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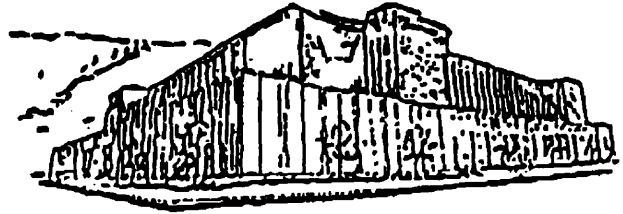
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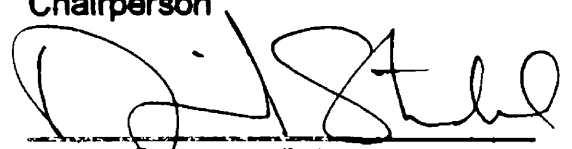
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Virus Occurrence and Transport
in a Cold-Water, Sand and Gravel Aquifer,
Frenchtown, Montana

by
Bruce Charles Lauerman
B.S. Northern Arizona University, 1987
presented in partial fulfillment of the requirements
for the degree of
Master of Science
The University of Montana
1999

Approved by:


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Virus Occurrence and Transport in an Unconfined, Sand and Gravel Aquifer, Western Montana

Committee Chair: Dr. William W. Woessner *WW*

Septic systems have the potential to introduce viruses into ground water, which can result in the transport of viruses downgradient from the source. Viruses may remain viable longer and be transported further in a coarse-grained, unconsolidated aquifer. However, few field-scale studies of virus transport in high hydraulic conductivity aquifers have been documented. For this study, the shallow groundwater in the vicinity of a 20,000 sq. ft septic drainfield was instrumented. Site characterization determined the shallow water table fluctuates between a depth of 7 and 14 ft, hydraulic conductivity ranges from 500 to 800 ft/day and the ground-water velocity approaches 7 ft/day.

Though no enteric viruses were detected in the groundwater above the detection limit of 1 virus/1000L, bacteriophage (virus) were observed in groundwater over 60 ft downgradient from the drainfield. A tracer experiment was conducted using slug sources of bromide and bacteriophage. Coliphage strains MS2 and PHIX-174 were seeded directly into groundwater at initial concentrations of 1.06×10^9 PFU/ml and 1.12×10^6 PFU/ml, respectively. In approximately 20 days, seeded viruses were detected at a downgradient distance of over 80 ft before exiting the tracer well network. Over this distance an 8 log reduction in virus concentration occurred. Analysis of breakthrough curves revealed times of peak concentrations of virus and the conservative bromide occurred at similar intervals. However, virus curves exhibited a pronounced tailing effect, suggesting significant attachment/detachment was occurring. Based on phage stability controls in the injection well, die-off is considered negligible in the 10° C groundwater during the seeding experiment. It appears attachment is an important mechanism controlling virus transport in a high velocity groundwater system. Nevertheless, a portion of the viruses initially attached are later released and remain viable for several months.

ACKNOWLEDGEMENTS

I express my gratitude to the Montana University System Department of Water Resources and to the National Water Research Institute (NWRI) for their generous funding of this research. Thanks to the Frenchtown School District and the community of Frenchtown for their open cooperation and interest.

Sincere thanks to my thesis committee, particularly Dr. William Woessner (Department of Geology) for his guidance, motivation and patience, and to Dr. Dan DeBorde and Mr. Patric Ball (Department of Biological Sciences) for their dedicated virology work. It has been my good fortune and pleasure to work with such a talented team of professionals on a great project.

Special thanks to my family, especially Mom and Dad; to my classmates; to my buddies Eric, Bill, and Jim; to Loreene and Judy in the Geology Office; and to Charlotte, for her selfless friendship and love.

TABLE OF CONTENTS

ABSTRACT	II
ACKNOWLEDGEMENTS	III
TABLE OF CONTENTS	IV
LIST OF TABLES	VI
LIST OF FIGURES	VII
INTRODUCTION	1
Purpose and Objectives	4
Organization of Thesis	5
PART I HYDROGEOLOGIC SITE CHARACTERIZATION	5
LOCATION AND SETTING	5
Soils Investigation	11
Instrumentation	14
Hydrogeologic Data Collection	21
Water Quality Sampling	23
Laboratory Methods	28
RESULTS	30
Physical Hydrogeology	30
Water Quality	46
Endogenous Viruses	59
DISCUSSION	69
Source History Complexities	69
Aquifer Heterogeneity	72
Inorganic Plume	74
Absence of Human Enterovirus	75
Endogenous Coliphage	77
CONCLUSIONS	78

PART II COLIPHAGE SEEDING EXPERIMENT	80
METHODS	80
RESULTS OF COLIPHAGE SEEDING EXPERIMENT	82
DISCUSSION	91
Virus Survival	92
Transport Distance	93
Comparison of Coliphage Seed and Bromide Tracer Test Results	93
Regulatory	98
CONCLUSIONS	99

LIST OF APPENDICES

APPENDIX A: Septic System/Water Supply Specifications.....	105
APPENDIX B: Soil Boring Logs	111
APPENDIX C: Effluent Loading Rates.....	157
APPENDIX D: Ground-Water Monitoring Well Construction Summaries	160
APPENDIX E: Potentiometric Data.....	202
APPENDIX F: Aquifer Test Data and Analyses	232
APPENDIX G: Bromide Tracer Test Data.....	235
APPENDIX H: Inorganic Water Quality Analytical Data	239
APPENDIX I: Coliform Water Quality Analytical Data	255
APPENDIX J: Coliphage Seeding Experiment Analytical Data	260

LIST OF TABLES

Table 1. Summary of Piezometer and Ground-Water Monitoring Well Completions.....	20
Table 2. Summary of Results: Hydraulic Conductivity of Coarse Sands and Gravels	39
Table 3. Summary of Results: Inorganic Chemistry of Groundwater	47
Table 4. Summary of Results: Coliphage in Groundwater.....	64
Table 5. Results of Groundwater Coliphage Sampling: May 30, 1996	66
Table 6. Summary of Results: Human Enterovirus in Septic Effluent.....	68
Table 7. Summary of Results: Human Enterovirus in Groundwater	68
Table 8. Summary of Results: Coliphage Seed Breakthrough Curves	84
Table 9. Summary of Results: Groundwater Field Parameters Measured During the Coliphage Seeding Experiment.....	89

LIST OF FIGURES

Figure 1:	Vicinity map	6
Figure 2:	Location map	8
Figure 3:	Site map	9
Figure 4:	Location of wells, piezometers and soil borings	12
Figure 5:	Unified Soil Classification System	13
Figure 6:	Tracer well network	18
Figure 7:	1MDS VIRUSORB sampling equipment	27
Figure 8:	Cross section A-A'	32
Figure 9:	Cross section B-B'	33
Figure 10:	Hydrographs: piezometer P1 and monitoring wells M35 and M37	36
Figure 11:	Potentiometric map, April 1995	37
Figure 12:	Potentiometric map, August 1995	38
Figure 13:	Distribution of hydraulic conductivity values estimated from slug tests	41
Figure 14:	Decrease in groundwater bromide concentrations, injection wells M19 and M38	43
Figure 15:	Transect 1 bromide breakthrough curves	44
Figure 16:	Transect 2 bromide breakthrough curves	45
Figure 17:	Plume of sodium-impacted groundwater, May 1996	49
Figure 18:	Plume of chloride-impacted groundwater, May 1996	50
Figure 19:	Plume of nitrate-impacted groundwater, May 1996	51

LIST OF FIGURES (CONT'D)

Figure 20:	Distribution of ammonium in groundwater, May 1996	52
Figure 21:	Plume of total nitrogen in groundwater, May 1996.....	53
Figure 22:	Ammonium concentration in groundwater vs. distance from drainfield, May 1996	55
Figure 23:	Distribution of electrical conductance of groundwater, May 1996.....	56
Figure 24:	Distribution of dissolved oxygen in groundwater, May 1996.....	57
Figure 25:	Wells testing positive for total coliform.....	60
Figure 26:	Wells testing positive for fecal coliform	61
Figure 27:	Variation of coliphage detected in the FHS septic tank.....	62
Figure 28:	Wells testing positive for coliphage.....	67
Figure 29:	Comparison of endogenous and seeded coliphage concentrations in groundwater	83
Figure 30:	MS2 breakthrough curves, wells M40, M41, T7 and T8.....	85
Figure 31:	PhiX174 breakthrough curves, wells M40, M41, T7 and T8.....	86
Figure 32:	Injection well M19: concentrations of MS2, PhiX174 and bromide	88
Figure 33:	Virus mortality: control experiment data	90
Figure 34:	Well M40: breakthrough curves for MS2, PhiX174 and bromide	94
Figure 35:	Well M41: breakthrough curves for MS2, PhiX174 and bromide	95
Figure 36:	Well T7: breakthrough curves for MS2, PhiX174 and bromide	96

INTRODUCTION

In the past two decades, an increasing awareness has developed regarding the ability of infectious human viruses to survive and be transported in soil water and groundwater systems. Of particular concern are enteric viruses, which replicate in the intestinal tract of humans and other animals and are commonly found in raw sewage. Enteric viruses have been detected in soil water and groundwater at numerous sewage discharge, treatment and disposal facilities (Wellings, et al., 1975; Keswick and Gerba, 1980; Vaughn, et al., 1983; Jansons, et al., 1987). Once present in the groundwater system, enteric viruses have been shown to survive for days and months in some aquifer environments (Keswick, et al., 1982; Bitton, et al., 1983; Jansons, et al., 1989). Furthermore, enteric viruses that persist in some aquifers have been transported significant distances from the source area. Mack, et al., (1972). reported isolating enteric viruses in a well approximately 100 m from a wastewater drainfield in Michigan. In New York, Vaughn, et al., (1983) reported detecting enteric viruses at a distance of over 67 m down-gradient from a subsurface septic disposal system.

These early works prompted research focused on identifying the factors controlling the transport and survival of viruses in groundwater systems. Results of field and laboratory experiments suggested adsorption was the primary physical mechanism acting to inhibit enteric virus transport (Gilbert, et al., 1976; Gerba, 1984). Laboratory column experiments found that adsorption of viruses

to soils was highly dependent on the strain of virus, and on the soil type (Goyal and Gerba, 1979). Others have reported the survival of viruses in soils and groundwater is related to a number of factors including soil type, temperature, pH, microbial load and dissolved oxygen (Keswick and Gerba, 1980; Jansons et al., 1989). Nevertheless, the quantitative aspects of transport and survival of enteric viruses in groundwater remain difficult to characterize. One challenge that needs to be resolved is the inability of researchers to detect low concentrations of enteric viruses (< 2 per 2000 L). In addition, field experiments using infectious enteric viruses have not been widely conducted due primarily to public health considerations, and few published works are available.

To circumvent some of these challenges, the last several years have seen the adoption of specific bacteriophage (coliphage) as safe surrogates for field studies of the behavior of infectious human viruses. Coliphage are often found in natural waters impacted by sewage wastes, and can be assayed by plaquing. Column experiments have been used to document the survival of coliphage in groundwater (Yahya et al., 1993) and the transport of bacteriophage in porous media (Grondin and Gerba, 1986; Bales, et al., 1989; Harvey, et al., 1993). Comparative rates of adsorption and the chemical factors controlling adsorption have been studied in column experiments (Goyal and Gerba, 1979; Bales, et al., 1993). Because coliphage are not infectious to humans, they have very recently been used in field experiments as models for the behavior of infectious enteric viruses in groundwater (Rossi, et al., 1994; Bales, et al., 1995).

According to Yates, et al., (1987) coliphage experiments have demonstrated that the fate of viruses in soils and groundwater is controlled by two primary processes: virus inactivation and the adsorption/desorption of viruses to substrate particles. Field and laboratory studies report specific chemical and physical factors which affect the ability of coliphage and enteric viruses to adhere to soil particles, including soil type, pH, ionic strength, dissolved oxygen, and hydrophobic effects (Gerba, 1984; Yates et al., 1987; Gerba, 1989; Bales, et al., 1993; Yahya, et al., 1993). Temperature was cited by Yates, et al., (1985) as "the single most important predictor of virus persistence in well water". Virus inactivation was found to be most significantly aided by increased temperature and decreased dissolved oxygen (Jansons, et al., 1989; Yahya, et al., 1993). Because colder water temperatures and well-oxygenated systems favor virus survival, it is expected that virus transport may be more extensive in a relatively cold and conductive, coarse-grained alluvial aquifer. However, additional field experiments are needed to document the transport of viruses in well-characterized hydrogeologic environments.

In light of limited research related to both enteric viruses and coliphage, and our inability to effectively detect the presence of enteric viruses in water at the low levels expected to pose a threat to human health, regulators face a difficult task in setting acceptable limits for pathogenic viruses in drinking water supplies. Under the draft Ground Water Rule (formerly the Draft Groundwater Disinfection Rule), the EPA has proposed that groundwater used for drinking

water should be treated such that the level of pathogenic viruses (and Giardia) in the treated water would result in a risk of less than one infection per 10,000 persons per year (USEPA, 1992). This risk translates to a concentration of 1 virus particle in 10^7 L (10,000,000 liters). Alternatively, the GWR will allow a variance for water providers to avoid the costs associated with chemical disinfection provided they can demonstrate "natural disinfection" occurs between potential sources of fecal contamination and water wells. However, reviews of the natural disinfection criteria and models used to grant disinfection variances suggest that more research is needed in this area, particularly in understanding the fate of pathogenic viruses in various hydrogeologic environments (Yates, 1990).

PURPOSE AND OBJECTIVES

The purpose of this research is to establish the horizontal distance viruses originating from a large septic system are transported in a conductive, cold water, sand and gravel aquifer. The specific objectives of this study will be to:

1. Characterize the physical hydrogeologic system, including definition of the site stratigraphy and hydraulic properties.
2. Document the chemical, microbial and viral conditions present in the septic system and shallow groundwater.
3. Conduct bromide and coliphage tracer tests within the shallow aquifer, and

4. Develop methods to predict the concentration and transport distances of human enteroviruses in similar groundwater systems.

ORGANIZATION OF THESIS

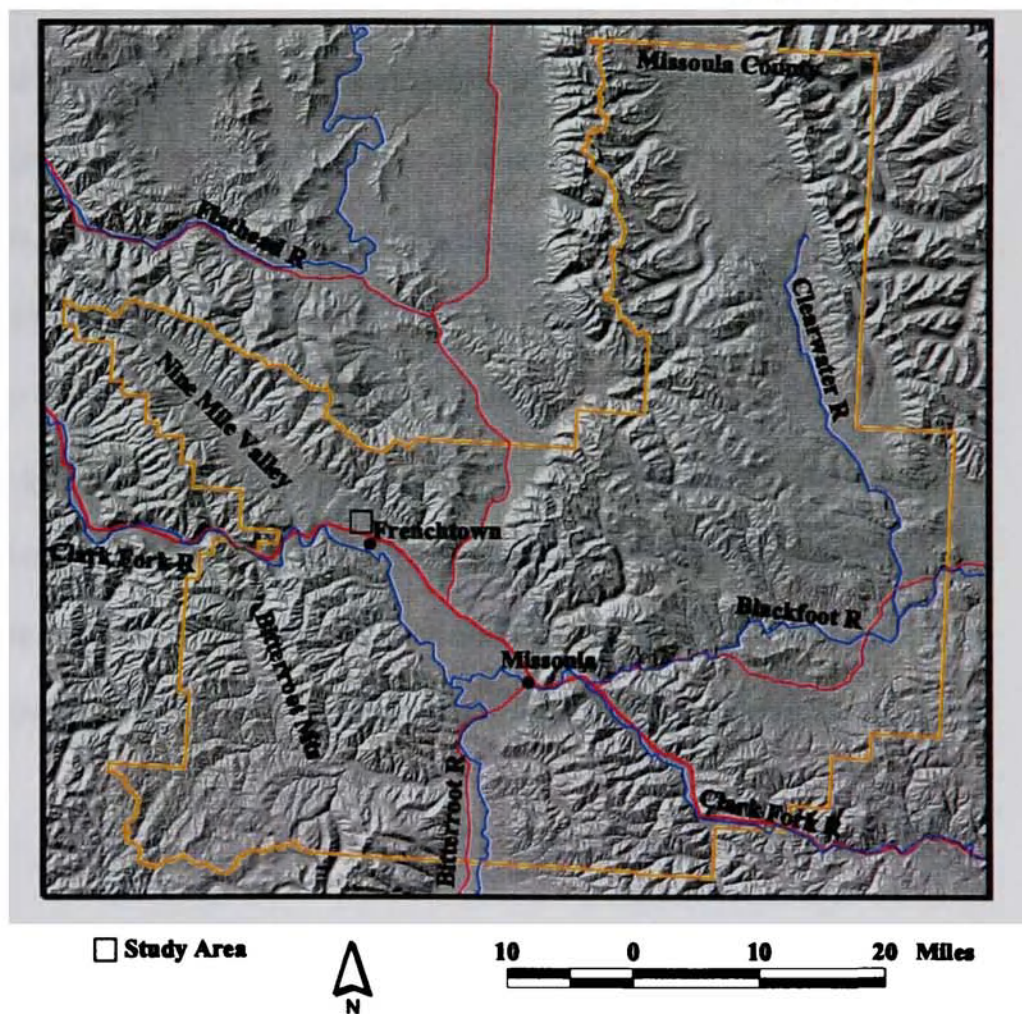
This thesis is organized under two major headings. Part I is the Hydrogeologic Site Characterization which describes the field and analytical methods used to characterize the site, presents the results of the investigation, and provides a discussion of the physical hydrogeology and ground-water quality of the site. Part II is the Coliphage Seeding Experiment which presents the methods and results of the virus seeding experiment, followed by a discussion and interpretation of the results of the experiment. All field and analytical data, and supporting documentation are included in the Appendices of the thesis.

PART I HYDROGEOLOGIC SITE CHARACTERIZATION

1.0 LOCATION AND SETTING

The Frenchtown High School (FHS) research site is located in western Montana, about 10 mi west of the city of Missoula (Figure 1). Frenchtown is a rural community with a population of about 2,000 people. The study site occupies the northwest end of the Missoula Valley, a broad west-northwest

FIGURE 1
VICINITY MAP



trending valley which is bounded to the north by the Nine Mile Divide and to the south by the Clark Fork River and the foothills of the Bitterroot Mountains. In the vicinity of Frenchtown, 9 to 18 ft of late Pleistocene alluvium composed of silty sands, sands and gravels form the valley floor (Smith, 1992). Underlying these alluvial deposits are 55 to 200 ft of Pleistocene sediments including about 100 to 120 ft of silty sands and interbedded clays, and a basal sand and gravel unit about 80 ft thick. These sediments unconformably overlie up to a few thousand feet of finer-grained Tertiary sediments (Geldon, 1979). Precambrian bedrock forms the valley bottom and surrounding mountains.

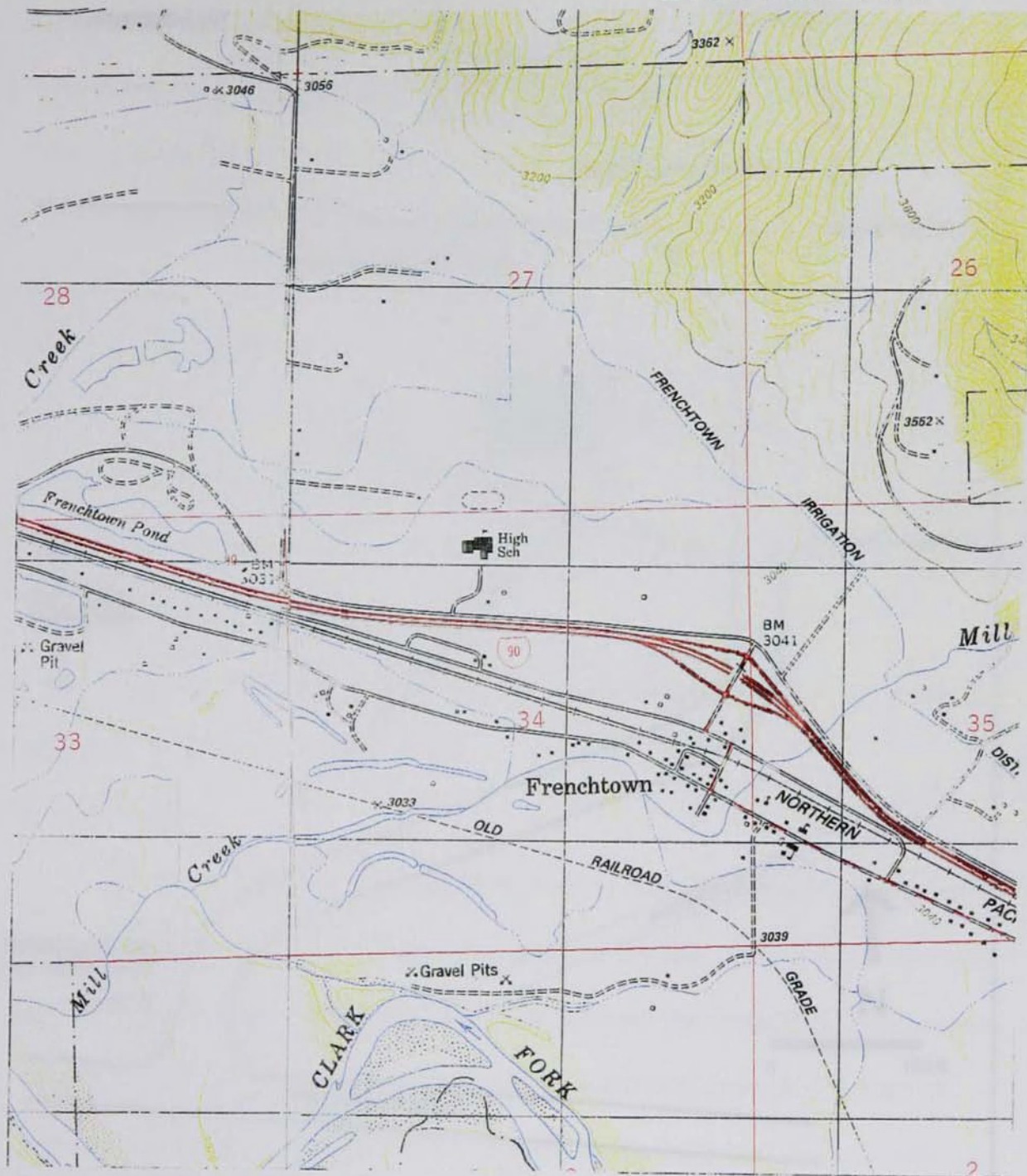
Shallow groundwater occurs in the vicinity of the site as an unconfined system in the surficial alluvium (0 to 30 ft). A deeper and separate regional confined aquifer is present in the basal gravels at a depth of about 170 to 250 ft. This basal aquifer is the primary source of domestic groundwater water supplies in the area.

Facility

The location of the FHS is Township 15N Range 12W Section 34, NE1/4 of the NW1/4 (Figure 2). The FHS was constructed in 1980, immediately north of Interstate-90. Figure 3 is a site map.

The sewage and wastewater produced by approximately 350 students and staff is disposed of by a septic system located in front of and south of the school. The septic system consists of a 15,000 gal septic tank from which effluent is pumped up and gravity fed to a 20,000 ft² drainfield. The drainfield is

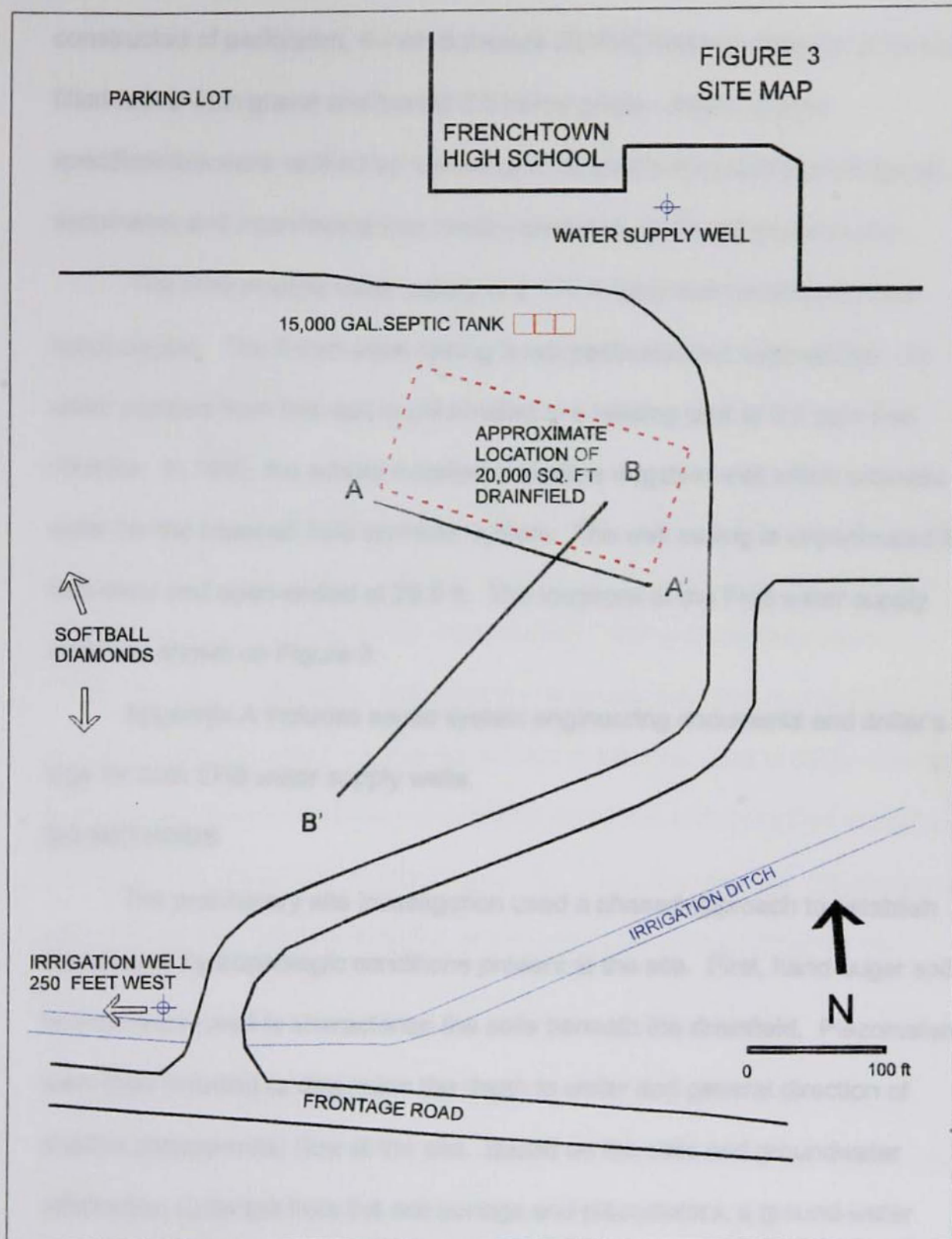
FIGURE 2
LOCATION MAP



USGS 7.5 Minute Quadrangle Maps
Frenchtown, MT and Huson, MT, 1984



QUADRANGLE LOCATION



constructed of perforated, 4-inch Schedule 20 PVC laterals nested in a trenches filled with 2-inch gravel and buried 2 ft below grade. Septic system specifications were verified by reviewing all available engineering and design documents and interviewing key construction and maintenance personnel.

The FHS potable water supply is a 177 ft deep well completed in the basal aquifer. The 6-inch steel casing is not perforated but open-ended. All water pumped from this well is chlorinated in a holding tank to 0.5 ppm free chlorine. In 1995, the school installed a shallow irrigation well which provides water for the baseball field sprinkler system. The well casing is unperforated 6-inch steel and open-ended at 25.5 ft. The locations of the FHS water supply wells are shown on Figure 3.

Appendix A includes septic system engineering documents and driller's logs for both FHS water supply wells.

2.0 METHODS

The preliminary site investigation used a phased approach to establish the general hydrogeologic conditions present at the site. First, hand auger soil borings were used to characterize the soils beneath the drainfield. Piezometers were then installed to determine the depth to water and general direction of shallow ground-water flow at the site. Based on the soils and groundwater information collected from the soil borings and piezometers, a ground-water monitoring well network was constructed. The monitoring wells were tested and sampled to characterize the physical and chemical properties of the aquifer.

Lastly, a network of closely-spaced wells was installed for the purpose of conducting ground-water tracer experiments. This section describes the field and analytical methods used to instrument and characterize the site. Figure 4 shows the locations of all soil borings, piezometers and ground-water monitoring wells constructed at the FHS.

2.1 Soils Investigation

Sample Collection

Ten (10) 3-in diameter hand auger borings (B1 through B10) were drilled to a depth of 8 to 10 ft below land surface, at which depth saturated soils and coarse gravels precluded further advancement. Soil grab samples were collected at 2.5 ft intervals. Soil samples were also collected during the installation of piezometers and ground-water monitoring wells at depth intervals of 2.5 or 5 ft. All soil samples were visually inspected and described using the Unified Soil Classification System (Figure 5). A log of boring was maintained for each soil boring, piezometer boring and monitor well boring (Appendix B).

Sieve Analysis

Standard sieve analyses were conducted on each of the soil samples collected. Sieve analyses and methodology are contained in an undergraduate thesis prepared by Swaren at The University of Montana (1995).

Soils were dried, split and weighed prior to being sieved through a set of six nested sieves ranging in size from -1 to 4 phi units (4 to 1/16 mm). For each

FIGURE 4
LOCATION OF WELLS,
PIEZOMETERS AND
SOIL BORINGS

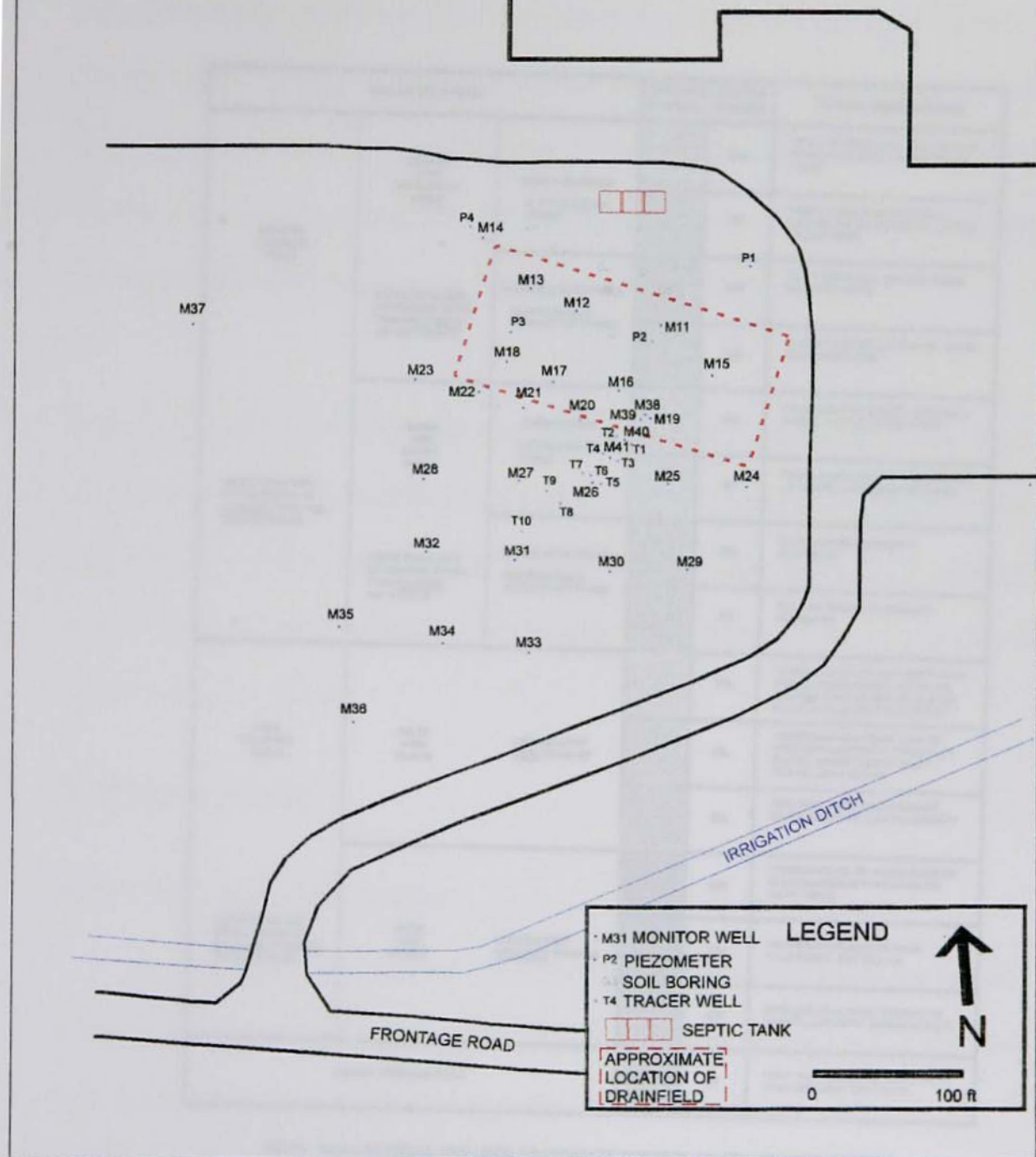


FIGURE 5 UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL GRADED GRAVELS, GRAVEL SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 60% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50			ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

soil sample, the distribution of grain size by weight was determined and a cumulative grain size distribution curve was generated. A statistical analysis was attempted to determine the mean grain size and the degree of sorting (Boggs, 1987). The grain size data were further used to estimate the distribution of hydraulic conductivity at the site using methods described by Hazen (1892). The Hazen Method relates hydraulic conductivity to the square of the effective grain size of a sediment sample using the following formula:

$$K = C(d_{10})^2$$

where K is hydraulic conductivity (cm/sec), C is coefficient based on the size and degree of sorting of the sediment particles, and d_{10} (cm) is the effective grain size. A value of $C = 100$ was used for this analysis, which roughly correlates to a medium to coarse, moderately-sorted sand according to Hazen's classification scheme (Fetter, 1994).

2.2 Instrumentation

Septic Effluent Pump Station

Wastewater generated at the school is pumped to a 15,000 gal septic tank. A pair of submersible pumps alternate lifting the effluent out of the tank and into the drain line where it is gravity fed to the drainfield. The effluent pumping system was instrumented with chart recorders to document effluent pumping cycles. Pump cycling data were combined with pumping curves to estimate daily effluent loading rates (Appendix C).

Piezometer Installation

The depth of the shallow water table and the approximate direction of groundwater flow were determined by installing four (4) piezometers (P1 through P4). Prior to piezometer installation, a 3-in diameter hand auger boring was advanced to a depth of 8 to 10 ft below grade. The piezometers were then installed within the soil boring using a jackhammer to advance 3/4-in diameter galvanized steel pipe to a depth of approximately 19 ft below grade. The bottom end of the galvanized pipe was equipped with a loosely fitting carriage bolt. Once the pipe was driven to the desired depth, the pipe was pulled back approximately 6 in to dislodge the carriage bolt and to allow water to enter the piezometer. The annulus was then backfilled with cuttings to a depth of 2 ft below grade and sealed with a 1.5 ft bentonite seal activated with water. Drill cuttings were placed around a 1 ft stickup and the drillsite was repaired to grade. The surface completion at each piezometer consists of a short, 3-inch diameter black steel protective casing with a lockable lid.

Ground-water Monitoring Well Installation

Based on the preliminary depth to water and grain size information collected, a ground-water monitoring well network was installed to characterize the physical properties of the aquifer and assess groundwater chemistry in the vicinity of, and immediately down-gradient from the septic drainfield. O'Keefe Drilling Company of Butte, Montana was contracted to perform auger drilling. A

Mobile B-61 truck-mounted hollow-stem auger rig was used to install thirty-one (31) 2-in diameter Schedule 40 PVC ground-water monitoring wells (M11 through M41). Well M37 is designated as a background well. It is located on-site but outside of the anticipated plume of septic impacted groundwater.

The well installation procedure was similar for each 2-in diameter monitoring well. At each well location, the drill rig advanced an 8-inch diameter boring to a total depth of 16 to 20 ft below land surface. Soil grab samples were collected from drill cuttings at 5-ft depth intervals. Soil samples were logged and sieved as described above. Well casing and screen was lowered through the 4.5 inch diameter hollow stem of the auger, and as the augers were withdrawn, the unconsolidated formation collapsed back around the well casing and screen. Typically, the lower, saturated portion of the borehole collapsed and the upper, unsaturated formation remained open. Once the auger flights were removed from the borehole, the remainder of the open annulus was backfilled with cuttings to a depth of 2 ft below grade. A 1.5 ft bentonite seal was placed in the annulus and activated with water. Drill cuttings were placed around a small stick-up and the drillsite was repaired to grade.

Monitoring wells are completed to a depth of 15 to 20 ft. All wells are completed with 10 ft of .020 slot screen, except wells M38 through M41, which are completed with 5 ft of .020 slot screen. Each well is equipped with a PVC bottom cap and a PVC slip cap. A short length of 3-in diameter black steel equipped with a lockable lid was later added as a protective surface casing at

each well. Appendix D contains a Monitor Well Construction Summary for each 2-in diameter well.

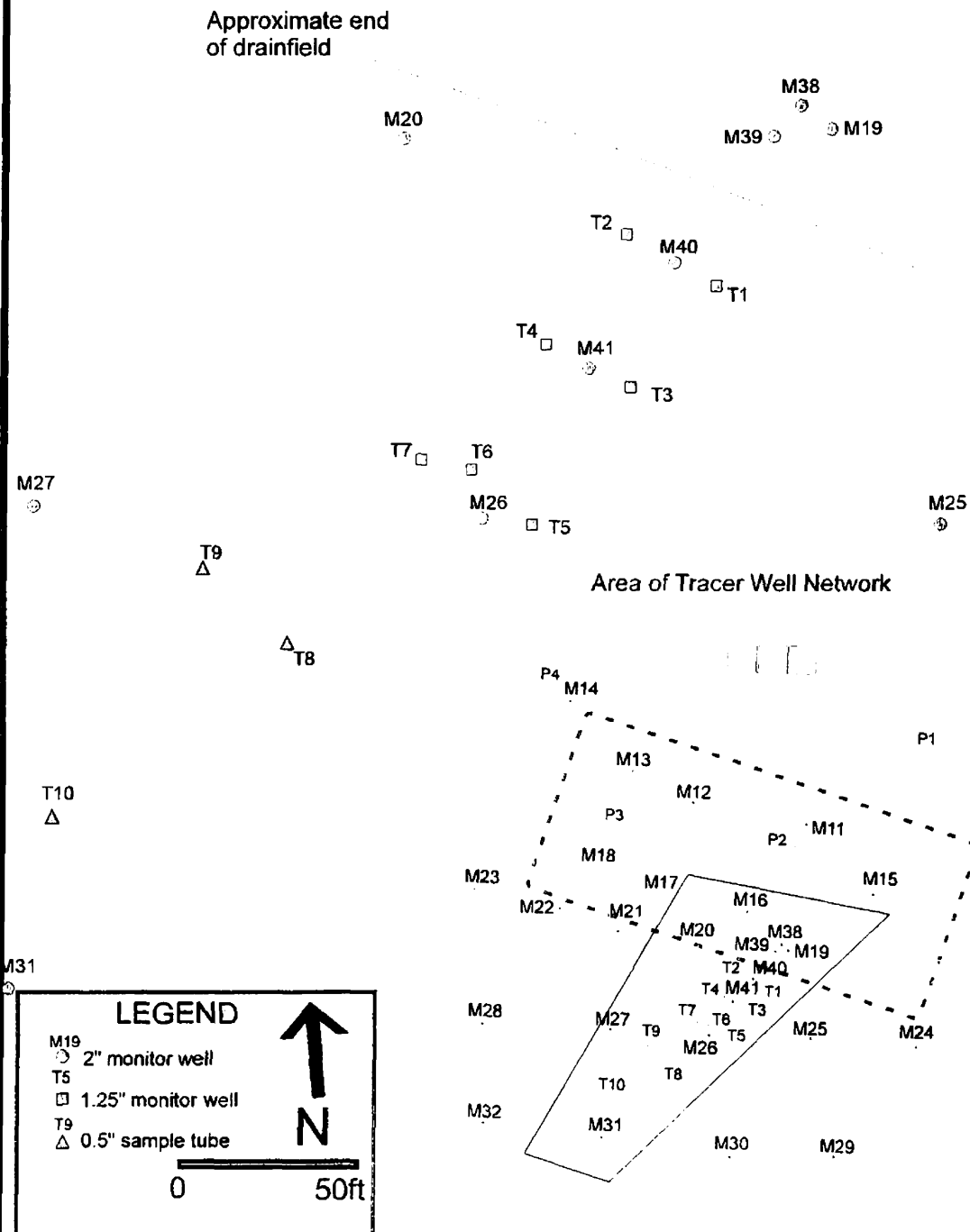
Each monitoring well was developed by swabbing, surging and bailing using a 1.6-in diameter Teflon or PVC bailer. A minimum of 25 gal of water was removed from each well during development. Additional well development was performed on wells M19, M26, M38, M39, M40 and M41 using a centrifugal pump to surge, swab and overpump at a rate of 15-20 gpm. Each of the six wells was developed for a minimum of 1 hr, until the well produced clear water even after vigorous surging. These more thoroughly developed wells were included in the groundwater tracer well network.

Tracer Well Network Installation

An array of ten small diameter wells (T1 through T10) were installed in the vicinity of the above-mentioned six wells for the purpose of conducting a groundwater tracer test and a virus seeding experiment (Figure 6). The tracer network is oriented parallel to the direction of ground-water flow at the downgradient edge of the drainfield and along the axis of the identified plume of septic impacted groundwater.

Seven wells (T1-T7) were installed to a depth of approximately 12 to 15 ft below land surface using a Geoprobe hydraulic press operated by West Central Environmental Consultants (WCEC) of Missoula, Montana. The wells are constructed of 1.25-in schedule 80 PVC and 2 ft of hand-slotted PVC screen.

**FIGURE 6
TRACER WELL NETWORK**



Prior to casing installation, a 1.5 in diameter core barrel was advanced with the Geoprobe press. Once gravels were encountered, the casing was driven into the borehole to a maximum depth of 15 ft or until the casing could not be advanced further. The wells have a natural pack filter. The open annulus of each well was backfilled with cuttings. A bentonite seal was placed from a depth of 0.5 to 1 ft and activated with water. The wells are completed with a 3-in diameter black steel surface casing equipped with a lockable lid. Wells T1 through T7 were developed by pumping and surging with a 0.5 in polyethylene tube and a peristaltic pump.

Three additional small diameter sampling devices (T8, T9 and T10) were installed using a method similar to the method described for piezometer installation. A jackhammer advanced a 1-in diameter galvanized steel pipe to a depth of 12 to 14 ft. Once the pipe was driven to depth, a 0.5-in diameter polyethylene tube was lowered down the center of the pipe. The bottom 2 ft of the polyethylene tubing had been perforated with a hand drill and wrapped in a fine mesh nylon screen. The steel pipe was removed and the tubing was left in place. The sample tubes are protected with a short stickup of 2-in diameter, Schedule 40 PVC casing.

Table 1 summarizes the well construction for all wells and piezometers at the FHS site. Monitor well construction summaries for wells T1 through T10 are included in Appendix D.

Table 1
Summary of Piezometer and Monitoring Well Completions

WELL ID	MP ELEV (feet)	CASING DIAMETER (inches)	TOTAL DEPTH BGS (feet)	SCREENED INTERVAL (feet)	COMMENTS
P1	100	0.75 GALV.	19	OPEN ENDED	
P2	99.8	0.75 GALV.	19	OPEN ENDED	ABANDONED
P3	99.71	0.75 GALV.	19	OPEN ENDED	ABANDONED
P4	99.99	0.75 GALV.	19	OPEN ENDED	ABANDONED
M11	99.76	2" PVC	17.1	7.1 - 17.1	
M12	99.83	2" PVC	17.1	7.1 - 17.1	
M13	99.89	2" PVC	17.3	7.3 - 17.3	
M14	99.87	2" PVC	17.2	7.2 - 17.2	
M15	99.52	2" PVC	16.6	6.6 - 16.6	
M16	99.49	2" PVC	17.7	7.7 - 17.7	
M17	99.57	2" PVC	17.4	7.4 - 17.4	
M18	99.51	2" PVC	16.7	6.7 - 16.7	
M19	99.27	2" PVC	17.3	7.3 - 17.3	
M20	99.2	2" PVC	16.6	6.6 - 16.6	
M21	99.2	2" PVC	16.3	6.3 - 16.3	
M22	99.35	2" PVC	16.5	6.5 - 16.5	
M23	102.01	2" PVC	18.5	8.5 - 18.5	ABANDONED
M24	99.34	2" PVC	15.8	5.8 - 15.8	
M25	99.38	2" PVC	15.8	5.8 - 15.8	
M26	99.13	2" PVC	17.6	7.6 - 17.6	
M27	99.18	2" PVC	16.9	6.9 - 16.9	
M28	101.46	2" PVC	19.1	9.1 - 19.1	
M29	99.78	2" PVC	17.1	7.1 - 17.1	
M30	99.85	2" PVC	16.6	6.6 - 16.6	
M31	99.76	2" PVC	17.2	7.2 - 17.2	
M32	101.34	2" PVC	18.6	8.6 - 18.6	
M33	100.95	2" PVC	17.4	7.4 - 17.4	
M34	101.67	2" PVC	19.2	9.2 - 19.2	
M35	101.57	2" PVC	19.4	9.4 - 19.4	
M36	102.75	2" PVC	19.2	9.2 - 19.2	
M37	102.26	2" PVC	19.1	9.1 - 19.1	BACKGROUND WELL
M38	99.18	2" PVC	15.4	10.4 - 15.4	
M39	99.16	2" PVC	15.2	10.2 - 15.2	
M40	99.08	2" PVC	15.3	10.3 - 15.3	
M41	99.05	2" PVC	15.5	10.5 - 15.5	
T1		1" PVC	12.4	10.4 - 12.4	
T2		1" PVC	13.7	11.7 - 13.7	
T3		1" PVC	14.3	12.3 - 14.3	
T4		1" PVC	13.3	11.3 - 13.3	
T5		1" PVC	13.5	11.5 - 13.5	
T6		1" PVC	14.3	12.3 - 14.3	
T7		1" PVC	14.6	12.6 - 14.6	
T8		0.5" PVC	11.2	9.2 - 11.2	
T9		0.5" PVC	13.2	11.2 - 13.2	
T10		0.5" PVC	13.6	11.6 - 13.6	

2.3 Hydrogeologic Data Collection

Water Level Measurements

All piezometers and ground-water monitoring wells were surveyed for vertical control. The measuring point (MP) at each instrument is the top of the well or piezometer casing. Piezometer P1 was assigned an arbitrary elevation of 100.00 ft and was used as the survey benchmark. MP elevations were surveyed to 0.01 ft. Water level measurements were recorded to 0.01 ft using a Solinst electric sounder. Monthly water level measurements were recorded between September 1994 and July 1996 at piezometers and 2-in diameter monitoring wells to document the depth to groundwater, and the direction and gradient of ground-water movement throughout the course of the study. All water level data are included in Appendix E.

Slug Tests

In October 1995, a total of thirty-seven "rising-head" slug tests were performed at eleven of the 2-in diameter ground water monitoring wells to estimate the horizontal distribution of hydraulic conductivity in the sand and gravel below a depth of 10 ft. A 1.6-in diameter bailer was used to instantly remove 0.29 gal of well water while a pressure transducer and a Hermit SE1000C data logger (In-Situ, Inc. Laramie, WY) recorded the recovery of the water level in the well. Values of local hydraulic conductivity were approximated

according to methods described by Bouwer and Rice (1976). The data were analyzed both manually and by using the software package AQTESOLV (Version 1.1), marketed by Geraghty and Miller, Inc (1991).

All slug test data, including Hermit .txt files and Aqtesolv .dat files are provided on computer disk in the back pocket of the thesis.

Pumping Tests

In April 1996, a constant rate discharge test were conducted on well M19 using a centrifugal pump and a 1.25-in diameter suction pipe. Well M19 was pumped at a rate of approximately 8.8 gpm for 34 min. Drawdown measurements were recorded in two observation wells (M38 and M39) located within 6 ft of well M26. Recovery data were collected at the observation wells. The aquifer test data was analyzed using the Cooper-Jacob method (1946) to directly estimate values of aquifer transmissivity and storativity. Values of hydraulic conductivity were approximated from calculated transmissivity values.

The constant rate discharge test and recovery plots are included in Appendix F.

Bromide Tracer Test

A groundwater tracer experiment was conducted within the tracer well network shown on Figure 6. Thirty-five gal of concentrated sodium bromide solution was injected at a depth of 12 ft below land surface into wells M19 and M38. The injection rate was roughly 1 gpm. The initial bromide concentration was 4,130 mg/L in well M19 and 5,250 mg/L in well M38. Wells in the tracer network were sampled for bromide over a period of 20 days. All samples were collected with a peristaltic pump and dedicated 0.5-in diameter polyethylene tubing. The sample tube inlet was positioned within the perforated interval of the well at a depth of 2 ft below the static water level in each well. Bromide analysis was done using ion chromatography as described below. All data collected during the bromide tracer test are included in Appendix G.

2.4 Water Quality Sampling

Water quality samples were collected from the monitoring wells and the septic tank using dedicated sampling equipment and a peristaltic pump. A 0.5-in diameter polyethylene tube was installed in each monitoring well and the septic tank. At each monitoring well, sample tube intakes were positioned about 2 ft below the measured water table. The sample tube intake in the septic tank was set at a depth of 10 ft below the top of the manhole of the final septic tank compartment, where the septic effluent is relatively reduced in solids. Standard ground-water sampling techniques were used (EPA, 1987). Each well was

purged of approximately 0.5 gal of water prior to sample collection. During well evacuation, field measurements of temperature, pH, electrical conductivity and dissolved oxygen were recorded. All samples were immediately labeled with the sample name, date and time, and packed on ice in a cooler for transport to The University of Montana Department of Geology Aqueous Geochemistry Laboratory. The thick-wall silicon tubing used in the peristaltic pump head was decontaminated between each well by flushing thoroughly with deionized water.

Inorganic Samples

All 2-in diameter ground-water monitoring wells and the septic tank were sampled for the following anions: nitrate (NO_3 as N), chloride (Cl), sulfate (SO_4) and phosphate (PO_4). Samples were also collected and analyzed for alkalinity (CaCO_3) and ammonium (NH_4). Cation analyses included Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Si, Sr, Ti and Zn.

Inorganic water quality samples were collected in clean polyethylene containers. Samples to be analyzed for anions were filtered using a 0.45 micron filter. Samples to be analyzed for cations were filtered with a 0.45 micron filter and preserved with concentrated nitric acid (HNO_3). Ammonium samples were preserved with concentrated sulfuric acid (H_2SO_4).

Coliform Bacteria Samples

Samples were collected from all monitoring wells and the septic tank and analyzed for total coliform and fecal coliform bacteria. Groundwater and septic

effluent samples were collected with dedicated equipment as described for collection of inorganic samples. The samples were not filtered. Coliform water samples were collected in EPA approved sterile 100 ml polyethelene containers. The thick-wall silicon tubing used in the peristaltic pump head was decontaminated between each well by flushing thoroughly with deionized water. All coliform water samples were immediately labeled with the sample name, date and time, and packed on ice in a cooler for immediate transport to The University of Montana Division of Biological Sciences (DBS) Bacteriology Laboratory.

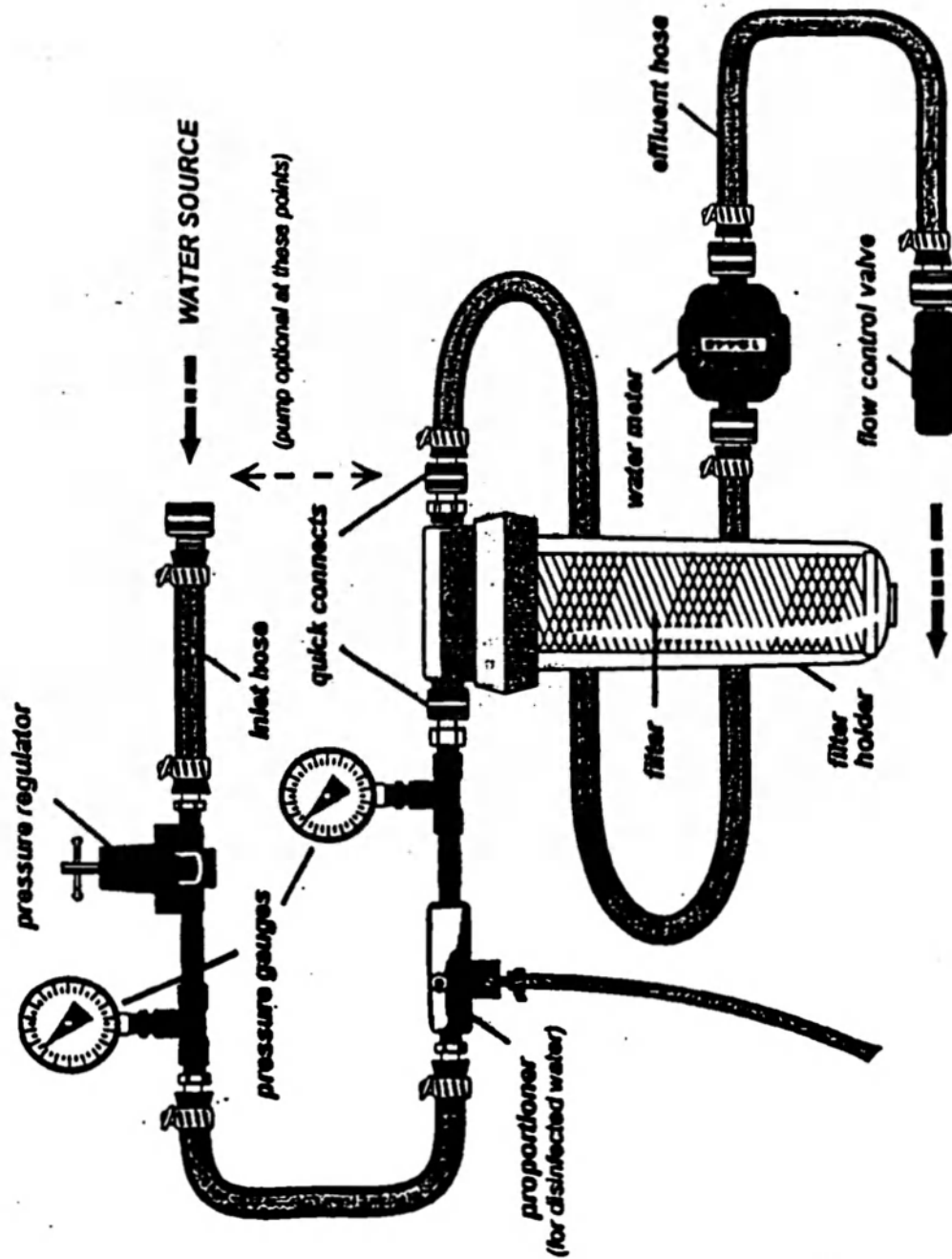
Virus Samples

Samples collected from all monitoring wells and the septic tank were analyzed for the presence of male-specific and somatic coliphage virus. Selected wells and the septic tank were sampled for the presence of human enterovirus. At each sampling location, coliphage samples were collected with sterile, dedicated equipment and a peristaltic pump. Special care was taken to prevent cross-contamination between sample collection locations, including using entirely dedicated equipment at each sampling location. Coliphage samples were limited in volume to 100 ml to 4 L. Sterile sample containers were filled completely to minimize head space. Samples were labeled and packed on ice for immediate or overnight delivery to The University of Montana DBS Virology Laboratory.

Sample collection and analysis of enterovirus in water and effluent is time consuming and relatively expensive. To maximize efficiency, enterovirus sampling was done only at the septic tank and at monitoring wells which, based on all other data collected, were likely to test positive for human enterovirus.

Enterovirus sampling equipment and methodologies were based on EPA guidelines (USEPA, 1994). In general, enterovirus assays required pumping 1,000 to 3,000 L of water or effluent through an autoclaved 1MDS Virusorb filter (CUNO, Meriden, CT) at a low flow rate ($<7\text{L/min}$). Where necessary, a polypropylene prefilter was used in-line before the 1MDS filter to remove suspended sediment. The sampling equipment is illustrated in Figure 7. The low rate of flow prevented the use of a totalizer to measure the volume of fluid pumped, so the total amount of fluid passing through the filter was calculated by frequently measuring the flow rate at the filter discharge with a 1 gal container and a stop watch. Filters were packed in ice and shielded from direct sunlight during sample collection to inhibit virus mortality. When sample collection was complete, excess water was drained from the filter cartridges and sterile aluminum foil was used to cover the filter cartridge openings. The filter cartridges were packed in ice for immediate delivery to The University of Montana DBS Virology Laboratory.

FIGURE 7
1-MDS VIRUSORB
SAMPLING
EQUIPMENT



2.5 Laboratory Methods

All water quality analyses were performed at The University of Montana. Samples of the groundwater and septic effluent from the septic tank were analyzed using standard methods to determine concentrations of inorganic, bacteriological and viral constituents. Quality assurance and quality control (QA/QC) analyses were performed to quantify error introduced in the data due to field and laboratory procedures. Laboratory QA/QC data are included in the appropriate appendix for each analysis.

Inorganic Chemistry

Inorganic analyses of groundwater and septic effluent included major cations and anions, alkalinity, and ammonia. Anions were analyzed in accordance with EPA Method 300 or 301 using a Dionex 2000I Ion Chromatograph (IC) equipped with Dionex AS4A separator columns. Cations analyses were performed using a Thermo-Jarrell Ash Atom Comp 800 Inductively Coupled Argon Plasma Emission Spectrometer (ICP-ES) and in accordance with EPA Method 200.7. Quality assurance and quality control (QA/QC) procedures for anion and cation included the analyses of USGS standards, method blanks, and field and laboratory duplicates.

Alkalinity was determined using manual colorimetric titration to pH 4.5 in accordance with EPA 310.1. Ammonia concentrations were determined using an Orion 95-12 electrode in accordance with EPA 350.3, or by spectroscopy

using a Milton Roy Spectronic 301 at 690 nm. Field duplicates and laboratory duplicates were run on approximately 10% of the samples analyzed for alkalinity and ammonia.

Coliform Bacteria

Bacterial assays were performed in the laboratory of Dr. Jim Gannon at The University of Montana DBS to document the presence or absence of fecal and total coliforms in groundwater and septic effluent. Analytical procedures were conducted in accordance with the American Public Health Association guidelines contained in "Standard Methods for Examination of Water and Wastewater" (1992). Total and fecal coliform bacteria were enumerated by the membrane filter (MF) technique. Total coliforms were cultured on m ENDO Broth MF (DIFCO Laboratories) and incubated at 35° C. Fecal coliforms were incubated on m FC Broth (DIFCO Laboratories) at 44.5° C. QA/QC included the analysis of field duplicates.

Viral Analyses

Samples of septic effluent and groundwater were analyzed for the occurrence of human enterovirus and coliphage using a variety of sampling and analytical techniques. All virus assays were performed by Dr. Dan DeBorde at The University of Montana Division of Biological Sciences in accordance with 40 CFR Part 141 and the USEPA Manual of Virological Methods (EPA, 1994), with some modifications.

Five of the enterovirus assays were performed using the 1MDS filtration apparatus as recommended in the USEPA ICR protocol. Within 4 to 8 hrs following collection, enteroviruses were eluted from the 1 MDS filter with a beef extract (3% BEG) and analyzed by plaquing or most probable number (MPN) analysis on Buffalo Green Monkey Kidney (BGM) cells. Three additional samples were assayed in a manner similar to the eluate from the 1MDS samples; two using unfiltered 1 L samples and one using a 10 L sample which was filtered through a negatively charged filter (Berg et al., 1984).

Grab samples for coliphage analysis were analyzed by either plaquing or MPN techniques on the appropriate bacterial host.

3.0 RESULTS

3.1 Physical Hydrogeology

Description of Soils

A total of ninety-three (93) soil samples were collected during the preliminary site characterization and subsequent installation of piezometers and ground-water monitoring wells. Sieve analyses were conducted on all soil samples as described in Section 2. Analysis of sieve data and cumulative grain size distribution curves were used to characterize the soils and estimate the distribution of hydraulic conductivity. The following is a general description of

each of the soil types based on sieve analyses and descriptions and observations recorded on boring logs.

Soil Type A; Sandy gravel: 1 to 3-in diameter quartzitic and argillitic gravels resembling Belt Supergroup clasts. Gravels are rounded to subangular, poorly to moderately sorted. Matrix of fine to coarse sand; predominantly poorly sorted medium to coarse sand comprising < 40% of sediment.

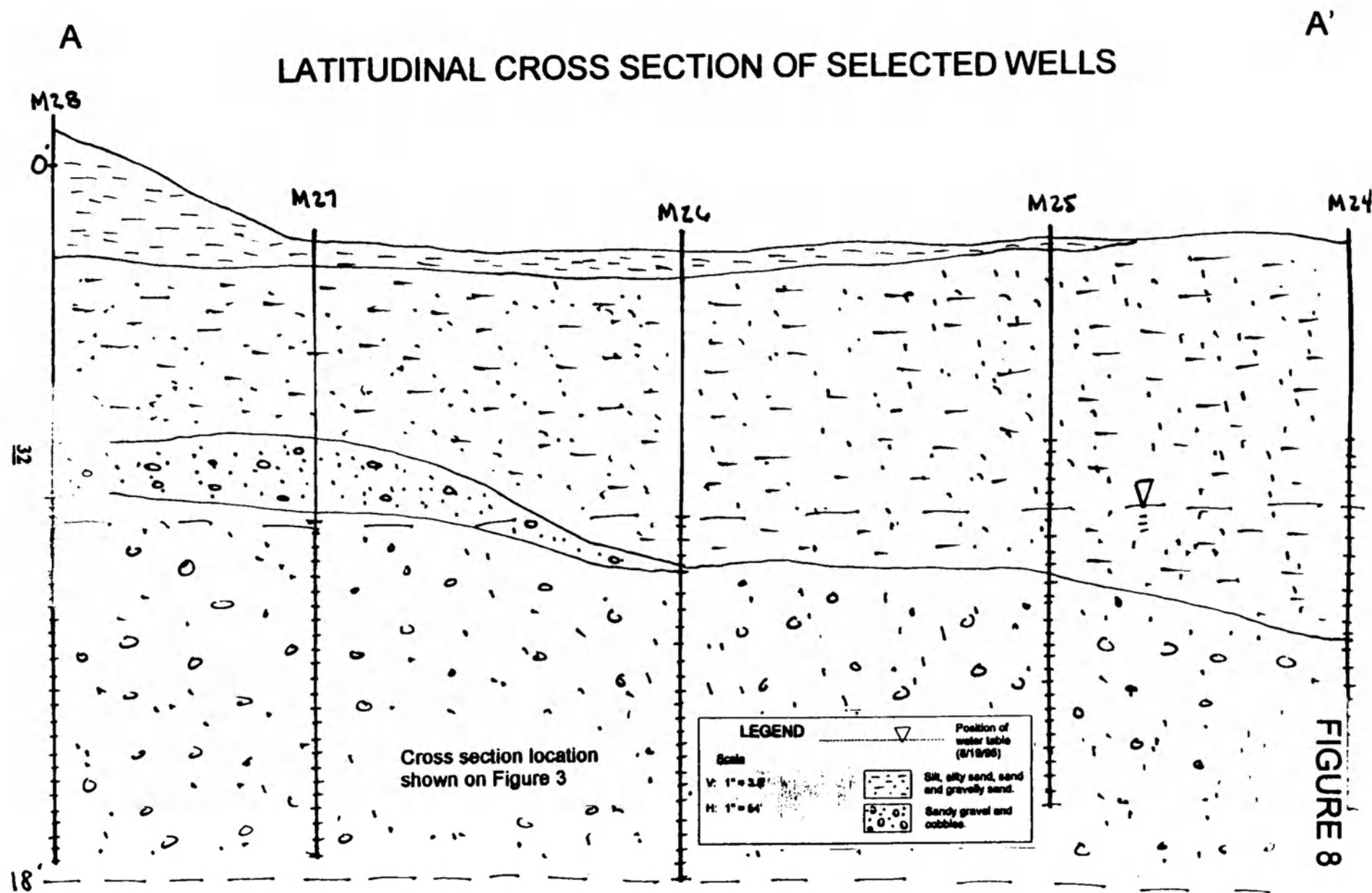
Soil Type B; Gravelly sand to clean sand: Fine to coarse sand, predominantly poorly sorted medium to coarse sand; <30% gravels, similar in composition to type A gravels, but smaller than 1-in diameter, moderately sorted, subangular to rounded. Locally fine, well sorted sands with no gravels and minor silt.

Soil Type C; Silty sands and silts: Mixtures of fine to medium sand and silt ranging from silty sand to silt. Light brown, tan. Little or no visible organic component.

Soil Type D; Topsoil: Black, organic-rich sandy loam, minor to moderate silt and clay.

Figures 8 and 9 are generalized lithologic cross sections of the upper 30 ft of alluvial deposits at the FHS site. Cross-section transects are shown on Figure 3.

Figure 8 is oriented west to east across the middle of the site (A to A'). Figure 9 is oriented parallel to the groundwater flow direction, from northeast to southwest (B to B'). Each lithologic cross section was prepared from sieve analyses and descriptions of soil samples collected during drilling. Drillholes constructed on site were advanced to a maximum depth of 20 ft; the nature of the alluvium from 20 to 30 ft depth is inferred from driller's logs of area water wells and verbal communications (Mr. Charles Hollensteiner, CKC Drilling, 8/19/95).



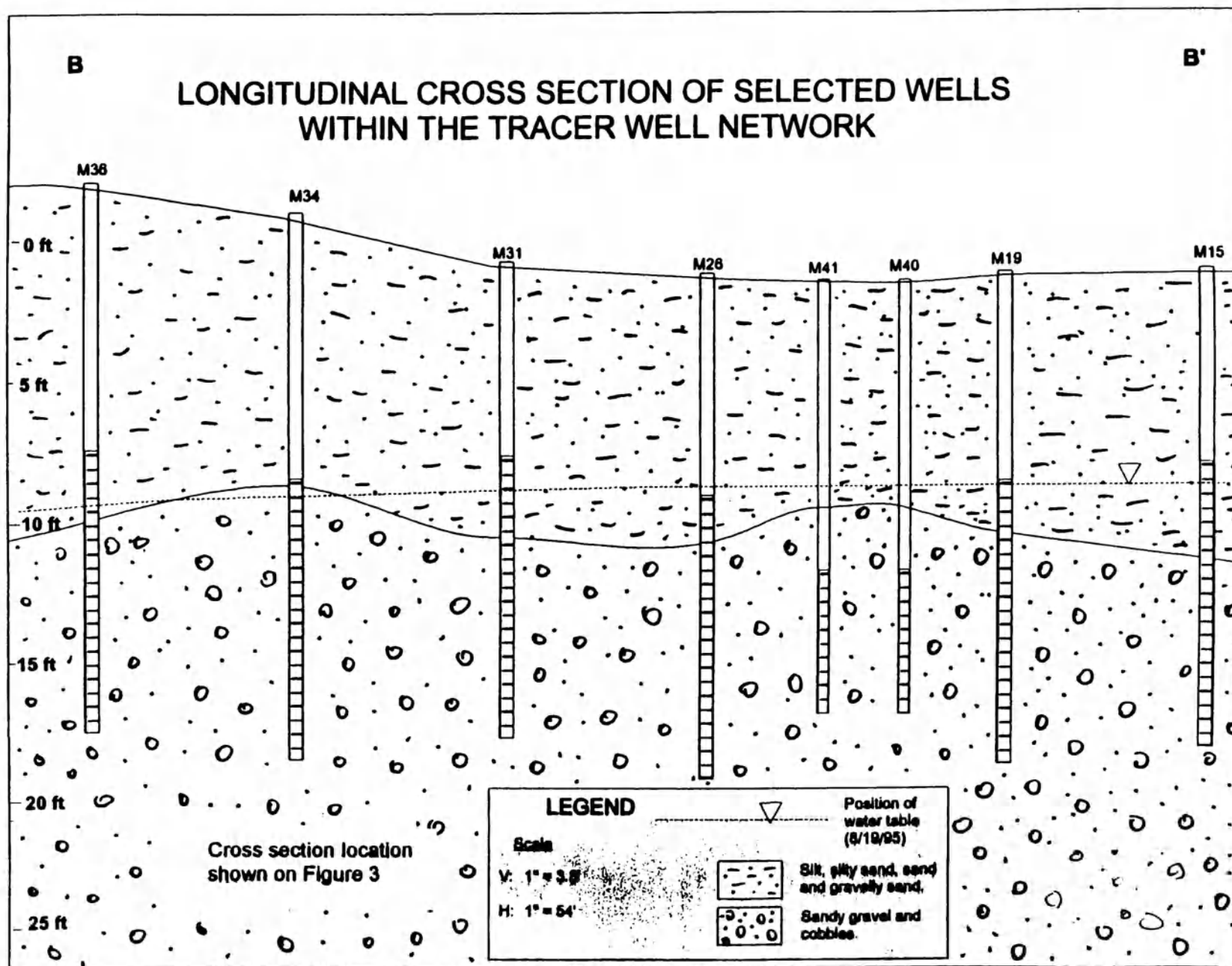


FIGURE 9

In general, the stratigraphy can be described as coarse sands and gravels (soil type A) from a depth of approximately 8 to 30 ft, overlain by well to poorly sorted sands and/or gravelly sands (soil type B), or silty sands and silts (soil type C) to near land surface. However, the site stratigraphy is laterally highly heterogeneous as would be expected in a fluvial depositional system.

The top 3 or 4 ft of soil in the vicinity of the drainfield is generally non-native or was disturbed by construction activities. A layer (6 in to 2 ft) of organic-rich topsoil (soil type D) covers much of the study area. This topsoil was placed during landscaping of the FHS, and thickens to the west, where an artificial topographic high was constructed for the softball fields.

Effluent Loading Rates

Effluent loading rates are approximately 3,500 gallons per day (gpd) when school is in session, and 600-900 gpd when school is closed during Summer and Christmas breaks, and on weekends. Individual effluent pumping events were approximately 160 gpm for a 2 min duration, for a total of 320 gal each. During the school day, loading events were observed to occur at irregular intervals throughout the day and generally did not occur at night. On weekends and during breaks, the loading events occurred less often but were observed to occur at any time during the day or night.

Potentiometric Data

Hydrographs of piezometer P1 from September, 1994 through July, 1996, and monitoring wells M35 and M37 from March 1995 through July, 1996 are shown as Figure 10. The water table began to rise when water from the Clark Fork River was turned in to the Frenchtown Irrigation District (FID) Canal in early May, and continued to rise through the irrigation season. When diversion ceased in early September, the water table abruptly began to decline. The water table continued a general declining trend throughout the Winter and into the Spring. While the water table of the shallow aquifer has been shown to rise and fall in response to recharge from local crop irrigation practices, it is reasonable to expect that the rising water table is due in part to upland recharge. The graph shows a slowing of the rate of water level decline in February of each year, and even a perceptible rise in the water table in March, 1996, possibly indicating the aquifer is being recharged from snowmelt or precipitation. The graph further shows the water level in the Spring of 1996 to be nearly 2 ft higher than the same time period in 1995, probably reflecting recharge to the shallow aquifer due to precipitation in the late 1995 and early 1996.

Figures 11 and 12 are potentiometric maps depicting the flow system of the shallow aquifer during annual lows and highs of the water table in the months of April and August, 1995, respectively. The hydrologic gradient measured across the site ranged from a low 0.0008 during April to a high of 0.002 measured in the month of August. Regardless of the elevation of the

HYDROGRAPH PIEZOMETER P1 AND MONITORING WELLS M35 AND M37

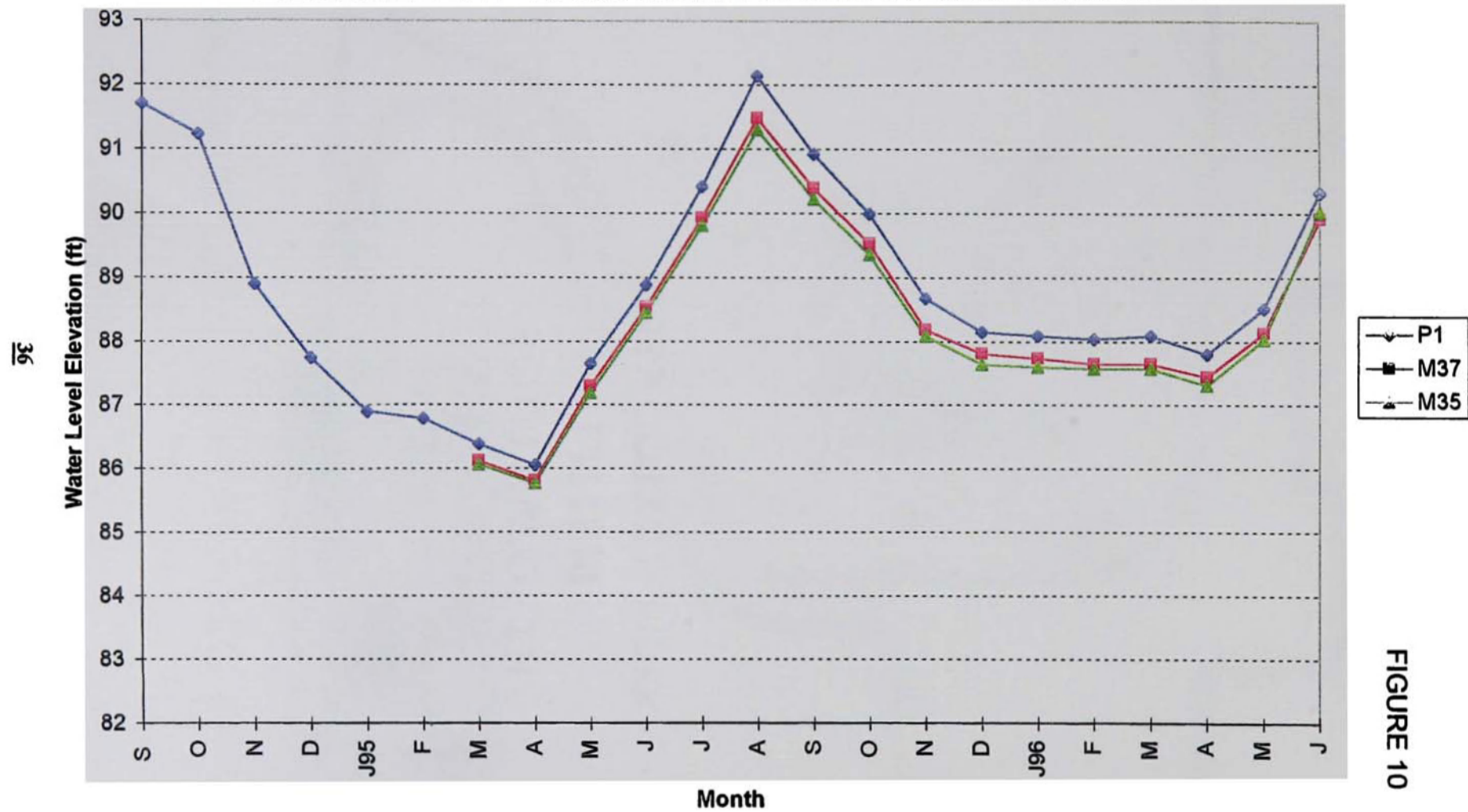


FIGURE 10

FIGURE 11
POTENTIOMETRIC
CONTOUR MAP
APRIL 12, 1995

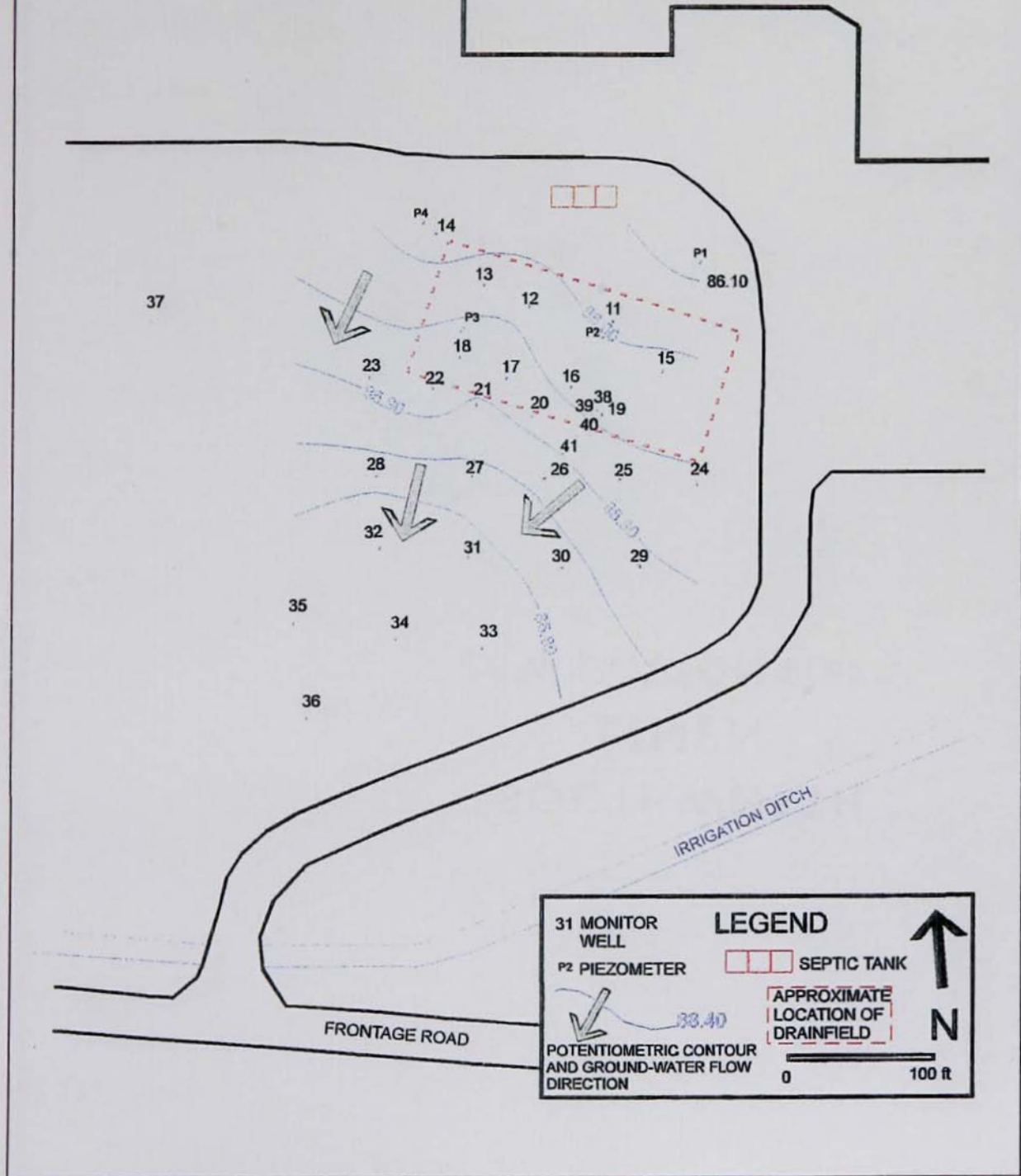
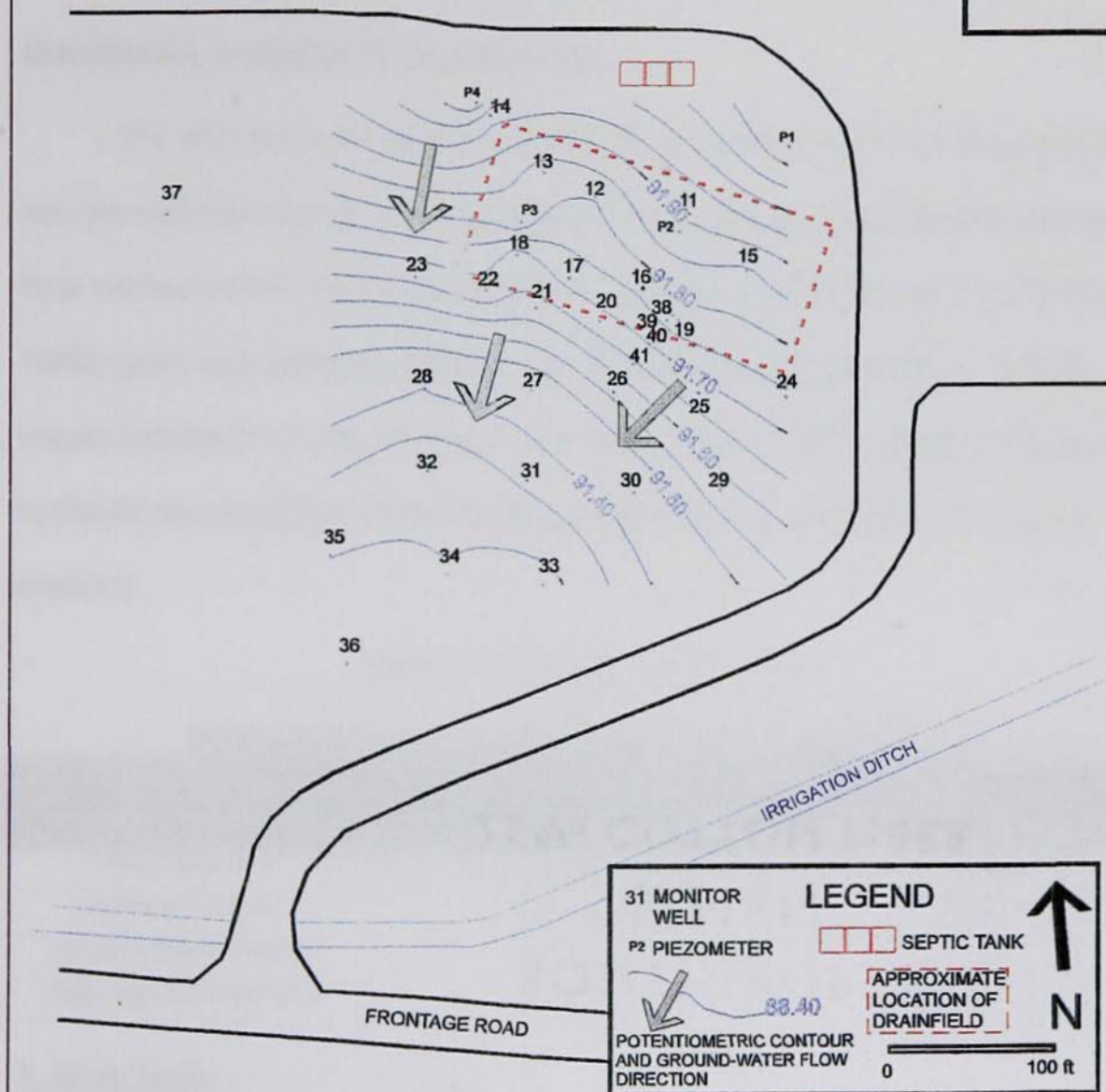


FIGURE 12
POTENTIOMETRIC
CONTOUR MAP
AUGUST 21, 1995



water table, the general direction of ground-water flow at the site is consistently to the south-southwest. The maps indicate a slight mound of groundwater in the vicinity of wells M17 and M21, possibly a function of recharge from the septic drainfield and/or localized lower hydraulic conductivity.

Distribution of Hydraulic Conductivity

The distribution of values of hydraulic conductivity (K) throughout the site was derived from four sources: analysis of slug test data using the Bouwer and Rice method (1976); time-drawdown plot of pumping test data (Cooper-Jacob, 1946); grain size analyses (Hazen, 1911) and back-calculation from velocity values obtained from the bromide tracer test. Table 2 lists a range of values of hydraulic conductivity for the coarse gravels obtained using each of the four methods.

Table 2. Summary of Results:

Hydraulic Conductivity of Coarse Sands and Gravels		
Method and (Number of Analyses)	Range of Measured Hydraulic Conductivity (ft/day)	Average Hydraulic Conductivity (ft/day)
Slug Tests (37)	7-200	109
Pumping Tests (1)	675-1040	857
Bromide Tracer Test (1)	700-1000	750
Grain Size Analyses (21)	3-630	41

A. Slug Tests

Slug tests were conducted on a total of 11 monitor wells in November, 1995 when the shallow water table was within the coarse gravels. Calculated hydraulic conductivities ranged from 7 to 196 ft/day, with a mean value of 109

ft/day (Figure 13). It is expected that lower values of hydraulic conductivity obtained through slug tests at wells M15, M20 and M37 may be attributed to insufficient well development, or possibly irreparable disturbance to the formation incurred during drilling. The median and upper values seem more reasonable when compared to values found in the literature for similar sediments (Fetter, 1980).

B. Pumping Tests

Time-drawdown analyses of drawdown and recovery data collected during short-term, continuous discharge pumping test of well M19 yielded transmissivity (T) values ranging from 13,500 to 20,800 ft²/day, and storativity (S) values of 1.9×10^{-5} to 6.6×10^{-2} . Assuming a saturated thickness (b) of 20 ft, the calculated range of hydraulic conductivity values is 675 to 1,040 ft/day.

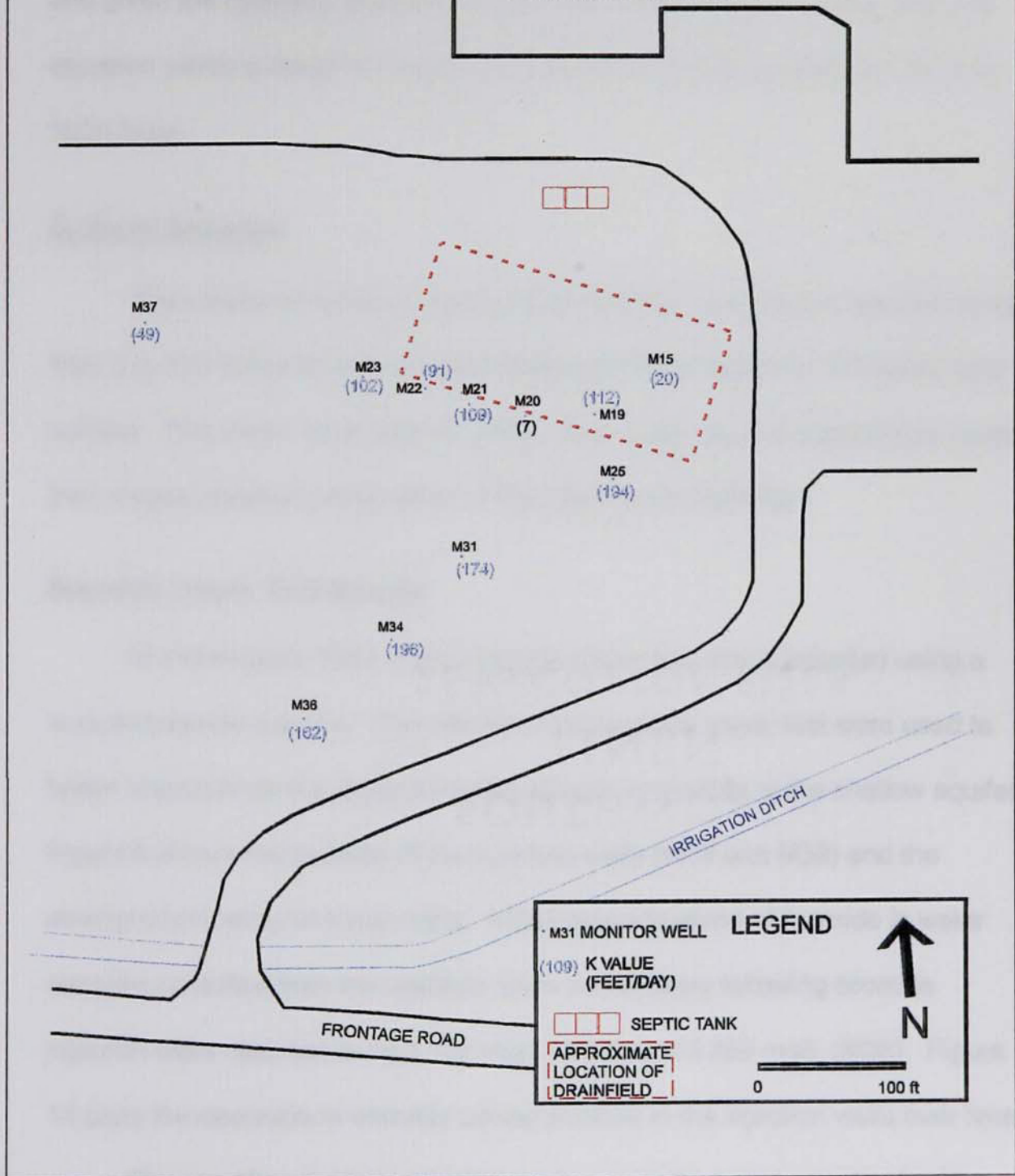
C. Bromide Tracer Test

Values of hydraulic conductivity can be back-calculated from groundwater velocity estimates determined from the bromide tracer test using the following equation:

$$V = (K(\Delta h / \Delta l)) / n$$

where: V = average linear velocity
K = hydraulic conductivity
 $\Delta h / \Delta l$ = gradient
n = average porosity

FIGURE 13
DISTRIBUTION OF
HYDRAULIC CONDUCTIVITY
FROM SLUG TESTS



The groundwater velocity (V) was estimated to range between 7 and 10 ft/day in the vicinity of the tracer well network. Assuming an average porosity (n) of 0.20 and given the hydraulic gradient ($\Delta h/\Delta l$) was 0.002 during the tracer test, the equation yields a range of hydraulic conductivity (K) values between 700 and 1000 ft/day.

D. Sieve Analyses

The values of hydraulic conductivity obtained using sieve analysis range from 3 to 630 ft/day for soil samples collected from a depth of 15 ft below land surface. The mean value was 41 ft/day. This mean value is significantly lower than values obtained using either of the other three methods.

Bromide Tracer Test Results

In mid-August 1995, a groundwater tracer test was conducted using a sodium bromide solution. The results of the bromide tracer test were used to better characterize the physical hydrogeologic properties of the shallow aquifer. Figure 6 shows the location of the injection wells (M19 and M38) and the downgradient array of tracer wells. Initial concentrations of bromide in water samples collected from the injection wells immediately following bromide injection were reported to be 4,130 mg/L (M19) and 5,250 mg/L (M38). Figure 14 plots the decrease in bromide concentrations in the injection wells over time.

Figures 15 and 16 are breakthrough curves for two transects of wells located 23 and 37 ft downgradient from the injection wells, (Transect 1 and

DECREASE IN BROMIDE CONCENTRATIONS INJECTION WELLS M19 AND M38

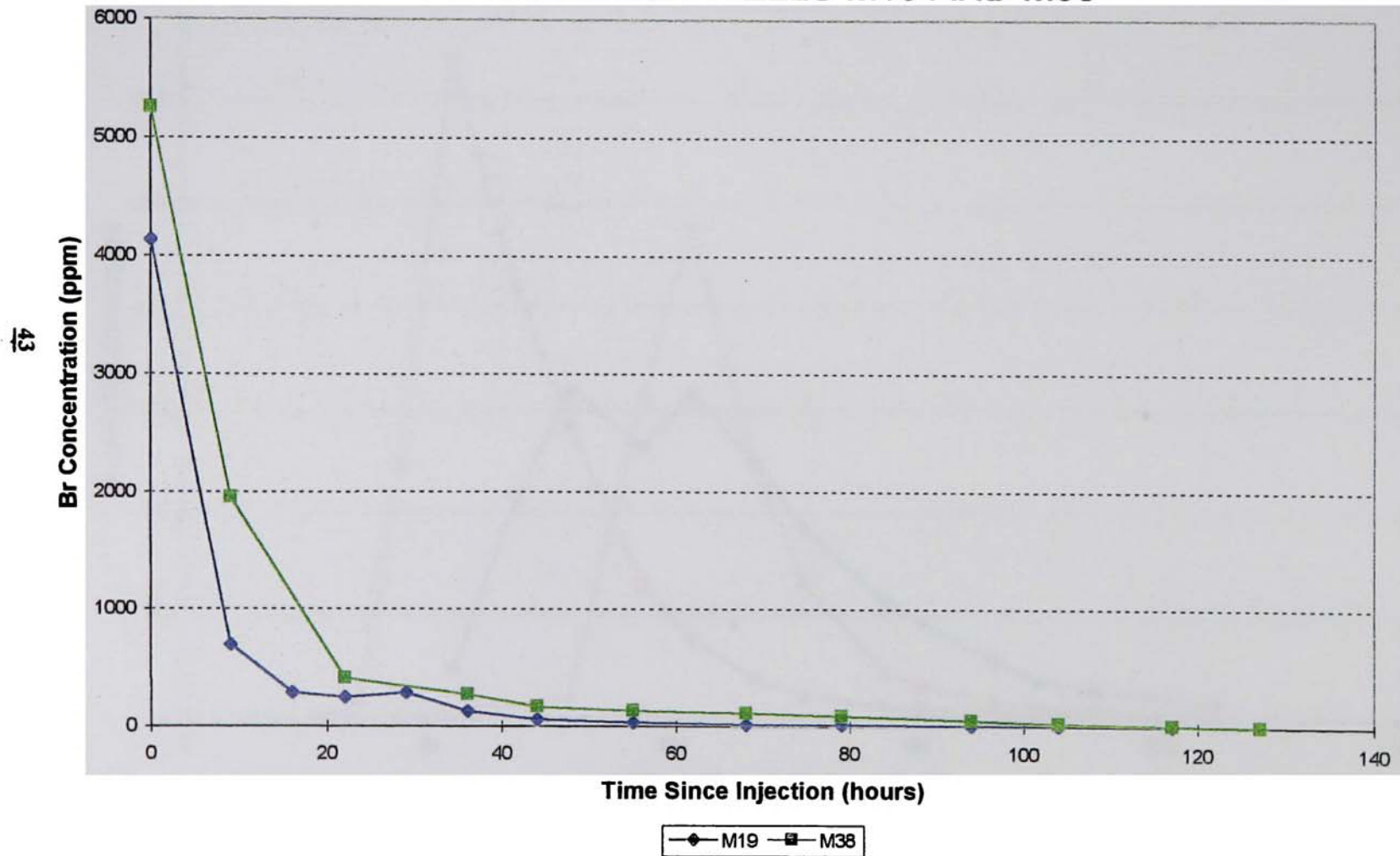


FIGURE 14

BROMIDE BREAKTHROUGH CURVES WELL TRANSECT 1 @ 23 FT DOWNGRADIENT

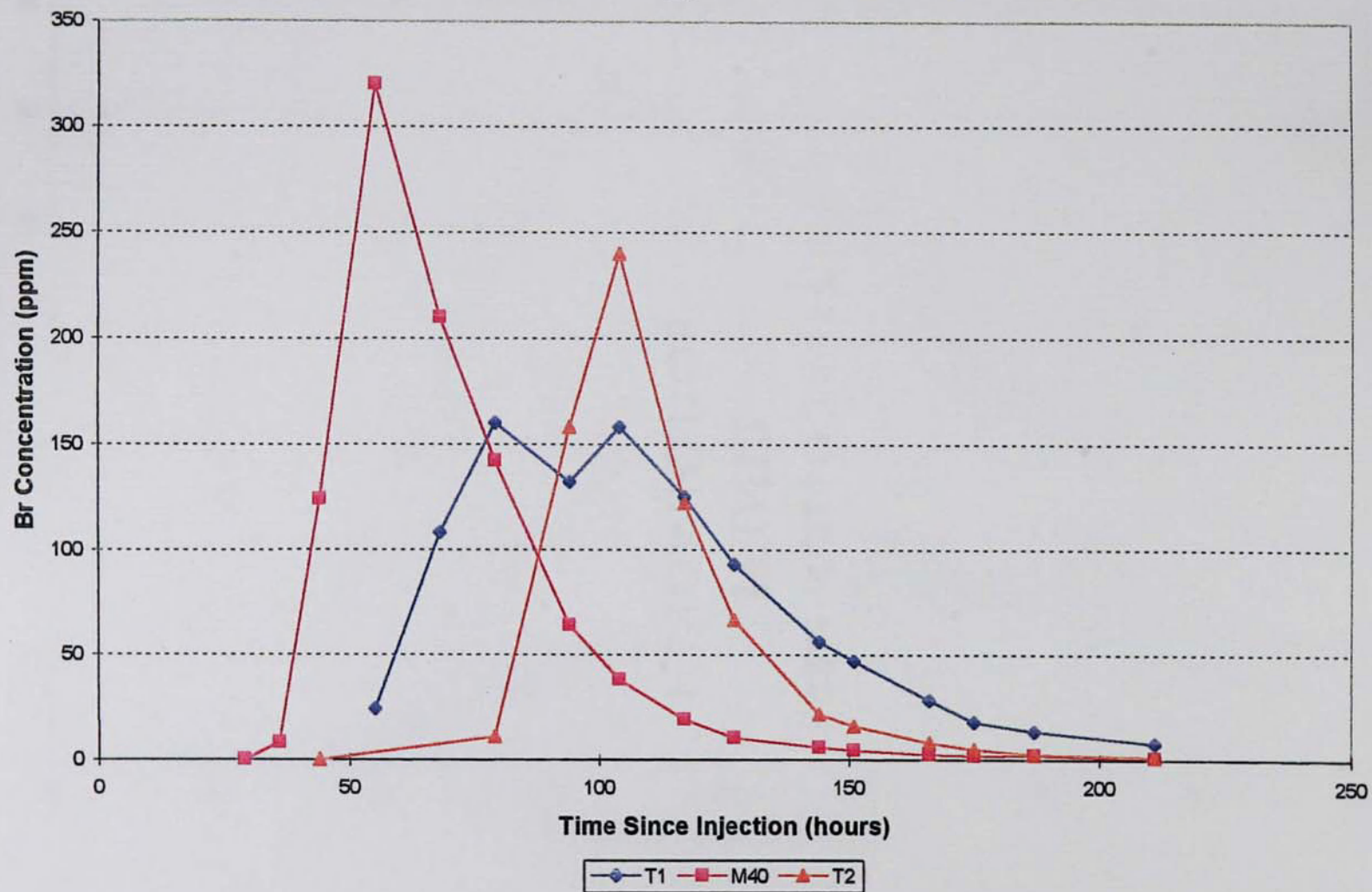


FIGURE 15

BROMIDE BREAKTHROUGH CURVES
WELL TRANSECT 2 @ 37 FT DOWNGRADIENT

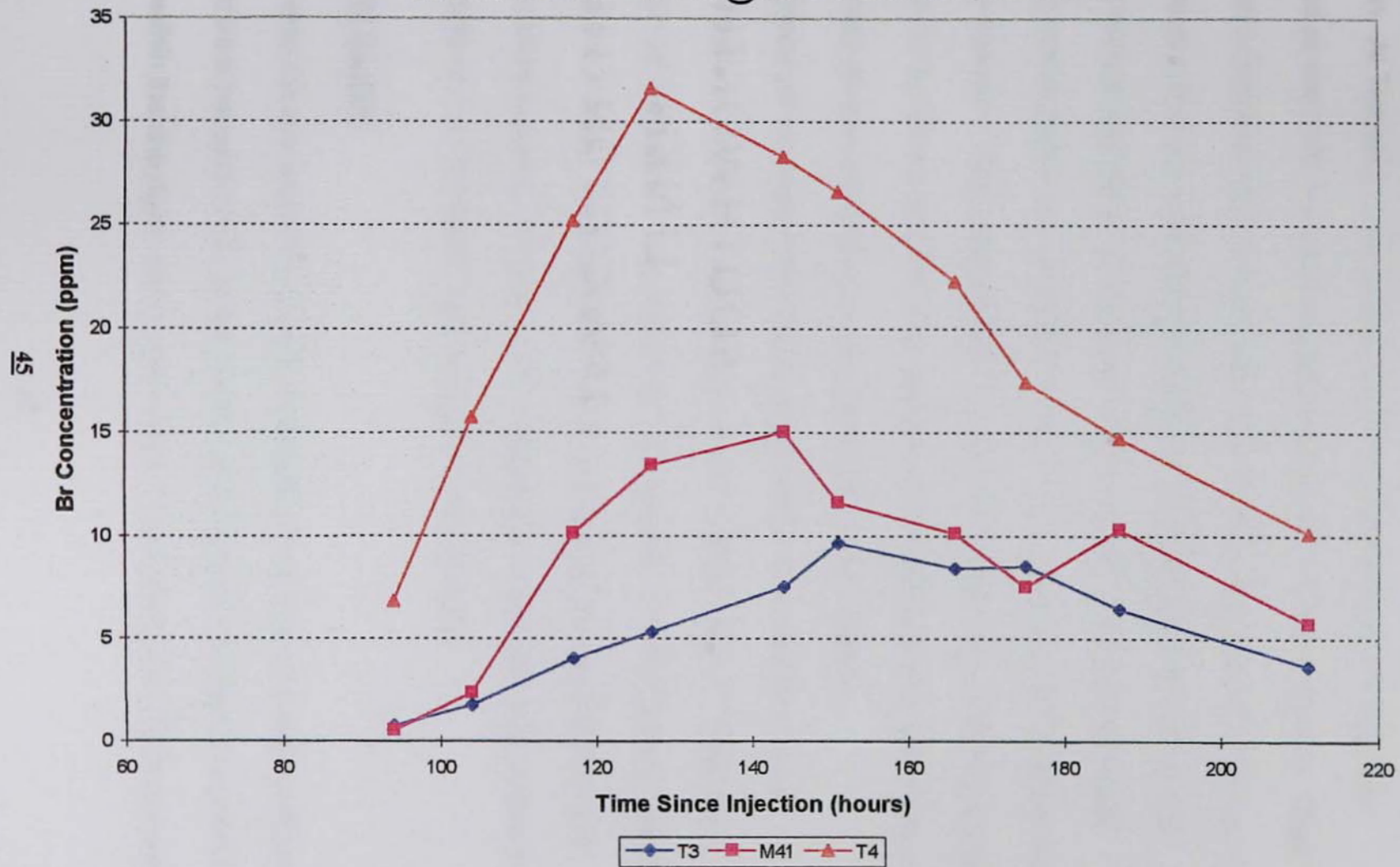


FIGURE 16

Transect 2, respectively). The breakthrough curves plot the measured concentration of bromide detected in wells as a function of time since tracer injection. At Transect 1, the greatest peak concentration of bromide was detected at well M40 in a water sample collected 55 hrs after injection. Peak exhibited a bimodal bromide peak; first at 79 hrs and then again at 104 hrs. It would appear from the data that the center of the main mass of the bromide passed through the center of Transect 1. At Transect 2, the greatest peak bromide concentration was detected at well T4 in a water sample collected 127 hrs after injection. Peak concentrations occurred in samples collected from wells M41 and T3 at 144 hrs and 151 hrs, respectively, suggesting the main mass of the bromide plume was moving to the west of the tracer network.

Based on the tracer test results, groundwater flow velocity from the injection wells to Transect 1 was approximately 10 ft/day, and 4.7 ft/day from Transect 1 to Transect 2. The calculated flow velocity from the injection wells to Transect 2 is 7 ft/day. As it appears that the tracer was exiting the tracer well network before reaching Transect 2, it is reasonable to estimate a groundwater flow velocity of 7 to 10 ft/day in the vicinity of the experiment.

3.2 Water Quality

Table 3 summarizes the results of inorganic analyses of a) septic effluent collected from the septic tank, b) the shallow groundwater sampled in well M15 located within the drainfield, and c) the shallow groundwater in background well

M37. The number of samples collected at each location are included in parentheses immediately next to the data. Complete inorganic water quality analytical data sets are included as Appendix H.

Table 3. Summary of Results: Inorganic Groundwater Chemistry

Analyte	Septic Effluent (Septic tank)	Well Screened beneath Drainfield (M15)	Background Well (M37)
Alkalinity-CaCO ₃ (mg/L)	226 - 398 (8)	68 - 292 (11)	170 - 194 (7)
Ammonium-N (mg/L)	11.8 - 74.8 (3)	1.1 - 23.1 (4)	<0.1 (4)
Chloride (mg/L)	13.8 - 50.0 (10)	13.8 - 42.9 (12)	2.3 - 3.9 (8)
Nitrate-N (mg/L)	<0.05 - 0.1 (10)	0.2 - 21.2 (12)	0.8 - 1.1 (8)
Phosphate (mg/L)	<0.5 - 7.6 (10)	<0.5 - 0.9 (12)	<0.5 (8)
Sulfate (mg/L)	0.8 - 10.0 (10)	8.4 - 16.2 (12)	16.0 - 20.4 (8)
Sodium (mg/L)	28.9 - 59.6 (10)	23 - 60.1 (8)	7.0 - 9.8 (7)
pH (units)	6.7 - 7.3 (10)	6 - 6.4 (8)	6.6 - 7.2 (6)
E.C. (microMohs/cm ²)*	525 - 843 (10)	323 - 790 (8)	311 - 375 (6)
Temperature (Celsius)**	13.3 - 21.8 (10)	8.5 - 12.2 (8)	6.4 - 11.7 (6)
TDS (mg/L)	230 - 420 (4)	210 - 292 (2)	161 (1)
Dissolved Oxygen (mg/L)	0.2 - 3.1 (8)	<0.1 - 3.0 (6)	3.4 - 6.4 (5)

* Electrical conductance corrected for 25° C

**The reported range of groundwater temperature includes measurement error. The mean annual temperature of groundwater at the FHS site is believed to be approximately 9 -11 degrees Celsius.

The background water quality of the shallow ground water in the vicinity of FHS is generally bicarbonate. It is relatively high in TDS, primarily due to phosphate. The water has a neutral pH, is oxygenated and has an average temperature of about 9 °C.

Inorganic Chemistry

Nitrogen in the septic tank occurs primarily in the form of ammonium at reported concentrations of 37.8 to 74.8 mg/L. Both nitrate (0.2 to 21.2 mg/L) and

ammonium (1.1 to 23.1 mg/L) were detected in groundwater beneath the septic drainfield (well M15). In the background well, nitrogen occurs as nitrate at concentrations consistently about 1 mg/L. Ammonium is not a significant form of nitrogen in the natural groundwater system. Chloride concentrations are elevated in the septic tank (13.8 to 50 mg/L) and the septic impacted groundwater in well M15 (13.8 to 42.9 mg/L) with respect to the background concentrations of 2 to 4 mg/L (well M37). Phosphate was generally not detected in the groundwater, but was present in the septic tank at concentrations ranging from 4.1 to 6.0 mg/L. Sulfate concentrations were highly variable in the tank, ranging from 0.8 to 10.0 mg/L. However, background sulfate concentrations in the groundwater were consistently between 8.4 and 20.4 mg/L. Sodium was the only cation reported to be significantly increased in the septic effluent (38.9 to 59.6 mg/L) and septic-impacted groundwater (23 to 60.1 mg/L) when compared to the background groundwater quality (7.0 to 9.8 mg/L).

Figures 17 through 21 depict the distribution of sodium, chloride and nitrate, ammonium and total nitrogen (nitrate + ammonium) concentrations in the shallow groundwater in the vicinity of the FHS septic system in May, 1996.

As shown in Table 3, ammonium concentrations are elevated in the septic tank with respect to the natural groundwater system. Unfortunately, few groundwater samples collected in the vicinity of the drainfield were analyzed for ammonium. Recognizing this gap in the data, attempts were made late in the study to document ammonium concentrations in the septic impacted

FIGURE 17
PLUME OF SODIUM-
IMPACTED GROUNDWATER
5/30/96

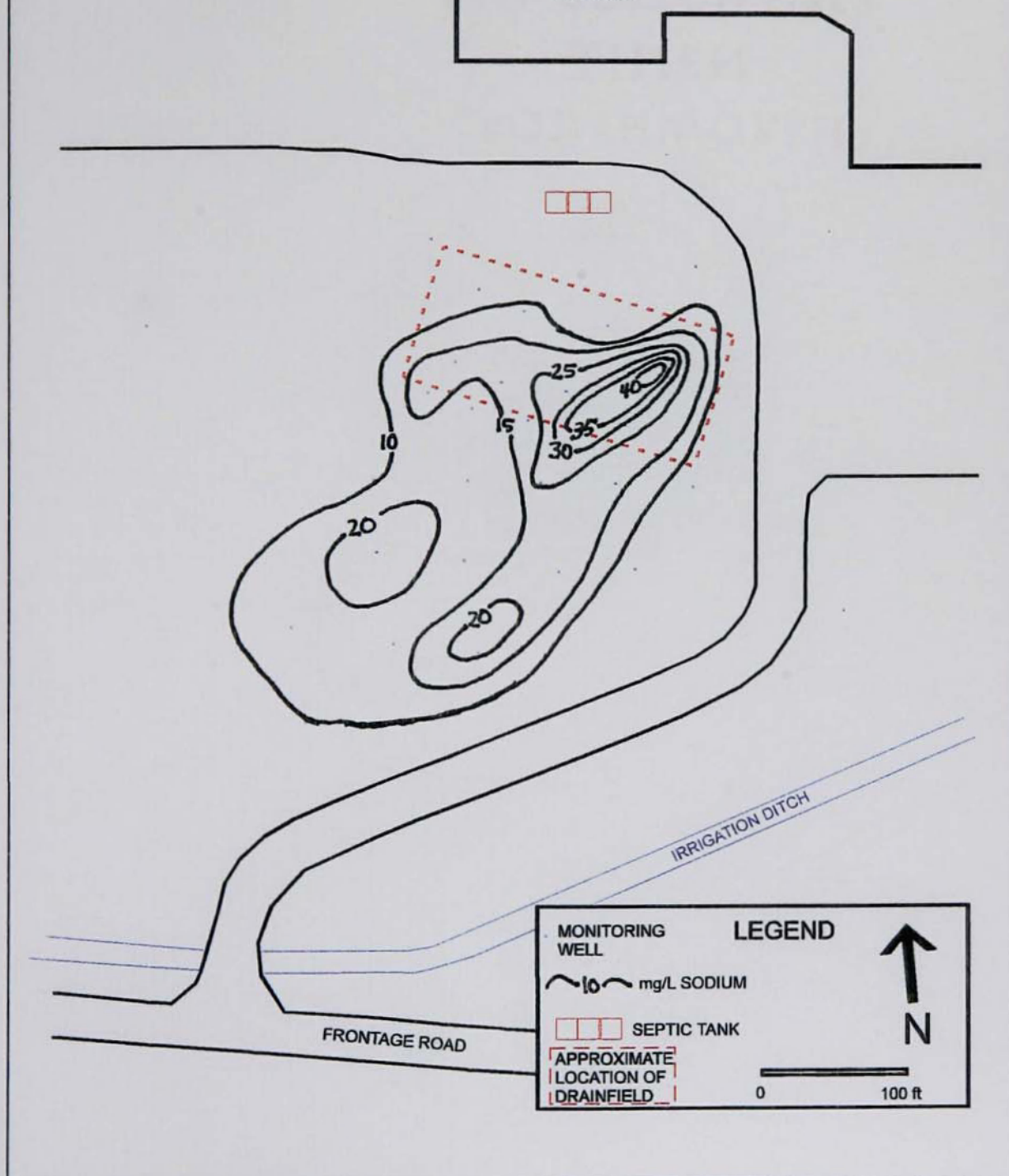


FIGURE 18
PLUME OF CHLORIDE-
IMPACTED GROUNDWATER
5/30/96

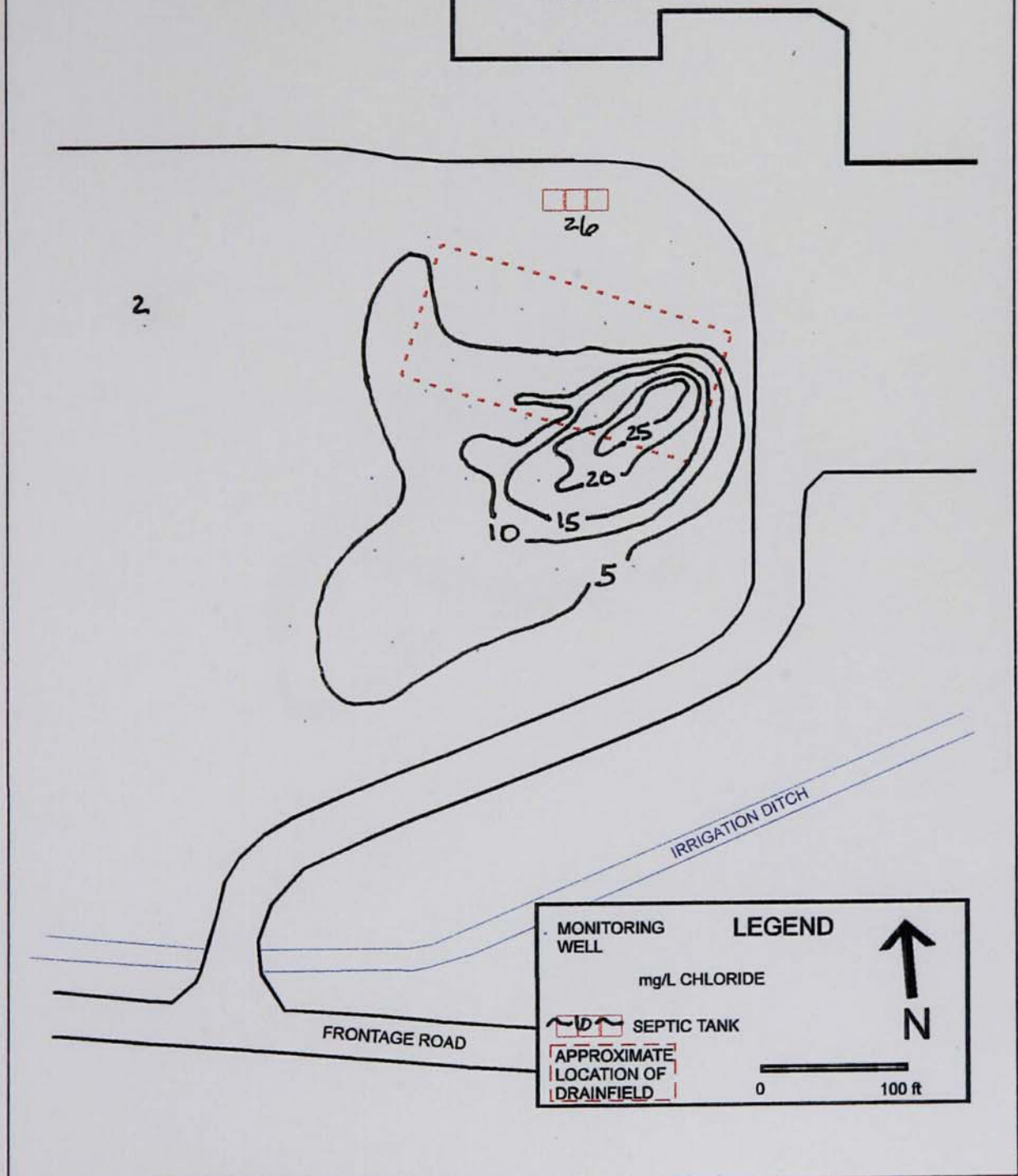


FIGURE 19
PLUME OF NITRATE (NO_3)
IMPACTED GROUNDWATER
5/30/96

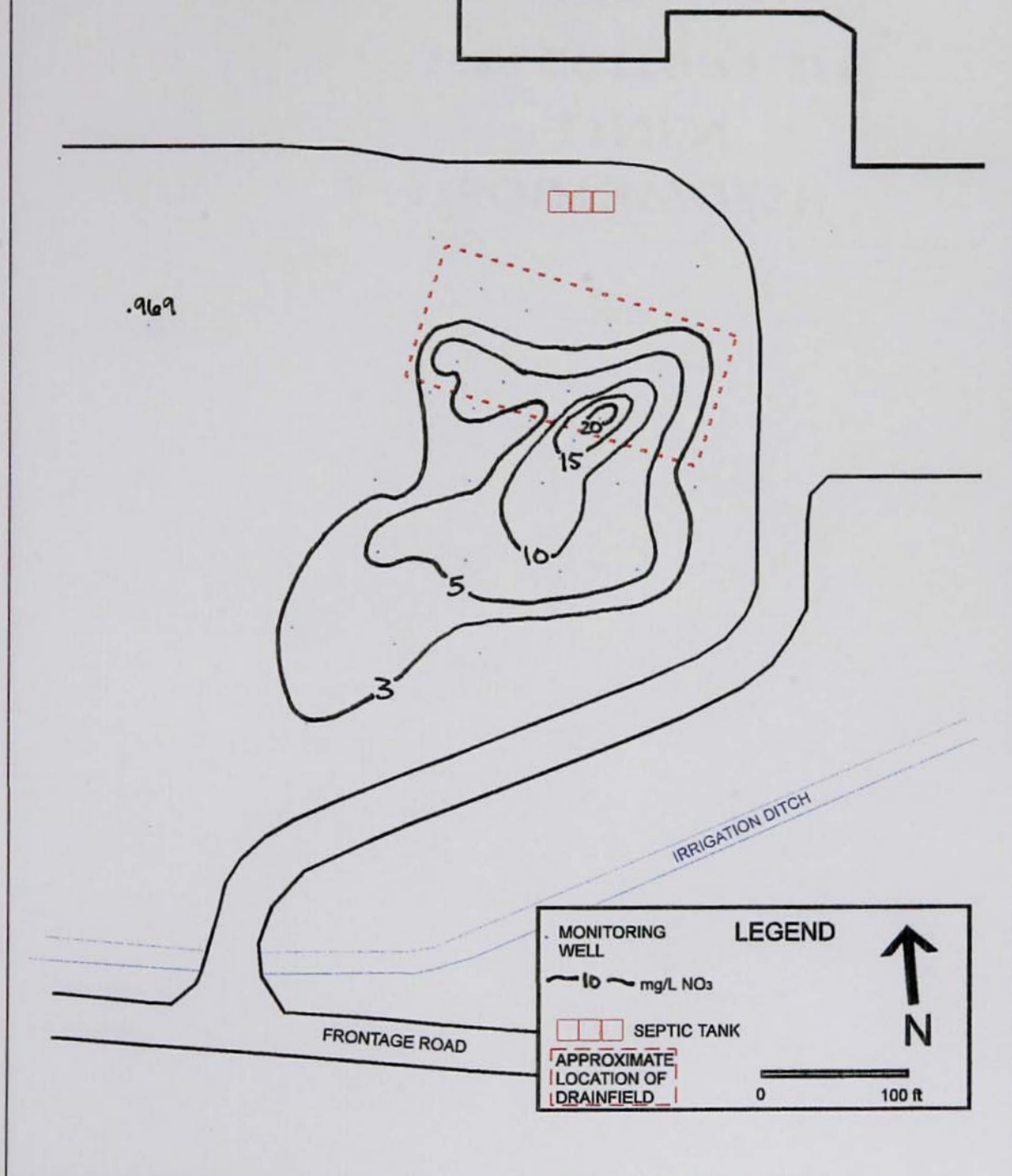


FIGURE 20
DISTRIBUTION OF AMMONIUM
(NH_4) IN GROUNDWATER
5/30/96

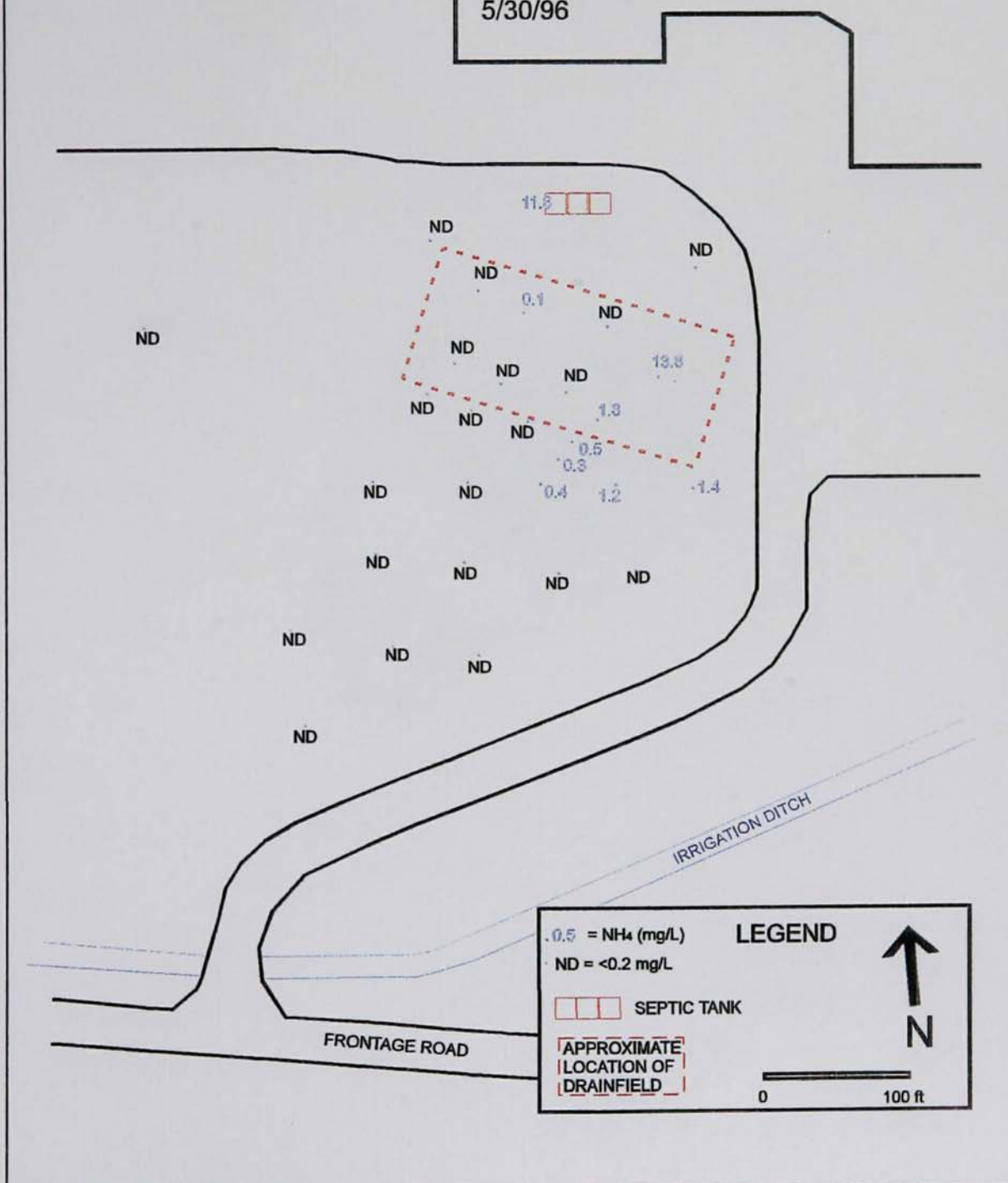
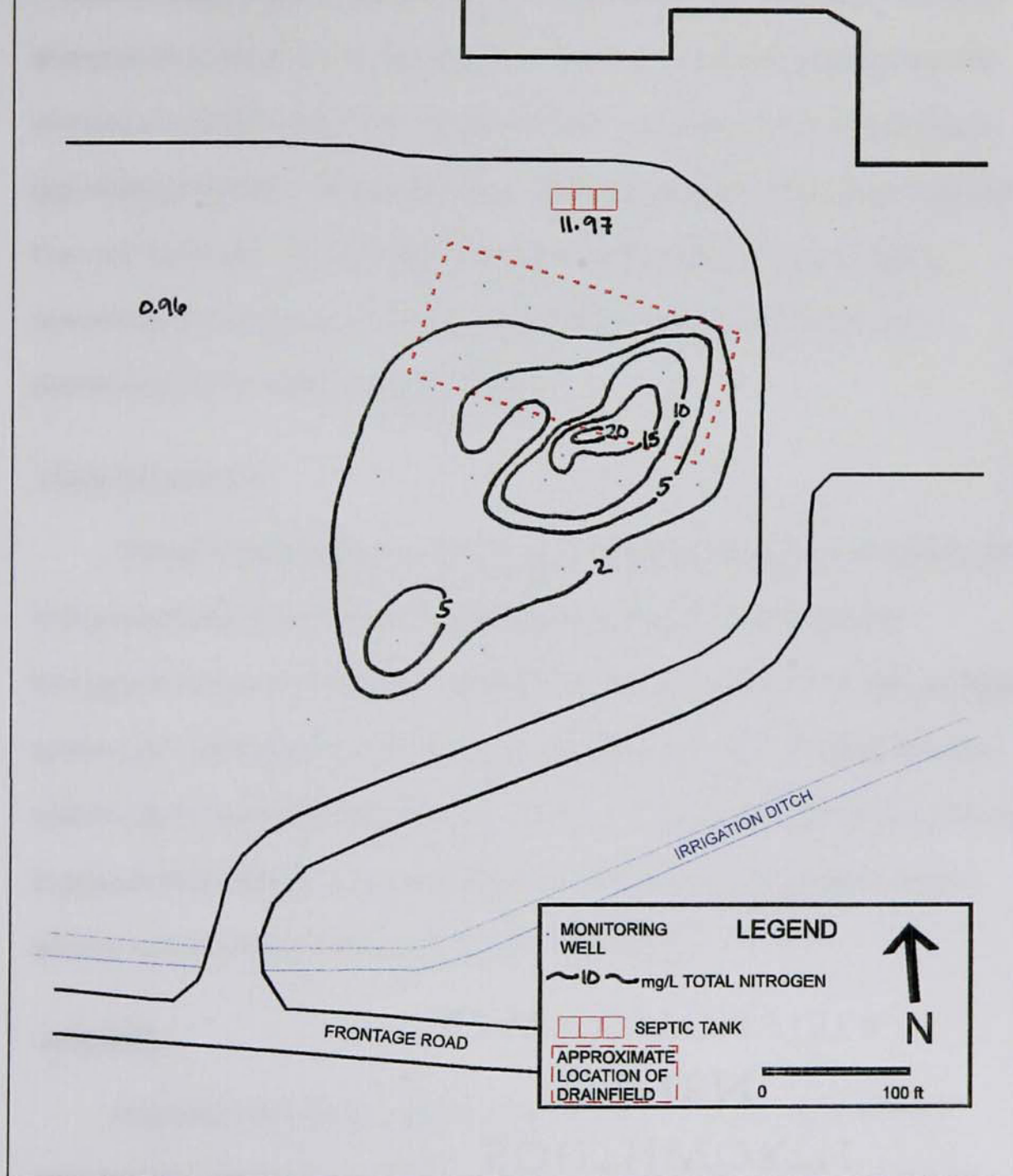


FIGURE 21
PLUME OF TOTAL NITROGEN
IN GROUNDWATER
5/30/96



groundwater. In October, 1995, samples of groundwater were collected and analyzed for the presence of ammonium using an ammonium specific electrode. A second round of groundwater samples were collected in late May, 1996 and analyzed for ammonium by spectroscopy, which proved more reliable than the ammonium specific electrode. Figure 22 plots concentrations of ammonium in groundwater samples collected in May, 1996 as a function of sampling distance from the drainfield. As expected, the data illustrates generally decreasing concentrations of ammonium in the groundwater downgradient from the drainfield and the origin of septic effluent.

Field Parameters

Values of temperature, pH, TDS, EC and DO measured in septic effluent and groundwater samples varied considerably spatially and temporally throughout the study (Table 3). Due to the buffering capacity of the groundwater system, pH, temperature and TDS were generally not useful in delineating the area of septic-impacted groundwater. However, measured values of EC and DO in groundwater appear to correlate with the presence of the inorganic plume issuing from the septic drainfield (Figures 23 and 24).

Alkalinity

Alkalinity (as CaCO_3) was detected in samples of the septic effluent collected from the septic tank at concentrations ranging from 226 to 398 mg/L. The average alkalinity concentration measured in the septic tank was 331 mg/L.

AMMONIUM CONCENTRATION IN GROUNDWATER
vs.
DISTANCE DOWNGRAIENT FROM DRAINFIELD

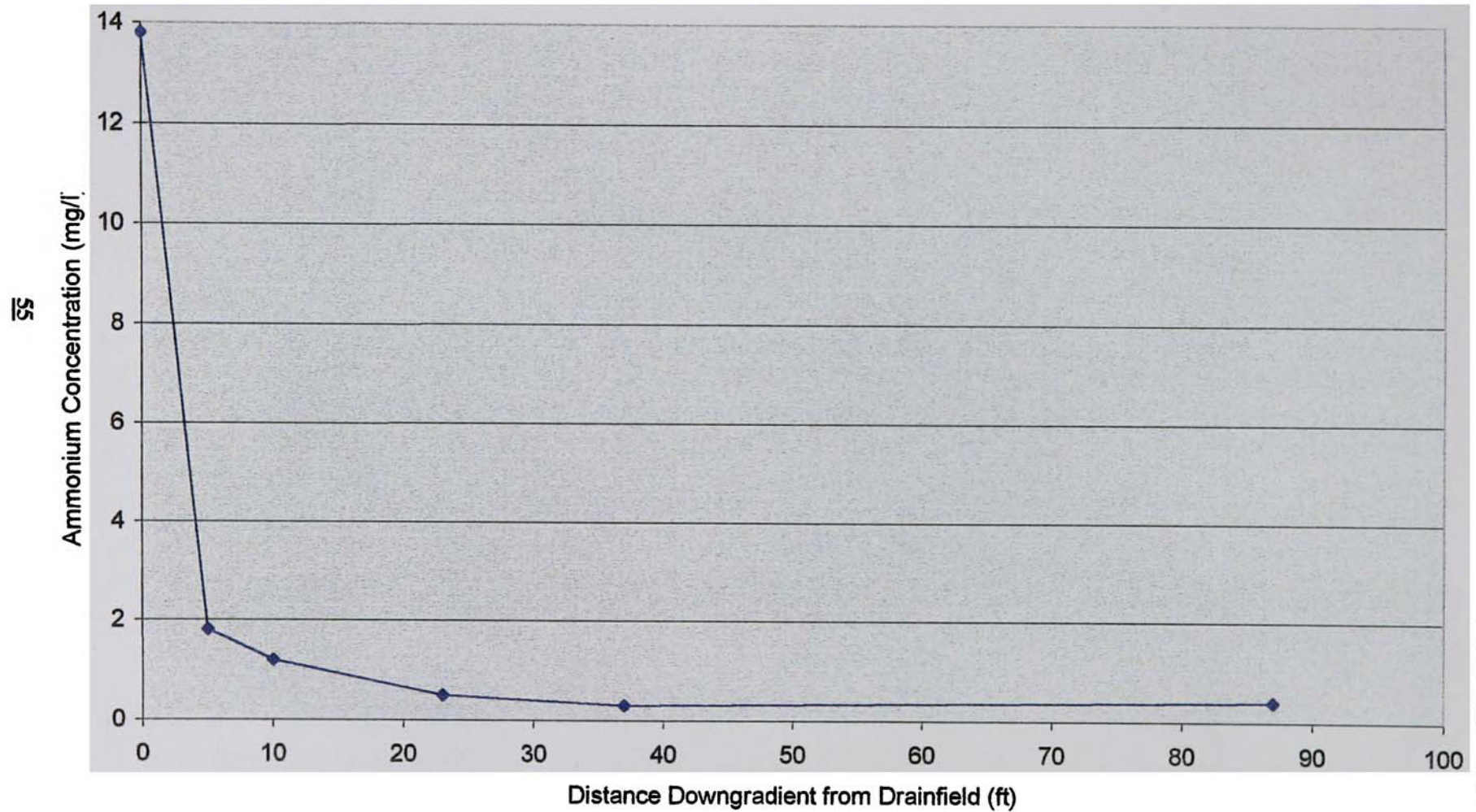


FIGURE 22

FIGURE 23
DISTRIBUTION OF ELECTRICAL
CONDUCTANCE IN GROUNDWATER
5/30/96

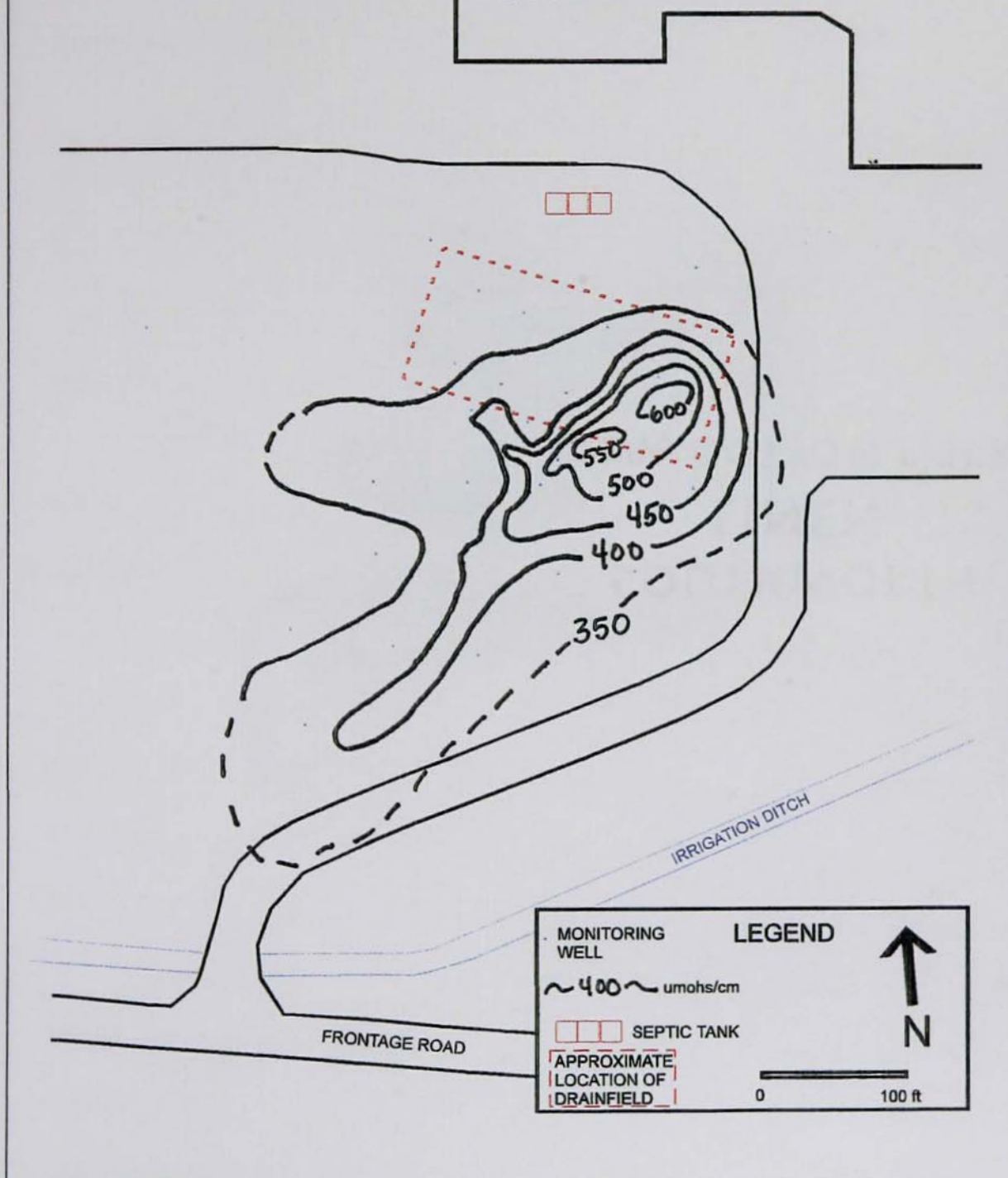
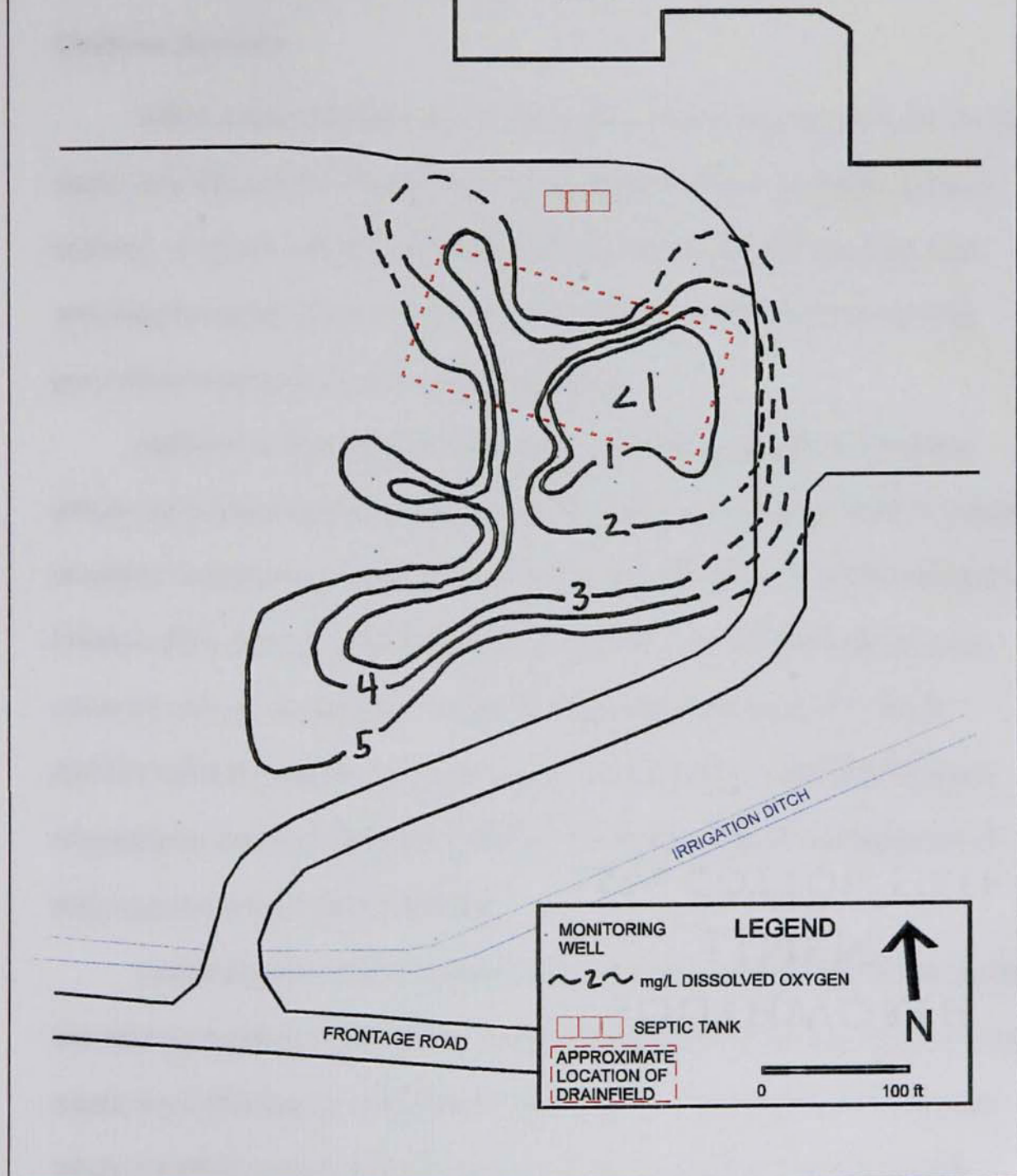


FIGURE 24
DISTRIBUTION OF DISSOLVED
OXYGEN IN GROUNDWATER
5/30/96



Background concentrations of alkalinity in the shallow groundwater measured in well M37 ranged from 170 to 194 mg/L, with an average alkalinity of 184 mg/L.

Coliform Bacteria

Water quality samples were collected of the shallow groundwater and the septic tank effluent and analyzed for the presence of fecal and total bacteria coliform. A total of 103 groundwater samples and 12 effluent samples were analyzed for fecal coliform. Total coliform analyses were performed on 153 groundwater samples and 14 effluent samples.

Attempts to quantify the distribution of coliform bacteria in the septic effluent and shallow groundwater were generally unsuccessful. Initial monitoring of coliform transport in the ground water system was done using the membrane filtration (MF) technique for coliform enumeration. Inconsistent results were obtained using three different media: m ENDO Broth MF and m FC Broth (DIFCO Laboratories) for the enumeration of total coliform and fecal coliform respectively, and m-ColiBlue24™ (HACH Company) used for the detection of both total and fecal coliform bacteria.

In subsequent testing of these three media and the MF technique against the most probable number (MPN) method, it was determined that none of these media were effective for the positive differentiation of coliforms in this system. While the MPN method was 100% accurate in identifying coliforms, the MF technique proved unreliable. The standard media used in the filtration method

are m ENDO and m FC. Approximately 20% of the positive isolates from these media proved to be either *Pseudomonas* spp. or *Bacillus* spp. The mColiBlue24™ was the least reliable, with 100% of the positive colonies selected for identification being *Bacillus* spp. In addition there was no growth on this medium when inoculated with samples from the tank even though all other media tested gave positive results at the same dilutions.

Figure 25 shows the well locations where total coliforms were detected in the shallow groundwater at any time during the course of the study. Figure 26 identifies well locations which tested positive for fecal coliforms at any time during the course of the study. Laboratory results of fecal and total coliform analyses are presented in Appendix I.

3.3 Endogenous Viruses

Coliphage

Coliphage were detected in all assays of 45 grab samples and 3 filtered 1-MDS samples of septic effluent collected from the septic tank from December, 1994 through September, 1995. Concentrations of male-specific coliphage found in the septic effluent were reported to range from 9.8×10^2 to 3.4×10^6 PFU/L, with a grand average of 674,000 PFU/L. Concentrations of somatic coliphage in the septic effluent ranged from 7.7×10^3 to 3.9×10^6 PFU/L, with a grand average of 466,000 PFU/L. Figure 27 shows the variation in reported

FIGURE 25
WELLS TESTING POSITIVE FOR
TOTAL COLIFORM (PFU/100ml)
5/30/96

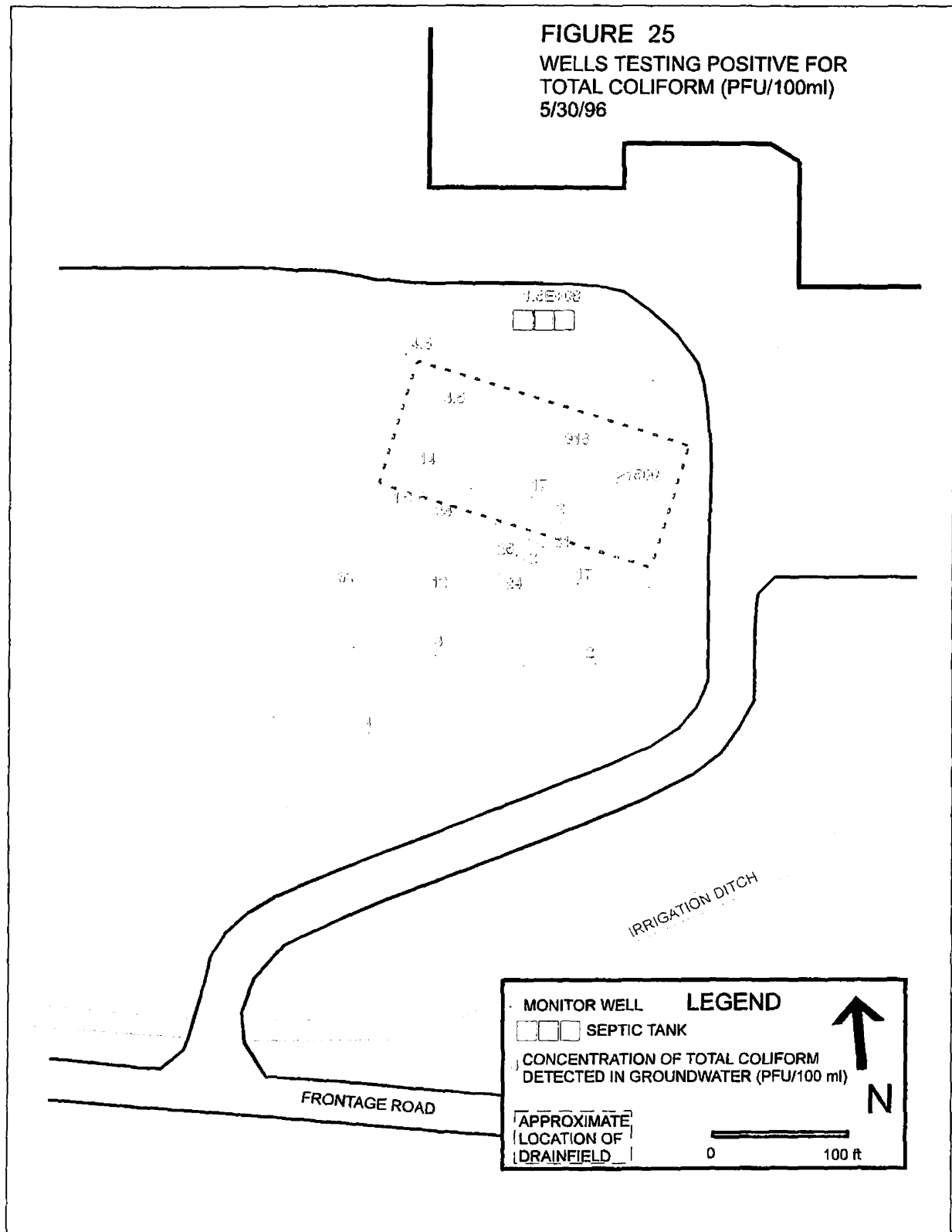
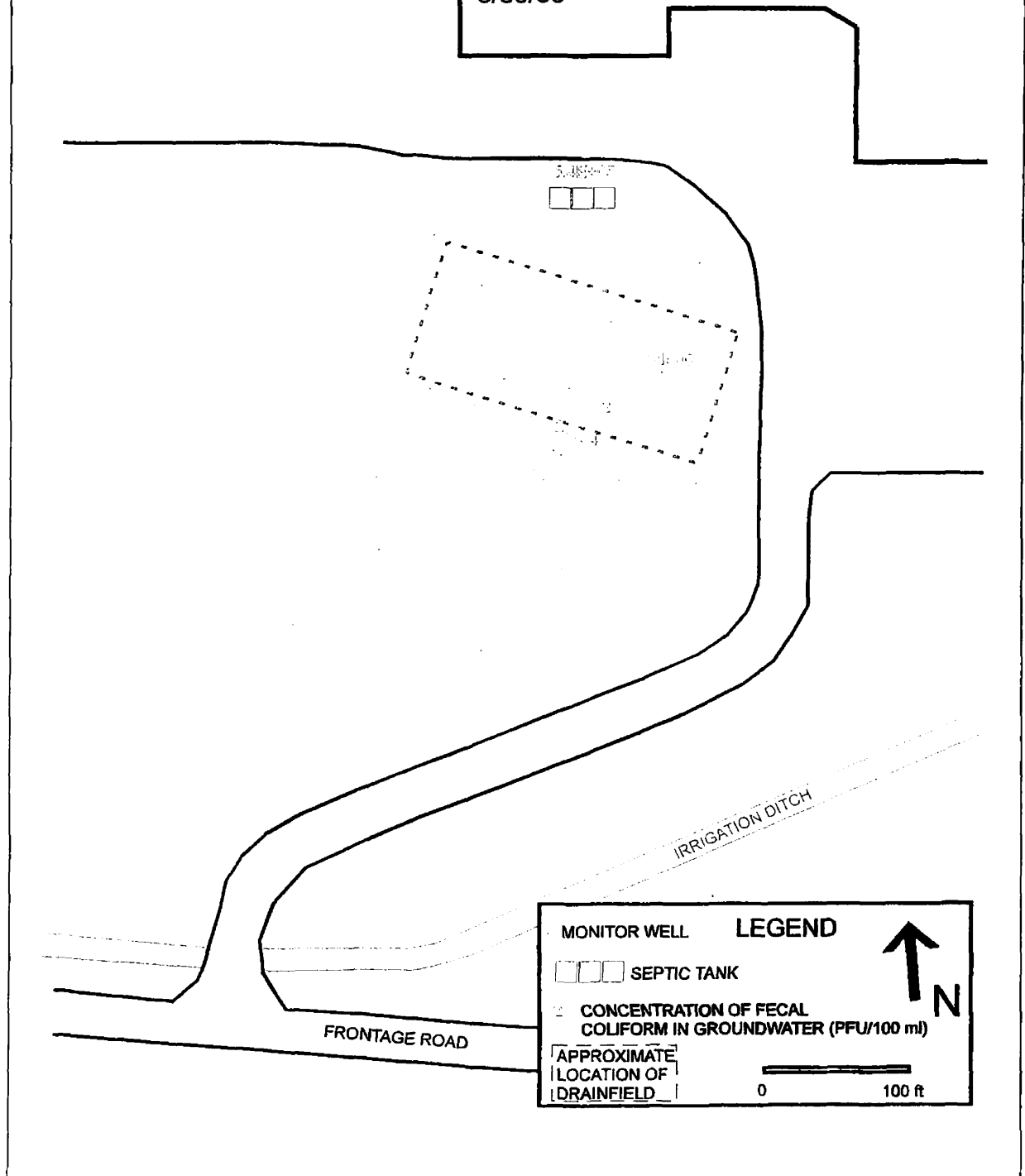


FIGURE 26
WELLS TESTING POSITIVE FOR
FECAL COLIFORM (PFU/100 ml)
5/30/96



VARIATION OF COLIPHAGE DETECTED IN THE FHS SEPTIC TANK DECEMBER 1994 TO JUNE 1995

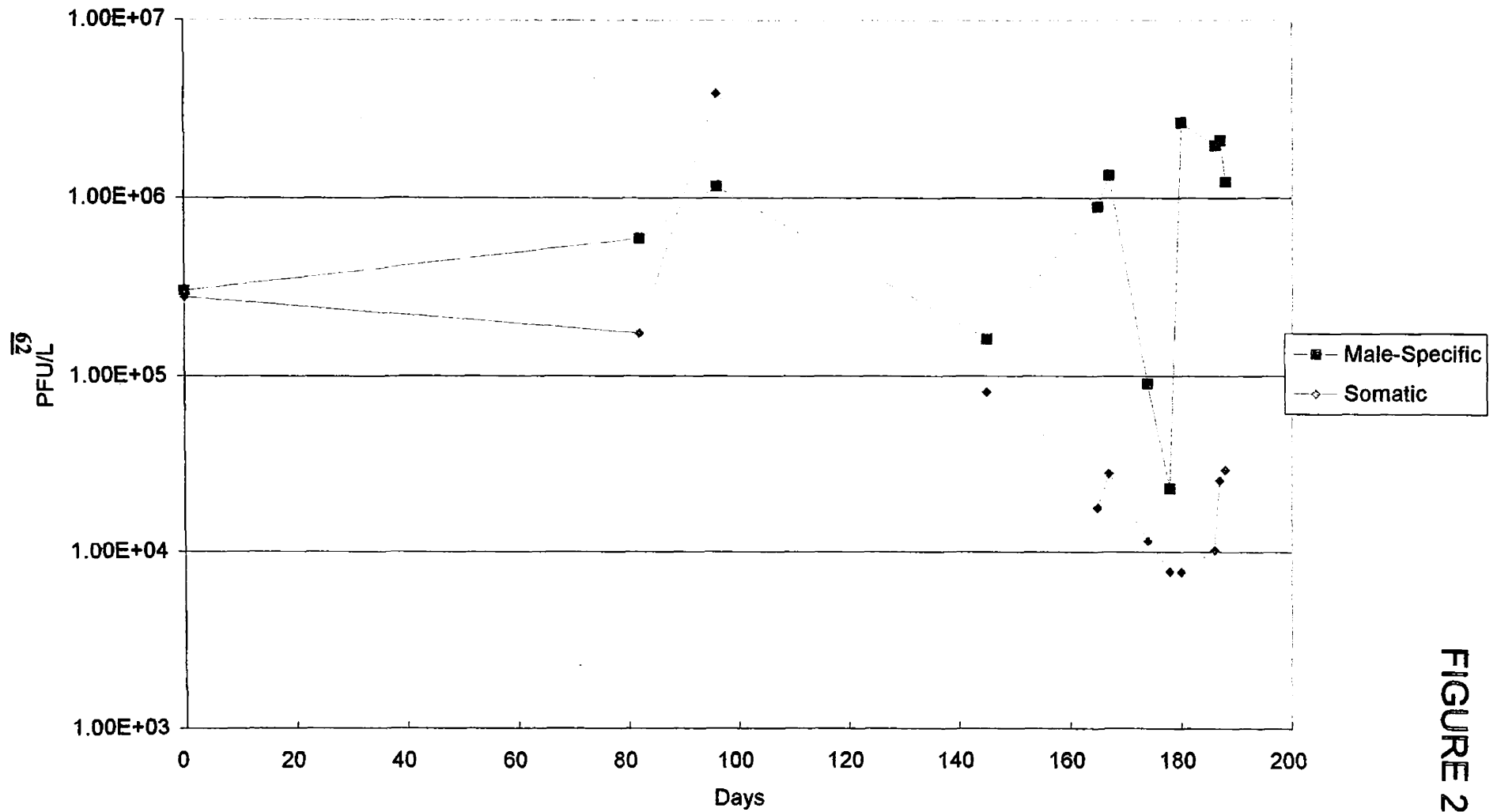


FIGURE 27

male specific and somatic coliphage populations in the septic tank from December 1994 to June 1995.

To document the short term variation of coliphage populations in the septic tank, samples of septic effluent were collected at least once a day during a 2-week interval from August 26 to September 8, 1995, (school resumed on August 30). Concentrations of both male-specific and somatic coliphage in the septic effluent were reported to increase by two orders of magnitude as school begins; male-specific coliphage concentrations increased from 2.6×10^4 to 3.4×10^6 PFU/L; somatic coliphage concentrations increased from 2.5×10^4 to 1.2×10^6 PFU/L.

From March 1, 1995 to May 30, 1996 a total of 108 grab samples of groundwater from 31 wells and 2 piezometers were collected and analyzed for the presence of male-specific and somatic coliphage using both plaquing and MPN techniques. Reported male-specific coliphage concentrations in groundwater ranged from a maximum of 56 PFU/ml (well M16) to a background minimum of <1 PFU in 3330 ml. Somatic coliphage concentrations ranged from 71.5 PFU/ml (well M16) to a background concentration of <1 PFU in 3330 ml. Table 4 summarizes the results of the ground-water coliphage sampling over the course of the study. Coliphage were detected in at least one groundwater sample collected from each of the wells which appear in bold print in Table 4. However, it is suspected that the initial coliphage sampling of monitoring wells

Table 4. Summary of Results: Coliphage in Groundwater

Well or Piezometer	Male-Specific Coliphage	Somatic Coliphage	Number of Samples
M11	<1 in 3330ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M12	<1 in 3330 ml to 5/ml	<1 in 3330 ml to 1/ml	3
M13	0.00066/ml to 29.5/ml	0.00066/ml to 45/ml	2
M14	0.00031/ml to <0.333/ml	<1 in 3330 ml to 0.5/ml	2
M15	0.9/ml to 20/ml	0.2/ml to 29/ml	13
M16	0.019/ml to 56/ml	0.018/ml to 71.5 /ml	12
M17	0.004/ml to 5/ml	0.0014/ml to 2.5/ml	2
M18	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M19	0.2/ml to 100/ml	0.2/ml to 23/ml	18
M20	0.0003/ml	0.005/ml	1
M21	<1 in 3330 ml to <1 in 3 ml	0.001/ ml to <1 in 3 ml	2
M22	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M23	<1 in 3ml	<1 in 3ml	1
M24	0.015/ml to <0.333/ml	0.002/ml to <0.333/ml	2
M25	0.009/ml to <0.333/ml	0.001/ml to <0.333/ml	2
M26	0.2 /ml to <1 in 1100 ml	0.0014/ml to <1 in 1100 ml	9
M27	0.003/ml to <0.333ml	0.083/ml to <0.333/ml	2
M28	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M29	<1 in 3330 ml to <1 in 3 ml	0.00031/ml to <0.333/ml	2
M30	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M31	<1 in 3330 ml to <1 in 3 ml	0.017/ml to <1 in 2000 ml	3
M32	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M33	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M34	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M35	<1 in 3330 ml to <1 in 3 ml	<1 in 3330 ml to <1 in 3 ml	2
M36	<1 in 3330 ml to 0.33/ml	<1 in 3330 ml to <1 in 3 ml	2
M37	0.00031/ml to <1 in 3ml	<1 in 3330 ml to <1 in 3 ml	3
M38	0.09/ml	0.1/ml	1
M39	0.03/ml	0.03/ml	1
M40	7.5/ml to 0.007/ml	0.007/ml to 0.009/ml	2
M41	14 in 3330 ml to 0.001/ml	0.006/ml to 0.001/ml	2
P1	<1 in 3330 ml to 0.33/ml	<1 in 3330 ml to <1 in 3 ml	2
P4	<1 in 3ml	<1 in 3ml	1

conducted March 1, 1995 may have yielded false positives due to contamination introduced during well drilling and construction.

On May 30, 1996, twenty-eight monitoring wells and 2 piezometers were sampled for the presence of both male-specific and somatic coliphage. Table 5 presents the coliphage results. Wells which tested positive for coliphage are shown in bold print. Figure 28 illustrates wells which tested positive for coliphage. Absolute values listed in the table represent direct counts obtained using plaquing techniques. Where a result of "< 1 in 3,330 ml" appears, it indicates MPN analysis was performed.

Human Enterovirus

A total of 7 samples of septic effluent were collected from the septic tank and assayed for human enterovirus. Enterovirus were isolated in two of seven samples collected of septic effluent in the septic tank. Both positives were collected using the 1MDS filtration apparatus. All other samples of the septic effluent tested negative for the presence of human enterovirus. Table 6 summarizes the results of sampling septic effluent for the presence of human enterovirus.

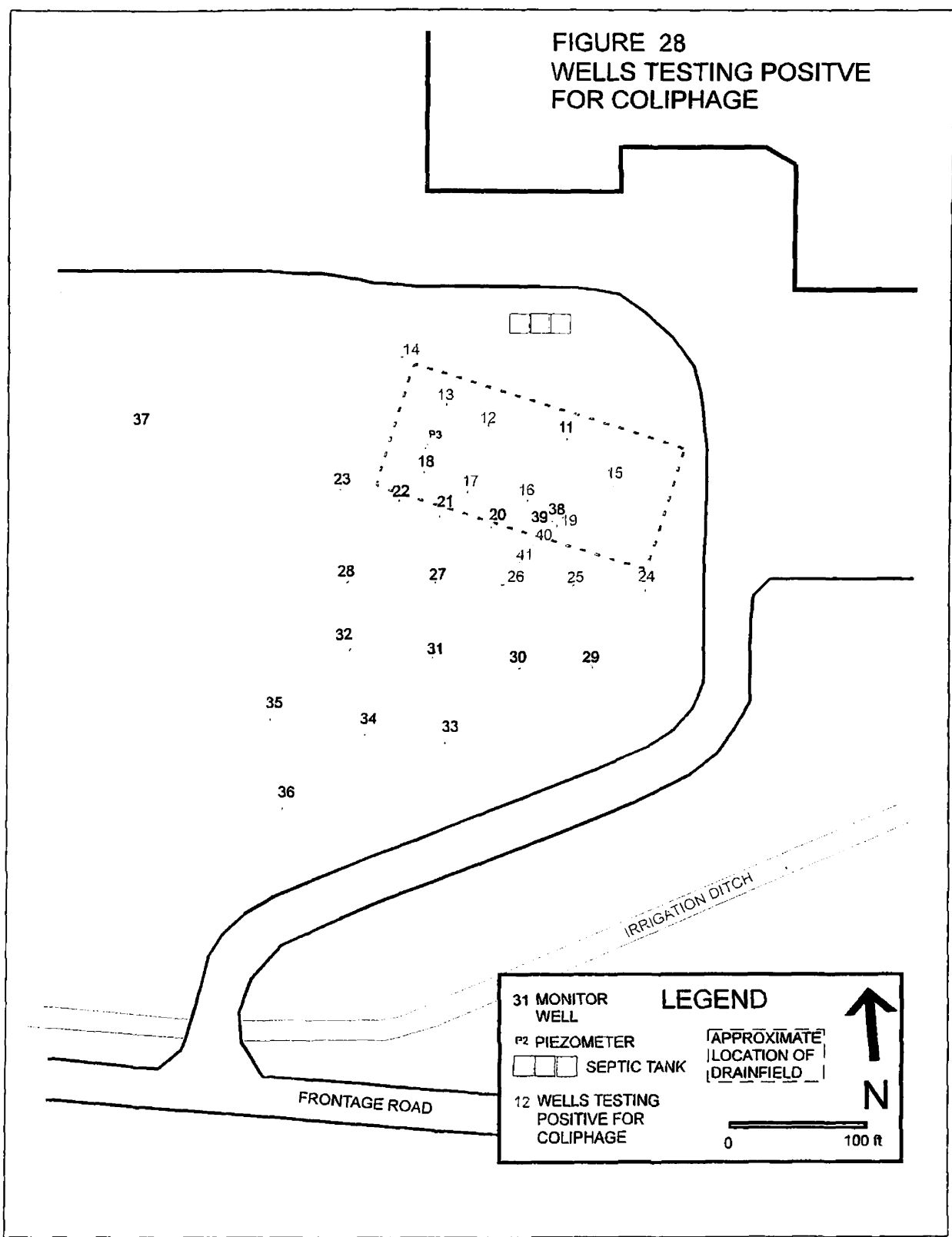
Wells M15, M16, M19, M25, M26, M31 and M37 were each sampled for human enterovirus using the 1MDS filtration apparatus. No enterovirus were detected

Table 5. Results of Groundwater Coliphage Sampling May 30, 1996

Well or Piezometer	Male-Specific Coliphage	Somatic Coliphage
M11	<1 in 3330 ml	<1 in 3330 ml
M12	<1 in 3330 ml	<1 in 3330 ml
M13	0.00066/ml	0.00066/ml
M14	0.00031/ml	<1 in 3330 ml
M15	20/ml	29/ml
M16	0.019/ml	0.018/ml
M17	0.004/ml	0.0014/ml
M18	<1 in 3330 ml	<1 in 3330 ml
M19	100/ml	23/ml
M20	0.0003/ml	0.005/ml
M21	<1 in 3330 ml	0.001/ml
M22	<1 in 3330 ml	<1 in 3330 ml
M23	N.A.	N.A.
M24	0.015/ml	0.002/ml
M25	0.009/ml	0.001/ml
M26	0.2/ml	0.0014/ml
M27	0.03/ml	0.083/ml
M28	<1 in 3330 ml	<1 in 3330 ml
M29	<1 in 3330 ml	0.00031/ml
M30	<1 in 3330 ml	<1 in 3330 ml
M31	<1 in 3330 ml	0.017/ml
M32	<1 in 3330 ml	<1 in 3330 ml
M33	<1 in 3330 ml	<1 in 3330 ml
M34	<1 in 3330 ml	<1 in 3330 ml
M35	<1 in 3330 ml	<1 in 3330 ml
M36	<1 in 3330 ml	<1 in 3330 ml
M37	0.00031/ml	<1 in 3330 ml
M38	N.A.	N.A.
M39	N.A.	N.A.
M40	7.5/ml	0.007/ml
M41	14/ml	0.006/ml
P1	<1 in 3330 ml	<1 in 3330 ml
P4	N.A.	N.A.

N.A. = Not Analyzed

FIGURE 28
WELLS TESTING POSITIVE
FOR COLIPHAGE



**Table 6. Summary of Results: Human Enterovirus Detected
in Septic Effluent**

Sample Date	Collection Method	Volume (liters)	Results	
			MPN	Plaquing
9/13/94	1MDS Filtration	140	4.42 virus/L	N.A.
12/9/94	1MDS Filtration	180	N.A.	None in 45 L
12/9/94	grab sample	1	N.A.	None in 0.26 L
3/15/95	1MDS Filtration	342	None in 134 L	None in 134 L
6/1/95	1MDS Filtration	95	N.A.	None in 31 L
6/7/95	1MDS Filtration	90	0.25 virus/L	N.A.
6/7/95	grab sample	1	None in 0.38 L	N.A.

Table 7. Summary of Results: Human Enterovirus in Groundwater

Well	Date	Volume Filtered (Liters)	Results	
			MPN	Plaquing
M15	3/15/95	1927	None in 733 L	None in 733 L
M16	3/1/95	726	None in 1429 L	N.A.
M19	5/31/95	1941	N.A.	None in 638 L
M25	3/15/95	2139	None in 823 L	None in 823 L
M26	3/1/95	603	None in 247 L	None in 82 L
M31	8/1/95	2709	None in 1440 L	N.A.
M37	8/1/95	2635	None in 1496 L	N.A.

in groundwater filtered at any of the FHS monitoring wells above a detection limit of approximately 1 virus/2,000 liters. Table 7 summarizes those sampling events.

4.0 DISCUSSION

4.1 Source History Complexities

The primary purpose of the site characterization was to investigate the shallow groundwater system in the vicinity of the FHS septic drainfield in order to identify the hydrogeologic and geochemical factors that might influence the occurrence and transport of viruses in groundwater. While the investigation was successful in characterizing several such aspects of the site, it also revealed inherent heterogeneities and complexities of the site and the septic disposal system which complicate the ability to identify factors controlling virus occurrence and transport in the shallow groundwater system.

The heterogeneities in the upper alluvium as described in Section 3.1 appear to be one reason for spatial variation in the delivery of septic effluent to the shallow groundwater. Analysis of nitrate, chloride and sodium water quality data consistently indicates that the plume of septic impacted groundwater originates in the southeastern portion of the drainfield, in the vicinity of wells M15 and M19. This would suggest that the drainfield is delivering the majority of effluent to the eastern half of the drainfield. It is believed that percolation of effluent delivered to the western half of the drainfield, in the vicinity of wells M21 and M22, is being retarded by the presence of shallow, finer-grained soils.

Three pieces of evidence support this interpretation. Firstly, engineering drawings indicate that the north end of the drainfield is constructed with four

concrete distribution boxes within the drainline manifold to facilitate even distribution of effluent across the width of the drainfield. (The system is then designed to gravity feed effluent down the drainline laterals where much of the percolation is expected to occur at the southern end of the drainfield). Secondly, patterns of snowmelt observed during the winter months, and vegetation growth in the spring months, mimicked the position of the drainfield laterals and suggested effluent was being distributed to the entire drainfield. Lastly, sewage was occasionally observed to surface in the northwest corner of the drainfield, probably indicating a backup of the system in the extremities of the western drainlines. Thus, it is likely that the finer-grained soils act to retard the downward migration of septic wastes, resulting in decreased impacts to groundwater quality beneath the western portion of the drainfield.

Another mechanism that affects the source history of septic effluent is the fluctuating water table, which provides for greater and lesser degrees of sewage treatment in the vadose zone. During the study, the depth of the shallow water table was observed to fluctuate by as much as 6 ft throughout the year, largely in response to the local irrigation schedule. The water table is the highest in July and August when comparatively little septic disposal occurs. As school resumes in September, irrigation is shut off and the water table declines, providing a greater vadose zone for septic waste treatment. The water table continues to decline until the Spring, when natural recharge and irrigation again cause the water table to rise. School recesses for the Summer and the cycle continues.

In addition to spatial variation in the distribution of septic effluent to the shallow groundwater caused by heterogeneities in the soils, temporal variation in the source history is introduced through the sporadic pumping schedule of the septic lift station. Pumping of effluent occurs as individual events dispersed throughout the day. Loading rates measured during the weekday, when school was in session, are nearly five times greater than those measured during the weekend. Also, loading rates are decreased when school is recessed nearly three months during the summer and about two weeks during the New Year. The erratic loading rate schedule suggests the septic source might be better conceptualized as numerous, irregularly spaced slug sources rather than a continuous source.

It is expected that the actual variation in wastewater chemistry would further complicate the source history. Analysis of the septic effluent and groundwater samples collected from well M15 (representing septic-impacted groundwater) confirms significant variation in the chemical composition of the septic effluent, and the resultant plume of septic-impacted groundwater. For instance, throughout the study, groundwater chloride concentrations ranged from <13.8 to 50 mg/L in the septic tank and 13.8 to 42.9 mg/L in groundwater collected at well M15. It is possible that more frequent sampling would have demonstrated even greater temporal variations in the chemistry of the septic effluent.

4.2 Aquifer Heterogeneity

Regardless of the source history, once septic effluent reaches the shallow groundwater, the transport of septic impacted groundwater will be controlled largely by the physical characteristics of the aquifer.

The top of the coarse sand and gravel unit is an irregular boundary occurring between a depth of 8 and 11 ft below land surface throughout the site. These sediments can be characterized as being uniformly more coarse than the overlying sediments. However, significant heterogeneity exists within the coarse sand and gravel system, both laterally and vertically, which adds heterogeneity to the aquifer system. This heterogeneity affects the distribution of septic impacted groundwater.

During the bromide tracer test, ground-water flow velocities were calculated to be approximately 10 ft/day within the first 23 ft of the tracer well network, between well M19 and well M40. During the same time period, and under similar gradients (.002), the calculated ground-water flow velocity decreased to 4.6 ft/day between well M40 and well T4, and 3.3 ft/day between wells T4 and T7. Such changes in ground-water flow velocities over a distance of 60 ft are likely to be related to varying values of hydraulic conductivity or, to a lesser extent, changes in porosity.

Slug test data appear to point to a range of hydraulic conductivities within the sand and gravel unit (7 to 196 ft/day). In general, it is likely that values of hydraulic conductivity obtained through slug tests performed in highly

transmissive aquifers may significantly underestimate the actual hydraulic conductivity because they do not adequately stress the aquifer. Additionally, slug tests are inherently limited because they only assess the character of the aquifer immediately adjacent to the well. Even in light of the limitations of slug tests, it can be said that each of the slug tests were comparable; they were all conducted using similar methods, on wells which were installed using the same method and of similar construction. This suggests that the spatial variations in hydraulic conductivity values determined from multiple slug tests conducted at numerous wells is real.

As stated in Section 3.0, estimated values of hydraulic conductivity derived from the sieve analyses were lower than estimates calculated from slug tests or back calculated from the bromide tracer experiment. These lower results may be explained by methodology (Swaren, 1995). The nested sieves ranged in mesh size from -1 to 4 phi, resulting in the exclusion of size fractions larger than coarse sand in the sieve analysis. (This omission is apparent when reviewing the bore logs completed during drilling.) Excluding gravels and pebbles from the sieve analysis decreases the d10 value, and effectively lowers the calculated value of hydraulic conductivity. In addition, the Hazen method is most applicable to sands (Fetter, 1994). Boring logs indicated that soils below 10 ft were predominantly sandy gravels, or gravelly sands. Therefore, the values of hydraulic conductivity obtained from sieve analysis should be viewed with skepticism.

Unfortunately, soil samples collected from drill cuttings at depths of 10 and 15 ft in well borings are not useful in observing variations in such sedimentary structures and stratigraphy which might cause changes in porosity and/or hydraulic conductivity values. Documenting variations in the sand and gravel unit was further complicated by the omitting the larger clasts in the grain size analysis, effectively ignoring grain size characteristics which could significantly affect aquifer transport properties.

4.3 Inorganic Plume

A plume of septic impacted water extends at least 300 feet downgradient from the drainfield. The plume is elongated and relatively narrow, indicating a point source which is being transported with the groundwater flow system. The plume is elevated in sodium, chloride, and total nitrogen (nitrate and ammonium). Of these constituents, nitrate is the primary health concern in drinking water supplies. At the source of septic impacted water, in the vicinity of well M15, concentrations of nitrate were found to be elevated well above background levels measured in well M37. However, as the plume disperses and is diluted downgradient, nitrate levels decrease and are only marginally above background levels at well M36, and well below regulatory standards for drinking water. Sodium and chloride, which are of lesser concern, are also diluted and dispersed downgradient. Identification of the plume was useful not only in characterizing the water quality conditions present in the vicinity of the drainfield,

but helped guide virus sampling efforts. The longitudinal axis of the plume also provided a logical location to construct the tracer well network and conduct the virus seeding experiment.

4.4 Absence of Human Enterovirus

The FHS was chosen as the study site for several reasons, one of the most important being that instrumenting a drainfield servicing a large population would improve the possibility of detecting human enterovirus in the septic system and shallow groundwater. Unfortunately, efforts to isolate virus from the septic tank were largely unsuccessful. There are a number of factors which might explain the inability to document the presence of enterovirus more frequently, or in greater numbers in the septic tank.

Firstly, the community of Frenchtown is a relatively closed population, and individuals may not be exposed to viruses as frequently as in a larger community. Additionally, human enterovirus would only be detected in the septic system if a sample were collected near the time when someone at FHS was infected and used the septic disposal system. Perhaps the timing of septic tank sampling events may not have been frequent enough to coincide with an occurrence of enterovirus. Another reasonable explanation is that an individual who was infected and feeling ill may not attend school.

Another limiting factor is the inability of human enterovirus to survive in the relatively inhospitable environment of septic wastewater in the septic tank.

Elevated effluent temperatures measured in the septic tank are not ideal for enterovirus survival. Also, viricidal chemicals and compounds, such as inorganic and organic cleaners, solvents and laboratory reagents are routinely discharged into the school's waste stream. Another possible explanation is that the school's water supply is chlorinated to a concentration of 0.5 mg/L. However, this is judged to be insignificant (verbal communication with Dr. Charles Gerba, April, 1995). All factors considered, the septic tank is considered a hostile environment for human enterovirus.

Finally, it has been demonstrated that the sampling efficiency of the 1MDS filtration method and subsequent assay is low, especially when used on septic effluent. Dr. DeBorde conducted experiments in which a known number of the attenuated polio virus was added to both unimpacted groundwater and to septic effluent and processed using 1MDS filtration and assay techniques. Enterovirus recovery was found to be 30 to 50% for unimpacted groundwater and less than 10% for septic effluent. It appears our ability to detect human enterovirus using 1MDS techniques may be limited.

Given the low numbers of enterovirus detected in the septic tank, it is not surprising that no enterovirus were detected in the shallow groundwater in the vicinity of the septic drainfield. The results of coliphage sampling indicate bacteriophage concentrations decreased by three orders of magnitude from the septic tank to the shallow groundwater beneath the drainfield. Assuming a similar fate of enterovirus, that same proportional reduction in enterovirus

populations associated with the septic disposal system would result in groundwater enterovirus concentrations of several orders of magnitude below 1MDS detection limits.

4.5 Endogenous Coliphage

Male-specific and somatic coliphage were found in the septic tank at similar average concentrations, on the order of 10^3 PFU/L to 10^6 PFU/L.

Samples of septic impacted water also assayed positive for coliphage, but at concentrations averaging 3 orders of magnitude less than in the septic tank.

Notably, there was a strong correlation between the location of the inorganic groundwater plume and the occurrence of endogenous coliphage; the highest concentrations of coliphage were associated with maximum concentrations of inorganic septic constituents.

Endogenous coliphage were regularly detected in groundwater samples of 4L or less collected from wells M19, M40, M41 and M26. These wells are located in the tracer well network; downgradient from the source of septic waste and within 37 ft of the drainfield. Larger sample volumes may have yielded positive assays of coliphage further downgradient.

Along this flowpath endogenous coliphage were reported to decrease in concentration at a rate of approximately 1 order of magnitude for every 15 ft of lateral transport. However, because of the complex source history of the septic

effluent, endogenous coliphage have limited use as indicators of rates of virus transport.

5.0 CONCLUSIONS

The FHS hydrogeologic site characterization provides the following conclusions:

- 1) The area of the FHS drainfield is underlain by heterogeneous sediments; fluvial sands and gravels. A shallow unconfined aquifer is present to a depth of roughly 30 ft. The position of the water table fluctuates between approximately 7 and 15 ft below land surface, largely in response to local irrigation practices. Hydraulic conductivity of the sandy gravel below a depth of 10 ft is estimated to be 800 ft/day. Ground-water flow is to south-southwest at an overall velocity of approximately 7 ft/day.
- 2) The FHS wastewater disposal system is a 20,000 ft² drainfield which receives approximately 3,000 gal of effluent per day during the school year. A plume of septic-impacted groundwater elevated in nitrate, chloride and sodium originates in the southeastern portion of the drainfield and extends downgradient from the drainfield at least 300 ft.
- 3) Fecal coliform bacteria were detected in the groundwater nearly 200 ft downgradient from the drainfield.
- 4) Human enterovirus were isolated in samples of septic effluent collected from the septic tank, although only sporadically and at low concentrations (< 6 viruses/ liter). No human enterovirus were detected in the shallow groundwater in the vicinity of the drainfield.

5) Male-specific and somatic coliphage were detected in the septic tank at average concentrations of 674,000 PFU/L and 466,000 PFU/L, respectively. Coliphage concentrations in the septic tank were observed to fluctuate by several orders of magnitude over short periods of time.

6) Average coliphage concentrations in the shallow groundwater were 3 orders of magnitude less than average septic tank concentrations. Coliphage were detected in the shallow groundwater system a maximum of 57 ft downgradient from the edge of the drainfield.

PART II COLIPHAGE SEEDING EXPERIMENT

On August 26, 1995, one week following the bromide tracer injection, a coliphage seeding experiment was begun within the tracer well network at the FHS site. The purposes of the experiment were to:

1. Document the horizontal transport and survival of coliphage in groundwater in this particular hydrogeologic environment, and
2. Relate the results of the coliphage seeding experiment to the results of the relatively conservative bromide tracer test in order to compare the transport of virus to the physical groundwater flow system.

6.0 METHODS

Immediately prior to seeding, groundwater samples were collected from wells M19, M38, M40, M41, and T7 to establish baseline coliphage concentrations. Baseline coliphage concentrations had been previously determined at wells M31 and M34. Wells T8, T9 and T10 were constructed after the seeding experiment commenced and no baseline coliphage data were collected.

Approximately 36 gal of well water was pumped from well M19 and used as the suspending medium for male-specific MS2 and somatic Φ X174 coliphage. Over a 20 min period, the seeding solution was siphoned back into the well at a depth of 12 ft below land surface; approximately 4 ft below the water table. The coliphage seed is considered a slug source. The water in the well casing was

surged for a short time using a PVC bailer. Samples were immediately taken of the well water in well M19 using a peristaltic pump. Initial concentrations of male-specific and somatic coliphage were assayed by plaquing and reported to be 1.06×10^9 PFU/ml and 1.12×10^8 PFU/ml, respectively.

Samples of groundwater were collected from wells in the tracer well network for a total of 33 days following seeding using a peristaltic pump and dedicated sampling equipment as described in Section 2.4. Sample sizes ranged from 100 to 1250 ml. Field measurements of pH, temperature, electrical conductance and dissolved oxygen were recorded. Samples were also collected for fecal and total coliform as described in Section 2.4. All water quality samples were labeled and stored on ice for immediate transport to the analytical laboratory.

An attempt was made to document the rate of survival of the seeded coliphage under the conditions present in the injection well. Two 30 ml Oakridge centrifuge tubes were filled with water collected from the injection well immediately after seeding. One tube was sealed with a rubber stopper and used as a control. The other was equipped with a dialysis membrane which allowed free chemical exchange between the seed water in the tube and the water in the well. The tubes were suspended below the water table in injection well M19. Over the course of the seeding experiment, 0.5 ml samples were periodically collected from the vials using a sterile syringe and analyzed for the presence of male-specific and somatic coliphage. A second sample of the seeded

groundwater in well M19 was held in the laboratory at 4°C and assayed for male-specific and somatic coliphage periodically throughout the seeding experiment.

All coliphage and coliform water quality samples were analyzed by The University of Montana DBS as described in Section 2.5 .

7.0 RESULTS OF COLIPHAGE SEEDING EXPERIMENT

One consideration in quantifying coliphage concentrations during the tracer experiment was the presence of resident, or endogenous coliphage populations within the shallow groundwater system. Figure 29 compares the levels of endogenous male-specific and somatic coliphage documented to be present in the system in the vicinity of the tracer well network (wells M19, M40, M41 and T7) to maximum concentrations observed in those wells during the coliphage seeding experiment. It can be seen that the levels of both male-specific and somatic coliphage introduced into injection well M19 were 6 to 10 orders of magnitude greater than endogenous coliphage concentrations. Maximum observed coliphage concentrations observed in tracer wells during the seeding experiment were also several orders higher than the levels of endogenous populations. It seems logical that the seeding experiment was not biased by the presence of resident coliphage.

It is interesting to note that similar concentrations of endogenous populations of somatic and male-specific coliphage were found in the shallow

COMPARISON OF ENDOGENOUS AND SEEDED COLIPHAGE IN TRACER WELL NETWORK

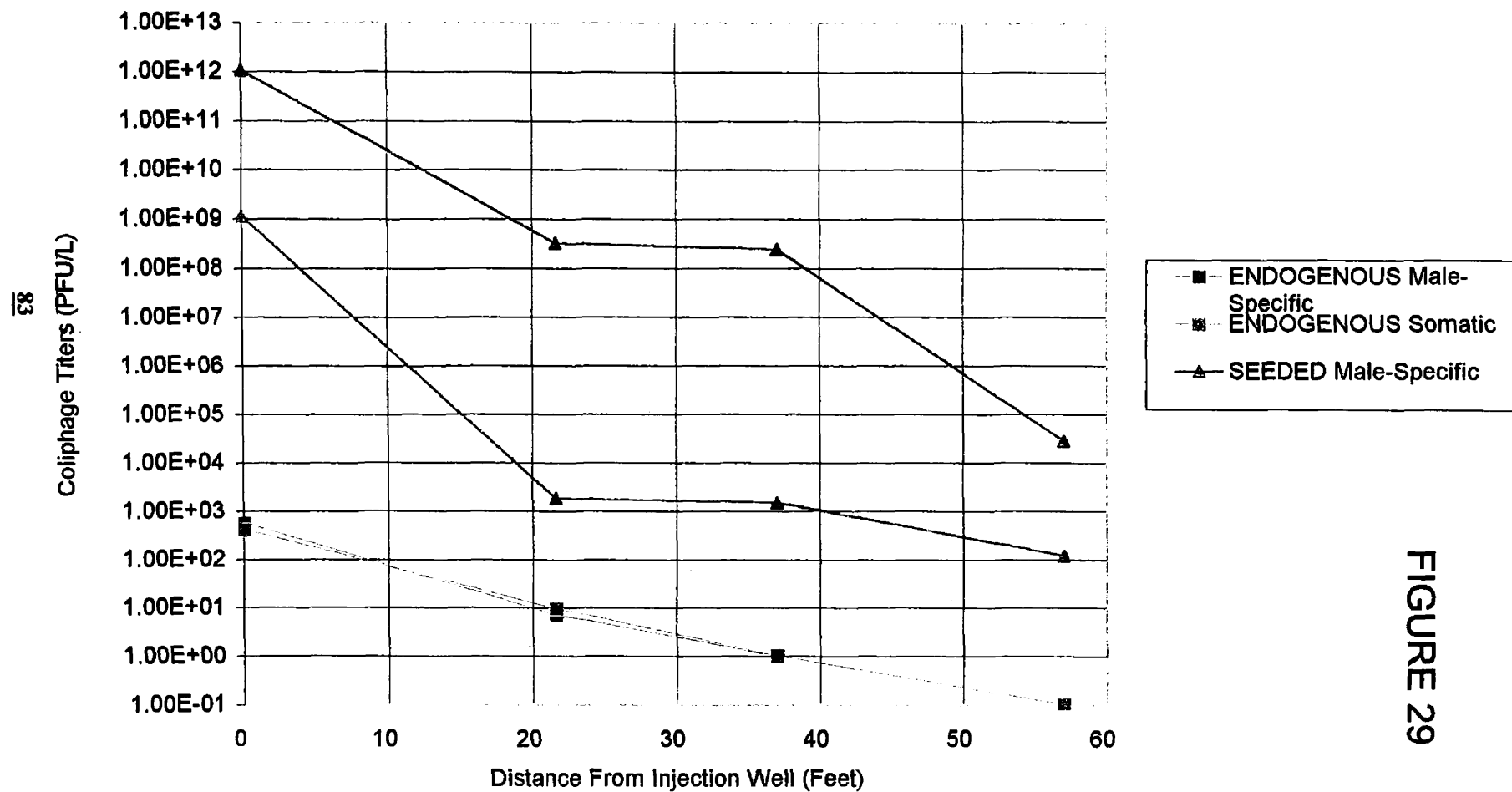


FIGURE 29

aquifer. Furthermore the concentrations of endogenous coliphage were documented to decrease with distance downgradient from the septic drainfield.

Breakthrough Curves

Figures 30 and 31 are breakthrough curves for MS2 and Φ X174 coliphage, respectively, in groundwater at wells M40, M41, T7 and T8, located downgradient from the injection well (M19). All groundwater coliphage concentrations are reported as average plaque forming units per milliliter (PFU/ml). The timing of peak coliphage seed concentrations reported in groundwater samples collected from each of the wells in the tracer network are summarized in Table 8.

Table 8. Summary of Results: Coliphage Seed Breakthrough Curves

Well	Distance Downgradient from Injection Well (ft)	MS2 Coliphage		Φ X174 Coliphage	
		Peak (PFU/ml)	Elapsed Time (hours)	Peak (PFU/ml)	Elapsed Time (hours)
M40	23	3.18×10^5	48	1.8	48
M41	37	2.4×10^5	132	1.5	108
T7	57	28.9	240	0.121	240, 312
T8	82	0.2	579	9.53×10^{-4}	480, 579
T10	112	0.02	603	8.9×10^{-4}	648
M31	126	0.002	744	8.9×10^{-4}	648

At well M40, located 23 ft downgradient from the injection well, peak concentrations of both MS2 (3.18×10^5 PFU/ml) and Φ X174 (1.8 PFU/ml) were reported in groundwater samples collected 48 hrs after coliphage injection.

MS2 BREAKTHROUGH CURVES WELLS M40, M41, T7 AND T8

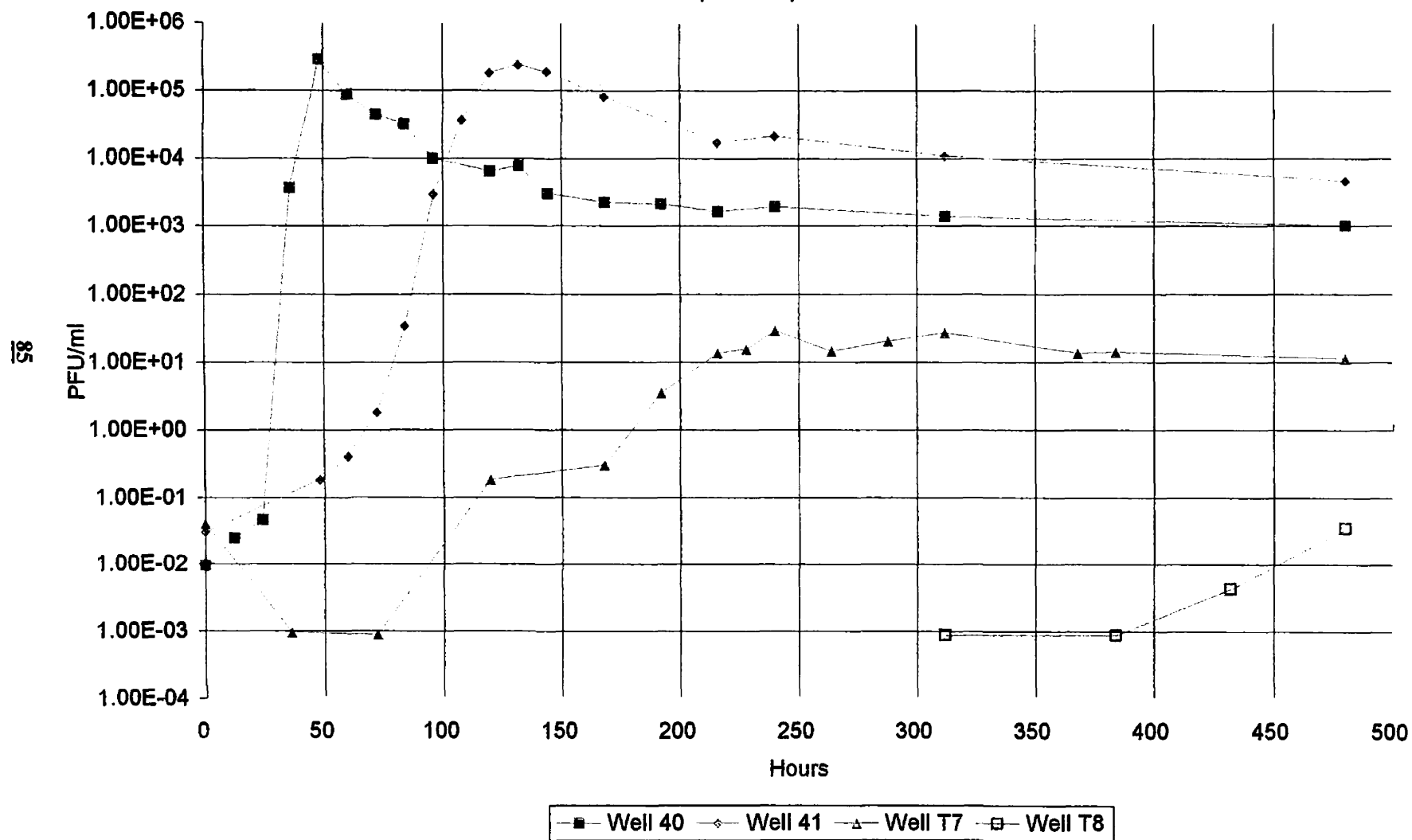


FIGURE 30

PhiX174 BREAKTHROUGH CURVES
WELLS M40, M41, T7 AND T8

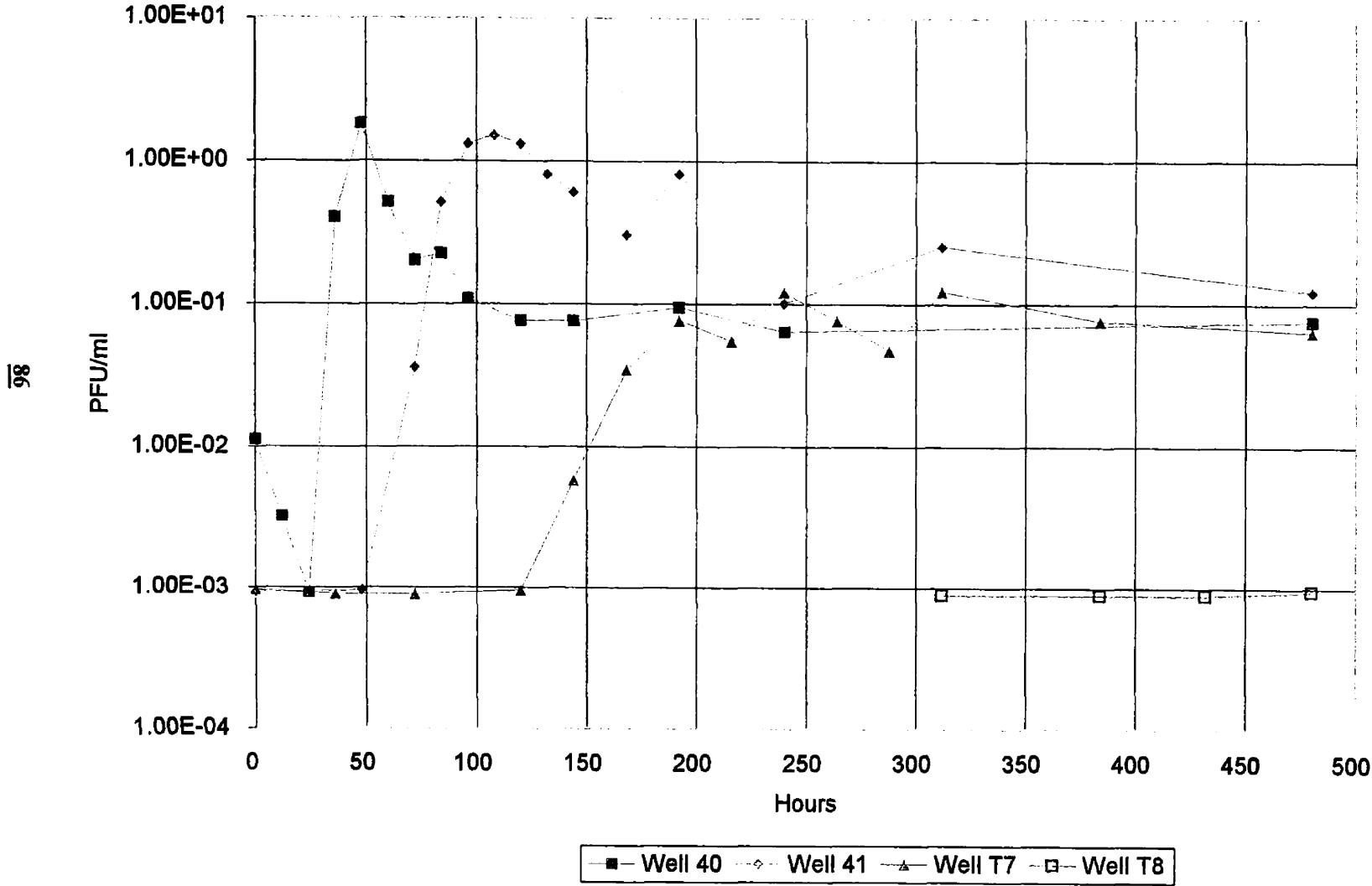


FIGURE 31

At well M41, located 37 ft downgradient from the injection well, the peak MS2 concentration (2.4×10^5 PFU/ml) was reported in the groundwater sample collected 132 hours after injection. Φ X174 peaked at a reported concentration of 1.5 PFU/ml in the groundwater sample collected 108 hrs after injection. Fifty-seven ft downgradient from the injection well at well T7, a peak MS2 concentration of 28.9 PFU/ml was reported in the groundwater sample collected 240 hrs (10 days) following injection. The concentration of Φ X174 in groundwater peaked at 0.121 PFU/ml at 240 hrs (10 days), and again at 312 hrs (13 days).

At well T8, located 82 ft downgradient from the injection well, the peak concentration of MS2 (0.2 PFU/ml) in groundwater was reported to occur 579 hrs (approximately 24 days) after injection. Φ X174 peaked twice at a concentration of 9.53×10^{-4} PFU/ml; first in the groundwater sample collected at 480 hrs (20 days) and again 579 hrs (approximately 24 days) after injection.

At well T10 (112 ft downgradient) the peak MS2 concentration (0.02 PFU/ml) occurred at 603 hours (approximately 25 days) after injection. A peak MS2 concentration of 0.002 PFU/ml was reported to occur after 744 hrs (31 days) at well M31, located 126 ft downgradient. Resolution is lost at wells T10 and M31, and it appears as though a concentration of 0.00089 PFU/ml may represent background conditions at those wells.

Figure 32 shows the decline in coliphage seed concentrations in groundwater at the injection well M19. The groundwater concentrations of MS2

INJECTION WELL M19 CONCENTRATIONS OF MS2, PhiX174 AND BROMIDE

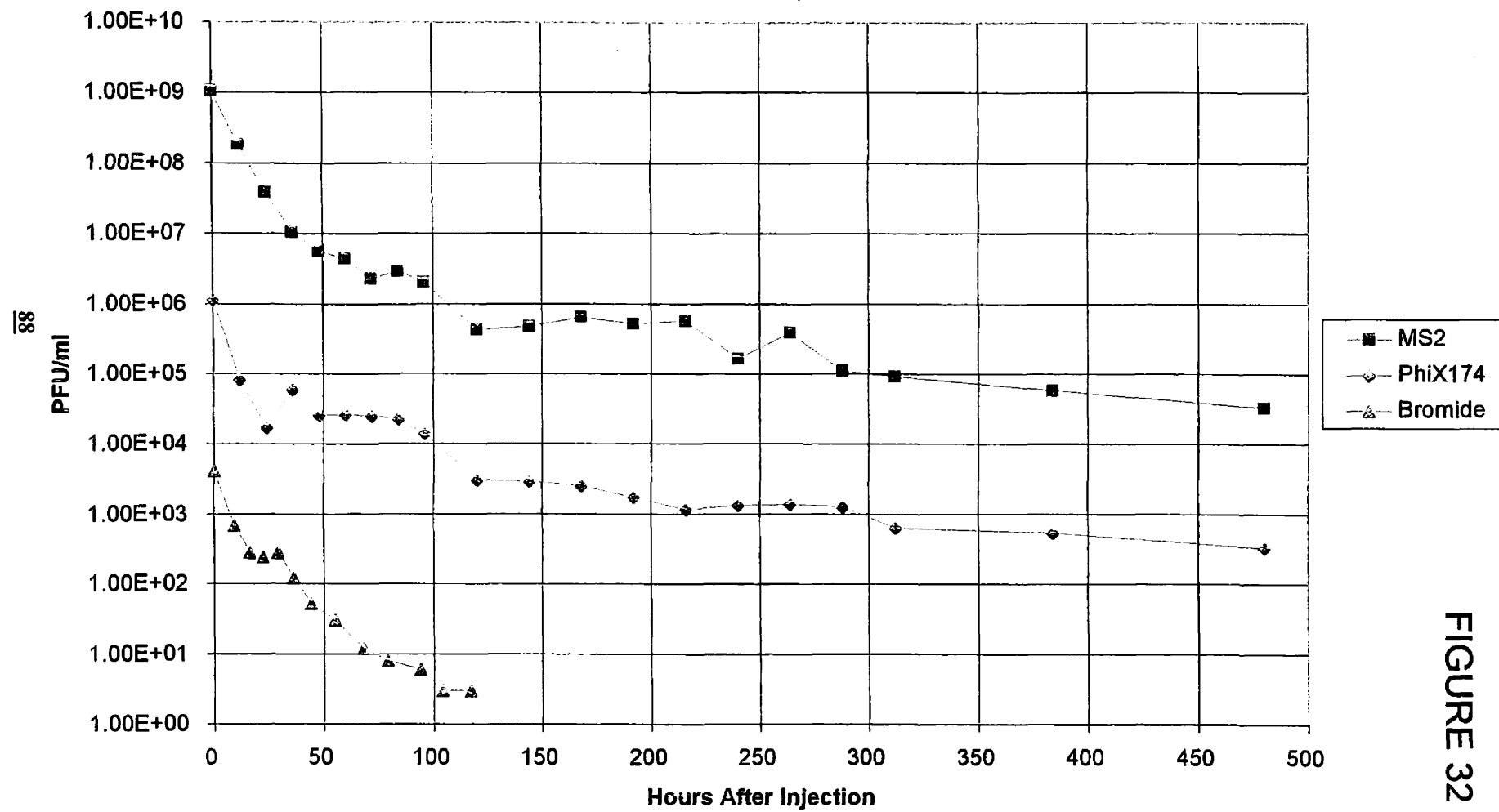


FIGURE 32

in injection well M19 reportedly decreased by six orders of magnitude (from 1.06×10^9 to 9880 PFU/ml) during the first 33 days (792 hrs) of the seeding experiment. During that same time period, the concentration of Φ X174 in groundwater at well M19 was reported to decrease by four orders of magnitude, from 1.12×10^6 to 269 PFU/ml.

Table 9 summarizes the range of recorded values of pH, temperature, electrical conductance and dissolved oxygen measured in groundwater at wells M19, M40, M41, T7 and T8 during the coliphage seeding experiment.

Table 9. Summary of Results:

Field Parameters Measured During the Coliphage Seeding Experiment

Well	pH (units)	Temperature (Celsius)	D. O. (mg/L)	E.C. (umhos/cm)
M19	6.2 - 7.3	12.7 - 16.2	0.8 - 1.8	305 - 360
M40	6.3 - 7.1	11.9 - 15.5	0.8 - 1.9	287 - 372
M41	6.2 - 6.9	13.2 - 15.4	0.8 - 1.8	299 - 372
T7	6.0 - 6.7	12.8 - 16.3	1.5 - 3.5	330 - 382
T8	6.3 - 7.0	13.4 - 15.5	2.7 - 3.8	273 - 325

Virus Mortality

Figure 33 charts coliphage concentrations in both the solution of seeded groundwater enclosed in an Oakridge tube which was suspended in the groundwater in injection well M19 and the laboratory control held at 4 °C. Unfortunately, the Oakridge tube equipped with the dialysis membrane appeared to rupture after about 2 days and was subsequently discontinued.

VIRUS MORTALITY: CONTROL EXPERIMENT DATA

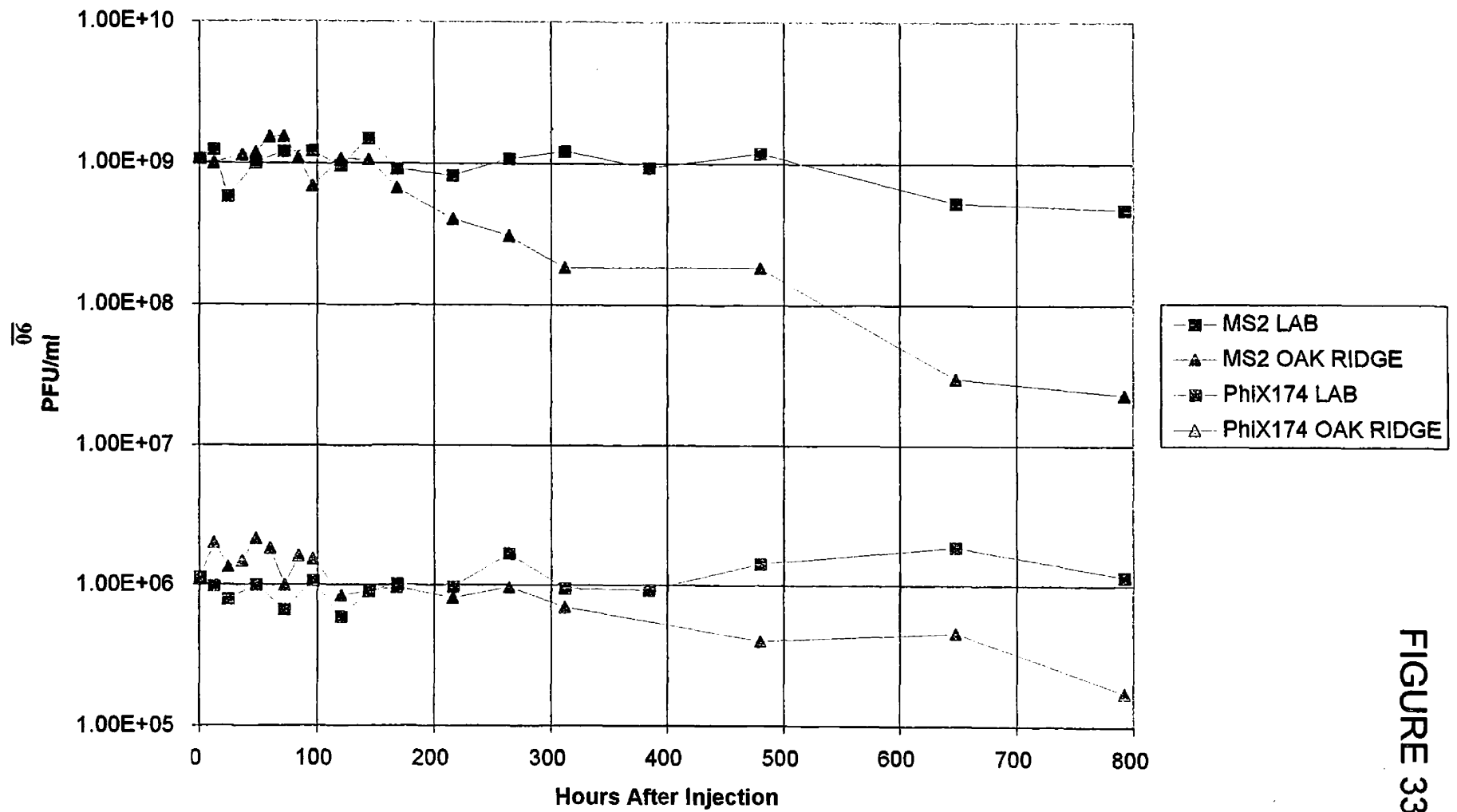


FIGURE 33

During the first 33 days of the seeding experiment, MS2 concentrations in the sealed tube decreased from 1.06×10^9 to 2.28×10^7 PFU/ml and Φ X174 concentrations decreased from 1.12×10^6 to 1.71×10^5 PFU/ml. Assays of the laboratory control samples of the seeded groundwater held at 4 °C reported a lesser coliphage die-off rate. Over the same 33 day period, the concentration of MS2 decreased from 1.06×10^9 to 4.72×10^8 PFU/ml. The concentration decrease of Φ X174 was negligible; the initial concentration was 1.12×10^6 PFU/ml and after 33 days the concentration was reported to be 1.15×10^6 PFU/ml. All field and laboratory data collected during the coliphage seeding experiment are presented in Appendix J.

8.0 DISCUSSION

The coliphage seeding experiment was marked by both successes and failures. In retrospect, the experiment could have been improved in a number of ways. Firstly, the tracer well network was not optimally placed along the axis of groundwater flow; the main mass of the coliphage plume exited the tracer network near the second transect of wells and traveled to the west of the wells. Long screen lengths and varied well completions did not allow the vertical distribution of the tracers to be documented. Also, the number of samples collected and assayed was limited due largely to uncertainties in effectively storing groundwater samples for extended periods of time. However, despite

these deficiencies several conclusions can be drawn from the results of the coliphage seeding experiment.

8.1 Virus Survival

The results of the coliphage seeding experiment confirmed that viruses may remain viable for a long period time in a cold water aquifer. As shown in Figure 32, during the seeding experiment, coliphage concentrations in the injection well M19 remain elevated several logs above background for 33 days after injection. In fact, coliphage concentrations above background were reported in groundwater samples collected from well M19 nine months after the injection of the coliphage seed.

The survivability of viruses in this cold-water aquifer is further indicated by the control experiment. Assays of the enclosed Oakridge tube suspended in the injection well M19, indicated a reduction in viral concentrations of only 1 to 2 logs over a 33 day interval, suggesting that virus mortality in a cold aquifer system is not a primary mechanism for the removal of viable virus as transport occurs. The laboratory control viruses archived at 4 °C fared even better, with no appreciable decrease in virus concentrations over the same time period. It is concluded that for tracer tests such as this, where high concentrations of coliphage are used as a seed, it would be acceptable to collect a large number of samples at frequent intervals during the tracer test, refrigerate the samples and perform assays later, as scheduling and data analyses dictate.

8.2 Transport Distance

The seeding experiment demonstrated that virus introduced into this hydrogeologic environment can be transported significant distances downgradient from the source. Ultimately, concentrations of MS2 coliphage above background levels were reported in well M31, 126 ft downgradient from the injection well.

However, it is likely that the coliphage seed was transported further downgradient than the results indicate. Because peak coliphage concentrations were greater in well T4 than in well M41, it is believed that the main mass of the coliphage seed moved to the west of the tracer network near Transect 2. This suggests that the peak concentrations of coliphage detected in well M31 do not represent the main mass of the coliphage seed, but rather the edge or shoulder of the coliphage seed. Therefore, it is possible that the coliphage seed was transported even further downgradient in the groundwater to the west of the tracer network.

8.3 Comparison of Coliphage Seed and Bromide Tracer Test Results

Rates of Travel

The breakthrough curves shown as Figures 34, 35 and 36 illustrate that the coliphage seed was transported downgradient at least the same rate as the conservative bromide tracer, if not faster. Similar times were required for the main mass of both the coliphage seed and the bromide tracer to arrive at well

WELL M40 BREAKTHROUGH CURVES MS2, PhiX174 AND BROMIDE

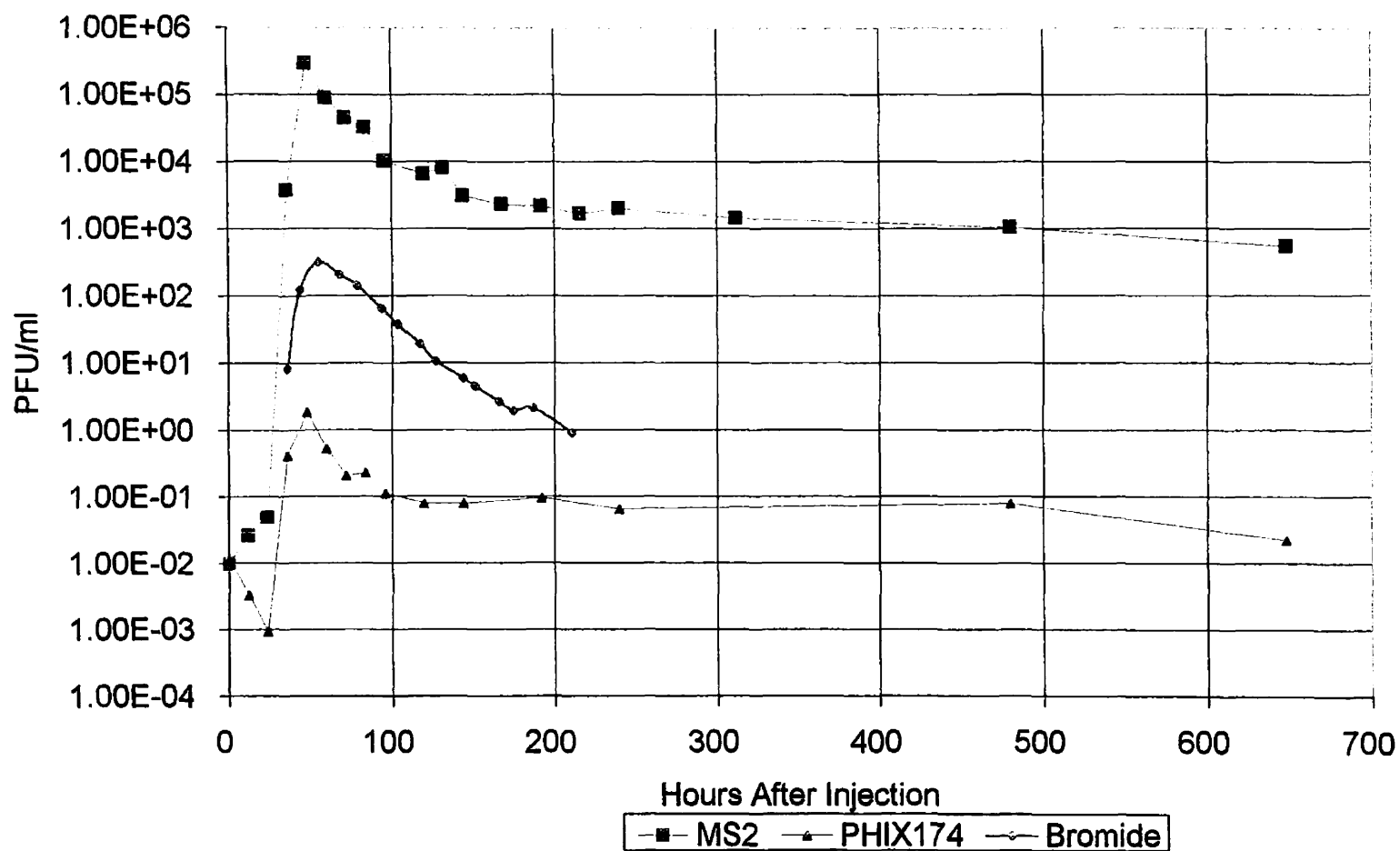


FIGURE 34

WELL M41 BREAKTHROUGH CURVES MS2, PhiX174 AND BROMIDE

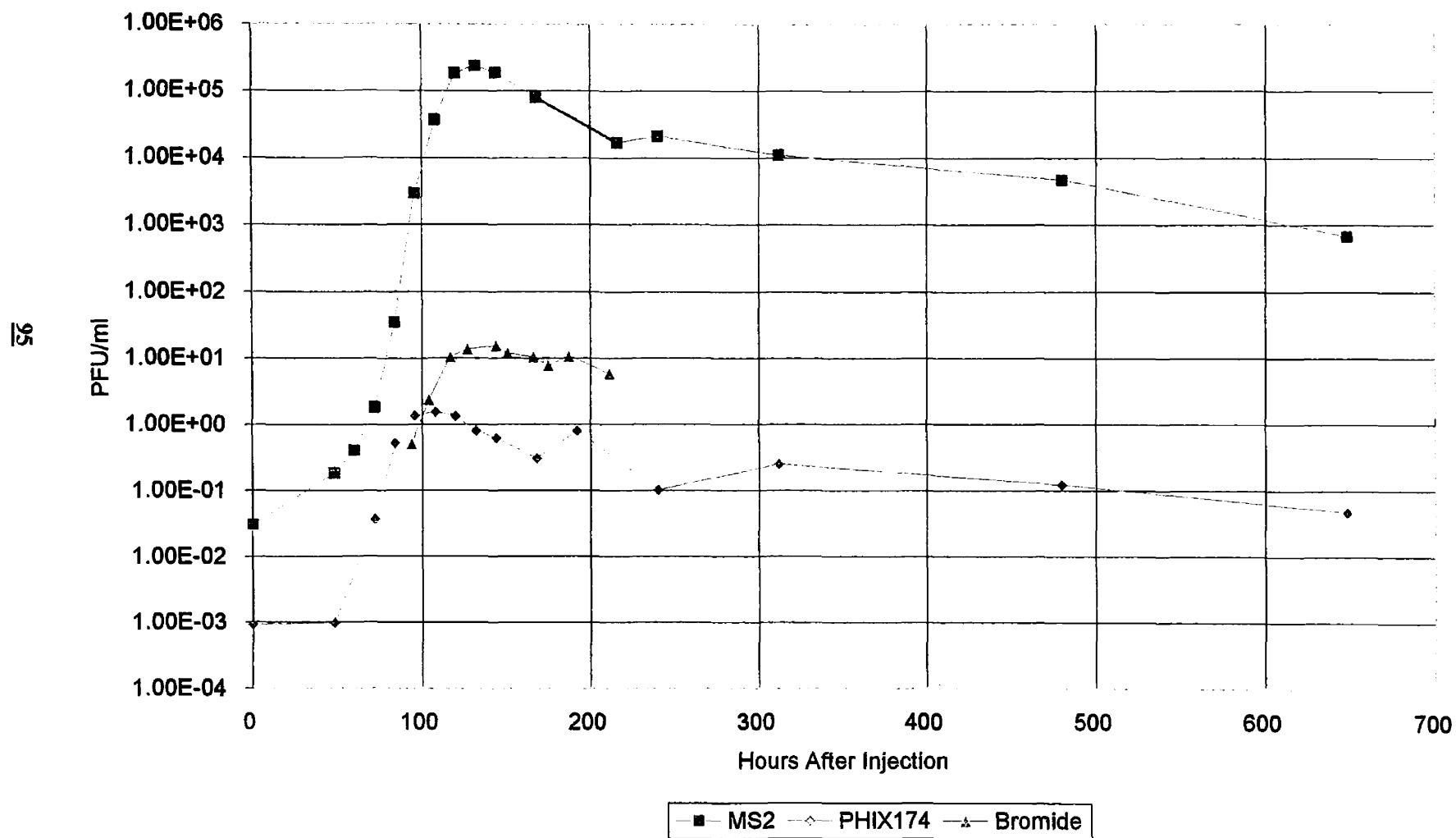


FIGURE 35

WELL T7 BREAKTHROUGH CURVES MS2, PhiX174 AND BROMIDE

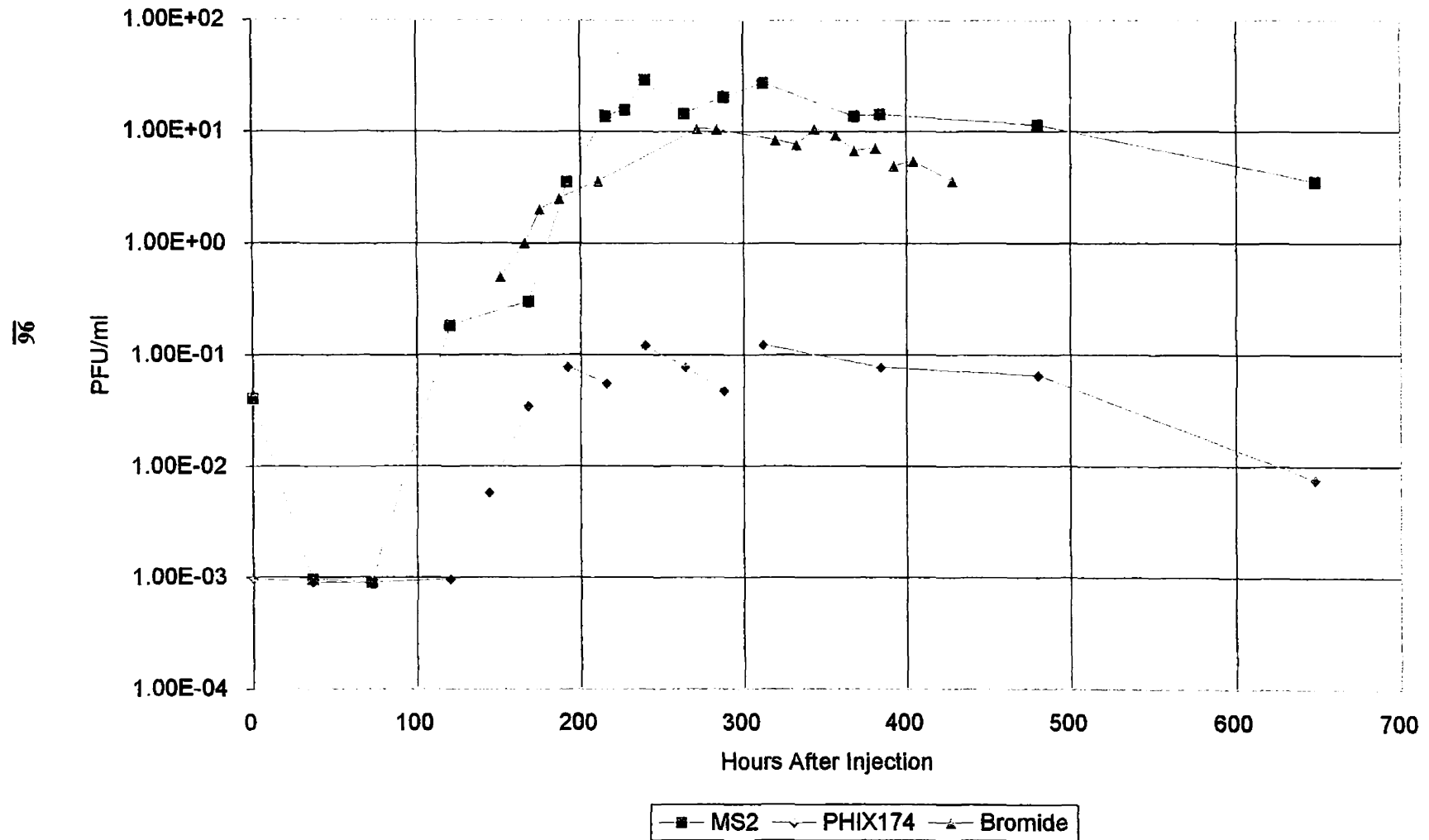


FIGURE 36

M40, in Transect 1. At well M41 in Transect 2, it appears that while peak concentrations of MS2 and bromide arrive at approximately the same time, the main mass of PhiX174 arrived several hours earlier. At well T7, in Transect 3, the breakthrough curves are not sharply defined, but it could be argued that peak concentrations of both MS2 and PhiX174 arrived ahead of the bromide slug.

Three possible explanations are offered for the observed results. First, the various "peak" concentrations are all dependent on the sampling interval, and it is probable that the true peak concentration (representing the main mass) for each constituent at each well sampled did not coincide with the collecting of a sample. A more rigorous sampling interval might provide a more accurate assessment of the comparative rates of travel for each of the tracers. Secondly, as was previously mentioned, it is likely that the tracer network was not optimally positioned to intercept the main mass of the tracers, and it is not appropriate to compare the apparent travel times. A third possibility is that the coliphage travel at rates faster than the bromide because their larger size results in a more direct route of travel. However, even if the last explanation were correct, it seems likely that such effects would be overshadowed by the sorptive characteristics of coliphage.

Coliphage Tailing Effect

Analysis of Figures 34, 35 and 36 also reveals that unlike the bromide tracer, the breakthrough curves for both MS2 and Φ X174 exhibited pronounced

tailing effects after the peak concentration had occurred. That is, the coliphage concentrations in the groundwater remained elevated once the main mass had moved beyond each of the tracer wells. This phenomenon manifests itself in the injection well (M19) as a slow decrease in coliphage concentrations over time. These concentration tails suggest the coliphage is not acting conservatively, as the bromide does, but are influenced by factors which do not affect the bromide tracer.

As discussed in the Introduction, the transport of viruses is largely controlled by sorption. The tailing effect seen in the breakthrough curves is probably due to the continuous processes of coliphage sorbing to aquifer materials and then desorbing, and being returned to the water column where they continue to be transported within the ground-water flow system.

8.4 Regulatory

As regulators wrestle with the complex issues associated with promulgating water quality standards for viruses in drinking water, a balance needs to be struck between what is acceptable, based on human health considerations, and what can reasonably be done by water providers and users to comply with such a health based standard. The technology to adequately isolate viruses in groundwater is still being developed, and the costs of chlorination (both monetary and potential health risks) precludes setting rigorous treatment guidelines. As explained in the Introduction, under the natural

disinfection criteria proposed by the EPA in the Draft Groundwater Disinfection Rule (DGDR), water utilities would be exempted from treatment requirements provided it can be demonstrated that natural disinfection will result in prevention of viral contamination of drinking water supplies.

Based upon the results of this pilot coliphage seeding experiment, it appears that a highly conductive, cold-water aquifer such as is present at the FHS represents a worst case scenario, Viruses introduced into the aquifer system survive for extended periods of time and remain available to be transported in groundwater.

Furthermore, although coliphage can be used to simulate the transport of human enterovirus, they cannot at this time be used as reliable indicators of the presence or absence of infectious virus; coliphage can be detected where human enterovirus cannot, and infectious virus may be present in the absence of coliphage. Regulators may have to adopt coliphage as an indicator of the potential presence of infectious virus for the time being.

9.0 CONCLUSIONS

Based upon observations made during the coliphage seeding experiment, and comparison of those observations with results of the bromide tracer experiment, the following conclusions are made:

- 1) Seeded coliphage were observed to survive for several months in the cold groundwater conditions present at the FHS site. Laboratory studies verified the low mortality rate of virus.
- 2) Thirty-three days after seeding, the coliphage seed was detected in the shallow groundwater more than 120 ft downgradient from the injection well. It is likely the coliphage was transported even further, beyond the tracer well network.
- 3) Within the temporal constraints of the sampling schedule, the coliphage seed appeared to move at the same rate or slightly faster than the conservative bromide tracer over a lateral distance of approximately 57 ft.
- 4) Unlike bromide, coliphage breakthrough curves exhibited a tailing effect in which concentrations of coliphage remain elevated and slowly decline as the main mass of coliphage moves beyond the well. Tailing effects are believed to represent the process of virus sorption to the aquifer material.
- 5) Although no human enterovirus were detected in the shallow groundwater in the vicinity of the FHS, the cold-water, highly transmissive characteristics of the shallow groundwater represent a worst case scenario in which viruses introduced into the aquifer can survive for extended periods of time and be transported significant distances from a source.

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APPENDIX A

Septic System Specifications and FHS Water Supply Wells Driller's Logs

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER Name <u>FRENCHTOWN HIGH SCHOOL</u> 2. CURRENT MAILING ADDRESS <u>School Dist 40</u> <u>Frenchtown, MT 59834</u>	6. WATER LEVEL Static water level <u>11</u> feet below land surface If flowing, closed-in pressure _____ psi gpm flow through _____ inch pipe Controlled by: _____ valve, _____ reducers, _____ other (If other, specify) _____																																				
3. WELL LOCATION SW 1/4 Section <u>27</u> NW 1/4 Section <u>34</u> Township <u>15 N</u> Range <u>21 W</u> E/W County <u>Missoula</u> Subdivision _____ Well Elevation _____ Accuracy: <u>± 10'</u> <u>± 50'</u> <u>± 100'</u>	7. WELL TEST DATA _____ pump _____ boiler _____ other (If other, specify) <u>Air Compressor</u> Pumping level below land surface: <u>100</u> ft. after <u>1</u> hrs. pumping <u>200</u> gpm _____ ft. after _____ hrs. pumping _____ gpm 8. WAS WELL PLUGGED OR ABANDONED? Yes ☐ No ☒ If yes, how? _____ 9. DATE STARTED <u>May 21, 1979</u> DATE COMPLETED <u>June 13, 1980</u>																																				
4. DRILLING METHOD _____ cable, _____ bored, _____ forward rotary, _____ reverse rotary, _____ jetted, other (specify) _____	10. WELL LOG Depth (ft.) From To Formation <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>0</td><td>3</td><td>Sandy Clay</td></tr> <tr><td>3</td><td>17</td><td>Sandy Clay, Sand & Gravel</td></tr> <tr><td>17</td><td>23</td><td>Sand, Gravel & Water</td></tr> <tr><td>23</td><td>39</td><td>Sand & Water</td></tr> <tr><td>39</td><td>78</td><td>Tan Clay</td></tr> <tr><td>78</td><td>88</td><td>Sand & Water</td></tr> <tr><td>88</td><td>97</td><td>Gray Clay</td></tr> <tr><td>97</td><td>122</td><td>Sand & Water</td></tr> <tr><td>122</td><td>160</td><td>Gray Clay</td></tr> <tr><td>160</td><td>165</td><td>Sand & Water</td></tr> <tr><td>165</td><td>174</td><td>Sand, Small Gravel & Water</td></tr> <tr><td>174</td><td>177</td><td>Gravel, Sand & Water</td></tr> </table>	0	3	Sandy Clay	3	17	Sandy Clay, Sand & Gravel	17	23	Sand, Gravel & Water	23	39	Sand & Water	39	78	Tan Clay	78	88	Sand & Water	88	97	Gray Clay	97	122	Sand & Water	122	160	Gray Clay	160	165	Sand & Water	165	174	Sand, Small Gravel & Water	174	177	Gravel, Sand & Water
0	3	Sandy Clay																																			
3	17	Sandy Clay, Sand & Gravel																																			
17	23	Sand, Gravel & Water																																			
23	39	Sand & Water																																			
39	78	Tan Clay																																			
78	88	Sand & Water																																			
88	97	Gray Clay																																			
97	122	Sand & Water																																			
122	160	Gray Clay																																			
160	165	Sand & Water																																			
165	174	Sand, Small Gravel & Water																																			
174	177	Gravel, Sand & Water																																			
5. WELL CONSTRUCTION AND COMPLETION <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Size of drilled hole</th> <th>Size and weight of casing</th> <th>From (feet)</th> <th>To (feet)</th> <th>Perforations Screen</th> <th>End Size</th> <th>From (feet)</th> <th>To (feet)</th> </tr> </thead> <tbody> <tr> <td>6"</td> <td>6" ID 17 lb per ft.</td> <td>3' 9"</td> <td>177</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> Was casing left open end? Yes ☒ No ☐ Was a packer or seal used? Yes ☐ No ☒ If so, what material _____ Was the well gravel packed? Yes ☐ No ☒ Was the well grouted? Yes ☐ No ☒ To what depth? _____ Material used in grouting _____ Well head completion: Pileless adapter _____ 12 in. above grade _____ other 3" 9" _____ (If other, specify) <u>above ground level</u> Pump horsepower _____ pump type _____ Pump intake level _____ foot below land surface Power (electric, diesel, etc.) _____	Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	End Size	From (feet)	To (feet)	6"	6" ID 17 lb per ft.	3' 9"	177					11. DRILLER'S CERTIFICATION This well was drilled under my jurisdiction and this report is true to the best of my knowledge. Date <u>June 13, 1980</u> Signature <u>Phil Noble</u> CAMP WELL DRILLING & PUMP SUPPLY 1522 S. 14th W., Missoula, MT 59801 Address _____ License No. _____																				
Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Screen	End Size	From (feet)	To (feet)																														
6"	6" ID 17 lb per ft.	3' 9"	177																																		

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

328 SOUTHWING

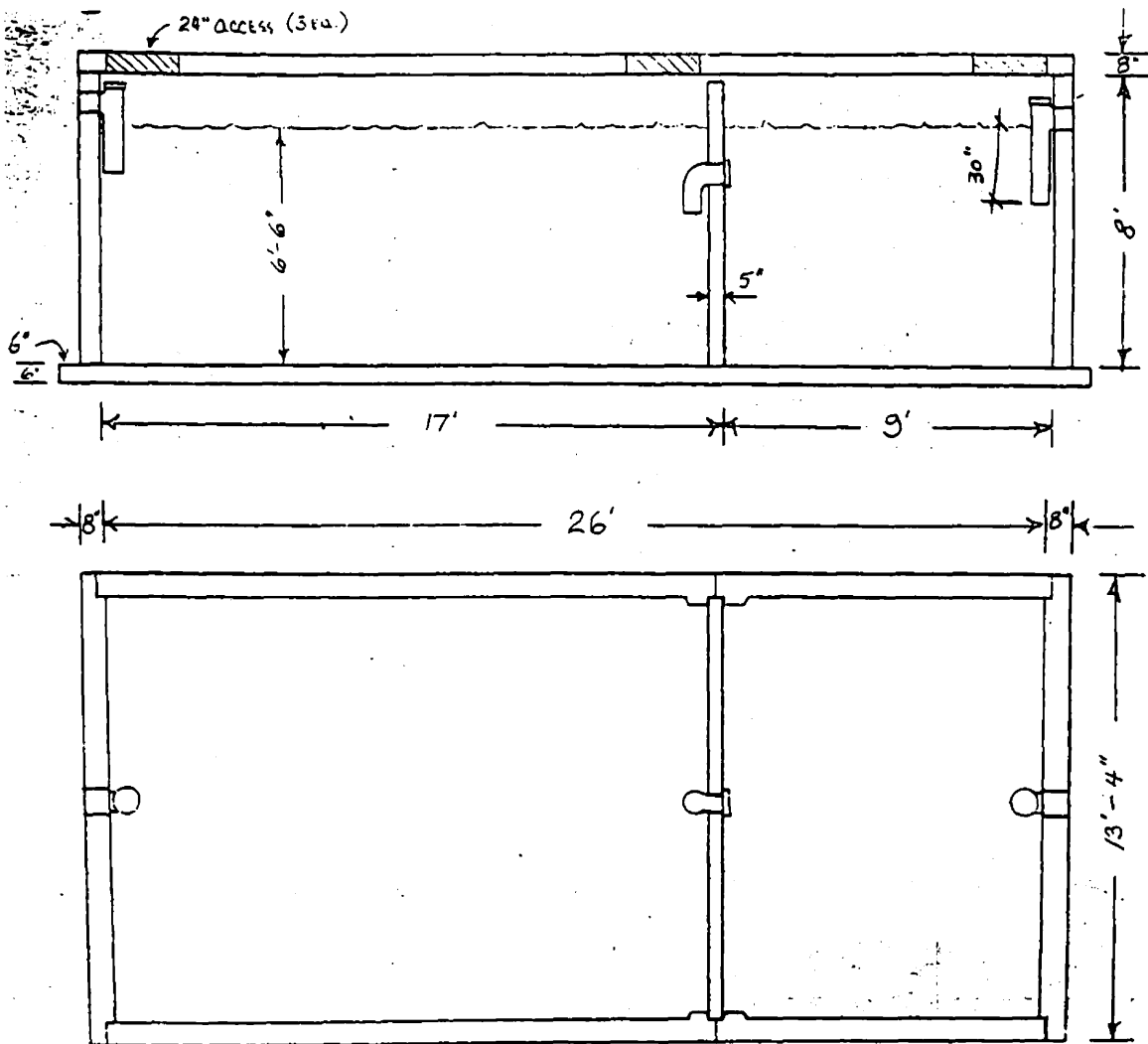
HELENA, MONTANA 59601

449-2634

DNRC

WELL OWNER COPY

[illegible]



REINFORCEMENT:
 FLOOR (CAST IN PLACE) - ONE
 MAT OF #5 REBAR 12" A.C.E.W.
 IN LOWER 1/2 LEVEL
 WALLS & ROOF (PRECAST PANELS)
 2 MATS OF #5 REBAR 12" A.C.E.W.
 IN UPPER & LOWER 1/2 LEVELS
 OF SLABS

Notes:
 PANELS ARE KEYED TOGETHER,
 WELDED, AND SEALED WITH NON-
 SHRINK GROUT
 Manhole extensions and bolt down
 gas tight covers as needed (not shown)

MISSOULA CONCRETE CONSTRUCTION
 BOX 3326 MISSOULA, MT 59802
 5/15/79 Dick Mager



ENGINEERING DETAILS - SK75/100

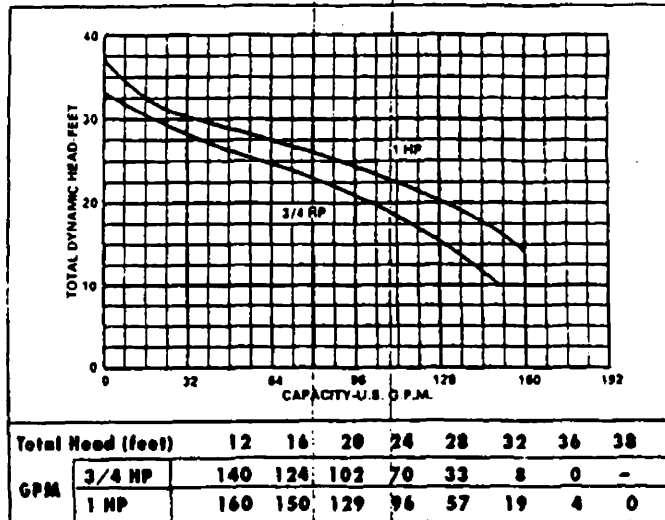
Pump Characteristics

Pump/Motor Unit	Submersible					
Manual Models	M7	M2	M6	M3	M4	M5
Horsepower	3/4					
Full Load Amps	10.4	9.0	4.0	3.5	1.8	1.5
Manual Models	M7	M2	M6	M3	M4	M5
Horsepower	1					
Full Load Amps	11.5	10.0	5.0	4.4	2.2	1.7
Motor Type	Cap.		Three-Phase			
R.P.M.	1750					
Phase Q	1		3			
Voltage	200	230	200	230	480	575
Hertz	60					
Temperature	140°F Ambient					
Design	A					
Insulation	Class A					
Discharge Size	2" NPT std. (3" opt.)					
Solids Handling	2" 					
Unit Weight	76 lbs.					
Power Cord	16/3, STWA, 10, 20' std. 16/4, STWA, 30, 20' std.					

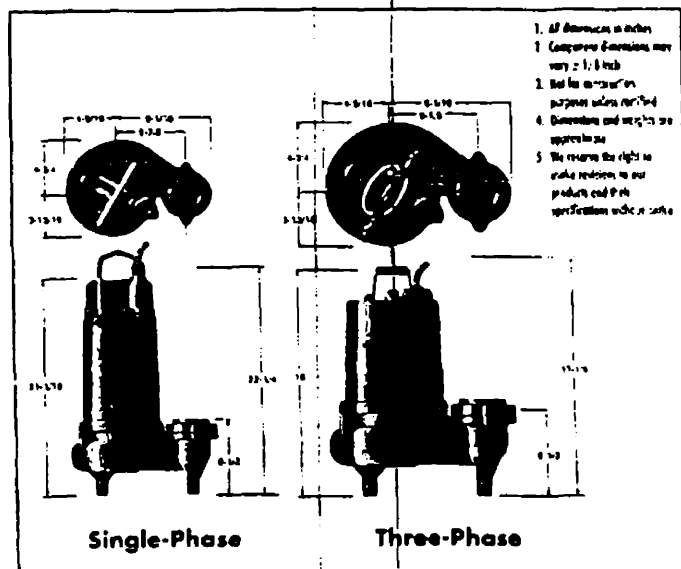
Materials of Construction

Handle	Steel
Lubricating Oil	Diatomaceous Oil
Motor Housing	Cast Iron
Pump Casing	Cast Iron
Shaft	Stainless Steel
Mechanical Shaft Seal	Seal Faces: Carbon/Ceramic Seal Body: Brass Spring: Stainless Steel Bellows: Buna-N
Impeller	Cast Iron
Upper Bearing	Single Row Ball Bearing
Lower Bearing	Single Row Ball Bearing
Fasteners	Stainless Steel

Performance Data



Dimensional Data



AURORA/HYDROMATIC Pumps, Inc.
1840 Boney Road, Ashland, Ohio 44805
(419) 289-3047

APPENDIX B

Soil Boring Logs

BY B. L. L. L. L. DATE 8/19/51 CHECKED BY DATE
 NO215432 DRILLING CONTR. DATE

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION F113	
										DRILLING METHOD: Hand auger and drive point		BORING NO. B-1			
										SAMPLING METHOD: Grab		SHEET 1 of 1			
										WATER LEVEL		DRILLING			
										TIME		START TIME			
										DATE		FINISH DATE			
										CASING DEPTH		DATE 8/19/54			
DATUM										ELEVATION		SURFACE CONDITIONS:			
SAMPLER TYPE	WATER LEVEL	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH								
G		1/2				0		grassy field							
G		2/5				1		fossil							
G		3/5				2	SM	silty sand, minor small gravel							
G		4/5				3		20% silt, 70% fine to medium sand							
G		5/5				4		10% gravel < 1/2" diameter							
G		6/5				5		sub rounded to subangular							
G		7/5				6		AD, decreasing gravel, decreasing silt							
G		8/5				7		gravelly sand, coarse sand, larger gravel							
G		9/5				8	SP	75% med. coarse sand subangular to							
G		10/5				9		25% gravels subangular							
G		11/5				10		T.D. of hand auger = 10' 5 1/2"							
G		12/5				11		(saturated)							
G		13/5				12		2" PVC well installed to 10' 5 1/2"							
G		14/5				13		See monitor well construction							
G		15/5				14		Summary							
G		16/5				15		M-1							
G		17/5				16									
G		18/5				17									
G		19/5				18									
G		20/5				19									
G		21/5				20									

DATE/TIME		ELEVATION		CASING DEPTH		SURFACE CONDITIONS	
SAMPLER TYPE	INCHES DOWN	DEPTH OF CASING	SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
4			1.5			0	Topsoil Silty sand 20% silt, 80% fine to medium sand primarily fine sand AD, decreasing silt, increasing coarse sand and pebbles AD, increasingly coarse, minor small gravel TD at head casing - 8' 6 1/2' (estimated) 1.5" PVC well installed to 10.5' b/s. See monitor well construction summary. M-2
4			2.5			1	
4			3.5			2	
4			4.5			3	
4			5.5			4	
4			6.5			5	
4			7.5			6	
4			8.5			7	
4			9.5			8	
4			10.5			9	
4			11.5			10	
4			12.5			11	
4			13.5			12	
4			14.5			13	
4			15.5			14	
4			16.5			15	
4			17.5			16	
4			18.5			17	
4			19.5			18	
4			20.5			19	
4			21.5			20	
4			22.5			21	
4			23.5			22	
4			24.5			23	
4			25.5			24	
4			26.5			25	
4			27.5			26	
4			28.5			27	
4			29.5			28	
4			30.5			29	
4			31.5			30	
4			32.5			31	
4			33.5			32	
4			34.5			33	
4			35.5			34	
4			36.5			35	
4			37.5			36	
4			38.5			37	
4			39.5			38	
4			40.5			39	
4			41.5			40	
4			42.5			41	
4			43.5			42	
4			44.5			43	
4			45.5			44	
4			46.5			45	
4			47.5			46	
4			48.5			47	
4			49.5			48	
4			50.5			49	
4			51.5			50	
4			52.5			51	
4			53.5			52	
4			54.5			53	
4			55.5			54	
4			56.5			55	
4			57.5			56	
4			58.5			57	
4			59.5			58	
4			60.5			59	
4			61.5			60	
4			62.5			61	
4			63.5			62	
4			64.5			63	
4			65.5			64	
4			66.5			65	
4			67.5			66	
4			68.5			67	
4			69.5			68	
4			70.5			69	
4			71.5			70	
4			72.5			71	
4			73.5			72	

FILE

3.

hard sugar & drive pond

3-3
SMIT

10

TIME:

DATE 10/1/83

3	
---	--

SURFACE COMPONENTS

grassy field

Topic: 1

cm, c. 1 by seed, no parallel

25-25.11

23 to 3:1 p
75% fine to v. fine sand

has to cost less, more people, more

poorly sorted, fine to med. sand

ADs may be subdivided - subgroups

41" diameter

TS of hand cipher = $p^+ b^+ b^-$
(Schnecke)

5 PVC membrane well installed

10.5 hrs.

See notebook well - contributions summary

2-3

DRILLING CONTR. 1204

[illegible]

BY B. Newman DATE 10/10/99 CHK'D BY NO215432 DAILING CONTR None

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION					
														FHS					
										DRILLING METHOD:		BORING NO.		SHEET					
										Hand auger w/ drive point		B-5		1 of 1					
										SAMPLING METHOD:		ORILLING							
										Grab									
										WATER LEVEL		START TIME		FINISH TIME					
										TIME									
										DATE		DATE		DATE					
														10/10/99					
										CASING DEPTH									
DATUM										ELEVATION									
SAMPLER TYPE	INCHES LOWER RECORDED	DEPTH OF CASING	SAMPLE NO	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:											
						0		grassy field											
						1		top soil											
G			1			2	SM	silty, gravelly sand											
			2			3		poorly sorted 75% fine-med sand											
						4	SP	20% silt											
						5		5% small gravels											
G			2			6		gravelly sand, no silt											
						7		85% fine to coarse sand (med)											
G			3			8	SM	15% gravels & 1" sub rounded-sub angular											
						9		finer, no gravels, silty fine sand											
						10		T.D. of hand auger = 8' b/lr. (saturated)											
						11		1.5" PVC monitor well installed to											
						12		10.5' b/lr.											
						13		See monitor well construction summary.											
						14		M-5											
						15													
						16													
						17													
						18													
						19													
						20													

DRILLING CONTN none

[illegible]

BY B. Luermann

DATE 10/25/94 CHK'D BY _____

No215432

DRILLING CONTR none

LOCATION OF BORING				JOB NO.		CLIENT		LOCATION	
DRILLING METHOD: <u>Hand auger and drive point</u>				BORING NO. <u>B-7</u>		SHEET <u>1 of 1</u>		DATE <u>10/25/94</u>	
SAMPLING METHOD: <u>Grabs</u>				START TIME		FINISH TIME		DATE	
WATER LEVEL				DATE		DATE		DATE	
CASING DEPTH				DATE		DATE		DATE	
SURFACE CONDITIONS:				grassy field					
topsoil									
Sandy silt, 80% silt									
20% fine - v. fine sand									
fine to medium sand, no silt									
poorly sorted									
Sandy silt, as at 2.5'									
medium sand, no silt									
(stratified)									
TD of hand auger = 10.5' bbl.									
2" PVC monitor well installed to									
11' 5 1/8."									
See monitor well construction summary									
M-7									

CATALOG		ELEVATION		SOIL GRAPH	
SAMPLER TYPE	INCHES DRIVEN	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT SAMPLER	NUMBER OF RINGS
✓			1		
✓			2.5		
✓			2.5		
✓			3.75		
✓			4		
✓			10		

DRILLING CONTR. none

[illegible]

LOCATION OF BORING					JOB NO.		CLIENT		LOCATION	
DRILLING METHOD: <u>Hand auger and drive point</u> SAMPLING METHOD: <u>Core</u> WATER LEVEL: ☐ TIME: ☐ DATE: ☐ CASING DEPTH: ☐					Boring No.		F148		Sheet	
					Boring No.		B-9		1 of 1	
					Start		Finish		Date	
					Time		Date		Time	
					Date		Date		Time	
SURFACE CONDITIONS:										
<u>Grassy field</u>										
top soil poorly sorted silty gravel and sand (possibly drainfield material) Sandy silt, mostly silt, near v. fine (sand)										
SM AB, increasing fine sand										
AB, " " " "										
Generally sand, 85% med. to coarse sand 15% gravel, sub rounded (saturated) 10-20% blower										
TD of hand auger = 11' 6"										
2" PVC Monitor well installed to 12.5' b/s										
See monitor well construction log										
M-9										

SAMPLER TYPE	INCHES OVER RECOVERED	DEPTH OF CASING	SAMPLE NO. SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	ELEVATION	
						DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	
						21	
						22	
						23	
						24	
						25	
						26	
						27	
						28	
						29	
						30	

BY B. Lawrence
 DATE 10/16/94 CHK'D BY _____

No215432 DRILLING CONTR. none

SSS-1 (2) (REV 11-90)

8. B Laverne

No215432

DRILLING CONTR. none

LOCATION OF BORING		JOB NO.		CLIENT		LOCATION	
DRILLING METHOD: Hand Auger and drive point		BORING NO. B-10		SHEET 1 of 1		DATE 10/26/94	
SAMPLING METHOD: Core		DRILLING START TIME FINISH TIME		DATE 10/26/94		DATE 10/26/94	
WATER LEVEL TIME DATE		Casing Depth		SURFACE CONDITION:		ELEVATION	
SAMPLER TYPE INCHES RECOVERED DEPTH OF CASING SAMPLE NO. BLOWS/FT. SAMPLER NUMBER OF RINGS DEPTH IN FEET SOIL GRAPH		grassy field		topsoil		0 1 2 3 4 5 6 7 8 9 10	
4 1 1/2 2 1/2 3 1/2 4 5 6 7 8 9 10		silty sand, medium to coarse sand (med)		silty sand, medium to coarse sand (med)		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		AB, increasing V fine - fine sand		AB, increasing V fine - fine sand		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		AB, silty		AB, silty		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		SF		SF		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		20' of hand auger = 10' 5 1/2' (estimated)		20' of hand auger = 10' 5 1/2' (estimated)		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		2" PVC water well installed		2" PVC water well installed		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		10' 3' BIC		10' 3' BIC		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		20' water well construction continuing		20' water well construction continuing		0 1 2 3 4 5 6 7 8 9 10	
4 2 1/2 3 1/2 4 5 6 7 8 9 10		M-10		M-10		0 1 2 3 4 5 6 7 8 9 10	

BY B. Lawrence
 DATE 8/27/94 CHK'D BY _____

No215432

DRILLING LENGTH None

SAMPLER TYPE	INCHES RECORDED	DEPTH OF CASING	SAMPLE NO SAMPLER DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH
						0	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

JOB NO. _____ CLIENT _____ LOCATION **FMS**

DRILLING METHOD:
Hand auger to 8'
 Driven pipe to 19.5'

BORING NO.
P-1
 SHEET
1 of 1

SAMPLING METHOD:
grab

WATER LEVEL _____
 TIME _____
 DATE _____

START TIME _____
 FINISH TIME _____

CASING DEPTH _____

DATE **8/27/94**
 TIME _____

SURFACE CONDITIONS:

grassy field

topsoil

from fine to medium sand
mostly fine sand

fine sand, noticeably sorted

v fine sand, well sorted

TD of hand auger, substituted

No samples collected past
depth of 7.5' due to obstructions
to 3 inches 3/4" galvanized
steel to TD = 19.5'. 6" steel
open-ended piezometer.

TD of piezometer

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION									
														FW5									
DRILLING METHOD: Hand auger to 8' Driven pipe to 19.5'										BORING NO. 1-2		SHEET 1 of 1											
														SAMPLING METHOD: GTS									
														WATER LEVEL:									
														TIME:									
DATE:										DATE:		DATE:											
CASING DEPTH:										8/27/94													
SURFACE CONDITIONS:																							
Grassy field																							
Topsoil																							
gravelly sand 7.5'. fine to coarse sand, predominantly medium sand																							
25% gravel 4" diameter sub graded to subcompactor																							
AG, decreasing gravel																							
AG, gravel increasing again																							
T.D. at hand auger, saturated																							
No soil samples collected																							
Used 7.5' VSS jackhammer																							
to advance 34" galvanized steel																							
to T.D. = 19.5' 6" shaker																							
Open-ended auger																							

DATUM		ELEVATION		SOIL GRAPH	
SAMPLER TYPE	INCHES DOWN	INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT SAMPLER
4	1	2.5	1	1	
4	2	2.5	2	2	
4	3	2.5	3	3	
4	4	2.5	4	4	
4	5	2.5	5	5	
4	6	2.5	6	6	
4	7	2.5	7	7	
4	8	2.5	8	8	
4	9	2.5	9	9	
4	10	2.5	10	10	
4	11	2.5	11	11	
4	12	2.5	12	12	
4	13	2.5	13	13	
4	14	2.5	14	14	
4	15	2.5	15	15	
4	16	2.5	16	16	
4	17	2.5	17	17	
4	18	2.5	18	18	
4	19	2.5	19	19	
4	20	2.5	20	20	

125

DRILLING CONTR. 01ceek
Bu He, MT

LOCATION OF BORING										JOB NO.	CUSTOMER	ELEVATION BORING NO.
												F145
DRILLING METHOD:										M-11		
Bore Hole Size: 8" H.S. Auger										SHEET		
SAMPLING METHOD:										1 or 1		
Casing Depth:										DATE: 1/27/45		
SURFACE CONDITIONS:										DATE: 1/27/45		
gassy field												
Topsoil												
generally sand 10% clay to coarse sand predominantly med. sand												
20% gravel - 1' diameter submerged to inch auger												
partial section (sand)												
sandy gravel 60% coarse gravel 1-2" diameter (sub to 5 ft) 40% fine to coarse sand												
SP												
SP												
AB, clearing sand (west)												
TD = 18'												
2" PVC Man-hv well installed												

DRILLING CONTR. O'Leary
Bulk, MT

NO215432

BY B. Lawrence
 DATE 11/27/95 CHK'D BY

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION	
														F148	
DRILLING METHOD:										BORING NO.		SHEET			
8" H.S. Auger										M-12		1 of 1			
SAMPLING METHOD:										DRILLING		START		FINISH	
Core												TIME		TIME	
WATER LEVEL										DATE		DATE			
DATE										11/27/95					
CASING DEPTH															
DATUM										ELEVATION		SURFACE CONDITIONS			
SAMPLER TYPE	INCHES DEPTH	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH								
						0		grassy field							
						1		Topsoil							
						2		H. & Septic drainfield lateral.							
						3		Silt & Pvc drainable in coarse 2-3" d. subangular gravel							
						4									
						5		Silty sand, minor gravel							
						6	SP	30% silt							
						7		50% fine to coarse sand (med)							
						8		more small gravel & pebbles (rough) to subangular							
						9		clean sand - medium							
						10		Sandy gravel 50% gravel 1" diam subangular to subangular							
						11		50% fine to coarse sand							
						12									
						13	GP	NA, decreasing sand, (wet)							
						14									
						15									
						16									
						17									
						18		TD = 18'							
						19		2" PVC Monitor Well Installed							
						20									

DRILLING CONTRA O'Keeke
Bulk, MT
 (No215432)
 BY B. Levens
 DATE 11/27/95 CHK'D BY

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION FHS					
										DRILLING METHOD: 8" 4.5 Auger				BORING NO. M-13					
										SAMPLING METHOD: Grab				SHEET 1 of 1					
										WATER LEVEL				START TIME		FINISH TIME			
										TIME				DATE		DATE			
										CABING DEPTH				DATE 11/27/95		DATE			
DATUM										ELEVATION									
SAMPLER TYPE	INCHES DOWN RECORDED	DEPTH OF CASING	SAMPLER NO.	BLOW/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:											
						0		grassy field											
						1		Top soil											
						2													
						3													
						4													
G			1.5			5	SM	Silty Sand, minor pebbles and gravel											
						6		20% silt											
						7		70% fine to coarse sand											
						8		predominantly med. sand											
						9		10% gravel and pebbles < 1" diam											
						10		rounded to subangular											
G			2.0			10	SP	Sandy gravel											
						11		60% gravel 1-2" diam.											
						12		subangular to subrounded											
						13		40% fine to coarse sand											
						14													
G			3.5			15	GP	AA, clayey sand. (wet)											
						16													
						17													
						18		TD = 18'											
						19		2" PVC Monitor Well Installed											
						20													

DRILLING CONTR. O'Keefe
Butte, MT

[illegible]

LOCATION OF BORING

JOB NO.

CUSTOM

LOCATION
F48

DRILLING METHOD:		BORING NO.	
8" HS Auger		M-15	
SAMPLING METHOD:		SHEET	
Core		1 of 1	
WATER LEVEL		START	FINISH
TIME		TIME	TIME
DATE		DATE	DATE
CASING DEPTH		1/27/95	

OBTAIN	SAMPLER TYPE	INCHES DEEPER	DEPTH OF CASING	SAMPLE NO	SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS
								0		Grassy field
								1		
								2		
								3		
								4		
								5	SM	Silty sand, some pebbles
								6		70% fine to medium sand
								7		30% silt and fine sand
								8		more pebbles 2" diameter (only) to
								9		submerged
								10	SP	clean sand
								11		
								12		
								13		
								14		
								15	SP	Sandy gravel 60-70% gravel
								16		1-2" diameter subrounded
								17		to subangular
								18		30-40% medium to coarse sand
								19		
								20		
								21		
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								100		

BY B. Lawrence DATE 11/27/95 CHK'D BY NO215432 DRILLING CONTR O'Leary Bu 46, MT

300 1 (2) (REV 11-90)

Topsoil
Silty loam
Silty sand, some pebbles
70% fine to medium sand
30% silt and fine sand
more pebbles 2" diameter (only) to
submerged
clean sand
Sandy gravel 60-70% gravel
1-2" diameter subrounded
to subangular
30-40% medium to coarse sand
Am, alternating sand (loose)
TD = 12'
2" PVC Monitor Well Installed

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ONLINE

TIME	...
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1421

1129695

Fuzzy Fields

132

NO2154327
 DATE 11/27/95
 CHK'D BY

DRILLING CONTR
 Rm Ht, MT

LOCATION OF BORING				JOB NO.		CLIENT		LOCATION	
								F145	
				DRILLING METHOD		BORING NO.		M-18	
				8" H. Auger		SHEET		1 of 1	
				SAMPLING METHOD		DRILLING			
				Grab		START TIME		FINISH TIME	
				WATER LEVEL		DATE		DATE	
				TIME		DATE		DATE	
				CASING DEPTH		DATE		DATE	
				12715					

OBTAIN		ELEVATION		SURFACE CONDITIONS				
SAMPLER TYPE	INCHES DEPTH	DEPTH OF CASING	SAMPLE NO	BLW/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						0		grassy field
						1		black silty loam
						2		fill sand to P.B. - non active silt
						3		
						4		
						5		silty sand -
4			15			6		85% medium to coarse sand
						7		minor silt, 4.5' to
						8		
						9		
						10		
4			2			11		sturdy gravel
			10			12		65% gravel ~ 1" diam
						13		subangular to subround
						14		90% fine to coarse sand
						15		
5			3			16		an. drusey sand (wet)
						17		
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TB: 10'
 2" PVC Monitor Well Installed

LOCATION OF BORING				JOB NO.	CLIENT	LOCATION
DRILLING METHOD 8" 14S Auger				BORING NO. M-21		
SAMPLING METHOD GWS				SHEET 1 of 1		
WATER LEVEL TIME				DRILLING START TIME		
DATE				DATE		
CASING DEPTH				DATE 11/27/95		
SURFACE CONDITIONS:						
grassy field						
Topsoil						
silty sandy loam - black minor gravel						
fill? non-unique						
silty sand. 70% sand, fine to med 30% silt						
AA						
gravelly sand 80% med - coarse sand 20% gravel 1-2" & subrounds subangular						
silty gravel 60% med fine to med 30-40% sand, med-coarse (well)						
TD: 15'						
2" PVC Manifold Well Installed						

SAMPLER TYPE	INCHES RECORDED	DEPTH OF CASING	SAMPLE NO. SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	ELEVATION	
								DATE	TIME
GT			1			0			
GT			2			1			
GT			3			2			
GT			4			3			
GT			5			4			
GT			6			5			
GT			7			6			
GT			8			7			
GT			9			8			
GT			10			9			
GT			11			10			
GT			12			11			
GT			13			12			
GT			14			13			
GT			15			14			
GT			16			15			
GT			17			16			
GT			18			17			
GT			19			18			
GT			20			19			
GT			21			20			
GT			22			21			
GT			23			22			
GT			24			23			
GT			25			24			
GT			26			25			
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GT			28			27			
GT			29			28			
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GT			42			41			
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GT			70			69			
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GT			99			98			
GT			100			99			

BY: B. Lawrence
 DATE: 11/27/95
 CHK'D BY:

No 215432
 DRILLING CONT: O'Keeffe
 P-4, MT

LOCATION OF BORING						JOB NO.		CLIENT		LOCATION	
										FH5	
						DRILLING METHOD		BORING NO.		M-22	
						9" 14 S. Aug				SHEET	
						SAMPLING METHOD				1 of 1	
						Cone				DRILLING	
						WATER LEVEL				START TIME	
						TIME				FINISH TIME	
						DATE				DATE	
						CASING DEPTH				DATE	
										1/27/95	
ELEVATION						SURFACE CONDITION					
DATE						grassy field					
SAMPLER TYPE						Tap Soil					
INCHES DRIVEN											
INCHES RECOVERED											
DEPTH OF CASING											
SAMPLE NO.											
SAMPLE DEPTH											
BLOWS/FT SAMPLE											
NUMBER OF RINGS											
DEPTH IN FEET											
SOIL GRAPH											
0						SM					
1											
2						Septic line trench encountered					
3						Raiser pit, light gravel at 2'					
4						with septic odor					
5						silty sand 50-60% fine sand					
6						40-50% silt					
7						AN					
8											
9						Gravelly sand 80% and heavier					
10						20-25% gravel					
11						1-2" diameter sub-siding to					
12						sand					
13						CP					
14						sandy gravel 60-70% gravel, AN					
15						(best) 30-40% mud to gravel					
16						sand					
17											
18						TD = 18'					
19						2" PVC Monitor Well Installed					
20											

NO 215432
 DRILLING CONTR
 BUTTE, MT
 BY: IS. LAWRENCE
 DATE: 1/28/85
 CHK'D BY:

LOCATION OF BORING							JOB NO.		CLIENT		LOCATION		
											F145		
							DRILLING METHOD:				BORING NO.		
							8" H.S. Auger				M-24		
							SAMPLING METHOD:				SHEET		
							Core				1 of 1		
							WATER LEVEL				DRILLING		
							TIME				START TIME		
							DATE				FINISH TIME		
							CASING DEPTH				DATE		
											1/28/85		
DATUM							ELEVATION						
SAMPLER TYPE	INCHES RECORDED	DEPTH OF CASING	SAMPLE IN	BLOW/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:					
						0		grassy field					
						1		Top soil					
						2							
						3							
						4							
G			1/5			5		Sand, minor silt and pebbles					
						6							
						7	SP						
						8							
						9							
G			2/10			10		Clean sand. v. fine to fine sand					
						11							
						12	K						
						13		wet					
G			3/15			14		gravelly sand 70% fine-med sand					
						15	SP	30% gravel < 1" diameter (subround)					
						16							
						17							
						18		TD: 18'					
						19	GP						
						20		2" PVC Monitor well installed.					

O'Leary
 DRILLING CONTRACTOR
 BUTTE, MT
 NO215439
 DATE 11/28/95
 CHK'D BY
 11/28/95

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION FHS	
DRILLING METHOD 8" 14.5" Auger										BORING NO. M26		SHEET 1 of 1			
SAMPLING METHOD Grab										DRILLING		START TIME 0840			
WATER LEVEL										FINISH TIME 0910		DATE 11/28/95			
TIME										DATE		DATE			
DATE										CASING DEPTH		DATE			
ELEVATION										SURFACE CONDITIONS		DATE			
DATUM										grassy field					
SAMPLER TYPE	INCHES DRIVER RECORDED	DEPTH OF CASING	INCHES SAMPLE DOWN	ALONG/H SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH								
						0		Silt, topsoil, brown dry							
						1									
						2									
						3									
						4									
G			1.5			5	SM	Silty sand 90% fine to v. fine sand (fine) 10% + silt							
						6									
						7									
						8									
						9		Concrete encountered							
G			2.1			10	GP	Sand and gravel 50/50 fine to medium sand and gravel 1/4 - 2" diam.							
						11									
						12									
						13									
G			3.15			15	GP	Sandy gravel, wet 70% coarse material 1/2 - 1 1/2" subrounded 30% fine to med. sand to rounded							
						16									
						17									
						18		TD = 17'							
						19		2" PVC well installed							
						20									

BY B. Lawrence
 DATE 1/20/15 CHM'D BY _____

No215432
 DRILLING CONTR O'kerke
Belle, MT

LOCATION OF BORING				JOB NO.	CLIENT	LOCATION
						<u>F145</u>
DRILLING METHOD: <u>8" 14.5 Auger</u>				BORING NO. <u>M-27</u>		
SAMPLING METHOD: <u>grab</u>				SHEET <u>1 of 1</u>		
WATER LEVEL TIME DATE				DRILLING START TIME END TIME		
CASING DEPTH				DATE <u>1/20/15</u>		

DATE		ELEVATION		SURFACE CONDITIONS				
SAMPLER TYPE	INCHES DRIVEN / RECOVERED	DEPTH OF CASING	SAMPLE NO	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						0		<u>Grassy Field</u>
						1		<u>Total</u>
						2		
						3		
						4		
						5		
						6		
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						100		

gravelly sand

75% fine to med sand

25% small gravel & 1 diameter

round to subround

Steady gravel, wet

60% coarse gravel

1-2" diameter

Subrounded

45% fine to coarse sand (medium)

FD=18'

2" PVC Manometer Well Installed

SM

90% fine-med sand

(fine)

15% silt

SM

gravelly sand

75% fine to med sand

25% small gravel & 1 diameter

round to subround

Steady gravel, wet

60% coarse gravel

1-2" diameter

Subrounded

45% fine to coarse sand (medium)

FD=18'

2" PVC Manometer Well Installed

DRILLING CONTR 01444
Bulle, MT

[illegible]

NO215432
 DRILLING CONTR. O'Leary
 Bath, VT
 BY K. L. Laverne
 DATE 1/28/15
 CHWD BY

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION FHS	
										DRILLING METHOD: 8" 11 S Auger		BORING NO. M-29			
										SAMPLING METHOD: Grab		SHEET 1 of 1			
										WATER LEVEL		ORILLING			
										TIME		START TIME			
										DATE		DATE			
										CASING DEPTH		DATE 1/28/15			
DATUM										ELEVATION		SURFACE CONDITIONS:			
SAMPLER TYPE	WATER LEVEL	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH								
						0		grassy field							
						1		Top soil							
						2									
						3									
						4									
G			1/5			5	SP	Gravelly sand, 80% fine to medium sand 20% sub rounded gravel < 1" d.							
						6									
						7									
						8									
						9									
G			2/10			10		AA, gravelly sand							
						11									
						12									
						13									
G			3/5			15	GP	AA, increasing gravel, wet gravelly sand / sandy gravel gravel increasing in size							
						16									
						17									
						18		TD = 18'							
						19									
						20		2" PVC Monitor well installed							

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION	
DRILLING CONTR. <u>O'Keefe</u> <u>BuHe, MT</u> No215432 BY <u>B. Lawrence</u> DATE <u>1/28/95</u> CHK'D BY _____ 000 1 120 1 REV 11 001										DRILLING METHOD: <u>8" 14.5 Auger</u>		BORING NO. <u>M-30</u>			
										SAMPLING METHOD: <u>Core</u>		SHEET <u>1 of 1</u>			
										WATER LEVEL TIME		START TIME			
										DATE		FINISH TIME			
										CASING DEPTH		DATE <u>1/28/95</u>			
SURFACE CONDITIONS:															
<u>grassy field</u>															
<u>Top soil</u>															
<u>SP</u> <u>Gravelly sand</u> <u>85% fine to medium sand</u> <u>15% subangular gravel 1-2" d.</u>															
<u>SP</u> <u>AA, gravelly sand, coarse</u>															
<u>SP</u> <u>Sandy gravel, wet</u> <u>70% gravel, AA</u> <u>30% fine to med. sand</u>															
<u>TD = 18'</u>															
<u>2" PVC Monitor Well Installed</u>															

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION	
DRILLING METHOD: 8" 1 1/2 S. Auger DRILLING METHOD: 1 or 1 WATER LEVEL: TIME: DATE: CASING DEPTH: SURFACE CONDITIONS:										BORING NO.		DATE			
										M-31		1/28/95			
SAMPLER TYPE	INCHES DRIVEN	INCHES RECOVERED	DEPTH OF CASING	SAMPLER NO.	SAMPLER DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:					
										grassy field					
								0		Top Soil					
								1							
								2							
								3							
								4							
								5	SM	Silty sand, coarse gravel					
								6		75% fine to v. fine sand					
								7		20% silt					
								8		5% pebbles and small gravel					
								9							
								10							
								11	SP	gravelly sand					
								12		80% fine to medium sand					
								13		20% small gravel and pebbles					
								14		4" d.					
								15		wet					
								16							
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								100							

420 1 (2) (REV 11-90)

BY: IS. Lawman
 DATE: 1/28/95 CHN'D BY:

NO215432 DRILLING CONTR: O. Kerk
Beth, MT

LOCATION OF BORING		JOB NO.		CLIENT		LOCATION F-145						
BY: <u>B. Lawrenson</u> DATE: <u>11/26/95</u> CHK'D BY: _____		DRILLING CONTR. <u>O'Leary</u> <u>Bulk, MT</u>		NO. <u>215432</u>		SCALE: _____						
DATE	SAMPLER TYPE	INCHES DOWN	DEPTH OF CASING	SAMPLE NO.	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:			
									DRILLING METHOD: _____ 8" 1 1/2 Auger SHEET M-32			
									SAMPLING METHOD: _____ Coreb ORILLING 1 or 1			
									WATER LEVEL: _____ TIME: _____ DATE: _____			
									CASING DEPTH: _____ DATE: 11/26/95			
									START TIME: _____ FINISH TIME: _____			
									2" PVC Monitor Well Installed			
									Top soil			
									Grassy field			
									Sandy gravel 50/50 fine to med. sand gravel 1-2" & surrounded by subangular (wet) AA, increasing gravel, decreasing sand gravel consistently 1-2" d. TO - 20' AA, sandy gravel, coarse gravel			

LOCATION OF BORING

JOB NO.

CLIENT

LOCATION

FHG

DRILLING METHOD:

8" 1/4 S. Auger

BORING NO.

M-35

SAMPLING METHOD:

gab

SHEET

1 of 1

WATER LEVEL

TIME

DATE

DATE

TIME

CASING DEPTH

11/2/195

DATUM

ELEVATION

SURFACE CONDITIONS:

grassy field

SAMPLER TYPE

HOLE'S

DEPTH

INCHES

RECORDED

DEPTH OF CASING

SAMPLE DE

SAMPLE DEPTH

BLOWS/FT SAMPLER

NUMBER OF RINGS

DEPTH IN FEET

SOIL GRAPH

20

19

18

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BY: B. Lanerman

DATE: 11/2/195

CHK'D BY:

No215432

DRILLING CONTR: O'Keefe

Bulk, MT

000 1 131 (REV 11-00)

LOCATION OF BORING				JOB NO.		CLIENT		LOCATION																																		
BY: <u>B. Lauer</u> DATE: <u>1/28/95</u> CHK'D BY: _____ No <u>215439</u> DRILLING CONTR: <u>O'Keefe</u> <u>Belle, MI</u>				DRILLING METHOD: <u>Q11 15 Auger</u>		BORING NO.: <u>M-36</u>																																				
				SAMPLING METHOD: <u>Core</u>		SHEET: <u>1 of 1</u>																																				
				WATER LEVEL: _____		START TIME: _____																																				
				TIME: _____		FINISH TIME: _____																																				
				DATE: _____		DATE: _____																																				
CASING DEPTH: _____				DATE: <u>1/28/95</u>																																						
SURFACE CONDITIONS:																																										
<u>Grassy field</u>																																										
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">DEPTH IN FEET</th> <th rowspan="2">SOIL GRAPH</th> <th rowspan="2">SAMPLER TYPE</th> <th rowspan="2">INCHES DRIVEN</th> <th rowspan="2">INCHES RECOVERED</th> <th rowspan="2">DEPTH OF CASING</th> <th rowspan="2">SAMPLE NO.</th> <th rowspan="2">SAMPLE DEPTH</th> <th rowspan="2">BLOWS/FT SAMPLER</th> <th rowspan="2">NUMBER OF RINGS</th> <th rowspan="2">ELEVATION</th> <th rowspan="2">DPT/M</th> </tr> </thead> <tbody> <tr> <th>0</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>7</th> <th>8</th> <th>9</th> <th>10</th> <th>11</th> <th>12</th> <th>13</th> <th>14</th> <th>15</th> <th>16</th> <th>17</th> <th>18</th> <th>19</th> <th>20</th> </tr> </tbody> </table>										DEPTH IN FEET	SOIL GRAPH	SAMPLER TYPE	INCHES DRIVEN	INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO.	SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	ELEVATION	DPT/M	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DEPTH IN FEET	SOIL GRAPH	SAMPLER TYPE	INCHES DRIVEN	INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO.	SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS													ELEVATION	DPT/M																			
										0	1	2	3	4	5	6	7	8	9	10	11			12	13	14	15	16	17	18	19	20										
<u>SM</u> <u>Heavy silt, brown, dry top soil</u> <u>90% silt, 10% fine to coarse sand</u> <u>ABA, increasing sand</u> <u>Seedy silt or silty sand</u> <u>50/50 silt and fine sand</u> <u>Spent increased ~ 12'</u> <u>Generally sandy, wet</u> <u>70% fine to coarse sand (mostly fine)</u> <u>33% small gravel (subrounded to round)</u> <u>1/4-3/4" gravel, moderately sorted</u> <u>TD = 20' 2" PVC well installed</u>																																										

NO215439
 DRILLING CONTRACTOR
 O'Leary
 DATE 7/13/95
 CHK'D BY
 B. Lawrence

LOCATION OF BORING				JOB NO.		CLIENT		LOCATION FITS			
				DRILLING METHOD: 8" H.S. Auger				BORING NO. M 38			
				SAMPLING METHOD: Core / Auger inspect.				SHEET 1 of 1			
				WATER LEVEL				START TIME		FINISH TIME	
				TIME				1645		1705	
				DATE				DATE		DATE	
DATUM				ELEVATION				CASING DEPTH 16.35			
DATE 7/13/95				TIME 1645				TIME 1705			

SAMPLER TYPE	MOISTURE CONTENT	DEPTH OF CASING	SAMPLE TYPE	BLANKET SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:
						0		grassy field
						1		Silt, brown, dry
						2		
						3		
						4		
G		1.5				5	SP	clean sand 100% fine to medium sand (fine)
						6		
						7		
						8		cravel encountered
						9	SP	
G		2.5				10		Sandy gravel (wF)
						11		60-70% gravel 1/2-1 1/2" sub rounded
						12		30% fine to medium sand (fine)
						13	GP	cravelly sand / sandy gravel AA
						14		
						15		
						16		
						17		TD = 17'
						18		2" PVC well installed
						19		
						20		

No 215439
 O'Leary
 B. Levern
 DATE 7/12/15
 CHK'D BY

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION	
														FITS	
										DRILLING METHOD		BORING NO.		SHEET	
										0" 1/2 S. Auger		M 39		1 of 1	
										SAMPLING METHOD		DRILLING			
										Cuts / Auger inspect					
										WATER LEVEL		START		FINISH	
												TIME		TIME	
										DATE		DATE		DATE	
										CASING DEPTH		16.4		7/12/15	

DATUM					ELEVATION					SURFACE CONDITIONS:	
SAMPLER TYPE	INCHES RECORDED	DEPTH OF CASING	DEPTH OF SAMPLE	BLOW/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH				
						0		grassy field			
						1		Silt, dry, brown			
						2					
						3	SM				
						4					
G			1/5			5		Clean sands			
						6	SP	100% fine to medium sand (fine)			
						7					
						8		Concrete encountered			
						9					
						10		Sand and gravel (wet)			
G			2/10			11		50/50 fine to med sand and			
						12		gravel 1/2-1 1/2" moderately sorted			
						13		Subrounded			
						14					
G			3/15			15	Gr	Sandy gravel			
						16		75% gravel AFS			
						17		25% fine - med sand AFS			
						18		TTS = 17'			
						19		2" PVC well installed			
						20					

NO 215439
 DRILLING CONTRACTOR
 O'Keefe
 Bette, MT
 DATE 7/13/15
 CHK'D BY
 B. Lawrence

LOCATION OF BORING										JOB NO.		CLIENT		LOCATION	
														FHS	
										DRILLING METHOD				BORING NO.	
										8" I & S Auger				M 40	
										SAMPLING METHOD				SHEET	
										Core's / Auger inspect				1 of 1	
										WATER LEVEL				DRILLING	
														START TIME	
														1740	
										TIME				1805	
										DATE				DATE	
										CASING DEPTH				7/13/15	

DATUM					ELEVATION					SURFACE CONDITIONS:	
SAMPLER TYPE	INCHES BORED	DEPTH OF CASING	SAMPLE DEPTH	BLOW COUNT	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH				
						0		grassy field			
						1		silt, clay, brown			
						2					
						3					
						4					
G			1' 5"			5	SM	silty sand			
						6		10% fine to med sand (fine)			
						7		20% silt			
						8		gravel (moderate)			
						9					
G			2' 10"			10	SP	sandy gravel, wet			
						11		70% gravel 1/2 - 1 1/2" diameter			
						12		subangular moderately sorted			
						13		30% fine to med sand (fine)			
						14					
G			3' 15"			15	GP	A-2, sandy gravel wet			
						16					
						17		TD = 17'			
						18		2" PVC well installed			
						19					
						20					

BY: B. Lawrence

DATE: 7/12/95 CHK'D BY: _____

No 215439

DRILLING CONTR: O'Leary

B. & H. M.

LOCATION OF BORING				JOB NO.		CLIENT		LOCATION	
								FH5	
DRILLING METHOD:				Bolt's Auger		BORING NO.		M41	
SAMPLING METHOD:				CMB / Auger inspect		SHEET		1 of 1	
WATER LEVEL						START		FINISH	
TIME						TIME		TIME	
DATE						DATE		DATE	
CASING DEPTH				16.0		DATE		7/18/95	
SURFACE CONDITIONS:									
grassy field									
silt, washed sand, dry									
SM									
silty sand									
gray fine to med sand (fine)									
25% silt									
gravel encased									
SM									
sandy gravel, wet									
70-90% gravel 1/8" - 1 1/2" probably									
rounded to subrounded coated									
35% fine to medium sand (fine)									
wet									
sandy gravel, wet									
TB = 17'									
2" PVC well installed									

ELEVATION		DATUM	
DEPTH IN FEET	SOIL GRAPH	SAMPLER TYPE	INCHES DEPTH
0			
1			
2			
3			
4			
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APPENDIX C

Septic Effluent Loading Rates

APPENDIX C

EFFLUENT LOADING RATES

DATE	WEEKDAY	PUMP CYCLES			EFFLUENT DELIVERED	
		PUMP 1	PUMP 2	TOTAL	TO DRAINFIELD (gal)	
1996						
12-Apr	W	5	4	9	2880	
13-Apr	TH	3	2	5	1600	
18-Apr	TU	4	3	11	3520	
19-Apr	W	6	5	11	3520	
20-Apr	TH	4	5	9	2880	
21-Apr	F	5	5	10	3200	
22-Apr	S	1	1	2	640	
23-Apr	SU	1	0	1	320	
24-Apr	M	5	5	10	3200	
27-Apr	TH	7	6	13	4160	
28-Apr	F	5	6	11	3520	
29-Apr	S	4	3	7	2240	
30-Apr	SU	2	1	3	960	
1-May	M	11	11	22	7040	
2-May	T	6	7	13	4160	
3-May	W	6	5	11	3520	
12-May	F	6	6	12	3840	
13-May	S	3	3	6	1920	
14-May	SU	1	2	3	960	
15-May	M	7	6	13	4160	
16-May	T	7	7	14	4480	
17-May	W	7	7	14	4480	
18-May	TH	7	7	14	4480	
20-May	S	4	4	8	2560	
21-May	SU	2	2	4	1280	
22-May	M	7	7	14	4480	
29-May	M	6	6	12	3840	
30-May	T	7	6	13	4160	
2-Jun	F	7	7	14	4480	
16-Jun	F	1	1	2	640	
17-Jun	S	1	2	3	960	
18-Jun	SU	2	2	4	1280	
19-Jun	M	2	2	4	1280	
20-Jun	T	1	1	2	640	
21-Jun	W	2	2	4	1280	
22-Jun	TH	1	1	2	640	
23-Jun	F	1	1	2	640	
24-Jun	S	2	2	4	1280	
25-Jun	SU	2	1	3	960	
26-Jun	M	2	2	4	1280	
27-Jun	T	1	1	2	640	
28-Jun	W	1	1	2	640	
29-Jun	TH	1	2	3	960	
1-Jul	S	1	1	2	640	
2-Jul	SU	0	1	1	320	
3-Jul	M	1	1	2	640	
1996						
4-Jul	T	1	0	1	320	
5-Jul	W	1	1	2	640	
6-Jul	TH	1	1	2	640	
7-Jul	F	1	1	2	640	
9-Jul	SU	1	0	1	320	
10-Jul	M	1	1	2	640	
11-Jul	T	1	1	2	640	
12-Jul	W	1	1	2	640	
13-Jul	TH	1	1	2	640	
14-Jul	F	1	1	2	640	
15-Jul	S	0	1	1	320	
22-Aug	T	3	2	5	1600	
23-Aug	W	2	2	4	1280	
24-Aug	TH	3	2	5	1600	
25-Aug	F	3	3	6	1920	
26-Aug	S	1	2	3	960	
27-Aug	SU	3	3	6	1920	
28-Aug	M	3	4	7	2240	
29-Aug	T	5	4	9	2880	

APPENDIX C

EFFLUENT LOADING RATES

DATE	WEEKDAY	PUMP CYCLES			EFFLUENT DELIVERED	
		PUMP 1	PUMP 2	TOTAL	TO DRAINFIELD (gal)	
30-Aug	W	8	8	12	3840	
31-Aug	TH	7	6	13	4160	
3-Sep	SU	1	1	2	640	
5-Sep	T	6	5	11	3520	
7-Sep	TH	8	8	12	3840	
9-Sep	S	3	3	6	1920	
10-Sep	SU	1	0	1	320	
11-Sep	M	5	5	10	3200	
14-Sep	TH	5	6	11	3520	
15-Sep	F	8	5	11	3520	
18-Sep	S	1	1	2	640	
23-Sep	SU	2	1	3	960	
25-Sep	M	8	5	11	3520	
26-Sep	T	8	5	11	3520	
27-Sep	W	5	5	10	3200	
28-Sep	TH	7	6	13	4160	
29-Sep	F	6	5	11	3520	
30-Sep	S	0	1	1	320	
1-Oct	SU	1	1	2	640	
7-Oct	S	1	1	2	640	
8-Oct	SU	0	1	1	320	
9-Oct	M	6	5	11	3520	
10-Oct	T	5	5	10	3200	
11-Oct	W	5	6	11	3520	
12-Oct	TH	7	7	14	4480	
13-Oct	F	8	6	12	3840	
18-Oct	W	5	5	10	3200	
1996						
19-Oct	TH	1	2	3	960	
20-Oct	F	1	1	2	640	
23-Oct	M	4	5	9	2880	
24-Oct	T	5	5	10	3200	
25-Oct	W	5	4	9	2880	
26-Oct	TH	5	6	11	3520	
27-Oct	F	4	4	8	2560	
28-Oct	S	5	5	10	3200	
30-Oct	M	19	18	37	11840	
31-Oct	T	29	28	57	18240	
1-Nov	W	7	8	15	4800	
2-Nov	TH	8	5	11	3520	
3-Nov	F	7	8	15	4800	
4-Nov	S	2	2	4	1280	
13-Nov	M	4	4	8	2560	
14-Nov	T	5	5	10	3200	
15-Nov	W	5	5	10	3200	
16-Nov	TH	5	5	10	3200	
17-Nov	F	5	5	10	3200	
18-Nov	S	3	3	6	1920	
19-Nov	SU	1	1	2	640	

APPENDIX D

Monitoring Well Construction Summaries

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Well No. M-11

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.76

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 1'
 Driller O'Keefe Drilling
BuHE, MT
 Rig Mobile B-61
 Bit(s) 1 hollow stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+0.5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>+1.1 - 7.2</u>	<u>C2</u>	<u>-</u>
<u>7.2 - 17.2</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/capC2 2" SCH 40 PVC blankScreen: S1 2" SCH 40 PVC .020
slot

S2 _____

Filter Pack: Natural pack :o:Grout Seal: NoneBentonite Seal: hole plug
0.5 - 2'

Comments:

TD = 17.2' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

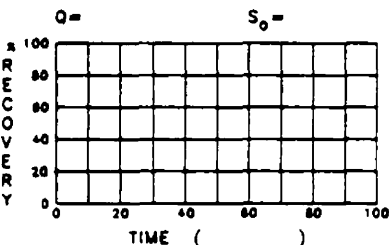
Well Development:

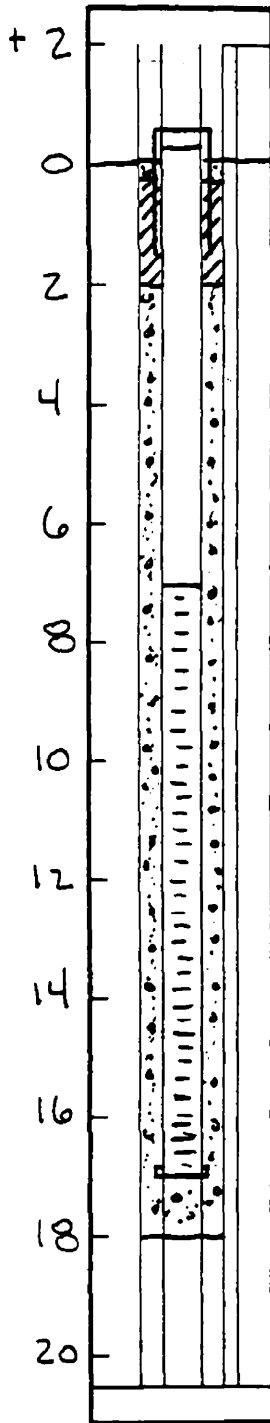
Swabbed and bailed

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

SITE NAME FHSLOCATION Frenchtown, MTSUPERVISED BY B. LauerDATE 1/27/95



Well No. M-12

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.83

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 2'
 Driller O'Keefe Drilling
Bufile, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
1.5 - 1.5	C1	-
1.2 - 7.3	C2	-
7.3 - 17.3	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020 slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug

0.5 - 2'

Comments:

TD = 17.3' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing:				
Filter Placement				
Cementing:				
Development				

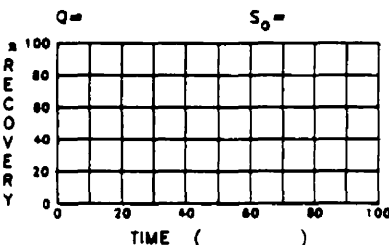
Well Development:

Swabbed and bailed

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

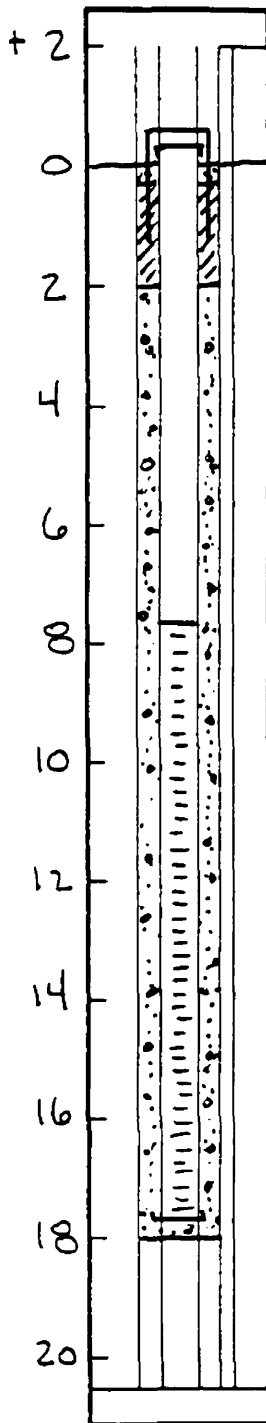


SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer

DATE 1/27/95



Well No. M-13

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.89

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Slick-up Height .4'
 Driller O'Keefe Drilling
BuHE, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>+4 - 7.7</u>	<u>C2</u>	<u>-</u>
<u>7.7 - 17.7</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020
Slot
 S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

Comments:

TD = 17.7' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

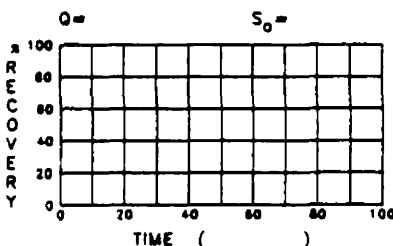
Well Development:

Swabbed and bailed.

Stabilization Test Data:

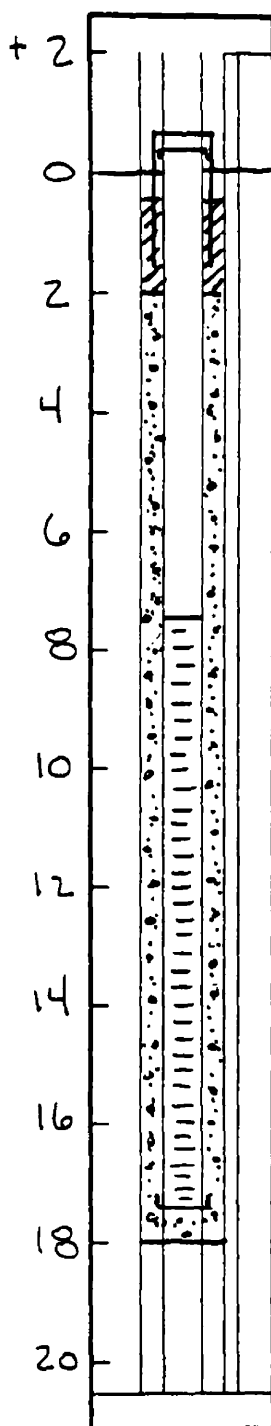
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/27/95



Well No. M-14

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.87

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height .3'
 Driller O'Keefe Drilling
Bullhead, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>1.5 - 1.5</u>	<u>C1</u>	-
<u>1.3 - 7.5</u>	<u>C2</u>	-
<u>7.5 - 17.5</u>	<u>S1</u>	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020
Slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug

0.5 - 2'

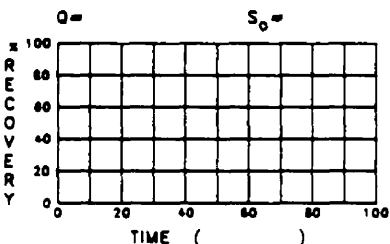
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

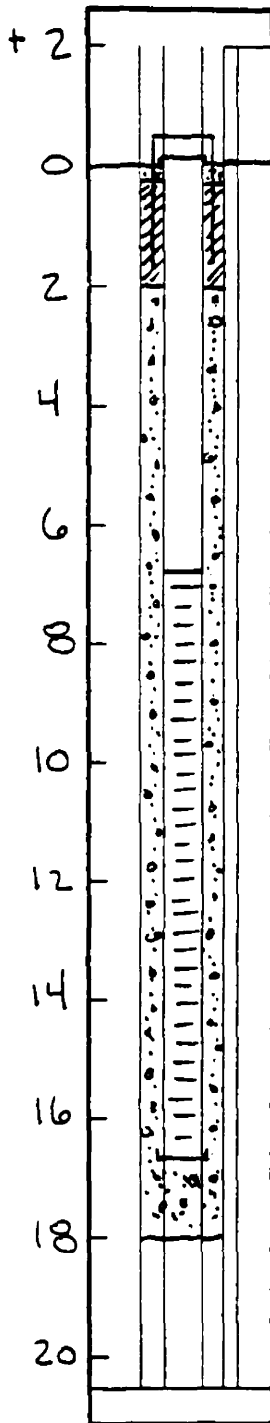
TD = 17.5' below TOC 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/27/95



Well No. M-15

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.52

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 1'
 Driller O'Keefe Drilling
Bull HC, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>0.5 - 1.5</u>	<u>C1</u>	
<u>1.1 - 6.7</u>	<u>C2</u>	
<u>6.7 - 16.7</u>	<u>S1</u>	

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020
Slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug

0.5 - 2'

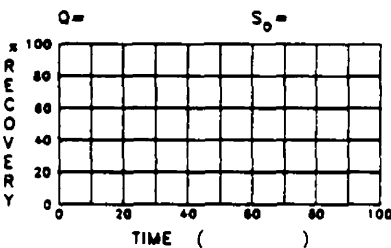
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

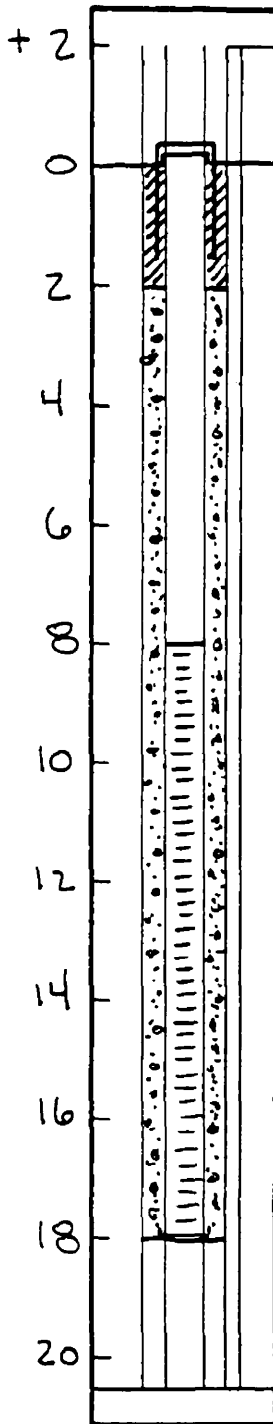
TD = 16.7' below TOC 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/27/95



Well No. M-16

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.49

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height .3'
 Driller O'Keefe Drilling
Bullhead, MT
 Rig Mobile B-61
 BH(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Basic: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>+3 - 8</u>	<u>C2</u>	<u>-</u>
<u>8 - 18</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap
 C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020 slot
 S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

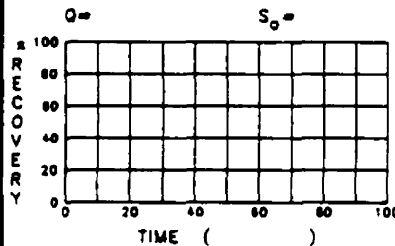
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

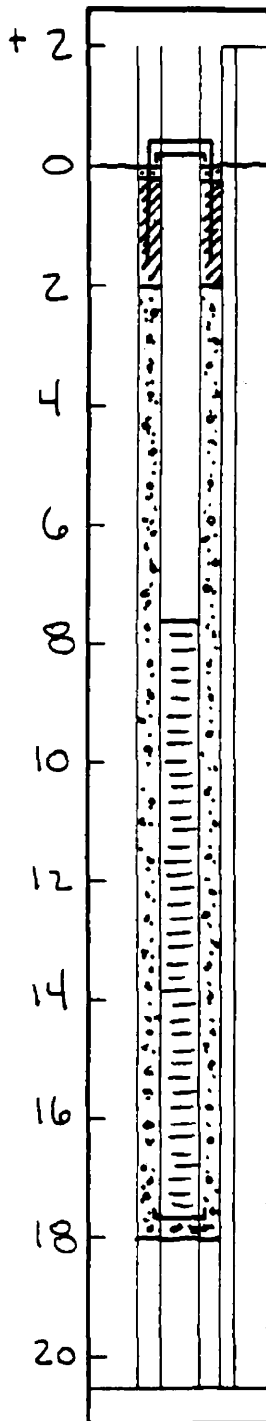
TD = 18' below TOC 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/27/95



Well No. M-17
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.57

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height .3'
 Driller O'Keefe Drilling
BuHe, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>+3 - 7.7</u>	<u>C2</u>	<u>-</u>
<u>7.7 - 17.7</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap
C2 2" SCH 40 PVC blank
 Screen: S1 2" SCH 40 PVC .020
Slat
S2

Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
25' - 2'

Comments:

ID = 17.7' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing:				
Filter Placement				
Cementing:				
Development				

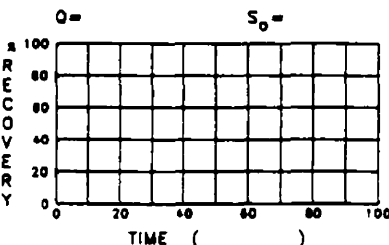
Well Development

Surbbed and bailed.

Stabilization Test Data:

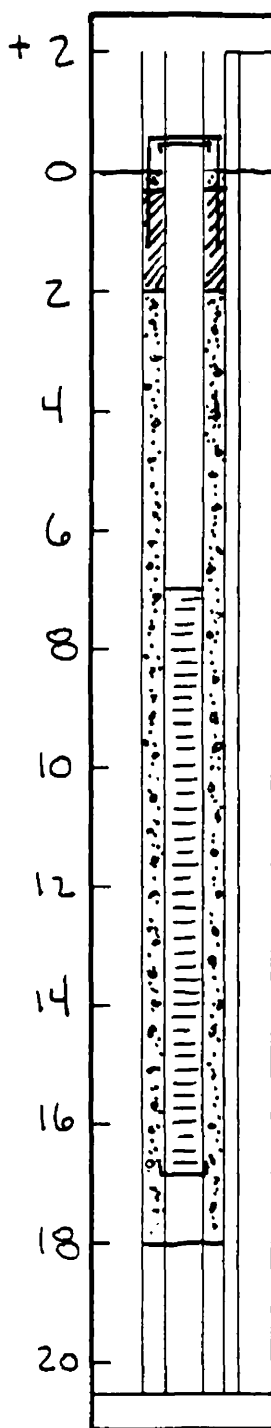
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FH2
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/27/95



Well No. M-18

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.51

Drilling Summary:

Total Depth 18'

Borehole Diameter 3"

Casing Set-up Height 4'

Driller O'Keefe Drilling

BuHe, MT

Rig Mobile B-61

Bit(s) Hollow Stem Auger

Drilling Fluid None

Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Coring:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____

Casing String (s): C = Casing S = Screen.

Depth	String(s)	
0.5 - 1.5	C1	-
4 - 7.1	C2	-
7.1 - 17.1	S1	-
-	-	-
-	-	-

Well Development:

Surcabled and bailed.

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020 Slot

S2 _____

Filter Pack: Natural pack

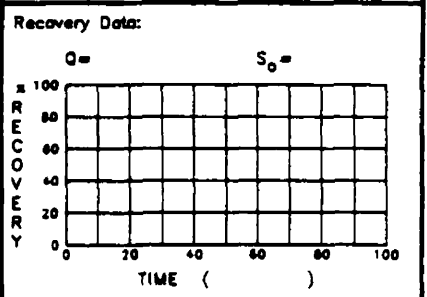
Grout Seal: None

Bentonite Seal: Hole plug

0.5 - 2'

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)



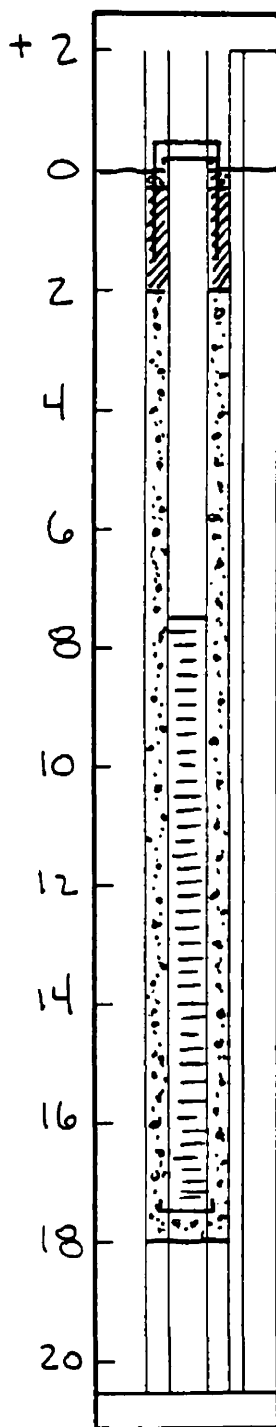
Comments: ID = 17.1' below TD C 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/27/95



Well No. M-19
 Boring No. X-Ref: Injection well

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.27

Drilling Summary:
 Total Depth 18'
 Borehole Diameter 3"
 Casing Stick-up Height 2'
 Driller O'Keefe Drilling
Buller, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:
 Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)
<u>0.5 - 1.5</u>	<u>C1</u>
<u>1.5 - 7.5</u>	<u>C2</u>
<u>7.5 - 17.5</u>	<u>S1</u>
_____	_____
_____	_____

 Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank
 Screen: S1 2" SCH40 PVC .020
Slot
S2
 Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
0.5 - 2'

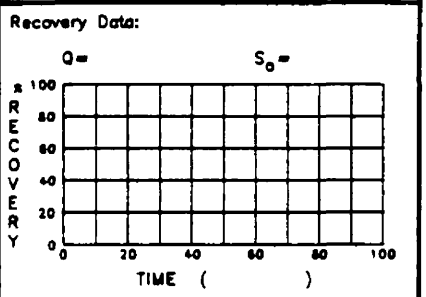
Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Development:
Swabbed and bailed.
Then pumped + surged
w/ contractor's pump.

Stabilization Test Data:

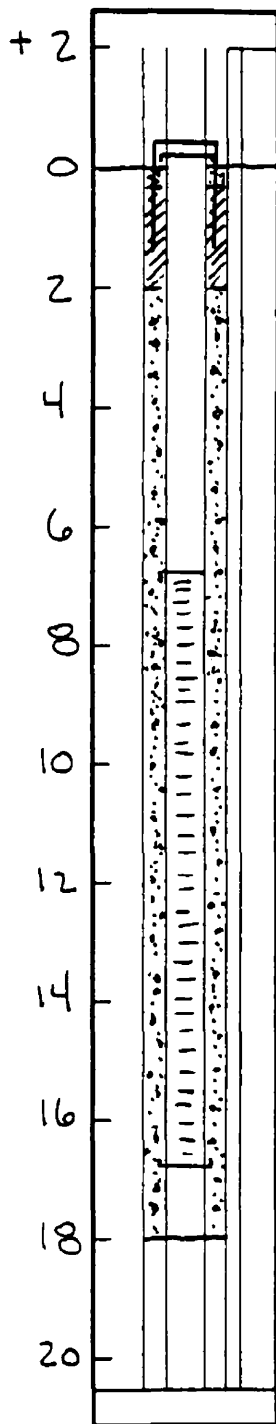
Time	pH	Spec. Cond.	Temp (C)



Comments:
TD = 17.5' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/27/95



Well No. M-20

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.20

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 2'
 Driller O'Keefe Drilling
B.H.R. MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
0.5 - 1.5	C1	-
1.5 - 6.75	C2	-
6.75 - 16.75	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank
 Screen: S1 2" SCH40 PVC .020
Slot
 S2 _____

Filter Pack: Natural pack 
 Grout Seal: None
 Bentonite Seal: Gate plug 
0.5 - 2'

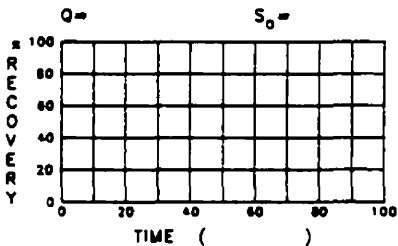
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

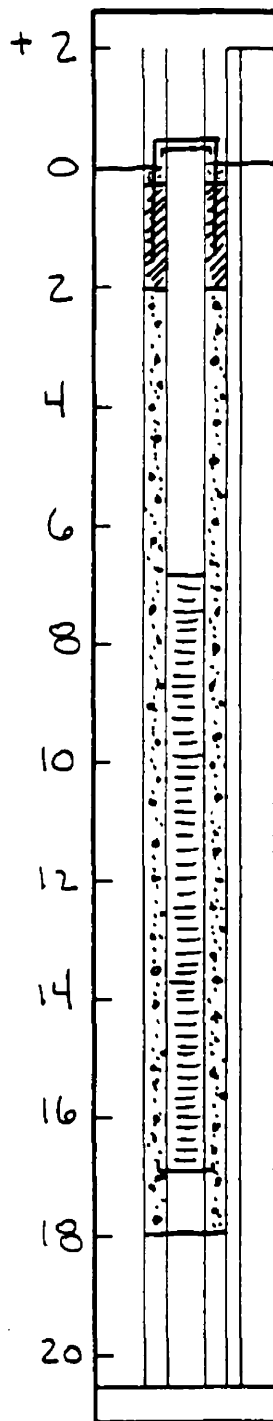


Comments:

TD = 16.75' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/27/95



Well No. M-21

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
Top of Casing 99.20

Drilling Summary:

Total Depth 18'
Borehole Diameter 8"
Casing Stick-up Height 5'
Driller O'Keefe Drilling
Bull Run, MT
Rig Mobile B-61
Bit(s) Hollow Stem Auger
Drilling Fluid None
Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____
Casing String (s): C = Casing S = Screen.

Depth	String(s)	
1 - 1	C1	
0.5 - 6.8	C2	
6.8 - 16.8	S1	

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020 slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5-2'

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing:				
Filter Placement				
Cementing:				
Development				

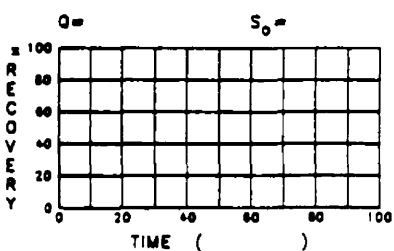
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

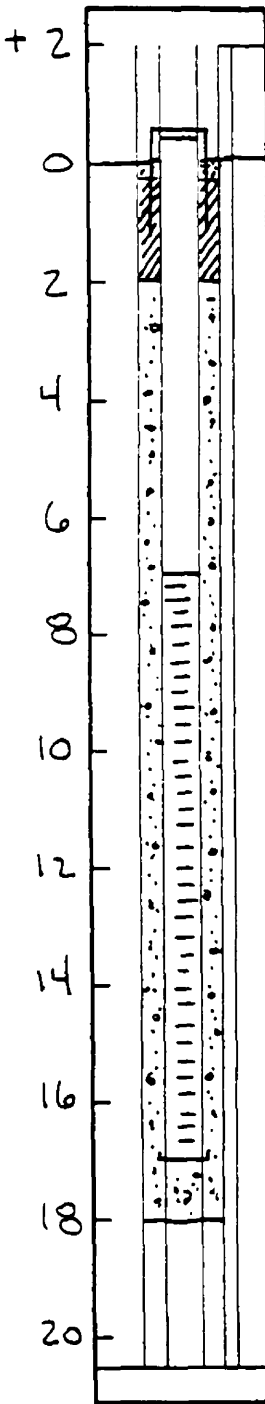


Comments:

TD = 16.8' below TOC 2" PVC

SITE NAME FHS
LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer
DATE 1/27/85



Well No. M-22

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.35

Drilling Summary:

Total Depth 17'
 Borehole Diameter 8"
 Casing Stick-up Height 5
 Driller O'Keefe Drilling
Bulk, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development				

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+1.0 - 1.0</u>	<u>C1</u>	<u>-</u>
<u>5 - 7</u>	<u>C2</u>	<u>-</u>
<u>7 - 17</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020
slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: hole plug
0.5 - 2'

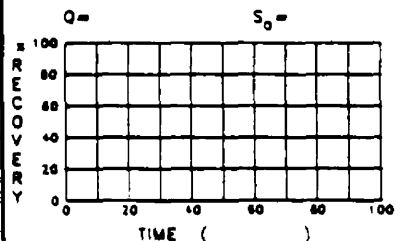
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

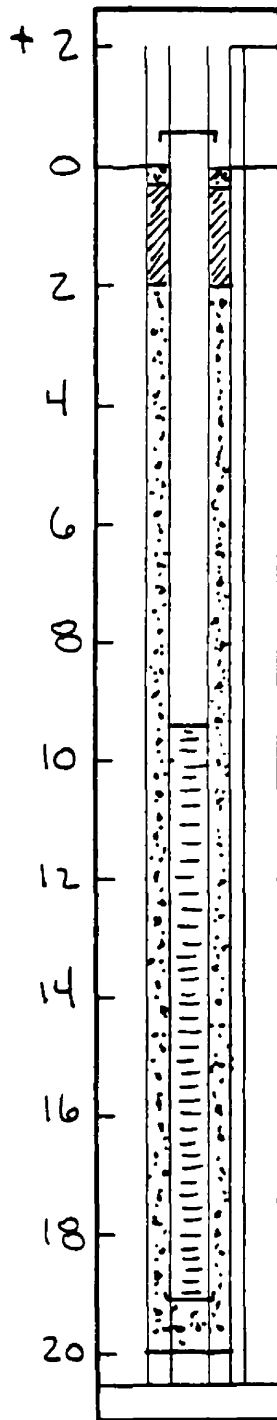
ID = 17' below TOC 2" PVC.

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer/mta

DATE 1/27/95



Well No. M-23
 Boring No. X-Ref: *

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing below grade *

Drilling Summary:

Total Depth 20'
 Borehole Diameter 8"
 Casing Stick-up Height 5' originally
 Driller O'Keefe Drilling
Bufile, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing none

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>none</u>	<u>C1</u>	<u>-</u>
<u>1.5 - 9.5</u>	<u>C2</u>	<u>originally</u>
<u>9.5 - 19.5</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank
 Screen: S1 2" SCH40 PVC .020
slot
S2

Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
0.5 - 2'

Comments:

TD = 19.5 below TOC 2" PVC (originally)
 * Well decommissioned 11/95. 2" PVC cut
and capped 1.5' below grade. Steel plate
buried 1' below grade for locating.

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

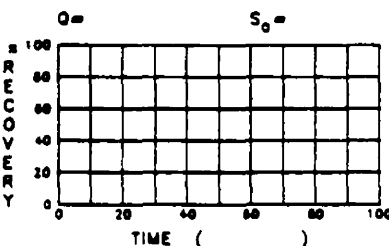
Well Development

Swabbed and bailed

Stabilization Test Data:

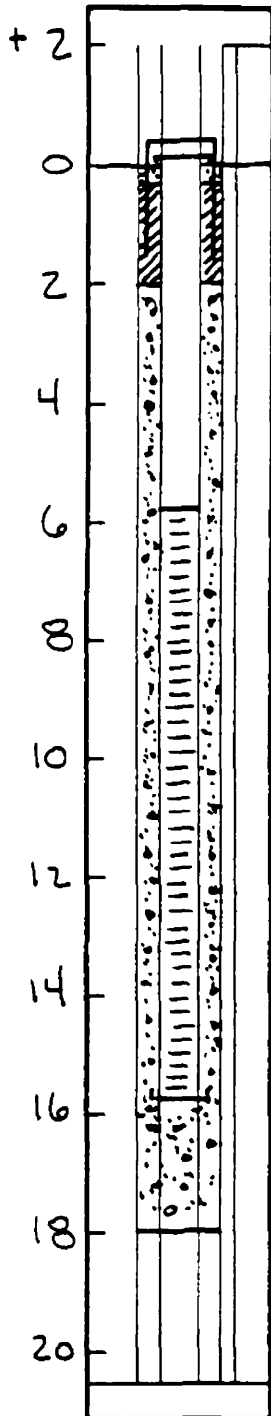
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer
 DATE 1/20/95



Well No. M-24

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.34

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height None
 Driller O'Keefe Drilling
BuHR, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
+25 - 1.5	C1	-
0 - 5.8	C2	-
5.8 - 15.8	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020
Slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

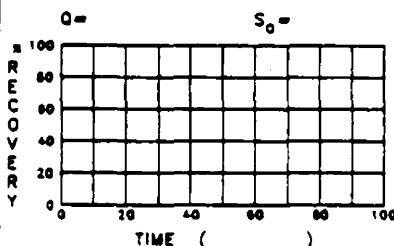
Well Development

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

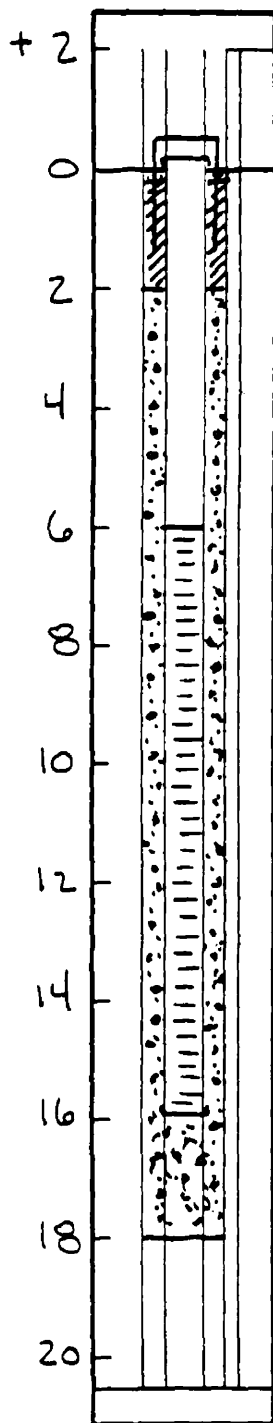
TD = 15.8' below TOC 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer

DATE 1/28/95



Well No. M-25

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.38

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Set-up Height 2'
 Driller O'Keefe Drilling
Buller, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>0.5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>1.5 - 6</u>	<u>C2</u>	<u>-</u>
<u>6 - 16</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC black

Screen: S1 2" SCH40 PVC .020
Slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

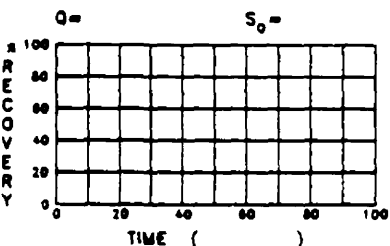
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



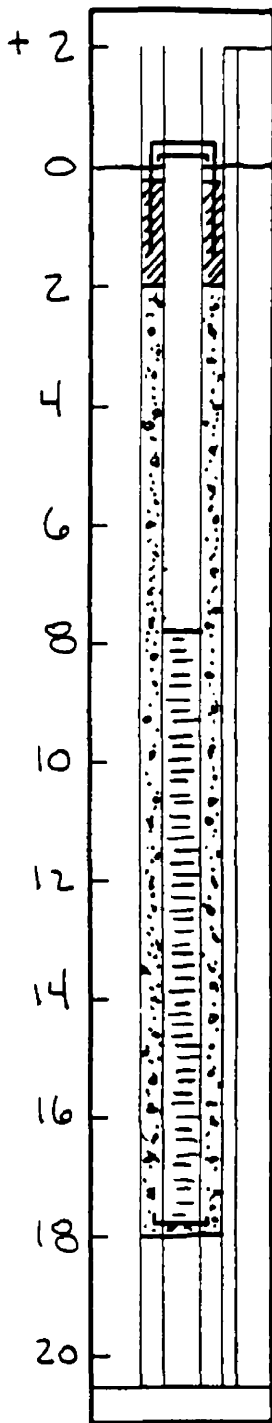
Comments:

TD = 16' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer

DATE 1/28/95



Well No. M-26

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.13

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 2
 Driller O'Keefe Drilling
Bufile, MT
 Rig Mobile B-41
 Bit(s) 1 hollow stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
0.5 - 1.5	C1	-
1.5 - 7.8	C2	-
7.8 - 17.8	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020
Slot

S2 _____

Filter Pack: Natural pack 1/2"

Grout Seal: None

Bentonite Seal: Half plug

0.5 - 2'

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

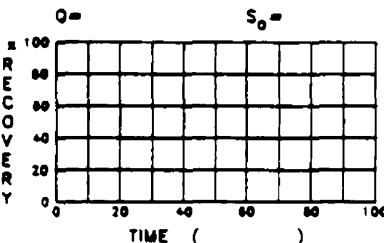
Well Development:

Swabbed and bailed.
Then pumped and surged
with contractor's pump.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



Comments:

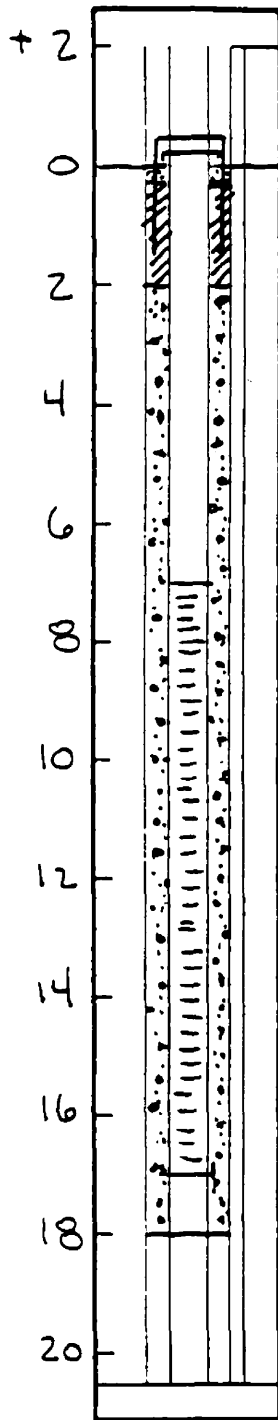
ID = 17.8' below TOC 2" PVC

SITE NAME FHS

LOCATION Frenchtown, MT

SUPERVISED BY B. Lowmeyer

DATE 1/28/95



Well No. M-27

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.18

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height .2'
 Driller O'Keefe Drilling
Bufile, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing:				
Filter Placement				
Cementing:				
Development				

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+1.5 - 1.5</u>	<u>C1</u>	<u>-</u>
<u>+2 - 7.1</u>	<u>C2</u>	<u>-</u>
<u>7.1 - 17.1</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020
slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug

0.5 - 2'

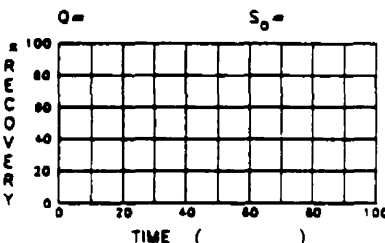
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



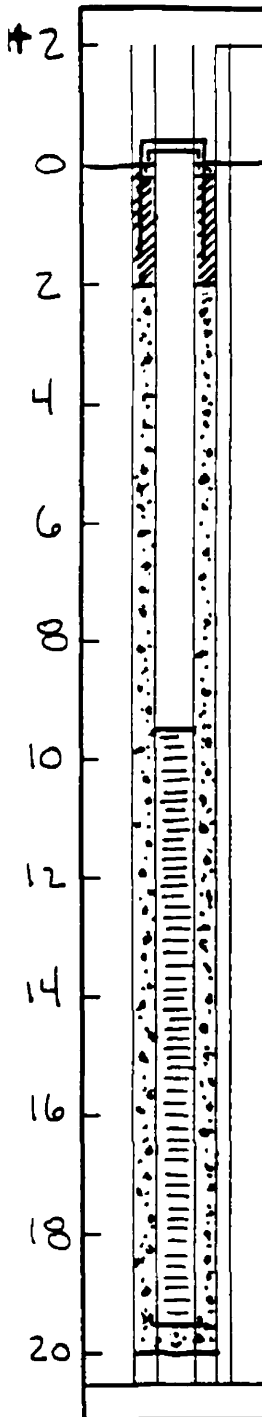
Comments:

TD = 17.1' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/28/95



Well No. M-28
 Boring No. X-Ref: _____
MONITOR WELL CONSTRUCTION SUMMARY
 Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 101.46

Drilling Summary:
 Total Depth 20'
 Borehole Diameter 8"
 Casing Stick-up Height .4'
 Driller O'Keefe Drilling
Bufile, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:
 Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)
<u>1.5 - 1.5</u>	<u>C1</u>
<u>1.4 - 9.5</u>	<u>C2</u>
<u>9.5 - 19.5</u>	<u>S1</u>
_____	_____
_____	_____
_____	_____

 Casing: C1 3" black steel w/cap
C2 2" SCH 40 PVC blank
 Screen: S1 2" SCH 40 PVC .020 slot
S2 _____
 Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
0.5 - 2'

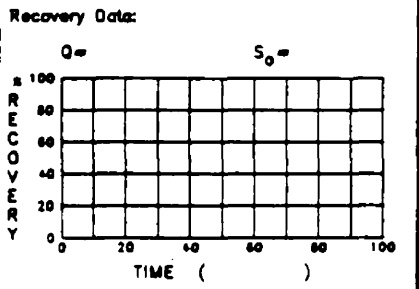
Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Development:
Swabbed and bailed.

Stabilization Test Data:

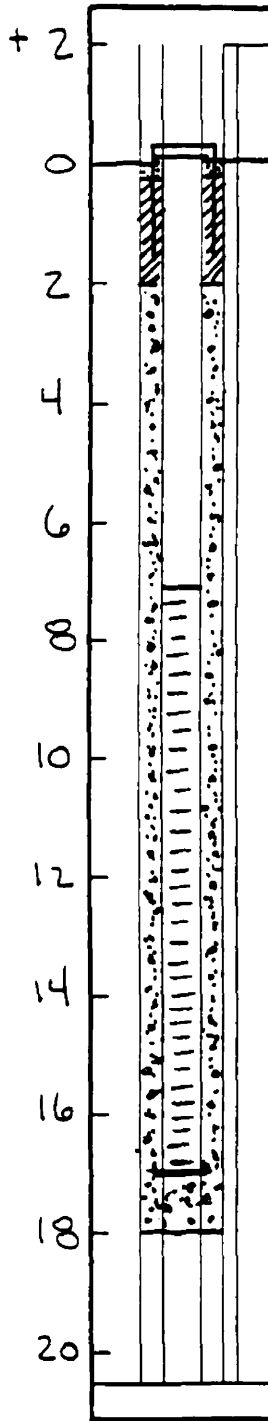
Time	pH	Spec. Cond.	Temp (C)



Comments:
TD = 19.5' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lawler
 DATE 1/23/95



Well No. M-29
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.78

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height none
 Driller O'Keefe Drilling
Bulk, MT
 Rig Mobile B-61
 Bit(s) 1 hollow stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>+5 - 1.5</u>	<u>C1</u>	
<u>0 - 7.1</u>	<u>C2</u>	
<u>7.1 - 17.1</u>	<u>S1</u>	

Casing: C1 3" black steel w/c.p

C2 2" SCH 40 PVC black

Screen: S1 2" SCH 40 PVC .020
slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: hole plug
0.5 - 2'

Comments:

ID = 17.1' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

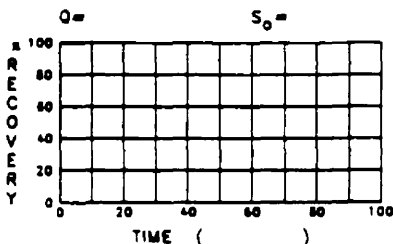
Well Development:

Swabbed and bailed.

Stabilization Test Data:

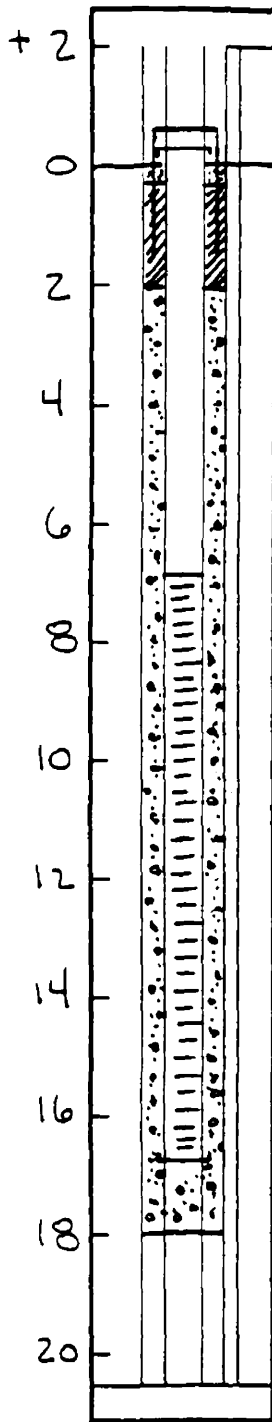
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHR
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/23/95



Well No. M-30
 Boring No. X-Ref: _____
 Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.85

MONITOR WELL CONSTRUCTION SUMMARY

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height 2'
 Driller O'Keefe Drilling
BuHE, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
+2 - 16.8	C1	-
16.8 - 18.8	C2	-
18.8 - 20.8	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/c.p.
C2 2" SCH 40 PVC blank
 Screen: S1 2" SCH 40 PVC .020
slot
 S2 _____

Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
0.5 - 2"

Comments:

TD = 16.8' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

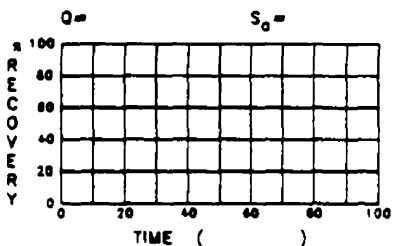
Well Development:

Surballed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Franchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/28/95

Well No. M-31
Boring No. X-Ref: _____

Elevation Ground Level	
Top of Casing	99.76

Well No. M-31
Boring No. X-Ref: _____

SUPERVISED BY B. Lauerman
DATE 1/28/45

SITE NAME FHS
LOCATION Frenchtown, MT

+ 2

Well No. M-32

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coord: _____

Elevation Ground Level _____

Top of Casing 101.34

Drilling Summary:

Total Depth 20'
 Borehole Diameter 8"
 Casing Stick-up Height None
 Driller O. Keith Drilling
 Rig B&K, MT
 Rig Mobile B-61
 Bits(s) Follow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basal: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)
<u>1.5' - 1.5'</u>	<u>C1</u>
<u>0' - 8.6'</u>	<u>C2</u>
<u>8.6' - 18.6'</u>	<u>S1</u>
_____	_____
_____	_____
_____	_____

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank
 Screen: S1 2" SCH40 PVC .020
slot

S2 _____

Filter Pack: Netural packGrout Seal: NoneBentonite Seal: Hold Plug0.5' - 2'

Comments:

TD = 18.6' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophysics Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Development

Stabilized and bailed.

Stabilization Test Data:

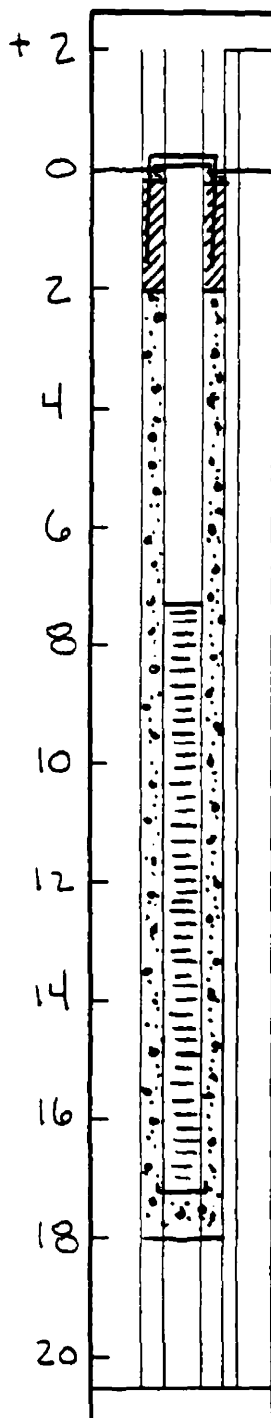
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

Q ₁₀₀		S ₁₀₀	
R	E	R	E
0	0	0	0
20	0	20	0
40	0	40	0
60	0	60	0
80	0	80	0
100	0	100	0

TIME ()

SUPERVISED BY B. LauermanDATE 1/28/95SITE NAME FHSLOCATION Frenchtown, MT



Well No. M-33

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 100.95

Drilling Summary:

Total Depth 18'
 Borehole Diameter 8"
 Casing Stick-up Height none
 Driller O'Keefe Drilling
BuHe, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
<u>0 - 1.5</u>	<u>C1</u>	-
<u>0 - 7.4</u>	<u>C2</u>	-
<u>7.4 - 17.4</u>	<u>S1</u>	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .070
Slot

S2 _____

Filter Pack: Natural pack +/-
25'

Grout Seal: None

Bentonite Seal: hole plug
0.5 - 2'

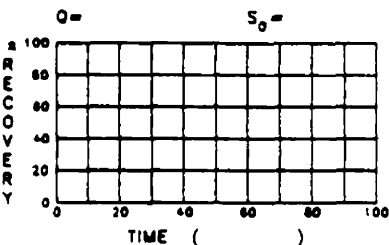
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



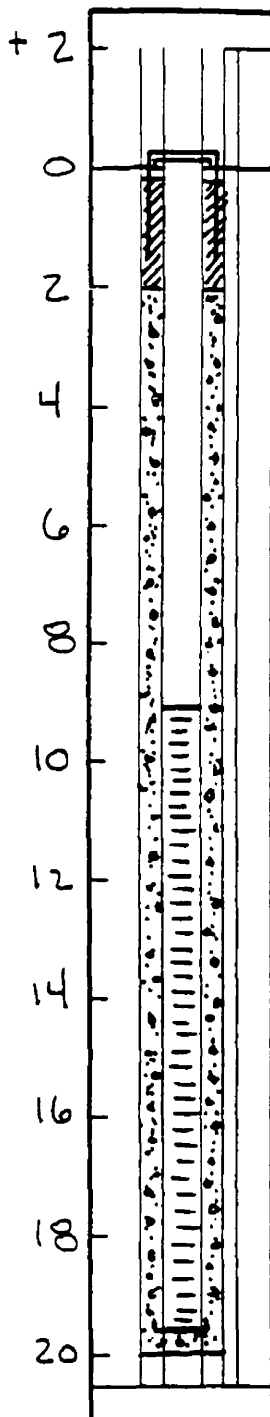
Comments:

TD = 17.4' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer

DATE 1/28/95



Well No. M-34
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 101.67

Drilling Summary:

Total Depth 20'
 Borehole Diameter 8"
 Casing Set-up Height 1'
 Driller O'Keefe Drilling
B.H.K. MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
0.5 - 1.5	C1	-
1.1 - 9.3	C2	-
9.3 - 19.3	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020
slat
 S2 _____

Filter Pack: Natural pack etc.

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

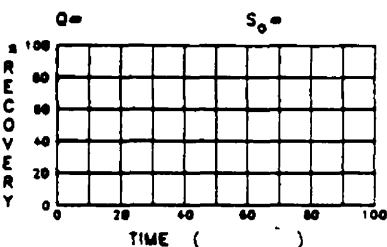
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

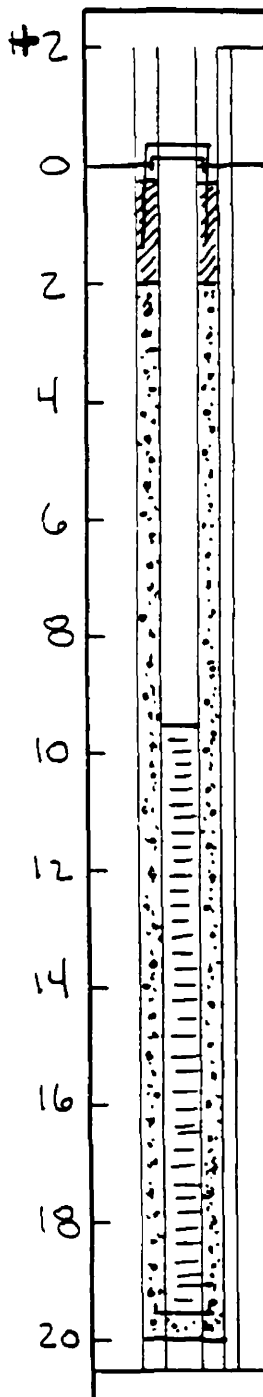


Comments:

TD: 19.3' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/28/95



Well No. M-35

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 101.57

Drilling Summary:

Total Depth 20'
 Borehole Diameter 8"
 Casing Stick-up Height 0.1'
 Driller O'Keefe Drilling
Butte, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
+5 - 1.5	C1	-
+1 - 9.5	C2	-
9.5 - 19.5	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020
slot

S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Hole plug
0.5 - 2'

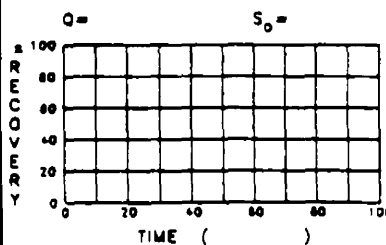
Well Development

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



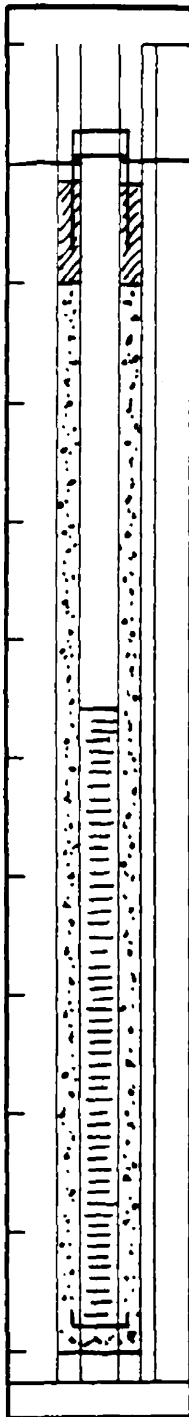
Comments:

ID = 19.5' below TOC 2" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
 DATE 1/28/95

+ 2
0
2
4
6
8
10
12
14
16
18
20



Well No. M-36

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____
Top of Casing 102.75

Drilling Summary:

Total Depth 20'
Borehole Diameter 8"
Casing Stick-up Height 1'
Driller O'Keefe Drilling
Buller, MT
Rig Mobile B-61
Bit(s) Hollow Stem Auger
Drilling Fluid None
Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
Casing String (s): C = Casing S = Screen.

Depth	String(s)	
7.5 - 1.5	C1	-
1.1 - 9.3	C2	-
9.3 - 19.3	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap

C2 2" SCH40 PVC blank

Screen: S1 2" SCH40 PVC .020 slot
S2 _____

Filter Pack: Natural pack ::::

Grout Seal: None

Bentonite Seal: Hot plug 
.5 - 2'

Comments:

TD = 19.3' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

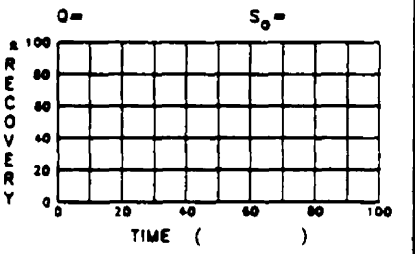
Well Development:

Swabbed and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
LOCATION Frenchtown, MT

SUPERVISED BY B. Lauer
DATE 1/28/95

+ 2

Well No. M-37
Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coord: _____ Elevation Ground Level _____
Top of Casing 102.26

Drilling Summary:

Total Depth 20'
Borehole Diameter 8"
Casing Start-up Height T-3
Other O'Keefe Drilling
Buck, MT
Rig Mobile 8-41
Bit(s) Hollow Stem Auger
Drilling Fluid None
Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log _____
Casing String (s): C = Casing S = Screen.

Depth	String(s)
<u>T-5 - 1.5</u>	<u>C1</u>
<u>T-3 - 9.4</u>	<u>C2</u>
<u>9.4 - 19.4</u>	<u>S1</u>

Casing: C1 3" black steel w/cap
C2 2" SCH40 PVC black

Screen: S1 2" SCH40 PVC .020
Slot

Filter Pack: Netural pack

Grout Seal: None

Benlomite Seal: hole plug

0.5 - 2'

Comments:

TD = 19.4' below TOC 2" PVC

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophy. Logging				
Casing				
Filter Placement				
Grouting				
Development				

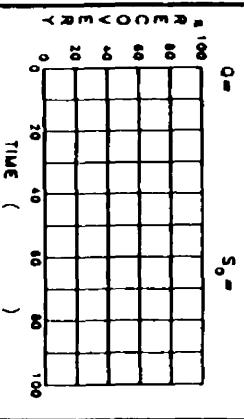
Well Development:

Swished and bailed.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



+ 2

18

16

14

12

10

8

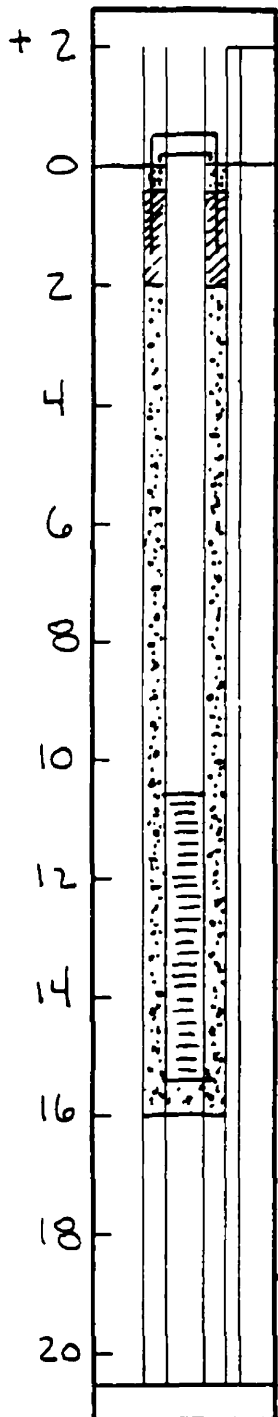
6

4

2

SUPERVISED BY B. Lauer
DATE 1/28/95

SITE NAME FHS
LOCATION Frenchtown, MT



Well No. M-38
 Boring No. X-Ref: Injection well

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.18

Drilling Summary:
 Total Depth 16'
 Borehole Diameter 8"
 Casing Stick-up Height .1'
 Driller O'Keefe Drilling
Bunker, MT
 Rig Mobile B-61
 Bit(s) 1" hollow stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Grouting				
Development				

Well Design & Specifications:
 Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

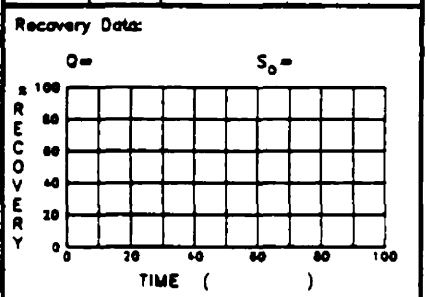
Depth	String(s)
+5' - 15.5'	C1
+1' - 10.5'	C2
10.5' - 15.5'	S1
- - -	- - -
- - -	- - -

Casing: C1 3" black steel w/cap
C2 2" SCH 40 PVC blank
 Screen: S1 2" SCH 40 PVC .020 slot
S2
 Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
.5' - 2'

Well Development:
Swabbed and bailed
Then pumped and surged w/ contractor's pump.

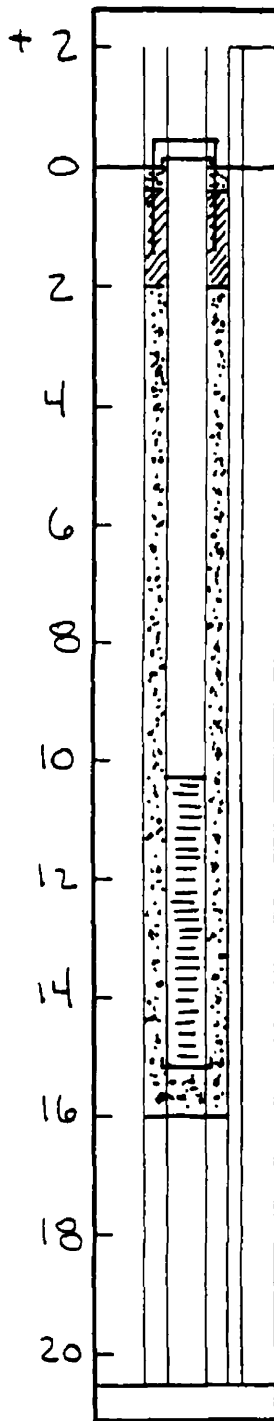
Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)



Comments:
TD = 15.5' below TOC 2" PVC.

SITE NAME FHS
 LOCATION Frenchtown, MT
 SUPERVISED BY B. Lauermaier / W. Woessner
 DATE 7/13/95



Well No. M-39
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing 99.16

Drilling Summary:

Total Depth 16'
 Borehole Diameter 8"
 Casing Stick-up Height 81'
 Driller O'Keefe Drilling
 Location BuHR, MT
 Rig Mobile B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Base: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
7.5 - 1.5	C1	-
7.1 - 10.3	C2	-
10.3 - 15.3	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap
 C2 2" SCH40 PVC blank
 Screen: S1 2" SCH40 PVC .020 slot
 S2 _____

Filter Pack: Natural pack
 Grout Seal: None
 Bentonite Seal: Hole plug
.5 - 2'

Comments:

TD = 15.3' below TOC 2" PVC.

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

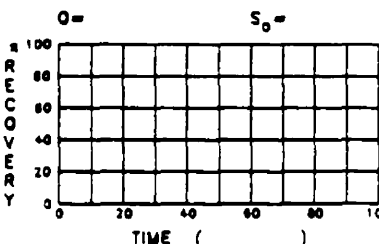
Well Development:

Swabbed and bailed.
Then pumped and surged
w/ contractor's pump.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauerstein / W. Woessner
 DATE 7/13/95

Well No. M-40
Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coordinates: _____

Elevation Ground Level _____

Top of Casing 99.08

Drilling Summary:

Total Depth 16'
Borehole Diameter 8"
Casing Stick-up Height 0.1'
Driller O'Keefe Drilling
Rig 3400 MT
Rig Mobile B-61
Bit(s) Hollow Stem Auger
Drilling Fluid None
Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophysics Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Design & Specifications:

Basin: Geologic Log X Geophysical Log
Casing String (s): C = Casing S = Screen.

Depth	String(s)
4.5 - 1.5	C1
1.1 - 10.4	C2
10.4 - 15.4	S1

Casing: C1 3" black steel w/csl
C2 2" SCH40 PVC black

Screen: S1 2" SCH40 PVC .020
Slot

S2 _____

Filter Pack: Netural pack

Grout Seal: None

Benlonte Seal: Hoty plug

S-2'

Comments: _____

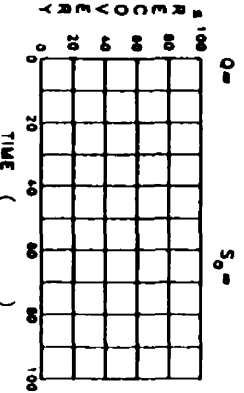
ID: 15.4' below TOC 2" PVC.

Swabbed and bailed.
Then pumped and surged w/
contract pump.

Stabilization Test Data:

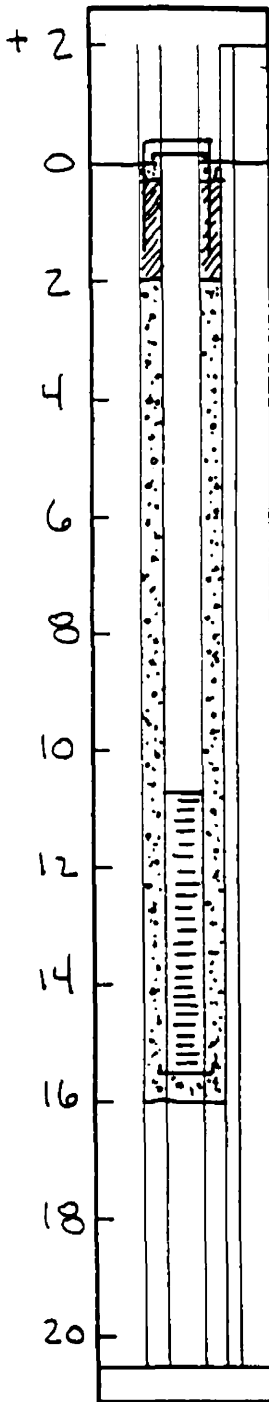
Time	pH	Spec. Cond.	Temp (C)
------	----	-------------	----------

Recovery Data:



SUPERVISED BY B. Lauerman / W. Woessner
DATE 7/13/95

SITE NAME FHS
LOCATION Frenchtown, MT



Well No. M-41
 Boring No. X-Ref: _____
 Elevation Ground Level _____
 Top of Casing 99.05

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing 99.05

Drilling Summary:

Total Depth 16'
 Borehole Diameter 8"
 Casing Stick-up Height _____
 Driller O'Keefe Drilling
Bunker, MT
 Rig Model B-61
 Bit(s) Hollow Stem Auger
 Drilling Fluid None
 Protective Casing C1

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Design & Specifications:

Basis: Geologic Log X Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	
+5 - 1.5	C1	-
+1 - 10.6	C2	-
10.6 - 15.6	S1	-
-	-	-
-	-	-

Casing: C1 3" black steel w/cap
C2 2" SCH 40 PVC blank

Screen: S1 2" SCH 40 PVC .020
slot
 S2 _____

Filter Pack: Natural pack

Grout Seal: None

Bentonite Seal: Half plug
.5 - 2'

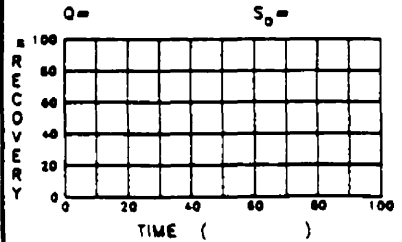
Well Development:

Swabbed and bailed
then pumped and surged w/
contractor's pump.

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

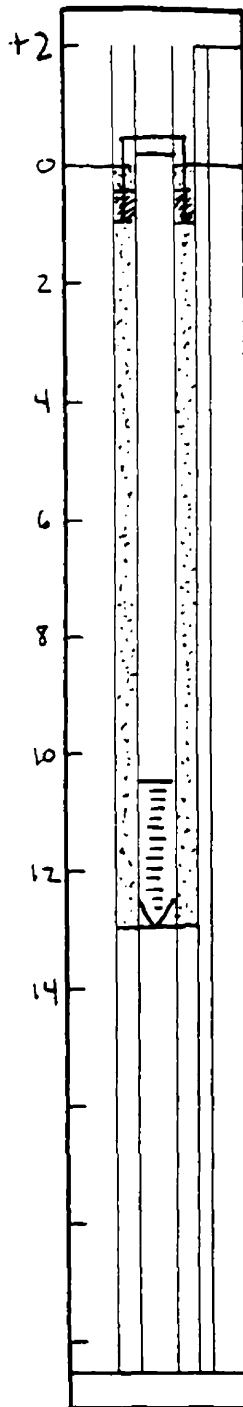


Comments:

TD = 15.6' below TOC 2" PVC.

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lowman/W. Woessner
 DATE 7/13/95



Well No. T1

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing _____

Drilling Summary:

Total Depth 12.55
 Borehole Diameter 1.5"
 Casing Stick-up Height 0.2"
 Driller W.C.E. Missoula, MT

Rig Creeper
 Bit(s) _____

Drilling Fluid None

Protective Casing C1

Well Design & Specifications:

Base: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
<u>1.5 - 1</u>	<u>C1</u>	<u>-</u>
<u>1.2 - 10.55</u>	<u>C2</u>	<u>-</u>
<u>10.55 - 12.55</u>	<u>S1</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>
<u>-</u>	<u>-</u>	<u>-</u>

Casing: C1 3" O.D. Black Steel w/
locksew 1.0
 C2 SC14 80 PVC 1.25" O.D.

Screen: S1 SC14 80 PVC 1.25" O.D.
(locksew) 1.0 w/ locksew
 S2 _____

Filter Pack: (none)
natural pack

Grout Seal: none

Bentonite Seal: 1.5" Plug
0.5 - 1'

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

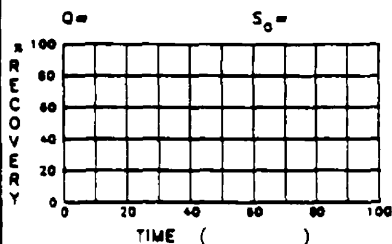
Well Development:

Pumped with 1/2" tubing
no persistance pump
until sand removed
clear

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

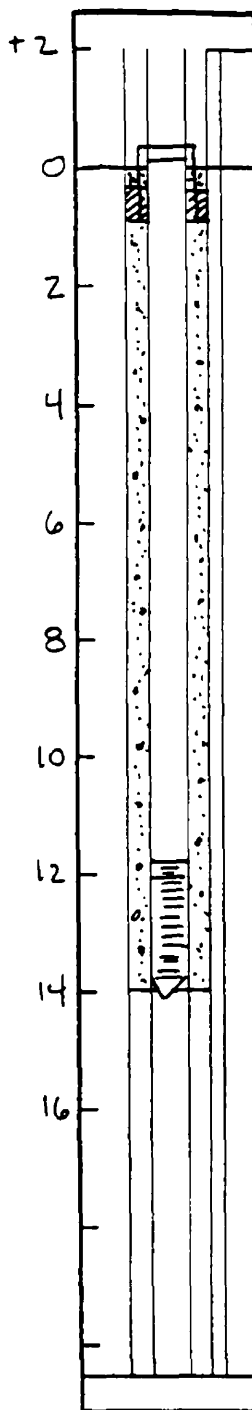
Recovery Data:



Comments: 12.55
TD = 12.55 below TOC 1.25" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B.C. Lauer
 DATE 7/31/95



Well No. T-2

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 _____ Top of Casing _____

Drilling Summary:

Total Depth 13.85'
 Borehole Diameter 1.5"
 Casing Stick-up Height 0.2'
 Driller WCEC Missoula, MT
 Rig Cree probe
 BH(s) _____
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Base: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
+0.5 - 1	C1	-
+1.2 - 11.85	C2	-
11.85 - 13.85	S1	-
-	-	-
-	-	-

Casing: C1 3" O.D. Black Steel w/
locktight 1.0
 C2 Sch 80 PVC 1.25" O.D.

Screen: S1 Sch 80 PVC 1.25" O.D.
1.0" slot w/ locktite
 S2 _____

Filter Pack: (None)
Natural pack

Grout Seal: None

Bentonite Seal: hole plug

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

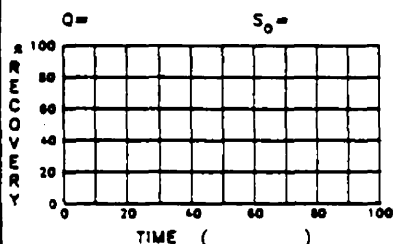
Well Development:

Pumped with 1/2" tubing
on peristaltic pump
until sand removed and
clear

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

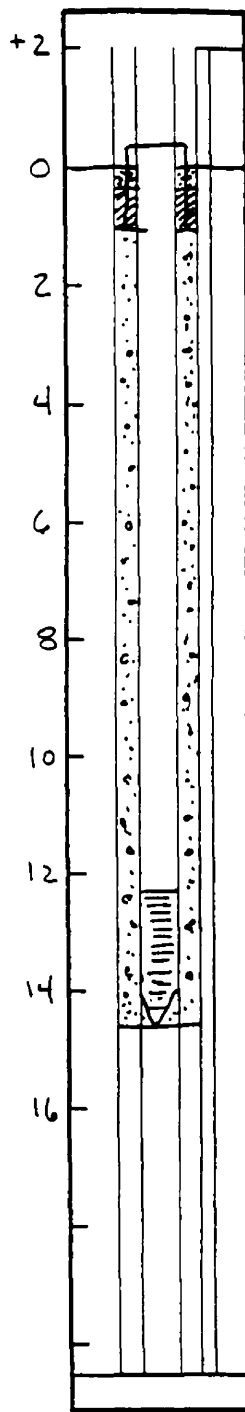


Comments:

TD = 13.85' below TOC 1.25" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B.C. Lauerman
 DATE 7/31/95



Well No. T-3

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing _____

Drilling Summary:

Total Depth 14.5'
 Borehole Diameter 1.5"
 Casing Slick-up Height 0.2'
 Driller W.C.C. Missoula, MT
 Rig Cresapex
 Bit(s) _____
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
0.5 - 1	C1	-
1.2 - 12.5	C2	-
12.5 - 14.5	S1	-
-	-	-
-	-	-

Casing: C1 3" O.D. Black Steel w/ 1/4" x 1/4" 1.0
 C2 Sch 80 PVC 1.25" O.D.

Screen: S1 Sch 80 PVC 1.25" O.D.
1.0" slot w/ backwash
 S2 _____

Filter Pack: (None)
Natural pack

Grout Seal: None

Bentonite Seal: 1.0" Plug

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

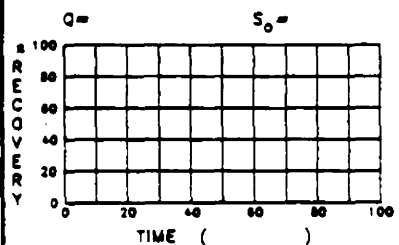
Well Development:

Pumped with 1/2" tubing
no peristaltic pump
until sand removed and
clear

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

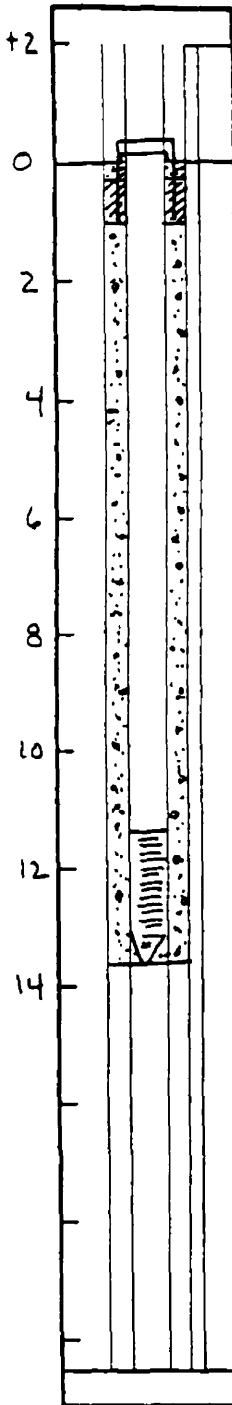


Comments:

ID = 14.50' below TUC 1.25" PVC.

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B.C. Lawarman
 DATE 7/31/95



Well No. T-4

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing _____

Drilling Summary:

Total Depth 13.45'
 Borehole Diameter 1.5"
 Casing Stick-up Height 0.3'
 Driller WCEC Missoula, MT

Rig Greaseprobe
 BHA(s) _____

Drilling Fluid None

Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
0.5 - 1	C1	-
0.2 - 11.45	C2	-
11.45 - 13.45	S1	-
-	-	-
-	-	-

Casing: C1 3" O.D. Black Steel w/
lockeys 1.0
 C2 Sch 80 PVC 1.25" O.D.

Screen: S1 Sch 80 PVC 1.25" O.D.
stand std H&B w/ hook & screw
 S2 _____

Filter Pack: (none)
natural pack

Grout Seal: none

Bentonite Seal: 1.5" Plug

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

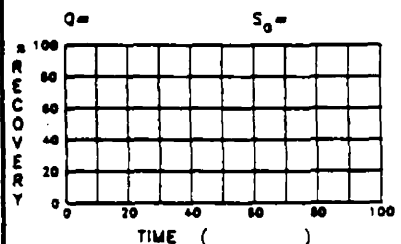
Well Development:

Pumped with 1/2" tubing
no aerispheric pump
until sand removed w/
clear

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

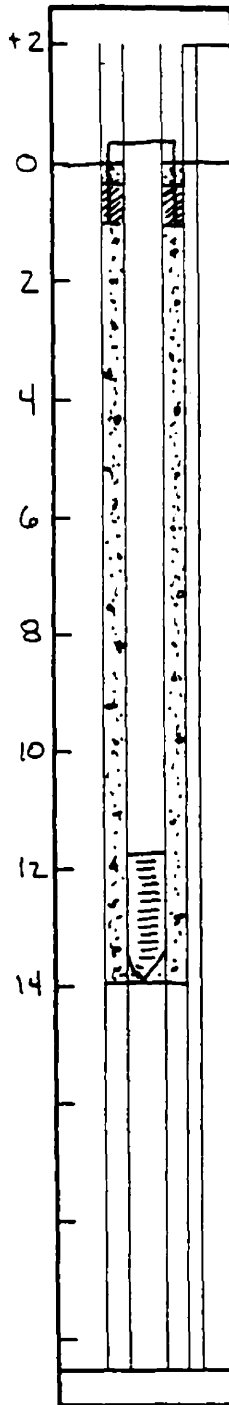


Comments:

TD = 13.45' below TOC 1.25" PVC

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY BC Lauerman
 DATE 7/31/95



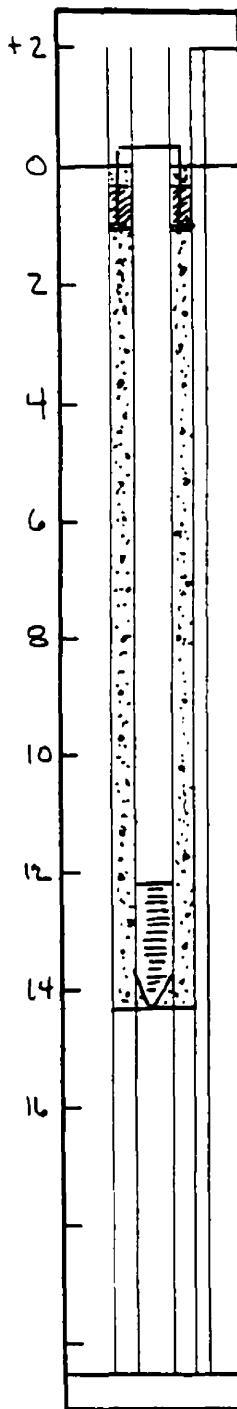
Well No. T-5
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 _____ Top of Casing _____

Drilling Summary: Total Depth <u>13.7'</u> Borehole Diameter <u>1.5"</u> Casing Stick-up Height <u>0.2'</u> Driller <u>W.C.C. Missoula, MT</u> Rig <u>Cecropia</u> Bit(s) _____ Drilling Fluid <u>None</u> Protective Casing <u>C1</u>		Construction Time Log: <table border="1"> <thead> <tr> <th rowspan="2">Task</th> <th colspan="2">Start</th> <th colspan="2">Finish</th> </tr> <tr> <th>Date</th> <th>Time</th> <th>Date</th> <th>Time</th> </tr> </thead> <tbody> <tr><td>Drilling</td><td></td><td></td><td></td><td></td></tr> <tr><td>Geophys. Logging</td><td></td><td></td><td></td><td></td></tr> <tr><td>Casing</td><td></td><td></td><td></td><td></td></tr> <tr><td>Filter Placement</td><td></td><td></td><td></td><td></td></tr> <tr><td>Grouting</td><td></td><td></td><td></td><td></td></tr> <tr><td>Development</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>		Task	Start		Finish		Date	Time	Date	Time	Drilling					Geophys. Logging					Casing					Filter Placement					Grouting					Development				
Task	Start		Finish																																							
	Date	Time	Date	Time																																						
Drilling																																										
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Casing																																										
Filter Placement																																										
Grouting																																										
Development																																										
Well Design & Specifications: Bore: Geologic Log _____ Geophysical Log _____ Casing String (s): C = Casing S = Screen. <table border="1"> <thead> <tr> <th>Depth</th> <th>String(s)</th> <th>Elevation</th> </tr> </thead> <tbody> <tr><td>+0.5 - 1</td><td>C1</td><td>-</td></tr> <tr><td>+0.2 - 11.7</td><td>C2</td><td>-</td></tr> <tr><td>11.7 - 13.7</td><td>S1</td><td>-</td></tr> <tr><td>-</td><td>-</td><td>-</td></tr> <tr><td>-</td><td>-</td><td>-</td></tr> </tbody> </table> Casing: C1 <u>3" O.D. Black Steel w/</u> <u>lockhead 1.0</u> C2 <u>Split Bu PVC 1.25" O.D.</u> Screen: S1 <u>Split Bu PVC 1.25" O.D.</u> <u>1.0" slot w/ lockhead</u> S2 _____ Filter Pack: <u>(none)</u> <u>natural pack</u> Grout Seal: <u>none</u> Bentonite Seal: <u>bulk plug</u>		Depth	String(s)	Elevation	+0.5 - 1	C1	-	+0.2 - 11.7	C2	-	11.7 - 13.7	S1	-	-	-	-	-	-	-	Well Development: <u>Pumped with 1/2" tubing</u> <u>and peristaltic pump</u> <u>(until sand removed &</u> <u>clear)</u> Stabilization Test Data: <table border="1"> <thead> <tr> <th>Time</th> <th>pH</th> <th>Spec. Cond.</th> <th>Temp (C)</th> </tr> </thead> <tbody> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> </tbody> </table>		Time	pH	Spec. Cond.	Temp (C)																	
Depth	String(s)	Elevation																																								
+0.5 - 1	C1	-																																								
+0.2 - 11.7	C2	-																																								
11.7 - 13.7	S1	-																																								
-	-	-																																								
-	-	-																																								
Time	pH	Spec. Cond.	Temp (C)																																							
Recovery Data: $Q =$ _____ $S_o =$ _____ <table border="1"> <thead> <tr> <th>TIME ()</th> <th>% RECOVERY</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>20</td><td></td></tr> <tr><td>40</td><td></td></tr> <tr><td>60</td><td></td></tr> <tr><td>80</td><td></td></tr> <tr><td>100</td><td></td></tr> </tbody> </table>		TIME ()	% RECOVERY	0	0	20		40		60		80		100		Comments: <u>TD = 13.7' below TOC 1.25" PVC</u> _____ _____																										
TIME ()	% RECOVERY																																									
0	0																																									
20																																										
40																																										
60																																										
80																																										
100																																										

SITE NAME FHS LOCATION Frenchtown, MT
 SUPERVISED BY B.C. Lawnerman DATE 7/31/95



Well No. T-6

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____

Elevation Ground Level _____

Top of Casing _____

Drilling Summary:

Total Depth 14.35'
 Borehole Diameter 1.5"
 Casing Stick-up Height 0.2'
 Driller W.C.F. Missen, MT

Rig Geoprobe
 Bit(s) _____

Drilling Fluid None

Protective Casing C1

Well Design & Specifications:

Basis: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
0.5 - 1	C1	-
0.2 - 12.35	C2	-
12.35 - 14.35	S1	-
-	-	-
-	-	-

Casing: C1 3" O.D. Black Steel w/
lockeys 1.0
 C2 SCH 80 PVC 1.25" O.D.

Screen: S1 SCH 80 PVC 1.25" O.D.
1.0" slotted w/ hex 3/4"
 S2 _____

Filter Pack: (none)
natural pack

Grout Seal: none

Bentonite Seal: 1.0" Plug

Comments:

TD: 14.35' below TOC 1.25" PVC.
14.35

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

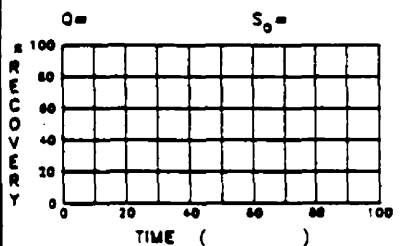
Well Development:

Pumped with 1/2" tubing
no peristaltic pump
until sand removed and
clear

Stabilization Test Data:

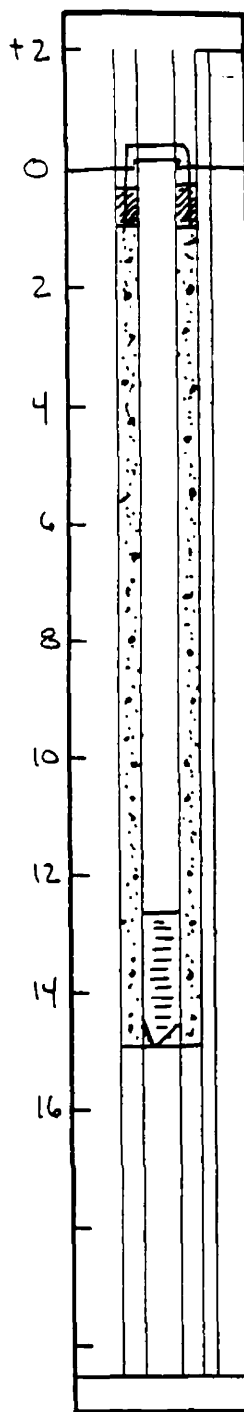
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B.C. Lauerman
 DATE 7/31/95



Well No. T-7

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____

Top of Casing _____

Drilling Summary:

Total Depth 14.75'
 Borehole Diameter 1.5"
 Casing Stick-up Height 0.2'
 Driller W.C.F.C. Missoula, MT
 Rig Ceco Probe
 BH(s) _____
 Drilling Fluid None
 Protective Casing C1

Well Design & Specifications:

Basin: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
+0.5 - 1	C1	-
+0.2 - 12.75	C2	-
12.75 - 14.75	S1	-
-	-	-
-	-	-

Casing: C1 3" O.D. Black Steel w/
1.625" I.D.
 C2 SCH 80 PVC 1.25" O.D.

Screen: S1 SCH 80 PVC 1.25" O.D.
1.625" I.D. w/ 1/2" slots
 S2 _____

Filter Pack: (None)
Natural pack

Grout Seal: None

Bentonite Seal: Water Plug

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

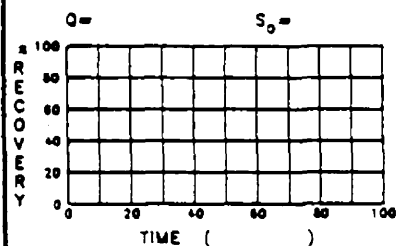
Well Development:

Pumped with 1/2" tubing
and peristaltic pump
until sand removed and
clear

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

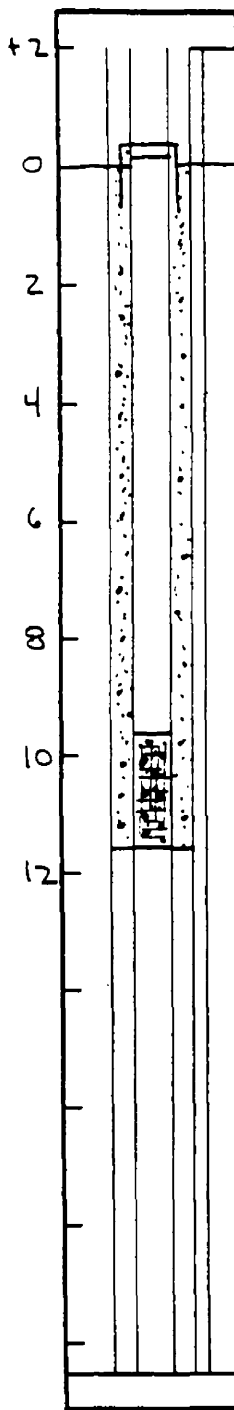


Comments:

TD: 14.75' below TOC 1.25" PVC.

SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B.C. Lauerman
 DATE 7/31/95



Well No. T-8
 Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
 Top of Casing _____

Drilling Summary:

Total Depth 11.4
 Borehole Diameter 3/4"
 Casing Stick-up Height 0.2
 Driller None
 Rig jackhammer
 Bit(s) _____
 Drilling Fluid None
 Protective Casing 2" PVC

Well Design & Specifications:

Basis: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
0.5 - 1	C1	-
0.2 - 9.4	C2	-
9.4 - 11.4	S1	-
-	-	-
-	-	-

Casing: C1 2" SCH 40 PVC
 C2 1/2" PVC tube
 Screen: S1 1/2" PVC tube, drilled
and wrapped w/ mesh.
 S2 _____

Filter Pack: None
natural pack
 Grout Seal: None
 Bentonite Seal: None

Comments:

TD = 11.4' below top of 1/2" tube.

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Comming:				
Development:				

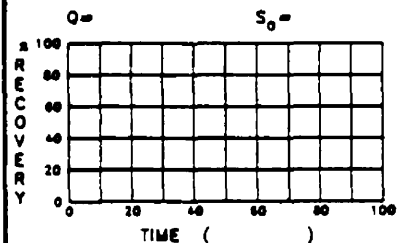
Well Development:

None

Stabilization Test Data:

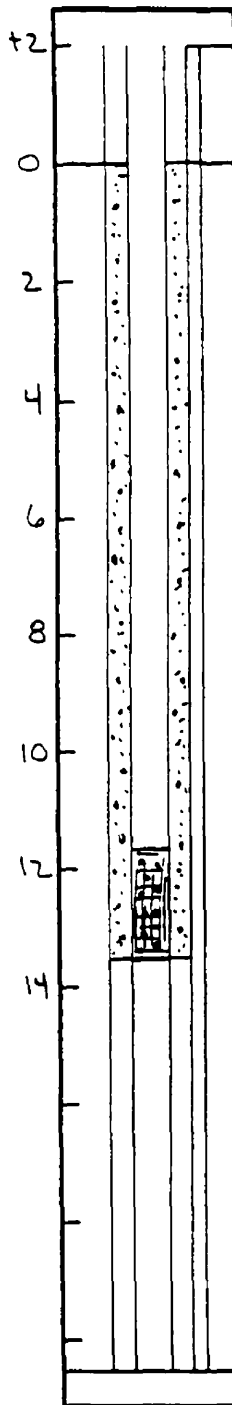
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FHS
 LOCATION Frenchtown, MT

SUPERVISED BY B. Lauerma / D. DeBorhe
 DATE 9/21/95



Well No. T-9
Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____
Top of Casing _____

Drilling Summary:

Total Depth 13.4'
Borehole Diameter 3/4"
Casing Stick-up Height 0.2
Driller none
Rig jackhammer
SPH(s) _____
Drilling Fluid none
Protective Casing C1

Well Design & Specifications:

Base: Geologic Log _____ Geophysical Log _____
Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
-	C1	-
0.2	C2	-
11.4	S1	-
-	-	-
-	-	-

Casing: C1 Self 40 PVC
C2 1/2" PVC tube
Screen: S1 1/2" PVC tube drilled and wrapped with mesh.
S2 _____

Filter Pack: none
Natural pebble
Grout Seal: none
Bentonite Seal: None

Comments:

TD = 13.4' below top of 1/2" tube.

Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

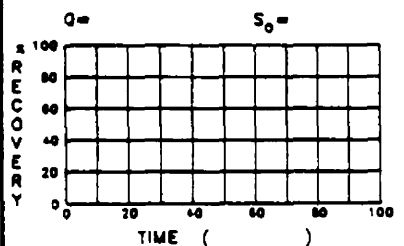
Well Development:

None

Stabilization Test Data:

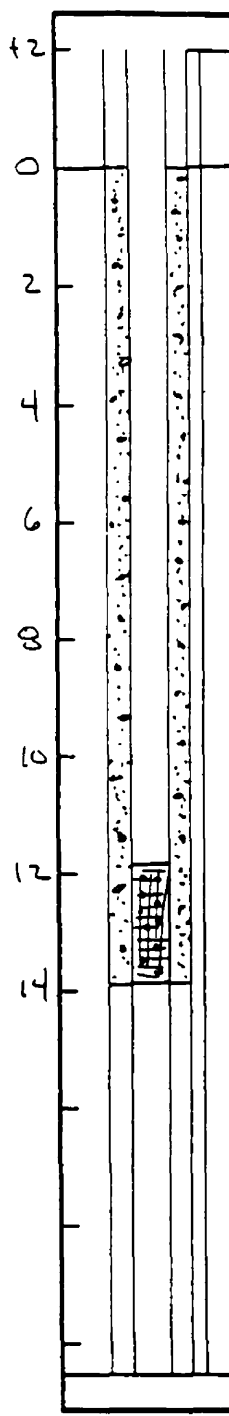
Time	pH	Spec. Cond.	Temp (C)

Recovery Data:



SITE NAME FLTS
LOCATION Frenchtown, MT

SUPERVISED BY B. Lewerenz / D. DeBorde
DATE 9/21/95



Well No. T-10
 Boring No. X-Ref: _____
MONITOR WELL CONSTRUCTION SUMMARY
 Survey Coords: _____ Elevation Ground Level _____
 Top of Casing _____

Drilling Summary:
 Total Depth 13.8'
 Borehole Diameter 3/4"
 Casing Stick-up Height 0.2
 Driller none
 Rig jackhammer
 BPs(s) _____
 Drilling Fluid none
 Protective Casing C1

Well Design & Specifications:
 Basis: Geologic Log _____ Geophysical Log _____
 Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
-	C1	-
- 11.8	C2	-
11.8 - 13.8	S1	-
-		-
-		-
-		-

Casing: C1 2" SCL 40 PVC
 C2 1/2" PVC tubing
 Screen: S1 1/2" PVC tubing, drilled and wrapped w/ mesh.
 S2 _____
 Filter Pack: none
Natural pack
 Grout Seal: none
 Bentonite Seal: none

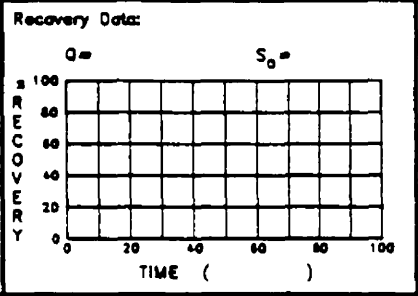
Construction Time Log:

Task	Start		Finish	
	Date	Time	Date	Time
Drilling				
Geophys. Logging				
Casing				
Filter Placement				
Cementing				
Development				

Well Development:
None

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)



Comments:
TD = 13.8' below top of 1/2" tube

SITE NAME FHS
 LOCATION Frenchtown, MT
 SUPERVISED BY B. Lawrence / D. DeBorja
 DATE 9/21/95

APPENDIX E

Potentiometric Data

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P1 (pneumatic)	1994				MP ELEVATION = 155.55
	6-Sep	9 13	8 22	91 78	
	13-Sep	10 13	8 25	91 75	
	15-Sep	10 24	8 29	91 71	
	28-Sep	10 14	8 3	91 7	
	29-Sep	8 13	8 31	91 69	
	30-Sep	10 47	8 52	91 48	
	3-Oct	10 17	8 45	91 55	
	4-Oct	11 16	8 47	91 53	
	5-Oct	10 09	8 5	91 5	
	6-Oct	10 58	8 57	91 43	
	14-Oct	11 01	8 6	91 4	
	17-Oct	10 15	8 78	91 24	
	18-Oct	11 12	8 87	91 13	
	19-Oct	10 18	8 9	91 1	
	24-Oct	10 26	9 31	90 69	
	27-Oct	8 37	9 88	90 12	
	28-Oct	11 00	10 3	89 7	
	31-Oct	10 18	10 18	89 84	
	1-Nov	10 28	10 25	89 75	
	2-Nov	10 15	10 34	89 66	
	3-Nov	10 28	10 45	89 55	
	4-Nov	10 17	10 48	89 54	
	7-Nov	10 25	10 85	89 35	
	8-Nov	10 17	10 74	89 26	
	9-Nov	10 48	10 78	89 22	
	10-Nov	10 28	10 95	89 05	
	14-Nov	11 25	11 1	88 9	
	16-Nov	10 31	11 17	88 83	
	17-Nov	10 12	11 2	88 8	
	18-Nov	10 37	11 25	88 75	
	21-Nov	10 17	11 39	88 61	
	23-Nov	10 01	11 47	88 53	
	28-Nov	10 48	11 7	88 3	
	29-Nov	10 11	11 75	88 25	
	30-Nov	10 36	11 8	88 2	
	1-Dec	10 51	11 85	88 15	
	6-Dec	10 31	12 01	87 99	
	8-Dec	10 44	12 1	87 9	
	12-Dec	11 11	12 25	87 75	
	20-Dec	10 38	12 5	87 5	
	10-Jan	11 16	13 01	86 99	
	12-Jan	10 33	13 08	86 94	
	16-Jan	10 42	13 1	86 9	
	20-Jan	11 09	13 11	86 69	
	24-Jan	13 38	13 15	86 85	
	26-Jan	13 00	13 2	86 8	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P1 confd	1999				
	15-Feb	12:56	13 15	86 85	slight recovery in first part of Feb
	17-Feb	13:00	13 21	86 79	
	1-Mar	9:02	13 29	86 71	
	15-Mar	13:47	13 61	86 39	
	22-Mar	11:06	13 66	86 34	
	5-Apr	9:53	13 9	86 1	
	12-Apr	12:22	13 94	86 06	
	11-May	12:51	13 36	86 64	water table rising
	19-May	16:32	12 34	87 66	
	29-May	10:25	12 02	87 96	
	31-May	13:01	11 51	88 49	
	6-Jun	13:53	11 11	88 69	
	26-Jun	10:29	10 04	89 96	
	17-Jul		9 58	90 42	
	21-Aug	20 49	7 66	92 14	
	30-Sep	11:01	9 07	90 93	water table declining
	17-Oct	15:06	10	90	
	14-Nov	14:56	11 32	88 66	
	6-Dec	13:47	11 64	88 18	
	1998				
	22-Jan	11:45	11 9	88 1	
	20-Feb	13:09	11 95	88 05	
	23-Mar	13:56	11 9	88 1	
	3-Apr	14:25	12 19	87 61	
	30-May	14:40	11 48	88 52	water table rising
	20-Jun	10:40	9 67	90 33	
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P2 (pneumobr)	1994				MP ELEVATION = 86.85
	23-Sep	10:21	8	91 6	
	26-Sep	11:03	8 2	91 6	
	27-Sep	10:36	8	91 6	
	28-Sep	10:16	8 2	91 6	
	29-Sep	8:14	8 28	91 52	
	30-Sep	10:48	8 39	91 41	
	3-Oct	10:19	8 45	91 35	
	4-Oct	11:17	8 45	91 35	
	6-Oct	11:01	8 55	91 25	
	7-Oct	10:18	8 6	91 2	
	10-Oct	10:27	8 75	91 05	
	11-Oct	10:18	8 63	90 97	
	12-Oct	10:17	8 9	90 9	
	13-Oct	10:16	8 67	90 83	
	14-Oct	11:03	9 02	90 78	
	17-Oct	10:19	9 26	90 54	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P2 cont'd	1984				
	18-Oct	11:14	9.38	90.44	
	18-Oct	10:19	9.41	90.39	
	24-Oct	10:29	9.75	90.05	
	26-Oct	11:09	9.88	89.94	
	27-Oct	8:35	9.89	89.91	
	31-Oct	10:19	10.19	89.81	
	1-Nov	10:31	10.28	89.54	
	2-Nov	10:16	10.31	89.49	
	3-Nov	10:28	10.38	89.42	
	4-Nov	10:19	10.41	89.39	
	7-Nov	10:28	10.61	89.19	
	8-Nov	10:18	10.65	89.15	
	9-Nov	10:49	10.7	89.1	
	10-Nov	10:27	10.85	88.95	
	14-Nov	11:27	11.01	88.79	
	15-Nov	10:14	11.05	88.75	
	16-Nov	10:32	11.1	88.7	
	17-Nov	10:13	11.15	88.65	
	18-Nov	10:38	11.2	88.6	
	21-Nov	10:18	11.34	88.46	
	22-Nov	10:45	11.38	88.44	
	23-Nov	10:02	11.5	88.3	
	28-Nov	10:47	11.65	88.15	
	29-Nov	10:12	11.67	88.13	
	30-Nov	10:37	11.75	88.05	
	1-Dec	10:52	11.78	88.04	
	6-Dec	10:32	11.91	87.89	
	8-Dec	10:45	12	87.8	
	12-Dec	11:12	12.13	87.67	
	20-Dec	10:37	12.4	87.4	
	1985				
	10-Jan	11:17	12.95	86.85	
	12-Jan	10:34	13	86.8	
	16-Jan	10:43	13.05	86.75	
	24-Jan	13:37	13.02	86.78	
	28-Jan	13:01	13.18	86.64	
	8-Feb	11:32	12.85	86.95	slight recovery in first part of Feb
	9-Feb	13:07	12.83	86.97	
	15-Feb	12:58	13.05	86.75	
	17-Feb	13:01	13.17	86.83	
	1-Mar	9:00	13.24	86.50	
	15-Mar	13:49	13.47	86.33	
	22-Mar	11:01	13.55	86.25	
	5-Apr	9:52	13.75	86.05	
	12-Apr	12:19	13.81	85.99	
	11-May	12:50	13.29	86.51	water table rising

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P2 cont'd	1984				
	19-May	18:31	12.28	87.54	
	23-May	10:24	11.08	87.84	
	31-May	15:00	11.42	88.38	
	6-Jun	13:52	11.01	88.79	
	28-Jun	10:28	9.97	89.83	
	17-Jul		9.53	90.27	
	21-Aug	20:40	7.9	91.9	
	30-Sep	11:00	9.08	90.74	water table declining
	17-Oct	15:00	9.94	89.86	
	14-Nov				DECOMMISSIONED
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P3 (piezometer)	1984				MP ELEVATION = 88.71
	28-Sep	10:21	8.23	91.48	
	29-Sep	9:43	8.23	91.48	
	3-Oct	10:21	8.45	91.26	
	5-Oct	10:14	8.47	91.24	
	6-Oct	11:03	8.55	91.18	
	7-Oct	10:20	8.8	91.11	
	10-Oct	10:29	8.75	90.98	
	11-Oct	10:18	8.83	90.88	
	12-Oct	10:18	8.9	90.81	
	13-Oct	10:17	8.97	90.74	
	14-Oct	11:04	9.02	90.69	
	17-Oct	10:19	9.28	90.45	
	18-Oct	11:14	9.36	90.35	
	19-Oct	10:19	9.41	90.3	
	24-Oct	10:29	9.75	89.98	
	26-Oct	11:10	9.85	89.86	
	28-Oct	11:03	9.95	89.78	
	31-Oct	10:20	10.02	89.69	
	1-Nov	10:32	10.28	89.42	
	2-Nov	10:18	10.28	89.45	
	3-Nov	10:30	10.34	89.37	
	4-Nov	10:20	10.39	89.32	
	7-Nov	10:28	10.59	89.12	
	8-Nov	10:19	10.82	89.09	
	9-Nov	10:50	10.88	89.03	
	10-Nov	10:29	10.75	88.98	
	15-Nov	10:15	11.04	88.67	
	16-Nov	10:33	11.09	88.62	
	17-Nov	10:14	11.12	88.59	
	18-Nov	10:39	11.18	88.53	
	21-Nov	10:19	11.3	88.41	
	22-Nov	10:48	11.34	88.37	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P3 (cecid)	1984				
	23-Nov	10 03	11 4	88 31	
	28-Nov	10 48	11 50	88 12	
	29-Nov	10 13	11 60	88 02	
	30-Nov	10 39	11 7	88 01	
	1-Dec	10 53	11 79	87 92	
	6-Dec	10 34	11 60	87 82	
	8-Dec	10 46	11 95	87 76	
	12-Dec	11 13	12 1	87 61	
	20-Dec	10 36	12 36	87 35	
	1985				
	10-Jan	11 18	12 87	86 84	
	12-Jan	10 35	12 8	86 81	
	16-Jan	10 44	12 97	86 74	
	24-Jan	13 36	12 96	86 73	
	28-Jan	13 02	13 14	86 57	
	8-Feb	11 35	12 76	86 95	slight recovery in first part of Feb
	9-Feb	13 06	12 8	86 91	
	15-Feb	12 59	13 02	86 89	
	17-Feb	13 03	13 16	86 55	
	1-Mar	8 58	13 14	86 57	
	15-Mar	13 51	13 36	86 35	
	22-Mar	11 02	13 44	86 27	
	5-Apr	9 51	13 71	86	
	12-Apr	12 26	13 77	85 94	
	11-May	12 45	13 25	86 46	water table rising
	19-May	16 26	12 21	87 5	
	23-May	10 19	11 9	87 81	
	31-May	14 53	11 38	86 33	
	6-Jun	13 45	11 04	86 67	
	28-Jun	10 22	10	86 71	
	17-Jul		9 51	90 2	
	21-Aug	20 32	7 88	91 83	
	30-Sep	10 55	9 01	90 7	water table declining
	17-Oct	15 06	9 95	89 76	
	14-Nov				DECOMMISSIONED
P4 (plazamor)	1984				HP ELEVATION = 95.33
	21-Sep	10 11	8	91 99	
	22-Sep	10 20	8 21	91 78	
	26-Sep	11 07	8 22	91 77	
	27-Sep	10 43	8 3	91 69	
	29-Sep	9 45	8 31	91 68	
	3-Oct	10 23	8 4	91 59	
	4-Oct	11 19	8 47	91 52	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P4 cont'd	1994				
	5-Oct	10:15	8.47	91.52	
	6-Oct	11:05	8.56	91.43	
	7-Oct	13:21	8.62	91.37	
	10-Oct	10:30	8.75	91.24	
	11-Oct	10:20	8.81	91.18	
	12-Oct	10:20	8.95	91.04	
	13-Oct	10:18	8.99	91	
	14-Oct	11:05	9.1	90.89	
	17-Oct	10:21	9.34	90.85	
	18-Oct	9:30	9.39	90.8	
	19-Oct	10:21	9.48	90.53	
	24-Oct	10:31	9.8	90.19	
	26-Oct	11:11	9.91	90.08	
	27-Oct	8:30	9.9	90.09	
	28-Oct	11:04	9.91	90.08	
	31-Oct	10:21	10.05	89.94	
	1-Nov	10:33	10.27	89.72	
	2-Nov	10:19	10.32	89.67	
	3-Nov	10:32	10.4	89.59	
	4-Nov	10:21	10.45	89.54	
	8-Nov	10:20	10.73	89.26	
	9-Nov	10:51	10.79	89.2	
	10-Nov	10:30	11.01	88.98	
	14-Nov	11:30	11.07	88.92	
	16-Nov	10:34	11.19	88.8	
	17-Nov	10:15	11.21	88.78	
	18-Nov	10:40	11.25	88.74	
	21-Nov	10:20	11.4	88.59	
	22-Nov	10:47	11.49	88.5	
	23-Nov	10:04	11.5	88.49	
	28-Nov	10:49	11.69	88.3	
	29-Nov	10:14	11.75	88.24	
	30-Nov	10:40	11.88	88.13	
	1-Dec	10:54	11.88	88.13	
	6-Dec	10:35	12.02	87.97	
	8-Dec	10:47	12.11	87.88	
	12-Dec	11:14	12.15	87.84	
	20-Dec	10:39	12.5	87.49	
	1995				
	10-Jan	11:19	13.02	86.97	
	12-Jan	10:36	13.01	86.96	
	16-Jan	10:45	13.12	86.87	
	20-Jan	11:12	13.12	86.87	
	24-Jan	13:39	13.15	86.84	
	26-Jan	13:03	13.15	86.84	
	8-Feb	11:38	12.92	87.07	slight recovery in first part of Feb

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
P4 cecid	1994				
	9-Feb	13:00	12.06	87.03	
	15-Feb	13:01	13.11	86.88	
	17-Feb	13:04	13.25	86.74	
	1-Mar	6:56	13.32	86.67	
	15-Mar	13:53	13.57	86.42	
	22-Mar	11:04	13.63	86.36	
	5-Apr	9:50	13.69	86.1	
	12-Apr	12:25	13.67	86.02	
	11-May	12:47	13.43	86.56	water table rising
	19-May	16:27	12.37	87.62	
	23-May	10:22	12.07	87.92	
	31-May	14:56	11.57	88.42	
	6-Jun	13:46	11.19	88.8	
	28-Jun	10:23	10.11	89.88	
	17-Jul		9.6	90.39	
	21-Aug	20:35	7.6	92.06	
	30-Sep	11:17	9.07	90.92	water table declining
	17-Oct	15:05	10.02	89.97	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W1	1994				MP ELEVATION = 88.35
	6-Sep	9:15	7.79	91.51	water table declining
	8-Sep	9:41	7.81	91.49	
	9-Sep	10:30	7.85	91.45	
	12-Sep	10:10	7.9	91.4	
	13-Sep	10:10	7.6	91.7	water table rising
	15-Sep	10:21	7.45	91.85	
	16-Sep	10:17	7.5	91.6	
	19-Sep	10:53	7.3	92	
	23-Sep	10:17	7.4	91.9	water table declining
	26-Sep	11:00	7.65	91.45	
	27-Sep	10:33	7.7	91.6	
	28-Sep	10:12	7.7	91.6	
	29-Sep	8:18	8.04	91.26	
	3-Oct	10:13	8.1	91.2	
	6-Oct	10:55	8.13	91.17	
	7-Oct	10:15	8.17	91.13	
	10-Oct	10:24	8.31	90.99	
	11-Oct	10:15	8.4	90.9	
	12-Oct	10:14	8.45	90.85	
	13-Oct	10:14	8.55	90.75	
	14-Oct	11:01	8.6	90.7	
	17-Oct	10:15	8.76	90.54	
	18-Oct	11:12	8.67	90.43	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
WY 60075					
	19-Oct	10:16	8.9	90.4	
	24-Oct	10:26	9.31	89.99	
	28-Oct	11:07	9.45	89.85	
	27-Oct	8:33	9.46	89.84	
	1-Nov	10:26	9.79	89.51	
	2-Nov	10:13	9.86	89.44	
	3-Nov	10:24	9.82	89.48	
	7-Nov	10:23	10.11	89.19	
	8-Nov	10:15	10.2	89.1	
	9-Nov	10:47	10.22	89.08	
	10-Nov	10:24	10.35	88.95	
	14-Nov	11:23			dry
	1995				
	31-May	14:47			dry
	28-Jun	10:16	9.59	89.71	water table rising
	17-Jul		9.08	90.24	
	21-Aug	20:26	7.55	91.75	
	30-Sep	10:27	8.51	90.79	water table declining
	17-Oct	15:01	9.33	89.97	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
WY 60076	1995				MP ELEVATION = 105.22
	31-May	15:11			dry
	28-Jun	10:30	10.36	89.86	water table rising
	17-Jul		9.85	90.37	
	21-Aug	20:42	8.23	91.99	
	30-Sep	11:06	9.4	90.82	water table declining
	17-Oct	14:56	10.3	89.92	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
WY 60077	1995				MP ELEVATION = 105.12
	31-May	15:10			dry
	28-Jun	10:31	10.33	89.79	water table rising
	17-Jul		9.85	90.27	
	21-Aug	20:43	8.24	91.88	
	30-Sep	11:06	9.41	90.71	water table declining
	17-Oct	14:57	10.28	89.84	
	14-Nov				DECOMMISSIONED

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
104	1998				MP ELEVATION = 100.04
	31-May	14 56			dry
	28-Jun	10 32	10 27	89 79	water table rising
	17-Jul		9 76	90 3	
	21-Aug	20 44	8 17	91 89	
	30-Sep	11 12	9 34	90 72	water table declining
	17-Oct	14 56	10 21	89 65	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
105	1998				MP ELEVATION = 100.31
	31-May	14 57			dry
	28-Jun	10 33	10 32	89 89	water table rising
	17-Jul		9 81	90 4	
	21-Aug	20 36	7 9	92 31	
	30-Sep	11 15	9 06	91 13	water table declining
	17-Oct	14 55	9 53	90 28	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
106	1998				MP ELEVATION = 89.88
	31-May	15 12			dry
	28-Jun	10 27	10 01	89 79	water table rising
	17-Jul		9 5	90 3	
	21-Aug	20 39	7 04	91 86	
	30-Sep	10 57	9 09	90 71	water table declining
	17-Oct	15 10	10	89 8	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
107	1998				MP ELEVATION = 89.34
	28-Jun	10 34	10 13	89 63	
	17-Jul		9 66	90 3	water table rising
	21-Aug	20 33	7 97	91 06	
	30-Sep	11 21	9 1	90 56	
	17-Oct	14 54	10 02	89 94	water table declining
	14-Nov				DECOMMISSIONED

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
100	1998				MP ELEVATION = 100.50
	28-Jun	10:35	10:35	89.73	
	17-Jul		9:58	90.22	water table rising
	21-Aug	20:31	8:29	91.79	
	30-Sep	10:36	9:41	90.67	
	17-Oct	15:02	10:31	89.77	water table declining
	14-Nov				DECOMMISSIONED
101	1998				MP ELEVATION = 99.45
	31-May	14:43	11:17	88.23	
	28-Jun	10:14	9:76	89.64	water table rising
	17-Jul		9:28	90.12	
	21-Aug	20:24	7:74	91.66	
	30-Sep	10:31	6:55	90.55	water table declining
	17-Oct	15:11	9:72	89.66	
	14-Nov				DECOMMISSIONED
102	1998				MP ELEVATION = 99.10
	31-May	14:44			dry
	28-Jun	10:12	9:98	89.6	water table rising
	17-Jul		9:48	90.12	
	21-Aug	20:21	7:51	91.67	
	30-Sep	10:37	9:03	90.55	water table declining
	17-Oct	15:13	9:51	89.67	
	14-Nov				DECOMMISSIONED
103	1998				MP ELEVATION = 99.50
	1-Mar	8:47	13:41	86.57	
	15-Mar	13:45	13:53	86.35	water table declining
	22-Mar	10:59	13:71	86.27	
	5-Apr	9:46	13:59	86.09	
	12-Apr	12:20	13:06	86.02	
	19-May	16:33	12:47	87.51	water table rising
	23-May	16:13	12:14	87.84	
	31-May	13:00	11:04	88.34	
	28-Jun	10:36	10:14	89.84	
	17-Jul		9:58	90.3	
	21-Aug	20:41	8:08	91.9	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W11 east	1988				
	30-Sep	11:04	9 25	90 73	
	17-Oct	14:51	10 11	89 87	water table declining
					NEW MP ELEVATION = 89.76
	14-Nov	14:57	11 27	88 49	
	8-Dec	13:48	11 77	87 99	
	1988				
	20-Feb	13:07	11 87	87 89	
	23-Mar	12:44	11 81	87 95	
	3-Apr	12:24	12 12	87 64	
	30-May	14:41	11 35	88 41	water table rising
	20-Jun	10:39	9 48	90 28	
	18-Jul		7 86	91 9	
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W12					MP ELEVATION = 168.83
	1-Mar	8 48	13 52	86 51	
	15-Mar	13 43	13 74	86 29	water table declining
	22-Mar	10 58	13 82	86 21	
	5-Apr	10 49	14	86 03	
	12-Apr	12:22	14 07	85 98	
	11-May	12 49	13 8	86 43	water table rising
	19-May	10 30	12 59	87 44	
	23-May	10:23	12 27	87 78	
	31-May	14:59	11 75	88 28	
	6-Jun	13:50	11 31	88 72	
	28-Jun	10:28	10 27	89 78	
	17-Jul		9 78	90 25	
	21-Aug	20 38	8 23	91 8	
	30-Sep	11:10	9 37	90 66	water table declining
	17-Oct	14 48	10 23	89 8	
					NEW MP ELEVATION = 89.83
	14-Nov	14 58	11 38	88 45	
	8-Dec	13 44	11 88	87 95	
	1988				
	20-Feb	13:05	11 87	87 88	
	23-Mar	12 48	11 91	87 92	
	3-Apr	14 23	12 22	87 61	
	30-May	14 42	11 48	88 37	water table rising
	20-Jun	10:38	9 57	90 28	
	18-Jul		7 91	91 92	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
BM3	1988				MP ELEVATION = 100.13
	1-Mar	8 44	13 6	86 53	
	15-Mar	13 41	13 82	86 31	water table declining
	22-Mar	10 57	13 91	86 22	
	5-Apr	9 48	14 00	86 04	
	12-Apr	12 23	14 18	85 87	
	11-May	12 48	13 80	86 44	water table rising
	19-May	16 29	12 87	87 48	
	23-May	10 20	12 38	87 77	
	31-May	14 54	11 84	88 29	
	6-Jun	13 48	11 4	88 73	
	28-Jun	10 25	10 38	89 77	
	17-Jul		9 89	90 24	
	21-Aug	20 37	8 31	91 82	
	30-Sep	11 14	9 45	90 88	water table declining
	17-Oct	14 50	10 31	89 82	
					NEW MP ELEVATION = 99.89
	14-Nov	14 55	11 42	88 47	
	8-Dec	13 43	11 93	87 86	
	1988				
	20-Feb	13 04	12 01	87 88	
	23-Mar	12 48	11 96	87 93	
	3-Apr	14 22	12 28	87 83	
	30-May	14 43	11 51	88 38	water table rising
	20-Jun	10 37	9 6	90 29	
	18-Jul		8 02	91 87	
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
BM4	1988				MP ELEVATION = 89.98
	1-Mar	8 07	13 29	86 59	
	15-Mar	13 39	13 52	86 38	water table declining
	22-Mar	10 55	13 6	86 28	
	5-Apr	9 49	13 78	86 1	
	12-Apr	12 24	13 85	86 03	
	11-May	12 48	13 39	86 49	water table rising
	19-May	16 28	12 34	87 54	
	23-May	10 21	12 05	87 83	
	31-May	14 55	11 55	88 33	
	6-Jun	13 47	11 11	88 77	
	28-Jun	10 24	10 02	89 86	
	17-Jul		9 54	90 34	
	21-Aug	20 34	7 91	91 97	
	30-Sep	11 18	9 07	90 81	water table declining
	17-Oct	14 53	9 94	89 94	
					NEW MP ELEVATION = 89.87
	14-Nov	14 53	11 31	88 56	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MP14 60010	1998				
	8-Dec	13:40	11.84	88.03	
	1998				
	20-Feb	13:03	11.93	87.94	
	23-Mar	12:49	11.88	87.99	
	3-Apr	14:20	12.17	87.7	
	30-May	14:44	11.42	88.45	water table rising
	20-Jun	10:36	9.48	90.39	
	18-Jul		7.89	91.98	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MP15	1998				MP ELEVATION = 89.33
	1-Mar	8:36	13.32	88.54	
	15-Mar	8:35	13.55	88.31	water table declining
	22-Mar	10:48	13.63	88.23	
	5-Apr	9:37	13.81	88.05	
	12-Apr	12:18	13.88	85.98	
	11-May	12:41	13.4	88.48	water table rising
	19-May	16:22	12.4	87.48	
	23-May	10:15	12.09	87.77	
	31-May	14:48	11.54	88.32	
	6-Jun	13:41	11.09	88.77	
	28-Jun	10:18	10.08	89.8	
	17-Jul		9.8	90.26	
	21-Aug	20:27	8.02	91.84	
	30-Sep	10:50	9.18	90.7	water table declining
	17-Oct	14:48	10.03	89.83	
					NEW MP ELEVATION = 89.62
	14-Nov	14:49	11.07	88.45	
	8-Dec	13:29	11.53	87.99	
	1998				
	20-Feb	9:15	11.6	87.92	
	23-Mar	12:40	11.56	87.98	
	3-Apr	14:27	11.86	87.68	
	30-May	14:25	11.1	88.42	water table rising
	20-Jun	10:30	9.23	90.29	
	18-Jul		7.59	91.93	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MP16	1998				MP ELEVATION = 88.48
	1-Mar	8:37	12.98	88.5	
	15-Mar	13:37	13.2	88.28	water table declining
	22-Mar	10:48	13.27	88.21	
	5-Apr	10:53	13.48	88.02	
	12-Apr	12:17	13.52	85.98	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W18 cont'd	1998				
	11-May	12 42	13 05	86 43	water table rising
	19-May	16 23	12 05	87 43	
	23-May	10 18	11 74	87 74	
	31-May	14 49	11 2	88 28	
	6-Jun	13 42	10 9	88 58	
	28-Jun	10 19	9 74	89 74	
	17-Jul		9 23	90 25	
	21-Aug	20 28	7 72	91 78	
	30-Sep	10 47	8 88	90 82	water table declining
	17-Oct	14 44	9 71	89 77	
					NEW MP ELEVATION = 89.49
	14-Nov	14 50	11 08	88 43	
	8-Dec	13 31	11 55	87 94	
	1999				
	20-Feb	13 00	11 83	87 88	
	23-Mar	13 01	11 58	87 91	
	3-Apr	14 31	11 88	87 61	
	30-May	14 27	11 12	88 37	water table rising
	20-Jun	10 32	9 24	90 25	
	18-Jul		7 64	91 85	
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W17	1998				MP ELEVATION = 89.89
	1-Mar	6 30	13 4	86 48	
	15-Mar	13 35	13 63	86 25	water table declining
	22-Mar	10 52	13 69	86 19	
	5-Apr	9 45	13 87	86 01	
	12-Apr	12 18	13 95	85 93	
	11-May	12 43	13 49	86 39	water table rising
	19-May	16 24	12 47	87 41	
	23-May	10 17	12 18	87 72	
	31-May	14 50	11 63	88 25	
	6-Jun	13 43	11 21	88 67	
	28-Jun	10 20	10 19	89 89	
	17-Jul		9 7	90 18	
	21-Aug	20 29	8 16	91 72	
	30-Sep	10 45	9 3	90 58	water table declining
	17-Oct	14 43	10 15	89 73	
					NEW MP ELEVATION = 89.67
	14-Nov	14 51	11 18	88 39	
	8-Dec	13 33	11 87	87 9	
	1999				
	20-Feb	13 01	11 75	87 82	
	23-Mar	12 54	11 71	87 88	
	23-May	10 17	12 16	87 72	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
BN7 cont'd	1998				
	3-Apr	14 33	12	87 57	
	30-May	14 28	11 25	88 32	water table rising
	20-Jun	10 33	9 38	90 21	
	18-Jul		7 8	91 77	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
BN8	1998				MP ELEVATION = 88.72
	1-Mar	8 41	13 27	88 45	
	15-Mar	13 33	13 49	88 23	water table declining
	22-Mar	10 54	13 58	88 18	
	5-Apr	9 44	13 74	85 98	
	12-Apr	12 15	13 81	85 91	
	11-May	12 44	13 38	86 36	water table rising
	19-May	16 25	12 34	87 38	
	23-May	10 18	12 03	87 89	
	31-May	14 51	11 51	88 21	
	6-Jun	13 44	11 07	88 65	
	28-Jun	10 21	10 08	89 88	
	17-Jul		9 58	90 18	
	21-Aug	20 30	8 05	91 87	
	30-Sep	10 42	9 18	90 58	water table declining
	17-Oct	14 41	10 02	89 7	
					NEW MP ELEVATION = 88.61
	14-Nov	14 53	11 15	88 38	
	8-Dec	13 38	11 82	87 89	
	1998				
	20-Feb	13 02	11 7	87 81	
	23-Mar	12 52	11 88	87 83	
	3-Apr	14 34	11 97	87 54	
	30-May	14 29	11 21	88 3	water table rising
	20-Jun	10 38	9 32	90 19	
	18-Jul		7 85	91 88	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
BN9	1998				MP ELEVATION = 88.35
	1-Mar	8 49	12 8	88 49	
	15-Mar	13 23	13 02	88 27	water table declining
	22-Mar	10 45	13 08	88 21	
	5-Apr	9 38	13 28	88 03	
	12-Apr	12 08	13 33	85 98	
	11-May	12 40	12 87	88 42	water table rising
	19-May	16 21	11 88	87 43	
	23-May	10 14	11 55	87 74	
	31-May	10 35	11 02	88 27	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
WTS 00073	1998				
	6-Jun	13 40	10 54	88 75	
	28-Jun	10 17	9 53	89 76	
	17-Jul		9 03	90 26	
	19-Aug		7 54	91 75	
	21-Aug	20 48	7 51	91 78	
	30-Sep		8 68	90 61	water table declining
	17-Oct	14 35	9 91	89 38	
					NEW MP ELEVATION = 89.27
	14-Nov	14 47	10 86	88 41	
	8-Dec	13 14	11 36	87 92	
	1999				
	20-Feb	12 42	11 43	87 84	
	23-Mar	13 04	11 4	87 87	
	3-Apr	14 40	11 7	87 57	
	30-May	14 33	10 93	88 34	water table rising
	20-Jun	10 27	9 06	90 21	
	18-Jul		7 5	91 77	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W-20	1998				MP ELEVATION = 88.20
	1-Mar	8 51	12 73	88 47	
	15-Mar	13 25	12 95	88 25	water table declining
	22-Mar	10 43	13 04	88 16	
	5-Apr	9 39	13 21	85 99	
	12-Apr	12 07	13 28	85 92	
	11-May	12 39	12 83	86 37	water table rising
	19-May	10 20	11 61	87 39	
	23-May	10 13	11 51	87 69	
	31-May	14 45	10 97	88 23	
	6-Jun	13 34	10 54	88 68	
	28-Jun	10 15	9 54	89 68	
	17-Jul		9 08	90 12	
	21-Aug	20 25	7 52	91 68	
	30-Sep	10 29	8 64	90 56	water table declining
	17-Oct	14 36	9 5	89 7	
					NEW MP ELEVATION = 89.20
	14-Nov	14 39	10 84	88 36	
	8-Dec	13 10	11 32	87 68	
	1999				
	20-Feb	12 59	11 4	87 8	
	23-Mar	13 50	11 33	87 87	
	3-Apr	14 38	11 67	87 53	
	30-May	14 32	10 91	88 29	water table rising
	20-Jun	10 31	9 04	90 16	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M21	1998				MP ELEVATION = 89.26
	1-Mar	8 53	12 77	86 43	
	15-Mar	13 28	12 99	86 21	water table declining
	22-Mar	10 41	13 06	86 14	
	5-Apr	9 40	13 24	85 98	
	12-Apr	12 08	13 31	85 89	
	11-May	12 38	12 85	86 35	water table rising
	19-May	10 19	11 84	87 36	
	23-May	10 12	11 54	87 66	
	31-May	14 42	11 01	88 19	
	8-Jun	13 33	10 58	88 62	
	28-Jun	10 13	9 58	89 62	
	17-Jul		9 08	90 12	
	21-Aug	20 23	7 58	91 62	
	30-Sep	10 33	8 68	90 52	water table declining
	17-Oct	14 37	9 55	89 65	
					NEW MP ELEVATION = 89.20
	14-Nov	14 36	10 68	88 32	
	8-Dec	13 07	11 35	87 85	
	1999				
	20-Feb	12 58	11 43	87 77	
	23-Mar	13 11	11 41	87 79	
	3-Apr	14 37	11 69	87 51	
	30-May	14 31	10 95	88 25	water table rising
	20-Jun	10 34	9 05	90 15	
	18-Jul		7 74	91 46	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M22	1998				MP ELEVATION = 89.35
	1-Mar	8 54	13 4	86 48	
	15-Mar	13 28	13 62	86 26	water table declining
	22-Mar	10 40	13 69	86 19	
	5-Apr	9 41	13 87	86 01	
	12-Apr	12 09	13 93	85 95	
	11-May	12 37	13 48	86 4	water table rising
	19-May	10 18	12 47	87 41	
	23-May	10 11	12 17	87 71	
	31-May	14 41	11 63	88 25	
	8-Jun	13 32	11 21	88 67	
	28-Jun	10 13	10 21	89 87	
	17-Jul		9 73	90 15	
	21-Aug	20 22	8 19	91 69	
	30-Sep	10 35	9 31	90 57	water table declining
	17-Oct	14 38	11 01	88 67	
					NEW MP ELEVATION = 89.35
	14-Nov	14 38	11 01	88 34	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W22 cont'd	1998				
	8-Dec	13.04	11.5	87.85	
	1998				
	20-Feb	12.57	11.58	87.77	
	23-Mar	13.08	11.55	87.8	
	3-Apr	14.38	11.03	87.42	
	30-May	14.30	11.09	88.28	water table rising
	20-Jun	10.35	9.2	90.15	
	18-Jul		7.83	91.52	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W23	1998				MP ELEVATION = 102.61
	1-Mar	8.42	15.57	88.44	
	16-Mar	13.30	15.79	88.22	water table declining
	22-Mar	10.39	15.88	88.15	
	5-Apr	9.43	16.03	85.98	
	12-Apr	12.09	16.1	85.91	
	11-May	12.38	16.05	88.38	water table rising
	19-May	16.17	14.84	87.37	
	23-May	10.10	14.39	87.62	
	31-May	14.40	13.81	88.2	
	6-Jun	13.30	13.38	88.63	
	28-Jun	10.11	12.38	89.63	
	17-Jul		11.9	90.11	
	21-Aug	20.20	10.35	91.66	
	30-Sep	10.39	11.47	90.54	water table declining
	17-Oct	14.40	12.33	89.88	
	14-Nov				DECOMMISSIONED
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W24	1998				MP ELEVATION = 88.71
	21-Feb	13.46	13.2	88.58	
	22-Feb	10.33	13.2	88.58	water table declining
	27-Feb	12.31	13.27	88.51	
	1-Mar	8.34	13.28	88.5	
	7-Mar	12.52	13.4	88.38	
	9-Mar	13.13	13.48	88.32	
	15-Mar	11.08	13.53	88.25	
	22-Mar	10.31	13.8	88.18	
	5-Apr	9.36	13.77	88.01	
	12-Apr	12.05	13.84	85.94	
	11-May	12.31	13.34	88.44	water table rising
	19-May	16.12	12.37	87.41	
	23-May	10.05	12.06	87.72	
	31-May	14.34	11.51	88.27	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W24 cont'd	1996				
	6-Jun	13 08	11 06	88 72	
	28-Jun	10 06	10 07	89 71	
	17-Jul		9 8	90 18	
	21-Aug	20 13	8 04	91 74	
	30-Sep	10 02	9 2	90 58	water table declining
	17-Oct	14 33	10 05	89 73	
					NEW MP ELEVATION = 89.34
	14-Nov	14 28	10 98	88 36	
	6-Dec	12 40	11 46	87 68	
	1998				
	20-Feb	12 50	11 57	87 77	
	23-Mar	13 08	11 5	87 84	
	3-Apr	14 47	11 79	87 55	
	30-May	14 24	11 03	88 31	water table rising
	20-Jun	10 21	9 18	90 18	
	18-Jul		7 81	91 53	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W25	1996				MP ELEVATION = 88.81
	1-Mar	8 32	13 14	86 47	
	15-Mar	8 36	13 37	86 24	water table declining
	22-Mar	10 33	13 44	86 17	
	5-Apr	9 35	13 62	85 99	
	12-Apr	12 04	13 68	85 93	
	11-May	12 32	13 21	86 4	water table rising
	19-May	16 13	12 21	87 4	
	23-May	10 06	11 91	87 7	
	31-May	14 31	11 68	87 93	
	6-Jun	13 09	10 91	88 7	
	28-Jun	10 07	9 93	89 88	
	17-Jul		9 46	90 13	
	21-Aug	20 11	7 93	91 68	
	30-Sep	10 00	9 07	90 54	water table declining
	17-Oct	14 31	9 92	89 69	
					NEW MP ELEVATION = 89.38
	14-Nov	15 00	11 02	88 36	
	6-Dec	12 42	11 51	87 67	
	1998				
	20-Feb	12 51	11 57	87 81	
	23-Mar	13 06	11 54	87 84	
	3-Apr	14 46	11 82	87 56	
	30-May	14 22	11 07	88 31	water table rising
	20-Jun	10 20	9 23	90 15	
	18-Jul		7 81	91 57	

APPENDIX E POTENTIOMETRIC DATA

WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
123	1998				MP ELEVATION = 88.33
	1-Mar	8 30	12 93	88 4	
	15-Mar	11 05	13 15	86 18	water table declining
	22-Mar	10 34	13 22	86 11	
	5-Apr	9 34	13 4	85 93	
	12-Apr	12 03	13 47	85 86	
	11-May	12 33	13 01	86 32	water table rising
	19-May	16 14	12 01	87 32	
	23-May	10 07	11 7	87 63	
	31-May	14 37	11 15	88 18	
	6-Jun	13 10	10 73	88 6	
	28-Jun	10 08	9 75	89 58	
	17-Jul		9 3	90 03	
	19-Aug		7 72	91 61	
	21-Aug	20 12	7 77	91 56	
	30-Sep	9 57	8 89	90 44	water table declining
	17-Oct	14 45	9 75	89 58	
					NEW MP ELEVATION = 89.13
	14-Nov	14 30	10 88	88 25	
	8-Dec	12 46	11 32	87 81	
	1998				
	20-Feb	12 53	11 39	87 74	
	23-Mar	13 18	11 37	87 76	
	3-Apr	14 45	11 65	87 48	
	30-May	9 24	10 92	88 21	water table rising
	20-Jun	10 19	9 03	90 1	
	16-Jul		7 65	91 73	
WELL ID.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
127	1998				MP ELEVATION = 89.24
	1-Mar	8 28	13 21	86 35	
	15-Mar	11 03	13 44	86 12	water table declining
	22-Mar	10 36	13 5	86 06	
	5-Apr	9 28	13 67	85 69	
	12-Apr	12 02	13 74	85 62	
	11-May	12 34	13 3	86 26	water table rising
	19-May	16 15	12 29	87 27	
	23-May	10 08	11 99	87 57	
	31-May	14 38	11 44	86 12	
	6-Jun	13 11	11 05	86 51	
	28-Jun	10 09	10 07	89 49	
	17-Jul		9 62	89 94	
	21-Aug	20 08	8 11	91 45	
	30-Sep	9 55	9 2	90 36	water table declining
					NEW MP ELEVATION = 89.18

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W27 63K'S	1998				
	17-Oct	14 29	10 08	89 5	
	14-Nov	14 32	10 98	88 2	
	8-Dec	12 49	11 44	87 74	
	1999				
	20-Feb	12 54	11 5	87 68	
	23-Mar	13 22	11 5	87 68	
	3-Apr	14 56	11 78	87 4	
	30-May	9 23	11 05	88 13	water table rising
	20-Jun	10 18	9 15	90 03	
	18-Jul		7 8	91 38	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
W29	1998				MP ELEVATION = 101.88
	21-Feb	13 47	15 47	86 41	
	22-Feb	10 35	15 5	86 38	water table declining
	27-Feb	12 27	15 55	86 33	
	1-Mar	8 27	15 55	86 33	
	7-Mar	12 49	15 65	86 23	
	9-Mar	13 13	15 67	86 21	
	15-Mar	11 02	15 77	86 11	
	22-Mar	10 37	15 84	86 04	
	5-Apr	9 25	16 01	85 87	
	12-Apr	12 01	16 07	85 81	
	11-May	12 35	15 63	86 25	water table rising
	19-May	16 18	14 83	87 25	
	23-May	10 09	14 33	87 56	
	31-May	14 39	13 78	88 1	
	6-Jun	13 12	13 37	88 51	
	28-Jun	10 10	12 43	89 45	
	17-Jul		12 02	89 88	
	21-Aug	20 06	10 48	91 4	
	30-Sep	9 53	11 56	90 32	water table declining
	17-Oct	14 28	12 42	89 46	
					NEW MP ELEVATION = 101.46
	14-Nov	14 33	13 3	88 16	
	8-Dec	12 53	13 75	87 71	
	1999				
	20-Feb	12 55	13 82	87 64	
	23-Mar	13 28	13 81	87 65	
	3-Apr	14 58	14 09	87 37	
	30-May	9 22	13 37	88 09	water table rising
	20-Jun	10 17	11 47	89 99	
	18-Jul		10 08	91 38	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M-25	1985				MP ELEVATION = 89.83
	1-Mar	8:20	13.48	88.42	
	15-Mar	10:55	13.68	86.2	water table declining
	22-Mar	10:28	13.75	88.13	
	5-Apr	9:21	13.92	85.98	
	12-Apr	11:57	13.99	85.89	
	11-May	12:30	13.53	88.35	water table rising
	19-May	16:11	12.54	87.34	
	23-May	10:04	12.23	87.85	
	31-May	14:33	11.68	88.2	
	8-Jun	13:07	11.28	88.62	
	28-Jun	10:05	10.29	89.59	
	17-Jul		9.78	90.1	
	21-Aug	20:02	8.3	91.58	
	30-Sep	9:42	9.41	90.47	water table declining
	17-Oct	14:20	10.28	89.6	
					NEW MP ELEVATION = 89.78
	14-Nov	14:28	11.49	88.29	
	8-Dec	12:37	11.97	87.81	
	1986				
	20-Feb	12:49	12.03	87.75	
	23-Mar	13:30	12.03	87.75	
	3-Apr	14:48	12.32	87.46	
	30-May	9:16	11.58	88.2	water table rising
	20-Jun	10:11	9.71	90.07	
	18-Jul		8.22	91.58	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M30	1986				MP ELEVATION = 100.42
	1-Mar	8:21	14.08	88.34	
	15-Mar	10:57	14.3	88.12	water table declining
	22-Mar	10:26	14.38	88.06	
	5-Apr	9:22	14.53	85.89	
	12-Apr	11:58	14.6	85.82	
	11-May	12:29	14.18	86.28	water table rising
	19-May	16:10	13.18	87.28	
	23-May	10:03	12.85	87.57	
	31-May	14:32	12.31	88.11	
	8-Jun	13:08	11.9	88.52	
	28-Jun	10:04	10.95	89.47	
	17-Jul		10.44	89.98	
	21-Aug	20:03	8.98	91.44	
	30-Sep	9:45	10.07	90.35	water table declining
	17-Oct	14:23	10.84	89.48	
					NEW MP ELEVATION = 89.86

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M30	1998				
	14-Nov	14 25	11 68	88 17	
	8-Dec	12 35	12 12	87 73	
	1998				
	20-Feb	13 48	12 17	87 68	
	23-Mar	13 29	12 2	87 65	
	3-Apr	14 48	12 48	87 37	
	30-May	9 19	11 75	88 1	water table rising
	20-Jun	10 12	9 88	89 99	
	18-Jul		8 44	91 41	
M31	1998				MP ELEVATION = 99.76
	1-Mar	8 23	13 45	88 31	
	15-Mar	10 58	13 68	88 1	water table declining
	22-Mar	10 25	13 73	88 03	
	5-Apr	9 23	13 91	85 85	
	12-Apr	11 59	13 97	85 79	
	11-May	12 28	13 53	86 23	water table rising
	19-May	10 09	12 54	87 22	
	23-May	10 02	12 22	87 54	
	31-May	14 31	11 68	88 08	
	8-Jun	13 05	11 27	88 49	
	28-Jun	10 03	10 32	89 44	
	17-Jul		9 84	89 92	
	19-Aug		8 35	91 41	
	21-Aug	20 04	8 4	91 36	
	30-Sep	9 47	9 47	90 29	water table declining
	17-Oct	14 24	10 33	89 43	
					NEW MP ELEVATION = 99.76
	14-Nov	14 17	11 62	88 14	
	8-Dec	12 32	12 06	87 7	
	1998				
	20-Feb	12 44	12 12	87 64	
	23-Mar	13 33	12 11	87 65	
	3-Apr	14 49	12 38	87 38	
	30-May	9 20	11 65	88 11	water table rising
	20-Jun	10 13	9 77	89 99	
	18-Jul		8 39	91 37	
M32	1998				MP ELEVATION = 101.88
	1-Mar	8 25	15 26	86 29	
	15-Mar	11 00	15 47	86 08	water table declining
	22-Mar	10 23	15 54	86 01	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M32 cont'd	1998				
	5-Apr	9:24	15.71	85.84	
	12-Apr	12:00	15.78	85.77	
	11-May	12:27	15.34	86.21	water table rising
	19-May	18:08	14.35	87.2	
	23-May	10:01	14.04	87.51	
	31-May	14:29	13.5	88.05	
	6-Jun	13:04	13.08	88.47	
	28-Jun	10:02	12.17	89.38	
	17-Jul		11.73	89.82	
	21-Aug	20:05	10.23	91.32	
	30-Sep	9:50	11.31	90.24	water table declining
	17-Oct	14:28	12.14	89.41	
					NEW MP ELEVATION = 101.34
	14-Nov	14:18	13.23	88.11	
	8-Dec	12:30	13.67	87.87	
	1998				
	20-Feb	10:43	13.77	87.57	
	23-Mar	13:35	13.72	87.82	
	3-Apr	14:50	13.99	87.35	
	30-May	9:21	13.28	88.08	water table rising
	20-Jun	10:14	11.38	89.98	
	18-Jul		10.01	91.33	
M33	1998				MP ELEVATION = 100.94
	1-Mar	8:18	14.68	88.28	
	15-Mar	10:53	14.9	88.06	water table declining
	22-Mar	10:21	14.98	88	
	5-Apr	9:30	15.12	85.84	
	12-Apr	11:58	15.19	85.77	
	11-May	12:28	14.78	86.2	water table rising
	19-May	18:07	13.77	87.19	
	23-May	10:00	13.48	87.5	
	31-May	14:28	12.91	88.05	
	6-Jun	13:03	12.51	88.45	
	28-Jun	9:59	11.59	89.37	
	17-Jul		11.11	89.85	
	21-Aug	19:55	9.68	91.28	
	30-Sep	9:31	10.75	90.21	water table declining
	17-Oct	14:19	11.61	89.35	
					NEW MP ELEVATION = 100.96
	14-Nov	14:15	12.87	88.08	
	8-Dec	12:27	13.31	87.64	
	1998				
	20-Feb	10:42	13.39	87.58	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS3 cont'd	1984				
	23-Mar	13:38	13.38	87.59	
	3-Apr	14:54	13.83	87.32	
	30-May	9:17	12.91	88.04	water table rising
	20-Jun	10:09	11.05	89.9	
	18-Jul		9.67	91.28	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS4	1985				MP ELEVATION = 102.64
	1-Mar	8:16	15.75	88.29	
	15-Mar	10:52	15.98	86.08	water table declining
	22-Mar	10:19	16.03	86.01	
	5-Apr	9:31	16.2	85.84	
	12-Apr	11:54	16.26	85.78	
	11-May	12:25	15.83	86.21	water table rising
	19-May	16:05	14.84	87.2	
	23-May	9:59	14.52	87.52	
	31-May	14:27	13.98	88.06	
	8-Jun	13:01	13.58	88.46	
	28-Jun	9:58	12.66	89.38	
	17-Jul		12.2	89.84	
	21-Aug	19:54	10.74	91.3	
	30-Sep	9:28	11.8	90.24	water table declining
	17-Oct	14:18	12.68	89.36	
					NEW MP ELEVATION = 101.67
	14-Nov	14:13	13.58	88.09	
	8-Dec	12:24	14.02	87.65	
	1986				
	20-Feb	10:40	14.1	87.57	
	23-Mar	13:39	14.08	87.59	
	3-Apr	14:53	14.35	87.32	
	30-May	9:16	13.64	88.03	water table rising
	20-Jun	10:08	11.75	89.92	
	18-Jul		10.4	91.27	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS8	1986				MP ELEVATION = 101.97
	1-Mar	8:14	15.68	86.29	
	15-Mar	10:50	15.9	86.07	water table declining
	22-Mar	10:17	15.97	86	
	5-Apr	9:19	16.14	85.83	
	12-Apr	11:53	16.2	85.77	
	11-May	12:24	15.77	86.2	water table rising
	19-May	16:03	14.78	87.19	
	23-May	9:58	14.46	87.51	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS3 cont'd	1995				
	31-May	14 23	13 92	88 05	
	6-Jun	13 00	13 52	88 45	
	28-Jun	9 57	12 6	89 37	
	17-Jul		12 16	89 81	
	21-Aug	19 53	10 67	91 3	
	30-Sep	9 23	11 74	90 23	water table declining
	17-Oct	14 17	12 61	89 36	
					NEW MP ELEVATION = 101.67
	14-Nov	14 24	13 48	88 09	
	8-Dec	12 22	13 92	87 65	
	1996				
	20-Feb	10 39	13 99	87 58	
	23-Mar	13 43	13 99	87 58	
	3-Apr	14 51	14 25	87 32	
	30-May	9 15	13 53	88 04	water table rising
	20-Jun	10 07	11 65	89 92	
	18-Jul		10 29	91 28	
MS4	1996				MP ELEVATION = 103.84
	21-Feb	13 46	17 24	86 34	
	22-Feb	10 39	17 25	86 33	water table declining
	27-Feb	12 29	17 3	86 28	
	1-Mar	8 12	17 31	86 27	
	7-Mar	12 50	17 41	86 17	
	9-Mar	13 14	17 5	86 08	
	15-Mar	10 48	17 53	86 05	
	22-Mar	10 15	17 59	85 99	
	5-Apr	9 17	17 76	85 82	
	12-Apr	11 51	17 82	85 76	
	11-May	12 23	17 39	86 19	water table rising
	19-May	16 01	16 4	87 18	
	23-May	9 57	16 07	87 51	
	31-May	14 25	15 54	88 04	
	6-Jun	12 58	15 14	88 44	
					NEW MP ELEVATION = 102.76
	14-Nov	14 06	14 71	86 04	water table declining
	8-Dec	12 18	15 14	87 61	
	1996				
	20-Feb				snowed under
	23-Mar	13 41	15 19	87 56	
	3-Apr	14 52	15 46	87 29	
	30-May	9 13	14 74	88 01	water table rising
	20-Jun	10 06	12 88	89 87	
	18-Jul		11 54	91 21	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS7	1998				MP ELEVATION = 102.33
	1-Mar	8:02	15.99	86.34	
	15-Mar	17:01	16.2	86.13	water table declining
	22-Mar	10:12	16.27	86.06	
	5-Apr	9:15	16.45	85.88	
	12-Apr	12:13	16.51	85.82	
	11-May	12:21	16.04	86.29	water table rising
	19-May	15:59	15.03	87.3	
	23-May	9:51	14.72	87.61	
	31-May	14:16	14.19	88.14	
	6-Jun	12:56	13.79	88.54	
	28-Jun	9:55	12.84	89.49	
	17-Jul		12.4	89.93	
	21-Aug	19:46	10.85	91.48	
	30-Sep	12:18	11.93	90.4	water table declining
	17-Oct	14:15	12.6	89.53	
					NEW MP ELEVATION = 102.26
	14-Nov	15:02	14.07	88.19	
	8-Dec	12:59	14.54	87.72	
	1998				
	20-Feb	10:34	14.6	87.66	
	23-Mar	13:47	14.6	87.66	
	13-Apr	15:00	14.81	87.45	
	30-May	14:45	14.12	88.14	water table rising
	20-Jun	10:04	12.24	90.02	
	18-Jul		10.78	91.48	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS8	1998				MP ELEVATION = 89.18
	8-Dec	13:17	11.25	87.93	
	1998				
	20-Feb	13:12	11.33	87.85	water table declining
	23-Mar	13:03	11.3	87.88	
	13-Apr	14:41	11.61	87.57	
	30-May	14:34	10.83	88.35	water table rising
	20-Jun	10:28	8.99	90.19	
	18-Jul		7.4	91.78	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
MS9	1998				MP ELEVATION = 88.18
	8-Dec	13:22	11.23	87.93	
	1998				
	20-Feb	13:13	11.3	87.86	water table declining
	23-Mar	13:51	11.29	87.87	
	13-Apr	14:42	11.58	87.58	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M33 cont'd	1998				
	30-May	14 35	10 82	88 34	water table rising
	20-Jun	10 25	8 97	90 19	
	18-Jul		7 37	91 79	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M40	1998				MP ELEVATION = 89.88
	14-Nov	14 48	10 7	88 38	
	8-Dec	13 24	11 19	87 89	water table declining
	1999				
	20-Feb	11 08	11 28	87 8	
	23-Mar	13 52	11 27	87 81	
	13-Apr	14 43	11 55	87 53	
	30-May	14 38	10 8	88 28	water table rising
	20-Jun	10 24	8 95	90 13	
	18-Jul		7 52	91 56	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
M41	1998				MP ELEVATION = 89.88
	14-Nov	14 45	10 73	88 32	
	8-Dec	13 26	11 21	87 84	water table declining
	1999				
	20-Feb	13 17	11 31	87 74	
	23-Mar	13 53	11 3	87 75	
	13-Apr	14 44	11 58	87 47	
	30-May	14 37	10 81	88 24	water table rising
	20-Jun	10 23	8 95	90 1	
	18-Jul		7 53	91 52	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y1	1998				MP ELEVATION = 101.00
	20-Feb	13 15	11 18	89 82	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y2	1998				MP ELEVATION = 89.87
	20-Feb	13 18	11 24	87 83	

APPENDIX E POTENTIOMETRIC DATA

WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y3	1998				MP ELEVATION = 88.88
	20-Feb	13:18	11:22	87.63	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y4	1998				MP ELEVATION = 89.32
	20-Feb				snowed under
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y5	1998				MP ELEVATION = 89.07
	20-Feb	13:23	11:32	87.75	
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y6	1998				MP ELEVATION = 89.00
	20-Feb				snowed under
WELL I.D.	DATE	TIME	DTW	WATER TABLE ELEVATION	COMMENTS
Y7	1998				MP ELEVATION = 89.01
	20-Feb	13:22	11:20	87.72	

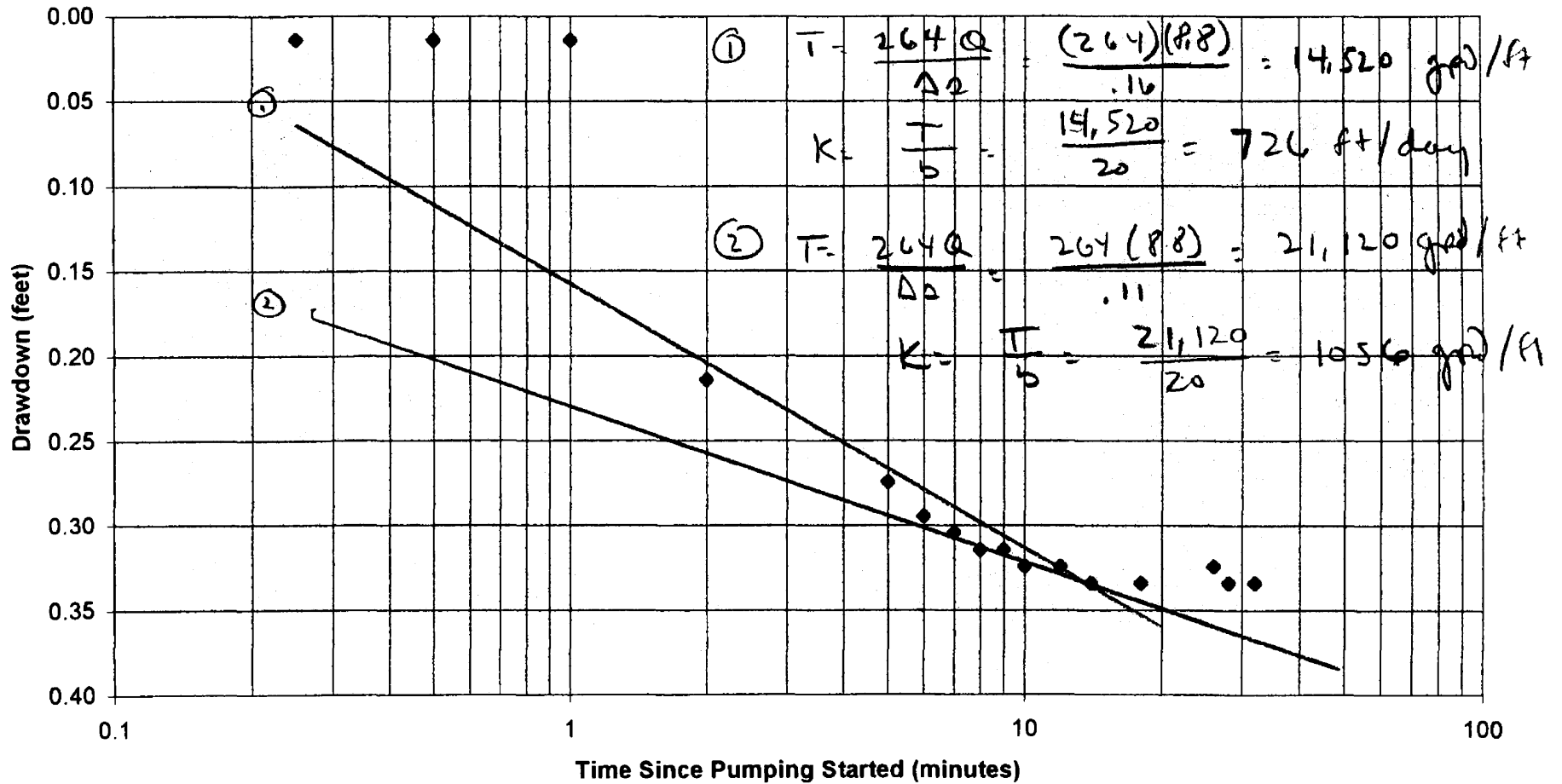
APPENDIX F

Aquifer Test Data and Analyses

Well M19 Constant Discharge Test

t (min)	Well M38		Well M39		t' (min)	Well M38		Well M39	
	Depth to Water (feet)	Drawdown (feet)	Depth to Water (feet)	Drawdown (feet)		Depth to Water (feet)	Residual (feet)	Depth to Water (feet)	Residual (feet)
0	13.01	0.00	15.00	0.00	0	13.31	0.3	15.04	0.04
0.25	13.02	0.014	15.00	0.00	0.25	13.13	0.12	15.03	0.03
0.5	13.02	0.014	15.00	0.00	0.5	13.08	0.07	15.02	0.02
1	13.02	0.014	15.00	0.00	0.75	13.05	0.04	15.01	0.01
2	13.22	0.214	15.02	0.02	1	13.04	0.03	15.01	0.01
5	13.28	0.274	15.03	0.03	2	13.02	0.01	15.01	0.01
6	13.30	0.294	15.03	0.03	3	13.01	0	15.00	0.00
7	13.31	0.304	15.04	0.04	4	13.01	0	15.00	0.00
8	13.32	0.314	15.04	0.04	5	13.01	0	15.00	0.00
9	13.32	0.314	15.04	0.04	6	13.01	0	15.00	0.00
10	13.33	0.324	15.04	0.04	10	13.01	0	15.00	0.00
12	13.33	0.324	15.04	0.04	12	13.01	0	15.00	0.00
14	13.34	0.334	15.04	0.04	14	13.01	0	15.00	0.00
18	13.34	0.334	15.04	0.04	16	13.00	-0.01	15.00	0.00
26	13.33	0.324	15.04	0.04	18	13.00	-0.01	15.00	0.00
28	13.34	0.334	15.04	0.04					
32	13.34	0.334	15.04	0.04					

Observation Well M38



APPENDIX G

Bromide Tracer Test Data

236

[illegible]

237

FRENCHTOWN HIGH SCHOOL																																										
BROMIDE TRACER TEST																																										
ELECTRICAL CONDUCTANCE FIELD MEASUREMENTS (MICROMHOS)																																										
TIME ELAPSED SINCE BROMIDE INJECTION (hours)																																										
	9	16	22	29	36	44	55	66	79	94	104	117	127	144	162	166	176	187	200	211	224	236	248	260	272	284	296	308	320	333	344	367	368	381	392	404	428	452	477			
WELL																																										
M19	950	840	575	550	495	442	371	347	342	350	338	334	333	344	323	332	305	339	309	329	321		338	350	328	341	341	331	340		348		360		355		354	342	339	344		
M38	1410	630	580	575	610	580	510	473	435	398	359	335	323	341	304	310																										
M39	375	352	367	365	328	332	322	315	318	322	311	304	305	318	297																											
T1	332	298	318	338	311	328	375	459	520	485	500	470	404	397	361		347	321	331		310		303						302					318		330		330		328		372
M40	305	293	303	319	305	441	500	520	467	370	259	333	314	322	307	289			312	287	311		311	311	302	299	309	308	310	304		318		330				328			372	
T2	318	293	304	311	298	308	317	304	321	468	540	443	377	344	322		307	301	281		299		290						300					314								
T3		343	364	378	350	358	360	350	368	353	349	345	340	352	340		313	332	311		310		313						311					321								
M41			334	363	320	336	331	329	334	345	339	348	343	353	331	318			330	315	326	311	321	328	320	313	325	315	313	310		304		330		321		319			332	
T4			383	375	347	382	362	355	370	369	369	389	394	398	382		357	370	335		339		327						319					328								
T5			318	338	305	304	321	311	319	328	330	304	321	329	325		304	302	285		270	389	284	295	279	311	293	288	298	280	260		289	314	295	303	296	287				
M26			344	381	332	333	349	334	348	341	336	342	341	349	341		319	332	309		322	339	310	312	315	339	319	317	302	319	311		311	337	311	329	309	299				
T6			450	480	449	452	459	440	474	461	440	433	424	437	423		414	409	390		379	399	381	380	358	380	370	371	359	361	375		342	361	341	360	339	320	329			
T7			378	413	388	371	403	368	441	362	360	375	375	381	372	345		359	349	370	341	372	363	380	370	370	382	380	362	370	364		379	379	361	359	348	332	332	332	325	
T8																																										
FRENCHTOWN HIGH SCHOOL																																										
BROMIDE TRACER TEST																																										
pH FIELD MEASUREMENTS																																										
TIME ELAPSED SINCE BROMIDE INJECTION (hours)																																										
	9	16	22	29	36	44	55	66	79	94	104	117	127	144	162	166	176	187	200	211	224	236	248	260	272	284	296	308	320	333	344	367	368	381	392	404	428	452	477			
WELL																																										
M19	6.37		6.1	6.3	6.4	6.5	6.8	6.7	6.7	6.7	6.5	6.5	6.5	6.9	6.4		6.5	6.6	6.4	6.5		6.9	6.8	7	7	6.8	7	7.3		6.5		6.6		6.3		6.4	6.7	6.6	6.8			
M38	6.16		6.2	6.4	6.1	6.2	6.3	6.4	6.8	6.2	6.3	6.1	6.3	6.1	6.4	6.1																										
M39	6.01		6.2	6.3	6.2	6.4	6.3	6.4	6.5	6.3	6.4	6.2	6.3	6.2	6.7																											
T1	6.22		6.3	6.4	6.2	6.3	6.5	6.4	6.7	6.4	6.4	6.4	6.5	6.4	6.7		6.3	6.3	6.4		6.4							6.8	6.6													
M40	6.25		6.4	6.6	6.4	6.4	6.6	6.6	6.9	6.7	6.7	6.5	6.6	6.5	6.9	6.6		6.3	6.5	6.4		6.7	6.9	6.7	7.1	7.1	7	7	7		6.3		6.4		6.3		6.4			6.7		
T2	6.41		6.5	6.6	6.5	6.5	6.7	6.8	7.1	6.6	6.5	6.4	6.6	6.6	6.7		6.4	6.6	6.6		6.5							6.7					6.6									
T3			6.2	6.4	6.2	6.2	6.4	6.4	6.6	6.6	6.3	6.3	6.4	6.3	6.6		6.1	6.2	6.4		6.1		6.2					6.8					6.3									
M41			6.4	6.6	6.5	6.5	6.8	6.7	6.7	6.8	6.4	6.4	6.6	6.5	6.5	6.3		6.5	6.4	6.3	6.4	6.6	6.9	6.2	6.9	6.9	7	6.8	6.9		6.3		6.4		6.2		6.4			6.8		
T4			6.1	6.4	6.2	6.2	6.4	6.4	6.4	7.1	6.4	6.2	6.4	6.4	6.4		6.1	6.3	6.3		6.5		6.3					6.9					6.3									
T5			6.2	6.4	6.2	6.3	6.5	6.4	6.6	6.8	6	6.2	6.4	6.2	6.8		6.1	6.1	6.2		6.2	6.3	6.2	6.2	6.4	6.7	6.4	6.5	6.6	6.2	6.2	6.1	6.3	6.4	6.2	6.3	6.4	6.1				
M26			6.2	6.5	6.2	6.3	6.4	6.6	6.5	6.8	6.4	6.4	6.4	6.3	6.7		6.2	6.3	6.3		6.2	6.3	6.2	6.5	6.6	6.7	6.3	6.4	6.9	6.2	6.3	6.3	6.5	6.4	6.3	6.3	6.3	6.4				
T6			6.1	6.3	6.1	6.2	6.3	6.3	6.4	6.5	6.2	6.2	6.3	6.2	6.7		6.1	6.3	6.1		6.6	6.3	6.2	6.3	6.5	6.6	6.3	6.6	6.6	6.4	6.1	6.2	6.4	6.4	6.2	6.3	6.2	6.3		6.5		
T7			6.2	6.2	6.1	6	6	6.3	6.3	6.3	6.2	6.2	6.2	6.1	6.7	6		6.1	6.3	6	6	6.1	6.2	6.4	6.6	6.7	6.3	6.7	6.6	6.1	6	6.1	6	6.2	6	6.2	6.1	6.3	6.4	6.3		
T8																																									7	

**APPENDIX G
BROMIDE TRACER TEST DATA**

Bromide (mg/l)				Temperature (°C)							pH				D O (mg/L)							
Hours	W19	W40	W41	T7	Hours	W19	W40	W41	T7	T8	Hours	W19	W40	W41	T7	T8	Hours	W19	W40	W41	T7	T8
0	4130				0	14.1	12.8	13.2			0	6.15	6.55	6.31	6.02		0	1.5	0.8	1	1	18
9	690				9						9						9					
12					12	15.8	15.5				12	6.48	6.34				12	3.1	1.9			
16	280				16						16						16					
22	240				22						22						22					
24					24	12.7	12.7				24	6.6	6.52				24	2.1	0.7			
29	280				29						29						29					
36	121	8			36	15.1	15.2	15.2	15.6		36	6.39	6.37	6.34	6.03		36	0.8	0.9	1.3	3.5	
44	52	124			44						44						44					
48					48	14.7	13.2	13.4	12.8		48	6.47	6.46	6.36	5.98		48	1.2	0.8	1.3	3.4	
55	30	320			55						55						55					
60					60		14.4	14.9	15.1		60		6.72	6.58	6.14		60		1.6	0.7	3.5	
68	12	210			68						68						68					
72					72	14.7	14	13.4	13.6		72	6.85	6.92	6.88	6.17		72	1.4	0.9	1.6	3.5	
79	8	142			79						79						79					
84					84	13.8	13.3	13.8	15.1		84	6.81	6.74	6.2	6.36		84	1	1.1	1.1	2.6	
94	6	64	0.5		94						94						94					
96					96	14.2	11.9	13.1	13.2		96	6.96	7.09	6.87	6.56		96	0.9		0.8	2.7	
104	3	38	2.3		104						104						104					
108					108	14.6	13.8	14.3	14.6		108	7.03	7.09	6.94	6.65		108	1.8	0.9	0.7	2.4	
117	3	19	10.11		117						117						117					
120					120	16.2	14.3	14.3	14.5		120	6.76	6.96	6.95	6.33		120	0.9	0.8	0.8	3.1	
127		10.4	13.4		127						127						127					
132					132						132	6.95	6.99	6.84	6.69		132					
144	5.8	15			144						144	7.3	7.02	6.9	6.59		144					
151	4.4	11.6	0.5		151						151						151					
156					156						156				6.09		156					
166	2.6	10.11	1		166						166						166					
168					168	15.6	15.1	15	14.5		168	6.5	6.31	6.25	6.02		168	0.8	1.8	0.7	2.5	
175	1.9	7.5	2		175						175						175					
180					180				16.3		180				6.11		180				2.4	
187	2.1	10.3	2.5		187						187						187					
192					192	16.2	15.4	15.8	16.2		192	6.57	6.35	6.37	6.04		192	0.9	0.8	1	3	
204					204				16.3		204				6.17		204				2.5	
211	0.9	5.7	3.6		211						211						211					
216					216	16.7	15.3	15.5	15.3		216	6.3	6.26	6.24	5.99		216	1.6	1	0.8	3.4	
228					228				16.3		228				6.15		228				3.3	
240					240	15.6	14.6	14.9	15.3		240	6.41	6.4	6.42	6.11		240	0.9	0.8	1	2.2	
252					252						252						252					
264					264	15			14		264	6.72			6.26		264	0.9			2.4	
272				10.63	272						272						272					
276					276						276						276					
284				10.52	284						284						284					
288					288	15.4			14.6		288	6.61			6.37		288	1			2.2	
296					296						296						296					
300					300						300						300					
308					308						308						308					
312					312						312	6.83	6.73	6.82	6.3	7.02	312					
320				8.44	320						320						320					
324					324						324						324					
333				7.62	333						333						333					
336					336						336						336					
344				10.6	344						344						344					
348					348						348						348					
357				9.37	357						357						357					
360					360						360						360					
368				6.72	368						368						368					
372					372						372						372					
381				7.1	381						381						381					
384					384						384						384					
392				4.92	392						392						392					
396					396						396						396					
404				5.48	404						404						404					
408					408						408						408					
420					420						420						420					
428				3.61	428						428						428					
432					432						432						432					
					444						444						444					
					456						456						456					
					468						468						468					
					480	13.8	13.4	13.5	13.3	13.8	480	6.67	6.57	6.55	6.36	6.64	480					

APPENDIX H

Inorganic Water Quality Analytical Data

APPENDIX H **ANALYTICAL RESULTS** **CATIONS**

Sample	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sr	Ti	Zn
6M11 2/8	2/13/95	ND	ND	ND	65.3	ND	ND	ND	ND	5.452	21.3	2.127	0.0115	12.6	ND	0.23	ND	10.1	0.1239	ND	0.017
6M12 2/8	2/13/95	ND	ND	0.051	51.7	ND	ND	ND	ND	7.994	16.7	5.075	0.0333	55.1	ND	0.43	ND	10.7	0.1512	ND	0.0141
6M13 2/8	2/13/95	ND	ND	0.068	79.8	ND	ND	ND	1.12	10.76	26.2	3.994	0.0127	40.4	ND	0.24	ND	13.7	0.1808	ND	0.0164
6M14 2/8	2/13/95	ND	ND	ND	83.7	ND	ND	ND	ND	6.506	22.6	6.018	0.0325	14.7	ND	ND	ND	8.03	0.1331	ND	0.0122
6M15 2/8	2/13/95	0.101	ND	0.078	29.8	ND	ND	ND	0.076	9.597	10.4	1.008	ND	32.1	ND	0.53	ND	8.38	0.0701	ND	0.0216
6M16 2/8	2/13/95	ND	ND	0.068	62.9	ND	ND	ND	0.033	10.86	20.9	5.828	ND	30.3	ND	0.65	ND	12	0.1393	ND	0.0106
6M17 2/8	2/13/95	ND	ND	0.052	66.7	ND	ND	ND	0.032	5.842	20.6	2.107	ND	20	ND	0.38	ND	12.9	0.1297	ND	0.0108
6M18 2/8	2/13/95	0.316	ND	ND	57.8	ND	ND	ND	ND	5.409	19.1	1.678	ND	13.6	ND	0.46	ND	13.2	0.117	ND	0.011
6M19 2/8	2/13/95	ND	ND	0.092	62.5	ND	ND	ND	0.248	17.52	22.4	2.072	ND	33.4	ND	1.3	ND	10.4	0.143	ND	0.0146
6M21 2/8	2/13/95	ND	ND	ND	73.9	ND	ND	ND	ND	4.988	17.3	1.37	ND	16.9	ND	0.48	ND	13.8	0.1365	ND	0.013
6M22 2/8	2/13/95	0.393	ND	0.057	53	ND	ND	ND	0.22	4.347	19.2	0.7476	ND	30.6	ND	0.47	ND	16	0.1274	ND	0.0131
6M23 2/8	2/13/95	1.11	ND	ND	54.4	ND	ND	ND	0.853	4.715	19	0.188	ND	7.9	ND	0.27	ND	15.2	0.1044	ND	0.0359
6M24 2/8	2/13/95	ND	ND	0.042	82.9	ND	ND	ND	0.121	5.004	19.6	0.1598	ND	14.6	ND	0.42	ND	12.3	0.1085	ND	0.0133
6M25 2/8	2/13/95	ND	ND	0.086	46.7	ND	ND	ND	ND	14.38	15.6	4.42	ND	30.2	ND	0.97	ND	13.1	0.0931	ND	0.0118
6M26 2/8	2/13/95	ND	ND	0.067	56.2	ND	ND	ND	ND	10.86	18.3	1.587	ND	20.9	ND	0.66	ND	11.7	0.1074	ND	0.0118
6M27 2/8	2/13/95	0.074	ND	ND	60.2	ND	ND	ND	0.065	5.741	19.8	0.3101	ND	12.7	ND	0.46	ND	13.2	0.1176	ND	0.0138
6M28 2/6	2/13/95	ND	ND	ND	56.8	ND	ND	ND	0.034	4.838	21.3	0.0347	ND	9.33	ND	0.41	ND	12.2	0.1091	ND	0.0518
6M29 2/6	2/13/95	ND	ND	ND	62.3	ND	ND	ND	ND	6.044	18.7	0.1533	ND	8.62	ND	0.5	ND	11	0.1001	ND	0.038
6M30 2/6	2/13/95	ND	ND	ND	71.5	ND	ND	ND	0.049	7.142	21.8	0.5312	ND	13.9	ND	0.51	ND	11.8	0.118	ND	0.0405
6M31 2/6	2/13/95	ND	ND	ND	68	ND	ND	ND	0.03	8.07	21.4	0.5539	ND	14.8	ND	0.72	ND	11.5	0.172	ND	0.0335
6M32 2/6	2/13/95	ND	ND	ND	59.2	ND	ND	ND	ND	6.145	18.9	0.1932	ND	10.7	ND	0.59	ND	11.8	0.1022	ND	0.0365
6M33 2/6	2/13/95	ND	ND	ND	83.5	ND	ND	ND	ND	8.396	20	1.442	ND	13.4	ND	0.48	ND	8.91	0.1064	ND	0.0441
6M34 2/6	2/13/95	ND	ND	ND	60.1	ND	ND	ND	ND	7.958	18.4	0.1164	ND	10.5	ND	0.73	ND	11.8	0.0986	ND	0.0412
6M35 2/6	2/13/95	ND	ND	ND	67.4	ND	ND	ND	ND	5.741	22.5	0.1399	ND	10.6	ND	0.4	ND	11.9	0.1185	ND	0.0704
6M36 2/6	2/13/95	0.079	ND	ND	82.5	ND	ND	ND	0.087	6.752	19.8	0.3742	ND	11.4	ND	0.47	ND	11.7	0.1074	ND	0.076
6M37 2/6	2/13/95	ND	ND	ND	56.9	ND	ND	ND	0.039	5.618	19.7	0.0138	ND	8.39	ND	0.49	ND	12	0.0998	ND	0.0264
6P1 3/1	3/8/95	ND	ND	ND	55.3	ND	ND	ND	ND	2.412	18.3	0.0155	ND	8.33	ND	ND	ND	11	0.1017	ND	0.9366
6P4 3/1	3/8/95	ND	ND	ND	53.2	ND	ND	ND	ND	2.371	18.4	0.0898	ND	8.08	ND	ND	ND	11.1	0.1034	ND	2.116
6M11 3/1	3/8/95	ND	ND	ND	62.8	ND	ND	ND	ND	3.689	20	1.35	ND	9.26	ND	ND	ND	10.8	0.1157	ND	0.0348
6M12 3/1	3/8/95	0.149	ND	ND	60.8	ND	ND	ND	0.133	3.553	19.7	2.022	ND	13	ND	0.22	ND	11.7	0.1318	ND	0.0306
6M13 3/1	3/8/95	ND	ND	0.067	84.5	ND	ND	ND	0.717	7.107	28.3	4.5	ND	33.6	ND	ND	ND	16	0.187	ND	0.0478
6M14 3/1	3/8/95	0.479	ND	ND	55.2	ND	ND	ND	0.365	3.112	19.6	1.392	ND	8.9	ND	ND	ND	12.6	0.1098	ND	0.0872
6M15 3/1	3/8/95	ND	ND	0.114	45.1	ND	ND	ND	ND	9.701	15.8	0.9642	ND	47.9	ND	0.29	ND	9.31	0.103	ND	0.2984
6M16 3/1	3/8/95	ND	ND	0.045	59.1	ND	ND	ND	0.038	5.036	19.1	0.8094	ND	23	ND	1.1	ND	11.8	0.1156	ND	0.0058
6M17 3/1	3/8/95	ND	ND	ND	60.2	ND	ND	ND	ND	3.112	19.5	0.8022	ND	14.6	ND	0.3	ND	11.8	0.1149	ND	0.0571
6M18 3/1	3/8/95	0.896	ND	ND	58	ND	ND	ND	0.702	2.512	20.1	0.1664	ND	12.7	ND	0.5	ND	15.1	0.1141	ND	0.0418
6M19 3/1	3/8/95	ND	ND	0.077	47.2	ND	ND	0.0102	0.046	12.12	17.5	1.122	ND	32.2	ND	2.1	ND	9.32	0.1085	ND	0.0286
6M21 3/1	3/8/95	ND	ND	ND	71.3	ND	ND	ND	ND	2.241	16.8	0.2392	ND	17.8	ND	0.33	ND	13.1	0.1366	ND	0.0397
6M22 3/1	3/8/95	0.106	ND	0.045	51.3	ND	ND	ND	0.064	2.077	20.4	0.2383	ND	21.6	ND	0.36	ND	14.1	0.1218	ND	0.0459
6M23 3/1	3/8/95	0.103	ND	ND	51.7	ND	ND	ND	0.058	2.106	18.5	0.0237	ND	8.04	ND	ND	ND	10.9	0.101	ND	0.0321
6M24 3/1	3/8/95	ND	ND	ND	57	ND	ND	ND	ND	2.453	18.2	0.0207	ND	10.9	ND	0.2	ND	10.8	0.1003	ND	0.022
6M25 3/1	3/8/95	0.462	ND	0.048	49	ND	ND	0.0124	0.666	6.142	16.4	2.705	ND	22.3	ND	0.49	ND	12.6	0.0943	ND	0.0482
6M26 3/1	3/8/95	ND	ND	0.056	52.3	ND	ND	ND	ND	6.285	17.2	0.7814	ND	24.5	ND	1.2	ND	10.8	0.0988	ND	0.0101
6M27 3/1	3/8/95	0.211	ND	ND	58.7	ND	ND	ND	0.178	2.936	19.3	0.2068	ND	11.9	ND	0.41	ND	12.2	0.1142	ND	0.0218
6M28 3/1	3/8/95	ND	ND	ND	56.5	ND	ND	ND	ND	1.888	22.1	0.0174	ND	9.83	ND	ND	ND	11.6	0.1126	ND	0.0185
6M29 3/1	3/8/95	0.289	ND	ND	56.8	ND	ND	ND	0.305	2.412	18.4	0.0318	ND	9.66	ND	ND	ND	11.3	0.1002	ND	0.0212
6M30 3/1	3/8/95	1.24	ND	0.045	64	ND	ND	ND	1.14	4.248	21.2	0.16	ND	16.7	ND	0.28	ND	15.1	0.1155	ND	0.087
6M31 3/1	3/8/95	0.07	ND	0.047	67	ND	ND	ND	0.099	6.56	22.4	0.2924	ND	18.8	ND	0.85	ND	11.1	0.1248	ND	0.024
6M32 3/1	3/8/95	ND	ND	ND	63.5	ND	ND	ND	ND	3.271	21.2	0.168	ND	11.6	ND	0.29	ND	11.6	0.1172	ND	0.0277
6M33 3/1	3/8/95	ND	ND	ND	56.6	ND	ND	ND	ND	3.9	18.3	1.142	ND	11.1	ND	ND	ND	9.25	0.1013	ND	0.0155

**APPENDIX H
ANALYTICAL RESULTS
CATIONS**

Sample	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sr	Ti	Zn
6M34 3/1	3/8/95	ND	ND	ND	55.9	ND	ND	ND	ND	3.547	18.7	0.0838	ND	11.1	ND	0.35	ND	11	0.102	ND	0.0178
6M35 3/1	3/8/95	ND	ND	ND	58.7	ND	ND	ND	ND	2.647	20.8	0.023	ND	9.84	ND	ND	ND	11.4	0.1087	ND	0.0248
6M36 3/1	3/8/95	ND	ND	ND	60.9	ND	ND	ND	ND	3.283	20.5	0.0847	ND	11.1	ND	0.22	ND	11.4	0.1091	ND	0.0554
6M37 3/1	3/8/95	ND	ND	ND	53.8	ND	ND	ND	ND	2.371	19.5	0.0081	ND	7.95	ND	ND	ND	11.1	0.1014	ND	0.2219
6TANK 3/1	3/8/95	ND	ND	0.189	47.1	ND	ND	0.0154	ND	21.02	15.8	0.0174	ND	55.1	ND	7	ND	11	0.1091	ND	0.024
6M15 3/15	5/28/95	ND	ND	ND	55.7	ND	ND	ND	0.036	NA	18.3	1.387	ND	23	ND	0.34	ND	9.2	0.1205	ND	0.0064
6M25 3/15	5/28/95	ND	ND	0.044	48.2	ND	ND	ND	ND	NA	15.7	1.33	ND	21.6	ND	1.1	ND	9.52	0.0975	ND	0.012
6TANK 3/15	5/28/95	ND	ND	0.25	44.9	ND	ND	ND	0.036	NA	15	0.0084	ND	55.9	ND	9.9	ND	9.47	0.1143	ND	0.0308
6P1 3/22	5/28/95	ND	ND	ND	53.4	ND	ND	ND	ND	NA	17.1	ND	ND	8.26	ND	0.22	ND	9.48	0.106	ND	0.5443
6P2 3/22	5/28/95	0.104	ND	ND	59.2	ND	ND	ND	0.087	NA	19.2	0.0144	ND	8.08	ND	0.28	ND	8.33	0.1024	ND	0.744
6P3 3/22	5/28/95	ND	ND	ND	53.1	ND	ND	ND	ND	NA	17.7	0.0088	ND	7.9	ND	0.22	ND	8.28	0.1076	ND	3.214
6P4 3/22	5/28/95	ND	ND	ND	51.2	ND	ND	ND	ND	NA	17.3	0.0101	ND	7.99	ND	0.23	ND	9.35	0.107	ND	1.54
6M11 3/22	5/28/95	0.137	ND	ND	53.7	ND	ND	ND	0.08	NA	17.4	0.1086	ND	8.1	ND	0.23	ND	9.61	0.1081	ND	0.032
6M12 3/22	5/28/95	0.114	ND	ND	58.3	ND	ND	ND	0.084	NA	18.4	0.1202	ND	8.51	ND	0.27	ND	9.77	0.116	ND	0.0174
6M13 3/22	5/28/95	0.212	ND	ND	55.1	ND	ND	ND	0.145	NA	18.6	0.2542	ND	8.76	ND	0.23	ND	10.1	0.1145	ND	0.0218
6M14 3/22	5/28/95	0.078	ND	ND	52.4	ND	ND	ND	0.045	NA	18.3	0.3353	ND	8.01	ND	0.22	ND	9.48	0.1112	ND	0.0194
6M15 3/22	5/28/95	0.201	ND	0.128	49.4	ND	ND	ND	0.251	NA	17.4	1.25	ND	51.7	ND	0.38	ND	9.57	0.1234	ND	0.1058
6M16 3/22	5/28/95	ND	ND	0.042	60.1	ND	ND	ND	ND	NA	20.1	4.613	ND	22.6	ND	0.43	ND	9.83	0.1459	ND	0.053
6M17 3/22	5/28/95	ND	ND	ND	59.8	ND	ND	ND	ND	NA	19	0.7242	ND	15.8	ND	0.47	ND	10	0.1227	ND	0.038
6M18 3/22	5/28/95	0.078	ND	ND	57.9	ND	ND	ND	0.032	NA	19.6	0.0101	ND	13.2	ND	0.57	ND	10	0.1234	ND	0.0285
6M19 3/22	5/28/95	ND	ND	0.078	51.8	ND	ND	ND	ND	NA	18.9	1.017	ND	34.1	ND	2.3	ND	7.17	0.125	ND	0.061
6M20 3/22	5/28/95	0.432	ND	ND	60.2	ND	ND	ND	0.284	NA	19.2	0.2311	ND	18.5	ND	0.41	ND	11.2	0.1188	ND	0.0446
6M21 3/22	5/28/95	ND	ND	ND	64.5	ND	ND	ND	ND	NA	16.8	0.3332	ND	14.8	ND	0.33	ND	10.3	0.1357	ND	0.0427
6M22 3/22	5/28/95	0.34	ND	ND	50.9	ND	ND	ND	0.221	NA	19.4	0.1351	ND	18.3	ND	0.38	ND	11.9	0.1297	ND	0.057
6M23 3/22	5/28/95	ND	ND	ND	49.8	ND	ND	ND	ND	NA	17.5	0.0078	ND	7.52	ND	0.27	ND	8.99	0.1051	ND	0.0492
6M24 3/22	5/28/95	ND	ND	ND	55.2	ND	ND	ND	ND	NA	17.3	0.236	ND	11	ND	0.34	ND	9.1	0.1063	ND	0.0793
6M25 3/22	5/28/95	ND	ND	ND	54.8	ND	ND	ND	ND	NA	17.2	0.3044	ND	14.7	ND	0.41	ND	9.27	0.1074	ND	0.0396
6M26 3/22	5/28/95	ND	ND	0.048	53.6	ND	ND	ND	ND	NA	17.4	0.8862	ND	24.1	ND	1.3	ND	9.24	0.1096	ND	0.0542
6M27 3/22	5/28/95	ND	ND	ND	56.7	ND	ND	ND	ND	NA	18.5	0.0088	ND	11.6	ND	0.48	ND	9.89	0.1188	ND	0.0562
6M28 3/22	5/28/95	ND	ND	ND	56.3	ND	ND	ND	ND	NA	20.9	ND	ND	9.28	ND	0.27	ND	9.68	0.1192	ND	0.1265
6M29 3/22	5/28/95	0.37	ND	ND	55.9	ND	ND	ND	0.411	NA	17.6	0.0404	ND	9.01	ND	0.28	ND	9.61	0.1086	ND	0.1505
6M30 3/22	5/28/95	ND	ND	0.042	57.7	ND	ND	ND	ND	NA	18.1	0.0212	ND	17.4	ND	0.37	ND	9.6	0.1111	ND	0.1005
6M31 3/22	5/28/95	ND	ND	0.045	60.8	ND	ND	ND	ND	NA	20.1	0.2097	ND	21.4	ND	1.2	ND	9.43	0.1253	ND	0.0932
6M32 3/22	5/28/95	ND	ND	ND	62.2	ND	ND	ND	ND	NA	20.2	0.0477	ND	12.6	ND	0.52	ND	9.88	0.1242	ND	0.0899
6M33 3/22	5/28/95	ND	ND	ND	57.6	ND	ND	ND	ND	NA	17.9	0.1042	ND	11	ND	0.23	ND	8.28	0.1105	ND	0.1265
6M34 3/22	5/28/95	ND	ND	ND	58.1	ND	ND	ND	ND	NA	18.7	ND	ND	10.9	ND	0.58	ND	9.35	0.1132	ND	0.1295
6M35 3/22	5/28/95	0.128	ND	ND	58.5	ND	ND	ND	0.105	NA	20.2	0.0121	ND	9.57	ND	0.33	ND	9.95	0.1172	ND	0.1507
6M36 3/22	5/28/95	ND	ND	ND	60.8	ND	ND	ND	ND	NA	20.1	0.022	ND	10.4	ND	0.34	ND	9.6	0.1191	ND	0.1984
6M37 3/22	5/28/95	0.121	ND	ND	52.5	ND	ND	ND	0.049	NA	18.7	0.0056	ND	9.78	ND	2.2	ND	9.27	0.1094	ND	0.2214
6TANK 3/22	5/28/95	ND	ND	0.205	44.1	ND	ND	ND	0.068	NA	15	0.0144	ND	52.1	ND	7.9	ND	9.11	0.1182	ND	0.0197
6M12 4/5	9/27/95	ND	ND	ND	58.3	ND	ND	ND	ND	2.473	18.6	0.0283	ND	8.72	ND	ND	ND	11.8	0.1143	ND	ND
6M18 4/5	9/27/95	ND	ND	0.075	63.5	ND	ND	ND	ND	6.25	20.7	1.527	ND	29.1	ND	1	ND	13.4	0.1384	ND	0.0123
6TANK 4/5	9/27/95	ND	ND	0.149	45.9	ND	ND	ND	0.032	25.17	15.5	0.0152	ND	59.6	ND	7.8	ND	11.4	0.1157	ND	0.0166
6M24 5/2	9/27/95	ND	ND	ND	55.6	ND	ND	ND	ND	2.381	17.6	0.0009	ND	9.33	ND	0.2	ND	11.2	0.1054	ND	0.007
6M25 5/2	9/27/95	ND	ND	0.042	55.4	ND	ND	ND	ND	4.028	17.8	0.5485	ND	20.6	ND	0.58	ND	11.8	0.1086	ND	0.0116
6M26 5/2	9/27/95	ND	ND	0.058	54.3	ND	ND	ND	ND	6.009	17.7	0.8171	ND	23.7	ND	1.2	ND	11.6	0.1089	ND	0.0218
6M27 5/2	9/27/95	ND	ND	ND	59.8	ND	ND	ND	ND	2.473	19.4	ND	ND	12.9	ND	0.42	ND	12.4	0.121	ND	0.0058
6M28 5/2	9/27/95	ND	ND	ND	60.5	ND	ND	ND	ND	2.041	21.6	ND	ND	9.65	ND	ND	ND	11.9	0.1249	ND	0.0214
6M29 5/2	9/27/95	ND	ND	ND	55.2	ND	ND	ND	ND	2.203	17.3	ND	ND	8.69	ND	0.2	ND	10.8	0.1029	ND	0.015
6M30 5/2	9/27/95	ND	ND	ND	54.4	ND	ND	ND	ND	3.046	17.2	0.0117	ND	17.5	ND	0.27	ND	11.2	0.1038	ND	0.0075

**APPENDIX H
ANALYTICAL RESULTS
CATIONS**

Sample	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sr	Ti	Zn
6M31 5/2	9/27/95	ND	ND	0.05	59.3	ND	ND	ND	ND	7.179	19.4	0.0845	ND	23.4	ND	1.1	ND	11.4	0.1217	ND	0.0156
6M32 5/2	9/27/95	ND	ND	0.042	65.9	ND	ND	ND	ND	3.106	21.1	0.0091	ND	17.3	ND	0.5	ND	12.6	0.1308	ND	0.0259
6TANK 5/2	9/27/95	ND	ND	0.26	46.6	ND	ND	ND	0.033	14.61	14.6	0.0087	ND	47.7	ND	4.4	ND	11	0.1153	ND	0.0184
6P1 5/23	9/27/95	ND	ND	ND	55.1	ND	ND	ND	0.119	1.989	17.3	0.015	ND	8.88	ND	0.19	ND	11.6	0.108	ND	0.7184
6P2 5/23	9/27/95	0.388	ND	ND	60.9	ND	ND	ND	0.275	2.15	19.4	0.0143	ND	8.58	ND	ND	ND	12.6	0.104	ND	1.167
6P3 5/23	9/27/95	ND	ND	ND	53.8	ND	ND	ND	ND	1.885	17.7	0.0052	ND	8.43	ND	ND	ND	11.7	0.1071	ND	2.892
6M11 5/23	9/27/95	ND	ND	ND	55.8	ND	ND	ND	ND	2.019	17.6	ND	ND	9.25	ND	0.2	ND	11.8	0.1103	ND	0.1271
6M12 5/23	9/27/95	ND	ND	ND	54.3	ND	ND	ND	ND	1.885	17.4	ND	ND	10.3	ND	0.32	ND	11.9	0.1089	ND	0.0148
6M13 5/23	9/27/95	ND	ND	ND	52.8	ND	ND	ND	ND	2.214	17.4	ND	ND	8.85	ND	0.23	ND	11.6	0.1077	ND	0.0626
6M14 5/23	9/27/95	ND	ND	ND	52.3	ND	ND	ND	ND	1.87	17.5	ND	ND	8.59	ND	0.2	ND	11.7	0.1081	ND	0.0053
6M15 5/23	9/27/95	ND	ND	0.169	53.5	ND	ND	ND	ND	15.42	18.1	1.039	ND	60.1	ND	0.39	ND	10.5	0.136	ND	0.049
6M16 5/23	9/27/95	ND	ND	0.058	55.3	ND	ND	ND	ND	6.189	17.3	1.746	ND	22.7	0.021	0.5	ND	12.4	0.1228	ND	0.0159
6M17 5/23	9/27/95	ND	ND	ND	54.2	ND	ND	ND	ND	3.942	16.7	0.0769	ND	18	ND	0.7	ND	12.2	0.1096	ND	0.0093
6M18 5/23	9/27/95	ND	ND	ND	55.8	ND	ND	ND	ND	1.906	18.3	ND	ND	15.2	ND	0.5	ND	12.7	0.1188	ND	0.0272
6M19 5/23	9/27/95	ND	ND	0.098	56.9	ND	ND	ND	ND	10.64	19.1	1.804	ND	38.2	ND	2.3	ND	11.4	0.1262	ND	0.0181
6M20 5/23	9/27/95	ND	ND	0.042	58.5	ND	ND	ND	ND	3.867	17.9	0.0188	ND	18.3	ND	0.59	ND	12.2	0.1164	ND	0.0066
6M21 5/23	9/27/95	0.341	ND	ND	60.1	ND	ND	ND	ND	1.776	16.7	0.0148	ND	13.5	ND	0.32	ND	14.6	0.1653	ND	0.0209
6M22 5/23	9/27/95	ND	ND	ND	56.9	ND	ND	ND	ND	1.387	21.3	0.0083	ND	19.4	ND	0.33	ND	13.8	0.1377	ND	0.0259
6M23 5/23	9/27/95	ND	ND	ND	50.4	ND	ND	ND	ND	1.866	17.1	ND	ND	7.77	ND	0.22	ND	11	0.1047	ND	0.0131
6M24 5/23	9/27/95	ND	ND	ND	55.1	ND	ND	ND	ND	1.923	16.6	ND	ND	9.14	ND	0.3	ND	10.9	0.1039	ND	ND
6M25 5/23	9/27/95	ND	ND	ND	34.4	ND	ND	ND	ND	6.439	11.5	0.0807	ND	15.1	ND	0.97	ND	11.3	0.0745	ND	0.0199
6M26 5/23	9/27/95	ND	ND	0.047	44.3	ND	ND	ND	ND	6.315	14.1	0.2468	ND	20.9	ND	1.5	ND	12.3	0.0942	ND	0.009
6M27 5/23	9/27/95	ND	ND	ND	55.4	ND	ND	ND	ND	2.047	23.7	ND	ND	12.1	ND	0.43	ND	12.5	0.1298	ND	0.0135
6M28 5/23	9/27/95	ND	ND	ND	56.1	ND	ND	ND	ND	1.718	18.8	ND	ND	9.55	ND	0.3	ND	11.6	0.1147	ND	0.0239
6M29 5/23	9/27/95	ND	ND	ND	54.3	ND	ND	ND	ND	1.649	16.4	ND	ND	8.67	ND	0.24	ND	10.6	0.1012	ND	ND
6M30 5/23	9/27/95	ND	ND	ND	52.5	ND	ND	ND	ND	2.751	16	ND	ND	19.6	ND	0.36	ND	11.7	0.1008	ND	0.0056
6M31 5/23	9/27/95	ND	ND	ND	63.2	ND	ND	ND	ND	1.912	19.6	ND	ND	14.2	ND	0.48	ND	12.3	0.1242	ND	0.009
6M32 5/23	9/27/95	ND	ND	0.045	62.7	ND	ND	ND	ND	2.528	19.7	0.0066	ND	18.1	ND	0.45	ND	12.5	0.1252	ND	0.0085
6M33 5/23	9/27/95	ND	ND	ND	73.3	ND	ND	ND	ND	3.915	22.4	ND	ND	24.3	ND	0.32	ND	9.72	0.1399	ND	0.0148
6M34 5/23	9/27/95	ND	ND	ND	64.5	ND	ND	ND	ND	3.14	19.8	ND	ND	14.4	ND	0.56	ND	11.9	0.1238	ND	0.0091
6M35 5/23	9/27/95	ND	ND	ND	59	ND	ND	ND	ND	1.957	19.1	ND	ND	13.1	ND	0.33	ND	12	0.1181	ND	0.0161
6M36 5/23	9/27/95	ND	ND	ND	62.9	ND	ND	ND	ND	2.214	19.9	ND	ND	10.2	ND	0.32	ND	11.7	0.1208	ND	0.0193
6M37 5/23	9/27/95	0.078	ND	ND	49.1	ND	ND	ND	ND	1.557	16.2	ND	ND	7.83	ND	0.29	ND	10.6	0.1009	ND	0.0093
6TANK 5/23	9/27/95	ND	ND	0.284	46.5	ND	ND	ND	0.102	18.88	14.3	0.0094	ND	49	ND	6.1	ND	11.1	0.1145	ND	0.0399
6M15 5/25	9/27/95	ND	ND	0.187	52.9	ND	ND	ND	ND	16.08	17.5	1.031	ND	59.4	ND	0.49	ND	9.8	0.1345	ND	0.0116
6M19 5/25	9/27/95	ND	ND	0.079	53.4	ND	ND	ND	ND	8.928	17.2	1.901	ND	31.1	ND	1.9	ND	10.9	0.113	ND	0.0037
6M26 5/25	9/27/95	ND	ND	0.042	41.4	ND	ND	ND	ND	6.663	12.9	0.1572	ND	19.7	ND	1.6	ND	12.3	0.0884	ND	ND
6M31 5/25	9/27/95	ND	ND	ND	62	ND	ND	ND	ND	1.861	19.1	ND	ND	14.1	ND	0.45	ND	12.1	0.1216	ND	ND
6M34 5/25	9/27/95	ND	ND	ND	63.3	ND	ND	ND	ND	3.062	19.4	ND	ND	14.3	ND	0.56	ND	11.7	0.1215	ND	ND
6TANK 5/25	9/27/95	ND	ND	ND	46.2	ND	ND	ND	0.038	17.4	14.5	0.008	ND	47.4	ND	6.4	ND	11.3	0.1155	ND	0.0131
6M21 6/1	11/30/95	0.09	ND	ND	72	ND	ND	ND	0.067	1.726	14.5	0.0057	ND	12	ND	0.24	ND	13.9	0.1524	ND	0.0052
6M22 6/1	11/30/95	ND	ND	ND	53.3	ND	ND	ND	ND	1.864	20.7	ND	ND	16.5	ND	0.28	ND	13.9	0.1297	ND	ND
6M23 6/1	11/30/95	0.688	ND	ND	50.2	ND	ND	ND	0.764	2.324	18.3	0.0649	ND	7.92	ND	0.25	ND	13.4	0.1077	ND	0.0539
6M24 6/1	11/30/95	ND	ND	ND	54.2	ND	ND	ND	ND	2.093	17.6	ND	ND	8.65	ND	0.2	ND	11.1	0.1061	ND	ND
6M25 6/1	11/30/95	ND	ND	ND	45.8	ND	ND	ND	ND	5.006	16.2	0.0274	ND	11.2	ND	0.73	ND	10.8	0.0958	ND	0.0056
6M26 6/1	11/30/95	ND	ND	ND	39.4	ND	ND	ND	ND	7.07	13.4	0.0707	ND	17.4	ND	1.6	ND	12.8	0.0889	ND	0.0089
6M27 6/1	11/30/95	ND	ND	ND	57.5	ND	ND	ND	ND	2.292	24.1	ND	ND	10.9	ND	0.3	ND	13.4	0.1421	ND	0.0119
6M28 6/1	11/30/95	ND	ND	ND	56.9	ND	ND	ND	ND	1.891	20.8	ND	ND	10.2	ND	ND	ND	12.4	0.1217	ND	0.0778
6M29 6/1	11/30/95	ND	ND	ND	58.6	ND	ND	ND	ND	2.009	18.5	ND	ND	8.39	ND	ND	ND	11.4	0.1114	ND	0.0282
6M30 6/1	11/30/95	ND	ND	ND	54.6	ND	ND	ND	ND	3.241	17.6	ND	ND	20	ND	0.34	ND	12.3	0.1075	ND	0.0115

**APPENDIX H
ANALYTICAL RESULTS
CATIONS**

Sample	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sr	Ti	Zn
6M31 8/1	11/30/95	ND	ND	ND	66.2	ND	ND	ND	ND	2.733	21.6	ND	ND	16.9	ND	0.44	ND	13.1	0.1329	ND	0.041
6M32 8/1	11/30/95	ND	ND	ND	62.4	ND	ND	ND	ND	2.943	20.6	ND	ND	18.6	ND	0.47	ND	12.8	0.1264	ND	0.0212
6M33 8/1	11/30/95	0.341	ND	ND	65.1	ND	ND	ND	0.279	3.93	20.7	0.022	ND	17.9	ND	0.37	ND	11.6	0.1256	ND	0.0221
6M34 8/1	11/30/95	ND	ND	ND	65.5	ND	ND	ND	3.383	21.3	ND	ND	ND	14.6	ND	0.49	ND	12.4	0.129	ND	0.0054
6M35 8/1	11/30/95	ND	ND	ND	60.7	ND	ND	ND	ND	2.265	20.2	ND	ND	11.6	ND	0.33	ND	12.2	0.12	ND	ND
6M36 8/1	11/30/95	0.114	ND	ND	66.1	ND	ND	ND	0.111	2.605	21.9	0.0261	ND	10.2	ND	0.34	ND	12.3	0.1287	ND	0.0223
6M37 8/1	11/30/95	ND	ND	ND	47.6	ND	ND	ND	1.817	18.6	ND	ND	ND	7.43	ND	0.28	ND	10.4	0.1024	ND	0.0041
6TANK 8/1	11/30/95	ND	ND	ND	51.1	ND	ND	0.0218	0.044	11.83	18.3	0.0073	ND	36.5	ND	6.8	-0.02	12.3	0.1288	ND	0.0251
6P1 8/7	11/30/95	ND	ND	ND	55.6	ND	ND	ND	ND	2.384	17.2	ND	ND	8.54	ND	0.31	ND	11.1	0.1076	ND	1.103
6P3 8/7	11/30/95	ND	ND	ND	52.2	ND	ND	ND	ND	1.982	17.4	ND	ND	8	ND	0.29	ND	11.5	0.1049	ND	2.368
6P4 8/7	11/30/95	ND	ND	ND	58.1	ND	ND	ND	ND	2.416	17.3	ND	ND	8.3	ND	0.39	ND	11.2	0.1165	ND	1.32
6M11 8/7	11/30/95	ND	ND	ND	59.1	ND	ND	ND	ND	2.462	17.2	ND	ND	8.51	ND	0.38	ND	11.4	0.1139	ND	0.0334
6M12 8/7	11/30/95	ND	ND	ND	56.5	ND	ND	ND	ND	2.332	16.8	ND	ND	9.33	ND	0.44	ND	11.4	0.1106	ND	0.023
6M13 8/7	11/30/95	ND	ND	ND	57.2	ND	ND	ND	ND	2.393	17.4	ND	ND	8.1	ND	0.4	ND	11.5	0.1126	ND	0.0091
6M14 8/7	11/30/95	ND	ND	ND	54.7	ND	ND	ND	ND	2.342	16.8	ND	ND	7.73	ND	0.38	ND	11.4	0.1095	ND	0.0206
6M15 8/7	11/30/95	ND	ND	ND	55.5	ND	ND	0.0103	ND	18.19	17.6	1.437	ND	52.9	ND	1.8	ND	12.7	0.1376	ND	0.0104
6M16 8/7	11/30/95	ND	ND	ND	50.6	ND	ND	ND	ND	5.587	14.5	0.4941	ND	15.9	ND	1	ND	11.7	0.102	ND	0.0087
6M17 8/7	11/30/95	ND	0.08	ND	58.3	ND	ND	ND	ND	4.981	16.7	0.077	ND	18.3	ND	0.96	ND	12.5	0.1157	ND	ND
6M18 8/7	11/30/95	ND	0.088	ND	56.2	ND	ND	ND	ND	2.297	17.2	ND	ND	12.3	ND	0.72	ND	12.3	0.116	ND	ND
6M19 8/7	11/30/95	ND	0.098	0.085	56.5	ND	ND	ND	ND	9.889	17.5	1.502	ND	33.9	ND	2.8	ND	11.8	0.1197	ND	ND
6M20 8/7	11/30/95	ND	0.095	ND	80.6	ND	ND	ND	ND	4.341	17.4	0.0175	ND	18.1	ND	0.77	ND	11.9	0.1176	ND	0.0189
6M21 8/7	11/30/95	ND	0.084	ND	78.3	ND	ND	ND	ND	1.724	13.5	ND	ND	13.9	ND	0.51	ND	13.3	0.158	ND	0.0596
6M22 8/7	11/30/95	ND	0.085	ND	56.9	ND	ND	ND	ND	1.928	19.5	ND	ND	16.9	ND	0.54	ND	14.1	0.1334	ND	0.0169
6M23 8/7	11/30/95	ND	0.077	ND	53.6	ND	ND	ND	ND	2.098	17	ND	ND	7.81	ND	0.45	ND	11.3	0.1091	ND	0.0056
6M24 8/7	11/30/95	ND	ND	ND	55.2	ND	ND	ND	ND	2.285	15.3	ND	ND	7.9	ND	0.54	ND	10.9	0.1014	ND	0.0176
6M25 8/7	11/30/95	ND	0.086	ND	46.5	ND	ND	ND	ND	4.477	14.9	0.0281	ND	9.02	ND	1.1	ND	10.4	0.0943	ND	0.0072
6M26 8/7	11/30/95	ND	0.095	ND	39.5	ND	ND	ND	ND	6.725	11.7	0.0232	ND	14.2	ND	2	ND	11.1	0.0838	ND	0.0126
6M27 8/7	11/30/95	ND	0.107	ND	62.4	ND	ND	ND	ND	2.438	22.1	ND	ND	9.44	ND	0.81	ND	12.7	0.1462	ND	0.0193
6M28 8/7	11/30/95	ND	0.083	ND	57.5	ND	ND	ND	ND	2.28	18	ND	ND	9.55	ND	0.51	ND	11.7	0.1155	ND	0.0659
6M29 8/7	11/30/95	ND	0.081	ND	56.3	ND	ND	ND	ND	2.28	15.6	ND	ND	8.03	ND	0.51	ND	10.8	0.102	ND	0.028
6M30 8/7	11/30/95	ND	0.077	ND	56	ND	ND	ND	ND	3.398	15.7	ND	ND	16	ND	0.81	ND	11.6	0.1037	ND	0.0273
6M31 8/7	11/30/95	ND	0.083	ND	64.8	ND	ND	ND	0.041	2.728	18.9	0.0108	ND	15.8	ND	0.78	ND	12.4	0.1241	ND	0.0245
6M32 8/7	11/30/95	ND	0.07	ND	63.4	ND	ND	ND	ND	3.115	18.1	ND	ND	16.8	ND	0.87	ND	12	0.1194	ND	0.0284
6M33 8/7	11/30/95	ND	0.075	ND	62.5	ND	ND	ND	ND	3.684	17.5	ND	ND	15.7	ND	0.58	ND	9.87	0.1142	ND	0.0285
6M34 8/7	11/30/95	ND	0.087	ND	67.9	ND	ND	ND	ND	3.551	19.3	ND	ND	14	ND	0.84	ND	12	0.1251	ND	0.0111
6M35 8/7	11/30/95	ND	0.094	ND	86.2	ND	ND	ND	ND	2.679	19.5	ND	ND	11.5	ND	0.63	ND	12	0.1222	ND	0.0241
6M36 8/7	11/30/95	ND	0.104	ND	70.7	ND	ND	ND	ND	2.933	20.3	ND	ND	9.6	ND	0.68	ND	11.7	0.1276	ND	0.0251
6M37 8/7	11/30/95	ND	0.075	ND	51.6	ND	ND	ND	ND	2.189	15.6	ND	ND	6.95	ND	0.59	ND	10.2	0.102	ND	0.013
6TANK 8/7	11/30/95	ND	0.089	0.055	51.2	ND	ND	ND	0.05	6.353	14	0.0098	ND	28.6	ND	3.9	ND	11.6	0.1193	ND	0.0199
6P1 5/30	8/17/96	ND	ND	ND	45.38	ND	ND	ND	ND	1.459	14.17	ND	ND	7.371	ND	ND	ND	10.85	0.0691	ND	0.2687
6M11 5/30	8/17/96	ND	ND	ND	46.2	ND	ND	ND	ND	1.576	14.53	ND	ND	7.697	ND	ND	ND	10.93	0.1014	ND	ND
6M12 5/30	8/17/96	ND	ND	ND	46.47	ND	ND	ND	ND	1.792	14.8	ND	ND	8.362	ND	ND	ND	10.83	0.1008	ND	ND
6M13 5/30	8/17/96	0.437	ND	ND	47.02	ND	ND	ND	0.4186	1.798	15.52	0.0185	ND	7.547	ND	ND	ND	12.83	0.1042	ND	ND
6M14 5/30	8/17/96	ND	ND	ND	44.2	ND	ND	ND	ND	1.576	14.8	ND	ND	7.359	ND	ND	ND	10.65	0.1004	ND	ND
6M15 5/30	8/17/96	ND	ND	0.1528	46.89	ND	ND	ND	9.69	18.37	14.51	1.147	ND	51.29	ND	13.3	ND	12.21	0.1204	ND	ND
6M16 5/30	8/17/96	ND	ND	ND	48.84	ND	ND	ND	ND	3.279	15.07	0.0872	ND	15.17	ND	0.4177	ND	11.86	0.1118	ND	ND
6M17 5/30	8/17/96	ND	ND	ND	52.48	ND	ND	ND	ND	2.327	16.3	ND	ND	13.64	ND	0.298	ND	12.02	0.1144	ND	ND
6M18 5/30	8/17/96	ND	ND	ND	47.43	ND	ND	ND	ND	1.744	15.23	ND	ND	12.45	ND	0.3817	ND	11.54	0.1107	ND	ND
6M19 5/30	8/17/96	ND	ND	0.0726	47.29	ND	ND	0.0171	ND	8.499	15.32	1.222	ND	34.32	ND	2.979	ND	11.21	0.1114	ND	ND
6M20 5/30	8/17/96	ND	ND	ND	48.08	ND	ND	ND	ND	2.335	14.79	ND	ND	12.62	ND	0.4156	ND	11.14	0.104	ND	ND

**APPENDIX H
ANALYTICAL RESULTS
CATIONS**

Sample	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sr	Ti	Zn
6M21 5/30	8/17/98	ND	ND	ND	70.52	ND	ND	ND	ND	1.062	14.48	ND	ND	11.38	ND	0.2196	ND	11.88	0.1598	ND	ND
6M22 5/30	8/17/98	ND	ND	ND	49.72	ND	ND	ND	ND	0.9428	17.97	ND	ND	15.3	ND	0.2991	ND	12.89	0.1266	ND	ND
6M24 5/30	8/17/98	ND	ND	ND	49.13	ND	ND	ND	ND	3.583	14.75	0.0385	ND	13.78	ND	0.581	ND	11.33	0.1076	ND	ND
6M25 5/30	8/17/98	ND	ND	0.0527	51.38	ND	ND	ND	ND	6.058	16.08	1.278	ND	27.38	ND	1.183	ND	11.57	0.1183	ND	ND
6M26 5/30	8/17/98	ND	ND	0.0601	50.01	ND	ND	ND	ND	8.035	16.08	0.3572	ND	29.73	ND	1.6	ND	11.47	0.1188	ND	ND
6M27 5/30	8/17/98	ND	ND	ND	51.45	ND	ND	ND	0.0355	1.406	17.03	ND	ND	10.34	ND	0.296	ND	12.12	0.1214	ND	ND
6M28 5/30	8/17/98	ND	ND	ND	49.4	ND	ND	ND	ND	1.42	18.39	ND	ND	8.587	ND	ND	ND	11.37	0.114	ND	ND
6M29 5/30	8/17/98	ND	ND	ND	49.54	ND	ND	ND	0.0336	1.677	14.66	0.0017	ND	8.92	ND	ND	ND	10.89	0.1049	ND	ND
6M30 5/30	8/17/98	ND	ND	ND	51.45	ND	ND	ND	ND	2.13	16.11	ND	ND	15.01	ND	0.2104	ND	11.34	0.1083	ND	ND
6M31 5/30	8/17/98	ND	ND	ND	52.74	ND	ND	ND	0.0597	1.751	16.66	0.0166	ND	11.25	ND	0.298	ND	11.63	0.1169	ND	ND
6M32 5/30	8/17/98	ND	ND	ND	53.56	ND	ND	ND	0.0465	2.291	17.46	0.0076	ND	11.95	ND	0.2991	ND	11.86	0.1194	ND	ND
6M33 5/30	8/17/98	ND	ND	ND	54.58	ND	ND	ND	0.0212	2.342	17.13	ND	ND	24.38	ND	0.2135	ND	10.72	0.1124	ND	ND
6M34 5/30	8/17/98	ND	ND	ND	50.74	ND	ND	ND	0.0347	3.087	16.3	ND	ND	14.36	ND	0.4424	ND	11.72	0.1111	ND	ND
6M35 5/30	8/17/98	ND	ND	ND	49.8	ND	ND	ND	0.0345	1.624	17.48	0.0022	ND	8.583	ND	ND	ND	11.19	0.1112	ND	ND
6M36 5/30	8/17/98	ND	ND	ND	53.9	ND	ND	ND	0.0342	1.958	17.45	ND	ND	8.503	ND	ND	ND	10.99	0.114	ND	ND
6M37 5/30	8/17/98	ND	ND	ND	48.22	ND	ND	ND	ND	1.405	15.79	ND	ND	7.427	ND	ND	ND	10.53	0.1045	ND	0.0052
6M40 5/30	8/17/98	ND	ND	0.0838	48.85	ND	ND	0.0131	ND	8.51	16.33	0.5813	ND	36.87	ND	2.765	ND	11.8	0.1186	ND	ND
6M41 5/30	8/17/98	ND	ND	0.0643	50.58	ND	ND	0.0108	0.0545	6.576	16.81	0.2651	ND	30.87	ND	1.739	ND	11.79	0.118	ND	0.0066
6TANK 5/30	8/17/98	ND	ND	0.0733	48.79	ND	ND	0.0135	0.1211	13.83	15.42	0.011	ND	53.47	ND	7.316	ND	11.32	0.1305	ND	0.0406

APPENDIX H CATION QA/QC

Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
BP1 5/30	8/17/96	ND	ND	ND	45.38	ND	ND	ND	ND	1.459	14.17	ND	ND	7.371	ND	ND	ND	10.85	0.0991	ND	0.2987
BP1FD 5/30	8/17/96	ND	ND	ND	45	ND	ND	ND	ND	1.711	13.91	ND	ND	7.409	ND	ND	ND	10.6	0.0957	ND	0.2899
RPD					0.84					15.90	1.85			0.51				2.33	3.49		0.45
BP2 3/22	5/28/95	0.104	ND	ND	59.2	ND	ND	ND	0.087	N.A.	19.2	0.0144	ND	8.08	ND	0.28	ND	9.33	0.1024	ND	0.744
BP2FD 3/22	5/28/95	0.124	ND	ND	58.4	ND	ND	ND	0.893	N.A.	19.4	0.0548	ND	8.1	ND	0.24	ND	12.2	0.1028	ND	6.283
RPD		17.54			1.36				172.08		1.04	118.78		0.25		8.00		26.66	0.20		157.05
BM11 2/8	2/13/95	ND	ND	ND	65.3	ND	ND	ND	ND	5.452	21.3	2.127	0.0115	12.6	ND	0.23	ND	10.1	0.1239	ND	0.017
BM11LD 2/8	2/13/95	ND	ND	ND	69	ND	ND	ND	ND	7.799	21.5	2.169	0.0111	12	ND	0.51	ND	10.3	0.1195	ND	0.0176
RPD					5.51					35.42	0.93	1.96		4.88		75.88		1.96	3.82		3.47
BM12 5/23	9/27/95	ND	ND	ND	54.3	ND	ND	ND	ND	1.885	17.4	ND	ND	10.3	ND	0.32	ND	11.9	0.1089	ND	0.0148
BM12LD 5/23	9/27/95	ND	ND	ND	51.9	ND	ND	ND	ND	1.773	16	ND	ND	9.88	ND	0.39	ND	11.3	0.1027	ND	0.015
RPD					4.52					6.12	8.38			4.16		19.72		5.17	5.88		1.34
BM13 3/22	5/28/95	0.212	ND	ND	55.1	ND	ND	ND	0.145	N.A.	18.6	0.2542	ND	8.78	ND	0.23	ND	10.1	0.1145	ND	0.0218
BM13FD 3/22	5/28/95	0.204	ND	ND	55.1	ND	ND	ND	0.141	N.A.	18.6	0.257	ND	8.77	ND	0.24	ND	10	0.1145	ND	0.0206
RPD		3.85			0.00				2.89		0.00	1.10		0.11		4.28		1.00	0.00		5.88
BM14 3/1	3/8/95	0.479	0.007	0.005	55.2	0.0003	0.0025	0.0049	0.365	3.112	19.6	1.392	0.002	8.9	0.004	0.18	ND	12.6	0.1088	0.0221	0.0872
BM14LD 3/1	3/8/95	0.491	ND	ND	57.3	ND	ND	ND	0.387	3.383	19.9	1.431	ND	9	ND	0.23	ND	13	0.1112	ND	0.0893
RPD		2.47			3.73				5.85	8.34	1.52	2.78		1.12		24.39		3.13	1.27		2.38
BM15 3/15	5/28/95	ND	ND	ND	55.7	ND	ND	ND	0.036	N.A.	18.3	1.387	ND	23	ND	0.34	ND	9.2	0.1205	ND	0.0084
BM15FD 3/15	5/28/95	ND	ND	0.04	55.4	ND	ND	ND	0.04	N.A.	18.3	1.376	ND	23.6	ND	0.32	ND	9.2	0.1213	ND	0.0074
RPD					0.54				10.53		0.00	0.68		2.58		6.06		0.00	0.68		14.49
BM15 5/23	9/27/95	ND	ND	0.189	53.5	ND	ND	ND	ND	15.42	18.1	1.039	ND	80.1	ND	0.39	ND	10.5	0.136	ND	0.046
BM15FD 5/23	9/27/95	ND	ND	0.17	53.4	ND	ND	ND	ND	15.54	18.2	1.036	ND	80.5	ND	0.38	ND	10.5	0.1384	ND	0.0339
RPD				0.59	0.19					0.78	0.55	0.29		0.66		8.00		0.00	0.29		38.43
BM15 5/25	9/27/95	ND	ND	0.187	52.9	ND	ND	ND	ND	16.08	17.5	1.031	ND	59.4	ND	0.49	ND	9.8	0.1345	ND	0.0116
BM15LD 5/25	9/27/95	ND	ND	0.186	53.1	ND	ND	ND	ND	16.04	17.4	1.033	ND	58.8	ND	0.52	ND	9.81	0.1337	ND	0.0118
RPD				0.60	0.38					0.25	0.57	0.19		1.02		5.84		0.10	0.60		1.71
BM15 6/7	11/30/95	ND	ND	ND	55.5	ND	ND	0.0103	ND	18.19	17.8	1.437	ND	52.9	ND	1.8	ND	12.7	0.1376	ND	0.0104
BM15LD 6/7	12/1/95	ND	ND	0.17	54.5	ND	ND	ND	0.033	18.05	19	1.416	ND	56.6	0.001	1.4	ND	13	0.1375	ND	0.0143
RPD					1.82					0.77	7.85	1.47		8.78		25.00		2.33	0.07		31.58
BM15FD 6/7	11/30/95	ND	ND	0.155	58.6	ND	ND	0.0165	ND	18.17	17.6	1.453	ND	52.5	ND	1.8	ND	12.7	0.138	ND	0.0238
RPD					1.96			48.27		0.11	0.00	1.11		0.76		0.00		0.00	0.29		78.36
BM16 2/8	2/13/95	ND	ND	0.086	62.9	ND	ND	ND	0.033	10.86	20.9	5.828	ND	30.3	ND	0.85	ND	12	0.1393	ND	0.0108
BM16FD 2/8	2/13/95	ND	ND	0.084	60.7	ND	ND	ND	0.03	10.41	20.4	5.875	ND	30.2	ND	0.56	ND	11.7	0.1376	ND	0.0112
RPD				2.35	3.56					4.23	2.42	2.63		0.33		14.88		2.53	1.23		5.50
BM16 3/1	3/8/95	ND	ND	0.045	59.1	ND	ND	ND	0.038	5.036	19.1	0.9094	ND	23	ND	1.1	ND	11.8	0.1156	ND	0.0056
BM16FD 3/1	3/8/95	ND	ND	0.044	58.9	ND	ND	ND	ND	4.959	19	0.8493	ND	22.9	ND	1.2	ND	11.8	0.1141	ND	ND
RPD				2.25	0.34					1.54	0.52	6.83		0.44		6.70		0.00	1.31		
BM16 4/5	9/27/95	ND	ND	0.075	63.5	ND	ND	ND	ND	6.25	20.7	1.527	ND	29.1	ND	1	ND	13.4	0.1384	ND	0.0123
BM16FD 4/5	9/27/95	ND	ND	0.067	59.9	ND	ND	ND	ND	5.984	19.4	1.413	ND	28.9	ND	0.97	ND	12.8	0.1305	ND	ND
RPD				11.27	5.83					4.68	6.48	7.78		7.86		3.05		4.58	5.88		
BM19 5/23	9/27/95	ND	ND	0.098	58.9	ND	ND	ND	ND	10.84	19.1	1.804	ND	38.2	ND	2.3	ND	11.4	0.1282	ND	0.0161
BM19FD 5/23	9/27/95	ND	ND	0.101	57.1	ND	ND	ND	ND	10.72	19	1.823	ND	38	ND	2.3	ND	11.4	0.1256	ND	0.0193
RPD				3.02	0.35					0.75	0.52	1.05		0.52		0.00		0.00	0.32		18.08

APPENDIX H CATION QAIQC

Sample Name	Date	Al	As	B	Ce	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
6M19 6/7	11/30/95	ND	0.098	0.085	58.5	ND	ND	ND	ND	9.889	17.5	1.502	ND	33.9	ND	2.8	ND	11.8	0.1197	ND	ND
6M19LD 6/7	12/1/95	ND	ND	0.102	54.5	ND	ND	ND	ND	9.505	18.6	1.46	ND	35.6	0.004	2.3	ND	11.9	0.1173	ND	ND
RPD				18.18	3.80					3.88	6.09	2.84		4.89		19.81		0.84	2.03		
6M20 5/23	9/27/95	ND	ND	0.042	58.5	ND	ND	ND	ND	3.867	17.9	0.0168	ND	18.3	ND	0.59	ND	12.2	0.1184	ND	0.0086
6M20LD 5/23	9/27/95	ND	ND	ND	57.1	ND	ND	ND	ND	4.026	17	0.0176	ND	17.9	ND	0.69	ND	11.8	0.112	ND	0.0086
RPD					2.42					4.08	5.16	6.58		2.21		15.63		3.33	3.85		0.00
6M21 3/22	5/28/95	ND	ND	ND	64.5	ND	ND	ND	ND	NA	16.8	0.3332	ND	14.8	ND	0.33	ND	10.3	0.1357	ND	0.0427
6M21FD 3/22	5/28/95	ND	ND	ND	65.2	ND	ND	ND	ND	NA	16.9	0.3334	ND	14.9	ND	0.33	ND	10.4	0.1372	ND	0.0483
RPD					1.08						0.59	0.86		0.67		9		0.97	1.10		6.09
6M22 5/30	8/17/96	ND	ND	ND	49.72	ND	ND	ND	ND	0.9428	17.97	ND	ND	15.3	ND	0.2991	ND	12.69	0.1266	ND	ND
6M22FD 5/30	8/17/96	ND	ND	ND	48.02	ND	ND	ND	0.0537	2.284	14.72	0.0059	ND	11.98	ND	0.3548	ND	11.18	0.1034	ND	ND
RPD					3.48					83.13	18.88			24.34		17.04		14.21	20.17		
6M24 2/8	2/13/95	ND	ND	0.042	62.8	ND	ND	ND	0.121	5.004	19.6	0.1598	ND	14.6	ND	0.42	ND	12.3	0.1085	ND	0.0133
6M24LD 2/8	2/13/95	ND	ND	0.04	63.8	ND	ND	ND	0.118	6.391	19.3	0.1591	ND	13.9	ND	0.62	ND	12.3	0.1043	ND	0.0137
RPD				4.88	1.42				2.51	24.34	1.54	0.44		4.81		38.48		0.00	3.85		2.86
6M28 3/1	3/8/95	ND	ND	0.056	52.3	ND	ND	ND	ND	6.285	17.2	0.7814	ND	24.5	ND	1.2	ND	10.8	0.0988	ND	0.0101
6M28LD 3/1	3/8/95	ND	ND	0.057	53.3	ND	ND	ND	ND	6.285	17.2	0.7788	ND	25.1	ND	1.2	ND	11	0.0992	ND	0.0101
RPD				1.77	1.89					0.46	0.00	2.78		2.42		0.00		1.83	0.40		0.00
6M28FD 3/1	3/8/95	ND	ND	0.06	52.1	ND	ND	ND	ND	6.23	17.3	0.7769	ND	24.9	ND	1.1	ND	10.9	0.0994	ND	0.0072
RPD				6.80	0.38					0.56	0.58	2.82		1.82		6.70		0.92	0.81		33.53
6M28 5/2	9/27/95	ND	ND	0.056	54.3	ND	ND	ND	ND	6.009	17.7	0.8171	ND	23.7	ND	1.2	ND	11.8	0.1099	ND	0.0216
6M28FD 5/2	9/27/95	ND	ND	0.057	54.5	ND	ND	ND	ND	5.951	17.8	0.81	ND	23.4	ND	1.2	ND	11.6	0.1093	ND	0.015
RPD				1.77	0.37					0.67	0.57	0.67		1.27		0.00		0.00	0.55		36.07
6M28 6/1	11/30/95	ND	ND	ND	39.4	ND	ND	ND	ND	7.07	13.4	0.0707	ND	17.4	ND	1.6	ND	12.8	0.0889	ND	0.0089
6M28LD 6/1	12/1/95	ND	ND	ND	40.3	ND	ND	ND	ND	6.734	13.4	0.073	ND	17.3	ND	1.6	ND	12.8	0.0879	ND	0.0125
RPD					2.26					4.67	0.00	3.20		0.58		0.00		0.00	1.13		33.84
6M28FD 6/1	11/30/95	ND	ND	ND	38.7	ND	ND	ND	ND	6.941	13.3	0.0888	ND	17.1	ND	1.6	ND	12.7	0.088	ND	ND
RPD					1.79					1.84	0.75	2.72		1.74		0.00		0.76	1.02		
6M28 6/7	11/30/95	ND	0.095	ND	39.5	ND	ND	ND	ND	6.725	11.7	0.0232	ND	14.2	ND	2	ND	11.1	0.0838	ND	0.0128
6M28LD 6/7	12/1/95	ND	ND	ND	39.2	ND	ND	ND	ND	6.569	12.9	0.0283	ND	15.1	-0.001	1.5	ND	11.5	0.0845	ND	0.0145
RPD					0.76					2.50	8.76	12.53		6.14		28.57		3.54	0.83		14.02
6M28FD 6/7	11/30/95	ND	0.087	ND	39.7	ND	ND	ND	ND	6.833	11.8	0.0223	ND	14.3	ND	2	ND	11.2	0.0842	ND	0.0204
RPD			8.79		0.51					1.59	0.85	3.86				0.00		0.90	0.48		47.27
6M28 2/8	2/13/95	ND	ND	ND	56.8	ND	ND	ND	0.034	4.836	21.3	0.0347	ND	9.33	ND	0.41	ND	12.2	0.1091	ND	0.0518
6M28FD 2/8	2/13/95	ND	ND	ND	57.7	ND	ND	ND	0.046	5.033	21.5	0.0359	ND	9.3	ND	0.45	ND	12.2	0.1088	ND	0.0486
RPD					1.57				30.00	3.85	0.93	3.40		0.32		9.30		0.00	2.32		10.57
6M28 5/2	9/27/95	ND	ND	ND	60.5	ND	ND	ND	ND	2.041	21.6	ND	ND	9.85	ND	ND	ND	11.9	0.1249	ND	0.0214
6M28LD 5/2	9/27/95	ND	ND	ND	59.7	ND	ND	ND	ND	1.532	20.2	ND	ND	9.72	ND	0.3	ND	11.5	0.1222	ND	0.0226
RPD					1.33					28.49	6.70			0.72				3.42	2.19		5.45
6M28 5/30	8/17/96	ND	ND	ND	49.4	ND	ND	ND	ND	1.42	18.39	ND	ND	8.587	ND	ND	ND	11.37	0.114	ND	ND
6M28FD 5/30	8/17/96	ND	ND	ND	49.07	ND	ND	ND	ND	1.539	18.71	ND	ND	8.886	ND	ND	ND	11.21	0.1138	ND	ND
RPD					0.67					8.04	1.73			3.42				1.42	0.18		
6M30 5/23	9/27/95	ND	ND	ND	52.5	ND	ND	ND	ND	2.751	16	ND	ND	19.8	ND	0.36	ND	11.7	0.1008	ND	0.0058
6M30LD 5/23	9/27/95	ND	ND	0.041	52.5	ND	ND	ND	ND	2.777	15.7	0.0052	ND	19.5	ND	0.42	ND	11.6	0.1	ND	0.0083
RPD					0.00					0.84	1.89			0.51		15.38		0.88	0.80		11.78

APPENDIX H CATION QA/QC

Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
6M31 6/1	11/30/95	N.D.	N.D.	N.D.	66.2	N.D.	N.D.	N.D.	N.D.	2.733	21.6	N.D.	N.D.	16.9	N.D.	0.44	N.D.	13.1	0.1329	N.D.	0.041
6M31FD 6/1	11/30/95	N.D.	N.D.	N.D.	65.6	N.D.	N.D.	N.D.	N.D.	2.374	21.4	N.D.	N.D.	15.7	N.D.	0.45	N.D.	13.1	0.1317	N.D.	N.D.
RPD					0.01					14.06	0.93			7.36		2.25		0.00	0.01		
6M32 2/8	2/13/95	N.D.	N.D.	N.D.	59.2	N.D.	N.D.	N.D.	N.D.	6.145	18.9	0.1932	N.D.	10.7	N.D.	0.59	N.D.	11.8	0.1022	N.D.	0.0365
6M32LD 2/8	2/13/95	N.D.	N.D.	N.D.	62.8	N.D.	N.D.	N.D.	N.D.	7.582	19.4	0.1995	N.D.	10.6	N.D.	0.81	N.D.	12.1	0.103	N.D.	0.0369
RPD					5.90					20.04	2.61	3.21		0.94		31.43		2.51	0.78		6.37
6M34 6/1	11/30/95	N.D.	N.D.	N.D.	65.5	N.D.	N.D.	N.D.	N.D.	3.383	21.3	N.D.	N.D.	14.6	N.D.	0.49	N.D.	12.4	0.129	N.D.	0.0054
6M34FD 6/1	11/30/95	N.D.	N.D.	N.D.	65.9	N.D.	N.D.	N.D.	N.D.	3.59	21.4	N.D.	N.D.	16	N.D.	0.51	N.D.	12.5	0.1304	N.D.	0.0243
RPD					0.61					5.94	0.47			8.15		4.00		0.80	1.08		127.27
6M34 6/7	11/30/95	N.D.	0.087	N.D.	67.9	N.D.	N.D.	N.D.	N.D.	3.551	19.3	N.D.	N.D.	14	N.D.	0.84	N.D.	12	0.1251	N.D.	0.0111
6M34FD 6/7	11/30/95	N.D.	0.079	N.D.	67.1	N.D.	N.D.	N.D.	N.D.	3.556	18.9	N.D.	N.D.	13.8	N.D.	0.85	N.D.	11.8	0.1227	N.D.	0.0111
RPD			0.84		1.19					0.14	2.08			1.44		1.18		1.88	1.94		0.00
6M37 3/1	3/8/95	N.D.	N.D.	N.D.	53.8	N.D.	N.D.	N.D.	N.D.	2.371	19.5	0.0081	N.D.	7.95	N.D.	N.D.	N.D.	11.1	0.1014	N.D.	0.2219
6M37LD 3/1	3/8/95	N.D.	N.D.	N.D.	53.9	N.D.	N.D.	N.D.	N.D.	1.918	19.4	0.0073	N.D.	8.25	N.D.	0.2	N.D.	11.2	0.1027	N.D.	0.2255
RPD					0.19					21.12	0.51	17.91		3.70				0.90	1.27		1.61
6M37 5/23	9/27/95	0.078	N.D.	N.D.	49.1	N.D.	N.D.	N.D.	N.D.	1.557	16.2	N.D.	N.D.	7.83	N.D.	0.29	N.D.	10.6	0.1009	N.D.	0.0093
6M37FD 5/23	9/27/95	N.D.	N.D.	N.D.	47.6	N.D.	N.D.	N.D.	0.03	1.577	15.8	N.D.	N.D.	7.66	N.D.	0.29	N.D.	10.3	0.0982	N.D.	0.0071
RPD					3.10					1.28	2.50			1.93		0.00		2.67	2.71		28.83
6TANK 6/1	11/30/95	N.D.	N.D.	N.D.	51.1	N.D.	N.D.	0.0218	0.044	11.83	18.3	0.0073	N.D.	36.5	N.D.	6.8	N.D.	12.3	0.1288	N.D.	0.0251
6TANKLD 6/1	12/1/95	N.D.	N.D.	0.108	53.1	N.D.	N.D.	N.D.	0.05	11.96	17.2	0.0094	N.D.	37.6	0.008	6.8	N.D.	12.6	0.1316	N.D.	0.0266
RPD					3.84				12.77	1.28	5.37	25.15		2.97		0.00		2.41	2.15		13.04
Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
BLANK	2/13/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	2/13/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2.058	N.D.	N.D.	N.D.	0.151	N.D.	0.25	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	2/13/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3.336	N.D.	N.D.	N.D.	0.251	N.D.	0.43	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	3/8/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	5/28/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.A.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	5/28/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.A.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	5/28/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.A.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	5/28/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.A.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.22	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.21	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	9/27/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.23	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.023	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	0.076	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.31	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	0.076	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.31	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.46	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	11/30/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.47	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	12/1/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	12/1/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	12/1/95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	8/17/96	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	8/17/96	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

APPENDIX H CATION QAIQC

Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
LITHIUM 450 288	3/8/95	0.016	-0.002	-0.002	0.802	0.0002	0.0011	0.0536	0.003	81.3	0.033	0.0007	0.0038	1.88	0.005	0.15	-0.012	-0.005	0.0055	0.0018	0.0918
USGS T107	2/13/95	0.231	0.01	0.143	12.7	0.0153	0.0133	0.0302	0.048	2.051	2.3	0.0502	0.0135	22.8	0.037	0.12	0.038	4.08	0.0589	0.0054	0.0878
USGS T107	2/13/95	0.217	0.017	0.142	13.4	0.0158	0.0131	0.0284	0.052	3.82	2.29	0.0517	0.0174	21.7	0.037	0.32	0.031	4.11	0.0589	0.0153	0.0911
USGS T107	2/13/95	0.208	0.005	0.139	13.8	0.0177	0.0155	0.0284	0.05	4.975	2.29	0.0521	0.0185	21	0.033	0.5	0.041	4.11	0.0583	0.0234	0.0935
USGS T107	3/8/95	0.233	0.018	0.143	13.4	0.018	0.0154	0.0334	0.058	1.735	2.37	0.0539	0.0187	22.5	0.033	0.12	0.011	4.04	0.0808	0.0055	
USGS T107	3/8/95	0.248	0.022	0.143	13.8	0.0187	0.0149	0.0342	0.081	1.547	2.38	0.0553	0.0158	22.8	0.03	0.18	0.01	4.08	0.0817	0.0052	0.0972
USGS T107	3/8/95	0.253	0.006	0.143	13.4	0.0184	0.0143	0.035	0.057	1.077	2.37	0.0548	0.0189	23.4	0.028	0.1	N D	4.04	0.0818	0.0028	0.0975
USGS T107	3/8/95	0.259	0.01	0.144	14	0.0201	0.0174	0.0364	0.058	1.485	2.44	0.0575	0.0173	23.8	0.032	0.15	0.008	4.18	0.0832	0.0057	0.1018
USGS T107	3/8/95	0.241	0.011	0.137	12.9	0.0193	0.0144	0.0353	0.054	1.769	2.11	0.0548	0.0113	24.1	0.033	0.21	-0.01	3.91	0.08	0.0028	0.0988
USGS T107	5/28/95	0.27	0.019	0.134	13.1	0.0174	0.0132	0.0008	0.058		2.28	0.052	0.0188	22.9	0.031	0.2	0.01	3.43	0.0849	0.0055	0.0949
USGS T107	5/28/95	0.272	0.024	0.132	13.2	0.0174	0.0147	0.0012	0.057		2.25	0.0518	0.02	22.8	0.031	0.21	0.029	3.42	0.085	0.0052	0.0955
USGS T107	5/28/95	0.278	0.021	0.13	13	0.0188	0.014	-0.0009	0.057		2.23	0.0508	0.0178	22.8	0.031	0.21	0.018	3.38	0.0845	0.0055	0.0958
USGS T107	5/28/95	0.286	0.033	0.133	13	0.0184	0.0148	0.0009	0.057		2.24	0.052	0.0184	22.8	0.035	0.15	0.017	3.4	0.0844	0.0049	0.0929
USGS T107	9/27/95	0.23	0.003	0.143	12.8	0.018	0.0127	0.0245	0.052	1.345	2.25	0.0504	0.0154	22.9	0.034	0.03	0.04	4.2	0.0833	0.0018	0.0856
USGS T107	9/27/95	0.241	0.009	0.141	12.8	0.0182	0.0125	0.0245	0.055	1.081	2.24	0.0504	0.0139	23.1	0.035	0.05	0.032	4.2	0.0835	0.0018	0.0882
USGS T107	9/27/95	0.244	0.018	0.141	12.7	0.0186	0.0118	0.0234	0.05	1.14	2.17	0.0511	0.0154	22.7	0.035	0.12	0.058	4.15	0.0825	0.0025	0.0874
USGS T107	9/27/95	0.284	0.011	0.148	13.2	0.0175	0.0125	0.0249	0.052	0.9847	2.2	0.053	0.0133	23.7	0.035	0.14	0.032	4.24	0.0844	0.0028	0.0895
USGS T107	9/27/95	0.248	0.015	0.135	12.8	0.0188	0.0108	0.0231	0.048	0.7123	2.1	0.0509	0.012	23.1	0.038	0.18	0.014	4.09	0.082	0.0018	0.0857
USGS T107	9/27/95	0.253	0.013	0.14	12.7	0.0177	0.0111	0.0245	0.049	0.8471	2.08	0.0508	0.0127	23	0.034	0.22	0.043	4.07	0.0814	0.0032	0.0875
USGS T107	9/27/95	0.238	0.01	0.144	12.8	0.0188	0.0084	0.0234	0.049	0.8129	2.05	0.0504	0.0118	23.2	0.032	0.21	0.023	4.02	0.0814	0.0028	0.088
USGS T107	11/30/95	0.251	0.023	0.119	13.2	0.0186	0.0153	0.034	0.058	1.342	2.34	0.0518	0.0159	23.1	0.022	0.11	0.019	4.3	0.0853	0.0054	0.0895
USGS T107	11/30/95	0.274	0.024	0.123	13.4	0.0129	0.0188	0.0348	0.058	0.9234	2.37	0.0528	0.0183	23.9	0.028	0.14	0.02	4.38	0.0879	0.0033	0.0893
Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
USGS T107	11/30/95	0.267	0.012	0.114	12.9	0.0138	0.0141	0.0325	0.052	1.019	2.21	0.0513	0.014	22.5	0.025	0.2	0	4.19	0.0841	0.0041	0.0874
USGS T107	11/30/95	0.255	0.092	0.118	13.7	0.0121	0.0158	0.0314	0.058	1.251	2.18	0.0538	0.0148	21.9	0.024	0.34	0.013	4.18	0.0885	0.0045	0.09
USGS T107	11/30/95	0.253	0.075	0.114	13.9	0.0133	0.0151	0.0314	0.057	1.382	2.13	0.0535	0.0143	21.5	0.025	0.42	0.007	4.18	0.0859	0.0062	0.093
USGS T107	11/30/95	0.243	0.08	0.105	13.4	0.0138	0.0119	0.0302	0.054	1.399	2.02	0.0519	0.017	20.8	0.025	0.48	0.02	4.02	0.0831	0.0074	0.0911
USGS T107	11/30/95	0.248	0.094	0.109	13.7	0.0129	0.0148	0.0302	0.053	1.497	2.03	0.0528	0.0159	20.5	0.03	0.55	0.014	4.04	0.0833	0.0087	0.0945
USGS T107	12/1/95	0.243	0.014	0.138	13.7	0.0195	0.0183	0.0183	0.083	1.037	2.39	0.0545	0.0184	23.5	0.028	0	0.02	4.35	0.0886	0.0021	0.093
USGS T107	12/1/95	0.285	0.038	0.143	13.8	0.0189	0.013	0.014	0.057	0.8368	2.33	0.0555	0.0191	23.5	0.033	0.11	-0.005	4.32	0.0886	0.0018	0.0986
USGS T107	12/1/95	0.28	0.024	0.139	13.8	0.0185	0.0153	0.0158	0.08	0.881	2.3	0.0558	0.0184	23.2	0.032	0.14	-0.009	4.28	0.0857	0.0025	0.0973
USGS T107	8/17/96	0.233	0.015	0.1282	13.54	0.0189	0.0139	0.03	0.084	0.9511	2.219	0.053	0.018	22.47	0.0248	-0.0188	0.031	3.894	0.0882	-0.0011	0.0818
USGS T107 VALUES		0.22	0.0108	0.13	11.7	0.0143	0.011	0.03	0.052	0.84	2.1	0.045	0.015	28.7	0.0281		0.028	3.8	0.081		0.0758
U M T107 VALUES		0.2384	0.0123	0.1341	12.8878	0.0189	0.0138	0.0324	0.0533	2.1112	2.2485	0.0517	0.0147	22.7909	0.0323	0.1015	0.0278	3.9327	0.0593	0.0032	0.0905
Sample Name	Date	Al	As	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	S	Ti	Zn
USGS T117	2/13/95	0.07	0.007	0.157	23.1	0.0028	0.0054	0.0044	0.501	3.385	11.1	0.2415	0.0145	22.2	0.009	0.32	-0.002	8.34	0.2558	0.0057	0.2025
USGS T117	3/8/95	0.083	0.009	0.154	23.8	0.0022	0.0055	0.0089	0.485	2.83	11.1	0.245	0.0109	21.3	0.009	0.34	-0.01	8	0.2514	0.0048	0.2055
USGS T117	5/28/95	0.101	0.024	0.148	23.4	0.0018	0.0058	-0.0272	0.515		10.8	0.2414	0.0145	21.8	0.009	0.39	0.008	5.21	0.2755	0.0054	0.211
USGS T117	9/27/95	0.079	0.008	0.158	23.4	0.003	0.0051	-0.0018	0.51	2.828	11	0.2418	0.0108	22	0.012	0.27	0.014	6.38	0.2737	0.0039	0.207
USGS T117	11/30/95	0.088	0.024	0.134	23.9	0.0006	0.0075	0.0088	0.524	2.625	11.2	0.2481	0.0183	22	0.005	0.33	0.013	6.48	0.2807	0.0082	0.2059
USGS T117	12/1/95	0.085	0.014	0.151	24.9	0.0038	0.0051	-0.0058	0.543	2.4	11.8	0.2561	0.0141	22.8	0.008	0.28	-0.009	6.59	0.2893	0.0033	0.2173
USGS T117 VALUES		0.079	0.0089	0.151	20.9	0.0022	0.0043	0.008	0.474	2.11	10.05	0.22	0.012	20	0.01		0.005	5.54	0.285		0.176
U M T117 VALUES		0.0822	0.0089	0.148	23.4888	0.0026	0.0053	0.0059	0.5003	4.5583	11.1218	0.2459	0.0121	21.8263	0.0118	0.3008	0.0082	6.0818	0.255	0.0018	0.2031

ANIONS

219

ANIONS

250

ANIONS

251

**APPENDIX H
ANALYTICAL RESULTS
ANIONS**

6/30/96 SAMPLE	ALK mg/L	CHLOR mg/L	NITRATE mg/L	PHOS mg/L	SULP mg/L		8/30/96 SAMPLE	FLUO mg/L	CHLOR mg/L	NITRATE mg/L	AMMON mg/L	TOTAL N mg/L	PHOS mg/L	SULP mg/L
P1	163	2 758	0 581	ND	20 216		M11	0 05	2 39	0 76	ND	0 76	0 00	15 35
P2	202	2 95	0 861	ND	19 727		M12	0 06	2 94	1 31	0 15	1 46	0 00	17 01
P3	196	3 805	0 885	ND	19 503		M13	0 06	2 57	1 52	ND	1 52	0 00	15 27
P4	208	2 686	0 58	ND	19 319		M14	0 09	4 80	0 76	ND	0 76	0 00	21 40
M11	193	4 428	0 969	ND	19 856		M15	0 46	25 59	0 22	13 80	14 02	3 74	0 00
M12	200	4 738	1 201	ND	19 92		M16	0 03	8 67	5 85	ND	5 85	0 17	14 03
M13	180	3 924	0 798	ND	19 496		M17	0 04	7 77	5 64	ND	5 64	0 11	14 39
M14	156	3 839	0 606	ND	19 247		M18	0 05	5 81	3 63	ND	3 63	0 14	16 05
M15	292	42 905	4 834	0 888	8 401		M19	0 05	19 04	8 75	1 80	10 55	1 31	9 71
M15FD	280	39 51	4 711	0 942	8 128		M20	0 04	6 27	4 48	ND	4 48	0 16	14 87
M16	187	7 308	2 082	0 398	18 372		M21	0 01	9 31	6 38	ND	6 38	0 00	18 98
M17	208	11 215	3 256	0 343	17 357		M22	0 03	7 16	3 39	ND	3 39	0 11	14 43
M18	152	5 472	3 242	0 143	19 371		M22FD	0 03	6 58	4 75	ND	4 75	0 17	14 97
M19	163	20 828	NA	1 605	17 888		M24	0 05	5 32	1 47	1 40	2 87	0 22	15 20
M20	235	7 95	1 196	0 286	17 584		M25	0 01	17 38	11 74	1 20	12 94	0 51	11 03
M21	191	8 887	4 595	ND	18 482		M26	0 03	19 08	16 12	0 40	16 52	0 68	11 09
M22	179	8 068	4 706	ND	19 458		M27	0 02	6 41	4 33	ND	4 33	0 10	15 48
M23	178	3 584	0 82	ND	18 941		M28	0 05	3 34	2 35	ND	2 35	0 00	17 16
M24	185	2 757	0 559	ND	20 59		M28FD	0 05	3 32	2 39	ND	2 39	0 00	16 75
M25	135	4 196	1 129	0 288	20 892		M29	0 03	2 54	0 98	ND	0 98	0 00	17 65
M26	124	4 908	3 645	1 073	20 32		M30	0 02	5 74	2 61	ND	2 61	0 00	16 26
M26FD	130	4 21	3 755	1 092	20 435		M31	0 03	5 98	3 90	ND	3 90	0 11	17 32
M27	204	7 988	3 7	ND	14 888		M32	0 04	5 92	3 82	ND	3 82	0 11	17 39
M28	193	3 857	2 05	ND	19 243		M33	0 13	3 73	1 11	ND	1 11	0 00	18 82
M29	176	3 056	0 656	ND	19 058		M34	0 03	7 55	5 24	ND	5 24	0 18	16 60
M30	186	7 841	8 495	ND	19 559		M35	0 06	2 76	1 45	ND	1 45	0 00	17 93
M31	203	12 221	6 084	ND	16 956		M36	0 04	3 39	1 90	ND	1 90	0 00	20 21
M32	195	11 611	4 938	ND	16 884		M37	0 07	1 98	0 96	ND	0 96	0 00	14 74
M33	230	4 151	1 631	ND	20 856		M40	0 00	21 26	19 59	0 50	20 09	1 18	10 02
M34	213	11 601	4 016	ND	16 692		M41	0 03	18 46	14 55	0 30	14 85	0 70	12 08
M34FD	212	11 996	4 123	ND	17 105		P1	0 05	1 62	0 61	ND	0 61	0 00	15 66
M35	210	10 115	4 2	ND	17 799		P1FD	0 05	1 64	0 61	ND	0 61	0 00	16 83
M36	221	10 532	3 805	ND	17 234		TANK	4 08	25 75	0 17	11 80	11 97	2 91	1 47
M37	171	2 844	1 048	ND	16 81									
TANK	226	13 765	ND	1 754	0 91									
NA = Not Analyzed														
ND = Not Detected At or Above the Laboratory Detection Limit														
10/17/96 SAMPLE	AMMON (mg/L)	10/17/96 SAMPLE	AMMON (mg/L)											
M15	23 1	M23	0 02											
M16	0 024	M26	0 42											
M17	0 025	M26FD	0 49											
M18	0 028	M31	0 019											
M19	2 46	M34	0 016											
M20	0 048	M36	0 021											
M21	0 025	M37	0 016											
M22	0 023	M41	0 72											

APPENDIX H FIELD PARAMETERS

EC							TDS							TEMP							DO						
SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm
P1	3/1/96	6.8	278	NA	9.5	NA	P1	3/22/96	7	280	180	11.1	3.5														
P4		6.77	250	NA	8.7	NA	P2		7	295	190	NA	4.9														
M11		6.75	281	NA	8.4	NA	P3		7	278	180	10.2	4														
M12		6.69	292	NA	9.2	NA	P4		7	274	170	11.1	4.9														
M13		6.74	411	NA	8	NA	M11		7	264	NA	10.5	4.1														
M14		7.22	238	NA	8.6	NA	M12		6	273	NA	9.1	4.6														
M15		6.1	349	NA	8.6	NA	M13		7	269	NA	9.4	4.5														
M16		6.29	301	190	NA	NA	M14		7	267	NA	9.6	4.2														
M17		6.5	338	NA	8.2	NA	M15		6	405	NA	8.5	2.1														
M18		6.48	290	NA	8.5	NA	M16		7	352	NA	8.6	5														
M19		6.02	321	NA	5.8	NA	M17		7	309	NA	9	3														
M20		NA	NA	NA	NA	NA	M18		7	302	NA	9.3	3.6														
M21		6.73	303	NA	7.1	NA	M19		6	372	NA	7.7	1.7														
M22		6.36	279	NA	8.1	NA	M20		7	321	NA	9.4	3.2														
M23		6.51	248	NA	8.7	NA	M21		7	311	NA	9.1	3.6														
M24		6.54	255	NA	7.2	NA	M22		7	285	NA	9.3	4.5														
M25		6.23	274	NA	6.3	NA	M23		7	253	NA	9.4	5.5														
M26		6.07	302	195	NA	NA	M24		7	275	NA	9.2	5.6														
M27		6.25	247	NA	5.9	NA	M25		7	280	NA	8.6	2.7														
M28		6.55	274	NA	8.5	NA	M26		7	312	NA	8.3	1.8														
M29		6.71	240	NA	5.7	NA	M27		7	279	NA	9	5.1														
M30		6.46	311	NA	6.8	NA	M28		7	292	NA	9.8	4														
M31		6.09	339	NA	7.7	NA	M29		7	272	NA	8.8	4.6														
M32		6.58	296	NA	7.7	NA	M30		7	301	NA	8.8	2.8														
M33		6.7	283	NA	7.5	NA	M31		7	328	NA	9.6	2.1														
M34		6.5	262	NA	8	NA	M32		7	319	NA	9.3	3.6														
M35		6.55	279	NA	8.2	NA	M33		7	299	NA	10.6	4.5														
M36		6.51	282	NA	7.9	NA	M34		7	310	NA	10.9	4.8														
M37		6.82	243	NA	8.4	NA	M35		7	311	NA	11.4	4														
TANK		7.26	700	NA	13.3	NA	M36		7	285	NA	11.4	4														
							M37		7	272	NA	10.5	6.4														
							TANK		7	720	355	16	0.9														
EC							TDS							TEMP							DO						
SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm	SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm
M15	3/15/96	6.36	323	210	8.5	NA	M24	6/2/96	7	313	180	10.7	5.4														
M25		6.34	297	198	8.5	NA	M25		7	364	208	11	4.3														
TANK		7.15	700	362	14.9	NA	M26		7	387	224	11.2	7.2														
							M27		7	332	192	10.2	6.9														
							M28		7	347	191	11	5.9														
							M29		8	322	202	10.9	7														
							M30		7	331	205	9.5	3.3														
							M31		7	372	240	9.7	2.6														
							M32		7	NA	360	10	2.7														
							TANK		8	660	319	17.9	0.9														
EC							TDS							TEMP							DO						
SAMPLE	Date	pH	micromohs/cm	mg/L	Celsius	ppm																					
M15	5/26/96	6.03	495	NA	11.3	3																					
M19		6.16	425	NA	10.3	4.1																					
M26		6.01	281	NA	10.3	8.8																					
M31		6.49	352	NA	10.5	8.2																					
M34		6.57	393	NA	10.8	8.1																					
TANK		7.17	770	NA	21	3.1																					

APPENDIX H FIELD PARAMETERS

[illegible]

APPENDIX I

Coliform Analytical Data

APPENDIX I

COLIFORM ANALYTICAL RESULTS

DATE	SAMPLE	TOTAL COLIFORM (CFU)	FECAL COLIFORM (CFU)	COMMENTS
9/23/94	P1	0	0	
	P2	0	0	
	P3	0	0	
	P4	0	0	
	P4FD	0	0	Field duplicate
	TANK	1.44E+08	8.00E+04	
2/6/96	M23	N.A.	0	
	M28	N.A.	0	
	M29	N.A.	0	
	M30	N.A.	0	
	M31	N.A.	0	
	M32	N.A.	0	
	M33	N.A.	0	
	M34	N.A.	0	
	M35	N.A.	0	
	M36	N.A.	0	
	M37	N.A.	0	
	TANK	N.A.	4.70E+05	
2/8/96	M11	N.A.	8	All samples collected on this date were likely contaminated during well installation.
	M12	N.A.	3900	
	M13	N.A.	440	
	M14	N.A.	13	
	M15	N.A.	104	
	M16	N.A.	300	
	M16FD	N.A.	196	Field duplicate
	M17	N.A.	3020	
	M18	N.A.	91	
	M19	N.A.	3080	
	M21	N.A.	3	
	M22	N.A.	3	
	M24	N.A.	11	
	M25	N.A.	0	
	M26	N.A.	8	
	M27	N.A.	8	
3/1/96	P1	0	N.A.	
	P4	0	N.A.	
	M11	45	N.A.	
	M12	4000	N.A.	
	M13	0	N.A.	
	M14	40	N.A.	
	M15	300	N.A.	
	M16	25	N.A.	
	M16FD	0	N.A.	Field duplicate
	M17	0	N.A.	
	M18	120	N.A.	
	M19	10000	N.A.	
	M21	40	N.A.	
	M22	25	N.A.	
	M23	0	N.A.	
	M24	38	N.A.	
	M25	0	N.A.	
	M26	0	N.A.	
	M26FD	0	N.A.	Field duplicate
	M27	0	N.A.	
	M28	0	N.A.	
	M29	0	N.A.	
	M30	0	N.A.	
	M31	0	N.A.	
	M32	0		
	M33	0	N.A.	
	M34	0	N.A.	

APPENDIX I **COLIFORM ANALYTICAL RESULTS**

DATE	SAMPLE	TOTAL COLIFORM (CFU)	FECAL COLIFORM (CFU)	COMMENTS
3/1/96 cont'd				
	M35	0	N.A.	
	M36	0	N.A.	
	M37	0	N.A.	
	TANK	0	N.A.	
3/16/96				
	M15	4	N.A.	
	M15FD	4	N.A.	Field duplicate
	M25	0	N.A.	
	TANK	2.00E+05	N.A.	
3/22/96				
	P1	0	0	
	P2	0	0	
	P2FD	0	0	Field duplicate
	P3	0	0	
	P4	0	0	
	M11	0	0	
	M12	0	0	
	M13	0	0	
	M13FD	0	0	Field duplicate
	M14	0	0	
	M15	0	4	
	M16	0	0	
	M17	1920	0	
	M18	0	0	
	M19	0	0	
	M20	0	0	
	M21	0	0	
	M21FD	0	0	Field duplicate
	M22	0	0	
	M23	0	0	
	M24	0	0	
	M25	0	0	
	M26	0	0	
	M27	0	0	
	M28	0	0	
	M29	0	0	
	M30	0	0	
	M31	0	0	
	M32	0	0	
	M33	0	0	
	M34	0	0	
	M35	0	0	
	M36	0	0	
	M37	0	0	
	TANK	0	0	
6/1/96				
	M15	0	0	
	M16	0	0	
	M17	14	1	
	M18	0	0	
	M19	3	0	
	M21	0	0	
	M22	12	0	
	M28	0	0	
	M31	0	0	
	M34	0	0	
	M36	0	0	
	TANK	1.10E+05	4.80E+04	

APPENDIX I **COLIFORM ANALYTICAL RESULTS**

DATE	SAMPLE	TOTAL COLIFORM (CFU)	FECAL COLIFORM (CFU)	COMMENTS		
8/26/96	M19	7	12			
	M40	0	0			
	M41	0	0			
	T7	8	5			
	TANK	2.10E+04	1.50E+04			
8/28/96	M19	0	0			
	M40	11	0		Questionable	
	M41	1	0			
	T7	0	0			
	TANK	2000	0			

APPENDIX I

COLIFORM ANALYTICAL RESULTS

DATE	SAMPLE	TOTAL COLIFORM (CFU)		FECAL COLIFORM (CFU)	
		(24 hour)	(48 hour)	(24 hour)	(48 hour)
8/28/98	M19	8	31	1	0
	M40	0	1	0	0
	M41	1	1	0	0
	T7	0	0	0	0
	TANK	3000	6.80E+04	3.90E+04	4.60E+04
9/1/98	M19	0	0	0	0
	M40	0	0	0	0
	M41	0	2	0	0
	T7	0	79	67	63
	TANK	3000	6.80E+04	3.90E+04	4.60E+04
9/3/98	M19	0	18	0	9
	M40	0	0	0	0
	M41	0	1	0	0
	T7	0	0	0	0
	TANK	0	2.90E+04	0	1.10E+04
9/8/98	M19	0	0	0	0
	M40	0	0	0	0
	M41	0	0	0	0
	T7	0	0	0	0
	TANK	0	7000	0	0
DATE	SAMPLE	TOTAL COLIFORM (CFU)		FECAL COLIFORM (CFU)	
		(24 hour)	(48 hour)	(24 hour)	(48 hour)
9/7/98	M19	8		0	
	T7	5		0	
	TANK	TNTC		1.40E+05	
DATE	SAMPLE	TOTAL COLIFORM (CFU)@48HRS		FECAL COLIFORM (CFU)@48HRS	
		(media A)	(media B)	(media B)	(media C)
9/16/98	M19	18	N.A.	N.A.	N.A.
	M40	TNTC/17	N.A.	N.A.	N.A.
	M41	TNTC/0	N.A.	N.A.	N.A.
	T7	0	N.A.	N.A.	N.A.
	TANK	2.00E+05	5.20E+04	1.80E+04	3.80E+04
DATE	SAMPLE	TOTAL COLIFORM (CFU)	FECAL COLIFORM (CFU)		
9/22/98	M19	15	N.A.		
	M40	14	N.A.		
	M41	4	N.A.		
	T7	0	N.A.		
	T8	0	N.A.		
	T9	15	N.A.		
	M31	3	N.A.		
	TANK	1.40E+05	N.A.		

APPENDIX J

Coliphage Seeding Experiment Field and Analytical Data

APPENDIX J
COLIPHAGE SEEDING EXPERIMENT
FIELD AND ANALYTICAL DATA

Hours	Lab Stock	After Seed	Enclosed	MS2-15597		Well 19	Well 40	Well 41	Well T7	Well T8	Well T9	Well T10	Well 31
				Dialysis									
0	6.35E+11	1.06E+09	1.06E+09	1.06E+09		1.06E+09	9.53E-03	3.02E-02	4.05E-02				
9													
12	7.63E+11	1.24E+09	9.95E+08	1.02E+09		1.81E+08	2.47E-02						
16													
22													
24	4.73E+11	5.80E+08		9.78E+08		3.84E+07	4.68E-02						
29													
36			1.15E+09	1.11E+09		1.04E+07	3.65E+03		9.53E-04				
44													
48	1.23E+12	9.96E+08	1.18E+09	1.06E+09		5.56E+06	2.86E+05	1.81E-01					
55													
60			1.53E+09	1.01E+09		4.45E+06	8.64E+04	4.00E-01					
68													
72	1.37E+12	1.20E+09	1.54E+09	1.06E+09		2.28E+06	4.35E+04	1.80E+00	8.90E-04				
79													
84			1.08E+09	3.64E+08		2.89E+06	3.20E+04	3.46E+01					
94													
96	1.10E+12	1.22E+09	6.88E+08	7.36E+08		2.01E+06	1.00E+04	2.92E+03					
104													
108								3.63E+04					
117													
120	1.49E+12	9.50E+08	1.06E+09	5.44E+08		4.25E+05	6.44E+03	1.81E+05	1.81E-01				
127													
132							7.87E+03	2.36E+06					
144	1.65E+12	1.49E+09	1.05E+09	3.04E+08		4.74E+05	3.02E+03	1.87E+05					
151													
156													
166													
168	1.03E+12	9.08E+08	6.66E+08	2.39E+08		6.46E+05	2.27E+03	7.95E+04	3.00E-01				
175													
180													
187													
192						5.20E+05	2.14E+03		3.50E+00				
204													
211													
216	1.10E+12	8.14E+08	4.00E+08	1.39E+08		5.64E+05	1.65E+03	1.70E+04	1.37E+01				
228									1.55E+01				
240						1.63E+05	1.96E+03	2.11E+04	2.89E+01				
252													
264	9.84E+11	1.07E+09	3.04E+08	5.90E+07		3.84E+05			1.44E+01				
272													
276													
284													
288						1.10E+05			2.04E+01				
296													
300													
308													
312	1.21E+12	1.21E+09	1.82E+08	3.85E+07		9.06E+04	1.41E+03	1.09E+04	2.71E+01	8.90E-04			
320													
324													
333													
336													
344													
348													
357													
360													
368									1.36E+01				
372													
381													
384	1.08E+12	9.30E+08				5.78E+04			1.41E+01	8.90E-04			
392													
396													
404													
408													
420													
428													
432										4.29E-03			
444													
456													
468													
480	1.328E+12	1.186E+09	181875000	13800000		32700	1020	4700	11.3	0.0349603			
579										0.2			
603													
648	6.5E+11	522000000	29800000	7420000		7800	535	660	3.5	0.0247207	1.3	0.001917	0.00089
696										0.0074478	1.8	0.000953	0.004066
744										0.0009535	0.3	0.00089	0.00201
792		472000000	22800000	6140000		9880				0.0020101	1.1	0.020184	0.006519
864													
912													
4080			8500			1240							
4272													

APPENDIX J
COLIPHAGE SEEDING EXPERIMENT
FIELD AND ANALYTICAL DATA

Hours	Lab Stock	After Seed	Enclosed	Phage 174 Dialysis	Well 19	Well 40	Well 41	Well T7	Well T8	Well T9	Well T10	Well 31
0	8.80E+08	1.12E+06	1.12E+06	1.12E+06	1.12E+06	1.10E-02	9.13E-04	9.53E-04				
9												
12	1.23E+09	9.75E+05	2.00E+06	9.08E+05	8.14E+04	3.20E-03						
16												
22												
24	1.22E+09	7.85E+05	1.34E+06	1.35E+06	1.72E+04	9.13E-04						
29												
36			1.48E+06	1.21E+06	5.85E+04	4.00E-01		8.90E-04				
44												
48	1.10E+09	9.92E+05	2.14E+06	2.73E+06	2.53E+04	1.80E+00	9.53E-04					
55												
60			1.83E+06	1.03E+06	2.63E+04	5.09E-01						
68												
72	5.40E+08	6.62E+05	9.90E+05	1.13E+06	2.50E+04	2.00E-01	3.59E-02	8.90E-04				
79												
84			1.61E+06	7.50E+05	2.23E+04	2.23E-01	5.09E-01					
94												
96	5.48E+08	1.07E+06	1.53E+06	7.55E+05	1.40E+04	1.08E-01	1.30E+00					
104												
108							1.50E+00					
117												
120	3.96E+08	5.82E+05	8.30E+05	4.22E+05	3.00E+03	7.63E-02	1.30E+00	9.53E-04				
127												
132							8.00E-01					
144	9.84E+08	8.90E+05	8.90E+05	4.38E+05	2.94E+03	7.63E-02	6.00E-01	5.74E-03				
151												
156												
166												
168	8.46E+08	1.01E+06	9.54E+05	3.54E+05	2.53E+03		3.00E-01	3.45E-02				
175												
180												
187												
192					1.72E+03	9.36E-02	8.00E-01	7.63E-02				
204												
211												
216	6.46E+08	9.66E+05	7.98E+05	3.01E+05	1.16E+03			5.45E-02				
228												
240					1.33E+03	6.40E-02	1.00E-01	1.21E-01				
252												
264	9.66E+08	1.65E+06	9.54E+05	2.75E+05	1.40E+03			7.63E-02				
272												
276												
284												
288					1.27E+03			4.68E-02				
296												
300												
308												
312	7.62E+08	9.44E+05	6.88E+05	2.43E+05	6.30E+02		2.50E-01	1.21E-01	8.90E-04			
320												
324												
333												
336												
344												
348												
357												
360												
368												
372												
381												
384	8.20E+08	9.13E+05			5.35E+02			7.63E-02	8.90E-04			
392												
396												
404												
408												
420												
428												
432									8.90E-04			
444												
456												
468												
480	458000000	1418000	396000	44800	327	0.076277	0.121356	0.0639602	9.53E-04			
579									9.53E-04	9.53E-04		
603												
648	807000000	1860000	450000	21400	162	0.0218739	0.0468487	0.0074478	0.00089	0.002889	0.00089	0.00089
696									0.00089	0.003198	0.00089	0.00089
744									0.00089	0.000953	0.00089	0.00089
792		1150000	171000	16100	268.5				0.00089	0.00201	0.00089	0.00089
864												
912												
4080			12800		140							
4272						0.05						