DEFINITION OF CONTAMINANT PLUMES FROM AN ONSITE SEWAGE DISPOSAL SYSTEM SERVING AN INDIVIDUAL HOME IN FLORIDA

Phase I Report

to

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DEFINITION OF CONTAMINANT PLUMES FROM AN ONSITE SEWAGE DISPOSAL SYSTEM SERVING AN INDIVIDUAL HOME IN FLORIDA

I. INTRODUCTION

The Soap and Detergent Association (SDA) has retained Ayres Associates to investigate the occurrence of certain chemical constituents in ground water below and downgradient of Onsite Sewage Disposal Systems (OSDS) in Florida. The purpose of the investigation is to define the contaminant plume of such a system and then to determine if key constituents of certain household cleaning products are present in the plume and if so, to what extent. This report describes the first phase of the investigation, the determination of the contaminant plume, and provides recommendations for a more detailed monitoring plan to complete the investigation.

Objectives

The specific objective of this phase of the project was to delineate the contaminant plume at the OSDS of a single family home in St. Johns County, Florida. The residence chosen was the subject of previous study by Ayres Associates as part of the Florida Onsite Sewage Disposal System Research Project and provided an excellent site for the SDA investigation.

Scope

The scope of this first phase was to use shallow ground water sampling for conservative, field measurable parameters to outline, in two dimensions, the approximate location of

shallow ground water impacted by the OSDS's subsurface wastewater infiltration system (SWIS). If this plume of impact could be delineated with conservative parameters such as chloride, conductivity or nitrate-nitrogen, then a plan for further study of other parameters would be recommended. In addition, this phase of the study investigated water use and wastewater characteristics to determine wastewater loading to the OSDS's infiltration system.

II. SITE CHARACTERISTICS

Residence Characteristics

The residence involved in this investigation is located in St. Johns County, Florida, just south of the city of Jacksonville. The home is in a subdivision of about 200 homes located about one-half mile east of the St. Johns River. A general location map of the study site is shown in Figure 1.

The home under study is a three bedroom, two bathroom home of fifteen (15) years of age. It is served by an OSDS consisting of a 900 gallon septic tank and a 210 square foot infiltration system made up of two-foot wide gravel-filled trenches. Further characteristics of the study residence are listed in Table 1. Figure 2 shows a plan view of the OSDS in the homes backyard.

Climate and Hydrology

The climate of St. Johns County is subtropical and is characterized by warm, humid summers and mild, dry winters with occasional frost from November to February. Annual average rainfall is approximately 54 inches. Rainfall is seasonal with the majority falling during the months of June through September. During these months, the rain usually falls from localized heavy showers of short duration.

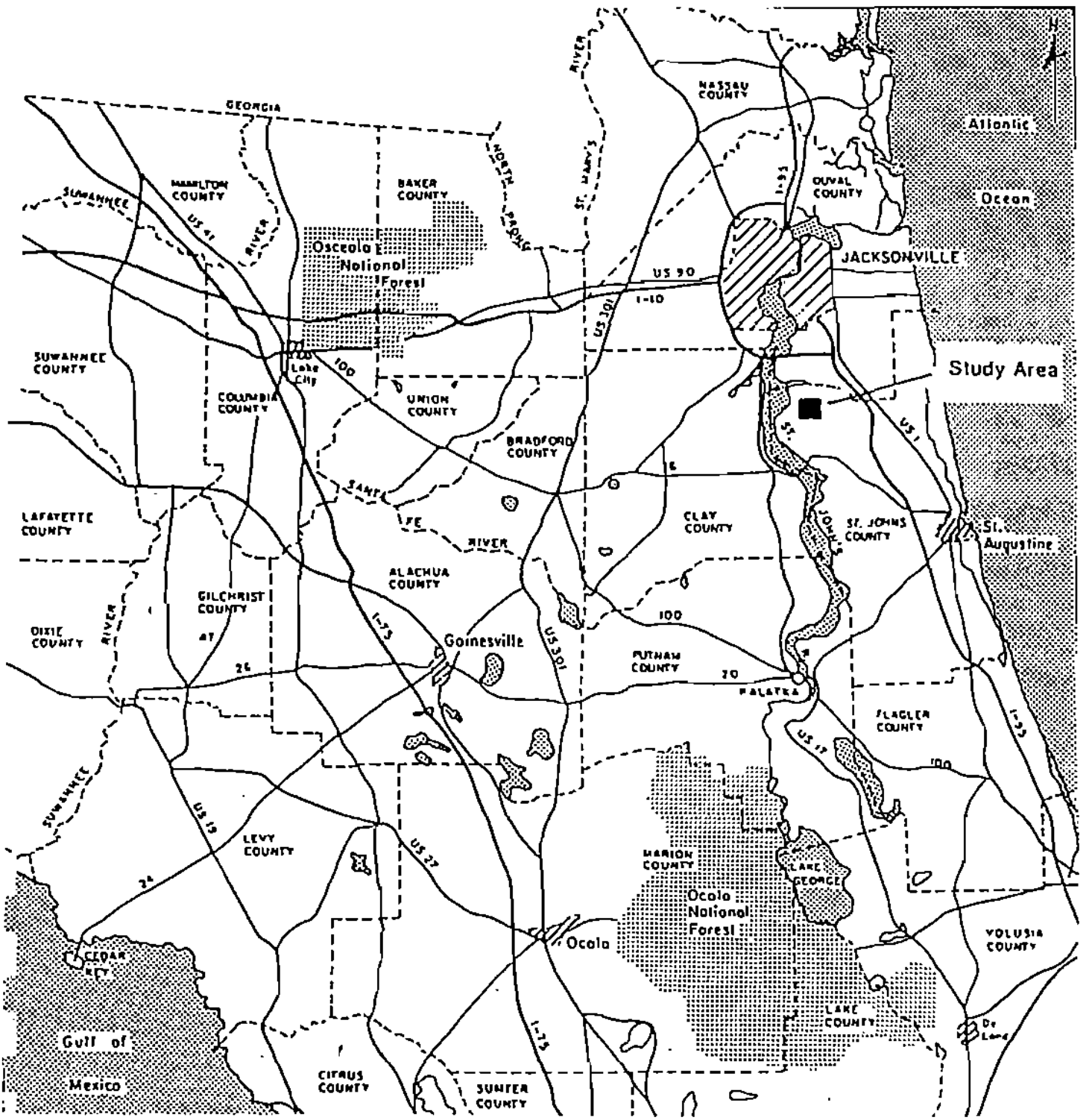


Figure 1. General location map of St. Johns County subdivision.

Table 1. Characteristics of individual OSDS monitoring site.[1]

Number Residents	4
Adults	2
Children	3, 7
Lot Size	0.47 acres
Age of Home	13 Years
Occupancy	7 Years
Number of Bedrooms	3
Number of Bathrooms	2
Dishwasher	Yes
Clothes Washer	Yes
Garbage Disposal	No
Water Softener	No
Septic Tank Size	900 Gallon
Date Last Pumped	August 1988
Drainfield Area	210 Ft^2
Drainfield Type	2 Foot wide, gravel-filled trenches
Effluent Distribution	Gravity flow, 4" perforated pipe

1 Based on homeowner survey results as of 1989.

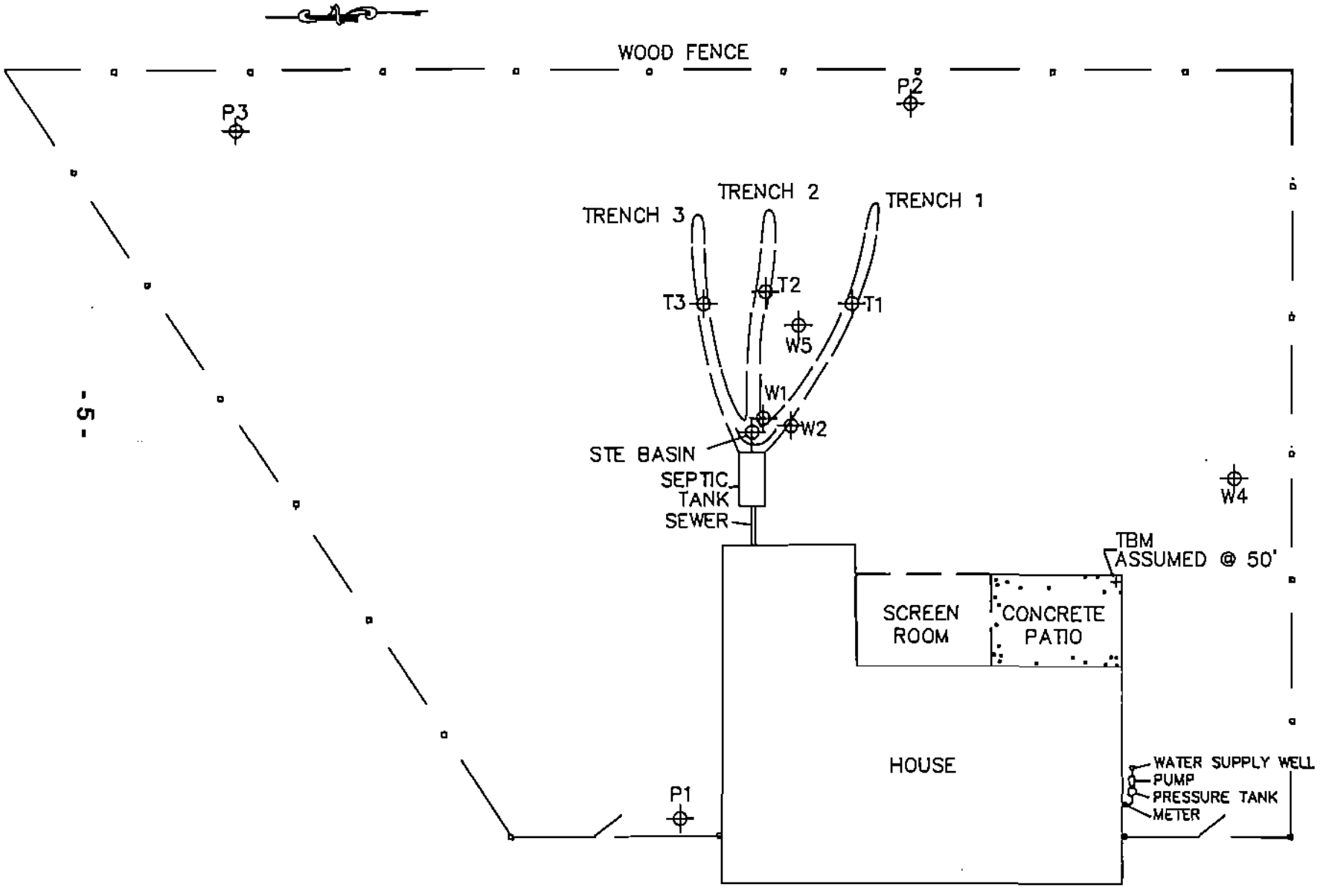


Figure 2. Plan view of OSDS study site.

The subdivision study site is located in the physiographic province referred to as the Coastal Lowlands. The topography of the lowlands is controlled by a series of marine terraces which were formed during Pleistocene time. Elevations at the site range from 10 to 15 feet above mean sea level (MSL). Surface drainage in the area is primarily through the St. Johns River and its tributaries. The St. Johns River generally flows northward to the Jacksonville area where it turns sharply toward the east and empties into the Atlantic Ocean.

The surface water drainage at the study site is restricted by its location on a relatively flat, topographically high area. The extremely permeable unsaturated zone within the surficial sand units encourages very rapid rainfall infiltration. The majority of surface runoff within the subdivision is directed south-southeastward towards a local topographic depression which is undeveloped. Drainage ultimately enters the St. Johns River via a creek just south of the site.

The region is underlain by two major hydrogeologic units of differing lithologies. The uppermost unit consists of clastic sediments including poorly to moderately consolidated sand, clay, and shell material of Miocene to Holocene age. This overlies a thick sequence of limestone and dolomite, commonly called the Floridan aquifer (Parker et. al., 1955).

Undifferentiated sediments of Pleistocene and Holocene age blanket the majority of the area. These sediments were deposited during the formation of marine terraces and beach ridges and are primarily composed of medium to fine grained quartz sand with some local iron oxide straining. This lithology is typical of the surficial sediments in the site area.

Soils

Soils throughout the subdivision site were derived from sandy marine sediments, and the morphology of the subdivision soils are therefore dominated by sandy profile descriptions.

Over 75 percent of the entire subdivision area and all of the area under study consisted of Tavares, Adamsville, and Ona fine sands. The drainage class of these soils are moderately well drained, somewhat poorly drained, and poorly drained, respectively. The USDA Soil Conservation Service (SCS) limitations for conventional septic system drainfields are classified as moderate, severe, and severe, respectively, with the limitations due to wetness and poor filtration.

The home and OSDS under study for this project are located on Adamsville fine sand, based on characteristics defined by the Soil Conservation Service (SCS). The Adamsville series is a somewhat poorly drained soil with rapid profile permeability. The water table is typically at 20 to 40 inches below grade for approximately 2 to 6 months of the year, and below 40 inches for the rest of the year. The typical Adamsville profile has a fine sand texture throughout. The water table has typically varied from 3 to 5 feet below grade in the area of the OSDS being investigated, based on past ground water monitoring at the site.

III. METHODS

Wastewater Quality and Quantity

Wastewater flow to the OSDS was estimated by installing water meters at several points on the household water system. A master meter was installed on the main supply line from the household well which monitored total water use. Individual meters were then installed on the exterior hose bibs to monitor outdoor water use. The home did not have an in-ground lawn sprinkler system. The home used a water to air heat pump system for household heating so an additional meter was installed on the down stream side of the heat pump to monitor its water use, which discharged to the ground outside the house. By subtracting out exterior water use, an estimate of wastewater flow was obtained which could be used to estimate loading the OSDS.

Wastewater quality had been measured previously at the study residence as part of the Florida Onsite Sewage Disposal System Research Project (Ayres Associates, 1989). As part of that effort, a septic tank effluent (STE) sampling basin had been installed between the septic tank and the infiltration system. To confirm that wastewater quality was consistent with previous monitoring results, a single grab sample of septic tank effluent was taken from the STE basin as part of this study. Wastewater quality was then compared with prior results and with literature values for STE quality.

OSDS Contaminant Plume Definition

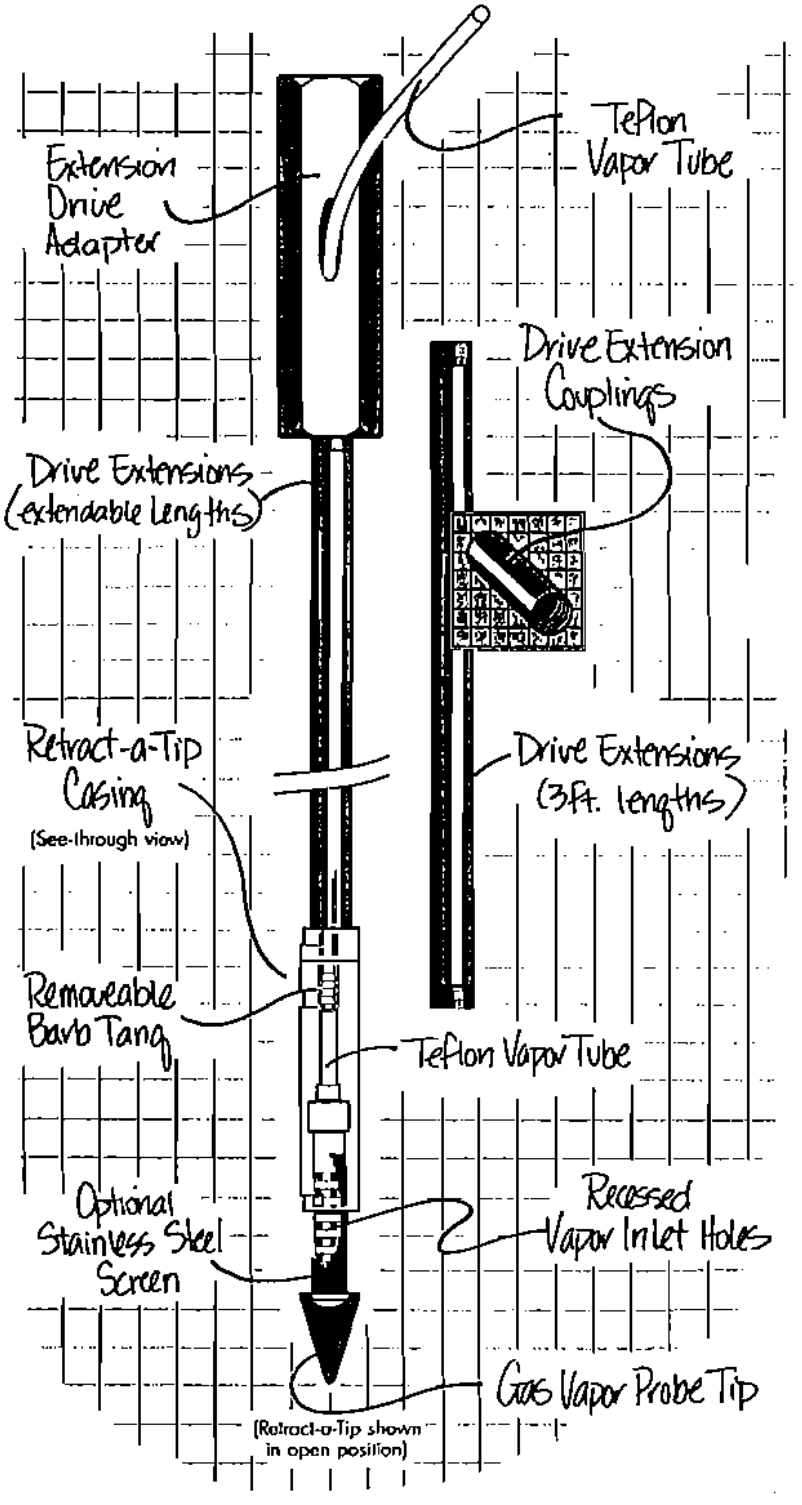
Definition of the contaminant plume from the OSDS's subsurface infiltration system was performed with data collected from several monitoring systems. Ground water piezometers and monitoring wells were used to measure ground water levels and to obtain samples. In addition, a stainless steel probe system with miniature well points was used to obtain individual ground water samples at numerous points around the infiltration system without the time and expense of permanent monitor wells.

Piezometers: Three ground water piezometers were installed at locations around the OSDS. These are shown on Figure 2 as P1, P2, and P3. Piezometers were constructed with 2-inch diameter PVC well screen of 3 foot length and 0.010 inch slot size. Blank PVC pipe was used to bring them up to ground surface. They were installed in the natural soil with a hand auger to a depth approximately one to two feet below the water table surface. The piezometers were used to determine ground water elevations and subsequently to estimate the direction of ground water flow.

Monitor Wells: Four ground water monitoring wells were installed near the subsurface infiltration system. These are labelled W1, W2, W4, and W5 on Figure 2. The monitor wells were constructed of 2-inch PVC well screen of five foot length and 0.010 inch slot size and blank PVC pipe to bring them up to ground surface. Monitor wells were installed by hand augering to the water table, then augering through a four-inch PVC casing which was advanced with the auger to three to four feet below the water table. The two-inch PVC monitor wells were then installed inside the four-inch casing. A clean, graded sand pack was placed around the monitor well and the four-inch casing removed leaving the sand packed monitor well in place. The monitor wells were developed by pumping them at four to five gallons per minute for five minutes after installation. These wells were subsequently sampled for various water quality parameters and this data was used to compare results with the individual ground water samples taken with the stainless steel probe unit.

Stainless Steel Probe: A stainless steel probe system originally designed for soil gas vapor monitoring in the unsaturated zone was used to take ground water samples around the site. Figure 3 shows a diagram of the unit (Arts Manufacturing, Idaho Falls). The probe unit utilized a miniature well point attached to ½ inch stainless tubing which was driven into the saturated zone. Ground water samples were then obtained through a teflon sampling tube inside the stainless tube by applying suction with a peristaltic pump on the teflon tubing. The entire probe system could then be pulled up and driven in at a new sample location. This system allowed collection of ground water samples from ten to fifteen different locations per day at the project site, and was especially useful for identifying the location of the contaminant plume. For more permanent monitoring, a disposable stainless tip and teflon tubing will be used which remains in the ground for obtaining additional ground water samples at the same location.

AMS RETRACT-A-TIP (PATENT PENDING)



The AMS Retract-a-Tip was designed to be used with all existing AMS gas vapor probe extensions, up-and-down hammer attachment and electric rotary hammer.

The unique design of the Retract-a-Tip enables a person to do a soil gas survey from around a spill area or a suspected spill area. The Retract-a-Tip is driven into the earth; and while the tip is being inserted, it can be opened at various depths and a vapor sample taken. After the last sample is taken, the Retract-a-Tip can be completely removed from the ground in its entirety—tip, Teflon tubing, and drive extensions. After the tip has been removed, it can then be completely disassembled and decontaminated in preparation for the next vapor study. If, after the sampling is done and long-term monitoring is needed, the AMS dedicated point system can be installed.

Art's Manufacturing & Supply
Manufacturers of soil sampling equipment for over 40 years

Figure 3. Schematic of stainless steel probe sampler.

IV. RESULTS

Wastewater Quantity and Quality

Table 2 shows a summary of the preliminary water use data collected at the study residence. This water use is based on only one week of meter data, therefore, its accuracy is unknown at this time. Future meter readings will provide additional data which should give a better estimate of wastewater flows. Assuming interior water use as an estimate of wastewater flow, these preliminary results indicate a flow of about 168 gallons per day (gpd) to the OSDS.

Table 2. Preliminary Water Use Summary

Total Use (gpd)	Exterior Use (gpd)	Heat Pump (gpd)	Estimated Interior Use (gpd)
900	67	665	168

Table 3 shows a summary of septic tank effluent quality. The table lists results of the single sampling performed as part of this project and the prior results at the site from the Florida OSDS Research Project. Most parameters from the recent sampling were well within the range of prior results, with the following exceptions. Total suspended solids (TSS) and total dissolved solids (TDS) were both slightly lower than previously, while chloride (Cl^-) and surfactant (Methylene blue active substance, MBAS) concentrations were both higher. The reasons for these differences are not clear but they could be due to changes in lifestyle and family, differences in household products which end up

Table 3. Septic tank effluent quality

Parameter	Previous Results*	This Study
Temp. (°C)	20.5 – 25.5 – 28.0 (5)	--- 23 ---
Cond. (umho/cm)	640 – 712 – 880 (5)	--- 800 ---
BOD_5 (mg/L)	108 – 139 – 163 (5)	--- 124 ---
TOC (mg/L)	--- 56 ---	--- 55 ---
TSS (mg/L)	74 – 93 – 122 (5)	--- 66 ---
TDS (mg/L)	330 – 415 – 498 (5)	--- 264 ---
NO^2-NO^3 (mgN/L)	0.01 – 0.06 – 0.17 (5)	--- 0.03 ---
TKN (mgN/L)	16 – 36 – 53 (5)	--- 48 ---
Total P (mg/L)	12 – 15 – 17 (5)	--- 17 ---
Cl^- (mg/L)	20 – 24 – 29 (5)	--- 40 ---
MBAS (mg/L)	3 – 5 – 8 (4)	--- 20 ---
FOG (mg/L)	15 – 25 – 36 (4)	--- 38 ---

* Results shown are mean, range, and number of samples.

as wastewater, or changes in septic tank performance. One known difference was the fact that the septic tank at the home had been pumped out between the recent and prior sampling dates. The differences in TSS, TDS and Cl^- are not as significant as the different in MBAS concentrations. Surfactant concentrations as measured by MBAS were 2 to 3 times higher than measured previously and significantly higher than any other household sampled as part of the Florida OSDS Research Project. This raises doubt about the accuracy of sampling and analyses for MBAS and it is felt that additional samples should be collected and analyzed to confirm these suspicions.

Other than the MBAS concentration these results indicate that the STE quality currently discharging to the OSDS infiltration system is similar to that previously reported for this home and also compares favorably to other studies of STE quality in the U.S. (Ayres Associates, 1989).

OSDS Contaminant Plume Definition

Ground water elevation data were collected on November 28, 1990 at piezometers P1, P2, and P3 and at monitor wells W4 and W5. The well casings were surveyed to common datum and depth to water in each well was measured and referenced to this casing elevation. An analysis of these data revealed that the general ground water flow direction at the site is south-southwest. This result agreed with previous flow direction measurements taken elsewhere in the study subdivision as part of the Florida OSDS Research project.

The stainless steel probe sampler was then used around the periphery and down gradient of the OSDS infiltration area to determine the location of any contaminant plume emanating from the system. Ground water samples from the miniature well point on the probe sampler and from the monitor wells and piezometers were analyzed in the field to identify areas of ground water impact from the OSDS. Field measurement of conductivity,

Chloride (Cl^-), and nitrate-nitrogen (NO_3-N) were used as parameters to identify system impacts. Conductivity was measured with a standard electronic field instrument calibrated with standard solutions. Chloride and nitrate were measured with field chemistry kits (Hach Company, Loveland, Colorado).

Forty-seven (47) sample points were analyzed including wells W-1, W-2, W-4, W-5, and piezometer P-2. Figure 4 shows the location of the sample points around the OSDS area. Several duplicate ground water samples were submitted to an analytical laboratory for confirmation and checking of the field analyses.

Table 4 shows the results of the comparison between field and lab analyses. As the table shows, field and laboratory results agree well for the chloride and conductivity measurements. Field measurements of nitrate did not compare well with duplicates sent to the lab however. It appears that the limited sensitivity of the field chemical kit for nitrate does not provide sufficient accuracy for nitrate quantification. The field kit did, however, provide a result that accurately detected the presence or absence of nitrate in the ground water samples, and was therefore useful in detecting ground water impacts around the OSDS area.

Table 4. Comparison between field and lab analyses.

LOCATION	PARAMETER					
	NO_3 (mg/L)		Cl^- (mg/L)		Cond. (umho/cm)	
	Field	Lab	Field	Lab	Field	Lab
A20	ND	0.01	11	10	315	310
D39	--	41	48	43	600	600
E54	ND	< 0.01	22	24	185	190
F39	> 10	43	---	43	625	600
W4	ND	< 0.01	12	9	270	280
X39	> 10	41	44	44	700	700
Y18	0.9	13	---	24	450	420
Z47	8	21	27	25	320	---

ND = None Detected
--- = No Data

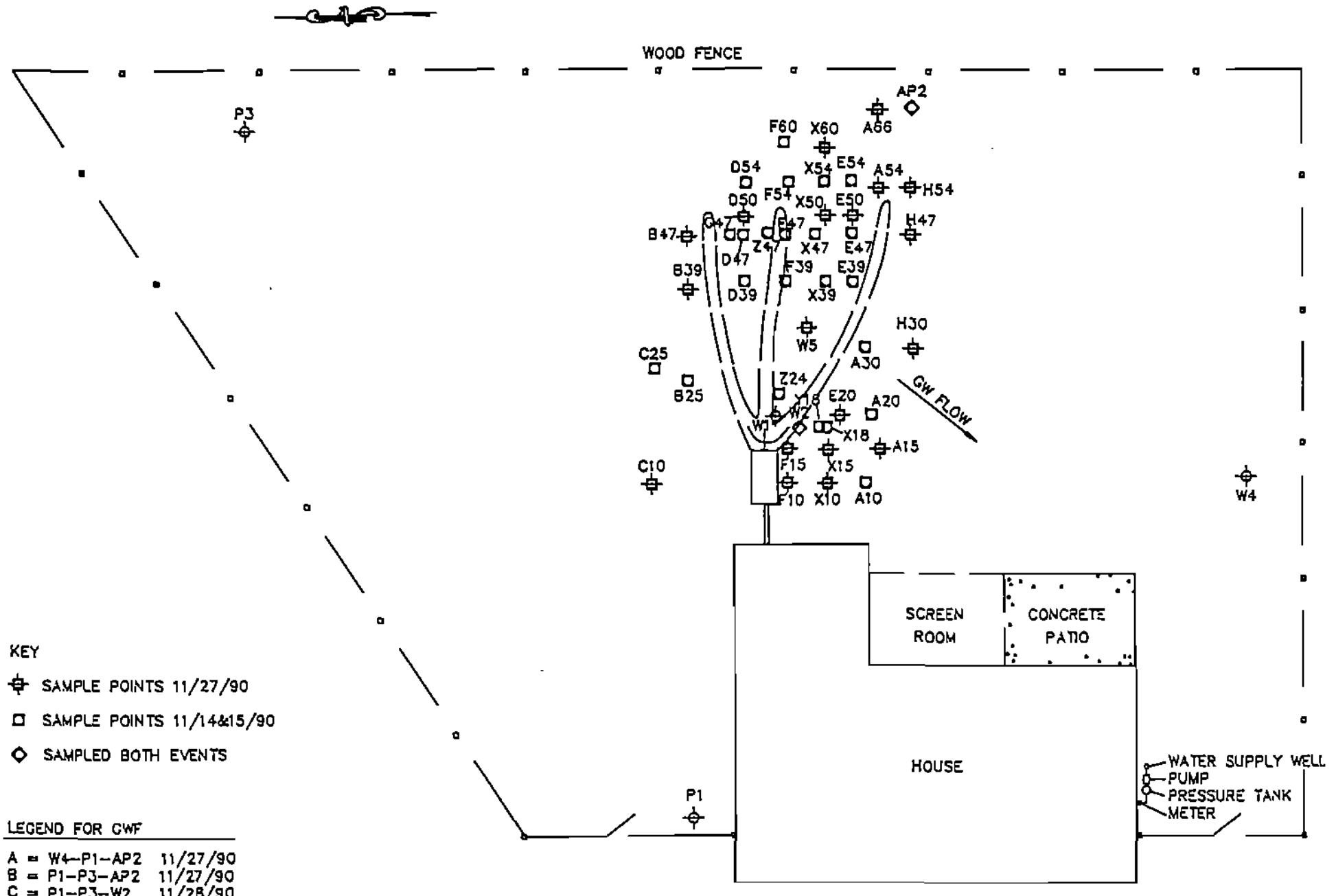


Figure 4. Ground water sample locations.

The results of the sample analyses for conductivity, chloride, and nitrate are shown graphically on Figures 5 through 7 as isoconcentration contours around the OSDS infiltration area. The areas of impacted ground water, or contaminant plumes, are seen as elevated levels of these parameters on the figures, and results are similar between the three parameters measured. The results shown on the conductivity and chloride diagrams are more accurate than the nitrate plume due to the relative accuracy of the field measurements discussed earlier. The diagrams show two areas of ground water impact near the OSDS, one east of the infiltration system and another extending southwest of the infiltration system in the direction of ground water flow.

The down gradient impact area to the southwest appears to be the plume associated with the infiltration of septic tank effluent in the drainfield trenches and agrees well with previous observations of system performance over the course of the OSDS Research Project. When the septic tank effluent (STE) sampling basin and the drainfield observation ports were originally installed in the system in late 1987, it was noted that the majority of the STE discharged from the septic tank flowed into the center of the three trenches. It was also noted at that time that most of the wastewater infiltration occurred in the area of the infiltration system closest to the septic tank. This observation was documented by soil sampling and analysis directly below the center trench, which showed increased concentrations of STE contaminants in soils closer to the septic tank outlet (Ayres Associates, 1989). The plume diagrams in Figures 5 through 7 agree with this data, showing peak ground water concentrations along and downgradient of the center trench, with the greatest impact directly downgradient of the septic tank outlet.

The source or cause of the impacted area to the east of the system is unknown. It appears unlikely that the OSDS infiltration area is the source of these impacts because the direction of ground water flow is southwest and the area of greatest wastewater

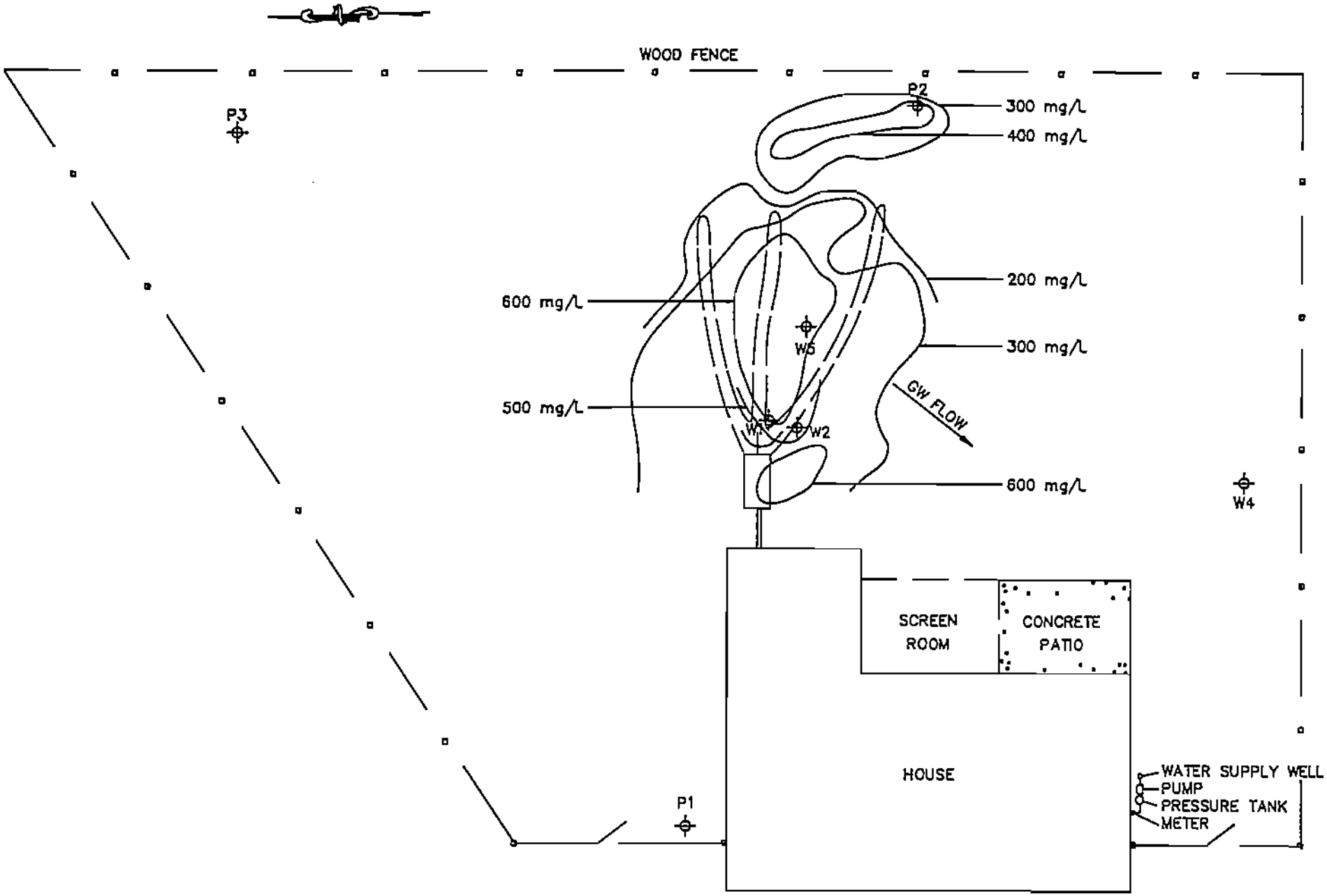


Figure 5. Conductivity Isoconcentration Contours.

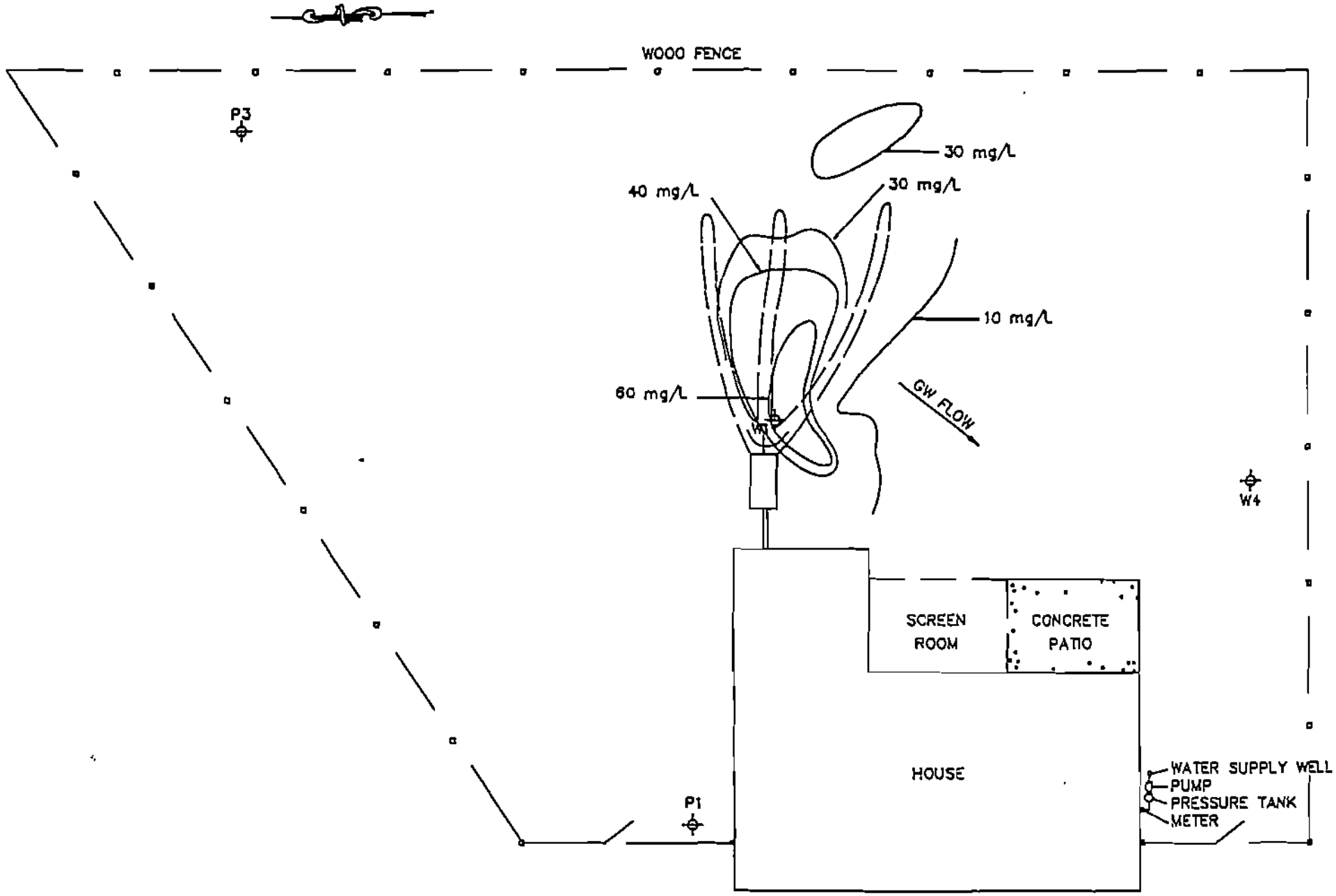


Figure 6. Chloride Isoconcentration Contours.

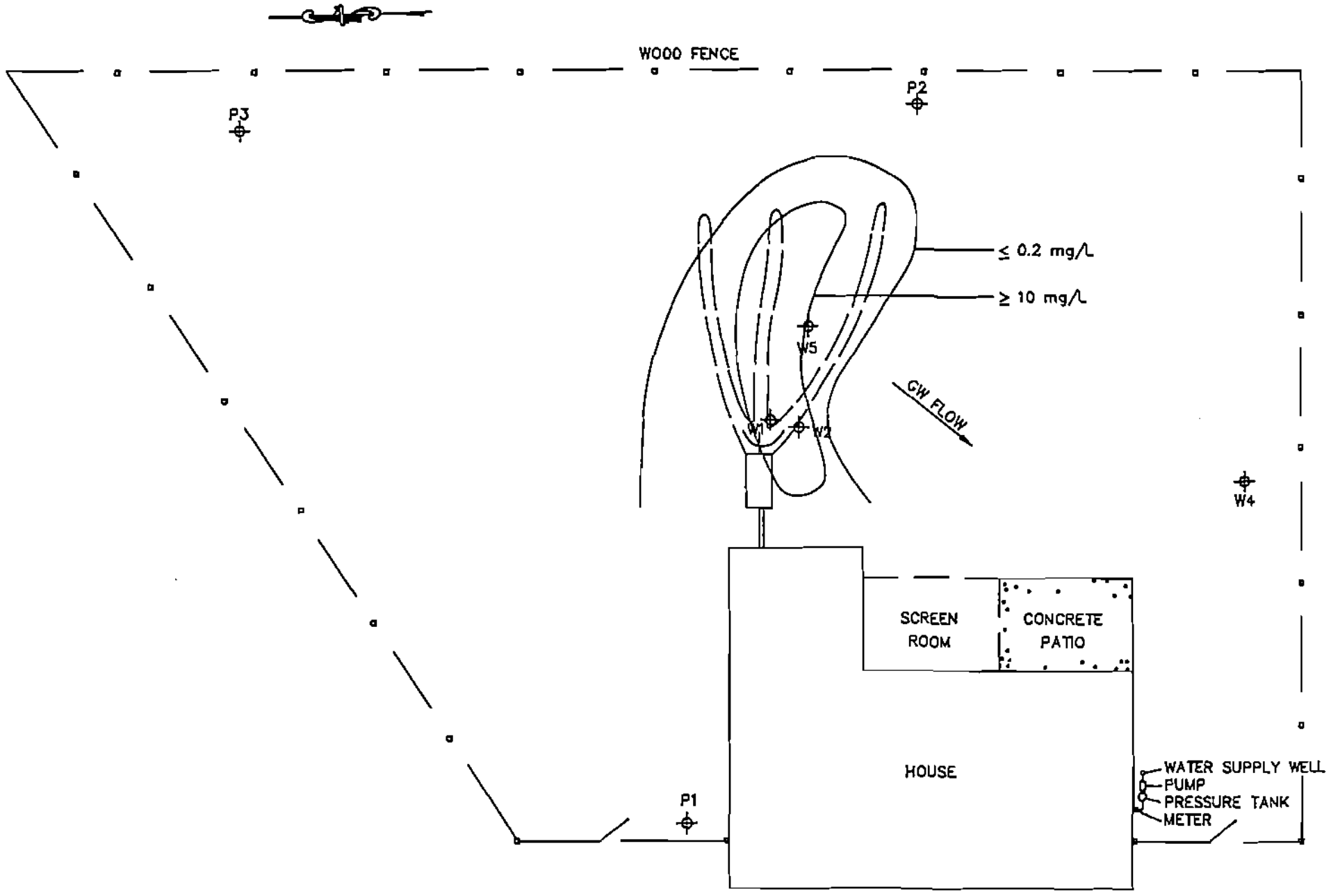


Figure 7. Nitrate-N Isoconcentration Contours.

application is near the outlet from the septic tank. This impacted area is also separated somewhat from the infiltration area by ground water of near background quality. These results seem to indicate that the source may be somewhere upgradient of the OSDS, or that the impacted area was the result of a past discharge of some sort. For the purposes of this study it will be assumed that this area of impact was not the result of the OSDS and it will not be considered in this analysis. If additional study is conducted at the site it may be possible to further define the source and nature of this area at that time.

It is interesting to note the relatively short distance downgradient that contaminants have been measured. Both the conductivity and chloride plumes extend only about 10 to 15 feet to the southwest of the area of infiltration. This would indicate an extremely slow rate of horizontal ground water movement, since the home is approximately 15 years of age. Ground water seepage velocities of 5 to 22 feet per year were estimated in the subdivision in 1988 based on baildown test and hydraulic gradient measurements taken on several monitoring wells further southwest in the subdivision. Although the previous results are higher than that indicated by the contaminant plumes, they too represent slow rates of ground water movement. Such rates are typical of flat areas of Florida, however, where minimal hydraulic gradients exist in the water table aquifer.

The above discussion assumes only horizontal movement of ground water and does not take into account any vertical component of flow. Since only shallow samples of ground water were taken with the probe system, no measurement of vertical contaminant movement was performed in this phase. Deeper sampling in the next phase will reveal whether any significant vertical flow component is present at the site. Also, deeper borings should be installed to estimate aquifer thickness in the vicinity of the study system.

V. CONCLUSIONS AND RECOMMENDATIONS

An OSDS study site has been identified in St. Johns County, Florida for an assessment of contaminant transport for the Soap and Detergent Association (SDA). A preliminary evaluation of the site has revealed that it should meet the needs of SDA as a means to study the fate of various household cleaning products used in homes served by OSDS.

Water use at the home was monitored and wastewater flow to the OSDS was estimated at 168 gpd based on the data collected. This estimate will be refined as the study progresses through additional water use monitoring. Wastewater quality was measured on a single sample of septic tank effluent (STE) and compared to previous monitoring at the site during the Florida OSDS Research Project. Parameters in the STE were generally in agreement with the previous work with the exception of Methylene Blue Active Substances (MBAS), a measure of surfactant content. Additional STE samples should be taken and analyzed for MBAS to get a better estimate of its concentration.

A preliminary delineation of the contaminant plume from the OSDS infiltration area was conducted using a miniature well point probe with field analysis for chloride, nitrate-nitrogen, and conductivity. This procedure was successful in defining the plume in two dimensions, i.e. a plan view of the plume location (see Figures 5 through 7). The plumes for conservative parameters such as chloride and conductivity indicated a very short distance of travel downgradient from the OSDS infiltration area. Further investigation of contaminant movement with depth in the aquifer is needed to ascertain if a strong vertical component of flow is present at the site.

Based on the work performed to date it appears that the site is acceptable for SDA's intended purpose and it is recommended that we move ahead with subsequent phases of work. The following is a proposed work plan for the next phase of the study.

Recommended Phase II Work Plan

Task 1 -- Water and Wastewater Monitoring.

Continue water use monitoring during Phase II to more accurately delineate wastewater flow to the OSDS. Collect two (2) additional septic tank effluent (STE) samples and analyze for MBAS, total suspended solids (TSS) , total dissolved solids (TDS), chlorides, and other selected parameters. Summarize STE quality data and compare to previous results. Conduct a homeowner survey to identify types of household cleaning products used in the home and obtain additional information related to water using habits in the home as related to washing and cleaning.

Task 2 -- Vertical Ground Water Flow Evaluation.

Install at least one deep boring to determine water table aquifer thickness and for determination of the vertical hydraulic gradient at the site. The boring will be installed to a depth of 30 feet or the first restrictive layer encountered. To estimate the vertical ground water flow component at the site, a deep piezometer will be installed in the borehole and a shallow piezometer will be placed next to it in a separate borehole. The vertical hydraulic gradient can then be calculated from the difference in water levels between the two piezometers.

Task 3 -- Permanent Downgradient Monitoring Network.

A more permanent ground water monitoring network will be installed downgradient of the OSDS infiltration area. In this phase, three rows of the disposable miniature probe

monitoring tips will be installed downgradient with three sample locations in each row. At each sample location, monitoring tips will be placed at three depths within the water table aquifer. This will result in the placement of twenty-seven (27) monitoring points downgradient of the infiltration area. Based on the results of this phase, additional sample points can be placed as needed in subsequent phases of work.

Task 4 -- Ground Water Sampling and Analyses.

Ground water samples will be taken at each monitoring point and analyzed for the following parameters:

* Conductivity, pH, and temperature in the field
* Chloride
* Ammonia N
* Nitrate N
* Total P
* Total Organic Carbon
* Total Dissolved Solids
* Fecal Coliform Bacteria
* MBAS

In addition, samples will be collected for various surfactant analyses by SDA determined laboratories. These samples will be collected in appropriate containers, preserved as specified, and shipped via UPS to the appropriate laboratory.

Task 5 -- Data Analyses and Status Report Preparation.

The data collected will be analyzed and summarized in tables and figures, and presented in a brief status report. This report will summarize the results to date and recommend the next phase of monitoring and data collection.

VI. PHASE III MONITORING PLAN

It is anticipated at this time that a third phase of the project will be required to complete the study at this OSDS site. The extent of additional work required in Phase III will depend on the success and results of the Phase II work, but will probably include additional ground water monitoring, vadose zone monitoring, and aquifer testing to determine saturated and unsaturated zone transport characteristics. In addition, tracer studies may be proposed to aid in determining fluid flow characteristics.

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Appendix A

Field Sampling Data

AYRES ASSOCIATES

SDA OSDS MONITORING

DATE: 11/14-15/90 SITE: Fredenhagen St. Johns

STATION	PARAMETER measured in Field Unless Noted					LOCATION
	COND.	TEMP.	pH	NO_3^-	Cl^-	X, Y
A10	290		6.9	ND	12.6	20, 10
A20	315		7.0	ND	10.7	21, 20
A30	280		7.2	ND	11.8	20, 30
B25	435		—	>1.0	—	-6.5, 25
C25	360		6.6	ND	23.9	-11.5, 27
D39	600		—	—	48.0	2, 40
D47	365		—	—	31.0	2, 47
D54	200		—	—	15.4	2.5, 55
E39	325		—	—	11.5	18, 40
E47	160		—	ND	12.5	18, 47
E54	185		—	ND	25.5	18, 55
F39	625		—	>10	46.5	8, 40
F47	600			>10	34.4	8, 47
F54	315		—	—	24.5	8.5, 55
F60	440			ND	15.0	8, 61
G47	240		—	ND	24.	0, 47
X18	295		7.1	ND	11.4	14, 18
X39	700			>10.	44.0	14, 40
X47	410			8.0	32.6	12.5, 47
X54	205			ND	29.5	14, 55
Y18	450		6.85	0.9	—	13, 18
Z24	660		7.0	>1.0	30.8	7, 23

Line 47 = F47, etc.

SDA OSDS MONITORING

DATE: 11/14-15/90 SITE: Fredenhagen St. Johns

STATION	PARAMETER					LOCATION
	COND.	TEMP.	pH	NO_3^-	Cl^-	X, Y
Z47	320		–	8.0	27.2	5.5, 47
W4	270		–	ND	12.3	76, 10
VW2	550		–	9.5	47.5	10, 18
AP2	485		6.6	ND	31.8	27.5, 66
STE pat						4.5, 17.7
T1 pat						19, 36
T2 pat						6.5, 38
T3 pat						-3.5, 36

SDA OSDS MONITORING

DATE: 11-29-90 SITE: Fredenhagen St. Johns

STATION	PARAMETER, COND.	TEMP.	pH	NO_3^-	Cl^-	LOCATION x, y
A15	350 @ site. 250 160 @ site	✓	7.00	<.2	9.6	22, 15
A54	190 50 @ site	✓	7.20	<.2	27.7	22, 54
A66	390	✓	6.90	<.2	33.1	22, 66
AP2	520	✓	6.90	<.2	31.5	27.5, 66
B39	1100	✓	6.80	<.2	13.5	-6.5, 39
B47	200	✓	6.60	<.2	22.2	-6.5, 47
C10	330	✓	6.60	<.2	15.2	-12, 10
D50	170	✓	6.80	<.2	21.6	2, 50
E20	310	✓	6.60	<.2	10.1	16, 20
E50	500	✓	6.80	>10 ✓	47.0	18, 50
F10	740 @ site ~~6,000~~	✓	6.20	>10 ✓	16.6	8, 10
F15	520	✓	6.30	9.3	47.0	8, 15
H30	340	✓	6.80	<.2	54.45	27, 30
H39	320	✓	7.00	<.2	23.1	27, 39
H47	280	✓	7.30	<.2	14.85	27, 47
H54	140	✓	7.20	<.2	42.90	27, 54
X10	570	✓	6.60	>10	64.35	14, 10
X15	640	✓	6.80	>10	72.60	14, 15
X50	470	✓	6.80	>10	71.77	14, 50
X60	330	✓	6.50	<.2	36.30	14, 60
VW1	510	✓	6.20	>10	61.05	6, 19
VW2	510	✓	6.40	>10	67.65	10, 18
WS	620	✓	6.60	>10	67.65	11, 33

Appendix B

Laboratory Analyses Data

AYRES ASSOCIATES

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, STE, sampled 11/15/90, 1645
SAL Sample No.: 02906-01
Date Received: 11/16/90

Parameter	Units	STE	Date Analysis Completed
BOD (5-Day @ 20 C)	mg/l	124	11/22/90
Total Suspended Solids	mg/l	66	11/20/90
Total Dissolved Solids	mg/l	264	11/2/90
Nitrate Nitrogen	mg/l as N	0.03	11/16/90
Nitrite Nitrogen	mg/l as N	< 0.01	11/16/90
Total Kjeldahl Nitrogen	mg/l as N	48	11/27/90
Chloride	mg/l	40	11/19/90
Foaming Agents (MBAS)	mg/l	20	11/16/90
Total Phosphorus	mg/l as P	17	11/27/90
Total Organic Carbon	mg/l	55	12/3/90
Oil and Grease	mg/l	38	11/20/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, TAP, sampled 11/15/90, 1700
SAL Sample No.: 02906-02
Date Received: 11/16/90

Parameter	Units	TAP	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	0.04	11/27/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/16/90
Chloride	mg/l	9	11/19/90
Specific Conductance	umhos/cm	280	11/19/90

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LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, A20, sampled 11/15/90, 1420
SAL Sample No.: 02906-03
Date Received: 11/16/90

Parameter	Units	A20	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90
Nitrate Nitrogen	mg/l as N	0.01	11/16/90
Chloride	mg/l	10	11/19/90
Specific Conductance	umhos/cm	310	11/19/90

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LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, D39, sampled 11/15/90, 0940
SAL Sample No.: 02906-04
Date Received: 11/16/90

Parameter	Units	D39	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90
Nitrate Nitrogen	mg/l as N	41	11/16/90
Chloride	mg/l	43	11/19/90
Specific Conductance	umhos/cm	600	11/19/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, E54, sampled 11/15/90, 1620
SAL Sample No.: 02906-05
Date Received: 11/16/90

Parameter	Units	E54	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90
Nitrate Nitrogen	mg/l as N	0.01	11/16/90
Chloride	mg/l	24	11/19/90
Specific Conductance	umhos/cm	190	11/19/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, F39, sampled 11/15/90, 1040
SAL Sample No.: 02906-06
Date Received: 11/16/90

Parameter	Units	F39	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	0.05	11/27/90
Nitrate Nitrogen	mg/l as N	43	11/16/90
Chloride	mg/l	43	11/19/90
Specific Conductance	umhos/cm	600	11/19/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, W4, sampled 11/15/90, 1440
SAL Sample No.: 02906-07
Date Received: 11/16/90

Parameter	Units	W4	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	0.22	11/27/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/16/90
Chloride	mg/l	9	11/19/90
Specific Conductance	umhos/cm	280	11/19/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, X39, sampled 11/15/90, 1435
SAL Sample No.: 02906-08
Date Received: 11/16/90

Parameter	Units	X39	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90
Nitrate Nitrogen	mg/l as N	41	11/16/90
Chloride	mg/l	44	11/19/90
Specific Conductance	umhos/cm	700	11/19/90

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, Y18, sampled 11/15/90, 1620
SAL Sample No.: 02906-09
Date Received: 11/16/90

Parameter	Units	Y18	Date Analysis Completed
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90
Nitrate Nitrogen	mg/l as N	13	11/16/90
Chloride	mg/l	24	11/19/90
Specific Conductance	umhos/cm	420	11/19/90

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Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Water, Fredenhagen, Z47, sampled 11/15/90, 1314
SAL Sample No.: 02906-10
Date Received: 11/16/90

Parameter	Units	Z47	Date Analysis Completed
Nitrate Nitrogen	mg/l as N	21	11/16/90
Chloride	mg/l	25	11/19/90

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LABORATORY REPORT

Project: SDA - St. John's County
Sample Description: Laboratory Blank
SAL Sample No.: 02906-Blank
Date Received: N/A

Parameter	Units	Laboratory Blank	Date Analysis Completed
BOD (5-Day @ 20 C)	mg/l	< 1.0	11/22/90
Total Suspended Solids	mg/l	< 1	11/20/90
Total Dissolved Solids	mg/l	4	11/2/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/16/90
Nitrite Nitrogen	mg/l as N	< 0.01	11/16/90
Total Kjeldahl Nitrogen	mg/l as N	0.07	11/27/90
Chloride	mg/l	< 1	11/19/90
Foaming Agents (MBAS)	mg/l	< 0.05	11/16/90
Total Phosphorus	mg/l as P	0.02	11/27/90
Total Organic Carbon	mg/l	< 1.0	12/3/90
Oil and Grease	mg/l	< 2.0	11/20/90
Specific Conductance	umhos/cm	0.41	11/19/90
Ammonia Nitrogen	mg/l as N	< 0.01	11/27/90

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December 12, 1990
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LABORATORY REPORT

Project: SDA - St. John's County

Parameter	Method	Detection Limit	
BOD (5-Day @ 20 C)	SM 507	1.0	mg/l
Total Suspended Solids	EPA 160.2	1	mg/l
Total Dissolved Solids	EPA 160.1	2	mg/l
Nitrate Nitrogen	EPA 352.1	0.01	mg/l as N
Nitrite Nitrogen	EPA 354.1	0.01	mg/l as N
Total Kjeldahl Nitrogen	EPA 351.4	0.01	mg/l as N
Chloride	SM 407 A	1	mg/l
Foaming Agents (MBAS)	SM 512 B	0.05	mg/l
Total Phosphorus	EPA 365.2	0.01	mg/l as P
Total Organic Carbon	EPA 415.1	1.0	mg/l
Oil and Grease	EPA 413.1	2.0	mg/l
Specific Conductance	EPA 120.1	0.1	umhos/cm
Ammonia Nitrogen	EPA 350.3	0.01	mg/l as N

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December 12, 1990
Project No. 02906

LABORATORY REPORT

Project: SDA - St. John's County
QC Description: Matrix Spike/Matrix Spike Duplicate Recoveries

Parameter	Sample No. Spiked	Accuracy Mean % R	Precision RPD	QC Control Limits Accuracy	Precision
BOD (5-Day @ 20 C)	02906-01	--	6.5	59.8-122.0	22.0
	GGA Solution	88	11	59.8-122.0	22.0
Total Suspended Solids	02877-12	96	6.6	76.7-102.0	29.9
Total Dissolved Solids	02912-03	102	1.1	58.3-143.5	8.1
Nitrate Nitrogen	02906-10	101	8.2	73.2-134.7	23.9
Nitrite Nitrogen	02906-01	85	0.0	46.8-136.4	12.4
Total Kjeldahl Nitrogen	02899-01	71	1.8	58.4-153.6	17.1
Chloride	02906-06	98	0.0	86.4-112.6	2.8
Foaming Agents (MBAS)	02906-01	100	3.3	69.7-135.6	23.6
Total Phosphorus	02906-01	95	0.0	79.5-121.2	47.2
Total Organic Carbon	02921-11	99	0.0	69.9-131.0	7.3
Oil and Grease	Reagent Water	96	3.5	71.8-118.7	25.6
Specific Conductance	02906-08	--	0.0	87.1-120.7	5.6
Ammonia Nitrogen	02899-01	88	2.1	77.1-123.1	19.3

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December 12, 1990
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LABORATORY REPORT

Project: SDA - St. John's County
QC Description: Matrix Spike/Matrix Spike Duplicate Recoveries

Note: Matrix Spike/Matrix Spike Duplicates are routinely analyzed concurrently with samples, in all methods, to assess the accuracy and precision of the techniques being carried out. Two of three aliquots of at least one sample in the set being processed are spiked with known equal concentrations of actual method analytes. These duplicate spiked aliquots are subjected to the analytical method in the same manner as the samples themselves.

Recovery of the spikes is determined by comparison of analyte concentrations in the two spiked aliquots to the analyte concentration in the unspiked sample aliquot. Accuracy is reported as percent of the analyte recovered versus the original concentration spiked (Percent Recovery), averaged for the duplicate spikes. Precision is reported as Relative Percent Difference between the duplicate spike measurements.

Quality Control results published for each method are representative of the sample set in which these project samples were included. The actual sample spiked is indicated. Each matrix type (water and/or soil) in a set is spiked at least once. A minimum of 10% of all samples are routinely spiked.

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, SDA VW-1, sampled 11/28/90, 1100
SAL Sample No.: 02930-01
Date Received: 11/28/90

Parameter	Units	SDA VW-1	Date Analysis Completed
Chloride	mg/l	50	12/13/90
Sulfate	mg/l	20	12/10/90
Nitrate Nitrogen	mg/l as N	31	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.45	12/11/90
Total Dissolved Solids	mg/l	392	12/5/90
Total Phosphorus	mg/l as P	13	12/11/90
Total Organic Carbon	mg/l	4.8	12/5/90
Foaming Agents (MBAS)	mg/l	0.12	11/30/90
Fecal Coliforms	Counts/100ml	53	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, GVP VW-1, sampled 11/28/90, 1100
SAL Sample No.: 02930-04
Date Received: 11/28/90

Parameter	Units	GVP VW-1	Date Analysis Completed
Chloride	mg/l	48	12/13/90
Sulfate	mg/l	26	12/10/90
Nitrate Nitrogen	mg/l as N	42	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.37	12/11/90
Total Dissolved Solids	mg/l	396	12/5/90
Total Phosphorus	mg/l as P	16	12/11/90
Total Organic Carbon	mg/l	4.2	12/5/90
Foaming Agents (MBAS)	mg/l	0.21	11/30/90
Fecal Coliforms	Counts/100ml	2	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, SDA W-4, sampled 11/28/90, 1030
SAL Sample No.: 02930-02
Date Received: 11/28/90

Parameter	Units	SDA W-4	Date Analysis Completed
Chloride	mg/l	10	12/13/90
Sulfate	mg/l	30	12/10/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.63	12/11/90
Total Dissolved Solids	mg/l	168	12/5/90
Total Phosphorus	mg/l as P	0.44	12/11/90
Total Organic Carbon	mg/l	11	12/5/90
Foaming Agents (MBAS)	mg/l	0.12	11/30/90
Fecal Coliforms	Counts/100ml	120	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, GVP W-4, sampled 11/28/90, 1030
SAL Sample No.: 02930-05
Date Received: 11/28/90

Parameter	Units	GVP W-4	Date Analysis Completed
Chloride	mg/l	10	12/13/90
Sulfate	mg/l	33	12/10/90
Nitrate Nitrogen	mg/l as N	0.03	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.59	12/11/90
Total Dissolved Solids	mg/l	186	12/5/90
Total Phosphorus	mg/l as P	0.25	12/11/90
Total Organic Carbon	mg/l	12	12/5/90
Foaming Agents (MBAS)	mg/l	0.07	11/30/90
Fecal Coliforms	Counts/100ml	< 1	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, SDA W-5, sampled 11/28/90, 1045
SAL Sample No.: 02930-03
Date Received: 11/28/90

Parameter	Units	SDA W-5	Date Analysis Completed
Chloride	mg/l	41	12/13/90
Sulfate	mg/l	17	12/10/90
Nitrate Nitrogen	mg/l as N	29	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.32	12/11/90
Total Dissolved Solids	mg/l	376	12/5/90
Total Phosphorus	mg/l as P	5.8	12/11/90
Total Organic Carbon	mg/l	4.3	12/5/90
Foaming Agents (MBAS)	mg/l	0.12	11/30/90
Fecal Coliforms	Counts/100ml	< 1	11/29/90

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LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Water, GVP W-5, sampled 11/28/90
SAL Sample No.: 02930-06
Date Received: 11/28/90

Parameter	Units	GVP W-5	Date Analysis Completed
Chloride	mg/l	46	12/13/90
Sulfate	mg/l	17	12/10/90
Nitrate Nitrogen	mg/l as N	25	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	0.37	12/11/90
Total Dissolved Solids	mg/l	392	12/5/90
Total Phosphorus	mg/l as P	12	12/11/90
Total Organic Carbon	mg/l	4.2	12/5/90
Foaming Agents (MBAS)	mg/l	0.08	11/30/90
Fecal Coliforms	Counts/100ml	1	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Trip Blank, prepared 11/26/90
SAL Sample No.: 02930-07
Date Received: 11/28/90

Parameter	Units	Trip Blank	Date Analysis Completed
Chloride	mg/l	< 1	12/13/90
Sulfate	mg/l	< 2	12/10/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	< 0.01	12/11/90
Total Dissolved Solids	mg/l	2	12/5/90
Total Phosphorus	mg/l as P	0.02	12/11/90
Total Organic Carbon	mg/l	< 1.0	12/5/90
Foaming Agents (MBAS)	mg/l	< 0.05	11/30/90
Fecal Coliforms	Counts/100ml	< 1	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
Sample Description: Laboratory Blank
SAL Sample No.: 02930-Blank
Date Received: N/A

Parameter	Units	Laboratory Blank	Date Analysis Completed
Chloride	mg/l	< 1	12/13/90
Sulfate	mg/l	< 2	12/10/90
Nitrate Nitrogen	mg/l as N	< 0.01	11/30/90
Total Kjeldahl Nitrogen	mg/l as N	< 0.01	12/11/90
Total Dissolved Solids	mg/l	2	12/5/90
Total Phosphorus	mg/l as P	0.02	12/11/90
Total Organic Carbon	mg/l	< 1.0	12/5/90
Foaming Agents (MBAS)	mg/l	< 0.05	11/30/90
Fecal Coliforms	Counts/100ml	< 1	11/29/90

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site

Parameter	Method	Detection Limit
Chloride	SM 407 A	1 mg/l
Sulfate	EPA 375.4	2 mg/l
Nitrate Nitrogen	EPA 352.1	0.01 mg/l as N
Total Kjeldahl Nitrogen	EPA 351.4	0.01 mg/l as N
Total Dissolved Solids	EPA 160.1	2 mg/l
Total Phosphorus	EPA 365.2	0.01 mg/l as P
Total Organic Carbon	EPA 415.1	1.0 mg/l
Foaming Agents (MBAS)	SM 512 B	0.05 mg/l
Fecal Coliforms	SM 909 C	1 Count/100mls

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
QC Description: Matrix Spike/Matrix Spike Duplicate Recoveries

Parameter	Sample No. Spiked	Accuracy Mean % R	Precision RPD	QC Control Limits Accuracy	Precision
Chloride	02931-02	99	1.7	86.4-112.6	2.8
Sulfate	02931-01	110	1.8	74.8-125.8	5.6
Nitrate Nitrogen	02930-05	80	0.0	73.2-134.7	23.9
Total Kjeldahl Nitrogen	02926-01	97	7.6	58.4-153.6	17.1
Total Dissolved Solids	02931-03	103	3.3	58.3-143.5	8.1
Total Phosphorus	02930-01	98	2.2	79.5-121.2	47.2
Total Organic Carbon	02930-01	101	2.5	69.9-131.0	7.3
Foaming Agents (MBAS)	02930-02	100	3.4	69.7-135.6	23.6
Fecal Coliforms	Pos.Control	--	0.0	--	80.7

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December 14, 1990
Project No. 02930

LABORATORY REPORT

Project: Ayres Project No. 1187.00 - SDA Fredenhagen Site
QC Description: Matrix Spike/Matrix Spike Duplicate Recoveries

Note: Matrix Spike/Matrix Spike Duplicates are routinely analyzed concurrently with samples, in all methods, to assess the accuracy and precision of the techniques being carried out. Two of three aliquots of at least one sample in the set being processed are spiked with known equal concentrations of actual method analytes. These duplicate spiked aliquots are subjected to the analytical method in the same manner as the samples themselves.

Recovery of the spikes is determined by comparison of analyte concentrations in the two spiked aliquots to the analyte concentration in the unspiked sample aliquot. Accuracy is reported as percent of the analyte recovered versus the original concentration spiked (Percent Recovery), averaged for the duplicate spikes. Precision is reported as Relative Percent Difference between the duplicate spike measurements.

Quality Control results published for each method are representative of the sample set in which these project samples were included. The actual sample spiked is indicated. Each matrix type (water and/or soil) in a set is spiked at least once. A minimum of 10% of all samples are routinely spiked.

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