

1-1971

The Effect of Las Vegas Wash effluent upon the water quality in Lake Mead

D. A. Hoffman

P. R. Tramutt

F. C. Heller

Bureau of Reclamation

Follow this and additional works at: https://digitalscholarship.unlv.edu/water_pubs



Part of the [Biology Commons](#), [Desert Ecology Commons](#), [Environmental Health and Protection Commons](#), [Environmental Indicators and Impact Assessment Commons](#), [Environmental Monitoring Commons](#), [Fresh Water Studies Commons](#), [Natural Resources Management and Policy Commons](#), [Sustainability Commons](#), [Terrestrial and Aquatic Ecology Commons](#), and the [Water Resource Management Commons](#)

Repository Citation

Hoffman, D. A., Tramutt, P. R., Heller, F. C., Bureau of Reclamation (1971). The Effect of Las Vegas Wash effluent upon the water quality in Lake Mead.

Available at: https://digitalscholarship.unlv.edu/water_pubs/20

This Technical Report is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Technical Report in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Technical Report has been accepted for inclusion in Publications (WR) by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact digitalscholarship@unlv.edu.

114310 71A

e-1

REC-ERC-71-11

**THE EFFECT OF LAS VEGAS
WASH EFFLUENT UPON THE
WATER QUALITY IN LAKE MEAD**

D. A. Hoffman

P. R. Tramutt

F. C. Heller

Engineering and Research Center

Bureau of Reclamation

January 1971

ACKNOWLEDGMENT

The authors wish to acknowledge the assistance provided by Region 3, Bureau of Reclamation, Boulder City, Nevada. The study was conducted under the supervision of L. O. Timblin, Jr., Chief, Applied Sciences Branch.

Reprint or republication of any of this material shall give appropriate credit to the Bureau of Reclamation, U.S. Department of the Interior.

CONTENTS

	Page
Introduction	1
Summary and Conclusions	1
Methods and Materials	1
Sample Stations	1
Sample Collection and Preservation	2
Discussion	2
Las Vegas Wash	3
Las Vegas Bay	4
Eutrophication of Lake Mead	6
List of References	6
Appendix A Tables	7
Appendix B Analytical Methods	23

LIST OF TABLES

Table

1	Station 4, chemical and physical field data, 1968, Lake Mead	9
2	Station 8, chemical and physical field data, 1968, Lake Mead	10
3	Station 10, chemical and physical field data, 1968, Lake Mead	11
4	Station 10A, chemical and physical field data, 1968, Lake Mead	12
5	Las Vegas Wash, chemical and physical field data, 1968	13
6	Chemical analysis, U.S. Geological Survey Gaging Station, Las Vegas Wash, 1968	14
7	Chemical analysis, Dump, Las Vegas Wash, 1968	14
8	Chemical analysis, North Shore Drive, Las Vegas Wash, 1968	15
9	Chemical analysis, Station 4, Lake Mead, 1968	16
10	Changes in water quality, Las Vegas Wash, 1968	17
11	Nitrogen series, Lake Mead, 1968	19
12	Phosphorus series, Lake Mead, 1968	20
13	Nitrogen, phosphate, chlorophyll A at 10 feet, and Secchi disk; Stations 4, 8, 10, 10A, Lake Mead, 1968	21
14	Organic material, Lake Mead, 1968	22

LIST OF FIGURES

Figure

1	Station locations	2
2	Dissolved oxygen and temperature Lake Mead, 1968	3
3	Stiff pattern interpretation of chemical water analyses, August 1968	3
4	Stiff pattern interpretation of chemical water analyses, November 1968	4
5	Nitrogen, phosphate, chlorophyll A, at 10 feet, Secchi disk, Stations 4, 8, 10, 10A, Lake Mead, 1968	5

INTRODUCTION

This study developed from observations made during an earlier study on Lake Mead which was reported in CHE-70, Water Quality Study of Lake Mead.¹ * Results from that study indicated that poor-quality water was flowing into the Las Vegas Bay reach of Boulder Basin, Lake Mead. Also reports of deteriorating water quality, resulting in taste and odors in domestic water supplies taken from Boulder Basin as well as a reduction in the attractiveness of Las Vegas Bay for recreational uses caused by aquatic plants and algae blooms, indicated a need for a concentrated study concerning the effects of flows from Las Vegas Wash upon the water quality in Boulder Basin.²

The principal sources of water into Las Vegas Wash are effluents from the Clark County sewage treatment plant and the Las Vegas City sewage treatment plant. Minor sources are waste from two power stations operated by Nevada Power Company, irrigation return and watershed runoff during periods of precipitation.² Thus the water in Las Vegas Wash is mainly effluent from sewage treatment plants. The water from the Wash flows into Las Vegas Bay, an arm of the Boulder Basin reach of Lake Mead.

It was determined that such a study should be conducted to describe selected water quality parameters in Las Vegas Wash, Las Vegas Bay, and Boulder Basin during different seasons. By this means, it would be possible to delineate adverse quality factors and their causes.

The main objectives of this study are to describe the water quality in Las Vegas Wash and the affect of that water on the water quality in Boulder Basin, Lake Mead.

SUMMARY AND CONCLUSIONS

Field surveys were made on Las Vegas Wash, Las Vegas Bay, and Boulder Basin reach of Lake Mead during 1968. The purposes of the surveys were to determine the quality of water entering Lake Mead from Las Vegas Wash and to determine the effect of that water on the water quality in Lake Mead.

On the basis of the data collected in the course of these surveys it was determined that the effluent from Las Vegas Wash contributes to the eutrophication and degradation of Lake Mead. This is due to the high amounts of total dissolved solids and the large amounts of algae supporting nutrients brought into the lake

from the Wash. An average of 4.48 tons per acre foot (329 kilo/100 m³) of total dissolved solids was calculated to be entering Lake Mead from the Wash during the period of study. Chlorophyll A values in Las Vegas Bay were 20 to 25 times those in Boulder Basin, indicating the presence of an algae bloom. Coincident changes in nitrogen forms, light penetration, and total insoluble phosphate were also noted during the period when the bloom was present.

An unaccountable increase in cations and anions occurs in the Wash. The source of this increase is not known, but may be due to unmeasured and undescribed ground-water inflow.

METHODS AND MATERIALS

Sample Stations

The sample stations used in this study were selected from those used in the earlier study reported in CHE-70.¹ In order to maintain continuity between the two studies, the same station numbers were used.

The key stations selected for obtaining data from Las Vegas Wash were as follows:

1. Gage.—U.S. Geological Survey Gage, located approximately 6 miles upstream from Lake Mead in Las Vegas Wash.
2. North Shore Drive (NSD).—Located at the culvert where North Shore Drive Highway, between Henderson and Overton, Nevada, crosses Las Vegas Wash.
3. Dump.—Located approximately 3 miles upstream from Lake Mead in Las Vegas Wash.

The key stations for obtaining data from Las Vegas Bay and Boulder Basin were 10A and 4, respectively. The data from these stations were supplemented with data from the secondary Stations 8 and 10. The station locations are shown on Figure 1. By comparing the data from the above stations, it is possible to determine the quality of water flowing down Las Vegas Wash into the Las Vegas Bay arm of the Boulder Basin reach of Lake Mead, and the effect of the effluent from Las Vegas Wash upon the water quality in Las Vegas Bay.

In order to determine seasonal differences, samples were collected during March 2-11, May 22-27, August 21-27, and November 15-19, 1968.

*These numbers indicate writings cited in List of References.

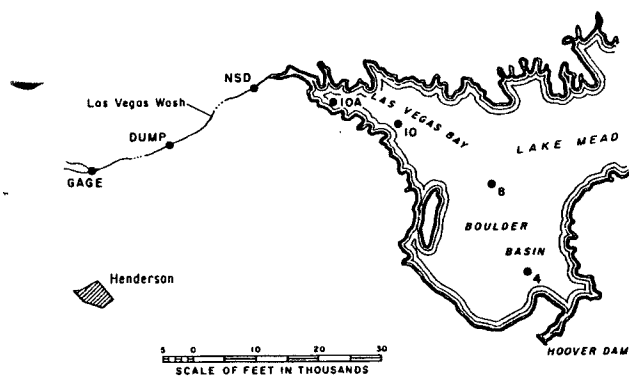


FIGURE 1 STATION LOCATIONS

Sample Collection and Preservation

Temperature and conductivity measurements were made in situ with a 400-foot probe. Water samples for all analyses were collected with 3-liter polyvinyl-chloride (PVC) Van Dorn-type samplers. Portions for specific analyses were taken from the sampler and processed as described below. Analyses for dissolved oxygen, carbon dioxide, alkalinity, and pH, were performed in the boat laboratory. The other analyses were performed in the chemistry laboratory, Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

1. Dissolved oxygen.—Water for dissolved oxygen analysis was immediately flowed from a Van Dorn sampler into a 350-milliliter (ml) BOD bottle, taking care that the bottle was overflowed and no bubbles were introduced. The analysis was by the Winkler Method (Sodium Azide Modification) (Appendix B).

2. Free carbon dioxide, alkalinity, pH.—Water for dissolved carbon dioxide, pH, and alkalinity was flowed into another 350-ml BOD bottle, taking care that the bottle was overflowed and no bubbles were introduced. Aliquots from this bottle were used for free carbon dioxide, pH, and alkalinity determinations. Methods of analyses are given in Appendix B.

3. Phosphorus.—A 500-ml portion was poured from the Van Dorn sampler into a graduate cylinder, magnesium carbonate added, and the sample filtered through a 45-micron filter. The filter had been previously soaked in four washes of distilled water for at least 1 hour per wash. The membrane filter

containing the residue was folded in half and placed in a similarly folded Whatman filter. Both filters were placed in a desiccator and kept at a low temperature in an ice chest. The filtrate was poured into 1,200-ml acid-washed pyrex bottles, 1 ml of saturated HgCl_2 added as a preservative and placed on ice. The iced filters and filtrate were placed in a freezer and kept frozen until thawed for analysis.

4. Nitrogen.—Approximately 850 ml of the sample were poured into 1-liter acid-washed plastic bottles, to which 2 ml of saturated HgCl_2 was added and the sample placed on ice. The samples were placed in a freezer and frozen and kept frozen until thawed for analysis.

5. Complete chemical analysis.—One-liter plastic bottles were filled from the Van Dorn sampler, no preservatives were added, and the sample was analyzed at the Denver laboratory by methods given in Appendix B.

6. Organic content.—One liter acid-washed plastic bottles were filled, 2 ml of HgCl_2 added as a preservative, and the samples kept at 40°F (4.4°C) or lower until analyzed.

7. Chlorophyll.—Two milligrams (mg) of bicarbonate were added to 1,000 ml of water and the sample filtered through a 45-micron membrane filter. The filter was folded, then wrapped in a folded Whatman filter, placed in a desiccator, then frozen and kept frozen until thawed for analysis.

So that other workers may compare the results of their studies with this one, the analytical procedures used are listed in Appendix B.

DISCUSSION

The annual temperature cycle in Lake Mead and concurrent dissolved oxygen, chemical and physical patterns, have been described in CHE-70. The field data collected during this study indicate that the warm monomictic temperature and negative heterograde dissolved oxygen cycles described in the earlier study are still present, Figure 2. The field data are given in Tables 1 through 5, Appendix A. In general, the seasonal changes in the parameters measured are similar at all stations. However, during May and August, the dissolved oxygen values at Station 10 in Las Vegas Bay, are lower at the 100- (30.5-) and 150-foot (45.7-meter) depths than at those depths at Station 4. As described

later in this report, an algae bloom was present at Station 10 during May and the dead algae settling from the shallow water into the 100-150-foot (30.5-45.7-m) depths would utilize the oxygen for oxidation of the organic material. Also, at this time, the dissolved oxygen values in the 10-foot (3-m) depths were higher at the Las Vegas Bay stations, reflecting the production of oxygen by the algae, Tables 1 and 3.

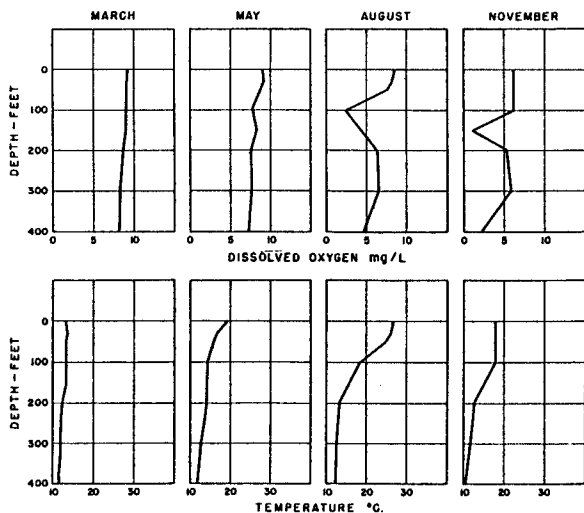


Figure 2. Dissolved oxygen and temperature—Lake Mead 1968.

Las Vegas Wash

One of the objectives of this study was to determine the quality of the water entering Lake Mead from Las Vegas Wash. Samples were collected from the Gage and North Shore Drive Stations during each of the four surveys. Since data from the first two surveys indicated that the salinity increased between the two stations, a third station, Dump, was established approximately halfway between them. Data from the Dump Station was collected during the August and November surveys. The data collected at these stations are given in Tables 5 through 8, Appendix A.

The changes in water quality between the three stations are given in Table 10, Appendix A. There was an increase in all parameters, between the upper and lower stations, except carbon dioxide and bicarbonate which decreased. The major part of the increase occurs between the Gage and Dump Stations. For example, the arithmetic average increase in Total Dissolved Solids (TDS) between the Gage and North Shore Drive was 1,884 mg/l for the four surveys. This increase may be due to a combination of the following factors:

evaporation, ground-water inflow, plant uptake, or solution from the streambed. Measurements to differentiate between these factors were not made during this study. However, recently initiated studies by the U.S. Geological Survey indicate that there is an increase in flow between the Gage and North Shore Drive. This would indicate the possibility of ground-water inflow. A study by the Federal Water Quality Administration (FWQA) in 1967 indicated that such an increase in TDS and flow could be due to seepage from waste ponds belonging to Basic Management, Incorporated, an industrial complex in Henderson, Nevada.²

The magnitude of the difference in chemical quality between the water entering Lake Mead from Las Vegas Wash and that in the Lake proper can be seen by examination of Tables 8 and 9. Figures 3 and 4 also show these differences by use of Stiff Diagrams.

On the basis of flow data taken from U.S. Geological Survey records and TDS collected during this study, an average TDS loading of 4.48 tons/acre-foot (329 kilo/100 m³) was calculated to be entering Lake Mead from the Wash.³ These values can be compared with the 1968 average of 0.91 tons/acre-foot (0.66 kilo/100 m³) carried by the Colorado River as measured at Grand Canyon.⁴ Thus, it is obvious that the salt load from Las Vegas Wash is an important contribution to the salinity of Lake Mead.

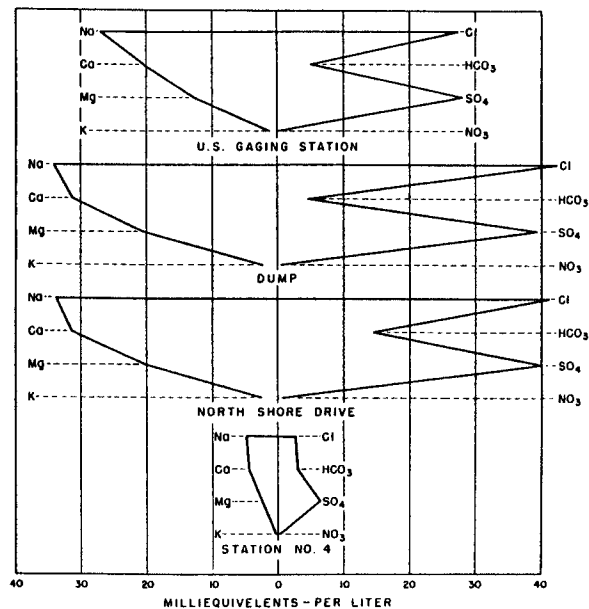


Figure 3. Stiff pattern interpretation of chemical water analyses—August 1968.

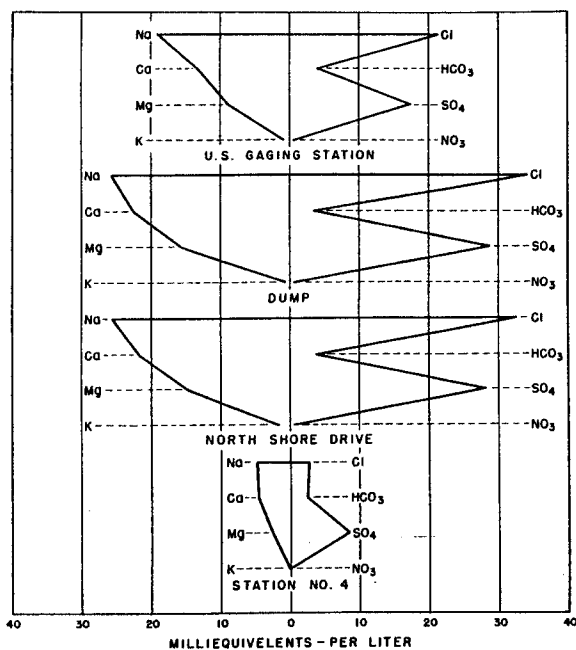


Figure 4. Stiff pattern interpretation of chemical water analyses—November 1968.

One question concerning the effect of the effluent from Las Vegas Wash upon the water quality in Las Vegas Bay is directed to the amount of algae supporting nutrients brought into the bay from the Wash. Older work indicates that phosphorus and nitrogen were the key nutrients contributing to algae blooms. More recent work, however, has indicated that micronutrients (such as molybdenum), vitamins, carbon sources (such as carbon dioxide, organic material), and enzymes may be key factors. In this study, various forms of nitrogen and phosphorus were measured.

Analysis for nitrate-nitrogen was according to the modified-modified Brucine method. Organic nitrogen was determined by the Kjeldahl method; and ammonia nitrogen according to the direct Nesslerization method, as given in Standard Methods.⁵ Larger amounts of nitrate-nitrogen, and ammonia-nitrogen were collected from Las Vegas Wash than in Las Vegas Bay or Boulder Basin. Within the Wash, the values increase between the Gage and North Shore Drive. This could be partially due to the nitrification of organic nitrogen to ammonia which is further oxidized to nitrate-nitrogen during passage of the effluent down the Wash. Correspondingly, the values for organic nitrogen decreased as the flow moved downstream, usually

one-half to one-third of the adjacent upstream station, Table 11. The contribution to the nitrate values by ground-water inflow is not known, but could be an important source.

The importance of phosphorus as an essential nutrient for algae and aquatic plants has been documented in the literature.⁶ The occurrence of blooms in bodies of water with very low amounts of phosphorus suggest that this element may be rapidly recycled between the inorganic and organic phases. Sources of phosphorus into Lake Mead include industrial and domestic waste water and dissolution of phosphate rock. The distribution of phosphorus at the study stations was based on methods of collection and analysis. The sample was filtered through a washed 45-micron millipore filter. This technique separated the sample into soluble and insoluble phosphorus. The method of analysis of the soluble portion was according to Jenkins giving soluble orthophosphate without addition of $K_2S_2O_8$.⁷ The analysis of the insoluble portion was also according to Jenkins with addition of $K_2S_2O_8$ giving total insoluble phosphorus. Thus, the results show the soluble orthophosphate, but not the soluble organic phosphate; and the total insoluble phosphate including ortho and organic phosphate. As with nitrogen, larger values for phosphorus were found in the Wash than in Las Vegas Bay or Boulder Basin during all four surveys. In all cases, the upper station, Gage, contained more orthophosphate than the lowest station, North Shore Drive. Samples collected from the middle station, Dump, indicate that most of the decrease occurred between the upper and middle stations, Table 12. This may reflect uptake of phosphorus by aquatic plants between the upper and middle stations. The reason for the increase between the Dump and North Shore Drive Stations is not known at this time. The values for total insoluble phosphate decreased between the upper and lower stations during March and November, remained the same during May, and increased in August.

Using the values of 0.01 mg/l of P and 0.3 mg/l of N as a basis for support of an algae bloom, it can be seen that the amount of these elements flowing into Lake Mead from the Wash are sufficient to support algae blooms.⁸

Las Vegas Bay

In order to determine the effect of the effluent from Las Vegas Wash upon the water quality in Las Vegas Bay, data collected from the bay was compared to similar data collected from Boulder Basin. Stations 10

and 10A in the bay were compared with Stations 4 and 8 in Boulder Basin. The following water quality parameters were compared: nitrogen, phosphorus, chlorophyll A, and secchi disk readings.

The rationale for establishing the relationship between these parameters follows. The measurement of chlorophyll can be used as a method to detect and compare the mass of algae between two areas. An increase in chlorophyll values indicates an increase in the mass of algae being considered. Higher chlorophyll values from one area than another would indicate the presence of a larger mass of chlorophyll bearing material, in this case algae, in the first area. This assumes, of course, that chlorophyll-bearing material is not being introduced into the area of concern from an outside source.

The secchi disk is used to measure the amount of light penetration. The lower the amount of light absorbing or scattering substances in the water the greater the values for secchi disk readings. An increase in the mass of algae would add to the material blocking out or absorbing light and hence result in a lower secchi disk reading. This assumes such material is not being brought in from an outside source.

The sequence of nitrogen utilization by algae can be simply described as nitrate and ammonia nitrogen being taken up from the water by algae. This was followed in this study by measurements of nitrate, organic, and ammonia nitrogen forms. During an algae bloom the values for organic nitrogen should be higher than before the bloom and those of nitrate and ammonia lower.

The sequence of phosphorus utilization as measured in this study assumed that orthophosphate values would decrease and total insoluble phosphate values would increase as the orthophosphate was taken up from the water by algae and held in the insoluble form.

To summarize the above sequences, if the data shows coincidental increase in chlorophyll, decrease in light penetration, increase in organic nitrogen, decrease in nitrate and ammonia nitrogen, increase in total insoluble phosphorus, and decrease in orthophosphorus at one station when compared to another station after both stations had similar values in these parameters, then it is reasonable to assume an increase in algae population occurred at the first station.

The data for chlorophyll A, nitrogen forms, and total insoluble phosphate from the 10-foot (3-m) depth, and secchi disk readings for Stations 4 and 8 in Boulder

Basin and Stations 10 and 10A in Las Vegas Bay are presented in Table 13 and Figure 5.

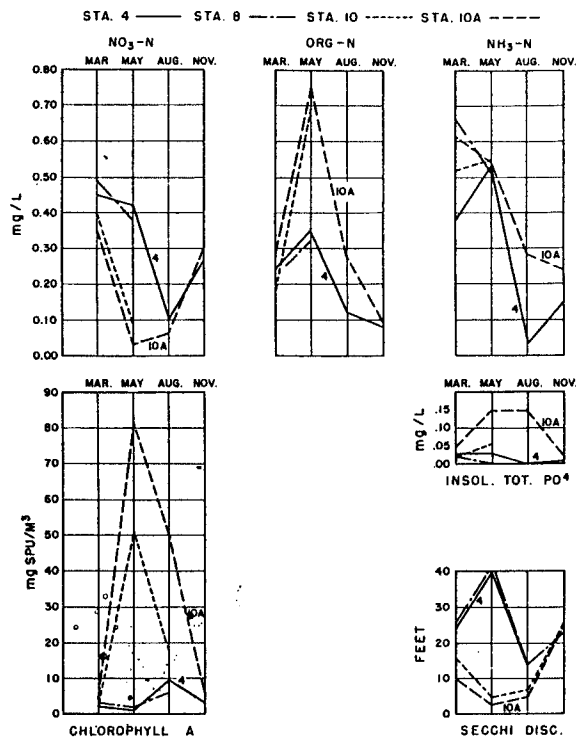


Figure 5. Nitrogen, phosphate, chlorophyll A, at 10 feet, Secchi disk, Stations 4, 8, 10, 10A, Lake Mead, 1968.

The data collected in March, show similarities in all parameters at all stations except that of ammonia-nitrogen. The data collected in May reflect the algae bloom at Stations 10 and 10A by increased chlorophyll A, total insoluble phosphate, and organic nitrogen values while the values for nitrate-nitrogen, and secchi disk decreased at these stations. Meanwhile the changes at Stations 4 and 8 reflect (on the basis of the above rationale) the beginning of an increase in algae population as indicated by decreased nitrate-nitrogen and increased organic-nitrogen. However, little or no changes occurred in phosphate and chlorophyll A.

The data collected during August and November from Station 10A in Las Vegas Bay, show the decrease in algae and coincident changes in the other parameters. The data from Station 4 during August is not as clear in that an increase in algae is indicated by chlorophyll A and nitrate-nitrogen values, but not by organic nitrogen and total insoluble phosphate values which

indicate a decrease in algae population. The reason for this apparent discrepancy is not known at this time.

As described earlier, the rate of decrease in dissolved oxygen is also greater at Stations 10 and 10A in Las Vegas Bay than at Stations 4 and 8 in Boulder Basin, Tables 2, 3, 4, and 5. This is probably due to decomposition of dead algae and organic material brought in from the Wash.

Samples for organic content were collected from Stations 4 and 10 during May, August, and November; and Station 10A in August. The higher values at Station 10 and 10A, during May and August, reflect the presence of the algae bloom, whereas all stations have similar values in November after the bloom, Table 14.

Eutrophication of Lake Mead

The question arises as to whether or not the discharge from Las Vegas Wash into the Las Vegas Bay reach of Lake Mead is causing or contributing to the "eutrophication" of Lake Mead. Three recent definitions of "eutrophication" are given below:

1. "The process of becoming more eutrophic, either as a natural phase in the maturing, or artificially, as by fertilization."

Eutrophic—"relating to or being in a well nourished condition. A eutrophic lake being one rich in dissolved nutrients, frequently shallow and with seasonal oxygen deficiency in the hypolimnion." Charles M. Weiss, "Relations of Phosphates to Eutrophication," Journal AWWA, August 1969, pp 387-391.

2. The term "eutrophic" means well nourished; thus, "eutrophication" refers to natural or artificial addition of nutrients to bodies of water and to the effects of added nutrients, page 3, Eutrophication, Causes, Consequence, Correctives. Proceedings of International Symposium on Eutrophication, Madison, Wisconsin, June 11-15, 1967, Edt Gerald A. Rohlich. Nat. Assoc. Sci., Washington, D.C. 20418, 1969, p 661.

3. "Eutrophication is a term meaning enrichment of water by nutrients through either man-created or

natural means." p 35, The Practice of Water Pollution Biology, Kenneth M. Mackenthun, FWPCA, USDI, 1969, p 281.

The key elements in the above definitions are: (1) addition of nutrients, and (2) affect of those nutrients. Simply put, the answer to the above question is yes, the discharge from Las Vegas Wash is contributing to the eutrophication of Lake Mead by adding nutrients which support an algae bloom in the Las Vegas Bay reach of Boulder Basin.

LIST OF REFERENCES

1. "Water Quality Study of Lake Mead," Report No. CHE-70, U.S. Bureau of Reclamation, Office of Chief Engineer, Denver, Colorado, 1967, Reprinted 1970, 155 pp
2. "Report on Pollution in Las Vegas Wash and Las Vegas Bay," USDI FWPCA, Cincinnati, Ohio, 1967, Memo., 18 pp
3. "Water Resources Data for Arizona," Part 1, Surface Water Records, USDI, Geological Survey, Washington, D.C., in press
4. "Quality of Water, Colorado River Basin," Progress Report NO. 5. USDI, in press
5. American Public Health Association, Inc., "Standard Methods for the Examination of Water and Waste Water," APHA, New York, 1965, 769 pp
6. Mackenthun, K. M., 1965, Nitrogen and Phosphorus in Water, USDHEW, Public Health Service, Washington, D.C., 111 pp
7. Jenkins, D., 1965, "A Study of Methods Suitable for the Analysis and Preservation of Phosphorus Forms in an Estuarine Environment," San. Eng. Lab. Report No. G5-18, University of California at Berkeley, November 1965, 50 pp
8. Sawyer, C. N., 1947, "Fertilization of Lakes by Agricultural and Urban Drainage," Journal New Eng. Wat. Wks. Assn., Vol. 61, No. 2, pp 109-127

APPENDIX A TABLES

Table 1

STATION 4, CHEMICAL AND PHYSICAL FIELD DATA, 1968, LAKE MEAD

Parameter	Depth (feet)	March	May	August	November
Temperature, degrees C	10	15.8	20.2	25.8	18.0
	25	15.0	19.5	25.6	18.0
	50	13.9	17.8	25.6	18.0
	100	13.0	15.0	22.5	18.0
	150	13.0	13.6	15.0	15.2
	200	12.5	12.8	13.3	13.0
	250	11.9	12.5	13.0	11.9
Dissolved oxygen—milligrams per liter	10	10.3	9.2	8.0	7.4
	25	10.2	9.4	—	—
	50	9.7	8.9	7.8	7.3
	100	8.4	8.1	3.2	7.3
	150	—	7.7	5.2	1.5
	200	8.0	7.6	6.8	4.9
Conductivity $K \times 10^6$ at 25° C micromhos/cm	10	1,035	1,030	1,050	1,000
	25	1,040	1,030	1,050	1,000
	50	1,040	1,030	1,060	1,000
	100	1,040	1,030	1,070	1,000
	150	1,050	1,040	1,050	950
	200	1,050	1,040	1,050	950
pH	10	8.3	8.7	8.9	8.6
	25	8.5	8.7	—	—
	50	8.3	8.6	8.8	8.6
	100	8.1	8.4	8.0	8.6
	150	—	8.3	8.1	8.0
	200	8.0	8.3	8.2	8.6
Alkalinity phth as CaCO_3 milligrams per liter	10	2.0	6.0	10.0	4.5
	25	2.0	6.2	—	—
	50	2.0	4.2	10.0	3.5
	100	0	1.0	0	3.3
	150	0	0	0	0
	200	0	0	0	0
Alkalinity MO as CaCO_3 milligrams per liter	10	116	127	97	111
	25	118	127	—	—
	50	119	127	98	110
	100	119	127	124	108
	150	—	128	121	128
	200	122	130	126	132
Carbon dioxide, milligrams per liter	10	0	0	0	0
	25	0	0	—	—
	50	0	0	0	0
	100	0.9	0	0.9	0
	150	—	0.9	0.9	3.6
	200	0.9	1.8	0.9	2.7
Secchi disk—feet		24.0	40.0	13.0	—

Table 2

STATION 8, CHEMICAL AND PHYSICAL FIELD DATA, 1968, LAKE MEAD

Parameter	Depth (feet)	March	May	August	November
Temperature, degrees C	10	15.0	20.9	26.4	18.5
	50	14.0	18.3	25.5	—
	100	13.4	15.5	17.0	—
	150	13.0	14.2	15.2	—
	200	12.6	13.5	14.0	—
Dissolved oxygen, milligrams per liter	10	10.4	9.1	8.1	—
	50	9.2	7.9	7.7	7.4
	100	8.3	8.1	3.7	7.3
	150	—	7.8	5.4	2.0
	200	8.1	7.8	6.9	4.2
Conductivity $K \times 10^6$ at 25° C micromhos/cm	10	1,020	1,030	1,050	—
	50	1,030	1,030	1,050	—
	100	1,040	1,030	1,050	—
	200	1,060	1,030	1,050	—
pH	10	8.3	8.7	8.5	8.3
	50	8.4	8.5	8.7	8.3
	100	8.3	8.4	8.0	—
	150	—	8.3	8.1	7.7
	200	8.2	8.2	8.1	7.8
Alkalinity phth as $CaCO_3$ milligrams per liter	10	4.0	7.0	9.0	2.0
	50	2.0	3.0	9.0	—
	100	1.0	2.0	0	2.0
	150	—	1.0	0	0
	200	0	0	0	0
Alkalinity MO as $CaCO_3$ milligrams per liter	10	119	127	100	109
	50	119	127	105	109
	100	119	128	123	—
	150	—	129	127	127
	200	118	134	132	131
Carbon dioxide, milligrams per liter	10	0	0	0	0
	50	0	0	0	0
	100	0	0	1.9	0
	150	—	0	1.3	4.1
	200	0.1	0.9	0.9	3.8
Secchi disk—feet		26.0	42.0	14.5	23.0

Table 3

STATION 10, CHEMICAL AND PHYSICAL FIELD DATA, 1968, LAKE MEAD

Parameter	Depth (feet)	March	May	August	November
Temperature, degrees C	10	18.2	20.8	27.0	18.3
	25	13.0	19.2	—	17.8
	50	11.6	17.8	25.2	17.8
	100	11.1	15.5	17.5	17.2
	150	11.6	13.5	14.9	15.6
Dissolved oxygen, milligrams per liter	10	10.4	11.3	8.2	7.7
	25	10.5	9.2	—	7.6
	50	9.1	8.6	5.2	7.6
	100	8.4	6.8	1.9	7.7
	150	8.7	7.0	3.8	2.0
Conductivity $K \times 10^6$ at 25° C micromhos/cm	10	1,005	1,045	1,110	1,000
	25	1,025	1,030	—	1,000
	50	1,025	1,050	1,110	1,000
	100	1,040	1,110	1,100	1,000
	150	1,125	1,025	1,080	900
pH	10	8.3	8.8	9.0	8.5
	25	8.5	8.6	—	8.5
	50	8.1	8.4	8.2	8.5
	100	8.1	8.2	8.0	8.5
	150	8.2	8.2	8.1	8.5
Alkalinity phth as $CaCO_3$ milligrams per liter	10	5.0	8.0	11.0	4.0
	25	4.0	5.0	—	3.0
	50	3.0	4.0	1.0	3.0
	100	3.0	0	0	0
	150	3.0	0	0	0
Alkalinity MO as $CaCO_3$ milligrams per liter	10	120	109	90	109
	25	115	125	—	108
	50	118	126	105	108
	100	119	128	125	109
	150	119	131	120	127
Carbon dioxide, milligrams per liter	10	0	0	0	0
	25	0	0	—	0
	50	0	0	0	0
	100	0	0.9	1.8	0
	150	0	1.8	1.8	0
Secchi—feet		16.0	5.5	7.0	26.0

Table 4

STATION 10A, CHEMICAL AND PHYSICAL FIELD DATA, 1968, LAKE MEAD

Parameters	Depth (feet)	March	May	August	November
Temperature, degrees C	10	15.0	20.8	27.3	18.0
	25	14.5	19.1	27.0	17.5
	50	14.2	—	25.3	17.2
Dissolved oxygen, milligrams per liter	10	11.5	12.4	9.1	8.1
	25	10.3	7.5	7.3	8.1
	50	9.7	—	3.4	8.1
Conductivity $K \times 10^6$ at 25° C micromhos/cm	10	1,060	1,100	1,180	1,000
	25	1,060	1,080	1,140	1,000
	50	1,125	—	1,230	1,300
pH	10	8.6	8.8	8.9	8.5
	25	8.4	8.4	8.8	8.5
	50	8.4	—	8.1	8.5
Alkalinity phth as CaCO_3 milligrams per liter	10	9.0	8.0	14.0	4.0
	25	4.0	3.0	10.0	4.0
	50	11.0	—	0	4.0
Alkalinity MO as CaCO_3 milligrams per liter	10	119	104	88	109
	25	115	121	90	111
	50	120	—	105	111
Carbon dioxide, milligrams per liter	10	0	0	0	0
	25	0	0	0	0
	50	0	—	1.4	0
Secchi disk—feet		10.0	5.0	5.5	25.0

Table 5

LAS VEGAS WASH, CHEMICAL AND PHYSICAL FIELD DATA, 1968

Parameter	Station	March	May	August	November
Temperature, degrees C	Gage	11.8	15.6	20.5	11.7
	Dump	—	—	22.0	11.7
	NSD	12.8	16.1	21.0	11.7
Dissolved oxygen, milligrams per liter	Gage	7.9	6.3	6.8	3.9
	Dump	—	—	8.2	9.9
	NSD	9.7	8.1	8.4	9.7
Conductivity $K \times 10^6$ at 25° C micromhos/cm	Gage	4,665	—	6,000	1,250
	Dump	—	—	8,400	1,800
	NDS	6,600	—	7,800	1,725
pH	Gage	7.8	7.8	7.8	7.6
	Dump	—	—	8.1	8.1
	NSD	8.2	8.1	8.2	8.2
Alkalinity phth as CaCO_3 milligrams per liter	Gage	0	0	0	0
	Dump	0	0	0	0
	NSD	7.0	—	4.0	—
Alkalinity MO as CaCO_3 milligrams per liter	Gage	236	247	260	209
	Dump	—	—	208	183
	NSD	208	226	215	195
Carbon dioxide, milligrams per liter	Gage	—	9.0	9.0	13.5
	Dump	—	—	1.9	2.7
	NSD	—	3.3	0	—
Flow—cubic feet per second	Gage	28.0	27.0	17.0	43.0

Table 6

CHEMICAL ANALYSIS, U.S. GEOLOGICAL SURVEY GAGING STATION, LAS VEGAS WASH, 1968

Parameter	Depth (feet)	March	May	August	November
K x 10 ⁶ at 25° C	Surface	4,161	3,684	5,276	3,742
pH	Surface	8.1	8.1	7.9	8.1
Total dissolved solids, milligrams per liter	Surface	3,342	3,136	4,136	2,808
Calcium, milligrams per liter	Surface	324	320	408	260
Magnesium, milligrams per liter	Surface	170	124	153	110
Sodium, milligrams per liter	Surface	453	400	621	437
Potassium, milligrams per liter	Surface	43	31	45	35
Carbonate, milligrams per liter	Surface	0	0	0	0
Bicarbonate, milligrams per liter	Surface	279	300	328	246
Sulfate, milligrams per liter	Surface	1,334	1,099	1,354	845
Chloride, milligrams per liter	Surface	611	660	973	760
Nitrate, milligrams per liter	Sulfate	0.11	5.0	24.8	16

Table 7

CHEMICAL ANALYSIS, DUMP, LAS VEGAS WASH, 1968

Parameter	Depth (feet)	March	May	August	November
K x 10 ⁶ at 25° C	Surface	—	—	7,205	5,632
pH	Surface	—	—	8.0	8.2
Total dissolved solids, milligrams per liter	Surface	—	—	6,164	4,544
Calcium, milligrams per liter	Surface	—	—	622	448
Magnesium, milligrams per liter	Surface	—	—	250	190
Sodium, milligrams per liter	Surface	—	—	782	593
Potassium, milligrams per liter	Surface	—	—	94	70
Carbonate, milligrams per liter	Surface	—	—	0	0
Bicarbonate, milligrams per liter	Surface	—	—	265	219
Sulfate, milligrams per liter	Surface	—	—	1,882	1,392
Chloride, milligrams per liter	Surface	—	—	1,505	1,221
Nitrate, milligrams per liter	Surface	—	—	52	34

Table 8

CHEMICAL ANALYSIS, NORTH SHORE DRIVE, LAS VEGAS WASH, 1968

Parameters	Depth (feet)	March	May	August	November
K x 10 ⁶ at 25° C	Surface	5,816	6,485	7,205	5,515
pH	Surface	8.3	8.2	8.0	8.3
Total dissolved solids, milligrams per liter	Surface	4,778	5,728	6,068	4,384
Calcium, milligrams per liter	Surface	476	526	622	434
Magnesium, milligrams per liter	Surface	244	249	245	181
Sodium, milligrams per liter	Surface	593	630	777	584
Potassium, milligrams per liter	Surface	70	70	90	66
Carbonate, milligrams per liter	Surface	0	0	0	0
Bicarbonate, milligrams per liter	Surface	254	275	275	240
Sulfate, milligrams per liter	Surface	1,714	1,824	1,930	1,358
Chloride, milligrams per liter	Surface	1,072	1,306	1,477	1,164
Nitrate, milligrams per liter	Surface	6.8	18	52	33

Table 9

CHEMICAL ANALYSIS, STATION 4, LAKE MEAD, 1968

Parameters	Depth (feet)	March	May	August	November
K x 10 ⁶ at 25° C	10	1,050	1,113	1,136	1,157
	100	1,055	1,108	1,117	1,157
	200	—	1,093	1,136	1,103
	240	—	—	1,100	—
pH	10	8.5	8.2	8.3	8.3
	100	8.5	8.2	8.0	8.3
	200	—	8.0	8.2	8.1
	240	—	—	8.0	—
Total dissolved solids, milligrams per liter	10	736	756	816	868
	100	734	776	812	900
	200	—	744	840	828
	240	—	—	760	—
Calcium, milligrams per liter	10	83	87	82	88
	100	84	86	88	88
	200	—	86	82	91
	240	—	—	87	—
Magnesium, milligrams per liter	10	31	31	33	31
	100	30	31	31	31
	200	—	30	32	29
	240	—	—	30	—
Sodium, milligrams per liter	10	98	98	112	113
	100	98	97	104	113
	200	—	97	112	103
	240	—	—	103	—
Potassium, milligrams per liter	10	5.5	5.9	6.6	6.3
	100	5.5	5.9	6.3	6.3
	200	—	5.9	6.6	5.5
	240	—	—	5.9	—
Carbonate, milligrams per liter	10	2.1	0	0	0
	100	3.3	0	0	0
	200	—	0	0	0
	240	—	—	0	—
Bicarbonate, milligrams per liter	10	144	152	123	132
	100	148	152	151	139
	200	—	154	122	159
	240	—	—	174	—
Sulfate, milligrams per liter	10	301	311	327	337
	100	290	303	306	336
	200	—	307	326	305
	240	—	—	296	—

Table 9—Continued

CHEMICAL ANALYSIS, STATION 4, LAKE MEAD, 1968

Parameter	Depth (feet)	March	May	August	November
Chloride, milligrams per liter	10	92	94	98	102
	100	89	93	94	102
	200	—	94	99	92
	240	—	—	89	—
Nitrate, milligrams per liter	10	0.6	1.2	1.2	8.7
	100	1.2	1.2	1.9	4.3
	200	—	1.2	0.6	6.8
	240	—	—	3.1	—

Table 10

CHANGES IN WATER QUALITY, LAS VEGAS WASH, 1968

Parameter*	March Gage—NSD	May Gage—NSD
Temperature, degrees C	1.0	0
D. O.	1.8	5.8
phth alk.	7.0	—
M. O. alk.	-28	-14
CO ₂	—	—
pH	0.4	0.6
Cond	1,655	2,801
TDS	1,436	2,592
Ca	152	206
Mg	74	127
Na	140	230
K	27.0	39
CO ₃	0	0
HCO ₃	-25	-25
SO ₄	380	725
Cl	461	646
NO ₃	6.7	13

Table 10—Continued

CHANGES IN WATER QUALITY, LAS VEGAS WASH, 1968

August

Parameter*	Gage—Dump	Dump—NSD	Gage—NSD
Temperature, degrees C	1.5	-1.0	0.5
D. O.	1.4	0.2	1.6
phth alk.	0	4.0	4.0
M. O. alk.	-52	7.0	-45
CO ₂	-7.1	-1.9	-9.0
pH	0.3	0.1	0.4
Cond	1,929	0	1,929
TDS	2,028	-96	1,932
Ca	214	0	214
Mg	97	-5	92
Na	161	-5.0	155
K	49	-4.0	45
CO ₃	0	0	0
HCO ₃	-63	10	-53
SO ₄	528	48	480
Cl	532	-28	504
NO ₃	37	0	37

November

Parameter*	Gage—Dump	Dump—NSD	Gage—NSD
Temperature, degrees C	0	0	0
D. O.	6.0	-0.2	5.8
phth alk.	0	0	0
M. O. alk.	-26	13.0	-13
CO ₂	-10.8	-	-10
pH	0.5	0.1	0.6
Cond	1,890	-117	1,773
TDS	1,736	-160	1,576
Ca	188	-14	174
Mg	80	-9.0	71
Na	156	-9.0	147
K	35	-4.0	31
CO ₃	0	0	0
HCO ₃	-27	21	-6.0
SO ₄	547	-34	513
Cl	461	-57	404
NO ₃	18	-1.0	17

*Conductivity $K \times 10^6$ at 25° C—micromhos/cm; pH—units; all others milligrams per liter.

Table 11

NITROGEN SERIES, LAKE MEAD, 1968

Station	Depth (feet)	Date	NO ₃ -N mg/l	Org-N mg/l	NH ₃ -N mg/l
4	5	3- 2-68	0.45	0.24	0.38
	25	3- 2-68	0.44	.35	0.60
8	10	3- 5-68	0.49	.22	0.66
	100	3- 5-68	0.52	.19	0.42
10	10	3- 4-68	0.39	.17	0.52
	100	3- 4-68	0.51	.27	0.59
10A	10	3- 4-68	0.35	.28	0.61
	25	3- 4-68	1.63	.32	0.70
NSD	Surface	3- 8-68	9.26	.16	1.23
Gage	Surface	3- 8-68	2.04	.76	0.62
4	10	5-24-68	0.42	.35	0.53
	25	5-24-68	0.44	.33	0.41
	50	5-24-68	0.44	.36	0.64
8	10	5-26-68	0.38	.32	0.51
	25	5-26-68	0.39	.29	0.57
	50	5-26-68	0.48	.31	0.37
10	10	5-23-68	0.08	.72	0.55
	25	5-23-68	0.37	.42	0.53
	50	5-23-68	0.42	.38	0.38
10A	10	5-23-68	0.03	.75	0.54
	25	5-23-68	0.36	.33	0.56
NSD	Surface	5-27-68	—	.10	1.39
Gage	Surface	5-27-68	1.90	.82	0.33
4	10	8-22-68	0.10	.12	0.04
	25	8-22-68	0.12	.28	0.10
10A	10	8-22-68	0.06	.28	0.28
	25	8-22-68	0.08	.33	0.39
NSD	Surface	8-21-68	12.4	.07	0.07
Dump	Surface	8-21-68	12.4	.08	0.50
Gage	Surface	8-21-68	3.1	.46	0.51
4	10	11-16-68	0.27	.08	0.15
10A	10	11-18-68	0.30	.09	0.24
NSD	Surface	11-16-68	13.3	.09	0.18
Dump	Surface	11-16-68	15.5	.04	0.24
Gage	Surface	11-16-68	6.86	.45	—

Table 12

PHOSPHORUS SERIES, LAKE MEAD, 1968

Station	Depth (feet)	Date	Ortho PO ₄ -mg/l	Total insoluble PO ₄ -mg/l
4	5	3- 2-68	—	0.04
4	10	3- 2-68	0.00	.03
4	25	3- 2-68	0.10	.02
8	10	3- 5-68	0.03	.02
8	25	3- 5-68	0.00	.02
10	10	3- 4-68	0.00	.02
10	50	3- 4-68	0.00	.02
10	100	3- 4-68	0.00	.02
10A	10	3- 4-68	0.00	.05
10A	25	3- 4-68	1.04	.13
NSD	Surface	3- 8-68	7.70	.06
Gage	Surface	3- 8-68	12.80	.04
4	10	5-25-68	0.00	.03
	25	5-25-68	0.00	.03
	50	5-25-68	0.00	.03
8	10	5-26-68	0.00	0.00
	25	5-26-68	0.00	0.00
	50	5-26-68	0.00	.03
10	10	5-23-68	0.00	.06
	25	5-23-68	0.00	.03
	50	5-23-68	0.00	0.00
10A	10	5-23-68	0.00	.15
	25	5-23-68	0.00	.06
NSD	Surface	5-27-68	8.80	.03
Gage	Surface	5-27-68	18.30	.03
4	10	8-22-68	0.00	0.00
4	25	8-22-68	0.00	.03
10A	10	8-22-68	0.00	.15
10A	25	8-22-68	0.03	.09
NSD	Surface	8-21-68	5.80	0.00
Gage	Surface	8-21-68	10.80	.06
Dump	Surface	8-21-68	5.40	0.00
4	10	11-16-68	0.00	.01
10A	10	11-16-68	0.00	.02
NSD	5	11-16-68	10.70	.07
Gage	Surface	11-16-68	17.20	.04
Dump	Surface	11-16-68	8.60	—

Table 13

NITROGEN, PHOSPHATE, CHLOROPHYLL A AT 10 FEET, AND SECCHI DISK
STATIONS 4, 8, 10, 10A, LAKE MEAD, 1968

Station	NO ₃ -N mg/l	Org-N mg/l	NH ₃ -N mg/l	Total insoluble PO ₄ mg/l	Chlorophyll A mgSPU/M ³	Secchi disk feet
March						
4	0.04	0.24	0.38	0.03	2.0	24
8	.49	.22	.66	.02	2.8	26
10	.39	.17	.52	.02	2.2	16
10A	.35	.28	.61	.05	4.3	10
May						
4	0.42	0.35	0.53	0.03	1.5	40
8	.38	.32	.51	0.00	2.4	42
10	.08	.72	.55	.06	50.7	5
10A	.03	.75	.54	.15	81.4	3
August						
4	0.10	0.12	0.04	0.00	9.6	13
8	—	—	—	—	6.1	14
10	—	—	—	—	17.5	7
10A	.06	.28	.28	0.15	49.4	5
November						
4	0.27	0.08	0.15	0.01	3.2	—
8	—	—	—	—	—	23
10	—	—	—	—	—	26
10A	.30	.09	.24	.02	6.1	25

NOTE: Orthophosphate values at all stations and sample periods were 0 mg/l except for Station 8 in March when value was 0.03.

Table 14

ORGANIC MATERIAL, LAKE MEAD, 1968

Station	Milligrams per liter			
	Depth (feet)	May	August	November
4	10	166	141	140
	25	171	150	161
	50	173	144	142
	100	192	149	148
	200	158	156	—
10	10	172	168	147
	25	180	172	147
	50	173	180	151
	100	188	164	149
	150	—	161	—
10A	10	—	197	—
	25	—	186	—
	50	—	196	—

APPENDIX B ANALYTICAL METHODS

METHODS OF ANALYSIS

- pH—Electrometric; Standard Methods, 12th Edition, pp 226-228
- Free Carbon Dioxide—Titrimetric; Standard Methods, 12th Edition, pp 82-83
- Alkalinity—Titrimetric; Standard Methods, 12th Edition, pp 48-52
- Dissolved Oxygen—Azide Modification of Idometric; Standard Methods, 12th Edition, pp 406-408
- Specific Conductance—Wheatstone Bridge; Standard Methods; 12th Edition, pp 280
- Total Residue—Residue-on-Evaporation; Standard Methods, 12th Edition, p 244
- Calcium—Complexometric; Standard Methods, 12th Edition, pp 74-75
- Magnesium—Calculation (total hardness-complexometric); Geological Survey Water Supply Paper—1450, D:23a-1
- Sodium—Flame Photometric; Standard Methods, 12th Edition, pp 274-277
- Potassium—Flame Photometric; Standard Methods, 12th Edition, pp 239-240
- Sulfate—Gravimetric; Standard Methods, 12th Edition, pp 287-290
- Chloride—Mohr Geological Survey Water-Supply Paper—1450, D:10
- *Nitrate-nitrogen—Modified Modified Brucine—"Determination of Nitrate in Estuarine Waters," Hoyd Kahnand Francis Brezenski, Analytical Chemistry, Volume 1, No. 6, June 1967
- *Organic-nitrogen—Standard Methods, 12th Edition, pp 208-211
- *Ammonium-nitrogen—Standard Methods, 12th Edition, pp 186-193
- *Soluble phosphate (orthophosphate)—"A study of Methods Suitable for the Analysis and Preservation of Phosphorus Forms in an Estuarine Environment," David Jenkins, U.S. Department of HEW, WPCA, San Francisco, California, pp 45-47
- *Total (insoluble) Phosphorus—"A Study of Methods Suitable for the Analysis and Preservation of Phosphorous Forms in an Estuarine Environment", David Jenkins, U.S. Department of HEW, WPCA, San Francisco, California, pp 49-50
- *Sample preservation—40 mg HgCl₂ per liter at 4° C

CONVERSION FACTORS--BRITISH TO METRIC UNITS OF MEASUREMENT

The following conversion factors adopted by the Bureau of Reclamation are those published by the American Society for Testing and Materials (ASTM Metric Practice Guide, E 380-68) except that additional factors (*) commonly used in the Bureau have been added. Further discussion of definitions of quantities and units is given in the ASTM Metric Practice Guide.

The metric units and conversion factors adopted by the ASTM are based on the "International System of Units" (designated SI for Systeme International d'Unites), fixed by the International Committee for Weights and Measures; this system is also known as the Giorgi or MKSA (meter-kilogram (mass)-second-ampere) system. This system has been adopted by the International Organization for Standardization in ISO Recommendation R-31.

The metric technical unit of force is the kilogram-force; this is the force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 9.80665 m/sec/sec, the standard acceleration of free fall toward the earth's center for sea level at 45 deg latitude. The metric unit of force in SI units is the newton (N), which is defined as that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 1 m/sec/sec. These units must be distinguished from the (inconstant) local weight of a body having a mass of 1 kg; that is, the weight of a body is that force with which a body is attracted to the earth and is equal to the mass of a body multiplied by the acceleration due to gravity. However, because it is general practice to use "pound" rather than the technically correct term "pound-force," the term "kilogram" (or derived mass unit) has been used in this guide instead of "kilogram-force" in expressing the conversion factors for forces. The newton unit of force will find increasing use, and is essential in SI units.

Where approximate or nominal English units are used to express a value or range of values, the converted metric units in parentheses are also approximate or nominal. Where precise English units are used, the converted metric units are expressed as equally significant values.

Table I

QUANTITIES AND UNITS OF SPACE

Multiply	By	To obtain
LENGTH		
Mil.	25.4 (exactly)	Micron
Inches	25.4 (exactly)	Millimeters
	2.54 (exactly)*	Centimeters
Feet	30.48 (exactly)	Centimeters
	0.3048 (exactly)*	Meters
	0.0003048 (exactly)*	Kilometers
Yards	0.9144 (exactly)	Meters
Miles (statute)	1,609.344 (exactly)*	Meters
	1.609344 (exactly)	Kilometers
AREA		
Square inches	6.4516 (exactly)	Square centimeters
Square feet	929.03*	Square centimeters
	0.092903	Square meters
Square yards	0.836127	Square meters
Acres	0.40469*	Hectares
	4,046.9*	Square meters
	0.0040469*	Square kilometers
Square miles	2,589,999	Square kilometers
VOLUME		
Cubic inches	16.3871	Cubic centimeters
Cubic feet	0.0283168	Cubic meters
Cubic yards	0.764555	Cubic meters
CAPACITY		
Fluid ounces (U.S.)	29.5737	Cubic centimeters
	29.5729	Milliliters
Liquid pints (U.S.)	0.473179	Cubic decimeters
	0.473166	Liters
Quarts (U.S.)	946.358*	Cubic centimeters
	0.946331*	Liters
Gallons (U.S.)	3,785.43*	Cubic centimeters
	3,785.43	Cubic decimeters
	3,785.33	Liters
	0.00378543*	Cubic meters
Gallons (U.K.)	4.54609	Cubic decimeters
	4.54596	Liters
Cubic feet	28.3160	Liters
Cubic yards	764.55*	Liters
Acre-feet	1,233.5*	Cubic meters
	1,233,500*	Liters

Table II
QUANTITIES AND UNITS OF MECHANICS

Multiply	By	To obtain
MASS		
Grains (1/7,000 lb)	64.79891 (exactly)	Milligrams
Troy ounces (480 grains)	31.1035	Grams
Ounces (avdp)	28.3496	Grams
Pounds (avdp)	0.45359237 (exactly)	Kilograms
Short tons (2,000 lb)	907.185	Kilograms
Long tons (2,240 lb)	0.907185	Metric tons
	1,016.05	Kilograms
FORCE/AREA		
Pounds per square inch	0.070307	Kilograms per square centimeter
	0.889476	Newtons per square centimeter
Pounds per square foot	4.88243	Kilograms per square meter
	47.8803	Newtons per square meter
MASS/VOLUME (DENSITY)		
Ounces per cubic inch	1.72999	Grams per cubic centimeter
Pounds per cubic foot	16.0185	Kilograms per cubic meter
	0.0160185	Grams per cubic centimeter
Tons (long) per cubic yard	1.32894	Grams per cubic centimeter
MASS/CAPACITY		
Ounces per gallon (U.S.)	7.4893	Grams per liter
Ounces per gallon (U.K.)	6.2362	Grams per liter
Pounds per gallon (U.S.)	119.829	Grams per liter
Pounds per gallon (U.K.)	99.779	Grams per liter
BENDING MOMENT OR TORQUE		
Inch-pounds	0.011521	Meter-kilograms
	1.12985 x 10 ⁶	Centimeter-dynes
Foot-pounds	0.138255	Meter-kilograms
	1.35582 x 10 ⁷	Centimeter-dynes
Foot-pounds per inch	5.4431	Centimeter-kilograms per centimeter
Ounce-inches	72.008	Gram-centimeters
VELOCITY		
Feet per second	30.48 (exactly)	Centimeters per second
	0.3048 (exactly)*	Meters per second
Feet per year	0.965873 x 10 ⁻⁶	Centimeters per second
Miles per hour	1.609344 (exactly)	Kilometers per hour
	0.44704 (exactly)	Meters per second
ACCELERATION*		
Feet per second ²	0.3048*	Meters per second ²
FLOW		
Cubic feet per second (second-foot)	0.028317*	Cubic meters per second
Cubic feet per minute	0.4719	Liters per second
Gallons (U.S.) per minute	0.06309	Liters per second
FORCE*		
Pounds	0.453592*	Kilograms
	4.4482*	Newtons
	4.4482 x 10 ⁻⁵ *	Dynes

Multiply	By	To obtain
WORK AND ENERGY*		
British thermal units (Btu)	0.252*	Kilogram calories
	1,055.06	Joules
Btu per pound	2.326 (exactly)	Joules per gram
Foot-pounds	1.35582*	Joules
POWER		
Horsepower	745.700	Watts
Btu per hour	0.293071	Watts
Foot-pounds per second	1.35582	Watts
HEAT TRANSFER		
Btu in./hr ft ² deg F (k, thermal conductivity)	1.442	Milliwatts/cm deg C
	0.1240	Kg cal/hr m deg C
Btu ft/hr ft ² deg F	1.4880*	Kg cal/m/hr m ² deg C
Btu/hr ft ² deg F (C, thermal conductance)	0.568	Milliwatts/cm ² deg C
	4.882	Kg cal/hr m ² deg C
Deg F hr ft ² /Btu (R, thermal resistance)	1.761	Deg C cm ² /milliwatt
Btu/lb deg F (c, heat capacity)	4.1868	J/g deg C
Btu/lb deg F	1.000*	Cal/gram deg C
Ft ² /hr (thermal diffusivity)	0.2581	Cm ² /sec
	0.09290*	M ² /hr
WATER VAPOR TRANSMISSION		
Grains/hr ft ² (water vapor transmission)	16.7	Grams/24 hr m ²
Perms (permeance)	0.859	Metric perms
Perm-inches (permeability)	1.87	Metric perm-centimeters

Table III
OTHER QUANTITIES AND UNITS

Multiply	By	To obtain
Cubic feet per square foot per day (seepage)	304.8*	Liters per square meter per day
Pound-seconds per square foot (viscosity)	4.8824*	Kilogram second per square meter
Square feet per second (viscosity)	0.092903*	Square meters per second
Fahrenheit degrees (change)*	5/9 exactly	Celsius or Kelvin degrees (change)*
Volts per mil	0.03937	Kilovolts per millimeter
Lumens per square foot (foot-candles)	10.764	Lumens per square meter
Ohm-circular mils per foot	0.001682	Ohm-square millimeters per meter
Milliuries per cubic foot	35.3147*	Milliuries per cubic meter
Milliamps per square foot	10.7639*	Milliamps per square meter
Gallons per square yard	4.527219*	Liters per square meter
Pounds per inch	0.17858*	Kilograms per centimeter

ABSTRACT

Effluents from the Clark County and Las Vegas, Nev sewage treatment plants are the principal sources of water flowing into Las Vegas Wash. Water in the Wash flows into Las Vegas Bay, an arm of the Boulder Basin reach of Lake Mead. A study was conducted to determine the quality of water in Las Vegas Wash and the effect of that water on the water quality of the lake. Large amounts of total dissolved solids and algae nutrients enter the lake from the Wash. Chlorophyll A values, indicators of algae blooms, were 20-25 times higher in Las Vegas Bay than in the control stations elsewhere in Lake Mead. An unaccountable increase in cations and anions occurs in the Wash. The source of the addition is not known but may be caused by unmeasured ground-water inflow. Methods of collections and analysis for nitrogen and phosphorus are described.

ABSTRACT

Effluents from the Clark County and Las Vegas, Nev sewage treatment plants are the principal sources of water flowing into Las Vegas Wash. Water in the Wash flows into Las Vegas Bay, an arm of the Boulder Basin reach of Lake Mead. A study was conducted to determine the quality of water in Las Vegas Wash and the effect of that water on the water quality of the lake. Large amounts of total dissolved solids and algae nutrients enter the lake from the Wash. Chlorophyll A values, indicators of algae blooms, were 20-25 times higher in Las Vegas Bay than in the control stations elsewhere in Lake Mead. An unaccountable increase in cations and anions occurs in the Wash. The source of the addition is not known but may be caused by unmeasured ground-water inflow. Methods of collections and analysis for nitrogen and phosphorus are described.

ABSTRACT

Effluents from the Clark County and Las Vegas, Nev sewage treatment plants are the principal sources of water flowing into Las Vegas Wash. Water in the Wash flows into Las Vegas Bay, an arm of the Boulder Basin reach of Lake Mead. A study was conducted to determine the quality of water in Las Vegas Wash and the effect of that water on the water quality of the lake. Large amounts of total dissolved solids and algae nutrients enter the lake from the Wash. Chlorophyll A values, indicators of algae blooms, were 20-25 times higher in Las Vegas Bay than in the control stations elsewhere in Lake Mead. An unaccountable increase in cations and anions occurs in the Wash. The source of the addition is not known but may be caused by unmeasured ground-water inflow. Methods of collections and analysis for nitrogen and phosphorus are described.

ABSTRACT

Effluents from the Clark County and Las Vegas, Nev sewage treatment plants are the principal sources of water flowing into Las Vegas Wash. Water in the Wash flows into Las Vegas Bay, an arm of the Boulder Basin reach of Lake Mead. A study was conducted to determine the quality of water in Las Vegas Wash and the effect of that water on the water quality of the lake. Large amounts of total dissolved solids and algae nutrients enter the lake from the Wash. Chlorophyll A values, indicators of algae blooms, were 20-25 times higher in Las Vegas Bay than in the control stations elsewhere in Lake Mead. An unaccountable increase in cations and anions occurs in the Wash. The source of the addition is not known but may be caused by unmeasured ground-water inflow. Methods of collections and analysis for nitrogen and phosphorus are described.