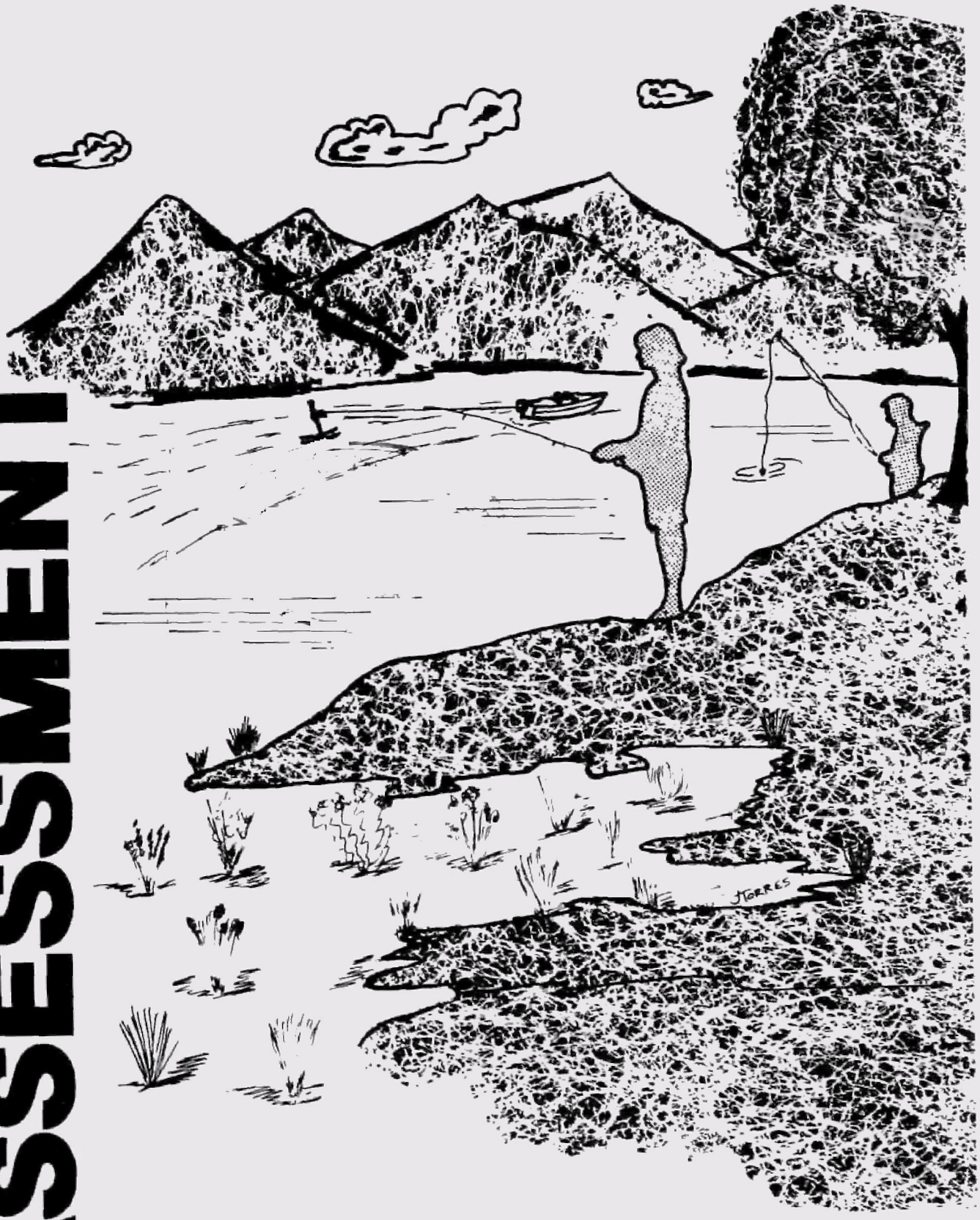
LAKE & RESERVOIR ASSESSMENT



U.S. ENVIRONMENTAL PROTECTION AGENCY
SURVEILLANCE & ANALYSIS DIVISION
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An Assessment of Region VIII Lakes and Reservoirs in Support of the 1976-305(b) Water Quality Inventory

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Table of Contents

Tables

Figures

INTRODUCTION

The nutrient most often limiting algal production in Region VIII's waterbodies is nitrogen (N:P ratio less than 14:1). Algal assays and intensive surveys, as available, generally confirm these conclusions.

Since phosphorous is usually the limited nutrient in waterbodies unimpacted by man's activities, results are opposite of what would be expected in this sparsely populated, lightly industralized region. It is highly likely, given the low relative point source loading of phosphorous, that higher than normal natural or "non-point" sources are responsible for nitrogen limitation. Development activities, such as mining, logging, farming, grazing and urbanization are suspect to be predominant factors in causing "non-point" source trophic problems, but the extent of this contribution is not clearly defined. Other sources or sources that dominate those originated by farming developments are further suspect since farming; although responsible for increased algal production, generally does not cause a shift from phosphorous to nitrogen limitation. Importantly, most waterbodies in this assessment were man-made.

Eutrophication is a dynamic process and further assessements must be carefully tempered with supplementary data. Awareness that nitrogen to phosphorous ratios are a static tool and that other nutrients could limit production; (this is not known to be the case) should certainly be recognized. Certain waterbodies may have algal blooms at N:P ratios of 8:1 or 20:1. Short detention times and/or large quantities of rooted plants tend to mitigate "dangerous" (Vollenweider) nutrient loadings

and could significantly slow eutrophication. Increased hydraulic flushing and removal of nutrients during runoff or turnover could also control highly enriched conditions.

Decision-making for permit and grant action must proceed despite finite resources of monitoring and data availability. This report, by communicating what is believed to be the present trophic state, can allow additional assessments; employing known dynamics or other data, and hopefully bring a clearer rationale for monitoring and cleanup activities.

DATA NEEDS

The National Eutrophication Survey (NES), now completed, has gone a long way toward collecting the needed Region VIII lake and reservoir data. Many important regional waterbodies were included in the 115 NES lake and reservoir coverage. A representative cross-section of lake conditions were sought with the NES coverage, including waterbodies affected and unaffected by point and non-point sources.

The NES data was by far the most useful block of information with both chemical and biological data coverage. Outside of the NES comprehensive nitrogen and phosphorous data coverage was only added for thirteen (13) lakes and reservoirs; even when reservoir outlet

stations were used. Moreover, little or no biological or other support data was available to augment these data. Comprehensive non-NES STORET data for only eight (8) lakes and reservoirs provided supplementary NES information.

Now, follow-up data gathering and gap filling should be carried on where the NES has left off. This can be accomplished through the 208 programs and the ongoing 106 programs. Table 1 offers a list of lakes with immediate data needs and Table 2 has a suggested priority list of lakes for ongoing monitoring.

TROPHIC CONDITIONS.

As shown in Table 3, eighty-three (83) of 115 NES lakes appear to be eutrophic, eighteen (18) seem in a transitional mesotrophic state, and fourteen (14) evidence oligotrophic conditions. Of the non-NES STORET stations assembled in Table 4, twenty-one (21) lakes and reservoirs were judged to be generally oligotrophic (suggesting a selection bias); eleven (11) were seen to be mesotrophic and twenty-eight (28) were assessed as eutrophic. (Ten were not assessable since dissolved phosphorous data was unavailable.)

Seventy-two (72) of the 115 NES lakes were nitrogen limited. Fifteen (15) were often nitrogen limited, and twenty-eight (28) lakes exhibited a basic phosphorous limitation. Assessment of the often very limited

non-NES STORET data were made for seventy-two (72) lakes and reservoirs and indicated nitrogen limitation for sixty-five (65) waterbodies. These data show only 7 phosphorous limited conditions and two of these seven (7) waterbodies had high nitrogen and phosphorous levels; specifically, John Martin Reservoir and Sterling in Colorado, suggestive of high inputs from farming activities.

Comparison of the NES lake data against non-NES STORET data, as shown in Table 5, confirmed, in most cases, the assessments made with the NES data alone.

CLEANUP CANDIDATES.

Using the numerical guidelines developed by EPA-Corvallis; highlighted in Table 6, as measured against known conditions or pressures that could accelerate eutrophy; together with uses of lakes or reservoirs for municipal drinking water as shown in Table 7; as well as conditions seemingly conducive to improvement, a number of lakes have been tentatively identified in Table 8 that seem likely candidates for nutrient limitation. These waterbodies were divided into two groups; first, those waterbodies that now have low levels of phosphorous and should be protected; and second, those where algal problems, if abated, would mitigate existing problems or return conditions to "natural" loadings. Although abatement efforts should generally focus on improvements via non-point source controls, grant activity, Clean Lake action and/or permit action may also be

appropriate in some cases as suggested in Table 8.

POINT SOURCE SUMMARY.

Eighteen (18) of the 115 NES lakes and reservoirs had point source input of suspected significance. Nonetheless, fourteen (14) of these waterbodies were predominantly phosphorous limited. Utah Lake near Provo, Utah,remained phosphorous limited despite significant phosphorous input from lakeshore sewage treatment plants and industrial activities; but, eutrophy was mitigated by high natural turbidity. Three (3) of these eighteen (18) were nitrogen limited, but had algal production intensified by limited or no hydraulic flushing; namely, Barr Lake in Colorado, Devils Lake in North Dakota and South Dakota's Madison Lake. The other nitrogen limited waterbody was Koocanusa Lake in Montana with an N:P ratio of 2:1. This lake is known to be impacted by inputs of dissolved phosphorous from the Canadian arm and has recently been filled.

Among the non-NES STORET data evaluated; five (5) lakes were believed to be impacted by potentially significant point sources. These are; Granby Lake (low quantity from Grand Lake) and Sterling Reservoir (intensive, but far upstream sources) in Colorado; Oahe Lake (intensive, but far upstream sources on the Cheyenne River) and Pocasse Lake in South Dakota; and Stump Lake in North Dakota. (Pocasse and Stump Lakes are also basically closed hydraulic systems.)

CLEANUP PROGRAM.

Regional strategy has not been pointed to nutrient removal from municipal or industrial point sources. Exceptions have been support of phosphorous removal from a few Colorado high country sewage treatment plants, endorsement of total containment for certain lagoon systems and a few industrial nitrate and phosphorous limitations.

Nutrient removal for critical waterbodies will be necessary on a case-by-case basis for some waterbodies; such as, Pactola Reservoir in South Dakota, and may require no additional nutrients or greatly decreased loading in order to avoid algal nuisances and problems. Other waterbodies; for example, Fremont Lake in Wyoming; which has a mean Secchi disc clarity of nearly 50 feet, may require special efforts to retain this unique condition.

Clean Lake applications designed to restore lakes, as provided by Section 314 of Public Law 92-500, will require data comparable in scope and detail to the NES data for proper assessment of the planned improvement. Nutrient removal from municipal sewage wastewaters is not part of the Clean Lake process. Except for unique circumstances, improved flushing via augmented inflow, rerouting of selected nutrient rich inflows or management of lake and reservoir flushing; for example, by selective draw-down, will be the prime means of lake cleanup.

Rerouting of sewage wastewater by collection and conveyance around waterbodies utilizing construction grant money should; in special instances such as Bear Lake in Utah, be encouraged outside of the "Clean Lakes" program and increased priority, as appropriate to the lake or reservoir, should then be assigned to these projects.

SUMMARY.

A lack of significant point sources to most waterbodies in Region VIII; along with a prevailing nitrogen limitation for 137 of 185 lakes and reservoirs surveyed, does suggest a high "natural" background for phosphorous or significant input from non-point sources. For this reason, non-point sources, once better identified and prioritized, should be the main avenue of nutrient removal effort in Region VIII.

Some construction grant and permit action will be important for certain waterbodies. Clean Lake grants may also be effective in limiting nutrients to a few, well chosen waterbodies.

The availability of nitrogen and phosphorous data for only 185 lakes and reservoirs out of more than 2,300 significant waterbodies identified in the state program plans suggests the general need for additonal data collection.

At each of four (4) critical levels used to gauge eutrophic conditions, seventy-two (72) percent of Region VIII's waterbodies with

comprehensive nutrient data had median total phosphorous concentrations of 0.025 mg/l or greater; sixty-six (66) percent had a mean Secchi disc depth of seventy-nine (79) inches or less; fifty-one (51) percent had a mean chlorophyll a level of 10 µg/l or more; and fifty-seven (57) percent had a minimum DO of less than 5.0 mg/l.

A trophic summary using all available STORET data as assembled in Table 9 indicated, twenty-one (21) percent of these lakes and reservoirs were oligotrophic, seventeen (17) percent were mesotrophic; and overall, sixty-seven (67) percent could expect eutrophic related problems.

GRAPHIC OVERVIEW.

A visual display of the tabular data is given in Figures 1 thru 6. These figures distill the lake and reserovir data and assessments for each state into a single visual aid. Trophic state from oligotrophic to eutrophic is illustrated by light to dark shaded areas around each waterbody. Immediate data needs are indicated by circles around these waterbodies and suggested ongoing monitoring (at present few federal or state programs routinely collect lake or reservoir data) is indicated by vertical lines surrounding the waterbody. Cleanup candidates are shown by crosshatched lines intersecting the vertical lines. Intended uses for fishing, swimming or culinary supply are also shown beneath each waterbody's name, if classified. Each Figure has the primary state and federal monitoring stations located on it to provide further usefulness for these graphics.

LANDSAT photos in infrared color have been assembled for each state to highlight general land use and drainage conditions relevant to the major lakes and reservoirs in Region VIII. These photos are identified by Figures 7 thru 12 and suggest the areal predominance of reservoirs on the mainstem of the Missouri and North Platte Rivers; numerous impoundments on the eastern Colorado slope of the Rocky Mountains; natural lakes in the Flathead Mountains of Montana; Bear Lake, Utah Lake and the Great Salt Lake in Utah; as well as the interstate waters of the Flaming Gorge and Glen Canyon Reservoirs.

Projects of the Bureau of Reclamation will continue to shape or reshape many of the waterbodies in Region VIII. Both the complexity and enormity of the Bureau's Oahe (final planning) and Garrison (final construction) diversion projects in South and North Dakota; respectively highlighted in Figures 13 and 14, suggest the potential effect of these diversions on new and existing waterbodies. Also the Bureau's ambitious Central Utah Project illustrated in Figure 15 will create or reshape several waterbodies in Utah. The short and long range effects of these and other major projects will require ongoing review to reassess monitoring priorities and the protection of intended uses.

*Table 1

LAKES AND RESERVOIRS WITH STORET DATA GAPS

A. Colorado

1. Sloans Lake - Denver County (A_2)
2. Morrow Point Reservoir - Gunnison County (B_1)
3. Standley Reservoir - Jefferson County (BS)
4. Chatfield - Jefferson County (B_1)
5. Walden Reservoir - Jackson County (B_1)
6. Boyd Lake - Larimer County (A_2)
7. Loveland Lake - Larimer County (A_2)
8. Bonney Lake - Kit Carson County (A_2)
9. Evergreen Lake - Jefferson County (B_1)
10. Monument Lake - Las Animas (BS)
11. South Platte drainage Reservoirs, Jackson (B_2), Prewitt (BS), Empire (BS), Julesburg (B_2), Riverside Reservoir (BS), Weld, Morgan, Logan, Washington, and Sedgwick Counties respectively.
12. Williams Fork Reservoir - Grand County (B_1)
13. Lake Estes - Larimer County (B_1)
14. Pueblo Reservoir - Pueblo County (BS)
15. Rio Grande Reservoir - San Juan County (BS)

A_1 - cold water fishable and swimmable
A_2 - warm water fishable and swimmable
B_1 - cold water fishable
B_2 - warm water fishable
BS - Basic Standards and Free Froms

*These lakes and reservoirs may be added to the lakes of ongoing interest - Table 2, as data becomes available. Lake classifications of each state are given in parenthesis.

B. MONTANA

1. Mystic Lake - Gallatin County ($B\text{-}D_1$)
2. Frances Lake - Pondera County ($B\text{-}D_1$)
3. Helena Lake - Lewis and Clark County ($B\text{-}D_1$)
6. Hauser Lake - Lewis and Clark County ($B\text{-}D_1$)
7. Hungry Horse - Flathead County ($B\text{-}D_1$)
8. Tiber Reservoir - Tooele and Liberty County ($B\text{-}D_2$)
9. Noxon Reservoir - Sanders County ($B\text{-}D_1$)
10. Cabinet Gorge Reservoir - Sanders County ($B\text{-}D_1$)
11. Medicine Lake - Sheridan County ($B\text{-}D_2$)
12. Fresno Reservoir - Hill County ($B\text{-}D_3$)
13. Deadmans Basin Reservoir - Wheatland County ($B\text{-}D_2$)

$A\text{-}O, D_1$ - cold water fishable and swimmable
$B\text{-}D_1$ - cold water fishable and swimmable
$B\text{-}D_2$ - cold water fishable (marginal salmonid) and swimmable
$B\text{-}D_3$ - fishable (non-salmonid) and swimmable

C. NORTH DAKOTA

1. Tschida Lake - Grant County
2. Long Lake - Burleigh and Kidder County
3. Des Lacs Lakes - Burke and Ward County
4. Arrowood Lakes - Stutsman County
5. Bowman Haley Reservoir - Bowman County
6. Patterson Lake - Stark County
7. Beaver Lake - Logan County

C. NORTH DAKOTA (cont.)

8. Lostwood Lakes - Burke and Montrail County

9. Tewaukon Lake - Sisseton Reservation

(Lakes classified by exception: I - natural species fishable and swimmable.)

D. SOUTH DAKOTA

1. Lewis and Clark Lake - Bon Homme and Yankton County (1,2,7,8,11)

2. Oglala Reservoir - Shannon County (3)

3. Mud Lake Reservoir - Brown County (5,8)

4. Belle Fourche Reservoir (Orman Reservoir) - Butte County (4,10)

5. Traverse Lake - Roberts County (4,10)

6. Willow Creek Reservoir - Browns County (1,5)

1 - drinking water supply
2 - cold water permanent fishable
3 - cold water - marginal fishable
4 - warm water permanent fishable
5 - warm water semi-permanent fishable
6 - warm water marginal fishable
7 - swimmable
8 - limited contact recreation
9 - wildlife propagation and stock watering
10 - irrigation water
11 - industrial

E. UTAH

1. Strawberry Reservoir - Wasatch County (CC/C)

2. Hyrum Reservoir - Cache County (CC/C)

3. Cutler Reservoir - Cache County (CW)

E. UTAH (cont.)

4. Wanship Reservoir - Summit County (CC/C)

5. East Canyon Reservoir - Summit County (CC/C)

C - fishable
CC - cold water fishable
CW - warm water fishable
R - swimmable

F. WYOMING

1. Jackson Lake - Teton County

2. Alcova Reservoir - Natrona County

3. Pathfinder Reservoir - Natrona County

4. Gurnsey Reservoir - Platte County

5. Wheatland Reservoir #2 - Albany County

6. Hattie Lake - Albany County

7. Bull Lake - Fremont County

Standards include temperature rise and fecal coliform limits during the recreation season - some waterbodies are classed "I" which corresponds to a higher D.O. requirement.

TABLE 2*

MAJOR LAKES OF ONGOING INTEREST IN PRIORITY ORDER

A. COLORADO

1. Three (3) lakes (Granby, Shadow Mountain and Grand Lakes) (A_1) C, R, G, U, PM, O - Big Thompson Project

2. Dillon (A_1) and Green Mountain Reservoirs (BS) C, R, G, PM, DW

3. Denver area - Sloans C (A_2), Cherry Creek C (A_2), Chatfield (B_1) and Standley (BS) Reservoirs - R and some PI

4. Pueblo Reservoir (BS) - R, PM, PI, O - upstream mining DW

5. Mine drainage (LaJara (B_1), Platoro (B_1), Navajo; R, C (BS), Standley (BS), Terrace (BS), San Cristobal (BS), Vallecito (B_1), Electra (B_1), Williams Fork Reservoir (B_1) and others - some PI

6. Carter Reservoir - DW, R, O - Big Thompson Project (A_1)

7. Horsetooth Reservoir - DW, R, O - Big Thompson Project (A_1)

8. Blue Mesa Reservoir - R, C (B_1)

9. Turquois Lake - DW, R (B_1)

10. Twin Lakes Reservior - DW, R (B_1)

11. Sterling Reservoir - G, PI, PM (B_2)

12. Two Buttes Reservoir - R, U (B_2)

*Priority for ongoing monitoring is made based on the relative importance based on recreational use, permit or grant action in force, use as a direct drinking supply, involvment in large diversion projects, candidacy for cleanup, and/or unique and other factors. See last page of table for legend. (Letters and/or numbers in parenthesis correspond to state use classification - See Table 1 for this breakdown.)

B. MONTANA

1. Flathead Lake - R, PM, G, C, O - Canadian Watershed and Canadian coal development (A-O, D_1)

2. Whitefish Lake - DW, PM, G, R, C (A-O, D_1)

3. Koocanusa Lake - R, C, O - Canadian watershed and phosphate sources (B, D_1)

4. McDonald Lake - U, C, R, G, PM (A-O, D_1)

5. Canyon Ferry Reservoir - G, O - significant headwater problems suspect (B, D_1)

6. Logging related (Mary Roonan (A-O, D_1), Seeley (B, D_1), Swan (A-O, D_1), Tally (B, D_1) and others)

7. Energy related (Yellowtail (B, D_1 see Wyoming), Tongue River (B, D_2) and Fort Peck Reservoirs (B, D_3) and others) -- A Tongue River Reservoir survey is planned as part of the energy program and a 208.)

8. Mine related (Georgetown Reservoir (A-O, D_1) and others)

9. St. Mary Lakes - R, U (A-O, D_1)

10. Tiber Reservoir - G, C (B, D_2)

Yellowtail Reservoir (B, D_1) (See Wyoming)

C. NORTH DAKOTA

1. Sakakawea Reservoir - G, R, O - irrigation development (I)

2. Darling Lake - C, R, O - Canadian watershed and wildlife area plus lake expansion

3. Sweetwater Lake - C, R, O - Diversion impact

4. Ashtabula Lake - R, O - Diversion impact

5. Metigoshe Lake - R, U, C, O - Eutrophic conditions may be worse than NES indicated

C. NORTH DAKOTA (cont.)

6. Pelican Lake - R, U, C
7. Devil's Lake - G, PM, O - Diversion impact (closed basin)
8. Jamestown Reservoir (Jim Lake) - G, R, O - Agricultural
9. Oahe Reservoir - R, O - Planned Diversion (I)

NOTE: Most lakes and reservoirs are not classified in North Dakota.

D. SOUTH DAKOTA

1. Oahe Reservoir - PI, DW, G, O - Planned Diversion (1, 2, 7, 8, 11)
2. Mitchell Lake - DW, G, R (1, 4)
3. Pactola Reservoir - G, PM, R, C (1, 2, 10)
4. Angostura Reservoir - PM, R, C (1, 4, 10)
5. Kampeska Lake - DW, R, G, C (1, 4)
6. Francis Case Lake - DW, R, G, (1, 4, 7, 8, 11)
7. Lewis and Clark Reservoir - DW, R (1, 4, 7, 8, 11)
8. Deerfield Lake - R, C (2)
9. Madison Lake - PM, R, G (closed basin) (5)
10. Byron Lake - O - Planned Diversion (5, 10)
11. Pocasse Lake - G, PM, C (5)
12. Mud Lake Reservoir - PM, G, R (5, 8)
13. Stockade Lake - O - Marginal cold water fishery (3)
14. Oglala Reservoir - O - Marginal cold water fishery (3)

E. UTAH

1. Bear Lake - G, C, R (CCR)
2. Deer Creek Reservoir - DW, R, G, C, PM, PI, O - Water use development (CC)
3. Powell Lake - R, O - Salinity and energy development (CCW)
4. Pineview Reservoir - DW, R, C (CC or C)
5. Strawberry Reservoir - C, DW, R, O - Water use development (CC)
6. Sevier Bridge Reservoir - R, C, PM (CW)
7. Echo Reservoir - PM, C (CC or C)
8. Fish Lake - C, R (CC or C)
9. Willard Bay Reservoir - PI, R (CW)
10. Utah Lake - PI, PM, R (CW)

Flaming Gorge (CCR) (See Wyoming)

F. WYOMING

1. Flaming Gorge Reservoir - R, C, G, O - Energy development (modeling is planned as part of 208) and high nitrate
2. Yellowtail Reservoir (Bighorn Lake) - R, C, PI, O - Energy development (semi-intensive survey planned by EPA Energy Office) and irrigation diversion project
3. Yellowstone Lake - R, (I)
4. Buffalo Bill Reservoir - DW, R, U
5. Glendo Reservoir - PM, PI, R, C
6. Seminoe Reservoir - PI, R, C
7. Keyhole Reservoir - C, PM, O - Energy development

F. WYOMING (cont.)

8. Palisades Reservoir - R, PM, G, C, O - Graze animals

9. Jackson Lake - R, (I)

10. Woodruff Narrows Reservoir - PM, G

11. Fontenelle Reservoir - R, O - Energy development

12. Pathfinder Reservoir = DW, R

13. Alcova Reservoir - DW, R

14. Fremont Lake - U, C

(Wyoming lake and reservoir standards require only certain limits during the recreation season.)

DW - Drinking Water Supply
PI - Point Source Industrial
PM - Point Source Municipal
R - High Recreation Use
G - Significant Grant Involved
U - Uniqueness
C - Candidate for decreased nutrient input via tertiary treatment and/or other grant activity and/or NPS controls
O - Others

TABLE 3
NES SUMMARY
(legend on last page of table)

O = oligotrophic
M = mesotrophic
E = eutrophic

LAKE CODE	LAKE NAME	TROPHIC STATE	MEDIAN TOTAL P (mg/l)	MEDIAN INORG N (mg/l)	500-MEAN SEC (inches)	MEAN CHLORA (µg/l)	15-MIN DO (mg/l)	MEDIAN DISS ORTHO P (mg/l)	INDEX NO.	**COMMENTS (such as, approx. mean depth and years or day approx. hydraulic retention time).
COLORADO										
0801	BARKER RESERVOIR (B1)	M	0.023	0.045	419.000	5.333	9.400	0.006	24	Shallow ≈20'
0802	BARR LAKE PS (BS)	E	0.930	1.090	451.333	28.767	10.200	0.730	110	Very shallow ≈10'/1 sample = 170,000 cells/ml.
0803	BLUE MESA RESERVOIR (B1)	M	* 0.019	0.040	395.750	6.817	13.800	0.005	26	Deep ≈100'/365 days avg.
0804	CHERRY CREEK LAKE (A2)	E	0.054	0.040	469.333	23.322	10.000	0.007	51	1 sample = 170 cells/ml Very shallow ≈10'
0805	CUCHARAS RESERVOIR (BS)	E	0.263	0.040	490.000	27.400	14.800	0.015	91	Shallow ≈20'
0806	DILLON RES. PS (A1)	O	* 0.009	0.040	181.750	3.150	9.200	0.002	6	475 days NES - Deep ≈100'
0807	GRAND LAKE PS PL (A1)	M	* 0.013	0.040	366.500	4.900	10.200	0.003	14	Veryddeep ≈150'
0808	GREEN MOUNTAIN RES. PS (BS)	M	* 0.010	0.040	391.167	5.833	9.100	0.002	12	Deep ≈75'/110 days avg.
0809	HOLBROOK LAKE (B2)	E	0.329	0.070	490.333	111.933	9.000	0.028	85	Very shallow ≈10'
0810	LAKE MEREDITH (B2)	E	0.397	0.110	489.667	164.678	10.400	0.098	104	Very shallow ≈10'
0811	MILTON RESERVOIR (BS)	E	0.846	2.280	429.333	5.900	9.200	0.808	84	Shallow ≈20'
0812	NAVAJO RESERVOIR (B1)	M↔E	* 0.027	0.120	436.316	2.168	11.200	0.010	41	Deep ≈100' / 170 days avg.
0813	SHADOW MTN. LK. PS (A1)	M	* 0.020	0.040	427.000+	5.700	9.200	0.003	16	Very shallow ≈10'
MONTANA										
3001	CANYON FERRY RES. (B-D1)	E	0.047	0.170	442.800	5.816	14.400	0.029	79	167 days NES/187 days avg., Deep 75'
3002	CLARK CANYON RES. (B-D1)	M↔E	0.049	0.160	398.750	2.375	12.000	0.027	55	332 days NES/shallow 25' 318 (midrange)
3003	FLATHEAD LK. PS (A-O,B-D1)	C O	* 0.008	0.050	267.833	1.273	9.000	0.004	5	Very deep =>150'/77 days avg.
3004	GEORGETOWN RES. PL(A-O, B-D1)	M	0.022	0.040	367.333	6.983	10.200	0.011	28	585 NES/564 days avg./shallow 20'
3005	HEBGEN RES. (B-B1)	M↔E	0.022	0.040	367.700	4.083	13.800	0.020	34	155 NES/192 days/moderate ≈40' avg
3006	KOOCANUSA RES. PS (B-D1)	M	* 0.045	0.100	337.643	2.669	10.400	0.044	40	271 NES/235 days avg./very deep ≈150'
3007	MARY RONAN LAKE (A-O, B-D1)	P	0.020	0.040	371.091	4.673	14.200	0.006	25	17.8 avg./avg./shallow 25' 17.3 yrs. NES
3008	MC DONALD LAKE (A-O, B-D1)	O	* 0.006	0.180	190.667	0.467	6.400	0.002	9	8 days NES/660 days avg./dee ≈100
3009	NELSON RESERVOIR (B-D3)	M↔E	* 0.029	0.075	456.750	7.233	11.400	0.007	49	325 days avg./Very shallow ≈1
3010	SEELEY LAKE (B-D1)	M	0.015	0.040	362.857	2.171	13.200	0.010	20	127 days NES/130 days agg. Moderate ≈40'
3011	SWAN LAKE (A-O, B-D1)	O	0.010	0.050	282.750	3.289	9.600	0.004	13	85 days NES/ 80 days avg./ Moderate ≈40'
3012	TALLY LAKE (B-D1)	O	0.011	0.050	339.167	2.083	9.200	0.004	11	1020 days NES/1280 days avg. Deep ≈100'
3013	TIBER RESERVOIR (B-D2)	M↔E	* 0.018	0.180	448.555	2.806	).600	0.004	33	695 days NES/ 537 days (midrange) Moderate ≈40'
3014	TONGUE RIVER RES. (B-D2)	E	0.051	0.050	474.111	16.878	13.600	0.008	66	78 days NES/76 days avg./ Shallow ≈25'
3016	WHITEFISH LK. (Lower)(A-O,B-D1)	O	* 0.008	0.040	290.000	1.400	7.000	0.003	1	950 days NES/960 days avg./ Deep ≈100'

NORTH DAKOTA

LAKE CODE	LAKE NAME	TROPHIC STATE		MEDIAN TOTAL P (mg/l)	MEDIAN INORG N (mg/l)	500-MEAN SEC (inches)	MEAN CHLORA (µg/l)	15-MIN DO (mg/l)	MEDIAN DISS ORTHO P (mg/l)	INDEX NO.	COMMENTS
3801	LAKE ASHTABULA PL	E		0.260	0.160	472.250	40.892	10.600	0.170	103	304 days NES/Shallow =20'
3802	LAKE AUDUBON	E	*	0.087	0.220	446.222	11.322	11.000	0.015	77	Shallow =20'
3803	BRUSH LAKE	E		0.066	0.095	449.143	29.114	9.000	0.010	58	Shallow =15'
3804	LAKE DARLING	E	*	0.274	0.250	466.750	60.075	11.600	0.180	111	510 days NES/Shallow =15'
3805	DEVILS LAKE PS	E		0.630	0.140	449.333	38.508	14.600	0.469	112	Shallow =20'
3806	JAMESTOWN RES. PL	E		0.144	0.365	438.667	19.400	8.800	0.078	78	610 days avg./Shallow =20'
3807	LAKE LA MOURE	E		0.438	0.380	421.400	19.720	15.000	0.290	107	Shallow =20'
3808	MATEJCEK LAKE	E		0.228	0.440	475.167	2.683	14.400	0.179	100	236 days NES/Shallow =20'
3809	LAKE METIGOSHE	M↔E	*	0.032	0.080	389.167	10.367	9.000	0.010	31	Shallow =20' representativeness challenged-eutrophic state seen as worse.
3811	PELICAN LAKE	M↔E	*	0.034	0.070	364.500	10.950	12.800	0.006	37	Shallow =10'
3812	LK. SAKAKAWEA (GARRISON) I	M		0.016	0.150	408.733	6.883	10.800	0.007	39	490 days avg./585 days NES Very deep =150'
3813	SPIRIT WOOD LAKE PL	E		0.156	0.290	417.833	34.667	15.000	0.082	98	23.9 yrs. NES/Shallow =25'
3814	SWEET BRIAR RESERVOIR	E		0.092	0.090	440.800	39.000	8.800	0.031	62	183 days NES/Very shallow =15'
3815	WHITMAN LAKE	E		0.260	0.260	478.333	27.067	9.200	0.185	97	255 days NES/Very shallow =15'
SOUTH DAKOTA											
4601	LAKE ALBERT (6)	E		0.321	0.170	489.111	106.289	9.200	0.019	96	8.6 yrs. NES/Very shallow <=10'
4602	ALVIN LAKE (4)	M↔E		0.067	0.970	442.833	4.700	9.400	0.017	61	294 days NES/Very shallow <=10'
4603	ANGOSTURA RES. PS (1,4,10)	M↔E	*	0.019	0.160	423.333	3.717	13.000	0.005	38	79 days NES/ 420 days avg., Moderate =40'
4604	BRANDT LAKE (5)	E		0.194	0.130	432.833	34.150	11.800	0.113	87	Very Shallow =10'
4605	LAKE BYRON PL (5,10)	E		0.443	0.370	488.333	149.350	9.000	0.146	109	12 yrs. NES/Very Shallow =10'
4606	CLEAR LAKE (4)	E	*	0.027	0.075	430.167	11.983	8.800	0.009	32	Very Shallow =10'
4607	CLEAR LAKE (6)	E		1.400	0.270	495.333	691.000	7.000	0.468	106	Very Shallow =10'
4608	COCHRANE LAKE (4) C	E		0.037	0.150	446.000	15.683	15.000	0.008	70	Very Shallow =10'
4609	COTTONWOOD LAKE (5)	E		0.685	0.265	490.333	112.017	8.600	0.417	105	32 days NES/Very Shallow =10
4610	DEERFIELD RESERVOIR (2)	M↔E	*	0.033	0.080	303.333	3.650	15.000	0.022	45	500 days avg. /300 days NES, Deep =75'
4611	ENEMY SWIM LAKE (4)	E		0.037	0.085	442.600	14.200	8.200	0.013	43	Shallow =10'
4612	LAKE HERMAN (6)	E		0.340	0.155	485.000	58.733	8.600	0.174	95	1170 days NES/Very Shallow =10'
4613	ST JOHN LAKE (6)	E		0.348	0.080	489.400	120.880	9.800	0.025	93	1160 days NES/Very Shallow =10'
4614	LAKE KAMPESKA PL (1,4) C	E		0.220	0.105	468.889	20.567	8.200	0.128	71	No outflow year of study/ Very shallow =10'

SOUTH DAKOTA

LAKE CODE	LAKE NAME	TROPHIC STATE		MEDIAN TOTAL P (mg/l)	MEDIAN INORG N (mg/l)	500-MEAN SEC (inches)	MEAN CHLORA (ug/l)	15-MIN DO (mg/l)	MEDIAN DISS ORTHO P (mg/l)	INDEX NO.	COMMENTS
4615	MADISON LAKE PS PL (5)	E		0.250	0.090	445.555	22.578	14.000	0.107	90	10.7 yrs. NES/Very Shallow =10'
4616	LAKE MITCHELL PL (1,4)	E		0.099	0.085	465.833	14.883	13.800	0.015	81	134 days NES/Shallow =20'
4617	LAKE NORDEN (5)	E		0.256	0.165	488.667	46.800	10.000	0.050	101	Very Shallow =10'
4618	OAKWOOD LAKE EAST (6) C	E		0.146	0.175	487.000	113.600	10.000	0.009	88	Very Shallow =10'
4619	OAKWOOD LAKE WEST (5) C	E		0.181	0.135	485.833	159.667	9.600	0.021	89	Very Shallow =10'
4620	PACTOLA RES PS (1,2,10)	O	*	0.011	0.070	248.444	1.478	11.000	0.006	17	310 days NES/Deep =100' 625 days avg.
4621	PICKEREL LAKE (4)	E		0.049	0.095	439.833	15.833	9.600	0.009	53	Shallow =20'
4622	LAKE POINSETT PL	E		0.115	0.315	468.444	40.211	10.000	0.023	92	Nooutflow year of study Very shallow =10'
4623	LAKE RED IRON SOUTH (4)	M→E		0.042	0.110	430.333	6.883	7.600	0.010	36	Very Shallow =10'
4624	RICHMOND LAKE (4)	E		0.187	0.150	410.000	18.467	10.000	0.144	74	52 yrs. NES/ Shallow =20'
4625	ROY LAKE (4)	E		0.034	0.070	431.000	13.333	11.000	0.010	50	Shallow =20'
4626	SAND LAKE (6)	E		0.489	0.110	471.800	65.790	12.800	0.288	108	11 days NES/Very Shallow =10'
4627	SHERIDAN LAKE (2) C	E		0.053	0.105	394.000	15.433	15.000	0.016	67	Moderate =40'/40 yrs. NES
4628	STOCKADE LAKE (3)	E		0.233	0.150	432.000	25.400	15.000	0.109	99	282 days NES/Shallow =25'
4629	LAKE VERMILLION (4)	E		0.211	0.100	472.833	100.800	9.200	0.092	86	1020 days/NES/Shallow =15'
4630	WALL LAKE (5)	E		0.194	0.160	441.667	55.267	7.400	0.076	76	No outflow year of study/ Very shallow =10'
4631	WAUBAY LAKE NORTH (6)	E		0.098	0.145	469.555	127.033	11.400	0.023	94	Very shallow =10'
	UTAH										
4901	BEAR LAKE PL (CCR)	O	*	0.011	0.040	304.905	0.805	10.000	0.003	7	23.1 yrs. NES/Outflow & pump controlled by UPL/Deep =75'
4902	LOWER BOWN'S RES (CC or C)	M	*	0.031	0.040	336.000	5.567	9.400	0.006	18	Very Shallow =15'
4903	DEER CREEK RES, PS (CC or C)	E		0.038	0.215	430.333	9.078	14.800	0.006	63	211 days NES/720 days avg. Hold over storage/Deep =75'
4904	ECHO RESERVOIR (CC or C)	E	*	0.047	0.170	450.333	6.967	14.000	0.012	73	135 days NES/Moderate =40'
4905	LYNN RESERVOIR (CC or C)	E		0.121	0.200	417.667	39.600	10.400	0.052	83	Shallow =20'
4906	FISH LAKE (CC or C)	M	*	0.023	0.040	152.000	12.483	10.400	0.004	21	58.7 yrs. NES/Moderate =75'
4907	HUNTINGTON NORTH RES (CC or C)	M		0.013	0.040	392.000	1.900	7.800	0.005	10	Shallow =20'
4908	JOE'S VALLEY RES (CC or C)	O		0.012	0.045	400.000	2.483	11.200	0.003	19	318 days NES/365 days avg. Deep =100'
4909	MINERSVILLE RES (CC or C)	E		0.192	0.060	445.000	33.583	8.600	0.107	65	269 days NES /Shallow =20'
4910	MOON LAKE (CC or C)	O→M		0.008	0.040	381.000	2.700	9.600	0.002	8	141 days NES/765 days avg. Deep =75'
4911	NAVAJO LAKE (CC or C)	O		0.016	0.040	368.000	2.000	6.000	0.003	4	365 days avg. /Very Shallow =10'

UTAH

LAKE CODE	LAKE NAME	TROPHIC STATE	MEDIAN TOTAL P (mg/l)	MEDIAN INORG N (mg/l)	500-MEAN SEC (inches)	MEAN CHLORA (µg/l)	15-MIN DO (mg/l)	MEDIAN DISS ORTHO P (mg/l)	INDEX NO.	COMMENTS
4912	NEWCASTLE RES. (CC or C)	E	0.051	0.040	428.667	12.467	13.600	0.009	48	Shallow ≈20'
4913	OTTER CREEK RES. (CC or C)	E	0.067	0.040	453.667	11.767	10.600	0.033	60	510 days NES/Shallow ≈20'
4914	PANQUITCH LAKE (CC or C)	E	0.071	0.040	426.500	45.950	14.200	0.010	64	800 days NES/Shallow ≈20'
4915	PELICAN LAKE (CW)	M↔E	0.044	0.050	438.500	6.350	9.600	0.004	30	Very Shallow ≈10'
4916	PINEVIEW RES. (CC or C)	E	* 0.028	0.300	435.083	5.692	14.600	0.006	59	249 days NES/535 days avg Shallow ≈20'
4917	PIUTE RESERVOIR (CC or C)	E	0.047	0.150	482.625	25.329	11.600	0.007	72	239 days NES/Holdover storage Shallow ≈20'
4918	PORCUPINE RES. (CC or C)	M↔E	0.025	0.110	440.000	7.860	12.400	0.011	56	Deep ≈75'
4919	PRUESS RESERVOIR (CW) (Garrison Res.)	M↔E	0.057	0.140	491.000	4.533	8.800	0.008	54	Very Shallow ≈10'
4920	SEVIER BRIDGE RES. PS (Yuba Res.) CW	E	* 0.026	0.355	449.778	18.222	12.400	0.008	68	620 days NES/Moderate ≈40'
4921	STARVATION RES. (CC or C)	M	0.016	0.040	394.583	5.675	13.200	0.004	23	660 days NES/220 days avg Moderate ≈50'
4922	STEINAKER RES. (CC or C)	O↔M	0.011	0.040	316.750	1.844	12.600	0.005	15	185 days (avg)/Holdover storage Moderate ≈50'
4923	TROPIC RESERVOIR (CC or C)	M	0.021	0.050	425.000	7.200	8.400	0.006	22	56 days (avg)/Shallow ≈20'
4924	UTAH LAKE PS PL (CW or C)	E	0.131	0.330	490.583	72.012	11.400	0.012	102	950 days NES/Very Shallow ≈10'
4925	MILLARD BAY RESERVOIR (CW)	E	0.044	0.060	457.182	7.567	13.000	0.009	57	Long term holdover storage/ Shallow ≈20'/220 days avg
	WYOMING									
5601	BIG SANDY RESERVOIR	E	0.087	0.060	487.667	4.383	8.800	0.020	52	550 days (avg)/Moderate ≈40'
5602	BOULDER LAKE	O	0.008	0.040	361.800	2.483	8.400	0.002	3	Deep ≈100'
5603	BOYSEN RESERVOIR	E	0.037	0.140	465.923	6.264	14.400	0.014	69	145 days - 200 days avg Deep ≈100'
5604	LAKE DE SMET	M↔E	* 0.033	0.040	409.000	11.167	9.400	0.006	27	Moderate ≈40'
5605	FLAMING GORGE RES ?	M↔E	* 0.014	0.605	385.120	5.611	12.200	0.003	3	160 days (avg)/Long holdover storage/Very deep ≈200'
5606	FREMONT LAKE	O	* 0.006	0.040	-22.000	3.783	7.400	0.002	2	Deep >≈100'
5607	GLENDO RES PS	E	* 0.045	0.320	459.182	8.473	12.600	0.014	80	Moderate ≈40'/110 days avg.
5608	KEY HOLE RES. PS	E	* 0.028	0.050	454.583	7.792	14.000	0.004	47	7.3 yrs avg./Shallow ≈10'
5609	OCEAN LAKE	M↔E	0.043	0.040	478.333	7.500	8.600	0.004	29	Shallow ≈20'
5610	SEMINOLE RESERVOIR	M↔E	* 0.030	0.130	447.000	2.536	11.000	0.007	42	Deep ≈100'/265 days avg.
5611	SODA LAKE	M↔E	0.063	0.040	387.500	5.575	15.000	0.014	46	Deep ≈75'
5612	VIVA NAUGHTON RES	E	0.065	0.110	430.000	25.067	13.200	0.024	75	Moderate ≈40'
5613	WOODRUFF NARROWS RES	E	0.069	0.105	470.000	12.950	13.200	0.019	82	30 days avg./Shallow ≈20'
5614	YELLOWTAIL RES. PS	M	* 0.026	0.310	364.500	5.410	10.000	0.017	44	135 days avg /Very deep ≈150

BORDERING REGION LAKE DATA

LAKE CODE	LAKE NAME		TROPHIC STATE	MEDIAN TOTAL P (mg/l)	MEDIAN INORG N (mg/l)	500-MEAN SEC (inches)	MEAN CHLORA (µg/l)	15-MIN DO (mg/l)	MEDIAN DISS ORTHO P (mg/l)	INDEX NO. (1)	COMMENTS
0408	Lake Powell (Utah - Arizona)	Utah (CCW)	M	0.010	0.410	339,830	3.081	13.8	(0.007)	39	Very deep ≈200'
1610	Palisade Reservoir (Wyoming - Idaho)		M	* 0.032	0.040	422,000	3.533	8.8	[0.007]	20	Very deep ≈150'
2709	Big Stone Lake (S.D. - Minnesota)	S.D. (4,10)	E	0.159	0.335	460.4	16.5	9.0	0.126	103	620 day NES/ Very shallow ≈10'

(1) Index number is calculated on how these lakes would rate among 112 Region VIII lakes.

Letters or numbers in parens indicate state use classifications - See Table 1 for a breakdown for each state.

Underlining is for highlighting.

PS = Potentially significant point sources.

Index number = Best (1) to Worst (112) trophic conditions in Region VIII.

C = Applied for clean lake grant.

Limited phosphorous conditions are circled.

PL = "Problem lakes in the U.S. - 1971".

Nearly limited phosphorous conditions are boxed.

* = Cleanup candidate as determined by this study.

** = Detention time for the year of the "NES" survey or as calculated from long-term data by the Bureau of Reclamation, U.S. Geological Survey or U.S. Environmental Agency is shown as the average or midrange.

COLORADO

TABLE 4 Non-NES

Lake (Reservoir) Trophic Assessment

(Legend on last page of table)

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N.: P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Anderson Reservoir #1 USGS (B1)	M↔O	-	-	0.010	0	<1	98	One sample = 2,000 cells/ml Very shallow 10'
Antero Reservoir USGS Listing (B1)	E↔M	-	-	0.025	0.025	1	59	One sample = 1,000 cells/ml. Very shallow ≈10'
Antero Reservoir - below at South Platte River 21CODBWC 001102 (B1)		-	0.120	-	0.037	-	-	
Avery Lake USGS (B1)	O↔M	-	-	0.060	0.010	<1	138	One sample = 10,000 cells/ml Moderate ≈60'
Bonham Reservoir USGS (B1)	O↔M	-	-	0.025	0.60	3	145	One sample = 580 cells/ml Shallow ≈20'
Carter Lake 112WRD 06742500 (A1)	E↔M	365	0.250	0.013	0.220	(17)	98	One sample = 68 cells/ml Deep ≈100' CND
Cheesman Reservoir 112WRD 06701000 (BS)	O↔M		-	0.030	0.020	1	216	One sample = 4,600 cells/ml Deep ≈100'
Cheesman Reservoir-below at South Platte River 21CODBWC 001109 (BS)			0.130	-	0.100	-	-	
Continental Reservoir USGS (B1)	E↔M	-	-	0.040	0.005	<1	24	One sample = 55,000 cells/ml Shallow ≈20'
Cottonwood Lake #1 West Basin USGS (B1)	O↔M	-	-	0.050	0.003	<1	135	Two samples = 17,000 cells/ml avg. Moderate ≈40'
Cottonwood Lake #1 East Basin USGS (B1)		-	-	0.030	0.0	<1	157	One sample = 11,000 cells/ml Shallow ≈25'
Crawford Reservoir USGS 384142107354400 (B1)	M↔E	-	-	0.030	0.130	4	132	Moderate ≈100'

TABLE 4

Lake (Reservoir) Trophic Assessment

COLORADO

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Delaney Lake South USGS 404208106272000 (B1)	M↔O	-	-	0.015	0.010	<1	156	Shallow ≈20'
Delaney Lake East (B1) USGS 404242106265900		-	-	0.010	0	<1	60	Shallow ≈20'
Delaney Lake North (B1) USGS 404245106275900		-	-	0.010	0	<1	168	One sample = 130,000 cells/ml Shallow ≈30'
Electra Lake USGS (B1)	O↔M	-	-	0.050	1.100	(21)	212	Significant NDS source suggested One sample = 10,000 cells/ml Shallow ≈30'
Eleven Mile Reservoir 112WRD 06695500 (B1)	O↔M	-	-	0.016	0.100	6	138	One sample = 200 cells/ml Deep ≈100'
Eleven Mile Reservoir (B1) below at South Platte River 21CODBWC 001106		-	0.070	-	0.100	-	-	
Garnet Mesa Reservoir (A2) (Sweitzer Lake) USGS	M↔O	-	-	0.020	0.020	1	59	One sample = 1,200 cells/ml Shallow ≈20'
Grandby Lake 112WRD 09018500 (A1) PL	O↔M	400	-	0.005	0.050	10	118	One sample = 6,600 cells/ml Deep ≈100'
Granby Lake - Below on Colorado River 112WRD 09019000 (A1)		-	-	0.010	0.140	(14)	-	
Gross Reservoir USGS (B1)	O↔M	-	-	0.015	0.020	1	178	One sample = 1,200 cells/ml Deep ≈100' CND
Gross Reservoir - below at Boulder Creek 21CODBWC 003103 (B1)		-	0.060	-	0.080	-	-	

TABLE 4

COLORADO

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Harriman Lake 21CODBWC 004202 (BS)	-	-	0.062	-	0.220	-	-	N/A
Horsetooth Reservoir 112WRD 06737500 (A1)	M↔E	325	0.026	0.038	0.370	10	-	Two algae samples = 110 cells/ml CND Deep ≈100'
Irene Lake USGS (B1)	-	-	-	0	0.025	<1	-	N/A
John Lake (B1) USGS 404729106283700	M↔O	-	-	0.010	0.045	4	100	Shallow ≈10'
John Martin Reservoir - Below on Arkansas River 112WRD 07130500 (B2)	E↔M	-	-	0.021	1.100	(52)	-	Significant NDS suggested Irrigation reservoir CND
LaJara Reservoir USGS (B1)	E↔M	-	-	0.060	0.330	6	7	One sample = 23,000 cells/ml Shallow ≈20'
Lemon Reservoir USGS (B1)	M↔O	220	-	0.005	0.005	1	110	One sample = 2,700 cells/ml Deep ≈100'
Neenoshe Reservoir USGS (B2)	E→M	-	-	0.025	0.005	<1	31	One sample = 59,000 plankton cells/ml Shallow ≈20'
Paonia Reservoir 385654107211800 (B1)	M↔E	-	-	0.015	0.095	6	72	One sample = 2,300 cells/ml Moderate ≈125'
Platoro Reservoir USGS (B1)	O↔M	-	-	0.010	0.005	<1	110	Rio Grande compact requires release to match inflow - Moderate ≈50' One sample = 870 cells/ml
Platte Canyon Reservoir at South Platte River 21CODBWC 001302 (BS)	-	-	0.050	-	0.080	-	-	N/A

COLORADO

TABLE 4

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Ralston Reservoir USGS (BS)	M↔O	-	-	0.010	0.050	5	90	One sample = 300 cells/ml Deep ≈100'
Ralston Reservoir - below at outlet 21CODBWC 003202		-	0.460	-	0.050	-	-	CND
Rifle Gap Reservoir PS 393734107452700 (B1)	M↔E	-	-	0	0.045	∞	63	Moderate ≈50'
Ruedi Reservoir USGS (B1)	O↔M	265	-	0.015	0	<1	150	One sample = 750 cells/ml Deep ≈100' Replacement storage
San Cristobal Lake USGS (BS)	O↔M	-	-	0.025	0.065	2	197	One sample = 710 cells/ml Moderate 70'
San Luis Lake USGS (B1)	E↔M	-	-	0.170	0.010	<1	62	One sample = 18,000 cells/ml Very shallow ≈10' Irrigation reservoir
Steamboat Lake (B1) USGS 404728106564200	E↔M	-	-	0.085	0.055	<1	59	Medium ≈70'
Sterling Reservoir (B2) USGS 404655103153500	E↔M	-	-	0.050	1550	31	19	One sample = 130,000 cells/ml Shallow ≈30' Significant NDS suggested
Taylor Park Reservoir 112WRD 09108500 (B1)	O→M	270	0.140	0.010	0.015	1	161	One sample = 1,500 cells/ml Deep ≈100'
Terrace Reservoir USGS (BS)	E↔M	-	-	0.035	0.020	<1	36	One sample = 600 cells/ml
Terry Lake (BS) USGS 401324105077100	E↔M	-	-	0.015	0.045	3	17	One chlor.a sample = 14 µg/l Very shallow ≈10'
Turquoise Lake 112WRD 07082400 (B1)	O↔M	250	-	0.010	0.010	1	98	One sample = 990 cells/ml Deep ≈100'

COLORADO

TABLE 4

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Twin Lakes Reservoir (B1) East Basin 112WRD 07085400	O↔M	-	-	0.015	0.027	2	178	One algae = 130 cells/ml Moderate ≈50'
Twin Lakes Reservoir (B1) West Basin 112WRD 07085400		-	-	0.015	0.030	2	166	One sample = 470 cells/ml Moderate ≈75'
Two Buttes Reservoir USGS (B2)	E↔M	-	-	0.030	0.085	3	24	One sample = 1,800 cells/ml Shallow ≈20'
Vallecito Reservoir 112WRD 09353000 (B1)	O↔M	135	-	0.010	0.015	1	161	One sample = 4,200 cells/ml Moderate ≈50' Significent NPS suggested
Vega Reservoir 112WRD 09096100 (B1)	E↔M	300	-	0.120	0	<1	98	One sample = 36,000 cells/ml Deep ≈100'
Willow Creek Reservoir USGS (B1)	O↔M	60	-	0.015	0.015	1	178	One sample = 1,800 cells/ml Deep ≈100'

TABLE 4

MONTANA

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Frazier Reservoir - Outlet 112WRD 06175400 (B-D3)	M↔E	-	0.057	0.050	0.040	1	-	-
Ft. Peck Reservoir near Pines 112MBRCE 293004 (B-D3)	O↔M	500	0.026	-	0.100	-	-	
Ft. Peck Reservoir below on Missouri River 112WRD 06132000 (B-D3)		500	0.019	-	0.020	-	-	One sample = 534 cells/ml
Ft. Peck Reservoir below on Missouri River (B-D3) 121MBRCE 293003		500	0.025	0.009	0.110	12	-	
Madison Reservoir - below on Madison River 21MTDHWQ 304107 (B-D1)	-	-	0.027	-	0.050	-	-	EPA study shows eutrophic conditions 69-71 N/A
Ruby River Reservoir - below on Ruby River 21MTHDWQ 304112 (B-D1)	-	40	0.015	-	0.090	-	-	N/A

TABLE 4

NORTH DAKOTA

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Homme Reservoir - below on Park River (South Branch) 112WRD 05089000	E↔M	32	-	0.084	0.500	6	-	-
Lake Alice near Church's Ferry 112WRD 05056250	E↔M	-	-	0.260	0.410	2	-	-
Lake Irvine near Church's Ferry 112WRD 05056260	E↔M	-	-	0.180	0.520	3	-	-
Stump Lake - East PS 112WRD 05056630	E↔M	-	-	0.840	0.100	<1	-	-
Stump Lake - West PS 112WRD 05056670		-	-	0.460	0.600	1	-	
Sweetwater Lake at Sweetwater 112WRD 05056220	E↔M	-	-	0.110	0.250	2	-	-

SOUTH DAKOTA

TABLE 4

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Big Bend Reservoir (Sharp Lake) - outfall 121MBRCE 460005 (1,2,7,8,11)	O↔M	5.5	0.010	0.010	0.200	20	-	-
Columbia Road Reservoir Outlet 1117 MBR (5,8)	E↔M	-	0.459	0.113	0.050	<1	-	-
Francis Case Lake (Ft. Randall Reservoir) below at Missouri River 112WRD 06453000 (1,4,7,8,11)	O↔M	80	0.017	-	0.150	-	-	One sample = 2,900 cells/ml and 1/µg/l chlor.a
Ft. Randall Reservoir - outfall 121MBRCE 460001		80	0.010	0.006	0.200	(33)	-	CND
Oahe Lake - Mobridge 121MBRCE 460012 (1,2,7,8,11)	O↔M	340	0.027	-	0.190	-	-	CND
Oahe Lake - at outfall 121MBRCE 460008		340	0.006	0.006	0.330	(55)	-	
Pocasse Lake PS 121MBRCE 460062 (5)	-	-	0.240	-	0.500	-	-	N/A
Shade Hill Reservoir 112WRD 06357000 (4,10)	E↔M	860	40	10	150	(15)	-	-

TABLE 4

UTAH

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients			*	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
			Tot. P mg/l	Diss. P mg/l	Total NO_3-N mg/l	N : P		
Mona Reservoir - outlet at Current Creek 31UTLINK 331090 CW	E↔M	-	-	0.200	183	1	-	-
Trial Lake - outlet to Washington Lake PS 21UTAH 491656 CC or C	O↔M	-	-	0.012	0.050	4	-	-
Washington Lake - outlet to Provo Lake 21UTAH 491657 CC or C	M↔O	-	-	0.024	0.150	6	-	-

(36)

TABLE 4

WYOMING

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Alcova Reservoir - below at North Platte River 112WRD 06642000	-	40	0.022	-	0.130	-	-	CND N/A
Buffalo Bill Reservoir - below at Shoshone River 112WRD 06282000	-	1060 or less	0.038	-	0.091	-	-	CND N/A
Duck Lake 1117MBR 571027	M↔O	-	0.040	0.012	<0.015	≈1	-	-
Fontenelle Reservoir - below at Green River 112WRD 09211200	-	75	0.007	-	0.080	-	-	CND N/A
Guernsey Reservoir - below at North Platte River 112WRD 06656000	-	zero flow thru	0.016	-	0.250	-	-	CND N/A
Heart Lake 1117MBR 571992	M↔E	-	0.060	0.040	<0.015	<1	-	-
Lewis Lake 1117MBR	M↔O	-	0.080	0.007	<0.060	<1	-	-
Shoshone Lake 1117MBR 571993	M↔E	-	0.060	0.040	<0.010	<1	-	-
Sylvan Lake 1117MBR 571043	M↔O	-	0.050	0.012	<0.025	≈2	-	-
Yellowstone Lake - Several stations 1117MBR	M↔O	-	0.060	0.024	<0.025	≈1	-	CND

Phosphorous Limited Condition is circled.
*Ratio of dissolved phosphorous to total inorganic nitrogen.
PL = Problem Lakes in the U.S.-1971.
Letter and/or numbers in parenthesis indicate state use classification (See Table 1 for a breakdown of these uses).

CND = Comprehensive nutrient data (non-NES).
N/A = No assessable data.
O = Oligotrophic E = Eutrophic
M = Mesotrophic
PS = Significant point source potential.

COLORADO

TABLE 5 NES Supplementary

Lake (Reservoir) Trophic Assessment

(Legend on last page of table)

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N:P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Barr Lake PS 395730104451700	E↔M	-	-	1.100	0.135	<1	21	One sample = 75,000 cells/ml One sample = 170,000 cells/ml Rated E in NES
Blue Mesa Reservoir USGS	O↔M	-	-	0.015	0.050	3	150	One sample = 760 cells/ml Rated M in NES
Dillon Reservoir PS 112WRD 09050600	O↔M	-	-	0.050	0.120	2	216	One sample = 510 cells/ml Rated O in NES
Dillon Reservoir - below on South Platte River 21CODBWC 002400		-	0.050	-	0.080	-	-	CND
Grand Lake PS 112WRD 09013900	O↔M	-	-	0.015	0.005	<1	98	One sample = 6,400 cells/ml Rated M in NES
Meredith Lake USGS	M↔E	-	-	0.020	0	<1	10	One sample = 300,000 cells/ml Irrigation Res. Rated E in NES
Navajo Reservoir USGS 370000107383800	M↔E	-	-	0.010	0.060	6	24	One sample = 1,200 cells/ml Rated M↔E in NES
Shadow Mountain Reservoir PL 112WRD 09014500	M↔O	-	0.020	0.025	0.071	3	79	One sample = 650 cells/ml Rated M in NES

MONTANA

TABLE 5

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Canyon Ferry Reservoir - below on Missouri River 112WRD 06058502	M↔O	-	-	0.019	0.100	6	-	Rated E in NES CND
Clark Canyon Reservoir below on Beaver Creek 21MTDHWQ 304103	M↔E	-	0.030	-	0.060	-	-	Rated M↔E in NES N/A
Flathead Lake 112WRD 12371550 PS	M↔O	-	0.036	0.013	0.052	4	-	Clean lake candidate Rated O in NES
Koocanusa Lake at Pinkham Creek 112WRD 12301600	M↔E	-	0.037	0.026	0.072	3	-	Mean chlor.a = 0.6 µg/l CND High algae = 3,400 cells/ml
Koocanusa Lake at Ten Mile Creek 112WRD 12301830		-	0.042	0.028	0.064	3	-	Mean chlor.a = 0.6 µg/l CND High algae = 22,000 cells/ml
Koocanusa Lake at Forebay near Libby 112WRD 12301919		-	0.038	0.018	0.061	4	-	Mean chlor.a = 0.4 µg/l CND High algae = 7,000 cells/ml
Koocanusa Lake at International PS 112WRD 12300110		-	0.035	0.013	0.023	2	-	Mean chlor.a = 0.8 µg/l CND One algae sample = Rated M in NES

NORTH DAKOTA

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Ashtabula Lake - below on Sheyenne River PL 112WRD 05058000	E↔M	-	-	0.140	0.500	4	-	Rated E in NES Blue-green algae blooms noted
Devils Lake PS Numerous 112 WRD Stations	E↔M	-	-	0.523	0.242	<1	-	Rated E in NES
Jamestown Reservoir PL 112WRD 06469000	E↔M	-	-	0.118	0.310	3	-	Blue-green algae blooms noted Rated E in NES
Sakakawea Lake - below on Missouri River 112WRD 06338490	O↔M	-	0.027	-	150	-	-	Rated M in NES CND
Sakakawea Lake - below on Missouri River 121MBRCE 370002		-	0.015	0.006	0.330	(55)	-	
Sakakawea Lake - Newtown 121MBRCE 370004		-	0.010	-	0.190	-	-	

TABLE 5

SOUTH DAKOTA

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients Tot. P mg/l	Nutrients Diss. P mg/l	Nutrients Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Angostura Reservoir - below at Cheyenne River 112WRD 06401500	M↔E	-	33	15	220	(15)	-	Rated M↔E in NES CND
Angostura Reservoir 31BLHICD AGB		-	23	100	200	2	132	
Big Stone Lake PL 21 SDAK01 46BSL1	E↔M	-	-	0.048	0.100	2	-	Rated E in NES report
Byron Lake - below at James River 1117 MBR	E↔M	-	0.498	0.247	0.050	<1	-	Rated E in NES
Pactola Reservoir - below at Rapid Creek 112WRD 06411500	M↔O	-	0.033	0.012	0.067	5	-	Rated O in NES CND
Pactola Reservoir - below at Rapid Creek 21 SDAK01 460920		-	-	0.032	0.330	10	-	

UTAH

TABLE 5
Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Bear Lake (Paris, Idaho PL Outlet) 112WRD 10059500	M↔O	-	0.030	0.015	0.250	(17)	-	Rated O in NES
Deer Creek REservoir - below on Provo River PS 31UTLINK 221516	E↔M	-	-	0.120	0.380	3	-	Rated E in NES
Deer Creek Reservoir - below on Provo River 112WRD 10159500		-	-	0.047	0.470	10	-	
Joe's Valley Reservoir at overflow 113FORS4	E↔M	-	-	0.070	1.250	(18)	-	Rated O in NES (Wide disparity with these data Significant NPS suggested
Piute Reservoir - below on Sevier River 112WRD 10191500	M↔E	-	-	0.031	0.240	8	-	Rated E in NES CND
**Utah Lake - outlet 31UTLINK 331158 PS	E↔M	-	-	0.053	0.865	(16)	-	Rated E in NES Localized blue-green algae and matted algae colonies noted
Utah Lake - on lake PS several UTLINK stations		-	-	0.360	0.980	3	-	

WYOMING

TABLE 5

Lake (Reservoir) Trophic Assessment

Lake/Location/Station (If appropriate)	Trophic State	Mean Hydr. Ret. (Days)	Nutrients: Tot. P mg/l	Nutrients: Diss. P mg/l	Nutrients: Total NO_3-N mg/l	* N : P	Secchi Disc. (in.)	Comments on biological data, NPS sources, etc.
Flaming Gorge - below at Green River NES (Wyoming) 112WRD 09234500	O↔M	-	0.007	0.013	0.727	-	-	One sample = 21 µg/l chlor.a Rated M↔E in NES (wide disparity with these data)
Flaming Gorge Numerous USGS sites		-	-	0.009	0.450	(50)	-	CND
Glendo Reservoir - below at North Platte River 112WRD 06652800	-	-	0.014	-	0.170	-	-	Rated E in NES N/A CND
Woodruff Narrows Reservoir below at Bear River 112WRD 10020300	M↔O	-	-	0.027	0.083	4	-	Rated E in NES (wide disparity with these data)

Phosphorous Limited Condition is circled.

*Ratio of dissolved phosphorous to total inorganic nitrogen.

PL = Problem Lakes in the U.S.-1971.

See Table 3 for lake classifications.

CND = Comprehensive nutrient data (non-NES).

N/A = No assessable data.

O = Oligotrophic

M = Mesotrophic

E = Eutrophic

PS = Significant point source potential

TABLE 6

TROPHIC CRITERIA

MEAN TOTAL P (mg/l)	MEAN SECCHI DISC (INCHES)	MEAN CHLOR-OPHYLL a (µg/l)	ALGAL ASSAY CONTROL YIELD (mg/l)	LAKE NUTRIENT RATIO (P:N)*	LIMITING NUTRIENT	TROPHIC CONDITION (**)
0.010	>146	0 TO 4	0 TO 7	1 TO >14	PHOSPHOROUS	O TO M
0.010 TO 0.025	146 TO 79	4 TO 10	8 TO 18	1 TO 14	GENERALLY PHOSPHOROUS; SOMETIMES NITROGEN	M TO O THRU M TO E
>0.025	<79	>10	>18	1 TO <14	NITROGEN	E TO M

* MEDIAN DISSOLVED PHOSPHOROUS: MEDIAN INORGANIC NITROGEN

** O = OLIGOTROPHIC, M = MESOTROPHIC, E = EUTROPHIC

NOTE: DISSOLVED OXYGEN IN THE HYPOLINION LESS THAN 5MG/L OR 2/3^{rds} OF SATURATION AND ALGAL CELL COUNT GREATER THAN 10,000/ML WERE ALSO CONSIDERED SIGNS OF EUTROPHY.

TABLE 7

Lakes and Reservoirs in Region VIII Used as a Drinking Water Supply

STATE	CITY SERVED	WATERBODY
Colorado	1. Arvada	Ralston Reservoir
	2. Aurora	Rampart Reservoir and Quincy Reservoir
	3. Boulder	Silver Lake Reservoir and Barker Meadow Reservoir
	4. Broomfield	Great Western Reservoir
	5. Cascade	Crystal Lake
	6. Climax	Buhers Lake and Chalk Mountain Res.
	7. Colorado Springs	Twin Lakes Reservoir, Turquoise Lake, Northfield Reservoir, Rosemont Reservoir, Homestake Reservoir, Clear Creek Reservoir
	8. Consolidated Mutual District	Maple Grove Reservoir
	9. Denver	Dillon Lake, Gross Reservoir, Marston Reservoir, Ralston Reservoir, Green Mountain Reservoir, Antero Reservoir, 11 Mile Reservoir and Cheesman Reservoir
	10. Evergreen	Evergreen Lake
	11. Frederick	Firestone Lake
	12. Greeley	Horsetooth Reservoir
	13. Little Thompson Valley District	Carter Reservoir
	14. Louisville	Marshall Lake

STATE	CITY SERVED	WATERBODY
Colorado	15. North Table Mountain Water and Sanitation District	Long Lake
	16. Norwood	Greeley Reservoir & Lone Concrete Reservoir
	17. Pueblo	Pueblo Reservoir
	18. Trinidad	Monument Lake
	19. Westminister	Standley Lake
Montana	1. Alberton	2 Reservoirs
	2. Anaconda	18 Lakes
	3. Bozeman	Mystic Lake
	4. Chester	Tiber Reservoir
	5. Conrad	Frances Lake
	6. Fortine	1 Reservoir
	7. Ft. Peck	Ft. Peck Reservoir
	8. Niehart	1 Reservoir
	9. Phillipsburg	Fred Burr Lake
	10. Polson	1 Reservoir
	11. Ronan	1 Reservoir
	12. Somers	Flathead Lake
	13. Whitefish	Whitefish Lake
North Dakota	1. Belcourt	Fish Lake
	2. Dickinson	Patterson Reservoir (Dickinson Dam)
South Dakota	1. Aberdeen	Willow Creek Res.
	2. Chamberlain	Francis Case Lake (Ft. Randall Res.)
	3. Faith	Durkee Lake

South Dakota	4. Fox Ridge	Oahe Lake
	5. Gettysburg	Oahe Lake
	6. Isabel	Isabel Lake
	7. Kennebec	Byre Lake
	8. Lake Andes	Francis Case Lake
	9. Mitchell	Mitchell Lake
	10. Mobridge	Oahe Lake
	11. Murdo	Murdo Reservoir
	12. Phillips	Waggoner Lake
	13. Randall Rural Water and Sanitation District (Proposed)	Francis Case Lake (Ft. Randall Res.)
	14. Springfield	Lewis and Clark Lake
	15. Watertown	Kampeska Lake
	16. Yankton	Lewis and Clark Lake
	17. Miscellaneous Users	Sharp Lake (Big Bend Reservoir)
Utah	1.. Ogden	Pineview Reservoir
	2. Salt Lake City	Deer Creek Reservoir and Mountain Dell Reservoir
Wyoming	1. Casper	Pathfinder Reserovir and Alcove Reservoir
	2. Cody	Buffalo Bill Reservoir
	3. Kemmerer	Hams Fork Reservoir

TABLE 8

*CLEANUP CANDIDATE
SUMMARY

1 = Protection may be needed
2 = Abatement " " "

A. Colorado

1

Dillon Reservoir (G&P)
Grand Lake (G&P)
Green Mountain Reservoir (G&P)
Shadow Mountain Reservoir (G&P)
Granby Reservoir (G&P)

2.

Blue Mesa Reservoir (G&P)
Navajo Reservoir
Sloans Lake (C)
Chatfield Lake (P)
Standley Reservoir

B. Montana

1.

Flathead Lake (G&P)
McDonald Lake (G)
Whitefish Lake (G)

2.

Koocanusa Reservoir (Int. Joint Comm.)
Nelson Reservoir
Tiber Reservoir

C. North Dakota

1.

None

2.

Audubon Reservoir (?)
Darling Lake (C)
Metigoshe Lake
Pelican Lake
Sweetwater Lake (C)

D. South Dakota

1.

Pactola Reservoir (G&P)

2.

Angostura Reservoir (G&P)
Deerfield Reservoir
Pocasse Lake (C)
Kampeska Lake (G)

E. Utah

1.

Bear Lake (G&C)

2.

Deer Creek Reservoir (G&P)
Echo Lake (G&P)
Fish Lake
Pineview Reservoir
Sevier Bridge Reservoir (G&P)
Strawberry Reservoir

F. Wyoming

1.

Flaming Gorge (?)
Fremont Lake

2.

DeSmet Lake
Keyhole Reservoir (G,P)
Seminoe Reservoir
Glendo Reservoir (P)
Palisades Reservoir (G,P)
Yellowtail Reservoir (P)

*(NPS control is assumed desirable for protection or abatement until it is known not to be part of the problem.)

C = Clean lake action may be appropriate
G = Grant activity " " "
P = Permit action " " "

Blank = NPS alone would be the prime vehicle of cleanup or protection.

TABLE 9

STATE-BY-STATE TROPHIC SUMMARY*

A. NES Summary

	O ↔ M	M ↔ O	M ↔ E E ↔ M	TOTAL
Colorado	1	5	7	13
Montana	5	4	6	15
North Dakota		1	13	14
South Dakota	1		31	32
Utah	5	6	15	26
Wyoming	2	2	11	15
TOTAL	14	18	83	115

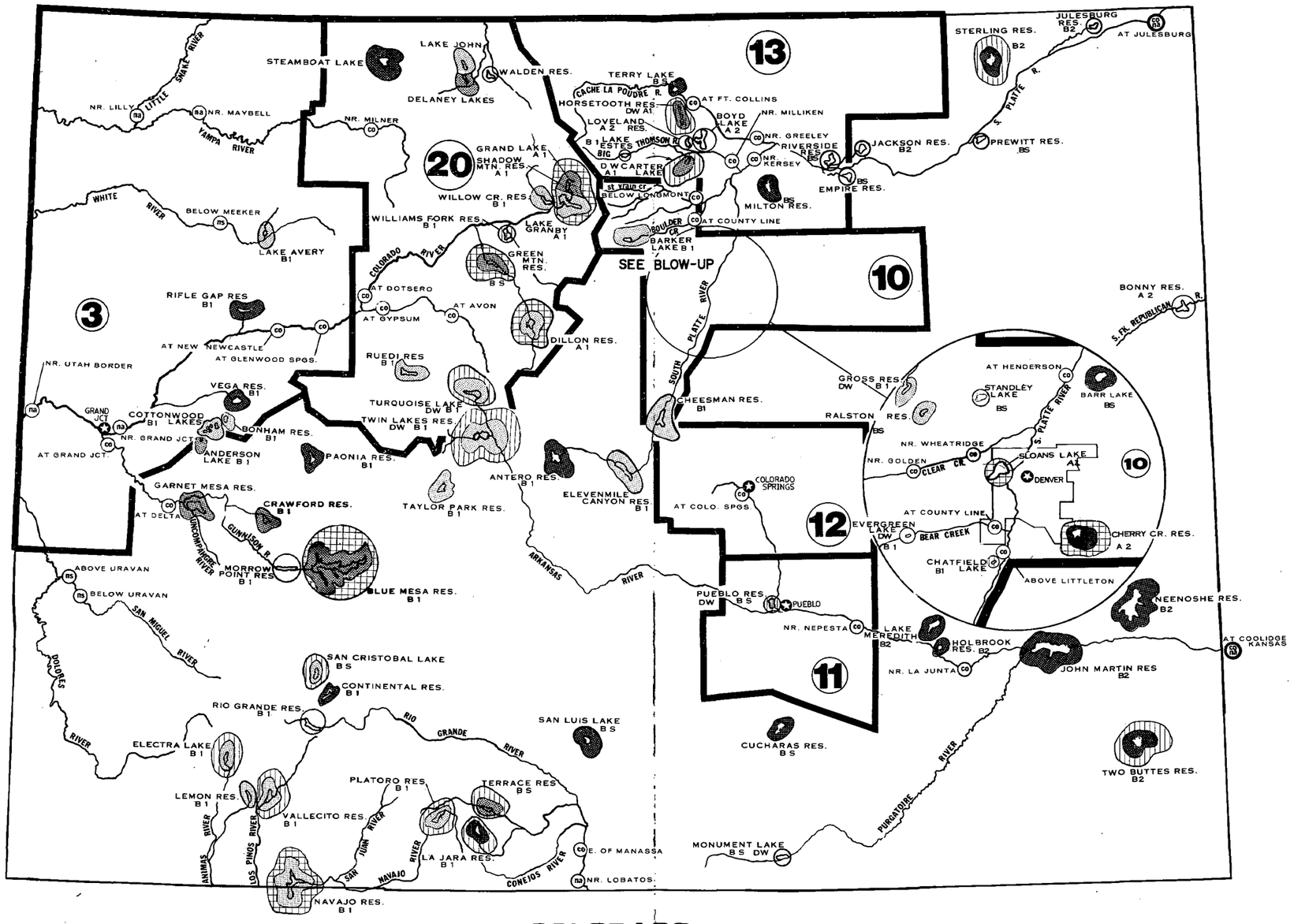
*Includes bordering state NES lakes and reservoirs.

B. Non-NES Summary

	O ↔ M	M ↔ O	M ↔ E E ↔ M	Not fully Assessable	TOTAL
Colorado	16	6	17	3	42
Montana	1		1	2	4
North Dakota			5		5
South Dakota	3		2	1	6
Utah	1	1	1		3
Wyoming	0	4	2	4	10
TOTAL	21	11	28	10	70

C. GRAND TOTAL

O ↔ M	M ↔ O	M ↔ E E ↔ M	Lack diss. phos. data	Waterbodies with nutrient data
35	29	111	10	185



COLORADO

0 10 20 30 40 50

ON-GOING MONITORING RECOMMENDED

ON-GOING MONITORING RECOMMENDED & CLEAN-UP CANIDATE

EUTROPHIC 80%

MESOTROPHIC 40%

OLIGOTROPIC 10%

BS BASIC

A/A2 FULLY SWIMMABLE & FISHABLE

B1/B2 SECONDARY SWIMMABLE & FULLY FISHABLE

NEED DATA

208 SECTION AREA

ON-GOING MONITORING & NEED DATA

DW DRINKING WATER SUUPPLY

CO STATE OF COLORADO PRIMARY STATION

RS USGS NATIONAL STREAM QUALITY ACCOUNTING NETWORK

RS EPA NATONAL WATER QUALITY SURVEILLANCE SYSTEM

CO/RS DOUBLE STATION

FIGURE 1 COLORADO LAKE & RESERVOIR ASSESSMENT

PREPARED BY ADMIN. SVC. BR. 8-76

J TORRES M KARAVITES

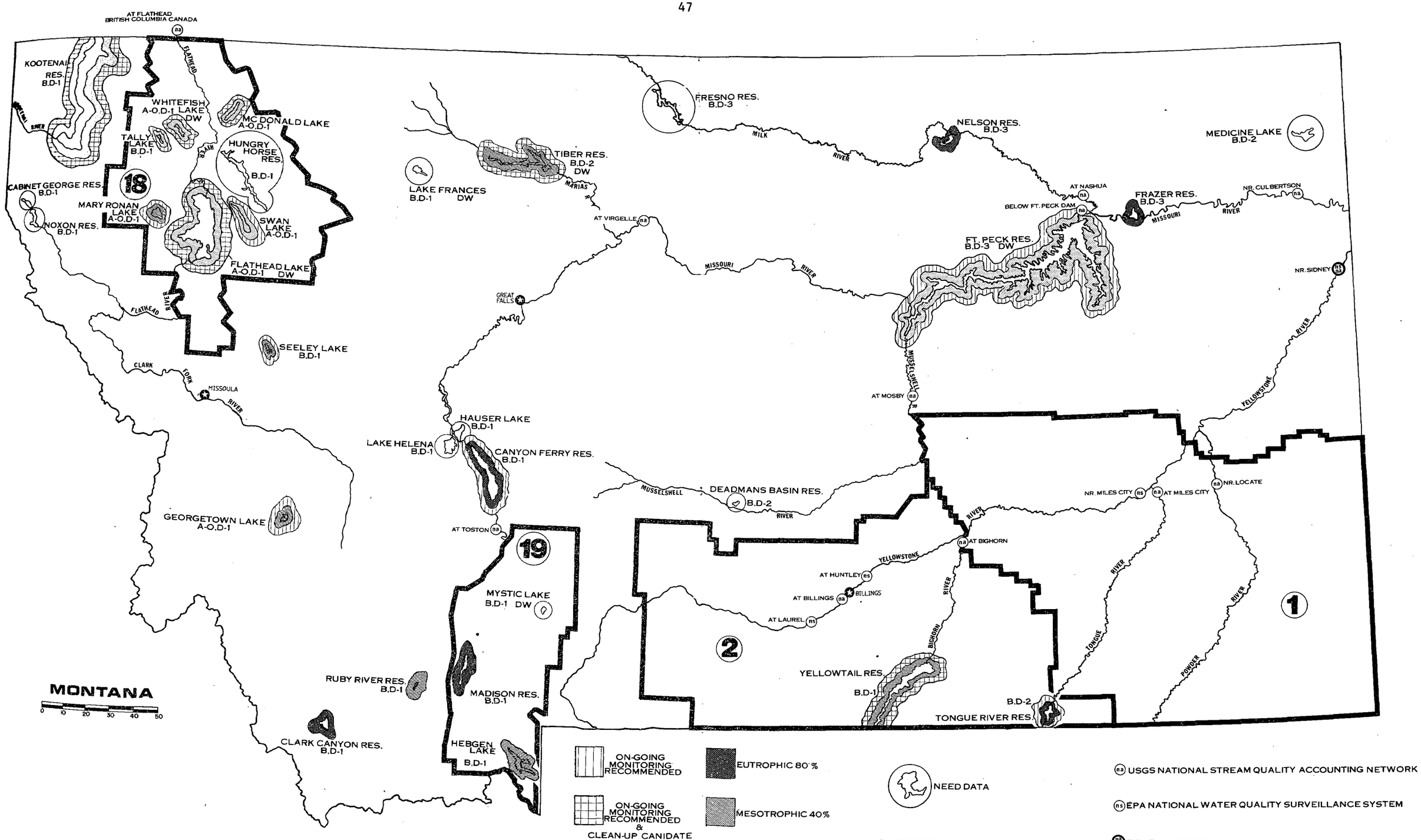
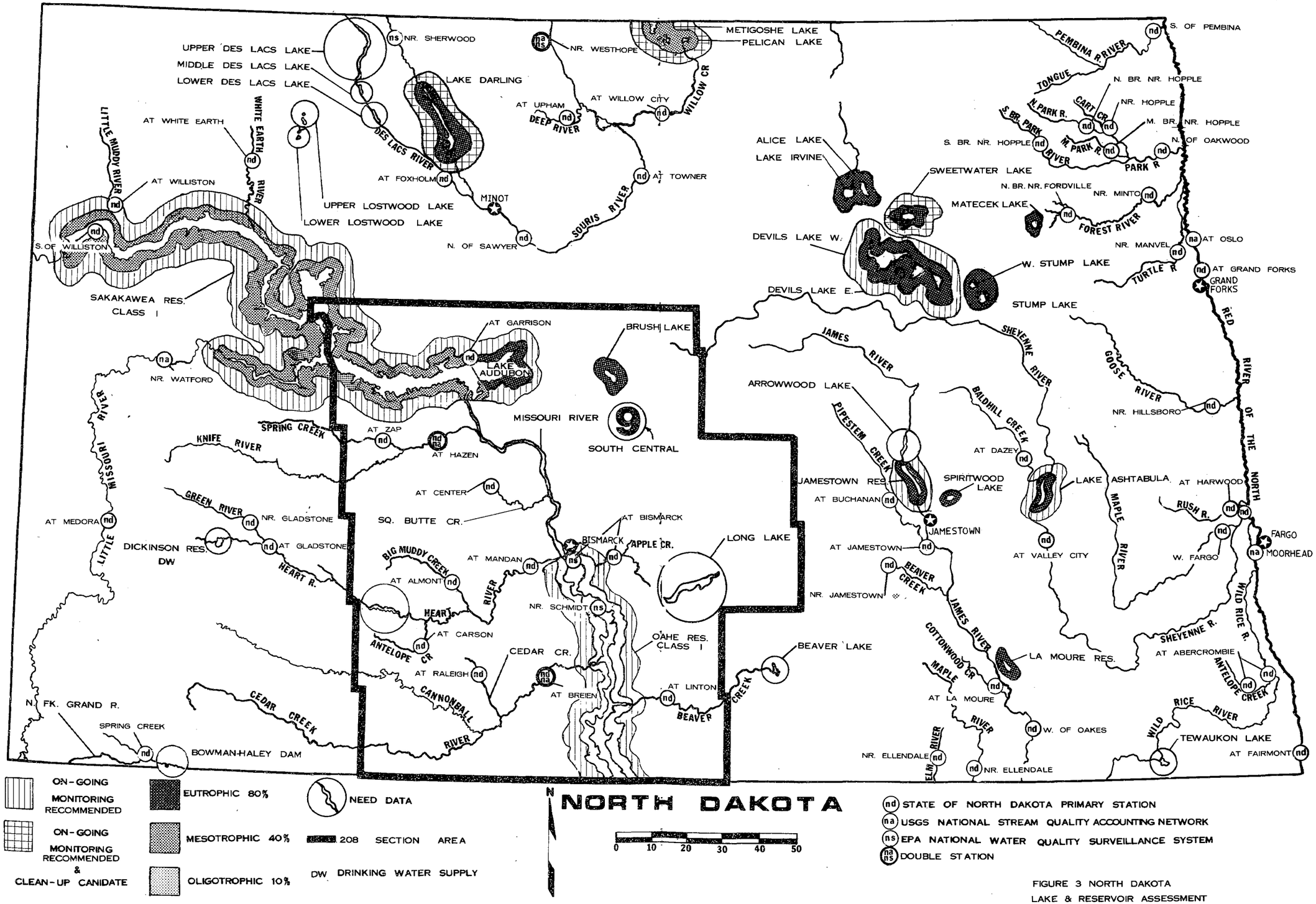


FIGURE 2 MONTANA LAKE & RESERVOIR ASSESSMENT

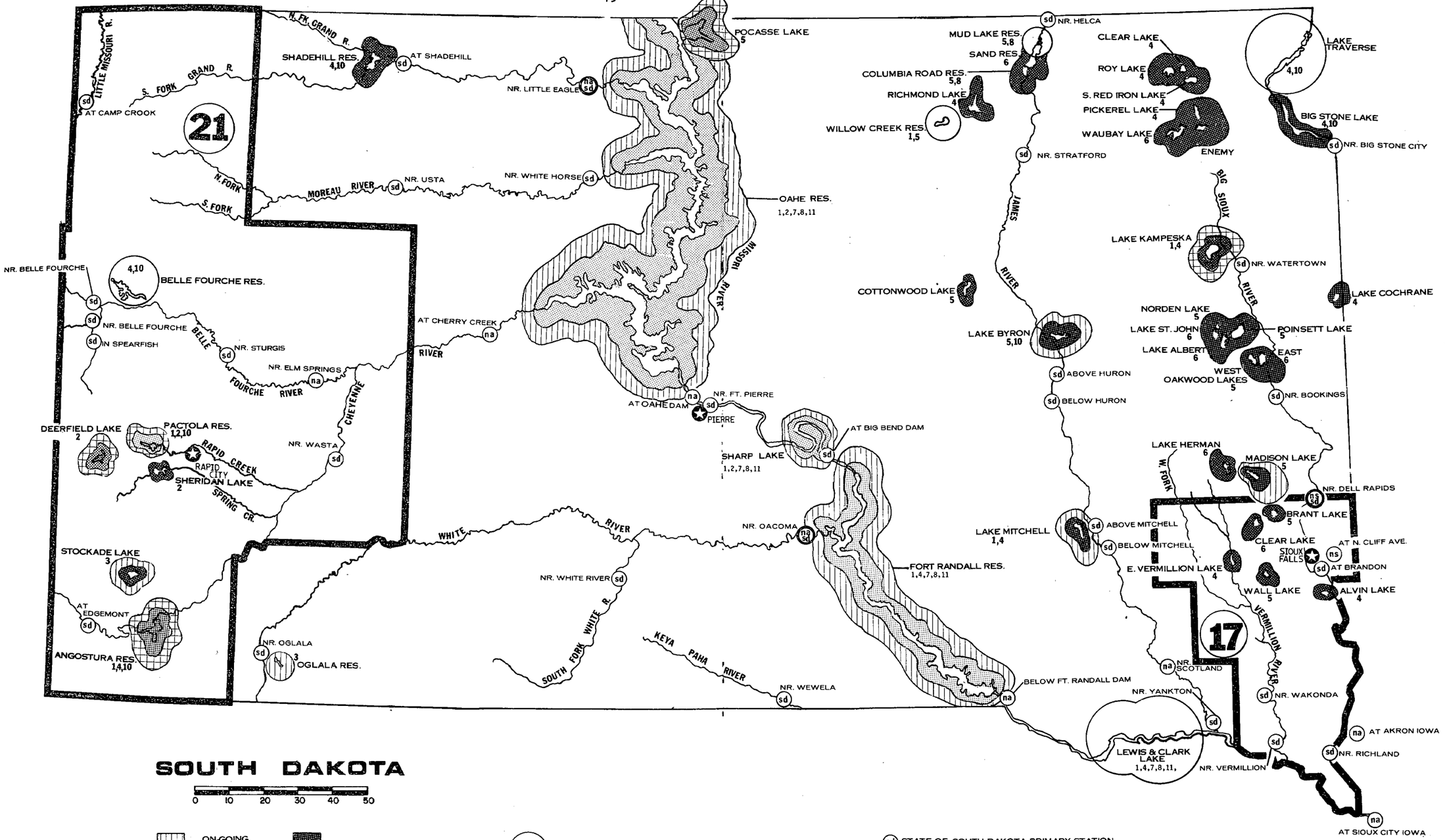
PREPARED BY ADMIN SVC BR 7-76
JTORRES MKARAVITES



CLASS I FULLY SWIMMABLE
CLASS IA FULLY SWIMMABLE AND SOFTENING MAY BE REQUIRED
CLASS II FULLY SWIMMABLE AND OTHER TREATMENT MAY BE REQUIRED
CLASS III FULLY SWIMMABLE AND DE-SALTING MAY BE REQUIRED

FIGURE 3 NORTH DAKOTA
LAKE & RESERVOIR ASSESSMENT

PREPARED BY-ADMIN. SVC. BR. 7-76
J. TORRES M.KARAVITES



SOUTH DAKOTA

0 10 20 30 40 50

ON-GOING MONITORING RECOMMENDED

ON-GOING MONITORING RECOMMENDED & CLEAN-UP CANIDATE

EUTROPHIC 80%

MESOTROPHIC 40%

OLIGOTROPHIC 10%

NEED DATA

208 SECTION AREA

ON-GOING MONITORING & NEED DATA

1 - DRINKING WATER SUPPLY
2 - COLD WATER PERMANENT FISHABLE
3 - COLD WATER MARGINAL FISHABLE
4 - WARM WATER PERMANENT FISHABLE
5 - WARM WATER SEMI - PERMANENT FISHABLE
6 - WARM WATER MARGINAL FISHABLE
7 - IMMERSION REC. (SWIMMABLE)
8 - LIMITED CONTACT REC.
9 - WILDLIFE PROGATION & STOCK WATERING
10 - IRRIGATION
11 - COMMERCIAL & INDUSTRIAL USE

(sd) STATE OF SOUTH DAKOTA PRIMARY STATION

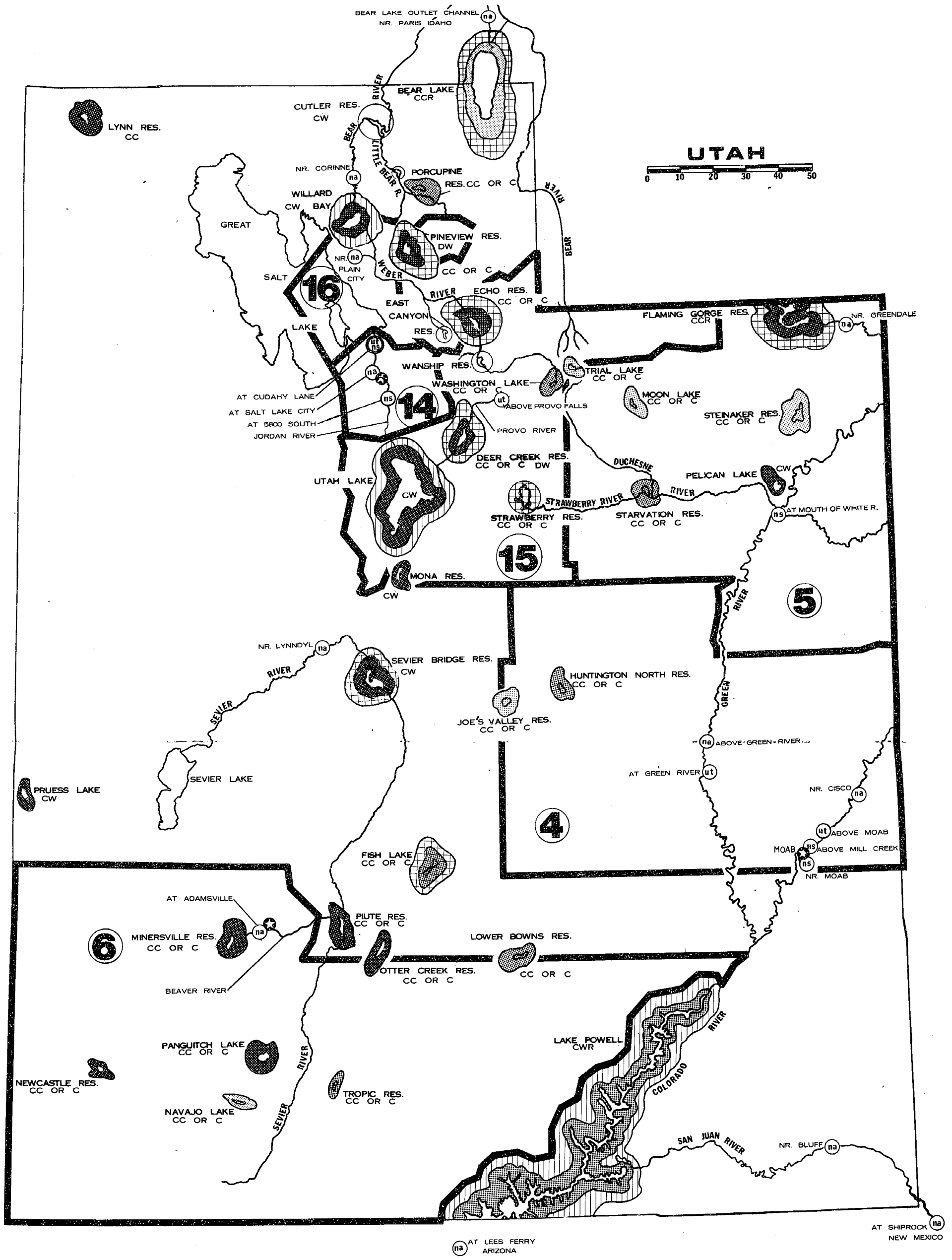
(na) USGS NATIONAL STREAM QUALITY ACCOUNTING NETWORK

(ns) EPA NATIONAL WATER QUALITY SURVEILLANCE SYSTEM

(sd/ns) DOUBLE STATION

FIGURE 4 SOUTH DOKOTA
LAKE & RESERVOIR ASSESSMENT

PREPARED BY ADMIN SVC. BR. 8-76
JTORRES MKARAVITES



C - FISHABLE

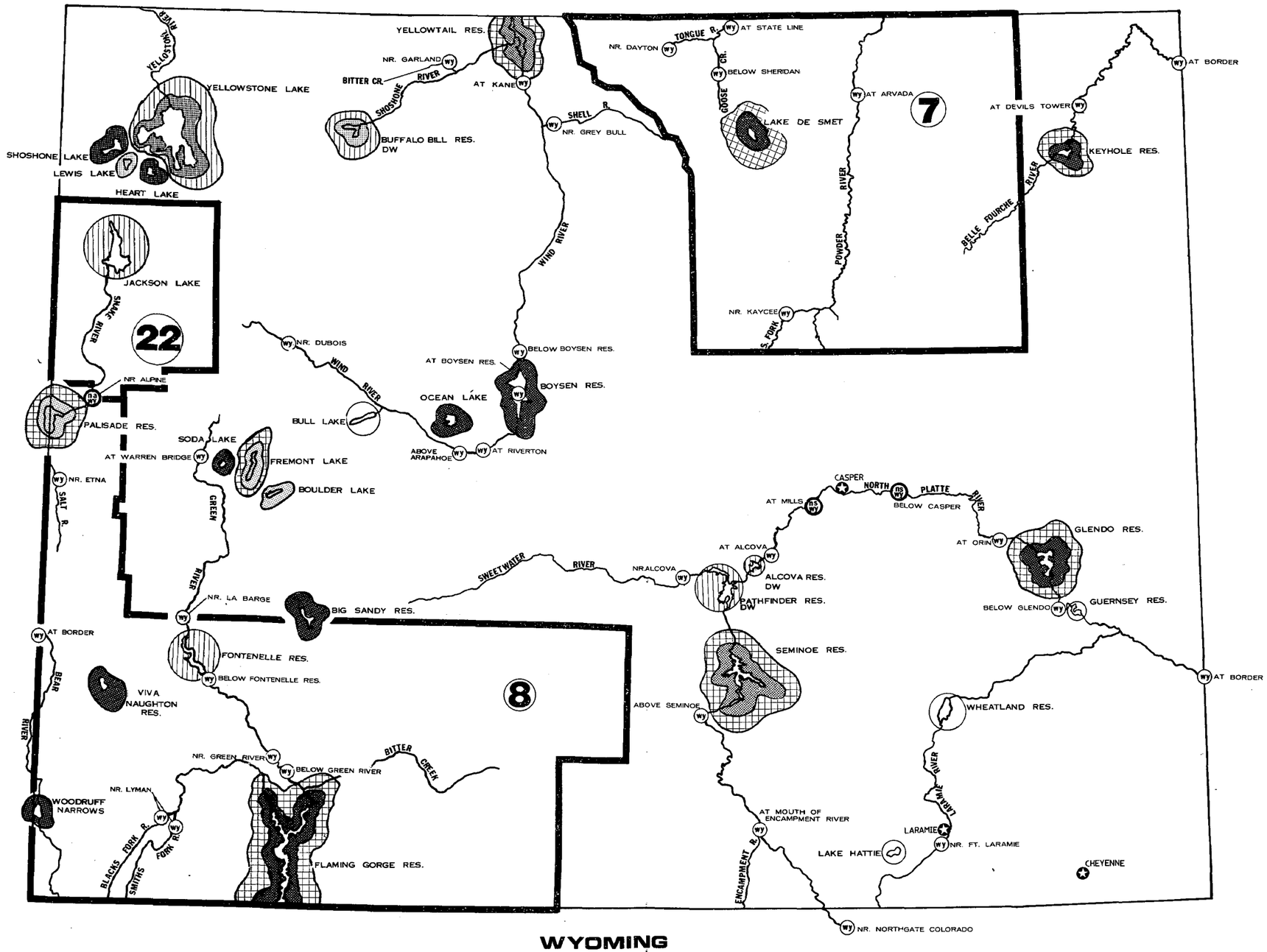
CC - COLD WATER FISHABLE ASSIGNED TO KNOWN COLD WATER FISHERIES

CW - WARM WATER FISHABLE

R - SWIMMABLE CLASS ASSIGNED AS NATURAL PURIFICATION ALLOWS

DW - DRINKING WATER SUPPLY

FIGURE 5 UTAH LAKE & RESERVOIR ASSESSMENT



WYOMING

0 10 20 30 40 50

ON-GOING MONITORING RECOMMENDED

ON-GOING MONITORING RECOMMENDED & CLEAN-UP CANIDATE

EUTROPHIC 80%

MESOTROPHIC 40%

OLIGOTROPHIC 10%

NEED DATA

208 SECTION AREA

ON-GOING MONITORING & NEED DATA

DW DRINKING WATER SUPPLY

(WY) STATE OF WYOMING PRIMARY STATION

(RB WY) USGS NATIONAL STREAM QUALITY ACCOUNTING NETWORK

(RS) EPA NATIONAL WATER QUALITY SURVEILLANCE SYSTEM

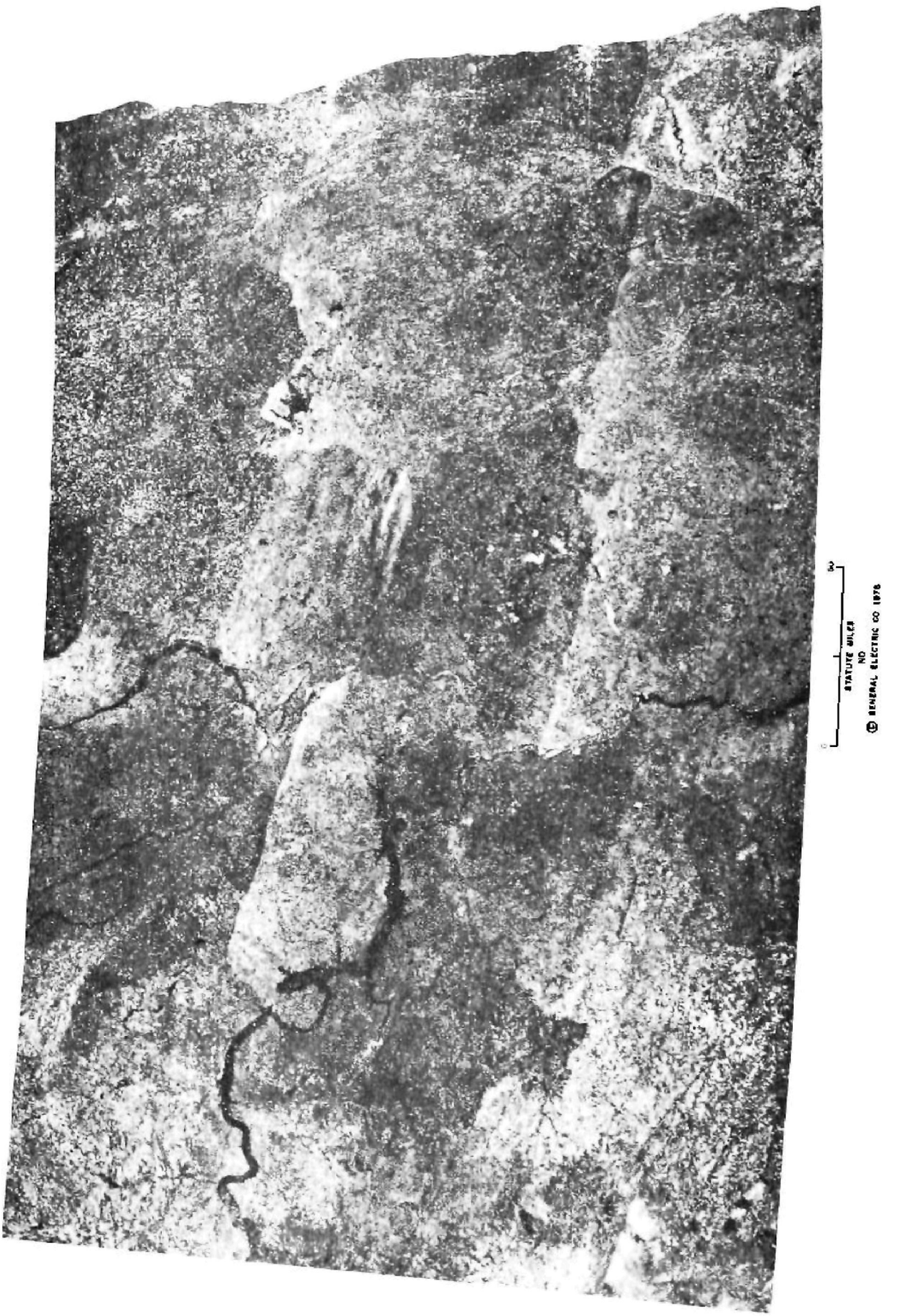
(WY RB RS) DOUBLE STATION

FIGURE 6 WYOMING
LAKE & RESERVOIR ASSESSMENT

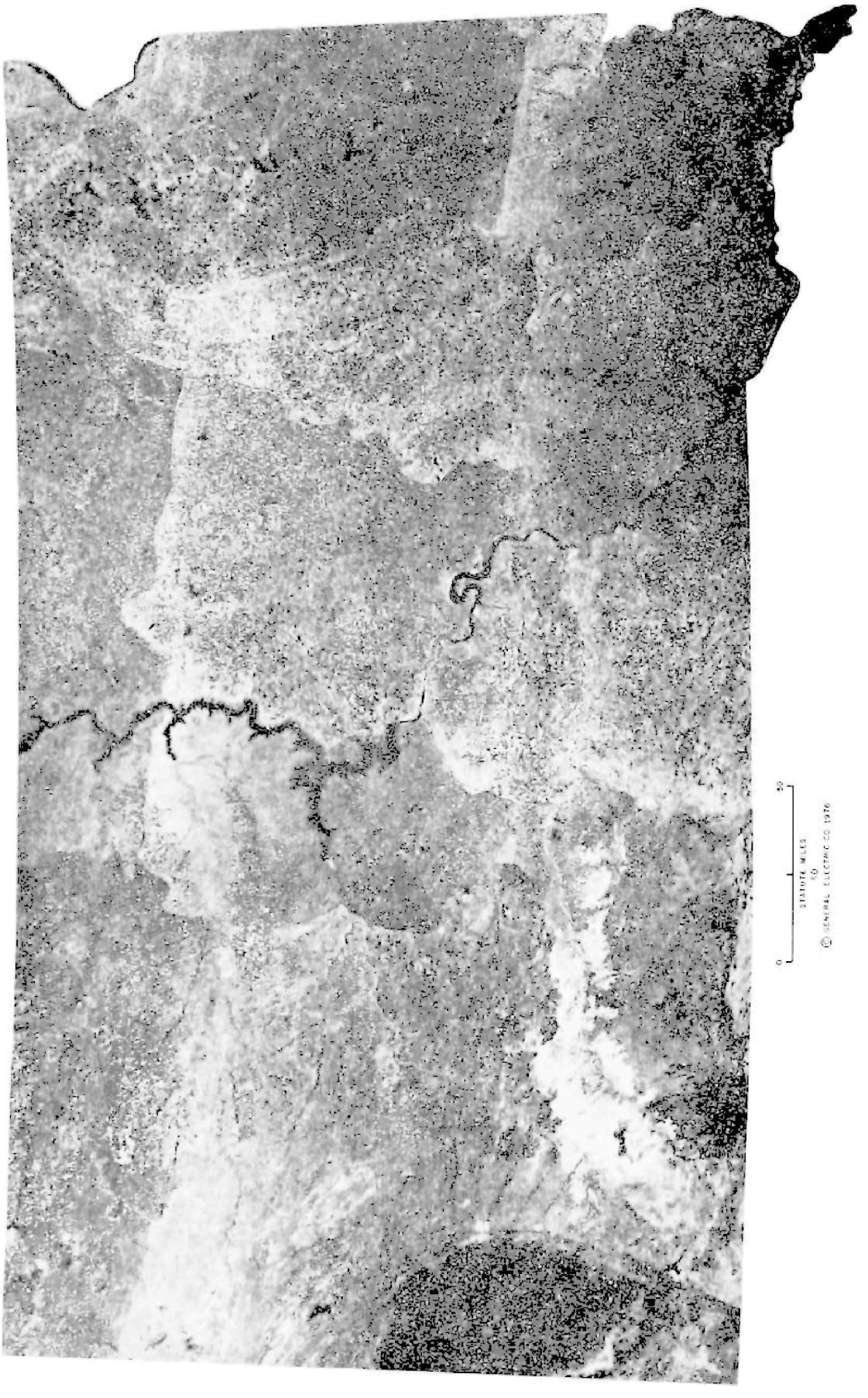
PRPARED BY ADMIN. SVC. BR. 7-76
JTORRES MKARAVITES

COLORADO LANDSAT
FIGURE 7

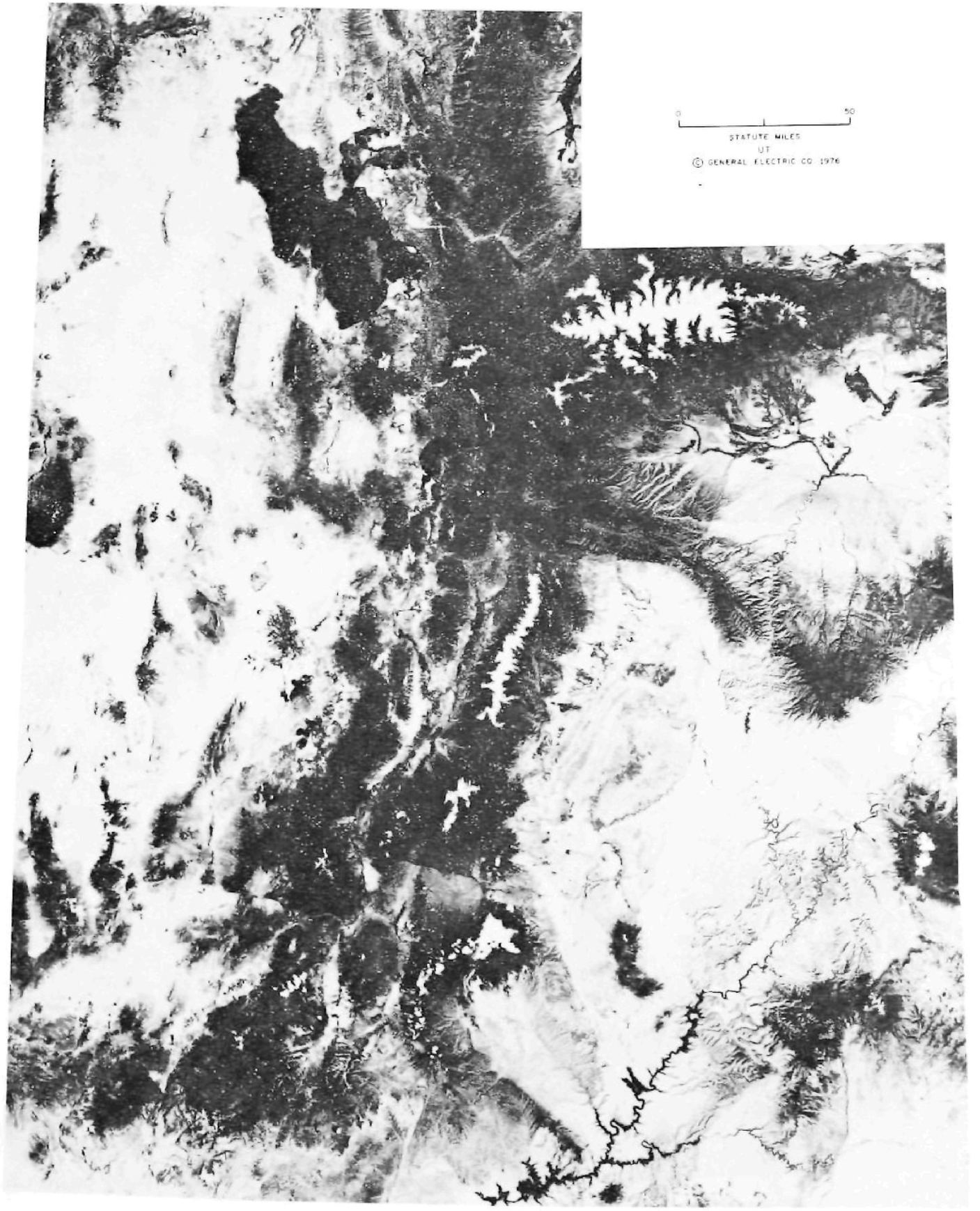
MONTANA LANDSAT
FIGURE 8



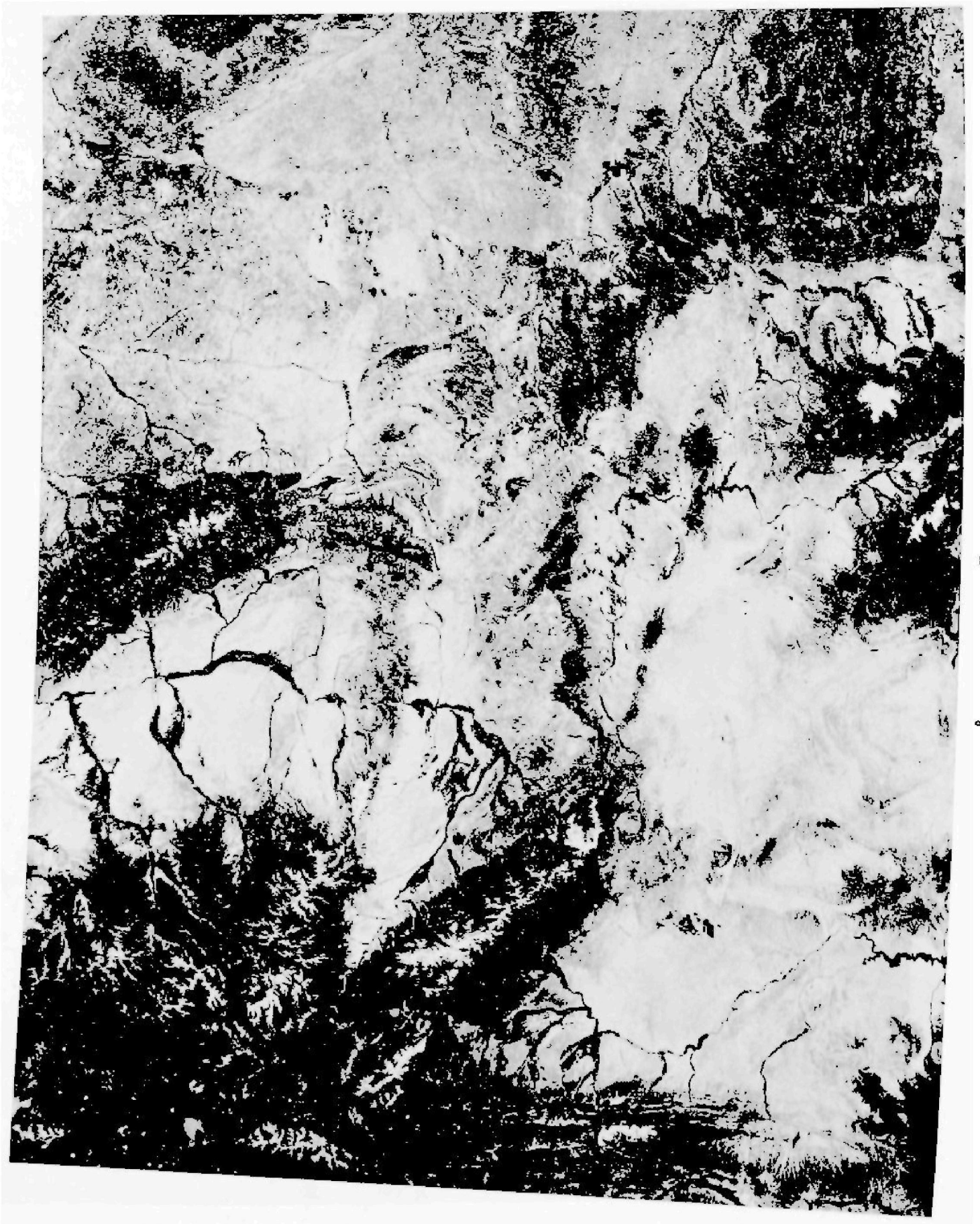
NORTH DAKOTA LANDSAT
FIGURE 9



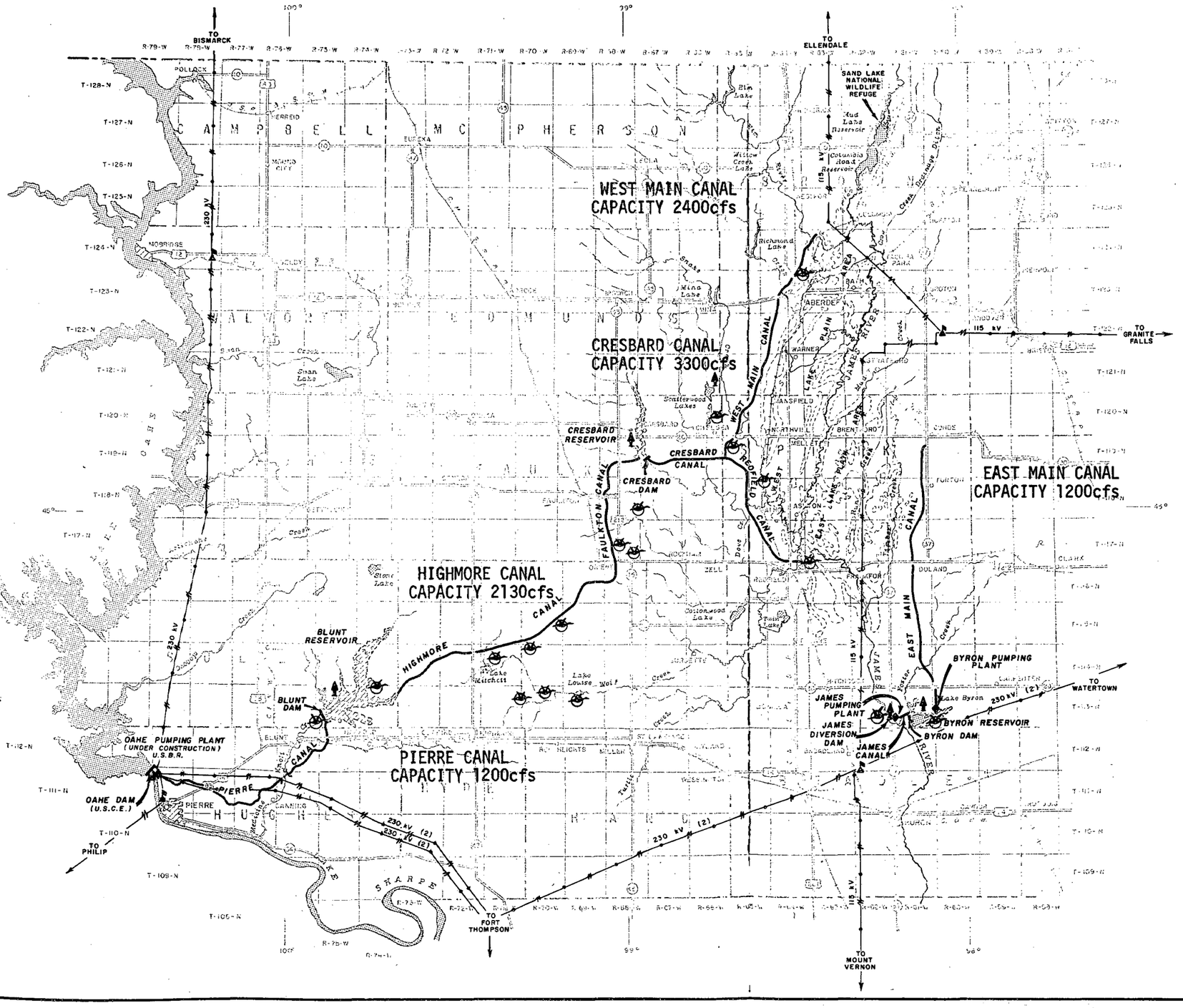
SOUTH DAKOTA LANDSAT
FIGURE 10

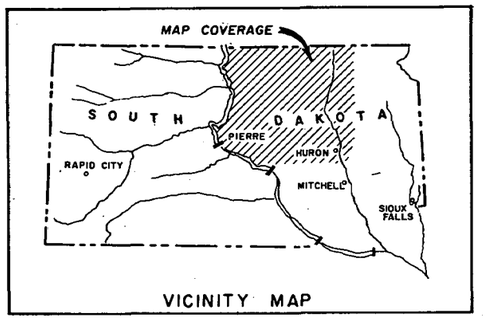


UTAH LANDSAT
FIGURE 11



WYOMING LANDSAT
FIGURE 12





VICINITY MAP

EXPLANATION

INITIAL DEVELOPMENT

- IRRIGABLE LAND AREA
- CANAL
- PUMPING PLANT
- SIPHON
- DAM AND RESERVOIR
- FISH AND WILDLIFE AREA
- RECREATION AREA

EXISTING FACILITIES

- DAM AND RESERVOIR / LAKE
- POWERPLANT
- U.S.B.R. TRANSMISSION LINE [(2) ON LINE DENOTES DOUBLE CIRCUIT]
- SUBSTATION
- RECREATION AREA
- FISH AND WILDLIFE AREA

FIGURE 13

UNITED STATES
DEPARTMENT OF THE INTERIOR
KENT FRIZZELL, ACTING SECRETARY
BUREAU OF RECLAMATION
GILBERT G. STAMM, COMMISSIONER

PICK—SLOAN MISSOURI BASIN PROGRAM

OAHE UNIT

INITIAL STAGE
SOUTH DAKOTA
UPPER MISSOURI REGION
MAP NO. 469-602-5170

10 0 10
SCALE OF MILES
10 0 10
SCALE OF KILOMETERS

SEPTEMBER 1975

STATUTE MILES
MY
© GENERAL ELECTRIC CO. 1976

GPO 831-890

FACTUAL DATA ON THE OAHE UNIT

AUTHORIZATION

The multipurpose Initial Stage of Oahe Unit was authorized by Public Law 90-453, on August 3, 1968, "for the principal purposes of furnishing a surface irrigation water supply for approximately 190,000 acres of land, furnishing water for municipal and industrial uses, controlling floods, conserving and developing fish and wildlife resources, and enhancing outdoor recreation opportunities . . ."

WATER SUPPLY

The water will be obtained principally from Lake Oahe formed by Oahe Dam on the Missouri River. Storage capacity of this reservoir is 23,600,000 acre-feet. Average annual flow of the Missouri River at Oahe Dam (1898-1972) is 18,525,000 acre-feet. Diversion from Lake Oahe to central South Dakota will average about 444,400 acre-feet annually, which is about 3 percent of the long-term average annual flow.

A portion of the water supply will be obtained from floodflows of the James River and from irrigation return flows accruing to the James River.

FEATURES OF THE INITIAL STAGE DEVELOPMENT

The principal supply works will include the Oahe Pumping Plant, 214 miles of main canals, three regulating reservoirs, the James Diversion Dam (existing), and the James Pumping Plant on the James River. Other irrigation works include 955 miles of distribution laterals, 935 miles of open drains, and 2,970 miles of closed (pipe) drains, and electrical distribution facilities for the pumping plants.

LOCAL PUBLIC AGENCIES

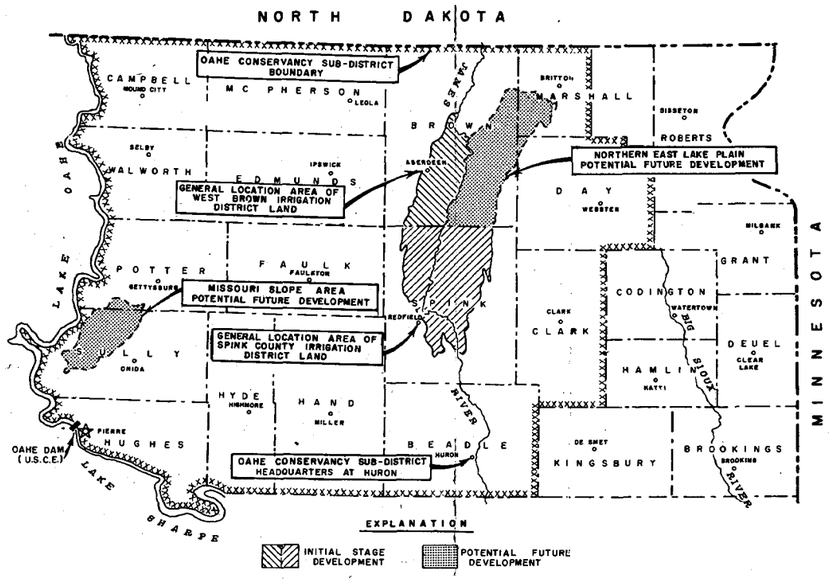
The Oahe Conservancy Sub-District, established by vote of the people, became fiscal agent for the Oahe Unit by contract with the United States on January 8, 1969. The Sub-District will provide centralized operation and maintenance of all multipurpose Unit facilities. As fiscal agent for the United States, the Sub-District will make appropriate collections from all water users for operating costs and repayment of construction costs.

The West Brown and Spink County Irrigation Districts have contracted with the Conservancy Sub-District for project irrigation water service.

IRRIGATION PLAN

Water will be pumped by Oahe Pumping Plant into the headworks of the 36-mile-long Pierre Canal for conveyance to Blunt Reservoir. Pumping lift will average 122 feet. From Blunt Reservoir, the water will flow by gravity through the Highmore and Faulkton Canals, a distance of 62 miles, to Cresbard Reservoir. From Cresbard Reservoir, the water will be conveyed a distance of 12 miles via Cresbard Canal to the West Main and Redfield Canals which will supply Missouri River water to West Lake Plain irrigable lands and to the James River. Some relift pumping of water will be required in the lateral distribution system.

Missouri River water, irrigation return flows, and James River floodflows will be pumped from the James River for East Lake Plain irrigation. The James Pumping Plant, to be located at the existing James Diversion Dam, will lift water from the James River into the headworks of James Canal. The pump lift will average 28.5 feet.



The James Canal will be about 3 miles in length and terminate at Byron Reservoir. Deliveries to East Lake Plain land will be made from Byron Reservoir by means of the Byron Pumping Plant and a canal and a lateral system. There would also be an extensive closed and open drainage system for all of the irrigable area.

CLIMATE

Annual precipitation averages about 19 inches and the average annual temperature is 45° F. in the Lake Plain. Annual precipitation has varied from less than 12 inches to more than 32 inches and temperatures have ranged from -40° F. to 115° F. During the growing season months there is an average of 11.5 hours of sunshine daily. The average frost-free period (32° F.) is 135 days. The average irrigation season extends 5 months, May through September. The consumptive use of irrigation water can vary from 8 inches to 15 inches depending on precipitation during the growing season.

NUMBER OF IRRIGABLE ACRES

The authorized Oahe Unit provides for development of 190,000 acres of irrigation in the Lake Plain area in West Brown and Spink County Irrigation Districts.

CHARACTER OF SOILS IN IRRIGABLE AREAS

Soils of land proposed for irrigation in the Lake Plain area are predominantly silty loam with some portions varying to silty-clay loam overlying glacial drift. Detailed land classification has identified over 190,000 acres suitable for irrigation. The relatively flat topography of the Lake Plain area makes it well suited for irrigation development.

ALTITUDE OF IRRIGABLE AREA

The Lake Plain area ranges in elevation between 1295 and 1310 feet above mean sea level, except where streams have cut shallow valleys.

LAND USE AND FARM ORGANIZATION

Irrigable lands are dispersed throughout the area and nearly all farm units will include both irrigated and nonirrigated lands. This integrated irrigation-dryland type of farm development will have a stabilizing influence extending far beyond the project boundaries. Area farmers will have a dependable and continuing nearby market for many of their feeder livestock with intensified feeding operations on integrated project farms. The Unit will also be producing a dependable feed supply which dryland farmers outside the project area could secure for their livestock breeding herds during periods of drought.

PRINCIPAL PRODUCTS

Under present dryland farming, principal agricultural products are corn, wheat, other small grains, alfalfa, feeder livestock, and some fat livestock. Under irrigation, the principal products are expected to be fat livestock, corn, and alfalfa. There will also be some small-grains, other feed crops, and significant acreages of sugar beets, potatoes, and vegetable crops which will be limited by markets and processing plants. Livestock raising and fattening will be the major farm enterprises under irrigation development. There will be some increased dairy production.

MARKETS

Present marketing facilities, with some increase in their capacity, will handle most of the increased agricultural production from irrigation development. Much of the livestock will be sold as feeders or direct to processors. Some livestock may be shipped to out-of-state markets. Dairy products would be sold through local processing plants. New local markets would be developed as needed for specialty crops such as sugar beets, potatoes, and vegetables.

MUNICIPAL AND INDUSTRIAL WATER

Opportunity for water delivery will be available to 17 or more municipalities and rural water systems. Feasibility studies for Oahe Unit municipal and industrial water facilities were authorized by Congress under Public Law 92-577, 92nd Congress, on October 27, 1972. These studies will be made, upon requests from municipalities, to determine the cost of additional facilities needed to provide water from the Oahe Unit system. Federal participation in construction of delivery works would require separate authorization by Congress and a commitment by the water users to repay costs.

RECREATION AND FISH AND WILDLIFE

Recreation facilities and fish and wildlife developments have been constructed at James Diversion Dam. Additional recreation facilities are proposed at the three regulating reservoirs and one existing lake at which the water level will be stabilized. Fish and wildlife developments are planned at 17 locations and will total about 12,000 acres of water and marsh and 28,000 acres of adjacent upland.

INCIDENTAL FLOOD CONTROL

Incidental flood control would result from diverting a portion of James River floodflows into Byron Reservoir.

Additional incidental flood control would result if channel modification measures as authorized were determined to be the most feasible alternative for the James River in the Lake Plain area.

ALTERNATIVES TO PROJECT FEATURES

Several features of the Oahe Unit plan require additional investigation and public input before selecting the most desirable alternative. Studies and public involvement are in progress on the effect Project operation and return flows will have on water quality of the James River, methods of handling increased James River flows, and alternative dam and reservoir sites for Byron Reservoir.

POTENTIAL FUTURE DEVELOPMENT

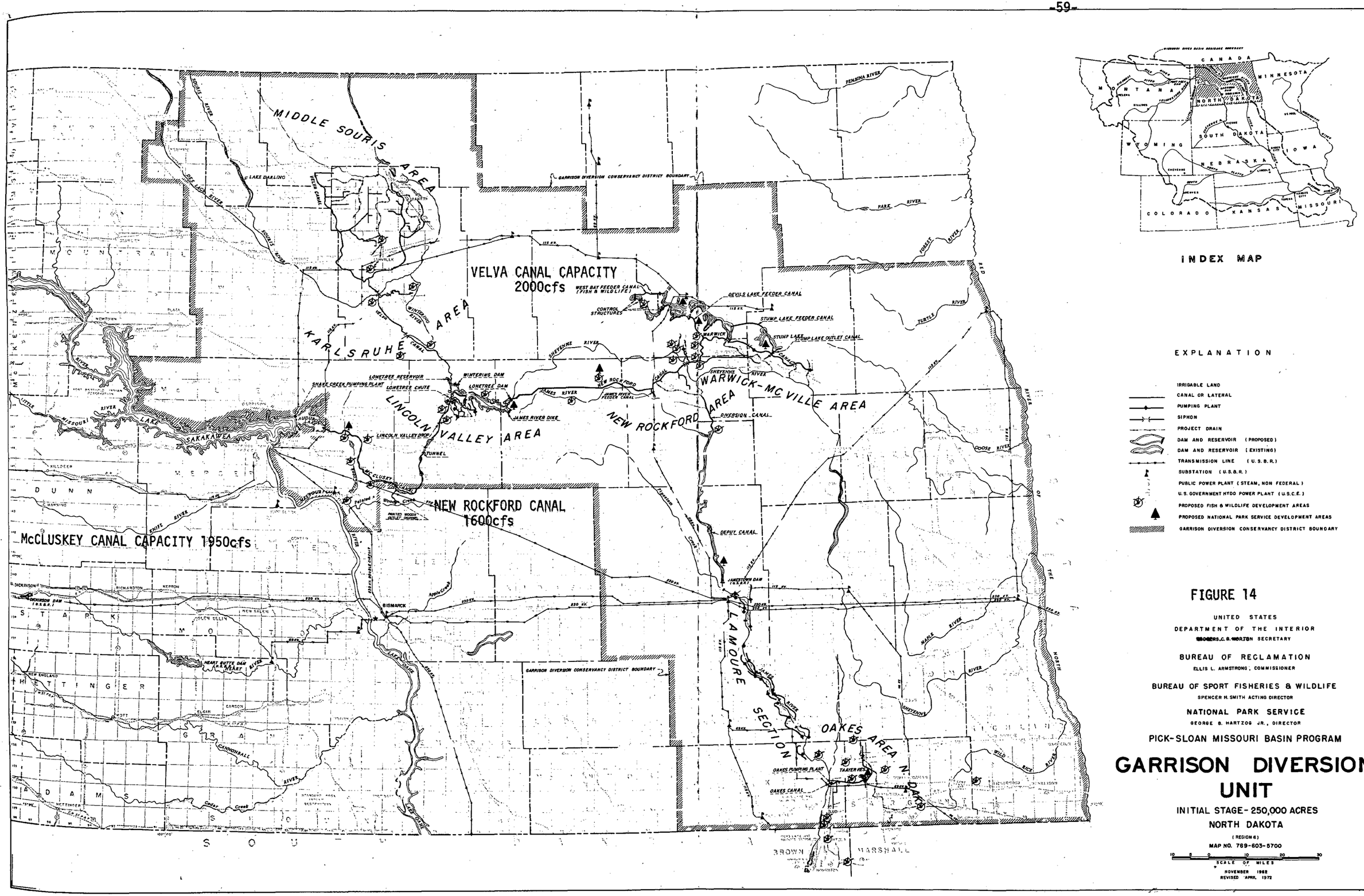
An additional 305,000 acres of land in the northern East Lake Plain and Missouri Slope areas are suitable for irrigation and have potential for future development. Strong local interest would be needed to obtain Congressional authorization and funding for feasibility studies. If completed future studies show development to be feasible, further Congressional authorization and funding would then be required before construction of facilities to serve these additional areas. Development of the potential areas would require enlargements of some of the facilities serving the initial 190,000 acres and construction of additional canals, laterals, and drainage facilities.

For additional information address inquiries to;

Bureau of Reclamation, P.O. Box 825
Huron, South Dakota 57350, or

Bureau of Reclamation, P.O. Box 2553
Billings, Montana 59103

SEPTEMBER 1975



INDEX MAP

EXPLANATION

- IRRIGABLE LAND
- CANAL OR LATERAL
- PUMPING PLANT
- SIPHON
- PROJECT DRAIN
- DAM AND RESERVOIR (PROPOSED)
- DAM AND RESERVOIR (EXISTING)
- TRANSMISSION LINE (U.S.B.R.)
- SUBSTATION (U.S.B.R.)
- PUBLIC POWER PLANT (STEAM, NON FEDERAL)
- U.S. GOVERNMENT HYDO POWER PLANT (U.S.C.E.)
- PROPOSED FISH & WILDLIFE DEVELOPMENT AREAS
- PROPOSED NATIONAL PARK SERVICE DEVELOPMENT AREAS
- GARRISON DIVERSION CONSERVANCY DISTRICT BOUNDARY

FIGURE 14

UNITED STATES
DEPARTMENT OF THE INTERIOR
[illegible] SECRETARY

BUREAU OF RECLAMATION
ELLIS L. ARMSTRONG, COMMISSIONER

BUREAU OF SPORT FISHERIES & WILDLIFE
SPENCER H. SMITH ACTING DIRECTOR

NATIONAL PARK SERVICE
GEORGE B. HARTZOG JR., DIRECTOR

PICK-SLOAN MISSOURI BASIN PROGRAM

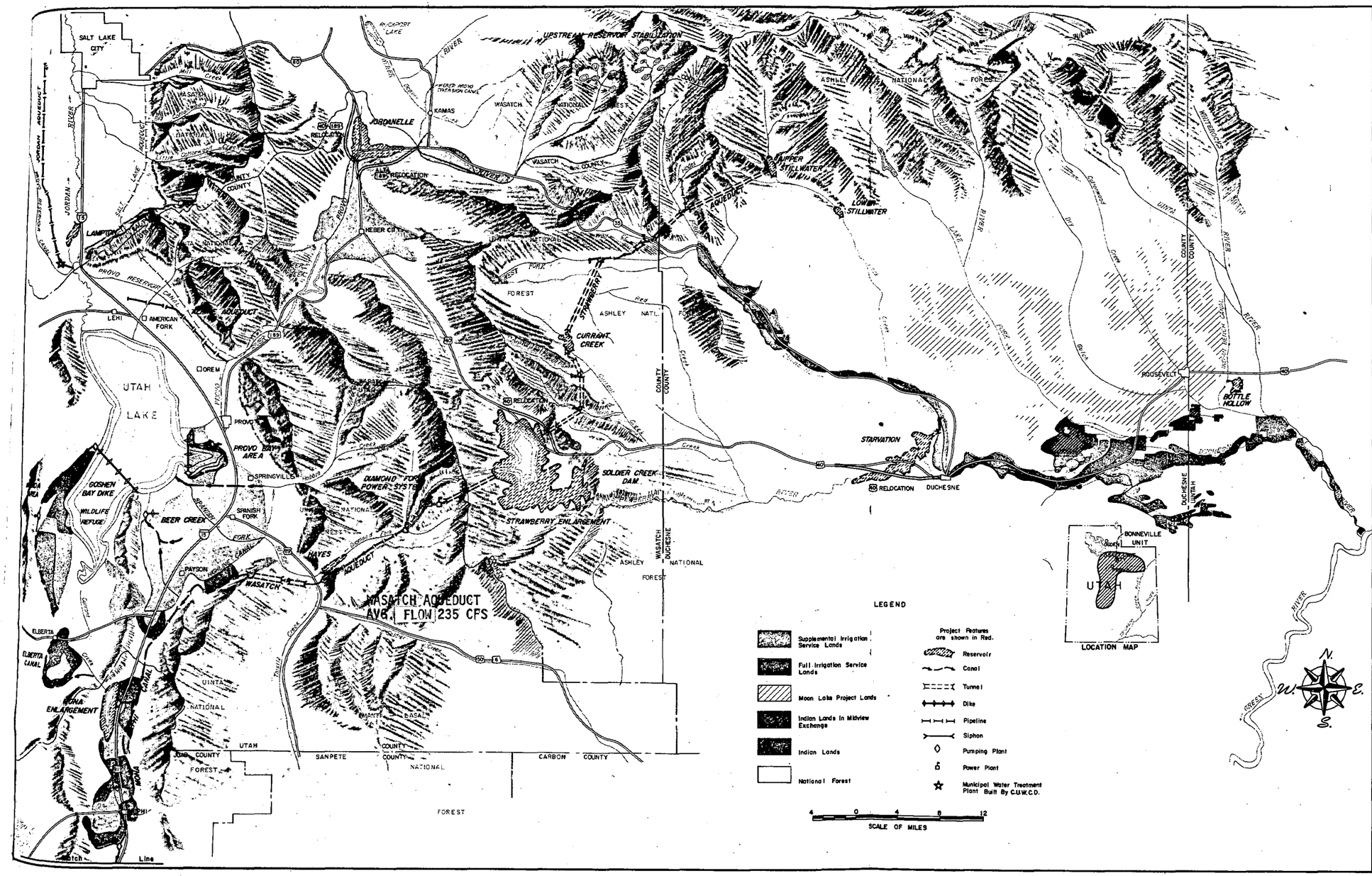
GARRISON DIVERSION UNIT

INITIAL STAGE - 250,000 ACRES
NORTH DAKOTA

(REGION 6)
MAP NO. 769-603-5700

10 8 0 10 20 30
SCALE OF MILES

NOVEMBER 1962
REVISED APRIL 1972



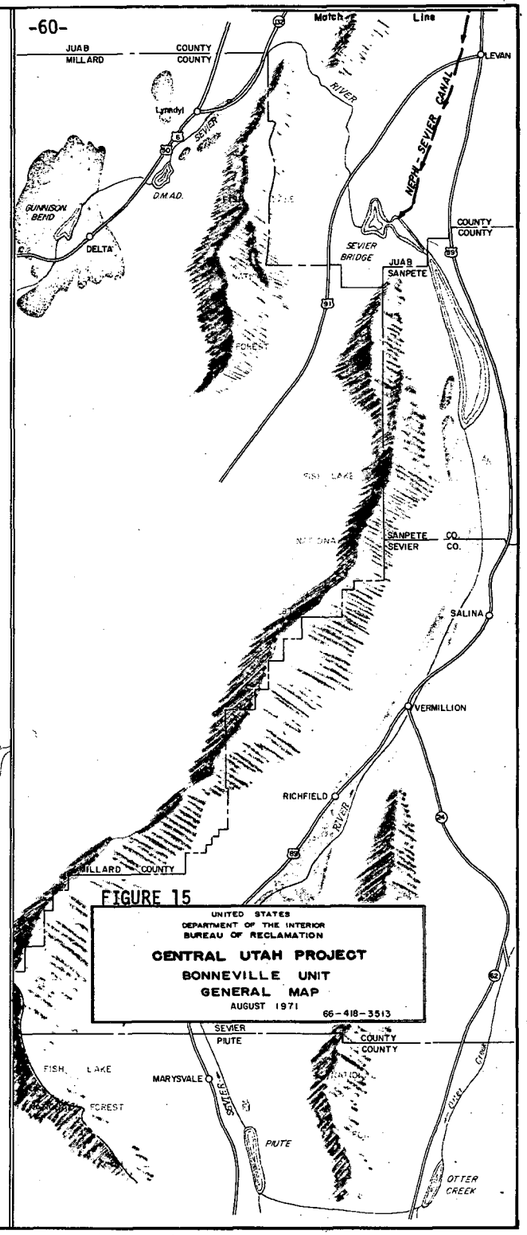


FIGURE 15

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL UTAH PROJECT
BONNEVILLE UNIT
GENERAL MAP

AUGUST 1971
66-418-3513

☆ U.S. Government Printing Office: 1976-777-430/34 Region 8 RECLAMATION — PRESS PUBLISHING COMPANY. 5M (8-71)