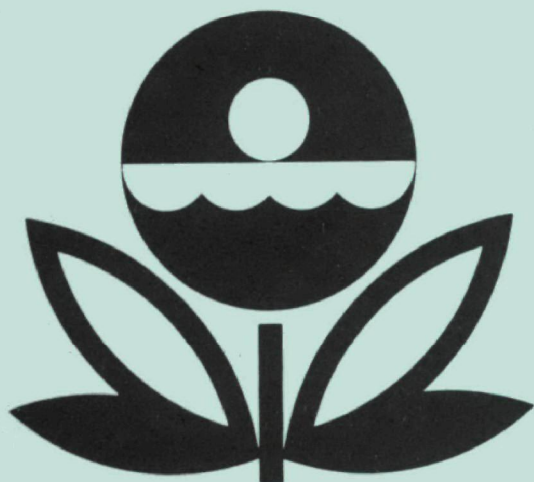


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES**



REPORT
ON
LOWER GRANITE RESERVOIR
GARFIELD AND WHITMAN COUNTIES
WASHINGTON
EPA REGION X
WORKING PAPER No. 876

**CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA**

REPORT
ON
LOWER GRANITE RESERVOIR
GARFIELD AND WHITMAN COUNTIES
WASHINGTON
EPA REGION X
WORKING PAPER No. 876

WITH THE COOPERATION OF THE
WASHINGTON DEPARTMENT OF ECOLOGY
AND THE
WASHINGTON NATIONAL GUARD
JULY, 1977

REPORT ON LOWER GRANITE RESERVOIR
GARFIELD AND WHITMAN COUNTIES, WASHINGTON
EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 876

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

July 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

- a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.
- b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.
- c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Washington Department of Ecology for professional involvement, to the Washington National Guard for conducting the tributary sampling phase of the Survey, and to those Washington wastewater treatment plant operators who provided effluent samples and flow data.

Ms. Barbara Blau, Lake Restoration Program, and the staff of the Washington Department of Ecology, Lake Restoration Program, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

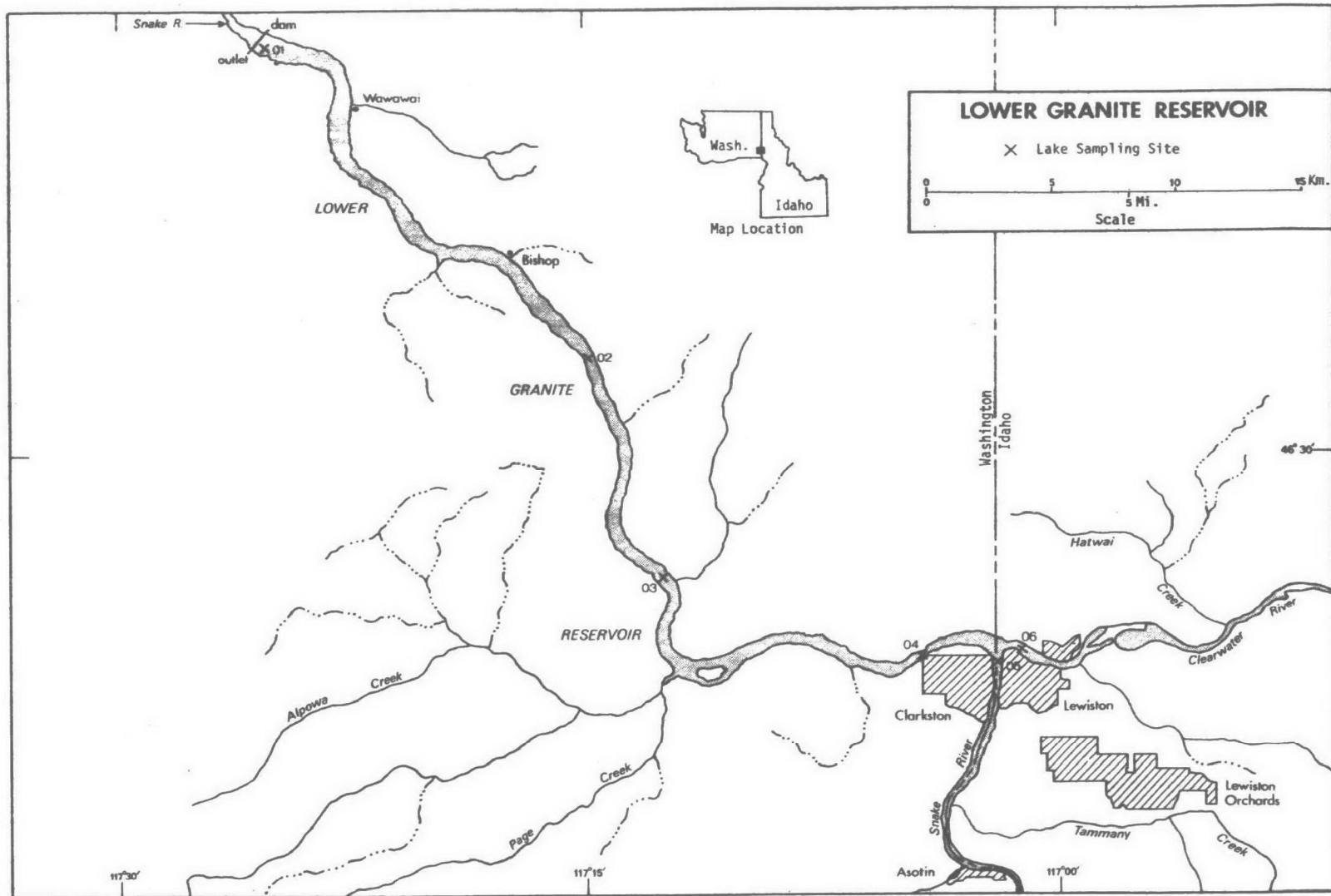
Major General Howard S. McGee, Adjutant General of Washington, and Project Officer Colonel Clinton C. Johnson, who directed the volunteer efforts of the Washington National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WASHINGTON

| <u>LAKE NAME</u> | <u>COUNTY</u> |
|-------------------------|-------------------|
| American Lake | Pierce |
| Banks Lake | Grant, Douglas |
| Chelan Lake | Chelan |
| Diamond Lake | Pend Oreille |
| Green Lake | King |
| Keechelus Lake | Kittitas |
| Mayfield Lake | Lewis |
| Medical Lake | Spokane |
| Moses Lake | Grant |
| Ozette Lake | Clallam |
| Sammamish Lake | King |
| Lake Whatcom | Whatcom |
| Lower Granite Reservoir | Garfield, Whatcom |



REPORT ON LOWER GRANITE RESERVOIR, WASHINGTON

STORET NO. 5313

I. INTRODUCTION

Lower Granite Reservoir was included in the National Eutrophication Survey (NES) as a water body of special interest to the Washington Department of Ecology. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

II. CONCLUSIONS

A. Trophic Condition:*

Based upon Survey data Lower Granite Reservoir is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Potential for primary productivity as measured by algal assay control yield was high in the lake on both sampling occasions. Secchi disc visibility was only about 1.5 m (60 inches) throughout the lake except at Station 06 where it was substantially higher. Of the 13 Washington lakes sampled in 1975, 2 had higher median total phosphorus levels (0.033 mg/l) 3 had higher median inorganic nitrogen values (0.150 mg/l) and

*See Appendix C.

2 had higher median orthophosphorus levels (0.022 mg/l) than Lower Granite Reservoir.

Survey limnologists did not observe any problem conditions during their visits to the lake.

B. Rate-Limitng Nutrient:

Algal assay results indicate nitrogen limitation in Lower Granite Reservoir during July sampling and phosphorus limitation in September. The lake data suggest primary limitation by nitrogen on both sampling rounds.

III. LAKE CHARACTERISTICS

A. Lake Morphometry:*

1. Surface area: 36.42 km².
2. Mean depth: 13.7 meters.
3. Maximum depth: 41.2 meters.
4. Volume: 498.954 x 10³ m³.

B. Precipitation:

1. Year of sampling: 67.0 cm.
2. Mean annual: 53.1 cm.

*Lake surface area and maximum depth were provided by the Washington Department of Ecology (1973). Mean depth and volume were estimated on the basis of National Eutrophication Survey (NES) data.

IV. LAKE WATER QUALITY SUMMARY

Lower Granite Reservoir was sampled two times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from six stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During both visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 36.9 meters at Station 01, 28.4 meters at Station 02, 26.5 meters at Station 03, 10.7 meters at Station 04, 9.8 meters at Station 05, and 7.9 meters at Station 06. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix B and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

LOWER GRANITE RESERVOIR
STORET CODE 5313

PHYSICAL AND CHEMICAL CHARACTERISTICS

| PARAMETER | N* | (7/23/75) | | | MAX DEPTH RANGE (METERS) | N* | (9/12/75) | | |
|--------------------------|----|-------------|--------|-----------|--------------------------|-------------|-------------|-----------|----------|
| | | RANGE | MEDIAN | S*** = 6 | | | RANGE | MEDIAN | S*** = 6 |
| TEMPERATURE (DEG CENT) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 16.4- 19.8 | 18.5 | 0.0- 1.5 | 12 | 12.7- 17.1 | 16.0 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 16.3- 18.5 | 18.0 | 7.9- 34.7 | 6 | 12.6- 16.6 | 14.9 | 6.4- 36.9 | |
| DISSOLVED OXYGEN (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 8.4- 9.4 | 8.6 | 0.0- 1.5 | 12 | 8.0- 9.4 | 8.8 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 8.0- 9.0 | 8.6 | 7.9- 34.7 | 6 | 7.8- 8.8 | 8.5 | 6.4- 36.9 | |
| CONDUCTIVITY (UMHOS) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 23.- 158. | 130. | 0.0- 1.5 | 12 | 13.- 358. | 241. | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 25.- 154. | 126. | 7.9- 34.7 | 6 | 13.- 356. | 223. | 6.4- 36.9 | |
| PH (STANDARD UNITS) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 7.7- 8.4 | 8.2 | 0.0- 1.5 | 12 | 8.2- 8.3 | 8.3 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 7.6- 8.3 | 8.1 | 7.9- 34.7 | 6 | 8.0- 8.3 | 8.2 | 6.4- 36.9 | |
| TOTAL ALKALINITY (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 13.- 68. | 57. | 0.0- 1.5 | 12 | 14.- 132. | 97. | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 16.- 69. | 53. | 7.9- 34.7 | 6 | 15.- 122. | 81. | 6.4- 36.9 | |
| TOTAL P (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 0.013-0.038 | 0.028 | 0.0- 1.5 | 12 | 0.014-0.061 | 0.041 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 0.015-0.036 | 0.030 | 7.9- 34.7 | 6 | 0.013-0.051 | 0.039 | 6.4- 36.9 | |
| DISSOLVED ORTHO P (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 0.006-0.024 | 0.019 | 0.0- 1.5 | 12 | 0.007-0.039 | 0.023 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 0.010-0.026 | 0.022 | 7.9- 34.7 | 6 | 0.008-0.040 | 0.023 | 6.4- 36.9 | |
| NO2+NO3 (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 0.020-0.120 | 0.100 | 0.0- 1.5 | 12 | 0.030-0.400 | 0.225 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 0.020-0.130 | 0.100 | 7.9- 34.7 | 6 | 0.020-0.410 | 0.200 | 6.4- 36.9 | |
| AMMONIA (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 0.020-0.020 | 0.020 | 0.0- 1.5 | 12 | 0.020-0.040 | 0.020 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 0.020-0.040 | 0.025 | 7.9- 34.7 | 6 | 0.020-0.040 | 0.020 | 6.4- 36.9 | |
| KJELDAHL N (MG/L) | | | | | | | | | |
| 0.-1.5 M DEPTH | 12 | 0.200-0.300 | 0.200 | 0.0- 1.5 | 12 | 0.200-0.500 | 0.300 | 0.0- 1.5 | |
| MAX DEPTH** | 6 | 0.200-0.300 | 0.200 | 7.9- 34.7 | 6 | 0.200-0.300 | 0.200 | 6.4- 36.9 | |
| SECCHI DISC (METERS) | 5 | 1.2- 3.4 | 1.4 | | 6 | 1.5- 2.7 | 1.8 | | |

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

| <u>Sampling Date</u> | <u>Dominant Genera</u> | <u>Algal Units per ml</u> |
|--------------------------|----------------------------|-----------------------------------|
| 07/23/75 | 1. <u>Skeletonema</u> | 630 |
| | 2. <u>Centric Diatoms</u> | 540 |
| | 3. <u>Fragilaria</u> | 210 |
| | 4. <u>Chroomonas</u> | 60 |
| | 5. <u>Nitzschia</u> | 60 |
| | Other genera | <u>150</u> |
| | Total | 1,650 |
| 09/12/75 | 1. <u>Melosira</u> | 810 |
| | 2. <u>Chroomonas</u> | 778 |
| | 3. <u>Skeletonema</u> | 195 |
| | 4. <u>Cyclotella</u> | 162 |
| | 5. <u>Nitzschia</u> | 130 |
| | Other genera | <u>812</u> |
| | Total | 2,887 |

2. Chlorophyll a -

| <u>Sampling Date</u> | <u>Station Number</u> | <u>Chlorophyll <u>a</u> ($\mu\text{g/l}$)</u> |
|--------------------------|---------------------------|--|
| 07/23/75 | 01 | 9.6 |
| | 02 | 4.5 |
| | 03 | 4.2 |
| | 04 | 2.5 |
| | 05 | 2.6 |
| | 06 | 5.1 |
| 09/12/75 | 01 | 5.1 |
| | 02 | 3.7 |
| | 03 | 4.5 |
| | 04 | 4.9 |
| | 05 | 5.3 |
| | 06 | 7.5 |

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 07/23/75 Stations 01-04

| <u>Spike (mg/l)</u> | <u>Ortho P Conc. (mg/l)</u> | <u>Inorganic N Conc. (mg/l)</u> | <u>Maximum Yield (mg/l-dry wt.)</u> |
|---------------------|---------------------------------|-------------------------------------|---|
| Control | 0.008 | 0.080 | 3.9 |
| 0.05 P | 0.058 | 0.080 | 4.1 |
| 0.05 P + 1.0 N | 0.058 | 1.080 | 17.2 |
| 1.00 N | 0.008 | 1.080 | 16.0 |

Stations 05, 06

| | | | |
|----------------|-------|-------|------|
| Control | 0.015 | 0.055 | 2.8 |
| 0.05 P | 0.065 | 0.055 | 2.9 |
| 0.05 P + 1.0 N | 0.065 | 1.055 | 27.6 |
| 1.00 N | 0.015 | 1.055 | 5.6 |

b. 09/12/75 Stations 01-03

| | | | |
|----------------|-------|-------|------|
| Control | 0.020 | 0.230 | 1.1 |
| 0.05 P | 0.070 | 0.230 | 9.7 |
| 0.05 P + 1.0 N | 0.070 | 1.230 | 20.6 |
| 1.00 N | 0.020 | 1.230 | 1.1 |

Stations 04-06

| | | | |
|----------------|-------|-------|------|
| Control | 0.020 | 0.240 | 1.6 |
| 0.05 P | 0.070 | 0.240 | 9.4 |
| 0.05 P + 1.0 N | 0.070 | 1.240 | 13.0 |
| 1.00 N | 0.020 | 1.240 | 2.1 |

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary production in Lower Granite Reservoir was high on both sampling occasions (07/23/75, 09/12/75). During July sampling, the addition of nitrogen spikes produced a substantial increase in yield over that of the control, indicating nitrogen limitation. During September sampling, a significant increase in yield accompanied the addition of orthophosphorus, indicating phosphorus limitation at that time. In all assays the maximum growth response over that of the control was achieved with the simultaneous addition of both nutrients.

The mean inorganic nitrogen to orthophosphorus ratio (N/P) in the lake data were approximately 6/1 and 10/1 in July and October, respectively, suggesting nitrogen limitation in Lower Granite Reservoir on both lake sampling occasions.

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Washington Department of Ecology. 1973. Lakes of Washington, Volume II. Washington State Water Program, Olympia, Washington.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B
PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 7/11/15
 NATI EUTROPHICATION SURVEY
 EPA-LAS VFGAS

531301
 46 39 03.0 117 25 03.0 3
 LOWER GRANITE RESERVOIR
 53023 WASHINGTON

11EPALES 760114 2111202
 0118 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CONDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT KJEL N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00471 PHOS-DIC ORTHO MG/L P |
|--------------------|-------------------|---------------|--------------------------------|---------------------|-------------------------------------|---|-------------------|---------------------------------|---------------------------------|--------------------------------|-------------------------------------|--------------------------------------|
| 75/07/23 | 09 45 | 0000 | 19.1 | 9.4 | 60 | 119 | 8.30 | 51 | 0.020 | 0.300 | 0.020K | 0.013 |
| | 09 45 | 0005 | 19.0 | 9.2 | | 116 | 8.40 | 49 | 0.020 | 0.300 | 0.030 | 0.010 |
| | 09 45 | 0015 | 18.7 | 8.6 | | 115 | 8.30 | 50 | 0.020 | 0.200K | 0.040 | 0.010 |
| | 09 45 | 0035 | 17.9 | 8.4 | | 120 | 8.00 | 52 | 0.020 | 0.200K | 0.090 | 0.022 |
| | 09 45 | 0075 | 17.4 | 8.2 | | 119 | 8.00 | 53 | 0.050 | 0.200K | 0.110 | 0.022 |
| | 09 45 | 0114 | 17.1 | 8.0 | | 122 | 7.95 | 54 | 0.040 | 0.200 | 0.110 | 0.019 |
| 75/09/12 | 09 30 | 0000 | 16.1 | 8.8 | 60 | 227 | 8.20 | 99 | 0.040 | 0.500 | 0.160 | 0.018 |
| | 09 30 | 0005 | 16.2 | 8.6 | | 243 | 8.20 | 94 | 0.020K | 0.300 | 0.170 | 0.019 |
| | 09 30 | 0035 | 15.7 | 8.4 | | 223 | 8.00 | 81 | 0.030 | 0.200 | 0.190 | 0.027 |
| | 09 30 | 0070 | 15.3 | 8.0 | | 216 | 7.95 | 79 | 0.030 | 0.200 | 0.190 | 0.023 |
| | 09 30 | 0121 | 14.7 | 7.8 | | 225 | 8.10 | 76 | 0.040 | 0.200 | 0.180 | 0.022 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLRPHYL A UG/L | 00031 INCDT LT REMNING PERCENT |
|--------------------|-------------------|---------------|-----------------------------|--------------------------------|---|
| 75/07/23 | 09 45 | 0000 | 0.038 | 9.6 | |
| | 09 45 | 0005 | 0.033 | | |
| | 09 45 | 0015 | 0.029 | | |
| | 09 45 | 0035 | 0.031 | | |
| | 09 45 | 0075 | 0.031 | | |
| | 09 45 | 0114 | 0.036 | | |
| 75/09/12 | 09 30 | 0000 | 0.042 | 5.1 | |
| | 09 30 | 0005 | 0.041 | | |
| | 09 30 | 0035 | 0.031 | | |
| | 09 30 | 0070 | 0.032 | | |
| | 09 30 | 0121 | 0.037 | | |

K VALUE KNOWN TO BE LESS
 THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
 NATL EUTROPHICATION SURVEY
 EPA-LAS VEGAS

531302
 45 32 55.0 117 15 05.0 3
 LOWER GRANITE RESERVOIR
 53075 WASHINGTON

11EPALES 760114 2111202
 0097 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATF4 TEMP CFMT | 00300 DO MG/L | 00077 TRANSP SECCHT INCHES | 00094 CONDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT N JFL N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00671 PHOS-DIS OPTMO MG/L P |
|--------------|-------------|------------|-----------------------|---------------|----------------------------|--------------------------------|-------------|------------------------|------------------------|------------------------|----------------------------|-----------------------------|
| 75/07/23 | 10 30 | 0000 | 18.6 | 8.8 | 48 | 130 | 8.10 | 57 | 0.020 | 0.200 | 0.100 | 0.015 |
| | 10 30 | 0005 | 18.4 | 8.6 | | 124 | 8.20 | 56 | 0.020 | 0.200K | 0.100 | 0.020 |
| | 10 30 | 0015 | 18.4 | 8.6 | | 130 | 8.20 | 56 | 0.020 | 0.200K | 0.100 | 0.021 |
| | 10 30 | 0030 | 18.4 | 8.6 | | 130 | 8.20 | 59 | 0.030 | 0.200 | 0.090 | 0.029 |
| | 10 30 | 0065 | 17.9 | 8.6 | | 128 | 8.10 | 56 | 0.030 | 0.200 | 0.100 | 0.025 |
| | 10 30 | 0093 | 17.9 | 8.4 | | 130 | 8.00 | 57 | 0.030 | 0.200K | 0.100 | 0.024 |
| 75/09/12 | 10 10 | 0000 | 15.9 | 9.0 | 96 | 241 | 8.25 | 82 | 0.020K | 0.200 | 0.170 | 0.019 |
| | 10 10 | 0005 | 15.9 | 8.2 | | 240 | 8.20 | 86 | 0.020K | 0.200 | 0.220 | 0.023 |
| | 10 10 | 0020 | 15.9 | 8.4 | | 238 | 8.20 | 86 | 0.020K | 0.200 | 0.220 | 0.024 |
| | 10 10 | 0045 | 15.7 | 8.2 | | 236 | 8.10 | 86 | 0.030 | 0.200 | 0.220 | 0.024 |
| | 10 10 | 0081 | 15.1 | 8.0 | | 220 | 8.20 | 87 | 0.020K | 0.200 | 0.220 | 0.023 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLORPHYL A UG/L | 00031 INCDT LT REMNING PERCENT |
|--------------|-------------|------------|-----------------------|------------------------|--------------------------------|
| 75/07/23 | 10 30 | 0000 | 0.028 | 4.5 | |
| | 10 30 | 0005 | 0.028 | | |
| | 10 30 | 0015 | 0.033 | | |
| | 10 30 | 0030 | 0.031 | | |
| | 10 30 | 0065 | 0.028 | | |
| | 10 30 | 0093 | 0.028 | | |
| 75/09/12 | 10 10 | 0000 | 0.036 | 3.7 | |
| | 10 10 | 0005 | 0.036 | | |
| | 10 10 | 0020 | 0.037 | | |
| | 10 10 | 0045 | 0.034 | | |
| | 10 10 | 0081 | 0.035 | | |

< VALUE KNOWN TO BE LESS
 THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
 NATH EUTROPHICATION SURVEY
 EPA-LAS VEGAS

531303
 46 27 05.0 117 12 45.0 3
 LOWER GRANITE RESERVOIR
 53003 WASHINGTON

11EPALES 760114 2111202
 0091 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CONDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT KJEL N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P |
|--------------|-------------|------------|-----------------------|---------------|----------------------------|--------------------------------|-------------|------------------------|------------------------|-----------------------|----------------------------|-----------------------------|
| 75/07/23 | 10 55 | 0000 | 18.3 | 9.0 | 54 | 129 | 8.20 | 54 | 0.020K | 0.200K | 0.100 | 0.021 |
| | 10 55 | 0005 | 18.2 | 8.6 | | 131 | 8.10 | 55 | 0.020 | 0.200K | 0.090 | 0.022 |
| | 10 55 | 0015 | 18.2 | 8.8 | | 128 | 8.15 | 57 | 0.020 | 0.200K | 0.090 | 0.020 |
| | 10 55 | 0030 | 18.1 | 10.2 | | 129 | 8.15 | 55 | 0.020 | 0.200K | 0.090 | 0.020 |
| | 10 55 | 0060 | 18.1 | 9.4 | | 129 | 8.20 | 57 | 0.020K | 0.200 | 0.090 | 0.020 |
| | 10 55 | 0087 | 18.1 | 8.6 | | 130 | 8.25 | 51 | 0.020 | 0.300 | 0.100 | 0.023 |
| 75/09/12 | 10 30 | 0000 | 15.9 | 9.2 | 84 | 237 | 8.25 | 84 | 0.020K | 0.300 | 0.220 | 0.022 |
| | 10 30 | 0005 | 15.9 | 8.8 | | 236 | 8.30 | 84 | 0.020K | 0.400 | 0.230 | 0.024 |
| | 10 30 | 0020 | 15.8 | 8.6 | | 238 | 8.20 | 86 | 0.020 | 0.200K | 0.240 | 0.025 |
| | 10 30 | 0050 | 15.8 | 8.8 | | 236 | 8.30 | 86 | 0.020 | 0.200K | 0.240 | 0.027 |
| | 10 30 | 0080 | 15.7 | 8.6 | | 234 | 8.25 | 86 | 0.020K | 0.200K | 0.240 | 0.025 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLRPHYL A UG/L | 00031 INCDT LT REMNING PERCENT |
|--------------|-------------|------------|-----------------------|-----------------------|--------------------------------|
| 75/07/23 | 10 55 | 0000 | 0.024 | 4.2 | |
| | 10 55 | 0005 | 0.024 | | |
| | 10 55 | 0015 | 0.026 | | |
| | 10 55 | 0030 | 0.027 | | |
| | 10 55 | 0060 | 0.031 | | |
| | 10 55 | 0087 | 0.028 | | |
| 75/09/12 | 10 30 | 0000 | 0.037 | 4.5 | |
| | 10 30 | 0005 | 0.040 | | |
| | 10 30 | 0020 | 0.040 | | |
| | 10 30 | 0050 | 0.035 | | |
| | 10 30 | 0080 | 0.041 | | |

K VALUE KNOWN TO BE LESS
 THAN INDICATED

STOPPET RETRIEVAL DATE 7/11/16
 NATL. FUTUREPPLICATION SURVEY
 FFA-LAS VEGAS

531304
 46 25 20.0 117 04 20.0 3
 LOWER GRANITE RESERVOIR
 53003 WASHINGTON

11EPALES 750114 2111202
 0035 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CONDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT KJEL N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00671 PHOS-DIS OPTHO MG/L P |
|--------------|-------------|------------|-----------------------|---------------|----------------------------|--------------------------------|-------------|------------------------|------------------------|-----------------------|----------------------------|-----------------------------|
| 75/07/23 | 11 30 | 0000 | 18.7 | 8.6 | 54 | 158 | 8.40 | 64 | 0.020K | 0.200K | 0.110 | 0.023 |
| | 11 30 | 0005 | 18.3 | 8.4 | | 140 | 8.35 | 57 | 0.020K | 0.200K | 0.100 | 0.021 |
| | 11 30 | 0015 | 18.2 | 8.6 | | 124 | 8.30 | 51 | 0.020 | 0.200K | 0.090 | 0.021 |
| | 11 30 | 0030 | 18.2 | 8.6 | | 122 | 8.30 | 52 | 0.020K | 0.200K | 0.090 | 0.021 |
| 75/09/12 | 10 55 | 0000 | 17.1 | 8.8 | 60 | 346 | 8.30 | 115 | 0.020K | 0.200 | 0.360 | 0.034 |
| | 10 55 | 0005 | 16.7 | 9.0 | | 312 | 8.30 | 109 | 0.020K | 0.200K | 0.340 | 0.037 |
| | 10 55 | 0020 | 15.2 | 8.6 | | 204 | 8.30 | 71 | 0.020K | 0.200K | 0.200 | 0.023 |
| | 10 55 | 0035 | 14.7 | 8.8 | | 159 | 8.30 | 67 | 0.020K | 0.200K | 0.180 | 0.024 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLOROPHYL A UG/L | 00031 INCDT LT REMNING PERCENT |
|--------------|-------------|------------|-----------------------|-------------------------|--------------------------------|
| 75/07/23 | 11 30 | 0000 | 0.028 | 2.5 | |
| | 11 30 | 0005 | 0.027 | | |
| | 11 30 | 0015 | 0.033 | | |
| | 11 30 | 0030 | 0.032 | | |
| 75/09/12 | 10 55 | 0000 | 0.050 | 4.9 | |
| | 10 55 | 0005 | 0.052 | | |
| | 10 55 | 0020 | 0.035 | | |
| | 10 55 | 0035 | 0.043 | | |

K VALUE KNOWN TO BE LESS
 THAN INDICATED

STOPET RETRIEVAL DATE 76/11/15
 NATL EUTROPHICATION SURVEY
 EPA-LAS VEGAS

531305
 45 25 05.0 117 02 00.0 3
 LOWER GRANITE RESERVOIR
 16069 WASHINGTON

11EPALES 760114 2111202
 0036 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CONDUCTIVITY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT K.I.F.L N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P |
|--------------|-------------|------------|-----------------------|---------------|----------------------------|-----------------------------------|-------------|------------------------|------------------------|--------------------------|----------------------------|-----------------------------|
| 75/07/23 | 11 50 | 0000 | 19.8 | 8.6 | | 153 | 8.30 | 66 | 0.020K | 0.200K | 0.120 | 0.018 |
| | 11 50 | 0005 | 18.6 | 8.6 | | 153 | 8.30 | 64 | 0.020K | 0.200 | 0.120 | 0.024 |
| | 11 50 | 0015 | 18.6 | 8.6 | | 159 | 8.30 | 67 | 0.020 | 0.200 | 0.120 | 0.019 |
| | 11 50 | 0032 | 18.5 | 8.8 | | 154 | 8.30 | 69 | 0.030 | 0.200 | 0.130 | 0.026 |
| 75/09/12 | 11 15 | 0000 | 16.6 | 9.0 | 60 | 344 | 8.30 | 117 | 0.020K | 0.200 | 0.320 | 0.032 |
| | 11 15 | 0005 | 16.6 | 8.0 | | 358 | 8.25 | 132 | 0.020K | 0.300 | 0.400 | 0.039 |
| | 11 15 | 0019 | 16.6 | 8.4 | | 356 | 8.30 | 122 | 0.020 | 0.400 | 0.400 | 0.041 |
| | 11 15 | 0030 | 16.6 | 8.4 | | 356 | 8.25 | 122 | 0.020K | 0.300 | 0.410 | 0.040 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLOROPHYL A UG/L | 00031 INCDT LT REMNING PERCENT |
|--------------|-------------|------------|-----------------------|-------------------------|--------------------------------|
| 75/07/23 | 11 50 | 0000 | 0.034 | 2.6 | |
| | 11 50 | 0005 | 0.033 | | |
| | 11 50 | 0015 | 0.040 | | |
| | 11 50 | 0032 | 0.034 | | |
| 75/09/12 | 11 15 | 0000 | 0.051 | 5.3 | |
| | 11 15 | 0005 | 0.053 | | |
| | 11 15 | 0019 | 0.053 | | |
| | 11 15 | 0030 | 0.051 | | |

K VALUE KNOWN TO BE LESS
 THAN INDICATED

START RETRIEVAL DATE 76/11/16
 NATL EUTROPHICATION SURVEY
 EPA-LAS VEGAS

531306
 46 25 40.0 117 01 08.0 3
 LOWER GRANITE RESERVOIR
 16069 WASHINGTON

11FPALES 760114 2111202
 0030 FEET DEPTH CLASS 00

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CONDUCTIVITY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CAC03 MG/L | 00610 NH3-N TOTAL MG/L | 00625 TOT KJFL N MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P |
|--------------|-------------|------------|-----------------------|---------------|----------------------------|-----------------------------------|-------------|------------------------|------------------------|-----------------------|----------------------------|-----------------------------|
| 75/07/23 | 12 15 | 0000 | 16.9 | 8.7 | 132 | 24 | 8.05 | 16 | 0.020K | 0.200 | 0.020 | 0.006 |
| | 12 15 | 0005 | 16.4 | 9.0 | | 23 | 7.70 | 13 | 0.020 | 0.200 | 0.020K | 0.004 |
| | 12 15 | 0015 | 16.4 | 9.8 | | 22 | 7.60 | 14 | 0.020 | 0.200K | 0.020K | 0.011 |
| | 12 15 | 0026 | 16.3 | 9.0 | | 25 | 7.60 | 16 | 0.020 | 0.200K | 0.020K | 0.010 |
| 75/09/12 | 11 40 | 0000 | 12.7 | 9.4 | 108 | 17 | 8.25 | 114 | 0.020K | 0.300 | 0.380 | 0.037 |
| | 11 40 | 0005 | 12.7 | 8.6 | | 13 | 8.25 | 14 | 0.020K | 0.300 | 0.030 | 0.007 |
| | 11 40 | 0021 | 12.6 | 8.8 | | 13 | 8.00 | 15 | 0.020K | 0.300 | 0.020K | 0.004 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00665 PHOS-TOT MG/L P | 32217 CHLRPHYL A UG/L | 00031 INCDT LT REMNING PFCENT |
|--------------|-------------|------------|-----------------------|-----------------------|-------------------------------|
| 75/07/23 | 12 15 | 0000 | 0.014 | 5.1 | |
| | 12 15 | 0005 | 0.013 | | |
| | 12 15 | 0015 | 0.015 | | |
| | 12 15 | 0026 | 0.015 | | |
| 75/09/12 | 11 40 | 0000 | 0.061 | 7.5 | |
| | 11 40 | 0005 | 0.014 | | |
| | 11 40 | 0021 | 0.013 | | |

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX C
PARAMETRIC RANKINGS OF LAKES
SAMPLED BY NES IN 1975
STATE OF WASHINGTON

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Washington lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in $\mu\text{g/l}$. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

LAKE DATA TO BE USED IN RANKINGS

| LAKE CODE | LAKE NAME | MEDIAN TOTAL P | MEDIAN INORG N | 500- MEAN SEC | MEAN CHLORA | 15- MIN DO | MEDIAN DISS ORTHO P |
|--------------|-------------------------|-------------------|-------------------|------------------|----------------|---------------|------------------------|
| 5301 | AMERICAN LAKE | 0.027 | 0.105 | 343.000 | 4.822 | 15.000 | 0.007 |
| 5302 | BANKS LAKE | 0.021 | 0.040 | 364.533 | 7.373 | 10.800 | 0.007 |
| 5303 | CHELAN LAKE | 0.005 | 0.070 | 111.900 | 0.905 | 6.400 | 0.003 |
| 5304 | DIAMOND LAKE | 0.014 | 0.060 | 303.667 | 14.537 | 14.200 | 0.010 |
| 5305 | GREEN LAKE | 0.027 | 0.050 | 415.000 | 2.983 | 10.600 | 0.009 |
| 5306 | KEECHELUS LAKE | 0.007 | 0.040 | 280.250 | 1.400 | 9.200 | 0.002 |
| 5307 | MAYFIELD LAKE | 0.014 | 0.100 | 402.000 | 4.250 | 10.600 | 0.007 |
| 5308 | MEDICAL LAKE | 0.275 | 0.225 | 401.714 | 16.425 | 15.000 | 0.166 |
| 5309 | MOSES LAKE | 0.115 | 0.150 | 463.600 | 29.060 | 14.600 | 0.038 |
| 5310 | OZETTE LAKE | 0.010 | 0.110 | 403.333 | 1.225 | 7.200 | 0.009 |
| 5311 | SAMMAMISH LAKE | 0.015 | 0.210 | 374.000 | 7.290 | 14.600 | 0.006 |
| 5312 | WHATCOM LAKE | 0.009 | 0.320 | 288.000 | 3.422 | 10.800 | 0.009 |
| 5313 | LOWER GRANITE RESERVOIR | 0.033 | 0.150 | 435.500 | 4.875 | 7.200 | 0.022 |

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

| LAKE CODE | LAKE NAME | MEDIAN TOTAL P | MEDIAN INORG N | 500- MEAN SEC | MEAN CHLORA | 15- MIN DO | MEDIAN DISS ORTHO P |
|--------------|-------------------------|-------------------|-------------------|------------------|----------------|---------------|------------------------|
| 5301 | AMERICAN LAKE | 29 (3) | 50 (6) | 67 (8) | 50 (6) | 4 (, 0) | 58 (7) |
| 5302 | BANKS LAKE | 42 (5) | 100 (12) | 58 (7) | 25 (3) | 46 (5) | 71 (8) |
| 5303 | CHELAN LAKE | 100 (12) | 67 (8) | 100 (12) | 100 (12) | 100 (12) | 92 (11) |
| 5304 | DIAMOND LAKE | 62 (7) | 75 (9) | 75 (9) | 17 (2) | 33 (4) | 25 (3) |
| 5305 | GREFN LAKE | 29 (3) | 83 (10) | 17 (2) | 75 (9) | 62 (7) | 46 (5) |
| 5306 | KEECHELIIS LAKE | 92 (11) | 92 (11) | 92 (11) | 83 (10) | 75 (9) | 100 (12) |
| 5307 | MAYFIELD LAKE | 62 (7) | 58 (7) | 33 (4) | 58 (7) | 62 (7) | 71 (8) |
| 5308 | MEDICAL LAKE | 0 (0) | 8 (1) | 42 (5) | 8 (1) | 4 (0) | 0 (0) |
| 5309 | MOSES LAKE | 8 (1) | 29 (3) | 0 (0) | 0 (0) | 21 (2) | 8 (1) |
| 5310 | OZETTE LAKE | 75 (9) | 42 (5) | 25 (3) | 92 (11) | 87 (10) | 33 (4) |
| 5311 | SAMMAMISH LAKE | 50 (6) | 17 (2) | 50 (6) | 33 (4) | 21 (2) | 83 (10) |
| 5312 | WHATCOM LAKE | 83 (10) | 0 (0) | 83 (10) | 67 (8) | 46 (5) | 46 (5) |
| 5313 | LOWER GRANITE RESERVOIR | 17 (2) | 29 (3) | 8 (1) | 42 (5) | 87 (10) | 17 (2) |