NMED/SWQ-10/2

WATER QUALITY SURVEY REPORTS FOR SELECTED NEW MEXICO LAKES

2008

MONITORING AND ASSESSMENT SECTION
SURFACE WATER QUALITY BUREAU
NEW MEXICO ENVIRONMENT DEPARTMENT
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LAKE WATER QUALITY MONITORING, TROPHIC STATE EVALUATION, AND STANDARDS EVALUATIONS FOR:

Lake Holloman, Otero County
Burn Lake, Doña Ana County

2008

EXECUTIVE SUMMARY

During 2008, the Monitoring and Assessment Section of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality and biological surveys of two lacustrine systems located in south-central New Mexico. These surveys were in fulfillment of work-plan commitments of the *FY 2008 §106 Work Program for Water Quality Management.*

Lake Holloman from dam, 2008.

The larger of the two lakes surveyed during 2008 was Lake Holloman, located on Holloman Air Force Base. Base personnel were interested in developing recreational uses at the lake for both base personnel and the general public. It was hoped that activities such as boating, swimming, camping, picnicking and fishing, could be added to the uses of waterfowl hunting and bird watching, which were already established seasonal uses. Before efforts and resources could be committed to this project, an intensive water quality evaluation was requested by the base commander, which led to this two-station, two-visit study. The second study was Burn Lake, a small municipal park lake located and managed within the City of Las Cruces, New Mexico. Burn Lake was also chosen for study due to its close proximity to Lake Holloman that enabled combined survey trips to allow for more expedient data acquisition and consequent classification of these lakes. In both cases, Lake Holloman and Burn Lake had never been surveyed by this agency, therefore no chemical, physical and biological information existed to confirm existing uses and use attainment.

Water quality sampling methods used during these surveys were in accordance with the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 2008).

The following lake survey reports provide information pertaining to water quality, biological integrity, trophic state, limiting nutrients, water quality criteria exceedences and water quality standards specific to designated and existing uses in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 2007).

Physical, chemical and biological sampling at lake stations include total and dissolved nutrients, total and dissolved metals, major ions including total dissolved solids, total suspended solids, hardness and alkalinity, radionuclides, volatile and semi-volatile organic compounds, cyanide, and microbiological collections. Samples were also collected for chlorophyll, phytoplankton and benthic diatom analyses.

Because of the large amount of data collected, only a pertinent subset is included in this report. All data are available upon request. The following summaries detail those results specifically related to the general physical nature, trophic state, limiting nutrient or criteria exceedences and consequent attainment status for designated or existing uses specific to each lake environment.

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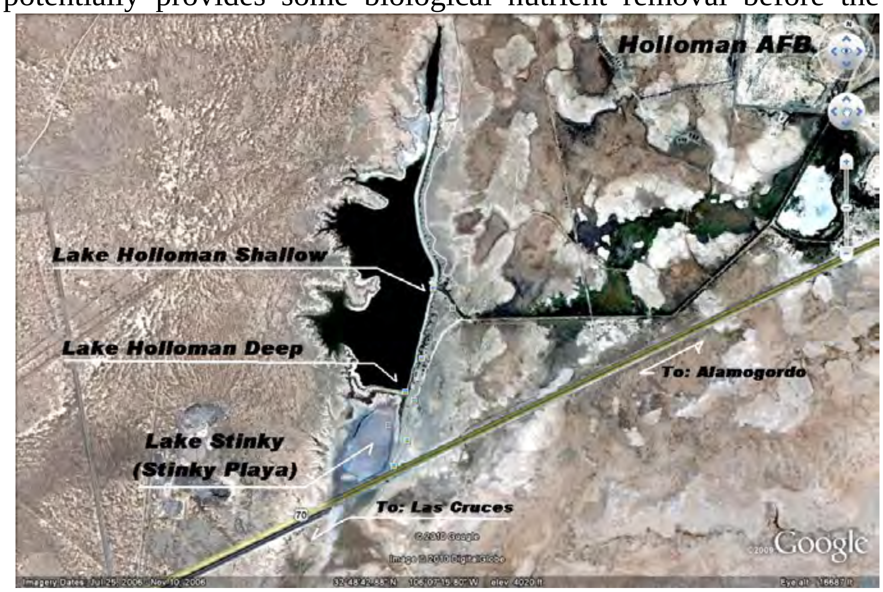
1.0 Lake Holloman, Otero County, May 13 and July 23, 2008

Background

During 2008, a water quality survey was conducted on Lake Holloman during spring and summer seasons, at two established sampling locations, Lake Holloman Deep near the dam and Lake Holloman Shallow near the eastern shore at the lagoon canal inlet and about one-half the length of the lake from the dam. Lake Holloman is a 0.61 km^2 (150 acre) playa lake basin that became an impoundment through the construction of an earthen dam in the 1960's (Holloman AFB 2009). The lake receives runoff from the Holloman Air Force Base and also receives a National Pollution Discharge Elimination System permitted waste water effluent discharge from the base residents. This permit has a maximum discharge limit of 1.5 million gallons per day, however, actual effluent discharge is much lower. In addition, much of this effluent is often diverted to a separate pond, Lagoon G, before draining to Lake Holloman. Lagoon G provides migratory bird and waterfowl habitat and potentially provides some biological nutrient removal before the effluent enters Lake Holloman. Lake volume calculated during an intensive limnological investigation (Cole et al., 1981) suggested that Lake Holloman would contain 0.98 X 10^6 m^3 (798 ac.ft,) at full pool. This volume is now unlikely due to almost thirty years of sedimentation and a lower lake level encountered during this survey. Without the aid of current lake bathymetric measurements, best estimates suggest a lake volume of about 0.648 X 10^6 m^3 (525 af) during this study effort. The study by Cole, et.al, was contracted by the Bureau of Land Management who managed the lake and immediate area at the time of the 1980 survey. This survey was designed, in part, to evaluate potential recreational, agricultural and wildlife uses by examining water quality, salinity, nutrient enrichment and consequent physical responses to determine the feasibility of these uses. Many of the conclusions reached by the earlier study appear similar to the current survey findings.



This present study was designed to address questions posed by personnel at Holloman AFB who were interested in the feasibility of developing recreational uses at Lake Holloman. Long range plans were to develop boating, swimming, camping, and picnicking to the already existing seasonal waterfowl hunting and bird watching uses that have been known and appreciated for years. Concerns about these potential uses, in light of the wastewater effluent discharge and a natural propensity toward high calcium sulfate (gypsum) salinity, initially led to discussions of the need for a multiseasonal water quality survey. The lack of recent lake sampling, and specifically identifying existing uses and evaluation of the associated standards related to the protection of these uses, further indicated the importance of this water quality survey effort.

Lake Holloman is located at an elevation of 1,225 meters (4,020 ft) above sea level and is located within a natural series of playa lake evaporation basins that are now permanently inundated by this lake. Additional remnant playa basins are located immediately below the Lake Holloman dam and are commonly referred to as Lake Stinky or Stinky Playa. This series of playa wetlands continues south of US 70, which is the highway that passes south of Holloman Air Force Base and Lake Holloman. The lake is located approximately 20 km (12 mi) from downtown Alamogordo and 90 km (55 mi) from Las Cruces, New Mexico. Also in close proximity to Lake Holloman is White Sands National Monument where the park headquarters is about 6 km (3.7 mi) to the southwest via US 70. The expansive white gypsum sand dunes that inspired the creation of this monument are also the source of the characteristic calcium sulfate salinity associated with Lake Holloman. The reservoir is generally characterized within the Southern Deserts of the Xeric West aggregate ecoregion (Omernik 2006). Precipitation recorded from nearby White Sands National Monument from over seventy years of meteorological records show precipitation averages 23 cm (9.0 in.) per year (WRCC – DRI 2009) and pan evaporation averages 128 cm (50.3 in) per year resulting in an approximate 107 cm (42.1 in) water deficit per year (Gabin and Lesperance 1977).

<u>Physical / Chemical Data</u>

Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile organics for water and sediment, radionuclides, perchlorate, *E. coli* bacteria, and cyanide, which cover all water quality parameters pertinent to the protection of designated or existing uses (Table 1.1). Physical measurements collected at Lake Holloman included Secchi depth, Forel-Ule color, pH, specific conductance, turbidity, dissolved oxygen, and temperature (Table 1.2).

Table 1.1. Chemical analyses performed seasonally by station.

Samples Collected	Lake Holloman Deep		Lake Holloman Shallow	
	Spring	Summer	Spring	Summer
Major Anions and Cations	X	X	X	X
Total Nutrients	X	X	X	X
Dissolved Nutrients	X	X	X	X
Total Mercury and Selenium	X	X	X	X
Dissolved Metals	X	X	X	X
Radionuclides	X	X	X	X
Volatile Organics (water)	X	X	X	X
Semi-Volatile Organics (water)	X	X	X	X
Volatile Organics (sediment)	X	X	X	X
Semi-Volatile Organics (sediment)	X	X	X	X
Cyanide	X	X	Samples too saline for analysis	Samples too saline for analysis
E. coli	X	X	X	X
Perchlorate	X	X		

Except for dissolved arsenic, all water quality parameters pertinent to the protection of designated and existing uses under water quality segment 20.6.4.99 were below the criteria. Two of four dissolved metals samples exceeded the human health criterion for arsenic (0.009 mg/L or 9.0 µg/L), which is applied to the aquatic life use applicable to this lake as explained in paragraph G, section 20.6.4.11 of the Water Quality Standards (NMAC 2007). Due to the high salinity naturally occurring at Lake Holloman, these samples required a 20 fold dilution which resulted in an arsenic detection limit of 0.02 mg/L. Undiluted samples provide a detection limit of 0.001 mg/L. Both exceedences were at the detection limit of 0.02 mg/L, or 20 µg/L, which draws into question the accuracy of these measurements under the highly saline conditions. However, the data indicated two of four exceedences for arsenic, and until further confirmation is available, this will remain the only cause of non-support of the aquatic life use (NMED/SWQB 2010).

Table 1.2. Physical Characteristics for Lake Holloman – 2008.

Physical Characteristics		Deep Station	Shallow Station
Secchi (m)	Sp	0.45	0.45
	Su	0.15	0.17
Forel Ule Color	Sp	18	18
	Su	16	16
Maximum Depth (m)	Sp	1.6	1.0
	Su	1.6	0.65
Euphotic Zone (m)	Sp	1.5	>1.0
	Su	0.50	>0.7
Surface Area km^2 (Acres)	Sp	0.61 km^2 (150 acres)	
	Su		
Storage Capacity m^3 (Ac. Ft.)	Sp	Est. 0.648 x 10^6 m^3 (525 Ac. Ft.)	
	Su		
Anoxic Hypolimnion * (Y/N)	Sp	No	No
	Su	No	No
Stratified (Y/N) @ depth (m)	Sp	No	No
	Su	No	No
pH (s.u.)	Sp	8.5	8.8
	Su	7.9	7.9
Specific Conductance (µS/cm)	Sp	44,340	44,202
	Su	47,560	46,904
Total Dissolved Solids (mg/L)	Sp	38,700	37,800
	Su	63,800	40,800
Turbidity (NTUs)	Sp	12.7	13.0
	Su	86.4	55.9
Integrated Sample surface to (m)	Sp	1.5	1.0
	Su	1.2	0.25
Dissolved Oxygen ** (mg/L)	Sp	8.36	5.93
	Su	5.70	9.40
Dissolved Oxygen Bottom (mg/L)	Sp	8.77	5.64
	Su	1.88	8.85
Temperature ** (°C)	Sp	18.53	19.56
	Su	27.46	29.64
Temperature Bottom (°C)	Sp	18.45	19.54
	Su	26.12	26.72

NOTES: * Anoxia exists when dissolved oxygen < 0.5 mg/L
** Dissolved oxygen and temperature are mean values from the epilimnion (upper 1/3 of water column)
Sp = Spring; Su = Summer; MDP = missing data point.

Lake Holloman meets both primary and secondary contact uses. One of four E. coli exceeded the primary contact standard, however under current assessment protocols, two exceedences are required to list a waterbody as impaired.

Due to the shallow characteristics at Lake Holloman, all depths encountered were less than two meters. Depth profiles showed dissolved oxygen, temperature and pH to be well below criteria maximums. Of interest are the characteristic results for specific conductance and salinity, where specific conductivity averaged 45,775 µS/cm with an associated salinity averaging 29.7‰ (parts per thousand) from an average of all measurements taken during this study. While different in chemical makeup from the predominantly sodium and chloride ocean waters, this calcium and sulfate dominated salinity at Lake Holloman is similar to ocean water and dictates by its very nature the types of uses that may be expected at this lake.

It is important to note that waterfowl and shorebirds use the upper portion of Lake Holloman where effluent discharge from the airbase waste water treatment facility serves to dilute the overall salinity of this portion of the lake. This clear and relatively low salinity contribution to the lake provides a localized microhabitat where greater concentration of vegetation and food resources attracts a greater complexity of waterfowl species.

Nutrient Data

Currently, lake and reservoir criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment practices. Recently the draft nutrient assessment protocol for lakes and reservoirs was reviewed and compared with both sampling runs at Lake Holloman to compare draft nutrient targets to those collected, and to evaluate the proposed nutrient assessment tool to this unique lake system.

In attempting to compare nutrient results using this assessment tool, one first realizes that this particular impoundment does not easily fit within the lentic categories provided. Originally a shallow playa lake basin, this man-made impoundment contains naturally saline groundwater input as well as effluent discharge and to a small extent runoff from seasonal rain events. With little, if any, flow to dilute and flush nutrient concentration, the lake serves as a concentration basin for nitrogen and phosphorus resulting in a relatively high chlorophyll *a* as a result of biological response to this input. While increased cyanobacterial concentrations might be expected due to the levels of nitrogen and phosphorus, this was not observed suggesting that high salinity may effect substantial blue-green algal growth. Some blue-green algae were identified in the phytoplankton analysis, however these were not dominant members of the community and at most comprised less than thirty percent of the total analysis, which is below the threshold level provided in the draft assessment protocol. Table 1.3 shows results for common nutrient variables.

Table 1.3. Nutrient Variables

		Deep Station	Shallow Station
Chlorophyll *a* (µg/L)	Spring	14.39	5.03
	Summer	28.41	52.33
Total Phosphorus (mg/L)	Spring	0.350	0.414
	Summer	0.770	0.629
Total Nitrogen (mg/L)	Spring	11.10	11.40
	Summer	19.95	13.95
Limiting Nutrient	Spring	P	P
	Summer	P	P
Cyanobacteria (%)	Spring	4.0%	1.0%
	Summer	22%	28.5%

Trophic State

Data collected during the 2008 study indicate that Lake Holloman may be classified as hypereutrophic according to Carlson's (1977) indices for Secchi depth, chlorophyll *a,* total phosphorus, total nitrogen, and algal community composition (Likens 1975) (Table 1.4). Chlorophyll, nitrogen and phosphorous results were strongly indicative of highly nutrient enriched conditions where many results could be interpreted as dystrophic though this condition would often be associated with tannin stained waters common to senescent waterbodies containing organic acids such as the conditions found in bog lakes. However, one common characteristic of lakes experiencing dystrophy seems to be the lack of calcium resulting in low bacterial action, which slows decay. Though calcium sulfate is the primary ionic constituent in Lake Holloman, the associated salinity may decrease bacterial activity resulting in conditions similar to dystrophic environments. As Cole (1983) states in his Textbook of Limnology, "Stained, murky waters, characterizing dystrophy, are not restricted to northern bogs; many southern waters in North America and elsewhere appear darkly colored although eutrophic." In the final analysis, it is probably more correct to recognize Lake Holloman as hypereutrophic where nutrient assimilation is impeded by the naturally occurring saline conditions. Phosphorus was the limiting nutrient for algal productivity during both spring and summer visits (Table 1.3).

Table 1.4. Trophic State (Carlson 1977)

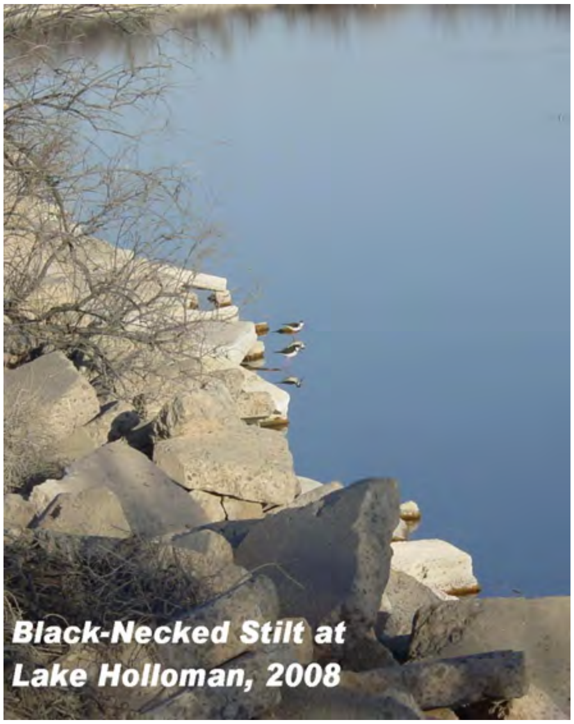
Lake Holloman		Deep Station	Shallow Station
Secchi Depth	Sp	Hypereutrophic	Hypereutrophic
	Su	Hypereutrophic	Dystrophic
Chlorophyll *a*	Sp	Eutrophic	Mesotrophic
	Su	Eutrophic	Eutrophic
Total Phosphorous	Sp	Dystrophic	Dystrophic
	Su	Dystrophic	Dystrophic
Total Nitrogen	Sp	Dystrophic	Dystrophic
	Su	Dystrophic	Dystrophic
Overall Trophic Condition		**Hypereutrophic**	

Biological Data

Phytoplankton

Phytoplankton samples were collected at each lake station during both spring and summer visits. In both deep and shallow spring samples, the diatom *Chaetoceros* was the most abundant, comprising about sixty percent of the phytoplankton community at the deep station and thirty-eight percent of the phytoplankton count at the shallow station. The second most abundant community member, also found at both stations was *Cryptomonas* followed by various diatom species. The deep station community consisted of four percent blue-green algae whereas the shallow station had only one percent cyanobacteria present. Summer samples showed a significant change in species composition with small nano-flagellates dominating the community at the deep station followed by the blue-green genus *Leptolyngbya*. The diatom genus *Nitzschia* and the blue-green genus *Pseudoanabaena* were also some of the most common phytoplankton species identified. As with the deep station, *Leptolyngbya* was the most abundant member of the phytoplankton community followed by small nano-flagellates and again, the diatom species of the genus *Nitzschia*. Summer phytoplankton community composition showed higher abundance of cyanobacteria. These blue-green algae comprised twenty-two percent of the sample at the deep station and about twenty-nine percent of the count at the shallow station. These concentrations were well below the threshold of fifty percent used in the draft nutrient assessment protocol currently being evaluated. Species richness for all four samples ranged between sixteen and twenty-one species with relatively high diversities according to Shannon and Weaver (1949). Evenness values ranged from 0.59 to 0.75 in the four samples collected.


Lake Holloman from dam, 2008.



Black-Necked Stilt at Lake Holloman, 2008

Periphyton Diatom Community Composition

A single multiple lake substrate sample (periphyton) was collected during the summer visit to determine diatom community composition. From this sample, 224 cells were counted and eleven diatom species were identified of which seven were included in the formal count. Most common was *Amphora Montana* Krasske, which comprised almost fifty four percent of the total community. The second most common diatom was *Nitzschia palea* var. *debilis* (Kütz.) Grun followed by *Amphora coffeiformis* (Ag.) Kütz. var. *coffeiformis*, a species common in brackish and saline environments. Diversity according to Shannon and Weaver (1949) was high, with an equitability value of about 0.70.

Water Quality Evaluation

Lake Holloman is an unclassified perennial water under water quality segment 20.6.4.99 in the *New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters* with designated uses of livestock watering and wildlife habitat, and presumed 101(a)(2) uses of primary contact and warmwater aquatic life (NMAC 2007). This study was designed to provide data needed to assess existing uses and to determine if other uses may be possible, specifically those that include proposed public recreational activities. Generally speaking, possible uses such as those associated with primary and secondary contact that would include swimming, boating, and fishing would not necessarily be deemed unattainable from these study results. However, the extremely saline environment is characteristically harsh enough to limit or dissuade most people from attempting these recreational activities. The use of watercraft, such as canoes, kayaks, and sail-boards might be possible, however fuel powered motors could be severely damaged due to scaling of cooling components in the motors by calcium sulfate accumulation. This scale buildup does not dissolve and flush, as does sodium chloride dominated salts, and may only be removable by physical means such as scraping or sand-blasting. The possibility of providing some form of sports fishery is limited because of the type and degree of salinity that naturally exists in Lake Holloman. A trial number of stripped bass were introduced to Lake Holloman because this species can tolerate some salinity as well as warm water conditions, however these fish did not survive. Wildlife uses that have been recognized and supported for years are bird watching and seasonal waterfowl hunting. These remain viable activities in the Lake Holloman and associated lagoon areas.

Assessment of physical and chemical data collected during 2008 indicated that primary contact, wildlife habitat, and livestock watering are fully supported. The warmwater aquatic life use is not supported due to two exceedences of the dissolved arsenic criterion for human health (Table 1.5). It is possible that arsenic may be a natural constituent of the highly saline soils surrounding the lake; however this does not change the assessment status. Livestock watering is a questionable use, but is automatically applied to most if not all waters of the state. It is unlikely that cattle could use this lake without suffering dire consequences.

Currently, Lake Holloman receives protection under section 20.6.4.99 NMAC which protects primary contact and warmwater aquatic life uses, and the presumed “fishable/swimmable” uses defined in the Clean Water Act §101(a)(2). If deemed organizationally expedient, this lake may be placed within a new water quality segment that recognizes its unique chemistry and habitat.

Excluding the criteria exceedence for arsenic, Table 1.5 suggests that all other uses are fully supported. This in an incomplete picture due to the high salinity naturally found in Lake Holloman, and due to the fact that salinity has not been recognized in New Mexico Water Quality Standards as a significant determinant to the type of uses that may exist within a waterbody. It has been shown that a unique community of salt tolerant organisms does populate Lake Holloman, but any possibility of providing a sport fishery is non-existent. Livestock watering is another use that, based upon current water quality criteria specific to this use, is assessed as fully supported even though cattle cannot drink this highly saline water. The uniqueness of Lake Holloman may challenge us to rethink the applicability of some criteria to the uses they are designed to protect.

Table 1.5. Summary of attainment status of designated and presumed uses for Lake Holloman (NMED/SWQB 2010).

Designated or Existing Use	Criteria Exceedence	Attainment Status
Warmwater Aquatic Life	Arsenic	Not Supporting
Primary Contact	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

2.0 Burn Lake, Dona Ana County, July 24 and October 9, 2008.

Background

In 2008, SWQB conducted a two-season water quality survey on a small municipal park lake located in Las Cruces, New Mexico. Burn Lake is a 6.3 Ha (15.5 ac) lake that was created as a borrow pit during the construction of Interstate-10 in the late 1960's. P.R. Burn lost the bid to build a portion of the interstate, but did win a contract to provide fill material. He purchased a tract of land next to the proposed highway and began providing fill material for the road construction extracting an estimated 3.25 million cubic yards of material before all was done. During the soil extraction, they dug into the shallow aquifer which began filling the lake, and so by chance, Mr. Burns and the City of Las Cruces now possessed a permanent though artificial lake. Attempting to make the most of the unexpected, the Burn family was issued a permit to open Burn Lake to recreation, and for a fee of one dollar, the community could swim, fish and boat (Schurtz 2010). Following an accident at the lake, and resulting increases in insurance rates, Burn agreed to sell the lake to the city for $125,000 dollars which included thirty-eight acres of surrounding land. The years that followed showed a decline in lake level, water quality and associated public use due to heavy groundwater withdrawal in surrounding agricultural areas. By the late 1980's, the city began viewing the lake as a floodwater catchment for untreated storm water, but even this source of water supply is undependable and rare in this normally arid environment resulting in decreasing water levels.

The City of Las Cruces continues to implement various phases of park improvement with construction of new bathrooms and other park facilities. Eventually an existing plan between the City of Las Cruces and Elephant Butte Irrigation District will result in the installation of pumps that will supply irrigation storage water in the lake as part of the district's irrigation infrastructure. This will allow for a larger pool size, dilution of accumulated nutrient load within the lake and subsequent improvement of overall water quality that would return the lake to conditions that better support the summer catfish and winter trout fisheries. Currently the park is open for some fishing and picnicking with playgrounds and soccer fields providing recreational opportunities. The purpose of the Burn Lake water quality study was to provide baseline data that identify the current conditions and potential uses of this lake. This study should address the various concerns of the community regarding the decline of water quality in recent years and offer some suggestions for improving lake conditions.

The lake is located at an elevation of 1,178 meters (3,865 ft) above sea level and is located within the Southern Deserts of the Xeric West aggregate ecoregion (Omernik 2006).

Precipitation records from the New Mexico State University agricultural station average 21.2 cm (8.35 in) per year (WRCC – DRI 2009) with pan evaporation averaging 140 cm (55 in) per year resulting in an approximate 123 cm (48.5 in) water deficit per year (Gabin and Lesperance 1977).

Physical / Chemical Data

Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile organics, radionuclides, bacteria, and cyanide, which cover all water quality parameters pertinent to the protection of designated or existing uses (Table 2.1). Physical measurements collected at Burn Lake included Secchi depth, Forel-Ule color, pH, specific conductance, turbidity, dissolved oxygen, and temperature (Table 2.2).

Table 2.1. Chemical analyses performed at Burn Lake – 2008.

Burn Lake	**Summer**	**Fall**
Major Anions and Cations	X	X
Total Nutrients	X	X
Dissolved Nutrients	X	X
Total Mercury and Selenium	X	X
Dissolved Metals	X	X
Radionuclides	X	X
Volatile Organics	X	X
Semi-Volatile Organics	X	X
Cyanide	X	X
E. coli	X	X

Table 2.2. Physical Characteristics for Burn Lake – 2008.

Characteristic	Burn Lake	
	Summer	**Fall**
Secchi Depth (m)	0.25	0.20
Forel Ule Color	12	13
Maximum Depth (m)	1.4	4.5
Euphotic Zone (m)	0.80	0.65
Surface Area km^2 (Acres)	0.063 (15.5)	
Storage Capacity m^3 (Ac. Ft.)	Est. 185,000 (150)	
Anoxic Hypolimnion * (Y/N)	N	N
Stratified (Y/N) @ depth (m)	N	N
pH (s.u.)	7.67	7.47
Conductivity (μS/cm)	499	466
Turbidity (NTUs)	213	61.4
Integrated Sample surface to (m)	0.25	3.5
Dissolved Oxygen ** (mg/L)	2.98	6.12
Dissolved Oxygen Bottom (mg/L)	2.69	6.44
Temperature ** (°C)	26.9	19.64
Temperature Bottom (°C)	26.88	19.65

NOTES: ***** Anoxia exists when dissolved oxygen < 0.5 mg/L
** Dissolved oxygen and temperature are mean values from the epilimnion (upper 1/3 of water column)
MDP = missing data point

Nutrient Data

Currently, lake and reservoir criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment practices. Recently, the draft nutrient assessment protocol for lakes and reservoirs was reviewed and compared using July and October sampling runs for Burn Lake. Burn Lake showed elevated nutrient concentrations for both nitrogen and phosphorus. Chlorophyll, an indicator of algae growth, responded to the high nutrient concentrations with concentrations greater than the threshold identified in the draft protocol. Even though blue-green algae were present, cyanobacterial concentrations were well below the threshold level in the draft protocol; however it is reasonable to assume that blue-green algae may experience seasonal blooms when conditions allow. Table 2.3 shows results for common nutrient variables.

Data collected during the 2008 study indicate that Burn Lake may be characterized as eutrophic according to Carlson's (1977) indices for Secchi depth, chlorophyll *a*, total phosphorus, total nitrogen, and algal community composition (Likens 1975) (Table 2.4). Nitrogen was the primary limiting nutrient for algal productivity during both survey visits (Table 2.3).

Table 2.3. Nutrient Variables

	Month	Burn Lake
Chlorophyll *a* (µg/L)	July	28.97
	October	5.61
Total Phosphorus (mg/L)	July	0.237
	October	0.068
Total Nitrogen (mg/L)	July	1.46
	October	0.270
Limiting Nutrient	July	N
	October	N
Secchi Depth	July	0.25
	October	0.20
Cyanobacteria (%)	July	23.5
	October	6.3

Table 2.4. Trophic State (Carlson 1977)

	Month	Burn Lake
Secchi Depth	July	Hypereutrophic
	October	Dystrophic
Chlorophyll *a*	July	Eutrophic
	October	Mesotrophic
Total Phosphorous	July	Oligotrophic
	October	Oligotrophic
Total Nitrogen	July	Eutrophic
	October	Oligomesotrophic
Overall Trophic Condition		**Eutrophic**

Biological Data

Phytoplankton

Phytoplankton community composition for Burn Lake was dominated by the diatom *Aulacoseira* followed by another member of the golden algae genus *Mallomonas* and the green algae member of the genus *Chlamydomonas,* the three of which attributed to about fifty-two percent of the total community. Five species of blue-green algae were among the twenty-one species identified and these comprised about 23.5 percent of the total community. Diversity according to Shannon and Weaver (1949) from the July sample was high with a resulting evenness value of 0.81.

The October, or fall, phytoplankton results showed the green algae *Carteria* totaled over thirty-two percent of the community composition, followed by *Cryptomonas* and *Mallomonas* species. These three totaled almost fifty-eight percent of the total community of nineteen genera. Four species of blue-green algae were identified in the sample, however unlike the summer phytoplankton sample results, the cyanobacteria represented only 6.3 percent of the total community. Diversity according to Shannon and Weaver (1949) from the October sample was high with a resulting evenness value of 0.77.

Periphyton Diatom Community Composition

A single multiple substrate shoreline sample (periphyton) was collected from Burn Lake during the July visit to determine community composition. Interesting is the agreement with the summer phytoplankton community results where the most common member of that sample was from the genus *Aulacoseira.* Though not the most common member of the diatom community, this member did comprise about 6.5 percent of the total diatom community. The most common diatom identified was *Navicula graciloides* (A. Mayer) var. *graciloides* with both *Nitzschia* *palea* (Kütz) Grun. var. *debilis* and *Gomphonema parvulum* (Kütz) var. *parvulum* having significant but lesser numbers. Combined, these three species represented sixty-five percent of the total diatom community which consisted of 18 identified species in the formal count and four additional species that were later identified. Diversity according to Shannon and Weaver (1949) was high with an equitability of 0.64.

Water Quality Status Assessment

Burn Lake is classified in water quality segment 20.6.4.99 with designated uses of livestock watering and wildlife habitat. In addition, marginal coldwater aquatic life is an existing use and primary contact is a presumed CWA 101(a)(2) use. All aquatic life uses are currently listed as not supporting due to the two exceedences for aluminum detected in both dissolved metals samples (Table 2.5). The other uses continue to be fully supported though livestock do not have access to this city park and primary contact is forbidden by the City of Las Cruces due to health and liability concerns arising from occasional exceedences of E. coli (NMED/SWQB 2010).

The creation of Burn Lake stemmed from the intrusion into subsurface water during borrow pit excavation, resulting in the first community park with water related recreation. As long as the ground water remained a dependable water supply to the lake conditions remained favorable. When groundwater withdrawal lowered the water table, supply was reduced to water from seasonal and rare storm events. Currently, catfish are stocked by New Mexico Department of Game and Fish (NMDGF) in the summer and trout are stocked during cooler winter months. Burn Lake is not a self-sustaining fishery, but the public has become used to the fishing opportunities artificially created at Burn Lake so the NMDGF continues to provide the fish to satisfy public demand.

The City of Las Cruces has been working on a multi-phased park improvement effort that would include the installation of pumps to divert and store Elephant Butte Irrigation District water for temporary storage in Burn Lake. Currently the only water supply to the lake comes from urban stormwater runoff. As an irrigation storage reservoir, the increased and dependable water supply would provide dilution and potential flushing of accumulated nutrients, metals, bacteria and other contaminants. If this plan is implemented it is likely that lake water quality as well as associated recreational activities will improve. Burn Lake will always be an artificial lake much like an aquarium provides an artificial habitat, and with that understanding comes the responsibility to occasionally change the water.

Table 2.5. Summary of attainment status of designated, existing, and presumed uses for Burn Lake (NMED/SWQB 2010).

Designated or Existing Use	Criteria Exceedence	Attainment Status
Marginal Coldwater Aquatic Life (existing use)	Aluminum	Not Supporting
Warmwater Aquatic Lake	Aluminum	Not Supporting
Primary Contact (though not permitted by City)	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

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