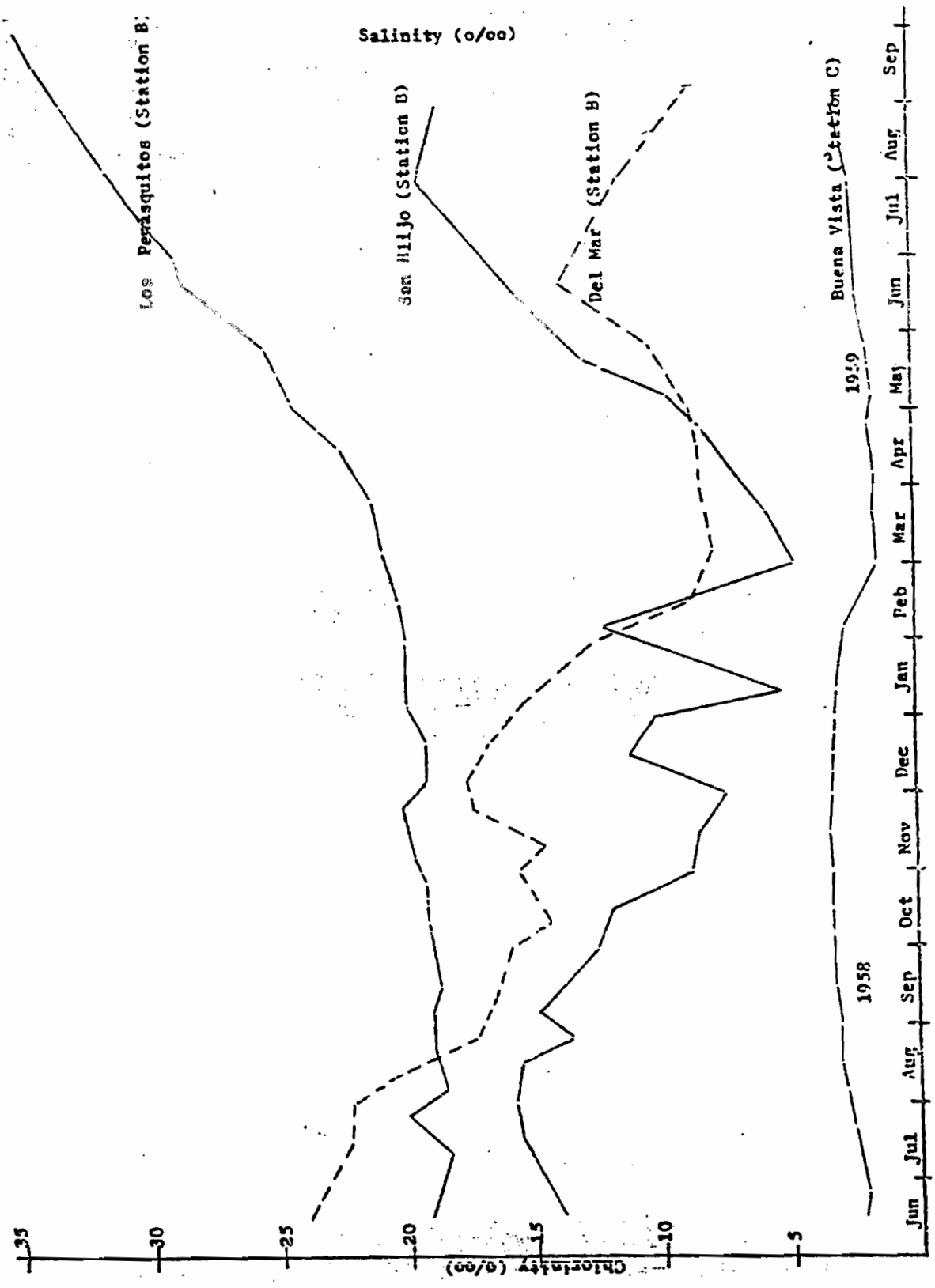

Figure A-3. Salinity values measured in Buena Vista Lagoon (Station C) and other area lagoons (from Carpelan 1960).

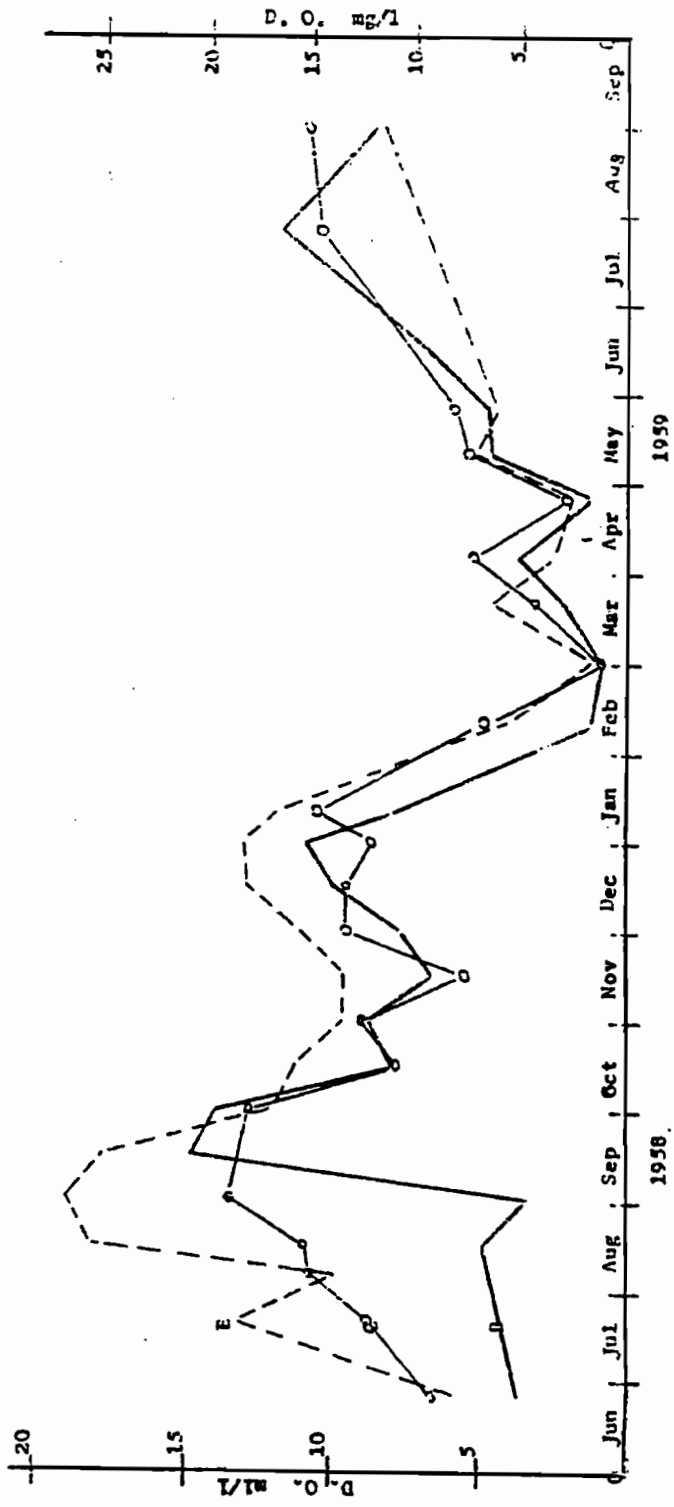

Figure A-4. Dissolved oxygen values measured in Buena Vista Lagoon in the Railroad Basin (Station B), Central Basin (Station C), and East Basin (Station E) (from Carpelan 1960).

6) The pattern of seasonal changes in concentrations of phosphate measured amongst the three basins reflected the influences of wastewater discharged into the Railroad Basin and stormwater runoff from Buena Vista Creek (Figure A-5). During summer and fall, phosphate levels were higher in the East Basin (Station E) than in the Central (Station C) and Railroad Basin (Station B). Concentrations increased throughout the lagoon during January and February (65 - 90 ug-at/l) due to seasonal runoff, but remained high (90 ug-at/l) only in the East Basin into April with prolonged creek runoff, decreasing in the other basins (22 - 50 ug-at/l) due to uptake. From May through July the concentrations were low throughout the lagoon (2 - 18 ug-at/l), and then began to increase (30 ug-at/l) in the Railroad Basin during August (Figure A-5).

7) Ammonia (NH3) concentrations exhibited a strong seasonal pattern throughout the lagoon. Concentrations were generally highest in the Railroad Basin, second highest in the Central Basin, and lowest in the East Basin (Figure A-6). The very high concentrations of ammonia (NH3) measured throughout the lagoon, particularly in the Railroad and Central Basins, reflected the very low oxygen levels (Figure A-4) at this time. Low oxygen levels probably slowed the rate of nitrification of ammonia to nitrate. The highest concentrations of 450 ug-at/l occurred in March 1959 after a period of high stormwater runoff. Carpelan (1960) mentions that floating algal mats covered the lagoon during some years (Table A-1).

Peters *et al.* (1985) monitored water quality conditions monthly in a number of San Diego lagoons, including 3 stations in Buena Vista Lagoon, for a period of 5 years (1979 - 1983). The objective of this study was to derive nutrient standards for coastal lagoons in San Diego County. Station C was located near the Highway 101 culvert (Central Basin), Station BN at the terminus of Lagoon View Drive (East Basin), and Station A1 upstream in Buena Vista Creek, about halfway between Jefferson Street and Haymar Street. Parameters measured included salinity, total inorganic nitrogen, total nitrogen, orthophosphate phosphorus, total phosphate phosphorous, chlorophyll a, and percent cover of the floating algal mat. Peters *et al.* results were as follows:

1) Salinity. Salinity ranged from about 0.5 - 3.2 ppt. The seasonal pattern, reflecting winter input of stormwater and summer evaporation, showed lowest values during February - May and highest values during September - November (Figure A-7).

2) Nutrients. Monthly measurements of Orthophosphate, Total Phosphate, Total Inorganic Nitrogen, and Total Nitrogen expressed as 6 month means for the wet season (October - March) and dry season (April - September) are shown in Table A-2, along with the proposed water quality standard for freshwater and brackish water lagoon conditions.

3) Chlorophyll a. The mean value of Chlorophyll a, as an indicator of phytoplankton density, measured during 1982 and 1983, of about 9 ug/l in the East Basin and about 25 ug/l in the Central Basin. These values indicate euthrophic conditions. A phytoplankton bloom was evident from August -November in the Central Basin, following the die-off of the floating algal mat.

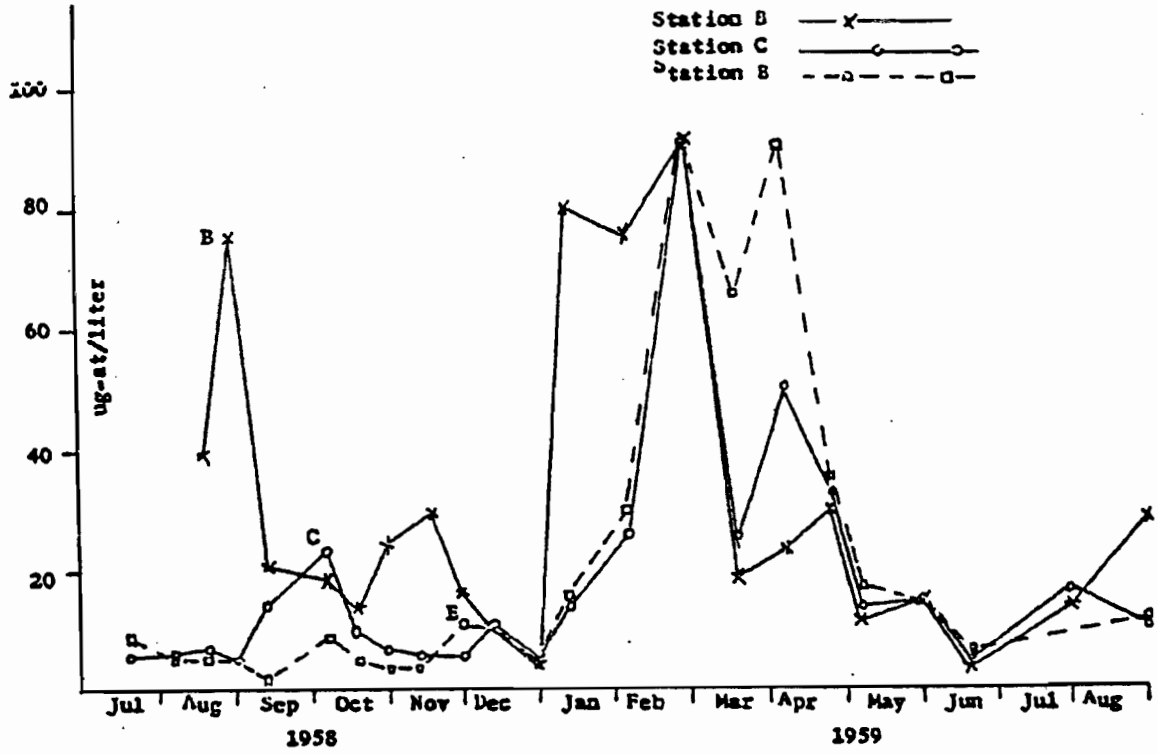

Figure A-5. Concentration of phosphate values measured in Buena Vista Lagoon in the Railroad Basin (Station B), Central Basin (Station C), and East Basin (Station E) (from Carpelan 1960).

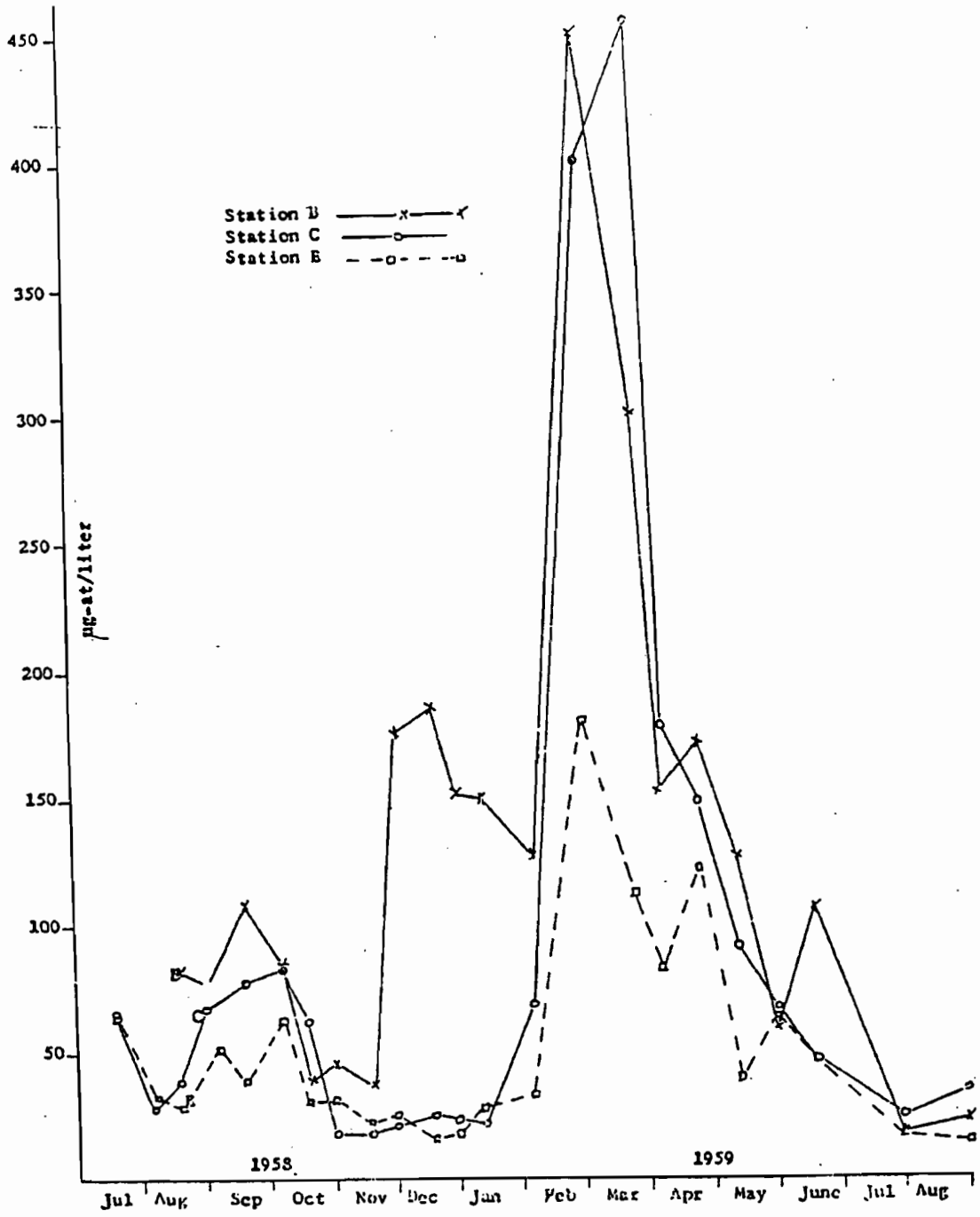

Figure A-6. Concentration of ammonia values measured in Buena Vista Lagoon in the Railroad Basin (Station B), Central Basin (Station C), and East Basin (Station E) (from Carpelan 1960).

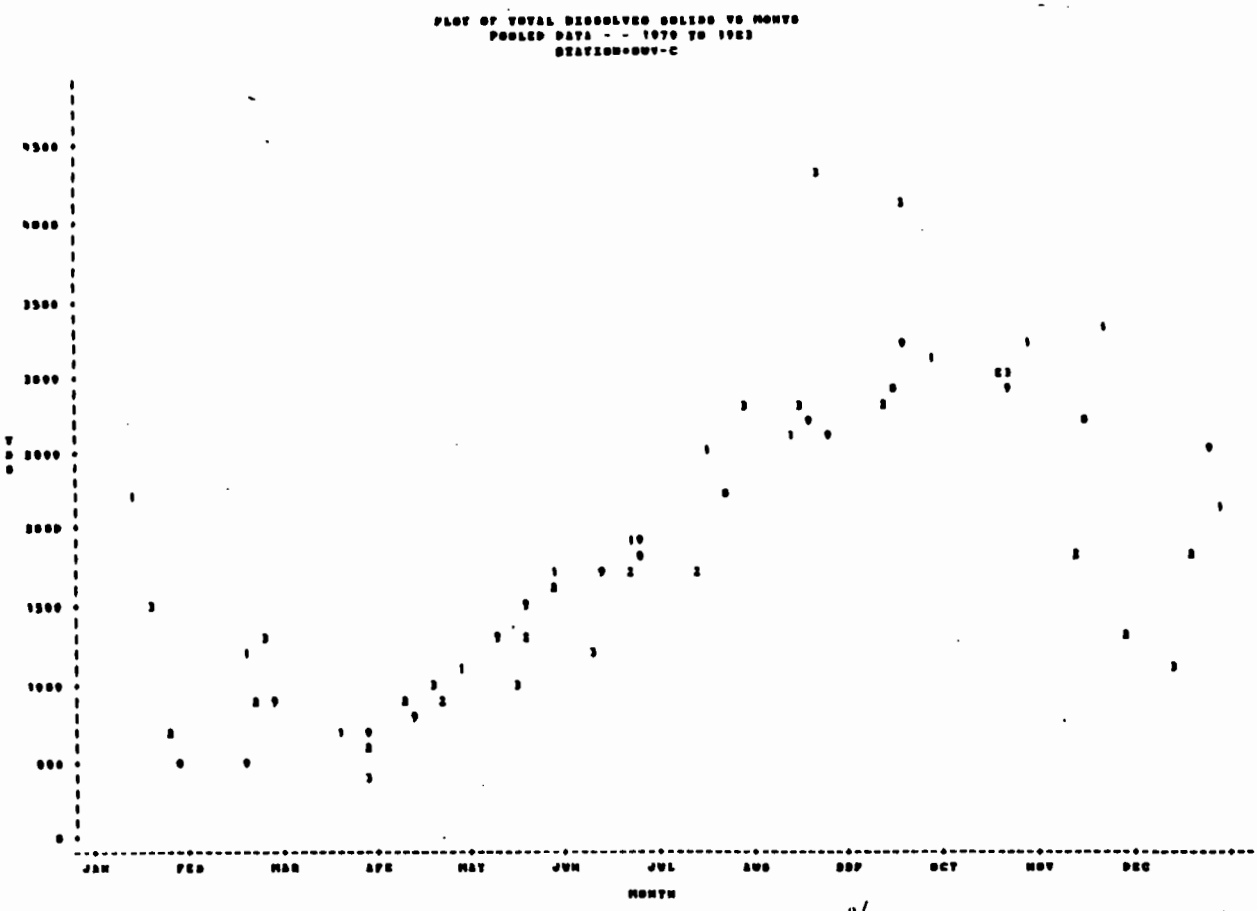

FIGURE 2. SALINITY, EXPRESSED AS TOTAL DISSOLVED SOLIDS (TDS)[a/], OF BUENA VISTA LAGOON (BUV) AT STATION C[b/] DURING 1979 - 1983.[c/]

[a/] TDS/1000 = Salinity in parts per thousand (0/00).

[b/] Location of station is shown on map in Figure 7.

[c/] Numbered data points indicate the last digit of year in which sample was collected, i.e. 9 = 1979.

Figure A-7. Salinity expressed as total dissolved solids of Buena Vista Lagoon Gauging Station during 1979 through 1983.

Table A-1. Cover (acreage) of floating algal mat estimated from aerial photographs.

Year	Basin				Total (ac)
	Weir	Railroad	Central	East	
1998	1.7	4.8	42.8	0	49.3
1999	2.1	2.6	53.1	12.2	57.8

Table A-2. Measured semi-annual mean concentrations of nutrients and proposed water quality standards for freshwater and brackish water lagoon (modified from Peters *et al.* 1985).

Parameter	DATE	Measured	Objective
Total Inorganic N (mg/l)	Oct-Mar	1.1	1.3
Total Inorganic N (mg/l)	Apr-Sep	0.60	0.75
Total Inorganic N (mg/l)	Annual	-	-
Total Nitrogen (mg/l)	Oct-Mar	2.5	2.6
Total Nitrogen (mg/l)	Apr-Sep	1.9	2.1
Total Nitrogen (mg/l)	Annual	-	-

Parameter	DATE	MEASURED	Objective
Orthophosphate Phosphorous (P) (mg/l)	Oct-Mar	0.13	-
Orthophosphate Phosphorous (P) (mg/l)	Apr-Sep	0.09	-
Orthophosphate Phosphorous (P) (mg/l)	Annual	-	0.16
Total Phosphate Phosphorous (P) (mg/l)	Oct-Mar	0.28	-
Total Phosphate Phosphorous (P) (mg/l)	Apr-Sep	0.20	-
Total Phosphate Phosphorous (P) (mg/l)	Annual	-	0.25

j) Floating Algal Mat. The floating algal mat began to develop in May, reached its maximum cover July - September, and then degraded rapidly by October - November. At Station C, the floating algal mat covered a minimum of 5 - 15% of the Central Basin every year, a minimum of 15 - 40% for 4 years, and 70 - 100% for 2 years. Station BN (East Basin) was only monitored intermittently.

APPENDIX B

WATER SAMPLE CHEMICAL ANALYSIS

(PAT-CHEM LABORATORIES)

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46738-SD1166 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:
Sample Date: 6-16-99
Sampled by: Customer
Location: Station #1

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.6 units
T.K. Nitrogen	351.3	0.05 mg/L		0.53 mg/L
Ammonia as N	350.2	0.02 mg/L		0.18 mg/L
Nitrate as N	300	0.1 mg/L		0.8 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.3 mg/L
Turbidity	180.1	0.5 NTU		2.5 NTU
Total Coliform	9221	2 mpn/100 mls		80 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		8 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46737-SD1167 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 6-16-99
Sampled by: Customer
Location: Station #2

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.5 units
T.K. Nitrogen	351.3	0.05 mg/L		0.51 mg/L
Ammonia as N	350.2	0.02 mg/L		0.08 mg/L
Nitrate as N	300	0.1 mg/L		0.6 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.3 mg/L
Turbidity	180.1	0.5 NTU		1.8 NTU
Total Coliform	9221	2 mpn/100 mls		240 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		13 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46734-SD1168 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 6-16-99
Sampled by: Customer
Location: Station #3

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		10.1 units
T.K. Nitrogen	351.3	0.05 mg/L		0.43 mg/L
Ammonia as N	350.2	0.02 mg/L		0.2 mg/L
Nitrate as N	300	0.1 mg/L		0.5 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.3 mg/L
Turbidity	180.1	0.5 NTU		0.5 NTU
Total Coliform	9221	2 mpn/100 mls		4 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990. Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46739-D1169 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 6-16-99
Sampled by: Customer
Location: Station #4

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.3 units
T.K. Nitrogen	351.3	0.05 mg/L		0.46 mg/L
Ammonia as N	350.2	0.02 mg/L	<	0.05 mg/L
Nitrate as N	300	0.1 mg/L		0.6 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.3 mg/L
Turbidity	180.1	0.5 NTU		0.9 NTU
Total Coliform	9221	2 mpn/100 mls		130 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46735-SD1170 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 6-16-99
Sampled by: Customer
Location: Station #5

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		7.9 units
T.K. Nitrogen	351.3	0.05 mg/L		1.1 mg/L
Ammonia as N	350.2	0.02 mg/L		0.75 mg/L
Nitrate as N	300	0.1 mg/L		0.5 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.4 mg/L
Turbidity	180.1	0.5 NTU		7.7 NTU
Total Coliform	9221	2 mpn/100 mls		30 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		8 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 46736-SD1171 P.O.#:

Report Date: 6/23/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 6-16-99
Sampled by: Customer
Location: Station #6

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		7.7 units
T.K. Nitrogen	351.3	0.05 mg/L		0.62 mg/L
Ammonia as N	350.2	0.02 mg/L		0.26 mg/L
Nitrate as N	300	0.1 mg/L		0.5 mg/L
Nitrite as N	300	0.1 mg/L	<	0.1 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Phosphate as P	300	0.5 mg/L	<	0.5 mg/L
Total Phosphorus	200.7	0.05 mg/L		0.3 mg/L
Turbidity	180.1	0.5 NTU		1.9 NTU
Total Coliform	9221	2 mpn/100 mls		300 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		70 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47229-SD1212 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station #1

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.9 units
T.K. Nitrogen	351.3	0.05 mg/L		1.48 mg/L
Ammonia	350.2	0.05 mg/L		0.07 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.04 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.05 mg/L
Turbidity	180.1	0.5 NTU		8.9 NTU
Total Coliform	9221	2 mpn/100 mls		130 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		4 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47230-SD1213 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station # 2

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.0 units
T.K. Nitrogen	351.3	0.05 mg/L		1.65 mg/L
Ammonia	350.2	0.05 mg/L		0.06 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		3.7 NTU
Total Coliform	9221	2 mpn/100 mls		280 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		8 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47231-SD1214 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station # 3

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.8 units
T.K. Nitrogen	351.3	0.05 mg/L		1.71 mg/L
Ammonia	350.2	0.05 mg/L		0.06 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		10.2 NTU
Total Coliform	9221	2 mpn/100 mls		4 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls	<	2 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47232-SD1215 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station # 4

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.2 units
T.K. Nitrogen	351.3	0.05 mg/L		4.33 mg/L
Ammonia	350.2	0.05 mg/L		0.20 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		1.3 NTU
Total Coliform	9221	2 mpn/100 mls		8 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls	<	2 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47989-SD1261 F.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:
Sample Date: 8-16-99
Sampled by: Customer
Location: Station # 1

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.0 units
T.K. Nitrogen	351.3	0.05 mg/L		1.99 mg/L
Ammonia	350.2	0.05 mg/L		0.12 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L		7 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		3.4 NTU
Total Coliform	9221	2 mpn/100 mls		240 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		7 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47233-SD1216 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station # 5

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.2 units
T.K. Nitrogen	351.3	0.05 mg/L		1.63 mg/L
Ammonia	350.2	0.05 mg/L		0.06 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.12 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.12 mg/L
Turbidity	180.1	0.5 NTU		14.6 NTU
Total Coliform	9221	2 mpn/100 mls		240 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		130 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47234-SD1217 P.O.#:

Report Date: 7/20/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 7-12-99
Sampled by: Customer
Location: Station # 6

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		7.9 units
T.K. Nitrogen	351.3	0.05 mg/L		1.97 mg/L
Ammonia	350.2	0.05 mg/L	<	0.05 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		1.6 NTU
Total Coliform	9221	2 mpn/100 mls		500 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		130 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47992-SD1262 P.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 8-16-99
Sampled by: Customer
Location: Station # 2

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.2 units
T.K. Nitrogen	351.3	0.05 mg/L		1.59 mg/L
Ammonia	350.2	0.05 mg/L		0.13 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L		5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		4.7 NTU
Total Coliform	9221	2 mpn/100 mls		900 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		2 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47991-SD1263 P.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 8-16-99
Sampled by: Customer
Location: Station #3

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.7 units
T.K. Nitrogen	351.3	0.05 mg/L		1.44 mg/L
Ammonia	350.2	0.05 mg/L		0.09 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		0.7 NTU
Total Coliform	9221	2 mpn/100 mls		13 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls	<	2 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		8 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47994-SD1264 P.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 8-16-99
Sampled by: Customer
Location: Station # 4

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.4 units
T.K. Nitrogen	351.3	0.05 mg/L		1.46 mg/L
Ammonia	350.2	0.05 mg/L		0.12 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		0.6 NTU
Total Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		30 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47993-SD1265 P.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 8-16-99
Sampled by: Customer
Location: Station # 5

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.1 units
T.K. Nitrogen	351.3	0.05 mg/L		1.69 mg/L
Ammonia	350.2	0.05 mg/L		0.13 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L		6 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		5.5 NTU
Total Coliform	9221	2 mpn/100 mls		23 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		23 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		33 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 47990-SD1266 P.O.#:

Report Date: 8/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 8-16-99
Sampled by: Customer
Location: Station # 6

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.2 units
T.K. Nitrogen	351.3	0.05 mg/L		1.80 mg/L
Ammonia	350.2	0.05 mg/L		0.11 mg/L
Nitrate as N	300	0.02 mg/L	<	0.02 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L	<	0.02 mg/L
Total Phosphorus	200.7	0.02 mg/L	<	0.02 mg/L
Turbidity	180.1	0.5 NTU		0.9 NTU
Total Coliform	9221	2 mpn/100 mls		900 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		2 mpn/100 mls
Enteroccus	9230	2 mpn/100 mls		2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49184-SD1343 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #1

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.9 units
T.K. Nitrogen	351.3	0.05 mg/L		1.76 mg/L
Ammonia	350.2	0.05 mg/L		0.13 mg/L
Nitrate as N	300	0.02 mg/L		0.25 mg/L
Nitrite as N	300	0.02 mg/L		0.03 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.12 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.12 mg/L
Turbidity	180.1	0.5 NTU		8.4 NTU
Total Coliform	9221	2 mpn/100 mls		1600 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		90 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls	<	2 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49135-SD1344 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #2

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		7.5 units
T.K. Nitrogen	351.3	0.05 mg/L		1.37 mg/L
Ammonia	350.2	0.05 mg/L		0.08 mg/L
Nitrate as N	300	0.02 mg/L		0.51 mg/L
Nitrite as N	300	0.02 mg/L		0.03 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.10 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.10 mg/L
Turbidity	180.1	0.5 NTU		1.6 NTU
Total Coliform	9221	2 mpn/100 mls	≥	1600 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls	≥	1600 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls		22 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49186-SD1345 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #3

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		9.0 units
T.K. Nitrogen	351.3	0.05 mg/L		1.35 mg/L
Ammonia	350.2	0.05 mg/L		0.12 mg/L
Nitrate as N	300	0.02 mg/L		0.10 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.08 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.08 mg/L
Turbidity	180.1	0.5 NTU		11.0 NTU
Total Coliform	9221	2 mpn/100 mls		900 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls		30 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49187-SD1346 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #4

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		7.8 units
T.K. Nitrogen	351.3	0.05 mg/L		1.23 mg/L
Ammonia	350.2	0.05 mg/L		0.14 mg/L
Nitrate as N	300	0.02 mg/L		0.09 mg/L
Nitrite as N	300	0.02 mg/L		0.03 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.13 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.13 mg/L
Turbidity	180.1	0.5 NTU		1.26 NTU
Total Coliform	9221	2 mpn/100 mls		900 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		300 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls		80 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49188-SD1347 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #5

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.5 units
T.K. Nitrogen	351.3	0.05 mg/L		1.32 mg/L
Ammonia	350.2	0.05 mg/L		0.09 mg/L
Nitrate as N	300	0.02 mg/L		0.25 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.24 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.24 mg/L
Turbidity	180.1	0.5 NTU		12.5 NTU
Total Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls		22 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

PAT-CHEM LABORATORIES

Customer: **Coastal Environments**
2166 Avendia de la Playa,Suite E
La Jolla, CA 92037

Attention: Allan Thum

Sample I.D.#: 49189-SD1348 P.O.#:

Report Date: 10/25/99

Subject: Buena Vista Lagoon Grab Sample

Sample Information:

Sample Date: 10-18-99
Sampled by: Customer
Location: Station #6

Results:

Parameter	EPA Method	Detection Limit		Analysis
pH	150.1	0.1 units		8.1 units
T.K. Nitrogen	351.3	0.05 mg/L		1.74 mg/L
Ammonia	350.2	0.05 mg/L		0.11 mg/L
Nitrate as N	300	0.02 mg/L	<	0.25 mg/L
Nitrite as N	300	0.02 mg/L	<	0.02 mg/L
BOD	405.1	5 mg/L	<	5 mg/L
Orthophosphate as P	365.2	0.02 mg/L		0.36 mg/L
Total Phosphorus	200.7	0.02 mg/L		0.36 mg/L
Turbidity	180.1	0.5 NTU		10.4 NTU
Total Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Fecal Coliform	9221	2 mpn/100 mls		50 mpn/100 mls
Enterococcus	9230	2 mpn/100 mls		4 mpn/100 mls

Comments: Sample was analyzed per EPA Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020).

Respectfully Submitted,

Pat Brueckner
Laboratory Director

CORPORATE OFFICE: 11990 Discovery Ct. • Moorpark, CA 93021 • (805) 532-0012 • FAX (805) 532-0016

EMERGENCY RESPONSE SAMPLING AT BUENA VISTA LAGOON

Final Report

EMERGENCY RESPONSE SAMPLING AT BUENA VISTA LAGOON

Final Report

Submitted To:

Encina Wastewater Authority
6200 Avenida Encinas
Carlsbad, California 92009

Submitted By:

MEC Analytical Systems, Inc.
2433 Impala Drive
Carlsbad, California 92008

March 25, 1997

TABLE OF CONTENTS

INTRODUCTION

Buena Vista Lagoon is located in northern San Diego County between the cities of Oceanside and Carlsbad. Highway 78 lies to the north, while Interstate 5 separates the inner lagoon (east of the freeway) from the outer lagoon (west of the freeway) (Figure 1). The inner lagoon extends east from the freeway to Jefferson Street and is also bordered on the south by Jefferson Street. The outer lagoon lies between Interstate 5 and the Pacific Ocean and is transected by Hill Street and the Atchison, Topeka, & Santa Fe Railroad. It consists of a large section between Hill Street and Interstate 5 and a smaller section west of Hill Street. A weir contains the water of the outer lagoon at the mouth (Figure 1). Buena Vista is a freshwater lagoon, with no tidal exchange from the Pacific Ocean.

On February 25, 1997, at 11:45 a.m., untreated sewage from the Buena Vista Sewage Pump Station located on the eastern end of the inner lagoon entered the adjacent Buena Vista Creek. In response to this spill, field sampling to monitor the sewage at Buena Vista Lagoon commenced immediately. The sampling effort was focused in the inner lagoon near the source as the spill entered Buena Vista Lagoon from the eastern extreme. Stations were established in the impacted area and in areas far from the source including the surf zone at the beach. The purposes of this sampling effort were to track the spread of the sewage plume and to assess the extent of fecal contamination. Dissolved oxygen concentrations and fecal coliform counts were used as indicators of sewage contamination.

The Buena Vista Sewage Pump Station was back in service at approximately 5:00 p.m. (1700) on February 25. Untreated sewage ceased flowing into the Buena Vista Creek at 5:00 p.m. on February 25. Portable pumps to recover the sewage from the lagoon began pumping into the Buena Vista Sewage Pump Station at 6:40 p.m. (1840) on February 25.

METHODS

Field sampling began within an hour of notification of the break on 25 February 1997. At 12:30 p.m. Encina Wastewater Authority (EWA) staff collected surface water samples for analysis of fecal coliforms. The samples were collected from the shore at five stations (Figure 2, Stations 11-15) located near the Buena Vista Sewage Pump Station. At 2:25 p.m. (1425), water samples for dissolved oxygen and fecal coliform were collected by MEC Analytical Systems, Inc. (MEC) from an Avon inflatable boat. These samples were collected at 10 stations within the inner lagoon (Figure 2, Stations 1-10). At 6:30 p.m.(1830) the same day, surf zone samples for coliform analysis were collected by EWA. These samples were collected along the surf zone at the mouth of the lagoon and 100 and 200 yds. north and south of the lagoon mouth (Figure 2). In the laboratory, samples were analyzed for dissolved oxygen using Winkler titrations and for total and fecal coliforms using the membrane filter technique. Dissolved oxygen data were reported in milligrams per liter (mg/L) and coliform data as colony forming units per 100 mL (cfu/100 mL).

On the morning of February 26, five additional surf zone samples for coliform analysis were collected by EWA. At 1:25 p.m. (1325), MEC collected water samples for dissolved oxygen and coliform analysis at the 10 inner lagoon stations (Stations 1-10), and at 3:40 p.m. (1540), EWA collected a water sample for coliform analysis at the Buena Vista Sewage Pump Station.

In the early morning of February 27, February 28, and March 6, 1997 surface water samples for dissolved oxygen and coliform analysis were collected by MEC at the 10 inner lagoon stations (Stations 1-10). A summary of sampling events is provided in Table 1.

RESULTS

Results of analyses for dissolved oxygen and fecal coliforms are found in Tables 2 and 3, respectively. In addition, values are mapped by date in Figures 3 to 7 and 8 to 15, respectively.

Dissolved Oxygen

On the afternoon of February 25, dissolved oxygen concentrations in the far eastern portion of the inner lagoon were 0 mg/L near the source of the sewage spill and 1.5 mg/L just north of this site (Figure 3). Dissolved oxygen concentrations were high (13.6 to 19.7 mg/L) elsewhere in the inner lagoon. (For comparison, in 1994, average dissolved oxygen in the afternoon in uncontaminated areas of the outer lagoon was 12.0 mg/L.) The values of 0 and 1.5 mg/L dissolved oxygen near the site of contamination indicated that the sewage plume was contained in the far eastern area. A strong wind from the west may have slowed the spreading.

On February 26, the dissolved oxygen concentration in the northern channel was 4.7 mg/L (Figure 4), a decrease from 16.1 mg/L the previous day. Dissolved oxygen concentrations at the east side of the central and southern channels also had decreased to 8.0 and 9.3 mg/L from 15.8 and 17.2 mg/L on February 25. On the other hand, values in the far eastern portion of the lagoon near the spill source had increased to 8.7 and 9.8 mg/L. It was apparent that although the plume was spreading west from its source, recovery had begun near the eastern extreme. Measurements in the central and western portion of the inner lagoon remained relatively high.

In the early morning on February 27, dissolved oxygen concentrations in the inner lagoon had decreased at most stations from the previous afternoon. This overall decrease in dissolved oxygen can be attributed to respiration by plants and animals during the night and the oxygen demand from the spreading of the sewage plume. (For comparison, in 1994, average dissolved oxygen just after dawn in uncontaminated areas of the outer lagoon was 2.4 mg/L.) The lowest dissolved oxygen concentration was found in the northern channel, measuring 4.0 mg/L (Figure 5), and indicated that the greatest sewage contamination occurred in this channel. Dissolved oxygen concentrations in the central and western areas of the lagoon dropped to 6.5 to 6.7 mg/L. The highest concentrations were

nearest the initial spill area. The increase here was probably due to the pumping and mixing in this area as the wastewater was pumped from the lagoon.

On February 28, sampling was also conducted in the early morning. The dissolved oxygen concentration in the northern channel increased from 4.0 mg/L the previous morning to 5.4 mg/L, indicating that the area in the northern channel was beginning to recover (Figure 6). Conversely, concentrations in the eastern and central portions of the inner lagoon decreased slightly, suggesting that although not as adversely impacted as the northern channel, these areas were still being affected by the plume. The dissolved oxygen concentrations in the western portion of the inner lagoon increased slightly from the previous morning, indicating that this area was impacted by the sewage spill. Low dissolved oxygen concentrations throughout the lagoon are indicative of an evenly dispersed oxygen demand due to the sewage spill.

The final day of sampling occurred on the morning of March 6. Dissolved oxygen concentrations measured throughout the inner lagoon were significantly higher than values measured on February 28 and indicated that the inner lagoon's dissolved oxygen had been replenished (Figure 7). Dissolved oxygen concentrations in the northern channel had increased to 11.0 mg/L, and concentrations in the eastern portion of the inner lagoon where the sewage spill occurred were higher than values measured for the central and western inner lagoon. These values, while not as high as those measured in the unaffected portion of the lagoon on the afternoon of February 25, appear to be representative of normal dissolved oxygen concentrations for the early morning period.

Fecal Coliforms

On February 25, water samples taken from the shore shortly after the sewage spill (12:30 p.m.) (1230) showed that fecal coliform values ranged from $\leq 1.0 \times 10^4$ to 2×10^6 cfu/100 mL near the discharge pump (Figure 8). Fecal coliform values taken two hours later were too numerous to count (TNTC) in the far eastern portion of the inner lagoon and 1.14×10^5 cfu/100 mL at the eastern side of the central channel (Figure 9). Fecal coliform counts in the rest of the inner lagoon ranged from < 100 cfu/100 mL in the western portion to 2×10^3 cfu/100 mL in the northern channel.

By the afternoon of February 26, high fecal coliforms had spread into the northern channel (7.6×10^5 cfu/100 mL) and the central portion of the inner lagoon (3×10^4 and $< 7.5 \times 10^4$ cfu/100 mL) (Figure 10). Coliforms in the eastern portion of the inner lagoon remained high with values exceeding 1×10^6 cfu/100 mL. The western inner lagoon remained unaffected. A water sample collected at the discharge pump in the Buena Vista Sewage Pump Station measured 6×10^5 cfu/100 mL fecal coliform.

Beginning on February 27, sampling was conducted shortly after dawn, and the large increase in coliform counts from the previous afternoon at most stations indicated a combination of plume spreading and diurnal effects. Night presents more favorable conditions for bacteriological growth

as darkness and lower temperatures are more suitable for bacterial reproduction. Therefore, coliform counts in the early morning are typically higher. Results from the morning of February 27 showed that the contamination was high in the northern channel as coliform counts increased to 1.2×10^6 cfu/100 mL (Figure 11). This result confirmed findings from the dissolved oxygen plume tracking data. Contamination had spread overnight to the western portion of the inner lagoon with coliform values increasing to as high as 1.0×10^5 cfu/100 mL. Coliform values remained high on the eastern side of the central channel and continued to decrease at the two far eastern stations.

On February 28, coliform values in most areas of the inner lagoon decreased indicating that overall recovery was occurring. The exception was in the western portion where coliform counts increased to 1.55×10^5 to 1.91×10^5 cfu/100 mL (Figure 12). The highest coliform value was found in the northern channel, measuring 6.2×10^5 cfu/100 mL. Both the coliform and dissolved oxygen data indicate that the sewage had been dispersed and mixed throughout the inner lagoon.

By March 6, coliform values showed significant decreases throughout the inner lagoon. Values ranged from $< 1 \times 10^3$ to 7×10^3 cfu/100 mL (Figure 13). These data suggest that by March 6 coliform counts had dropped to near the lagoon's environmental norm and that the inner lagoon was approaching recovery.

As directed by the Health Department, water samples for coliform analysis were also collected in the surf zone near the mouth of the lagoon. On the evening of February 25, coliform counts ranged from 24 to 46 cfu/100 mL near the mouth of the lagoon (Figure 14). The following morning, coliform counts ranged from 3 to 6 cfu/100 mL in this area (Figure 15).

Comparison to 1994 Spill

In comparison to the sewage spill into Buena Vista Lagoon on August 23, 1994, among other factors the 1997 spill was much smaller in volume and the return of the contaminated lagoon water was begun earlier and therefore the spill had much less of an impact to the lagoon. Compared to 1994, when the spill occurred in the summer, water temperatures in the lagoon in February were colder, which would result in higher concentrations of dissolved oxygen. The strong wind from the west at the time of the 1997 spill probably also reduced the spreading of the plume from the eastern extreme. After the spill in 1994, dissolved oxygen values of 0 persisted over the eastern extreme and northern channel of the inner lagoon for six days. In contrast, in 1997, extremely low dissolved oxygen values (0 and 1.5 mg/L) were found only on the day of the spill and were confined to a smaller area in the eastern area of the lagoon.

In 1994, fecal coliform values were elevated to 1.6×10^6 in the eastern portion of the inner lagoon. These high concentrations persisted for three days, then began to decrease gradually. After six days, values were < 10,000 mpn/100 mL. In 1994, fecal coliforms were elevated only in the eastern extreme of the inner lagoon. Heavy vegetation in the channels prevented the spread of the

contamination to the central and western portions of the inner lagoon. In 1997, the highest coliform concentrations were again found in the eastern extreme and decreased gradually in the days following the spill. However, without the vegetation to contain the sewage, the contamination spread to the central portion of the inner lagoon on the day after the spill and to the western portion of the inner lagoon two days after the spill. As in 1994, fecal coliform levels gradually decreased, and all areas of the inner lagoon were approaching recovery within 10 days of the spill.

CONCLUSIONS

Sewage contamination from a spill at the Buena Vista Sewage Pump Station resulted in low dissolved oxygen and high fecal coliforms in the eastern portion of the inner lagoon on the day of the spill (February 25, 1997). The day after the spill, the contamination had spread further west and into the northern channel, but the far western portion of the inner lagoon remained unaffected, and the eastern region showed signs of recovery due to pumping near the source of the spill. By February 27, the contamination was fairly evenly distributed throughout the inner lagoon. Sampling on February 28 showed that fecal coliform levels increased further in the western portion of the inner lagoon but improved in other areas. By March 6, nine days after the spill, dissolved oxygen was again high, and fecal coliform concentrations had decreased throughout the inner lagoon.

Table 1. Sampling events.

Date	Time	
February 25	1130	Notification of potential spill.
	1230-1250	EWA sampled 5 stations (Stations 11-15) along shoreline of Inner Lagoon for fecal coliforms.
	1425-1525	MEC sampled 10 stations (Stations 1-10) in Inner Lagoon for dissolved oxygen and fecal coliforms.
	1830-1840	EWA sampled 5 stations at the beach for fecal coliforms.
February 26	0800-0815	EWA sampled 5 stations at the beach for fecal coliforms.
	1325-1425	MEC sampled 10 stations (Stations 1-10) in Inner Lagoon for dissolved oxygen and fecal coliforms.
	1540	EWA sampled at the Buena Vista Sewage Pump Station for fecal coliforms.
February 27	0730-0820	MEC sampled 10 stations (Station 1-10) in Inner Lagoon for dissolved oxygen and fecal coliforms.
February 28	0715-0800	MEC sampled 10 stations (Stations 1-10) in Inner Lagoon for dissolved oxygen and fecal coliforms.
March 6	0710-0810	MEC sampled 10 stations (Stations 1-10) in Inner Lagoon for dissolved oxygen and fecal coliforms.

Table 2. Dissolved oxygen (mg/L) at Buena Vista Lagoon.
Note: Samples were collected in the afternoon on February 25 and 26 and in the morning on February 27, 28, and March 6, 1997.

Station	DATE AND TIME				
	February 25 1425 to 1525	February 26 1325 to 1425	February 27 0730 to 0820	February 28 0715 to 0800	March 6 0710 to 0810
1	16.6	16.3	6.7	7.4	11.1
2	16.5	16.7	6.6	7.0	10.6
3	13.6	15.4	6.5	6.9	9.5
4	19.7	11.0	6.6	6.4	11.2
5	18.1	17.0	6.7	6.2	11.2
6	17.2	9.3	6.7	6.2	14.0
7	15.8	8.0	7.6	6.9	12.5
8	0	9.8	8.0	7.0	13.8
9	1.5	8.7	8.8	6.7	12.5
10	16.1	4.7	4.0	5.4	11.0

Table 3. Fecal coliforms (cfu/100 mL) at Buena Vista Lagoon and beach stations.

Station	DATE AND TIME				
	February 25, 1997 (PM)	February 26, 1997 (PM)	February 27, 1997 (AM)	February 28, 1997 (AM)	March 6, 1997 (AM)
LAGOON					
1	<100	200	$9.84x10^4$	$1.55x10^5$	1,000
2	<100	300	$1.02x10^5$	$1.77x10^5$	3,000
3	100	100	$1.00x10^5$	$1.91x10^5$	<1,000
4	300	$<7.50x10^4$	$1.96x10^5$	$1.62x10^5$	2,000
5	400	$3.03x10^4$	$1.19x10^5$	$1.19x10^5$	1,000
6	<1,000	$1.10x10^6$	$6.50x10^5$	$1.00x10^5$	7,000
7	$1.14x10^5$	$1.09x10^6$	$1.28x10^6$	$1.35x10^5$	5,000
8	TNTC	$1.25x10^6$	$9.60x10^5$	$3.00x10^4$	2,000
9	TNTC	$1.20x10^6$	$8.15x10^5$	$7.00x10^4$	2,000
10	2,000	$7.60x10^5$	$1.24x10^6$	$6.20x10^5$	2,000
SHORELINE (Spill Area)					
11	$<1x10^4$				
12	$2x10^6$				
13	$<1x10^4$				
14	$1x10^4$				
15	$<1x10^4$				
BEACH					
	(PM)	(AM)			
200 yds. north	24	3			
100 yds. north	41	4			
Mouth	34	6			
100 yds. south	41	4			
200 yds. south	46	5			

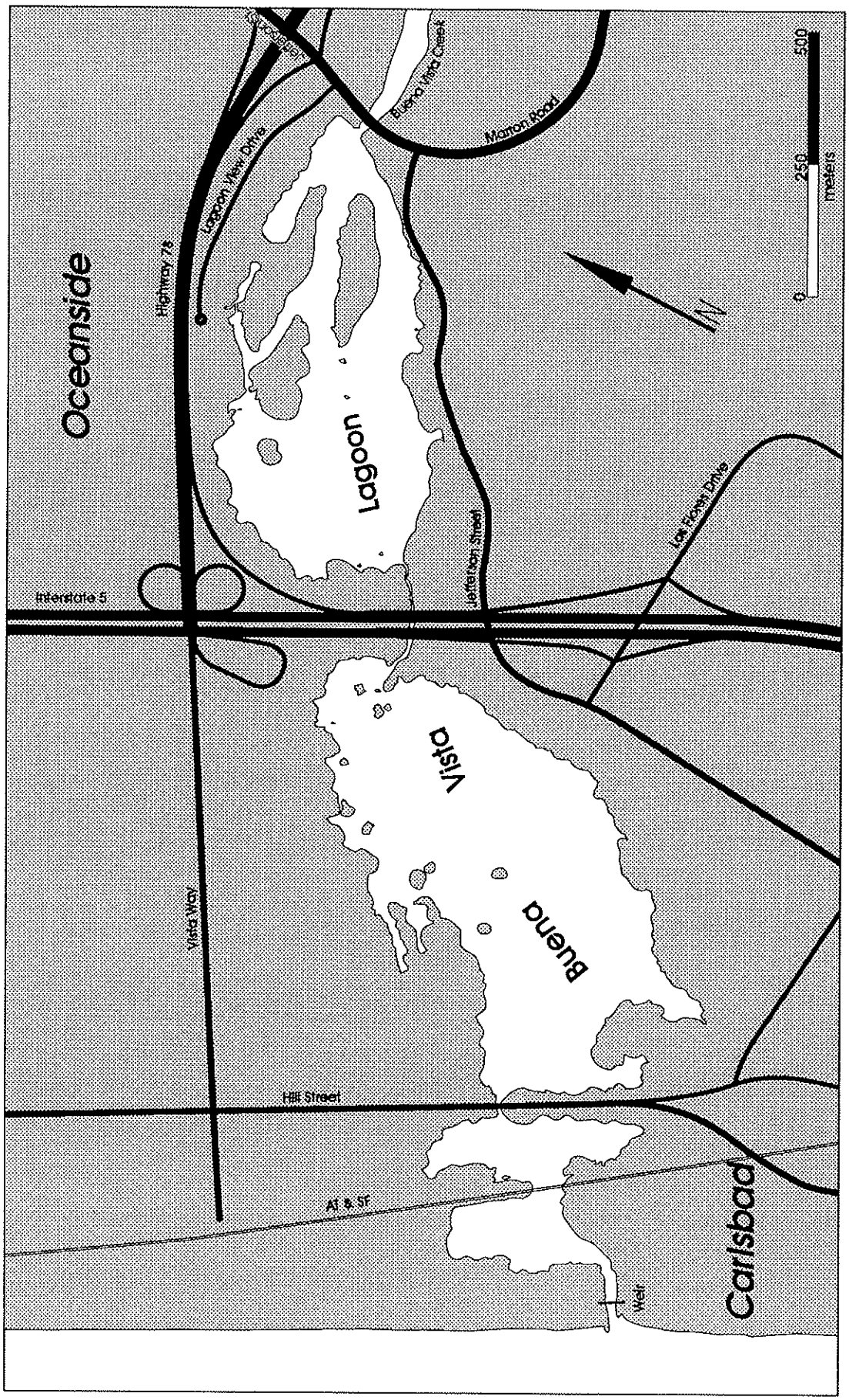

Figure 1. Buena Vista Lagoon.

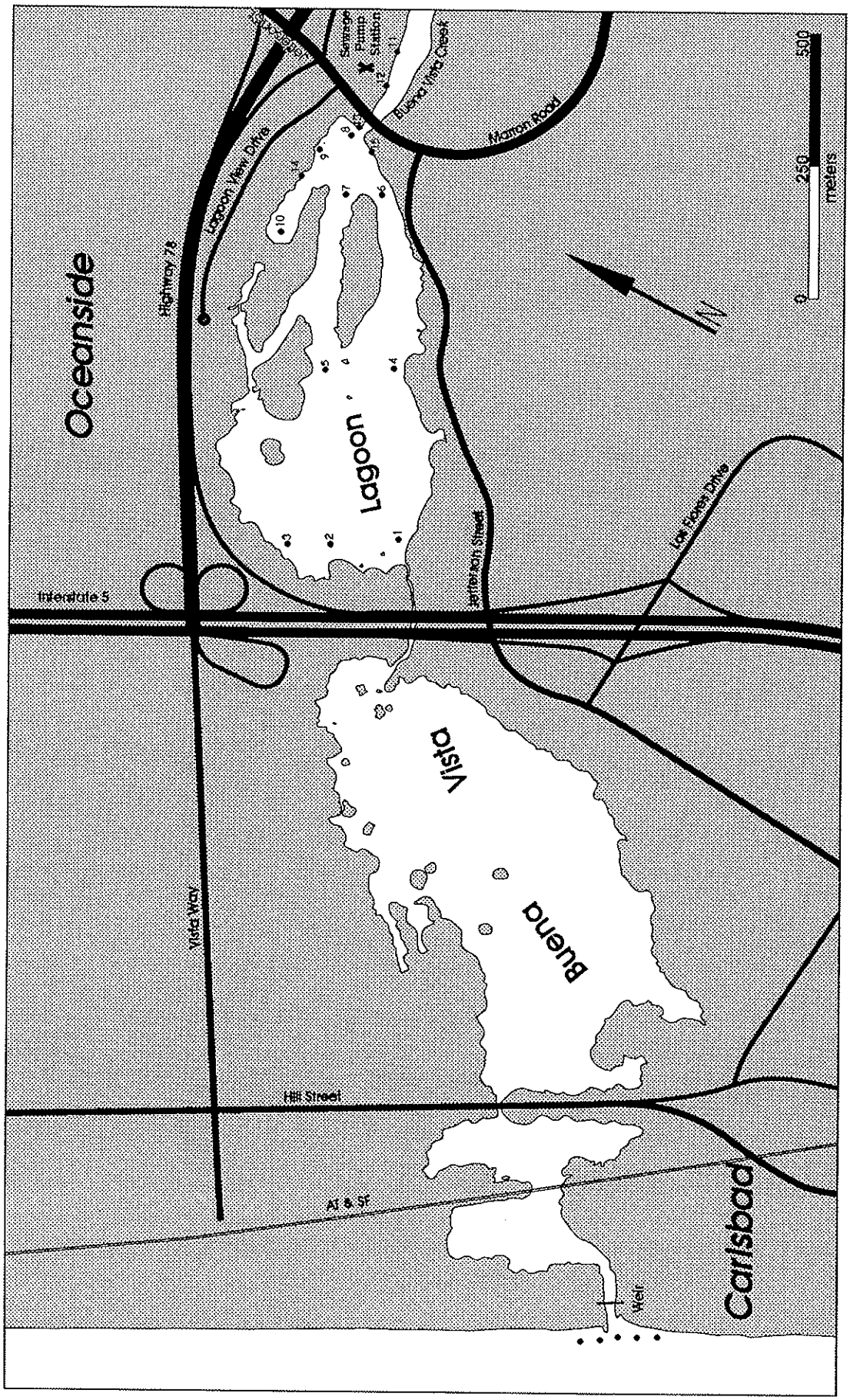

Figure 2. Buena Vista Lagoon Sampling Locations. Stations 1 through 10 were sampled from an inflatable boat, and Stations 11 through 15 were sampled from shore.

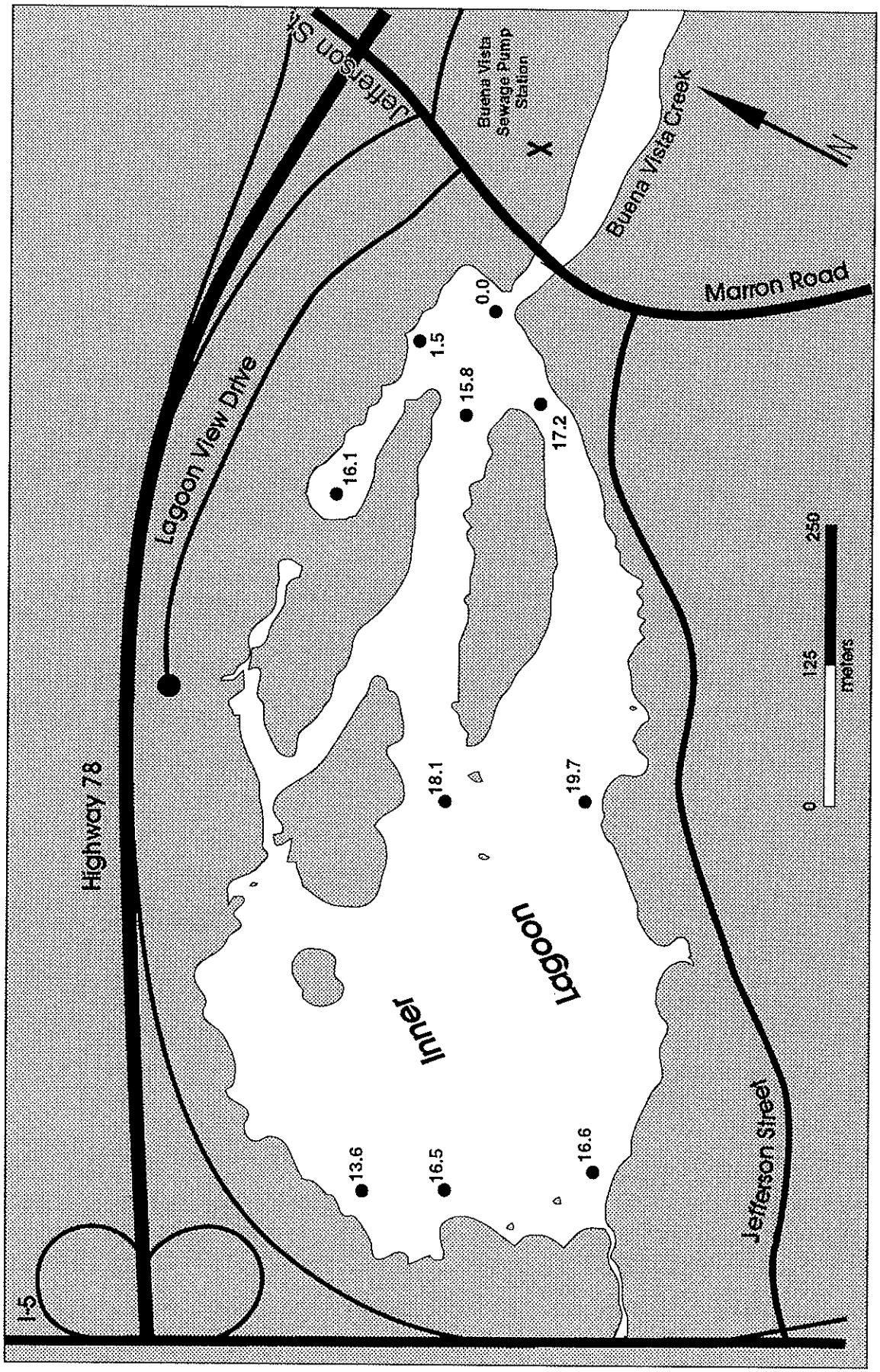

Figure 3. Dissolved Oxygen (mg/L) at Buena Vista Lagoon, 1425 to 1525, February 25, 1997.

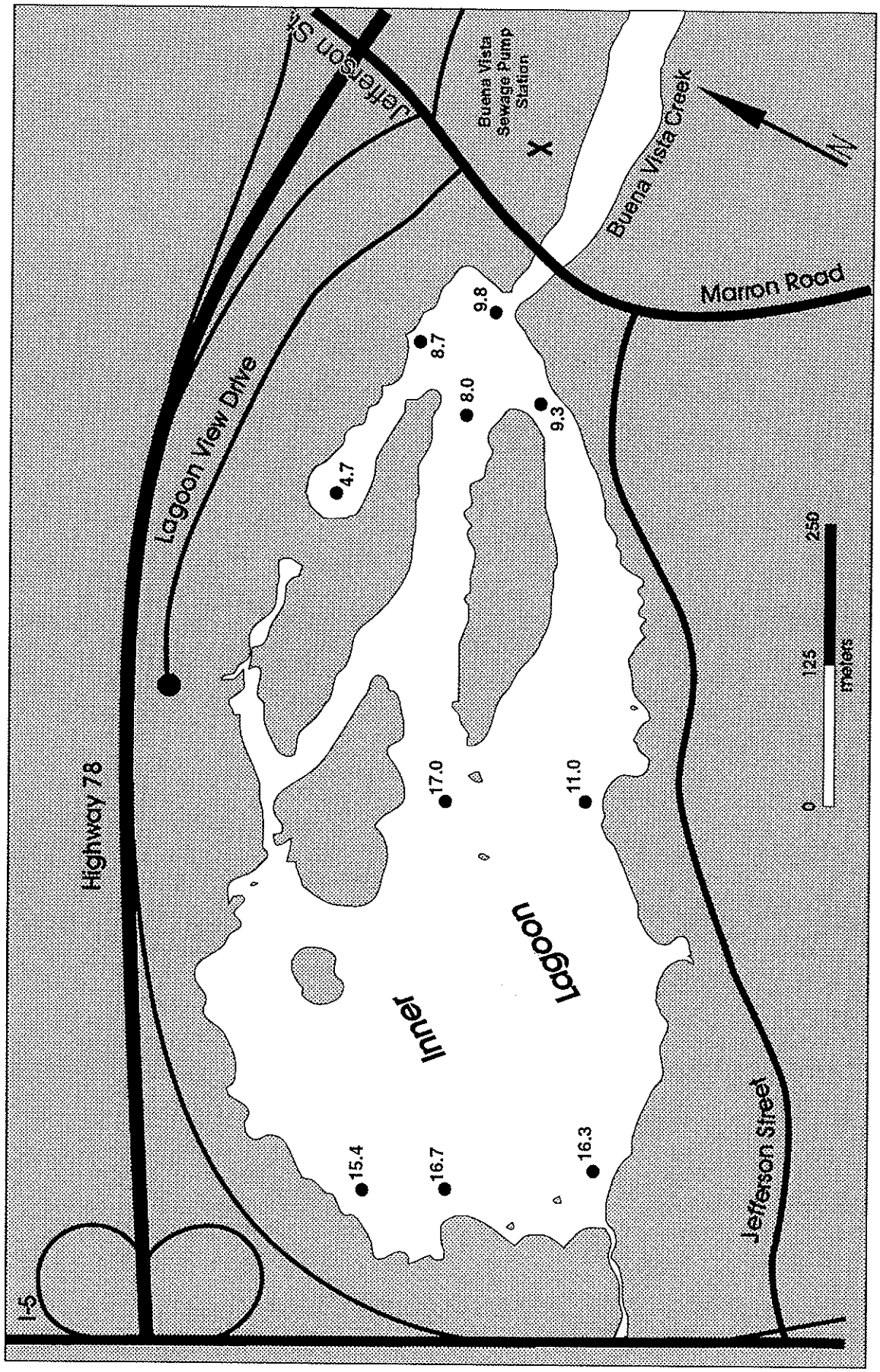

Figure 4. Dissolved Oxygen (mg/L) at Buena Vista Lagoon, 1325 to 1425, February 26, 1997.

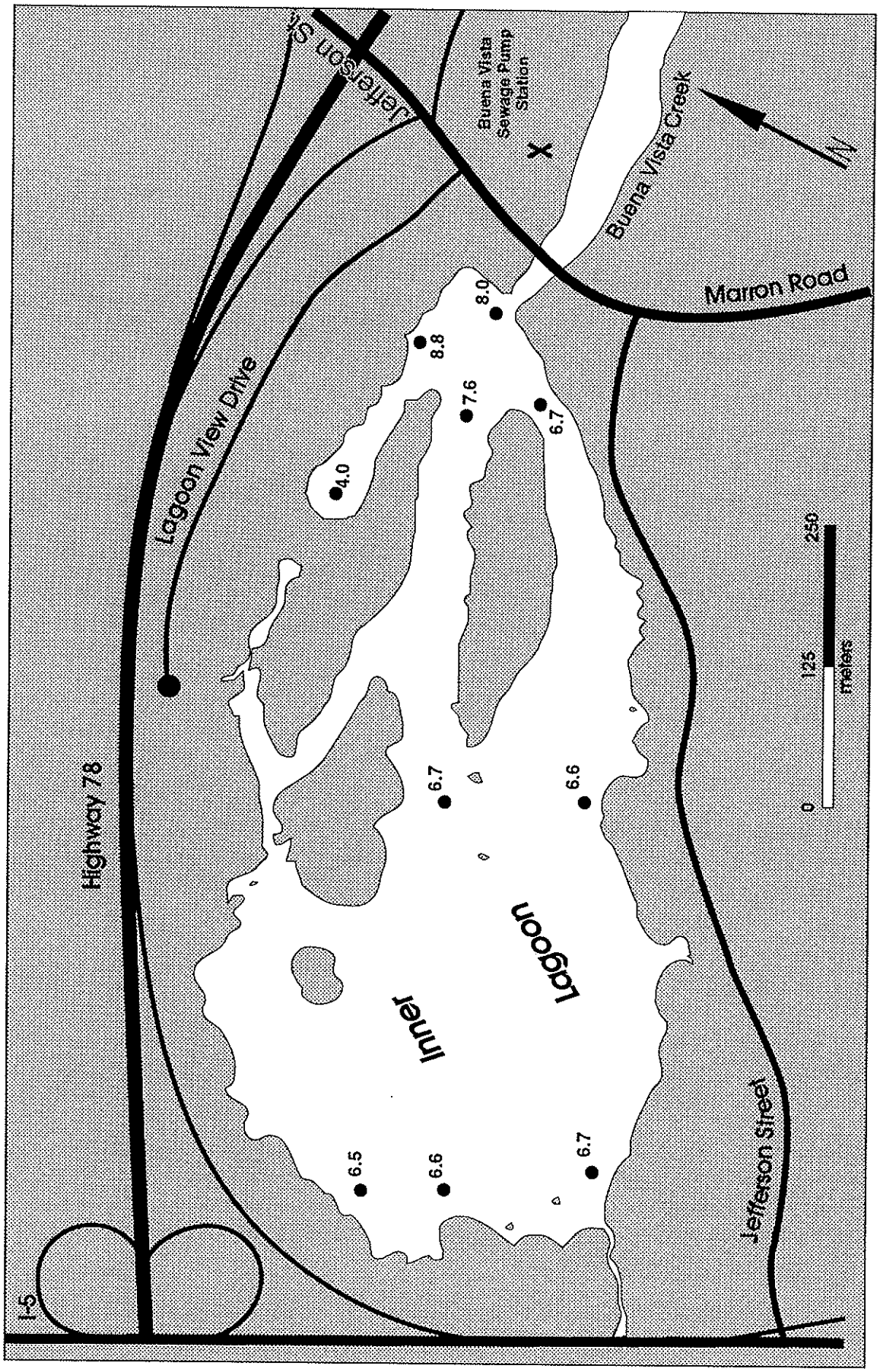

Figure 5. Dissolved Oxygen (mg/L) at Buena Vista Lagoon, 0730 to 0820, February 27, 1997.

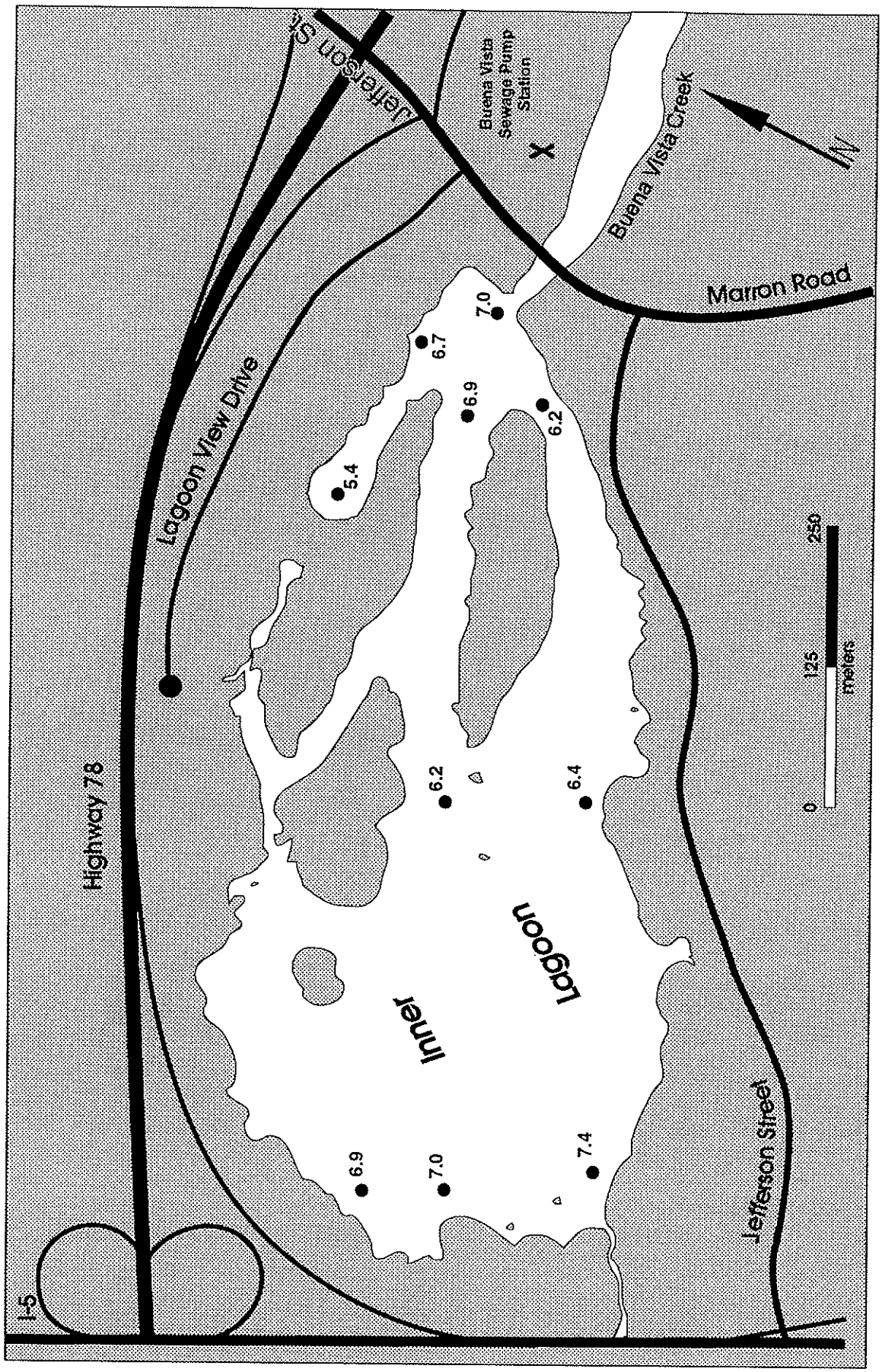

Figure 6. Dissolved Oxygen (mg/L) at Buena Vista Lagoon, 0715 to 0800, February 28, 1997.

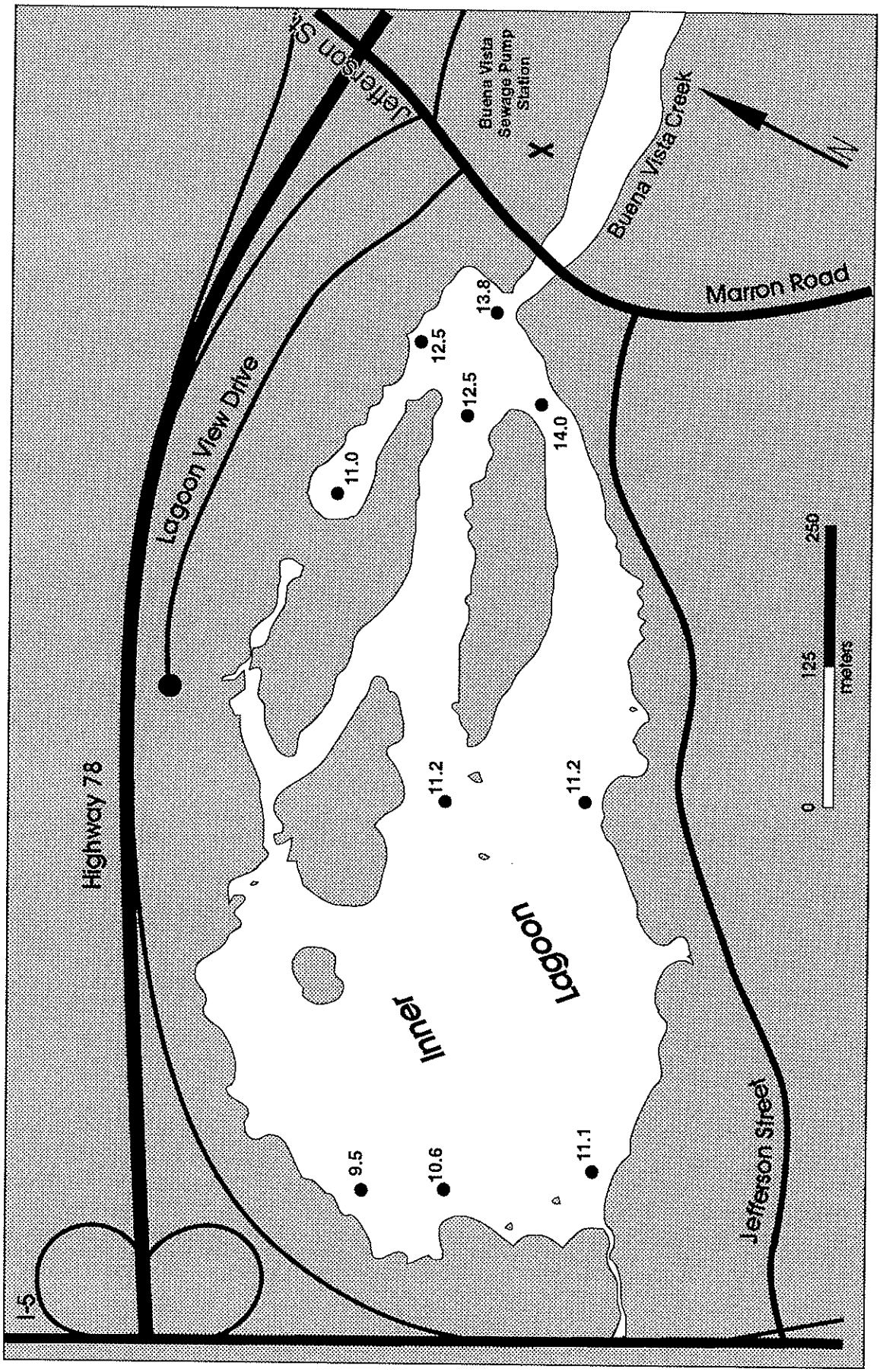

Figure 7. Dissolved Oxygen (mg/L) at Buena Vista Lagoon, 0710 to 0810, March 6, 1997.

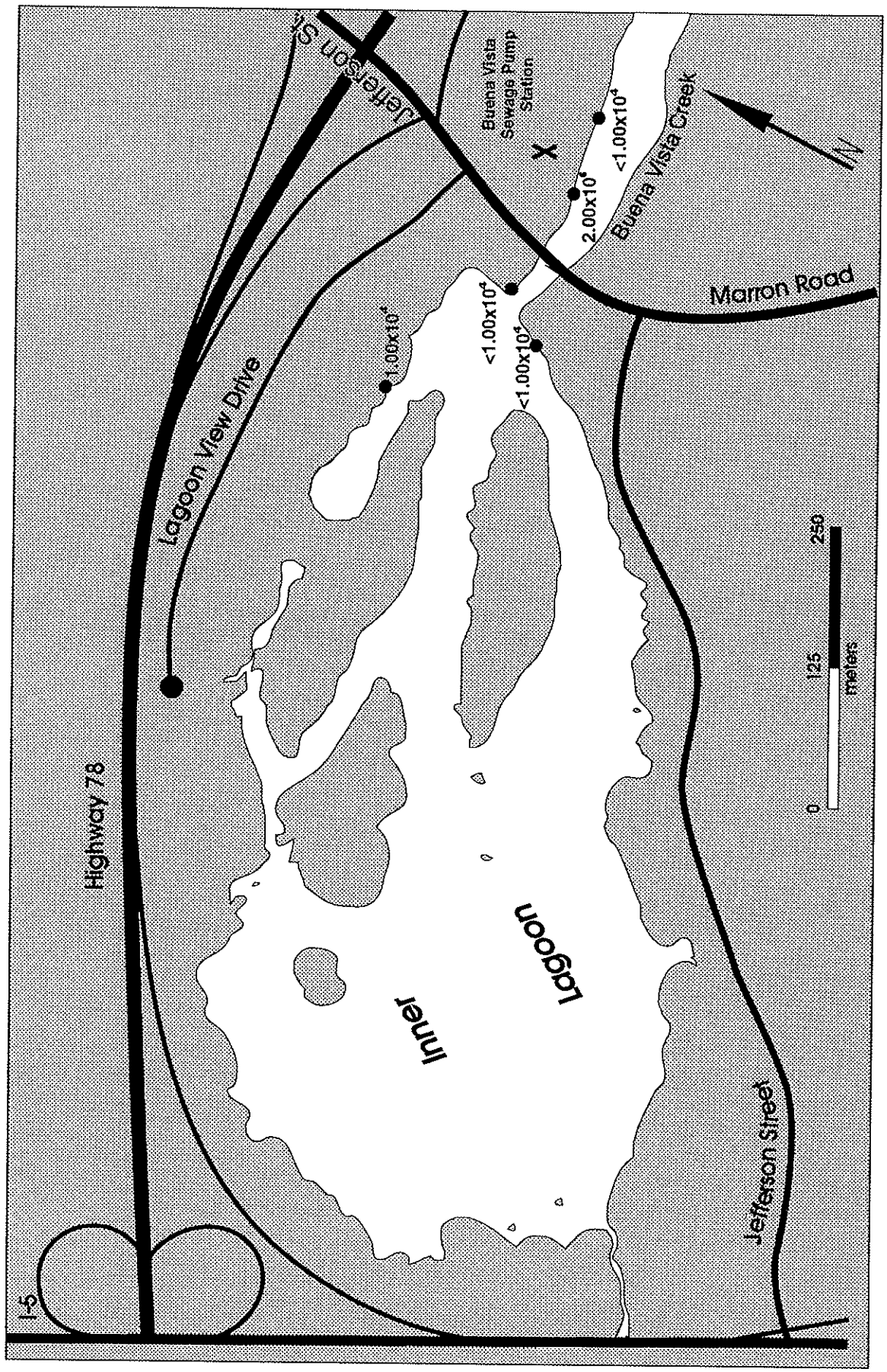

Figure 8. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 1230 to 1255, February 25, 1997.

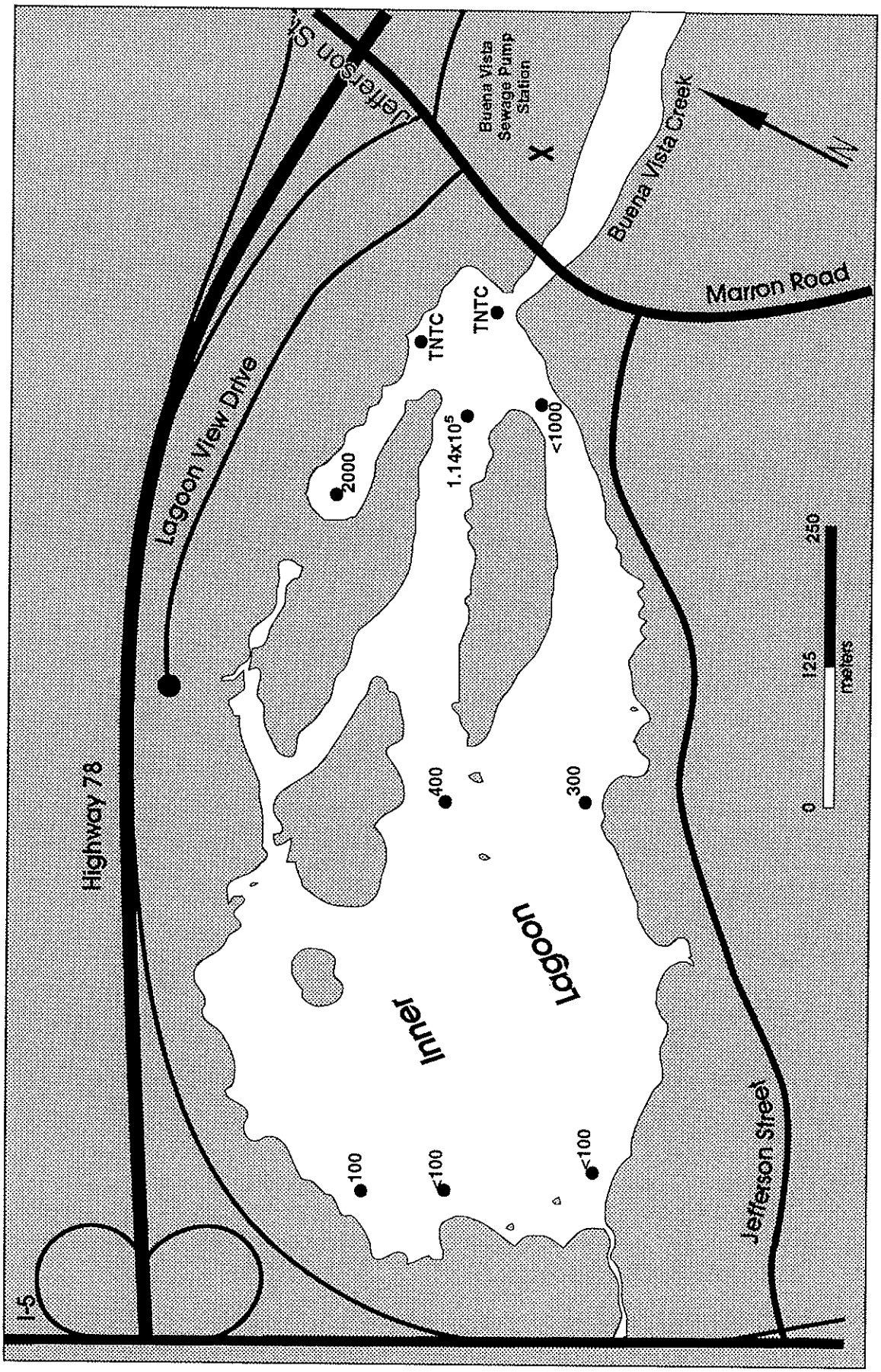

Figure 9. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 1425 to 1525, February 25, 1997.

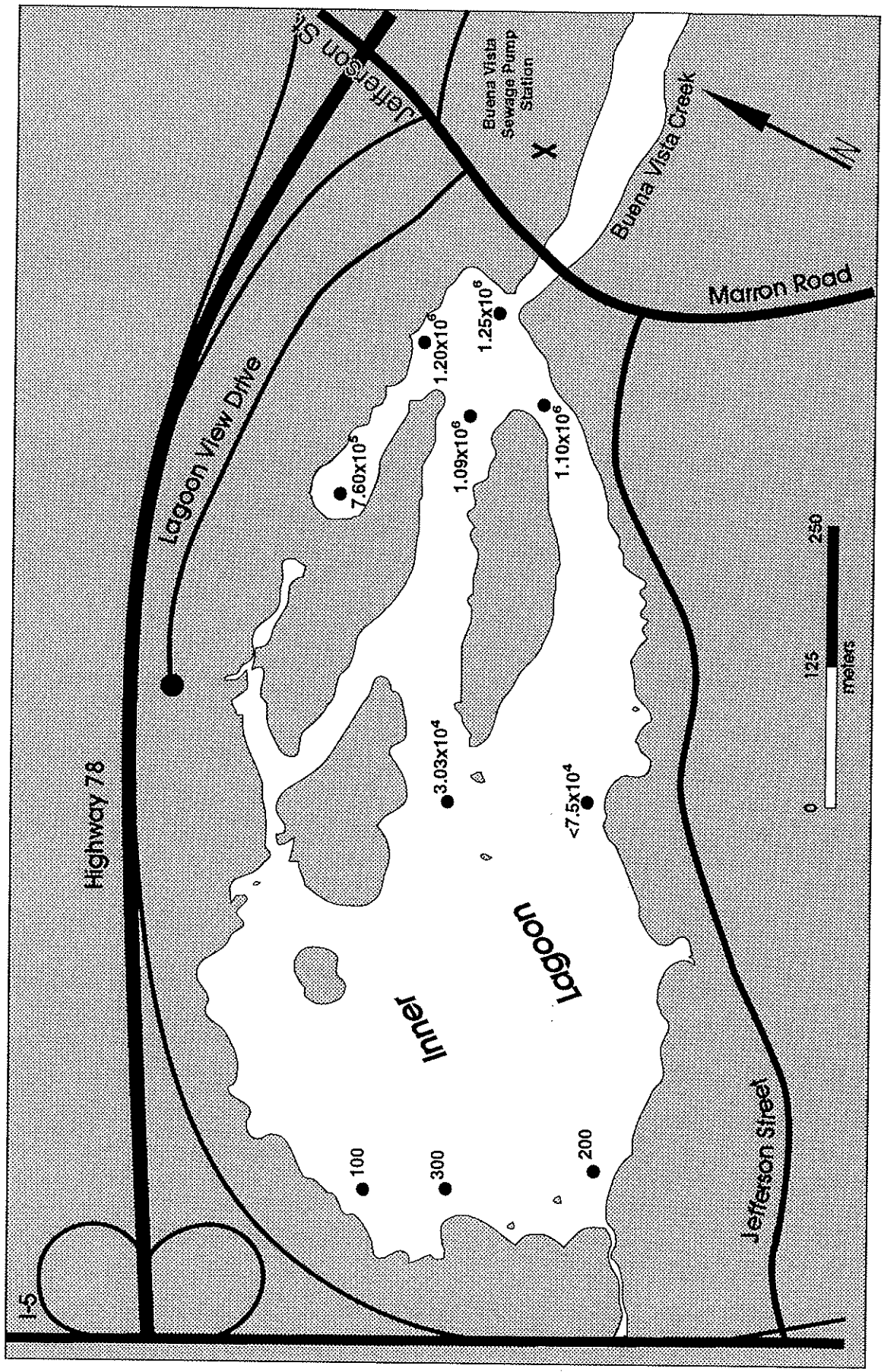

Figure 10. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 1325 to 1425, February 26, 1997.

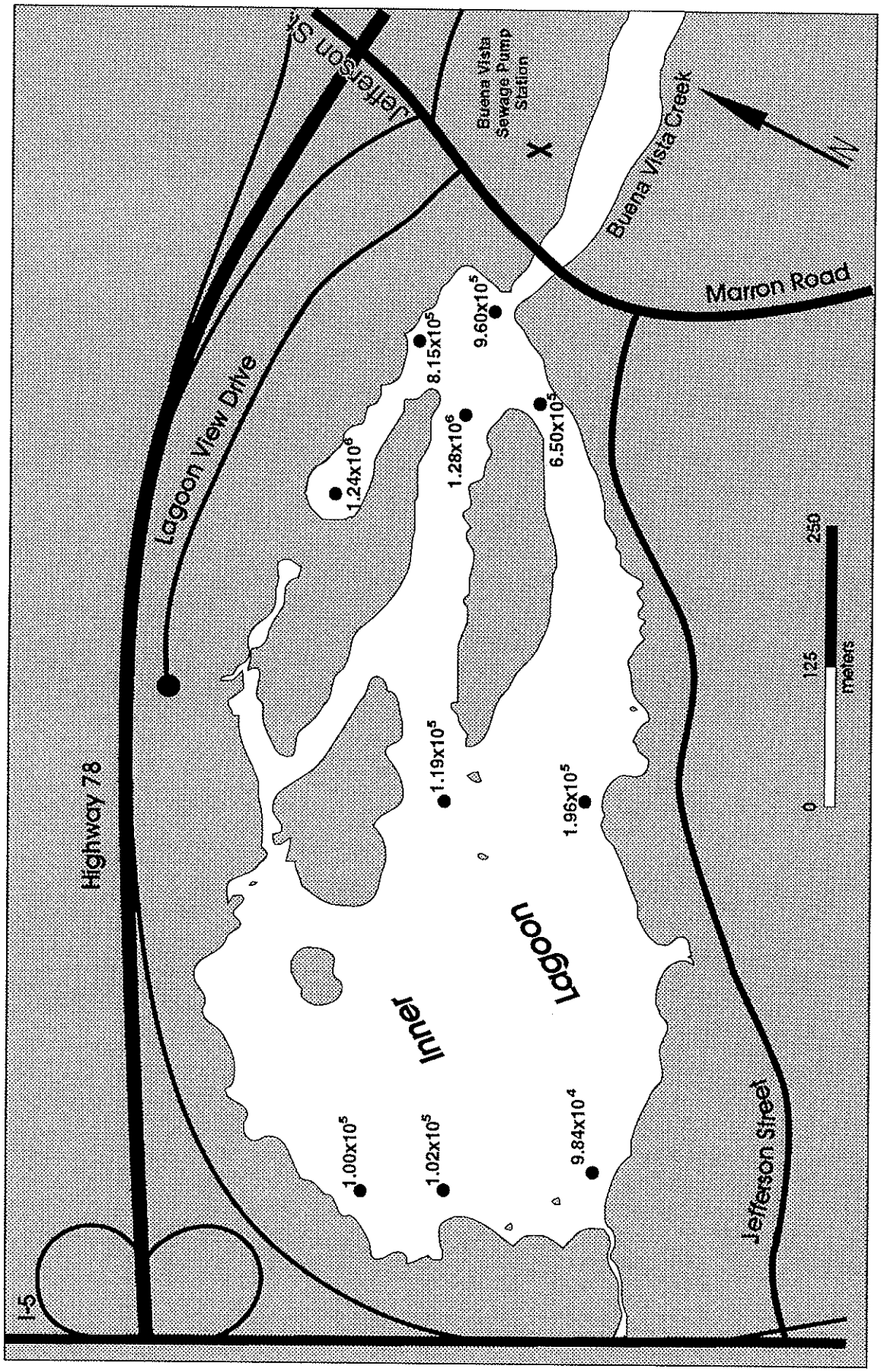

Figure 11. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 0730 to 0820, February 27, 1997.

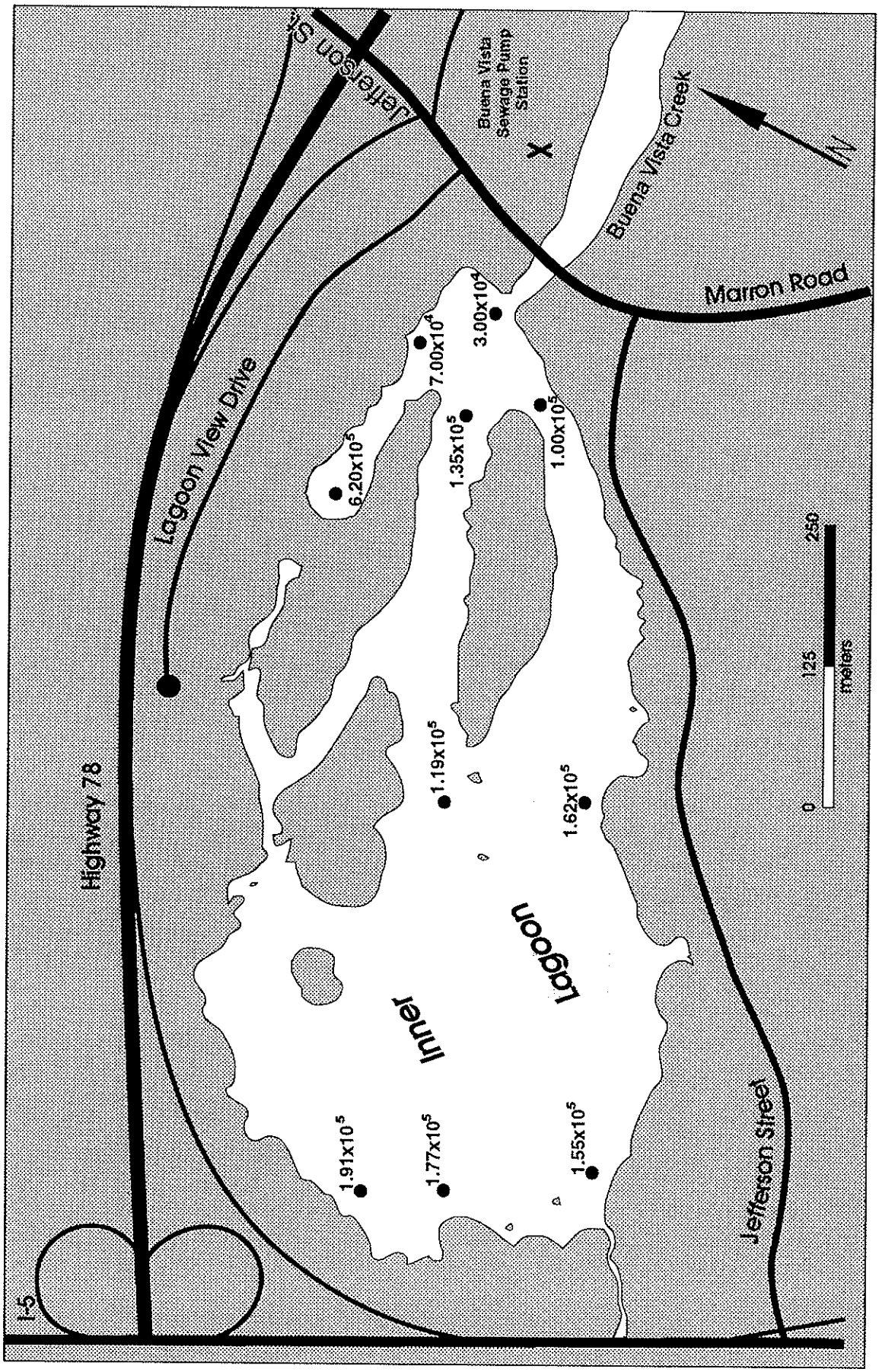

Figure 12. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 0715 to 0800, February 28, 1997.

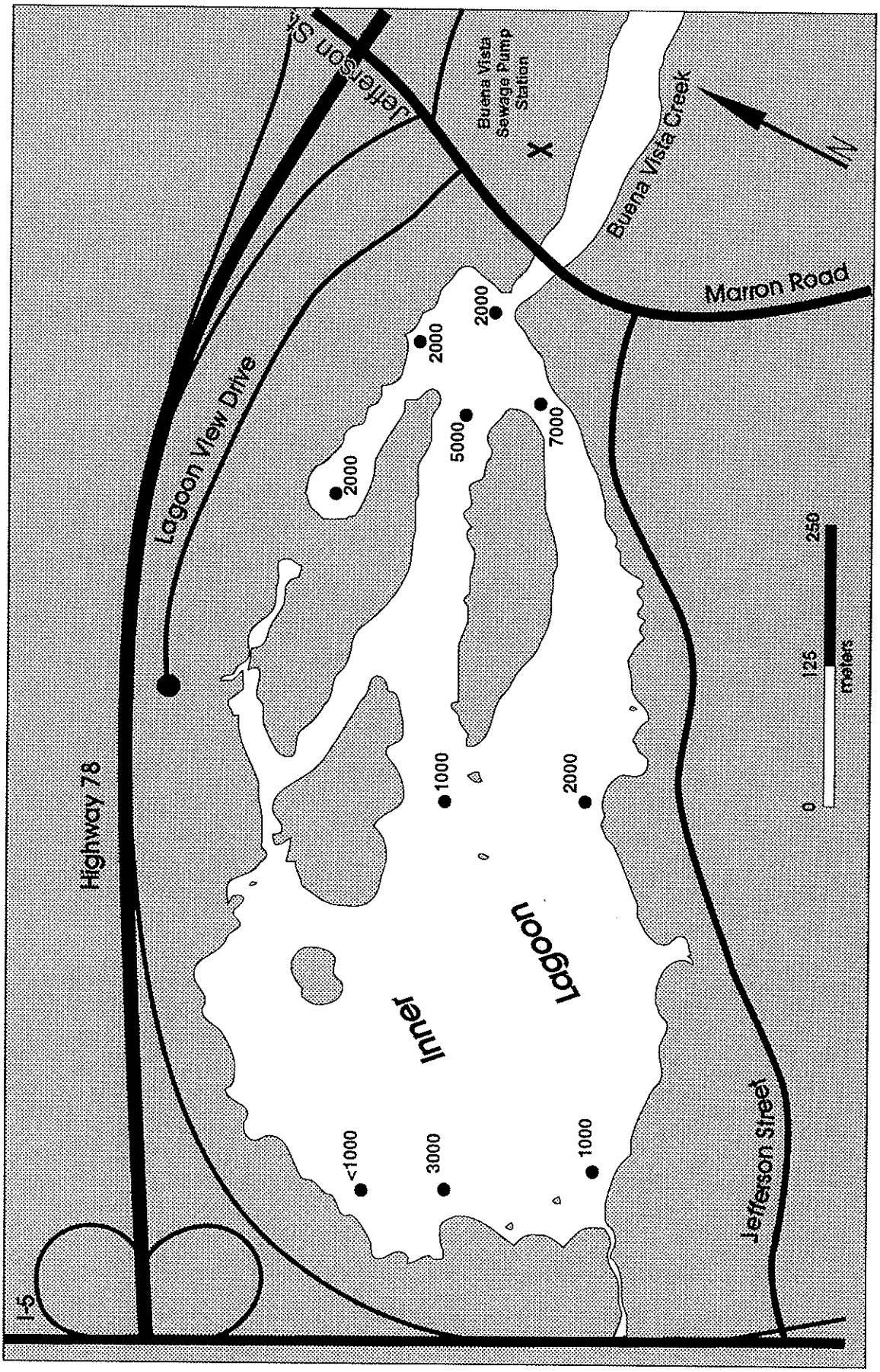

Figure 13. Fecal Coliforms (cfu/100 ml) at Buena Vista Lagoon, 0710 to 0810, March 6, 1997.

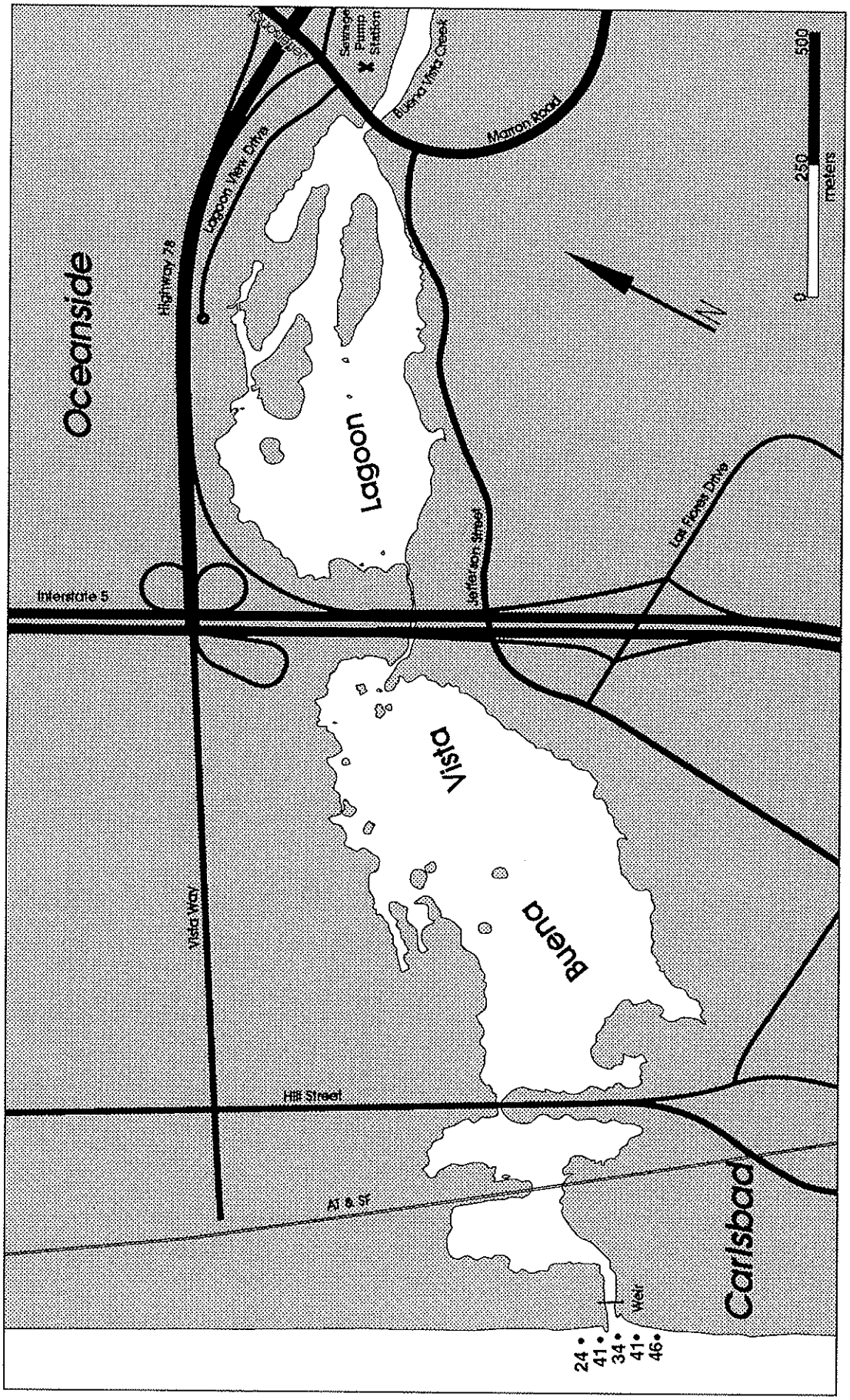

Figure 14. Fecal Coliforms (cfu/100 ml) at Surfzone Locations, 1830 to 1840, February 25, 1997.

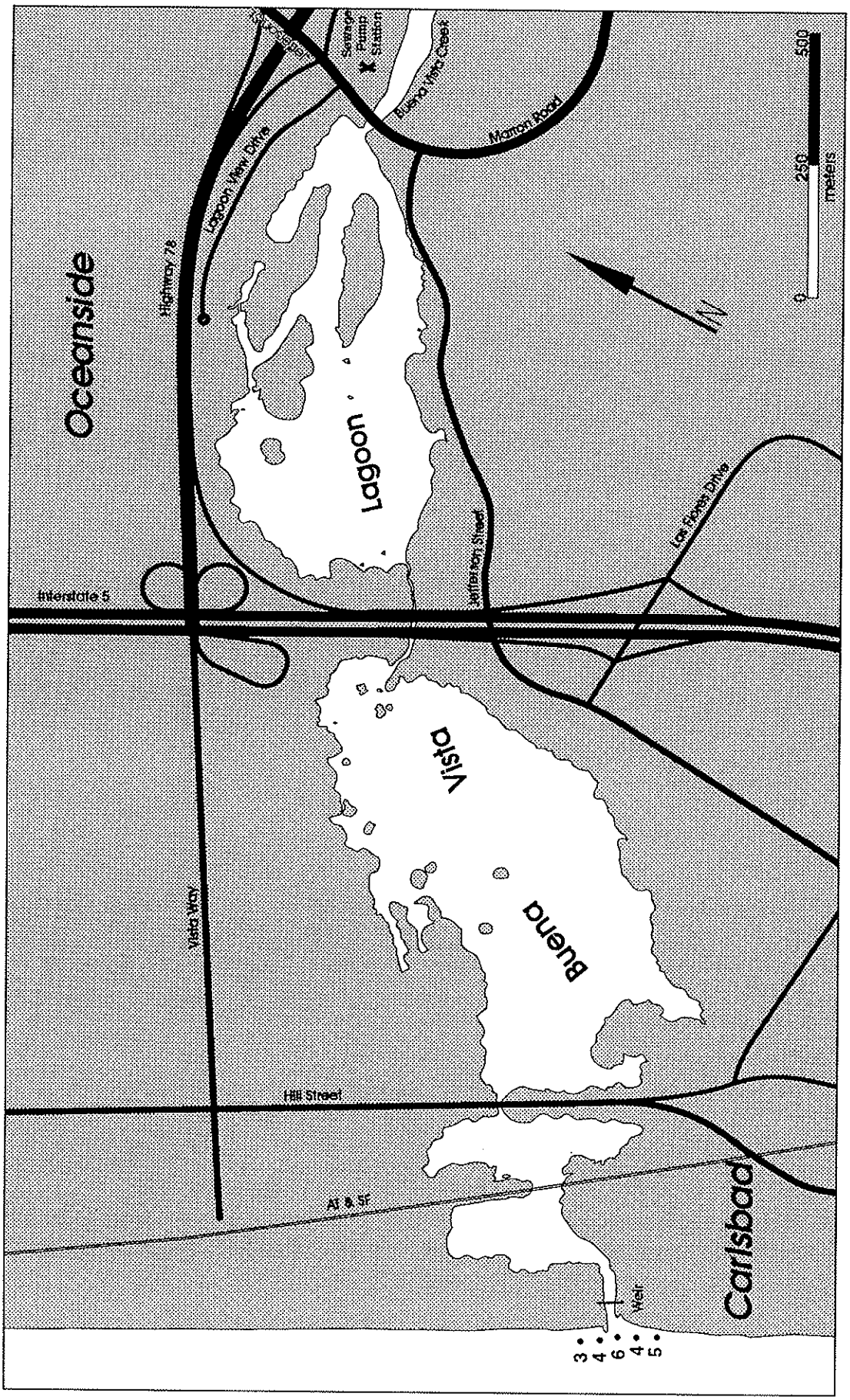

Figure 15. Fecal Coliforms (cfu/100 ml) at Surfzone Locations, 0800 to 0815, February 26, 1997.

EMERGENCY RESPONSE SAMPLING AT BUENA VISTA LAGOON

Final Report

EMERGENCY RESPONSE SAMPLING AT BUENA VISTA LAGOON

Final Report

Submitted To:

City of Vista
600 Eucalyptus Avenue
Vista, California 92085

Submitted By:

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September 30, 1994

TABLE OF CONTENTS

INTRODUCTION

In response to a sewage spill from the Buena Vista pump station, field sampling was conducted at Buena Vista Lagoon in late August and early September 1994. The purposes of this sampling effort were to track the spread of the sewage plume and to document background conditions in unaffected areas of the lagoon. Dissolved oxygen concentrations and fecal coliform counts were used as indicators of sewage contamination.

Buena Vista Lagoon is located in northern San Diego County between the cities of Oceanside and Carlsbad. Highway 78 lies to the north, while Interstate 5 separates the inner lagoon (east of the freeway) from the outer lagoon (west of the freeway) (Figure 1). Hill Street and the Atchison, Topeka, & Santa Fe Railroad cross the western portion of the outer lagoon. Buena Vista is considered a freshwater lagoon as there is no tidal exchange from the Pacific Ocean.

METHODS

Field sampling was conducted from August 23 through September 16, 1994. Sampling was extensive immediately following the spill with surveys conducted generally once or twice a day. Most sampling took place in the mid-afternoon from 1330 to 1600. On selected days, sampling also was conducted just after dawn. Samples were collected for dissolved oxygen and fecal coliforms, although for certain surveys additional parameters were measured. A summary of the survey dates, times, and parameters measured is found in Table 1.

The sampling effort was focused on the inner lagoon as the spill entered Buena Vista Lagoon from the eastern extreme. Stations were established in the impacted area and in areas far from the source. As the plume spread, some adjustments were made in the location of stations or in the number of stations in a particular area. All stations are mapped by survey in Appendix A.

On August 23, 24, and 25, water samples for coliform analysis were collected and analyzed by Encina Wastewater Authority. Samples were collected from the shore at five stations spread over the entire lagoon (Appendix A). In the laboratory, samples were analyzed for total and fecal coliforms using the membrane filter technique. Data were reported as colony forming units per 100 ml (cfu/100 ml).

More extensive sampling began on August 24. Water samples were collected throughout the inner lagoon by MEC Analytical Systems, Inc. (MEC) from an Avon inflatable boat. A Van Dorn sampler was used to collect water just below the surface and, at some of the deeper stations, at midwater and bottom depths as well. Depth was determined using a weighted tape measure. Samples were analyzed for dissolved oxygen in the field using Winkler titrations, and values were reported in milligrams per liter (mg/l). On August 26, MEC began collecting additional water samples for coliform analysis. Samples were collected by placing the sterilized container directly into the water at the surface. Samples were analyzed for total and fecal coliforms by Sierra Laboratories using the membrane filter technique. Values were reported as most probable number per 100 ml (mpn/100 ml). Samples were collected for coliforms through September 8 and for dissolved oxygen through September 16.

On August 26, 27, and 28, surveys were conducted in both the inner and outer lagoons. Samples also were collected near the weir at the western extreme of the lagoon and from the surfzone of the ocean. Data from these surveys provide information on the background (unaffected) conditions of the lagoon.

On August 28 and 30 and September 2, field measurements of temperature (°C) and salinity (‰) were recorded from a YSI meter (Model 33). On September 2, additional samples were collected for Biochemical Oxygen Demand (BOD), Total Kjeldahl Nitrogen (TKN), and chlorophyll-a. These samples were analyzed by Columbia Analytical Services, Inc. Samples for BOD were analyzed by EPA Method 405.1, and values were reported in mg/l. EPA Method 351.4 was used to measure TKN in mg/l. Samples filtered for chlorophyll-a were analyzed by Standard Method 10200 H, and values were reported in milligrams per cubic meter (mg/m^3).

RESULTS

Results of analyses for dissolved oxygen, coliforms, salinity, temperature, BOD, TKN, and chlorophyll-a are tabulated by survey in Appendix A. Surface values for dissolved oxygen and fecal coliforms are mapped by survey in Figures 1-DO to 21-DO and 1-FC to 17-FC.

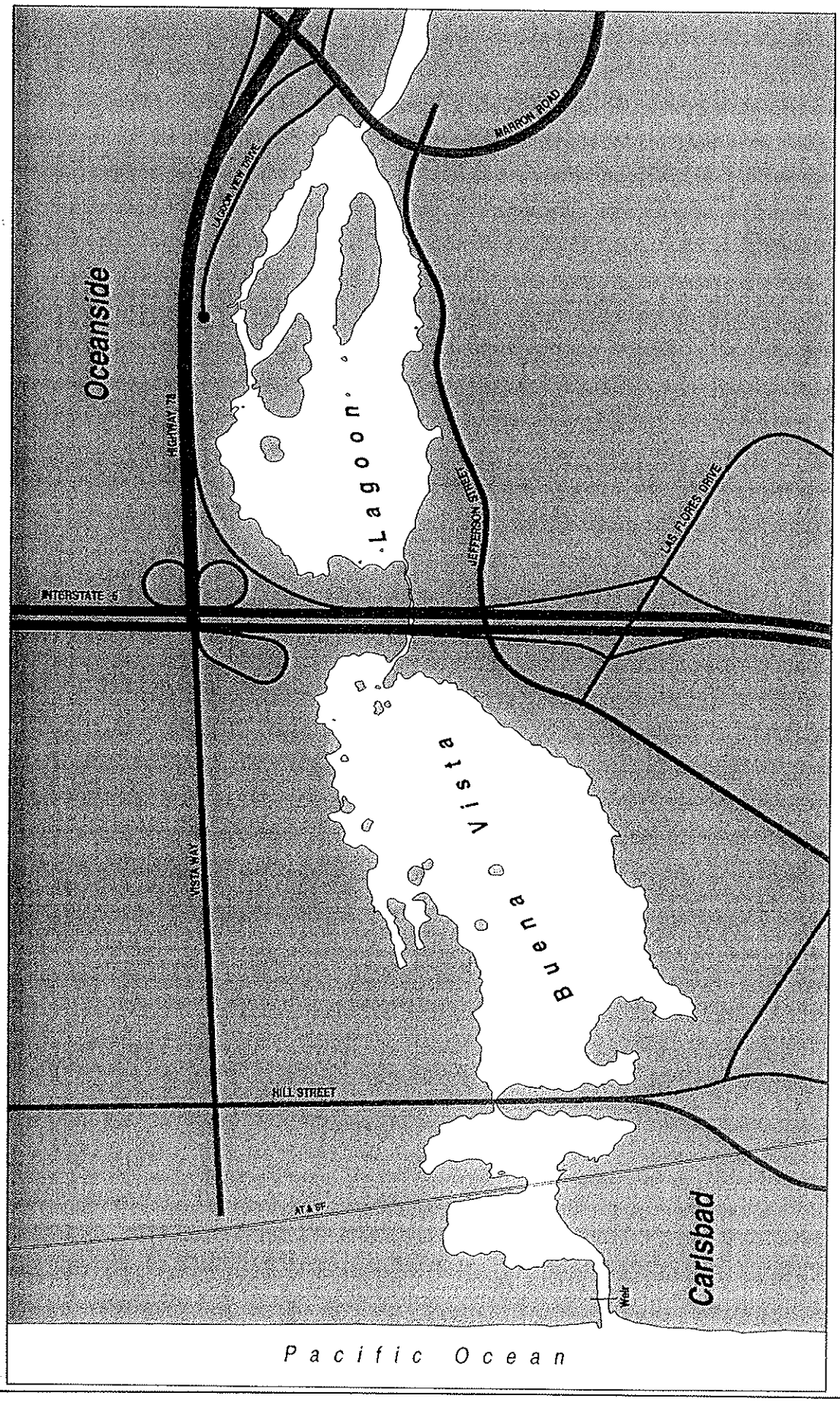


Figure 1. Buena Vista Lagoon

Table 1. Parameters measured for each survey at Buena Vista Lagoon.

DATE	TIME	NUMBER OF STATIONS	PARAMETER
August 23	0800	5	coliforms
August 24	0800	5	coliforms
August 24	1500	23	dissolved oxygen
August 25	0800	5	coliforms
August 25	1330	9	dissolved oxygen
August 26	0630	12	dissolved oxygen
August 26	1330	17	dissolved oxygen
August 26	1825	22	coliforms, dissolved oxygen
August 27	0600	22	coliforms, dissolved oxygen
August 27	1400	22	coliforms, dissolved oxygen
August 28	0600	23	coliforms, dissolved oxygen
August 28	1330	23	coliforms, dissolved oxygen, temperature, salinity
August 29	1500	12	coliforms, dissolved oxygen
August 30	0600	12	coliforms, dissolved oxygen
August 30	1330	14	coliforms, dissolved oxygen, temperature*, salinity*
August 31	1330	10	coliforms*, dissolved oxygen
September 1	1330	8	coliforms*, dissolved oxygen
September 2	0630	8	dissolved oxygen
September 2	1315	8	coliforms*, dissolved oxygen, temperature, salinity, BOD, TKN, chlorophyll-a
September 4	1330	6	coliforms*, dissolved oxygen
September 6	1330	6	coliforms*, dissolved oxygen
September 8	1330	8	coliforms*, dissolved oxygen
September 12	1330	6	dissolved oxygen
September 16	1415	6	dissolved oxygen

* Not measured at every station

Dissolved Oxygen

In the morning of August 24, dissolved oxygen concentrations in the inner lagoon were 0 mg/l in the eastern area and northern channel and 8.9 to 18.1 mg/l in the central and western areas (Figure 1-DO). The values of 0 mg/l dissolved oxygen indicated that the sewage plume occupied the eastern area and northern channel of the inner lagoon at this time. The flowering plant *Ruppia maritima* was observed to the west of the contaminated area in the central and southern channels. Dissolved oxygen concentrations were high in the vegetated area (Figure 1-DO).

On August 25, dissolved oxygen concentrations again were 0 mg/l in the eastern portion and northern channel of the inner lagoon (Figure 2-DO). It was apparent that the thick plant growth of *R. maritima* was preventing the spread of the plume through the central and southern channels. Measurements in the vegetated area were 15.9 to 17.0 mg/l, indicating that this area was a barrier to the spread of the sewage and a buffer in that it could compensate for any reduction in dissolved oxygen.

Just after dawn on August 26, dissolved oxygen was 0 mg/l in the contaminated area, but concentrations in the *R. maritima* and in the center of the inner lagoon had dropped to 1.5 to 5.9 mg/l (Figure 3-DO), indicating heavy use of the oxygen for respiration during the night. By afternoon of the same day, dissolved oxygen in the *R. maritima* and in the center of the inner lagoon had been replenished (Figure 4-DO). Concentrations in the western area of the inner lagoon also were high. In contrast, values were low (0 to 2.4 mg/l) in the northern center of the inner lagoon (Figure 4-DO), indicating that the contamination had spread across the narrow connection of the northern channel. Samples taken that evening showed a similar pattern, with the eastern portion of the inner lagoon clearly affected and the western portion of the inner lagoon and entire outer lagoon clearly unaffected (Figure 5-DO).

On August 27 and 28, monitoring was conducted just after dawn and in midafternoon in both the inner and outer lagoons. As before, dissolved oxygen concentrations were 0 mg/l in the eastern area and northern channel of the inner lagoon (Figures 6-DO to 9-DO). Concentrations were low in the morning and high in the afternoon in the uncontaminated western area of the inner lagoon and the entire outer lagoon and surfzone of the ocean. Dense growth of *R. maritima* was found throughout the entire outer lagoon. (Note that vegetation in the outer lagoon is not indicated in the figures.) In the afternoon of August 28, dissolved oxygen in the northern central area of the inner lagoon measured 2.7 mg/l, showing that conditions in the affected area had not changed.

On August 29, dissolved oxygen concentrations began to increase in the contaminated area. In the eastern region, values ranged from 0.2 to 4.4 mg/l, and the northern central area had a dissolved oxygen concentration of 11.9 mg/l (Figure 10-DO). Dissolved oxygen was still 0 mg/l in the northern channel. The central and western areas remained unaffected. Similar patterns were observed on August 30 (Figures 11-DO and 12-DO). On August 31, dissolved oxygen showed an increase in the northern channel (Figure 13-DO), and on September 1, surface water concentrations were high (8.2 to 16.8 mg/l) throughout the inner lagoon (Figure 14-DO).

Dissolved oxygen had decreased in all areas by the early morning of September 2 (Figure 15-DO) and then was replenished through photosynthesis by the afternoon of the same day (Figure 16-DO). Dissolved oxygen concentrations remained high (4.2 to 22.9 mg/l) throughout the inner lagoon from September 4 to 16 (Figures 17-DO to 21-DO).

August 24, 1994 1500

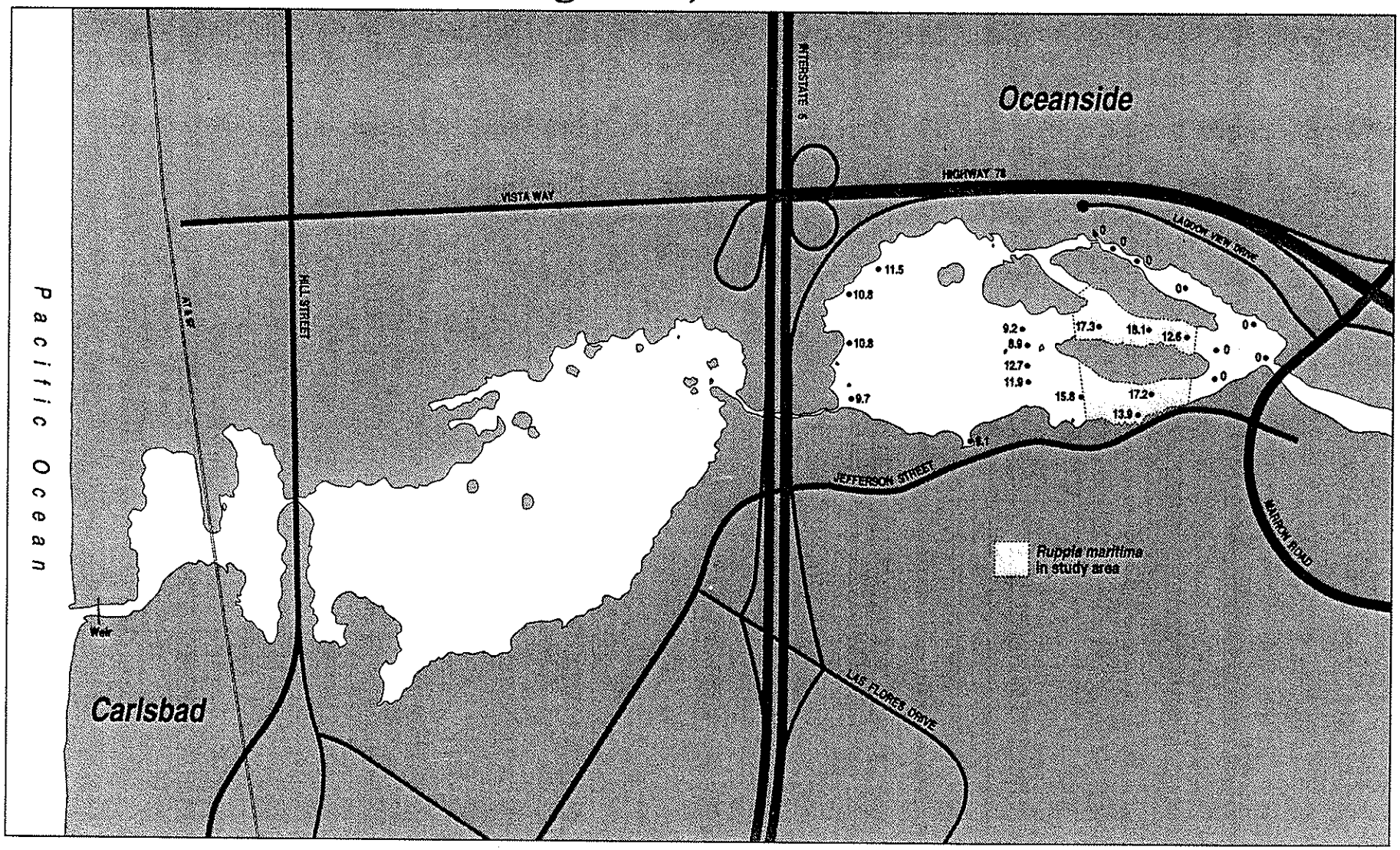


Figure 1-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1500, August 24, 1994.

August 25, 1994 1300

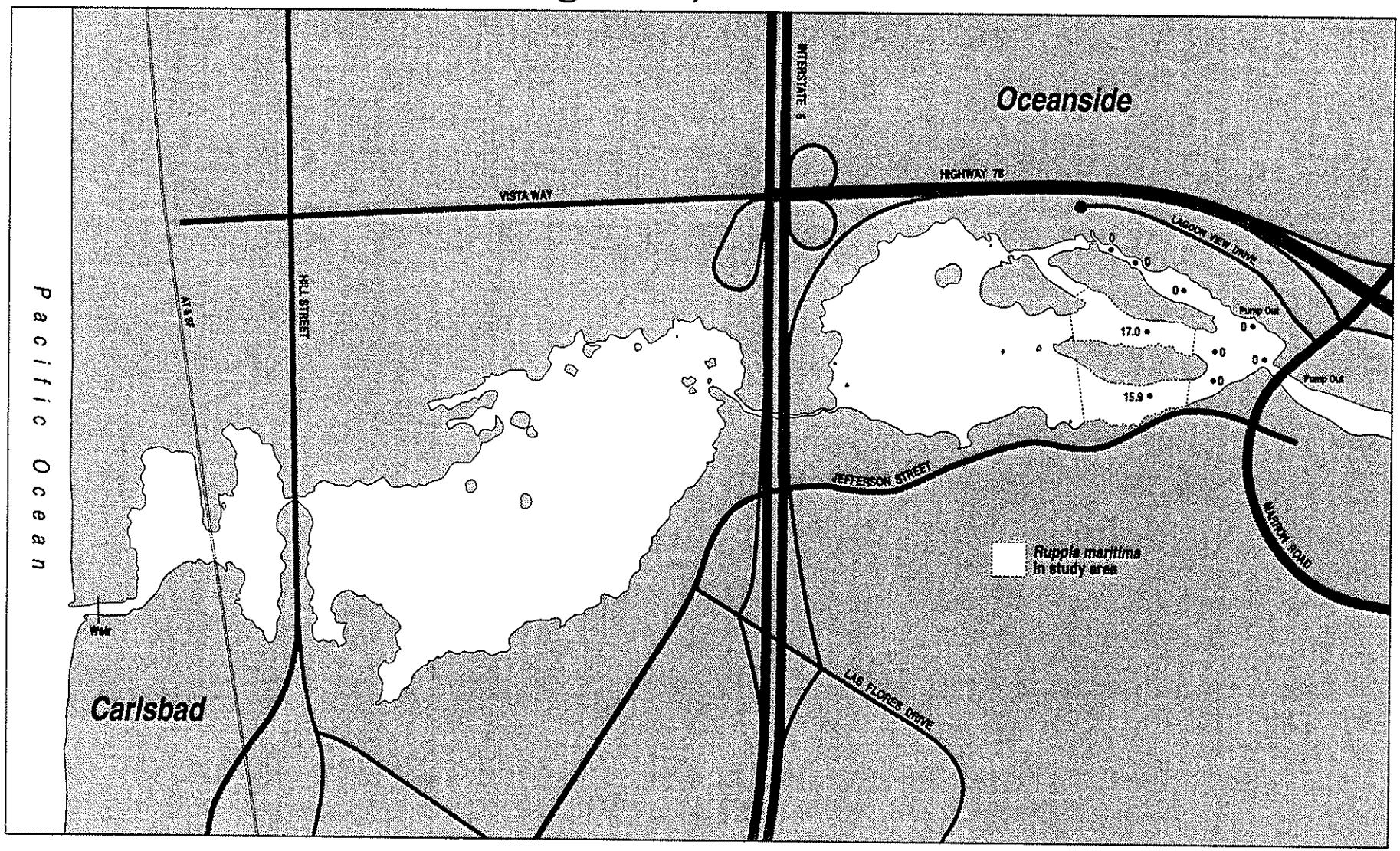


Figure 2-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 25, 1994.

August 26, 1994 0630

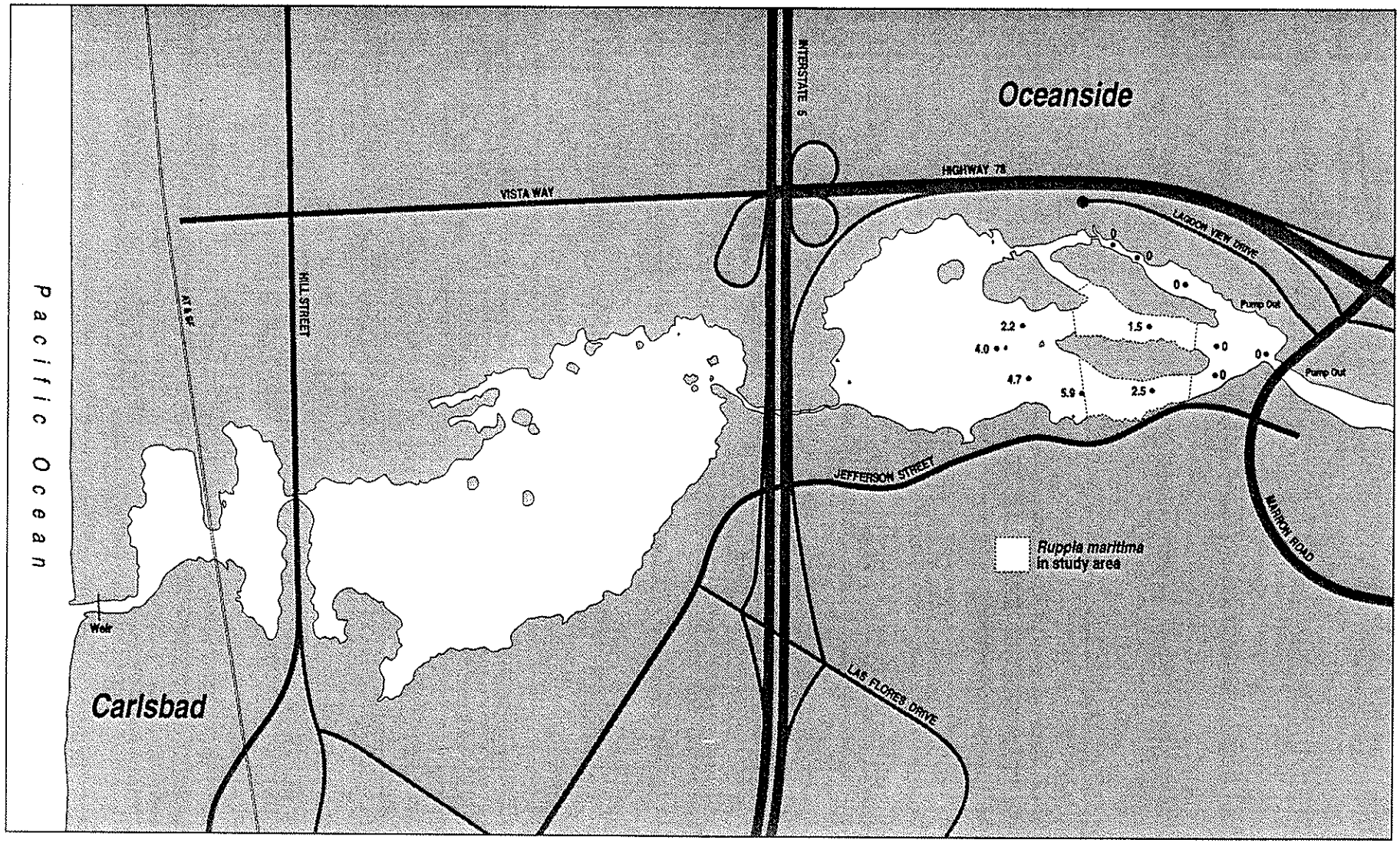


Figure 3-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 0630, August 26, 1994.

August 26, 1994 1330

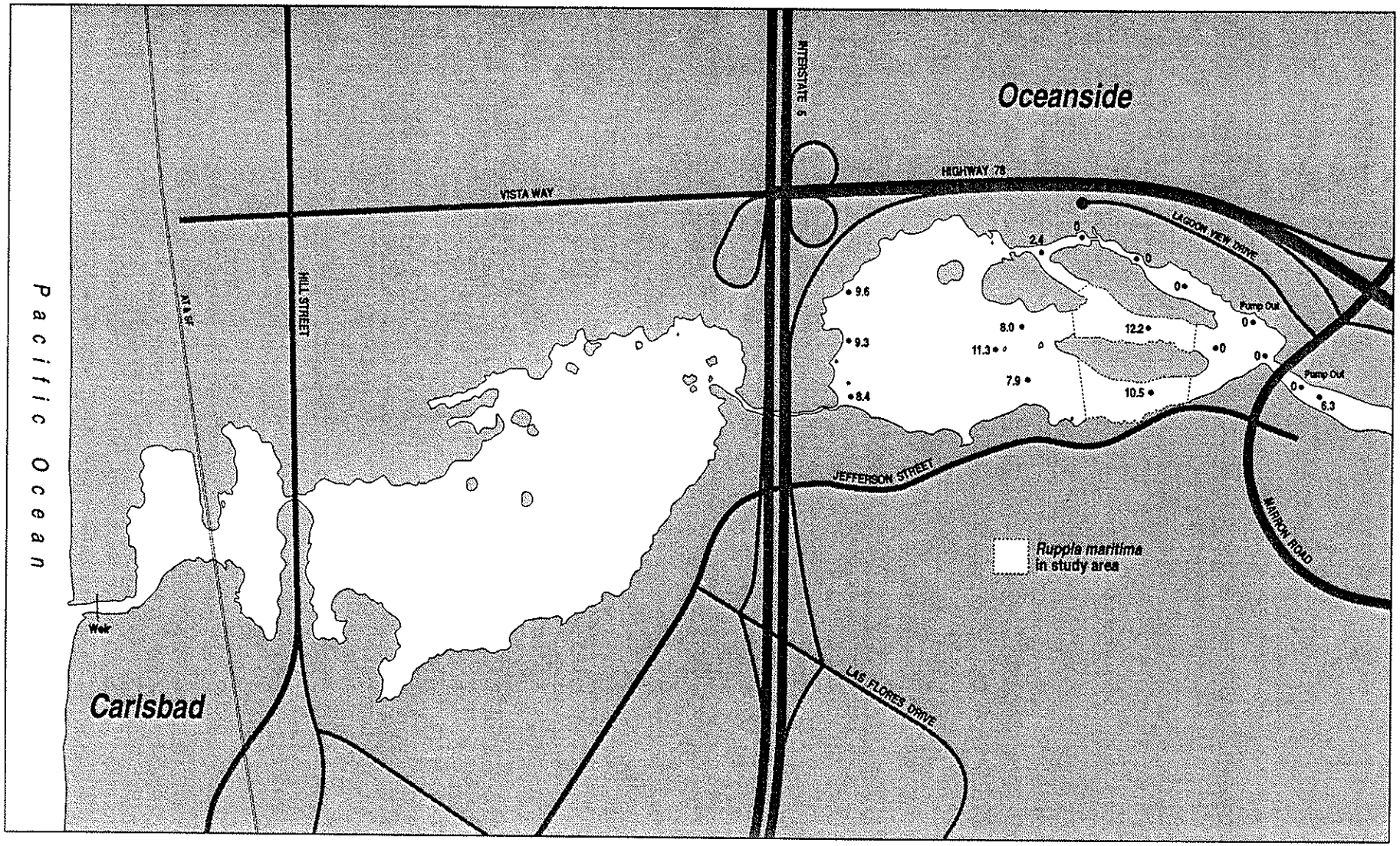


Figure 4-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 26, 1994.

August 26, 1994 1825

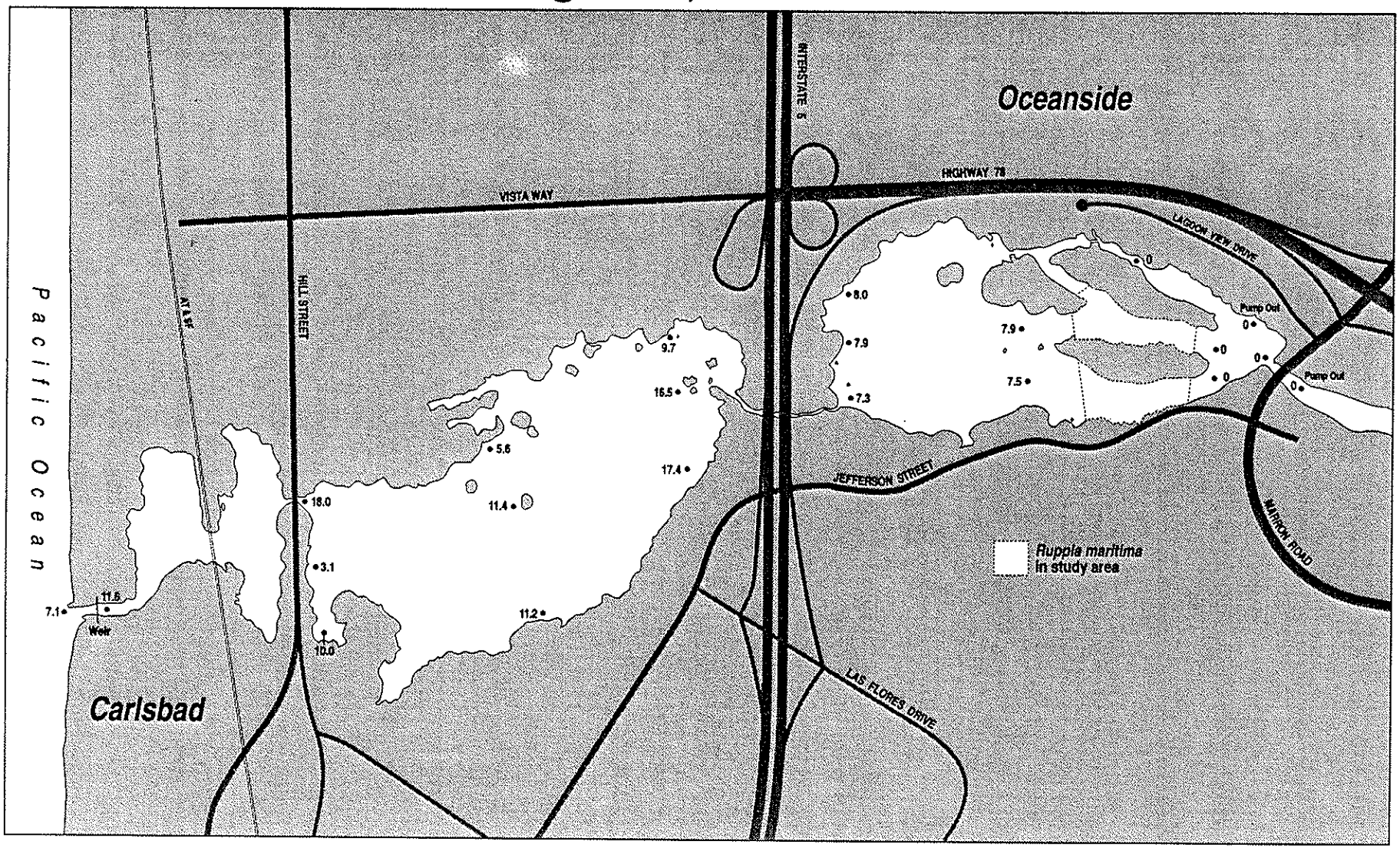


Figure 5-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1825, August 26, 1994.

August 27, 1994 0600

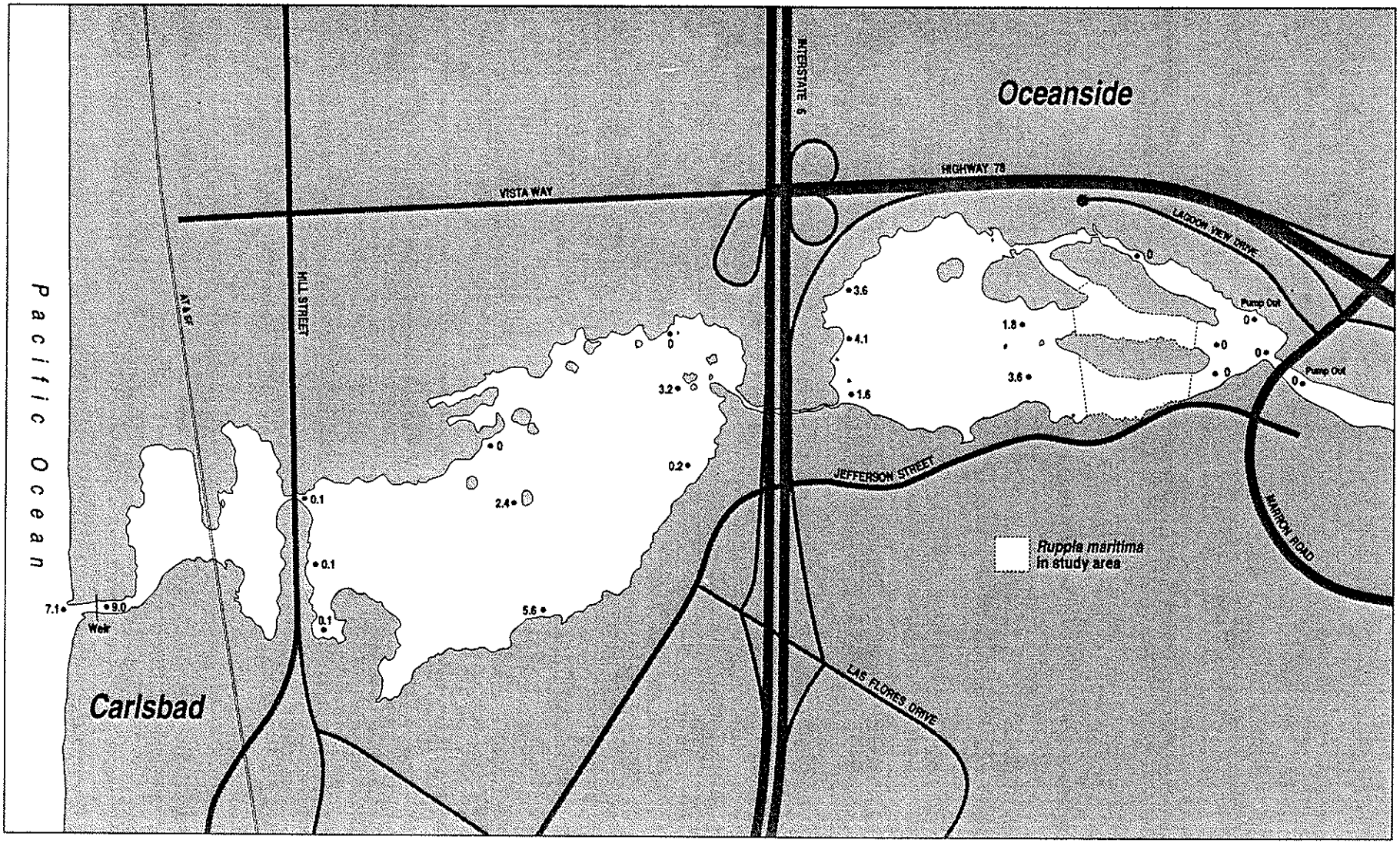


Figure 6-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 0600, August 27, 1994.

August 27, 1994 1400

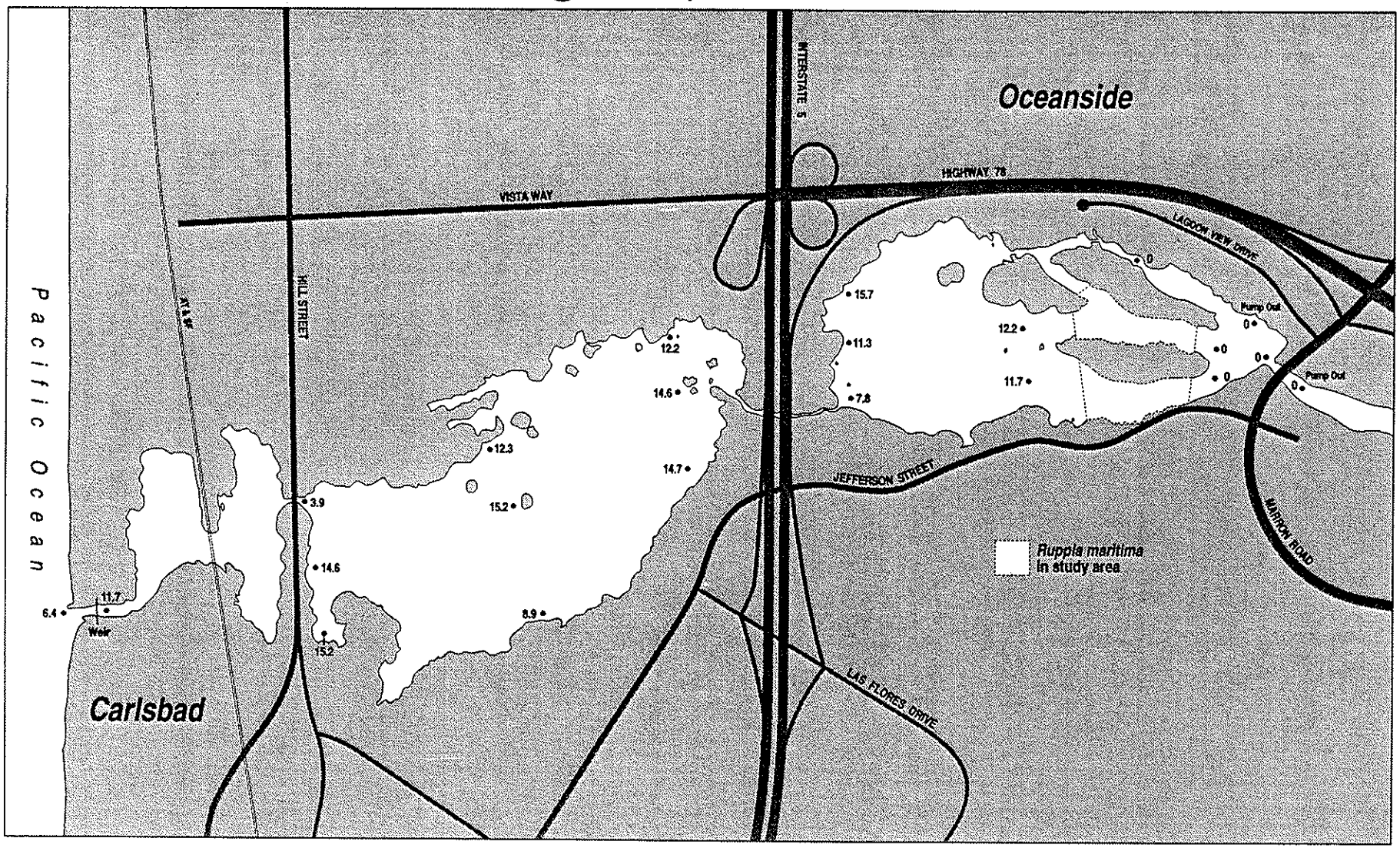


Figure 7-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon. 1400, August 27, 1994.

August 28, 1994 0600

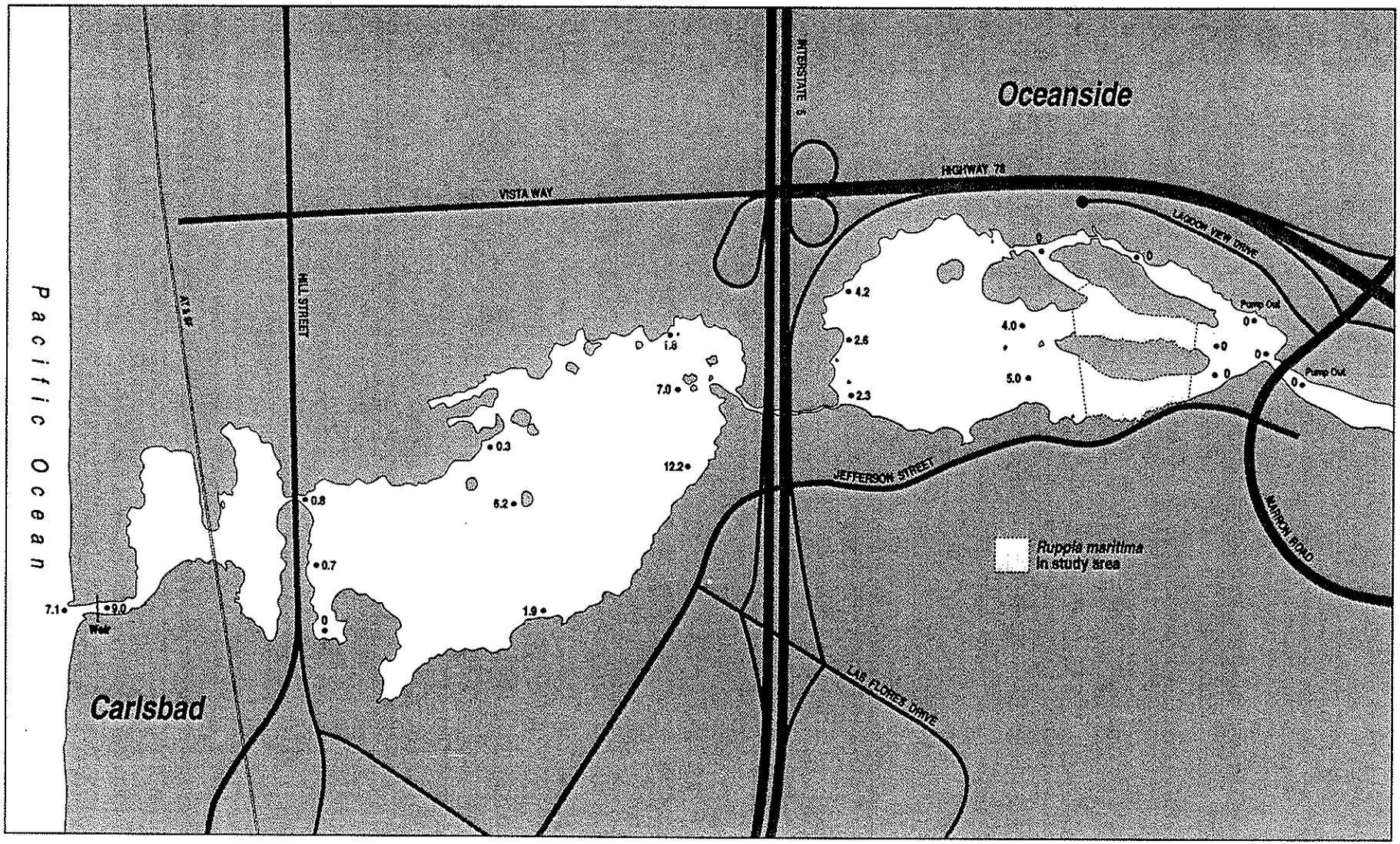


Figure 8-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 0600, August 28, 1994.

August 28, 1994 1330

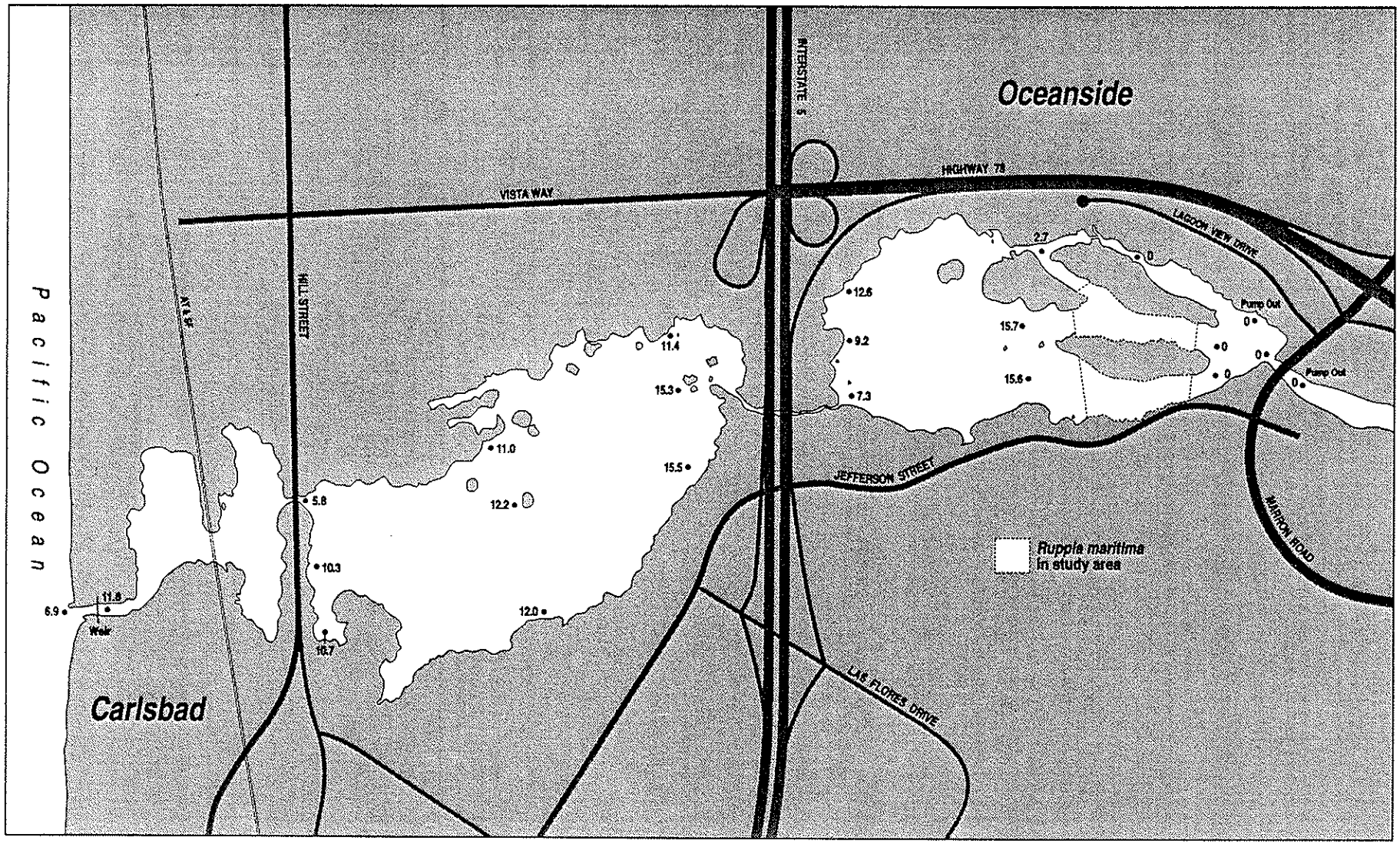


Figure 9-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 28, 1994.

August 29, 1994 1500

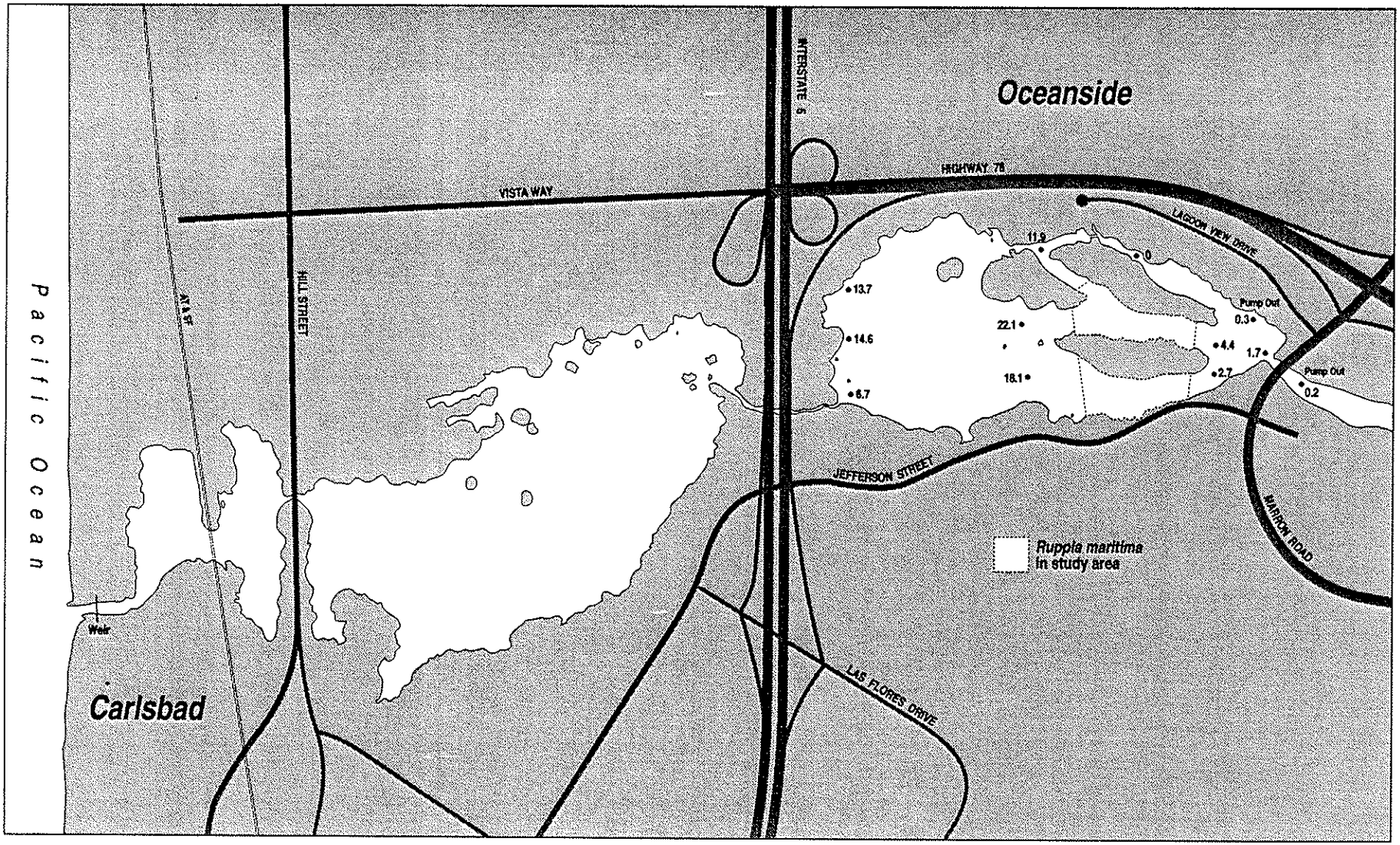


Figure 10-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1500, August 29, 1994.

August 30, 1994 0600

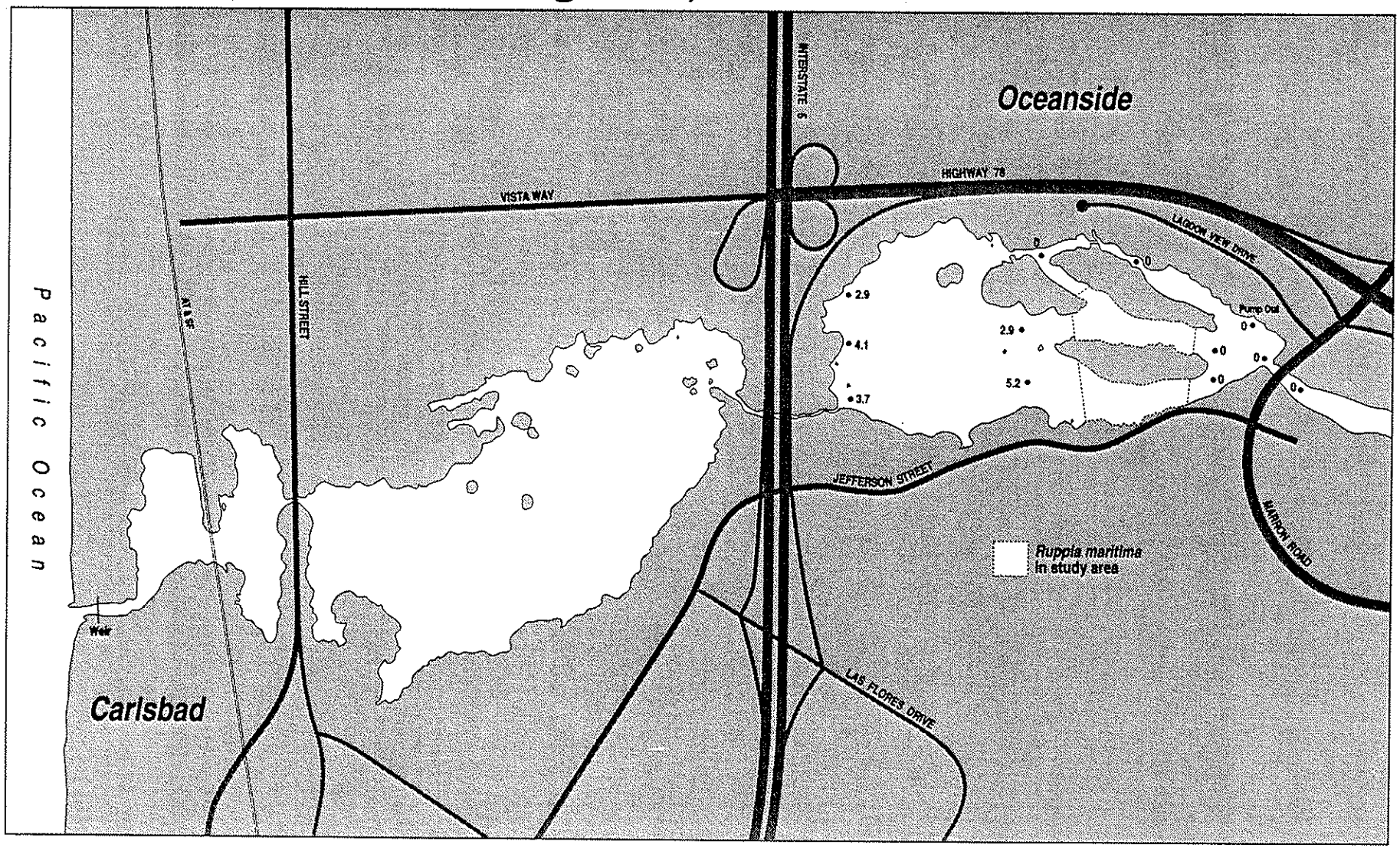


Figure 11-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 0600, August 30, 1994.

August 30, 1994 1330

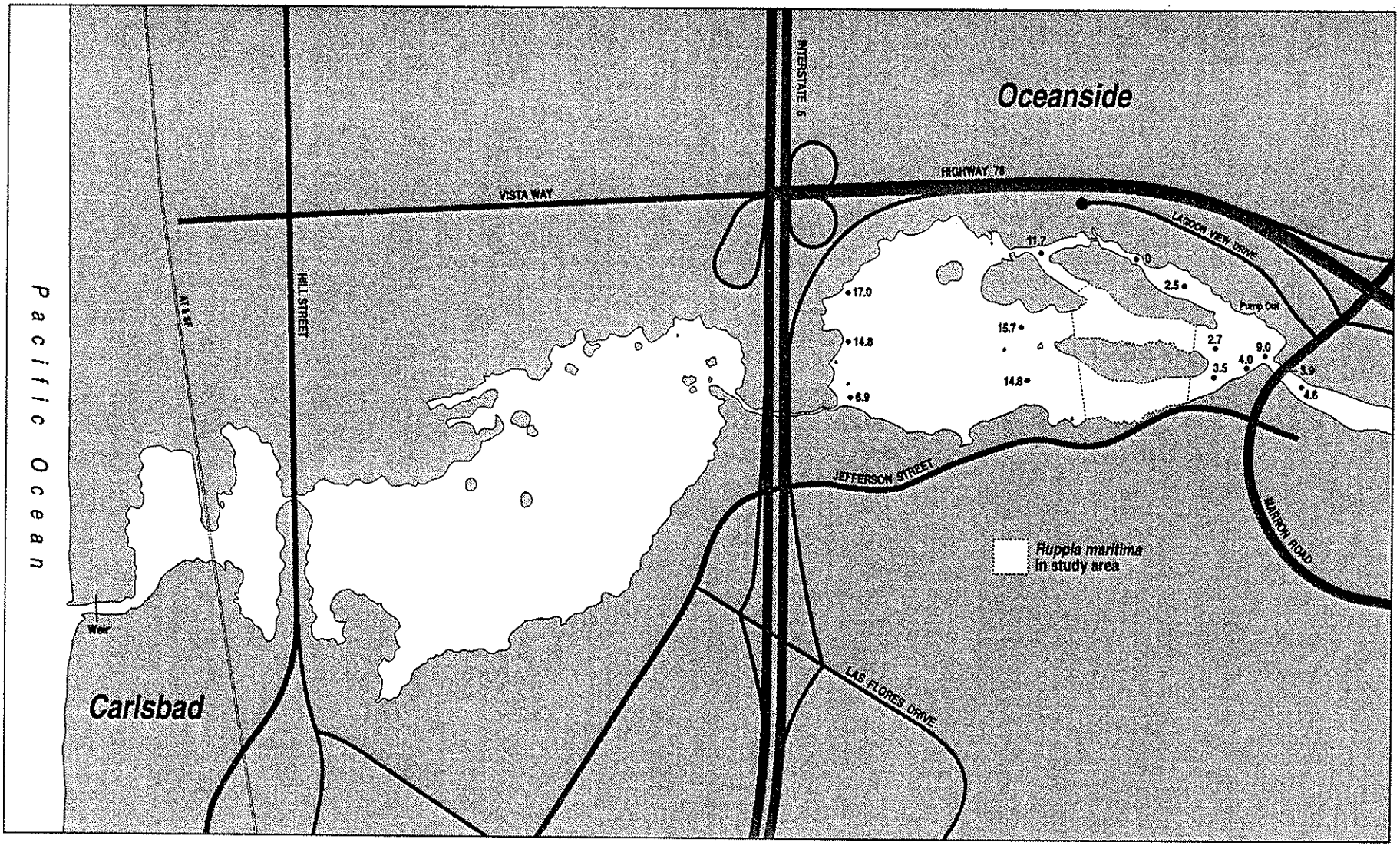


Figure 12-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 30, 1994.

August 31, 1994 1330

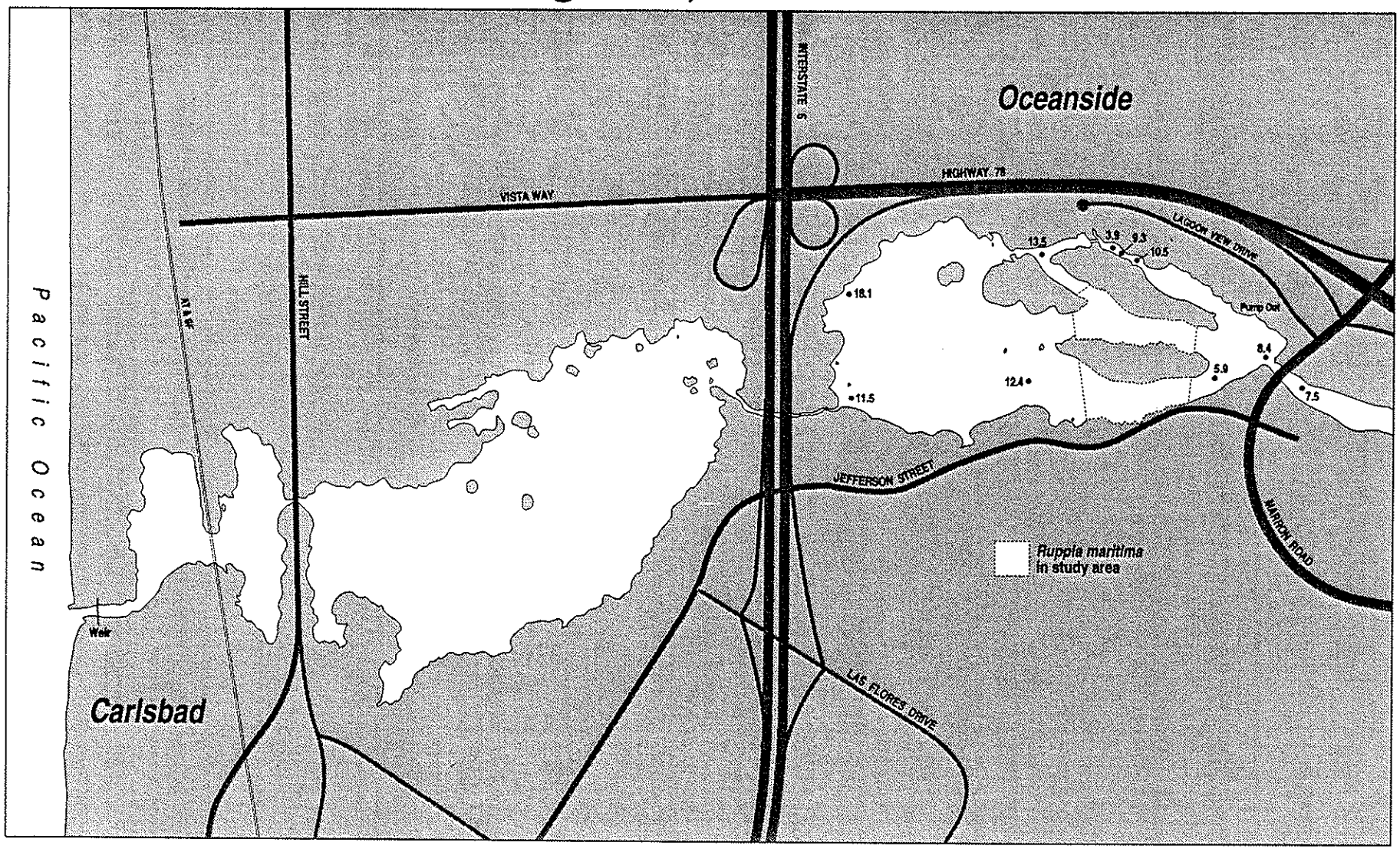


Figure 13-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 31, 1994.

September 1, 1994 1330

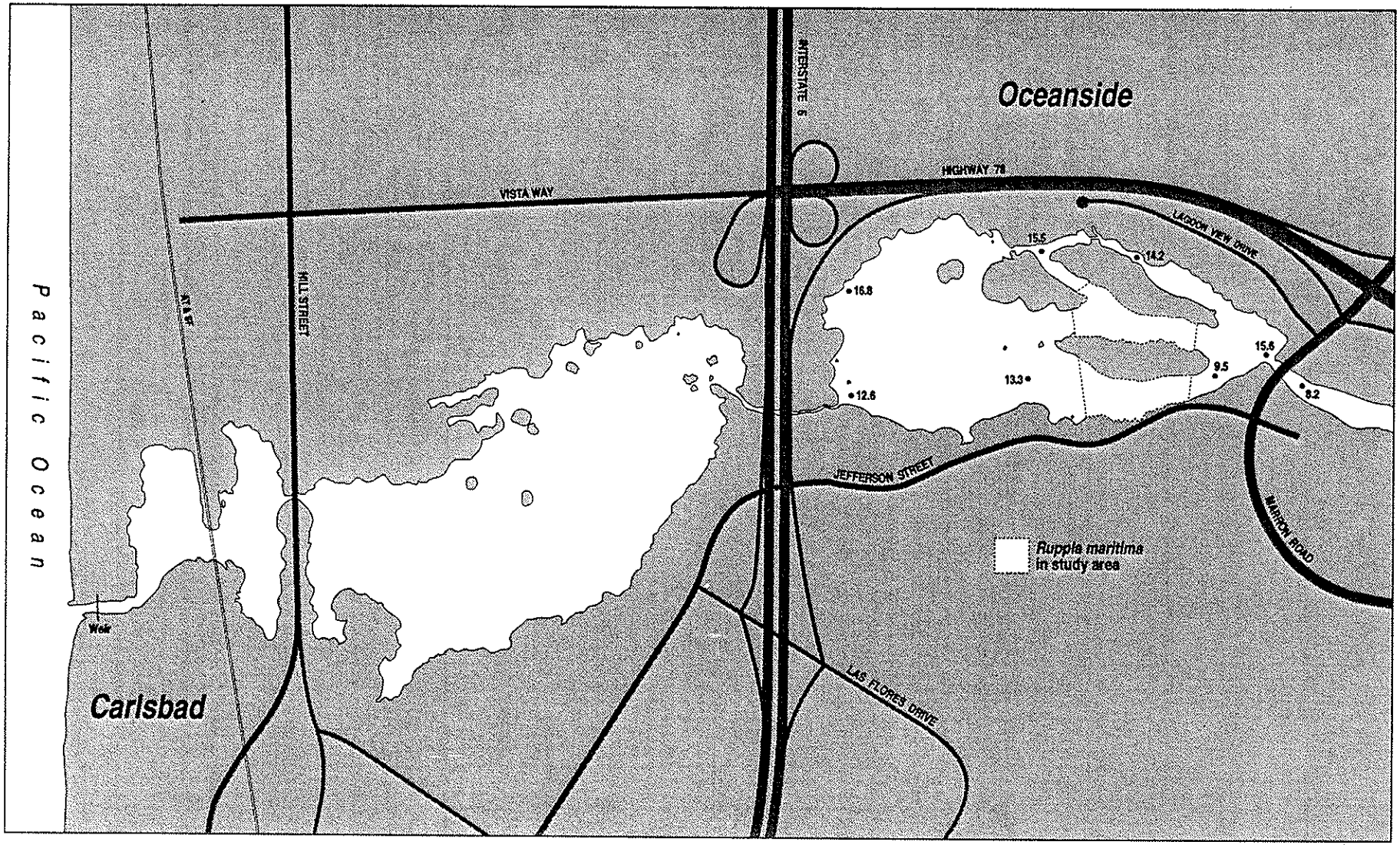


Figure 14-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 1, 1994.

September 2, 1994 0630

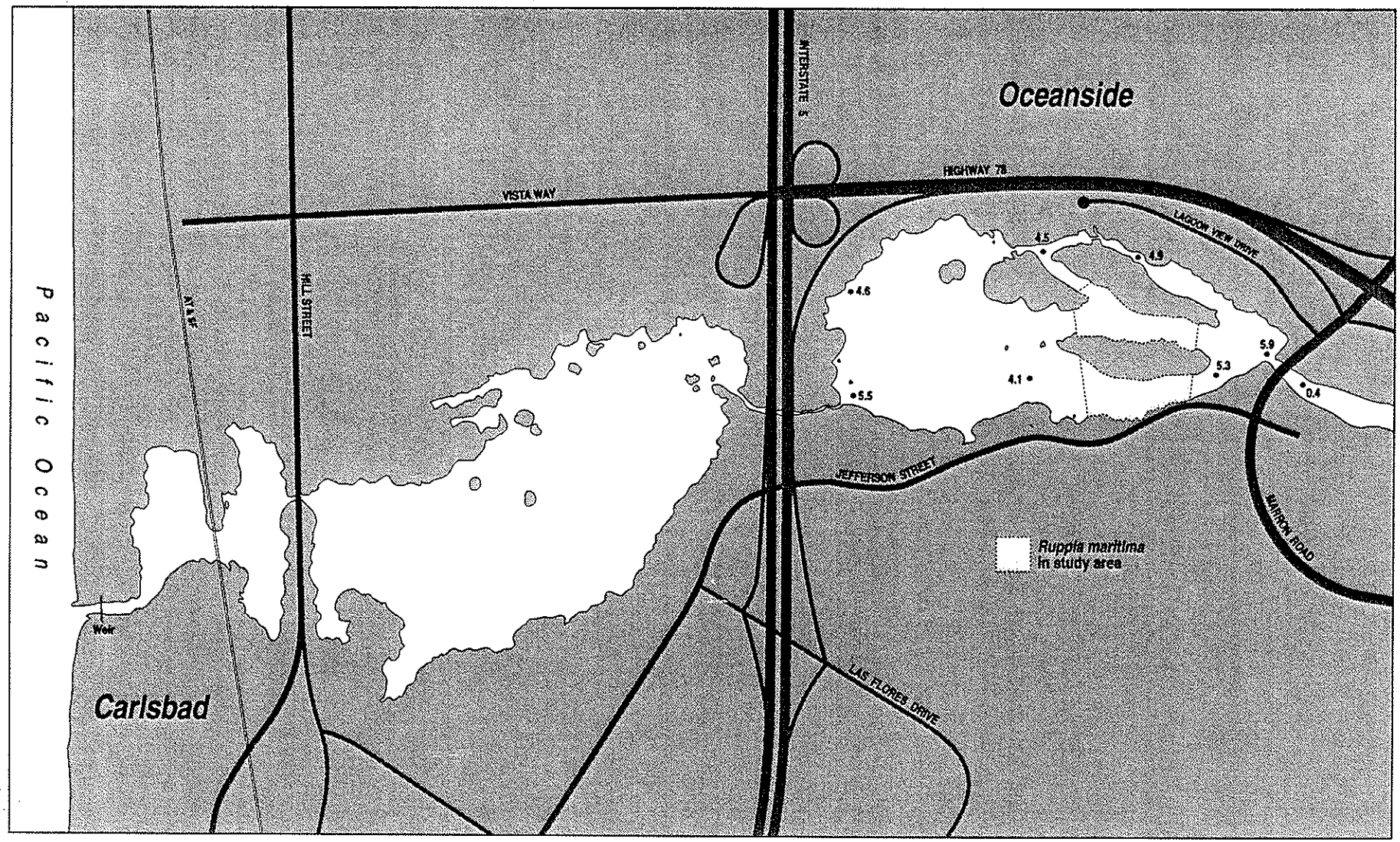


Figure 15-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 0630, September 2, 1994.

September 2, 1994 1315

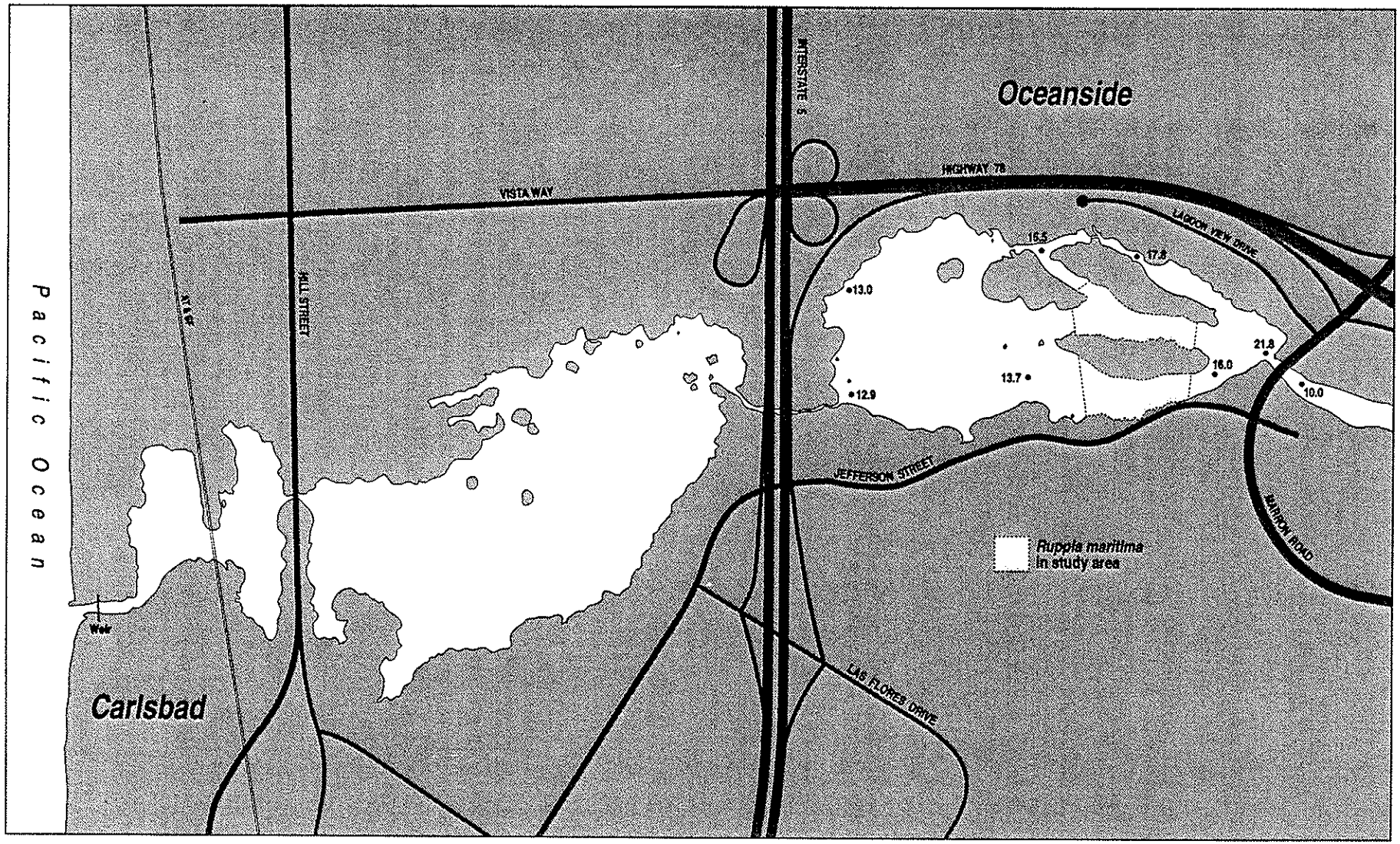


Figure 16-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1315, September 2, 1994.

September 4, 1994 1330

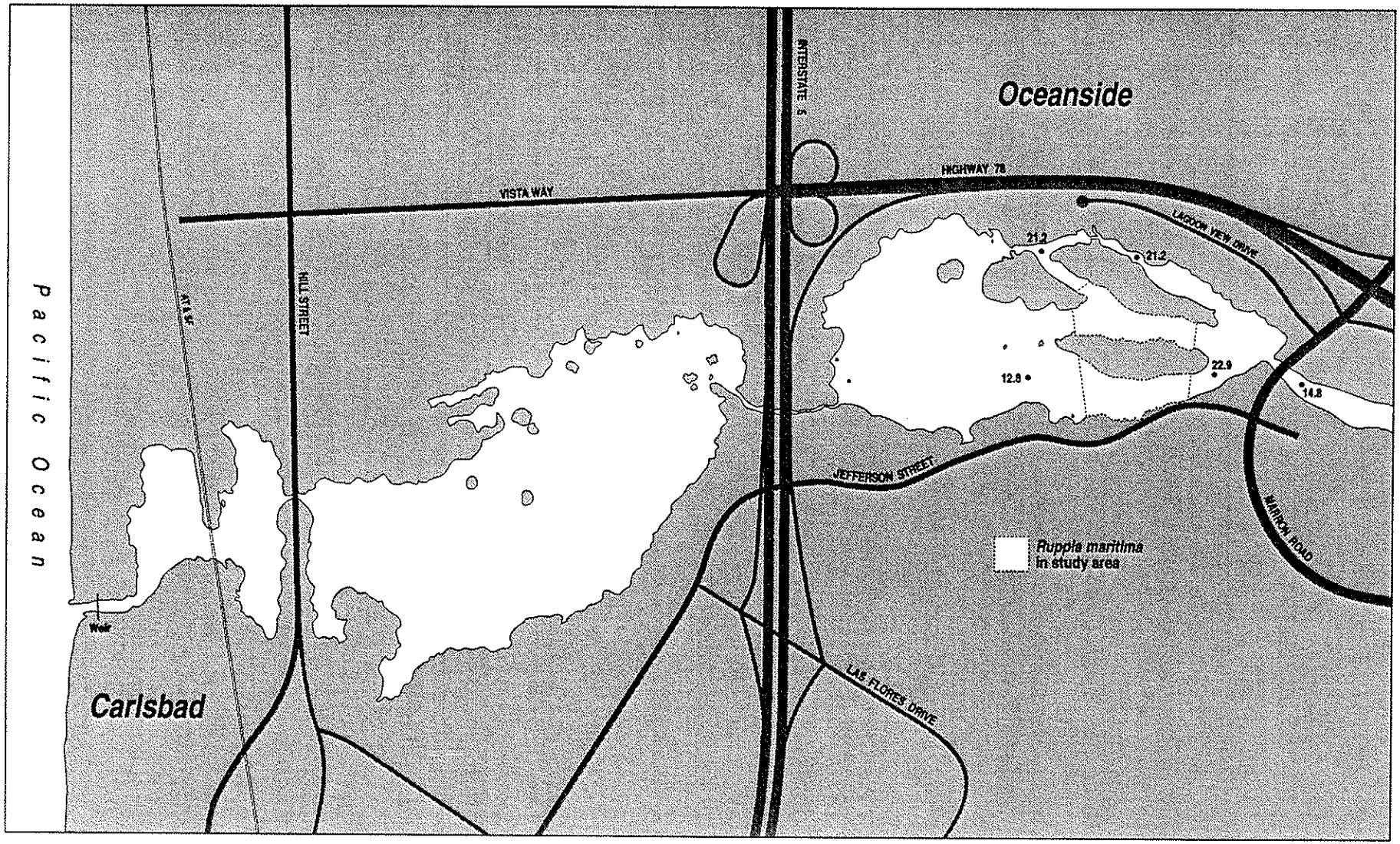


Figure 17-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 4, 1994.

September 6, 1994 1330

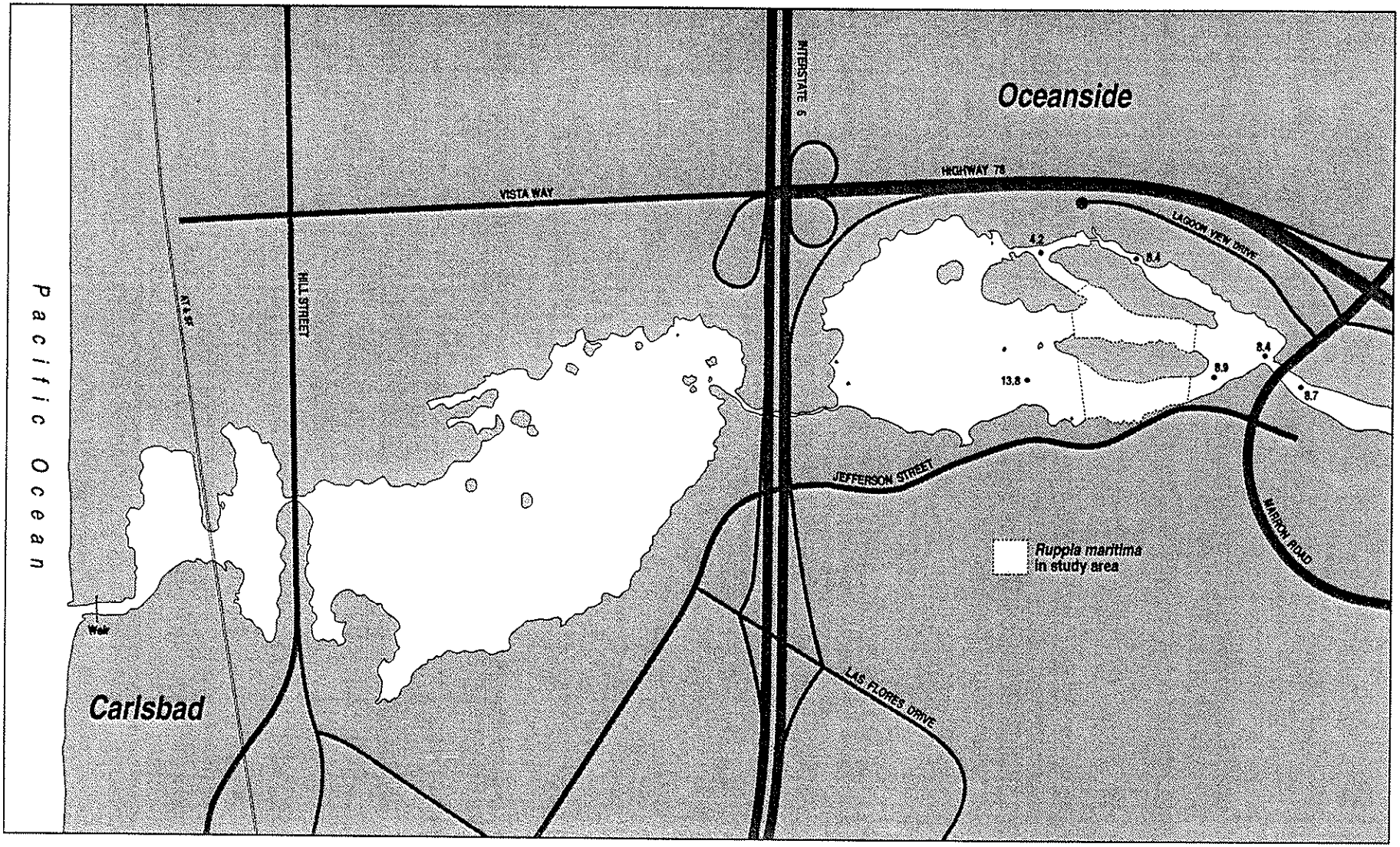


Figure 18-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 6, 1994.

September 8, 1994 1330

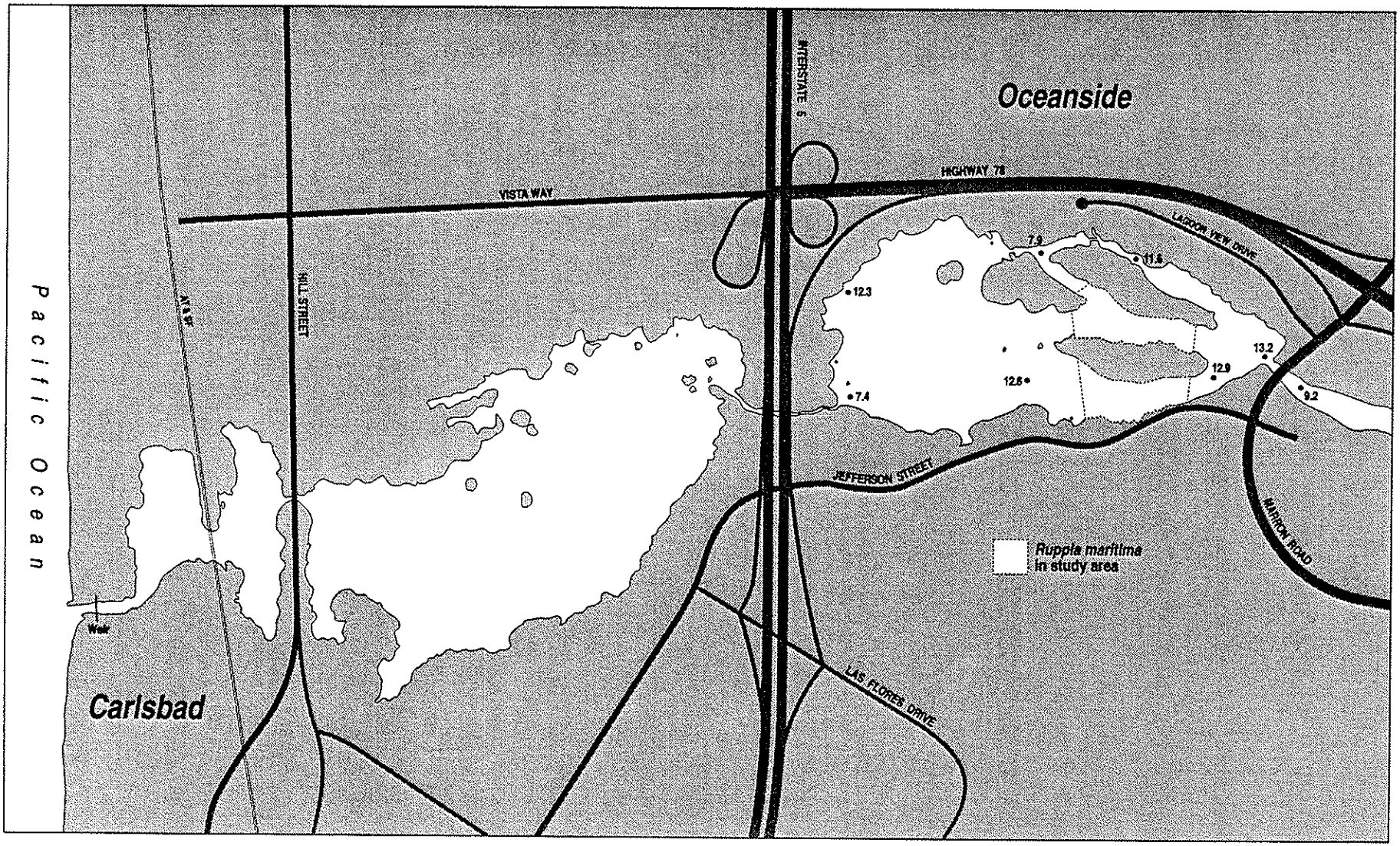


Figure 19-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 8, 1994.

September 12, 1994 1330

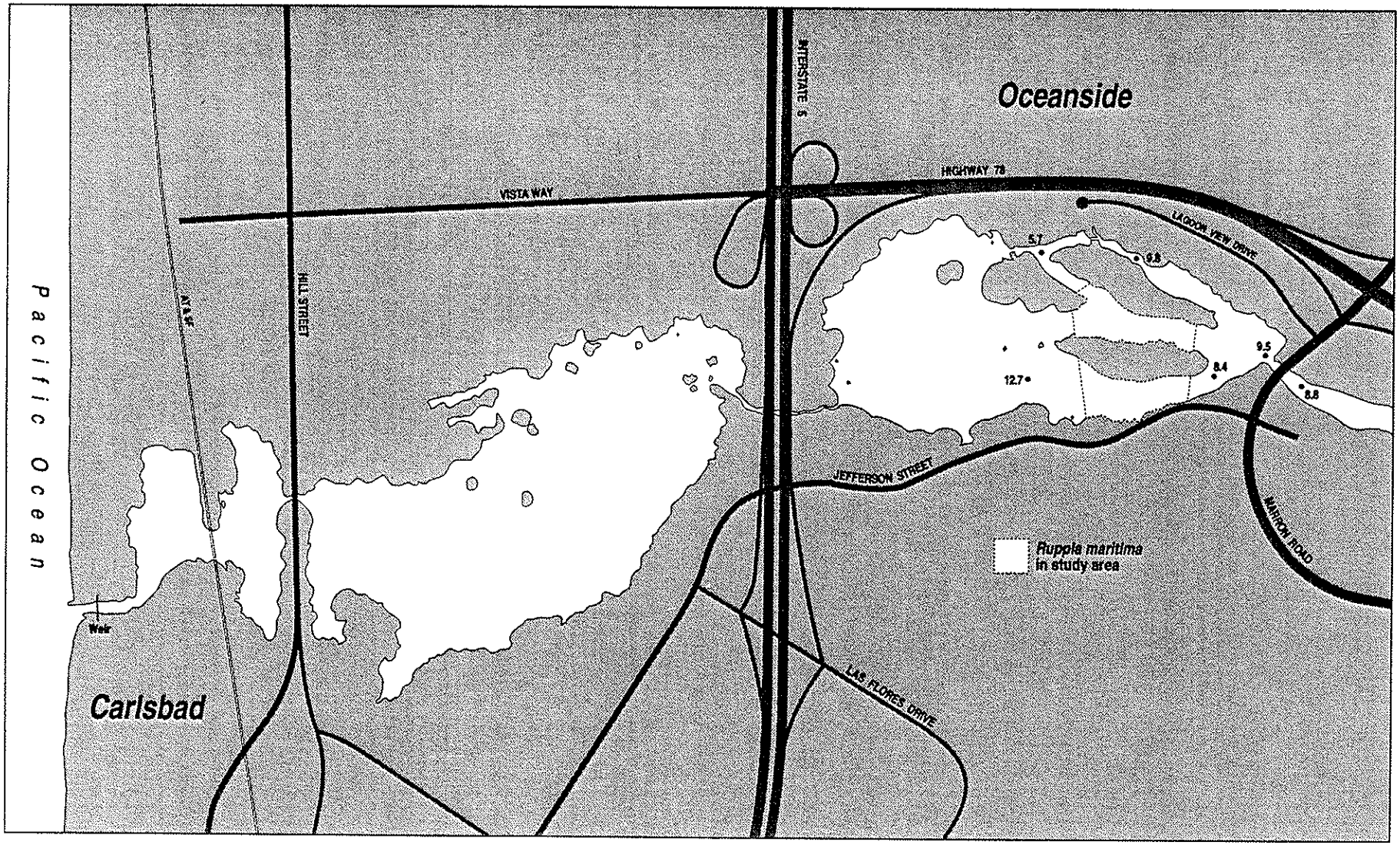


Figure 20-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 12, 1994.

September 16, 1994 1415

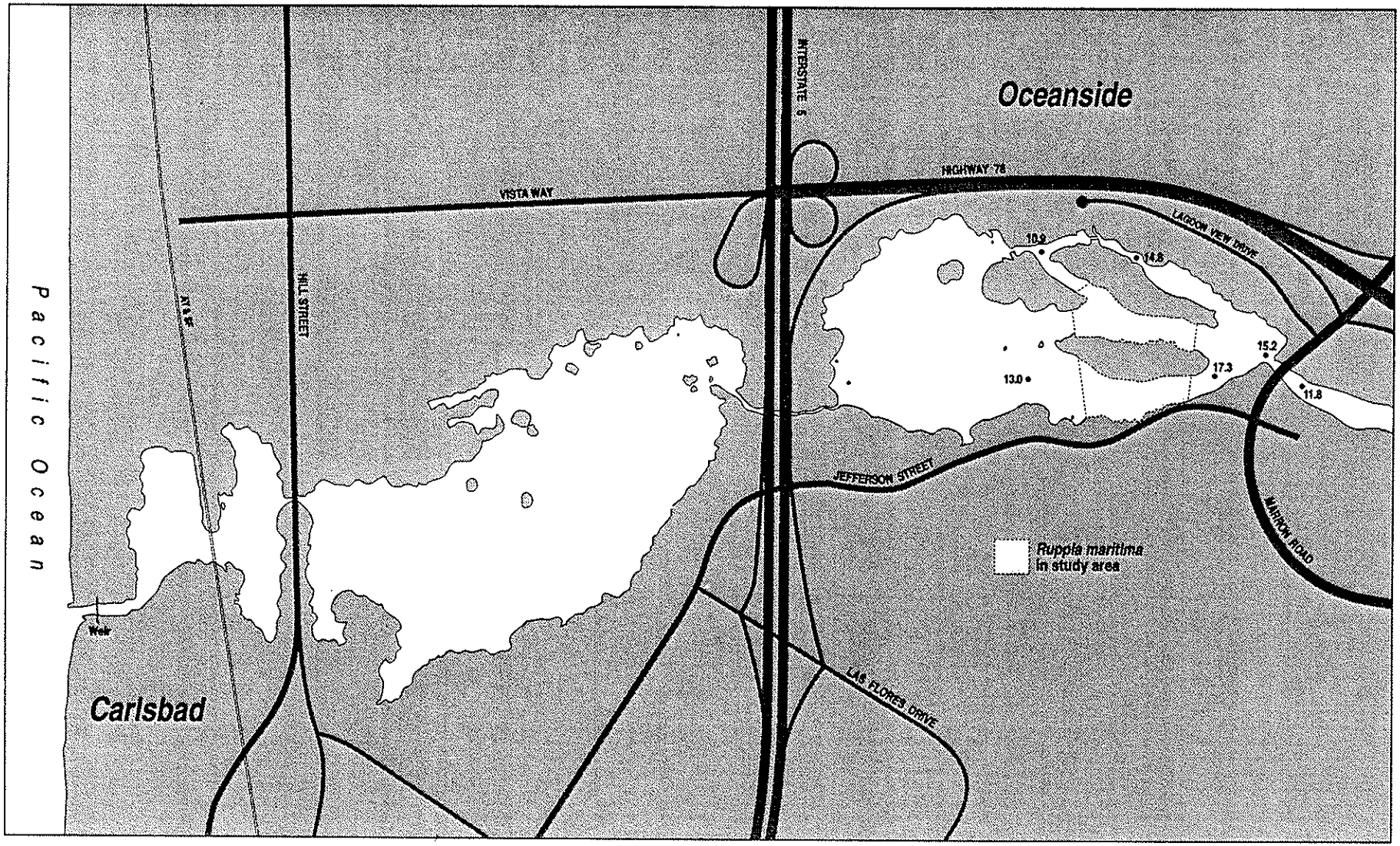


Figure 21-DO. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1415, September 16, 1994.

Plume Tracking

The sewage plume was tracked using dissolved oxygen concentrations in surface waters. A series of five plates documents sequential stages of plume activity.

Plate I. On August 24, the contamination covered the easternmost portion of the inner lagoon and the northern channel. Spreading was prevented through the central and southern channels by dense growth of *R. maritima*. Most of the inner lagoon and all of the outer lagoon were unaffected.

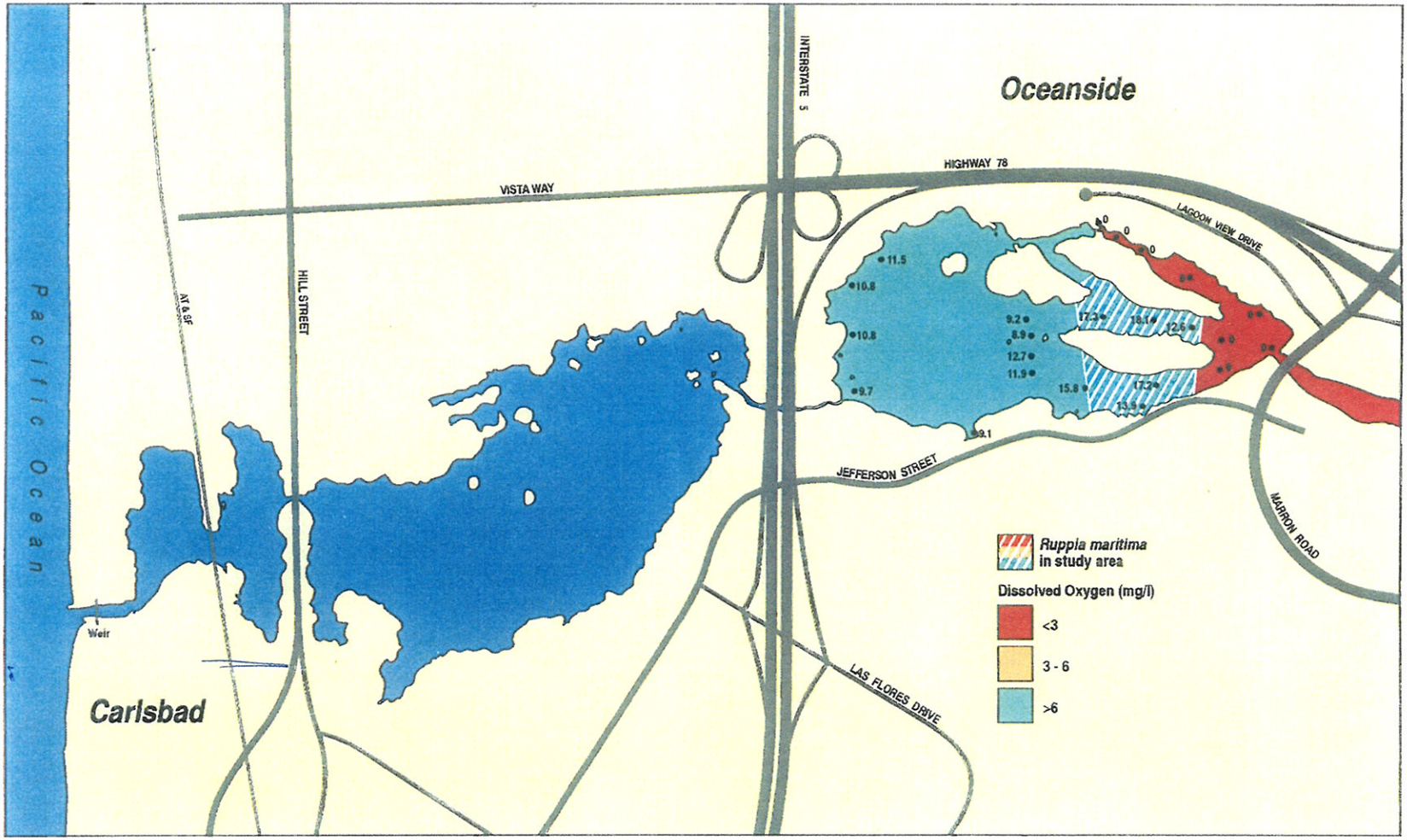
Plate II. On August 26, the contamination had spread from the northern channel through a narrow connection to the northern central area of the inner lagoon. The vegetation continued to block spreading through the central and southern channels.

Plate III. On August 29, the northern central area of the inner lagoon had recovered. However, contamination penetrated slightly through the eastern area of the vegetation towards the center of the inner lagoon. The central and western areas of the inner lagoon remained unaffected.

Plate IV. On August 30, the eastermost portion of the inner lagoon and the northern channel showed signs of recovery. The areal extent of dissolved oxygen concentrations <3 mg/l had diminished. The central and western areas of the inner lagoon remained unaffected.

Plate V. On September 1, contamination was no longer evident. Dissolved oxygen concentrations were uniformly high throughout the inner lagoon.

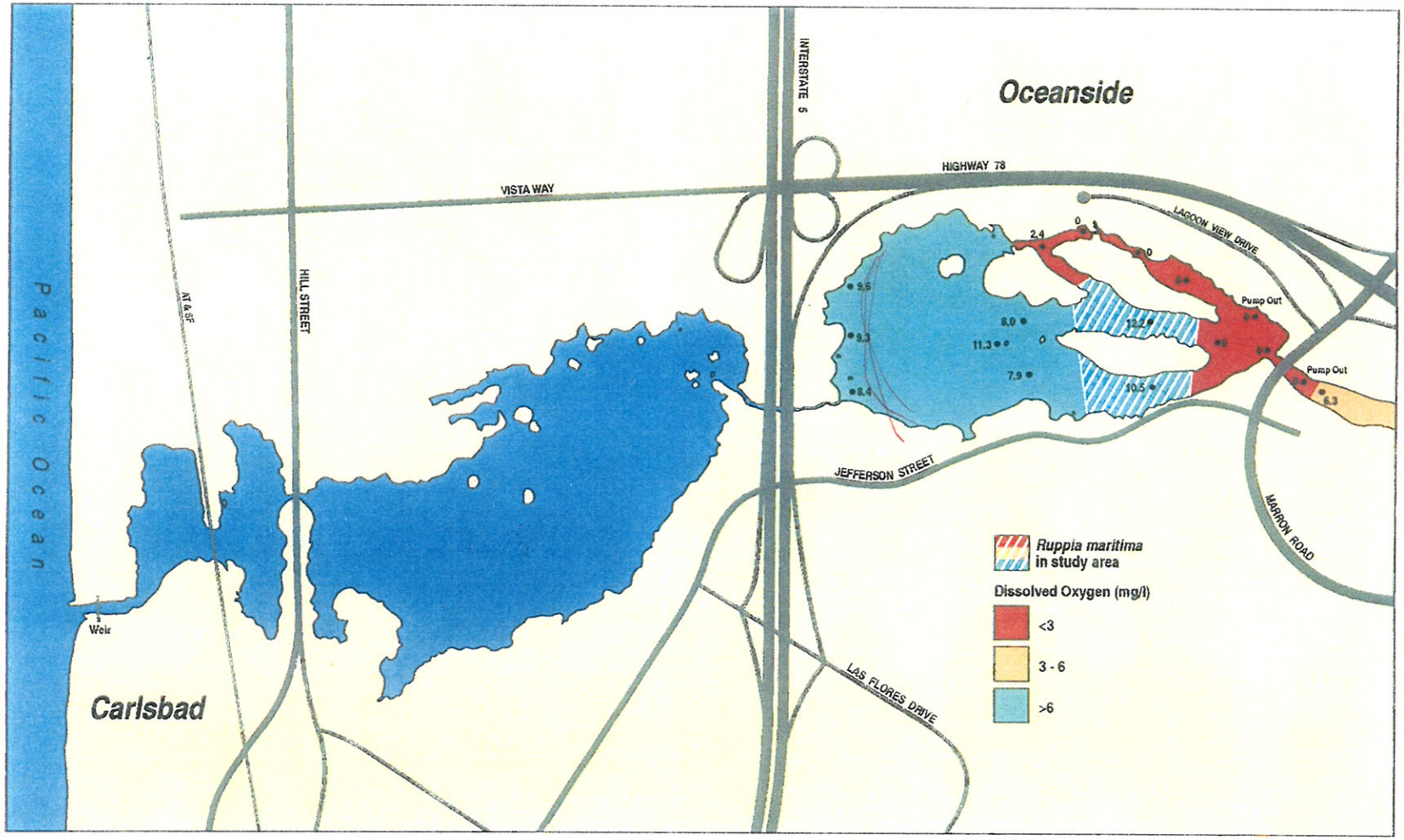
Plate I. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1500, August 24, 1994.



Buena Vista Lagoon

Dissolved Oxygen (mg/l)
August 24, 1994
1500

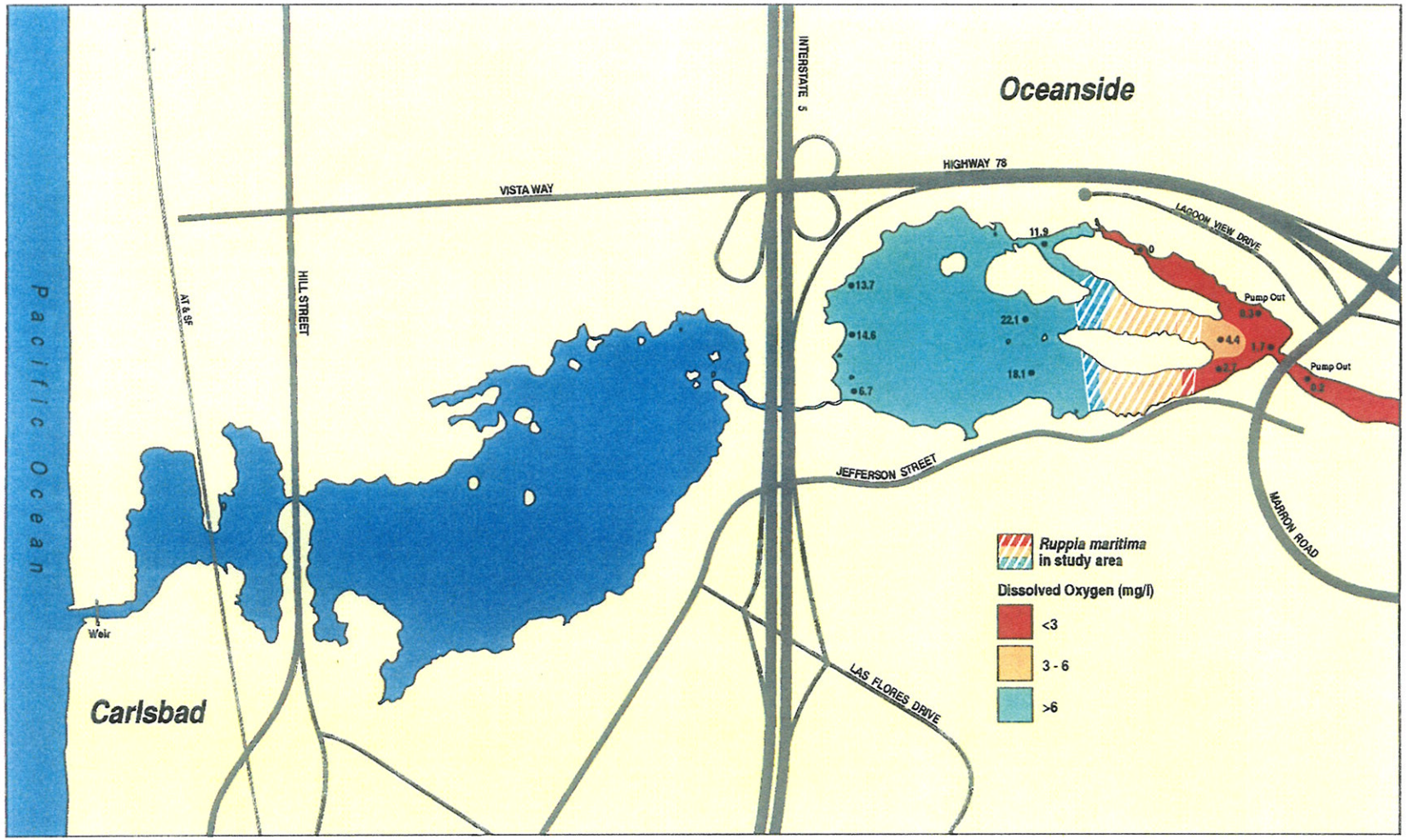
Plate II. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 26, 1994.



Buena Vista Lagoon

Dissolved Oxygen (mg/l)
August 26, 1994
1330

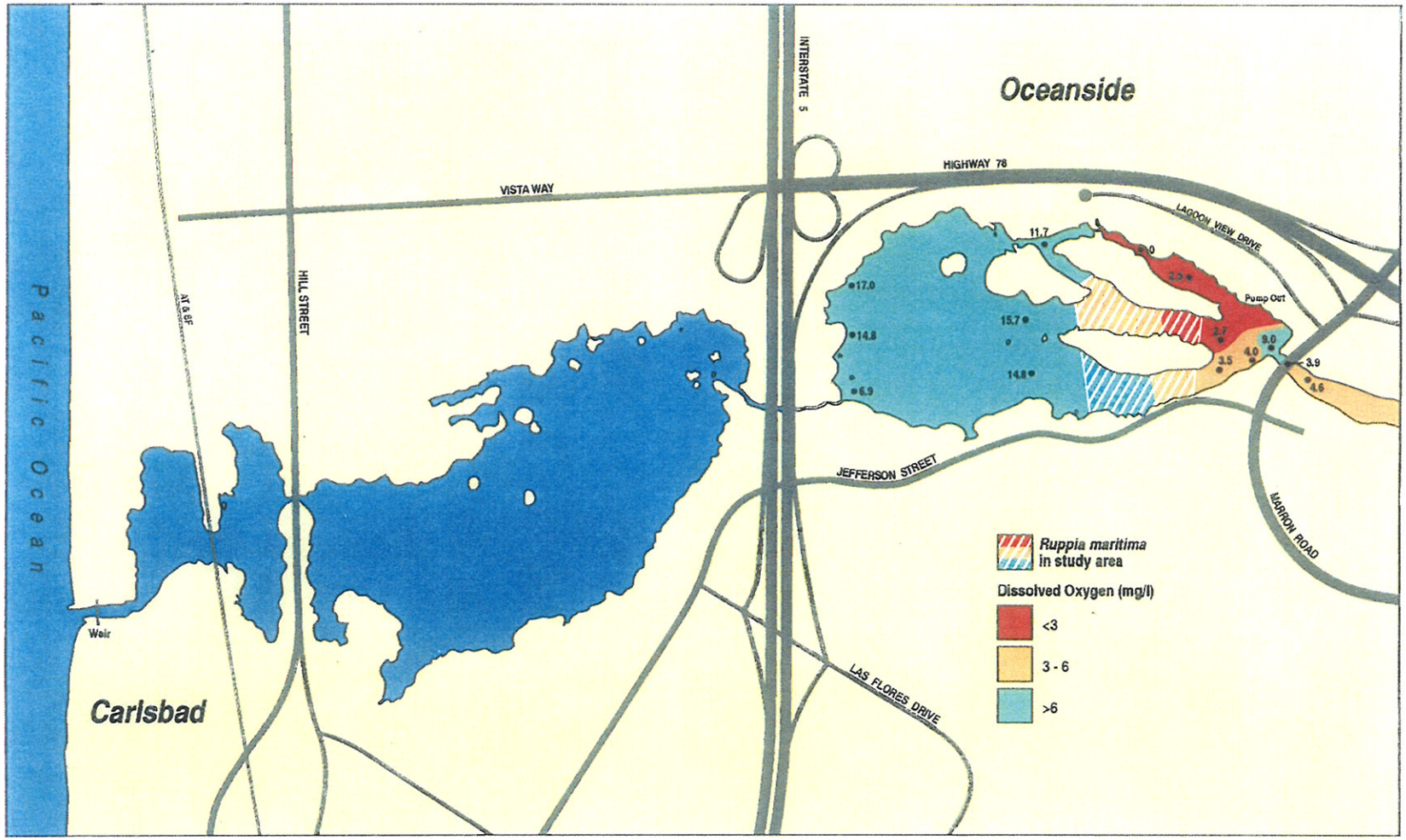
Plate III. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1500, August 29, 1994.



Buena Vista Lagoon

Dissolved Oxygen (mg/l)
August 29, 1994
1500

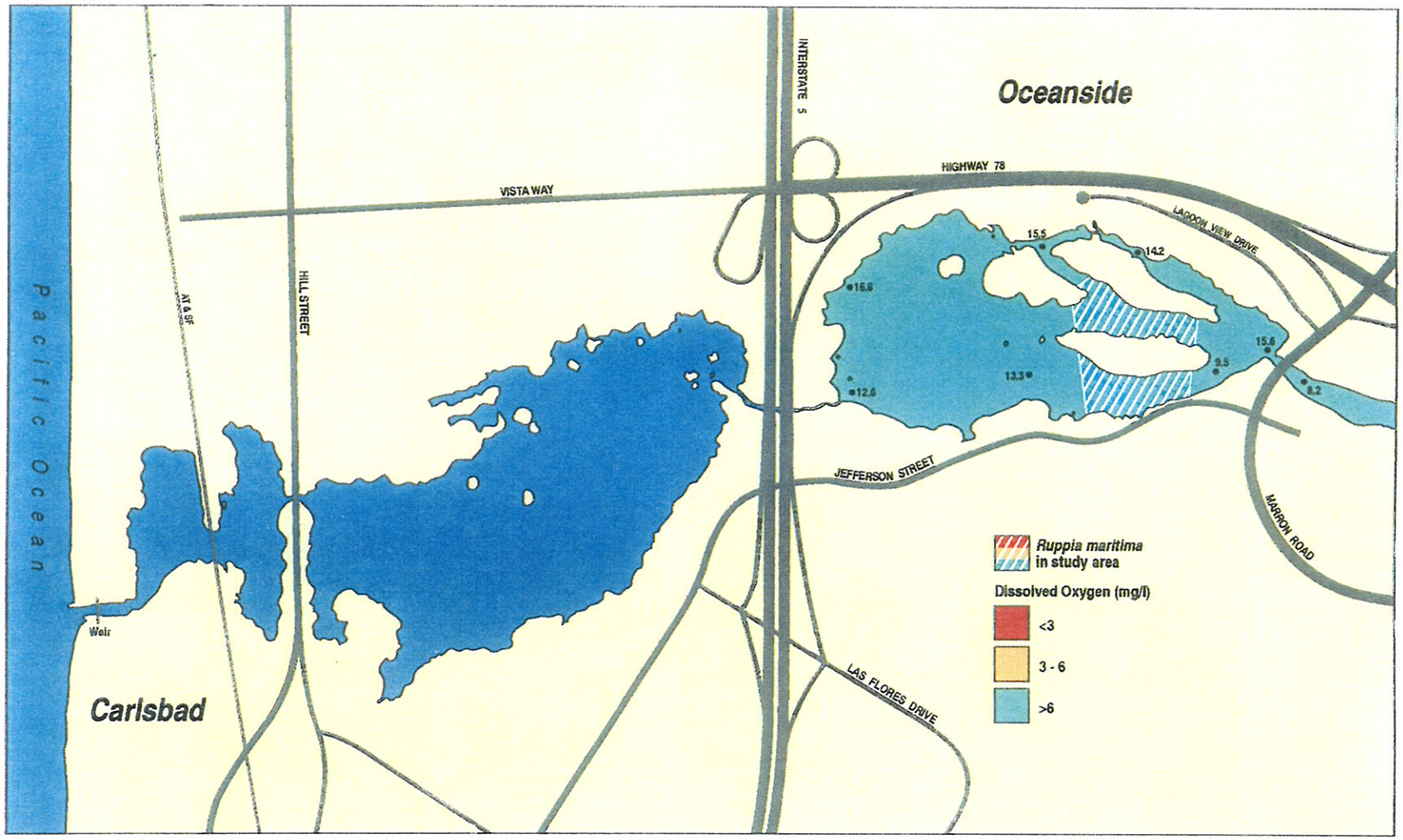
Plate IV. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, August 30, 1994.



Buena Vista Lagoon

Dissolved Oxygen (mg/l)
August 30, 1994
1330

Plate V. Dissolved Oxygen (mg/l) at Buena Vista Lagoon, 1330, September 1, 1994.



Buena Vista Lagoon

Dissolved Oxygen (mg/l)
September 1, 1994
1330