jun-87	MB377	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	<.01
03/17/87	SO205	<.005	<.001	0.02	<.01	0.11	<.01	<.02	<.03	<.001	0.07
04/02/87	SO248	<.005	<.001		<.01	0.10	<.01	<.02		<.001	0.25
04/10/87	SO264	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.10
04/24/87	SO284	<.005	<.001	<.02	<.01	0.04	<.01	<.02	<.03	<.001	0.16
05/27/87	SO336	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.10
06/12/87	SO358	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.06
07/02/87	SO380	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.003	<.001	0.07
17-Mar-87	DW208	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.21
06-Apr-87	DW257	<.005	<.001		<.01	<.03	<.01	<.02		<.001	0.09
11-Apr-87	DW270	<.005	<.001	<.02	<.01	0.06	<.01	<.02	<.03	<.001	0.11
24-Apr-87	DW287	<.005	<.001	<.02	<.01	0.05	<.01	<.02	<.03	<.001	0.03
27-May-87	DW332	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.03
12-Jun-87	DW361	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.04
02-Jul-87	DW384	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
19-Feb-87	EW193	<.005	<.001	<.02	<.01	0.05	<.01	<.02	<.03	<.001	0.02
17-Mar-87	EW207	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
06-Apr-87	EW256	<.005	<.001		<.01	0.11	0.01	<.02		<.001	0.02
11-Apr-87	EW271	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
24-Apr-87	EW286	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.03
27-May-87	EW334	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
12-Jun-87	EW360	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.01
02-Jul-87	EW382	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.03	<.001	0.02
19-Feb-87	CW192	<.005	<.001	<.02	0.13	0.05	<.01	<.02	<.03	<.001	0.04
17-Mar-87	CW206	<.005	<.001	<.02	0.03	0.19	<.01	<.02	<.03	<.001	0.01
02-Apr-87	CW249	<.005	<.001		0.07	0.08	<.01	<.02		<.001	0.03
11-Apr-87	CW272	<.005	<.001	0.04	0.17	0.15	<.01	<.02	<.03	<.001	0.04
24-Apr-87	CW285	<.005	<.001	<.02	0.07	<.03	<.01	<.02	<.03	<.001	0.01
27-May-87	CW335	<.005	<.001	<.02	0.05	<.03	<.01	<.02	<.03	<.001	0.03
12-Jun-87	CW359	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.03	<.001	<.01
02-Jul-87	CW381	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.03	<.001	0.02

MB=MADISON WELL SO=SOUTHGATE OFFICE WELL DW=DEARBORN WELL EW=ENGINE REBUILDERS WELL CW=CHECKER AUTO

Rocky Mountain Analytical Laboratory

SAMPLE DESCRIPTION INFORMATION

for

UNIVERSITY OF MONTANA

RMA Sample No.	Sample Description	Sample Type	Date Sampled	Date Received
62095-001	SOUTH WIAI 1-6	Water	09/15/86	09/18/86
62095-002	BLAINE BWI 4-6	Water	09/15/86	09/18/86

ANALYTICAL RESULTS

for

University of Montana

PESTICIDES

Parameter	Units	62095-01		62095-02	
Aldrin	ug/L	ND	(0.004)	ND	(0.004)
alpha BHC	ug/L	ND	(0.003)	ND	(0.003)
beta BHC	ug/L	ND	(0.006)	ND	(0.006)
gamma BHC (Lindane)	ug/L	ND	(0.004)	ND	(0.004)
delta BHC	ug/L	ND	(0.009)	ND	(0.009)
Chlordane	ug/L	ND	(0.04)	ND	(0.04)
4,4'-DDT	ug/L	ND	(0.012)	ND	(0.012)
4,4'-DDE	ug/L	ND	(0.004)	ND	(0.004)
4,4'-DDD	ug/L	ND	(0.011)	ND	(0.011)
Dieldrin	ug/L	ND	(0.002)	ND	(0.002)
alpha Endosulfan	ug/L	ND	(0.014)	ND	(0.014)
beta Endosulfan	ug/L	ND	(0.04)	ND	(0.04)
Endosulfan sulfate	ug/L	ND	(0.066)	ND	(0.066)
Endrin	ug/L	ND	(0.006)	ND	(0.006)
Endrin aldehyde	ug/L	ND	(0.023)	ND	(0.023)
Heptachlor	ug/L	ND	(0.003)	ND	(0.003)
Heptachlor epoxide	ug/L	ND	(0.083)	ND	(0.083)
PCB-1242	ug/L	ND	(0.12)	ND	(0.12)
PCB-1254	ug/L	ND	(0.5)	ND	(0.5)
PCB-1221	ug/L	ND	(0.12)	ND	(0.12)
PCB-1232	ug/L	ND	(0.12)	ND	(0.12)
PCB-1248	ug/L	ND	(0.15)	ND	(0.15)
PCB-1260	ug/L	ND	(0.5)	ND	(0.5)
PCB-1016	ug/L	ND	(0.12)	ND	(0.12)
Toxaphene	ug/L	ND	(0.24)	ND	(0.24)

BDL = Below Detection Limit. *Measured as azobenzene. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

BASE/NEUTRAL ORGANICS

Parameter	Units	62095-01		62095-02	
Acenaphthene	ug/L	BDL	(5)	BDL	(5)
Acenaphthylene	ug/L	BDL	(5)	BDL	(5)
Anthracene	ug/L	BDL	(5)	BDL	(5)
Benzidine	ug/L	BDL	(20)	BDL	(20)
Benzo(a)anthracene	ug/L	BDL	(5)	BDL	(5)
Benzo(a)pyrene	ug/L	BDL	(5)	BDL	(5)
3,4-Benzofluoranthene	ug/L	BDL	(5)	BDL	(5)
Benzo(g,h,i)perylene	ug/L	BDL	(5)	BDL	(5)
Benzo(k)fluoranthene	ug/L	BDL	(5)	BDL	(5)
Bis(2-chloroethoxy)methane	ug/L	BDL	(5)	BDL	(5)
Bis(2-chloroethyl)ether	ug/L	BDL	(5)	BDL	(5)
Bis(2-chloroisopropyl)ether	ug/L	BDL	(5)	BDL	(5)
Bis(2-ethylhexyl)phthalate	ug/L	BDL	(5)	BDL	(5)
4-Bromophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)
Butylbenzyl phthalate	ug/L	BDL	(5)	BDL	(5)
2-Chloronaphthalene	ug/L	BDL	(5)	BDL	(5)
4-Chlorophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)
Chrysene	ug/L	BDL	(5)	BDL	(5)
Dibenzo(a,h)anthracene	ug/L	BDL	(5)	BDL	(5)
1,2-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)
1,3-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)
1,4-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)
3,3'-Dichlorobenzidine	ug/L	BDL	(20)	BDL	(20)
Diethyl phthalate	ug/L	BDL	(5)	BDL	(5)
Dimethyl phthalate	ug/L	BDL	(5)	BDL	(5)
Di-n-butyl phthalate	ug/L	BDL	(5)	BDL	(5)
2,4-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)
2,6-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)
Di-n-octyl phthalate	ug/L	BDL	(5)	BDL	(5)
1,2-Diphenylhydrazine*	ug/L	BDL	(5)	BDL	(5)
Fluoranthene	ug/L	BDL	(5)	BDL	(5)

BDL = Below Detection Limit. *Measured as azobenzene. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

BASE/NEUTRAL ORGANICS (CONT.)

Parameter	Units	62095-01		62095-02	
Fluorene	ug/L	BDL	(5)	BDL	(5)
Hexachlorobenzene	ug/L	BDL	(5)	BDL	(5)
Hexachlorobutadiene	ug/L	BDL	(5)	BDL	(5)
Isophorone	ug/L	BDL	(5)	BDL	(5)
Naphthalene	ug/L	BDL	(5)	BDL	(5)
Nitrobenzene	ug/L	BDL	(5)	BDL	(5)
N-Nitrosodimethylamine	ug/L	BDL	(5)	BDL	(5)
N-Nitrosodi-n-propylamine	ug/L	BDL	(5)	BDL	(5)
N-Nitrosodiphenylamine*	ug/L	BDL	(5)	BDL	(5)
Phenanthrene	ug/L	BDL	(5)	BDL	(5)
Pyrene	ug/L	BDL	(5)	BDL	(5)
1,2,4-Trichlorobenzene	ug/L	BDL	(5)	BDL	(5)
2-Chlorophenol	ug/L	BDL	(5)	BDL	(5)
2,4-Dichlorophenol	ug/L	BDL	(5)	BDL	(5)
2,4-Dimethylphenol	ug/L	BDL	(5)	BDL	(5)
4,6-Dinitro-o-cresol	ug/L	BDL	(10)	BDL	(10)
Hexachlorocyclopentadiene	ug/L	BDL	(5)	BDL	(5)
Hexachloroethane	ug/L	BDL	(5)	BDL	(5)
Indeno(1,2,3-cd)pyrene	ug/L	BDL	(5)	BDL	(5)

BDL = Below Detection Limit. *Measured as diphenylamine. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

VOLATILE ORGANICS

Parameter	Units	62095-01		62095-02	
Acrolein	ug/L	BDL	(100)	BDL	(100)
Acrylonitrile	ug/L	BDL	(100)	BDL	(100)
Benzene	ug/L	BDL	(5)	BDL	(5)
Bromoform	ug/L	BDL	(5)	BDL	(5)
Carbon tetrachloride	ug/L	BDL	(5)	BDL	(5)
Chlorobenzene	ug/L	BDL	(5)	BDL	(5)
Chlorodibromomethane	ug/L	BDL	(5)	BDL	(5)
Chloroethane	ug/L	BDL	(10)	BDL	(10)
2-Chloroethylvinyl ether	ug/L	BDL	(5)	BDL	(5)
Chloroform	ug/L	BDL	(5)	BDL	(5)
Dichlorobromomethane	ug/L	BDL	(5)	BDL	(5)
1,1-Dichloroethane	ug/L	BDL	(5)	BDL	(5)
1,2-Dichloroethane	ug/L	BDL	(5)	BDL	(5)
1,1-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)
1,2-Dichloropropane	ug/L	BDL	(5)	BDL	(5)
1,3-Dichloropropylene (c&t)	ug/L	BDL	(5)	BDL	(5)
Ethylbenzene	ug/L	BDL	(5)	BDL	(5)
Methylbromide	ug/L	BDL	(10)	BDL	(10)
Methylchloride	ug/L	BDL	(10)	BDL	(10)
Methylene chloride	ug/L	BDL	(10)	BDL	(10)
1,1,2,2-Tetrachloroethane	ug/L	BDL	(5)	BDL	(5)
Tetrachloroethylene	ug/L	BDL	(5)	6	(5)
Toluene	ug/L	BDL	(5)	BDL	(5)
1,2-trans-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)
1,1,1-Trichloroethane	ug/L	BDL	(5)	BDL	(5)
1,1,2-Trichloroethane	ug/L	BDL	(5)	BDL	(5)
Trichloroethylene	ug/L	BDL	(5)	BDL	(5)
Vinyl chloride	ug/L	BDL	(10)	BDL	(10)

BDL = Below Detection Limit. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

ACIDS

Parameter	Units	62095-01		62095-02	
2,4-Dinitrophenol	ug/L	BDL	(10)	BDL	(10)
2-Nitrophenol	ug/L	BDL	(5)	BDL	(5)
4-Nitrophenol	ug/L	BDL	(10)	BDL	(10)
p-Chloro-m-cresol	ug/L	BDL	(5)	BDL	(5)
Pentachlorophenol	ug/L	BDL	(5)	BDL	(5)
Phenol	ug/L	BDL	(5)	BDL	(5)
2,4,6-Trichlorophenol	ug/L	BDL	(5)	BDL	(5)

BDL = Below Detection Limit. *Measured as azobenzene. Detection limits in parentheses.

Rocky Mountain Analytical Laboratory

SAMPLE DESCRIPTION INFORMATION

for

University Of Montana

RMA Sample No.	Sample Description	Sample Type	Date Sampled	Date Received
61913-01	#1 Blanche Outfall	Water	8/12/86	8/18/86
61913-02	#2 Missoulian Outfall	Water	8/12/86	8/18/86
61913-03	#3 Buttrey's	Water	8/12/86	8/18/86

September 12, 1986

ANALYTICAL RESULTS

for

University of Montana

BASE/NEUTRAL AND ACID PRIORITY POLLUTANTS

Parameter	Units	61913-01		61913-02		61913-03	
Acenaphthene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Acenaphthylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Anthracene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Benzidine	ug/L	BDL	(20)	BDL	(20)	BDL	(20)
Benzo(a)anthracene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Benzo(a)pyrene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
3,4-Benzofluoranthene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Benzo(g,h,i)perylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Benzo(k)fluoranthene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Bis(2-chloroethoxy)methane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Bis(2-chloroethyl)ether	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Bis(2-chloroisopropyl)ether	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Bis(2-ethylhexyl)phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
4-Bromophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Butylbenzyl phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2-Chloronaphthalene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
4-Chlorophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Chrysene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Dibenzo(a,h)anthracene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,3-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,4-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
3,3'-Dichlorobenzidine	ug/L	BDL	(20)	BDL	(20)	BDL	(20)
Diethyl phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Dimethyl phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Di-n-butyl phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2,6-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)

BDL = Below Detection Limits. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

BASE/NEUTRAL AND ACID PRIORITY POLLUTANTS (CONT.)

Parameter	Units	61913-01		61913-02		61913-03	
Di-n-octyl phthalate	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2-Diphenylhydrazine*	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Fluoranthene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Fluorene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Hexachlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Hexachlorobutadiene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Hexachlorocyclopentadiene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Hexachloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Indeno(1,2,3-cd)pyrene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Isophorone	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Naphthalene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Nitrobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
N-Nitrosodimethylamine	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
N-Nitrosodi-n-propylamine	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
N-Nitrosodiphenylamine*	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Phenanthrene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Pyrene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2,4-Trichlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2-Chlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dimethylphenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
4,6-Dinitro-o-cresol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
2,4-Dinitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
2 Nitrophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
4-Nitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
p-Chloro-m-cresol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Pentachlorophenol	ug/L	7	(5)	BDL	(5)	BDL	(5)
Phenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
2,4,6-Trichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)

BDL = Below Detection Limits. Detection limits in parentheses. * = Value Outside QC Limits.

ANALYTICAL RESULTS

for

University of Montana

VOLATILE PRIORITY POLLUTANTS

Parameter	Units	61913-01		61913-02		61913-03	
Acrolein	ug/L	BDL	(100)	BDL	(100)	BDL	(100)
Acrylonitrile	ug/L	BDL	(100)	BDL	(100)	BDL	(100)
Benzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Bromoform	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Carbon tetrachloride	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Chlorobenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Chlorodibromomethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Chloroethane	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
2-Chloroethylvinyl ether	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Chloroform	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Dichlorobromomethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,1-Dichloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2-Dichloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,1-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2-Dichloropropane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,3-Dichloropropylene (c&t)	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Ethylbenzene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Methylbromide	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
Methylchloride	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
Methylene chloride	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
1,1,2,2-Tetrachloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Tetrachloroethylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Toluene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,2-trans-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,1,1-Trichloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
1,1,2-Trichloroethane	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Trichloroethylene	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Vinyl chloride	ug/L	BDL	(10)	BDL	(10)	BDL	(10)

BDL = Below Detection Limits. Detection limits in parentheses.

ANALYTICAL RESULTS

for

University of Montana

PRIORITY POLLUTANT PESTICIDES/PCBS

Parameter	Units	61913-01		61913-02		61913-03	
Aldrin	ug/L	ND	(0.04)	ND	(0.04)	ND	(0.04)
alpha BHC	ug/L	ND	(0.03)	ND	(0.03)	ND	(0.03)
beta BHC	ug/L	ND	(0.06)	ND	(0.06)	ND	(0.06)
gamma BHC (Lindane)	ug/L	ND	(0.04)	ND	(0.04)	ND	(0.04)
delta BHC	ug/L	ND	(0.09)	ND	(0.09)	ND	(0.09)
Chlordane	ug/L	ND	(0.08)	ND	(0.08)	ND	(0.08)
4,4'-DDT	ug/L	ND	(0.024)	ND	(0.024)	ND	(0.024)
4,4'-DDE	ug/L	ND	(0.008)	ND	(0.008)	ND	(0.008)
4,4'-DDD	ug/L	ND	(0.022)	ND	(0.022)	ND	(0.022)
Dieldrin	ug/L	ND	(0.004)	ND	(0.004)	ND	(0.004)
alpha Endosulfan	ug/L	ND	(0.028)	ND	(0.028)	ND	(0.028)
beta Endosulfan	ug/L	ND	(0.08)	ND	(0.08)	ND	(0.08)
Endosulfan sulfate	ug/L	ND	(0.132)	ND	(0.132)	ND	(0.132)
Endrin	ug/L	ND	(0.012)	ND	(0.012)	ND	(0.012)
Endrin aldehyde	ug/L	ND	(0.046)	ND	(0.046)	ND	(0.046)
Heptachlor	ug/L	ND	(0.006)	ND	(0.006)	ND	(0.006)
Heptachlor epoxide	ug/L	ND	(0.166)	ND	(0.166)	ND	(0.166)
PCB-1242	ug/L	ND	(1.2)	ND	(1.2)	ND	(1.2)
PCB-1254	ug/L	ND	(1)	ND	(1)	ND	(1)
PCB-1221	ug/L	ND	(1.2)	ND	(1.2)	ND	(1.2)
PCB-1232	ug/L	ND	(1.2)	ND	(1.2)	ND	(1.2)
PCB-1248	ug/L	ND	(0.3)	ND	(0.3)	ND	(0.3)
PCB-1260	ug/L	ND	(1)	ND	(1)	ND	(1)
PCB-1016	ug/L	ND	(1.2)	ND	(1.2)	ND	(1.2)
Toxaphene	ug/L	ND	(0.48)	ND	(0.48)	ND	(0.48)

ND = Not Detected.   Detection limits in parentheses.

ROCKY MOUNTAIN A. LYTICAL LABORATORY

Organic Analytical Methodology

Parameter	Units	Nominal Detection Limit[a]	Methodology	Reference[1]	Preservation Bottle No.	Maximum Holding Time [b]
Purgeables	ug/l	1	Purge & Trap GC/MS	624	11	14 days
Base/Neutrals	ug/l	10	Extraction/GC/MS	625	12	7 days/40 days
Acids	ug/l	10	Extraction/GC/MS	625	12	7 days/40 days
Organochlorine Pesticides/PCB's	ug/l	0.01	Extraction/GC/ECD	608	13	7 days/40 days
		10	Extraction/GC/MS	625	12	7 days/40 days
Phenoxy Herbicides	ug/l	0.01	Extraction/GC/ECD	(2)	14	7 days/40 days
Total Organic Halogen (TOX)	ug/l	5	Adsorption/Coulometric	450.1(3)	15	-
Trihalomethanes (THM)	ug/l	1	Extraction/GC/ECD	(4)	11	14 days
		1	Purge & Trap GC/MS	(4)	11	14 days
Dioxin	ug/l	0.005	Extraction/GC/MS/ECD	613	16	7 days/40 days
Purgeable Halocarbons	ug/l	0.01	Purge & Trap/GC/Hall	601	11	14 days
Purgeable Aromatics	ug/l	1	Purge & Trap/GC/PID	602	17	14 days
Acrolein & Acrylonitrile	ug/l	100	Purge & Trap/GC/FID	603	18	14 days
Phenols by GC	ug/l	10	Extraction/GC/FID	604	16	7 days/40 days
Benzidines	ug/l	0.1	Extraction/HPLC	605	19	7 dyas/40 days
Phthalate Esters	ug/l	10	Extraction/GC/FID	606	12	7 days/40 days
Nitrosamines	ug/l	1	Extraction/GC/NPD	607	20	7 days/40 days
Nitroaromatics/isophorone	ug/l	1	Extraction/GC/FID & GC/ECD	609	12	7 days/40 days
Polynuclear Aromatics	ug/l	0.5	Extraction/HPLC	610	20	7 days/40 days
Haloethers	ug/l	1	Extraction/GC/Hall	611	17	7 days/40 days
Chlorinated Hydrocarbons	ug/l	0.02	Extraction/GC/ECD	612	12	7 days/40 days
Organophosphorus Pesticides	ug/l	0.1	Extraction/GC/NPD	622(5)	12	7 days/40 days
Triazine Pesticides	ug/l	0.1	Extraction/GC/NPD	(6)	12	7 days/40 days

References

(1) Federal Register, Vol. 44, No. 233, Monday, December 3, 1979.
(2) "Method for Chlorinated Phenoxy Acid Herbicides in Industrial Effluents", Federal Register, Vol. 38, No. 75, Part II.
(3) "Total Organic Halide", US EPA-EMSL, Cincinnati, November, 1980.
(4) Federal Register, Vol. 44, No. 231, Thursday, November 29, 1979, Appendix, Part I.
(5) "Method 622-Organophosphorus Pesticides", Proposed EPA Method, 304 (h) Committee.
(6) Federal Register, Vol. 38, No. 75, 1973.

Notes

[a] Nominal values are the best achievable with the listed analytical method for a typical component. Interferences in specific samples may result in a higher detection limit.

[b] Applicable to NPDES Wastes as updated by Robert C. Booth, Director, EMSL-Cincinnati, September 22, 1981. Where two times are given, the first refers to the time to extraction, the second to the time of instrumental analysis.

APPENDIX E

NITROGEN, OIL AND GREASE AND TOTAL METALS

NITROGEN FORMS, OIL AND GREASE TOTAL METALS (mg/1)

RUNOFF DATE	SAMPLE	dis KN	TKN	NO3-NO	tot NO3-NO2	O&G	As	Cd	Cu	Cr	Fe	Pb	Mn	Hg	Ni	Zn
26-Jan-87	M0160	6.3		2.28		7										
29-Jan-87	M0164	1.8		0.89		4										
01-Feb-87	M0168	2.5	4.1	0.48	0.43	14	<.005	<.001	0.05		6.77	0.14	0.38	<.001		0.26
05-Feb-87	M0175		1.9			2	<.005	<.001	<.01	<.02	2.28	0.03	0.19	<.001	<.03	0.09
	M0182		4.3		0.78	8	<.005	<.001	0.05		11.2	0.3	0.46	<.001		0.47
26-Jan-87	B0161	5.9		3.12		10										
27-Jan-87	B0162	4.5		1.87		10										
29-Jan-87	B0165	2.6		1.17		7										
01-Feb-87	B0171		2.4		0.25	7	<.005	<.001	0.03		6.05	0.19	0.36	<.001		0.3
05-Feb-87	B0173		2.4			6	<.005	<.001	0.05	0.03	12	0.21	0.39	<.001	<.03	0.38
13-Feb-87	B0184		3		0.3	6	<.005	<.001	0.04		9.1	0.21	0.33	<.001		0.33
16-Mar-87	SD200	0.9														
16-Mar-87	SD202	1.3				3										tot NO
27-Jan-87	BP163	2		0.72		11										
VADOSE ZONE																
3 FT SOUTH																
21-Mar-87	216	0.3														
13 FT SOUTH																
21-Mar-87	217	0.7														
3 FT BLAINE																
07-Feb-87	178	1.6														
21-Mar-87	214	0.1														
15 FT BLAINE																
07-Feb-87	179	0.70				<1										
15-Feb-87	187	0.6		2.14												
07-Mar-87	195	0.4		2.52												
16-Mar-87	204	0.5				1										
21-Mar-87	215	0.40														
22-Mar-87	222	0.30														
25-Mar-87	232	0.20														
26-Mar-87	235	0.30														
27-Mar-87	238	0.40														
31-Mar-87	242	0.30				1										
05-Apr-87	251	0.40				2										
08-Apr-87	259					<1										
10-Apr-87	265					2										

CONT'

GROUNDWATER (mg/l)

DATE	SAMPLE	dis KN	TKN	NO3-NO	tot NO3-NO2	O&G
07-Feb-87	SW180					1
07-Mar-87	SW198	0.3		1.28		
27-Mar-87	SW228					3
07-Feb-87	BW177	0.30				<1
23-Mar-87	BW227					<1

APPENDIX F

EMC'S OF SINGLE DRAIN SITES

EMC'S FOR SINGLE DRAIN SITES

	BLAINE RESIDENTIAL SITE(mg/l)				SOUTH COMMERCIAL SITE (mg/l)		
	BD	BD	BD	BD	SD	SD	SD
	30-Sep-86	18-Mar-87	15-May-87	25-May-87	16-Mar-87	15-May-87	25-May-87
EMC HCO3	4.5	8.2	5.3	4.4	41.4	18.8	12.0
EMC Cl	1.01	0.74	0.56	0.24	25.31	6.33	1.37
EMC SO4	1.8	1.2	1.2	0.8	8.1	6.3	1.9
EMC NO3	0.15	0.09	0.12	0.05	0.43	0.29	0.07
EMC Ca	1.5	2.0	2.0	1.2	8.7	6.9	3.8
EMC Mg	0.3	0.2	0.3	0.2	1.1	0.8	0.4
EMC Na	0.6	1.5	0.9	0.6	24.8	5.6	2.0
EMC K	0.31	0.48	1.17	0.61	2.73	2.00	0.81
EMC TDS	10.6	16.1	11.8	8.2	113.9	47.9	22.6
EMC As	<.005	<.005	<.005	<.005	<.005	<.005	<.005
EMC Cd	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EMC Cr	<.02	<.02	<.02	<.02	0.04	<.03	<.02
EMC Cu	<.01	<.01	0.01	<.01	<.01	<.01	<.01
EMC Fe	<.03	0.09	0.07	<.03	0.17	0.20	<.03
EMC Pb	<.01	0.01	<.01	<.01	<.01	0.01	<.01
EMC Mn	<.02	0.02	0.04	<.02	0.07	0.10	0.03
EMC Ni	<.03	<.03	<.03	<.03	<.03	<.03	<.03
EMC Hg	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EMC Zn	0.02	0.02	0.03	<.01	0.03	0.06	0.02

APPENDIX G

QUALITY CONTROL

BLANKS GROSS CHEMISTRY (mg/l)

Date	Sample #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K
04-Jun-86	R07	4.9	1.1	0.70	<.5	<.01	<.1	<.01	0.1	0.1
08-Jun-86	R015	5	0	<.01	<.5	<.01	<.1	<.01	0.1	0.2
28-Jun-86	R022	5.1	-0.5	0.55	<.5	0.01	<.1	<.01	0.2	<.01
08-Jul-86	GW30	6.3	0.72	0.07	<.5	0.05	0.3	0.04	0.07	<.01
14-Jul-86	LY37	5.4	-0.65	0.81	<.5	0.04	0.1	0.03	0.2	0.15
14-Jul-86	LY38	metals only								
03-Sep-86	GW49	6	0.11	<.01	<.5	0.01	<.1	<.01	0.06	<.01
08-Sep-86	GW61	5.7	0.13	<.01	<.5	0.02	<.1	<.01	0.06	<.01
11-Sep-86	GW72	5.7	0	<.01	<.5	<.01	<.1	<.01	0.04	<.01
30-Sep-86	R096	5.8	0	<.01	<.5	<.01	<.1	<.01	0.04	<.01
03-Oct-86	GW100	5.9	0	<.01	<.5	<.01	<.1	<.01	<.01	<.01
05-Nov-86	GW129	5.6	0.06	<.01	<.5	<.01	<.1	<.01	0.06	<.01
18-Mar-87	GW213	5.8	0	<.01	<.5	<.01	<.1	<.01	<.01	<.01
05-Apr-87	GW250	6.3	1.4	0.04	<.5	0.02	0.3	0.07	0.14	<.01
22-Apr-87	GW275	6.2	0.5	0.02	0.5	0.01	0.3	0.04	0.02	<.01
15-May-87	R0310	5.6	0	0.01	0.5	0.01	0.1	0.1	0.1	0.1
11-Jun-87	GW357	6.0	0.7	<.01	<.5	0.01	0.2	0.02	<.01	<.01
16-Jun-87	GW368	5.7	0	<.01	<.5	<.01	<.1	<.01	<.01	<.01
06-Jul-87	GW390	5.6	0	<.01	<.5	<.01	<.1	<.01	<.01	<.01

SPLITS GROSS CHEMISTRY

04-Jun-86	8	6.4	53	7.80	19.4	0.96	20.8	4.2	8.8	13.8
	2	6.5	53.7	7.80	18.1	0.99	21.6	4.4	8.9	12.6
08-Jun-86	16	6.6	17.5	0.90	2.6	0.13	4.8	0.9	1.6	2.6
	13	6.8	17.4	0.88	2.3	0.12	4.9	0.8	1.7	2.6
06-Oct-86	101	metals only								
	106									
06-Oct-86	105	8.3	268.6	7.40	19.5	1.68	62.8	17.4	11.9	2.3
	107	8.5	268	7.45	19.2	1.71	62.7	17.4	11.8	2.3
27-Oct-86	120	8	256.6	5.92	20.1	1.49	59.4	16.5	10.6	2.5
	122	8	258.6	5.73	19.4	1.44	59.4	16.5	10.6	2.5
01-May-87	293	8.3	217	19.50	19	0.79	53.1	14.3	9.0	1.8
	302	8.4	215.9	9.39	19.1	0.91	52.1	14.2	8.8	1.8
08-May-87	301	metals only								
	302									
08-May-87	296	8.3	235.3	15.40	10	2.73	49.3	9.8	26.7	11.4
	303	8.3	235.2	15.30	9.4	2.63	49.2	9.8	27.1	11.2
22-May-87	319	8.2	187.2	3.06	21	0.52	44.9	12.2	6.6	1.6
	325	8.2	186.9	3.04	20.4	0.51	45.6	12.3	6.6	1.8
27-May-87	335	8.3	227.7	5.34	17.3	0.76	52.2	14.3	8.6	1.9
	333	8.4	225.6	5.32	17.6	0.75	51.4	14.0	8.6	1.9
06-Jun-87	348	8.2	241	13.20	20.3	1.21	59.6	16.4	10.5	2.6
	349	8.2	242.1	12.70	20	1.24	58.2	16.8	10.5	2.7

DUPLICATES GROSS CHEMISTRY (mg/l)

Date	Sample #	pH	HCO3	Cl	SO4	NO3	Ca	Mg	Na	K
^8-Jul-86	28	8.1	184.8	3.58	16.5	0.71	44.5	12.0	6.8	1.5
	29	8	185.2	3.42	15.7	0.65	44.5	12.0	6.7	1.6
03-Oct-86	98	8.2	184.6	3.19	15.5	0.57	43.5	12.0	6.5	1.5
	99	8.1	184	3.14	15.6	0.58	43.5	12.0	6.5	1.5
24-Oct-86	120	8	256.6	5.92	20.1	1.49	59.4	16.5	10.6	2.5
	121	7.9	255.5	5.77	18.6	1.47	59.2	16.5	10.6	2.5
07-Feb-87	176	8	184.3	2.84	20.8	0.44	44.5	12.4	6.4	1.6
	177	8	184.3	2.84	20.9	0.44	44.5	12.4	6.4	1.7
22-Apr-87	282	8.1	185.1	3.00	21.8	0.50	44.5	12.3	6.8	1.7
	283	8.2	184.8	3.00	22.3	0.49	44.5	12.4	6.7	1.7

BLANKS METALS (mg/l)

Date	Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
04-Jun-86	R07	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.05
08-Jun-86	R015	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
28-Jun-86	R022	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.02
08-Jul-86	GW30	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
14-Jul-86	LY38	<.005	<.001	<.02	<.01	0.06	<.01	<.02	<.001	0.04	<.01
03-Sep-86	GW49	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
08-Sep-86	GW61	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.06
11-Sep-86	GW72	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
30-Sep-86	R096	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
03-Oct-86	GW100	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
05-Nov-86	GW129	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
18-Mar-87	GW213	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.02
05-Apr-87	GW250	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
22-Apr-87	GW275	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
15-May-87	R0310	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
11-Jun-87	GW357	<.005	<.001	<.02	<.01	<.03	0.01	<.02	<.001	<.03	<.01
16-Jun-87	GW368	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
06-Jul-87	GW390	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01

SPLITS METALS

04-Jun-86	8	<.005	<.001	<.02	<.01	0.27	<.01	0.24	<.001	<.03	0.09
	2	<.005	<.001	<.02	<.01	0.28	<.01	0.24	<.001	<.03	0.09
08-Jun-86	16	<.005	<.001	<.02	<.01	0.06	<.01	0.04	<.001	<.03	0.02
	13	<.005	<.001	<.02	<.01	0.07	<.01	0.04	<.001	<.03	0.03
06-Oct-86	101	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	0.03
	106	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	0.02
06-Oct-86	105	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	107	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
27-Oct-86	120	no metals									
	122										
01-May-87	293	no metals									
	302										
08-May-87	301	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	302	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
08-May-87	296	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	303	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
22-May-87	319	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	325	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
27-May-87	335	<.005	<.001	<.02	0.05	<.03	<.01	<.03	<.001	<.03	0.03
	333	<.005	<.001	<.02	0.06	<.03	<.01	<.03	<.001	<.03	0.01
06-Jun-87	348	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	349	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01

DUPLICATES METALS (mg/l)

Date	Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
08-Jul-86	28	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	29	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
03-Oct-86	98	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	99	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
24-Oct-86	120	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	121	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
07-Feb-87	176	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	177	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
22-Apr-87	282	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01
	283	<.005	<.001	<.02	<.01	<.03	<.01	<.03	<.001	<.03	<.01

STANDARD REFERENCE NBS STD 1643b (mg/l)

Date	Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
07-Jul-86	27	0.050	0.018		0.02	0.10	0.02	0.03	<.001		0.06
29-Jul-86	42	0.051	0.019		0.02	0.10	<.01	0.03	<.001		0.05
06-Oct-86	108	0.047	0.018	<.02	0.02	0.09	0.02	0.03	<.001	0.04	0.06
27-Oct-86	123	0.049	0.018	<.02	0.03	0.10	0.02	0.03	<.001	<.03	0.06
10-Nov-86	134	0.052	0.019	<.02	0.02	0.10	<.01	0.03	<.001	0.04	0.06
23-May-87	324	0.054	0.019	0.02	0.02	0.10	0.02	0.03	<.001	0.04	0.06
29-May-87	337	0.051	0.018	0.02	0.02	0.09	0.02	0.03	<.001	0.04	0.07
12-Jun-87	351	0.050	0.018	<.02	0.02	0.09	0.02	0.03	<.001	0.04	0.06
16-Jun-87	369	0.053	0.017	<.02	0.02	0.10	0.02	0.03	<.001	0.04	0.06
06-Jul-87	391	0.049	0.018	<.02	0.02	0.10	0.02	0.03	<.001	0.04	0.06

TARGET RANGE (mg/l)

As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Zn
0.05	0.020±0.001	0.0189±0.0004	0.022±.0004	0.100±0.008	0.0241±0.0007	0.028±.002	0.050±0.003	0.067±0.002

INTERNAL LABORATORY QUALITY ASSURANCE - ENERGY LABORATORIES

SPIKED ANALYSIS

Date	Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
21-Jul-86	6401	100	94		98	97	97	99	86		94
21-Jul-86	6411	100	95		97	98	96	97	86		98
21-Jul-86	6421	100	97		98	99	95	97	88		94
15-Aug-86	7351	100	95		99	100	89	97	102		98
25-Nov-86	9961	108	104		100	101	96	102	100		101
25-Nov-86	9971	100	104		104	103	104	104	100		104
25-Nov-86	9972	96	104		100	98	100	102	110		102
25-Nov-86	9973	104	104		101	103	102	102	112		104
25-Nov-86	9974	100	101		102	103	96	99	90		99
25-Nov-86	9975	100	102		100	101	95	98	100		98
02-Dec-86	11151	108	103		108	108	99	104	112		103
02-Dec-86	11161	104	105		108	101	104	102	112		101
20-Jul-87	7551	108	105	109	107	99	88	105	89	100	105
20-Jul-87	7561	95	106	113	107	103	100	105	101	102	103
20-Jul-87	7571	101	103	107	106	103	96	102	111	101	103
20-Jul-87	7581	90	106	109	109	103	104	104	89	108	103
20-Jul-87	7591	109	99	105	100	100	95	98	111	96	98
20-Jul-87	7601	100	107	112	109	105	102	108	89	103	103
20-Jul-87	7611	93	106	114	107	106	108	105	101	102	108
20-Jul-87	7621	100	96	96	104	110	98	99	101	97	97
20-Jul-87	7631	100	104	101	102	109	100	102	101	98	108
20-Jul-87	7641	100	96	100	100	103	102	100	91	98	98
20-Jul-87	8141	96	100	96	102	103	92	100	93	97	96

INTERNAL LABORATORY QUALITY ASSURANCE - ENERGY LABORATORIES

DUPLICATE ANALYSIS

Date	Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
	10	<.005	<.001		0.01	0.88	0.04	0.11	<.001		0.12
21-Jul-86	dup	<.005	<.001		0.02	0.88	0.04	0.11	<.001		0.12
	20	<.005	<.001		<.01	0.09	<.01	0.04	<.001		0.09
21-Jul-86	dup	<.005	<.001		<.01	0.1	<.01	0.04	<.001		0.09
	36	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
15-May-86	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	50	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	60	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	70	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	80	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	91	<.005	<.001		<.01	0.05	<.01	<.02	<.001		0.03
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	104	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
25-Nov-87	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	112	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
02-Dec-86	dup	<.005	<.001		<.01	<.03	<.01	<.02	<.001		<.01
	123	0.049	0.018		0.03	0.10	0.02	0.03	<.001		0.06
02-Dec-86	dup	0.050	0.018		0.02	0.10	0.02	0.03	<.001		0.06
	276	<.005	<.001	0.07	0.03	0.33	<.01	0.34	<.001	0.03	0.08
20-Jul-87	dup	<.005	<.001	0.07	0.03	0.33	<.01	0.34	<.001	0.03	0.08
	286	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.03
20-Jul-87	dup	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	0.02
	297	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
20-Jul-87	dup	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
	308	<.005	<.001	<.02	<.01	0.14	0.01	0.11	<.001	<.03	0.06
20-Jul-87	dup	<.005	<.001	<.02	<.01	0.14	<.01	0.1	<.001	<.03	0.06
	318	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
20-Jul-87	dup	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
	329	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
20-Jul-87	dup	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
	337	0.051	0.018	0.02	0.02	0.09	0.02	0.03	<.001	0.04	0.07
20-Jul-87	dup	0.052	0.018	0.02	0.02	0.10	0.02	0.03	<.001	0.04	0.06
	349	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
20-Jul-87	dup	<.005	<.001	<.02	<.01	<.03	<.01	<.02	<.001	<.03	<.01
	359	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.001	<.03	<.01
20-Jul-87	dup	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.001	<.03	<.01
	369	0.053	0.017	<.02	0.02	0.1	0.02	0.03	<.001	0.04	0.06
20-Jul-87	dup	0.052	0.017	<.02	0.09	0.02	0.02	0.03	<.001	0.05	0.06
	380	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.001	<.03	0.07
23-Jul-87	dup	<.005	<.001	<.02	0.03	<.03	<.01	<.02	<.001	<.03	0.07

REFERENCE SAMPLES (mg/1)

Date	Target R	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
21-Jul-86	*	0.027	0.001		0.006	0.026	0.018	0.011	0.0018		0.022
25-Nov-86	**	0.025	0.026		0.097	0.099	0.105	0.099	0.0017		0.104
20-Jul-87	***	0.028	0.126	0.098	0.095	0.084	0.097	0.099	0.099	0.0021	0.093
23-Jul-87	***	0.027	0.026	0.099	0.097	0.092	0.094	0.099	0.099	0.0017	0.098

TARGET RANGES

*As	0.021	-0.034	**As	0.020	-0.034	***As	0.020	-0.032
Cd	0.001	-0.003	Cd	0.020	-0.028	Cd	0.020	-0.028
Cr			Cr			Cr	0.078	-0.119
Cu	0.004	-0.012	Cu	0.088	-0.113	Cu	0.088	-0.113
Fe	0.005	-0.033	Fe	0.083	-0.119	Fe	0.083	-0.119
Pb	0.010	-0.025	Pb	0.083	-0.116	Pb	0.083	-0.116
Mn	0.003	-0.019	Mn	0.088	-0.111	Mn	0.088	-0.111
Hg	0.010	-0.0022	Hg	0.0014	-0.0022	Hg	0.0014	-0.0022
Ni			Ni			Ni	0.0015	-0.0025
Zn	0.003	-0.019	Zn	0.086	-0.115	Zn	0.086	-0.115