STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

ONSITE SEWAGE DISPOSAL SYSTEM (OSDS) RESEARCH IN FLORIDA

The Capability of Fine Sandy Soil for Septic Tank Effluent Treatment:

A Field Investigation at an *In-Situ* Lysimeter Facility in Florida

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HRS

State of Florida
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Under HRS Contract No. LP-596
Dr. Kevin M. Sherman, Project Administrator

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By:

AYRES
ASSOCIATES

3901 Coconut Palm Drive, Suite 100
Tampa, Florida 33619

PRINCIPAL INVESTIGATORS

Damann L. Anderson, P.E.
Richard J. Otis, P.E.
Richard A. Apfel, CPSS

Project Team

Jennifer I. McNeillie, P.G.
Clayton G. Hamilton
Diane Mulville-Friel
Jeffrey A. Rawls

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Numerous individuals and companies contributed to the success of this project. Members of the OSDS Ad Hoc advisory committee are acknowledged for their input on the experimental plan and study variables. Ron Kuehl of Florida Soil and Environmental Sciences is acknowledged for his assistance in classifying and sampling soils at the research site. The staff of the University of Florida, Institute of Food and Agricultural Sciences, Soil Genesis and Characterization Laboratory are gratefully acknowledged for the soils analyses and characterization work on the soil samples.

Construction of the lysimeter facility was no easy task and D.E. Britten, Inc. performed admirably in keeping the construction on schedule and making all the unplanned changes and additions to the structure. Likewise, Bingham Septic Tank, Inc. is commended for an outstanding job installing the tanks, pumps, forcemain, and infiltration cells for the project.

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EXECUTIVE SUMMARY

Concerns over the potential adverse impacts from onsite sewage disposal system (OSDS) use on Florida's groundwater resources led to initiation of the Florida OSDS Research Project in 1986. Since the project began, a series of studies and field investigations have been conducted to evaluate the impact of high density OSDS use on groundwater and surface water quality and to determine the capability of Florida soils to accept and treat septic tank effluent under various conditions. This report represents the final investigative phase of the initial research project prior to making recommendations for improved OSDS practices in Florida.

This phase of the research was conducted to investigate the wastewater treatment capabilities of fine sandy soils common to Florida under controlled experimental conditions in the field. Field studies of existing subdivisions and individual OSDS were conducted previously to address OSDS treatment effectiveness and potential impacts to ground and surface water. However, the data generated during field studies of existing systems often were inconsistent due to variable wastewater and groundwater flow and characteristics in the field. Controlled experimental work by other investigators has been conducted using laboratory soil columns primarily, but field conditions can not typically be duplicated in the laboratory. This is particularly true in Florida where heavy thunderstorms, which are not easily simulated in the laboratory, may be affecting treatment performance on the very porous sandy soils. For these reasons, a field study on natural soils was proposed that maintained control over selected variables important to evaluation of treatment capability.

To accomplish this, a unique field lysimeter research facility was designed, constructed, and operated under controlled conditions. The facility was designed specifically to evaluate the capability of fine sandy soil for treatment of septic tank effluent (STE) under various conditions. Key variables investigated were the thickness of unsaturated soil below the wastewater infiltration system and the hydraulic loading rate of STE to the infiltration system. Multiple *in-situ* soil infiltration cells, or lysimeters, were designed so that

experiments at two STE hydraulic loading rates and two unsaturated soil thicknesses could be conducted simultaneously with the same wastewater on the same soil. In addition, numerous soil physical/chemical parameters and meteorological conditions were monitored to aid in interpretation of the results. This report describes the lysimeter site selection and characterization, the investigative methodology, and the results of the lysimeter facility monitoring for the first six months of operation.

The lysimeter research facility was constructed at the University of South Florida (USF) in Tampa. The site was selected because of its close location to the research team, the uniform fine sandy soil at the site, depth to groundwater, and the availability of septic tank effluent for facility operation. The facility consisted of a subsurface gallery structure built between two rows of infiltration cells, or soil lysimeters. Twenty infiltration cells were constructed, each operated independently at various experimental conditions. A summary of the experimental conditions evaluated is listed below.

Summary of Lysimeter Facility Study Variables

Controlled Variables	Values of Variables Studied
Soil Type	fine sand (Quartzipsamment)
Unsaturated Zone Thickness	2 feet below infiltrative surface 4 feet below infiltrative surface
Hydraulic Loading Rate of STE	0.75 gallons/day/ft^2 1.50 gallons/day/ft^2

Triplicate STE infiltration cells were operated for each experimental condition above. In addition, one infiltration cell at each condition was operated with a tap water feed instead of STE to act as controls and to evaluate any impact of the natural soil. Also, four natural soil infiltration cells without any loading were monitored to evaluate natural soil conditions and impacts of rainfall.

Undisturbed soil samples were collected for analyses of several physical, chemical, and microbiological soil characteristics to aid in interpretation of future results of soil water sampling. Grain size analyses indicated that soils at the site were very uniform and consisted primarily of fine to very-fine grained quartz sand similar to Candler fine sand. The clay sized fraction of the soil was less than 3 percent. Soil water parameters were plotted to develop soil moisture retention curves and to calculate unsaturated hydraulic conductivity. pH of the soils ranged from 6.2 to 7.0. The percentage of organic carbon ranged from 0.05 to 0.15, $CaCO_3$ percentages were less than 2.5 percent. Extractable aluminum and iron and total phosphorous were not detected in the soils at the site. The cation exchange capacity was less than one. Background counts of fecal coliform and fecal streptococcus in soil samples obtained prior to system startup were below detectable levels.

Two methods were used to collect soil water samples below the infiltration cells for monitoring of STE treatment efficiency. Stainless steel pan soil water samplers were installed at 2 feet and 4 feet below the infiltrative surface of the cells by hydraulically jacking them into the unsaturated soil. These "pressure free" pan samplers were designed to provide a barrier to percolation for collection of soil water samples by gravity. Porous ceramic soil water samplers were installed in small borings into the soil at the same depths. These ceramic samplers extracted soil water by vacuum.

Operation of the lysimeter facility was begun in August, 1992. Although it was anticipated that soil water would saturate on top of the stainless steel sampling pans, saturation did not occur so gravity sampling from the pans was not possible. Soil moisture measurements indicated that the soil above the pans was very wet, within several percent of saturation, but just enough soil moisture tension existed to hold water in the soil pores. Samples were easily obtained from the ceramic samplers, but these samples were limited because porous ceramic is known to filter out most bacteria and can not be used for bacterial analyses. Therefore, a procedure was developed to apply a very small vacuum to the sample tube on the pan samplers which was successful in providing soil water samples from the pans.

Based on 6 months of operational data, the preliminary results of the lysimeter facility monitoring showed substantial attenuation of key parameters related to STE treatability in the fine sandy soils. Effective removal of total organic carbon (TOC), surfactants (as MBAS), total phosphorus (TP), and total kjeldahl nitrogen (TKN), were observed at both the 2 foot and 4 foot unsaturated thicknesses. Although TP removal was high, there were indications at the 2 foot, 1.5 gal/day/ft^2 loading level that the phosphorus capacity of the soil was being approached. TOC reductions were on the order of 80 percent, while MBAS was reduced by over 99 percent. TKN reductions were in excess of 97 percent indicating almost complete nitrification of the STE nitrogen applied to the cells. The nitrate nitrogen (NO_3) generated from nitrification was transported to both the 2 foot and 4 foot depths at relatively high concentrations. No positive sample results were obtained for fecal coliform or fecal streptococcus bacteria below the infiltration systems, indicating significant attenuation of these fecal indicators in the sandy soil.

The experiment showed effective removal of key parameters at both levels of the variables tested. It appeared that phosphorus removal was effected negatively by less unsaturated zone travel and greater hydraulic loading. The effect of cumulative rainfall appeared to dilute the sample concentrations, however this was not consistent. It was hypothesized that the intensity and duration of rainfall events may be the most important factor for infiltration system performance related to precipitation.

The results obtained at the lysimeter facility were limited by the soil moisture status above the sampling pans. As discussed in the report, the soil moisture status more closely resembled the capillary fringe above a water table than a true saturated soil condition. Thus, the soil may have been slightly drier than if a true saturated condition existed, and this may have affected the treatment which occurred in the unsaturated zone.

Based on the preliminary results from the lysimeter facility and the short duration of operation and monitoring conducted thus far, it was recommended that additional work be conducted at the facility. Specific recommendations are as follows:

1. The short period of facility operation has not allowed the infiltration cells to mature. Clogging of the infiltrative surfaces has not yet developed, and it is recommended that facility operation be continued at existing loading rates until the reduction in infiltrative capacity due to clogging can be measured. This will allow an evaluation of the long-term hydraulic and treatment performance of fine sand as related to wastewater loading rate and system life.

2. The soil moisture above the sampling pans should be increased prior to further sampling. It is recommended that a higher capacity and less expensive source of water be developed to supply the artificial water tables. A higher flow rate to the water tables combined with minor modifications to their design would improve the soil moisture condition.

3. Increased monitoring of the subsoil aeration status should be implemented prior to clogging development so that the relationship between soil aeration and clogging can be better evaluated.

4. Additional tracer testing should be conducted as the infiltration cells mature to better evaluate unsaturated zone travel time and to examine the effects of a mature clogging layer on the travel time.

5. Simultaneous sampling of the porous ceramic soil water samplers and the stainless steel pan samplers should be conducted and an analysis of significant differences made.

6. A detailed assessment of rainfall and sample results should be performed during the upcoming rainy season. Rainfall intensity and duration should be compared to water quality results. Evapotranspiration should also be evaluated at the site, and a detailed water balance conducted to better evaluate dilution.

7. Although significant attenuation of key STE parameters were demonstrated in the fine sandy soil studied, several important parameters remain which were not evaluated as part of this study. Future investigations at the site should include the fate and transport of enterovirus and several common toxic organic compounds. Prior to conducting such an investigation, the ceramic soil water samplers should be replaced with new porous stainless steel soil water samplers at the 2 foot and 4 foot pan depths.

8. The research project described herein represents a beginning to what should be an on-going onsite wastewater treatment system (OWTS) research program in Florida. Continuing research will help to provide answers to many remaining questions regarding the performance and impacts of onsite system practices. It is recommended that future research focus on long-term, detailed studies of single specific systems or controlled experiments in the field and laboratory such as the USF lysimeter station facility.

SECTION 1.0
INTRODUCTION

The Florida Onsite Sewage Disposal System (OSDS) Research Project began in 1986 with the goal of determining "whether high density installation of OSDS, installation of OSDS under certain soil and water table conditions, and current methods of system installation are polluting state groundwater" (Chapter 381.273 (3), Florida Statutes). Since the project began, a series of studies have been completed which addressed the concerns of the legislature. This is the final investigative phase of the project prior to making recommendations for improved OSDS practices in Florida.

This phase of the research was conducted to investigate the wastewater treatment capabilities of fine sandy soils common to Florida under controlled experimental conditions in the field. Field studies of existing subdivisions and individual OSDS were conducted previously to address OSDS treatment effectiveness and potential impacts to ground and surface water (Ayres Associates, 1989, 1993). However, the data generated during field studies of existing systems often were inconsistent due to variable wastewater and groundwater flow and characteristics in the field. Controlled experimental work by other investigators has been conducted using laboratory soil columns primarily, but field conditions can not typically be duplicated in the laboratory. This is particularly true in Florida where heavy thunderstorms, which are not easily simulated in the laboratory, may be affecting treatment performance on the very porous sandy soils. Therefore, a field study on natural soils was proposed that maintained control over selected variables important to evaluation of treatment capability. A field research station was designed and constructed to accomplish these objectives.

1.1 OBJECTIVES

The objective of this phase of the research was to determine the capability of a major Florida soil (fine sand) to accept and treat septic tank effluent under unsaturated conditions. This included determination of the effects of unsaturated soil thickness (separation distance from infiltration system bottom to groundwater) and wastewater hydraulic loading rate on the soil treatment capability.

1.2 SCOPE OF WORK

To accomplish this objective, a field research facility was designed, constructed and operated under controlled conditions. Replicated *in-situ* soil infiltration cells, or lysimeters, were designed so that treatment performance at two wastewater hydraulic loading rates and two unsaturated soil thicknesses could be monitored simultaneously with the same wastewater on the same soil over time. Detailed soils characterization was conducted and changes in soil physical/chemical characteristics were monitored with time. In addition, monitoring of temperature, humidity, and rainfall were conducted to aid in interpretation of the results.

This report describes the lysimeter site selection and characterization, facility design and construction, investigative methodology, and results of the lysimeter facility monitoring for the first six months of operation. Finally, conclusions are presented based on the monitoring to date and recommendations are made for future research at the lysimeter station.

SECTION 2.0
SITE SELECTION AND CHARACTERIZATION

2.1 SITE SELECTION

Numerous criteria were established for selection of a site suitable for construction and operation of the lysimeter research facility. The basic criteria consisted of the following:

- Soil conditions which typify those in which a significant number of OSDS are installed in Florida. Based on previous phases of the research, a fine sand was specified. To minimize variation in the treatability data to be collected, a uniform fine sand with little or no horizonation was desired.

- Depth to groundwater greater than ten feet below grade to allow construction of the facility to approximately eight feet below grade.

- A site of at least 1/4 acre in size.

- A reliable source of typical domestic septic tank effluent (STE) within a reasonable distance of the facility.

- STE of sufficient quantity to supply the facility experimental needs.

- A landowner amenable to research facility construction and monitoring access for a period of 2 to 3 years.

- A site within reasonable travel distance from the project office to minimize monitoring time.

Location of a site which met the above criteria proved difficult. Numerous HRS properties such as childrens homes, detention centers, and others, were inspected for potential sites but none were suitable. Eventually, a site at the University of South Florida (USF) in Tampa was located which met most of the criteria established above. An agreement was reached with USF to construct the facility and detailed site characterization and facility design was subsequently begun.

2.2 SITE LOCATION

The site selected was located on the far east side of the USF Tampa campus, between Sycamore and 50th streets. The campus athletic fields are located immediately west of the site and a group of University Christian centers and campus ministries are located to the north. The Christian centers utilized conventional septic tank systems for wastewater treatment and disposal and thus provided a source of septic tank effluent for the research facility. The Episcopal University Center (EUC), located approximately 600 feet north of the research site, was chosen for a STE source as it housed three to four University students and contained kitchen and clotheswashing facilities. Figure 2.2.1 shows a general location map of the area.

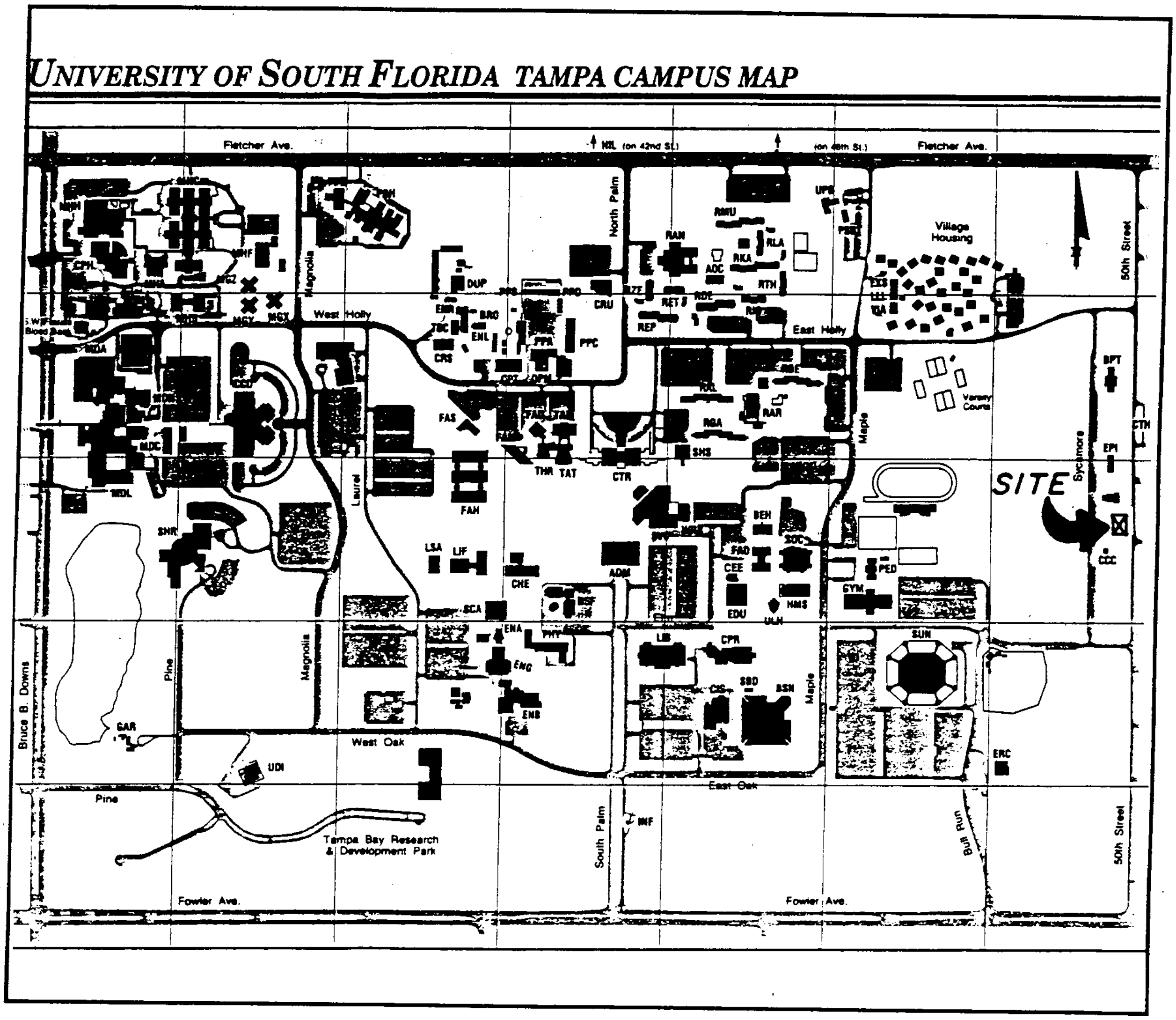

Figure 2.2.1. General Location Map of Lysimeter Research Station Site.

2.3 SITE CHARACTERIZATION

2.3.1 Topography and Drainage

The selected site was approximately 1/3 acre in size in an "L" shaped configuration. Figure 2.3.1 shows the research facility layout and the site topography and drainage.

The site has a slope of 1 to 2 percent towards the west-northwest, which results in 1 to 2 feet of elevation difference across the site. Surface drainage is primarily northwest across the site. A berm was constructed around the east and south sites of the facility to divert this drainage away from the lysimeter station. The orientation of the research facility was based on ground elevations and distance from trees and other vegetation.

2.3.2 Soils Characterization

Detailed characterization of the soils at the lysimeter station was accomplished through description of test pits, laboratory analysis of soil samples and undisturbed soil cores, and *in-situ* soil testing. Ayres Associates was assisted by several Florida soil scientists in performing this portion of the project.

According to the Soil Survey of Hillsborough County, soils at the site were mapped as Candler fine sand by the USDA Soil Conservation Service (USDA SCS, 1989). Candler fine sand is an excessively drained soil usually found in upland areas. Typically, this soil has a surface layer of dark gray fine sand that extends to approximately 6 inches below ground surface (bgs). The subsurface layer extends to a depth of 74 inches. In the upper part of the subsurface, it is a light yellowish brown fine sand and in the lower part it is a very pale brown sand. The next layer to a depth of about 80 inches is a mixture of very pale brown sand and strong brown loamy sand lamellae that are about 1/16 to 1/4 of an inch thick and 2 to 6 inches long. The seasonal high water table of Candler fine sand is at a depth of more than 80 inches. According to Southwest Florida Water Management District well log information obtained in the vicinity, the surface of the groundwater is located more than 20 feet below grade. Permeability of the Candler sand is rapid and the available water capacity is low. According to the soil survey, Candler sand has a slight limitation rating for conventional septic tank systems.

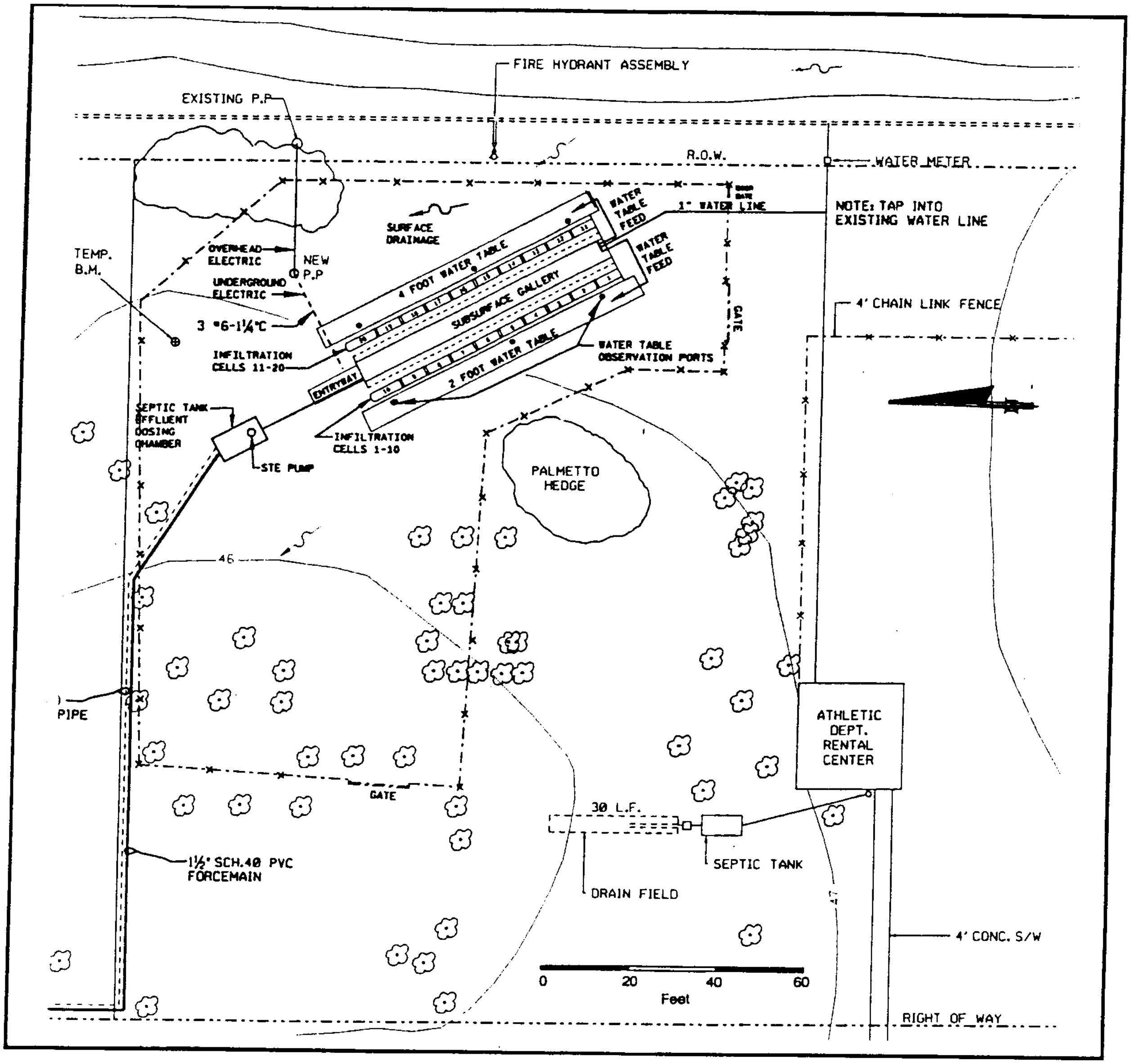

Figure 2.3.1. Lysimeter Research Site Topography and Drainage.

Florida Soil and Environmental Sciences, was retained to describe the soils at the site and to obtain samples for laboratory analyses. Laboratory analyses of soil samples were conducted by the Soil Genesis and Characterization Laboratory at the University of Florida, Institute of Food and Agricultural Sciences (IFAS), under a Sponsored Program Agreement between Ayres Associates and the University of Florida.

Ronald Kuehl and Stanley H. Crownover of Florida Soil and Environmental Sciences excavated three testpits at the lysimeter station on May 8, 1992. See Figure 2.3.2 for the testpit locations. Soil descriptions obtained from the testpits are provided in Appendix A.

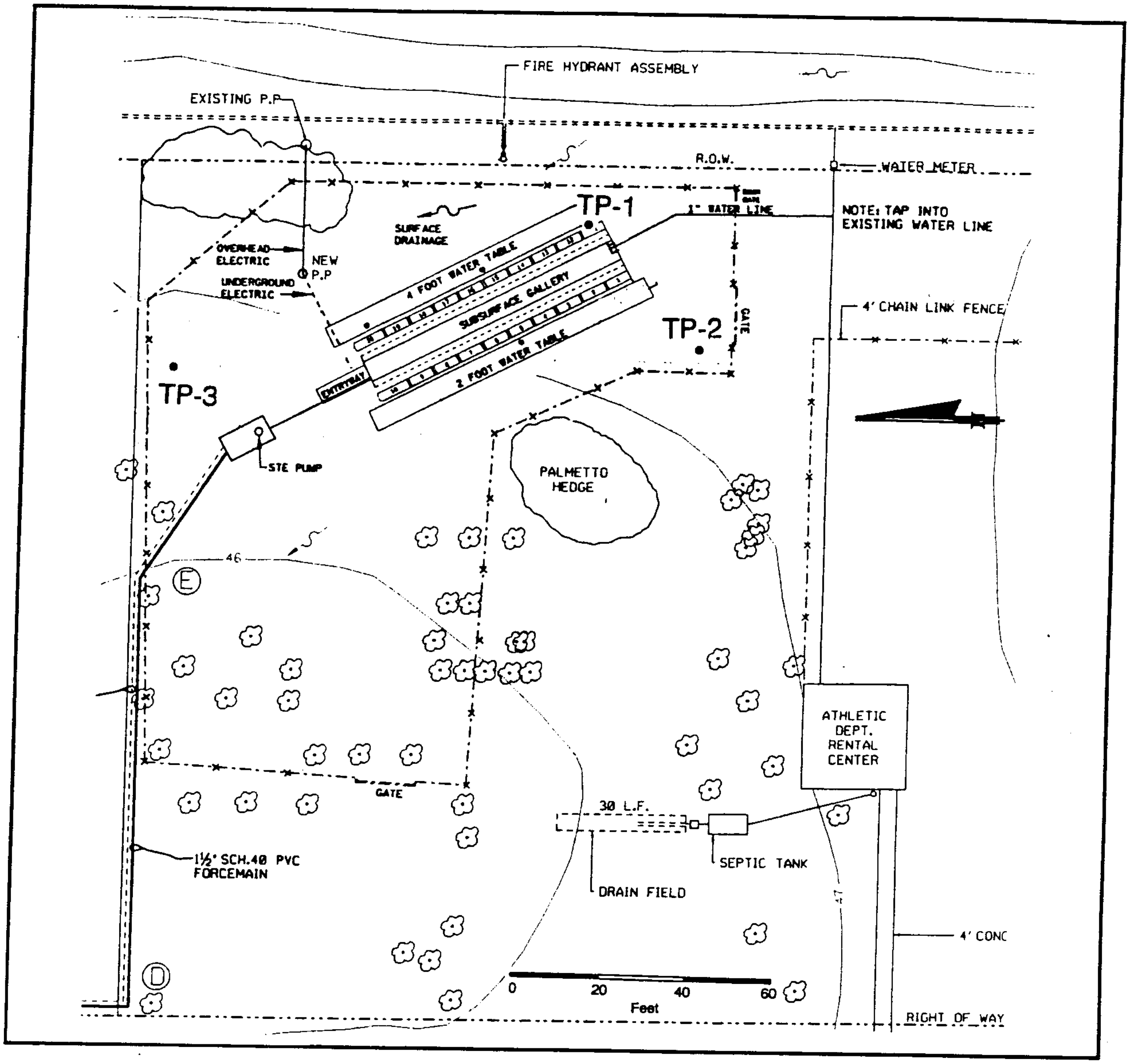

Figure 2.3.2. Soil Testpit Locations at Lysimeter Research Site.

In general, the soil descriptions from the testpits are similar to the profile of Candler fine sand, however, the soil colors described in the subsurface horizons at the testpits appear to be reversed with depth when compared to the soil survey descriptions. No lamellae were observed as is characteristic of Candler fine sand.

Florida Soil and Environmental Services also collected undisturbed soil samples for laboratory analyses. The soil samples were collected at depths that corresponded to a known elevation below the infiltrative surfaces of the wastewater infiltration cells. Personnel from Ayres Associates collected samples at the same depth intervals at testpit 1 for bacteriological analyses. Southern Analytical, Inc. performed the microbiological laboratory analyses. The laboratory analyses performed included:

Physical Characteristics of Soils

- Grain Size Analysis
- Bulk Density
- Soil Water Parameters

Chemical and Microbiological Characteristics of Soils

- Soil pH
- Percent Organic Carbon
- % Calcium Carbonate
- Cation Exchange Capacity (CEC)
- Extractable Aluminum and Iron
- Total Phosphorous
- Clay Mineralogy
- Total Heterotrophic Bacteria
- Fecal Coliform Bacteria
- Fecal Streptococcus Bacteria

The results of the laboratory analyses are summarized by the tables and figures contained in Appendices A and B. A description of the characterization results is given in the following paragraphs.

Physical Characteristics of Soil **--** Grain size analyses were conducted to determine uniformity of the soil, predominant grain size of the soil, and the presence or absence of clay which, in turn, determines many of the hydraulic properties of the soil. The USDA classification of soil separates less than 2.0 mm was used. Appendix A, Table A-1 is a summary of the grain size analyses conducted at the three testpits at various depth intervals. The soils at the site are primarily sand (97.4% to 98.2%). The silt fraction of the samples ranged from 0.1 to 0.5 percent with the highest percentage found at testpit 3 in the sample obtained from 0-1 foot below the infiltrative surface. The clay fraction of the samples ranged from 1.5 to 3.1 percent with the highest percentage encountered at testpit 2 from 1 to 2 feet below the infiltrative surface. Of the sand fraction, 0 percent of the sand fraction was very coarse, 0 to 0.2 percent of the sand was coarse, 2.2 to 3.8 percent of the sand was medium-grained, 70.4 to 74.4 percent was fine-grained and 21.2 to 24.8 percent of the sand fraction was very fine-grained. Grain-size distribution curves for soil samples obtained during construction of the lysimeter station are shown in Figures A-1 through A-3

(Appendix A). The grain size analyses data indicate that soils at the site are very uniform, well sorted and very fine to fine-grained.

Bulk density is used to characterize the density of the solid soil matrix. Bulk density is defined as the mass of dry soil per volume of soil. Table A-2 summarizes the bulk density and saturated hydraulic conductivity values for soils sampled at the lysimeter station. In this case, bulk density was used to determine the similarity of the soil to Candler fine sand and to determine if compaction of the soils occurred during construction at the site. The bulk density of soils at the lysimeter site ranged from 1.46 gm/cm^3 to 1.54 gm/cm^3 which is consistent with literature values recorded for Candler fine sand (USDA, 1989; Kablan et al., 1989). Bulk densities in the area closer to the construction (testpit 1) did not differ significantly from those obtained in the area that remained relatively undisturbed during construction (testpit 2).

Soil water parameters determined included volumetric soil water content and gravimetric soil water content at various pressures and the saturated hydraulic conductivity. Using these parameters, unsaturated hydraulic conductivities, and porosities for the soils were calculated. The unsaturated hydraulic conductivity was determined using a equation that estimates the hydraulic conductivity from pore-size distributions as calculated from the soil-water-characteristic data $\theta(h)$ (Kablan, et al., 1989). Table A-3 lists the soil water parameter data for pressure (soil moisture tension) and percent H_2O volume. Three replicate analyses were conducted on each soil sample. The average of the replicates was used to plot the soil moisture retention curves shown in figures A-4 through A-11 (Appendix A). Figures A-12 through A-19 (Appendix A) are plots of soil moisture tension vs. unsaturated hydraulic conductivity. The soil moisture retention curves and the graphs of unsaturated hydraulic conductivity show the uniformity of particle size and hydraulic properties of the soils with depth. The soil moisture retention curves also show the sudden drop in volumetric water content above a given soil moisture tension typical of a sand with very uniform grain and pore size.

Chemical and Microbiological Characteristics of Soils -- Chemical parameters were determined using the methods found in Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties (1982). Microbiological analyses were performed in accordance with Standard Methods (1989). The results of these analyses are contained in Tables B-1 through B-3 (Appendix B) and are summarized in the following paragraphs.

Soil pH, a measure of the acidity or alkalinity of the soils, may affect chemical transport of anions. Because most minerals are negatively charged at normal pH, anions may be repulsed from the mineral surface and preferentially move to the center of the pore space where they move with the highest water velocity. The pH of the soils at the lysimeter station ranged from 6.2 to 7.0 which is essentially neutral.

The soil organic fraction often has a highly reactive surface that may have properties characteristic of material with a high specific surface area (Jury et al., 1991) and, therefore, would tend to adsorb inorganics affecting solute transport. The percentage of organic carbon in the soil at the site ranged from 0.05 to 0.15 which is very low.

$CaCO_3$ can affect solution and precipitation reactions within the soil. The percentage of $CaCO_3$ in the soils ranged from 0 to 2.2 indicating that solution and/or precipitation reactions and subsequent interaction with inorganics would be negligible.

The extractable aluminum and iron content of the soils is a measure of ligand exchange. Ligand exchange is postulated to occur when the oxygen ions on a hydrous oxide surface are replaced by anions that can coordinate with Al^{3+} and Fe^{3+} ions. At normal (neutral) pH the adsorption of SO_4, NO_3 or Cl is usually negligible. Extractable aluminum and iron was not detectable in any of the soil samples analyzed at the site.

The total phosphorus content of the soils was analyzed. Phosphorus tends to adsorb onto soil particles. If phosphorus were found in the soils it would indicate that some of the available sites for phosphorus adsorption would be occupied leaving fewer sites available for the adsorption, and subsequent attenuation, of phosphorus in the wastewater. Measurable quantities of phosphorus were not detected in the soil samples analyzed.

Clay minerals may have a profound influence on many physical and chemical processes that occur within the unsaturated zone, primarily because of their small size and relatively large and reactive surface area. Also, clay minerals are important in determining the cation exchange capacity (the total quantity of cations that are retained by electrostatic attraction to a negatively charged surface) of a soil. Clay minerals were not found to constitute a large portion of the soils at the site. The primary clay mineral identified through x-ray diffraction, was hydroxy interlayered vermiculite which is a weathering product of schist. Table B-2 lists the minerals identified in the clay fraction and their percentages. The cation exchange capacity (CEC) of vermiculite is the highest of any mineral group, however the low total percentage of clay minerals would indicate that the CEC of the soil as a whole would be low. This is confirmed by the results of the CEC conducted on soils at the site (Appendix B, Table B-1). The CEC of any soil sample obtained was less than 1 meq/g. Approximately 20 percent of the clay fraction was kaolinite, a clay mineral which has a low (generally less than 0.1meq/g) CEC and little isomorphic substitution in its crystal lattice. Seventeen to 26 percent of the clay fraction was gibbsite, an aluminum hydroxide. Eight to thirteen percent of the clay fraction was quartz.

Microbiological analyses were conducted on soils obtained from testpit 1 to determine the background levels of bacteria that normally typify wastewater such as fecal coliform and fecal streptococcus. A total plate count of all bacteria was also conducted. The results are included on Table B-3 (Appendix B). Detectable numbers or colonies of fecal coliform and fecal streptococcus were not observed. The total heterotrophic bacteria counts range from 64,000 CFU/gram at the infiltrative surface to 29,000 CFU/gram 3 to 4 feet below the infiltrative surface.

SECTION 3.0
INVESTIGATION METHODOLOGY

3.1 EXPERIMENTAL DESIGN

Experimentation at the USF Lysimeter Station was designed to evaluate the effect of unsaturated soil thickness and wastewater hydraulic loading rate on the capability of fine sandy soil for treatment of septic tank effluent. The controlled variables in the experiment were wastewater source, soil type, unsaturated soil thickness, and hydraulic loading rate. A single wastewater source typical of domestic septic tank effluent was used for loading the facility. Tap water was used for control experiments. Fine sand was chosen for soil type due to its abundance in Florida and its relatively limited treatment capability compared to finer textured soils. In selecting values for the unsaturated soil thickness and hydraulic loading, it was desired to utilize a range that represented typical conditions in Florida, but that could be changed if necessary based on the results of preliminary stages of research.

The physical design of the lysimeter facility depended on the unsaturated soil thickness chosen for the experimental design. It was decided the design should allow for testing a range of unsaturated soil thicknesses from less than to greater than the 2 foot value required by Chapter 10D-6. A range from 1 to 4 feet was chosen which represented values one-half to twice that currently required and would allow an evaluation of the effects of various depths to a water table below the infiltrative surface.

Similarly, it was desired to test wastewater hydraulic loading rates which ranged from less than to greater than those currently specified in Florida for the fine sandy soil at the study site. The facility was constructed to allow a range from 0 to 1.5 gallons per day per square foot (gpd/ft^2) of infiltration system bottom area.

The experimental facility was designed to allow the range of unsaturated thickness and hydraulic loading rates described above. There were limitations to how many levels of these two variables could be tested simultaneously, however, due to the time and cost associated with measuring the response to each set of experimental conditions. It was decided that the initial experimental setup should include a relatively low and high value of each. Table 3.1.1 summarizes the controlled variables and the values selected for initial investigation.

Table 3.1.1 **Summary of Lysimeter Facility Study Variables.**

Controlled Variables	Study Values Selected
Soil Type	Fine Sand (Quartzipsamment)
Unsaturated Thickness	2 feet and 4 feet
Hydraulic Loading Rate	0.75 gpd/ft^2 and 1.50 gpd/ft^2

The primary response variable which was measured was the quality of soil water or treated effluent and included measurement of total organic carbon (TOC), total kjeldahl nitrogen (TKN), nitrate nitrogen (NO_3-N), total phosphorus (TP), chloride (Cl), surfactants (as methylene blue active substances (MBAS)), fecal coliform (FC), and fecal streptococcus (FS) bacteria, and several other conventional water quality indicators. In addition, soil moisture content, oxidation-reduction potential (ORP), and temperature were measured below the infiltration areas to evaluate soil characteristics. Climatic conditions, such as temperature and rainfall were also measured to better evaluate the treatment data.

3.2 LYSIMETER FACILITY DESIGN, CONSTRUCTION, AND OPERATION

3.2.1 Facility Design and Construction

Once the research site was chosen and surveyed, a detailed facility design was prepared. The primary objectives of the design were to:

- Design a series of infiltration cells identical to a segment of a conventional infiltration system which could be constructed in undisturbed soil.
- Design a sampling gallery which would allow monitoring and sampling of soil and water below the infiltration cells without disturbing the soil unnecessarily.
- Design a STE application system for each infiltration cell which would allow independent hydraulic loading to each cell.

- Develop an artificial water table system which would increase soil moisture near the experimental infiltration cells to near saturation at the desired depth.
- Provide structural, plumbing and electrical drawings and details for construction of the entire facility.

Gallery, Artificial Water Tables, and Infiltration Cells: Figures 3.2.1 and 3.2.2 show a plan view and sectional view, respectively, of the lysimeter station facility at the USF site. Of prime importance for the lysimeter facility function was the maintenance of undisturbed soil conditions in the area where the infiltration cells would eventually be constructed. To facilitate construction, a site survey was made to establish a base line and elevation benchmark for the facility. The lengthwise boundaries of the gallery, infiltration cell area, and artificial water tables were staked and reference lines were set for construction.

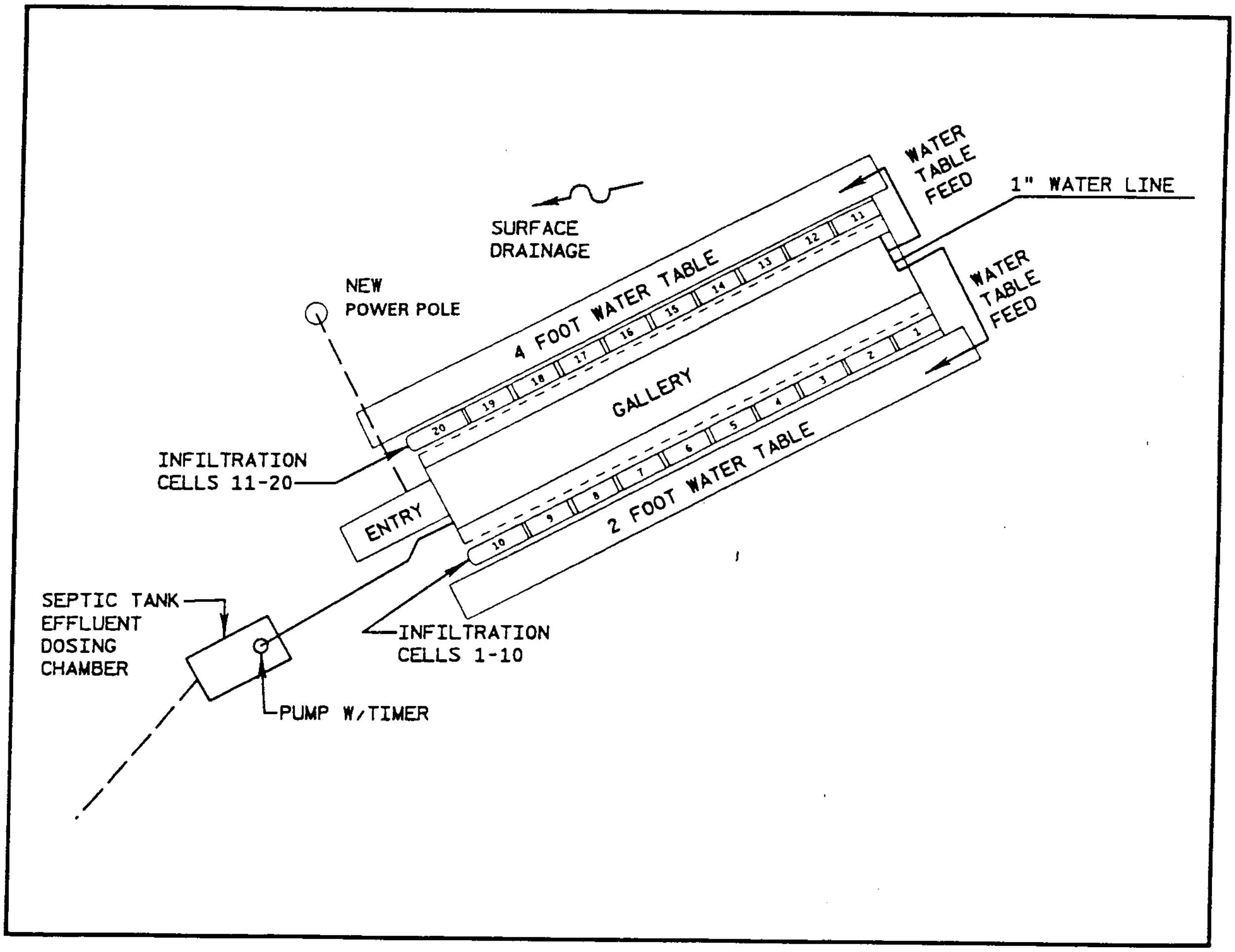

Figure 3.2.1. Plan View of Lysimeter Station Facility.

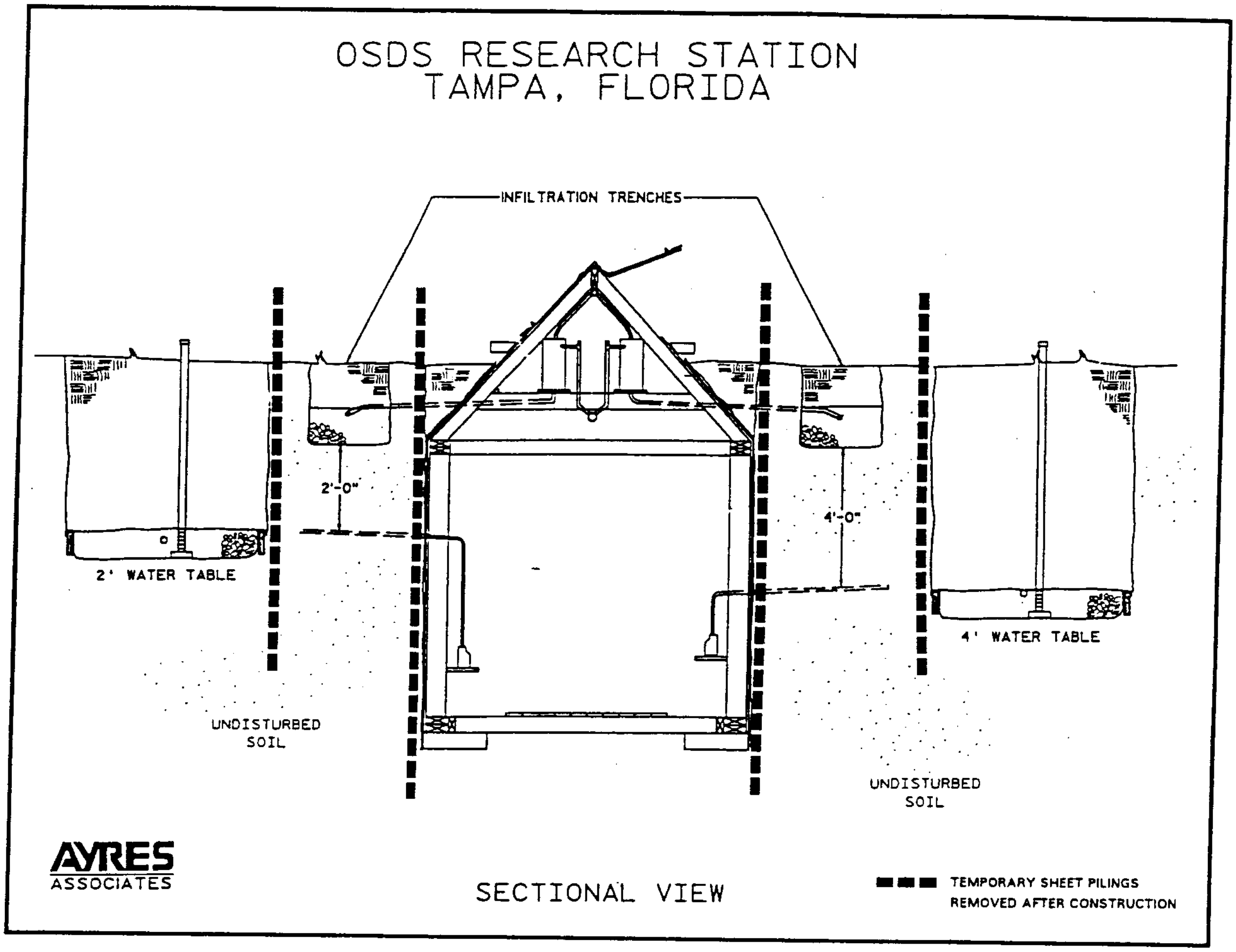

Figure 3.2.2: Sectional View of Lysimeter Station Facility.

Steel sheet-piling was vibrated into place along the reference lines to protect the undisturbed soil area. A total of four parallel 80 foot long rows of sheet piling were installed and left in position while the gallery and artificial water tables were constructed. The 8 foot wide space between the two center rows of pilings was excavated to a depth of 9 feet below grade using a track mounted backhoe. The gallery was constructed within the excavation between these pilings. The gallery was constructed of pressure treated timber. All but the upper 2.5 feet of the structure is located below grade, and the below grade portion is covered with 4 mil plastic film. A stairway was constructed on the northerly end of the gallery for access. The exposed portion of the roof was covered with rolled roofing material and gutters were installed on both sides of the roof along the entire length to divert rainwater and prevent channeling along the sides of the structure below grade.

The two outside rows of sheet piling were installed four feet on either side of the two center rows protecting the gallery structure. This left a four foot by eighty foot strip of soil on each side of the gallery which was to remain undisturbed for construction of the wastewater infiltration cells. On the outside of each of these strips, the area was excavated to install the artificial water tables (See Figures 3.2.1 and 3.2.2). An artificial water table was installed at approximately 6.5 ft below grade on the easterly side of the gallery, and another was installed approximately 4 feet below grade on the westerly side. The installed water tables allow a 4 foot unsaturated zone below the infiltration cells on the east and a 2 foot unsaturated zone on the west.

The area of excavation for the artificial water tables was 6 feet wide and 75 feet long. The bottom of the excavations were leveled and an open bottom box frame of 2 in. by 6 in. treated lumber was constructed in each excavation. The box frame was lined with a 10 mil polypropylene liner which was stapled in position on the top of the box frame to form a water-tight basin. The side of the frame closest to the gallery in each excavation was placed 0.10 feet lower than the other so that water would overflow the basin towards the gallery. The liner was covered with a 1 inch sand layer to prevent punctures. Three vertical observation ports constructed of 4 inch PVC were placed in each water table to measure water table height during the study. The remainder of the box frame was filled with pea gravel containing a 1 inch diameter perforated PVC pipe placed 2 inches into the pea gravel along the entire length of each water table. This pipe was brought to grade with a solid wall pipe and capped for later connection to the water supply. The entire box frame was then covered with a geotextile fabric and the excavation was backfilled to grade with the native materials. The observation ports were cut to extend approximately 3 feet above finished grade and capped.

Once construction of the gallery and water tables was completed, the sheet-piling was pulled out vertically, leaving undisturbed soil next to the gallery walls. Two foot wide wastewater infiltration trenches approximately 55 feet long were constructed on either side of the gallery, approximately 18 inches from the gallery walls. Each of these trenches was divided into eight individual wastewater infiltration cells, separated by a 12 inch barrier divider wall which prevented wastewater movement from one cell to another. Observation ports, similar to those installed in the artificial water tables, were placed on the infiltrative surface of each cell and extended above grade for monitoring of any wastewater ponding occurring in the cells. Aggregate ranging from 3/4 to 1-1/2 in. in size was placed in trenches to a depth of 9 inches. A 6 ft. length of 1 in. diameter Schedule 40 PVC pipe with

3/8 in. holes spaced every 12 in. was centered in each cell to serve as the effluent distribution line. An additional 3 in. of aggregate was installed and the entire trench was covered with a geotextile fabric before the trench areas were backfilled and graded.

The eight infiltration cells on each side of the gallery had separate liquid distribution systems to which loading could be controlled. Thus, sixteen separate infiltration systems could be operated simultaneously, eight next to the 4 foot water table and eight next to the 2 foot water table. In addition, two control cells were established on each side of the gallery to examine the quality of water percolating through the soil. These cells consisted only of a column of natural soil and did not contain a distribution system or gravel.

Water and Wastewater Distribution: To intercept wastewater from the Episcopal University Center (EUC), a 275 gallon pump tank was installed between the existing septic tank and drainfield. The pump tank was installed so that it would remain full and flow by gravity to the drainfield, unless the pump was activated. The 1/3 hp pump was activated by a float control located in a 1050 gallon storage tank installed at the lysimeter station. The second tank served as an effluent supply tank for the research facility and was located 20 ft. north of the gallery entryway. Approximately 550 ft. of 1-1/2 in. Schedule 40 PVC forcemain connects the interceptor pump to the supply tank. The forcemain was installed 2 ft. below grade by a small trenching machine. A second 1/3 hp pump in the supply tank feeds effluent to dosing pots located in the gallery. Water is supplied to the facility by connection to the municipal water system.

A total of sixteen dosing pots were constructed and located in the peak of the gallery to supply predetermined volumes of wastewater or water to each infiltration cell. The dose pots are fabricated from 8 in. diameter Schedule 40 PVC pipe. The 16 in. lengths of pipe were fitted with custom top and bottoms constructed of 1/4 in. thick PVC flat stock. The bottom was epoxied in place to make the dose pot water tight. The dosed liquid is supplied to the infiltration trench cells through a 1 in. Schedule 40 PVC pipe which exits the bottom of the dose pot, through an electrically operated valve, and connects to a 1 in. line that serves the distribution line within the cell. Liquid flows by gravity from the dose pots to the trench cells. Water or effluent are fed into the top of the dosing pots by 3/4 in. and 1-1/4 in. Schedule 40 PVC lines, respectively. Overflow lines of 1 in vinyl tubing conduct excess liquid from the dosing pots to a 1-1/2 in. Schedule 40 PVC drain line which is directed to a small gravel drainfield located approximately 30 ft. northwest of the gallery structure.

3.2.2 Lysimeter Facility Operation

A programmable electronic controller (Allen Bradley Model SLC 150) was used to fill dose pots. Through a series of timer, delay and relay circuits, the controller either switched on the effluent pump, located in the supply tank outside of the gallery, or opened an electric valve on the water supply line. The dose pots were allowed to fill to overflowing at a predetermined liquid level based on the desired loading rate to each cell. A time delay assured that the dose pots remained at the appropriate level until an electric valve was activated which allowed the dose liquid to flow by gravity into the infiltration trench cells.

Wastewater was distributed to the cells 6 times per day on a schedule designed to approximate the loading from a single family home. Doses were applied at 6:00, 7:00, and 8:00 a.m., and noon, 6:00 and 7:00 p.m. each day. On each side of the gallery, 3 cells received 0.75 gpd/ft^2 STE loading and 3 cells received 1.5 gpd/ft^2 STE loading. The remaining two cells received tap water, one at each loading rate, on the same loading schedule as the STE cells. These cells were used as additional controls to examine effects which were not related to wastewater loading. Thus, the experimental conditions consisted of the following: triplicate STE cells at 0.75 gpd/ft^2 and 1.50 gpd/ft^2 with a two foot unsaturated zone, triplicate STE cells at 0.75 gpd/ft^2 and 1.50 gpd/ft^2 with a 4 foot unsaturated zone, one tap water cell at each loading rate and unsaturated thickness, and two natural cells at each unsaturated thickness. These conditions, summarized in Table 3.2.1, allowed an evaluation of STE treatment capability of the soil as a function of unsaturated thickness and wastewater loading rate.

Table 3.2.1. Summary of Lysimeter Station Experimental Conditions.

Number of Infiltration Cells	Unsaturated Thickness (ft.)	Loading Rate (gpd/ft^2)	Loading Type
3	2	0.75	STE
3	2	1.50	STE
1	2	0.75	Water
1	2	1.50	Water
2	2	0.00	None
3	4	0.75	STE
3	4	1.50	STE
1	4	0.75	Water
1	4	1.50	Water
2	4	0.00	None

The twenty infiltration cells that were constructed were randomly assigned the experimental conditions listed in Table 3.2.1. The exception was the natural soil control cells which were not loaded. These cells were purposely placed at the end of each row of infiltration cells to avoid placing a dry soil column in between loading cells thus affecting soil moisture conditions in the loaded cells. Table 3.3.1 and 3.3.2 show the result of the random assignment of cell conditions and the locations of all monitoring equipment within the cells.

Table 3.3.1 USF Lysimeter Study Experimental Plan for Cells with Two Feet of Unsaturated Soil.

	Cell Number									
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Water Type	None	STE	STE	Water	STE	STE	Water	STE	STE	None
Hydraulic Load (gpd/ft^2)	0	0.75	1.5	0.75	0.75	1.5	1.5	0.75	1.5	0
Instrumentation										
Pan Soil Water Sampler	X	X	X	X	X	X	X	X	X	X
Infiltration Cell Observation Ports		X	X	X	X	X	X	X	X	
Ceramic Soil Water Sampler										
1.0 feet			X		X	X		X		
2.0 feet			X	X	X	X	X	X		X
3.0 feet										
4.0 feet										
Soil Moisture Tensiometers										
0.5 feet			X	X	X	X	X	X		X
1.0 feet			X		X					
2.0 feet			X		X					
4.0 feet										
Oxidation/Reduction Probe										
0.5 feet			X	X	X		X			X
1.0 feet			X		X					
2.0 feet			X		X					
4.0 feet										
Thermometer										
0.5 feet						X				X
2.0 feet						X				X
4.0 feet										

Table 3.3.2 USF Lysimeter Study Experimental Plan for Cells with Four Feet of Unsaturated Soil.

Variables	Cell Number 11	12	13	14	15	16	17	18	19	20
Water Type	None	STE	STE	STE	STE	Water	STE	STE	Water	None
Hydraulic Load (gpd/ft^2)	0	1.5	0.75	1.5	0.75	1.5	0.75	1.5	0.75	0
Instrumentation										
Pan Soil Water Sampler	X	X	X	X	X	X	X	X	X	X
Observation Ports		X	X	X	X	X	X	X	X	
Ceramic Soil Water Sampler										
1.0 feet			X	X	X			X		
2.0 feet	X		X	X	X	X		X	X	
3.0 feet			X	X	X			X		
4.0 feet	X		X	X	X	X		X	X	
Soil Moisture Tensiometers										
0.5 feet	X		X	X	X	X		X	X	
1.0 feet				X	X					
2.0 feet			X	X	X			X		
4.0 feet				X	X					
Oxidation/Reduction Probe										
0.5 feet			X	X		X			X	
1.0 feet										
2.0 feet			X	X						
4.0 feet			X	X						
Thermometer										
0.5 feet				X						
2.0 feet				X						
4.0 feet				X						

3.3 MONITORING EQUIPMENT

Several instruments, including stainless steel bi-metal thermometers, porous ceramic soil water samplers, soil moisture tensiometers and multiple mercury manometers, oxidation/reduction probes, and stainless steel pan soil water samplers, were used to monitor the unsaturated zone characteristics of the site. Two types of soil water samplers were used at the lysimeter station. Stainless steel pan soil water samplers were intended to collect a pressure free soil water sample for virus and volatile organic analysis. Porous ceramic soil water samplers were used to obtain additional soil water samples from the desired unsaturated depth even if complete saturation was not reached in the soil above the pans. Stainless steel pan soil water samplers were installed in all twenty infiltration cells of the lysimeter station. The following section describes individual monitoring and sampling devices used at the research station and how these devices were installed and calibrated (if necessary).

Monitoring and sampling devices were decontaminated prior to their installation. Immediately prior to their installation, soil temperature probes and tensiometers were rinsed twice with tap water, once with a dilute chlorine (Clorox) solution, and then rinsed with copious amounts of distilled water. Soil water sampler tubes and associated "O" rings and extraction caps were rinsed with tap water then a dilute chlorine solution and a final distilled water rinse. The chlorine solution was also drawn through each of the soil water sampler's porous ceramic cups followed by a distilled water rinse which was also drawn through the cups. Soil water sampler tubes, ceramic cups, extraction caps, and associated "O" ring seals were then air dried, assembled and wrapped in aluminum foil until installation.

3.3.1 Stainless Steel Pan Soil Water Samplers

Stainless steel pan soil water samplers were designed to collect soil water at the two primary unsaturated depths. The pans were fabricated from 10 gauge 304 stainless steel and were 24 inches wide and 40 inches long with a 2 inch lip on three sides. The pans were creased in the center on the long axis maintaining a 175 degree angle. A 1/4 inch stainless steel tube with slots was welded into the base of the crease. This tube extends several inches past the end of the pan on the gallery side and serves as a conduit for water collected on the pan.

Stainless steel pan soil water samplers were installed below each individual infiltration cell, at the 2 foot level in cells 1 through 10 (shallow water table cells) and at the 4 foot level in cells 11 through 20 (deep water table cells). Stainless steel sampling pans were installed in slots cut in the gallery sidewalls at the desired elevations. The pans were hydraulically jacked into the unsaturated soil beneath the infiltration cells from inside the gallery. Pan orientation was maintained at an approximate 5 percent slope upward to allow water to drain through the collecting tube and into the gallery. The pans extended to within approximately 12 inches of the artificial water tables. Horizontal separation prevent the water tables from flowing onto the pans and diluting the samples. The purpose of the water tables was only to maintain adequate moisture content in the soil to simulate conditions present above a 2 foot or 4 foot water table.

3.3.2 Porous Ceramic Soil Water Samplers

Porous ceramic soil water samplers (*Soilmoisture Equipment Corp.,* Model 1905) were installed directly below the center of the infiltration trench to intercept percolating septic tank effluent at different depths. The samplers consisted of a 36 inch long, transparent acrylic extension tube (7/8 inch outside diameter and 3/8 inch inside diameter) complete with a 4 inch long 1 Bar, high-flow, screw-top porous ceramic cup attached to one end and a screw-top extraction cap to the other. Porous ceramic cups were chosen with the following physical properties: 19 to 28 psi bubbling pressure, 45 percent porosity by volume, and 2.5 um pore size.

Soil water samplers were installed in seven of the cells with 4 feet of unsaturated soil and seven cells with 2 feet of unsaturated soil. See Figure 3.3.1 for the locations of the samplers. Ceramic soil water samplers were installed 2.0 feet below the infiltrative surface of the cell in all fourteen cells. In addition to the 2.0 foot interval, cells 13 (STE, low-loading), 14 (STE, high-loading), 15 (STE, low-loading) and 18 (STE, high-loading) had soil water samplers installed at 1.0, 3.0 and 4.0 feet. Cells 11 (control, no-loading), 16 (water, high-loading) and 19 (water, low-loading) had samplers installed at the 2.0 and 4.0 levels. Cells 3 (STE, high-loading), 5 (STE, low-loading), 6 (STE, high-loading), and 8 (STE, low-loading) had soil water samplers installed at both 1.0 and 2.0 feet.

The proposed installation depths for the soil water samplers were measured from the known elevation of the trench bottom and were marked on the facility's sidewall. A drill with a 1 inch bit was used to drill holes in the wood prior to installation. A 7/8 in. diameter metal insertion tube was then inserted horizontally through the hole. Insertion tubes were hammered into the sidewalls at specified depths below the infiltration surface. The tubes were inserted at a slight downward angle until the porous ceramic tip of the samplers was approximately 30 inches into the soil which corresponded to the midpoint of the infiltration area. The insertion tubes removed a soil core creating a small borehole. Soil water samplers were carefully installed into this borehole using constant hand pressure. The insertion tubes were decontaminated with a dilute chlorine solution and final distilled water rinse between each use. Non-toxic plumbers putty was used to seal the space between the wooden sidewall and the soil water sampler tube.

3.3.3 Soil Moisture Tensiometers and Multiple Mercury Manometers

Soil moisture tensiometers and multiple mercury manometers (*Soilmoisture Equipment Corp.,* Model 2310) were used in conjunction to measure soil moisture tension and to determine moisture content of soil in the unsaturated zone. Tensiometers consisted of a porous ceramic cup attached to a 36 inch long, transparent plastic tube (3/4 inch outside diameter) and a neoprene stopper on the opposite end to seal. Tensiometers, also referred to as cup tubes, were attached with nylon tubing to multiple manometer boards. The multiple manometers had connections for as many as five cup tubes for use as a multiple tensiometer measuring system. Mercury manometer unit scales were graduated directly in millibars of soil suction with 0-850 millibars range. Soil suction could be read to an accuracy of 1 millibar. Each of the five manometer tubes were connected to and measured with the same manometer scale so that direct comparison of the soil suction values could be made. The multiple manometer assembly lends itself to measuring the soil suction values at a given depth in five separate locations or five separate depths at the same location or a combination of the two.

Soil moisture tensiometers were installed in seven of the cells (cells 11, 13, 14, 15, 16, 18, and 19) with four feet of unsaturated soil and seven cells (cells 3, 4, 5, 6, 7, 8, and 10) with two feet of unsaturated soil. Tensiometers were installed 0.5 feet below the infiltrative surface in all fourteen cells. In addition to the 0.5 foot level, cells 14 (high-loading) and 15 (low-loading) had tensiometers installed at the 1.0, 2.0, and 4.0 feet levels, cells 13 (low-loading) and 18 (high-loading) had tensiometers installed at the 2.0 feet, and cells 3 (high-loading) and 5 (low-loading) had tensiometers installed at 1.0 and 2.0 feet. Soil moisture tensiometer installation depths were measured and marked on sidewalls and a drill was used to cut holes in the wood for subsequent installation.

Soil moisture tensiometers were installed in the same manner as the soil water samplers except that the angle and depth of installation was greater, approximately 75° and 32.5 inches, respectively. Multiple manometer boards were mounted on building roof beams and tensiometers were connected according to the assembly instructions. Mercury reservoirs on manometers were filled 3/4 full, approximately 2 ounces of mercury. Tensiometers were filled with recently boiled then cooled water to eliminate dissolved gases which can inhibit the sensitivity of the instrument.

Calibration of the manometer involved adjustment of the millibar scale and correction for relative elevation. The scale adjustment entailed aligning the zero reading on the millibar scale with the top of the mercury in the mercury reservoir. Measurements of the soil moisture content were then read directly from each manometer location in millibars. An additional correction for the millibar readings was calculated based on the difference between the elevation of the porous ceramic tip of the cup tube and the top of the mercury in the mercury reservoir.

3.3.4 Oxidation/Reduction Probes

Oxidation/reduction probes (ORP) were used to determine whether oxidizing or reducing conditions exist in the soil. The probes measure oxidation/reduction (redox) potential in millivolts and are used to evaluate the fate of various chemical parameters in the soil. The ORPs consist of a platinum electrode (Jensen Instruments) and a calomel reference electrode (Fisher Scientific Model 13-620-259). The calomel reference electrode consists of a reference element surrounded by an electrolyte (gelled saturated KCl solution) contained in an outer tube. When immersed in a solution, electrical contact is made between the sample and the electrolyte at an opening located at the end of the electrode. The opening or junction forms a conductive bridge between the reference electrode, sample, and indicating electrode. A gel-filled polymer bodied electrode with a porous polymer junction was used.

Oxidation/reduction probe assemblies were installed in four of the cells (cells 13, 14, 16, and 19) with four feet of unsaturated soil and five cells (cells 3, 4, 5, 7, and 10) with two feet of unsaturated soil. ORPs were installed 0.5 feet below the infiltrative surface in all nine cells. In addition to the 0.5 foot level, cells 14 (high-loading) and 13 (low-loading) had ORPs installed at 2.0, and 4.0 feet, cells 3 (high-loading) and 5 (low-loading) had ORPs installed at 1.0 and 2.0 feet. ORP installation depths were measured and marked on sidewalls and a drill was used to cut holes in the wood for subsequent installation.

The ORP assemblies were installed in a manner similar to the soil water samplers and the soil moisture tensiometers. An insertion tool was used to remove soil cores approximately 30 inches in length. Platinum electrodes were then placed into the borings, and pushed into undisturbed soil approximately 4 inches past the end of the borehole. Calomel reference electrodes were placed within the same borehole and pushed into undisturbed soil approximately 5 inches past the end of the borehole, slightly above the platinum electrodes. Soil was backfilled into the boring and packed tightly around the electrode.

The redox potential of the soils beneath the infiltrative surface was obtained using an Orion Model 290A combination pH/mV/ISE portable meter. Checking redox electrodes is necessary only when there is evidence of a malfunction. To check the integrity of the electrode two solutions are prepared. Solution (A) consists of potassium ferrocyanide and potassium ferricyanide, and Solution (B) consists of potassium ferrocyanide, potassium ferricyanide and potassium fluoride. By placing the electrode into each solution and allowing stabilization a 66 mV increase should be realized in a properly functioning redox electrode.

3.3.5 Stainless Steel Bi-Metal Thermometers

Stainless steel bi-metal thermometers (*Reotemp,* Model A) were used to measure soil temperature. The thermometers were 36 inches long with a bi-metal helix coil sensor located in the bottom 2 in. of the stem. Graduations ranged between -10° to 110°C with 1° divisions. Thermometer accuracy was guaranteed within 1 percent of its full scale.

Soil temperature probes were installed horizontally in cells 6 and 10 at 0.5 feet and 2.0 feet and in cell 14 at 0.5, 2.0, and 4.0 feet below the infiltrative trenches. Cells 6 and 14 were chosen because they were representative of STE high-loading in cells with 2 feet and 4 feet of unsaturated soil, respectively. Cell 10 was a control cell that received no loading. An additional thermometer was installed vertically to a depth of 36 inches 20 feet northwest of the test building to obtain background temperature readings.

3.3.6 Bromide Electrode

An Orion solid-state specific ion electrode and a pH/mV/ISE meter were used during the course of a bromide tracer test. See Section 3.4.6 for bromide tracer test methodology. Calibration for bromide detection was achieved utilizing the Orion Model 290A portable meter connected to an Orion bromide ion specific electrode (ISE) and double junction reference electrode. The integrity of the bromide electrode can be determined by checking the slope of the electrode (mV). The slope of the electrode is determined by placing the electrode into 100 ml solution of distilled water containing 2 ml of ionic strength adjuster (ISA) and in two steps pipeting 1 ml of 1000 ppm bromide standard solution into the distilled water solution. After allowing for stabilization and recording the result an additional 10 ml of 1000 ppm bromide standard is added to the distilled water solution. The difference between the two stabilized readings should be in the range of -54 to -60 mV/decade. Once the slope of the electrode is established and determined to be within range, a three point calibration of the Orion Model 290A is performed. The three point calibration consists of using bromide standards of 10 ppm, 100 ppm, and 1000 ppm.

3.4 DATA COLLECTION AND ANALYSIS

3.4.1 Temperature and Rainfall Data

Weekly rainfall and temperature data were collected from the University of South Florida (USF) Geography Department. These data were recorded by the USF Geography Department utilizing chart recorders attached to a rain gauge and thermometer. Temperature and rainfall data were collected beginning August 3, 1992 and ending March 2, 1993.

3.4.2 Soil Moisture Tension (SMT)

Soil moisture tension data was recorded from the manometers in millibars during sampling events. Soil moisture tension data was collected beginning August 25, 1992 and ending March 2, 1993. Soil moisture tension data was corrected based on the elevation of the ceramic tensiometer cup relative to the top of the mercury reservoir.

3.4.3 Oxidation/Reduction Potential

The oxidation/reduction data of the soils beneath the infiltration surface were collected with the use of an Orion Model 290A portable pH/mV/ISE meter. The readings were taken directly in millivolts (mV) and recorded during sampling events from August 1992 through March 1993. The data were used to determine whether an oxidizing or reducing environment existed beneath the infiltrative surface and to chart changes in oxidation/reduction after the initiation of loading.

3.4.4 Soil Water Sampling

Porous Ceramic Soil Water Samplers -- Water samples were obtained from beneath the infiltrative surface of the cells at various levels using porous ceramic soil water samplers. Soil water was collected under vacuum into a 1 liter glass Erlenmeyer flask. Glass tubing was inserted into a two hole stopper which, in turn, was inserted into the Erlenmeyer flask. Vacuum tubing connected the ceramic soil water sampler to the intake glass tube of the glass sample collection flask. A separate vacuum suction line was connected to the other tube in the stopper. Vacuum pressure was then used to draw the sample from the ceramic soil water sampler into the collection flask. Soil water samples were collected initially with a vacuum hand pump that operated at a maximum of 90 centibars. However, the hand pump proved too time consuming for extracting samples from 26 soil water samplers. An electric laboratory vacuum pump that operated at 0 to 800 millibars was attached through a series of tubing connected to each soil water sampler. Pinch clamps were connected to tubing so that vacuum pressure could be applied to desired cells. The amount of vacuum pressure required to extract soil moisture was determined by the moisture content of the soil, however, vacuum pressures applied rarely exceeded 300 mbars.

Stainless Steel Pan Soil Water Samplers -- Water was collected from the stainless steel pan soil water samplers in a flask. This was achieved by placing a rubber stopper with two glass tubes inserted through the stopper and placing a vacuum tube to one glass tube and attaching the sampler to the other glass tube. The amount of vacuum pressure required to extract soil moisture was generally less than 100 mbars.

3.4.5 Bromide Tracer Testing

A bromide test was initiated at the site on February 5, 1993. Slugs of bromide tracer were prepared by dissolving 500 grams of NaBr in approximately 1 liter of water which resulted a solution which contained 388.2 g/L bromide. This concentrated solution was then apportioned to the dose pots of the infiltration cells in such a way as to yield approximately 10, 000 mg/L bromide to each cell. Five infiltration cells on the 2-foot unsaturated soil side and five infiltration cells on the 4-foot unsaturated soil side were dosed with the bromide tracer. The cells which received tracer slugs are listed below:

2-Foot Unsaturated Zone

Cell 5: Effluent, Low-Loading
Cell 3: Effluent, High-Loading
Cell 4: Water, Low-Loading
Cell 7: Water, High-Loading
Cell 10: Control, No-Loading

4-Foot Unsaturated Zone

Cell 15: Effluent, Low-Loading
Cell 14: Effluent, High-Loading
Cell 19: Water, Low-Loading
Cell 16: Water, High-Loading
Cell 11: Control, No-Loading

The infiltration cells were dosed at approximately 4:30 P.M. on Friday, February 5, 1993. The cells were then monitored approximately every 12 hours until February 12, 1993. Control cell 11 never produced enough water to sample. Control cell 10 produced water samples, however tracer was not detected above background levels in this cell. Bromide concentration was measured directly using an ion selective electrode, a double junction reference electrode and an Orion 290A pH/mV/ISE portable meter.

SECTION 4.0
RESULTS AND DISCUSSION

4.1 LYSIMETER FACILITY OPERATION

After construction of the lysimeter station was completed, the facility was prepared for operation. Initially, the supply tank at the gallery site was filled with tap water and the pump at the EUC was kept in the off position so wastewater would not be pumped to the facility. Therefore, any operational problems could be remedied while the facility was using only tap water. Operation with tap water loading was initiated in June, 1992 and was continued until August, 1992. During this time all electrical circuits, pump operations, valve opening/closing, plumbing connections, and electronic controller operations were checked for proper operation. Numerous problems were discovered in the facility operation and changes were made to ensure proper operation once wastewater loading began. Water supply to the artificial water tables was initiated and initial infiltration rates of the cells were also measured during this start-up period. The installation of all monitoring devices was also completed.

Wastewater dosing was initiated with septic tank effluent (STE) from the EUC on August 25, 1992. Monitoring of STE quality began one week prior, and soil water sampling two weeks after start-up. Meteorological data collection and routine measurements of all monitoring apparatus were also begun at startup.

4.2 WASTEWATER AND TAP WATER QUALITY

Septic tank effluent was sampled nine times during the lysimeter study to establish a baseline of wastewater quality input to the infiltration cells. The tap water supply, which also fed the water control cells, was only sampled three times as the concentrations of most parameters in the municipal supply did not vary appreciably. Results of the STE and tap water sampling are tabulated in Appendix C (Table C-1 and C-2, respectively), and a statistical summary of these results are shown in Table 4.2.1. Average BOD and TSS concentrations were 96 and 39 mg/L, respectively, for STE samples. These values were at the lower end of the range one might expect for domestic STE based on previous studies in Florida (Ayres Associates, 1989). Nitrogen and phosphorus concentrations were in the range reported previously. The total nitrogen concentration of the STE was

Table 4.2.1. **Septic Tank Effluent and Tap Water Quality Summary**

Parameter	Septic Tank Effluent				Tap Water			
	mean	st. dev.	range	n	mean	st. dev.	range	n
BOD_5 (mg/L)	96.4	34.6	46.0 - 156.0	9	<1	n/a	<1 - <1	3
TOC (mg/L)	49.2	11.8	33.0 - 68.0	9	3.0	0.8	2.1 - 3.6	3
TKN (mg/L)	47.2	5.2	40.0 - 53.0	9	1.4	0.1	1.3 - 1.5	3
Org.-N (mg/L)	6.0	4.2	3.0 - 9.0	2	0.2	0.2	0.1 - 0.3	3
NH_3-N (mg/L)	40.5	3.5	38.0 - 43.0	2	1.2	0.3	1.0 - 1.5	3
NO_3-N (mg/L)	0.04	0.05	0.01 - 0.16	9	0.10	0.10	0.02 - 0.27	3
TP (mg/L)	9.6	3.1	7.2 - 17.0	9	0.03	0.01	0.02 - 0.04	3
MBAS (mg/L)	9.5	4.2	4.6 - 17.0	9	<0.05	n/a	<0.05-<0.05	3
FOG (mg/L)	17.3	12.5	9.8 - 50.0	9	<2	n/a	<2 - <2	2
F. Coli. (log #/100 ml)	4.65	0.57	3.64 - 5.43	9	<1	n/a	<1 - <1	3
F. Strep. (log #/100 ml)	3.47	1.06	1.89 - 5.32	9	<1	n/a	<1 - <1	3
Cl (mg/L)	75.7	20.2	44.0 - 110.0	9	23.3	6.4	16.0 - 28.0	3
SO_4 (mg/L)	217	344	45 - 1100	9	90	66	20 - 150	3
Conductivity (umho/cm)	826	325	330 - 1200	8	493	146	390 - 660	3
pH	7.7	n/a	7.5 - 8.0	9	7.9	n/a	7.8 - 8.0	3
TDS (mg/L)	499	72	400 - 610	9	317	91	222 - 404	3
TSS (mg/L)	39	34	17 - 128	9	1	n/a	<1 - 1	3
VSS (mg/L)	20	4	16 - 23	3	<1	n/a	<1 - <1	2

approximately 47 mg/L, of which approximately 40 mg/L was ammonia nitrogen and the remainder organic nitrogen. Total phosphorus concentration averaged 9.6 mg/L for STE samples. Fecal coliform counts averaged 4.5×10^4 organisms per 100 ml which are similar to previous results but were also slightly lower than typical STE. Overall, the STE was slightly less concentrated than typical residential STE in biodegradable organics, suspended solids, and bacterial numbers, but similar in nutrient concentrations and other parameters.

As expected, the tap water was typical of a municipal water supply. Small concentrations of TOC and nitrogen were detected. Chloride, sulfate, conductivity and total dissolved solids showed the highest concentrations and averaged 23, 90, 493, and 317 mg/L, respectively. The pH of the tap water ranged from 7.8 to 8.0 compared to 7.5 to 8.0 for the STE.

4.3 METEOROLOGICAL CONDITIONS

Meteorological data was collected from a weather station at the USF geography building located approximately 1/4 mile west of the lysimeter station. Ambient temperature, relative humidity, and rainfall was measured continuously and a summary of these data, by day, are included in Appendix D. This section gives a brief summary of the data. Refer to Appendix D for more detail.

Ambient temperature data collected over the study period, in degrees Fahrenheit, are tabulated in Table D-1. Average daily temperatures in the low 80°s with daily lows in the lower 70°s and highs in the upper 80°s to mid 90°s were common the first month of facility operation (September). As the study progressed, average temperatures dropped. In December through February, temperatures averaged in the upper 50°s to lower 60°s, with daily lows in the 40°s and highs in the upper 60°s to lower 70°s.

Humidity data are tabulated in Table D-2, as percent relative humidity. Relative humidity varied during the day from 50 to 90 percent during September and from 40 to 90 percent thereafter. The exception occurred when winter cold fronts moved through the Tampa Bay area, bringing dryer air to the region. Daily humidity levels would then range from 35 to 80 percent.

Rainfall data are summarized in Table D-3. Several weeks with total rainfall in excess of 3 inches occurred in the first two months of facility operation. Rainfall could potentially effect STE treatment at the site and also increase dilution of STE parameters in the soil. The effects of rainfall will be discussed in subsequent sections.

4.4 SOIL PHYSICAL/CHEMICAL CHARACTERISTICS

4.4.1 Soil Moisture

Soil moisture was determined by measuring soil moisture tension (SMT) via the tensiometers installed below the infiltration trenches and referencing the SMT to soil moisture retention curves generated from laboratory tests on undisturbed soil cores. For a given SMT, the moisture retention curve provided an estimate of soil moisture content, as percent by volume. Appendix A contains the soil moisture retention curves and laboratory data for soil samples obtained at the lysimeter site. As discussed in the site characterization section, soil at the site was very uniform in grain size and thus yielded very uniform soil moisture retention curves. Figure 4.4.1 shows soil moisture retention curves with depth below the infiltration cells from TP-1, located near cell 11 (see Table 2.3.1 and 2.3.2 for locations). Table E-1 contains the SMT measurements made over the course of the study at various sub-cell locations.

Soil moisture varied with rainfall as one would expect, but a characteristic moisture trend developed below the cells receiving either water or STE: Soil moisture content was highest at the sampling pans, lowest in the midsection of the soil profile, and somewhere in between those two readings at a depth 0.5 feet below the infiltrative surface. The reason for this is as follows: the top portion of the soil below infiltrative surfaces is relatively moist due to the constant application of wastewater. As the applied liquid percolates downward, it spreads throughout the soil due to the soil matrix potential gradient, and this results in a lower moisture content. Once the liquid nears the sampling pans, moisture content increases due to the impermeable pans. This moisture trend was evident in both the 2 foot thick cells and the 4 foot thick cells.

Although soil moisture increased at the sampling pans, it was realized shortly after startup that it may be difficult to obtain soil water samples from the pans by gravity. It appeared that soil saturation at the pan surface did not occur under the loading and artificial water table conditions initially set up at the facility. It was hoped that a steady state moisture condition would develop below the infiltration trenches with time which would allow saturation on the pans, but this has not occurred after seven months of operation.

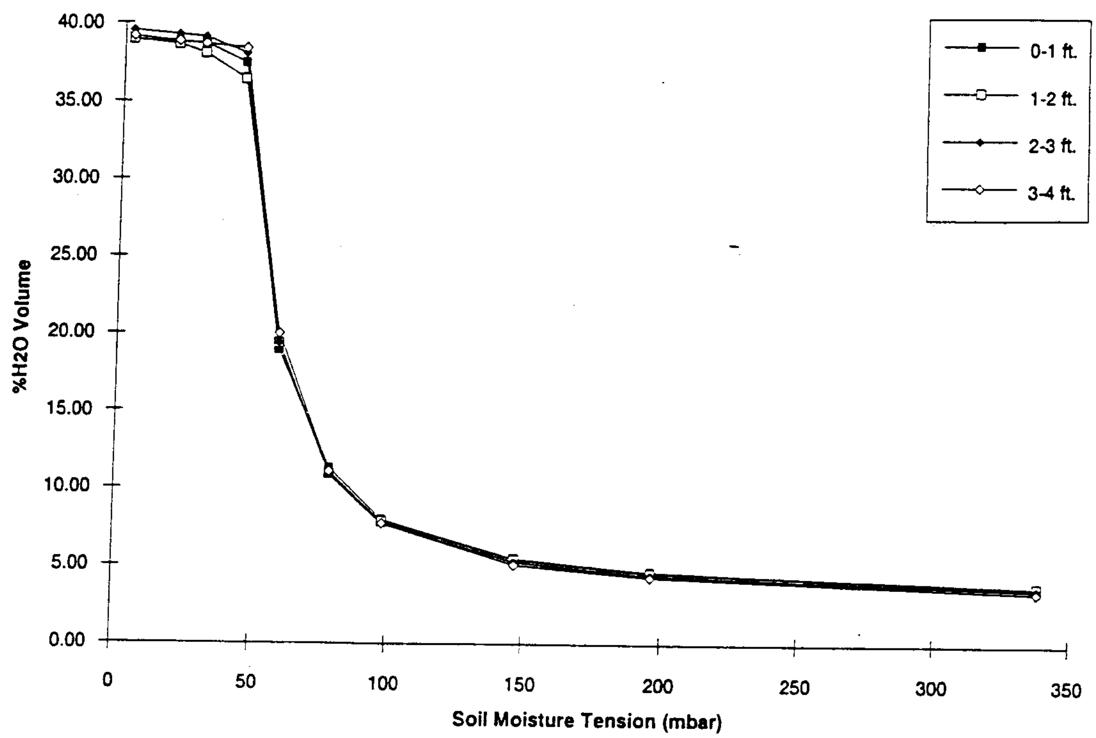

Figure 4.4.1. Soil Moisture Retention Curves for Various Depths Below Infiltrative Surface.

Examination of the soil moisture characteristics at the site explain the reason for this. The soil moisture retention curves on Figure 4.4.1 show four curves for sample depths of 1 - 4 feet below the infiltrative surface. These data show the uniformity of the soils with depth. The curves also show the sudden drop in volumetric water content above a given soil moisture tension typical of a sand with very uniform grain and pore size. Soil moisture tension in soils immediately above the pans under operating conditions was 35 - 40 millibars (mb) at the 2 foot pans and 40 - 45 mb at the 4 foot pans. Comparing this data to the soil moisture retention curves in Figure 4.4.1 indicates that the soil moisture content above the pans was within several percent by volume of saturation, but just enough soil moisture tension remained to hold water in the soil pores.

4.4.2 Soil Oxidation/Reduction Potential

Oxidation/Reduction potential (ORP) was measured in-situ below selected infiltration cells. The ORP measurements are contained in Table E-2 (Appendix E). Figures E1 - E9 show ORP with time since startup for various infiltration cells. ORP measurements prior to lysimeter station startup generally ranged between 350 and 400 millivolts (mv). Once the water tables were filled and water or wastewater loading began, the ORP decreased below the loaded cells due to increased moisture and decreased soil aeration. After the initial decrease, ORP measurements ranged between 250 and 350 mv, changing mostly due to changes in rainfall. Measurements to date have indicated positive ORP, or oxidizing conditions below all cells monitored. In contrast to the loaded cells, the ORP of cell 10, an unloaded control cell, has steadily increased since facility startup. This is because of decreasing rainfall since startup, and subsequent drying and increased aeration of the natural soil.

It was hoped that a relationship between ORP and soil clogging of the infiltrative surface could be determined during this experiment, especially for the high loading rate STE cells. It has been postulated that as increased aerobic biological activity occurs due to wastewater loading, the aeration status of the subsoil environment can change from oxidizing to reducing (Siegrist et. al., 1983; Siegrist et. al., 1985). Unfortunately, the lysimeter experiment was not run long enough to develop any significant clogging in the infiltration cells. Further monitoring should be conducted to evaluate this hypothesis.

4.4.3 Soil Temperature

Soil temperature was measured at various locations in the soil profile below several infiltration cells. Soil temperature was monitored to determine thermal gradients and heat flow within the soil over the study period. It also was used to determine if there is a relation between soil temperature and treatment efficiency. Cell 6, a 2 foot unsaturated zone cell, cell 14, a 4 foot unsaturated zone cell, and cell 10, an unloaded control cell were monitored for soil temperature. The soil temperature measurements are contained in Table E-3. At startup, soil temperature was approximately 28°C at a depth of 0.5 feet below the infiltrative surface and approximately 27°C at depths of 2.0 and 4.0 feet. In cell 10, the unloaded control cell, the soil temperature was the same at the shallow depth but was 26°C at the 2 foot depth. As air temperatures dropped later in the year, soil temperatures also decreased, and reached a minimum in February. At their lowest values, soil temperatures were 17°C. In the 2 foot unsaturated zone cell, the low temperature was similar at the pan and at the 0.5 foot depth, but in the 4 foot unsaturated cell the temperature was higher with depth, from 17°C at 0.5 feet to 18°C at 2.0 feet to 19°C at the 4 foot pan. It appeared that once air temperatures dropped below soil temperatures, the shallower soil profile was most affected by the colder air and heat flow during that time period was upward.

4.4.4 Unsaturated Zone Travel Time

Bromide tracer tests were conducted in one cell for each experimental condition to estimate travel time through the unsaturated zone. The tracer curves relating bromide concentration and time are shown in Figures E-10 and E-11 (Appendix E). Table 4.4.1 summarizes the results of the testing.

Table 4.4.1. Summary of Bromide Tracer Test Results

	Unsaturated Zone Travel Time[1]	
Loading Rate (type)	2 foot unsaturated zone	4 foot unsaturated zone
0.75 gpd/ft^2 (water)	3.0 days	4.8 days
0.75 gpd/ft^2 (STE)	3.0 days	4.0 days
1.50 gpd/ft^2 (water)	3.6 days	3.8 days
1.50 gpd/ft^2 (STE)	3.3 days	3.3 days

[1] Based on time from bromide application to peak bromide concentration at pans.

Estimated travel times were similar between the water and STE loaded cells at both hydraulic loading rates. This would be expected because soil clogging had not yet occurred to any extent in the wastewater cells. At the 0.75 gpd/ft^2 loading rate, the estimated travel time through the 2 foot cells, based on bromide concentrations, was 3.0 days. At the same loading rate in the 4 foot cells, travel time increased to 4.4 days, using the average of the STE and water cells. These estimates would seem reasonable, i.e. a longer travel time for a greater distance. At the 1.50 gpd/ft^2 hydraulic loading rate however, a completely different result was obtained. Both the 2 and 4 foot unsaturated zones yielded similar travel times. In addition, the travel time estimated for the high loaded

2 foot cells was longer than that for the low loaded 2 foot cells. The reason for these results is not clear. Certainly, one would expect the higher loading to reduce travel time, as was the result in the 4 foot cells when loading increased from 0.75 to 1.50 gpd/ft^2. The odd result thus appears to be the high loaded 2 foot cells, which yielded almost the same travel time as the four foot high loaded cells and a lower travel time than the 2 foot low loaded cells. One possible reason for this could be uneven distribution in the infiltration cells which resulted in a longer flow path for the cells in question. It would seem coincidental however that both high loaded 2 foot cells would exhibit this same result. Tracer testing of additional cells should be conducted to better evaluate unsaturated travel time. Also, additional testing should be conducted as soil clogging increases to determine changes in travel time as infiltration systems mature.

4.5 SOIL WATER QUALITY

Soil water samples were obtained routinely from September, 1992 to February, 1993 during this phase of lysimeter station operation. Tables F1 - F20 (Appendix F) include the individual sampling results for each lysimeter infiltration cell.

4.5.1 Porous Ceramic Cup vs. Stainless Steel Pan Soil Water Samplers

Because the stainless steel pan soil water samplers did not yield samples by gravity, the porous ceramic soil water samplers were used for soil water sampling for the first five sampling events. By applying a vacuum on the porous ceramic, the soil moisture tension (i.e. soil suction) was overcome and soil water could be pulled into the sampler. However, the porous ceramic samplers are limited because they provide very small sample volumes (typically < 300 ml per hour) and cannot be used for bacterial sampling. Bacteria potentially can be filtered out by the porous ceramics which is a significant limitation because fecal indicator bacteria were a primary response variable in the experiment. Once sufficient soil moisture data were collected, it was apparent that the soil immediately above the pans was very close to saturation. Therefore, it was decided to apply a very low vacuum to the sampling tubes of the pan lysimeter to attempt to obtain a soil water sample. Based on the SMT data collected at the pans, a vacuum of 50 mb was applied which was successful in releasing soil water for sampling. In fact, far greater quantities of sample could be obtained with this method than from the porous ceramic. Initial samples contained small quantities of soil particles and were turbid, but samples cleared with each sample event. Subsequent samples were taken from the pans with this method.

A comparison of the data between the porous ceramic samplers and the stainless pan samplers was conducted to determine if there were differences between measured water quality. The results for total organic carbon (TOC), nitrate (NO_3), total phosphorus (TP), and chloride were analyzed using a two-tailed Student's t-test at the 95 percent level of significance. The means of the data for each experimental condition were analyzed for each of the above water quality parameters. This resulted in a total of 16 statistical tests, four for each parameter. For example, the mean of the TOC data from the ceramic samplers was compared to the mean of the TOC data from the pan samplers at the following four experimental conditions: 1) the high loading rate, 2 foot cells, 2) the high loading rate, 4 foot cells, 3) the low loading rate, 2 foot cells, and 4) the low loading rate, 4 foot cells.

Of the 16 statistical tests run, 12 indicated acceptance of the null hypothesis that there was no significant difference between water quality obtained from the two sampler types. The four tests that indicated a potential difference were the low loading 2 foot TOC results, the low loading 4 foot NO_3 results, the low loading 4 foot chloride results, and the high loading two foot chloride results. Each of these showed that the pan sampler water quality was significantly less than the ceramic sampler water quality for these parameters. This was a surprising result because it was expected that the TP or TOC data would be most sensitive to differences which existed because of the sampling method and that the NO_3 or chloride results would not be affected by sampler type. A closer look at the data revealed that any potential difference probably was not due to sampler type, but to time trends in the data. In general, the porous ceramic samples were taken early in the study and the pan samples taken later in the study. Since weather conditions and STE quality varied with time, the soil water quality would also be expected to vary. To make a final determination of differences between sampler types, samples need to be taken simultaneously from both devices and compared. This is recommended for future sampling events. For the purposes of this initial assessment of lysimeter facility performance, it was assumed that no difference existed between sampler type for the parameters monitored with the exception of bacteria and suspended materials.

4.5.2 Soil Water Quality Monitoring Assessment

Table 4.5.1 shows preliminary results of the lysimeter station soil water monitoring, key parameters for the study are included. This table is based on the means of the results from the triplicate cells within each experimental condition through the first six months of facility operation. The data from the ceramic suction samplers was combined with that from the stainless steel pan samplers for all except the bacterial analyses. Only pan samples were included for the bacteria results. Septic tank effluent sample results are also shown on the table for each parameter, for comparison. Detailed results for all parameters are contained in Appendix F.

Soil water quality monitoring of the tap water control cells indicated that the soil itself would not contribute to concentrations of the parameters measured as the STE percolated through to the pans, except for TOC. Tap water increased in TOC concentration by approximately 2 to 4 mg/L as it percolated through the natural soil at the site, regardless of loading rate or unsaturated soil thickness. All other parameters in the tap water appeared to pass through relatively unchanged.

The average soil water quality results are interesting when compared to the average quality of the applied STE. These preliminary results indicate significant attenuation of TOC, MBAS, TP, and TKN in both the 2 foot and 4 foot cells. In fact, little difference in attenuation was observed between the two unsaturated zone thicknesses for these parameters. TOC reductions were on the order of 80 percent, while MBAS was reduced by over 99 percent. TKN reductions were in excess of 97 percent indicating almost complete nitrification of the STE nitrogen applied. Total phosphorus was reduced by over 96 percent for all conditions except the high loading 2 foot cells. Since the phosphorus capacity of the soil is limited, phosphorus will eventually "break through" a given unsaturated soil thickness and enter the water table. Continued sampling of the cells should occur so that time to phosphorus breakthrough can be measured and the phosphorus capacity of the soil estimated.

The reductions in concentration discussed above are due in part to dilution of the effluent with natural soil moisture. Based on the reduction in chloride concentrations, which should be due almost entirely to this dilution, it appears that 40 to 45 percent of the reductions stated above may be dilution related. It should be noted that the reduction in chloride in

Table 4.5.1. Summary of Lysimeter Station STE and Soil Water Sampling.

Parameter	Statistics	STE Value	Infiltrative Surface			
			Two Feet Below		Four Feet Below	
			0.75 gpd/ft2	1.5 gpd/ft2	0.75 gpd/ft2	1.5 gpd/ft2
Total Organic Carbon (TOC) mg/L	n	9	28	30	26	25
	mean	49.2	8.2	8.8	8.7	9.3
	s.d.	11.8	3.5	2.9	4.6	3.3
	min	33.0	3.7	3.6	4.4	5.6
	max	68.0	17.0	18.0	25.0	18.0
Fecal Coliform (F. Coli) #/100 ml	n	9	18	18	15	15
	mean	84,556	--	--	--	--
	s.d.	92,953	--	--	--	--
	min	4,400	<1	<1	<1	<1
	max	270,000	<1	<10	<1	<1
Fecal Streptococus (F. Strep.) #/100 ml	n	9	18	18	14	14
	mean	27,909	--	--	--	--
	s.d.	68,518	--	--	--	--
	min	77	<1	<1	<1	<1
	max	210,000	<1	<2	<1	<1
Total Kjeldahl Nitrogen (TKN) mg/L	n	9	29	31	26	25
	mean	47.2	0.78	0.88	0.78	1.19
	s.d.	5.2	0.23	0.29	0.35	0.61
	min	40.0	0.40	0.35	0.25	0.57
	max	53.0	1.40	1.60	2.10	3.50
Nitrate Nitrogen (NO_3-N) mg/L	n	9	29	31	25	25
	mean	0.04	24.4	22.9	14.7	23.5
	s.d.	0.05	10.1	10.4	7.7	6.9
	min	0.01	1.7	0.0	2.0	11.0
	max	0.16	39.0	38.0	29.0	35.0
Total Phosphorus (TP) mg/L	n	9	29	32	26	25
	mean	9.6	0.38	1.23	0.20	0.37
	s.d.	3.1	0.76	1.78	0.36	0.46
	min	7.2	0.01	0.02	0.02	0.02
	max	17.0	3.80	8.80	1.80	2.00
Surfactants (MBAS) mg/L	n	9	27	29	25	25
	mean	9.5	0.05	0.05	0.05	0.05
	s.d.	4.2	0.01	0.01	0.01	0.00
	min	4.6	0.05	0.05	0.05	0.05
	max	17.0	0.08	0.09	0.08	0.06

Table 4.5.1. Continued.

Parameter	Statistics	STE Value	Infiltrative Surface			
			Two Feet Below		Four Feet Below	
			0.75 gpd/ft2	1.5 gpd/ft2	0.75 gpd/ft2	1.5 gpd/ft2
Total Dissolved Solids (TDS) mg/L	n	9	28	30	26	25
	mean	499	470	480	375	501
	s.d.	72	131	129	108	99
	min	400	184	192	200	334
	max	610	620	654	592	656
Chloride (Cl) mg/L	n	9	28	28	25	25
	mean	77	42	44	30	41
	s.d.	20	15	14	12	9
	min	44	9	14	9	22
	max	110	65	65	49	58

the low loaded 4 foot cells is unusually high and was not included in this estimate. The reason for this disparity is unclear.

The nitrification of STE nitrogen discussed above resulted in NO_3 nitrogen concentrations in excess of 20 mg/L at both the 2 foot and 4 foot unsaturated thickness. Although this suggests a reduction in total nitrogen from STE concentrations, it appears that most of this reduction is due to dilution with natural soil moisture as discussed above. Substantial concentrations of NO_3 nitrogen would thus be expected to enter groundwater from onsite wastewater systems in these fine sandy soils.

Once the stainless steel pan samplers were functional, fecal coliform and fecal streptococcus bacterial samples were collected for analyses. No detection of fecal coliform or fecal streptococcus have occurred after six sampling events. It appears that these fecal indicator bacteria have been effectively attenuated in the unsaturated fine sandy soil below the infiltration trenches.

4.5.3 Effects of Study Variables on Treatment

The effects of unsaturated zone thickness and hydraulic loading rate on treatment of the applied STE are somewhat difficult to assess based only on six months of facility operation. Several trends appear to be indicated in this data however which will be discussed here.

Unsaturated Zone Thickness: As mentioned in the previous section, little difference was measured between the 2 foot and 4 foot unsaturated zones, as both provided significant attenuation of the measured parameters which are typically removed by soil. The one exception was total phosphorus, which appeared to be showing signs of breakthrough in the 2 foot STE cells, especially at the higher loading rate. If this is the case, increasing the unsaturated depth from 2 feet to 4 feet would result in an increase in the time until phosphorus would impact groundwater below an OSDS infiltration system. This is not an unexpected result, but further monitoring would allow determination of how much time would be gained by the additional unsaturated zone.

Hydraulic Loading Rate: The effects of loading rate were somewhat contradictory. In the 2 foot unsaturated cells, the STE loading rate showed little effect on soil water quality, except for phosphorus. TOC, MBAS and fecal bacteria removals and nitrification were similarly high at both loading rates. Total phosphorus appeared to breakthrough at the end of the monitoring period at the high loading rate, indicating that the soil may be approaching the limit of its phosphorus removal capabilities, and that the lower loading rate would provide a longer period of phosphorus removal below an infiltration system. In the 4 foot unsaturated cells, loading rate appeared to show more effect. Conservative parameters such as chloride and TDS were higher in soil water four feet below the high loaded cells as compared to the low loaded cells. This would be expected due to a lower dilution effect from precipitation with higher STE applications, but such an effect was not noticed in the 2 foot cells. TOC was slightly higher in the high loaded cells, indicating a potential effect of loading rate. TKN and NO_3 concentrations were also higher, indicating a potential effect of loading on nitrification. These effects were not noticed in the 2 foot cells, making conclusions difficult. TP, MBAS and fecal bacteria were significantly reduced at both loading rates.

Rainfall: Figures F1 - F20 show individual soil water quality results for each sampling date graphically with rainfall measurements. The rainfall shown for each date is the 4-day cumulative total rainfall immediately preceding that sampling date. The four day total was chosen based on the unsaturated zone travel time estimates from the bromide tracer tests, which indicated a 3 to 4 day travel time. The data are somewhat difficult to interpret, but some parameters appeared to show a dilution effect from rainfall. To illustrate, Figures 4.5.1 and 4.5.2 show graphs for nitrate and total phosphorus from the high loaded, two foot unsaturated STE cells. To evaluate these, one must look at the period from 10/21/92 to

1/20/93. Sample dates from 10/21 to 12/21/92 had zero 4-day rainfall totals, and somewhat high concentrations of the two parameters. Sample dates from 12/21/92 to 1/18/93 had increasing 4-day rainfalls, up to almost 2 inches for the 1/18 sampling event, but generally decreasing concentrations of the two parameters. The 1/20/93 sample date had very low 4-day rainfall and concentrations increased again. By 1/27/93 rainfall amounts had increased once more, but the concentrations did not decrease as they had previously, especially for phosphorus. Thus, the effect of rainfall appears to be to dilute sample concentrations in many cases, but not always, and the reason for this is unclear. It is suspected that the intensity and duration of a given storm is the determining factor, and more detailed rainfall data should be collected to determine if this is the case.

Limitations of Lysimeter Station Soil Moisture Status: While the results above show excellent treatment of STE by fine sandy soil, the results need to be evaluated in light of the operational status of the lysimeter station. First, saturated conditions did not form at the pan samplers, and this indicates that the soil below the infiltration trenches may be somewhat drier than would be the case if an actual water table were present at the two and four foot depths. Soil moisture measurements at the pans below the infiltration trench were within several percent of saturation, so the soil was very wet, but not completely saturated. Based on the soil moisture retention data collected from samples at the site, it appears that the lysimeter conditions at present more closely simulate 2 foot and 4 foot distances to a capillary fringe, rather than a true saturated condition. Thus, the reductions in some parameters observed to date may be somewhat higher than would occur with true water table conditions. It is felt that such conditions could be simulated at the lysimeter station with minor modifications to the artificial water table design. Second, the results are based on only 6 months of operation and do not represent a mature system. Results could change once a mature biological zone has established at the infiltrative surface of the cells.

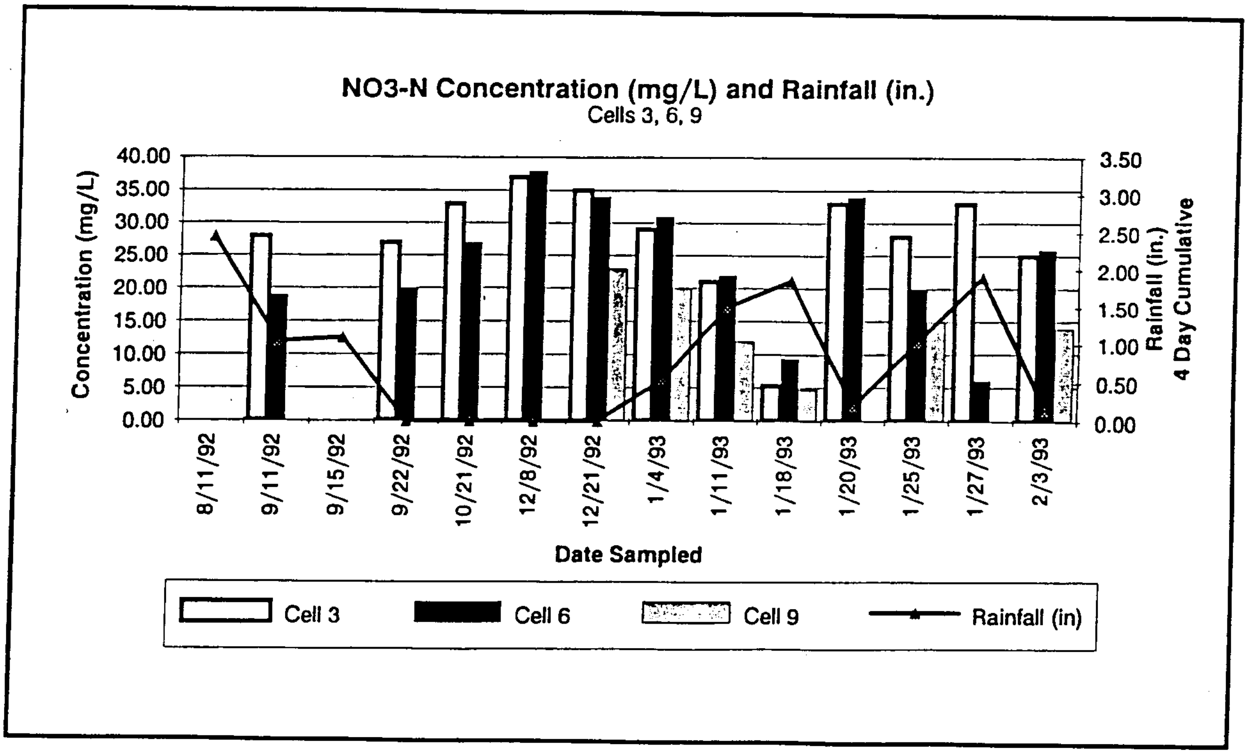

Figure 4.5.1 Nitrate-Nitrogen Concentrations in Soil Water with Sample Date and 4-Day Cumulative Rainfall (Selected Data, See Appendix F).

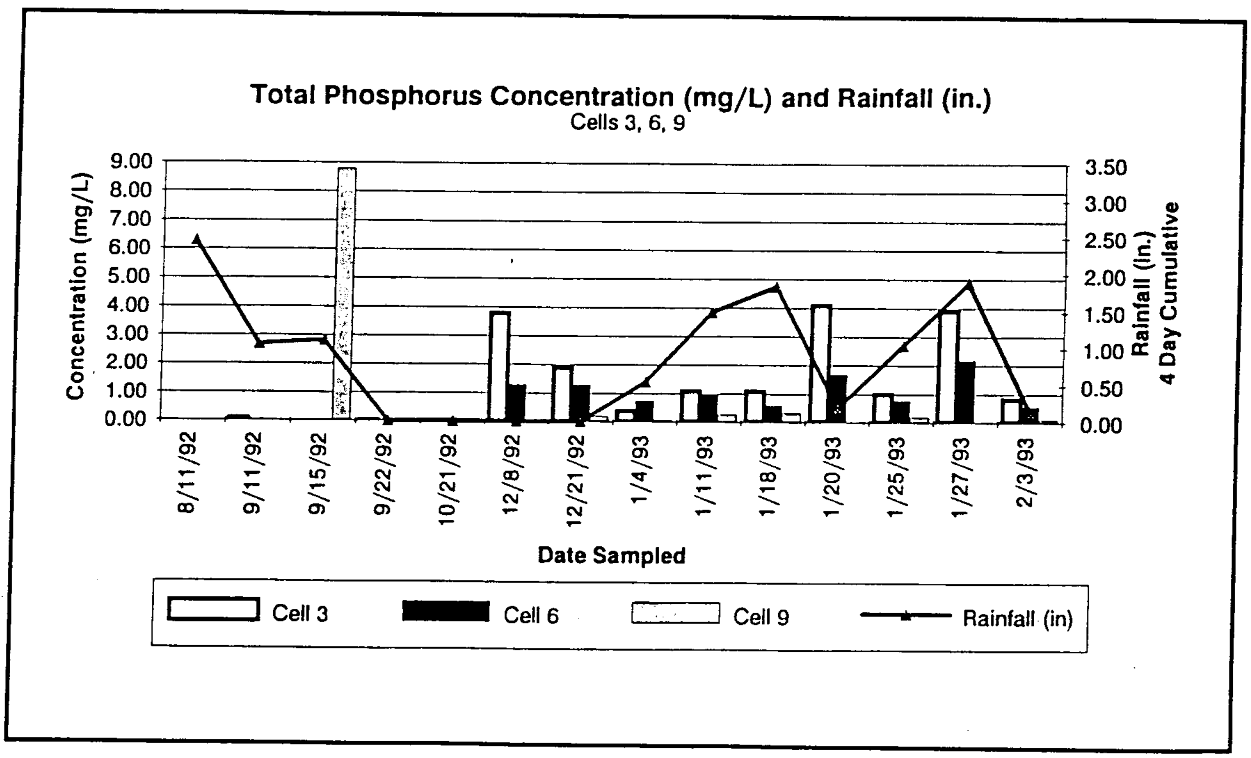

Figure 4.5.2 Total Phosphorus Concentrations in Soil Water with Sample Date and 4-Day Cumulative Rainfall (Selected Data, See Appendix F).

SECTION 5.0
CONCLUSIONS AND RECOMMENDATIONS

The lysimeter facility results presented herein are preliminary and may not represent a mature infiltration system or long-term treatment performance. Based on 6 months of operational data, the preliminary lysimeter facility monitoring showed substantial attenuation of key parameters related to STE treatability in the fine sandy soils. Effective removal of total organic carbon (TOC), surfactants (as MBAS), total phosphorus (TP), and total kjeldahl nitrogen (TKN), were observed at both the 2 foot and 4 foot unsaturated thicknesses. No positive sample results were obtained for fecal coliform or fecal streptococcus bacteria below the infiltration systems, indicating significant attenuation of these fecal indicators in the sandy soil. Nitrate nitrogen (NO_3) was generated from nitrification of the TKN, as expected, and was transported to both the 2 foot and 4 foot depths at relatively high concentrations.

The effects of both unsaturated thickness and hydraulic loading were difficult to interpret due to the effective removal of key parameters at both levels of the variables. However, it appeared that phosphorus removal was effected negatively by less unsaturated zone and greater hydraulic loading. The effect of cumulative rainfall appeared to dilute the sample concentrations, but the data were not consistent and it was hypothesized that the intensity and duration of individual rainfall events may be the most important factor for infiltration system performance related to precipitation.

The results obtained at the lysimeter facility discussed above were also limited by the soil moisture status above the sampling pans. As discussed, the soil moisture status may more closely resemble the capillary fringe above a water table than a true saturated soil condition. Thus, the soil may have been slightly drier than if a true saturated condition existed, and this may have affected the treatment which occurred in the unsaturated zone.

Based on the preliminary results from the lysimeter facility and the short duration of operation and monitoring conducted thus far, it is recommended that additional work be conducted at the facility. The following specific recommendations are made based on experience to date:

1. The short period of facility operation has not allowed the infiltration cells to mature. Clogging of the infiltrative surfaces has not yet developed, and it is recommended that facility operation be continued at existing loading rates until the reduction in infiltrative capacity due to clogging can be measured. This will allow an evaluation of the long-term hydraulic and treatment performance of fine sand as related to wastewater loading rate and system life.

2. The soil moisture above the sampling pans should be increased prior to further sampling. It is recommended that a higher capacity and less expensive source of water be developed to supply the artificial water tables. A higher flow rate to the water tables combined with minor modifications to their design would improve the soil moisture condition.

3. Increased monitoring of the subsoil aeration status should be implemented prior to clogging development so that the relationship between soil aeration and clogging can be better evaluated.

4. Additional tracer testing should be conducted as the infiltration cells mature to better evaluate unsaturated zone travel time and to examine the effects of a mature clogging layer on the travel time.

5. Simultaneous sampling of the porous ceramic soil water samplers and the stainless steel pan samplers should be conducted and an analysis of significant differences made.

6. A detailed assessment of rainfall and sample results should be performed during the upcoming rainy season. Rainfall intensity and duration should be compared to water quality results. Evapotranspiration should also be evaluated at the site, and a detailed water balance conducted to better evaluate dilution.

7. Although significant attenuation of key STE parameters were demonstrated in the fine sandy soil studied, several important parameters remain which were not evaluated as part of this study. Future investigations at the site should include the fate and transport of enterovirus and several common toxic organic compounds. Prior to conducting such an investigation, the ceramic soil water samplers should be replaced with new porous stainless steel soil water samplers at the 2 foot and 4 foot pan depths.

8. The research project described herein represents a beginning to what should be an on-going onsite wastewater treatment system (OWTS) research program in Florida. Continuing research will help to provide answers to many remaining questions regarding the performance and impacts of onsite system practices. It is recommended that future research focus on long-term, detailed studies of single specific systems or controlled experiments in the field and laboratory such as the USF lysimeter station facility.

SECTION 6.0
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APPENDIX A

PHYSICAL CHARACTERISTICS OF SOIL

TABLE A-3. Continued.

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	1-2	
TP2-1	3.5	3.4321	40.86	40.19	40.42	40.49	0.34
(0-1 ft.)	20	19.612	40.28	39.79	40.39	40.15	0.32
	30	29.418	40.1	39.69	40.12	39.97	0.24
	45	44.127	35.12	36.96	38.36	36.81	1.62
	60	58.836	18.38	17.81	19.71	18.63	0.98
	80	78.448	10.26	10.18	10.01	10.15	0.13
	100	98.06	7.13	7.29	6.81	7.08	0.24
	150	147.09	5.08	5.19	4.76	5.01	0.22
	200	196.12	4.41	4.43	4.08	4.31	0.20
	345	338.307	3.68	3.7	3.35	3.58	0.20

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	2-3	
TP2-2	3.5	3.4321	40.96	40.1	38.65	39.90	1.17
(1-2 ft.)	20	19.612	40.9	39.94	38.41	39.75	1.26
	30	29.418	40.86	39.72	38.2	39.59	1.33
	45	44.127	37.22	36.99	38.04	37.42	0.55
	60	58.836	18.14	25.35	17.92	20.47	4.23
	80	78.448	10.23	15.18	10.12	11.84	2.89
	100	98.06	7.47	7.54	7.03	7.35	0.28
	150	147.09	5.39	4.94	4.98	5.10	0.25
	200	196.12	4.75	4.21	4.18	4.38	0.32
	345	338.307	3.9	3.35	3.42	3.56	0.30

NOTE: All depths are measured from the base of the infiltrative surface.

TABLE A-3. Continued.

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	1-2	
TP3-1	3.5	3.4321	41.33	42.13	41.43	41.63	0.44
(0-1 ft.)	20	19.612	41.17	42.12	41.31	41.53	0.51
	30	29.418	41.08	42.07	40.38	41.18	0.85
	45	44.127	30.34	41.37	38.06	36.59	5.66
	60	58.836	17.27	20.34	20.66	19.42	1.87
	80	78.448	10.42	10.85	10.96	10.74	0.29
	100	98.06	7.6	7.49	7.76	7.62	0.14
	150	147.09	5.61	5.35	5.41	5.46	0.14
	200	196.12	4.82	4.67	4.48	4.66	0.17
	345	338.307	4.05	3.8	3.74	3.86	0.16

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	2-3	
TP3-2	3.5	3.4321	40.54	40.82	40.69	40.68	0.14
(1-2 ft.)	20	19.612	40.5	40.79	40.66	40.65	0.15
	30	29.418	40.45	40.79	40.66	40.63	0.17
	45	44.127	38.99	40.61	37.02	38.87	1.80
	60	58.836	19.09	20.99	20.13	20.07	0.95
	80	78.448	11.01	10.56	10.21	10.59	0.40
	100	98.06	8.06	7.38	7.2	7.55	0.45
	150	147.09	5.92	5.17	5.19	5.43	0.43
	200	196.12	5.29	4.5	4.48	4.76	0.46
	345	338.307	4.44	3.74	3.71	3.96	0.41

NOTE: All depths are measured from the base of the infiltrative surface.

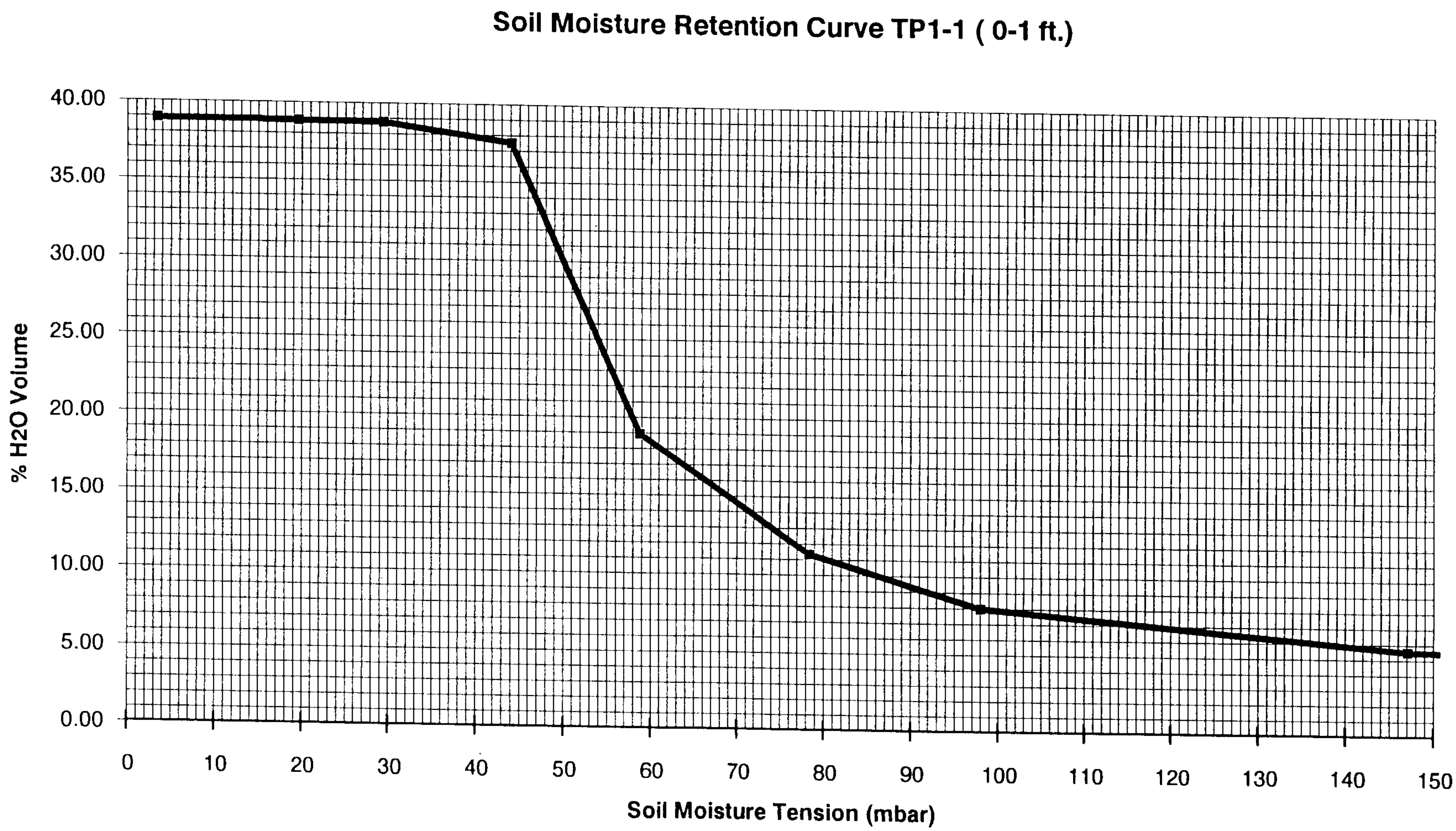


FIGURE A-4. Soil Moisture Tension vs % H2O Volume For Soil Obtained At TP-1 (O-1 Ft. Below Infiltrative Surface).

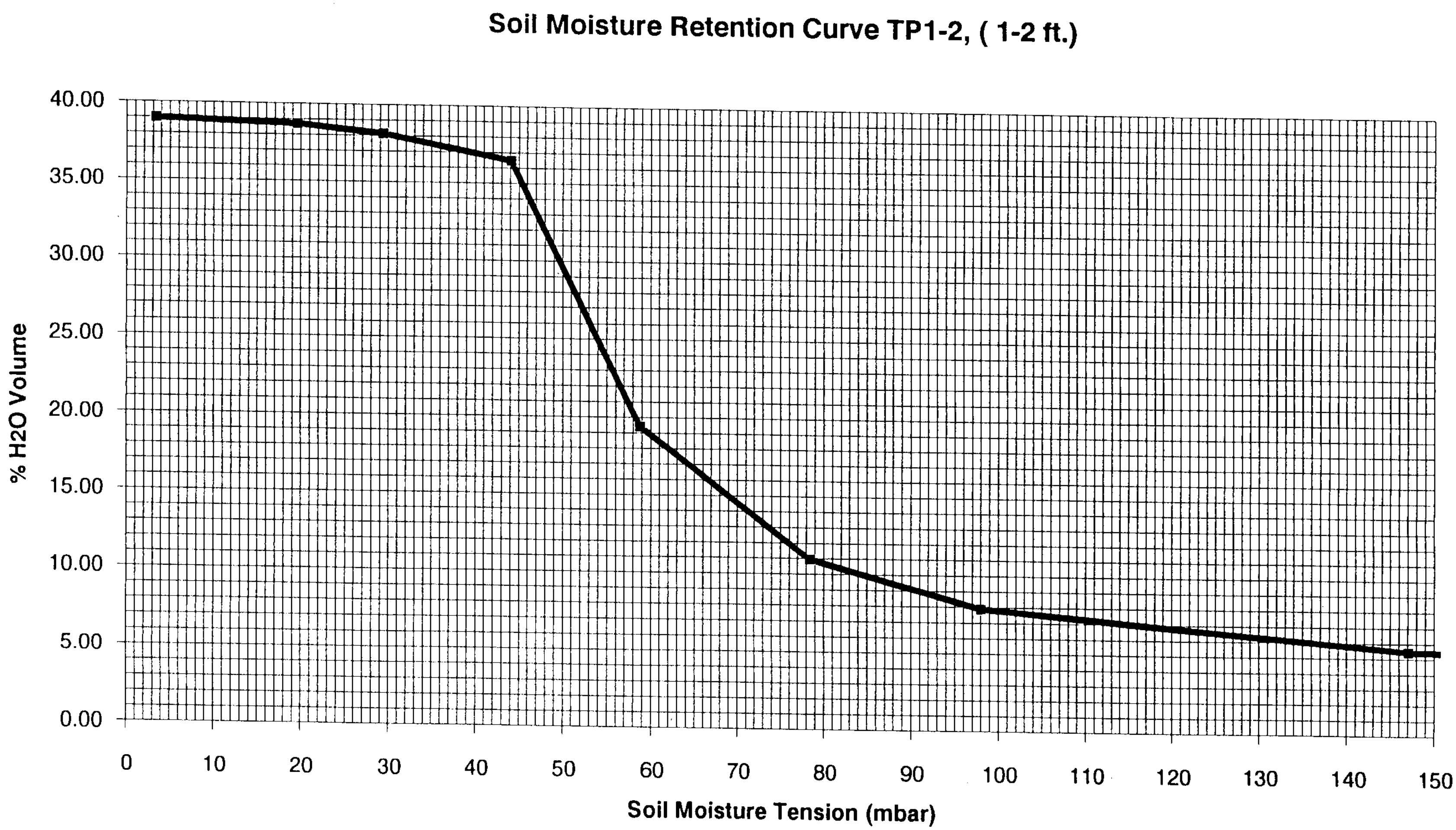


FIGURE A-5. Soil Moisture Tension vs % H2O Volume Obtained For Soil At TP-1 (1-2 Ft. Below The Infiltrative Surface).

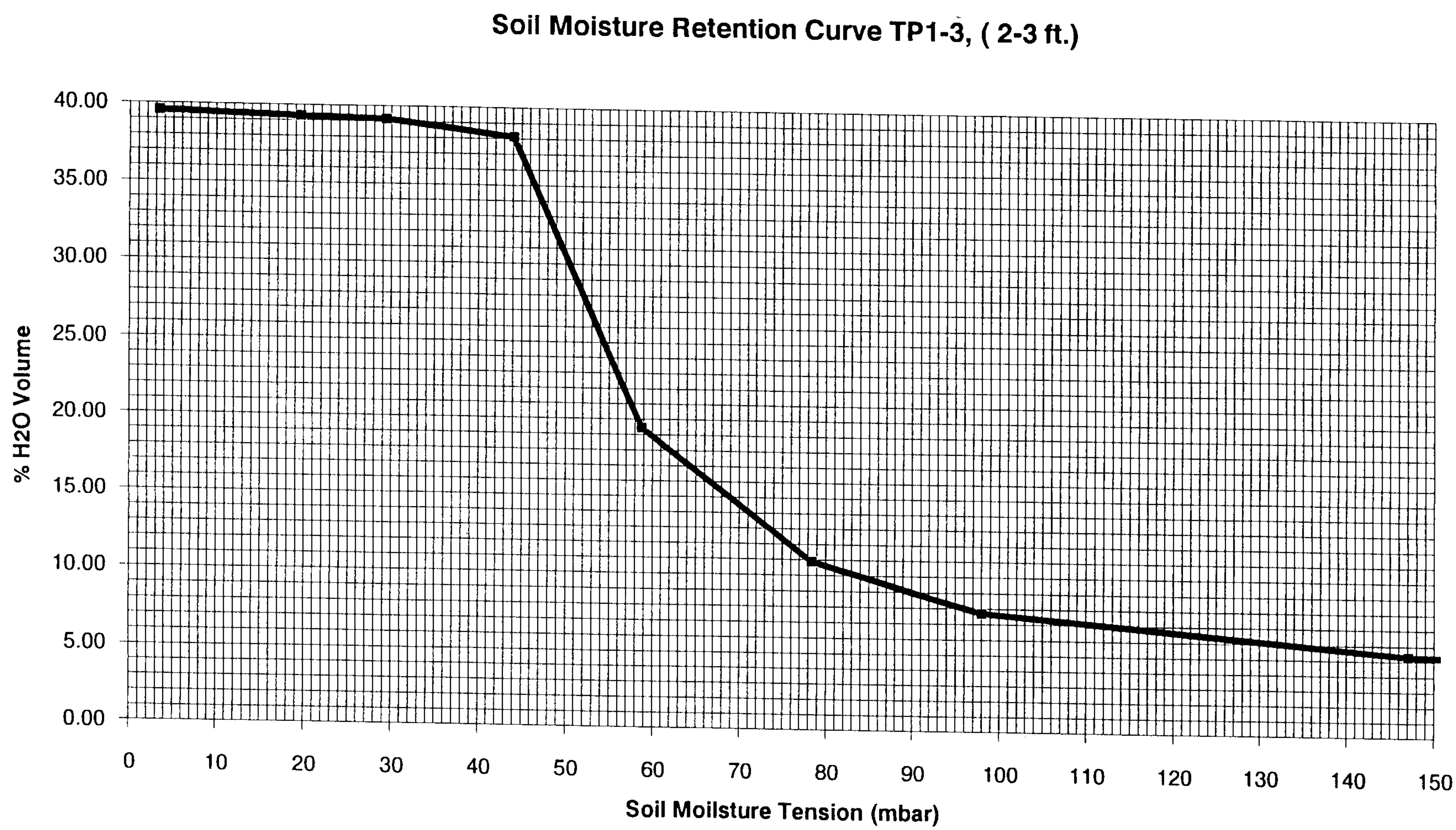


FIGURE A-6. Soil Moisture Tension Vs % H2O For Soil Obtained At TP-1 (2-3 Ft. Below The Infiltrative Surface).

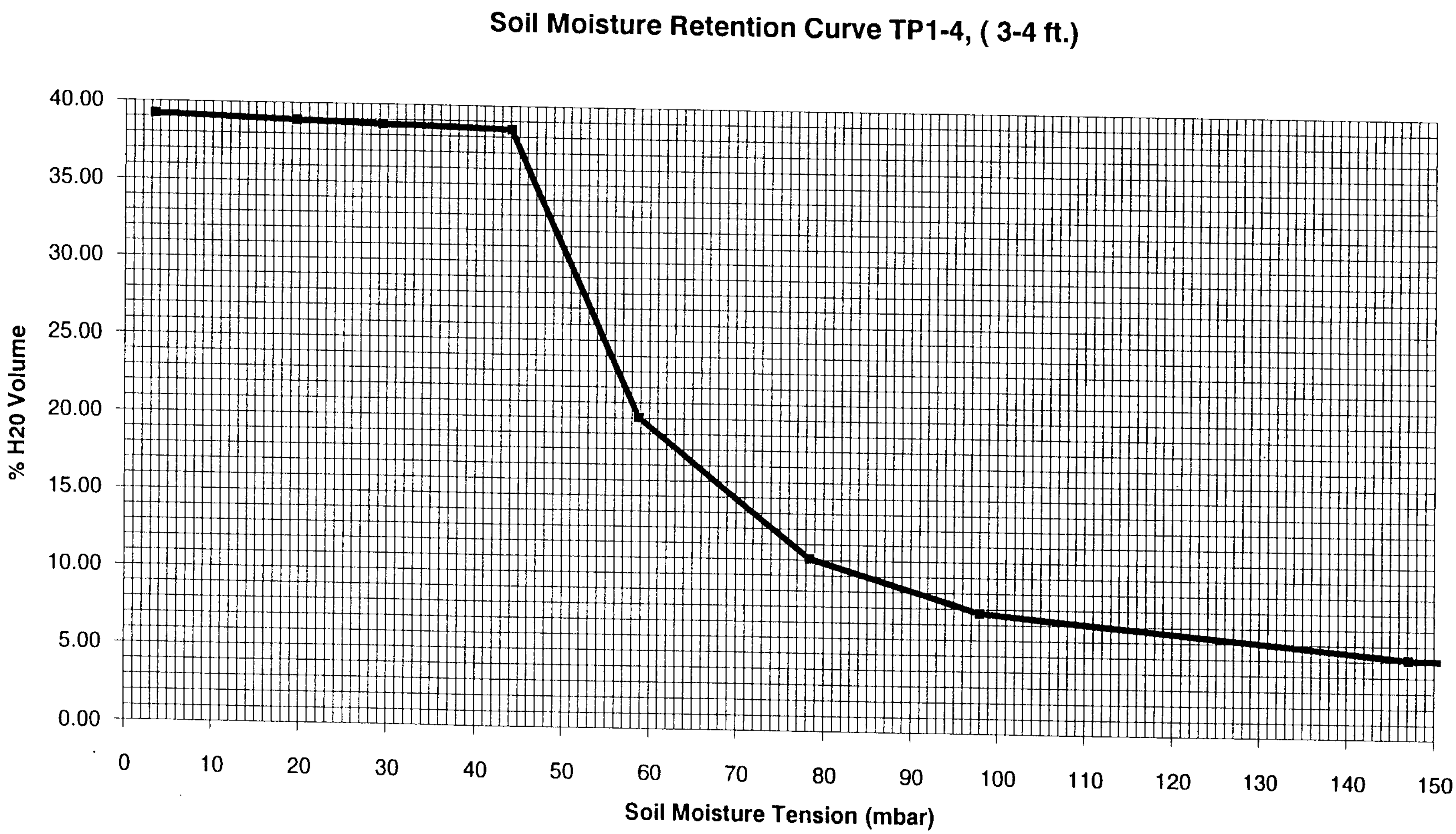


FIGURE A-7. Soil Moisture Tension vs % H2O Volume For Soil Obtained At TP-1 (3-4 Ft. Below The Infiltrative Surface).

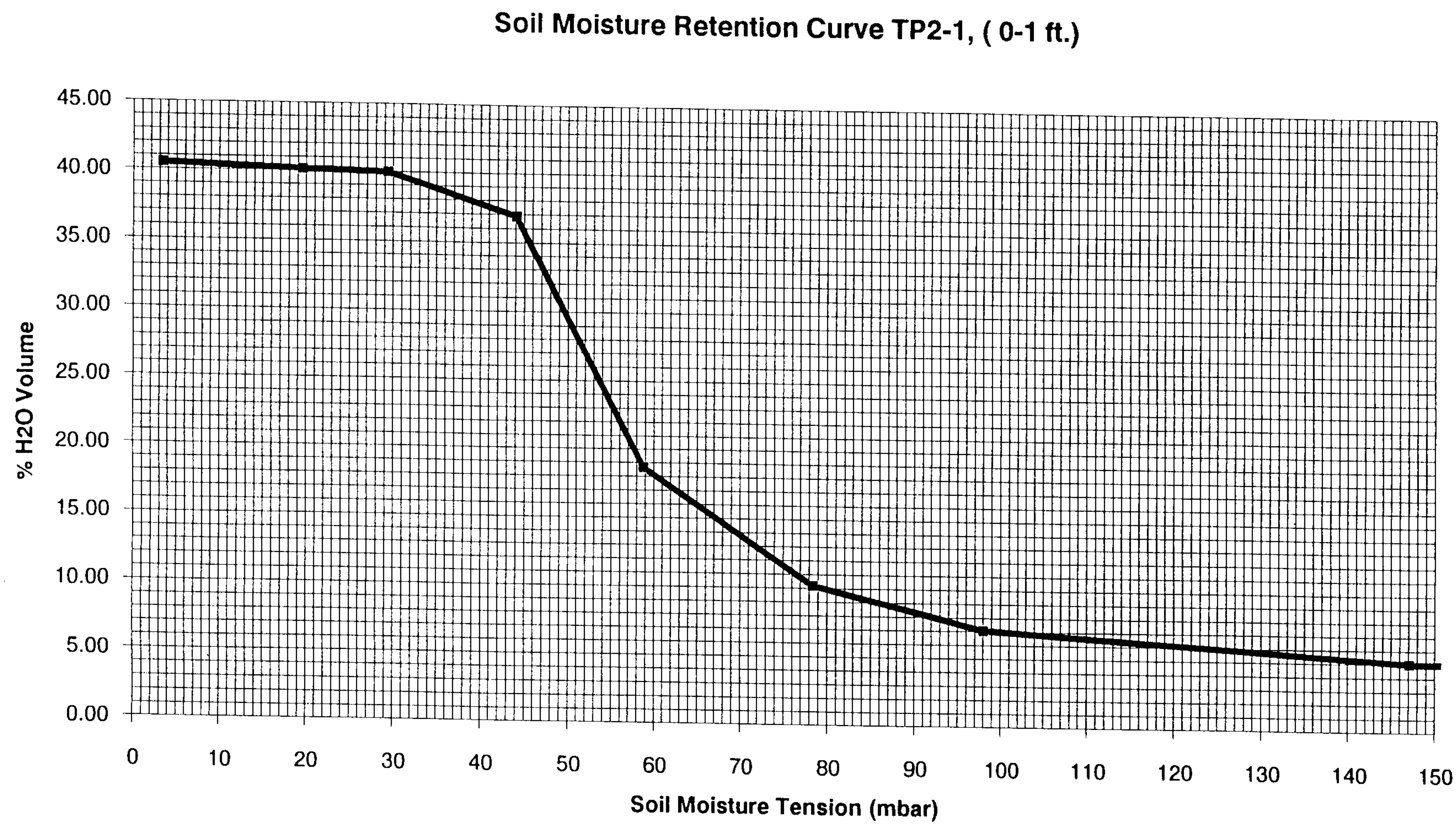


FIGURE A-8. Soil Moisture Tension vs % H_2O Volume For Soil Obtained At TP-2 (0-1 Ft. Below The Infiltrative Surface).

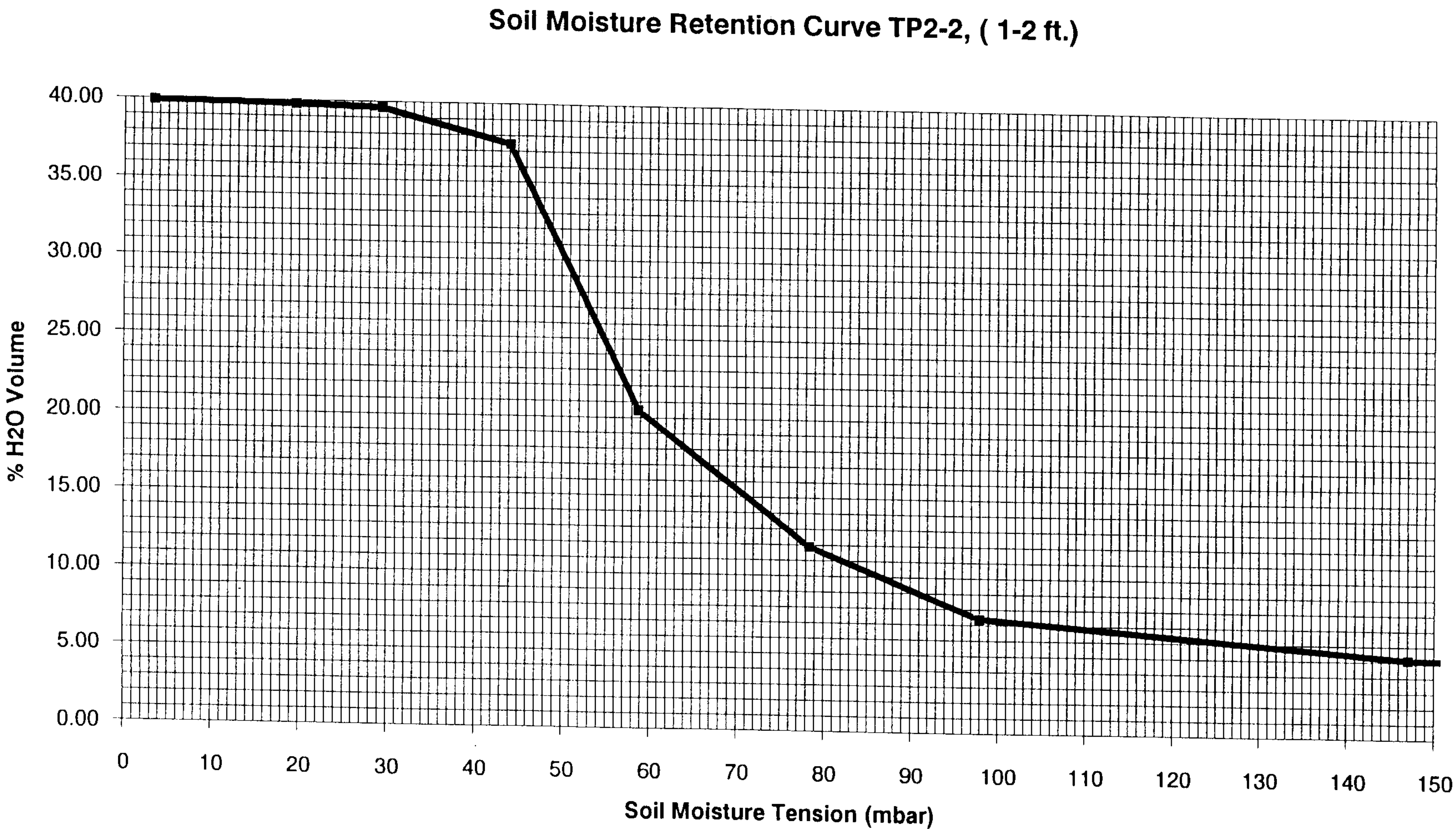


FIGURE A-9. Soil Moisture Tension vs % H_2O Volume For Soil Obtained At TP-2 (1-2 Ft. Below The Infiltrative Surface).

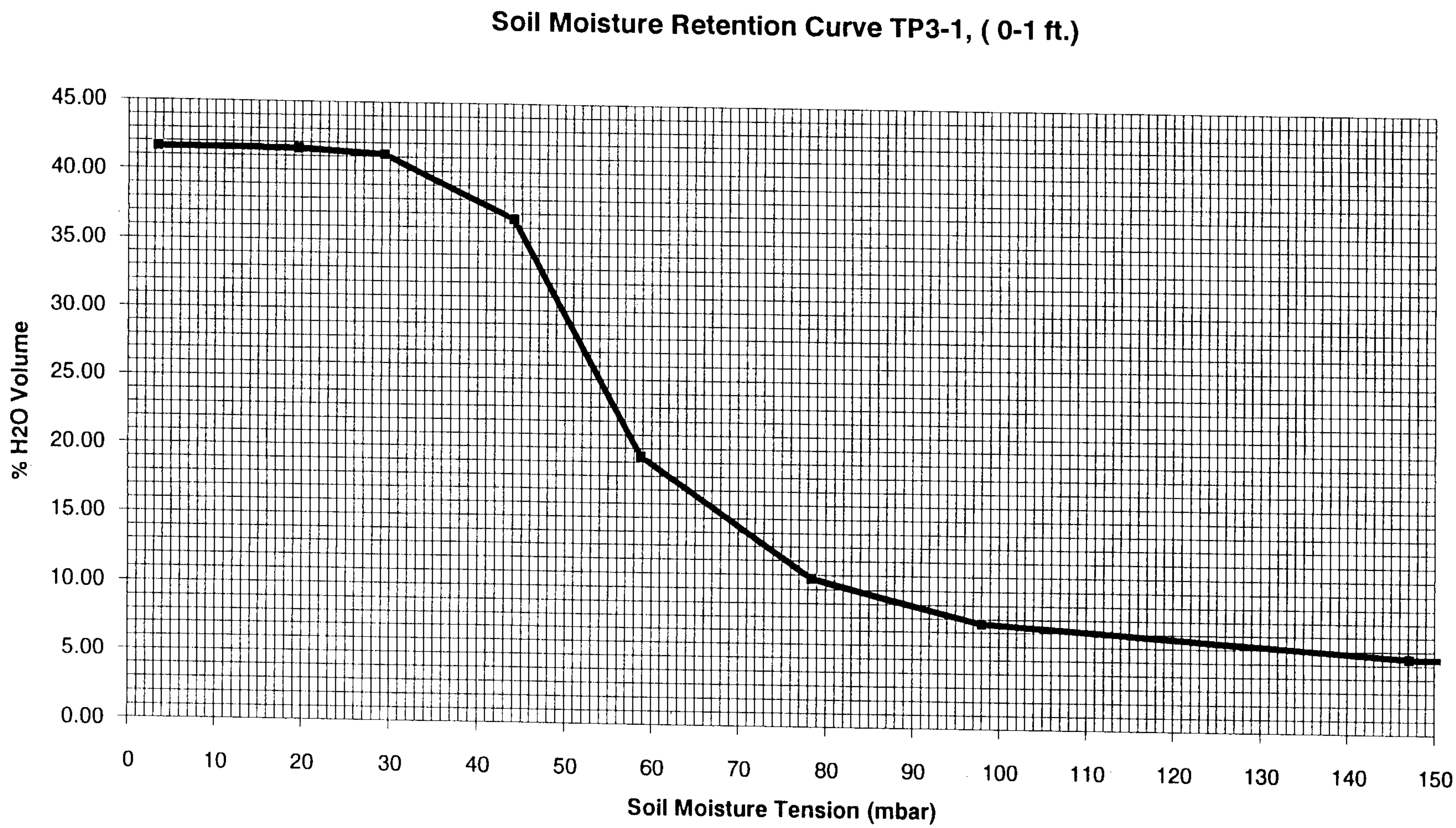


FIGURE A-10. Soil Moisture Tension vs %H2O Volume For Soil Obtained At TP-3 (0-1 Ft. Below The Infiltrative Surface).

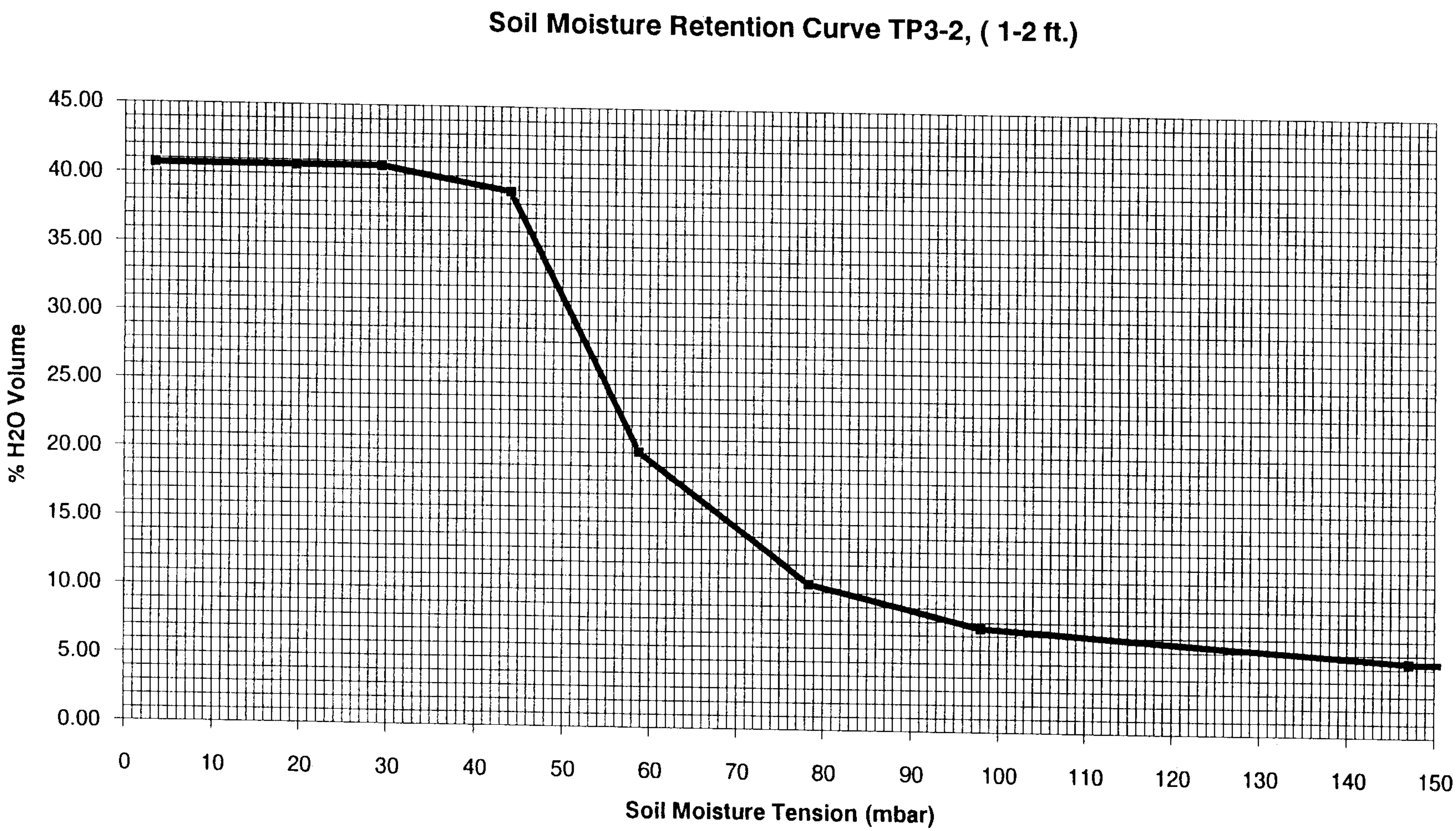


FIGURE A-11. Soil Moisture Tension vs %H2O Volume For Soil Obtained At TP-3 (1-2 Ft. Below The Infiltrative Surface).

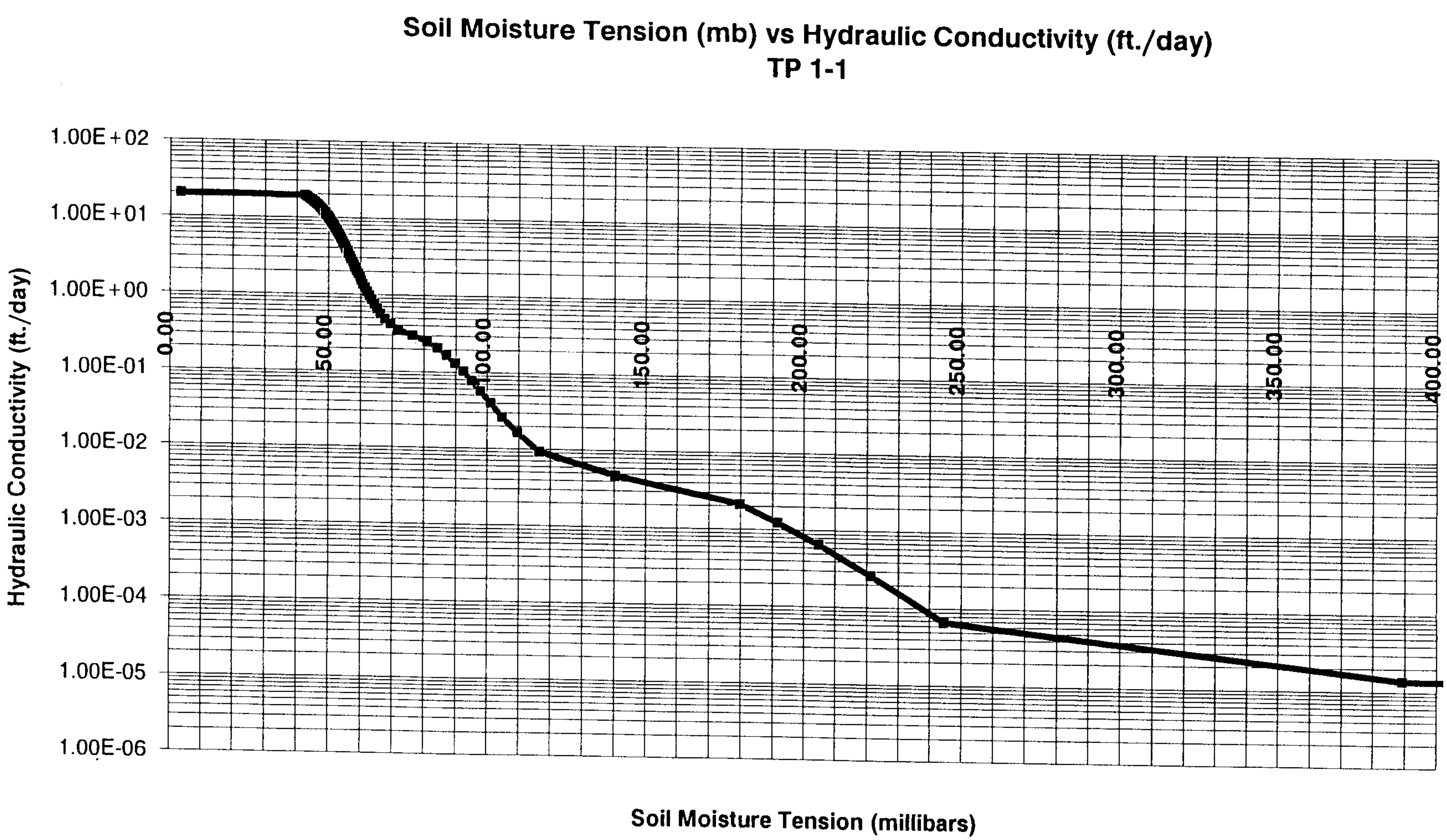


Figure A-12. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-1 (0-1 Foot Below Infiltrative Surface).

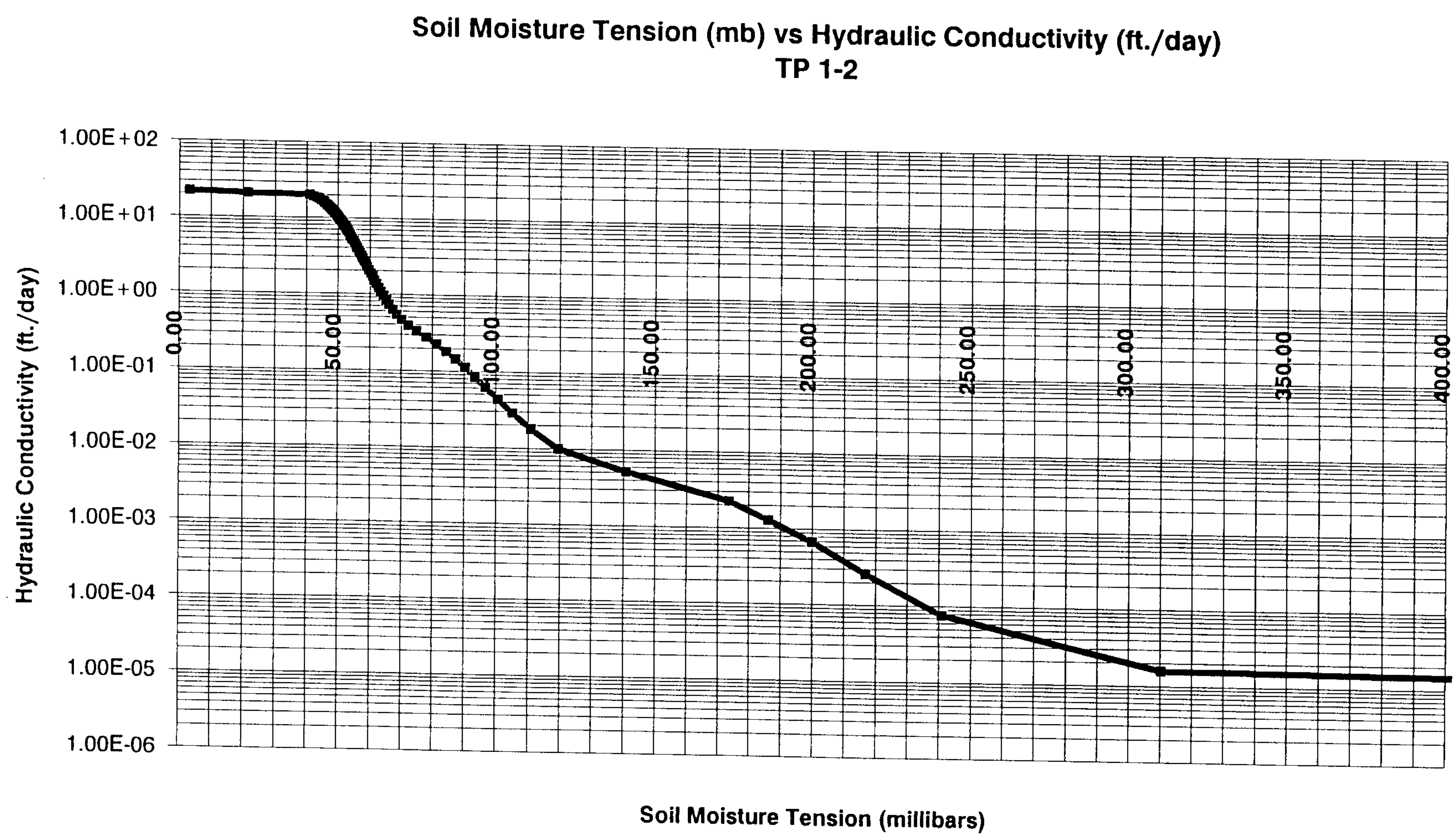


Figure A-13. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-1 (1-2 Feet Below Infiltrative Surface).

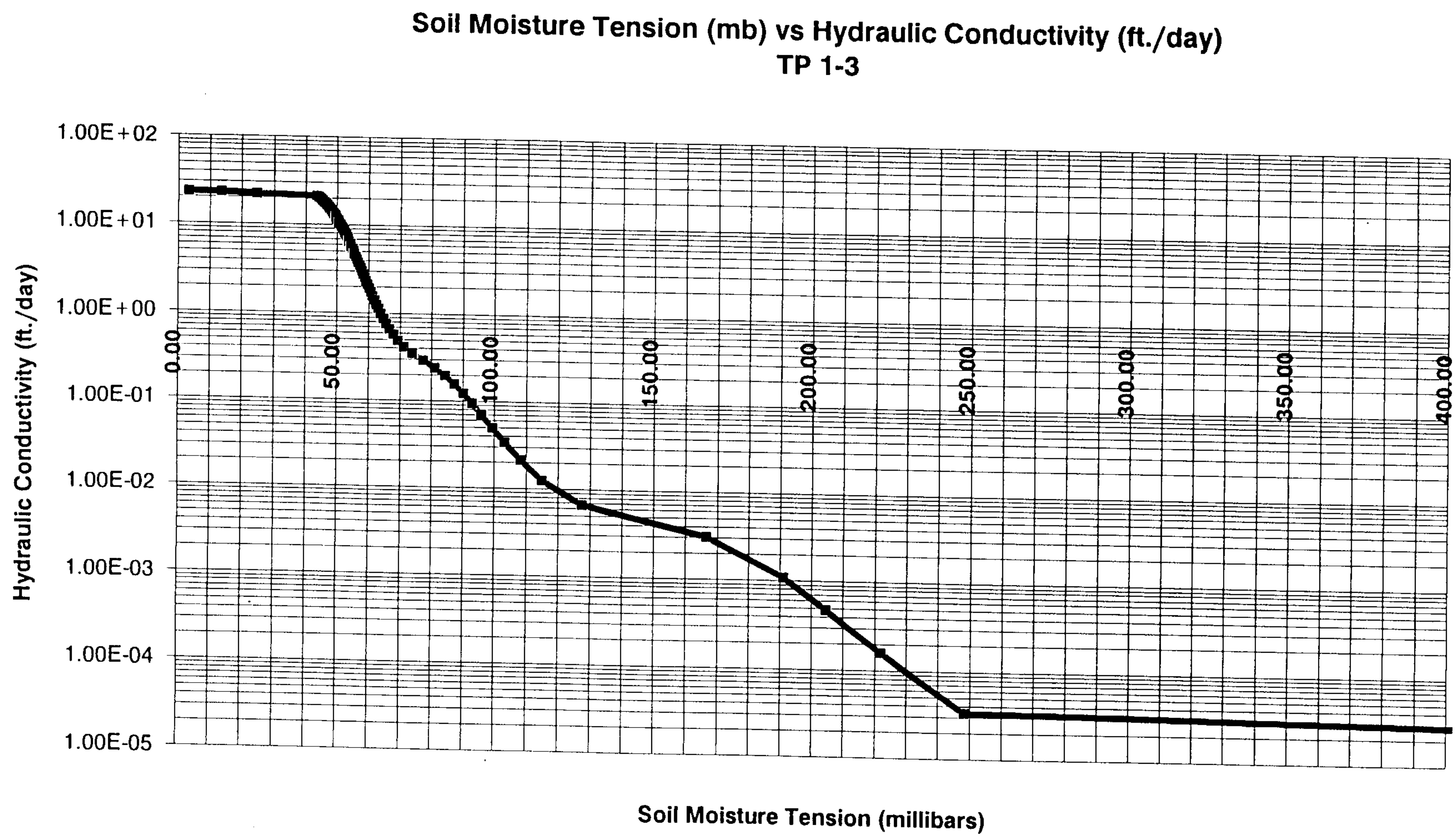


Figure A-14. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-1 (2-3 Feet Below Infiltrative Surface).

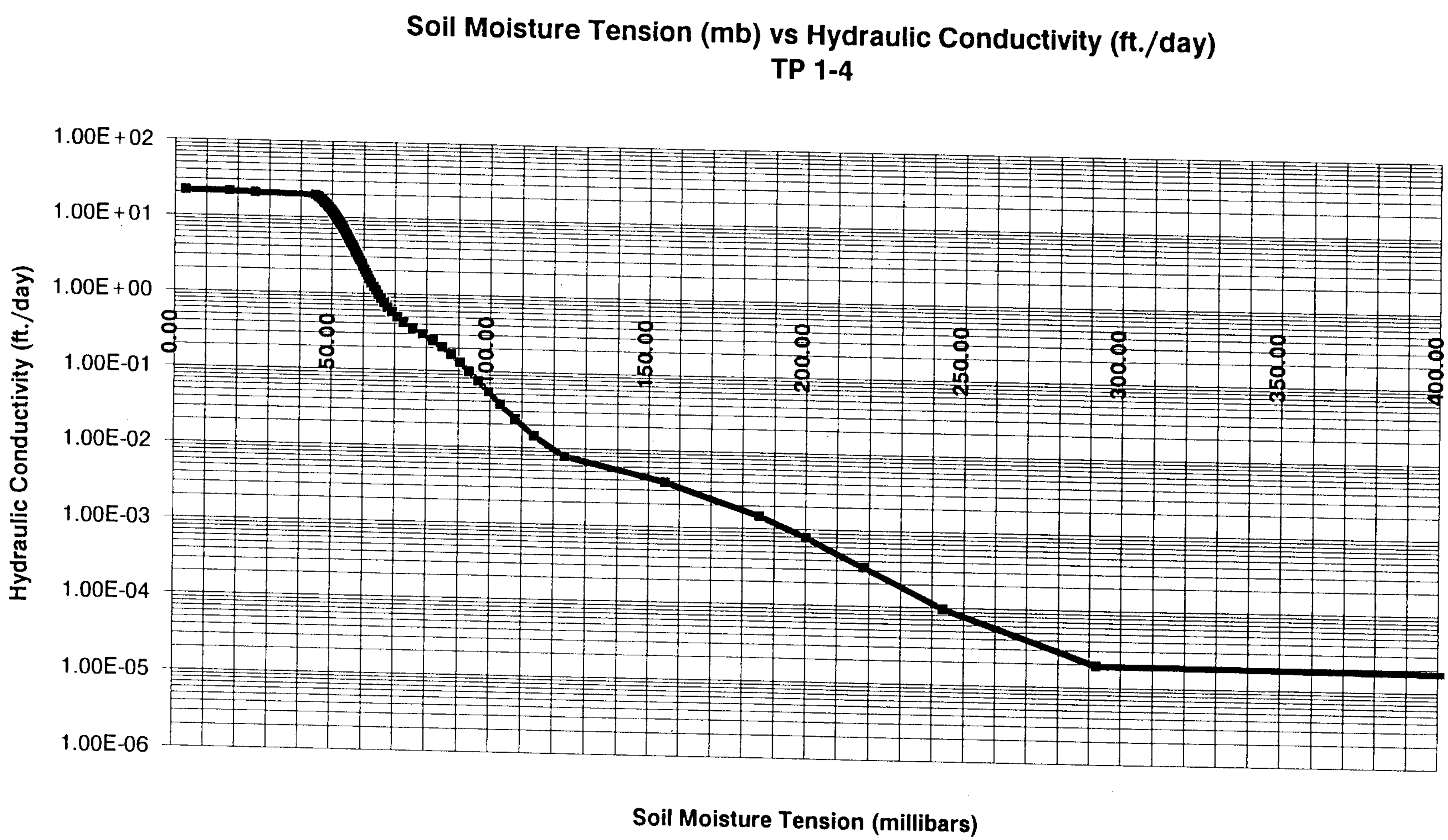


Figure A-15. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-1 (3-4 Feet Below Infiltrative Surface).

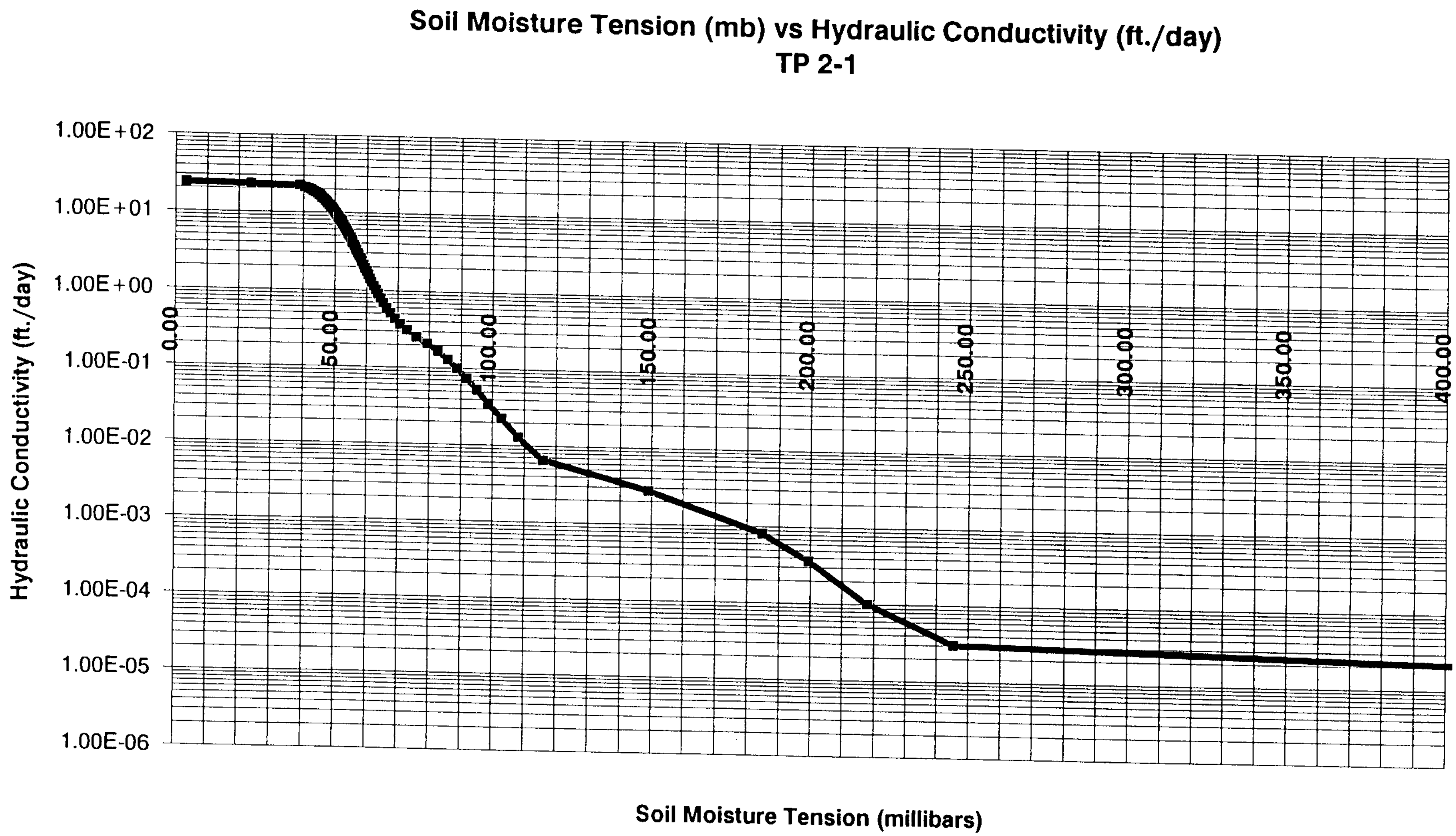


Figure A-16. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-2 (0-1 Foot Below Infiltrative Surface).

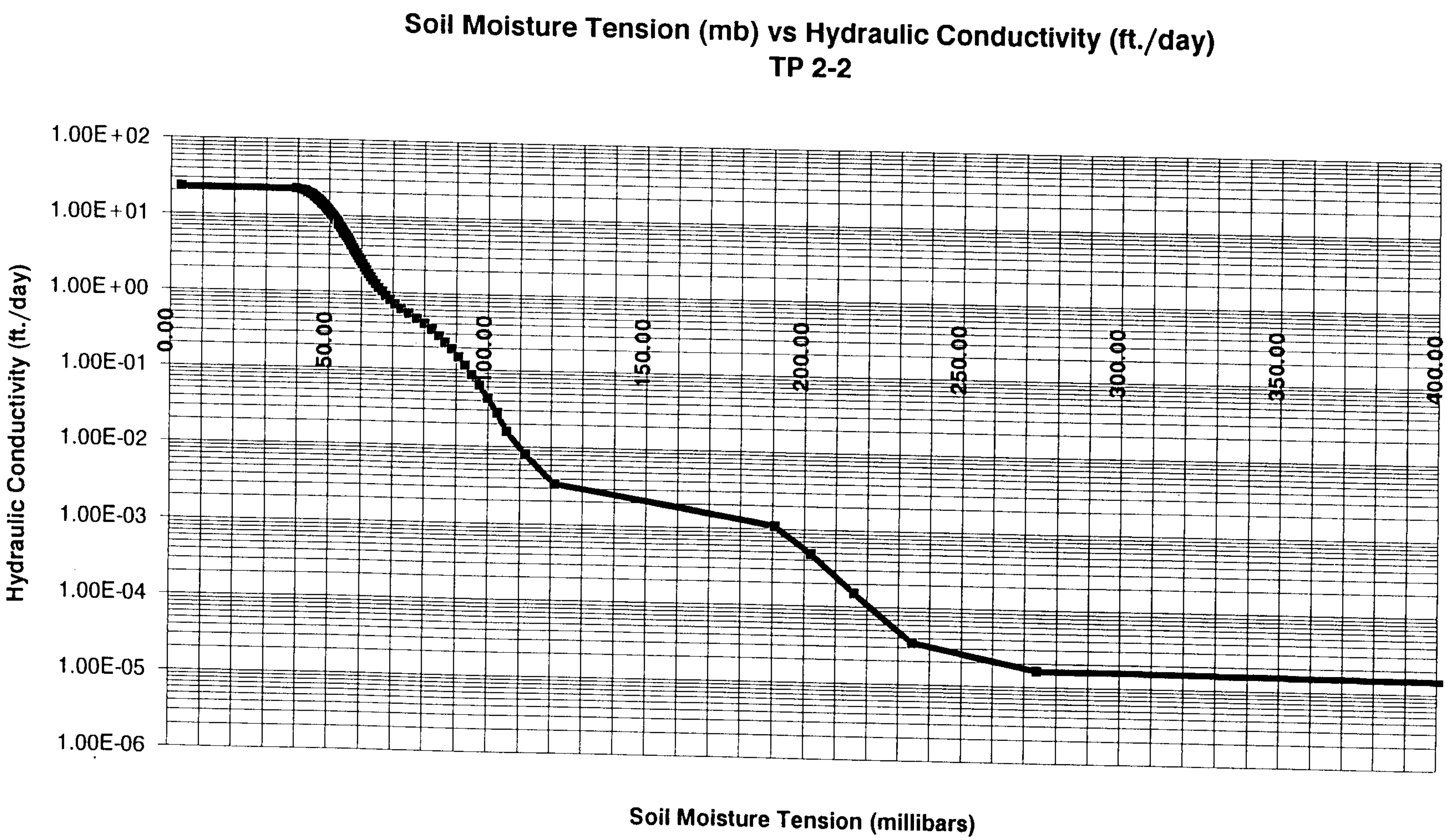


Figure A-17. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-2 (1-2 Feet Below Infiltrative Surface).

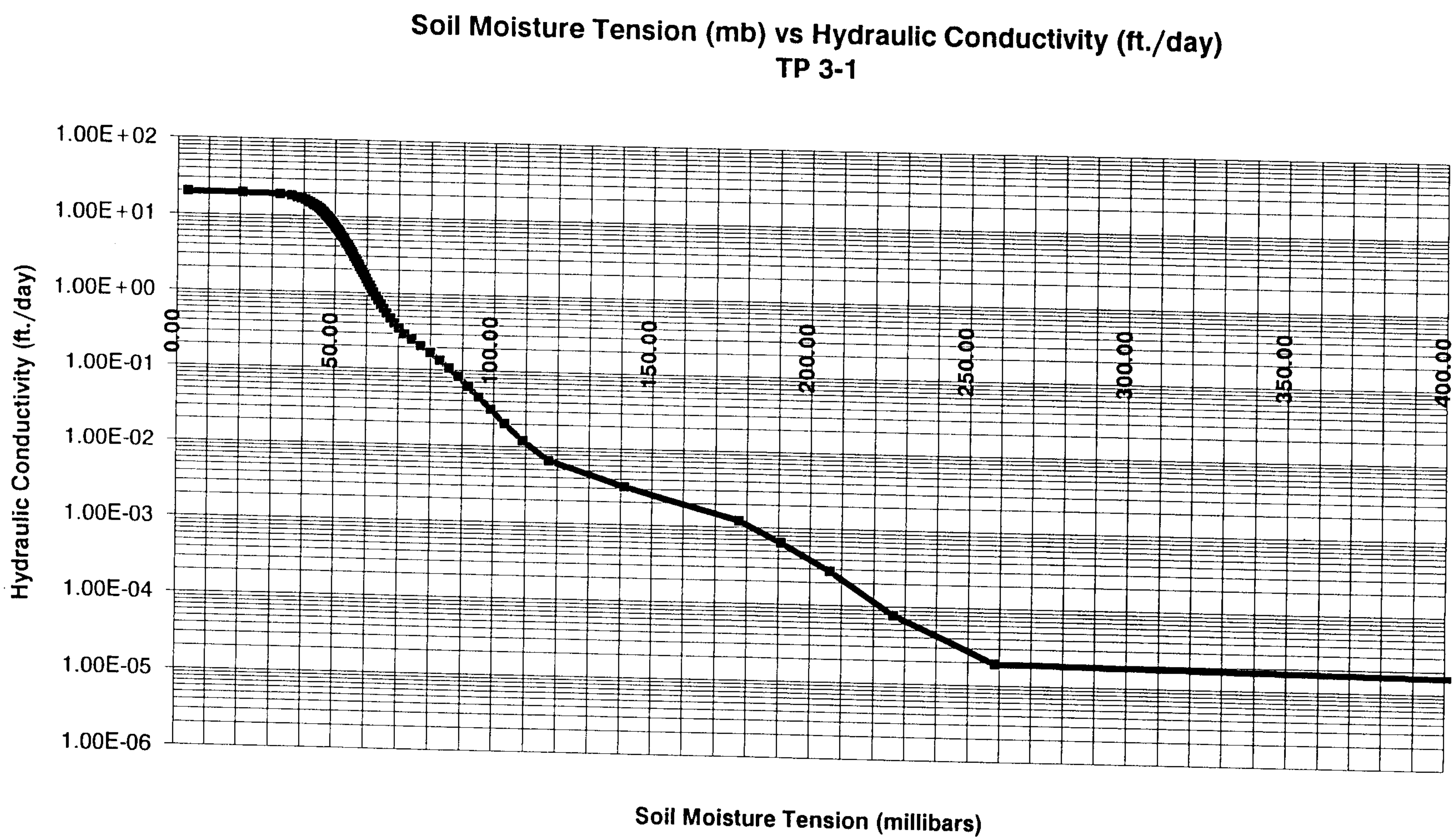


Figure A-18. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-3 (0-1 Foot Below Infiltrative Surface).

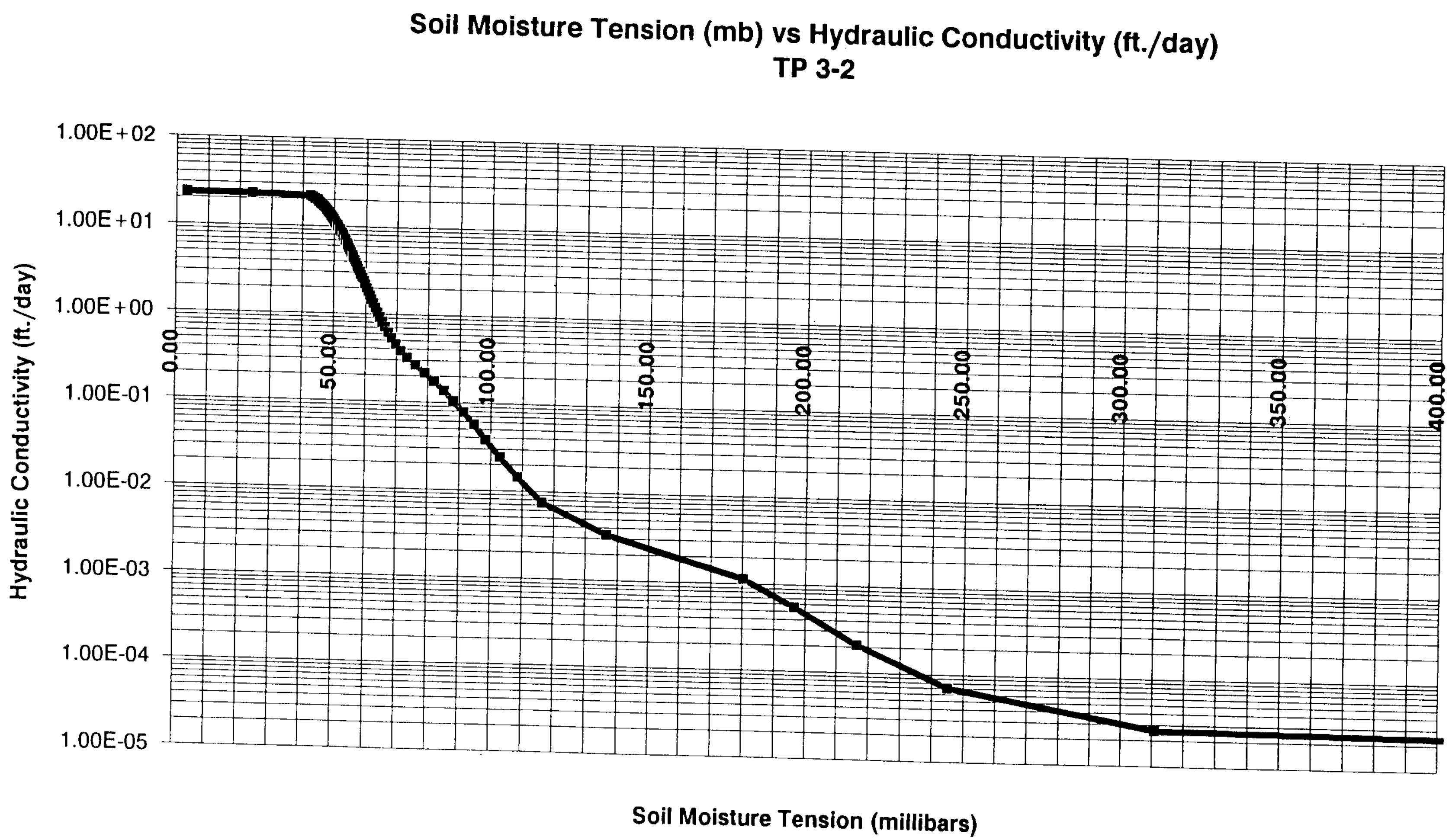


Figure A-19. Average Unsaturated Hydraulic Conductivity vs Soil Moisture Tension For TP-3 (1-2 Feet Below Infiltrative Surface).

TESTPIT SOIL DESCRIPTIONS

Site TP-1

- A horizon--0 to 8 inches; Dark gray (10YR 4/1) fine sand; very weak fine granular structure; loose; many fine roots; many uncoated sand grains; clear wavy boundary.
- E1 horizon--8 to 15 inches; Very pale brown (10YR 7/3) fine sand; loose; single grained; common fine roots; many uncoated sand grains; gradual wavy boundary.
- E2--15 to 23 inches; Very pale brown (10YR 7/4) fine sand; single grained; few fine roots; many uncoated sand grains; common gray (10YR 5/1) fillings in old root channels; gradual wavy boundary.
- E3--23-70 inches; Brownish yellow (10YR 6/6) fine sand; loose; single grained; few fine roots; large roots at a depth of about 40 to 48 inches; some black (10YR 2/1) charcoal flecks at a depth of approximately 30 to 38 inches; few strong brown (7.5YR 5/6) and brown (10YR 5/3) mottles; many uncoated sand grains; gradual wavy boundary.
- E4--70-80 inches; Yellow (10YR 7/6) fine sand; loose; single grained; few fine roots; few brown (10YR 5/3) mottles; many uncoated sand grains.

Site TP-2

- A horizon--0 to 9 inches; Dark grayish brown (10YR 3/2) fine sand; very weak fine granular structure; loose; many fine roots; many uncoated sand grains; clear wavy boundary.
- E1 horizon--9 to 17 inches; Pale brown (10YR 6/3) fine sand; loose; single grained; common fine roots; many uncoated sand grains; gradual wavy boundary.
- E2--17 to 28 inches; Very pale brown (10YR 7/4) fine sand; loose; single grained; few fine roots; many uncoated sand grains; gradual wavy boundary.
- E3--28-40 inches; Brownish yellow (10YR 6/6) fine sand; loose; single grained; few fine roots; few strong brown (7.5YR 5/6) and brown (10YR 5/3) mottles; many uncoated sand grains; gradual wavy boundary.
- E4--40-52 inches; Yellow (10YR 7/6) fine sand; loose; single grained; few fine roots; few brown (10YR 5/3) mottles; many uncoated sand grains.

TESTPIT SOIL DESCRIPTIONS (continued)

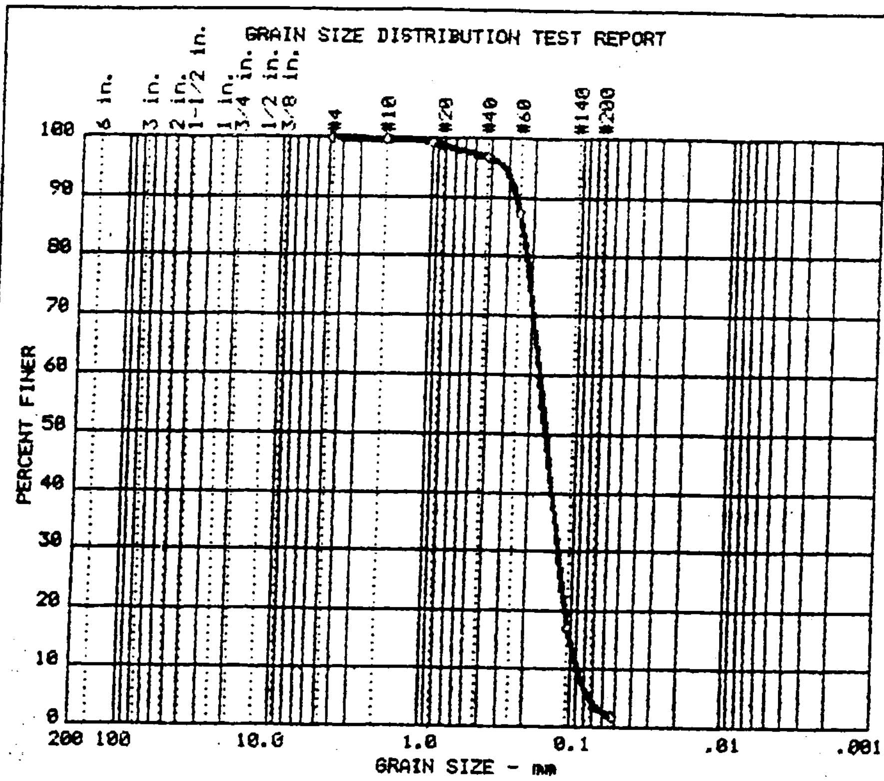
SITE TP-3

- A horizon--0 to 7 inches; Very dark gray (10YR 3/1) fine sand; very weak fine granular structure; loose; many fine roots; many uncoated sand grains; clear wavy boundary.
- E1 horizon--7 to 15 inches; Pale brown (10YR 6/3) fine sand; loose; single grained; common fine roots; many uncoated sand grains; gradual wavy boundary.
- E2--15 to 26 inches; Light yellowish brown (10YR 6/4) fine sand; loose; single grained; few fine roots; many uncoated sand grains; gradual wavy boundary.
- E3--26-48 inches; Yellow (10YR 7/6) fine sand; loose; single grained; few fine roots; few strong brown (7.5YR 5/6) and brown (10YR 5/3) mottles; many uncoated sand grains; gradual wavy boundary.

Table A-1. **Grain Size Analysis of USF Soil Samples.**

Sample ID Number	Weight Percent Sand Fractions					Weight Percent		
	very coarse (1-2mm)	coarse (.5-1mm)	medium (.25-.5mm)	very fine (.1-.25mm)	fine (.05-.1mm)	Sand	Silt	Clay
TP-1 (0 - 1 feet)[1]	0	0.2	2.4	74.2	21.4	98.2	0.2	1.6
TP-1 (1 - 2 feet)	0	0.0	2.4	70.8	24.8	98.0	0.2	1.8
TP-1 (2 - 3 feet)	0	0.0	2.2	73.0	23.2	98.4	0.1	1.5
TP-1 (3 - 4 feet)	0	0.0	2.2	70.4	25.4	98.0	0.2	1.8
TP-2 (0 - 1 feet)	0	0.2	2.6	74.4	21.2	98.4	0.1	1.5
TP-2 (1 - 2 feet)	0	0.2	2.6	72.0	22.0	96.8	0.1	3.1
TP-3 (0 - 1 feet)	0	0.2	3.8	70.8	22.6	97.4	0.5	2.1
TP-3 (1 - 2 feet)	0	0.2	3.6	72.0	22.2	98.0	0.3	1.7

[1] All depths are measured from the base of the infiltrative surface.



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
O	0.0	0.1	95.3	4.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
O			0.24	0.17	0.16	0.125	0.1008	0.0904	0.99	1.9

MATERIAL DESCRIPTION	USCS	AASHTO
O Sand	SP	

Project No.: 929.00
Project: Ayres Associates - Florida office
O Location: OSDS Lusimeter - Hor 1 @ 3"

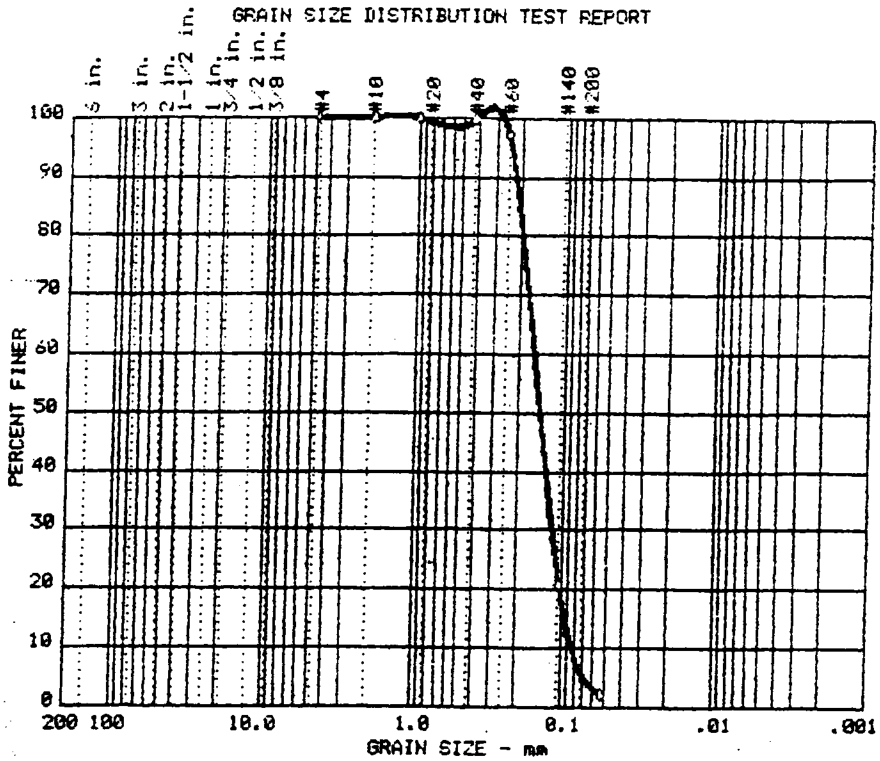
Date: 9-17-91

GRAIN SIZE DISTRIBUTION TEST REPORT
AYRES ASSOCIATES

Remarks:

Figure A-1. Grain Size Distribution Curve for Soil Obtained at Testpit Located Midway on the Deep Trench Outer Wall (3 inches below grade).

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
O	0.0	0.0	94.1	5.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
O			0.21	0.16	0.14	0.118	0.0954	0.0650	1.03	1.9

MATERIAL DESCRIPTION	USCS	AASHTO
O Sand	SP-SM	

Project No.: 929.00
Project: Ayres Associates - Florida office
O Location: OSDS Lysimeter - Hor 2 @ 16"

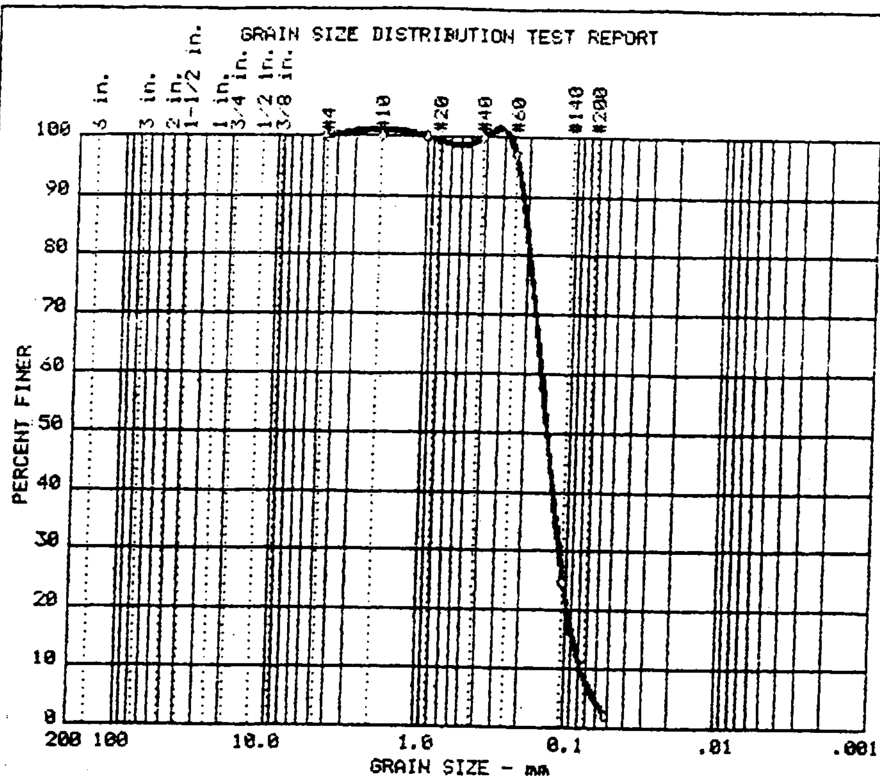
Date: 9-17-91

Remarks:

GRAIN SIZE DISTRIBUTION TEST REPORT

AYRES ASSOCIATES

Figure A-2. Grain Size Distribution Curve for Soil Obtained at Testpit Located Midway on the Deep Trench Outer Wall (16 inches below grade).



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
O	0.0	0.0	91.4	8.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
O			0.20	0.16	0.14	0.113	0.0884	0.0775	1.05	2.0

MATERIAL DESCRIPTION	USCS	AASHTO
O Sand	SP-SM	

Project No.: 929.00
Project: Ayres Associates - Florida office
O Location: OSDS Lysimeter - Hor 3 @ 36"

Date: 9-17-91

GRAIN SIZE DISTRIBUTION TEST REPORT

AYRES ASSOCIATES

Remarks:

Figure A-3. Grain Size Distibution Curve for Soil Obtained at Testpit Located Midway on the Deep Trench Outer Wall (36 inches below grade).

Table A-2. Bulk Density and Saturated Hydraulic Conductivities for Soil Samples Obtained at Testpits at Lysimeter Station.

Sample ID Number	Bulk Density (g/cm^3)	Ksat (ft/day)
TP-1 (0-1 ft)[1]	1.54	18.19
TP-1 (1-2 ft)	1.50	18.19
TP-1 (2-3 ft)	1.48	20.78
TP-1 (3-4 ft)	1.50	20.78
TP-2 (0-1 ft)	1.46	22.34
TP-2 (1-2 ft)	1.49	22.34
TP-3 (0-1 ft)	1.51	20.78
TP-3 (1-2 ft)	1.49	18.19

[1] All depths are measured from the base of the infiltrative surface.

TABLE A-3. Detailed Soil Moisture Tension Data

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	TEST 2	TEST 3	0-1 ft.	
TP1-1	3.5	3.4321	39.27	38.35	39.11	38.91	0.49
(0-1 ft.)	20	19.612	39.14	38.32	38.96	38.81	0.43
	30	29.418	39.06	38.3	38.87	38.74	0.40
	45	44.127	36.39	37.89	38.25	37.51	0.99
	60	58.836	19.79	19.33	17.68	18.93	1.11
	80	78.448	11.69	11.5	10.74	11.31	0.50
	100	98.06	8.14	7.96	7.82	7.97	0.16
	150	147.09	5.6	5.38	5.48	5.49	0.11
	200	196.12	4.75	4.6	4.63	4.66	0.08
	345	338.307	3.93	3.68	3.67	3.76	0.15

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	TEST 2	TEST 3	1-2 ft.	
TP1-2	3.5	3.4321	39.4	38.9	38.61	38.97	0.40
(1-2 ft.)	20	19.612	39.03	38.42	38.57	38.67	0.32
	30	29.418	38.86	36.86	38.57	38.10	1.08
	45	44.127	36.93	35.54	36.89	36.45	0.79
	60	58.836	19.06	19.05	20.06	19.39	0.58
	80	78.448	10.85	10.66	11.32	10.94	0.34
	100	98.06	7.79	7.54	8.18	7.84	0.32
	150	147.09	5.38	5.16	5.77	5.44	0.31
	200	196.12	4.57	4.28	4.85	4.57	0.29
	345	338.307	3.73	3.49	4.03	3.75	0.27

NOTE: All depths are measured from the base of the infiltrative surface.

TABLE A-3. Continued.

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	2-3 ft.	
TP1-3	3.5	3.4321	39.18	39.05	40.41	39.55	0.75
(2-3 ft.)	20	19.612	38.93	38.92	40	39.28	0.62
	30	29.418	38.89	38.82	39.72	39.14	0.50
	45	44.127	36.9	38.71	38.71	38.11	1.05
	60	58.836	17.28	19.55	21.45	19.43	2.09
	80	78.448	10.01	10.94	11.64	10.86	0.82
	100	98.06	7.14	7.71	8.21	7.69	0.54
	150	147.09	4.89	5.27	5.67	5.28	0.39
	200	196.12	4.02	4.46	4.73	4.40	0.36
	345	338.307	3.29	3.62	3.9	3.60	0.31

	Pressure (cm)	Pressure (mbar)	%H2O Vol.	%H2O Vol.	%H2O Vol.	Average	St. Dev.
			TEST 1	**TEST 2**	**TEST 3**	3-4 ft.	
TP1-4	3.5	3.4321	39.18	39.53	38.79	39.17	0.37
(3-4 ft.)	20	19.612	38.8	39.22	38.58	38.87	0.33
	30	29.418	38.44	39.11	38.49	38.68	0.37
	45	44.127	38.36	38.96	38.03	38.45	0.47
	60	58.836	20.17	21.12	18.85	20.05	1.14
	80	78.448	10.99	11.48	10.78	11.08	0.36
	100	98.06	7.57	8.08	7.49	7.71	0.32
	150	147.09	4.79	5.57	4.94	5.10	0.41
	200	196.12	4.06	4.72	4.16	4.31	0.36
	345	338.307	3.16	3.81	3.29	3.42	0.34

NOTE: All depths are measured from the base of the infiltrative surface.

APPENDIX B

CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF SOIL

Table B-1. **Chemical Characteristics of USF Soils Samples.**

Sample ID Number	pH	%Org. Carbon	% $CaCo_3$	CEC (me/100g)	Alum. (mg/kg)	Iron (mg/kg)	TP (mg/kg)
TP-1 (0-1 ft)[1]	6.2	0.15	0.0	0.53	0.0	0.0	0.0
TP-1 (1-2 ft)	6.3	0.10	0.0	0.81	0.0	0.0	0.0
TP-1 (2-3 ft)	7.0	0.06	1.0	0.45	0.0	0.0	0.0
TP-1 (3-4 ft)	7.0	0.05	2.2	0.45	0.0	0.0	0.0
TP-2 (0-1 ft)	6.5	0.05	0.0	0.35	0.0	0.0	0.0
TP-2 (1-2 ft)	6.5	0.05	0.0	0.47	0.0	0.0	0.0
TP-3 (0-1 ft)	6.6	0.10	0.0	0.83	0.0	0.0	0.0
TP-3 (1-2 ft)	6.4	0.07	1.6	0.60	0.0	0.0	0.0

[1] All depths are measured from the base of the infiltrative surface.

Table B-2. Percent Clay Mineralogy of USF Soil Samples.

Sample ID Number	Montmorillonite	Hydroxy Interlayered Vermiculite	Kaolinite	Gibbsite	Quartz
TP-1 (0 - 1 feet)[1]	8	43	20	21	8
TP-1 (1 - 2 feet)	0	43	20	26	11
TP-1 (2 - 3 feet)	0	47	20	23	10
TP-1 (3 - 4 feet)	0	45	18	23	14
TP-2 (0 - 1 feet)	0	47	19	26	8
TP-2 (1 - 2 feet)	0	45	21	26	8
TP-3 (0 - 1 feet)	0	52	18	17	13
TP-3 (1 - 2 feet)	0	50	19	21	10

[1] All depths are measured from the base of the infiltrative surface.

Table B-3. Summary of Microbiological Analysis of Soil Samples Obtained at Testpit 1.

Sample ID Number	Heterotrophic Plate Count (CFU/g)	Fecal Coliform (MPN/100g)	Fecal Streptococcus (MPN/100g)
TP-1 (0 - 1 feet)[1]	64,000	<21	<21
TP-1 (1 - 2 feet)	52,000	<21	<21
TP-1 (2 - 3 feet)	43,000	<21	<21
TP-1 (3 - 4 feet)	29,000	<21	<21

CFU - Colony Forming Units per gram of dry soil.
MPN - Most Probable Number of organisms per 100 grams of dry soil.
[1] All depths are measured from the base of the infiltrative surface.

APPENDIX C

WASTEWATER AND TAPWATER QUALITY DATA

Table C-1. Septic Tank Effluent Monitoring Results

Sample Dat	BOD mg/l	TOC mg/l	TKN mg/l	OrgN mg/l	NH3-N mg/l	NO3 mg/l	TP mg/l	MBAS mg/l	FOG mg/l	F.Coli log#/100 ml	F. Strep log#/100 ml	Cl- mg/l	SO4 mg/l	Sp. Con. umho/cm	pH	TDS mg/l	TSS mg/l	VSS mg/l
8/11/92	156.0	68.0	53.0	- -	- -	0.16	17.0	6.7	50.0	5.43	4.15	80	45	- -	- -	442	128	- -
9/11/92	95.0	51.0	43.0	- -	- -	0.01	12.0	4.6	9.8	4.28	4.18	84	340	900	8.0	400	17	- -
10/21/92	46.0	36.0	40.0	- -	- -	0.01	8.4	7.8	13.0	4.71	5.32	55	74	920	8.0	450	44	- -
12/8-9/92	144.0	65.0	52.0	- -	- -	0.03	8.2	15.0	18.0	3.64	2.15	110	79	1200	7.5	516	28	- -
12/21-22/92	104.0	42.0	47.0	- -	- -	0.03	8.4	17.0	16.0	4.08	1.89	76	69	1200	8.0	552	21	- -
1/11-12/93	81.0	33.0	45.0	- -	- -	0.03	7.2	9.1	13.0	4.79	2.93	94	130	410	7.7	610	22	- -
1/18-19/93	91.0	49.0	52.0	- -	- -	0.03	8.1	11.0	12.0	4.69	3.43	61	1100	330	7.6	592	24	16
1/25-26/93	78.0	46.0	41.0	3	38	0.02	7.4	5.0	11.0	4.93	3.74	77	52	940	7.8	458	28	22
2/3-4/93	73.0	53.0	52.0	9	43	0.01	9.3	9.2	13.0	5.32	3.46	44	62	710	7.5	474	37	23
Mean	96.4	49.2	47.2	6.0	40.5	0.04	9.6	9.5	17.3	4.65	3.47	75.7	217	826	7.8	499	39	20
Std. Dev.	34.6	11.8	5.2	4.2	3.5	0.05	3.1	4.2	12.5	0.57	1.06	20.2	344	325	N/A	72	34	4
min	46.0	33.0	40.0	3.0	38.0	0.01	7.2	4.6	9.8	3.64	1.89	44.0	45	330	7.5	400	17	16
max	156.0	68.0	53.0	9.0	43.0	0.16	17.0	17.0	50.0	5.43	5.32	110.0	1100	1200	8.0	610	128	23
n	9	9	9	2	2	9	9	9	9	9	9	9	9	8	8	9	9	3

- - = Not Sampled

Table C-2. Tap Water Monitoring Results

Sample Date	BOD mg/l	TOC mg/l	TKN mg/l	OrgN mg/l	NH3-N mg/l	NO3 mg/l	TP mg/l	MBAS mg/l	FOG mg/l	F.Coli log#/100 ml	F. Strep log#/100 ml	Cl- mg/l	SO4 mg/l	Sp. Con. umho/cm	pH	TDS mg/l	TSS mg/l	VSS mg/l
1/20-21/93	<1	3.20	1.30	0.30	1	0.27	0.02	<0.05	<2	<1	<1	26	150	660	8.0	404	1	- -
1/25-26/93	<1	2.10	1.50	0.05	1.5	0.02	0.04	<0.05	<2	<1	<1	16	20	390	7.8	222	<1	<1
2/3-4/93	<1	3.60	1.30	0.34	0.96	0.12	0.02	<0.05	<2	<1	<1	28	99	430	7.9	324	<1	<1
Mean	<1	3.0	1.4	0.23	1.15	0.14	0.03	<0.05	<2	<1	<1	23.3	90	493	7.9	317	<1	<1
Std. Dev.	N/A	0.8	0.1	0.16	0.30	0.13	0.01	N/A	N/A	N/A	N/A	6.4	66	146	N/A	91	N/A	N/A
min	<1	2.1	1.3	0.05	0.96	0.02	0.02	<0.05	<2	<1	<1	16.0	20	390	7.8	222	<1	<1
max	<1	3.6	1.5	0.34	1.50	0.27	0.04	<0.05	<2	<1	<1	28.0	150	660	8.0	404	1	<1
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2

N/A = Not Applicable
- - = Not Sampled

APPENDIX D

METEOROLOGICAL DATA

Table D-1. Ambient Temperature Recorded Near USF Site

Observation Dates		Temperature Degrees Fahrenheit					
Week		Daily			Weekly		
Beginning	Day	Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
8/3/92	8/3/92	74	93	84	73	92	82
	8/4/92	74	87	81			
	8/5/92	74	89	82			
	8/6/92	72	98	85			
	8/7/92	72	93	83			
	8/8/92	71	92	82			
	8/9/92	71	93	82			
8/10/92	8/10/92	71	91	81	73	89	81
	8/11/92	72	91	82			
	8/13/92	75	86	81			
	8/14/92	74	91	83			
	8/15/92	74	88	81			
	8/16/92	71	86	79			
8/17/92	8/17/92	71	87	79	73	91	82
	8/18/92	72	91	82			
	8/19/92	74	91	83			
	8/20/92	73	93	83			
	8/21/92	72	93	83			
	8/22/92	72	95	84			
	8/23/92	74	85	80			
8/24/92	8/24/92	N/A	N/A	N/A	71	86	79
	8/25/92	N/A	N/A	N/A			
	8/26/92	73	91	82			
	8/27/92	72	91	82			
	8/28/92	72	83	78			
	8/29/92	69	76	73			
	8/30/92	71	87	79			
8/31/92	8/31/92	70	89	80	71	90	80
	9/1/92	70	90	80			
	9/2/92	69	89	79			
	9/3/92	72	90	81			
	9/4/92	71	89	80			
	9/5/92	72	89	81			
	9/6/92	71	92	82			
9/7/92	9/7/92	N/A	N/A	N/A	71	90	80
	9/8/92	74	91	83			
	9/9/92	71	90	81			

Table D-1. Continued.

Observation Dates		Temperature Degrees Fahrenheit					
Week		Daily			Weekly		
Beginning	Day	Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
	9/10/92	67	89	78			
	9/11/90	72	88	80			
	9/12/92	71	90	81			
	9/13/92	71	90	81			
9/14/92	9/14/92	68	88	78	70	89	80
	9/15/92	70	89	80			
	9/16/92	73	90	82			
	9/17/92	71	89	80			
	9/18/92	69	91	80			
	9/19/92	68	89	79			
	9/20/92	70	90	80			
9/21/92	9/21/92	72	93	83	73	90	81
	9/22/92	73	92	83			
	9/23/92	75	88	82			
	9/24/92	72	89	81			
	9/25/92	73	88	81			
	9/26/92	73	88	81			
	9/27/92	72	89	81			
9/28/92	9/28/92	70	87	79	70	81	75
	9/29/92	72	87	80			
	9/30/92	67	81	74			
	10/1/92	66	75	71			
	10/2/92	66	70	68			
	10/3/92	69	83	76			
	10/4/92	77	82	80			
10/5/92	10/5/92	66	77	72	68	81	74
	10/6/92	62	76	69			
	10/7/92	63	80	72			
	10/8/92	69	84	77			
	10/9/92	70	87	79			
	10/10/92	71	87	79			
	10/11/92	72	74	73			
10/12/92	10/12/92	63	77	70	60	82	71
	10/13/92	53	77	65			
	10/14/92	57	81	69			
	10/15/92	60	84	72			
	10/16/92	63	86	75			
	10/17/92	63	86	75			

Table D-1. Continued.

Observation Dates		Temperature Degrees Fahrenheit					
Week		Daily			Weekly		
Beginning	Day	Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
	10/18/92	64	83	74			
10/19/92	10/19/92	56	75	66	56	78	67
	10/20/92	53	77	65			
	10/21/92	57	77	67			
	10/22/92	58	79	69			
	10/23/92	62	76	69			
	10/24/92	54	81	68			
	10/25/92	55	78	67			
10/26/92	10/26/92	58	83	71	61	83	72
	10/27/92	57	83	70			
	10/28/92	63	81	72			
	10/29/92	59	84	72			
	10/30/92	60	83	72			
	10/31/92	65	85	75			
	11/1/92	63	83	73			
11/2/92	11/2/92	67	82	75	64	75	69
	11/3/92	69	86	78			
	11/4/92	68	85	77			
	11/5/92	74	84	79			
	11/6/92	65	70	68			
	11/7/92	52	57	55			
	11/8/92	50	63	57			
11/9/92	11/9/92	62	74	68	60	75	68
	11/10/92	67	77	72			
	11/11/92	63	82	73			
	11/12/92	70	81	76			
	11/13/92	67	73	70			
	11/14/92	50	67	59			
	11/15/92	43	70	57			
11/16/92	11/16/92	46	70	58	63	78	70
	11/17/92	53	70	62			
	11/18/92	61	74	68			
	11/19/92	60	78	69			
	11/20/92	65	78	72			
	11/21/92	69	80	75			
	11/22/92	70	81	76			
11/23/92	11/23/92	70	84	77	60	75	68
	11/24/92	69	84	77			

Table D-1. Continued.

Observation Dates		Temperature Degrees Fahrenheit					
Week Beginning	Day	Daily			Weekly		
		Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
	11/25/92	71	84	78			
	11/26/92	70	83	77			
	11/27/92	54	73	64			
	11/28/92	48	59	54			
	11/29/92	41	59	50			
11/30/92	11/30/90	38	65	52	44	68	56
	12/1/92	46	63	55			
	12/2/92	45	66	56			
	12/3/92	40	63	52			
	12/4/92	43	72	58			
	12/5/92	50	72	61			
	12/6/92	44	73	59			
12/7/92	12/7/92	55	76	66	50	68	59
	12/8/92	62	69	66			
	12/9/92	47	71	59			
	12/10/92	60	69	65			
	12/11/92	51	63	57			
	12/12/92	41	59	50			
	12/13/92	37	N/A	N/A			
12/13/92	12/14/92	46	71	59	58	76	67
	12/15/92	54	71	63			
	12/16/92	56	75	66			
	12/17/92	63	77	70			
	12/18/92	59	79	69			
	12/19/92	68	79	74			
	12/20/92	62	77	70			
12/20/92	12/21/92	N/A	N/A	N/A	59	78	68
	12/22/92	N/A	N/A	N/A			
	12/23/92	N/A	79	N/A			
	12/24/92	62	77	70			
	12/25/92	53	77	65			
	12/26/92	60	79	70			
	12/27/92	59	79	69			
12/28/92	12/28/92	N/A	N/A	N/A	58	74	66
	12/29/92	49	67	58			
	12/30/92	51	67	59			
	12/31/92	60	76	68			
	1/1/93	64	79	72			

Table D-1. Continued.

Observation Dates		Temperature Degrees Fahrenheit					
		Daily			Weekly		
Week Beginning	Day	Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
	1/2/93	59	78	69			
	1/3/93	62	75	69			
1/4/93	1/4/93	66	76	71	67	78	72
	1/5/93	67	81	74			
	1/6/93	66	74	70			
	1/7/93	65	79	72			
	1/8/93	70	80	75			
	1/9/93	N/A	N/A	N/A			
	1/10/93	N/A	N/A	N/A			
1/11/93	1/11/93	68	80	74	56	69	63
	1/12/93	67	77	72			
	1/13/93	55	70	63			
	1/14/93	54	67	61			
	1/15/93	55	65	60			
	1/16/93	46	62	54			
	1/17/93	47	64	56			
1/18/93	1/18/93	N/A	N/A	N/A	60	76	68
	1/19/93	N/A	75	N/A			
	1/20/93	56	75	66			
	1/21/93	61	77	69			
	1/22/93	61	77	69			
	1/23/93	60	77	69			
	1/24/93	60	75	68			
1/25/93	1/25/93	55	65	60	47	67	57
	1/26/93	43	60	52			
	1/27/93	43	63	53			
	1/28/93	41	68	55			
	1/29/93	47	73	60			
	1/30/93	54	70	62			
	1/31/93	48	71	60			
2/1/93	2/1/93	49	65	57	50	67	58
	2/2/93	47	65	56			
	2/3/93	42	67	55			
	2/4/93	48	67	58			
	2/5/93	53	67	60			
	2/6/93	51	72	62			
	2/7/93	57	65	61			
2/8/93	2/8/93	53	59	56	49	67	58

Table D-1. Continued.

Observation Dates		Temperature Degrees Fahrenheit					
Week		Daily			Weekly		
Beginning	Day	Minimum	Maximum	Mean	Avg Min	Avg Max	Mean
	2/9/93	43	63	53			
	2/10/93	52	73	63			
	2/11/93	53	75	64			
	2/12/93	47	61	54			
	2/13/93	44	68	56			
	2/14/93	N/A	N/A	N/A			
2/15/93	2/15/93	N/A	73	N/A	49	68	59
	2/16/93	58	74	66			
	2/17/93	64	71	68			
	2/18/93	49	60	55			
	2/19/93	34	59	47			
	2/20/93	42	68	55			
	2/21/93	47	73	60			
2/22/93	2/22/93	62	64	63	48	66	57
	2/23/93	50	67	59			
	2/24/93	43	65	54			
	2/25/93	44	71	58			
	2/26/93	50	67	59			
	2/27/93	46	64	55			
	2/28/93	41	65	53			
3/1/93	3/1/93	N/A	N/A	N/A	56	70	63
	3/2/93	60	73	67			
	3/3/93	60	77	69			
	3/4/93	56	68	62			
	3/5/93	56	67	62			
	3/6/93	50	71	61			
	3/7/93	55	64	60			
3/8/93	3/8/93	51	71	61	48	71	60
	3/9/93	54	81	68			
	3/10/93	49	78	64			
	3/11/94	50	77	64			
	3/12/93	55	79	67			
	3/13/93	40	67	54			
	3/14/93	35	47	41			

N/A - Data not available due to equipment failures.

3/2/93 Bromide Tracer Test

2/22/93 Sample Days at USF

Table D-2. Relative Humidity Recorded Near USF Site

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
8/2/92	8/3/92	54	90	50	90
	8/4/92	62	90		
	8/5/92	64	90		
	8/6/92	50	90		
	8/7/92	56	90		
	8/8/92	56	90		
	8/9/92	58	90		
8/10/92	8/10/92	54	90	54	93
	8/11/92	56	93		
	8/12/92	68	92		
	8/13/92	62	90		
	8/14/92	64	88		
	8/15/92	70	90		
	8/16/92	64	90		
8/17/92	8/17/92	56	88	49	90
	8/18/92	49	90		
	8/19/92	54	88		
	8/20/92	56	90		
	8/21/92	55	90		
	8/22/92	N/A	N/A		
	8/23/92	N/A	N/A		
8/24/92	8/24/92	N/A	N/A	50	89
	8/25/92	56	86		
	8/26/92	52	88		
	8/27/92	50	88		
	8/28/92	73	89		
	8/29/92	83	88		
	8/30/92	66	89		
8/31/92	8/31/92	63	90	52	92
	9/1/92	58	90		
	9/2/92	57	92		
	9/3/92	57	91		
	9/4/92	64	90		
	9/5/92	58	89		
	9/6/92	52	90		
9/7/92	9/7/92	N/A	N/A	53	90
	9/8/92	53	90		

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
	9/9/92	54	90		
	9/10/92	58	90		
	9/11/92	58	90		
	9/12/92	54	90		
	9/13/92	54	89		
9/14/92	9/14/92	56	89	50	90
	9/15/92	55	90		
	9/16/92	54	90		
	9/17/92	50	90		
	9/18/92	52	90		
	9/19/92	54	90		
	9/20/92	52	90		
9/21/92	9/21/92	53	89	53	90
	9/22/92	56	90		
	9/23/92	61	90		
	9/24/92	60	90		
	9/25/92	58	90		
	9/26/92	60	89		
	9/27/92	53	89		
9/28/92	9/28/92	59	88	58	90
	9/29/92	58	88		
	9/30/92	64	90		
	10/1/92	66	90		
	10/2/92	90	90		
	10/3/92	71	90		
	10/4/92	65	90		
10/5/92	10/5/92	52	80	52	90
	10/6/92	62	90		
	10/7/92	65	90		
	10/8/92	62	89		
	10/9/92	54	88		
	10/10/92	53	88		
	10/11/92	74	88		
10/12/92	10/12/92	N/A	N/A	42	90
	10/13/92	42	86		
	10/14/92	50	88		
	10/15/92	44	90		
	10/16/92	46	89		
	10/17/92	46	88		
	10/18/92	49	88		
10/19/92	10/19/92	45	76	44	91

Table D-2. Continued.

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
	10/20/92	45	87		
	10/21/92	50	90		
	10/22/92	45	89		
	10/23/92	60	90		
	10/24/92	44	91		
	10/25/92	51	90		
10/26/92	10/26/92	54	90	46	90
	10/27/92	50	90		
	10/28/92	53	90		
	10/29/92	46	90		
	10/30/92	51	90		
	10/31/92	48	90		
	11/1/92	51	88		
11/2/92	11/2/92	58	90	50	90
	11/3/92	50	90		
	11/4/92	58	90		
	11/5/92	65	89		
	11/6/92	52	88		
	11/7/92	72	90		
	11/8/92	70	90		
11/9/92	11/9/92	73	90	40	92
	11/10/92	55	84		
	11/11/92	51	87		
	11/12/92	54	92		
	11/13/92	66	88		
	11/14/92	44	78		
	11/15/92	40	80		
11/16/92	11/16/92	54	80	50	92
	11/17/92	64	92		
	11/18/92	54	90		
	11/19/92	50	88		
	11/20/92	64	90		
	11/21/92	68	90		
	11/22/92	67	90		
11/23/92	11/23/92	60	88	56	91
	11/24/92	65	88		
	11/25/92	58	89		
	11/26/92	56	90		
	11/27/92	82	90		

Table D-2. Continued.

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
	11/28/92	60	90		
	11/29/92	57	91		
11/30/92	11/30/92	40	91	40	92
	12/1/92	55	92		
	12/2/92	68	91		
	12/3/92	44	89		
	12/4/92	50	91		
	12/5/92	68	92		
	12/6/92	57	90		
12/7/92	12/7/92	63	90	44	92
	12/8/92	72	92		
	12/9/92	54	91		
	12/10/92	60	90		
	12/11/92	49	69		
	12/12/92	44	89		
	12/13/92	47	92		
12/14/92	12/14/92	46	89	46	90
	12/15/92	61	88		
	12/16/92	61	90		
	12/17/92	54	84		
	12/18/92	49	89		
	12/19/92	53	88		
	12/20/92	51	90		
12/21/92	12/21/92	N/A	N/A	44	90
	12/22/92	N/A	N/A		
	12/23/92	54	88		
	12/24/92	44	88		
	12/25/92	63	88		
	12/26/92	58	88		
	12/27/92	58	90		
12/28/92	12/28/92	N/A	N/A	54	90
	12/29/92	63	88		
	12/30/92	69	88		
	12/31/92	67	88		
	1/1/93	60	88		
	1/2/93	54	89		
	1/3/93	55	90		
1/4/93	1/4/93	71	90	62	90
	1/5/93	62	88		

Table D-2. Continued.

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
	1/6/93	73	89		
	1/7/93	66	88		
	1/8/93	66	88		
	1/9/93	N/A	N/A		
	1/10/93	N/A	N/A		
1/11/93	1/11/93	60	90	45	91
	1/12/93	66	90		
	1/13/93	58	91		
	1/14/93	76	90		
	1/15/93	66	90		
	1/16/93	45	91		
	1/17/93	48	90		
1/18/93	1/18/93	N/A	N/A	45	89
	1/19/93	45	88		
	1/20/93	54	88		
	1/21/93	54	89		
	1/22/93	53	88		
	1/23/93	54	88		
	1/24/93	58	88		
1/25/93	1/25/93	83	94	36	95
	1/26/93	78	95		
	1/27/93	36	90		
	1/28/93	40	90		
	1/29/93	44	90		
	1/30/93	52	87		
	1/31/93	43	90		
2/1/93	2/1/93	48	89	46	92
	2/2/93	50	90		
	2/3/93	46	92		
	2/4/93	54	91		
	2/5/93	62	92		
	2/6/93	59	91		
	2/7/93	50	81		
2/8/93	2/8/93	64	92	34	92
	2/9/93	60	90		
	2/10/93	52	88		
	2/11/93	54	88		
	2/12/93	63	90		
	2/13/93	34	90		

Table D-2. Continued.

Observation Dates		Percent Relative Humidity			
Week		Daily		Weekly	
Beginning	Day	Minimum	Maximum	Minimum	Maximum
	2/14/93	N/A	N/A		
2/15/93	2/15/93	40	82	34	90
	2/16/93	55	90		
	2/17/93	77	90		
	2/18/93	44	87		
	2/19/93	34	78		
	2/20/93	44	90		
	2/21/93	58	88		
2/22/93	2/22/93	80	88	34	90
	2/23/93	34	78		
	2/24/93	37	85		
	2/25/93	46	89		
	2/26/93	88	90		
	2/27/93	48	90		
	2/28/93	39	88		
3/1/93	3/1/93	N/A	N/A	36	92
	3/2/93	36	84		
	3/3/93	52	92		
	3/4/93	52	90		
	3/5/93	48	86		
	3/6/93	44	92		
	3/7/93	60	89		
3/8/93	3/8/93	42	89	34	93
	3/9/93	34	89		
	3/10/03	35	90		
	3/11/93	40	90		
	3/12/93	42	93		
	3/13/93	50	84		
	3/14/93	44	80		

N/A - Data not available due to equipment failures.

3/2/93 Bromide Tracer Test

2/22/93 Sample Days at USF

Table D-3. Precipitation Recorded Near USF Site

Observation Dates		Precipitation Events			
Week Beginning	Sample Dates	Days	Time (range)	Daily Total (inches)	Weekly Total (inches)
8/3/92-8/10/92		8/4/92	2:00 P.M.	1.30	
		8/9/92	2:00 P.M. - 2:30 P.M.	1.80	
		8/9/92	4:00 P.M. - 4:30 P.M.	0.55	
		8/9/92	9:30 P.M. - 10:00P.M.	0.10	3.75
8/10/92-8/17/92	8/11/92-LY	8/11/92	3:00 P.M. - 4:00 P.M.	0.70	
		8/12/92	12:00 P.M. - 2:00 P.M.	1.20	
		8/12/92	7:00 P.M. - 8:00 P.M.	0.15	
		8/13/92	10:00 P.M. - 10:30 P.M	0.10	
		8/13/92	11:00 P.M. - 11:30 P.M.	0.15	
		8/14/92	4:00 P.M. - 5:00 P.M.	1.30	
		8/15/92	12:30 P.M. - 1:00P.M.	0.20	
		8/16/92	6:00 P.M. - 6:30 P.M.	0.05	3.85
8/17/92-8/24/94		8/22/92	7:00 P.M. - 10:00 P.M.	1.65	1.65
8/24/92-8/31/92		8/28/92	10:00 P.M. - 3:00 P.M.	1.20	
		8/29/92	8:00 A.M. - 4:00 P.M.	2.65	
		8/30/92	12:30 P.M. - 1:00 P.M.	0.40	4.25
8/31/92-9/7/92		9/3/92	10:00 A.M. - 8:00 P.M.	0.80	
		9/4/92	12:00 P.M. 12:00 A.M.	0.70	1.50
9/8/92-9/14/92	9/11/92-LY	9/11/92	12:30 P.M. - 1:00 P.M.	1.05	1.05
9/14/92-9/21/92	9/15/92-LY	N/P	N/P	N/P	
		9/14/92	9:00 PM - 9:30 P.M.	0.05	
		9/17/92	10:00 P.M. - 11:00 P.M.	0.15	0.20
9/21/92-9/28/92	9/22/92-LY	N/P	N/P	N/P	
		9/23/92	5:00 A.M. - 6:00 A.M.	0.70	
		9/23/92	9:00 P.M. - 10:00 P.M.	0.05	
		9/25/92	4:30 A.M. - 5:00 A.M.	0.20	
		9/26/92	3:00 A.M. - 5:00 A.M.	0.40	1.35
9/28/92-10/5/92		10/1/92	6:00 P.M. - 12:00 A.M.	0.20	

Table D-3. Continued.

Observation Dates		Precipitation Events			
Week Beginning	Sample Dates	Days	Time (range)	Daily Total (inches)	Weekly Total (inches)
		10/2/92	12:01 A.M. - 12:00 A.M.	3.10	3.30
10/5/92-10/12/92	10/5/92-PAN	N/A	N/A	N/A	N/A
10/12/92-10/19/92		N/P	N/P	N/P	N/P
10/19/92-10/25/92	10/21/92-LY	N/P	N/P	N/P	N/P
10/25/92-11/2/92		N/P	N/P	N/P	N/P
11/2/92-11/11/92		11/5/92	6:00 P.M. - 10:00 P.M.	0.35	
		11/7/92	10:30 A.M. - 12:00 P.M.	0.15	0.50
11/11/92-11/16/92		11/14/92	8:00 P.M. - 10:00 P.M	0.40	0.40
11/16/92-11/23/92		11/22/92	11:00 A.M. - 1:00 P.M.	0.15	0.15
11/23/92-11/30/92		11/27/92	3:00A.M. - 6:00 P.M.	1.40	1.40
11/30/92-12/7/92		12/2/92	3:00 A.M. - 4:00 A.M.	0.10	0.10
12/7/92-12/14/92	12/8/92-LY	N/P	N/P	N/P	
	12/9/92-LY	N/P	N/P	N/P	
	12/10/92-LY	12/10/92	7:00A.M. - 8:00 A.M.	0.45	0.45
12/14/92-12/21/92		N/P	N/P	N/P	N/P
12/21/92-12/29/92	12/21/92-PAN	N/A	N/A	N/A	
	12/22/92-PAN	N/A	N/A	N/A	N/A
12/29/92-1/4/93		N/P	N/P	N/P	N/P
1/4/93-1/11/93	1/4/93-PAN	1/4/93	1:00 P.M. - 1:30 P.M.	0.55	
	1/5/93-PAN	N/P	N/P	N/P	
		1/6/93	1:00 P.M. - 1:30 P.M.	0.05	
		1/8/93	8:30 P.M. - 12:00 A.M.	0.25	

Table D-3. Continued.

Observation Dates		Precipitation Events			
Week Beginning	Sample Dates	Days	Time (range)	Daily Total (inches)	Weekly Total (inches)
		1/9/93	12:01 A.M. - 6:00 A.M.	0.70	
		1/10/93	6:00 P.M. - 12:00 A.M.	0.05	
		1/11/93	12:01 A.M - 3:00 P.M.	0.50	2.10
1/11/93-1/18/93	1/11/93-PAN	N/P	N/P	N/P	
	1/12/93-PAN	N/P	N/P	N/P	
		1/14/93	3:30 P.M. - 4:00 P.M.	0.25	
		1/15/93	4:00 P.M. - 8:30 P.M.	1.40	
		1/16/93	5:00 A.M. - 5:30 A.M.	0.20	1.85
1/18/93-1/25/93	1/18/93-PAN	N/P	N/P	N/P	
	1/19/93-PAN	N/P	N/P	N/P	
	1/20/93-LY	N/P	N/P	N/P	
	1/21/93-LY	N/P	N/P	N/P	N/P
1/25/93-2/1/93	1/25/93-PAN	1/25/93	4:00 P.M. - 12:00 A.M.	0.50	
	1/26/93-PAN	1/26/93	12:01 A.M. - 6:30 A.M.	0.55	
		1/26/93	9:00 P.M. - 12:00 A.M.	0.70	
	1/27/93-LY	1/27/93	12:01 A.M. - 2:30 A.M.	0.15	1.90
	1/28/93-LY	N/P	N/P	N/P	
2/1/93-2/8/93	2/3/93-PAN	N/P	N/P	N/P	
	2/4/93-PAN	N/P	N/P	N/P	
	2/7/93-BRT	N/P	N/P	N/P	N/P
2/8/93-2/15/93	2/8/93-BRT	N/P	N/P	N/P	
	2/9/93-BRT	N/P	N/P	N/P	
	2/10/93-BRT	N/P	N/P	N/P	
	2/11/93-BRT	2/11/93	7:30 P.M. - 8:00 P.M.	0.60	
	2/12/93-BRT	N/P	N/P	N/P	0.60
2/15/93-2/22/93	2/15/93-BRT	N/P	N/P	N/P	
	2/17/93-BRT	2/17/93	2:00 A.M. - 3:30 A.M.	0.65	
	2/19/93-BRT	N/P	N/P	N/P	0.65

Table D-3. Continued.

Observation Dates		Precipitation Events			
Week Beginning	Sample Dates	Days	Time (range)	Daily Total (inches)	Weekly Total (inches)
2/22/93-3/2/93	2/22/93-BRT	2/22/93	2:00 P.M. - 3:00 P.M.	1.05	
	2/26/93-BRT	2/26/93	6:00 A.M. - 9:00 A.M.	0.70	1.75
3/2/93-3/8/93	3/2/93-BRT	N/P	N/P	N/P	
		3/3/93	N/A	1.23	
		3/6/93	N/A	0.01	
		3/7/93	N/A	0.02	1.26
3/8/93-3/15/93		3/13/93	4:00 P.M - 12:00 A.M.	1.25	
		3/14/93	12:01 A.M. - 12:00 P.M.	1.20	2.45

N/A - Not available instrument failure

N/P - No precipitation recorded

APPENDIX E

SOIL MONITORING DATA

TABLE E-1: Tensiometer Measurements Below Selected Infiltration Cells (millibars).

Cell Number	3			4	5			6	7	8	10	11	13		14				15				16	18		19
Variable Levels	STE HIGH LOADING			WATER LOW LOADING	STE LOW LOADING			STE HIGH LOADING	WATER HIGH LOADING	STE LOW LOADING	NO LOADING	NO LOADING	STE LOW LOADING		STE HIGH LOADING				STE LOW LOADING				WATER HIGH LOADING	STE HIGH LOADING		WATER LOW LOADING
Tensiometer Depth	SM-0.5**	SM-1.0	SM-2.0	SM-0.5	SM-0.5	SM-1.0	SM-2.0	SM-0.5	SM-0.5	SM-0.5	SM-0.5	SM-0.5	SM-0.5	SM-2.0	SM-0.5	SM-1.0	SM-2.0	SM-4.0	SM-0.5	SM-1.0	SM-2.0	SM-4.0	SM-0.5	SM-0.5	SM-2.0	SM-0.5
Date	Corrected Tensiometer Reading (mbars).*																									
8/25/92	45.08	40.13	21.24	47.38	46.97	42.43	26.84	50.57	49.58	48.48	NA	41.88	49.58	50.75	64.99	46.04	41.55	46.47	45.58	34.94	53.05	42.17	47.78	57.88	38.84	46.09
9/3/92	45.08	50.13	33.24	50.38	46.97	54.43	42.84	47.57	45.58	48.48	73.88	55.88	46.58	64.75	54.99	48.04	57.55	44.47	53.58	60.94	67.05	49.17	44.78	55.88	54.84	48.09
10/21/92	49.08	52.13	34.24	53.38	47.97	54.43	42.84	50.57	45.58	50.48	81.88	57.88	47.58	64.75	54.99	52.04	61.55	46.47	55.58	62.94	69.05	50.17	46.78	55.88	58.84	50.09
12/8/92	41.08	48.13	32.24	45.38	41.97	48.43	38.84	28.57	45.58	46.48	421.88	41.88	41.58	50.75	42.99	48.04	55.55	40.47	49.58	56.94	61.05	46.17	44.78	44.88	50.84	54.09
12/21/92	35.08	50.13	34.24	49.38	34.97	50.43	40.84	34.57	39.58	43.48	327.88	46.88	35.58	60.75	32.99	50.04	68.55	42.47	51.58	56.94	62.05	46.17	38.78	38.88	58.84	56.09
1/4/92	60.08	66.13	38.24	49.38	53.97	60.43	37.84	68.57	40.58	68.48	256.88	52.88	67.58	64.75	71.99	68.04	61.55	40.47	59.58	61.94	62.05	45.17	39.78	63.88	58.84	57.09
1/11/93	37.08	46.13	28.24	48.38	37.97	44.43	32.84	36.57	32.59	36.59	232.88	37.88	35.58	52.75	34.99	46.04	51.55	40.47	47.58	52.94	53.05	44.17	42.78	34.79	43.36	42.39
1/18/93	44.08	44.13	26.24	47.38	41.97	44.43	33.84	46.57	44.59	43.59	57.88	43.88	46.58	52.75	38.99	46.04	47.55	36.47	45.58	44.94	53.05	39.17	42.78	45.79	42.36	46.39
1/25/93	51.08	52.13	36.24	91.38	44.97	46.43	40.84	31.57	81.59	48.59	86.88	61.88	49.58	60.75	47.99	52.04	55.55	31.47	52.58	52.94	59.05	47.17	84.78	47.79	50.36	86.39
1/28/93	32.08	48.13	28.24	42.38	35.97	46.43	34.84	34.57	44.59	42.59	52.88	40.88	35.58	53.75	24.99	52.04	53.55	34.47	47.58	51.94	49.05	38.17	34.78	41.79	49.36	42.39
2/1/93	44.08	54.13	34.24	46.38	41.97	50.43	40.84	42.57	44.59	45.59	71.88	50.88	43.58	58.75	40.99	50.04	57.55	40.47	49.58	56.94	59.05	42.17	42.78	43.79	50.36	46.39
2/8/93	47.08	53.13	34.24	50.38	47.97	49.43	38.84	46.57	49.59	49.59	91.88	62.88	44.58	57.75	45.99	50.04	53.55	43.47	55.58	58.94	57.05	46.17	46.78	48.79	50.36	49.39
2/9/93	53.08	41.13	38.24	55.38	49.97	50.43	40.84	44.57	54.59	54.59	89.88	63.88	50.58	58.75	52.99	55.04	56.55	44.47	31.58	57.94	59.05	42.17	52.78	55.79	54.36	57.39
2/10/93	49.08	40.13	39.24	49.38	43.97	50.43	39.84	46.57	48.59	48.59	91.88	65.88	46.58	58.75	45.99	52.04	56.55	42.47	52.58	56.94	57.05	45.17	48.78	50.79	54.36	51.39
2/11/93	42.08	39.13	40.24	47.38	39.97	45.43	39.84	40.57	44.59	44.59	83.88	66.88	43.58	60.75	40.99	52.04	58.55	44.47	47.58	56.94	58.05	45.17	43.78	43.79	56.36	49.39
2/12/93	43.08	40.13	40.24	46.38	38.97	49.43	40.84	40.57	40.59	44.59	83.88	67.88	41.58	58.75	39.99	50.04	55.55	44.47	49.58	58.94	59.05	44.17	42.78	42.79	56.36	49.39
2/15/93	43.08	39.13	37.24	48.38	41.97	50.43	39.84	42.57	44.59	44.59	81.88	64.88	42.58	58.75	40.99	52.04	56.55	44.47	47.58	54.94	58.05	44.17	44.78	43.79	54.36	50.39
2/16/93	35.08	39.13	38.24	47.38	37.97	53.43	40.84	35.57	40.59	44.59	80.88	63.88	30.58	58.75	29.99	54.04	57.55	42.47	49.58	54.94	59.05	44.17	38.78	43.79	58.36	49.39
2/17/93	49.08	48.13	36.24	57.38	43.97	52.43	38.84	46.57	46.59	48.59	79.88	61.88	41.58	56.75	46.99	50.04	56.55	42.47	51.58	54.94	57.05	44.17	48.78	49.79	54.36	50.39
2/19/93	43.08	51.13	36.24	47.38	41.97	48.43	36.84	46.57	46.59	44.59	71.88	45.88	41.58	56.75	44.99	52.04	53.55	40.47	51.58	52.94	55.05	46.17	46.78	48.79	52.36	49.39
2/22/93	45.08	52.13	58.24	47.38	41.97	51.43	38.84	42.57	48.59	48.59	74.88	45.88	43.58	N/A	42.99	52.04	57.55	39.47	51.58	52.94	55.05	42.17	46.78	48.79	55.36	50.39
2/26/93	55.08	52.13	34.24	47.38	49.97	50.43	36.84	46.57	46.59	51.59	65.88	41.88	47.58	56.75	48.99	54.04	55.55	38.47	53.58	56.94	55.05	42.17	48.78	50.79	52.36	50.39
3/2/93	53.08	54.13	34.24	47.38	43.97	52.43	36.84	48.57	50.59	52.59	65.88	45.88	49.58	54.75	50.99	54.04	57.55	40.47	55.58	56.94	53.05	40.17	50.78	51.79	54.36	52.39
SUM	933.63	994.80	745.13	1067.91	904.46	1044.07	808.68	905.02	979.41	995.79	2495.64	1142.52	926.25	1161.00	942.69	1077.86	1174.64	872.79	1047.25	1154.69	1222.02	933.51	971.36	1008.14	1103.43	1082.35
n	21	21	21	21	21	21	21	21	21	21	20	21	21	20	21	21	21	21	21	21	21	21	21	21	21	21
MEAN	44.46	47.37	35.48	50.85	43.07	49.72	38.51	43.10	46.64	47.42	124.78	54.41	44.11	58.05	44.89	51.33	55.94	41.56	49.87	54.99	58.19	44.45	46.26	48.01	52.54	51.54
ST. DEVIATION	6.48	6.86	7.14	9.86	4.75	4.11	3.76	8.50	9.20	6.05	101.25	10.13	7.46	4.26	10.94	4.57	5.27	3.78	5.44	6.06	4.61	2.87	9.72	6.92	5.53	8.94
MINIMUM	32.08	39.13	21.24	42.38	34.97	42.43	26.84	28.57	32.59	36.59	52.88	37.88	30.58	50.75	24.99	46.04	41.55	31.47	31.58	34.94	49.05	38.17	34.78	34.79	38.84	42.39
MAXIMUM	60.08	66.13	58.24	91.38	53.97	60.43	42.84	68.57	81.59	68.48	421.88	67.88	67.58	64.75	71.99	68.04	68.55	46.47	59.58	62.94	69.05	50.17	84.78	63.88	58.84	86.39

* Tensiometer readings corrected for elevation difference of manometer and ceramic cup.

** Tensiometer Depth In Feet (i.e. SM-0.5 = Soil Moisture Tension at 0.5 Feet Below The Infiltrative Surface).

Table E-2. Soil ORP Readings

Cell Number	3.0			4.0	5.0			7.0	10.0	13.0			14.0			16.0	19.0
ORP Depth	ORP-0.5	ORP-1.0	ORP-2.0	ORP-0.5	ORP-0.5	ORP-1.0	ORP-2.0	ORP-0.5	ORP-0.5	ORP-0.5	ORP-2.0	ORP-4.0	ORP-0.5	ORP-2.0	ORP-4.0	ORP-0.5	ORP-0.5
ORP Reading (mV)																	
8/25/92	395.3	390.8	947.4	355.7	354.1	338.1	388.4	374.6	475.6	354.6	340.0	377.0	363.1	360.0	372.7	341.9	356.1
9/3/92	349.9	292.2	851.8	345.5	319.8	361.8	305.8	373.5	480.3	290.6	266.9	337.6	306.5	300.9	269.0	367.7	372.6
10/21/92	371.3	314.4	932.8	353.8	336.9	375.0	326.5	370.4	473.7	253.9	292.1	320.5	307.3	312.4	333.1	357.4	353.9
12/8/92	362.8	287.5	746.6	298.6	350.7	372.1	351.7	341.7	488.7	272.1	273.2	281.9	293.8	240.8	304.7	323.0	326.9
12/21/92	366.0	288.5	701.0	289.7	349.6	362.1	325.0	330.0	491.0	261.7	271.5	261.7	277.5	258.7	303.5	314.2	319.8
1/4/93	359.5	275.3	675.9	288.3	320.2	360.9	331.0	324.4	485.7	247.2	269.6	247.1	262.5	257.7	290.5	307.2	312.9
1/11/93	359.2	270.2	690.7	290.6	318.9	353.3	343.4	324.7	490.3	261.7	266.5	251.3	312.7	254.8	269.7	316.2	314.3
1/18/93	332.9	291.0	705.3	297.4	342.7	346.2	340.6	330.5	501.3	269.2	261.6	240.7	306.9	256.6	268.4	319.4	322.6
1/25/93	357.2	290.9	727.1	263.4	325.8	356.2	334.9	315.3	495.0	255.0	257.8	235.4	273.9	262.8	269.4	301.9	299.0
2/1/93	356.4	292.8	727.8	300.3	345.7	352.1	342.5	323.3	498.7	261.0	256.8	232.5	339.8	258.7	278.4	325.7	317.0
2/10/93	375.1	292.7	684.1	311.2	315.1	350.5	311.4	322.9	497.4	256.0	228.1	240.7	300.5	277.6	301.0	356.6	324.7
2/15/93	379.5	298.5	708.8	309.4	328.5	272.3	356.3	322.9	498.8	260.8	263.3	242.9	285.4	276.9	344.0	336.4	323.2
2/22/93	379.3	291.0	705.3	318.0	349.8	340.5	363.3	319.6	493.4	262.4	261.4	244.5	285.5	274.6	331.3	337.7	321.7
2/26/93	380.8	290.4	674.8	321.0	346.0	343.8	365.1	318.5	497.8	250.8	360.3	245.6	301.7	274.4	321.9	341.5	323.3
3/2/93	376.3	286.8	663.3	316.5	330.1	342.2	365.5	317.2	498.1	225.8	259.2	226.1	281.1	270.5	315.5	332.6	314.5
SUM	5,501.5	4,453.0	11,142.7	4,659.4	5,033.9	5,227.1	5,151.4	5,009.5	7,365.8	3,982.8	4,128.3	3,985.5	4,498.2	4,137.4	4,573.1	4,979.4	4,902.5
n	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
MEAN	366.8	296.9	742.8	310.6	335.6	348.5	343.4	334.0	491.1	265.5	275.2	265.7	299.9	275.8	304.9	332.0	326.8
STANDARD DEVIATION	15.3	27.7	91.7	25.8	13.6	23.8	22.2	21.1	8.7	28.2	33.3	44.4	25.8	29.5	31.7	19.1	19.2
MINIMUM	332.9	270.2	663.3	263.4	315.1	272.3	305.8	315.3	473.7	225.8	228.1	226.1	262.5	240.8	268.4	301.9	299.0
MAXIMUM	395.3	390.8	947.4	355.7	354.1	375.0	388.4	374.6	501.3	354.6	360.3	377.0	363.1	360.0	372.7	367.7	372.6

Table E-3: Soil Temperature At Lysimeter Station

	Background	Cell 6		Cell 10		Cell 14		
		6T-0.5	6T-2.0	10T-.05	10T-2.0	14T-0.5	14T-2.0	14T-4.0
Date								
8/25/92	N/A	28.0	26.0	28.0	26.0	28.0	27.0	27.0
9/3/92	N/A	26.0	24.0	26.0	26.0	26.0	26.0	26.0
12/8/92	N/A	19.0	18.8	19.0	19.8	18.8	19.3	21.0
12/21/92	N/A	19.0	18.5	19.0	19.2	18.7	18.5	20.0
1/4/93	N/A	20.0	19.8	20.0	20.0	19.5	19.8	20.5
1/11/93	N/A	21.5	20.5	21.0	20.5	21.0	20.5	21.0
1/18/93	N/A	20.0	20.0	20.0	20.5	19.5	20.0	21.0
1/25/93	N/A	20.5	20.0	20.0	20.5	20.0	20.0	21.0
2/1/93	N/A	18.0	18.0	18.5	19.0	17.5	18.5	20.0
2/10/93	18.5	17.5	17.0	17.5	18.0	17.0	17.5	18.5
2/15/93	18.5	18.0	17.5	18.0	18.0	17.5	18.0	19.0
2/17/93	N/A	18.0	18.0	18.5	18.0	18.0	18.0	18.0
2/19/93	N/A	18.0	18.0	18.0	18.5	18.0	18.0	19.0
2/26/93	N/A	18.0	18.0	18.0	18.0	17.0	18.0	19.0
3/2/93	18.0	18.0	17.5	17.5	18.0	17.0	17.5	19.0
SUM	55.0	299.5	291.6	299.0	300.0	293.5	296.6	310.0
n	3	15	15	15	15	15	15	15
MEAN	18.3	20.0	19.4	19.9	20.0	19.6	19.8	20.7
STD DEV.	.3	3.1	2.5	3.1	2.6	3.3	2.9	2.6
MIN.	18.0	17.5	17.0	17.5	18.0	17.0	17.5	18.0
MAX.	18.5	28.0	26.0	28.0	26.0	28.0	27.0	27.0

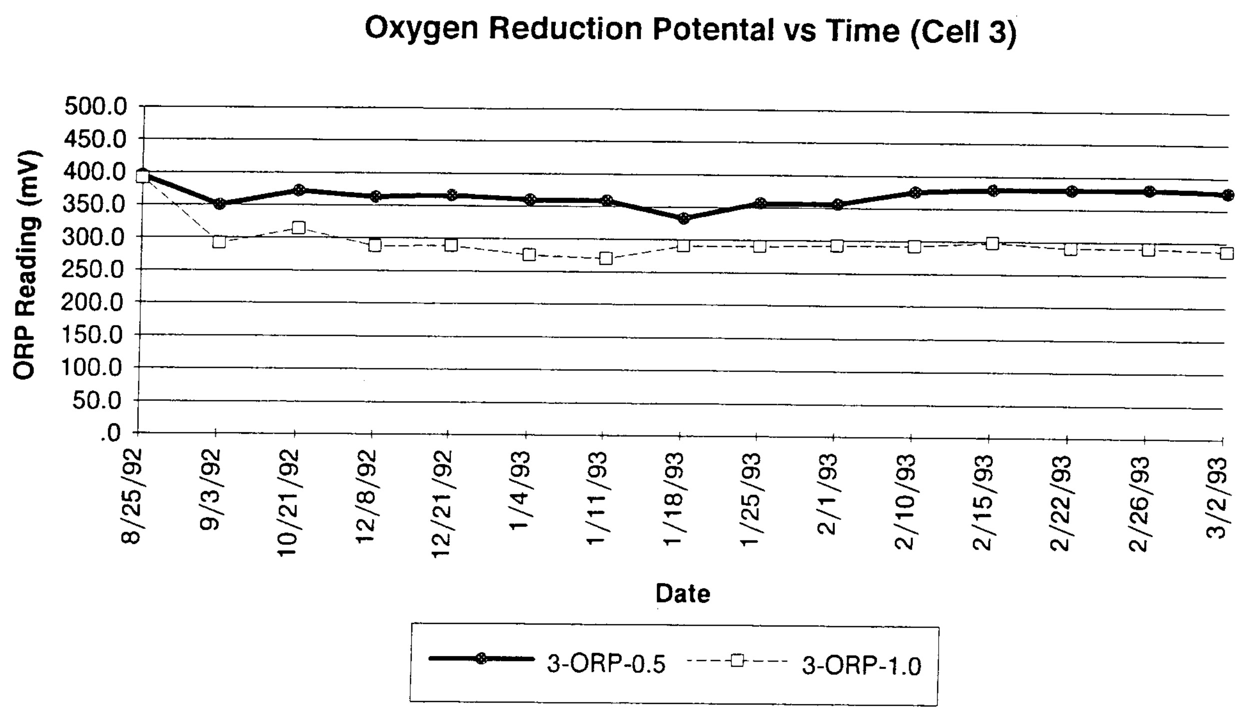


Figure E-1. ORP Measurements in Cell 3 (STE, High Loading).

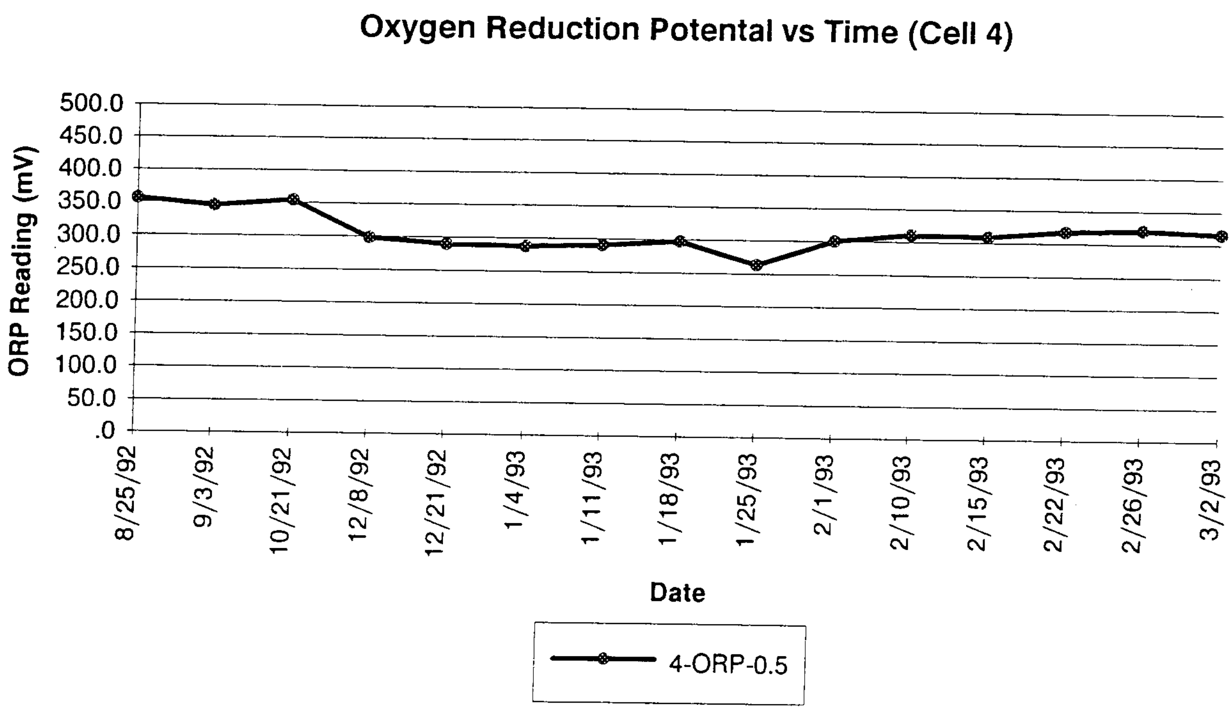


Figure E-2. ORP Measurements in Cell 4 (Water, Low-Loading).

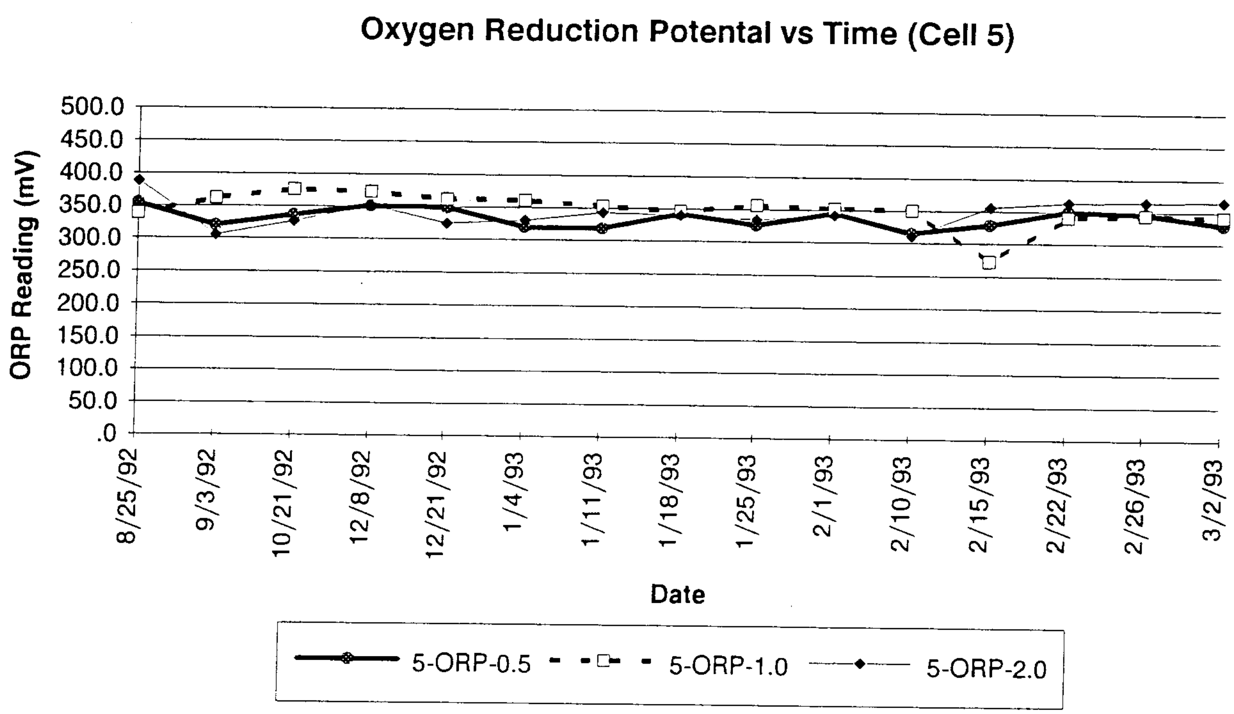


Figure E-3. ORP Measurements in Cell 5 (STE, Low-Loading).

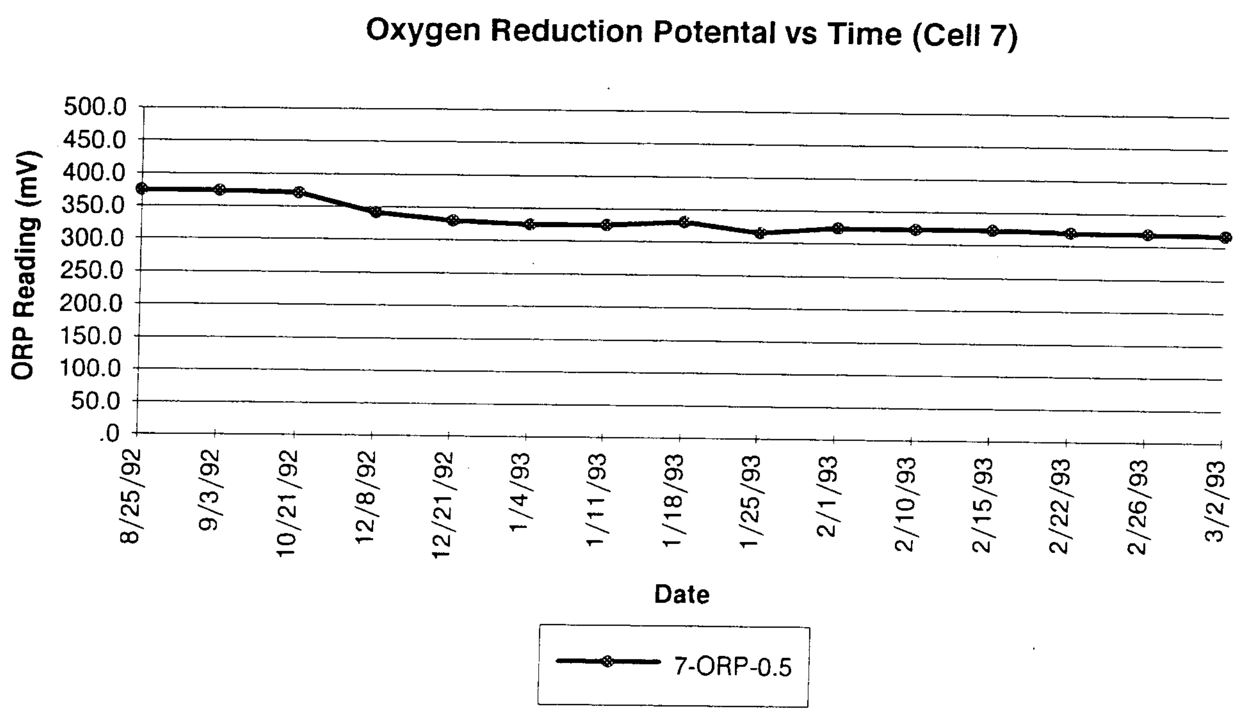


Figure E-4. ORP Measurements in Cell 7 (Water, High-Loading).

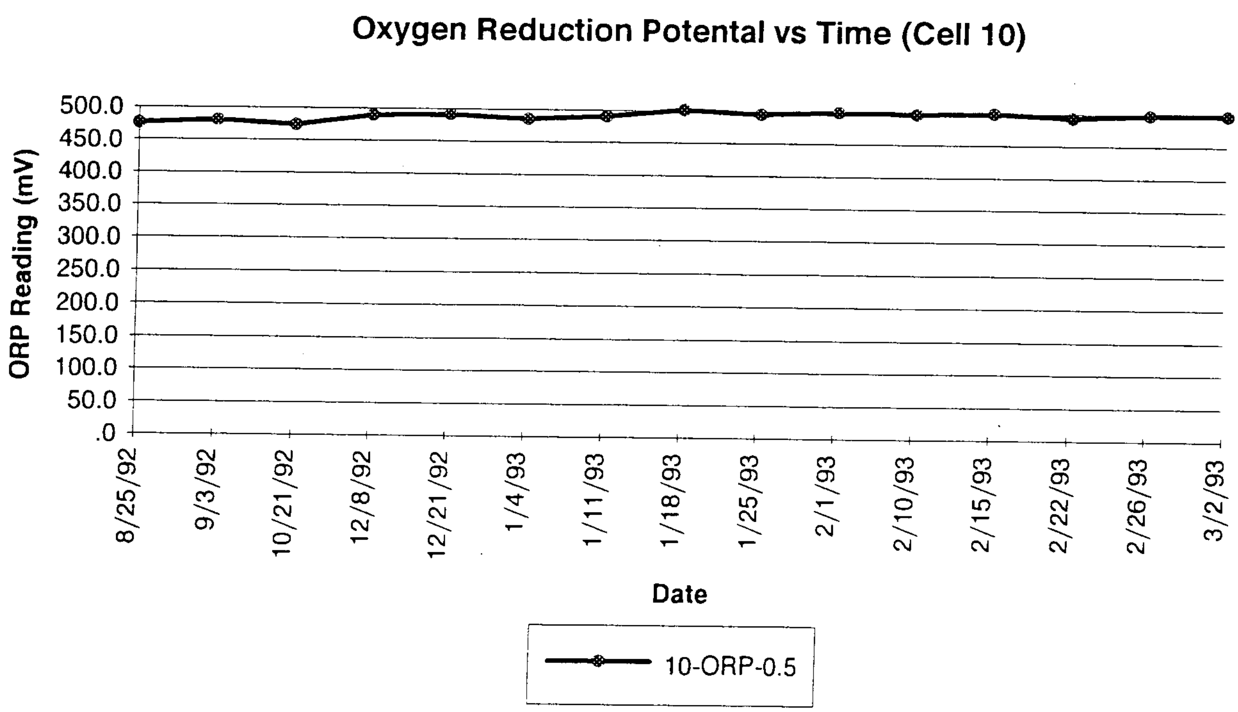


Figure E-5. ORP Measurements in Cell 10 (Control, No-Loading).

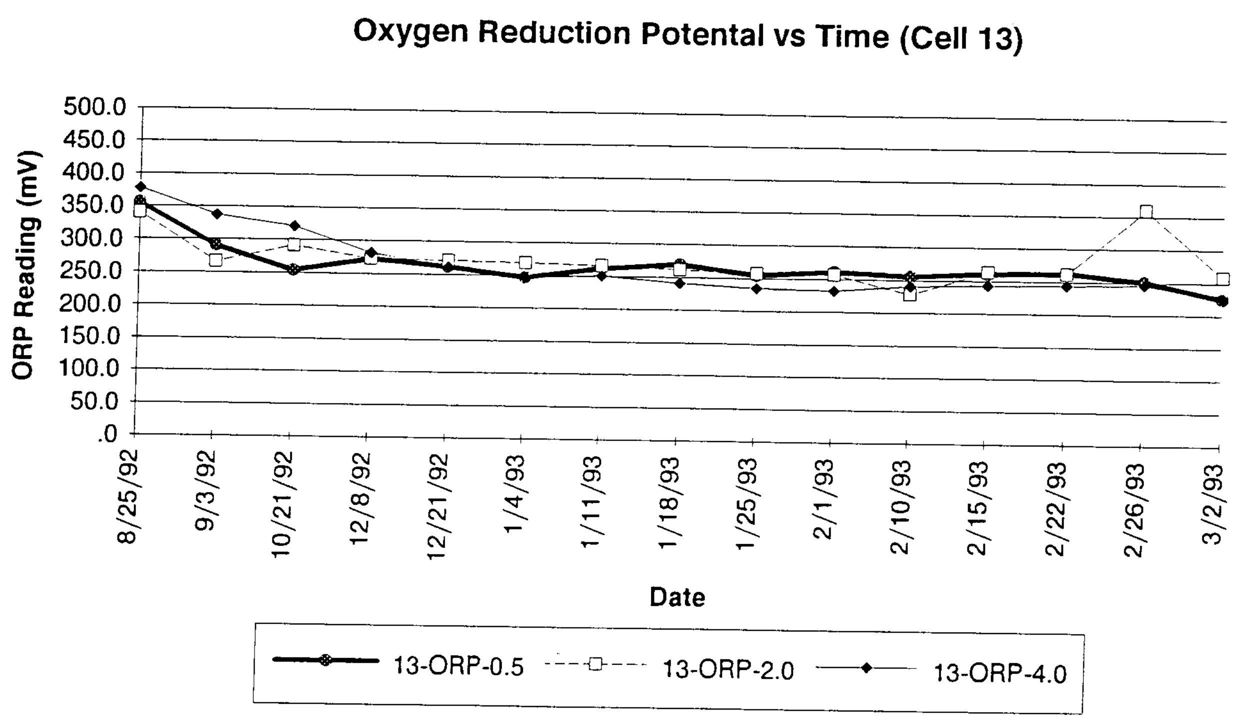


Figure E-6. ORP Measurements In Cell 13 (STE, Low-Loading).

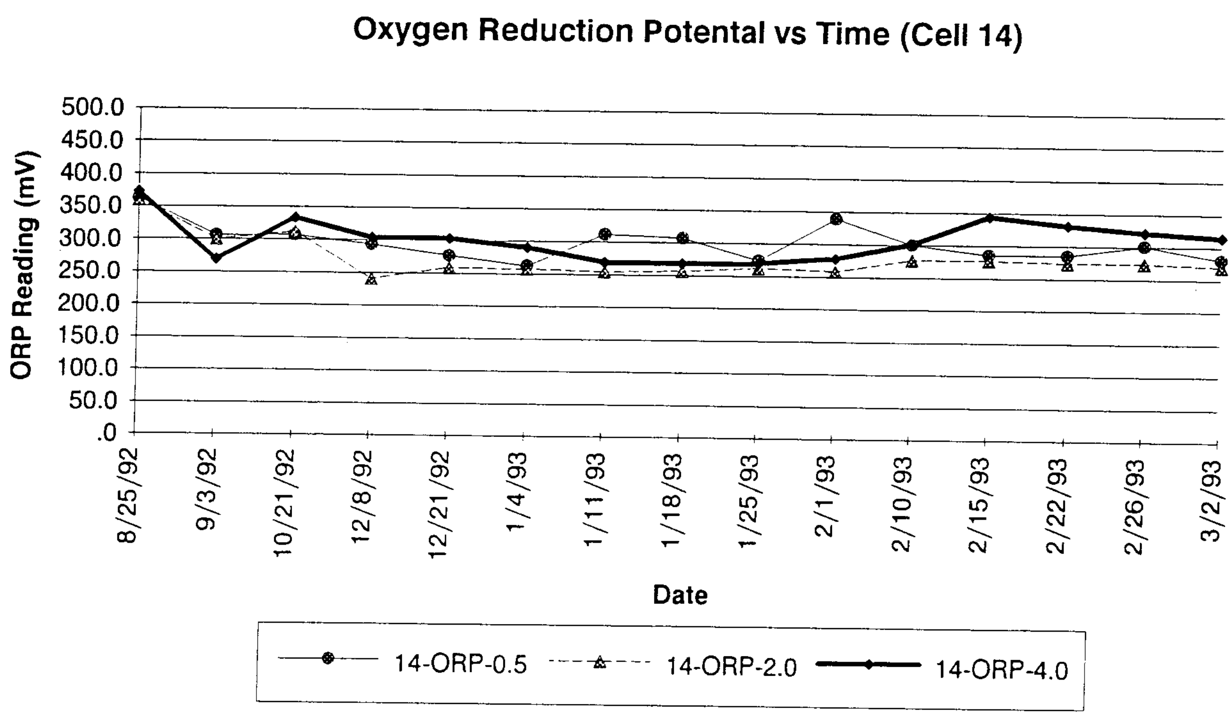


Figure E-7. ORP Measurements In Cell 14 (STE, High-Loading).

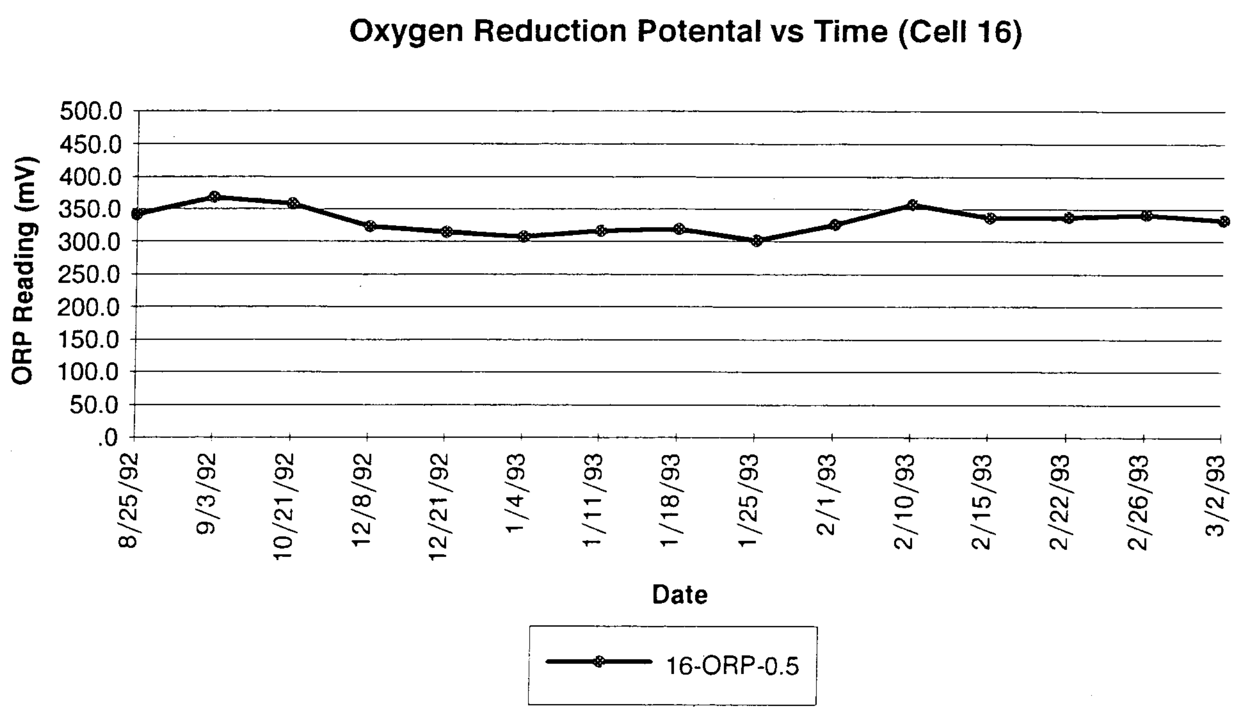


Figure E-8. ORP Measurements in Cell 16 (Water, High-Loading).

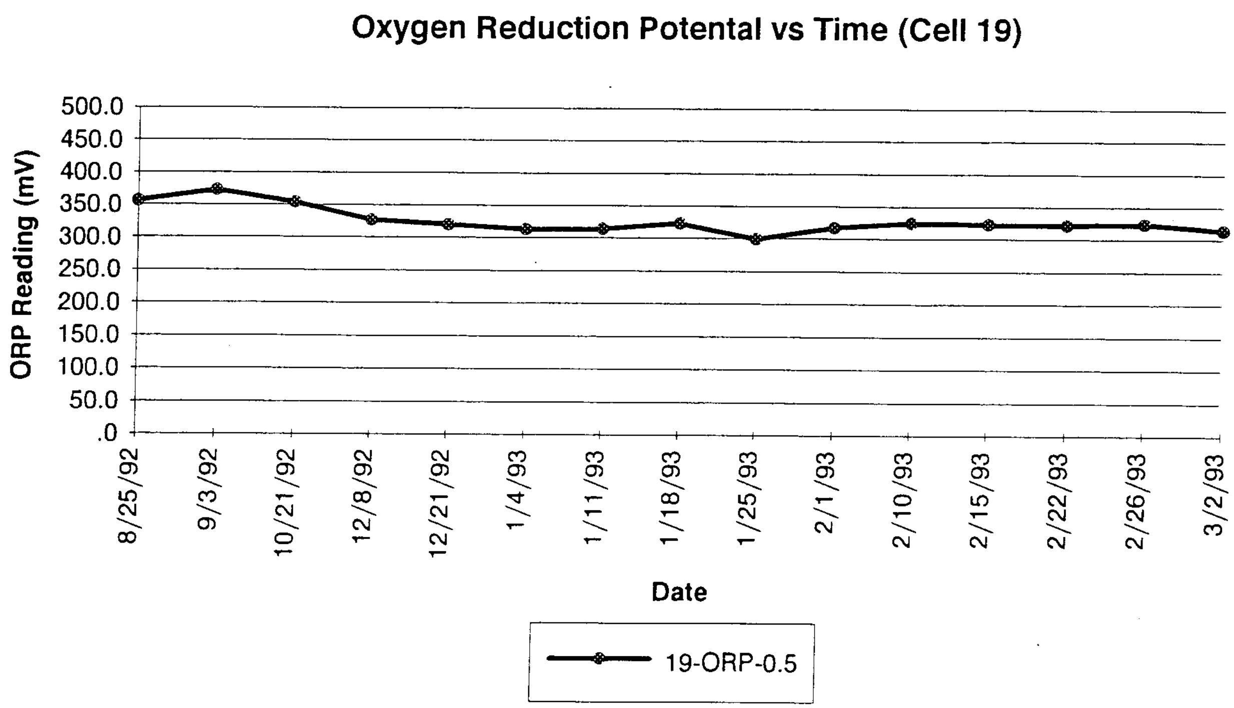


Figure E-9. ORP Measurements in Cell 19 (Water, Low-Loading).

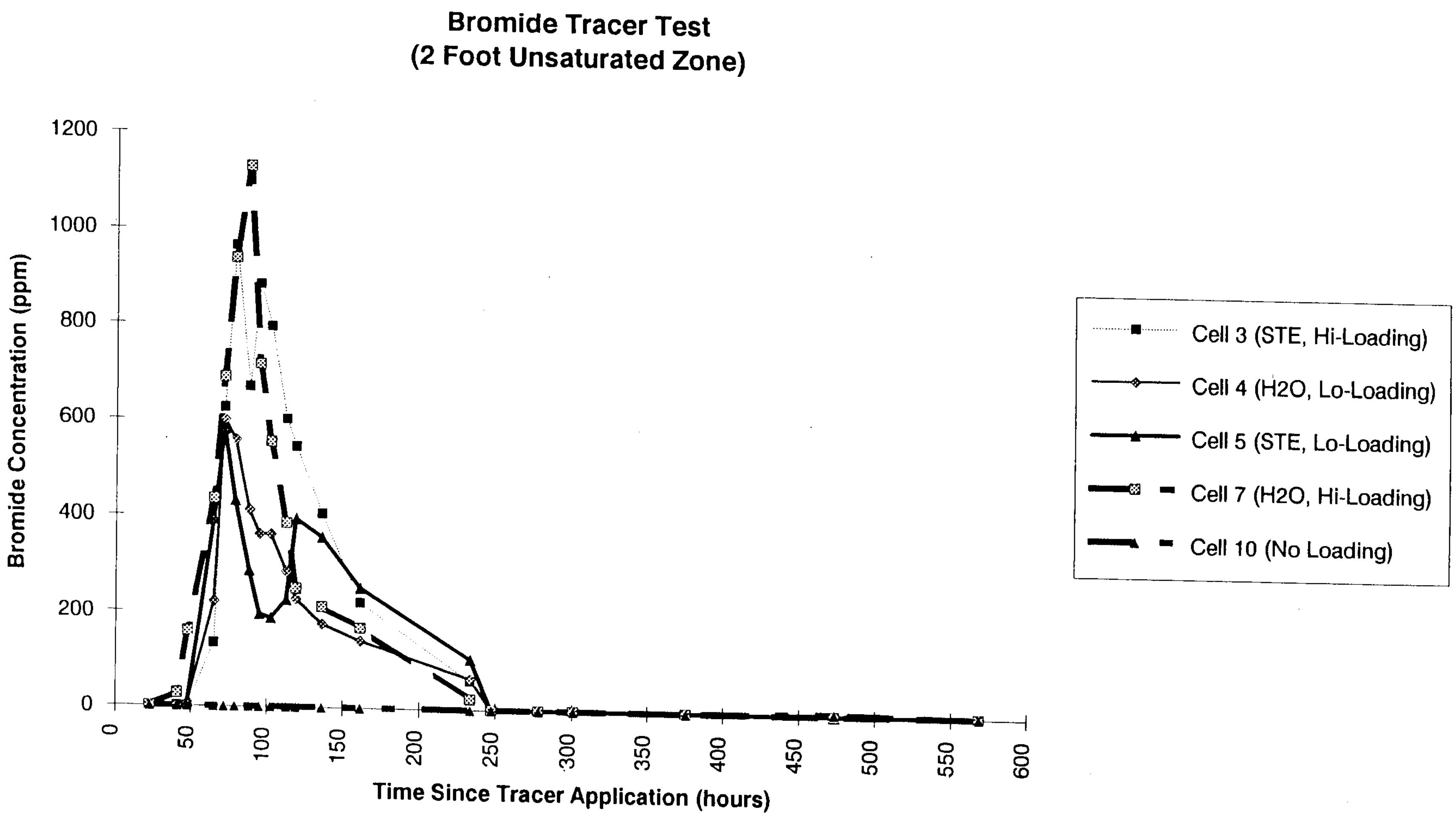


Figure E-10. Bromide Tracer Concentration vs Time (2 Foot Unsaturated Zone).

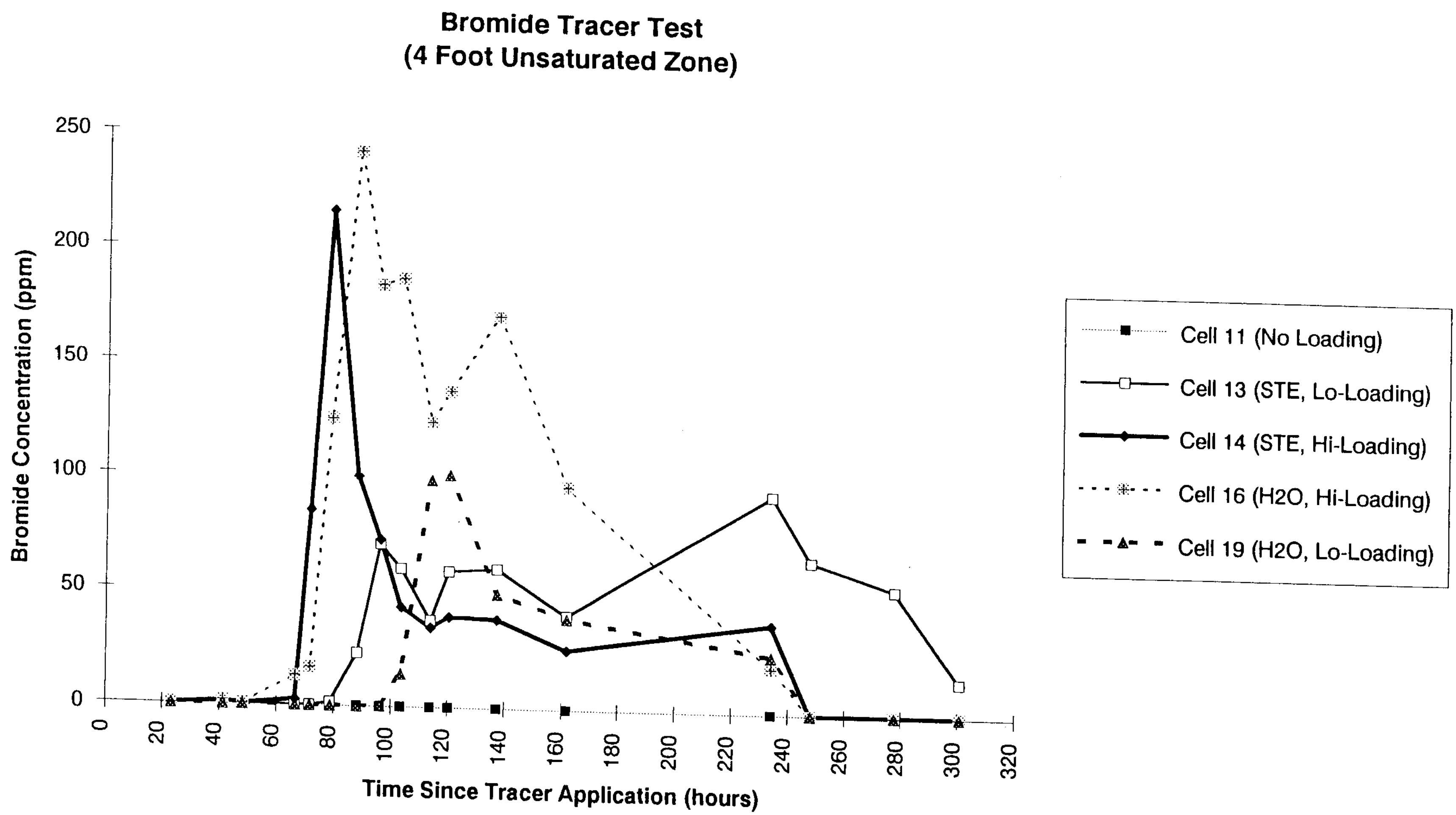


Figure E-11. Bromide Tracer Concentration vs Time (4 Foot Unsaturated Zone).

APPENDIX F

SOIL WATER QUALITY DATA

Table F-1. Total Organic Carbon (TOC) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

2 feet below infiltrative surface

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control Cell 10	0.75 gpd/ft2 Soil Water Results Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	H2O Control Cell 4
8/11/92	Ceramic Cup	TOC	68.00	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TOC	51.00	- -	- -	- -	10.00	12.00	11.00	1.41	- -
9/15/92	Ceramic Cup	TOC	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/22/92	Ceramic Cup	TOC	- -	- -	- -	- -	17.00	14.00	15.50	2.12	- -
10/5/92	S.S. Pan	TOC	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	TOC	36.00	- -	- -	- -	11.00	9.00	10.00	1.41	8.50
12/8-9/92	Ceramic Cup	TOC	65.00	- -	- -	- -	16.00	7.50	11.75	6.01	5.60
12/21-22/92	S.S. Pan	TOC	42.00	- -	- -	6.40	8.90	5.70	7.00	1.68	6.10
1/4-5/93	S.S. Pan	TOC	- -	- -	- -	5.10	6.90	6.50	6.17	0.95	6.10
1/11-12/93	S.S. Pan	TOC	33.00	- -	- -	4.80	7.20	5.50	5.83	1.23	5.80
1/18-19/93	S.S. Pan	TOC	49.00	- -	5.30	4.20	7.20	6.10	5.83	1.52	6.90
1/20-21/93	Ceramic Cup	TOC	- -	3.20	- -	- -	- -	8.10	8.10	NA	3.90
1/25-26/93	S.S. Pan	TOC	46.00	2.10	- -	13.00	9.40	7.90	10.10	2.62	- -
1/27-28/93	Ceramic Cup	TOC	- -	- -	- -	- -	- -	7.20	7.20	NA	3.10
2/3-4/93	S.S. Pan	TOC	53.00	3.60	6.50	3.70	4.90	4.70	4.43	0.64	4.80
		SUM	443.00	8.90	11.80	37.20	98.50	94.20	229.90		50.80
		n	9	3	2	6	10	12	28		9
		MEAN	49.22	2.97	5.90	6.20	9.85	7.85	8.21		5.64
		STD. DEV.	11.83	0.78	0.85	3.46	3.92	2.73	3.51		1.60
		MIN.	33.00	2.10	5.30	3.70	4.90	4.70	3.70		3.10
		MAX	68.00	3.60	6.50	13.00	17.00	14.00	17.00		8.50

Sample Date	1.5 gpd/ft2 Soil Water Results Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	H2O Control Cell 7
8/11/92	- -	- -	- -	- -	- -	- -
9/11/92	12.00	11.00	- -	11.50	0.71	- -
9/15/92	- -	- -	- -	- -	- -	- -
9/22/92	18.00	12.00	- -	15.00	4.24	- -
10/5/92	- -	- -	8.80	8.80	N/A	- -
10/21/92	13.00	8.60	- -	10.80	3.11	8.90
12/8-9/92	12.00	8.90	- -	10.45	2.19	4.90
12/21-22/92	9.30	9.70	6.20	8.40	1.92	4.10
1/4-5/93	11.00	9.90	7.50	9.47	1.79	5.50
1/11-12/93	7.40	7.60	6.50	7.17	0.59	3.90
1/18-19/93	7.70	7.90	6.90	7.50	0.53	4.80
1/20-21/93	6.70	7.40	- -	7.05	0.49	3.90
1/25-26/93	10.00	6.20	- -	8.10	2.69	6.10
1/27-28/93	5.30	11.00	- -	8.15	4.03	2.90
2/3-4/93	5.70	5.40	3.60	4.90	1.14	3.30
SUM	118.10	105.60	39.50	263.20		48.30
n	12	12	6	30		10
MEAN	9.84	8.80	6.58	8.77		4.83
STD. DEV.	3.64	2.01	1.73	2.92		1.73
MIN.	5.30	5.40	3.60	3.60		2.90
MAX	18.00	12.00	8.80	18.00		8.90

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit.
This value was used in statistical calculations.

Table F-2. Total Organic Carbon (TOC) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface												
					0.75 gpd/ft2						1.5 gpd/ft2						
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	TOC	68.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TOC	51.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	TOC	- -	- -	13.00	12.00	- -	12.50	0.71	- -	- -	- -	9.30	9.30	- -	- -
9/22/92	Ceramic Cup	TOC	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	TOC	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	TOC	36.00	- -	25.00	19.00	- -	22.00	4.24	- -	- -	9.20	17.00	13.10	5.52	8.40
12/8-9/92	Ceramic Cup	TOC	65.00	- -	7.00	9.70	- -	8.35	- -	47.00	- -	9.40	7.60	8.50	1.27	5.00
12/21-22/92	S.S. Pan	TOC	42.00	- -	5.90	9.80	6.30	7.33	2.15	9.20	8.10	10.00	8.20	8.77	1.07	9.30
1/4-5/93	S.S. Pan	TOC	- -	- -	6.10	10.00	6.40	7.50	2.17	8.00	6.40	7.20	6.90	6.83	0.40	8.10
1/11-12/93	S.S. Pan	TOC	33.00	- -	5.20	8.10	6.20	6.50	1.47	7.40	7.70	9.00	7.50	8.07	0.81	7.70
1/18-19/93	S.S. Pan	TOC	49.00	- -	5.50	7.60	6.80	6.63	1.06	8.00	7.30	13.00	9.30	9.87	2.89	8.10
1/20-21/93	Ceramic Cup	TOC	- -	3.20	5.70	5.70	- -	5.70	0.00	- -	- -	9.00	6.90	7.95	1.48	4.30
1/25-26/93	S.S. Pan	TOC	46.00	2.10	8.50	8.40	12.00	9.63	2.05	- -	16.00	18.00	9.10	14.37	4.67	- -
1/27-28/93	Ceramic Cup	TOC	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	TOC	53.00	3.60	4.40	6.80	5.20	5.47	1.22	4.50	6.00	5.60	7.70	6.43	1.12	4.60
		SUM	443.00	8.90	86.30	97.10	42.90	226.30		84.10	51.50	90.40	89.50	231.40		55.50
		n	9	3	10	10	6	26		6	6	9	10	25		8
		MEAN	49.22	2.97	8.63	9.71	7.15	8.70		14.02	8.58	10.04	8.95	9.26		6.94
		STD. DEV.	11.83	0.78	6.25	3.73	2.43	4.61		16.23	3.72	3.59	2.97	3.30		1.97
		MIN.	33.00	2.10	4.40	5.70	5.20	4.40		4.50	6.00	5.60	6.90	5.60		4.30
		MAX	68.00	3.60	25.00	19.00	12.00	25.00		47.00	16.00	18.00	17.00	18.00		9.30

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-3. Total Kjeldahl Nitrogen (TKN) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
						Soil Water Resulst					H2O Control	Soil Water Resulst					H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	TKN	53.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/11/92	Ceramic Cup	TKN	43.00	--	--	--	0.68	0.72	0.70	0.03	--	0.74	0.66	--	0.70	0.06	--
9/15/92	Ceramic Cup	TKN	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/22/92	Ceramic Cup	TKN	--	--	--	--	0.70	0.72	0.71	0.01	--	0.81	0.51	--	0.66	0.21	--
10/5/92	S.S. Pan	TKN	--	--	--	--	--	--	--	--	--		--	1.20	1.20	N/A	--
10/21/92	Ceramic Cup	TKN	40.00	--	--	--	0.74	0.87	0.81	0.09	0.35	0.92	1.30	--	1.11	0.27	0.30
12/8-9/92	Ceramic Cup	TKN	52.00	--	--	--	1.30	0.76	1.03	0.38	0.38	1.10	1.20	--	1.15	0.07	0.36
12/21-22/92	S.S. Pan	TKN	47.00	--	--	0.73	1.40	1.00	1.04	0.34	0.96	1.60	1.60	0.68	1.29	0.53	0.35
1/4-5/93	S.S. Pan	TKN	--	--	--	0.67	0.66	0.57	0.63	0.06	2.20	0.66	1.00	0.79	0.82	0.17	1.50
1/11-12/93	S.S. Pan	TKN	45.00	--	--	0.50	0.74	0.94	0.73	0.22	0.64	0.88	0.97	0.66	0.84	0.16	0.29
1/18-19/93	S.S. Pan	TKN	52.00	--	0.43	0.40	0.94	0.64	0.66	0.27	0.51	0.88	0.78	0.35	0.67	0.28	0.34
1/20-21/93	Ceramic Cup	TKN	--	1.30	--	--	--	0.87	0.87	--	0.21	0.88	0.74	--	0.81	0.10	0.25
1/25-26/93	S.S. Pan	TKN	41.00	1.50	--	0.44	1.10	0.81	0.78	0.33	--	1.10	0.76	0.54	0.80	0.28	0.88
1/27-28/93	Ceramic Cup	TKN	--	--	--	--	0.63	0.95	0.79	0.23	0.28	0.62	0.76	--	0.69	0.10	0.17
2/3-4/93	S.S. Pan	TKN	52.00	1.30	0.18	0.52	0.75	0.90	0.72	0.19	0.44	0.96	1.00	0.71	0.89	0.16	0.39
		SUM	425.00	4.10	0.61	3.26	9.64	9.75	22.65		5.97	11.15	11.28	4.93	27.36		4.83
		n	9	3	2	6	11	12	29		9	12	12	7	31		10
		MEAN	47.22	1.37	0.31	0.54	0.88	0.81	0.78		0.66	0.93	0.94	0.70	0.88		0.48
		STD. DEV.	5.19	0.12	0.18	0.13	0.27	0.13	0.23		0.62	0.26	0.31	0.26	0.29		0.41
		MIN.	40.00	1.30	0.18	0.40	0.63	0.57	0.40		0.21	0.62	0.51	0.35	0.35		0.17
		MAX	53.00	1.50	0.43	0.73	1.40	1.00	1.40		2.20	1.60	1.60	1.20	1.60		1.50

NOTE:
-- = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-4. Total Kjeldahl Nitrogen (TKN) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	4 feet below infiltrative surface: 0.75 gpd/ft2 Soil Water Resulst Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	H2O Control Cell 19	1.5 gpd/ft2 Soil Water Resulst Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	H2O Control Cell 16
8/11/92	Ceramic Cup	TKN	53.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TKN	43.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	TKN	- -	- -	0.48	0.52	- -	- -	- -	- -	- -	- -	0.57	- -	- -	- -
9/22/92	Ceramic Cup	TKN	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	TKN	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	TKN	40.00	- -	1.20	1.10	- -	1.15	0.07	- -	- -	0.75	1.10	0.93	0.25	0.52
12/8-9/92	Ceramic Cup	TKN	52.00	- -	0.88	0.93	- -	0.91	0.04	0.49	- -	1.00	1.10	1.05	0.07	0.44
12/21-22/92	S.S. Pan	TKN	47.00	- -	1.10	2.10	0.80	1.33	0.68	1.60	1.00	2.20	1.10	1.43	0.67	3.20
1/4-5/93	S.S. Pan	TKN	- -	- -	0.51	0.73	0.63	0.62	0.11	2.00	0.76	0.68	3.50	1.65	1.61	0.75
1/11-12/93	S.S. Pan	TKN	45.00	- -	0.56	0.91	0.66	0.71	0.18	0.74	0.97	1.40	1.30	1.22	0.23	1.40
1/18-19/93	S.S. Pan	TKN	52.00	- -	0.52	0.83	0.78	0.71	0.17	1.00	1.10	0.78	1.50	1.13	0.36	0.93
1/20-21/93	Ceramic Cup	TKN	- -	1.30	0.58	0.56	- -	0.57	0.01	- -	- -	0.88	0.76	0.82	0.08	0.32
1/25-26/93	S.S. Pan	TKN	41.00	1.50	0.59	0.67	0.70	0.65	0.06	- -	0.91	1.40	1.80	1.37	0.45	- -
1/27-28/93	Ceramic Cup	TKN	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2/3-4/93	S.S. Pan	TKN	52.00	1.30	0.90	0.25	0.79	0.65	0.35	0.46	0.84	0.94	1.30	1.03	0.24	0.71
																0.71
		SUM	425.00	4.10	7.32	8.60	4.36	20.28		6.29	5.58	10.03	14.03	29.64		8.98
		n	9	3	10	10	6	.26		6	6	9	10	25		9
		MEAN	47.22	1.37	0.73	0.86	0.73	0.78		1.05	0.93	1.11	1.40	1.19		1.00
		STD. DEV.	5.19	0.12	0.27	0.50	0.07	0.35		0.63	0.12	0.48	0.81	0.61		0.88
		MIN.	40.00	1.30	0.48	0.25	0.63	0.25		0.46	0.76	0.68	0.57	0.57		0.32
		MAX	53.00	1.50	1.20	2.10	0.80	2.10		2.00	1.10	2.20	3.50	3.50		3.20

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit.
This value was used in statistical calculations.

Table F-5. Nitrate-Nitrite Nitrogen (NO3-N) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
						Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	NO3-N	0.16	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	NO3-N	0.01	- -	- -	- -	29.00	25.00	27.00	2.83	- -	28.00	19.00	- -	23.50	6.36	- -
9/15/92	Ceramic Cup	NO3-N	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/22/92	Ceramic Cup	NO3-N	- -	- -	- -	- -	28.00	22.00	25.00	4.24	- -	27.00	20.00	- -	23.50	4.95	- -
10/5/92	S.S. Pan	NO3-N	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.01	- -	- -	- -
10/21/92	Ceramic Cup	NO3-N	0.01	- -	- -	- -	33.00	25.00	29.00	5.66	0.42	33.00	27.00	- -	30.00	4.24	0.01
12/8-9/92	Ceramic Cup	NO3-N	0.03	- -	- -	- -	39.00	39.00	39.00	0.00	0.65	37.00	38.00	- -	37.50	0.71	0.18
12/21-22/92	S.S. Pan	NO3-N	0.03	- -	- -	27.00	36.00	25.00	29.33	5.86	0.25	35.00	34.00	23.00	30.67	6.66	0.05
1/4-5/93	S.S. Pan	NO3-N	- -	- -	- -	27.00	36.00	32.00	31.67	4.51	0.15	29.00	31.00	20.00	26.67	5.86	0.01
1/11-12/93	S.S. Pan	NO3-N	0.03	- -	- -	28.00	31.00	21.00	26.67	5.13	0.07	21.00	22.00	12.00	18.33	5.51	0.05
1/18-19/93	S.S. Pan	NO3-N	0.03	- -	0.01	1.70	12.00	2.50	5.40	5.73	0.01	5.40	9.50	4.80	6.57	2.56	0.12
1/20-21/93	Ceramic Cup	NO3-N	- -	0.27	- -	- -	- -	29.00	29.00	N/A	0.13	33.00	34.00	- -	33.50	0.71	0.52
1/25-26/93	S.S. Pan	NO3-N	0.02	0.02	- -	15.00	28.00	9.70	17.57	9.42	- -	28.00	20.00	15.00	21.00	6.56	0.01
1/27-28/93	Ceramic Cup	NO3-N	- -	- -	- -	- -	34.00	19.00	26.50	10.61	0.08	33.00	6.10	- -	19.55	19.02	0.01
2/3-4/93	S.S. Pan	NO3-N	0.01	0.12	0.01	11.00	29.00	14.00	18.00	9.64	0.34	25.00	26.00	14.00	21.67	6.66	0.14
		SUM	0.33	0.41	0.02	109.70	335.00	263.20	707.90		2.10	334.40	286.60	88.81	709.81		1.10
		n	9	3	2	6	11	12	29		9	12	12	7	31		10
		MEAN	0.04	0.14	0.01	18.28	30.45	21.93	24.41		0.23	27.87	23.88	12.69	22.90		0.11
		STD. DEV.	0.05	0.13	0.00	10.82	7.15	9.86	10.12		0.21	8.40	9.77	8.07	10.41		0.16
		MIN.	0.01	0.02	0.01	1.70	12.00	2.50	1.70		0.01	5.40	6.10	0.01	0.01		0.01
		MAX	0.16	0.27	0.01	28.00	39.00	39.00	39.00		0.65	37.00	38.00	23.00	38.00		0.52

NOTE:
- - = Not Sampled
N/A = Not Applicable
[ ] = Shaded number indicates value less than detection limit.
This value was used in statistical calculations.

Table F-6. Nitrate-Nitrite Nitrogen (NO3-N) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	NO3-N	0.16	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	NO3-N	0.01	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	NO3-N	- -	- -	20.00	11.00	- -	- -	- -	- -	- -	- -	21.00	- -	- -	- -
9/22/92	Ceramic Cup	NO3-N	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	NO3-N	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	NO3-N	0.01	- -	29.00	29.00	- -	29.00	0.00	- -	- -	26.00	29.00	27.50	2.12	1.80
12/8-9/92	Ceramic Cup	NO3-N	0.03	- -	29.00	- -	- -	29.00	- -	- -	- -	34.00	35.00	34.50	0.71	0.61
12/21-22/92	S.S. Pan	NO3-N	0.03	- -	13.00	18.00	20.00	17.00	3.61	0.04	29.00	24.00	27.00	26.67	2.52	0.17
1/4-5/93	S.S. Pan	NO3-N	- -	- -	12.00	11.00	17.00	13.33	3.21	0.04	26.00	24.00	26.00	25.33	1.15	0.17
1/11-12/93	S.S. Pan	NO3-N	0.03	- -	10.00	22.00	19.00	17.00	6.24	0.04	30.00	25.00	34.00	29.67	4.51	0.07
1/18-19/93	S.S. Pan	NO3-N	0.03	- -	6.70	2.00	9.30	6.00	3.70	0.01	16.00	11.00	15.00	14.00	2.65	0.04
1/20-21/93	Ceramic Cup	NO3-N	- -	0.27	21.00	16.00	- -	18.50	3.54	- -	- -	27.00	28.00	27.50	0.71	1.10
1/25-26/93	S.S. Pan	NO3-N	0.02	0.02	12.00	2.90	15.00	9.97	6.30	- -	19.00	12.00	17.00	16.00	3.61	- -
1/27-28/93	Ceramic Cup	NO3-N	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	NO3-N	0.01	0.12	9.20	4.00	9.60	7.60	3.12	0.15	21.00	13.00	19.00	17.67	4.16	0.29
		SUM	0.33	0.41	161.90	115.90	89.90	367.70		0.28	141.00	196.00	251.00	588.00		4.25
		n	9	3	10	9	6	25		5	6	9	10	25		8
		MEAN	0.04	0.14	16.19	12.88	14.98	14.71		0.06	23.50	21.78	25.10	23.52		0.53
		STD. DEV.	0.05	0.13	8.09	9.24	4.62	7.72		0.05	5.68	7.93	6.89	6.90		0.62
		MIN.	0.01	0.02	6.70	2.00	9.30	2.00		0.01	16.00	11.00	15.00	11.00		0.04
		MAX	0.16	0.27	29.00	29.00	20.00	29.00		0.15	30.00	34.00	35.00	35.00		1.80

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-7. Total Phosphorus (TP) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control Cell 10	2 feet below infiltrative surface, 0.75 gpd/ft2, Soil Water Results: Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	H2O Control Cell 4	1.5 gpd/ft2, Soil Water Results: Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	H2O Control Cell 7
8/11/92	Ceramic Cup	TP	17.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TP	12.00	- -	- -	- -	0.04	0.03	0.04	0.01	- -	0.08	0.03	- -	0.06	0.04	- -
9/15/92	Ceramic Cup	TP	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	8.80	8.80	- -	- -
9/22/92	Ceramic Cup	TP	- -	- -	- -	- -	0.03	0.02	0.03	0.01	- -	0.03	0.02	- -	0.03	0.01	- -
10/5/92	S.S. Pan	TP	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.70	0.70	- -	- -
10/21/92	Ceramic Cup	TP	8.40	- -	- -	- -	0.03	0.01	0.02	0.01	0.05	0.02	0.11	- -	0.07	0.06	0.03
12/8-9/92	Ceramic Cup	TP	8.20	- -	- -	- -	1.30	0.01	0.66	N/A	0.01	3.80	1.30	- -	2.55	1.77	0.02
12/21-22/92	S.S. Pan	TP	8.40	- -	- -	0.34	0.63	0.07	0.35	0.28	0.60	1.90	1.30	0.20	1.13	0.86	0.06
1/4-5/93	S.S. Pan	TP	- -	- -	- -	0.03	0.30	0.04	0.12	0.15	0.20	0.39	0.76	0.07	0.41	0.35	0.15
1/11-12/93	S.S. Pan	TP	7.20	- -	- -	0.04	0.56	0.09	0.23	0.29	0.14	1.10	1.00	0.27	0.79	0.45	0.05
1/18-19/93	S.S. Pan	TP	8.10	- -	0.13	0.06	1.00	0.09	0.38	0.53	0.26	1.10	0.61	0.33	0.68	0.39	0.05
1/20-21/93	Ceramic Cup	TP	- -	0.02	- -	- -	- -	0.03	0.03	N/A	0.02	4.10	1.70	- -	2.90	1.70	0.02
1/25-26/93	S.S. Pan	TP	7.40	0.04	- -	0.06	1.30	0.08	0.48	0.71	- -	1.00	0.81	0.20	0.67	0.42	0.25
1/27-28/93	Ceramic Cup	TP	- -	- -	- -	- -	3.80	0.07	1.94	2.64	0.01	3.90	2.20	- -	3.05	1.20	0.02
2/3-4/93	S.S. Pan	TP	9.30	0.02	0.18	0.07	0.82	0.07	0.32	0.43	0.08	0.84	0.58	0.13	0.52	0.36	0.06
		SUM	86.00	0.08	0.31	0.60	9.81	0.61	11.02		1.37	18.26	10.42	10.70	39.38		0.71
		n	9	3	2	6	11	12	29		9	12	12	8	32		10
		MEAN	9.56	0.03	0.16	0.10	0.89	0.05	0.38		0.15	1.52	0.87	1.34	1.23		0.07
		STD. DEV.	3.13	0.01	0.04	0.12	1.07	0.03	0.76		0.19	1.55	0.68	3.02	1.78		0.07
		MIN.	7.20	0.00	0.00	0.03	0.03	0.01	0.01		0.01	0.02	0.02	0.07	0.02		0.02
		MAX	17.00	0.04	0.18	0.34	3.80	0.09	3.80		0.60	4.10	2.20	8.80	8.80		0.25

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-8. Total Phosphorus (TP) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	TP	17.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TP	12.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	TP	- -	- -	0.05	0.02	- -	0.04	0.02	- -	- -	- -	0.03	0.03	- -	- -
9/22/92	Ceramic Cup	TP	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	TP	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	TP	8.40	- -	0.03	0.05	- -	0.04	- -	- -	- -	0.02	0.03	- -	- -	0.01
12/8-9/92	Ceramic Cup	TP	8.20	- -	0.02	0.04	- -	0.03	- -	0.10	- -	0.03	0.04	0.04	0.01	0.04
12/21-22/92	S.S. Pan	TP	8.40	- -	0.32	1.80	0.16	0.76	0.90	1.30	0.78	2.00	0.48	1.09	0.81	2.30
1/4-5/93	S.S. Pan	TP	- -	- -	0.06	0.06	0.05	0.06	0.01	0.28	0.24	0.15	0.08	0.16	0.08	0.37
1/11-12/93	S.S. Pan	TP	7.20	- -	0.12	0.60	0.05	0.26	0.30	0.34	0.30	0.89	0.14	0.44	0.40	0.75
1/18-19/93	S.S. Pan	TP	8.10	- -	0.06	0.45	0.11	0.21	0.21	0.30	0.13	0.30	0.19	0.21	0.09	0.46
1/20-21/93	Ceramic Cup	TP	- -	0.02	0.02	0.02	- -	0.02	0.00	- -	- -	1.30	0.02	0.66	0.91	0.02
1/25-26/93	S.S. Pan	TP	7.40	0.04	0.20	0.24	0.06	0.17	0.09	- -	0.34	0.56	0.40	0.43	0.11	- -
1/27-28/93	Ceramic Cup	TP	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	TP	9.30	0.02	0.36	0.25	0.08	0.23	0.14	0.09	0.28	0.40	0.15	0.28	0.13	0.19
		SUM	86.00	0.08	1.24	3.53	0.51	5.28		2.41	2.07	5.65	1.56	9.28		4.14
		n	9	3	10	10	6	26		6	6	9	10	25		8
		MEAN	9.56	0.03	0.12	0.35	0.09	0.20		0.40	0.35	0.63	0.16	0.37		0.52
		STD. DEV.	3.13	0.01	0.13	0.55	0.04	0.36		0.45	0.22	0.66	0.16	0.46		0.77
		MIN.	7.20	0.00	0.02	0.02	0.05	0.02		0.10	0.24	0.02	0.03	0.02		0.01
		MAX	17.00	0.04	0.36	1.80	0.16	1.80		1.30	0.78	2.00	0.48	2.00		2.30

NOTE:
- - = Not Sampled
N/A = Not Applicable
= Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-9. Surfactants (MBAS) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

						2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	MBAS	6.70	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	MBAS	4.60	- -	- -	- -	0.05	0.05	0.05	0.00	- -	0.05	0.05	- -	0.05	0.00	- -
9/15/92	Ceramic Cup	MBAS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	N/A	- -	- -
9/22/92	Ceramic Cup	MBAS	- -	- -	- -	- -	0.08	0.05	0.07	0.02	- -	0.09	0.06	- -	0.08	0.02	- -
10/5/92	S.S. Pan	MBAS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	N/A	- -	- -
10/21/92	Ceramic Cup	MBAS	7.80	- -	- -	- -	0.08	0.05	0.07	0.02	0.05	0.06	0.05	- -	0.06	0.01	0.05
12/8-9/92	Ceramic Cup	MBAS	15.00	- -	- -	- -	0.06	0.05	0.06	0.01	0.05	0.06	0.05	- -	0.06	0.01	0.05
12/21-22/92	S.S. Pan	MBAS	17.00	- -	- -	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
1/4-5/93	S.S. Pan	MBAS	- -	- -	- -	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
1/11-12/93	S.S. Pan	MBAS	9.10	- -	- -	0.06	0.07	0.05	0.06	0.01	0.06	0.06	0.05	0.05	0.05	0.01	0.05
1/18-19/93	S.S. Pan	MBAS	11.00	- -	0.05	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
1/20-21/93	Ceramic Cup	MBAS	- -	0.05	- -	- -	- -	0.05	0.05	N/A	0.05	0.05	0.05	0.05	0.05	0.00	0.05
1/25-26/93	S.S. Pan	MBAS	5.00	0.05	- -	0.05	0.05	0.05	0.05	0.00	- -	0.05	0.05	0.06	0.05	0.01	0.05
1/27-28/93	Ceramic Cup	MBAS	- -	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	MBAS	9.20	0.05	0.05	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
		SUM	85.40	0.15	0.10	0.31	0.59	0.55	1.45		0.41	0.62	0.56	0.36	1.54		0.45
		n	9	3	2	6	10	11	27		8	11	11	7	29		9
		MEAN	9.49	0.05	0.05	0.05	0.06	0.05	0.05		0.05	0.06	0.05	0.05	0.05		0.05
		STD. DEV.	4.24	0.00	0.00	0.00	0.01	0.00	0.01		0.00	0.01	0.00	0.00	0.01		0.00
		MIN.	4.60	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05	0.05	0.05	0.05		0.05
		MAX	17.00	0.05	0.05	0.06	0.08	0.05	0.08		0.06	0.09	0.06	0.06	0.09		0.05

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-10. Surfactants (MBAS) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
					Soil Water Results					H2O Control	Soil Water Results					H2O Control
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	MBAS	6.70	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	MBAS	4.60	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	MBAS	- -	- -	0.05	0.05	- -	0.05	0.00	- -	- -	- -	0.05	0.05	- -	- -
9/22/92	Ceramic Cup	MBAS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	MBAS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	MBAS	7.80	- -	0.05		- -	0.05	N/A	- -	- -	0.06	0.05	0.06	0.01	0.05
12/8-9/92	Ceramic Cup	MBAS	15.00	- -	0.05	0.05	- -	0.05	- -	0.09	- -	0.05	0.05	0.05	0.00	0.05
12/21-22/92	S.S. Pan	MBAS	17.00	- -	0.06	0.05	0.05	0.05	0.01	0.05	0.06	0.05	0.06	0.06	0.01	0.05
1/4-5/93	S.S. Pan	MBAS	- -	- -	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
1/11-12/93	S.S. Pan	MBAS	9.10	- -	0.05	0.08	0.05	0.06	0.02	0.05	0.06	0.06	0.05	0.06	0.01	0.05
1/18-19/93	S.S. Pan	MBAS	11.00	- -	0.05	0.05	0.05	0.05	0.00	0.05	0.06	0.05	0.05	0.05	0.01	0.05
1/20-21/93	Ceramic Cup	MBAS	- -	0.05	0.05	0.05	- -	0.05	0.00	- -	- -	0.05	0.05	0.05	0.00	0.05
1/25-26/93	S.S. Pan	MBAS	5.00	0.05	0.05	0.05	0.05	0.05	0.00	- -	0.05	0.05	0.05	0.05	0.00	- -
1/27-28/93	Ceramic Cup	MBAS	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	MBAS	9.20	0.05	0.05	0.05	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.00	0.05
		SUM	85.40	0.15	0.51	0.48	0.30	1.29		0.34	0.33	0.47	0.51	1.31		0.40
		n	9	3	10	9	6	25		6	6	9	10	25		8
		MEAN	9.49	0.05	0.05	0.05	0.05	0.05		0.06	0.06	0.05	0.05	0.05		0.05
		STD. DEV.	4.24	0.00	0.00	0.01	0.00	0.01		0.02	0.01	0.00	0.00	0.00		0.00
		MIN.	4.60	0.05	0.05	0.05	0.05	0.05		0.05	0.05	0.05	0.05	0.05		0.05
		MAX	17.00	0.05	0.06	0.08	0.05	0.08		0.09	0.06	0.06	0.06	0.06		0.05

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-11. Fecal Coliform (F. coli) Water Quality Results With Simulated 2-Foot Unsaturated Zone (# colonies/100 ml).

						2 feet below infiltrative surface										
						0.75 gpd/ft2						1.5 gpd/ft2				
Sample Date	Sample Device	Paramete	STE Value	TAP H2O	No Dose Control	Soil Water Results					H2O Control	Soil Water Results					H2O Control
			log #/100 ml		Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92		F. coli	5.43	- -													
9/11/92		F. coli	4.28	- -													
9/15/92		F. coli	- -	- -													
9/22/92		F. coli	- -	- -													
10/5/92	S.S. Pan	F. coli	- -	- -													
10/21/92		F. coli	4.71	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	<10	- -	- -	- -
12/8-9/92		F. coli	3.64	- -													
12/21-22/92	S.S. Pan	F. coli	4.08	- -													
1/4-5/93	S.S. Pan	F. coli	- -	- -	- -	<1	<1	<1	- -	- -	<1	<1	<1	<1	- -	- -	<1
1/11-12/93	S.S. Pan	F. coli	4.79	- -	- -	<1	<1	<1	- -	- -	<1	<1	<1	<1	- -	- -	<1
1/18-19/93	S.S. Pan	F. coli	4.69	- -	- -	<1	<1	<1	- -	- -	<1	<1	<1	<1	- -	- -	<1
1/20-21/93		F. coli	- -	<1	<1	<1	<1	<1	- -	- -	<1	<1	<1	<1	- -	- -	<1
1/25-26/93	S.S. Pan	F. coli	4.93	<1	- -	<1	<1	<1	- -	- -	- -	<1	<1	<1	- -	- -	<1
1/27-28/93		F. coli	- -	- -													
2/3-4/93	S.S. Pan	F. coli	5.32	<1	<1	<1	<1	<1	- -	- -	<1	<1	<1	<1	- -	- -	<1
		SUM	41.87	- -	- -												
		n	9	3	2	6	6	6	18		5	6	6	6	18		6
		MEAN	4.65	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		STD. DEV	0.57	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		MIN.	3.64	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1
		MAX	5.43	<1	<1	<1	<1	<1	<1		<1	<1	<1	<10	<10		<1

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-12. Fecal Coliform (F. coli) Water Quality Results With Simulated 4-Foot Unsaturated Zone (# colonies/100 ml).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
		log #/100 ml			Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92		F. coli.	5.43	- -												
9/11/92		F. coli.	4.28	- -												
9/15/92		F. coli.	- -	- -												
9/22/92		F. coli.	- -	- -												
10/5/92	S.S. Pan	F. coli.	- -	- -												
10/21/92		F. coli.	4.71	- -	- -	- -	- -			- -	- -	- -	- -			- -
12/8-9/92		F. coli.	3.64	- -												
12/21-22/92	S.S. Pan	F. coli.	4.08	- -												
1/4-5/93	S.S. Pan	F. coli.	- -	- -	- -	- -	- -			- -	- -	- -	- -			- -
1/11-12/93	S.S. Pan	F. coli.	4.79	- -	<1	<1	<1			<1	<1	<1	<1			<1
1/18-19/93	S.S. Pan	F. coli.	4.69	- -	<1	<1	<1			<1	<1	<1	<1			<1
1/20-21/93		F. coli.	- -	<1	<1	<1	<1			<1	<1	<1	<1			<1
1/25-26/93	S.S. Pan	F. coli.	4.93	<1	<1	<1	<1			- -	<1	<1	<1			- -
1/27-28/93		F. coli.	- -	- -												
2/3-4/93	S.S. Pan	F. coli.	5.32	<1	<1	<1	<1			<1	<1	<1	<1			<1
		SUM	41.87	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		n	9	3	5	5	5	15		4	5	5	5	15		4
		MEAN	4.65	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		STD. DEV.	0.57	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		MIN.	3.64	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1
		MAX	5.43	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1

NOTE:
- - - = Not Sampled
- N/A = Not Applicable
- ▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-13. Fecal Streptococci (F. strep.) Water Quality Results With Simulated 2-Foot Unsaturated Zone (#colonies/100ml).

						2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	Soil Water Results					H2O Contro	Soil Water Results					H2O Contro
			log #/100 ml		Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92		F. strep	4.15														
9/11/92		F. strep	4.18														
9/15/92		F. strep	--														
9/22/92		F. strep	--														
10/5/92	S.S. Pan	F. strep	--	--	--	--	--	--	--	--	--	--	--	<2	--	--	--
10/21/92		F. strep	5.32	--													
12/8-9/92		F. strep	2.15	--													
12/21-22/92	S.S. Pan	F. strep	1.89	--	--	<1	<1	<1	--	--	<1	<1	<1	<1	--	--	<1
1/4-5/1993	S.S. Pan	F. strep	--	--	--	<1	<1	--	--	--	<1	<1	<1	<1	--	--	<1
1/11-12/93	S.S. Pan	F. strep	2.93	--	--	<1	<1	<1	--	--	<1	<1	<1	<1	--	--	<1
1/18-19/93	S.S. Pan	F. strep	3.43	--	<1	<1	<1	<1	--	--	<1	<1	<1	--	--	--	<1
1/20-21/93		F. strep	--	<1													
1/25-26/93	S.S. Pan	F. strep	3.74	<1	--	<1	<1	<1	--	--	--	<1	<1	<1	--	--	<1
1/27-28/93		F. strep	--	--													
2/3-4/93	S.S. Pan	F. strep	3.46	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	--	--	<1
		SUM	31.25	--	--												
		n	9	3	2	6	6	6	18		5	6	6	6	18		6
		MEAN	3.47	--	--	--	--	--	--		--	--	--	--	--		--
		STD. DEV.	1.06	--	--	--	--	--	--		--	--	--	--	--		--
		MIN.	1.89	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1
		MAX	5.32	<1	<1	<1	<1	<1	<1		<1	<1	<1	<2	<2		<1

NOTE:
-- = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-14. Fecal Streptococci (F. strep.) Water Quality Results With Simulated 4-Foot Unsaturated Zone (# colonies/100 ml).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
			log #/100 ml		Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92		F. strep	4.15	- -												
9/11/92		F. strep	4.18	- -												
9/15/92		F. strep	- -	- -												
9/22/92		F. strep	- -	- -												
10/5/92	S.S. Pan	F. strep	- -	- -	- -	- -	- -			- -	- -	- -	- -			- -
10/21/92		F. strep	5.32	- -												
12/8-9/92		F. strep	2.15	- -												
12/21-22/92	S.S. Pan	F. strep	1.89	- -	- -	- -	- -			- -	- -	- -	- -			- -
1/4-5/1993	S.S. Pan	F. strep	- -	- -	<1	<1	- -			- -	<1	<1	- -			- -
1/11-12/93	S.S. Pan	F. strep	2.93	- -	<1	<1	<1			<1	<1	<1	<1			<1
1/18-19/93	S.S. Pan	F. strep	3.43	- -	<1	<1	<1			<1	<1	<1	<1			<1
1/20-21/93		F. strep	- -	- -												
1/25-26/93	S.S. Pan	F. strep	3.74	<1	<1	<1	<1			- -	<1	<1	<1			- -
1/27-28/93		F. strep	- -	- -												
2/3-4/93	S.S. Pan	F. strep	3.46	<1	<1	<1	<1			<1	<1	<1	<1			<1
		SUM	31.25	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		n	9	2	5	5	4	14		3	5	5	4	14		3
		MEAN	3.47	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		STD. DEV.	1.06	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -		- -
		MIN.	1.89	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1
		MAX	5.32	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1		<1

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-15. Chloride Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control Cell 10	2 feet below infiltrative surface: 0.75 gpd/ft2 Soil Water Results Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	H2O Control Cell 4	1.5 gpd/ft2 Soil Water Results Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	H2O Control Cell 7
8/11/92	Ceramic Cup	Chloride	80.00	- -		- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	Chloride	84.00	- -	- -	- -	59.00	56.00	57.50	2.12	- -	57.00	58.00	- -	57.50	0.71	- -
9/15/92	Ceramic Cup	Chloride	- -	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
9/22/92	Ceramic Cup	Chloride	- -	- -	- -	- -	65.00	63.00	64.00	1.41	- -	63.00	65.00	- -	64.00	1.41	- -
10/5/92	S.S. Pan	Chloride	- -	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/21/92	Ceramic Cup	Chloride	55.00	- -	- -	- -	51.00	52.00	51.50	0.71	31.00	51.00	51.00	- -	51.00	0.00	30.00
12/8-9/92	Ceramic Cup	Chloride	110.00	- -	- -	- -	51.00	49.00	50.00	1.41	28.00	51.00	52.00	- -	51.50	0.71	29.00
12/21-22/92	S.S. Pan	Chloride	76.00	- -	- -	43.00	49.00	48.00	46.67	3.21	22.00	49.00	50.00	40.00	46.33	5.51	27.00
1/4-5/93	S.S. Pan	Chloride	- -	- -	- -	49.00	52.00	55.00	52.00	3.00	29.00	52.00	49.00	51.00	50.67	1.53	30.00
1/11-12/93	S.S. Pan	Chloride	94.00	- -	- -	44.00	43.00	40.00	42.33	2.08	23.00	36.00	35.00	32.00	34.33	2.08	33.00
1/18-19/93	S.S. Pan	Chloride	61.00	- -	2.00	9.20	21.00	11.00	13.73	6.36	7.60	17.00	15.00	14.00	15.33	1.53	16.00
1/20-21/93	Ceramic Cup	Chloride	- -	26.00	- -	- -	- -	46.00	46.00	N/A	27.00	58.00	54.00	- -	56.00	2.83	29.00
1/25-26/93	S.S. Pan	Chloride	77.00	16.00	- -	31.00	53.00	23.00	35.67	15.53	- -	- -	37.00	36.00	36.50	0.71	11.00
1/27-28/93	Ceramic Cup	Chloride	- -	- -	- -	- -	- -	38.00	38.00	N/A	12.00	59.00	- -	- -	59.00	N/A	12.00
2/3-4/93	S.S. Pan	Chloride	44.00	28.00	1.80	19.00	46.00	25.00	30.00	14.18	19.00	36.00	38.00	25.00	33.00	7.00	24.00
		SUM	681.00	70.00	3.80	195.20	490.00	506.00	1,191.20		198.60	529.00	504.00	198.00	1,231.00		241.00
		n	9	3	2.00	6	10	12	28		9	11	11	6	28		10
		MEAN	75.67	23.33	1.90	32.53	49.00	42.17	42.54		22.07	48.09	45.82	33.00	43.96		24.10
		STD. DEV.	20.16	6.43	0.14	15.76	11.63	15.49	15.05		7.97	13.46	13.72	12.71	14.20		8.09
		MIN.	44.00	16.00	1.80	9.20	21.00	11.00	9.20		7.60	17.00	15.00	14.00	14.00		11.00
		MAX	110.00	28.00	2.00	49.00	65.00	63.00	65.00		31.00	63.00	65.00	51.00	65.00		33.00

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-16. Chloride Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	- -	Chloride	80.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	Chloride	84.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	Chloride	- -	- -	40.00	29.00	- -	34.50	7.78	- -	- -	- -	38.00	38.00	N/A	- -
9/22/92	Ceramic Cup	Chloride	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/5/92	S.S. Pan	Chloride	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/21/92	Ceramic Cup	Chloride	55.00	- -	45.00	47.00	- -	46.00	1.41	- -	- -	47.00	47.00	47.00	0.00	31.00
12/8-9/92	Ceramic Cup	Chloride	110.00	- -	46.00	49.00	- -	47.50	2.12	27.00	- -	51.00	49.00	50.00	1.41	28.00
12/21-22/92	S.S. Pan	Chloride	76.00	- -	28.00	38.00	33.00	33.00	5.00	22.00	41.00	45.00	42.00	42.67	2.08	26.00
1/4-5/93	S.S. Pan	Chloride	- -	- -	30.00	31.00	34.00	31.67	2.08	25.00	41.00	49.00	50.00	46.67	4.93	29.00
1/11-12/93	S.S. Pan	Chloride	94.00	- -	25.00	38.00	32.00	31.67	6.51	18.00	45.00	48.00	48.00	47.00	1.73	30.00
1/18-19/93	S.S. Pan	Chloride	61.00	- -	17.00	14.00	21.00	17.33	3.51	9.20	31.00	30.00	30.00	30.33	0.58	16.00
1/20-21/93	Ceramic Cup	Chloride	- -	26.00	40.00	- -	- -	40.00	N/A	- -	- -	58.00	51.00	54.50	4.95	26.00
1/25-26/93	S.S. Pan	Chloride	77.00	16.00	24.00	11.00	31.00	22.00	10.15	- -	35.00	29.00	33.00	32.33	3.06	- -
1/27-28/93	Ceramic Cup	Chloride	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	Chloride	44.00	28.00	16.00	8.80	19.00	14.60	5.24	8.40	32.00	22.00	29.00	27.67	5.13	14.00
		SUM	681.00	70.00	311.00	265.80	170.00	746.80		109.60	225.00	379.00	417.00	1,021.00		200.00
		n	9	3	10	9	6	25		6	6	9	10	25		8
		MEAN	75.67	23.33	31.10	29.53	28.33	29.87		18.27	37.50	42.11	41.70	40.84		25.00
		STD. DEV.	20.16	6.43	11.05	15.18	6.56	11.53		7.94	5.65	12.09	8.59	9.31		6.44
		MIN.	44.00	16.00	16.00	8.80	19.00	8.80		8.40	31.00	22.00	29.00	22.00		14.00
		MAX	110.00	28.00	46.00	49.00	34.00	49.00		27.00	45.00	58.00	51.00	58.00		31.00

NOTE:

- - = Not Sampled

N/A = Not Applicable

▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-17. Sulfate (SO4) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

						2 feet below infiltrative surface										
						0.75 gpd/ft2						1.5 gpd/ft2				
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	Soil Water Results					H2O Control	Soil Water Results				H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	SO4	45.00	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
9/11/92	Ceramic Cup	SO4	340.00	- -	- -	- -	89.00	83.00	86.00	4.24	- -	93.00	88.00	- -	90.50	3.54	- -
9/15/92	Ceramic Cup	SO4	- -	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
9/22/92	Ceramic Cup	SO4	- -	- -	- -	- -	94.00	93.00	93.50	0.71	- -	92.00	93.00	- -	92.50	0.71	- -
10/5/92	S.S. Pan	SO4	- -	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/21/92	Ceramic Cup	SO4	74.00	- -	- -	- -	79.00	75.00	77.00	2.83	88.00	100.00	76.00	- -	88.00	16.97	83.00
12/8-9/92	Ceramic Cup	SO4	79.00	- -	- -	- -	120.00	130.00	125.00	7.07	140.00	140.00	140.00	- -	140.00	0.00	140.00
12/21-22/92	S.S. Pan	SO4	69.00	- -	- -	110.00	140.00	110.00	120.00	17.32	120.00	130.00	110.00	89.00	109.67	20.50	120.00
1/4-5/93	S.S. Pan	SO4	- -	- -	- -	100.00	140.00	130.00	123.33	20.82	110.00	130.00	130.00	130.00	130.00	0.00	140.00
1/11-12/93	S.S. Pan	SO4	130.00	- -	- -	170.00	150.00	130.00	150.00	20.00	94.00	130.00	130.00	95.00	118.33	20.21	130.00
1/18-19/93	S.S. Pan	SO4	1,100.00	- -	- -	19.00	66.00	21.00	35.33	26.58	29.00	45.00	41.00	34.00	40.00	5.57	60.00
1/20-21/93	Ceramic Cup	SO4	- -	150.00	5.00	- -	- -	- -	N/A	N/A	100.00	150.00	140.00	- -	145.00	7.07	100.00
1/25-26/93	S.S. Pan	SO4	52.00	20.00	- -	65.00	120.00	57.00	80.67	34.30	- -	- -	87.00	88.00	87.50	0.71	27.00
1/27-28/93	Ceramic Cup	SO4	- -	- -	- -	- -	- -	79.00	79.00	N/A	49.00	100.00	- -	- -	100.00	N/A	45.00
2/3-4/93	S.S. Pan	SO4	62.00	99.00	6.00	24.00	59.00	29.00	37.33	18.93	53.00	49.00	44.00	38.00	43.67	5.51	68.00
		SUM	1,951.00	269.00	11.00	488.00	1,057.00	937.00	2,370.00		783.00	1,159.00	1,079.00	474.00	2,712.00		913.00
		n	9	3	2	5	9	10	24		9	11	11	6	28		10
		MEAN	216.78	89.67	5.50	81.33	105.70	85.18	98.75		87.00	105.36	98.09	79.00	96.86		91.30
		STD. DEV.	343.62	65.50	0.71	57.40	32.68	38.63	38.05		36.42	34.96	35.52	36.73	35.65		40.84
		MIN.	45.00	20.00	5.00	19.00	59.00	21.00	19.00		29.00	45.00	41.00	34.00	34.00		27.00
		MAX	1,100.00	150.00	6.00	170.00	150.00	130.00	170.00		140.00	150.00	140.00	130.00	150.00		140.00

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-18. Sulfate (SO4) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface												
					0.75 gpd/ft2						1.5 gpd/ft2						
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	SO4	45.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	N/A	N/A	- -
9/11/92	Ceramic Cup	SO4	340.00	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
9/15/92	Ceramic Cup	SO4	- -	- -	68.00	67.00	- -	67.50	0.71	- -	- -	- -	69.00	69.00	N/A	- -
9/22/92	Ceramic Cup	SO4	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/5/92	S.S. Pan	SO4	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
10/21/92	Ceramic Cup	SO4	74.00	- -	100.00	96.00	- -	98.00	2.83	- -	- -	86.00	76.00	81.00	7.07	83.00
12/8-9/92	Ceramic Cup	SO4	79.00	- -	110.00	140.00	- -	125.00	21.21	110.00	- -	130.00	110.00	120.00	14.14	120.00
12/21-22/92	S.S. Pan	SO4	69.00	- -	63.00	80.00	82.00	75.00	10.44	71.00	120.00	100.00	96.00	105.33	12.86	140.00
1/4-5/93	S.S. Pan	SO4	- -	- -	76.00	54.00	86.00	72.00	16.37	84.00	110.00	130.00	130.00	123.33	11.55	130.00
1/11-12/93	S.S. Pan	SO4	130.00	- -	67.00	87.00	120.00	91.33	26.76	83.00	160.00	150.00	170.00	160.00	10.00	140.00
1/18-19/93	S.S. Pan	SO4	1,100.00	- -	51.00	26.00	63.00	46.67	18.88	36.00	92.00	69.00	98.00	86.33	15.31	60.00
1/20-21/93	Ceramic Cup	SO4	- -	150.00	130.00	82.00	- -	106.00	33.94	- -	- -	130.00	150.00	140.00	14.14	92.00
1/25-26/93	S.S. Pan	SO4	52.00	20.00	63.00	23.00	80.00	55.33	29.26	- -	92.00	67.00	91.00	83.33	14.15	- -
1/27-28/93	Ceramic Cup	SO4	- -	- -	- -	- -	- -	N/A	N/A	- -	- -	- -	- -	N/A	N/A	- -
2/3-4/93	S.S. Pan	SO4	62.00	99.00	24.00	17.00	30.00	23.67	6.51	24.00	51.00	38.00	55.00	48.00	8.89	35.00
		SUM	1,951.00	269.00	752.00	672.00	461.00	1,885.00		408.00	625.00	900.00	1,045.00	2,570.00		800.00
		n	8	3	10	10	6	26		6	6	9	10	25		8
		MEAN	216.78	89.67	75.20	67.20	76.83	72.50		68.00	104.17	100.00	104.50	102.80		100.00
		STD. DEV.	343.62	65.50	30.65	38.37	29.56	32.58		32.29	36.12	37.57	36.30	35.23		39.06
		MIN.	45.00	20.00	24.00	17.00	30.00	17.00		24.00	51.00	38.00	55.00	38.00		35.00
		MAX	1,100.00	150.00	130.00	140.00	120.00	140.00		110.00	160.00	150.00	170.00	170.00		140.00

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-19. Specific Conductance (umhos/cm) Water Quality Results With Simulated 2-Foot Unsaturated Zone.

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control Cell 10	2 feet below infiltrative surface, 0.75 gpd/ft2, Soil Water Results, Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	H2O Control Cell 4	1.5 gpd/ft2, Soil Water Results, Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	H2O Control Cell 7
8/11/92	Ceramic Cup	Specific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	Specific Con	900.00	- -	- -	- -	820.00	780.00	800.00	28.28	- -	820.00	760.00	- -	790.00	42.43	- -
9/15/92	Ceramic Cup	Specific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/22/92	Ceramic Cup	Specific Con	- -	- -	- -	- -	790.00	63.00	426.50	514.07	- -	760.00	740.00	- -	750.00	14.14	- -
10/5/92	S.S. Pan	Specific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	Specific Con	920.00	- -	- -	- -	740.00	720.00	730.00	14.14	500.00	720.00	710.00	- -	715.00	7.07	480.00
12/8-9/92	Ceramic Cup	Specific Con	1,200.00	- -	- -	- -	830.00	970.00	900.00	98.99	610.00	920.00	880.00	- -	900.00	28.28	630.00
12/21-22/92	S.S. Pan	Specific Con	1,200.00	- -	- -	820.00	920.00	840.00	860.00	52.92	500.00	920.00	890.00	760.00	856.67	85.05	600.00
1/4-5/93	S.S. Pan	Specific Con	- -	- -	- -	820.00	900.00	850.00	856.67	40.41	580.00	880.00	900.00	880.00	886.67	11.55	630.00
1/11-12/93	S.S. Pan	Specific Con	410.00	- -	- -	870.00	880.00	740.00	830.00	78.10	520.00	800.00	680.00	640.00	706.67	83.27	620.00
1/18-19/93	S.S. Pan	Specific Con	330.00	660.00	140.00	880.00	540.00	300.00	573.33	291.43	290.00	460.00	390.00	330.00	393.33	65.06	440.00
1/20-21/93	Ceramic Cup	Specific Con	- -	- -	- -	- -	- -	860.00	860.00	N/A	- -	1,100.00	940.00	- -	1,020.00	113.14	- -
1/25-26/93	S.S. Pan	Specific Con	940.00	390.00	- -	- -	810.00	440.00	625.00	261.63	- -	- -	610.00	610.00	610.00	0.00	- -
1/27-28/93	Ceramic Cup	Specific Con	- -	- -	- -	- -	- -	640.00	640.00	N/A	350.00	810.00	- -	- -	810.00	N/A	310.00
2/3-4/93	S.S. Pan	Specific Con	710.00	430.00	140.00	380.00	630.00	430.00	480.00	132.29	370.00	610.00	570.00	460.00	546.67	77.67	430.00
		SUM	6,610.00	1,480.00	280.00	3,770.00	7,860.00	7,633.00	19,263.00		3,720.00	8,800.00	8,070.00	3,680.00	20,550.00		4,140.00
		n	8	3	2	5	10	12	27		8	11	11	6	28		8
		MEAN	826.25	493.33	140.00	754.00	786.00	636.08	713.44		465.00	800.00	733.64	613.33	733.93		517.50
		STD. DEV.	325.05	145.72	0.00	210.90	120.39	271.33	219.34		115.02	168.94	167.47	198.56	182.40		119.97
		MIN.	330.00	390.00	140.00	380.00	540.00	63.00	63.00		290.00	460.00	390.00	330.00	330.00		310.00
		MAX	1,200.00	660.00	140.00	880.00	920.00	970.00	970.00		610.00	1,100.00	940.00	880.00	1,100.00		630.00

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-20. Specific Conductance (umhos/cm) Water Quality Results With Simulated 4-Foot Unsaturated Zone.

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	4 feet below infiltrative surface — 0.75 gpd/ft2 — Soil Water Results — Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	H2O Control — Cell 19	1.5 gpd/ft2 — Soil Water Results — Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	H2O Control — Cell 16
8/11/92	Ceramic Cup	pecific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	pecific Con	900.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	pecific Con	- -	- -	660.00	540.00	- -	600.00	84.85	- -	- -	- -	660.00	660.00	- -	- -
9/22/92	Ceramic Cup	pecific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	490.00
10/5/92	S.S. Pan	pecific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	pecific Con	920.00	- -	720.00	760.00	- -	740.00	28.28	- -	- -	710.00	- -	710.00	N/A	- -
12/8-9/92	Ceramic Cup	pecific Con	1,200.00	- -	840.00	820.00	- -	830.00	14.14	550.00	- -	950.00	890.00	920.00	42.43	610.00
12/21-22/92	S.S. Pan	pecific Con	1,200.00	- -	530.00	670.00	700.00	633.33	14.14	370.00	800.00	840.00	800.00	813.33	23.09	580.00
1/4-5/93	S.S. Pan	pecific Con	- -	- -	560.00	530.00	710.00	600.00	90.74	440.00	760.00	900.00	900.00	853.33	80.83	600.00
1/11-12/93	S.S. Pan	pecific Con	410.00	- -	490.00	710.00	760.00	653.33	96.44	390.00	920.00	950.00	1,200.00	1,023.33	153.73	620.00
1/18-19/93	S.S. Pan	pecific Con	330.00	660.00	450.00	360.00	570.00	460.00	105.36	280.00	720.00	660.00	770.00	716.67	55.08	440.00
1/20-21/93	Ceramic Cup	pecific Con	- -	- -	830.00	660.00	- -	745.00	120.21	- -	- -	1,100.00	1,100.00	1,100.00	0.00	570.00
1/25-26/93	S.S. Pan	pecific Con	940.00	390.00	470.00	340.00	640.00	483.33	150.44	- -	640.00	590.00	680.00	636.67	45.09	- -
1/27-28/93	Ceramic Cup	pecific Con	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2/3-4/93	S.S. Pan	pecific Con	710.00	430.00	340.00	340.00	450.00	376.67	63.51	240.00	640.00	530.00	580.00	583.33	55.08	350.00
		SUM	6,610.00	1,480.00	5,890.00	5,730.00	3,830.00	15,450.00		2,270.00	4,480.00	7,230.00	7,580.00	19,290.00		4,260.00
		n	8	3	10	10	6	26		6	6	9	9	24		8
		MEAN	826.25	493.33	589.00	573.00	638.33	594.23		378.33	746.67	803.33	842.22	803.75		532.50
		STD. DEV.	325.05	145.72	167.63	179.07	113.03	157.71		111.61	106.33	190.79	204.74	176.43		96.77
		MIN.	330.00	390.00	340.00	340.00	450.00	340.00		240.00	640.00	530.00	580.00	530.00		350.00
		MAX	1,200.00	660.00	840.00	820.00	760.00	840.00		550.00	920.00	1,100.00	1,200.00	1,200.00		620.00

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-21. pH Water Quality Results With Simulated 2-Foot Unsaturated Zone.

Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
						Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	pH	8.0	- -	8.00	- -	7.30	7.30	7.30	0.00	- -	7.10	0.03	- -	3.57	5.00	- -
9/15/92	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7.10	- -	7.10	- -	- -
9/22/92	Ceramic Cup	pH	- -	- -	- -	- -	7.20	7.70	7.45	0.35	- -	7.10	7.20	- -	7.15	0.07	- -
10/5/92	S.S. Pan	pH		- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7.60	7.60	- -	- -
10/21/92	Ceramic Cup	pH	8.0	- -	8.00	- -	7.80	8.10	7.95	0.21	8.20	7.40	7.30	- -	7.35	0.07	- -
12/8-9/92	Ceramic Cup	pH	7.5	- -	7.50	- -	8.00	8.00	8.00	0.00	8.10	8.10	7.10	- -	7.60	0.71	- -
12/21-22/92	S.S. Pan	pH	8.0	- -	8.00	7.60	7.40	7.20	7.40	0.20	7.60	7.40	7.10	7.00	7.17	0.21	- -
1/4-5/93	S.S. Pan	pH	7.6	- -	7.60	7.60	7.50	7.60	7.57	0.06	7.80	7.60	7.40	7.50	7.50	0.10	- -
1/11-12/93	S.S. Pan	pH	7.7	- -	7.70	7.60	7.40	7.60	7.53	0.12	7.80	7.50	7.70	7.30	7.50	0.20	7.40
1/18-19/93	S.S. Pan	pH	7.6	- -	7.40	7.80	7.40	7.30	7.50	0.26	8.00	7.60	7.60	7.00	7.40	0.35	7.50
1/20-21/93	Ceramic Cup	pH	- -	8.0	7.50	- -	- -	7.70	- -	- -	8.20	7.70	7.50	- -	7.60	0.14	8.20
1/25-26/93	S.S. Pan	pH	7.8	7.8	- -	7.70	7.40	7.30	7.47	0.21	- -	7.70	7.20	7.00	7.30	0.36	7.30
1/27-28/93	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	- -	7.90	7.60	- -	- -	7.60	N/A	7.90
2/3-4/93	S.S. Pan	pH	7.5	7.9	7.50	7.80	7.60	7.50	7.63	0.15	7.90	7.70	7.40	7.10	7.40	0.30	7.60
		SUM	69.7	23.7	69.20	46.10	75.00	83.30	204.40		71.50	90.50	80.63	50.50	221.63		45.90
		n	9	3	9	6	10	11	27		9	12	12	7	31		6
		MEAN	7.74	7.90	7.69	7.68	7.50	7.57	7.57		7.94	7.54	6.72	7.21	7.15		7.65
		STD. DEV.	0.21	0.10	0.25	0.10	0.24	0.29	0.24		0.20	0.27	2.12	0.25	1.35		0.34
		MIN.	7.5	7.8	7.40	7.60	7.20	7.20	7.20		7.60	7.10	0.03	7.00	0.03		7.30
		MAX	8.0	8.0	8.00	7.80	8.00	8.10	8.10		8.20	8.10	7.70	7.60	8.10		8.20

NOTE:
- - = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-22. pH Water Quality Results With Simulated 4-Foot Unsaturated Zone.

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standard Deviation	Cell 19	Cell 12	Cell 14	Cell 18	Mean	Standard Deviation	Cell 16
8/11/92	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	pH	8.0	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/15/92	Ceramic Cup	pH	- -	- -	7.20	7.20	- -	7.20	0.00	- -	- -	- -	7.10	7.10	- -	- -
9/22/92	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/5/92	S.S. Pan	pH		- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	pH	8.0	- -	7.70	7.90	- -	7.80	0.14	- -	- -	7.60	7.50	7.55	0.07	8.00
12/8-9/92	Ceramic Cup	pH	7.5	- -	8.10	- -	- -	8.10	- -	8.20	- -	7.50	7.80	7.65	0.21	7.60
12/21-22/92	S.S. Pan	pH	8.0	- -	7.40	7.00	7.50	7.30	0.26	7.60	7.20	7.40	7.70	7.43	0.25	7.50
1/4-5/93	S.S. Pan	pH	7.6	- -	7.10	7.40	7.80	7.43	0.35	7.70	7.60	7.70	8.00	7.70	0.21	7.90
1/11-12/93	S.S. Pan	pH	7.7	- -	7.40	7.40	7.60	7.47	0.12	7.60	7.40	7.50	7.80	7.57	0.21	7.70
1/18-19/93	S.S. Pan	pH	7.6	- -	7.30	7.40	7.80	7.50	0.26	7.80	7.20	7.70	8.00	7.63	0.40	7.60
1/20-21/93	Ceramic Cup	pH	- -	8.0	7.60	8.00	- -	7.80	0.28	8.20	- -	7.50	7.90	7.70	0.28	8.20
1/25-26/93	S.S. Pan	pH	7.8	7.8	7.60	7.60	7.80	7.67	0.12	- -	7.50	7.80	8.00	7.77	0.25	- -
1/27-28/93	Ceramic Cup	pH	- -	- -	- -	- -	- -	- -	- -	8.20	- -	7.50	7.80	7.65	0.21	7.60
2/3-4/93	S.S. Pan	pH	7.5	7.9	7.70	7.40	7.80	7.63	0.21	7.70	7.40	7.60	7.70	7.57	0.15	7.80
		SUM	69.7	23.7	75.10	67.30	46.30	188.70		63.00	44.30	75.80	85.30	205.40		69.90
		n	9	3	10	9	6	25		8	6	10	11	27		9
		MEAN	7.74	7.90	7.51	7.48	7.72	7.55		7.88	7.38	7.58	7.75	7.61		7.77
		STD. DEV.	0.21	0.10	0.29	0.32	0.13	0.28		0.28	0.16	0.12	0.27	0.24		0.23
		MIN.	7.5	7.8	7.10	7.00	7.50	7.00		7.60	7.20	7.40	7.10	7.10		7.50
		MAX	8.0	8.0	8.10	8.00	7.80	8.10		8.20	7.60	7.80	8.00	8.00		8.20

NOTE:
- - - = Not Sampled
- N/A = Not Applicable
- = Shaded number indicates value less than detection l
  This value was used in statistical calculations.

NOTE:
- - - = Not Sampled
- N/A = Not Applicable
- ▭ = Shaded number indicates value less than detection limit.
  This value was used in statistical calculations.

Table F-23. Total Dissolved Solids (TDS) Water Quality Results With Simulated 2-Foot Unsaturated Zone (mg/L).

						2 feet below infiltrative surface											
						0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	No Dose Control	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 10	Cell 2	Cell 5	Cell 8	Mean	Standard Deviation	Cell 4	Cell 3	Cell 6	Cell 9	Mean	Standard Deviation	Cell 7
8/11/92	Ceramic Cup	TDS	442.00	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/11/92	Ceramic Cup	TDS	400.00	- -	- -	- -	544.00	512.00	528.00	22.63	- -	554.00	504.00	- -	529.00	35.36	- -
9/15/92	Ceramic Cup	TDS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
9/22/92	Ceramic Cup	TDS	- -	- -	- -	- -	514.00	488.00	501.00	18.38	- -	500.00	474.00	- -	487.00	18.38	- -
10/5/92	S.S. Pan	TDS	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
10/21/92	Ceramic Cup	TDS	450.00	- -	- -	- -	480.00	460.00	470.00	14.14	270.00	470.00	450.00	- -	460.00	14.14	280.00
12/8-9/92	Ceramic Cup	TDS	516.00	- -	- -	- -	620.00	612.00	616.00	5.66	372.00	636.00	640.00	- -	638.00	2.83	380.00
12/21-22/92	S.S. Pan	TDS	552.00	- -	- -	546.00	600.00	538.00	561.33	33.72	324.00	636.00	620.00	498.00	584.67	75.48	380.00
1/4-5/93	S.S. Pan	TDS	- -	- -	- -	538.00	596.00	590.00	574.67	31.90	368.00	582.00	576.00	558.00	572.00	12.49	390.00
1/11-12/93	S.S. Pan	TDS	610.00	- -	- -	556.00	588.00	468.00	537.33	62.14	322.00	528.00	494.00	402.00	474.67	65.19	386.00
1/18-19/93	S.S. Pan	TDS	592.00	- -	106.00	186.00	332.00	184.00	234.00	84.88	176.00	286.00	250.00	224.00	253.33	31.13	248.00
1/20-21/93	Ceramic Cup	TDS	- -	404.00	- -	- -	- -	580.00	580.00	N/A	304.00	654.00	624.00	- -	639.00	21.21	370.00
1/25-26/93	S.S. Pan	TDS	458.00	222.00	- -	362.00	552.00	268.00	394.00	144.68	- -	530.00	406.00	408.00	448.00	71.02	150.00
1/27-28/93	Ceramic Cup	TDS	- -	- -	- -	- -	- -	424.00	424.00	N/A	200.00	538.00	192.00	- -	365.00	244.66	164.00
2/3-4/93	S.S. Pan	TDS	474.00	324.00	96.00	266.00	462.00	298.00	342.00	105.15	242.00	454.00	434.00	288.00	392.00	90.62	284.00
		SUM	4,494.00	950.00	202.00	2,454.00	5,288.00	5,422.00	13,164.00		2,578.00	6,368.00	5,664.00	2,378.00	14,410.00		3,032.00
		n	9	3	2	6	10	12	28		9	12	12	6	30		10
		MEAN	499.33	316.67	101.00	409.00	528.80	451.83	470.14		286.44	530.67	472.00	396.33	480.33		303.20
		STD. DEV	72.30	91.22	7.07	160.88	86.90	136.12	130.82		69.70	100.45	141.27	124.96	128.94		92.77
		MIN.	400.00	222.00	96.00	186.00	332.00	184.00	184.00		176.00	286.00	192.00	224.00	192.00		150.00
		MAX	610.00	404.00	106.00	556.00	620.00	612.00	620.00		372.00	654.00	640.00	558.00	654.00		390.00

NOTE:
- - - = Not Sampled
- N/A = Not Applicable
- ▭ = Shaded number indicates value less than detection limit. This value was used in statistical calculations.

Table F-24. Total Dissolved Solids (TDS) Water Quality Results With Simulated 4-Foot Unsaturated Zone (mg/L).

					4 feet below infiltrative surface											
					0.75 gpd/ft2						1.5 gpd/ft2					
Sample Date	Sample Device	Parameter	STE Value	TAP H2O	Soil Water Results					H2O Control	Soil Water Results					H2O Control
					Cell 13	Cell 15	Cell 17	Mean	Standar Deviatio	Cell 19	Cell 12	Cell 14	Cell 18	Mean	tandard Deviatio	Cell 16
8/11/92	Ceramic Cup	TDS	442.00	--	--	--	--	--	--	--	--	--	--	--	--	--
9/11/92	Ceramic Cup	TDS	400.00	--	--	--	--	--	--	--	--	--	--	--	--	--
9/15/92	Ceramic Cup	TDS	--	--	438.00	352.00	--	395.00	60.81	--	--	--	428.00	428.00	--	--
9/22/92	Ceramic Cup	TDS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/5/92	S.S. Pan	TDS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/21/92	Ceramic Cup	TDS	450.00	--	460.00	480.00	--	470.00	14.14	--	--	440.00	430.00	435.00	7.07	280.00
12/8-9/92	Ceramic Cup	TDS	516.00	--	528.00	592.00	--	560.00	45.25	340.00	--	620.00	584.00	602.00	25.46	376.00
12/21-22/92	S.S. Pan	TDS	552.00	--	326.00	416.00	438.00	393.33	N/A	230.00	524.00	528.00	518.00	523.33	5.03	368.00
1/4-5/93	S.S. Pan	TDS	--	--	348.00	328.00	454.00	376.67	59.34	266.00	496.00	572.00	590.00	552.67	49.89	360.00
1/11-12/93	S.S. Pan	TDS	610.00	--	308.00	452.00	494.00	418.00	67.72	254.00	612.00	628.00	656.00	632.00	22.27	388.00
1/18-19/93	S.S. Pan	TDS	592.00	--	254.00	216.00	338.00	269.33	97.55	162.00	428.00	398.00	446.00	424.00	24.25	246.00
1/20-21/93	Ceramic Cup	TDS	--	404.00	514.00	404.00	--	459.00	62.43	--	--	636.00	632.00	634.00	2.83	334.00
1/25-26/93	S.S. Pan	TDS	458.00	222.00	304.00	202.00	390.00			--	432.00	364.00	444.00	413.33	43.14	--
1/27-28/93	Ceramic Cup	TDS	--	--	--	--	--	N/A	N/A	--	--	--	--	N/A	N/A	--
2/3-4/93	S.S. Pan	TDS	474.00	324.00	210.00	200.00	314.00	298.67	77.78	156.00	380.00	334.00	402.00	372.00	34.70	234.00
		SUM	4,494.00	950.00	3,690.00	3,642.00	2,428.00	9,760.00		1,408.00	2,872.00	4,520.00	5,130.00	#####		2,586.00
		n	9	3	10	10	6	26		6	6	9	10	25		8
		MEAN	499.33	316.67	369.00	364.20	404.67	375.38		234.67	478.67	502.22	513.00	500.88		323.25
		STD. DEV	72.30	91.22	109.59	130.80	69.86	108.31		69.20	83.20	120.03	95.04	99.08		61.23
		MIN.	400.00	222.00	210.00	200.00	314.00	200.00		156.00	380.00	334.00	402.00	334.00		234.00
		MAX	610.00	404.00	528.00	592.00	494.00	592.00		340.00	612.00	636.00	656.00	656.00		388.00

NOTE:
-- = Not Sampled
N/A = Not Applicable
▭ = Shaded number indicates value less than detection limit.
This value was used in statistical calculations.

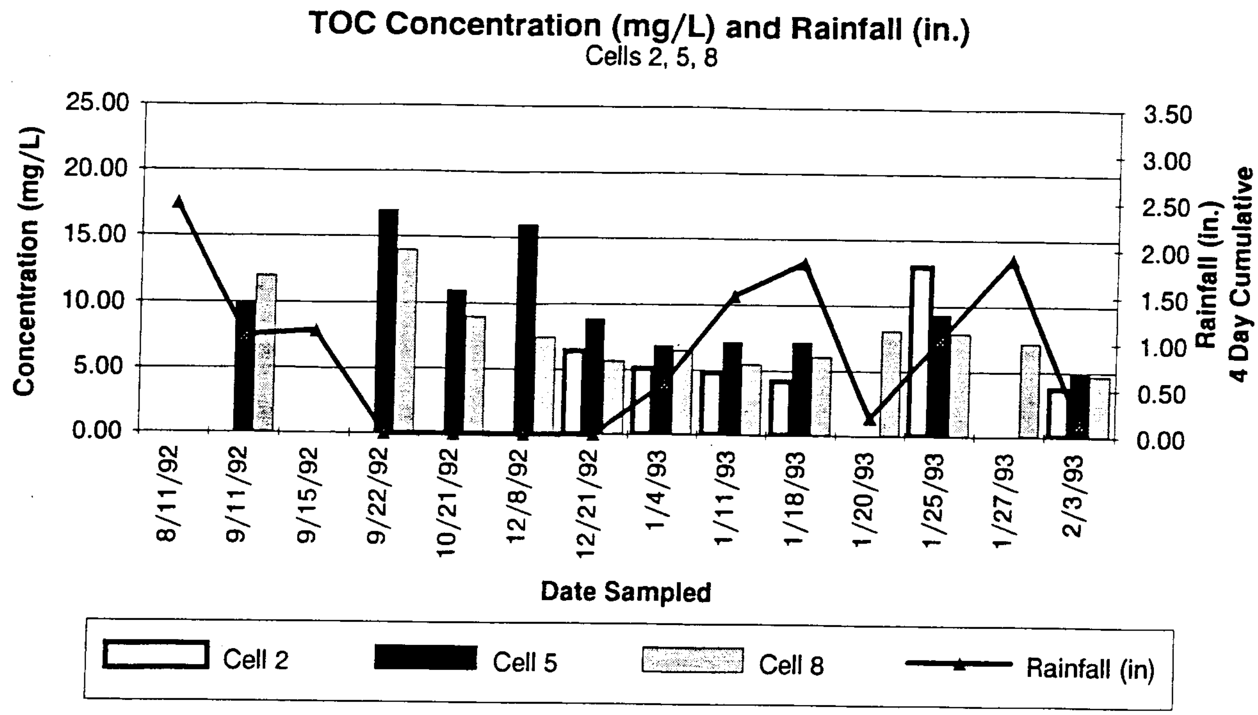


Figure F-1. Soil Water TOC Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 2-foot Unsaturated Zone).

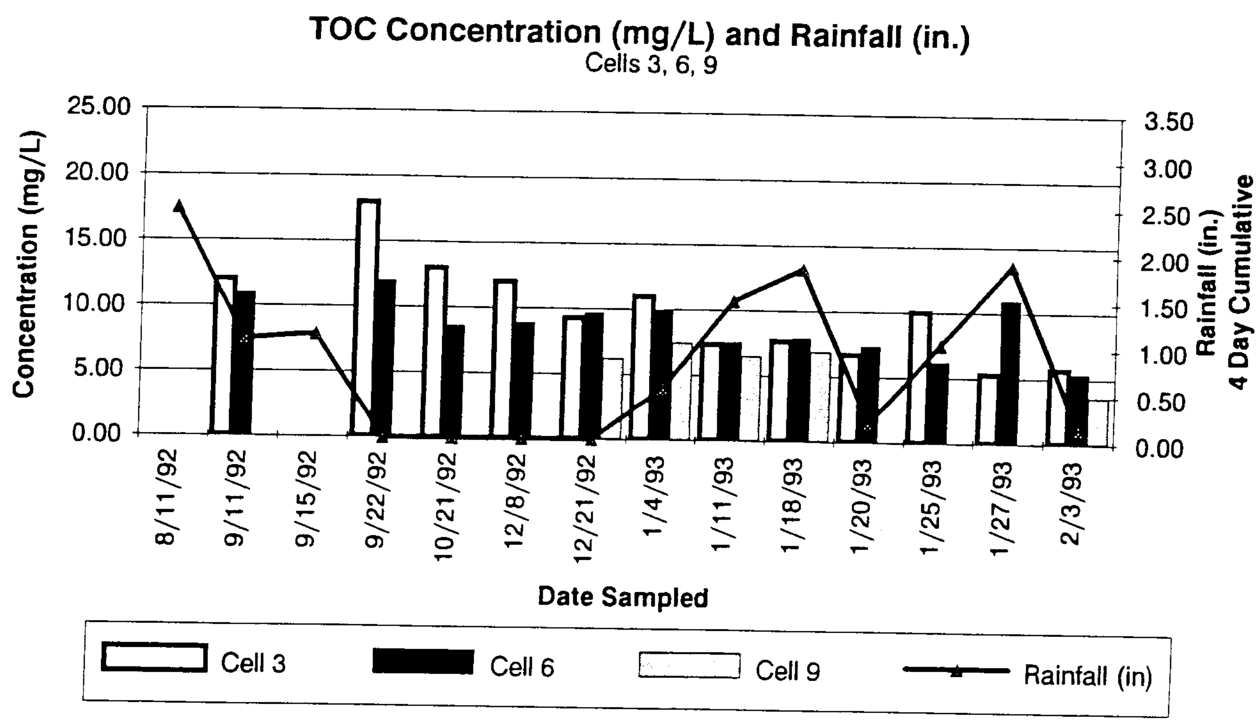


Figure F-2. Soil Water TOC Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 2-foot Unsaturated Zone).

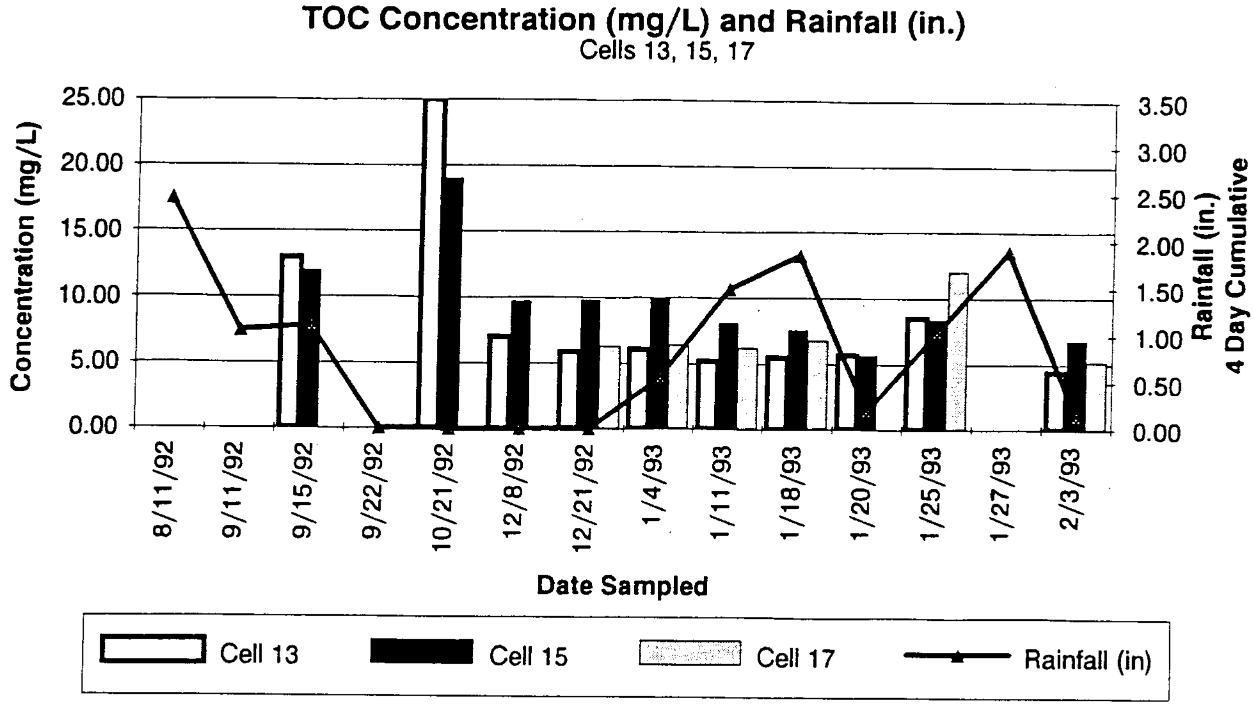


Figure F-3. Soil Water TOC Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 4-foot Unsaturated Zone).

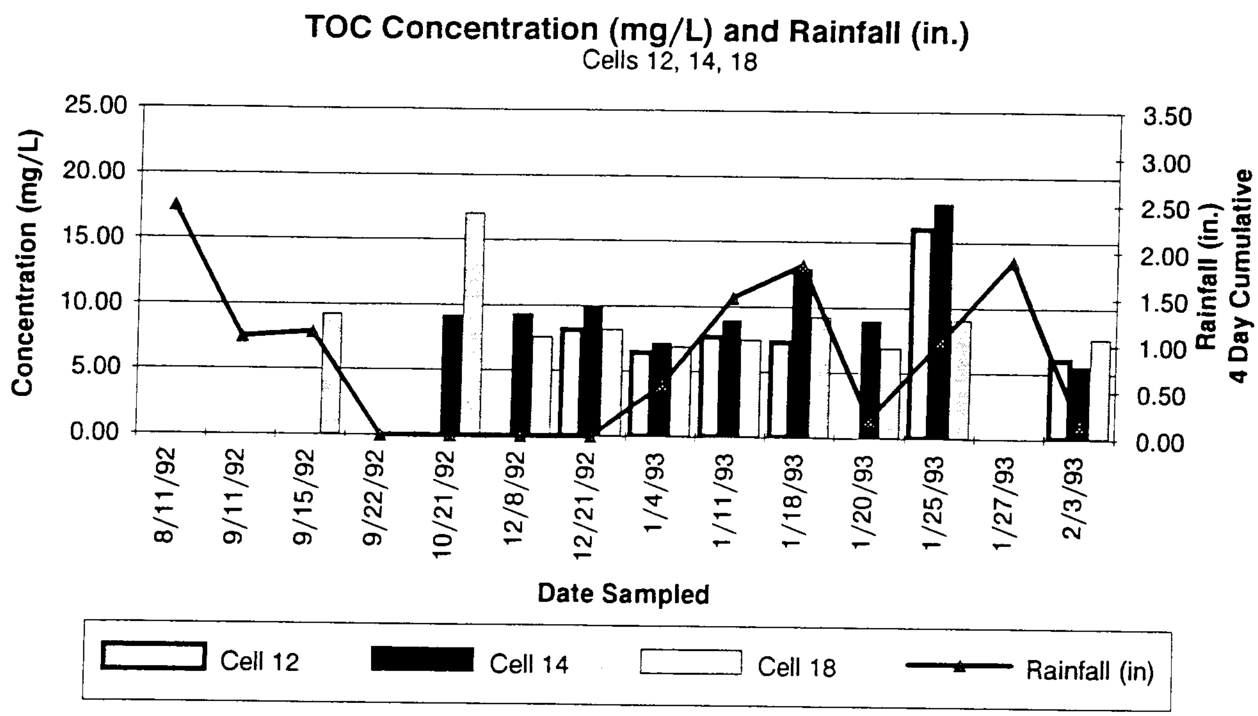


Figure F-4. Soil Water TOC Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 4-foot Unsaturated Zone).

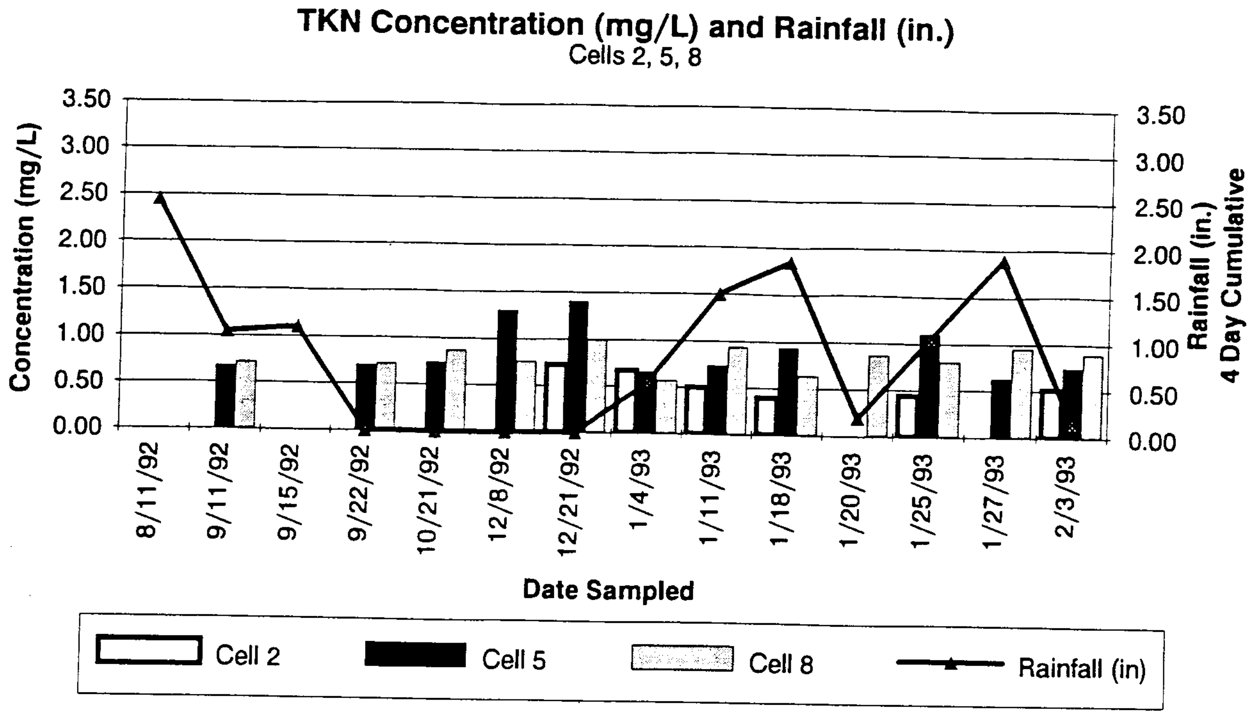


Figure F-5. Soil Water TKN Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 2-foot Unsaturated Zone).

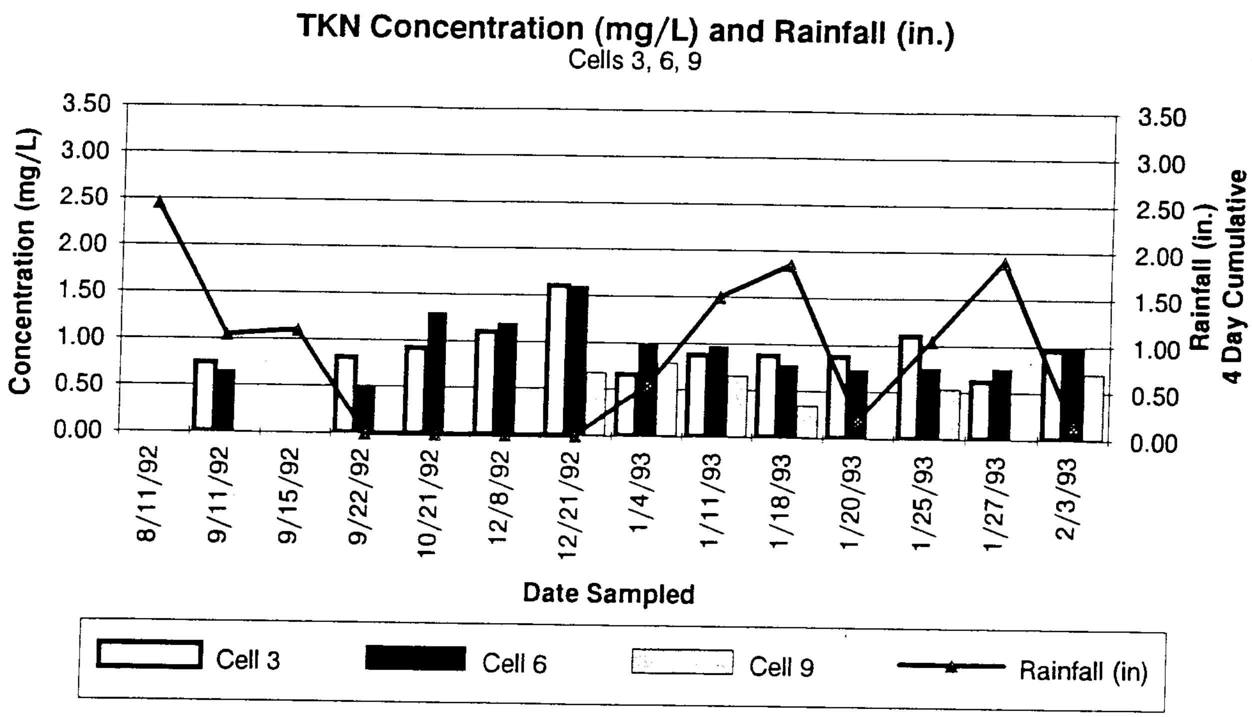


Figure F-6. Soil Water TKN Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 2-foot Unsaturated Zone).

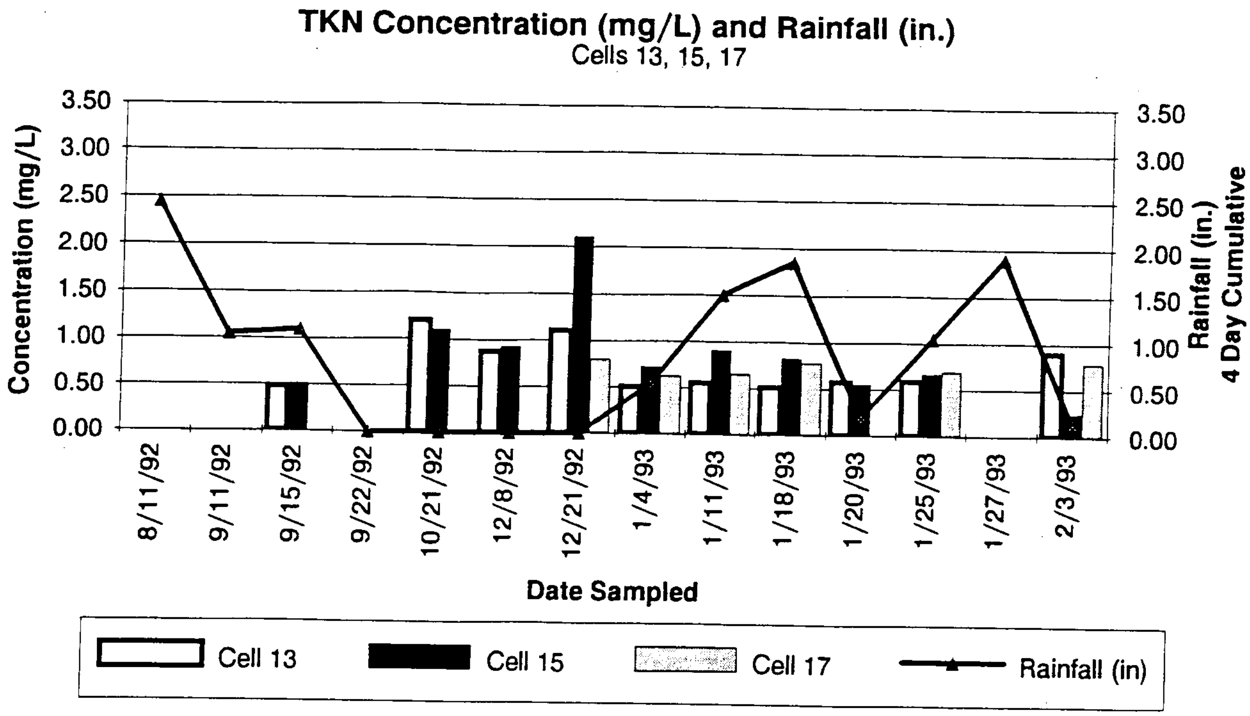


Figure F-7. Soil Water TKN Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 4-foot Unsaturated Zone).

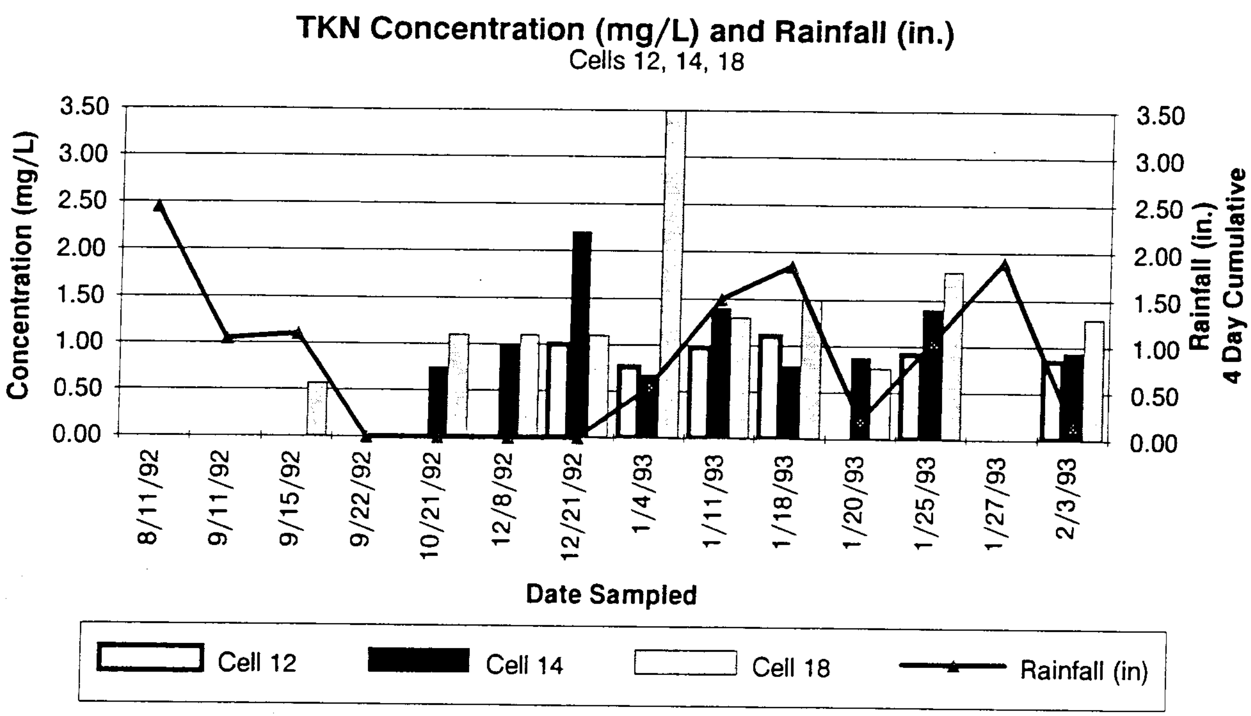


Figure F-8. Soil Water TKN Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 4-foot Unsaturated Zone).

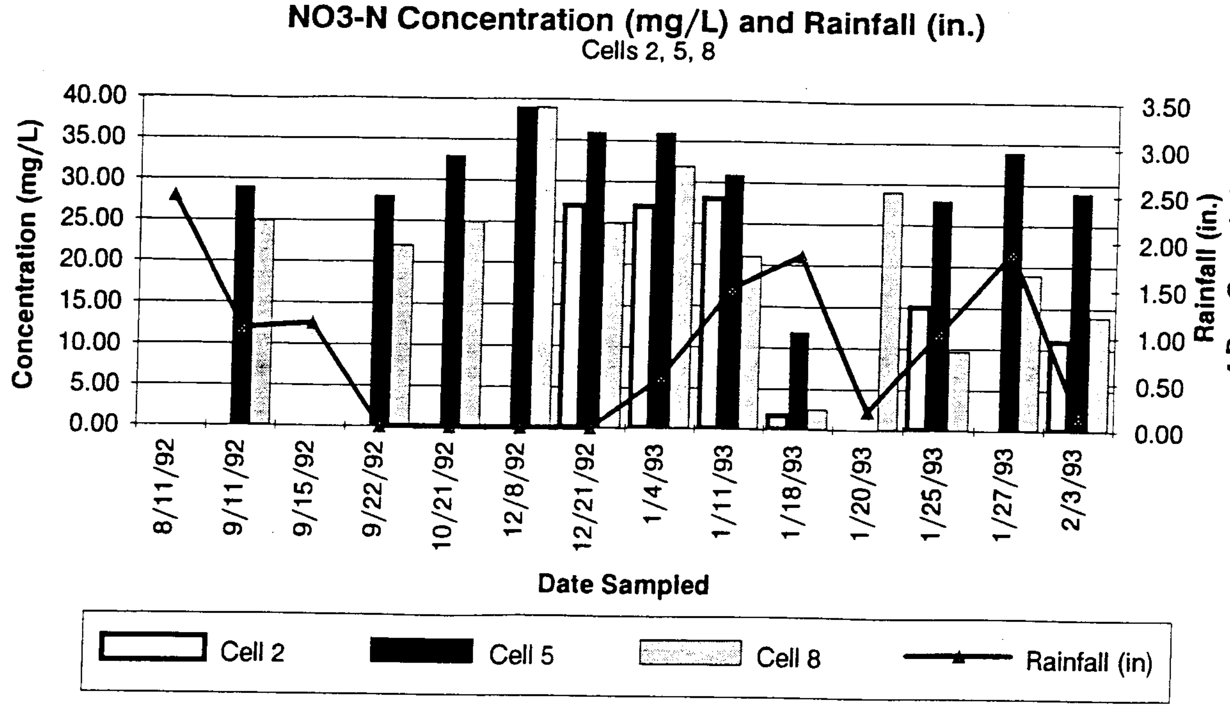


Figure F-9. Soil Water NO_3-N Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 2-foot Unsaturated Zone).

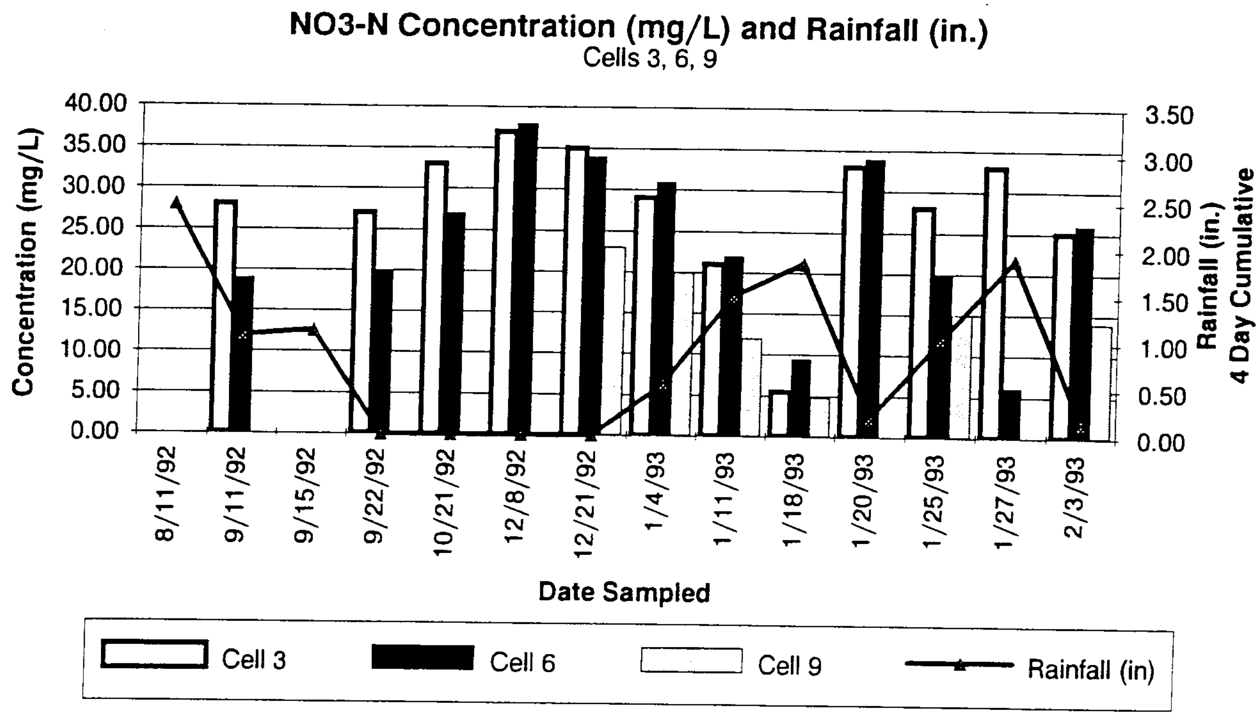


Figure F-10. Soil Water NO_3-N Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 2-foot Unsaturated Zone).

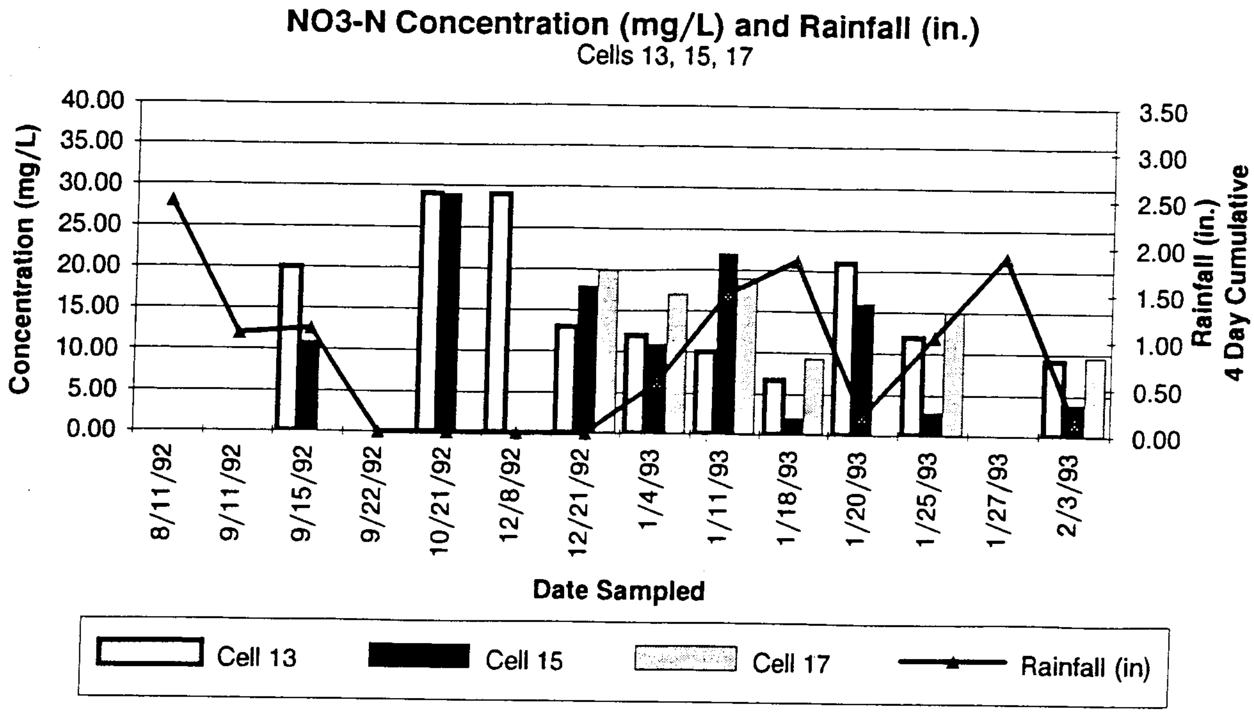


Figure F-11. Soil Water NO_3-N Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 4-foot Unsaturated Zone).

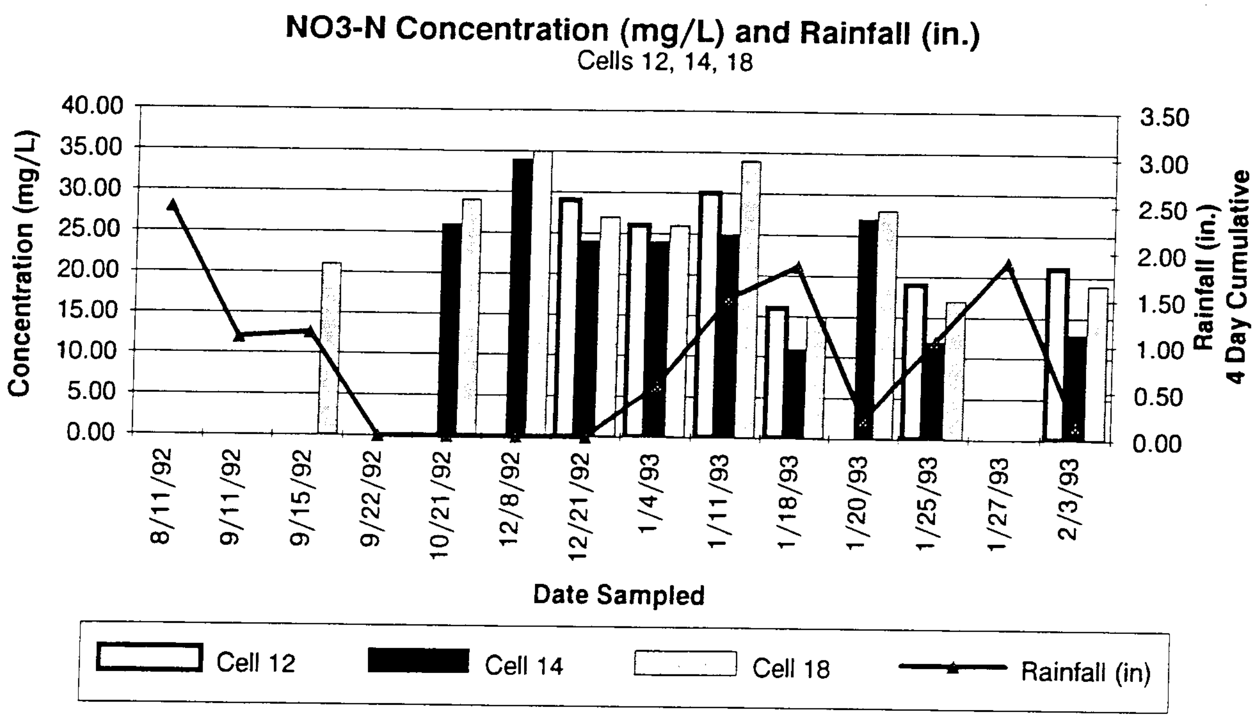


Figure F-12. Soil Water NO_3-N Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 4-foot Unsaturated Zone).

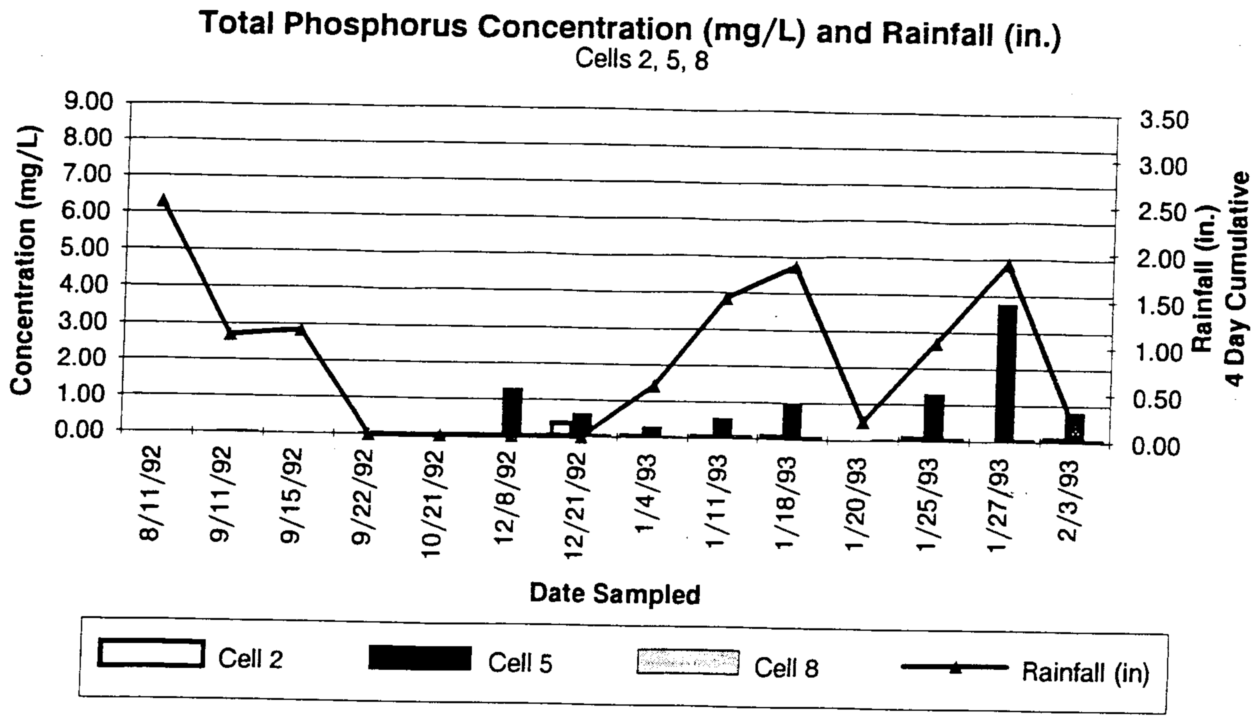


Figure F-13. Soil Water TP Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 2-foot Unsaturated Zone).

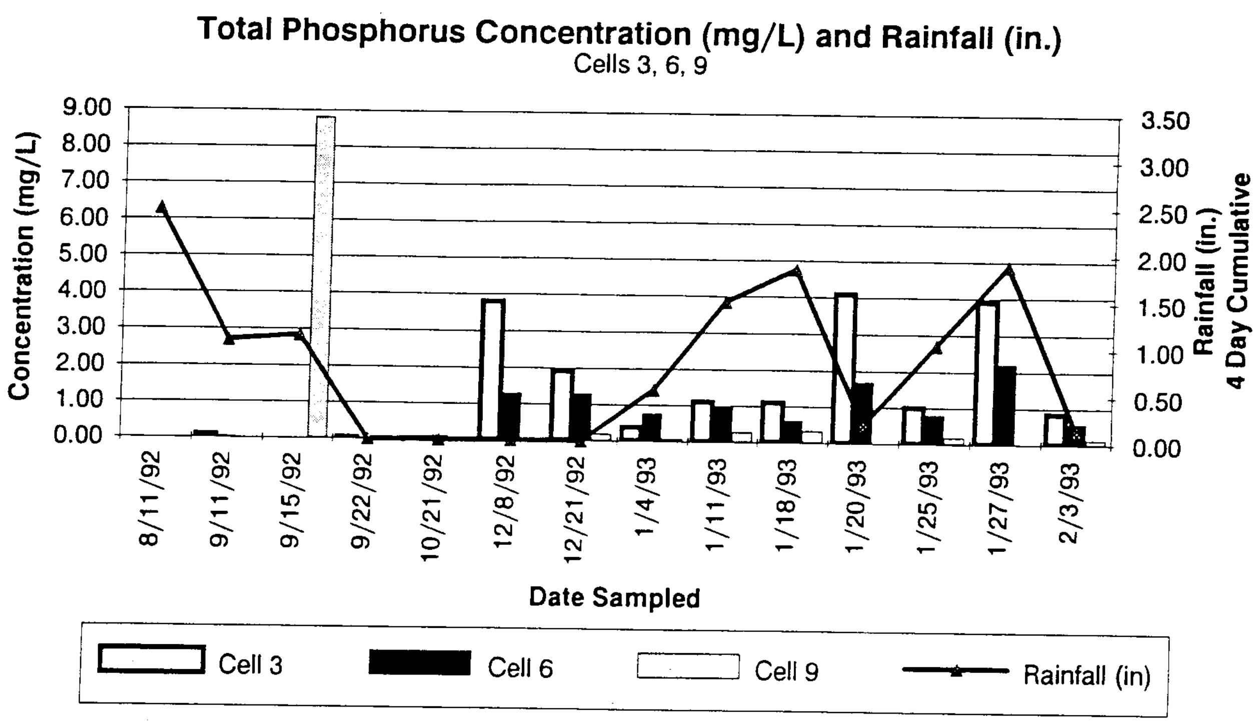


Figure F-14. Soil Water TP Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 2-foot Unsaturated Zone).

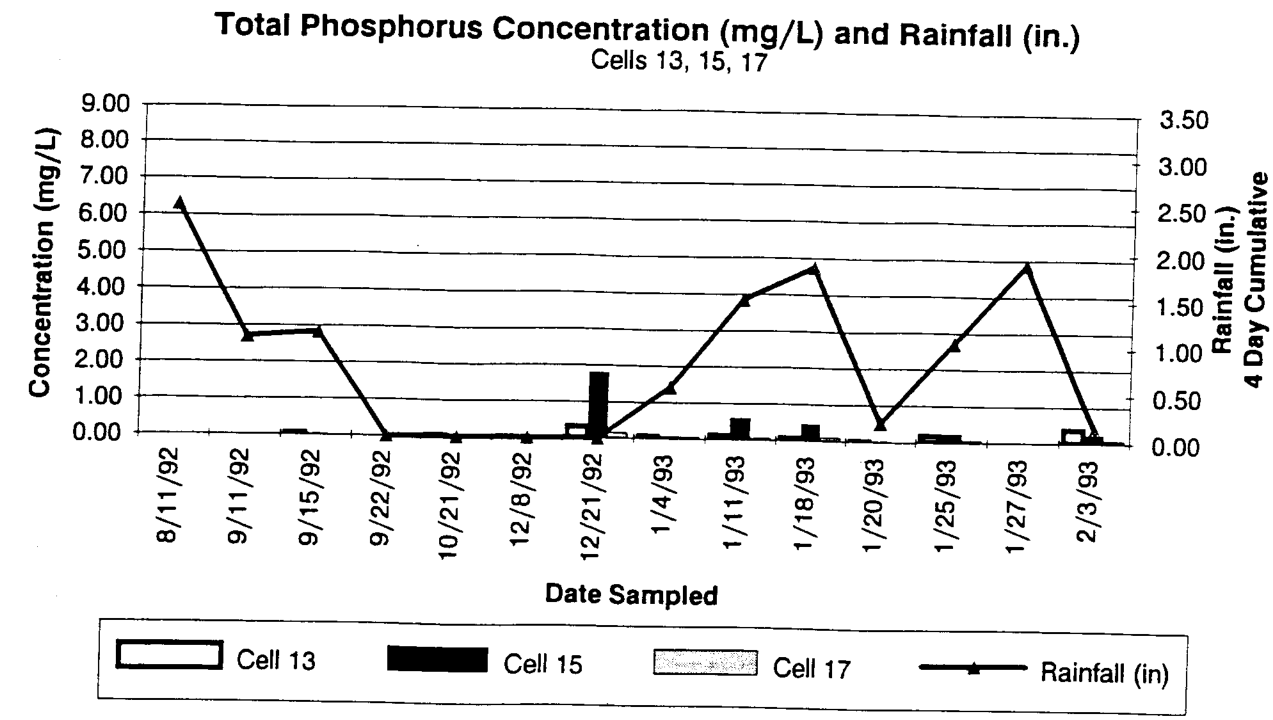


Figure F-15. Soil Water TP Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 4-foot Unsaturated Zone).

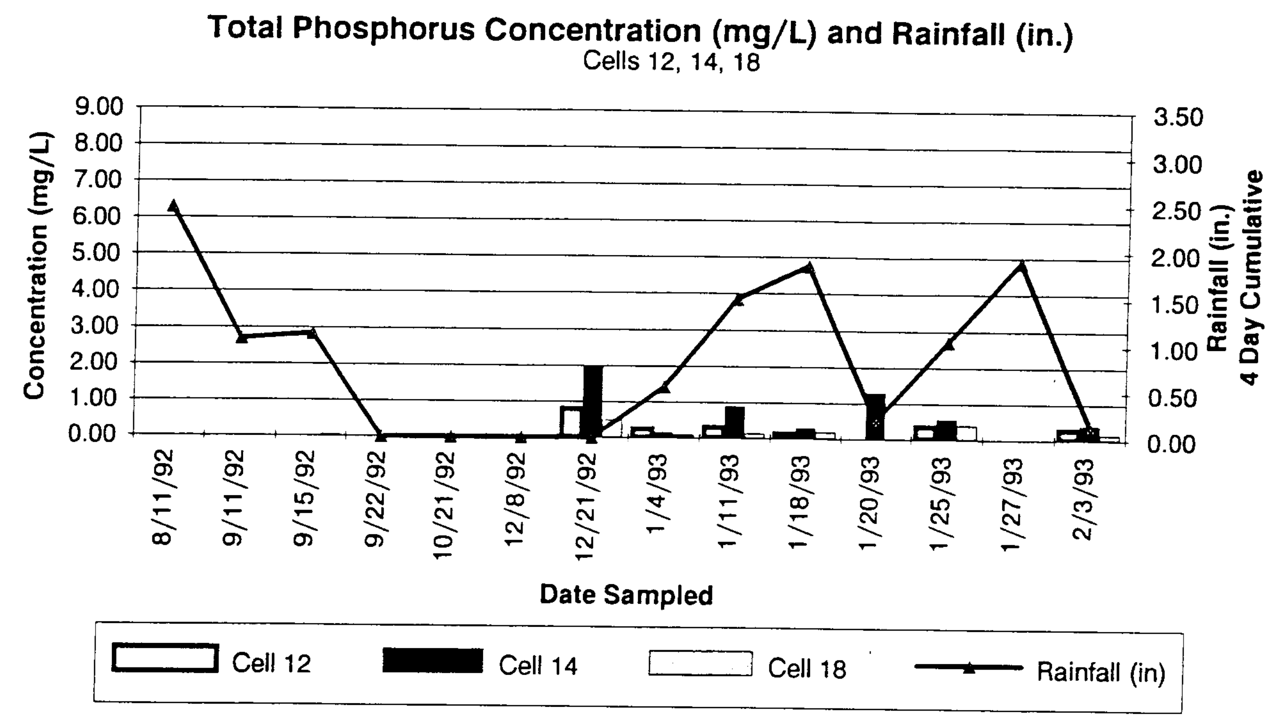


Figure F-16. Soil Water TP Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 4-foot Unsaturated Zone).

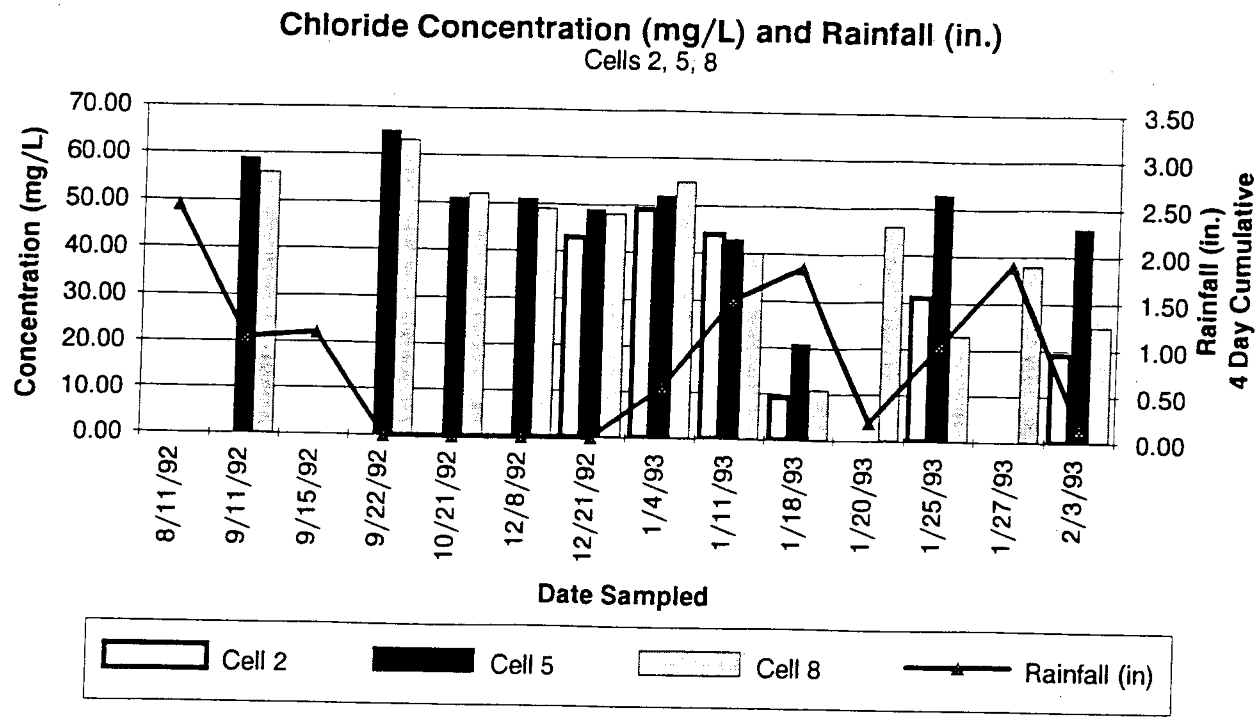


Figure F-17. Soil Water Chloride Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 2-foot Unsaturated Zone).

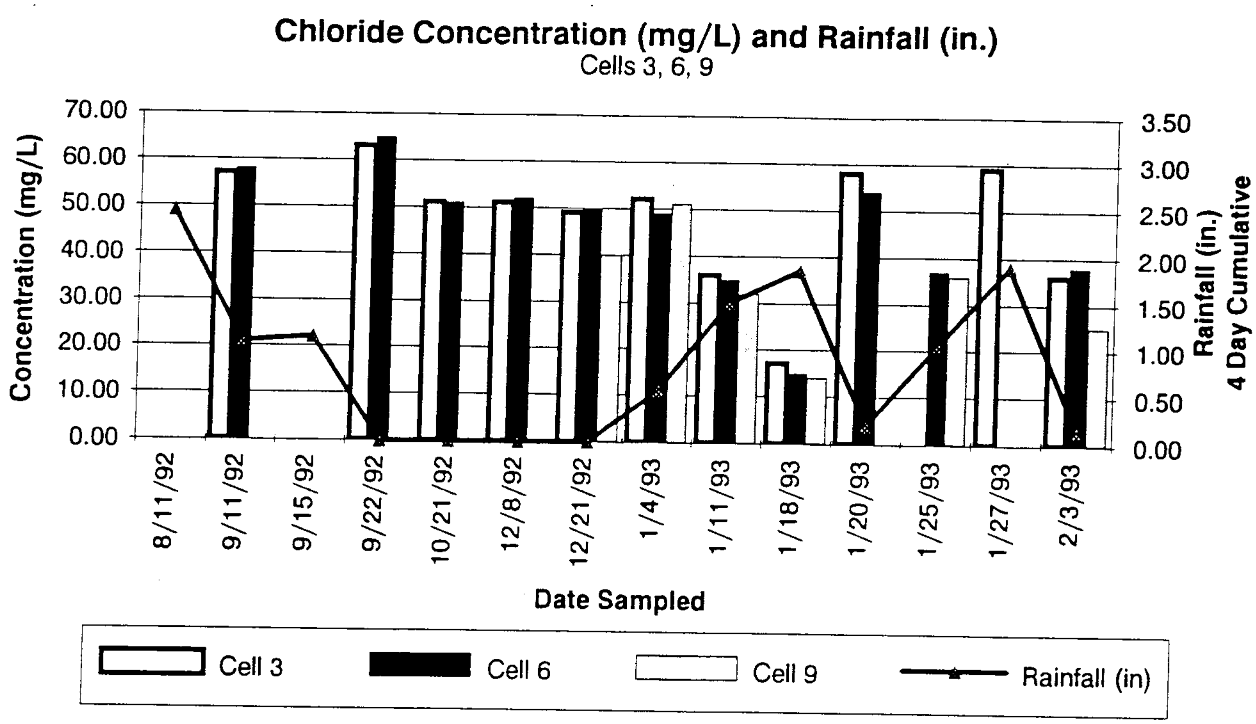


Figure F-18. Soil Water Chloride Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 2-foot Unsaturated Zone).

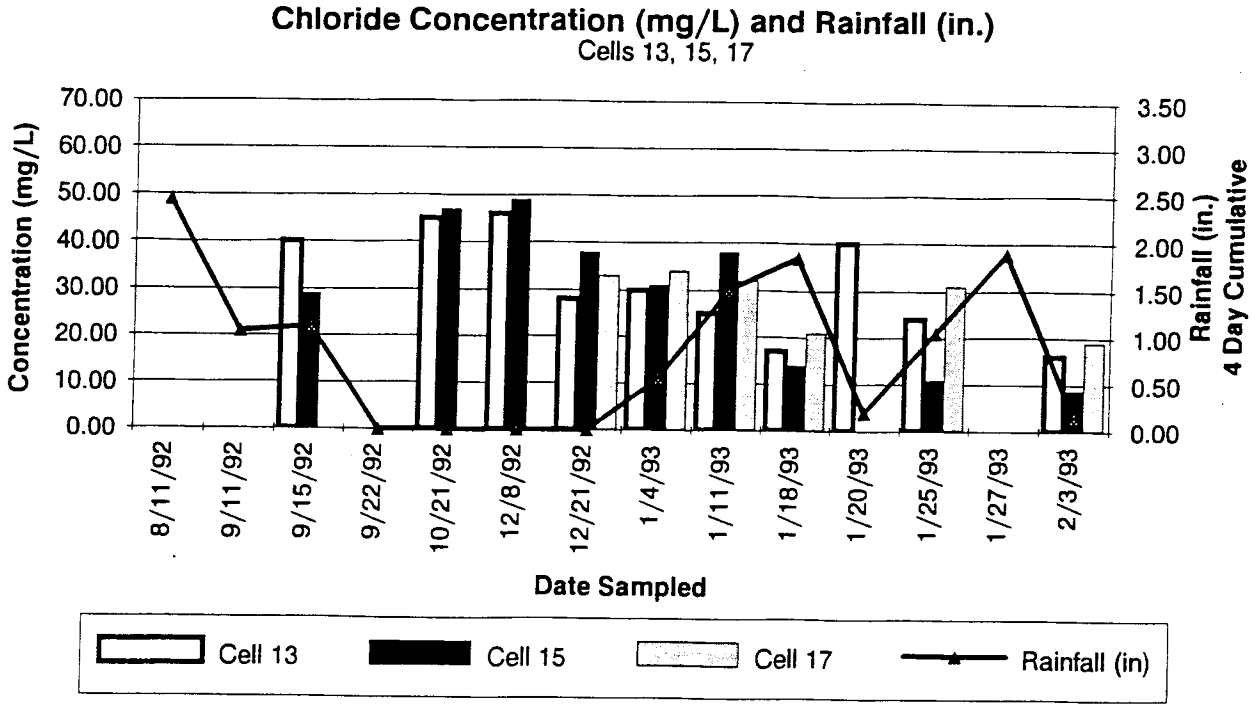


Figure F-19. Soil Water Chloride Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, Low-Loading Rate, 4-foot Unsaturated Zone).

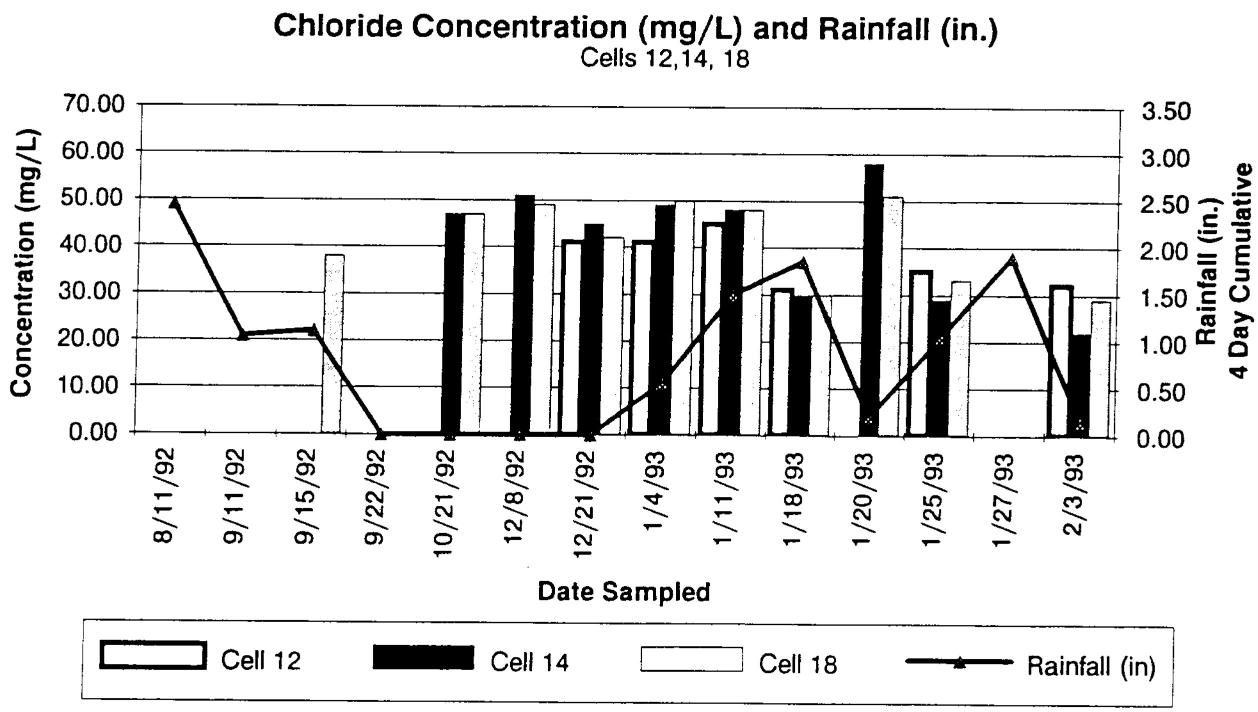


Figure F-20. Soil Water Chloride Concentrations and 4 Day Cumulative Rainfall by Sample Date (STE, High-Loading Rate, 4-foot Unsaturated Zone).