Note:

The Following Changes have been made to the August version of this Rationale.

- **Corrected volume calculations in Table 2**
- **Changed sample references from LVB to LWLVB**

Rationale for Proposed Revisions to the Nevada Water Pollution Control Regulations NAC 445A.195 - NAC 445A.197 Las Vegas Bay and Lake Mead

Draft

Prepared by:

Nevada Division of Environmental Protection
Bureau of Water Quality Planning
October 2004

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Figures and Tables

BACKGROUND

Section 303 of the Clean Water Act requires that states periodically review and, as appropriate, modify water quality standards. The following includes proposed revisions to the State of Nevada (State) Water Pollution Control Regulations water quality standards for Lake Mead and the rationale to support the proposed revisions. The State Environmental Commission (SEC) adopted revisions to the water quality standards for Las Vegas Wash and Lake Mead on December 17, 1987, July 5, 1994 and August 4, 1998. The U.S. Environmental Protection Agency (EPA) is required by section 303 of the Clean Water Act and the implementing regulation located in 40 CFR part 131 to review and approve or disapprove state adopted water quality standards. EPA has approved the SEC adopted water quality standards.

Lake Mead

Impounding the Colorado River behind Hoover Dam in 1935 formed Lake Mead. The reservoir is located in the Mohave Desert where maximum summer temperatures commonly exceed 104°F (40°C) from July through September, and winds greater than 19 mi/hr (30 km/hr) are frequent. The Nevada portion of the Lake has three major basins, which proceeding from upstream to downstream are; Gregg Basin, Virgin Basin and Boulder Basin (Figure 1). The Moapa and Virgin Rivers discharge into the Overton Arm of the Virgin Basin, and the Wash discharges into the narrow inlet of Las Vegas Bay, a large arm of Boulder Basin (Figures I and 2). Lake Mead is a deep, warm, monomictic lake. Thermal stratification develops in May and June and a classical thermocline develops between a depth of 33 and 48 ft (10 and 15 meters) in July. Turnover begins in October and the lake is completely destratified by January.

Reaches

Lake Mead is divided into two reaches or segments that consider the physical characteristics, differing land uses, and beneficial uses of each. The reaches begin at the confluence of Las Vegas Wash and Lake Mead.

The two existing reach designations for Lake Mead are:

- NAC 445A.194 Lake Mead not covered by NAC 445A.196; and,
- NAC 445A.196 Lake Mead from the western boundary of Las Vegas Marina Campground to the confluence of Las Vegas Wash.

Beneficial Uses

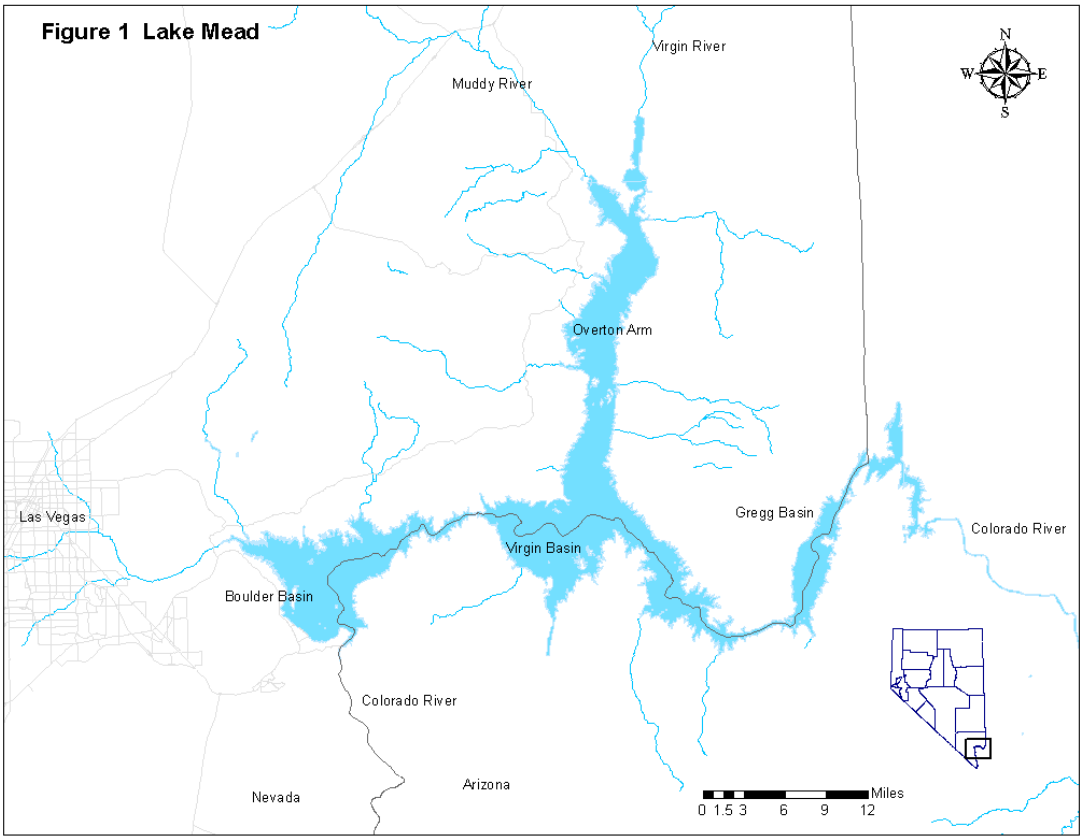
Beneficial uses designated for the Lake Mead reach (NAC 445A. 194) include:

1. Irrigation;
2. Watering of livestock;
3. Recreation involving contact with the water;
4. Recreation not involving contact with the water;
5. Industrial supply;
6. Municipal or domestic supply, or both;
7. Propagation of wildlife; and
8. Propagation of aquatic life, including without limitation a warm-water fishery.

Beneficial uses designated for the reach of Lake Mead from the western boundary of Las Vegas Marina Campground to the confluence of Las Vegas Wash (NAC 445A.196), include:

1. Irrigation;
2. Watering of livestock
3. Recreation not involving contact with the water;
4. Industrial supply;
5. Propagation of wildlife; and

6. Propagation of aquatic life, excluding fish. This paragraph does not preclude the establishment of a fishery.



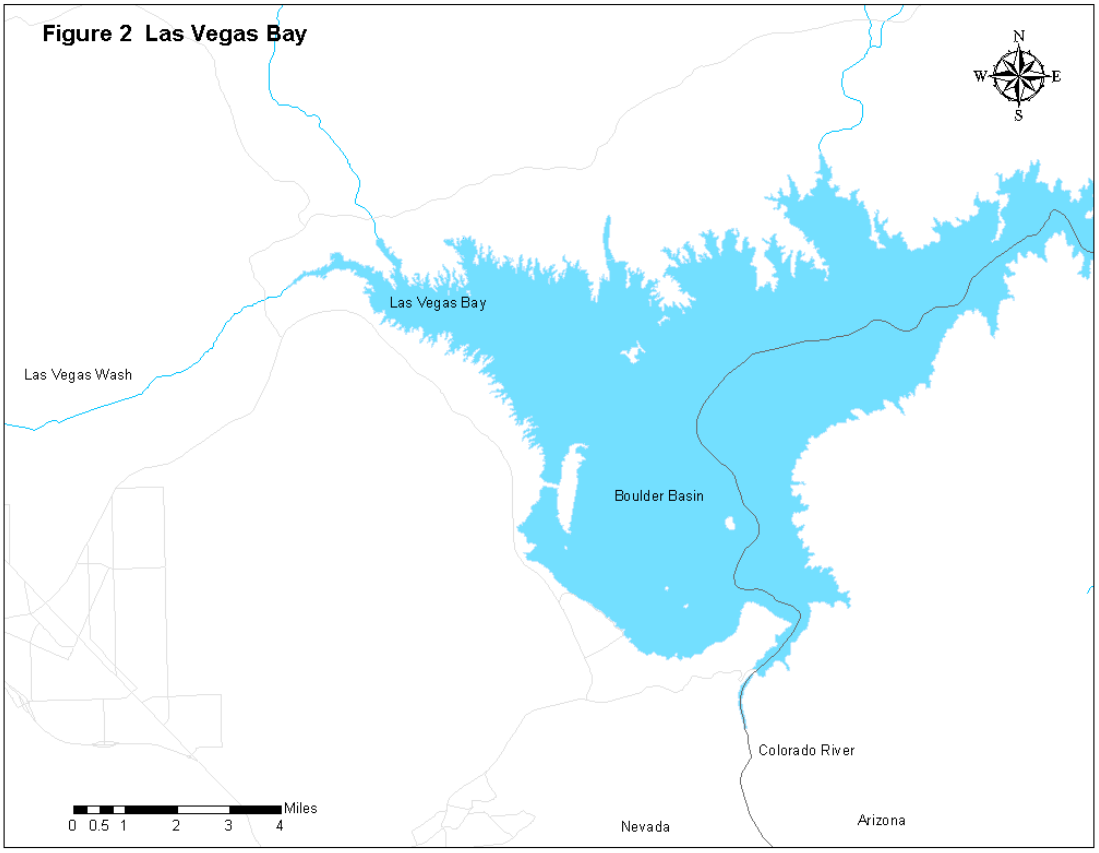


Figure 2 Las Vegas Bay
N
W
E
S
Las Vegas Bay
Las Vegas Wash
Boulder Basin
Colorado River
Miles
0 0.5 1 2 3 4
Nevada
Arizona

PROPOSED CHANGES TO WATER QUALITY STANDARDS

In the subsequent discussions, the Nevada Administrative Code (NAC) is referenced as follows;

NAC 445A. 194 and 195 as Lake Mead
NAC 445A. 196 and 197 as Inner Las Vegas Bay

Changes are proposed for both the Lake Mead Reach (NAC 445A.195) and the Inner Las Vegas Bay Reach (NAC 445A.196 and 197). Proposed changes include:

- Adjustments to the reach descriptions, and sample locations, and
- An update of the ammonia standard.

The changes are shown below and a rational follows.

Lake Mead Reach (NAC 445A.195)

The following text shows the existing chlorophyll and un-ionized ammonia criteria, with proposed additions in **Bold** and proposed deletions [~~struck out~~]. The Chlorophyll a standards are listed in footnote b and the ammonia standard in footnote c.

NAC 445A.195 Lake Mead excluding area covered by NAC 445A.197. (NRS 445A.425, 445A.520)

Lake Mead

PARAMETER	REQUIREMENTS TO MAINTAIN EXISTING HIGHER QUALITY	WATER QUALITY STANDARDS FOR BENEFICIAL USES	BENEFICIAL USES AS DESIGNATED IN NAC 445A.194 (Most Stringent Use Listed First)
Temperature Single Value	ΔT 0°C [a]	ΔT 2°C [a]	Propagation of aquatic life, including, without limitation, a warm-water fishery.
pH Single Value	95% of samples not to exceed 8.8 SU	Within Range 6.5-9.0 SU	Propagation of aquatic life, including, without limitation, a warm-water fishery, recreation involving contact with water, propagation of wildlife, municipal or domestic supply, or both, industrial supply, irrigation and watering of livestock.
Dissolved Oxygen Single Value	—	≥5 mg/l in the epilimnion or average in water column during periods of nonstratification	Propagation of aquatic life, including, without limitation, a warm-water fishery, watering of livestock, recreation involving contact with water, recreation not involving contact with water, municipal or domestic supply, or both, and propagation of wildlife.
Chlorophyll a–µg/l	b		Recreation involving contact with water, propagation of aquatic life, including, without limitation, a warm-water fishery, recreation not involving contact with water and municipal or domestic supply, or both.
[~~Un-Ionized~~] **Total** Ammonia **(as N)** – mg/l	—	c	Propagation of aquatic life, including, without limitation, a warm-water fishery.
Total Dissolved Solids Single Value	Flow Weighted Annual Average Concentration ≤723 mg/l measured below Hoover Dam[d] —	— ≤1000 mg/l	Municipal or domestic supply, or both, and irrigation.
Chloride Single Value	e	≤400 mg/l [e]	Municipal or domestic supply, or both, watering of livestock and propagation of wildlife.
Sulfate Single Value	e	≤500 mg/l [e]	Municipal or domestic water supply, or both.
Suspended Solids Single Value	—	≤25 mg/l	Propagation of aquatic life, including, without limitation, a warm-water fishery, and recreation not involving contact with water.
Nitrogen Species as N Single Value	Total Inorganic Nitrogen 95% of Samples ≤4.5 mg/l	Nitrate ≤ 10 mg/l Nitrite ≤1 mg/l	Municipal or domestic supply, or both, watering of livestock, propagation of aquatic life, including, without limitation, a warm-water fishery, and propagation of wildlife.

PARAMETER	REQUIREMENTS TO MAINTAIN EXISTING HIGHER QUALITY	WATER QUALITY STANDARDS FOR BENEFICIAL USES	BENEFICIAL USES AS DESIGNATED IN NAC 445A.194 (Most Stringent Use Listed First)
Turbidity Single Value	f	≤25 NTU	Propagation of aquatic life, including, without limitation, a warm-water fishery, municipal or domestic supply, or both, recreation involving contact with water and recreation not involving contact with water.
Fecal Coliform		≤200/400[g] MF or MPN/100 ml	Recreation involving contact with water, irrigation, recreation not involving contact with water, municipal or domestic supply, or both, propagation of wildlife and watering of livestock.
E. Coli 30-day Log Mean Single Value	— —	≤126 MF/100 ml ≤235 MF/100 ml	Recreation involving contact with water, recreation not involving contact with water, municipal or domestic supply, or both, irrigation and watering of livestock.
Color-Pt-Co Units Single Value	h	—	Recreation not involving contact with water and municipal or domestic supply, or both.

a. Maximum allowable increase in temperature above water temperature at the boundary of an approved mixing zone.
b. The requirements for chlorophyll a are:
   (1) Not more than one monthly mean in a calendar year at Station ~~[3]~~ **Las Vegas Bay 1.85 (LWLVB 1.85)** may exceed 45µg/l.
   (2) The mean for chlorophyll a in summer (July 1-September 30) must not exceed 40 µg/l at Station ~~[3]~~ **LWLVB 1.85**, and the mean for 4 consecutive summer years must not exceed 30 µg/l. The sample must be collected from the center of the channel and must be representative of the top 5 meters of the channel. "Station ~~[3]~~ **LWLVB 1.85**" means the center of the channel at ~~[which the depth is from 16 to 18 meters]~~ **a distance of 1.85 miles into Las Vegas Bay from the confluence of Las Vegas Wash with Lake Mead.**
   (3) The mean for chlorophyll a in the growing season (April 1-September 30) must not exceed 16 µg/l at **Station** ~~[LM4]~~ **LWLVB 2.7** and 9 µg/l at **Station** ~~[LM5]~~ **LWLVB 3.5.** "**Station** ~~LM4~~ **LWLVB 2.7"** is located ~~just outside of the Las Vegas Bay launch ramp and marina, next to buoy RW "1".~~ **a distance of 2.7 miles into Las Vegas Bay from the confluence of Las Vegas Wash with Lake Mead. "Station** ~~LM5~~ **LWLVB 3.5"** is located ~~next to buoy RW "A" with the southshore landmark of Crescent island.~~ **a distance of 3.5 miles into Las Vegas Bay from the confluence of Las Vegas Wash with Lake Mead.**
   (4) The mean for chlorophyll a in the growing season (April 1-September 30) must not exceed 5 µg/l in the open water of Boulder Basin, Virgin Basin, Gregg Basin and Pierce Basin. The single value must not exceed 10 µg/l for more than 5 percent of the samples.
   (5) Not less than two samples per month must be collected between the months of March and October. During the months when only one sample is available, that value must be used in place of the monthly mean.
c. ~~See footnote b to NAC 445A.197.~~ **The ambient water quality criteria for ammonia are specified in NAC 445A.118.**
d. The details of this standard are set forth in the "1996 Review-Water Quality Standards for Salinity, Colorado River System" approved by the commission on March 25, 1998.
e. The combination of this constituent with other constituents comprising TDS must not result in the violation of the TDS standards for Lake Mead and the Colorado River.
f. Turbidity must not exceed that characteristic of natural conditions by more than 10 Nephelometric Units.
g. Based on a minimum of not less than five samples taken over a 30-day period, the fecal coliform bacterial level must not exceed a log mean of 200 per 100 ml nor must more than 10 percent of the total samples taken during any 30-day period exceed 400 per 100 ml.
h. Color must not exceed that characteristic of natural conditions by more than 10 units Platinum-Cobalt Scale.

The commission recognizes that at entrances of tributaries to Lake Mead, localized violations of standards may occur.

Las Vegas Bay Reach (NAC 445A.196 and 197)

The following text shows the existing Reach designations, with proposed additions in **Bold** and proposed deletions ~~[struck out]~~. The reach changes include both NAC 445A.196 and NAC 445A.197.

NAC 445A.196 Requirements to maintain existing higher quality for area of Lake Mead from

~~[western boundary of Las Vegas Bay Campground to]~~ **the confluence of Las Vegas Wash with Lake Mead to 1.2 miles into Las Vegas Bay from the confluence; standards for beneficial uses; goal of requirements and standards. (NRS 445A.425, 445A.520)**

1. The requirements to maintain existing higher quality become effective when the existing water quality is higher than the water quality standard for beneficial uses, as determined by the commission. Once the requirements to maintain existing higher quality become effective, the requirements are applicable thereafter. For the area of Lake Mead from the ~~western boundary of the Las Vegas Bay Campground to the confluence of the Las Vegas Wash,~~ **confluence of Las Vegas Wash with Lake Mead to 1.2 miles into Las Vegas Bay from the confluence,** the requirements to maintain existing higher quality are set forth in NAC 445A.197, and include, without limitation, requirements relating to temperature, pH, total inorganic nitrogen, total dissolved solids and turbidity.

2. The water quality standards for beneficial uses for Lake Mead from the ~~western boundary of the Las Vegas Bay Campground to the confluence of the Las Vegas Wash~~ **confluence of Las Vegas Wash with Lake Mead to 1.2 miles into Las Vegas Bay from the confluence,** are set forth in NAC 445A.197, and include, without limitation, standards relating to temperature, pH, dissolved oxygen, nitrate, nitrite, un-ionized ammonia, total dissolved solids, suspended solids, turbidity and fecal coliform. The beneficial uses for this area are:

(a) Irrigation;
(b) Watering of livestock;
(c) Recreation not involving contact with the water;
(d) Industrial supply;
(e) Propagation of wildlife; and
(f) Propagation of aquatic life, including, without limitation, a warm-water fishery.

3. The goal of the requirements of subsection 1 and the standards of subsection 2 is to ensure that all of Lake Mead is fishable and swimable by the next triennial review required by the Clean Water Act, 33 U.S.C. §§ 1251 et seq.

NAC 445A.197 Lake Mead from ~~[western boundary of Las Vegas Bay Campground to]~~ the confluence of Las Vegas Wash with Lake Mead to 1.2 miles into Las Vegas Bay from the confluence (NRS 445A.425, 445A.520). Control point at ~~[the Western Boundary of the Las Vegas Bay Campground]~~ **1.2 miles into Las Vegas Bay from the confluence of Las Vegas Wash with Lake Mead.**

Inner Las Vegas Bay

PARAMETER	REQUIREMENTS TO MAINTAIN EXISTING HIGHER QUALITY	WATER QUALITY STANDARDS FOR BENEFICIAL USES	BENEFICIAL USES AS DESIGNATED IN NAC 445A.196 (Most Stringent Use Listed First)
Temperature Single Value	ΔT 0°C [a]	ΔT 2°C [a]	Propagation of aquatic life, including, without limitation, a warm-water fishery.
pH Single Value	95% of samples not to exceed 8.9 SU	Within Range 6.5-9.0 SU	Propagation of aquatic life, including, without limitation, a warm-water fishery, propagation of wildlife, irrigation, industrial supply and watering of livestock.
Dissolved Oxygen Single Value	—	≥5 mg/l	Propagation of aquatic life, including, without limitation, a warm-water fishery, watering of livestock, recreation not involving contact with water and propagation of wildlife.
Nitrogen Species as Single Value	Total Inorganic Nitrogen 95% of Samples ≤5.3 mg/l	Nitrate ≤90 mg/l Nitrite ≤5 mg/l	Propagation of aquatic life, including, without limitation, a warm-water fishery, watering of livestock and propagation of wildlife.
~~[Un-Ionized]~~ **Total** Ammonia **(as N)** – mg/l	—	b	Propagation of aquatic life, including, without limitation, a warm-water fishery.
Total Dissolved Solids Single Value	c	≤3000 mg/l	Watering of livestock and irrigation.
Suspended Solids Single Value	—	≤25 mg/l	Propagation of aquatic life, including, without limitation, a warm-water fishery and recreation not involving contact with water.

PARAMETER	REQUIREMENTS TO MAINTAIN EXISTING HIGHER QUALITY	WATER QUALITY STANDARDS FOR BENEFICIAL USES	BENEFICIAL USES AS DESIGNATED IN NAC 445A.196 (Most Stringent Use Listed First)
Turbidity Single Value	d	≤25 NTU	Propagation of aquatic life, including, without limitation, a warm-water fishery and recreation not involving contact with water.
Fecal Coliform MF or MPN/100 ml Single Value	—	e	Propagation of wildlife, recreation not involving contact with water, irrigation and watering of livestock.

a. Maximum allowable increase in temperature above water temperature at the boundary of an approved mixing zone.

b ~~The 4-day average for the concentration of un-ionized ammonia in the vertical column of water and the four-sample rolling average for each interval sampled must not exceed 0.05 mg/l more often than once every 3 years. The daily value for this average must account for diurnal fluctuation. Data must be collected at Station 2 from at least three locations between the surface and total depth. This standard is not applicable to the area between Station 2 and the confluence of the Las Vegas Wash. The single value must not exceed 0.45 mg/l more often than once every 3 years. "Station 2" means the center of the channel at which the depth is 10 meters.~~

The ambient water quality criteria for ammonia are specified in NAC 445A.118 and apply at Station LWLVB 1.2. "Station LWLVB 1.2" means the center of the channel at a distance of 1.2 miles into Las Vegas Bay from the confluence of Las Vegas Wash with Lake Mead.

c. Any increase in total dissolved solids must not result in a violation of the standards set forth in "1996 Review-Water Quality Standards for Salinity, Colorado River System" approved by the commission on March 25, 1998.

d. Turbidity must not exceed that characteristic of natural conditions by more than 10 Nephelometric Units.

e. Any discharge from a point source into Las Vegas Wash must not exceed a log mean of 200 per 100 ml based on a minimum of not less than five samples taken over a 30-day period nor may more than 10 percent of the total samples taken during any 30-day period exceed 400 per 100 ml.

The commission recognizes that, because of discharges of tributaries, localized violations of standards may occur in the inner Las Vegas Bay.

RATIONALE

Sample Locations

Since Hoover Dam was completed in 1935 and Lake Mead was filled to the 1,213-foot elevation in 1942, there have been two other severe drought periods that have affected the lake's level. Bureau records show the lake's level was lower than it is now from 1961 through 1972 as well as from 1944 through 1957. Runoff entering the Colorado River is the second lowest experienced in the past 40 years; 1977 brought lesser runoffs, according to the Bureau of Reclamation. Reclamation officials figure that the Colorado River has 15 million acre-feet of runoff in an average year. An acre-foot is the amount of water it takes to cover an acre with 1 foot of water. In 2004, the federal government projects there will be 3.4 million acre-feet of runoff. Figure 3 illustrates Lake Mead water level elevation from 1997 through 2003, and shows the lake level drop of approximately 75 feet since 2000.

The proposed water quality standards revisions reflect a change in how monitoring stations are located in the Inner Las Vegas Bay and Lake Mead. The current criteria put stations 2 and 3 (LM2 and LM3) at a specified depth. The stations move out when the lake level falls, and in when the lake level rises. However, stations LM4 and LM5 are at fixed locations. Because the lake level has dropped substantially, station 2 (LM2) has approached the location of LM4, and station 3 (LM3) has moved out past station LM4 and is approaching LM5. As a result, stations LM4 and LM5 are no longer representative of the part of the lake they were intended to characterize when their positions were fixed at a time that a higher lake level existed.

The possibility of locating stations LM4 and LM5 by depth was considered, however, depth-located stations do not keep their spacing as they move due to changing lake elevations. Station 2 (LM2), for example, was originally located about 1.2 miles from the mouth of Las Vegas Wash, and station 3 (LM3) was located 1.85 miles from the mouth. By the early 1990s, however, station 2 had moved right next to station 3. It was 1.8 miles from the mouth, and station 3 was still at 1.85. The original distance between them, about 0.65 miles, had dropped to 0.05 miles.

The relative positions of the stations are more properly defined by locating them a fixed distance from the confluence between Las Vegas Wash and Lake Mead. This technique preserves the distance from one station to another. In the past, determining distances between stations would have been difficult, but GPS equipment has solved this problem. Because station 3 was originally 1.85 miles from the confluence, we propose defining it as 1.85 miles from the confluence (now referred to as Las Vegas Bay (LWLVB) 1.85). For the same reason, we propose locating LM 4 (now referred to as LWLVB 2.7) at 2.7 miles from the confluence, and LM 5 (now referred to as LWLVB 3.5) at 3.5 miles from the confluence.

Figure 3 illustrates the Las Vegas Bay portion of Boulder Basin and shows different lake levels and sample locations. The spotted portion shows the 1220 ft lake water elevation, the section shown in blue is at the 1140 elevation and the yellow line shows the lake level at the 1100 ft elevation. LM2, LM3, LM4 and LM5 are the original sample sites and LM2A, LM3A, LM4A, and LM5A are the proposed sites determined by the distance from the confluence method. Reference point is located at confluence of Lake Mead and Las Vegas Wash at 1220 elevation.

Tables 1 and 2 show volume and depth information of the different sampling points, both current and proposed, for different elevations. Note that Table 2 compares the volume and depth differences for each elevation for all the old and new locations. Due to the shape of the lake bottom, the volume of water shown for each station at the differing elevations will generally decrease while the water depth at each station will increase.

Table 1 Comparison Of Original And Proposed Sample Sites

Site	Elevation	Volume (acre feet)	Miles from confluence	Depth (m)	Miles from reference point
Current sites					
LM2	1220	1,923	1.2	14	1.2
LM3	1220	5,700	1.85	18	1.85
LM4	1220	21,318	2.7	39	2.7
LM5	1220	68,441	3.5	50	3.5
LM4	1140	1106	0.3	15	2.7
LM5	1140	12208	1.1	26	3.5
Proposed sites					
LWLVB 1.2	1140	5,004	1.2	30	3.7
LWLVB 1.85	1140	10,451	1.85	39	4.3
LWLVB 2.7	1140	21,695	2. 7	58	5.2
LWLVB 3.5	1140	46,074	3.5	72	6
LWLVB 1.2	1100	1,314	1.2	18	3.7
LWLVB 1.85	1100	4,184	1.85	27	4.3
LWLVB 2.7	1100	9,897	2. 7	46	5.2
LWLVB 3.5	1100	25,241	3.5	60	6

Notes-

- Reference point is located at confluence of Lake Mead and Las Vegas Wash at 1220 elevation.
- LM2, LM3, LM4 and LM5 are the original sites.
- LWLVB 1.2, LWLVB 1.85, LWLVB 2.7, and LWLVB 3.5 are the sites determined by the distance from the confluence method.

Table 2 Volume And Depth Comparisons At Different Elevations

Site	Elevation	Volume at 1220 (acre feet)	Volume at 1140 (acre feet)	Volume Change from 1220 (acre feet)	Volume at 1100 (acre feet)	Volume Change from 1220 (acre feet)
LWLVB 1.2	1220	1,923	5,004	+ 3,081	1,314	- 609
LWLVB 1.85	1220	5,700	10,451	+ 4,751	4,184	- 1,516
LWLVB 2.7	1220	21,318	21,695	+ 377	9,897	- 11,421
LWLVB 3.5	1220	68,441	46,074	- 22,367	25,241	- 43,200

Site	Elevation	Depth (in m) at 1220 ft	Depth (in m) at 1140 ft	Depth Change (in m) from 1220 ft	Depth (m) at 1100 ft	Depth Change (in m) from 1220 ft
LWLVB 1.2	1220	14	30	+ 16	18	+ 4
LWLVB 1.85	1220	18	39	+ 21	27	+ 9
LWLVB 2.7	1220	39	58	+ 19	46	+ 7
LWLVB 3.5	1220	50	72	+ 22	60	+ 10

Data Summary
Figures 5 through 10 show box plots of nitrate data for Las Vegas Bay from 1997 to 2003. Figures 5 and 6 show the nitrate data for all four current Las Vegas Bay sample sites (LM2, LM3, LM4 and LM 5) for 1997 and 2002. Figures 7 through 10 show each station for the years 1997 – 2003. Due to the lake level drop, site LM4 only has data into 2002. For each of these plots, the data shown includes samples collected from all depths.

Figure 5 shows all four sample sites in 1997 and Figure 6 shows the same sites in 2002. The median values for all four sites have apparently increased from 1997 to 2002 but the sites LM 2 and LM3 for 2002 are very similar. Figures 7 through 10 show the data for each site year by year. Sites LM2 and LM3 generally show little difference from 1997 to 2003, while sites LM4 and LM5 indicate increases in data values and increasing trend of the medians. This supports the concept that these sample sites are not representative of the portion of the bay they were supposed to characterize.

Reach Description
Inner Las Vegas Bay (NAC 445A.196) is defined as the area of Lake Mead from the western boundary of Las Vegas Bay Campground to the confluence of Las Vegas Wash. The Lake Mead water surface level has dropped to the extent that this reach no longer exists under this definition. Redefining the inner bay as a non-static water body will establish the reach by linking it to the lake elevation. NDEP is proposing to define the Inner Las Vegas Bay reach as Lake Mead from the confluence of Lake Mead with Las Vegas Wash to 1.2 miles into Las Vegas Bay from the confluence. This was the original length of the inner bay reach and will allow the reach to move as the lake level fluctuates.

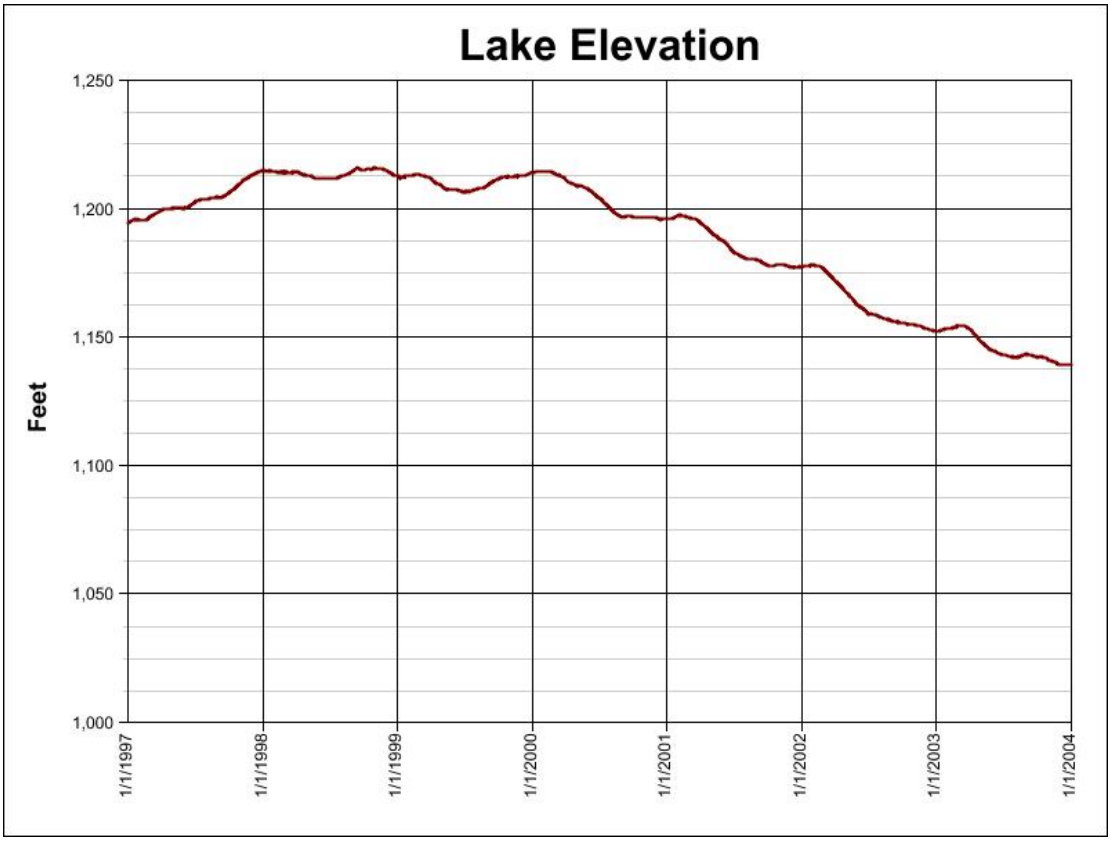


Figure 3 Lake Mead Surface Elevation

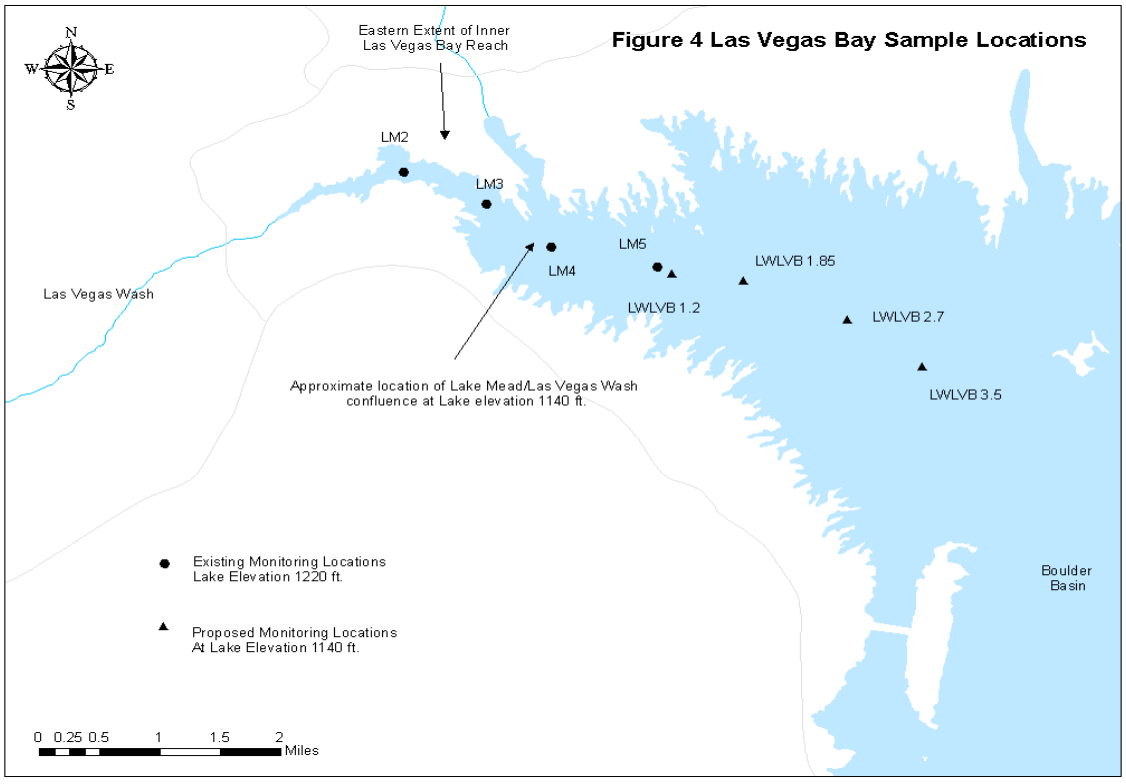


Figure 4 Las Vegas Bay Sample Locations

Figure 5
Nitrate Las Vegas Bay 1997

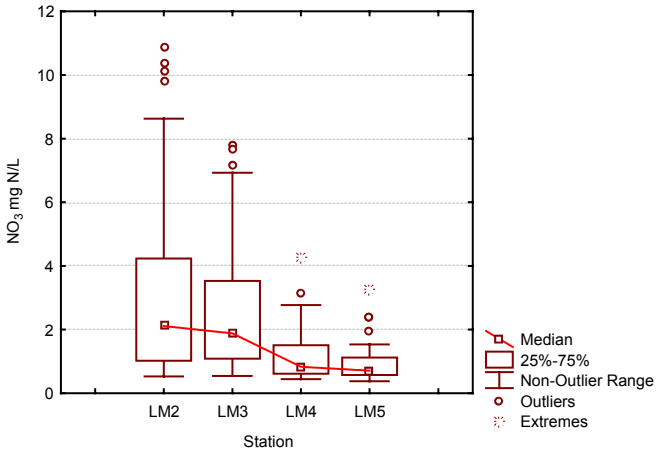


Figure 6
Nitrate Las Vegas Bay 2002

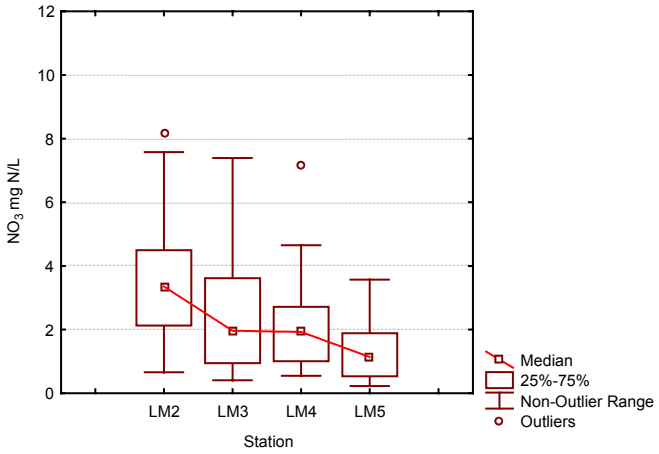


Figure 7
Nitrate LM2 1997 - 2003

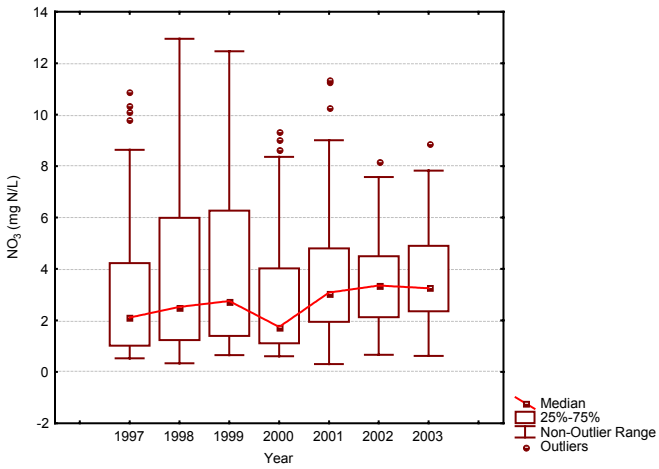


Figure 8
Nitrate LM3 1997 - 2003

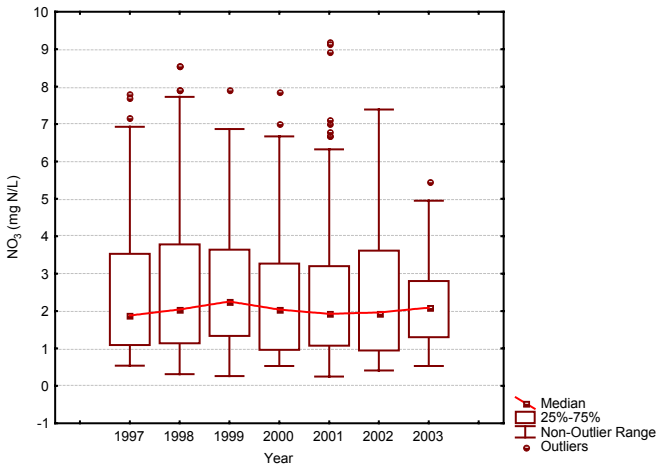


Figure 9
Nitrate LM4 1997 - 2002

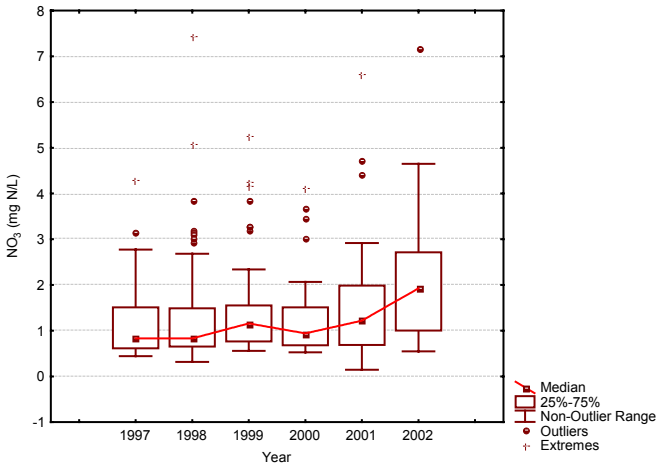
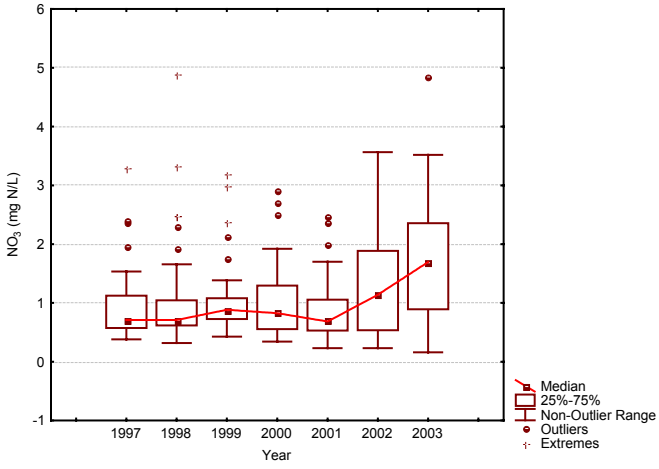


Figure 10
Nitrate LM5 1997 - 2003



Ammonia

The most up to date recommendations for developing freshwater aquatic life criteria for ammonia have been published by the U. S. Environmental Protection Agency (EPA) in "1999 Update of Ambient Water Quality Criteria for Ammonia." The document provides the rationale and methodology used in formulating revised acute and chronic aquatic life ammonia water quality criteria that addresses the temperature and pH-dependence of ammonia toxicity.

Aquatic life water quality toxicity criteria are generally expressed as acute or chronic values. Acute refers to the toxic effects in the short term (1 hour average) and acute symptoms include visible signs of stress, like disorientation and death. Chronic refers to toxicity in the long term (30 day average); the chronic effects being not as visible and much more subtle. These effects may include poor life cycle success, decreased reproduction, kidney dysfunction, and gill tissue damage.

EPA initially published ammonia aquatic life criteria in 1984. The procedures used to develop the 1984 criteria resulted in determination of single value criteria expressed as un-ionized ammonia. The recommended aquatic life criteria for un-ammonia were 0.02 mg/l for coldwater fish and 0.06 mg/l for warmwater fish. Revisions were made to the 1984 criteria based on subsequent ammonia toxicity research and recalculating the ammonia aquatic life criteria. Revised freshwater criteria for ammonia were published in 1992, 1996, and 1998. The procedures used in these revisions resulted in a calculated un-ionized ammonia criterion which varied depending on the pH and temperature of the water body.

The 1999 update contains EPA's most recent recommendation for aquatic life criteria for total ammonia and supercedes all previous freshwater aquatic life ammonia criteria. The new proposed criteria reflect recent research and data since 1984, and are a revision of several of the procedures used to determine the 1984 criteria. As a result, the recommended 1999 criteria are not single values but instead are site-specific values determined via algebraic relationships. The acute criteria for ammonia are dependent on pH and whether sensitive coldwater species are present. Chronic criteria are recommended based on the pH and temperature of the water body and are categorized depending on whether early fish life stages are present or absent. In previous criteria recommended by EPA, when chronic toxicity data was lacking, an acute chronic ratio relationship was used to estimate the chronic criteria. In the 1999 update both the acute and chronic criteria are expressed in terms of total ammonia nitrogen rather than un-ionized ammonia.

NDEP updated the ammonia criteria for most of the State in 2002, except for Lake Mead, the lower Carson River, the Humboldt River and Lake Tahoe and its Tributaries. At that time, NDEP felt that it would be better to update the ammonia standards for Lake Mead and the other remaining the waters on an individual basis. Accordingly, NDEP is now proposing to update the ammonia standard for Las Vegas Bay and Lake Mead to conform with the EPA recommended 1999 criteria.

The existing ammonia standard for Las Vegas Bay and Lake Mead is:

> The 4-day average for the concentration of un-ionized ammonia in the vertical column of water and the four-sample rolling average for each interval sampled must not exceed 0.05 mg/l more often than once every 3 years. The daily value for this average must account for diurnal fluctuation. Data must be collected at Station 2 from at least three locations between the surface and total depth. This standard is not applicable to the area between Station 2 and the confluence of the Las Vegas Wash. The single value must not exceed 0.45 mg/l more often than once every 3 years. "Station 2" means the center of the channel at which the depth is 10 meters.

The proposed ammonia standard will change from un-ionized ammonia to total ammonia nitrogen,

and from a single value to a site specific determination calculated by equations depending on the presence or the absence of sensitive coldwater fish species and if fish early life stages are present. The full ammonia standard (NAC 445A.118) with the algebraic equations and tables is attached as Appendix A.

APPENDIX A

NAC 445A.118 – Ammonia Water Quality Standards

NAC 445A.118 Water quality criteria for total ammonia. (NRS 445A.425, 445A.520)

1. The acute criteria of water quality with regard to the concentration of total ammonia are subject to the following:

(a) The 1-hour average concentration of total ammonia, in milligrams of nitrogen per liter, for the protection of freshwater aquatic life is shown in Table 1.

(b) For cold-water fisheries, the concentration of total ammonia, in milligrams of nitrogen per liter, must not exceed the applicable acute criterion listed under "Cold-Water Fisheries" set forth in Table 1, more than once every 3 years on average.

(c) For warm-water fisheries, the concentration of total ammonia, in milligrams of nitrogen per liter, must not exceed the applicable acute criterion listed under "Warm-Water Fisheries" set forth in Table 1, more than once every 3 years on average.

2. The chronic criteria of water quality with regard to the concentration of total ammonia are subject to the following:

(a) The 30-day average concentration of total ammonia, in milligrams of nitrogen per liter, for the protection of freshwater aquatic life is shown in Tables 2 and 3.

(b) The concentration of total ammonia, in milligrams of nitrogen per liter, expressed as a 30-day average must not exceed the applicable chronic criterion listed in Tables 2 and 3 more than once every 3 years on average, and the highest 4-day average within the 30-day period must not exceed 2.5 times the applicable chronic criterion.

(c) Table 3 must not be used unless the division receives acceptable documentation of the absence of freshwater fish in early life stages.

TABLE 1: ACUTE WATER QUALITY CRITERIA FOR TOTAL AMMONIA FOR FRESHWATER AQUATIC LIFE (mg nitrogen/l)

pH	Cold-Water Fisheries[1]	Warm-Water Fisheries[2]
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20

TABLE 1: ACUTE WATER QUALITY CRITERIA FOR TOTAL AMMONIA FOR FRESHWATER AQUATIC LIFE (mg nitrogen/l)		
pH	Cold-Water Fisheries[1]	Warm-Water Fisheries[2]
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

[1] The acute water quality criteria for total ammonia for cold-water fisheries were calculated using the following equation, which may also be used to calculate unlisted values:

Acute water quality criteria for ammonia (cold-water fisheries) =

$$\left[\frac{0.275}{1+10^{7.204-\mathrm{pH}}}\right]+\left[\frac{39.0}{1+10^{\mathrm{pH}-7.204}}\right]$$

[2] The acute water quality criteria for total ammonia for warm-water fisheries were calculated using the following equation, which may also be used to calculate unlisted values:

Acute water quality criteria for ammonia (warm-water fisheries) =

$$\left[\frac{0.411}{1+10^{7.204-\mathrm{pH}}}\right]+\left[\frac{58.4}{1+10^{\mathrm{pH}-7.204}}\right]$$

TABLE 2: CHRONIC WATER QUALITY CRITERIA FOR TOTAL AMMONIA FOR WATERS WHERE FRESHWATER FISH IN EARLY LIFE STAGES MAY BE PRESENT (mg nitrogen/l)[1]										
	Temperature (°C)									
pH	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208

TABLE 2: CHRONIC WATER QUALITY CRITERIA FOR TOTAL AMMONIA FOR WATERS WHERE FRESHWATER FISH IN EARLY LIFE STAGES MAY BE PRESENT (mg nitrogen/l)[1]										
	Temperature (°C)									
pH	0	14	16	18	20	22	24	26	28	30
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

[1] The chronic water quality criteria for total ammonia for waters where freshwater fish in early life stages may be present were calculated using the following equation, which may also be used to calculate unlisted values:

Chronic water quality criteria for ammonia (fish in early life stages present) =

$$\left[\frac{0.0577}{1+10^{7.688-pH}}+\frac{2.487}{1+10^{pH-7.688}}\right] x\ MIN\left[2.85, 1.45\ x\ 10^{0.028x(25-T)}\right]$$ where:

T=°C
x means multiplication
MIN means the lesser of the two values separated by the comma

TABLE 3: CHRONIC WATER QUALITY CRITERIA FOR TOTAL AMMONIA FOR WATERS WHERE FRESHWATER FISH IN EARLY LIFE STAGES ARE ABSENT (mg nitrogen/l)[1]										
	Temperature (°C)									
pH	0-7	8	9	10	11	12	13	14	15[2]	16[2]
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

[1] The chronic water quality criteria for total ammonia for waters where freshwater fish in early life stages are absent were calculated using the following equation, which may also be used to calculate unlisted values:

Chronic water quality criteria for ammonia (fish in early life stages absent) =

$$\left[\frac{0.0577}{\left(1+10^{7.688-pH}\right)}+\frac{2.487}{\left(1+10^{pH-7.688}\right)}\right] x\ 1.45\ x\left[10^{0.028x(25-MAX(T,7))}\right]$$

where:

T=°C

x means multiplication

MAX means the greater of the two values separated by the comma

[2] At 15°C and above, the criteria for waters where freshwater fish in early life stages are absent is the same as the criteria for waters where freshwater fish in early life stages may be present.

NOTES FOR TABLES 1, 2 AND 3:

- pH and temperature are field measurements that must be taken at the same time and location as the water sample destined for the laboratory analysis of ammonia.
- If the field-measured pH or the temperature values, or both, fall between the tabular values set forth in this section, the field-measured values or temperature values, as appropriate, must be rounded according to standard rounding procedures to the nearest tabular value to determine the applicable ammonia standard, or the equations provided in this section may be used to calculate unlisted values.