LAKE LAS VEGAS
RESORT

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♦ MEMORANDUM ♦

TO: **Wendell McCurry**
NDEP

FROM: **Steve Weber** Steve
Lake Biologist

DATE: **April 4, 1996**

SUBJECT: **LAKE LAS VEGAS 1995 LAKE AND LAS VEGAS WASH REPORTS**

****

Please find enclosed our 1995 reports. I have sent copies to Lew Dodgion under separate cover. If you have any questions or comments regarding these reports, please feel free to contact me at (702)565-0015.

Enclosures

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WATER QUALITY MONITORING IN LAKE LAS VEGAS: LAKE LAS VEGAS PROJECT 1995

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I. PROJECT BACKGROUND

Lake Las Vegas was conceived in 1964 by J. Carlton Adair, then President of the Port Holiday Authority. The 2243 acre development project was known as Port Holiday, and the lake was called "Lake Adair." Project land was acquired from the federal government under a land exchange act (PL 88-639) authorized by Congress on October 8, 1964. Approximately 170 acres of privately owned land in the Lake Mead National Recreation Area (LMNRA) was exchanged for 2243 acres in Las Vegas Wash (LVW). That property was located along the western border of the LMNRA in Las Vegas Wash (Figure 1).

Carlton Adair halted the project in 1971, though a considerable amount of engineering and feasibility work had been done. The project remained idle until 1982 when it was reinitiated as the Lake at Las Vegas Project by Barry Silverton and the Pacific Malibu Development Corporation of Los Angeles, CA. Pacific Malibu and its prime consultant J.M. Montgomery (JMM) Consulting Engineers conducted extensive engineering and environmental studies during 1984-1987. Transcontinental Properties (TCP) of Scottsdale, AZ, acquired controlling interest in the project in 1988. TCP and its consultants completed the engineering and environmental studies and obtained the necessary local, state, and federal permits required to start construction of the project. Construction was started on April 1, 1989. The project is now called Lake Las Vegas Joint Venture.

II. PROJECT DESCRIPTION

Lake Las Vegas ultimately will consist of six hotels, five golf courses, 3,500 - 5,000 dwelling units, condominium developments, and commercial and civic developments. At full development, it will have an estimated permanent population of 12,500 people and a tourist population of 32,500.

The focal point of the project is a 320 acre recreational lake. The lake is being formed behind a 4800 ft. zoned, S-shaped embankment dam, 1500 ft. upstream of North Shore Road. The 190 ft. high dam was constructed with 3.0 million cubic yards of locally available materials. The lake will be maintained at 1403 ft. above MSL. At that level, it will have a capacity of 10,000 acre feet, 320 surface acres, a two mile length, a one mile width, and 12.3 miles of shoreline.

The lake is being filled with water drawn from Lake Mead. About 7,000 acre feet will be required annually for project irrigation, seepage, and evaporative losses from the lake.

LVW wastewaters are by-passed under the lake through twin 84 inch diameter pipelines. The bypass system is 9,450 ft. in length and designed to pass flows up to 1760 CFS. Flows currently average about 220 CFS in LVW.

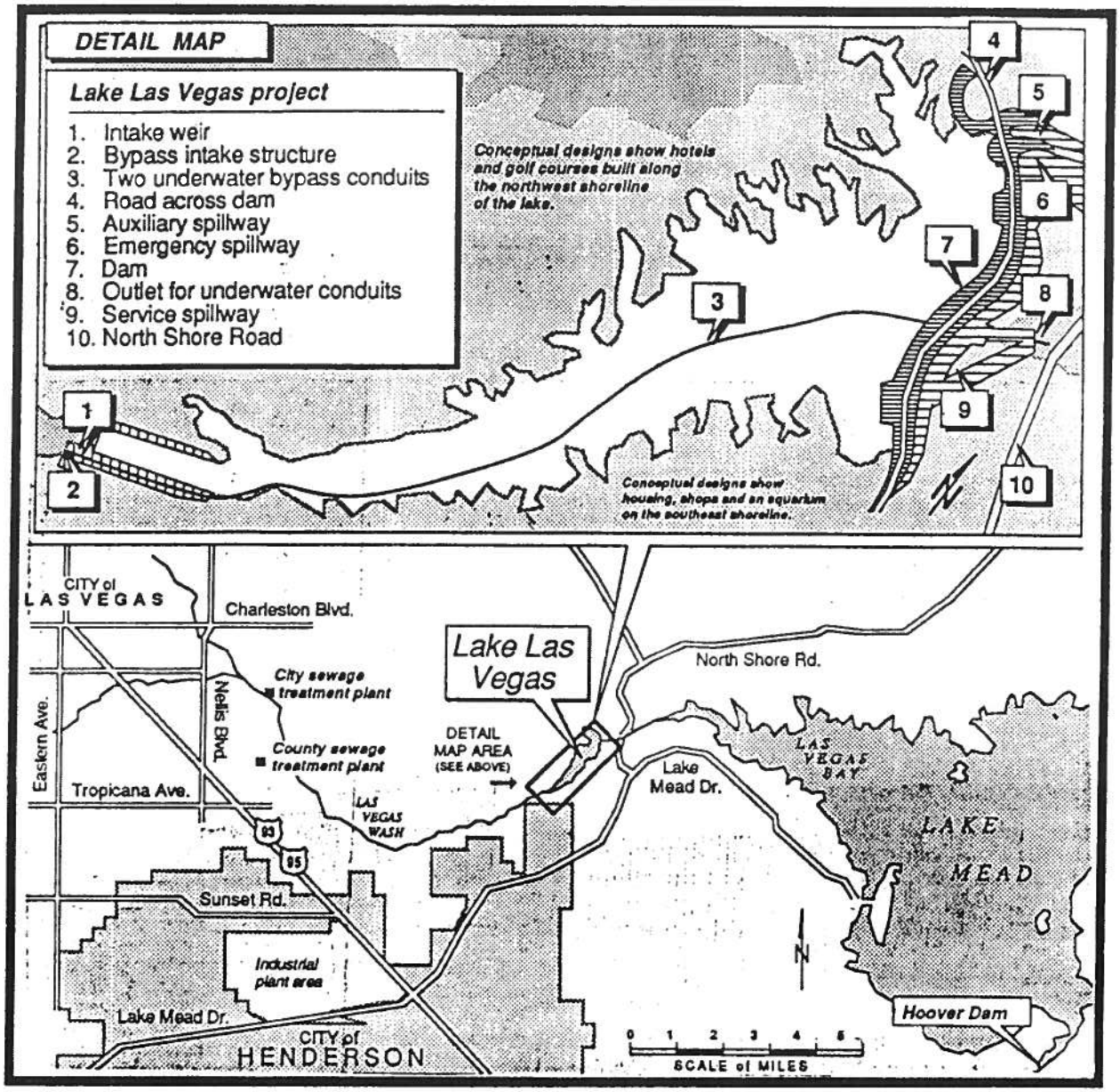

Figure 1. Location and description of the Lake Las Vegas Joint Venture (Las Vegas Review Journal map by Jim Day July 28, 1991).

III. WATER QUALITY HISTORY

Water quality in Lake Las Vegas itself and potential effects of the project on waters in LVW and Lake Mead have been major concerns since the project's inception in 1964. A water quality assessment was first made in 1968 as part of the engineering feasibility studies that were conducted by Tipton and Kalmback, Inc., Engineers of Denver, CO. Extensive water quality studies have been conducted since 1984 when the project was reintiated by Pacific Malibu Development Corporation, Los Angeles, CA. The following chronology is a summary of those studies and other water quality related activities.

A. Chronology of Lake Las Vegas Water Quality Activities

Date	Activities
Mar. 7, 1984	Pacific Malibu Development Corporation applies for a 404 permit (#8562) to the U.S. Army Corps of Engineers (USACE) to place fill material in LVW during construction of a dam and appurtenant works.
Mar. 16, 1984	James M. Montgomery (JMM) Consulting Engineers, consultant for Pacific Malibu, requests water quality certification for LLV from the Nevada Division of Environmental Protection (NDEP).
May 16, 1984	NDEP administrator, L.H. Dodgion recommends that a water quality assessment be done for LLV, including analysis of impacts in LVW and Lake Mead.
May 1984	JMM issues a 19 page report about general water quality impacts of LLV.
June 24, 1984	NDEP issues water quality certification for LLV under Section 404 of the Clean Water Act.
June 29, 1984	JMM prepares an Environmental Assessment for LLV.
Aug. 7, 1984	USACE holds a public hearing in Henderson, NV on the 404 permit (#8562) request from Pacific Malibu.
Sept. 19, 1984	U.S. Environmental Protection Agency (EPA) expresses written concern to USACE about potential water quality impacts of LLV on LVW and Lake Mead.
Nov. 1984	JMM issues a 9 page report entitled: "Water Quality Impact Analysis for Lake at Las Vegas."
Nov. 23, 1984	USACE issues a conditional 404 permit (#8562) for LLV. Special condition b.(4) requires that Pacific Malibu, ----"develop a detailed plan for water quality monitoring and operation and maintenance of the lake." Special condition c. requires that Pacific Malibu comply with the Clark County 208 Water Quality Management Plan.
April 1985	JMM prepares a draft, "Water Quality Criteria and Operations and Maintenance Plan for Lake at Las Vegas" report.
May 1985	JMM revises the draft, "Water Quality Criteria and Operations and Maintenance Plan for Lake at Las Vegas" report.
July 10, 1985	USACE accepts JMM water quality management plan and signs off on Special Condition b.(4) of permit application #8562.
Dec. 14, 1987	USACE extends permit application #8562 to December 31, 1989 provided the developer satisfies provisions of Clark County 208 Plan by June 30, 1988.

Feb. 25, 1988	JMM revises water quality plan to include an evaluation of impacts associated with urban and stormwater runoff.
Mar. 24, 1988	JMM issues a 18 page report entitled, "Lake at Las Vegas Project Water Quality Management Plan."
Mar. 28, 1988	City of Henderson and Transcontinental Properties (TCP), the new joint project owners, request an amendment to the Clark County 208 Plan for the LLV.
Apr. 4, 1988	JMM issues revised "Lake at Las Vegas Project Water Quality Management Plan."
Apr. 5, 1988	Board of Clark County Commissioners conditionally approves the Clark County 208 Plan amendment for LLV. One condition requires that a water quality monitoring and maintenance plan be enforced for LLV. Another requires that a variance be granted by the Clark County Regional Flood Control District (CCRFCD).
Aug. 11, 1988	USACE requests public comment on the amended 404 permit application #8562A for LLV.
Nov. 22, 1988	Dr. Larry J. Paulson develops a, "Water Quality Monitoring Program: Lake at Las Vegas Project" at the request of TCP.
Dec. 2, 1988	Harza Engineers completes its draft technical review of LLV for the CCRFCD.
Dec. 1988	TCP and its consultants respond to Harza Engineers' draft report.
Jan. 5, 1989	Harza Engineers issues its final technical review of LLV.
Jan. 12, 1989	CCRFCD denies the flood control variance for LLV.
Mar. 1, 1989	TCP contracts with Dr. Larry Paulson and the Lake Mead Limnological Research Center, UNLV, for a five month water quality monitoring program in LVW (March 1 - July 31, 1989).
Mar. 10, 1989	CCRFCD approves flood control variance for LLV.
Mar. 12, 1989	TCP and its contractor, Washington Construction Co. (WCC), begin construction on the dam abutment outside 100 year flood plain.
Mar. 13, 1989	Water quality sampling program begins in LVW.
Mar. 30, 1989	USACE issues 404 permit #8562A for LLV.
Apr. 1, 1989	TCP and WCC start construction on bypass pipeline and diversion inlet structure for LLV.
Aug. 9, 1989	Flood occurs in Las Vegas Wash.
Aug. 21, 1989	Saline spring surfaces in trench of bypass pipeline.
Jan. 1, 1990	TCP contracts with Dr. Larry J. Paulson and his firm West Lakes for water quality monitoring in Las Vegas Wash.
Jan. 19, 1990	Flood occurs in Las Vegas Wash.
Feb. 15, 1990	Bypass pipeline and diversion inlet structure completed.
Feb. 16, 1990	Las Vegas Wash flows diverted into bypass pipeline.
Feb. 17, 1990	WCC starts work on earthen dam.
March 7, 1990	Saline spring surfaces mid-way through reservoir site, forming a small lake upstream of coffer dam.
Apr. 1, 1990	Dr. Larry J. Paulson publishes technical report on results of water quality monitoring in Las Vegas Wash during 1989.
June 11, 1990	Large flood occurs in Las Vegas Wash. Flows were estimated at 3400 CFS and over-topped the intake structure, spilling about 700 acre feet of stormwaters into the LLV reservoir site.

July 16, 1990	Another large flood occurs in Las Vegas Wash.
Oct. 1990	WCC starts work on water inlet pipeline for LLV.
Dec. 26, 1990	Water inlet pipeline completed. TCP starts filling the LLV reservoir at about 800 GPM. Inlet waters combine with saline spring waters to increase size of lake above coffer dam.
Jan. 1991	Dr. Larry J. Paulson and his firm publishes water quality monitoring report for Las Vegas Wash during 1990.
Feb. 28, 1991	Moderate flood occurs in Las Vegas Wash.
March 1, 1991	Moderate flood occurs in Las Vegas Wash.
March 28, 1991	Large flood occurs in Las Vegas Wash. Stormwaters over-topped the intake structure and spilled into the LLV reservoir site.
May 25, 1991	Water inlet flows increased to 5600 GPM to accelerate filling of LLV reservoir.
June 24, 1991	Intensive water quality monitoring program started in LLV reservoir by Dr. Larry Paulson and his firm West Lakes.
June 27, 1991	WCC completes construction of sediment basin in Las Vegas Wash just upstream of intake structure.
July 1, 1991	Saline spring waters mix with inlet waters and flow into reservoir site.
August 20, 1991	WCC completes construction of LLV dam. Dam approved by Nevada State Engineer's office.
Aug.-Sept. 1991	Inflowing waters cause substantial erosion of alluvial deposits in the old Las Vegas Wash channel.
Aug.-Nov. 1991	Higher than expected algal growth occurs in LLV reservoir due to phosphorus inputs from spring waters and erosion of alluvial deposits.
Dec. 4, 1991	Water levels reach 1367 feet, 37 feet below the normal operating level of 1403 feet.
Dec. 31, 1991	Water levels reach 1370 feet, 33 feet below the normal operating level of 1403 feet.
Jan. 6, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 48 acre feet of stormwater into LLV.
Feb. 13, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 472 acre feet of stormwater into LLV.
Feb. 14, 1992	Water levels reach 1378 feet, 25 feet below the normal operating level of 1403 feet.
March 5, 1992	Dr. Larry J. Paulson publishes technical report on results of water quality monitoring in Las Vegas Wash during 1991.
March 8, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 569 acre feet of stormwater into LLV. Water levels reach 1381.3 feet in LLV.
March 23, 1992	Dr. Larry J. Paulson publishes technical report on results of water quality monitoring in LLV during 1991.
March 24, 1992	Moderate open water algae bloom occurs in LLV as a result of nutrient inputs from stormwater spills.
March 27, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 1087 acre feet of stormwater into LLV. Water levels reach 1387.9 feet in LLV.
March 28, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 109 acre feet of stormwater into LLV.
March 30, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 470 acre feet of stormwater into LLV.

March 31, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 603 acre feet of stormwater into LLV. Water levels reach 1391.5 feet in LLV.
April 7, 1992	Another moderate open water algae bloom occurs in LLV as a result of nutrient inputs from late March stormwater spills.
April-May 1992	Zooplankton explode in LLV and graze open water algae. Transparency increases to nearly 30 feet in lower end of the lake. Attached algae bloom occurs on rip-rap and underwater debris.
May-June 1992	Crayfish population in LLV augmented by stocking in an effort to control growth of attached algae.
July 7, 1992	Bluegreen algae bloom occurs in upper LLV due to nutrient inputs from springs.
Oct. 25, 1992	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 330 acre feet of stormwater into LLV.
Jan. 19, 1993	Moderate flood occurs in Las Vegas Wash.
Feb 8-9, 1993	Flood occurs in Las Vegas Wash, over-tops the intake structure and spills 1785 acre feet of stormwater into LLV. Water levels reach 1399.5 feet in LLV
Nov. 30, 1993	A total of 3,300 catchable rainbow trout stocked in LLV
March 19, 1994	A total of 50,000 fathead minnows, 20,000 channel catfish and 1,000 goldfish stocked in LLV.
Aug. 8-9, 1994	Moderate flood occurs in LVW..
Aug. 11, 1994	Sediment basin in LVW just uplake of LLV upgraded and lined with concrete.
Dec. 9, 1994	Another 5,200 catchable rainbow trout and 1,000 fingerling rainbow trout stocked in LLV.
Jan. 10, 1995	Flood occurs in LVW, over-tops the intake structure and spills 452 acre feet of stormwater into LLV. Water levels reach 1395.72 feet in LLV.
Jan. 11, 1995	Flood occurs in LVW, over-tops the intake structure and spills 412 acre feet of stormwater into LLV. Water levels reach 1397.31 feet in LLV.
Jan. 25, 1995	Flood occurs in LVW, over-tops the intake structure and spills 411 acre feet of stormwater into LLV. Water levels reach 1400.00 feet in LLV.
Jan. 26, 1995	Flood occurs in LVW, over-tops the intake structure and spills 570 acre feet of stormwater into LLV. Water levels reach 1401.75 feet in LLV.
March 27, 1995	LLV stocked with 1,400 largemouth bass and 2000 crayfish.
June 11, 1995	LLV stocked with 10,000 bluegill sunfish.
June 18, 1995	LLV stocked with 50,000 fathead minnows.
Oct. 23, 1995	LLV stocked with 50,000 fathead minnows
Dec. 28, 1995	LLV stocked with 10,000 rainbow trout fingerlings.

IV. WATER QUALITY MONITORING PROGRAM

The revised Clark County 208 Water Management Plan approved by the Clark County Board of County Commissioners on April 5, 1988 and certified by the State of Nevada on August 8, 1988 required that a water quality monitoring program be developed for Lake Las Vegas. The monitoring is required to insure that water quality standards are not being violated by construction activities and operations of the reservoir. The water quality monitoring program was started on Lake Las Vegas in June 1991. Results of water quality monitoring during 1991 were presented in Paulson et al. (1992b); those for 1992 were presented in Paulson et al. (1993b); those for 1993 were presented in Paulson et al. (1994b) and those for 1994 in Paulson et al. (1995b).

A. Lake Las Vegas Sampling Stations

Water quality sampling was conducted in Lake Las Vegas monthly in January, February, November, and December during 1995. Sampling was done biweekly during March and October and weekly during April through September.

Water quality sampling was conducted at stations shown in Figure (2). Primary monitoring stations in the reservoir were located at fixed points along the center channel in the deepest part of the reservoir (Figure 2). Physical measurements and limited sampling also were conducted periodically in select coves and sites near spring inflows (Figure 2).

B. Field Measurements

Temperature, pH, dissolved oxygen, and specific conductance were measured by 1 m intervals in the epilimnion and 5 m intervals in the hypolimnion at all stations with a Hydrolab Surveyor Model III Water Quality Analyzer (Table 1). Duplicate measurements were made on about 10% of the measurements. Transparency was measured at each lake station with a Secchi disc.

C. Chemical and Biological Analyses

Depth integrated water samples were collected from 0 - 2.5 m at main-lake sampling stations (Table 1). Samples also were collected quarterly at 5 m, 10 m, and 20 m at Station LLV-1A with a Van Dorn sampler. Samples requiring filtration were filtered through 0.45 µm Millipore filters.

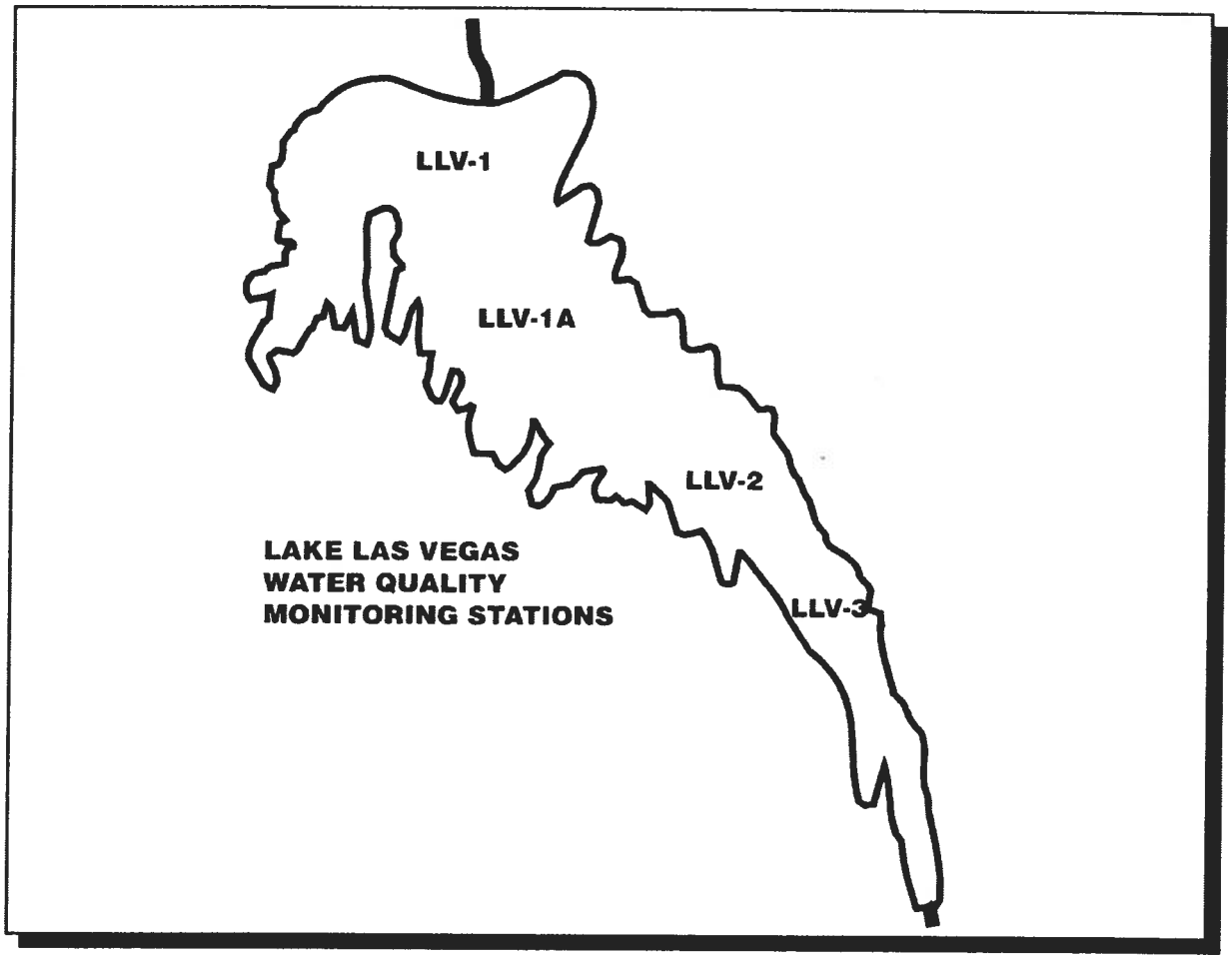

Figure 2. Locations of water quality monitoring stations in Lake Las Vegas.

Analyses were run on field duplicates for about 10% of the samples. The chemical and biological analyses were run with EPA-approved methods at West Lakes. Additional samples were collected quarterly at 0 - 2.5 m, 5 m, 10 m, and 20 m at station LLV-1A and shipped to the Nevada Health Laboratory in Reno, Nevada for analyses of major anions and cations. Samples were collected from the surface and near the bottom at station LLV-1A in November 1995 and immediately shipped to the National Water Testing Laboratory in Cleveland, Ohio for analyses of toxic compounds.

Zooplankton samples were collected at LLV-1 in a vertical tow from 0-15 m with an 80 μ Wisconsin plankton net. Phytoplankton (algae) were collected monthly from the surface (0 - 2.5 m) from station LLV-1. Phytoplankton identifications were made by Dr. Jeff Janik (with the California Department of Water Resources). Zooplankton identifications and counts were made by West Lakes.

Table 1. Physical measurements and chemical and biological analyses performed in Lake Las Vegas during 1995.

	Sampling Program		
Measurements	Depth(s)	Frequency	Method(s)
Physical			
Temperature (°C)	1.0 m Intervals Surface to Bottom	Variable[1]	Leavitt et al. (1990)
Dissolved Oxygen (mg/l)	"	"	"
pH (Std. Units)	"	"	"
Conductivity (µmhos/cm)	"	"	"
Secchi Depth (m)	Surface	"	"
Turbidity (NTU)	0 - 2.5 m Int.	"	"
Chemical			
Total Nitrogen (µg/l)	0 - 2.5 m Int.	"	APHA (1992)
Ammonia-N (µg/l)	"	"	"
Nitrite+Nitrate-N (µg/l)	"	"	"
Total Phosphorus (µg/l)	"	"	"
Ortho-Phosphorus (µg/l)	"	"	"
Total Suspended Solids (mg/l)	"	"	"
Total Dissolved Solids (mg/l)	"	"	"
Major Anions/Cations (mg/l)	"	"	"
Biological			
Chlorophyll-a (µg/l)	"	"	Leavitt et al. (1990)
Phytoplankton Counts (mg/m^3)	"	"	
Zooplankton Counts (No./l)	0 - 15 m Tow		"

D. Water Quality Guidelines

Water quality standards have not been established for Lake Las Vegas. However, the water quality guidelines presented in Table 2 are patterned after standards for open waters of Lake Mead (NAC 445.1351). These guidelines were established to protect and enhance the following beneficial uses in Lake Las Vegas:

1). Irrigation;
2). Recreation not involving contact with the water (boating, sailing, canoeing) ;
3). Recreation involving contact with the water (swimming, bathing, diving)
4). Propagation of wildlife; and
5). Propagation of aquatic life, including a warmwater fishery.

Table 2. Water quality guidelines for Lake Las Vegas (Revised from: NAC 445.1351, Water Quality Standards for Lake Mead).

1. The lake waters should be free of:

    a. Visible floating, suspended, or settleable solids,
    b. Sludge banks, lime infestations, heavy growths of attached plants (periphyton) and animals, or of floating algae mats,
    c. Discoloration or excessive turbidity,
    d. Visible oil or slicks,
    e. Surfactant concentrations that will produce foam when water is agitated or aerated,
    f. Toxicants in toxic amounts;

2. The pH as measured in standard units should range between 7.0-9.0 in 90% of the measurements;

3. Dissolved oxygen concentrations should be 5 mg/l in the epilimnion during stratification, and 5 mg/l throughout the water column the rest of the year;

4. The average chlorophyll-a concentration in the epilimnion (0-2.5 m) should not exceed 0.005 mg/l during April through September. The average must include at least two samples per month. The single value must not exceed .010 mg/l in 10% of the samples;

5. In all lake areas, the log mean of not less than five fecal coliform samples taken over a 30 day period during the recreational season (April-September) should not exceed 200 MPN/100 ml and not over 10% of such samples should exceed 400 MPN/100 ml;

6. Average temperature in the epilimnion should not exceed 2°C above ambient temperature (eg. temperature in epilimnion in Lake Mead);

7. Total dissolved solids concentrations should not exceed an annual average of 2000 mg/l throughout the water column;

8. Turbidity must not exceed that characteristic of natural conditions by more than 10 NTU.

V. WATER QUALITY MONITORING RESULTS

A. Reservoir Water Levels

Water for Lake Las Vegas is pumped from the hypolimnion of Lake Mead through either the Southern Nevada Water System or the Basic Management Incorporated (BMI) pipelines. The inflow was first started on December 26, 1990 at a rate of about 800 GPM. The inflow was increased to 5600 GPM on May 25, 1991 and held at that rate during most of 1991.

Surface elevations in Lake Las Vegas increased steadily in 1991 (Figure 3). The water level increased from 1320 ft. on May 30, 1991 to 1370 ft. by December 1991. Major flooding in Las Vegas Wash resulted in several inflows of stormwater into Lake Las Vegas during winter and early spring of 1992 (Table 3). The stormwater inflows from Las Vegas Wash quickly filled Lake Las Vegas. In a three month period between January and March 1992, the water level increased by nearly 22 ft. (Figure 3). The sharpest rise occurred between March 27 - 31, 1992 when the lake level increased by 10 ft., bringing the level to 1391 ft. (Figure 3). The lake level increased to about 1393 ft. by the end of 1992.

Another large flood occurred in Las Vegas Wash on February 8 - 9, 1993. This flood spilled 1785 acre feet of stormwater into Lake Las Vegas. The water level increased by about 6 ft. overnight, and the lake reached its highest level of 1399.5 ft. on February 10, 1993. That is 3.5 ft. from its normal operating level of 1403 ft. Inflows from Lake Mead were shut off for the rest of 1993. Water levels decreased through evaporation to year-end levels of about 1391 ft. (Figure 3).

There were no stormwater inflows in Lake Las Vegas during 1994. Surface elevations were at an annual minimum of 1392.5 ft. in January 1994 (Figure 3). Water for Lake Las Vegas during 1994 was pumped from Lake Mead. Inflows ranged from 314 - 490 acre feet per month during winter and spring. Inflows were reduced considerably during summer and water levels receded about one foot (Figure 3). Inflows were turned on again in August, reaching a maximum of 746 acre feet during October. Surface elevations reached an annual maximum of 1395.6 ft. on December 31, 1994 (Figure 3).

A series of large storms in January 1995 loaded 2030 acre feet of stormwater into Lake Las Vegas (Table 3). Water levels increased from 1395.6 ft. in early January to nearly 1402 ft. by the end of the month (Figure 4). Inflows from Lake Mead were about 250 acre feet per month during April - July 1995 (Table 4). This kept water levels in the lake near full capacity. Inflows were reduced to 69 acre feet in August and 13 acre feet in September (Table 4). Water levels decreased to about 1400 ft. by late summer. Inflows were increased again in the fall and winter. Water levels remained near 1400 ft. for the rest of the year.

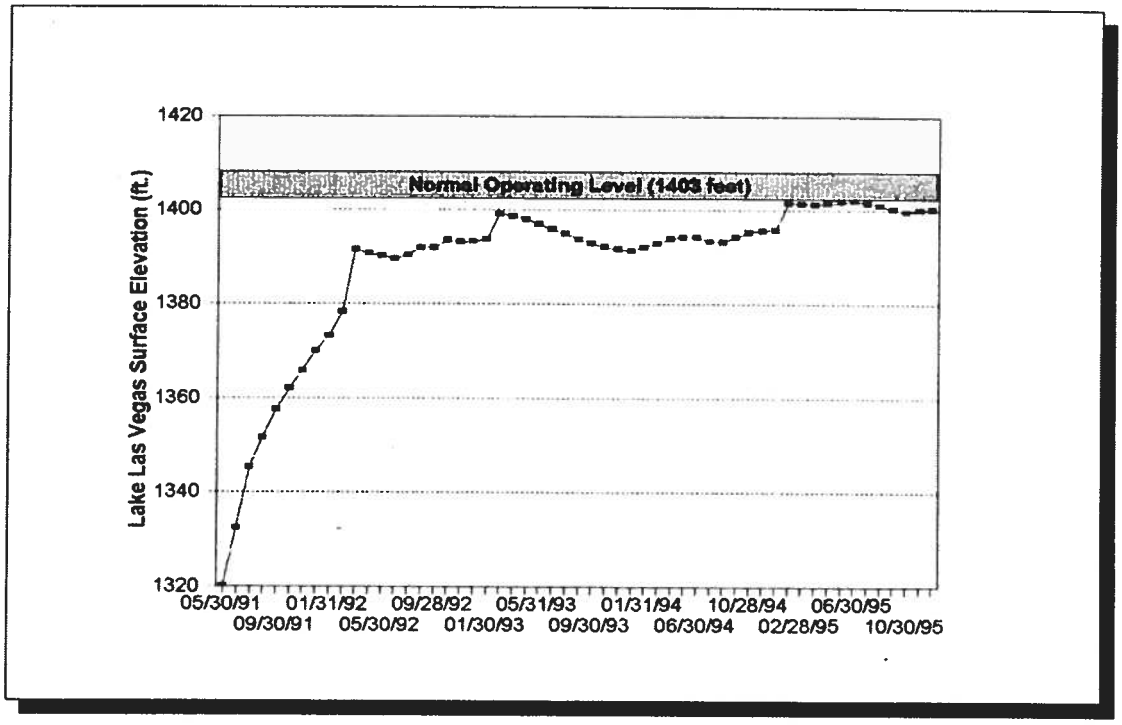

Figure 3. Surface water elevations in Lake Las Vegas during June 1991 - December 1995.

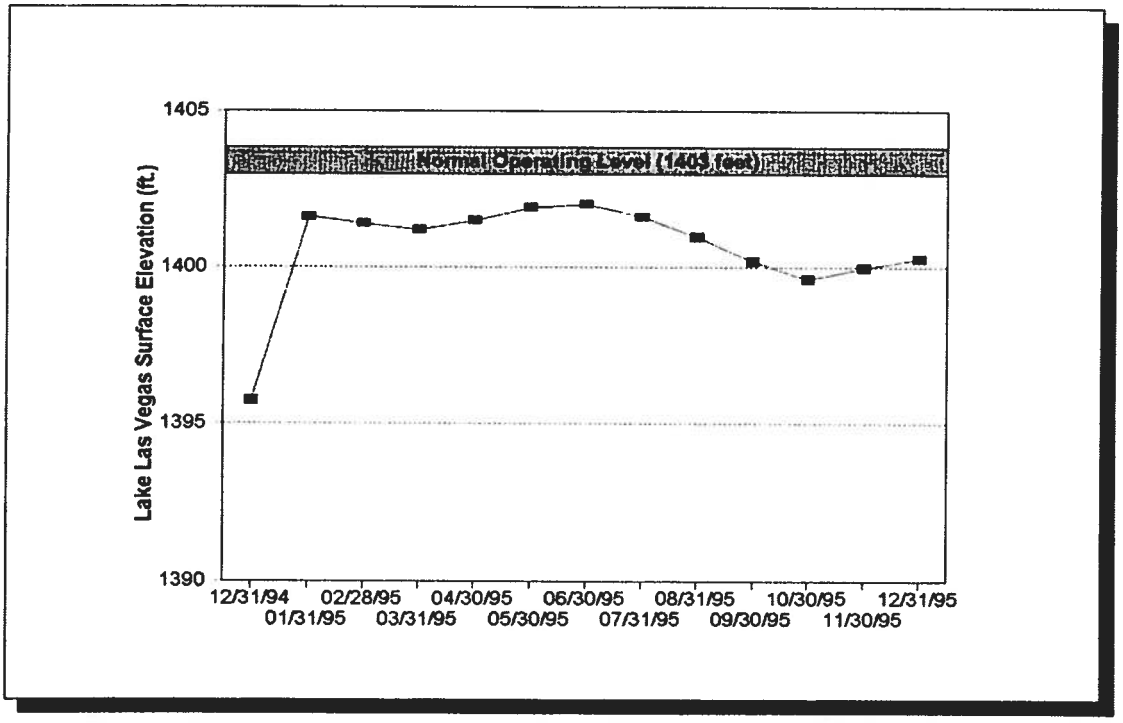

Figure 4. Surface water elevations in Lake Las Vegas during January 1 - December 31, 1995.

Table 3. Volumes of stormwater inflows into Lake Las Vegas from floods in Las Vegas Wash during 1992 - 1995.

Date	Stormwater Volumes (acre feet)
January 6, 1992	48
February 13, 1992	472
March 8, 1992	569
March 27, 1992	1087
March 28, 1992	109
March 30, 1992	470
March 31, 1992	603
October 25, 1992	330
February 8, 1993	1785
January 10, 1995	497
January 11, 1995	453
January 25, 1995	452
January 26, 1995	627
Total	7502

Table 4. Monthly inflows (acre feet) to Lake Las Vegas from Lake Mead during 1995.

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
21	273	147	258	304	310	254	69	13	179	100	264

B. **Quality Control**

There was less than 5% difference between field duplicates for temperature, dissolved oxygen, pH, conductance, TDS and transparency (Table 5). Differences between duplicates were less than 20% for all constituents, except for chlorophyll-a, which had a 22 % difference (Table 5). Chlorophyll-a concentrations were quite low in Lake Las Vegas and near the limits of detection. A 22% variation between duplicates seems high but only represents a concentration difference of a few parts per billion.

Table 5. Precision estimates for physical measurements and chemical and biological constituents based on analyses of field duplicate samples collected in Lake Las Vegas during 1995.

Statistics	Temperature (°C)	Oxygen (mg/l)	Conductance (µM/cm)	pH (Std. Units)	TDS (mg/l)	TSS (mg/l)	Turbidity (NTU)	Transparency (m)
Average % Difference	0.5	2.6	0.3	0.1	1.2	19.8	6.0	2.9
Standard Deviation	0.6	3.9	0.3	0.1	0.9	22.2	6.4	4.1
Number of Observations	33	33	33	32	35	31	35	31

Table 5. continued.

Statistics	Ammonia-N (µg/l)	Nitrite+Nitrate-N (µg/l)	Total-N (µg/l)	Ortho-P (µg/l)	Total-P (µg/l)	Chlorophyll-a (µg/l)
Average % Difference	20.2	4.9	12.2	20.4	18.9	21.9
Standard Deviation	16.3	7.9	20.4	21.7	19.5	18.1
Number of Observations	34	35	21	33	34	33

C. Variations in Water Quality

Physical Measurements

Surface temperatures in Lake Las Vegas ranged from 8 - 10°C at all stations during January and February 1995 (Figure 5). Temperatures increased steadily during March and April. Surface temperatures reached 14°C by the end of March, nearly 3°C higher than bottom temperatures (Figure 6). Surface temperatures continued to increase in May and July (Figure 5). The lake was stratified by June with the thermocline located between 10 and 15 m (Figure 6). The maximum surface temperatures of 28 - 29°C occurred during August. Temperatures gradually decreased during September (Figure 5). The lake began mixing in late September as the thermocline dropped to between 20 and 25 m (Figure 6). Bottom temperatures were about 16°C. Surface temperatures dropped sharply in October - December. Temperatures were back to about 11°C, throughout the water column by mid-December (Figure 6). There were minor differences in surface temperatures among the main-lake stations throughout the year (Figure 5).

Dissolved oxygen (DO) concentrations in surface waters ranged from highs of 11 - 11.5 mg/l during winter months to lows of 8 - 8.5 mg/l during the summer (Figure 7). There were minor differences in surface DO concentrations at the main-lake stations. Some oxygen depletion developed in deep water by late March when DO dropped in 4.5 mg/l in the hypolimnion (Figure 8). DO concentrations in the hypolimnion were less than 0.5 mg/l during summer and early fall. Hypolimnetic DO concentrations were replenished in the fall when the lake mixed. DO concentrations ranged from 11.0 - 11.5 mg/l throughout the water column by mid-December (Figure 8).

There were some seasonal variations in pH of surface waters in Lake Las Vegas during 1995 (Figure 9). The lowest pH of about 7.7 - 7.9 occurred during fall and winter months, and the highest pH of about 8.1 - 8.3 occurred during spring and early summer. There were some vertical variations in pH during thermal stratification (Figure 10). The pH dropped from about 8.1 - 8.2 in the epilimnion to about 7.2 - 7.3 in the hypolimnion in late June and September (Figure 10). The pH was nearly uniform throughout the water column by mid-December when the lake was completely mixed.

Conductance was about 2700 µmho/cm in surface waters of Lake Las Vegas during early January 1995 (Figure 11). The stormwater inflows during mid and late January reduced conductance in surface waters to 2550 - 2600 µmho/cm at all stations (Figure 11). Conductance increased steadily during the spring and early summer, reaching a maximum of 3000 µmho/cm by August (Figure 11). Inflows of freshwater from Lake Mead caused conductance to decrease at the uplake station, LLV-3, on a couple of occassions during the spring. Conductance decreased to about 2850 µmho/cm in surface waters in the fall and winter, most likely due to mixing and higher inflows of Lake Mead water. There were slight vertical differences in conductance during thermal stratification, with the highest values typically occurring at the surface (Figure 12).

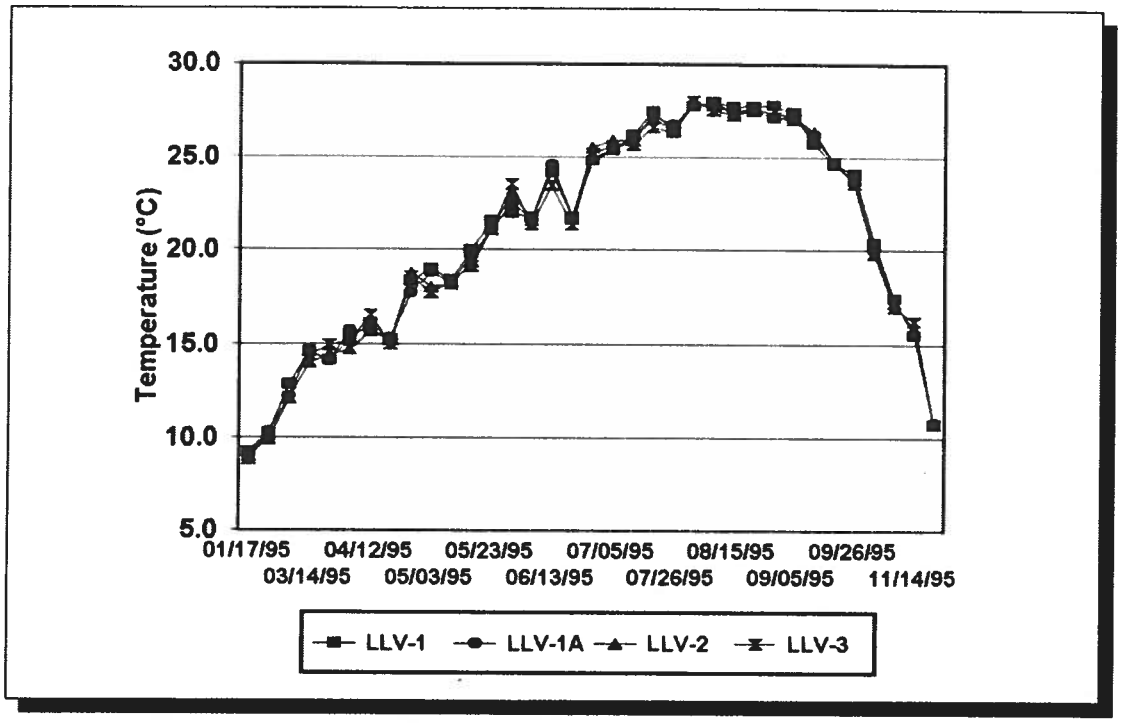

Figure 5. Temperatures in surface waters (0 m) at main-lake stations in Lake Las Vegas during January - December 1995.

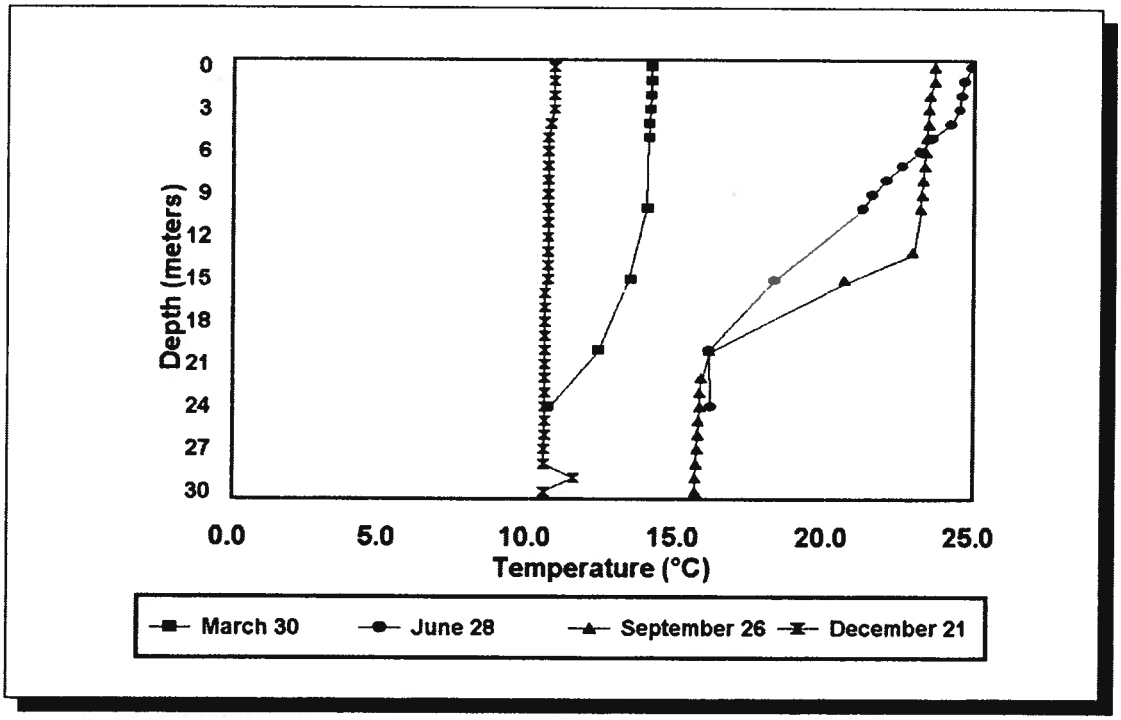

Figure 6. Temperature profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

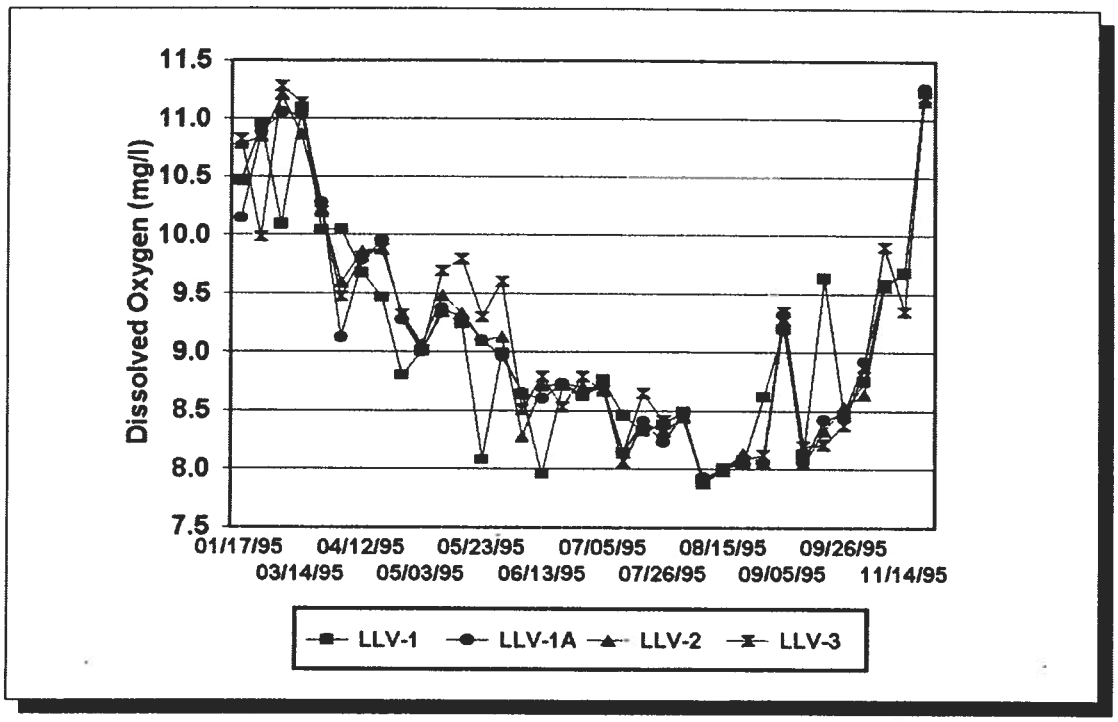

Figure 7. Dissolved oxygen in surface waters (0 m) at main-lake stations in Lake Las Vegas during January - December 1995.

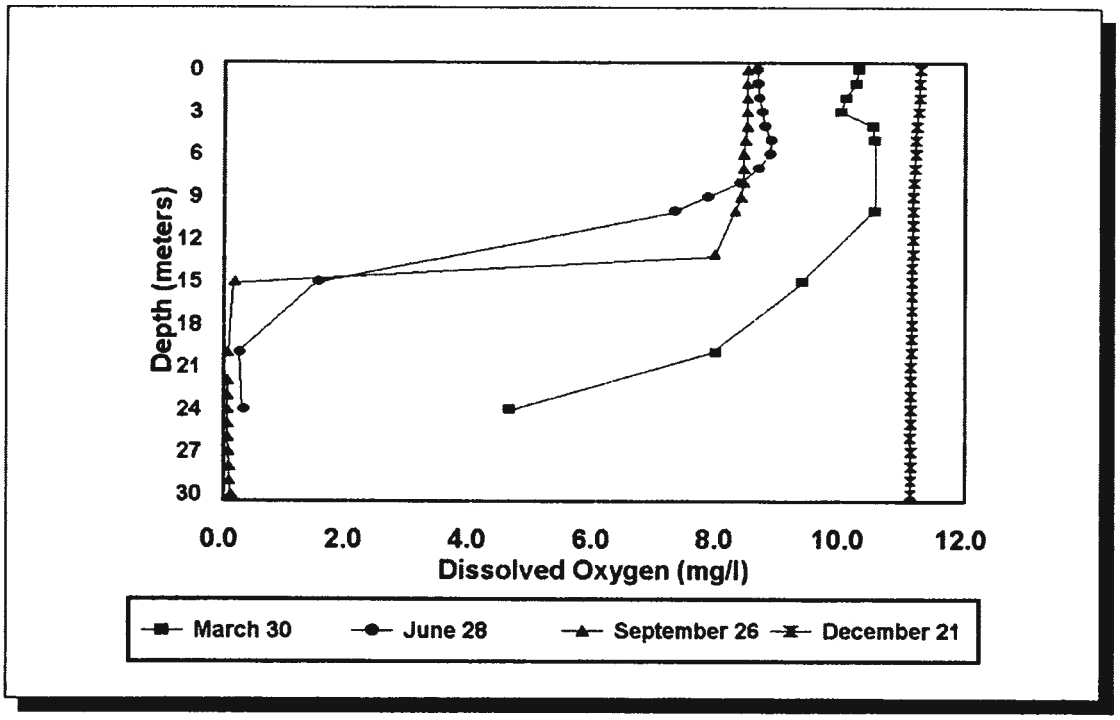

Figure 8. Dissolved oxygen profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

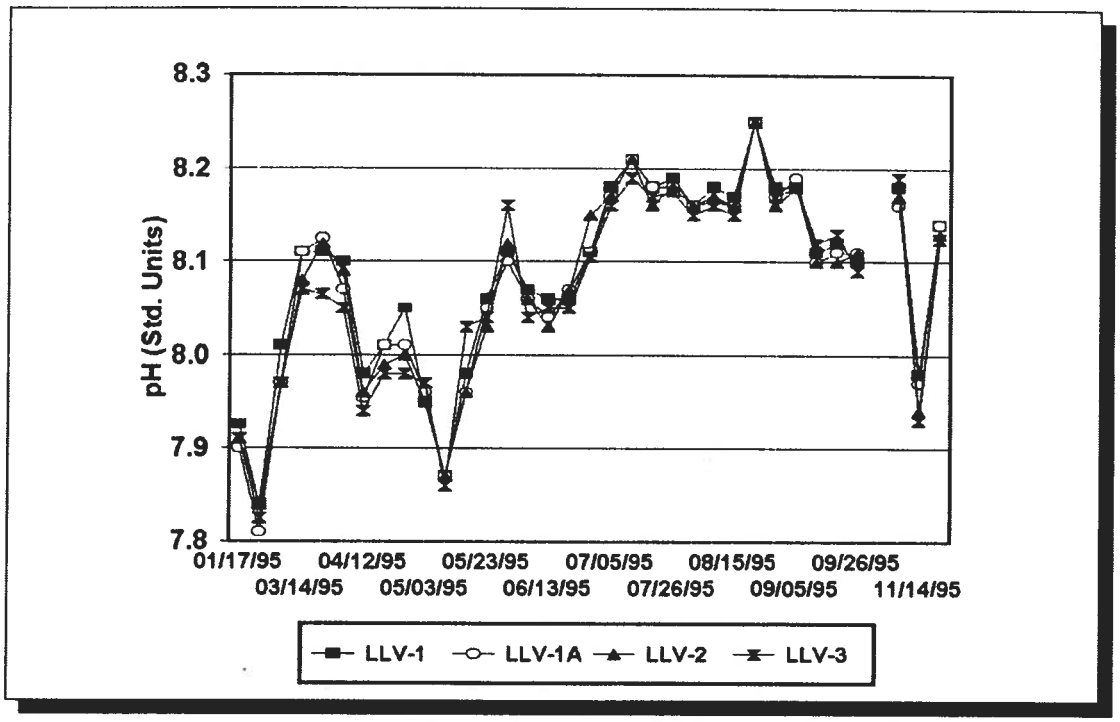

Figure 9. pH in surface waters (0 m) at main-lake stations in Lake Las Vegas during January - December 1995.

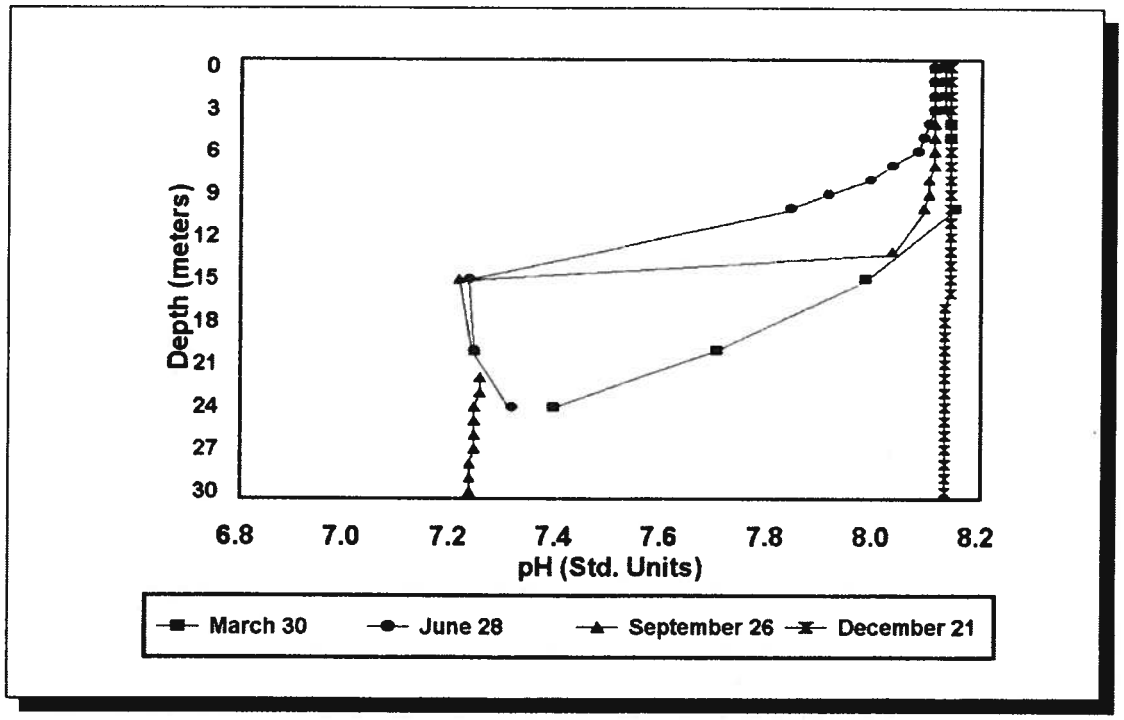

Figure 10. pH profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

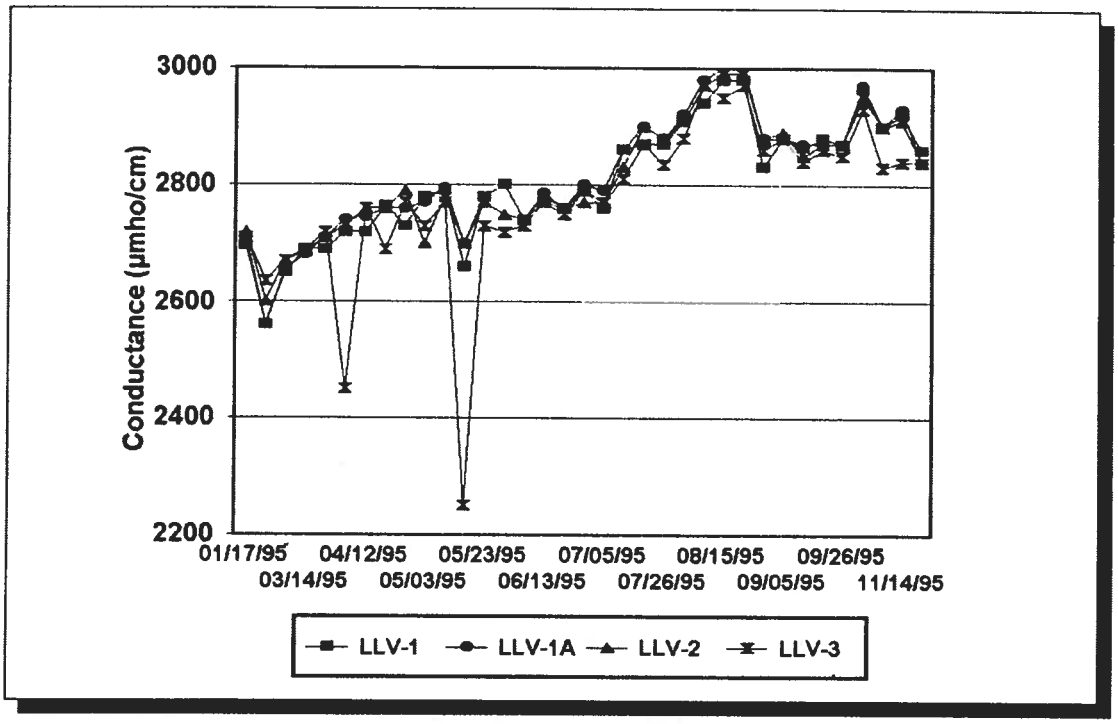

Figure 11. Conductance in surface waters (0 m) at main-lake stations in Lake Las Vegas during January - December 1995.

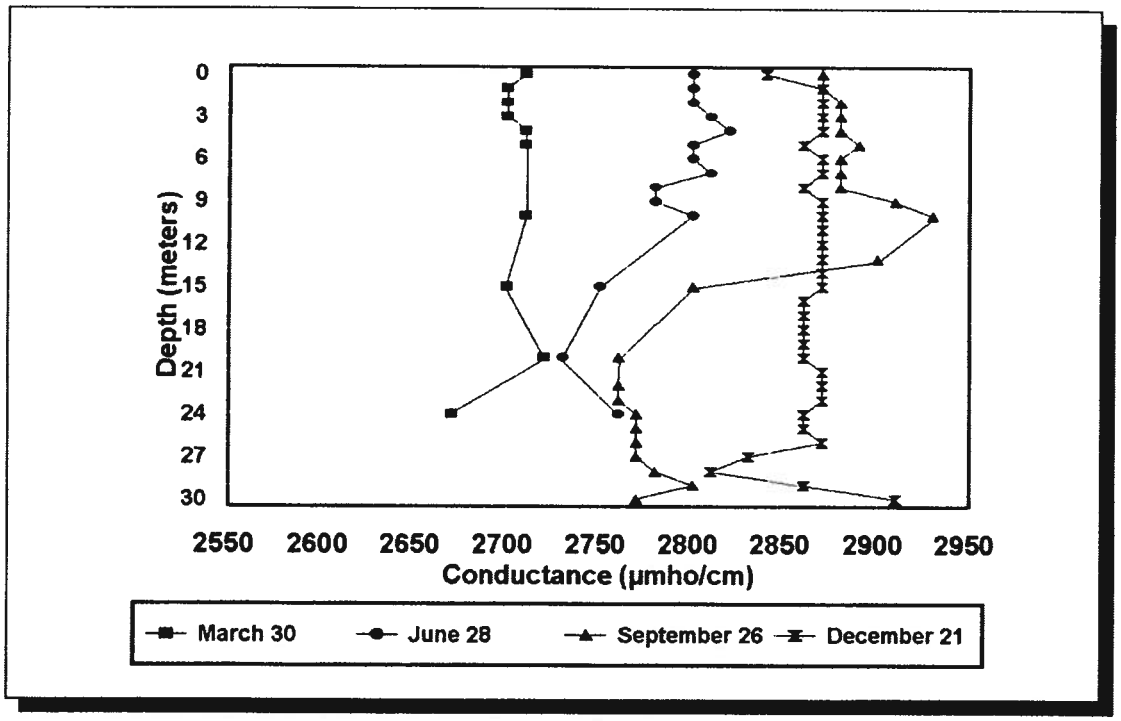

Figure 12. Conductance profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

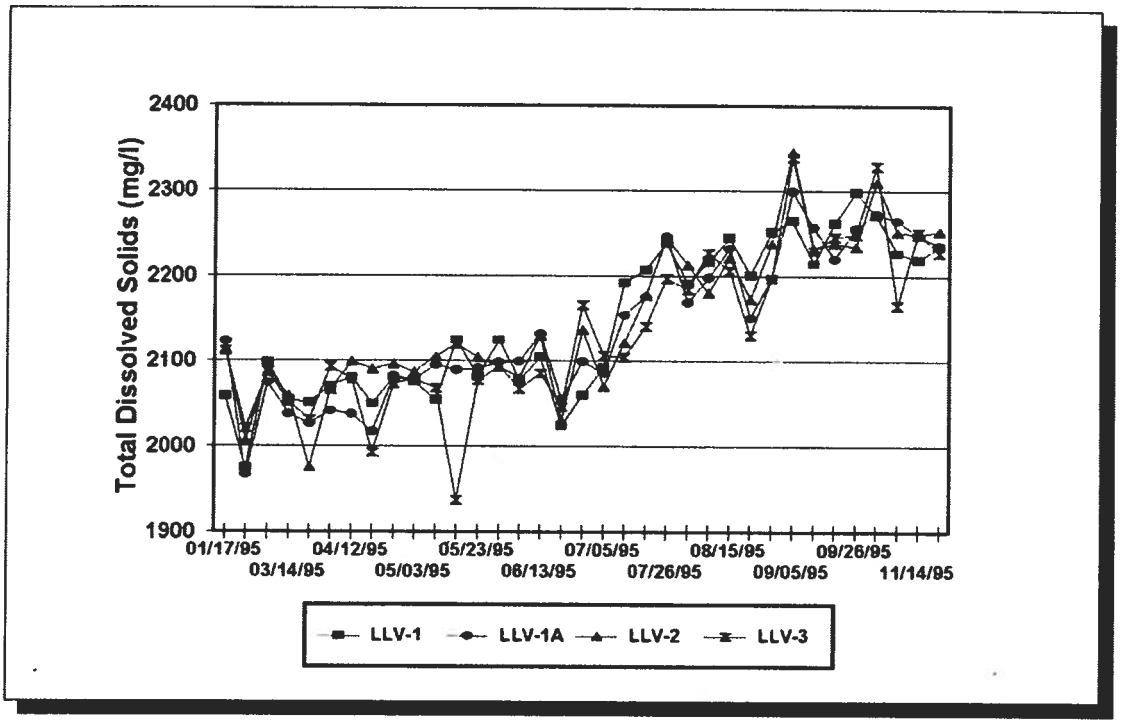

Figure 13. TDS in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995.

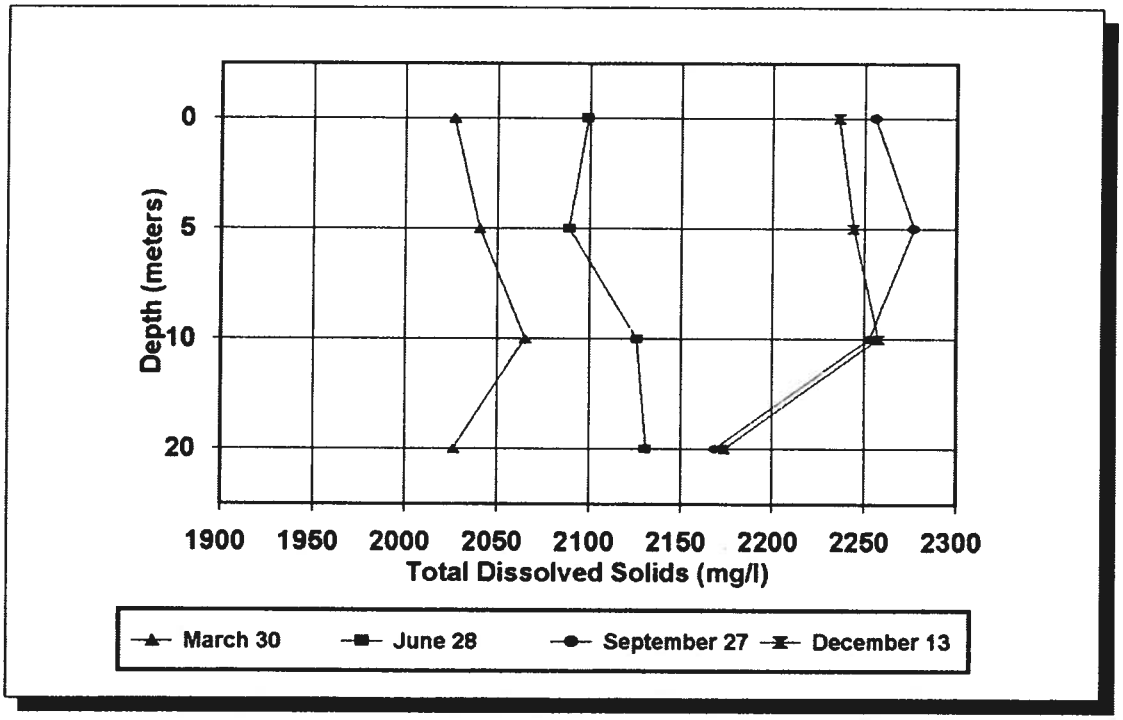

Figure 14. TDS profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

The same trends were evident in total dissolved solids (TDS) concentrations as in conductance measurements. TDS in surface waters increased from lows of about 2100 - 2200 mg/l in January to annual highs of about 2300 mg/l by late summer (Figure 13). TDS decreased back to 2200 - 2300 mg/l throughout the lake during fall and winter. There were minor vertical variations in TDS in Lake Las Vegas during 1995 (Figure 14).

Nutrient Concentrations

Nutrient concentrations in Lake Las Vegas varied considerably with depth and season (Figures 15 - 24). Ortho-phosphorus concentrations in surface waters were quite variable, ranging up to over 50 µg/l after the January stormwater inflows (Figure 15). Ortho-phosphorus decreased to levels ranging from 1 - 2 µg/l by spring and remained there for the rest of the year. Ortho-phosphorus concentrations increased in the hypolimnion during the spring, summer and fall (Figure 16). Ortho-phosphorus reached levels of nearly 25 µg/l near the bottom in late September. By December, after the lake had mixed, ortho phosphorus concentrations were 1 - 2 µg/l throughout the water column (Figure 16).

Total phosphorus concentrations in surface waters were quite variable throughout the year, ranging from lows of about 5 - 10 µg/l to highs near 50 - 70 µg/l (Figure 17). Total phosphorus increased at all stations after the January stormwater inflows. Concentrations of total phosphorus usually were highest at the up-lake station, LLV-3. Total phosphorus in the hypolimnion increased to levels of 30 - 40 µg/l during thermal stratification (Figure 18). Total phosphorus concentrations were nearly uniform throughout the water column by mid-December.

Ammonia-N concentrations in surface waters reached levels of 400 - 700 µg/l after the January floods. (Figure 19). Ammonia-N decreased steadily to lows of 5 - 10 µg/l by mid-April (Figure 19). Ammonia-N in surface waters increased again during May followed by another decrease during in June - August. Ammonia-N increased from lows of about 10 µg/l in early Septmber to about 100 - 200 µg/l during the fall and winter (Figure 19). Ammonia-N was nearly 700 µg/l in the hypolimnion by late September (Figure 20).

Nitrite+nitrate-N concentrations in surface waters were about 400 - 500 µg/l during early January 1995 (Figure 21). Nitrite+nitrate-N concentrations increased to nearly 1200 mg/l at some stations after the January floods (Figure 21). Concentrations of nitrite+nitrate-N in surface waters decreased to about 700 µg/l after the floods, followed by a slight increase during early summer. Nitrite+nitrate-N concentrations dropped steadily after early July and were about 400 µg/l at all stations by mid-December. There were only minor variations in nitrite+nitrate-N concentrations among the four main-lake sampling stations throughout the year. Nitrite+nitrate-N concentrations were nearly uniform top to bottom late March and June and December (Figure 22).

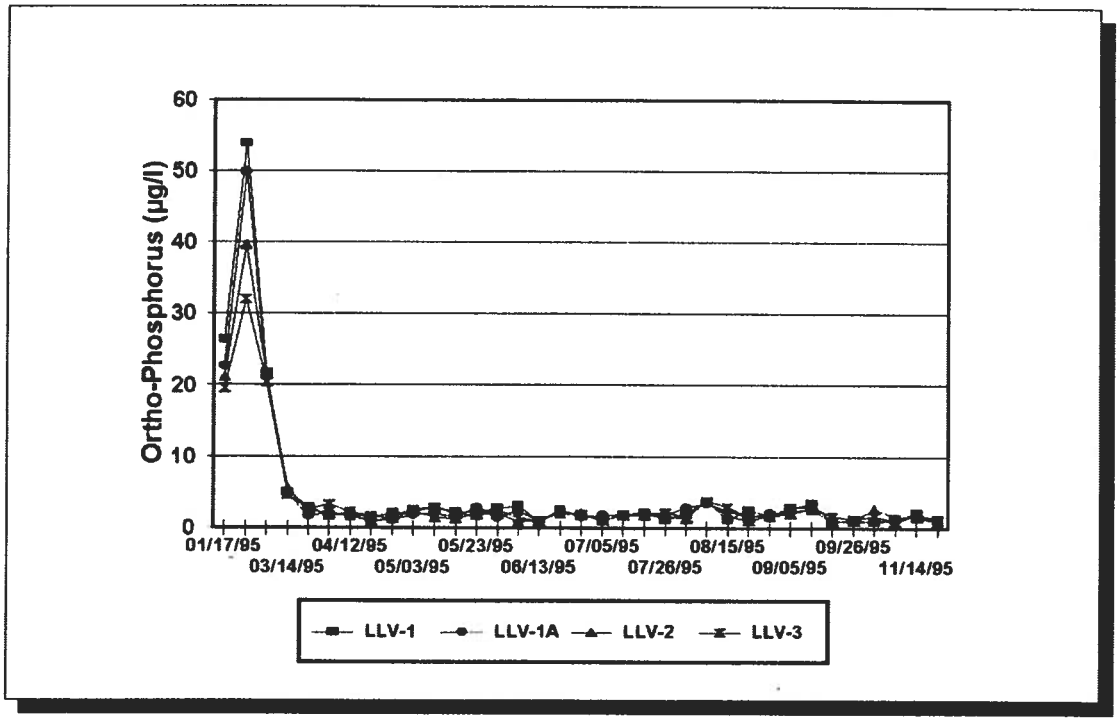

Figure 15. Ortho-phosphorus in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995

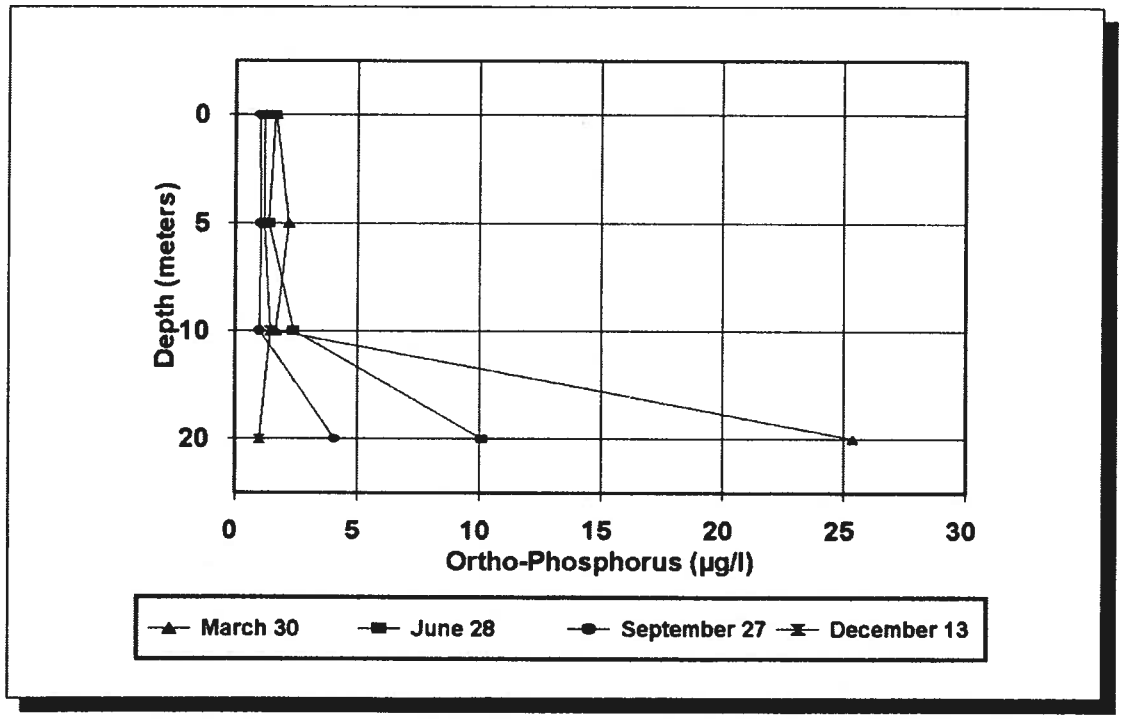

Figure 16. Ortho-phosphorus profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

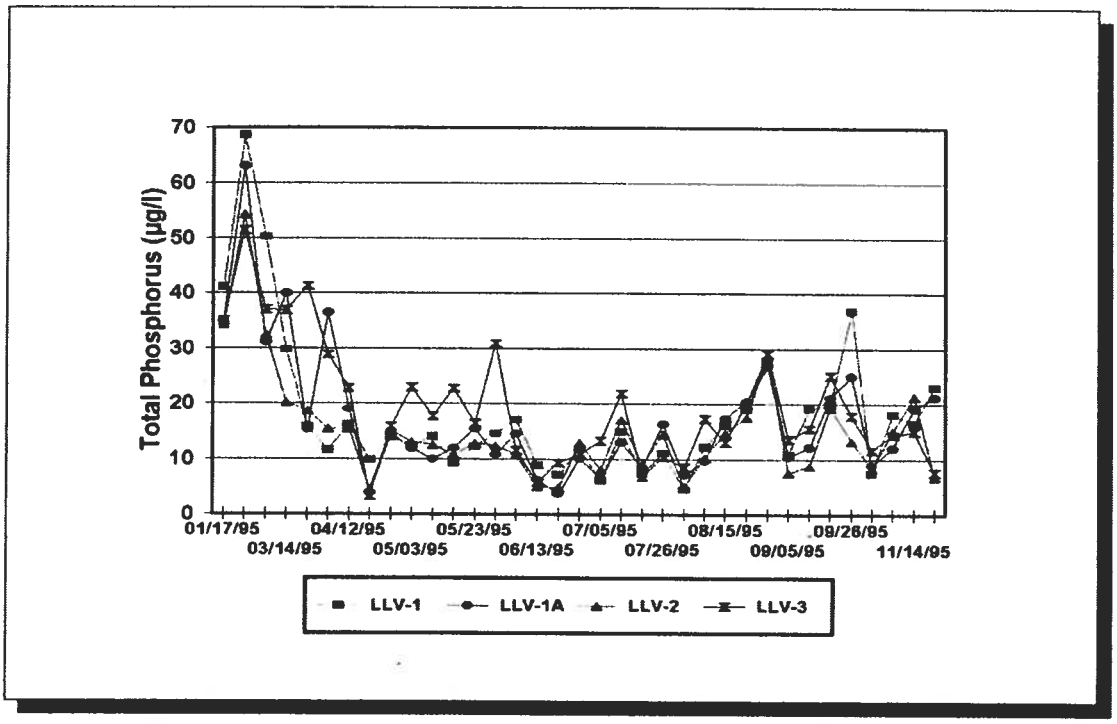

Figure 17. Total phosphorus in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995

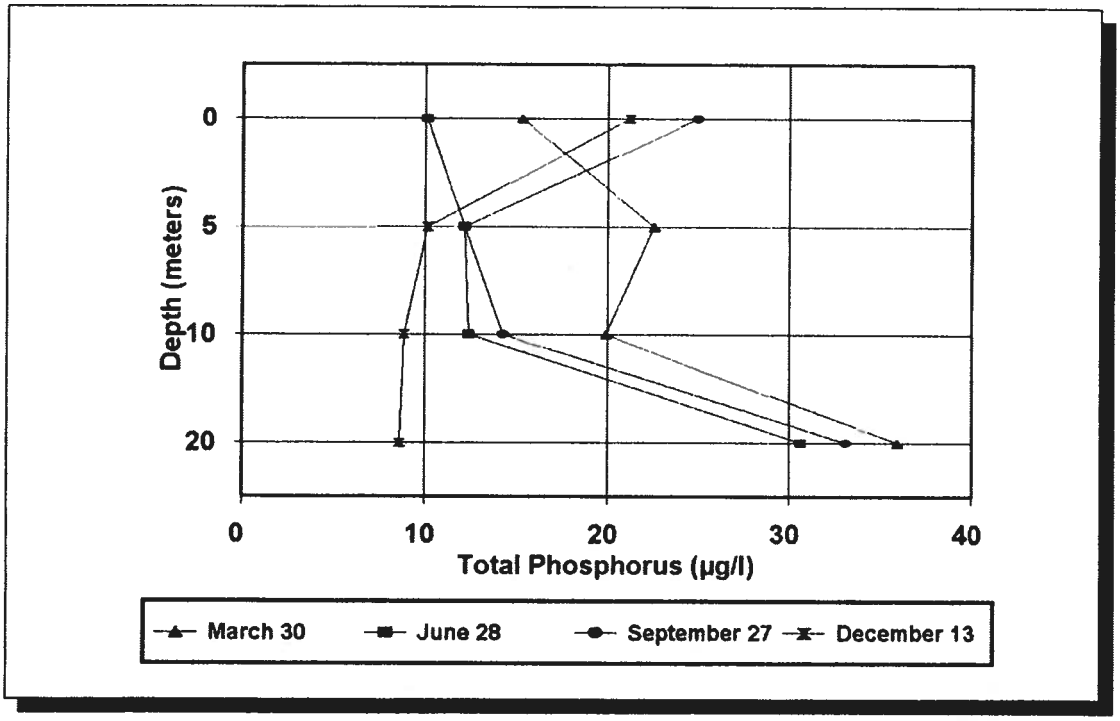

Figure 18. Total phosphorus profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

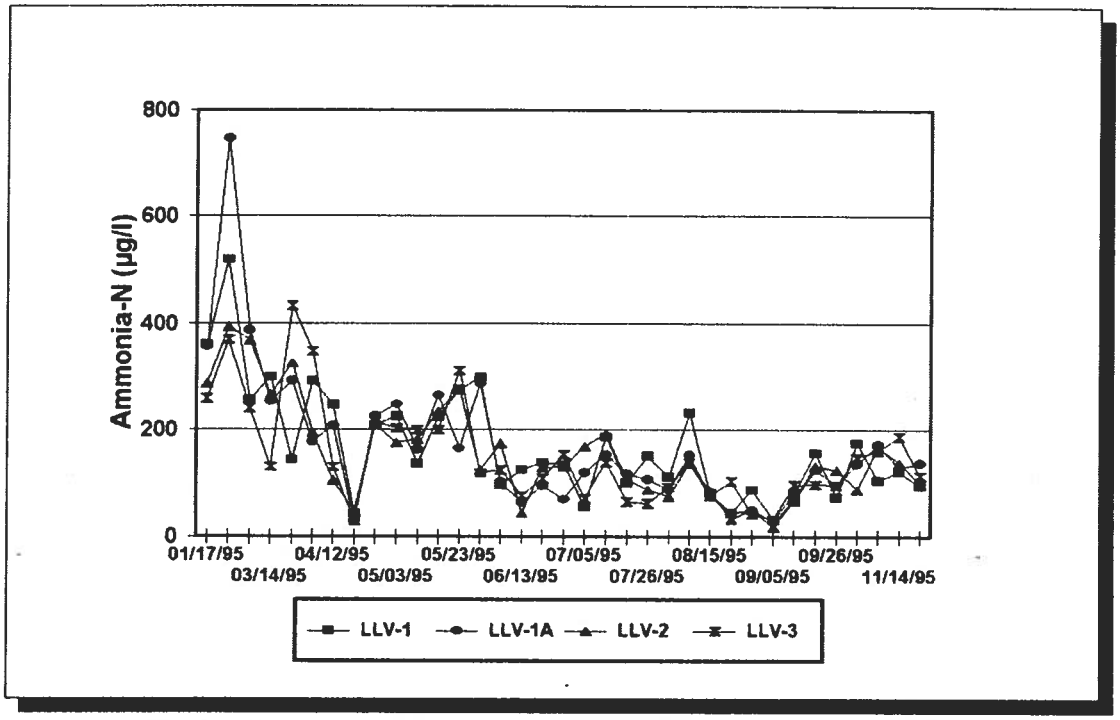

Figure 19. Ammonia-N in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995

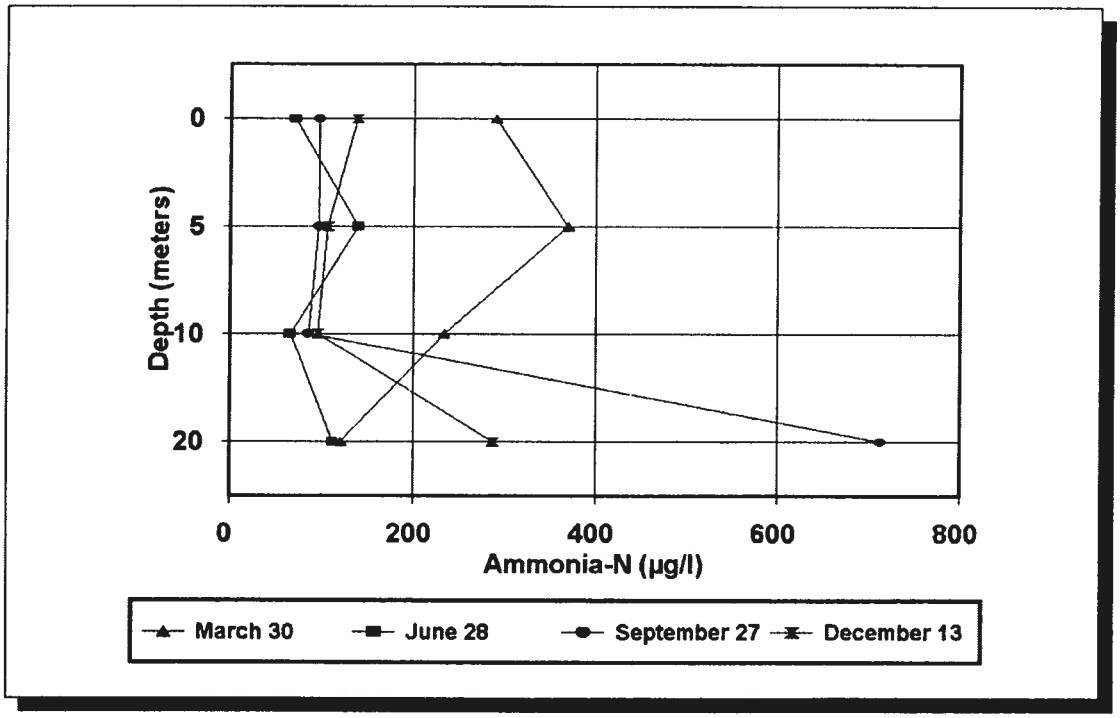

Figure 20. Ammonia-N profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

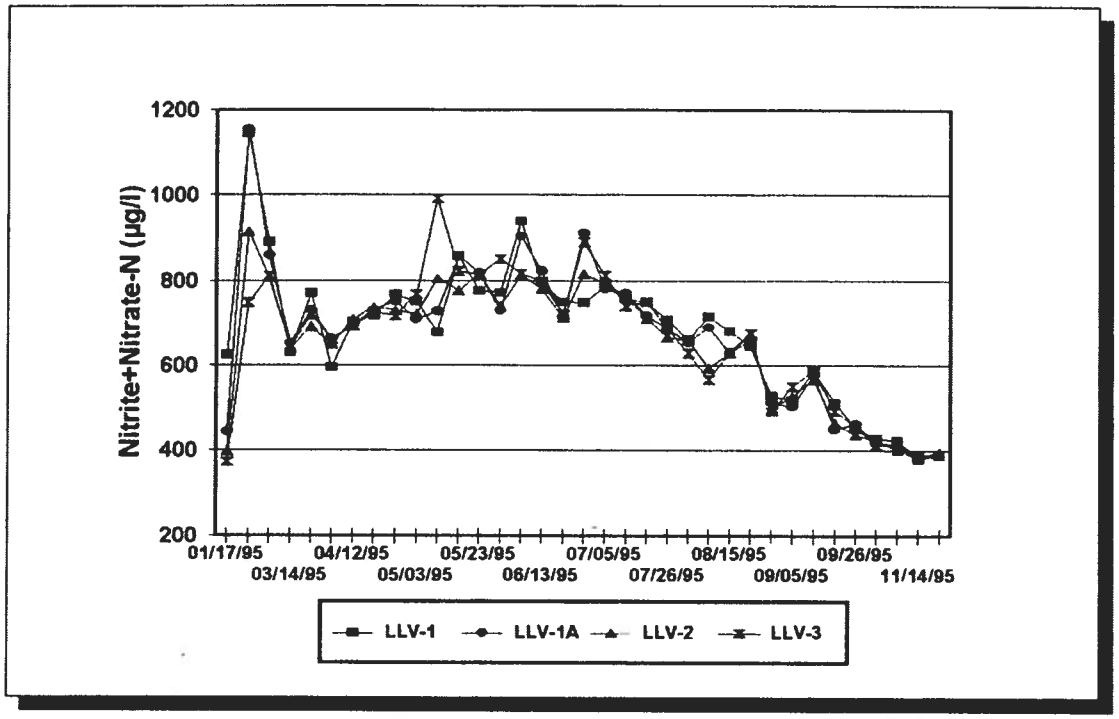

Figure 21. Nitrite+nitrate-N in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995

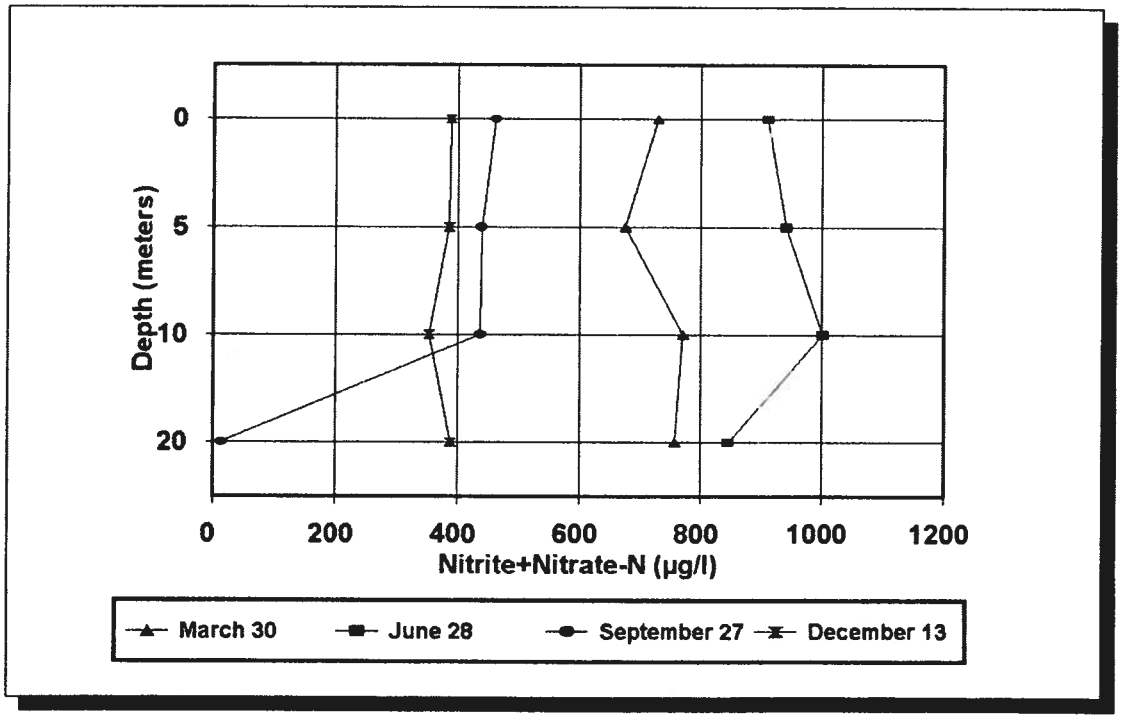

Figure 22. Nitrite+nitrate-N profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

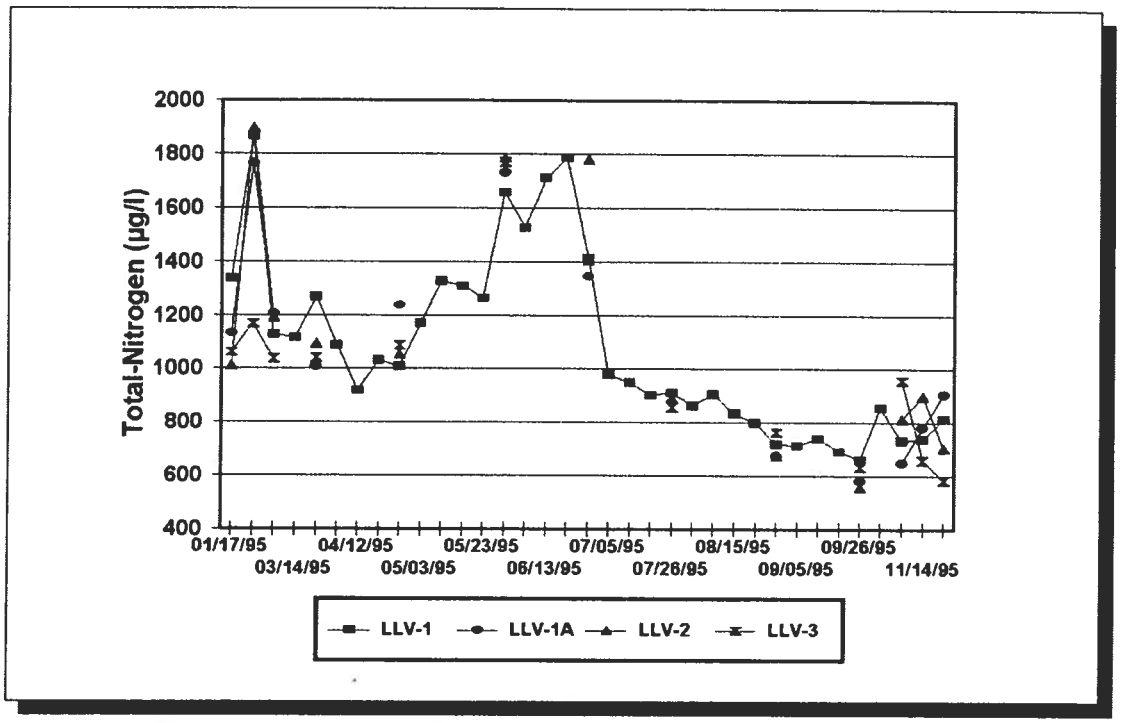

Figure 23. Total nitrogen in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995

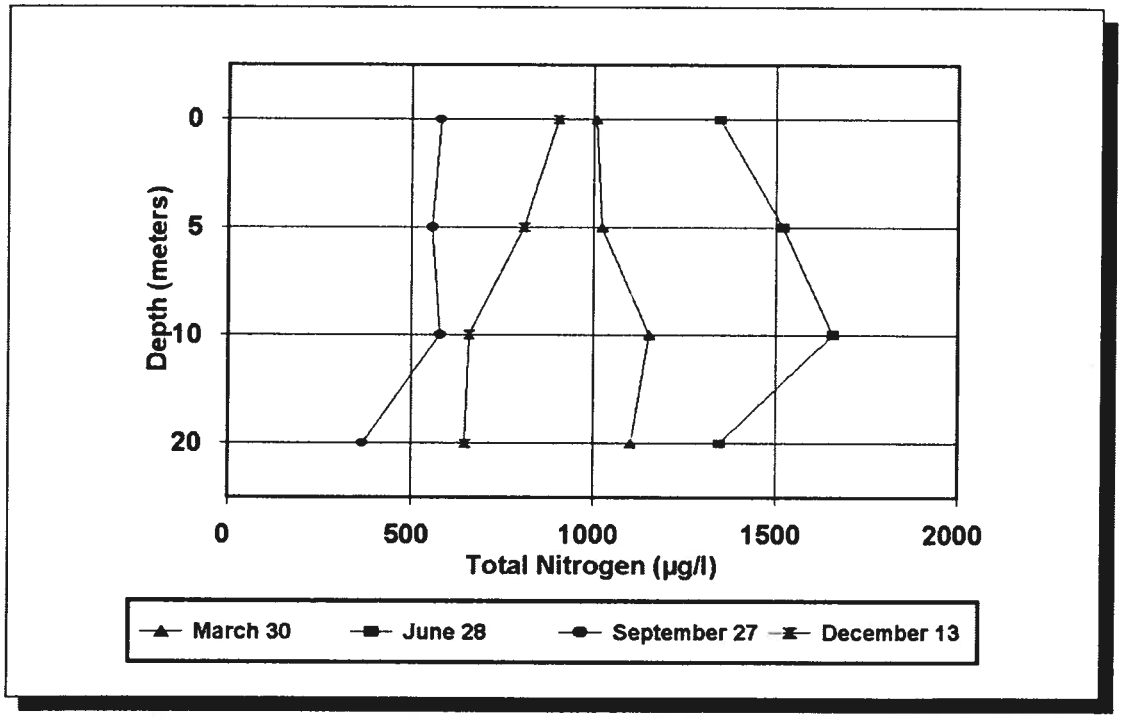

Figure 24. Total nitrogen profiles at station LLV-1A in Lake Las Vegas during March, June, September, and December 1995.

Nitrite+nitrate-N dropped to < 5 µg/l in the hypolimnion during September, most likely due to denitrification under the anaerobic conditions (Figure 22).

Total nitrogen concentrations reached a maximum of about 1800 µg/l after the January stormwater inflows (Figure 23). Total nitrogen concentrations decreased during spring, followed by an increase again during June (Figure 23). Total nitrogen concentrations decreased again July and August and reached their mimimum of about 700 µg/l during late September. Total nitrogen concentrations were slightly lower in the hypolimnion than epilimnion during late March June and September (Figure 24). During mid-December, total nitrogen was about 900 µg/l at the surface and about 600 µg/l near the bottom.

Transparency/Turbidity

There were considerable seasonal and spatial variations in transparency in Lake Las Vegas during 1995. Transparency typically was highest at the down lake stations, LLV-1 and LLV-1A (Figure 25). Transparency at station LLV-3 in the upper end of the lake rarely exceeded 4 m (Figure 25).

Transparency varied considerably at all stations throughout the year (Figure 25). Transparency was lowest during May and July - August when it ranged between 1 - 4 m at all stations. Transparency was highest at the main-lake stations, where it ranged as high as 8 - 11 m, during late February and early March (Figure 25). Transparency was also quite high during late June and early July when it was about 6 - 8 m at the down lake stations. Transparency decreased back to about 2 - 5 m at all stations again in late summer, followed by an increase again in the early fall. Transparency was about 3 -5 m at all stations by the end of the year.

Transparency varied inversely with changes in turbidity and total suspended solids (TSS), although there was considerable variability in TSS. TSS in surface waters reached levels near 20 mg/l (Figure 26), and turbidity ranged as high as 7.0 NTU (Figure 27) at the up lake station, LLV-3. Turbidity typically was about 2 - 4 NTU and TSS 1 - 5 mg/l at the down-lake stations. Turbidity and TSS were extremely variable at the up-lake station throughout the year. This is largely due to wind driven, re-suspension of fine sediments deposited in that part of the lake during stormwater spills. When high winds blow from the south - southeast, sediments frequently are transported down-lake as far as the dam. Shoreline erosion also contributes to high turbidity in the lake during windy days.

Major Ion Concentrations

Salinity in Lake Las Vegas was dominated by calcium and sulfate (Table 6). Sulfate concentrations averaged about 900 mg/l at station LLV-1A on March 30. Calcium averaged about 235 mg/l on that date. Collectively, these two ions comprised about 55% of the TDS. Concentrations of sodium, chloride, and bicarbonate also are

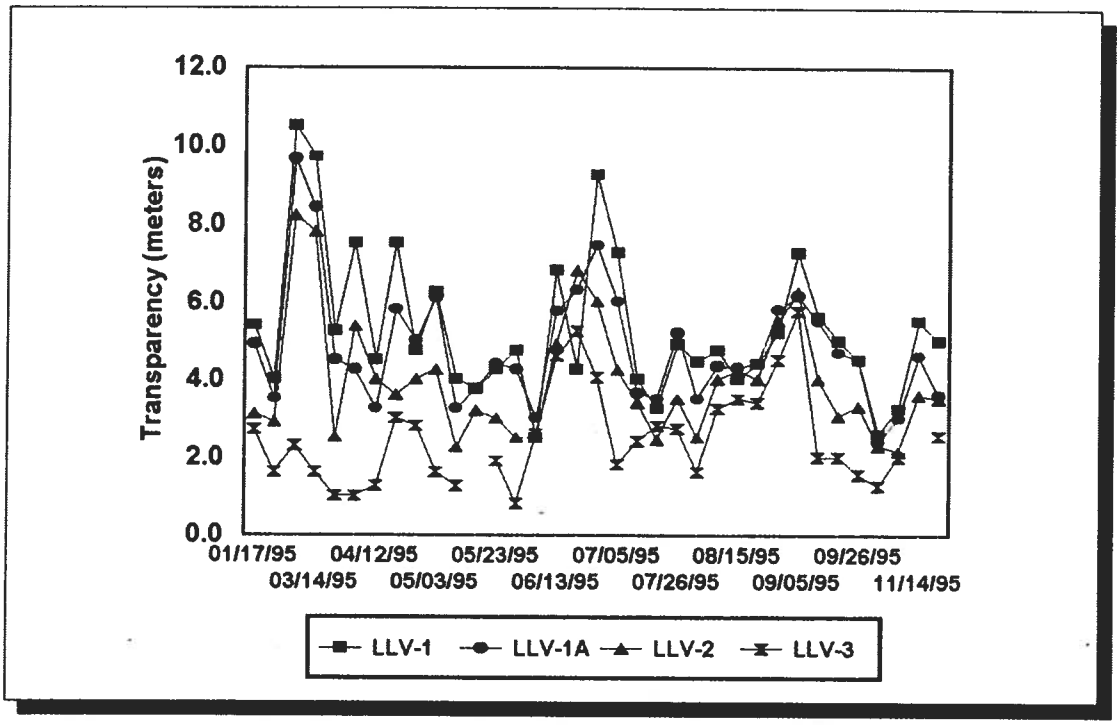

Figure 25. Transparency in surface waters at main-lake stations in Lake Las Vegas during January - December 1995.

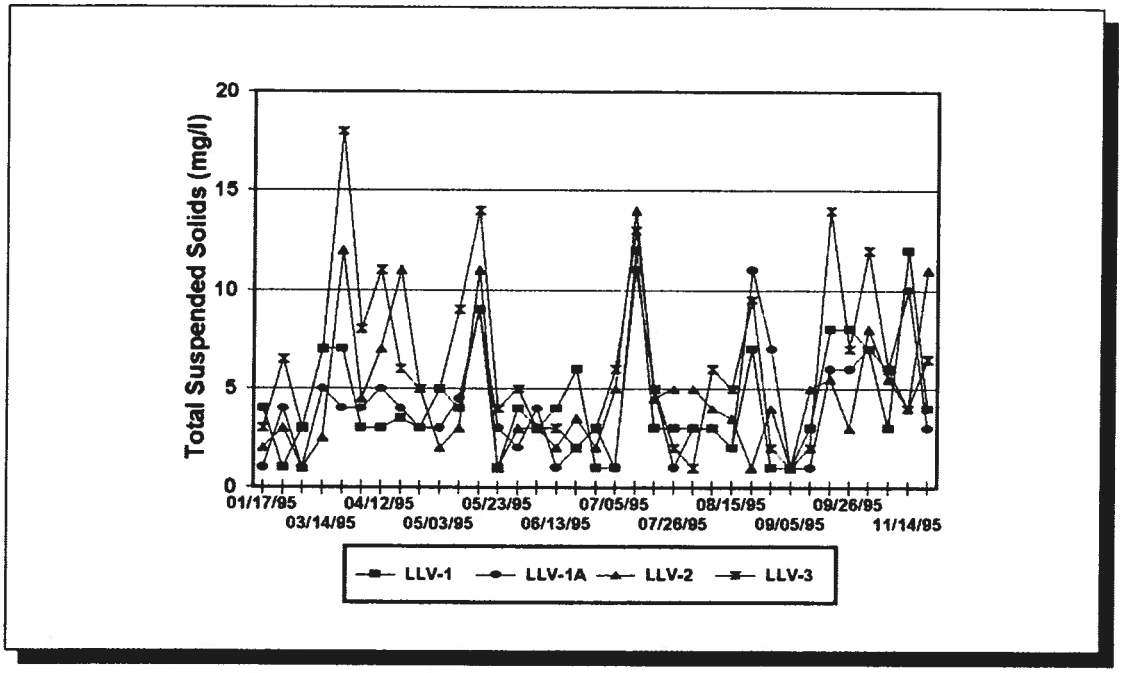

Figure 26. TSS in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995.

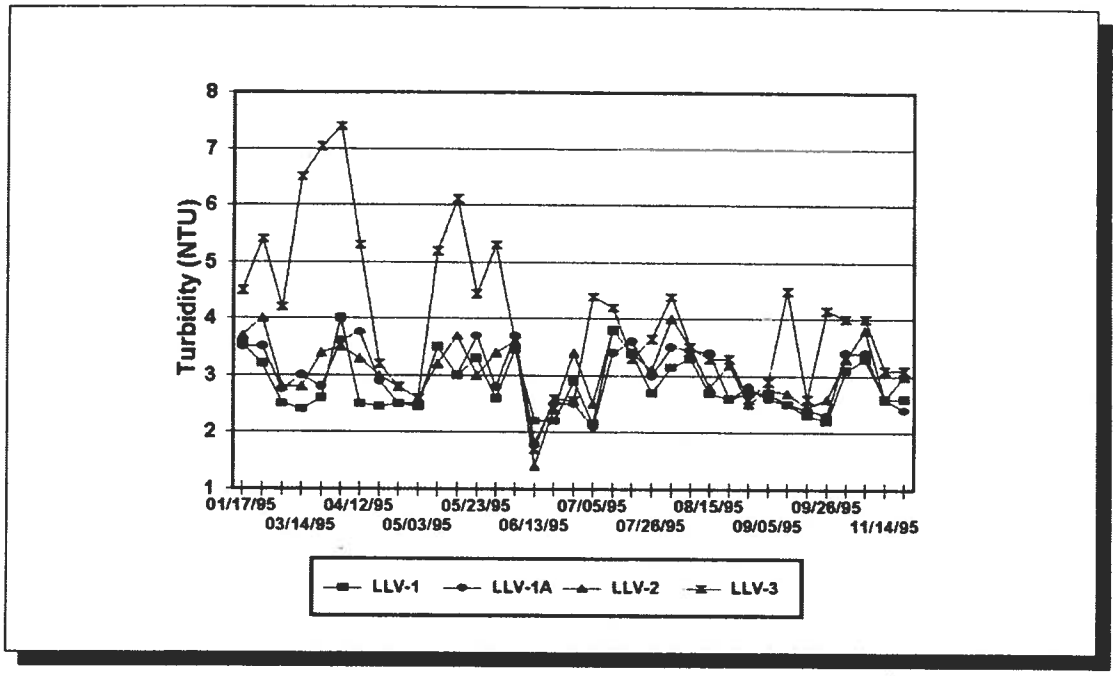

Figure 27. Turbidity in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995.

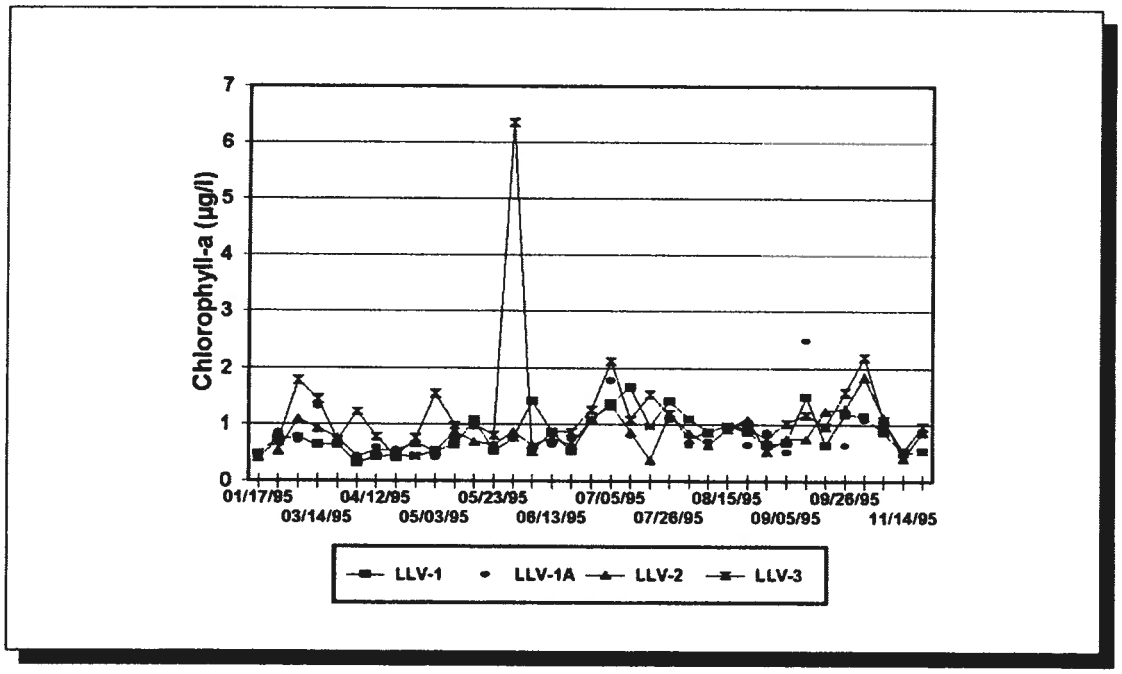

Figure 28. Chlorophyll-a in surface waters (0 - 2.5 m) at main-lake stations in Lake Las Vegas during January - December 1995.

quite high in Lake Las Vegas. Sodium was about 230 mg/l, chloride about 270 mg/l, and bicarbonate about 110 mg/l on March 30.

Concentrations of all major ions except bicarbonate increased during the year. Bicarbonate concentrations decreased from an average of about 120 mg/l on June 28 to about 96 mg/l by December 21. Bicarbonate also was the only ion where concentrations were lower in the epilimnion than hypolimnion during periods of thermal stratification. Concentrations of the other ions, and TDS, were generally similar in the hypolimnion and epilimnion.

Table 6. Major ion concentrations at various depths in Lake Las Vegas during March, June, September, and December 1995.

Date	Depth	TDS	Ca^{++}	NA^{+}	Mg^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
03/30/95	0	2026	253	228	72	24	107	267	867
03/30/95	5	2040	230	228	72	24	107	264	972
03/30/95	10	2065	227	228	72	24	110	269	972
03/30/95	20	2026	227	228	72	24	107	267	883
06/28/95	0	2099	280	254	73	19	117	278	954
06/28/95	5	2089	280	246	73	20	119	283	889
06/28/95	10	2126	280	258	71	19	119	282	1111
06/28/95	20	2131	272	242	72	20	129	274	898
09/26/95	0	2256	280	252	80	29	86	306	1231
09/26/95	5	2277	278	248	78	30	92	311	1157
09/26/95	10	2253	284	256	80	29	88	316	1116
09/26/95	20	2169	280	238	76	26	120	300	1041
12/21/95	0	2236					98	326	1319
12/21/95	5	2244	282	282	78	24	96	330	1328
12/21/95	10	2258	274	242	77	26	98	325	1372
12/21/95	20	2174	286	252	76	25	96	321	1328

Chlorophyll-a and Phytoplankton Species

Chlorophyll-a concentrations in surface waters were low, ranging from about 0.5 - 2.0 µg/l at all stations throughout most of 1995 (Figure 28). There were no significant

seasonal trends evident in the data. Chlorophyll-a increased to its highest level of 6.2 µg/l at LLV-3 during late May (Figure 28). Chlorophyll-a typically was similar at all stations, although it often was slightly higher at the up-lake station. Chlorophyll-a concentrations were only about 0.5 µg/l througout the lake during the late fall and winter.

Phytoplankton biomass in Lake Las Vegas was dominated by the green algae and small cryptophytes, chrysophytes and diatoms (Figure 29). Bluegreen algae were rare in the lake throughout the year.

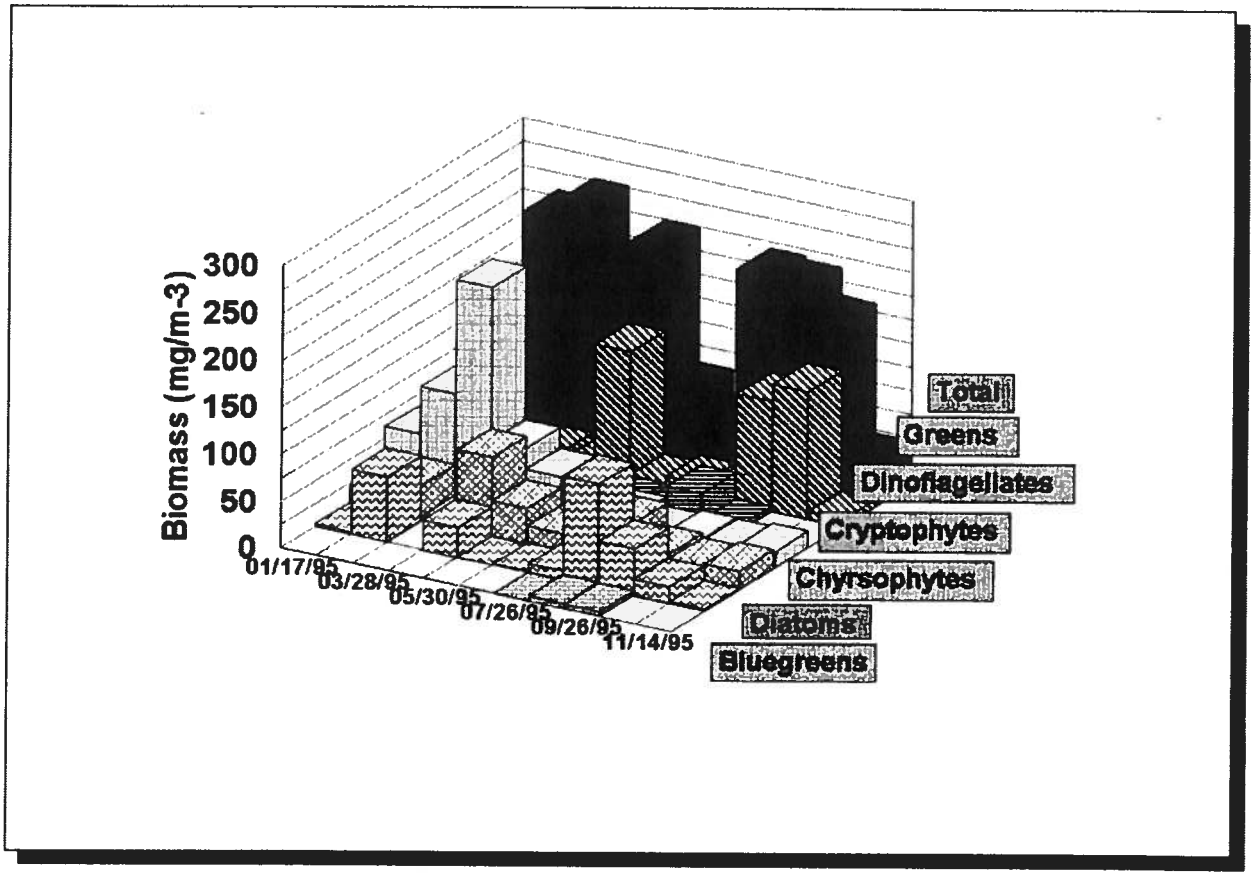

Figure 29. Abundance of major phytoplankton groups at station LLV-1 during 1995.

Numerous species of phytoplankton (open water algae) were identified in the samples collected at station LLV-1 during 1995 (Table 7). The phytoplankton community was comprised of species from six taxonomic divisions. The most diverse groups were the Chlorophyta and Cryptophyta. None of the phytoplankton species identified in Lake Las Vegas were of the noxious or "scum" forming types. There were only three species of bluegreen algae identified in the samples, and they were observed in low numbers during late summer and early fall.

Table 7. Phytoplankton species identified at 0 - 2.5 m at station LLV-1 during April - September 1995.

CHLOROPHYTA (Green Algae)

Ankyra judayi
Chlamydomonas sp.
Eudorina elegans
Oocystis borgei
Oocystis sp.
Planktonema lauterbornii
Platymonas ellipitica
Scenedesmus bijuga
Sphaerocytis schroedteri

PYRRHOPHYTA (Dinoflagellates)

Glenodinium pulvisculus
Gymnodinium sp.
Peridinuim sp.

BACILLARIOPHYTA (Diatoms)

Anomoeoneis vitrea
Cyclotella sp.
Cymbella sp.
Nitzschia sp.
Synedra sp.

CRYPTOPHYTA (Cryptomonads)

Cryptomonas erosa
Cryptomonas marssonii
Katablepharis ovalis
Rhodomonas minuta

CHRYSOPHYTA (Golden Algae)

Chrysochromulina parva
Kephyrion sp
Ochromonas sp.
Pseudopedinella erkensis

CYANOPHYTA (Bluegreen Algae)

Aphanocapsa delicatissima
Merismopedia minina
Oscillatoria limnetica

Bacteria and BOD

Recreational uses of Lake Las Vegas currently are very limited since homes are not completed or occupied by residents. Fecal coliform and BOD_5 sampling is, therefore, only done on a quarterly basis at stations LLV-1 and LLV-2. Fecal coliform counts and BOD_5 in surface waters at both stations were at or below the detection limits during each quarter of 1995 (Table 8).

Table 8. Fecal coliform counts (MPN/100ml) and biochemical oxygen demand (mg/l) in surface waters (0 - 2.5 m) at stations LLV-1 and LLV-2 during 1995.

Station	Date	Fecal Coliforms (MPN/100ml)	Biochemical Oxygen Demand (mg/l)
LLV-1	03/30/95	< 2	< 2
LLV-2	03/30/95	< 2	< 2
LLV-1	06/28/95	< 2	< 2
LLV-2	06/28/95	< 2	< 2
LLV-1	09/26/95	< 2	< 2
LLV-2	09/26/95	< 2	< 2
LLV-1	12/21/95	2	< 2
LLV-2	12/21/95	2	< 2

Toxic Substances

Water samples for toxic analyses were collected from the surface and bottom of station LLV-1 once during November 1995, when the lake was completely mixed. These samples were analyzed at the National Testing Laboratory in Cleveland, Ohio for toxic metals, trihalomethanes, pesticides, herbicides, PCBs, and various other organic and inorganic chemicals. Results of analyses for 1995 show that concentrations of sodium, chloride, sulfate, TDS, and hardness were the only constituents that exceeded the recommended MCLs (maximum contaminant levels) for minerals in drinking water (Appendix 1). Trace metals concentrations were well below the recommended MCLs. Concentrations of trihalomethanes, pesticides, herbicides and other toxic organic compounds also were below levels of detection (usually <.001 - .002 mg/l).

Pan Evaporation

A Class A evaporation pan was installed on the service spillway, just up-lake of the dam, in August 1993. Water levels in the pan were monitored frequentlythroughout 1995 and used to estimate monthly rates of pan evaporation at Lake Las Vegas

(Table 9). The highest evaporation occurred during the summer months. Pan evaporation totaled nearly 75 inches during June, July and August when southern Nevada experienced extremely hot summer air temperatures. The lowest rates of evaporation occurred during the winter months.

Table 9. Monthly rates of pan evaporation at Lake Las Vegas during 1995.

Month	Evaporation (inches)
January	2.45
February	4.05
March	-
April	9.29
May	10.59
June	12.07
July	26.62
August	27.28
September	21.36
October	11.79
November	10.97
December	8.40

Zooplankton Species Composition and Abundance

Numerous species of zooplankton have been identified in 0 - 15 m vertical plankton tows at station LLV-1 since population monitoring began in 1991 (Table 10). Rotifers are the most diverse zooplankton group in the lake with 11 species, followed by the copepods with 8 species, and cladocerans with 5 species.

Copepods, mainly the juvenile stages, dominated the population in terms of numbers during 1995 (Figure 29). They reached peak abundance during the late summer with a maximum density of over 60/liter during early August. Copepods were also quite numerous during most of the growing season.

Table 10. Zooplankton species identified in 0 - 15 m vertical plankton tows at station LLV-1 during 1991 - 1995.

COPEPODA (Copepod Zooplankton)

Cyclops sp.
Cyclops vernalis
Diacyclops biscupidatus
Diaptomus siciloides
Eurythemora sp.
Eurythemora affinis
Mesocyclops edax
Onychocamptus sp.

CLADOCERA (Cladoceran Zooplankton)

Alona guttata.
Daphnia pulex
Daphnia galeata mendotae
Bosmina longirostris
Chydorus sphaericus

ROTIFERA (Rotifer Zooplankton)

Asplanchna priodonta
Brachionus havanensis
Hexarthra sp.
Keretella cochlearis
Keretella quadrata
Lecane (Monostyla) lunaris
Lecane (Lecane) luna
Notholca sp.
Polyarthra sp.
Syncheata sp.
Testudinella sp.

Cladocerans were the second most abundant zooplankton group in the lake during 1995 (Figure 29). Cladocerans were numerous during all seasons except summer. Rotifers were present in low numbers, or not at all, throughout the year (Figure 29).

The cladocerans were comprised mainly of the large ***Daphnia*** species. These species comprise a large percentage of the zooplankton biomass because of their large size. ***D. pulex*** dominated the population throughout the year (Figure 30). ***D. galeata mendotae*** was present in very low numbers, or not at all, during most of 1995.

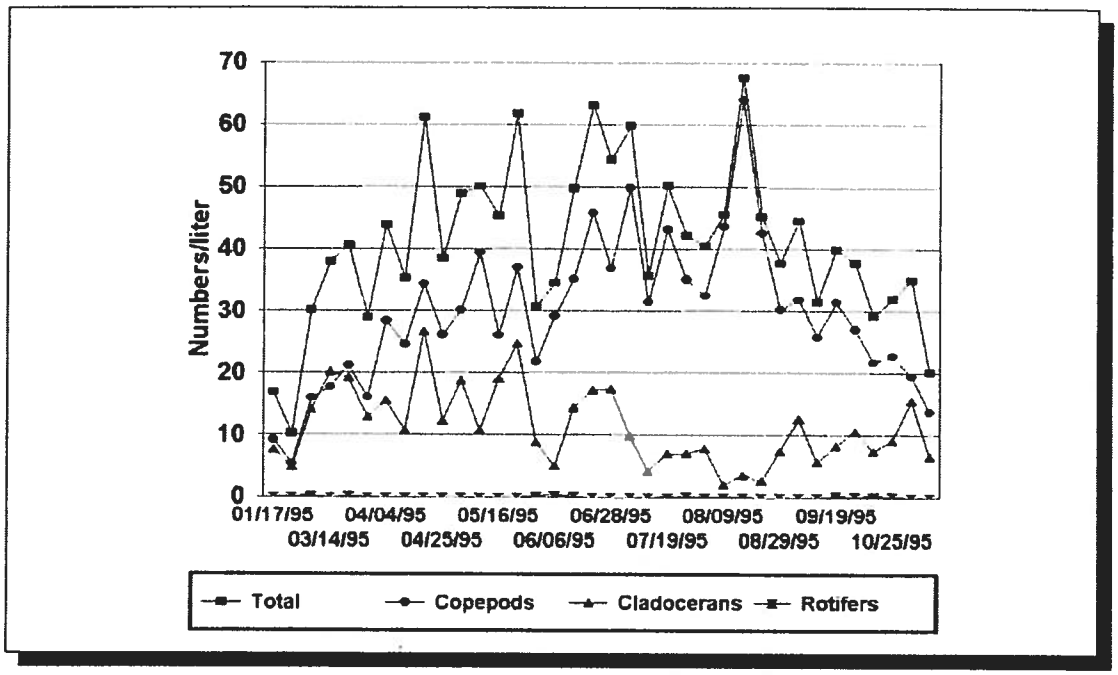

Figure 30. Seasonal changes in abundance of major zooplankton groups in 0 - 15 m plankton tows collected at station LLV-1 during January - December 1995.

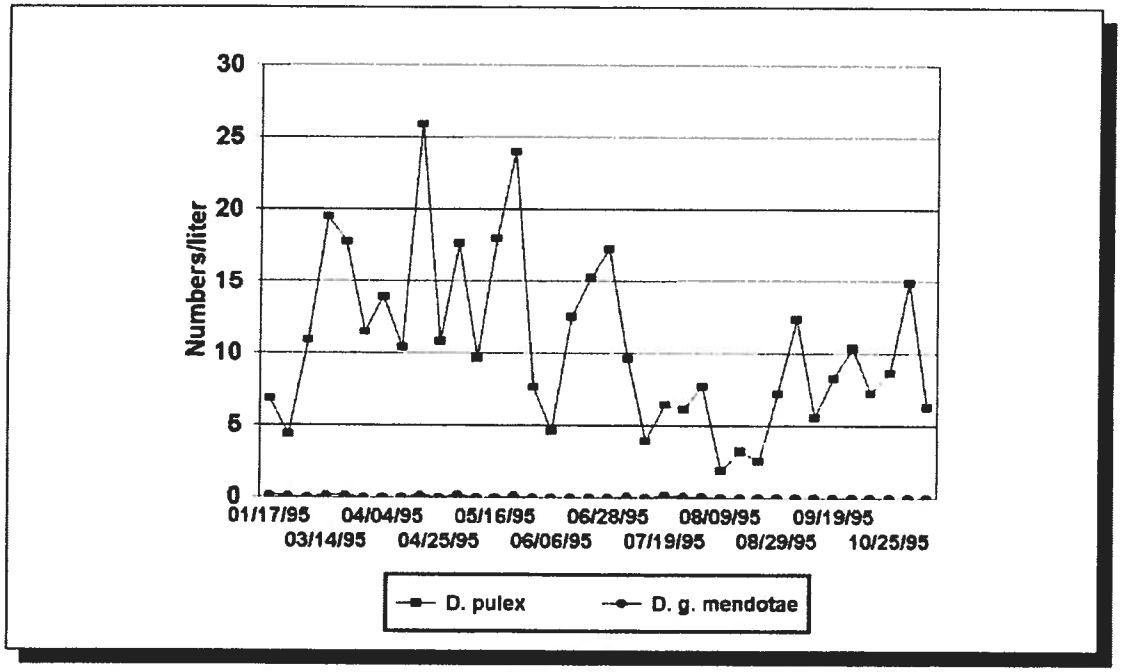

Figure 31. Seasonal changes in abundance of ***Daphnia*** species in 0 - 15 m plankton tows collected at station LLV-1 during January - December 1995.

VI. SUMMARY

Floods in Las Vegas Wash during January 1995 loaded 2030 acre feet of stormwater into Lake Las Vegas, bringing the lake to an elevation of 1402 ft., one foot from full capacity. Water for Lake Las Vegas during the rest of the year was pumped from Lake Mead. Inflows ranged from 147 - 310 acre feet per month during late winter through mid summer. Inflows were reduced considerably during August and September but then increased again in the fall. Surface elevations were about 1402 ft. at the end of the year.

Record air temperatures in southern Nevada increased surface temperatures in Lake Las Vegas to nearly 29°C in August. Pan evaporation totaled 75 inches during the hot summer months of July, August and September. TDS in Lake Las Vegas was about 2050 mg/l in surface waters early in 1995. Winter and spring inflows of freshwater from Lake Mead held TDS to below 2100 mg/l through early July. Inflows were reduced during summer. This, combined with very high rates of evaporation, increased TDS to about 2300 mg/l. TDS decreased again with inflows of freshwater during the fall, and it was about 2250 mg/l by the end of 1995. Calcium and sulfate comprised about 60% of the TDS. All ions except bicarbonate increased slightly in concentration during the year. Bicarbonate decreased slightly during 1995, most likely due to uptake of carbon by phytoplankton.

TDS in Lake Las Vegas exceeded the proposed guideline of 2000 mg/l for most of the year. The TDS guideline was established to keep salinity in the lake at levels acceptable for irrigation. The project was designed so lake waters can be withdrawn for on-site irrigation. The lake currently has no outflow and evaporation will continue to increase TDS until ions reach saturation and precipitate, or are diluted by inflows from Lake Mead. It will take several years for development to reach the point where irrigation demands are sufficient to keep TDS in the lake at acceptable levels. Initially, water drawn from the lake for irrigation may have to be blended with Lake Mead water to dilute the TDS.

Nutrient concentrations in surface waters were very high following the stormwater inflows in January. Total phosphorus concentrations reached levels of 60 - 70 µg/l. Ammonia-N increased to about 400 µg/l and nitrite-nitrate-N reached a peak of nearly 1200 µg/l. Yet, chlorophyll-a concentrations were extremely low, averaging < 1.0 µg/l for most of the year. ***Daphnia pulex**, the main* zooplankton grazer in the lake, was quite numerous most of the year, except during a brief period in late summer. Grazing is believed to be an important factor in keeping chlorophyll-a so low, despite high nutrient concentrations early in the year.

The water quality in Lake Las Vegas was within the proposed water quality guidelines for recreational uses. Chlorophyll-a was well below the proposed guideline of 5 µg/l during the April - September growing season. The chlorophyll-a guideline is

applied at that time of year to protect water quality during the peak recreation period. Fecal coliforms were at, or below, the limits of detection, as were concentrations of toxic metals, pesticides, herbicides and other toxic organic compounds. Except for TDS and related ions, water quality in Lake Las Vegas continues to be very good even though about 40 -50% of the lake's volume has come from stormwater inflows. There has been no significant outflow since the lake was first impounded in December 1990.

VII. WATER QUALITY REFERENCE DOCUMENTS

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VIII. Appendices

DATE COLLECTED	DATE RECEIVED	DATE COMPLETED	SAMPLE CODE
11/14/95	11/15/95	12/01/95	5110269

CUSTOMER ADDRESS
LIV 1A-OM
LAKE WATER

DEALER ADDRESS
WEST LAKES 2545 CHANDLER AVE. SUITE 8 LAS VEGAS, NV 89120-

WaterTest
CORPORATION OF AMERICA
28 DANIEL PLUMMER RD.
GOTTSTOWN, NH 03045

DRINKING WATER ANALYSIS RESULTS

NOTE: "*" The MCL (Maximum Contaminant Level) or an established guideline has been exceeded for this contaminant.
"ND" This contaminant was not detected at or above our stated detection level.
"**" Bacteria results may be invalid due to lack of collection information or because the sample has exceeded the 30-hour holding time.
TNTC: Too Numerous To Count NBS: No bacteria sample submitted.
TNTC-NC: Although there was no indication of Total Coliform, the number of non-coliform bacteria detected in the sample was Too Numerous To Count.

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Microbiological:			
Total coliform (organism/100ml)	0	0	PRESENCE
Inorganic chemicals - metals:			
Aluminum	0.2	0.1	0.117
Arsenic	0.05	0.010	0.015
Barium	2.0	0.30	ND
Cadmium	0.005	0.002	ND
Chromium	0.1	0.004	ND
Copper	1.3	0.004	ND
Iron	0.3	0.020	ND
Lead	0.015	0.002	0.003
Manganese	0.05	0.004	0.005
Mercury	0.002	0.001	ND
Nickel	0.1	0.02	ND
Selenium	0.05	0.002	ND
Silver	0.1	0.002	ND
Sodium	---	1.0	309
Zinc	5.0	0.004	0.008
Inorganic chemicals - other, and physical factors:			
Alkalinity (Total as CaCO3)	---	10.0	90.0
Chloride	250	5.0	282*
Fluoride	2.0	0.5	0.900
Nitrate as N	10	0.5	ND
Nitrite as N	1.0	0.5	ND
Sulfate	250	5.0	1144*
Hardness (suggested limit = 100)		10.0	1058*
pH (Standard Units)	6.5-8.5	---	7.03
Total Dissolved Solids	500	20.0	2193*
Turbidity (Turbidity Units)	1.0	0.1	0.900
Organic chemicals -			
Bromoform	0.1	0.004	ND
Bromodichloromethane	0.1	0.002	ND
Chloroform	0.1	0.002	ND
Dibromochloromethane	0.1	0.004	ND
Total THMs (sum of four above)	0.1	0.002	ND

NOTE: SODIUM REQUIRED DILUTION 1:20. CHLORIDE, FLUORIDE AND SULFATE REQUIRED DILUTION 1:10.

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Benzene	0.005	0.001	ND
Vinyl Chloride	0.002	0.001	ND
Carbon Tetrachloride	0.005	0.001	ND
1,2-Dichloroethane	0.005	0.001	ND
Trichloroethylene	0.005	0.001	ND
1,4-Dichlorobenzene	0.075	0.001	ND
1,1-Dichloroethylene	0.007	0.001	ND
1,1,1,-Trichloroethane	0.20	0.001	ND
Bromobenzene	---	0.002	ND
Bromomethane	---	0.002	ND
Chlorobenzene	0.1	0.001	ND
Chloroethane	---	0.002	ND
Chloromethane	---	0.002	ND
2-Chlorotoluene	---	0.001	ND
4-Chlorotoluene	---	0.001	ND
Dibromochloropropane (DBCP)	---	0.001	ND
Dibromomethane	---	0.002	ND
1,2-Dichlorobenzene	0.6	0.001	ND
1,3-Dichlorobenzene	0.6	0.001	ND
Dichlorodifluoromethane	---	0.002	ND
1,1-Dichloroethane	---	0.002	ND
Trans-1,2-Dichloroethylene	0.1	0.002	ND
cis-1,2-Dichloroethylene	0.07	0.002	ND
Dichloromethane	0.005	0.002	ND
1,2-Dichloropropane	0.005	0.002	ND
trans-1,3-Dichloropropene	---	0.002	ND
1,3-Dichloropropene	---	0.002	ND
2,2-Dichloropropane	---	0.002	ND
1,1-Dichloropropene	---	0.002	ND
1,3-Dichloropropane	---	0.002	ND
Ethylbenzene	0.7	0.001	ND
Ethylenedibromide (EDB)	---	0.001	ND
Styrene	0.1	0.001	ND
1,1,1,2-Tetrachloroethane	---	0.002	ND
1,1,2,2-Tetrachloroethane	---	0.002	ND
Tetrachloroethylene (PCE)	0.005	0.002	ND
1,2,4-Trichlorobenzene	---	0.002	ND
1,2,3-Trichlorobenzene	---	0.002	ND
1,1,2-Trichloroethane	0.005	0.002	ND
Trichlorofluoromethane	---	0.002	ND
1,2,3-Trichloropropane	---	0.002	ND
Toluene	1.0	0.001	ND
Xylene	10	0.001	ND
Organic chemicals - pesticides, herbicides & PCBs			
Alachlor	0.002	0.001	ND
Atrazine	0.003	0.002	ND
Chlordane	0.002	0.001	ND
Aldrin	---	0.002	ND
Dichloran	---	0.002	ND
Dieldren	---	0.001	ND
Endrin	0.002	0.0001	ND
Heptachlor	0.0004	0.0004	ND
Heptachlor Epoxide	0.0002	0.0001	ND
Hexachlorobenzene	0.001	0.0005	ND
Hexachlorocyclopentadiene	0.05	0.001	ND
Lindane	0.0002	0.0002	ND
Methoxychlor	0.04	0.002	ND
PCBs	0.0005	0.0005	ND
Pentachloronitrobenzene	---	0.002	ND
Silvex 2,4,5-TP	0.05	0.005	ND
Simazine	0.004	0.002	ND
Toxaphene	0.003	0.001	ND
Trifluralin	---	0.002	ND
2,4-D	0.07	0.010	ND

I certify that the analyses performed for this report are accurate, and that the laboratory tests were conducted by methods approved by the U.S. Environmental Protection Agency or variations of these EPA methods. These test results are intended to be used for informational purposes only and may not be used for regulatory compliance.

PRESIDENT, WATERTEST CORPORATION OF AMERICA

DATE COLLECTED	DATE RECEIVED	DATE COMPLETED	SAMPLE CODE
11/14/95	11/15/95	12/01/95	5110266

CUSTOMER ADDRESS
LEV 1A-20M LAKE WATER

DEALER ADDRESS
WEST LAKES 2545 CHANDLER AVE. SUITE 8 LAS VEGAS, NV 89120-

WaterTest
CORPORATION OF AMERICA

28 DANIEL PLUMMER RD.
GOTTSTOWN, NH 03045

DRINKING WATER ANALYSIS RESULTS

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TNTC-NC: Although there was no indication of Total Coliform, the number of non-coliform bacteria detected in the sample was Too Numerous To Count.

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Microbiological:			
Total coliform (organism/100ml)	0	0	PRESENCE
Inorganic chemicals - metals:			
Aluminum	0.2	0.1	0.122
Arsenic	0.05	0.010	0.012
Barium	2.0	0.30	ND
Cadmium	0.005	0.002	ND
Chromium	0.1	0.004	ND
Copper	1.3	0.004	ND
Iron	0.3	0.020	ND
Lead	0.015	0.002	0.004
Manganese	0.05	0.004	0.007
Mercury	0.002	0.001	ND
Nickel	0.1	0.02	ND
Selenium	0.05	0.002	ND
Silver	0.1	0.002	ND
Sodium	---	1.0	316
Zinc	5.0	0.004	ND
Inorganic chemicals - other, and physical factors:			
Alkalinity (Total as CaCO3)	---	10.0	88.0
Chloride	250	5.0	282*
Fluoride	2.0	0.5	0.900
Nitrate as N	10	0.5	ND
Nitrite as N	1.0	0.5	ND
Sulfate	250	5.0	1147*
Hardness (suggested limit = 100)		10.0	1062*
pH (Standard Units)	6.5-8.5	---	7.08
Total Dissolved Solids	500	20.0	2204*
Turbidity (Turbidity Units)	1.0	0.1	1.40*
Organic chemicals -			
Bromoform	0.1	0.004	ND
Bromodichloromethane	0.1	0.002	ND
Chloroform	0.1	0.002	ND
Dibromochloromethane	0.1	0.004	ND
Total THMs (sum of four above)	0.1	0.002	ND

NOTE: SODIUM REQUIRED DILUTION 1:20. CHLORIDE, FLUORIDE AND SULFATE REQUIRED DILUTION 1:10.

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Benzene	0.005	0.001	ND
Vinyl Chloride	0.002	0.001	ND
Carbon Tetrachloride	0.005	0.001	ND
1,2-Dichloroethane	0.005	0.001	ND
Trichloroethylene	0.005	0.001	ND
1,4-Dichlorobenzene	0.075	0.001	ND
1,1-Dichloroethylene	0.007	0.001	ND
1,1,1,-Trichloroethane	0.20	0.001	ND
Bromobenzene	---	0.002	ND
Bromomethane	---	0.002	ND
Chlorobenzene	0.1	0.001	ND
Chloroethane	---	0.002	ND
Chloromethane	---	0.002	ND
2-Chlorotoluene	---	0.001	ND
4-Chlorotoluene	---	0.001	ND
Dibromochloropropane (DBCP)	---	0.001	ND
Dibromomethane	---	0.002	ND
1,2-Dichlorobenzene	0.6	0.001	ND
1,3-Dichlorobenzene	0.6	0.001	ND
Dichlorodifluoromethane	---	0.002	ND
1,1-Dichloroethane	---	0.002	ND
Trans-1,2-Dichloroethylene	0.1	0.002	ND
cis-1,2-Dichloroethylene	0.07	0.002	ND
Dichloromethane	0.005	0.002	ND
1,2-Dichloropropane	0.005	0.002	ND
trans-1,3-Dichloropropene	---	0.002	ND
1,3-Dichloropropene	---	0.002	ND
2,2-Dichloropropane	---	0.002	ND
1,1-Dichloropropene	---	0.002	ND
1,3-Dichloropropane	---	0.002	ND
Ethylbenzene	0.7	0.001	ND
Ethylenedibromide (EDB)	---	0.001	ND
Styrene	0.1	0.001	ND
1,1,1,2-Tetrachloroethane	---	0.002	ND
1,1,2,2-Tetrachloroethane	---	0.002	ND
Tetrachloroethylene (PCE)	0.005	0.002	ND
1,2,4-Trichlorobenzene	---	0.002	ND
1,2,3-Trichlorobenzene	---	0.002	ND
1,1,2-Trichloroethane	0.005	0.002	ND
Trichlorofluoromethane	---	0.002	ND
1,2,3-Trichloropropane	---	0.002	ND
Toluene	1.0	0.001	ND
Xylene	10	0.001	ND
Organic chemicals - pesticides, herbicides & PCBs			
Alachlor	0.002	0.001	ND
Atrazine	0.003	0.002	ND
Chlordane	0.002	0.001	ND
Aldrin	---	0.002	ND
Dichloran	---	0.002	ND
Dieldren	---	0.001	ND
Endrin	0.002	0.0001	ND
Heptachlor	0.0004	0.0004	ND
Heptachlor Epoxide	0.0002	0.0001	ND
Hexachlorobenzene	0.001	0.0005	ND
Hexachlorocyclopentadiene	0.05	0.001	ND
Lindane	0.0002	0.0002	ND
Methoxychlor	0.04	0.002	ND
PCBs	0.0005	0.0005	ND
Pentachloronitrobenzene	---	0.002	ND
Silvex 2,4,5-TP	0.05	0.005	ND
Simazine	0.004	0.002	ND
Toxaphene	0.003	0.001	ND
Trifluralin	---	0.002	ND
2,4-D	0.07	0.010	ND

I certify that the analyses performed for this report are accurate, and that the laboratory tests were conducted by methods approved by the U.S. Environmental Protection Agency or variations of these EPA methods. These test results are intended to be used for informational purposes only and may not be used for regulatory compliance.

PRESIDENT, WATERTEST CORPORATION OF AMERICA