NMED/SWQ-07/3

WATER QUALITY ASSESSMENTS FOR SELECTED NEW MEXICO LAKES

2002

Monitoring and Assessment Section
Surface Water Quality Bureau
New Mexico Environment Department
1190 St. Francis Drive - P.O. Box 26110
Santa Fe, New Mexico 87502

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LAKE WATER QUALITY MONITORING, TROPHIC STATE EVALUATION, AND STANDARDS ASSESSMENTS FOR:

Navajo Reservoir, Lake Farmington and Jackson Lake

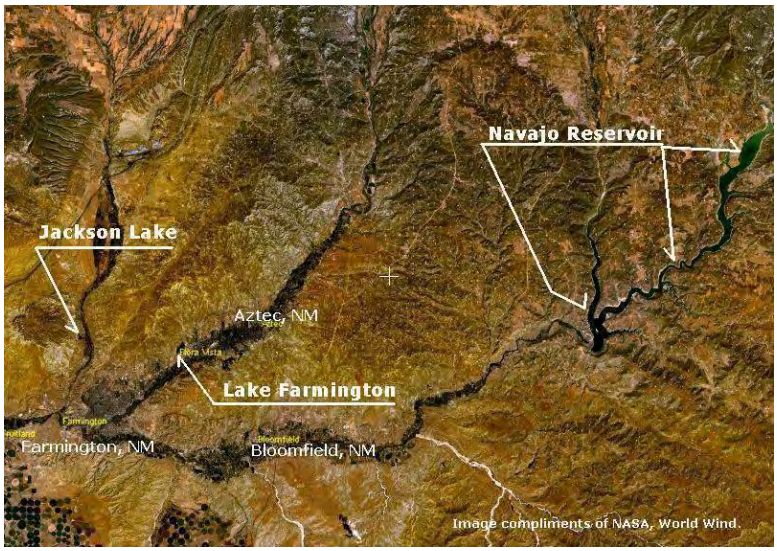
2002

EXECUTIVE SUMMARY

Navajo Reservoir at Pine Site Marina

Lake water quality surveys and assessments were completed in fulfillment of work-plan commitments of the *FY 2001-2002 section 106 Work Program for Water Quality Management.* This program was partially funded by a grant from the U.S. Environmental Protection Agency.

During 2002 the Monitoring and Assessment Section of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality and biological assessment surveys of three lake systems. Navajo Reservoir, Lake Farmington (formerly Beeline) and Jackson Lake were studied concurrently with an intensive Total Maximum Daily Load (TMDL) River study conducted within the San Juan River watershed. Studying lakes in this way helps to insure a timely return to the lake system as watersheds are revisited, and also add to the understanding of surface waters within the drainage basin. Water quality sampling methods were in accordance with the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 2002).



The following assessments provide information pertaining to water quality, biological integrity, trophic state, limiting nutrients, water quality criteria exceedences and water quality standards specific to designated, existing or attainable uses that are described in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC, 2006).

Water chemistry sampling at lake stations included total and dissolved nutrients, total and dissolved metals, major ions including TDS, hardness and alkalinity, radionuclides, organic scans, cyanide, and microbiological collections. Phytoplankton and benthic diatom samples were collected for analysis. The following assessments do not include all data results, except for those specifically related to general physical nature, trophic state, limiting nutrient or criteria exceedances and consequent standards violations. All data are available upon request.

TABLE OF CONTENTS

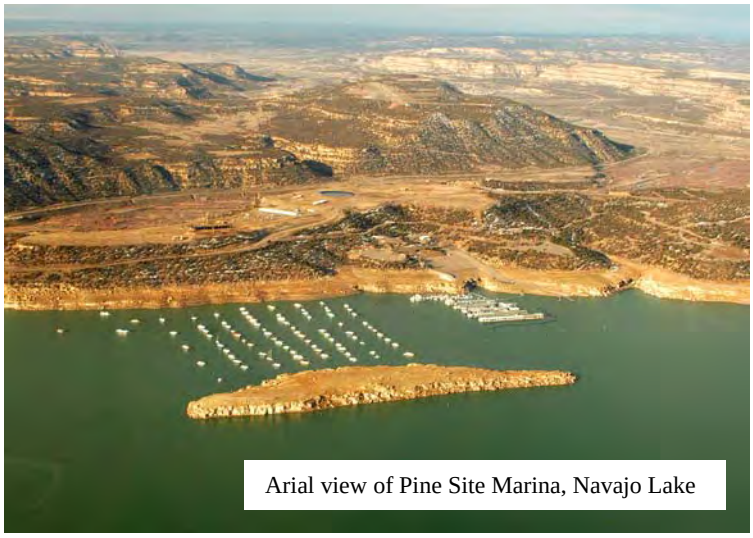
LAKE SURVEYS

Water Quality and Biological Assessment Survey of Navajo Reservoir, San Juan and Rio Arriba County's, April 16, July 16 and October 29, 2002.

Danny R. Davis, Principal Investigator

Navajo Reservoir was built by the U.S. Bureau of Reclamation and completion of the earth-rock fill dam was in June of 1963 though BOR began impounding water in June of 1962. Also contributing to the lake are Frances Creek, La Jara Creek, the Piedra River and Sambrito Creek, the Los Pinos River, Spring Creek and numerous canyons resulting in a 8,365 km^2 (3,230 mi^2) watershed area (Potter, 1990). Maximum surface area is about 63.3 km^2 (24.44 mi^2) resulting in a watershed to lake surface ratio of 132/1, and a hydrologic retention time of 1.4 years. Maximum storage capacity is 1.709 million acre-feet at a corresponding elevation of 6,085 feet above mean sea level, however, the storage pool varied from 1.255 to .8486 million acre-feet during this three-season study. The Reservoir is located within the Arizona/New Mexico Plateau ecoregion contained within Aggregate Ecoregion III (the Xeric West) (Omernik, 1987) and receives an average of 29.2 cm (11.5 in) of precipitation per year with pan evaporation averaging 95.1 cm (37.4 in) resulting in a deficit of 69.5 cm (27.4 in) (Gabin and Lesperance 1977.

Navajo Lake State Park operates a substantial recreational facility where camping, swimming, boating and other activities are provided. Boat ramps are provided at both the Pine Site, which is the main park facility, and at Sims Mesa located across the lake from Pine Site. The lake and facilities are located about 25 miles east of Bloomfield, New Mexico via New Mexico 64 and New Mexico 511.



Arial view of Pine Site Marina, Navajo Lake

Water quality standards for Navajo Reservoir are set forth in section 20.6.4.406 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 2006), where uses of coldwater aquatic life, warmwater aquatic life, irrigation storage, livestock watering, wildlife habitat, municipal and industrial water storage and primary contact are designated. Principal fish species consist of rainbow and brown trout, kokanee salmon, northern pike, large and small mouth bass, crappie, and channel catfish.

Table 1A. Seasonal station characteristics for Navajo Reservoir, 2002

Physical Characteristics	Deep at Dam		Navajo at Simms Mesa		Navajo at Gooseneck	
Anoxic Hypolimnion (Y/N)	Sp	N	Sp	N	Sp	N
	Su	N	Su	N	Su	N
	Fall	N	Fall	N	Fall	N
Stratified (Y/N) @ depth (M)	Sp	N	Sp	N	Sp	N
	Su	Y (8-9)	Su	Y (8-9)	Su	Y (7-8)
	Fall	Y (16-17)	Fall	N	Fall	N
pH (s.u.)	Sp	7.43	Sp	7.66	Sp	7.89
	Su	8.3	Su	8.24	Su	8.35
	Fall	7.86	Fall	8.70	Fall	8..55
Conductivity (µS)	Sp	207	Sp	206	Sp	210
	Su	228	Su	230	Su	235
	Fall	268	Fall	272	Fall	276
Turbidity (NTU's)	Sp	3.07	Sp	3.17	Sp	2.77
	Su	1.68	Su	3.47	Su	3.08
	Fall	1.49	Fall	2.66	Fall	2.01
Integrated Sample surface to (m)	Sp	7.4	Sp	7.0	Sp	7.0
	Su	16.0	Su	9.0	Su	8.0
	Fall	44.5	Fall	12.0	Fall	12.0
Dissolved Oxygen Surface (mg/L)	Sp	10.8	Sp	11.33	Sp	11.43
	Su	6.90	Su	6.94	Su	6.77
	Fall	8.60	Fall	8.29	Fall	8.35
Dissolved Oxygen Bottom (mg/L)	Sp	9.91	Sp	10.04	Sp	10.48
	Su	3.08	Su	2.16	Su	6.09
	Fall	7.02	Fall	7.11	Fall	7.35
Temperature Surface (ºC)	Sp	5.52	Sp	8.08	Sp	9.03
	Su	24.09	Su	24.08	Su	25.52
	Fall	12.93	Fall	13.01	Fall	13.09
Temperature Bottom (ºC)	Sp	4.64	Sp	6.82	Sp	10.48
	Su	5.32	Su	15.43	Su	9.05
	Fall	5.98	Fall	12.52	Fall	13.06
Chlorophyll *a* (µg/L)	Sp	0.514	Sp	1.87	Sp	QR
	Su	2.06	Su	2.62	Su	2.55
	Fall	0.79	Fall	1.26	Fall	QR

Table 1A. Seasonal station characteristics for Navajo Reservoir, 2002

Physical Characteristics	Deep at Dam		Navajo at Simms Mesa		Navajo at Gooseneck	
Secchi (m)	Sp	2.2	Sp	2.0	Sp	2.4
	Su	3.5	Su	2.0	Su	2.2
	Fall	4.8	Fall	3.5	Fall	3.5
Forel Ule Color	Sp	9	Sp	9	Sp	9
	Su	10	Su	10	Su	11
	Fall	6	Fall	6	Fall	7
Maximum Depth (m)	Sp	>75	Sp	17.6	Sp	28.8
	Su	>75	Su	12.0	Su	20
	Fall	46.8	Fall	17.25	Fall	15.75
Euphotic Zone (m)	Sp	7.4	Sp	7.0	Sp	7.0
	Su	9.0	Su	6.6	Su	7.0
	Fall	14.5	Fall	10.0	Fall	12.0
Surface Area (Acres)	Sp	11,304	Sp	11,304	Sp	11,304
	Su	9,249	Su	9,249	Su	9,249
	Fall	MDP	Fall	MDP	Fall	8,???
Storage Capacity (Ac. Ft.)	Sp	1,254,600	Sp	1,254,600	Sp	1,254,600
	Su	1,053,900	Su	1,053,900	Su	1,053,900
	Fall	848,600	Fall	848,600	Fall	848,600

Sp = Spring; Su = Summer; MDP = missing data point; (QR) = questionable result.

Table 2A. Trophic State for Navajo Reservoir, 2002 (Carlson, 1977)

Trophic State (Carlson, 1977)	Deep at Dam		Navajo at Simms Mesa		Navajo at Gooseneck	
Secchi depth	Sp	M	Sp	E	Sp	M
	Su	M	Su	E	Su	M
	Fall	OM	Fall	M	Fall	M
Chlorophyll *a*	Sp	O	Sp	OM	Sp	Questionable Result
	Su	OM	Su	M	Su	OM
	Fall	M	Fall	OM	Fall	Questionable Result
Total Phosphorus	Sp	O	Sp	O	Sp	O
	Su	O	Su	O	Su	O
	Fall	O	Fall	O	Fall	O
Total Nitrogen	Sp	OM	Sp	OM	Sp	OM
	Su	OM	Su	OM	Su	OM
	Fall	OM	Fall	OM	Fall	OM
Overall Trophic Condition			**Oligomesotrophic**			

O = Oligotrophic, OM = Oligomesotrophic, M = Mesotrophic, ME = Mesoeutrophic, E = Eutrophic.

Table 3A. Nitrogen (N) /Phosphorus (P) Ratio

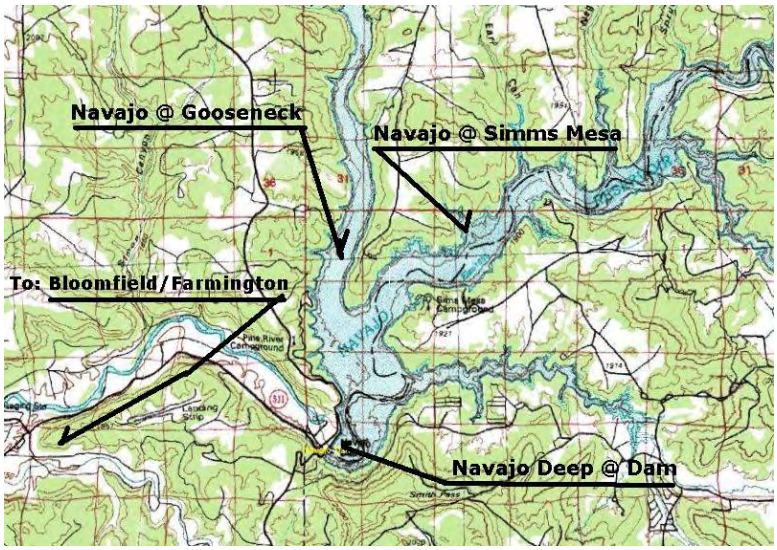
	Deep at Dam		Navajo at Simms Mesa		Navajo at Gooseneck	
Limiting Nutrient	Sp	N	Sp	N/P	Sp	N/P
	Su	P	Su	P	Su	N/P
	Fall	P	Fall	N/P	Fall	P
Overall Limiting Nutrient			**Co-limiting**			

Table 4A. Use Attainment

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Coldwater Aquatic Life	1 Al, <15%, Fish Hg	Not Supporting
Warmwater Aquatic Life	1 Al, <15%, Fish Hg	Not Supporting
Irrigation Storage	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Municipal and Industrial Water Storage	None	Fully Supporting
Primary Contact	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Navajo Reservoir were measured and are listed in Table 1A. Table 2A shows the trophic state variation observed both seasonally and between stations for Secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. The overall trophic condition of Navajo Reservoir in 2002, according to Carlson (1977) and Likens (1975) is oligomesotrophic (Table 2A). Nitrogen to phosphorous ratios for all stations during the seasonal sampling runs resulted in one N limiting result, four P limiting results and four co-limiting calculations. Overall nutrient values show that nitrogen and phosphorous are co-limiting in Navajo Reservoir (Table 3A).



Phytoplankton community composition during the three seasons consisted mostly of members of the Cryptophyta and Chrysophyta with small numbers of Chlorophyta supporting the oligomesotrophic determination's earlier discussed. Diatom community composition has not been completed; however, results are forthcoming and will be included herein once data are available.

San Juan River entering Navajo Reservoir in Colorado

Navajo Reservoir, as a whole, was not stratified during the spring sampling effort and also was not stratified at Sims and Gooseneck stations in the fall. All stations were stratified during the summer sampling effort and at the dam station during the fall. At no time were anoxic conditions observed within the hypolimnetic waters (Table 1A).

Lake chemistry sampling consisted of total, dissolved and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteriological and cyanide, which cover all standards criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences are listed in Table 4A and discussed below.

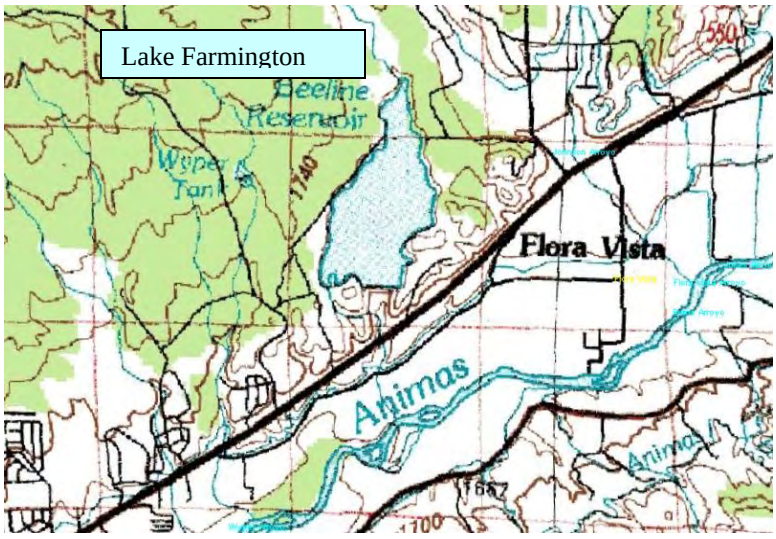
There were no physical or chemical exceedences of criteria except for a slightly elevated aluminum result from the spring sampling run at the Sims Mesa station (3 ppb above criteria of 87 ppb), however assessment protocols do not consider one exceedence an impairment.

Continuing fish consumption advisories for elevated levels of mercury in fish tissue in selected fish species within Navajo Reservoir remain in effect resulting in impairment for all aquatic life uses. Until such time as power plants and other sources of mercury are forced to reduce their emissions, this condition will continue. All other uses were fully supported during this study.

Water Quality and Biological Assessment Survey of Lake Farmington (Beeline), San Juan County, July 17, 2002.

Danny R. Davis, Principal Investigator

Lake Farmington, in north-western New Mexico is about 9.7 km (6 mi) northwest of Farmington, New Mexico. This 198 acre lake was originally named Beeline Reservoir, previously owned by the Beeline oil and gas refinery. Beeline sold the reservoir to the city of Farmington in 1963, whereupon the name was changed. The lake is an off-channel impoundment and receives water by way of the original "Farmers Ditch", which originates near Aztec, New Mexico. A relatively new supply source, the "Animas #2 intake," was completed in 1982 and diverts pumped water from the Animas River to the lake, a distance of about one-half mile.



Lake Farmington serves as the primary water supply for the City of Farmington. The New Mexico Department of Game and Fish provides both warm and cold water species to satisfy the fishing public, who may fish from shore, or float in non-gasoline powered boats. There are trails for hiking and biking enthusiasts (Davis, 1992).

Lake Farmington resides within the Arizona/New Mexico Plateau ecoregion contained within Aggregate Ecoregion III (the Xeric West) (Omernik, 1987) and receives an average of 20.6 cm (8.12 in) of precipitation per year with pan evaporation averaging 97 cm (38.11 in) resulting in a deficit of 77.5 cm (30.48 in) (Gabin and Lesperance 1977). Water quality standards in section 20.6.4.99 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* apply to Lake Farmington. The designated uses are: aquatic life, wildlife habitat, livestock watering and secondary contact. A site specific temperature criterion of 34°C applies. In addition, SWQB staff note

existing uses of coldwater and warmwater aquatic life, municipal water supply, and irrigation storage that need to be protected.

Table 1B. Physical characteristics for Lake Farmington, 2002.

Physical Characteristics	Deep Station	Shallow Station
Secchi Depth (m)	3.5	2.7
Forel Ule Color	8	6
Maximum Depth (m)	25.25	4.1
Euphotic Zone (m)	8.7	>4
Surface Area (Acres)	198	198
Anoxic Hypolimnion (Y/N)	Yes	No
Stratified (Y/N) @ (m)	Yes @ 9-10 m	N
pH (s.u.) Surface	8.22	8.19
Conductivity (µS) (Surface)	674	655
Turbidity (NTUs)	3.66	4.64
Integrated sample surface to (m)	24	3.5
Dissolved Oxygen Surface (mg/L)	7.2	7.1
Dissolved Oxygen Bottom (mg/L)	0.91	7.14
Temperature Surface (°C)	24.5	24.9
Temperature Bottom (°C)	7.78	23.6
Chlorophyll *a* (µg/L)	1.96	1.40

Table 2B. Trophic State for Lake Farmington, 2002. (Carlson, 1977)

Trophic State Indices	Season	Deep Station	Shallow Station
Secchi depth	Summer	Meso	Meso
Chlorophyll *a*	Summer	OligoMeso	OligoMeso
Total Phosphorus	Summer	Meso	Meso
Total Nitrogen	Summer	OligoMeso	OligoMeso
Overall Trophic Condition	**Oligomesotrophic**		

Table 3B. Nitrogen (N) /Phosphorus (P) Ratio

	Deep Station	Shallow Station
Limiting Nutrient	**N/P**	**N/P**

Table 4B. Use Attainment

Designated or Existing Use	Criteria Exceedence	Attainment Status
Coldwater Aquatic Life	Hg/Fish Tissue	Not Supporting
Warmwater Aquatic Life	Hg/Fish Tissue	Not Supporting
Municipal Water Supply	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Irrigation	None	Fully Supporting
Secondary Contact	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Lake Farmington were measured and are listed in Table 1B. Table 2B shows the trophic state variation observed between stations for Secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. The overall trophic condition of Lake Farmington in 2002, according to Carlson (1977) and Likens (1975), is oligomesotrophic with nitrogen and phosphorus being co-limiting on the day of sampling (Tables 2B and 3B).

The previous, multiseasonal study, conducted by the author in 1991 also resulted in a oligomesotrophic determination for overall lake trophic condition, however, as with the 1991 study, the practice of applying copper sulfate to this municipal water supply to control algal growth continues. Though this practice is not sanctioned or approved through water quality standards, some cities continue to control algal growth in this fashion. It is likely that this method of algal control will continue, though requirements for applicator training and certification is expected.

Of the six phytoplankton genera identified from the sample, about two-thirds were members of the Chrysophyta and Cryptophyta with the remaining being representatives of the Chlorophyta. The dominance of these members of the phytoplankton community agrees with the oligomesotrophic determination. Results for the benthic diatom community composition are forthcoming.

Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, microbiological and cyanide, which covers all standards criteria pertinent to the protection of all designated uses. Phytoplankton, diatom and chlorophyll analyses were also performed. These data are available upon request, though any criteria exceedences are listed in Table 4 and discussed below.

As Table 4B indicates, there are existing uses that the current standards segment associated with this lake does not recognize. However, existing and attainable uses are noted in the SWQB Assessment Database in order to afford waters, such as Lake Farmington, more protection than that given by their respective criteria. According to NM's Antidegradation Policy (20.6.4.8), "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." Therefore, during assessment procedures, it is the more protective uses (in this case, the existing uses) that are assessed against the criteria.

Physical and chemical criteria showed full support of all attainable uses. Fish consumption advisories for elevated levels of mercury in fish tissue in selected fish species within Lake Farmington remain in effect resulting in nonsupport of both cold and warmwater aquatic life uses. Until mercury levels fall below levels of concern, this nonsupport of aquatic life uses will continue.

Water Quality and Biological Assessment Survey of Jackson Lake, San Juan County, July 17, 2002.

Danny R. Davis, Principal Investigator

Jackson Lake, in north-western New Mexico is located approximately eight miles northwest of Farmington, New Mexico via State road 64 west and State road 170 north to the State Wildlife Area and lake. The initial purchase of the area was made in 1948 by the State of New Mexico as a wildlife preserve, and the 60 acre Jackson Lake itself was purchased along with additional lands in 1960 resulting in a total wildlife preserve of 840 acres. The lake is located at an elevation of 1,673 meters (5,489 ft.) above sea level. The New Mexico Department of Game and Fish (NMDG&F) maintains a local fishery at the lake offering large-mouth bass, channel catfish and trout. During hunting season, some waterfowl hunting is allowed on the preserve, however, no boating, camping, picnic tables or toilets are provided at the lake. Fields within the preserve are habitat for quail, pheasant and mourning dove. Resident and wintering deer have access to the fields, and songbirds and birds of prey frequent the preserve and river area.

Jackson Lake is located within the Arizona/New Mexico Plateau ecoregion contained within Aggregate Ecoregion III (the Xeric West) (Omernik, 1987) and receives an average of 21.4 cm (8.4 in) of precipitation per year with pan evaporation averaging 100 cm (39 in) resulting in a deficit of 81 cm (31.8 in) (Gabin and Lesperance 1977). Water quality standards in section 20.6.4.99 of the *New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC, 2006) apply to for Jackson Lake. The designated uses are: aquatic life, wildlife habitat, livestock watering and secondary contact. A site specific temperature

criterion of 34°C applies. Specifically, SWQB staff note existing aquatic life uses of coldwater and warmwater aquatic life.

Table 1C. Physical characteristics for Jackson Lake, 2002.

Physical Characteristics	Jackson Deep @ Dam
Secchi Depth (m)	0.50
Forel Ule Color	14
Maximum Depth (m)	3.9
Euphotic Zone (m)	3.0
Surface Area (Acres)	Est. 50
Anoxic Hypolimnion (Y/N)	N
Stratified (Y/N) @ (m)	N
pH (s.u.) (Surface)	8.16
Conductivity (µS) (Surface)	3,268
Turbidity (NTUs)	12.2
Integrated sample surface to (m)	3.0
Dissolved Oxygen Surface (mg/L)	6.20
Dissolved Oxygen Bottom (mg/L)	5.53
Temperature Surface (°C)	23.06
Temperature Bottom (°C)	22.89
Chlorophyll *a* (µg/L)	5.79

Table 2C. Trophic State for Jackson Lake, 2002 (Carlson, 1977)

Trophic State Indices	Season	Deep Station
Secchi depth	Summer	Eutrophic
Chlorophyll *a*	Summer	Mesotrophic
Total Phosphorus	Summer	Eutrophic
Total Nitrogen	Summer	Eutrophic
Overall Trophic Condition	**Eutrophic**	

Table 3C. Nitrogen (N) /Phosphorus (P) Ratio

	Deep Station
Limiting Nutrient	**N/P**

Table 4C. Use Attainment

Designated or Existing Use	Criteria Exceedence	Attainment Status
Cold Water Aquatic Life	None	Fully Supporting
Warm Water Aquatic Life	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Livestock watering	None	Fully Supporting
Secondary Contact	None	Fully Supporting

Water Quality Assessment

Physical characteristics of Jackson Lake were measured and are listed in Table 1C. Table 2C shows the trophic state variation observed on the day of sampling for Secchi depth, chlorophyll *a,* total phosphorus, and total nitrogen. The overall trophic condition of Jackson Lake in 2002, according to Carlson (1977) and Likens (1975), is eutrophic with nitrogen and phosphorus being co-limiting on the day of sampling (Tables 2C and 3C).

Of the six phytoplankton genera identified from the sample, over 80 percent were members of the Euglenophyta with Chlorophyta and one member of the Pyrrhophyta completing the community. The dominance of these members of the community are expected when eutrophic conditions exist. Benthic diatom community composition results have not been completed, however, these results are forthcoming and will be provided upon request.

Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, cyanide and bacteriological samples, which covers all standards criteria pertinent to the protection of all designated or existing uses for Jackson Lake. Phytoplankton, diatom and chlorophyll analyses were also performed. These data are available upon request, though any criteria exceedences are listed in Table 4C and discussed below.

During the study visit the lake continued to suffer from a persistent and prolonged drought. The resulting low water level, estimated to be 10 to 12 meters below average pool, caused increased temperature and concentrated nutrients resulting in an enriched state. However, there were no exceedences of water quality criteria based upon the most current assessment protocol. All existing uses were fully supported during the sampling visit.

As Table 4C indicates, there are existing uses that the current standards segment associated with this lake does not recognize. However, existing and attainable uses are noted in the SWQB Assessment Database in order to afford waters, such as Jackson Lake, more protection than that given by their respective criteria. According to NM's Antidegradation Policy (20.6.4.8), "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." Therefore, during assessment procedures, it is the more protective uses (in this case, the existing uses) that are assessed against the criteria. Continued management of the public use areas and exclusion of livestock from riparian areas should insure that Jackson Lake remains an attractive wildlife area, and fishing destination.

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