Water Quality in the Upper Floridan Aquifer in the Vicinity of Drainage Wells, Orlando, Florida

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 90-4175

Prepared in cooperation with the
FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION

Tallahassee, Florida
1991

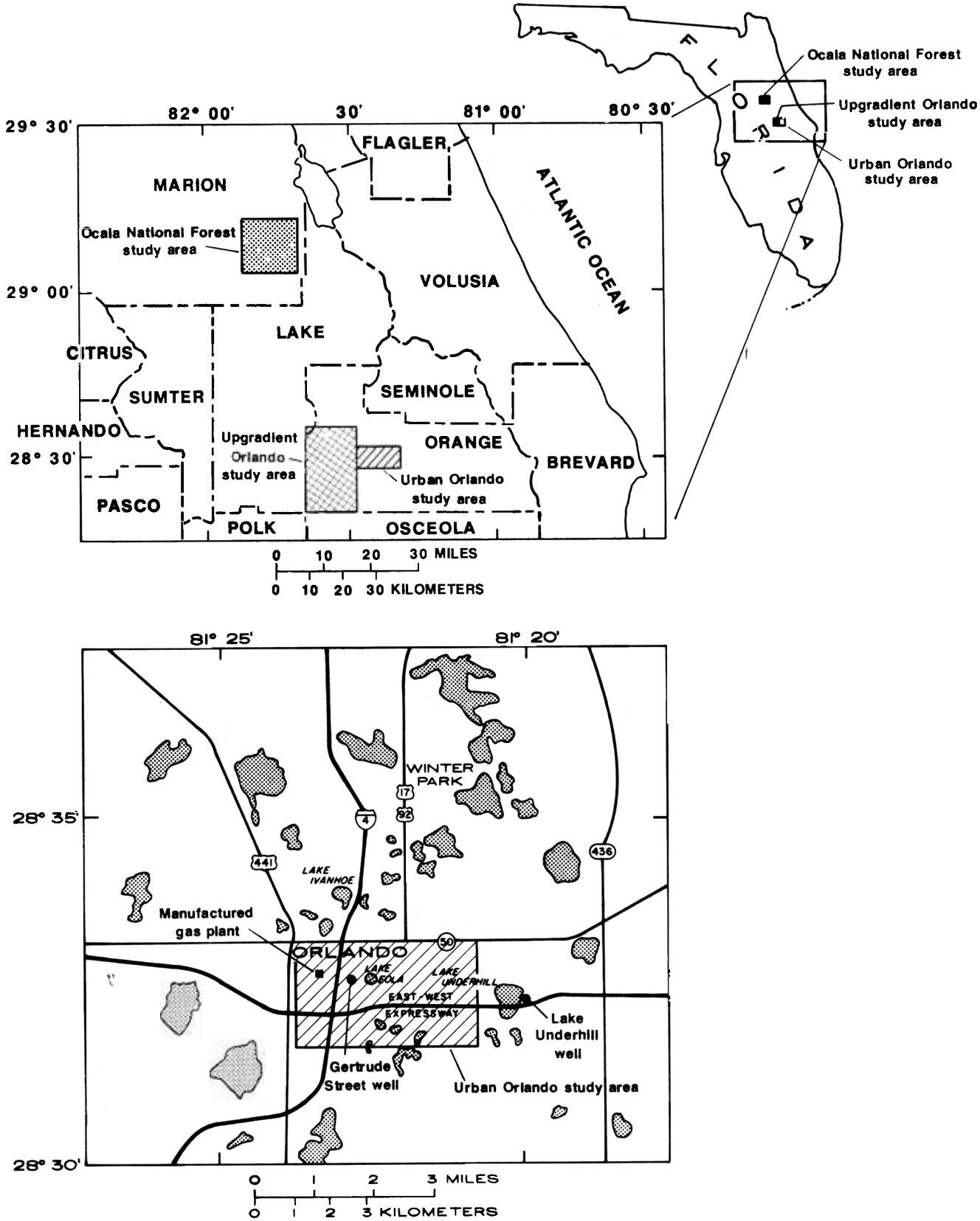

Figure 1. Study areas.

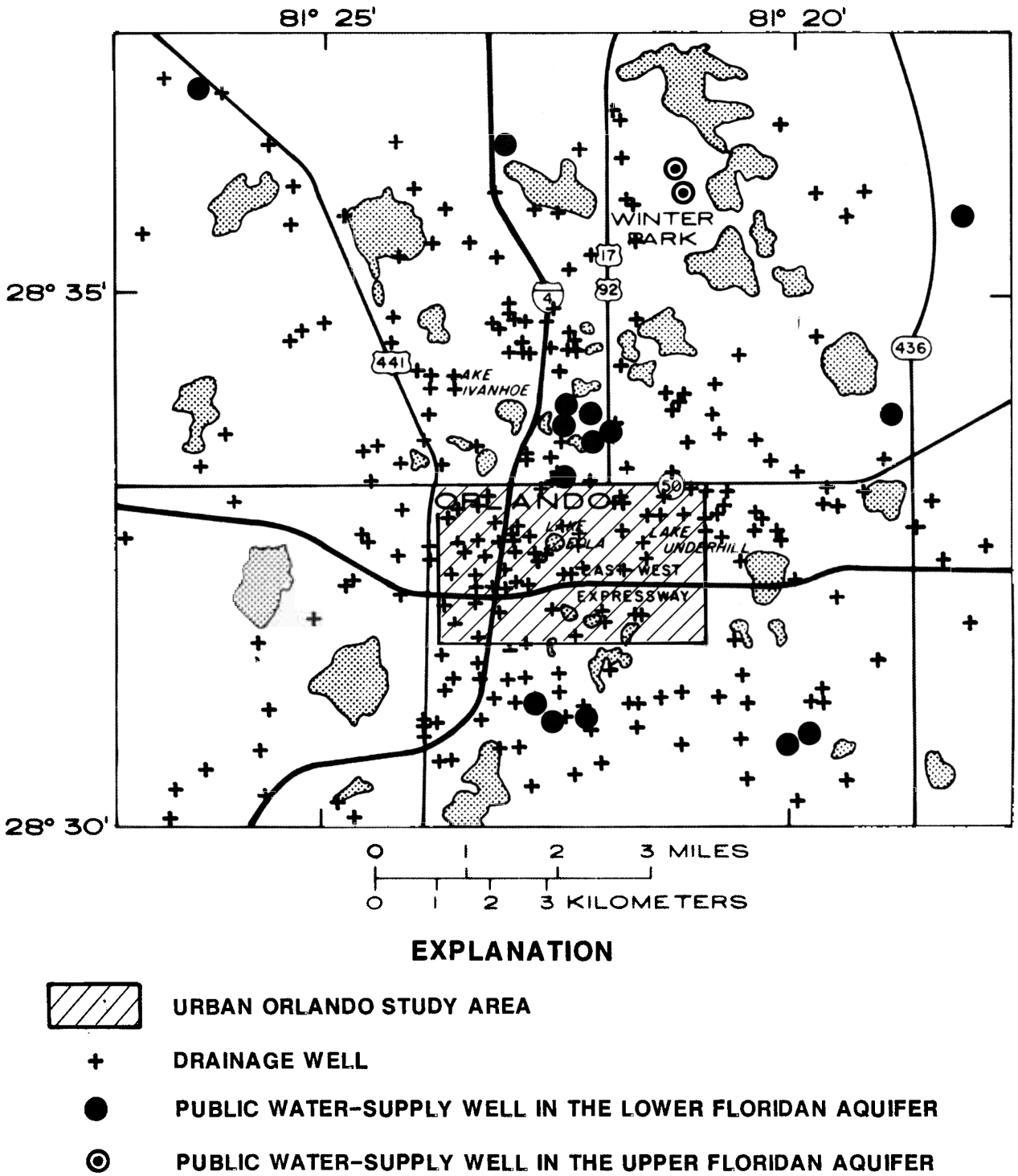

Figure 2. Location of drainage wells and public-supply wells within the study area.

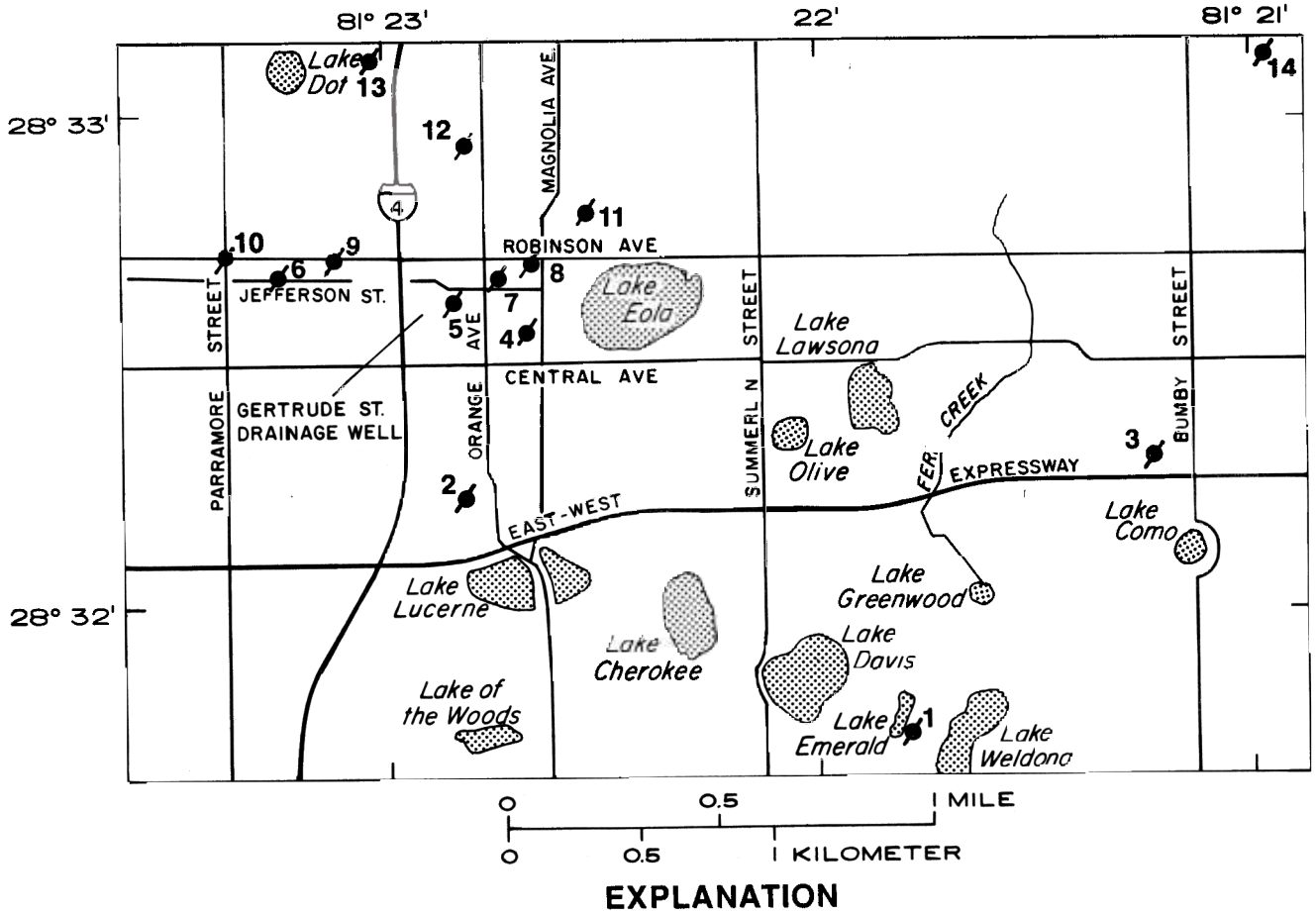

Figure 3. Location of wells sampled within the urban Orlando area.

Table 1. *Upper Floridan aquifer wells in the Orlando area sampled as part of the study*

Site number	Site identification number	Current use of well	Depth (feet)	Diameter (inches)
Urban Orlando sites				
	283147081214701	Lake augmentation	428	12
2	283218081224801	Air conditioning	Unknown	6
3	283223081211501	Irrigation	214	4
4	283235081223801	Engine cooling	Unknown	6
[1]5	283240081225001	Observation	247	4
6	283241081231501	Pressure relief	275	12
7	283242081224201	Irrigation	Unknown	6
8	283243081224101	do.	290	6
9	283243081230701	Drainage	199	6
10	283244081232001	do.	376	12
11	283252081223101	Irrigation	260	4
12	283300081224701	do.	231	4
13	283309081230001	do.	Unknown	4
14	283310081205901	do.	257	6
Lake Underhill sites				
[2]15	283219081195501	Observation	375	4
[3]16	283219081195601	do.	375	4
[4]17	283219081195701	Drainage	375	20

[1]Gertrude Street monitoring well.
[2]Lake Underhill monitoring well 1.
[3]Lake Underhill monitoring well 2.
[4]Lake Underhill monitoring well 3.

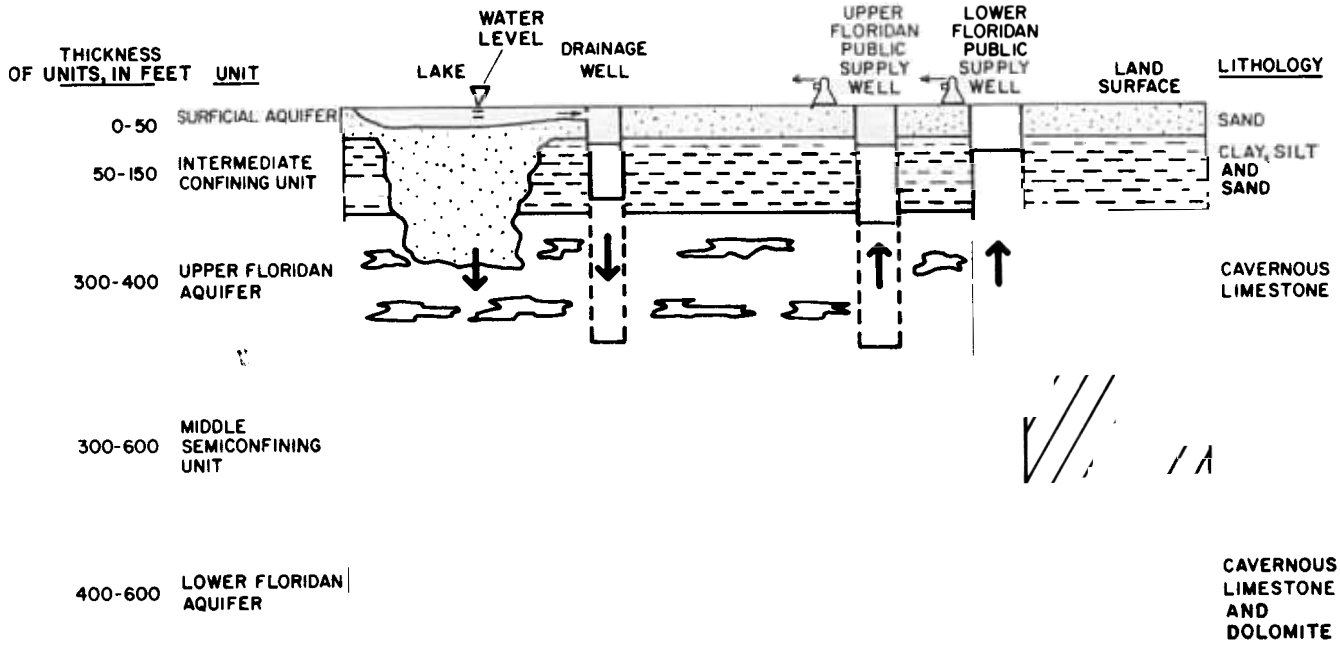

Figure 4. Generalized hydrogeologic section in the Orlando area.

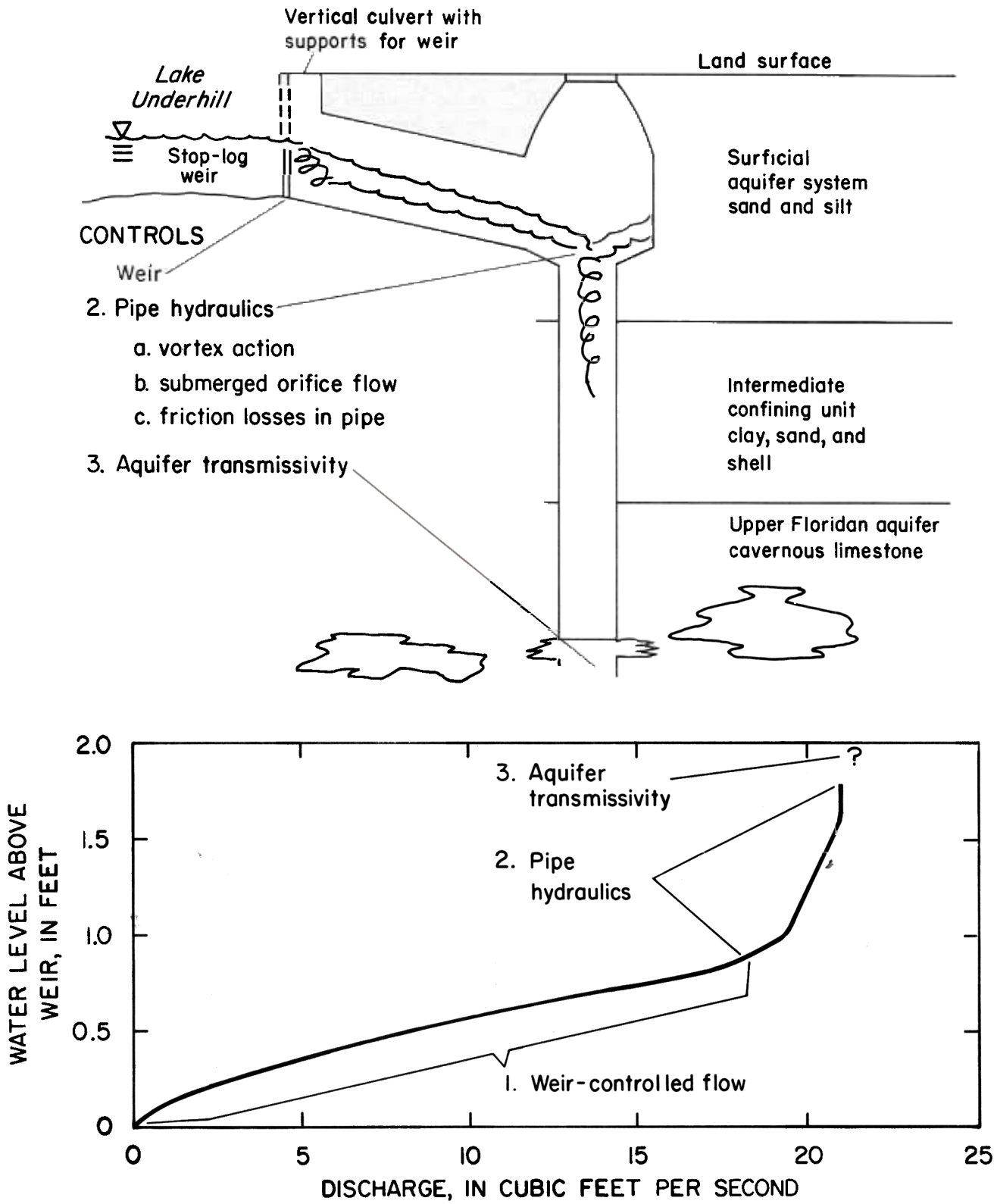

Figure 9b. Factors that affect flow into the Lake Underhill drainage well.

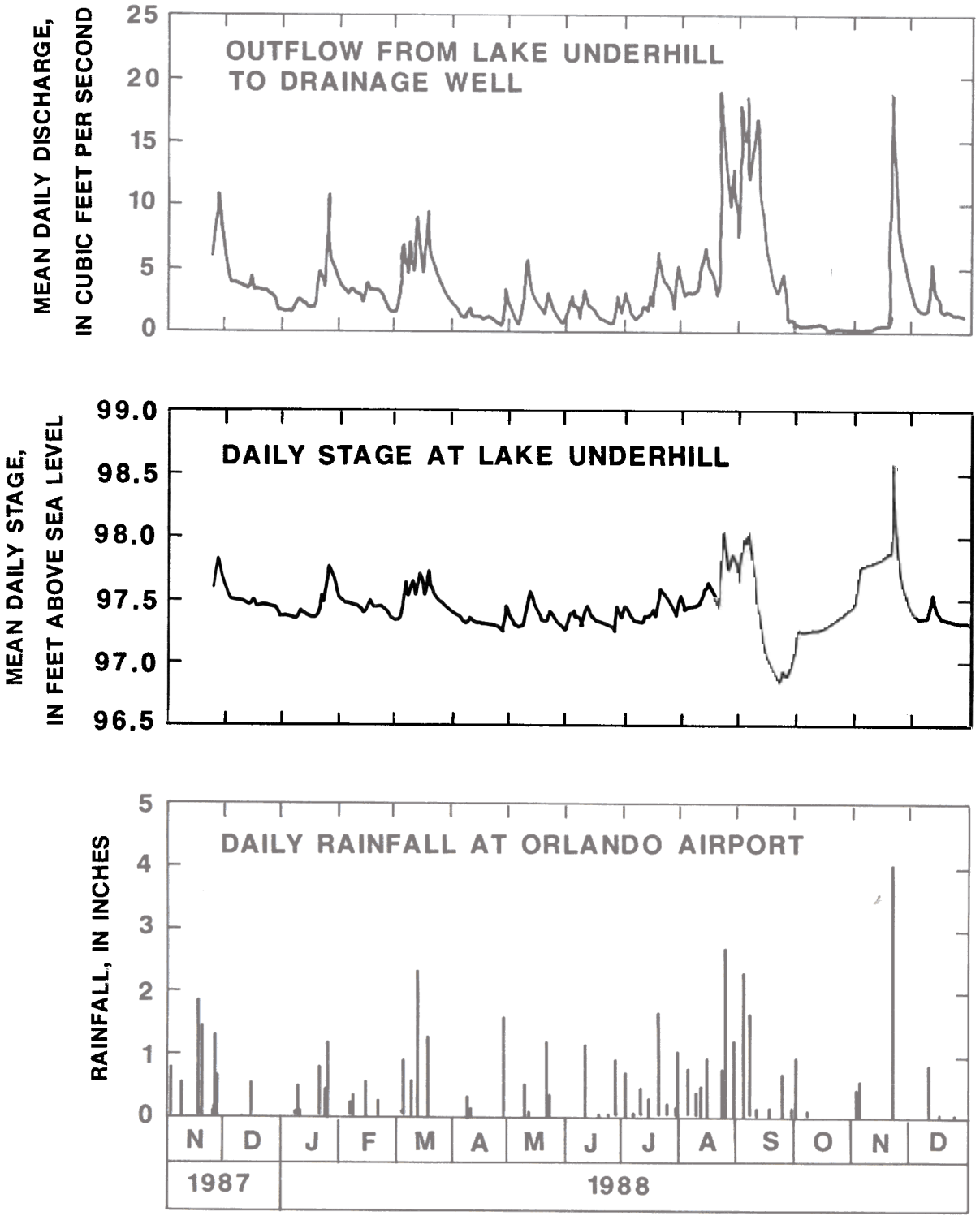

Figure 10. Hydrograph showing stage and outflow at Lake Underhill and rainfall at Orlando, November 1987 through December 1988.

Table 3. *Statistical summary of chemical analyses of water from 18 wells upgradient from Orlando and 9 wells from the Ocala National Forest area*

[N is number of wells. (n) is number of samples. For wells having more than one sample, a median value for all samples from the well was determined and placed into a data set. From this data set, another median was determined, and is the median listed in the table. Range is the maximum and minimum values from the data set. Concentrations are in milligrams per liter, unless otherwise noted. µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, micrograms per liter]

Constituent	Upgradient from Orlando				Ocala National Forest			
	N	(n)	Median	Range	N	(n)	Median	Range
	18	(28)	251	198 - 373	8	(8)	233	151 - 322
	15	(23)	7.5	6.6 - 8.3	8	(17)	8.0	7.9 - 8.1
	7	(8)	.03	.0 - .07	8	(8)	<.20	<.20 - .50
	7	(8)	.02	.0 - .14	9	(17)	.04	.01 - .52
	7	(8)	.11	.05 - .30	9	(9)	.05	.03 - .31
	6	(7)	4.0	.0 - 6.0	8	(8)	1.0	.0 - 2.5
	13	(20)	33	28 - 38	9	(17)	32	17 - 52
	13	(20)	8.4	3.8 - 17	9	(17)	7.4	4.0 - 9.3
	13	(20)	6.6	4.1 - 11	9	(17)	4.3	3.2 - 7.1
	13	(20)	.9	.6 - 1.9	9	(17)	0.7	.4 - 1.4
	18	(28)	8.9	2.0 - 14	9	(14)	8.4	4.5 - 11.0
	13	(20)	5.7	0.4 - 18	9	(17)	2.6	<.10 - 17
	7	(7)	40	<10 - 60	8	(8)	20	<10 - 520
	7	(7)	<10	<10 - 20	9	(13)	<10	<10 - 20

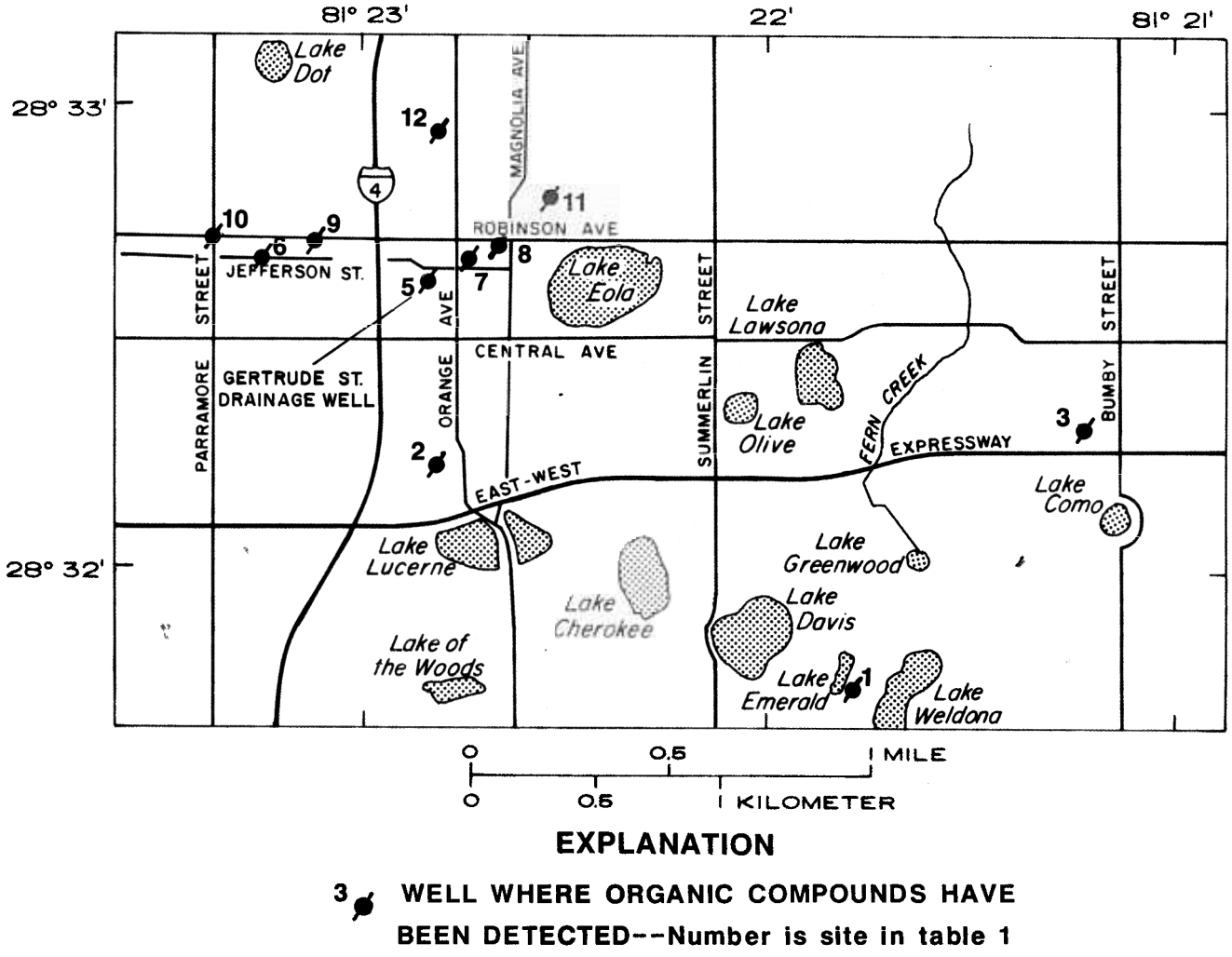

Figure 11. Map showing sites where organic compounds have been detected in ground water.

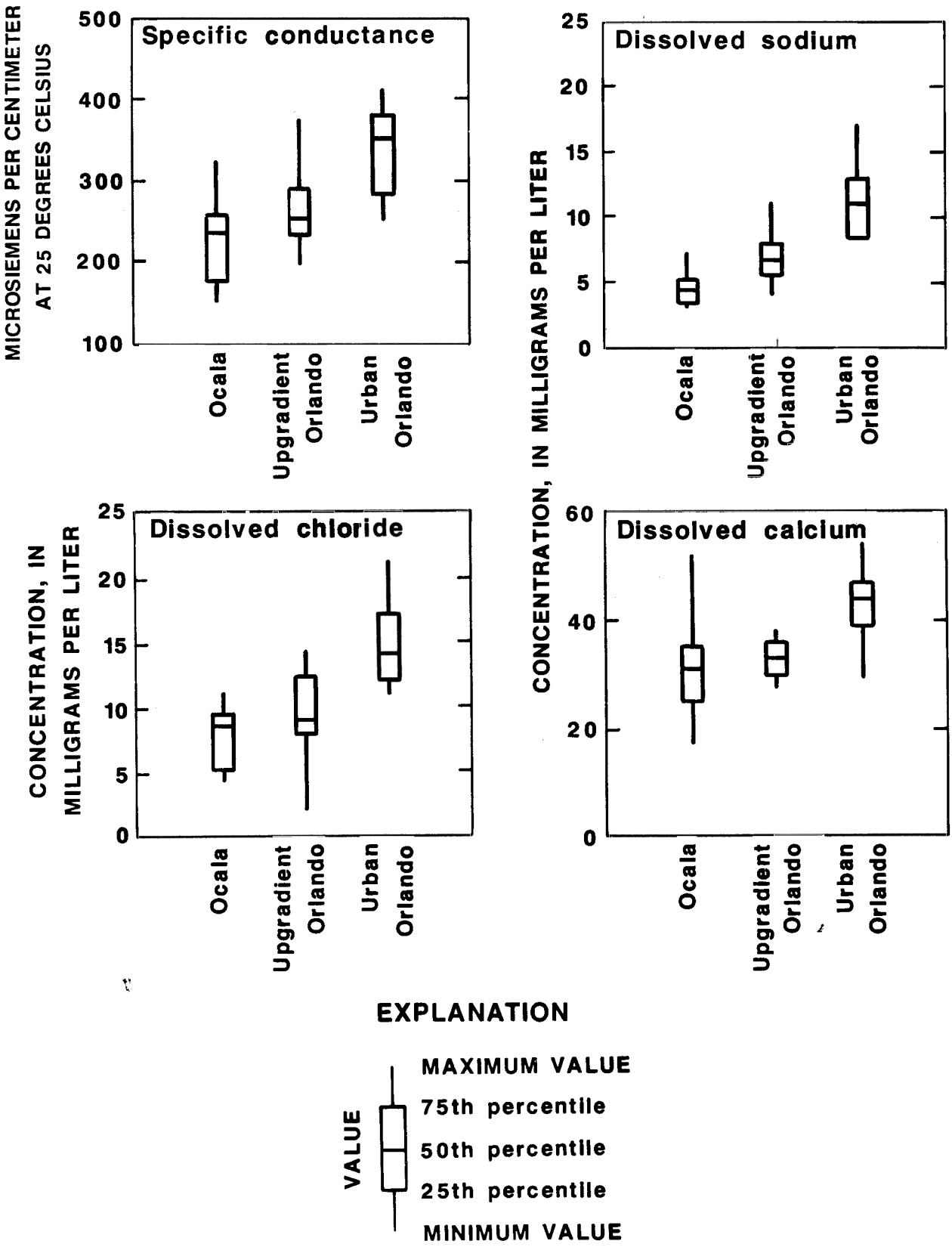

Figure 12. Box plots of specific conductance, sodium, cl , and calcium in water from wells in the Ocala National Forest, upgradient from Orlando and the urban study area.

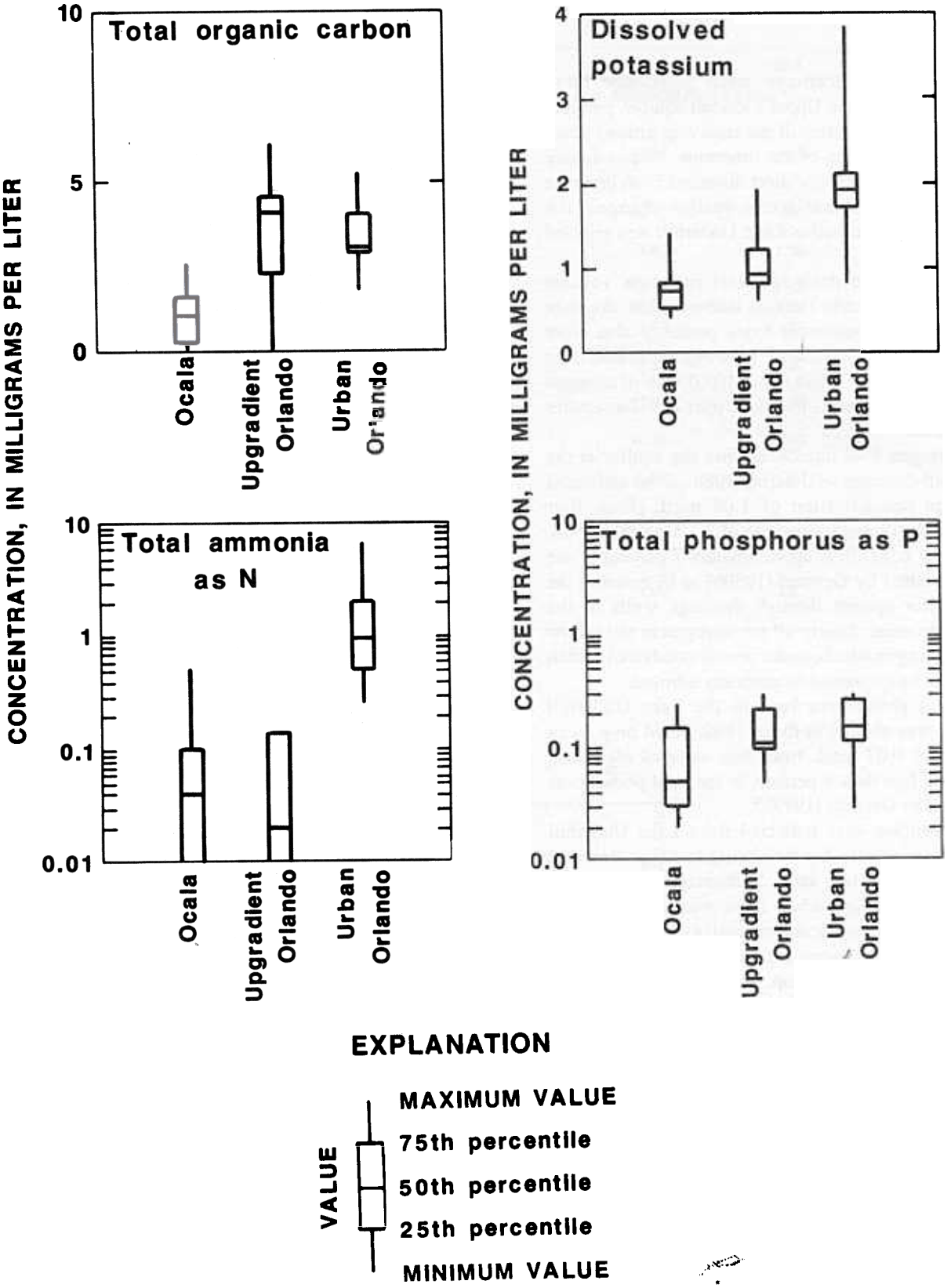

Figure 13. Box plots of total organic carbon, potassium, ammonia, and phosphorus in water from wells in the Ocala National Forest upgradient from Orlando and the urban study area.

Table 6. *Median values of selected constituents and physical properties of water from 11 wells in the urban Orlando area, well 16*

[Concentrations are median values, in milligrams per liter, unless otherwise stated. N, number of samples; µS/cm, microsiemens per centimeter at 25 degrees Celsius] mg/L, micrograms per liter]

Constituent	Urban Orlando area		Lake Underhill monitoring well 2		Gertrude Street monitoring well	
	N	Median	N	Median	N	Median
Specific conductance µS/cm, field	19	357	3	430	3	381
pH, in standard units	17	7.6	3	7.8	3	7.6
Total organic nitrogen as N	30	.24	4	.33	3	.20
Total ammonia as N	30	.97	4	.14	3	1.30
Total phosphorus as P	30	.16	3	.13	3	.16
Total organic carbon	30	3.0	4	3.7	3	2.9
Dissolved calcium	31	44	4	62	3	47
Dissolved magnesium	31	8.6	4	6.2	3	10
Dissolved sodium	31	11	4	5.8	3	13
Dissolved potassium	31	1.9	4	2.4	3	1.9
Dissolved chloride	25	14	4	9.7	3	14.0
Dissolved sulfate	31	7.8	4	48	3	7.2
Dissolved iron, in µg/L	18	65	3	18	3	70
Total recoverable manganese, in µg/L	26	10	3	30	3	10

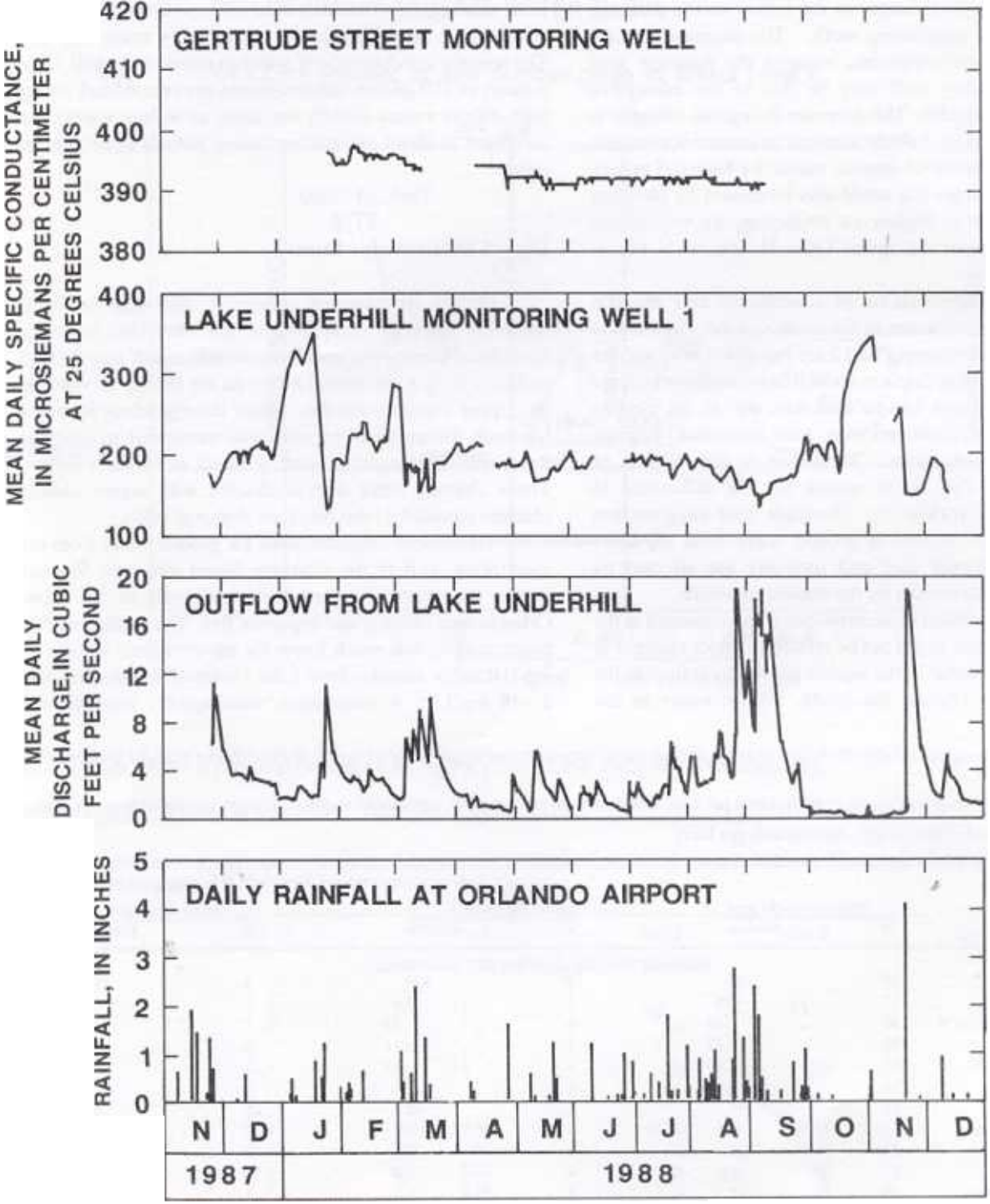

Figure 14. Hydrograph showing specific conductance of water in the Gertrude Street monitoring well and Lake Underhill monitoring well 1, outflow from Lake Underhill, and rainfall at Orlando.

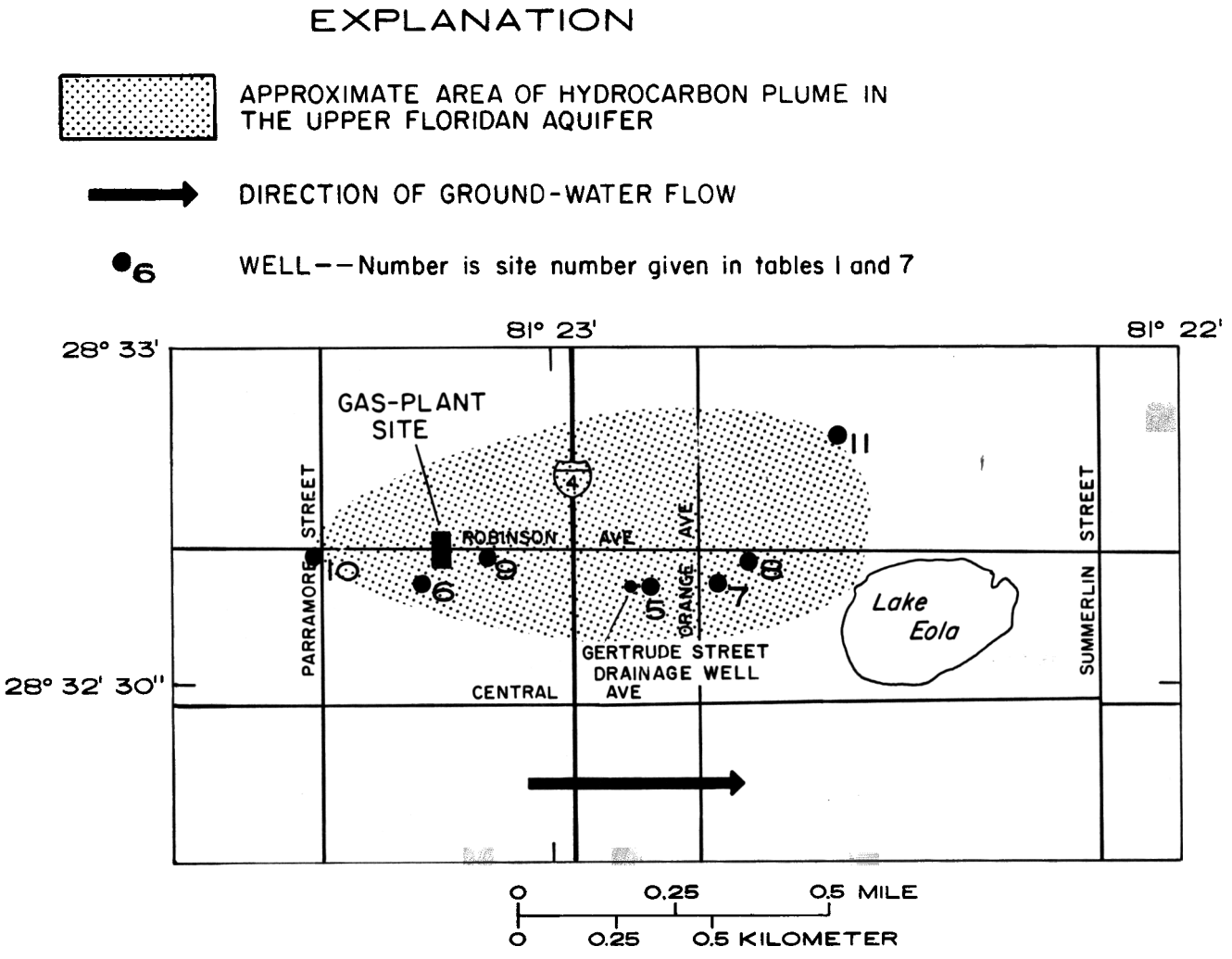

Figure 15. Map shown approximate extent of the hydrocarbon plume in the urban Orlando area.

Table 7. *Organic compounds detected in water from wells within the hydrocarbon plume*

[Number is concentration in micrograms per liter. An asterisk (*) indicates compound was not detected. Compounds with (total) include all isomers added together. TIOC values are semiquantitative]

Compound Name	Site 10	Site 9	Site 7	Site 8	Site 11
		Compounds with authentic reference standards			
Volatiles					
Benzene		94	86	53	0.2
Ethylbenzene		7.6	.30	*	*
Toluene		1.2	*	*	*
Xylene		15	.60	.20	*
Polycyclics					
Acenaphthene	0.14	32.73	18.79	10.32	4.04
Acenaphthylene*		.92	.10	*	*
Anthracene	*	2.81	.38	.09	*
Fluoranthene	*	3.94	1.12	.38	.09
Fluorene	*	15.28	1.94	.30	.06
Naphthalene	.04	257.82	7.51	.32	*
Phenanthrene	*	17.21	1.68	.16	*
Phenol,2,4,-dimethyl	.24	.27	.56		
Phenol	*	1.84	2.02		
Pyrene	*	6.94	2.46	.62	.63

Table 7. *Organic compounds detected in water from wells within the hydrocarbon plume--Continued*

[Number is concentration in micrograms per liter. An asterisk (*) indicates compound was not detected. Compounds with (total) include all isomers added together. TIOC values are semiquantitative.]

Compound Name	Site 10	Site 9	Site 7	Site 8	Site 11
		Tentatively identified organic compounds from automated library search			
Volatiles					
Thiophene	*	1.43	3.00	2.33	0.26
Polycyclics					
Benzene, propyl		1.81	40	.86	
Benzo[b]thiophene methyl isomers (total)		10.00	1.60	1.70	1.30
Benzo[b]thiophene dimethyl isomers (total)		5.00	*	.40	.30
1H-Indene, 2,3-dihydro-		68.22	19.70	1.88	
1H-Indene, 2,3-dihydro-1-methyl		3.05	1.67	.84	
Naphthalene, ethyl isomers (total)		14.00	1.80	1.00	.40
Naphthalene, methyl isomers (total)	x	140.00	17.00	4.00	
Naphthalene, dimethyl isomers (total)		90.00	10.50	7.00 2.30	
Naphthalene, trimethyl isomers (total)		12.70	.80	.70	.50
9H-Fluorene, methyl isomers (total)		12.00	1.60		1.10
4H-Cyclopenta [def] phenanthrene		4.00	.60	.81	.40
1,1'-Biphenyl, methyl isomers (total)		14.00	1.00	3.2	.70

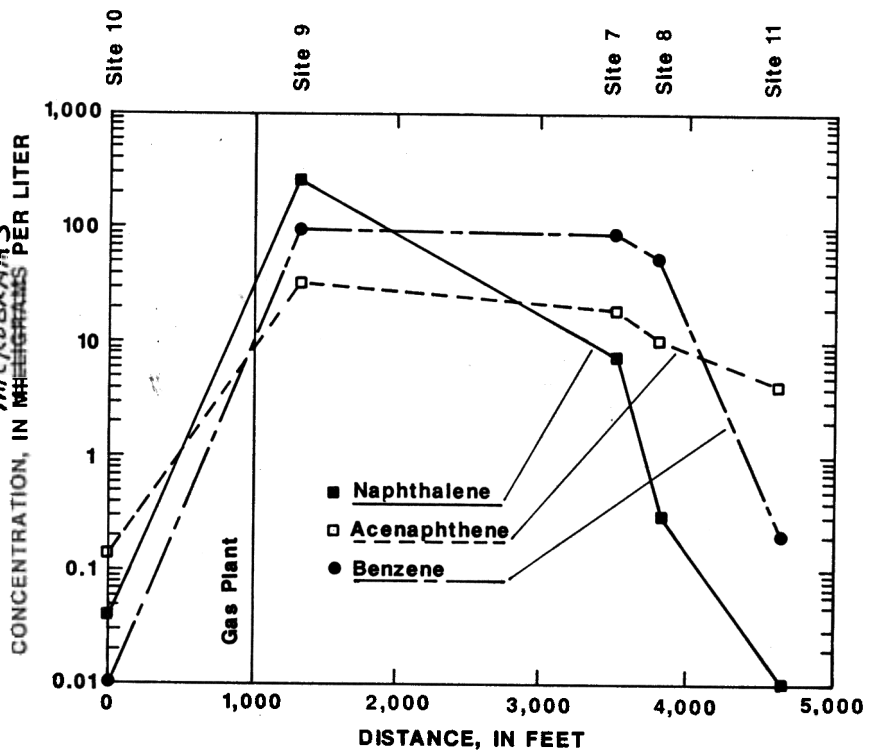

Figure 16. Profiles of acenaphthene, naphthalene, and benzene in water from wells within the hydrocarbon plume.