

Perchlorate Monitoring Results

Henderson, Nevada to the Lower Colorado River

December 2005 Report

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Based on Monitoring Data from

- Nevada Division of Environmental Protection
- Southern Nevada Water Authority
- Metropolitan Water District (MWD) of Southern California
- **Tronox (formerly Kerr McGee)**

**PERCHLORATE MONITORING RESULTS:
HENDERSON, NEVADA TO THE LOWER COLORADO RIVER**

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PERCHLORATE MONITORING RESULTS HENDERSON, NEVADA TO THE LOWER COLORADO RIVER

I. EXECUTIVE SUMMARY

1. Introduction and Purpose

This report summarizing perchlorate monitoring results in Henderson, Las Vegas Wash, Lake Mead and the Lower Colorado River has been compiled to measure the effectiveness of perchlorate remediation efforts in Henderson, Nevada, and to keep interested agencies and others informed on the latest perchlorate monitoring data. It is designed to present an overview of the data so that all parties have the same information. It does not include all of the monitoring data available, just a manageable set of the most representative data. Please refer to **Appendix B: Background** for details about the perchlorate problem, applicable standards, **Tronox's (formerly Kerr McGee)** control strategy, **AMPAC's (American Pacific Corp; referred to as PEPCON in previous reports)** control strategy and travel times/flushing times.

This report will allow agencies to assess the effectiveness of control elements, track progress of control efforts and their downstream benefits, and more accurately predict perchlorate concentrations at downstream locations.

Several agencies have contributed data to this report, including the Nevada Division of Environmental Protection (Las Vegas Wash at North Shore Road and the Lower Colorado River at Willow Beach), Southern Nevada Water Authority (Las Vegas Wash downstream of the seep, Lake Mead/Las Vegas Bay and Lake Mead/Saddle Island) and Metropolitan Water District (MWD) of Southern California (Colorado River Aqueduct). **Tronox** has also contributed substantial data to this report (ground water monitoring and mass removal data at the Slurry Wall, Athens Road and the Seep Area).

This report addresses only the perchlorate releases from **Tronox and AMPAC** in Henderson, Nevada and their impacts on Las Vegas Wash, Lake Mead and the lower Colorado River. There are many other perchlorate releases throughout the United States which have created their own separate and distinct perchlorate plumes. This report does not address any of these other releases.

2. Summary of Surface Water and Groundwater Quality Trends

- Monthly averages are presented where more than one sample per month is collected.
- Ground water and surface water concentrations show significant seasonal variability.
- Ground water concentrations are declining as a result of **Tronox's** capture and control efforts at three locations: slurry wall on **Tronox** property, Athens Road about half way to Las Vegas Wash, and seep area near Las Vegas Wash. Ground water extraction wells in these three locations are removing approximately 1700 to 2000 pounds of perchlorate per day.

- Surface Water concentrations in Las Vegas Wash, Lake Mead and the Lower Colorado River have declined by **85%, 70% and 60%, respectively**, since seep capture and treatment began in November 1999. Additional decreases **may occur** in 2006 due to **improved** capture at Athens Road (**continuous capture began on October 22, 2002**) and the seep area **wellfield (continuous wellfield operation with 4 wells began on 10/22/02; 5 more wells were added on 3/24/03, and a 10th well began operation in July 2005)**.
- In the last 2 years, concentrations of perchlorate at Saddle Island (AMSWTF Raw Water) in Lake Mead have ranged from **2 to 8 ppb** which is below the recently adopted US EPA reference dose drinking water equivalent level (DWEL) of 24.5 ppb, but at times greater than California's Public Health Goal of 6 ppb.
- Average perchlorate concentrations in Lake Mead were probably higher than expected in 2002, 2003 and 2004 because a 5 year long drought resulted in less water entering Lake Mead and lowered the Lake level **about 90 feet between January 2000 and December 2004**. This resulted in about a 44% decrease in the Lake volume. **During 2005 the Lake level rose 13-14 feet to 1137.5 feet**. If the drought **continues/reemerges in 2006 and beyond**, perchlorate concentrations in Lake Mead may not decline as much as expected. The intake depth of the AMSWTF was lowered from 1050 to 1000 feet on June 29, 2004, which would be expected to decrease perchlorate concentrations somewhat.
- Peak levels of surface water concentrations at the Colorado River Aqueduct near Parker Dam have declined gradually, but steadily from 9 ppb to less than 4 ppb since seep capture began in November 1999. Gradual declines in peak levels are expected to continue in 2006.
- In the last 2 years, concentrations of perchlorate at the Colorado River Aqueduct near Parker Dam have ranged from non-detect (ND = 2 ppb) to **5.6 ppb**, which is below the recently adopted US EPA reference dose drinking water equivalent level (DWEL) of 24.5 ppb. Since June 2002, all of the monthly samples have been at or below California's Public Health Goal of 6 ppb. In 2004 nine of the twelve monthly samples were non-detect (ND = 4 ppb). In 2005 **all twelve monthly samples were less than 4 ppb**.

3. Recent Developments and Current Status

This is the **eighth and last** in a regular series of reports on the progress of the perchlorate cleanup in Henderson, Nevada. This report has evolved over time to best suit the needs of the interested parties. **Given the significant decreases in perchlorate releases that have been achieved and the associated decreases in drinking water concentrations in Lake Mead and the Colorado River, we don't believe that future reports of this type are necessary. The data will continue to be collected by the respective parties, but they will not be compiled into a single report. Anyone interested in the data collected in the future should visit the Nevada Division of Environmental Protection (NDEP) website [www.ndep.nv.gov] (for North Shore Road or Willow Beach data) or contact Todd Croft of NDEP at 702 486-2850 ext 230. At the NDEP homepage, scroll down near the bottom of the page and click on "Southern Nevada Perchlorate Cleanup Project."**

The ground water and surface water systems included in this report are complex systems, and the data at each sampling location are influenced by many factors, including 1) natural variability, 2) seasonal variability, 3) Lake Mead water levels and flow dynamics, 4) Colorado River flow dynamics, and 5) ground water flow dynamics, etc. As such, it is important to remember that one data point does not constitute a trend, and that water quality improvements will not necessarily occur in a steady, straight-line fashion.

In January 2002 EPA proposed a new reference dose for perchlorate of **0.00003 mg/kg, with a associated** drinking water equivalent level of 1 ppb. **This reference dose would have replaced the provisional reference dose DWEL of 4-18 ppb, but it was never finalized. In order to resolve disagreements about how to interpret the health effects data,** the National Academy of Sciences (NAS) reviewed the health effects data for perchlorate and issued their report to EPA on January 10, 2005. The NAS recommended a perchlorate reference dose of 0.0007 mg/kg. On February 18, 2005 EPA adopted a perchlorate reference dose of 0.0007 mg/kg/day, **which can be used to calculate** a drinking water equivalent level (DWEL) of 24.5 ppb, assuming that all perchlorate exposure comes from drinking water, **and using standard adult body weight and water consumption estimates. On January 26, 2006 EPA's Office of Solid Waste and Emergency Response (OSWER) issued "Assessment Guidance for Perchlorate," which recommends using 24.5 ppb as a starting point for evaluation of federal cleanup sites. EPA is currently working to determine whether or not a national drinking water regulation for perchlorate would present a meaningful opportunity for health risk reduction.** California adopted a perchlorate Public Health Goal of 6 ppb on March 11, 2004 and is expected to adopt a state MCL for perchlorate in **2006.**

In 2003 Kerr McGee constructed a new fluidized bed reactor (FBR), biologically based perchlorate treatment plant to replace the existing ion exchange units. The Plant Ion Exchange Units (12) began operating in October 2002, while the Wash Ion Exchange Units (3) began operating in November 1999. The new FBR plant was in startup/shakedown mode from December 2003 through September 2004 and became fully operational in November 2004. The perchlorate concentration and mass discharged from the new treatment plant have decreased to less than 18 ppb and less than **0.21** pounds per day, respectively, based on a flow of 1000 gallons per minute. The Plant Ion Exchange Units have not operated since March 2004; the Wash Ion Exchange Units have not operated since June 2004. **All ion exchange units were decommissioned by Tronox during the fall of 2005, but the units still remain on-site.**

In 2003 McGinley and Associates conducted a perchlorate modeling effort for the Nevada Division of Environmental Protection for the portion of Las Vegas Wash impacted by perchlorate releases to the Wash itself and to the Las Vegas Wash gravels. Assuming 90% or better capture of all perchlorate sources to Las Vegas Wash, the modeling predicted that perchlorate mass loading at North Shore Road would decline to 100 pounds per day or less by October 2004. This would represent about a 90% reduction from the amount of perchlorate entering Las Vegas Wash prior to any controls (about **900 to 1000** pounds per day; initial perchlorate controls began in November 1999). In late 2003 the North Shore Road mass loading was in the 250 to 280 pounds

per day range, slightly higher than predicted by the McGinley and Associates modeling. In late 2004, the mass loading was generally in the 110 to 140 pounds per day range (when not influenced by rainfall events). **In late 2005, the mass loading has generally been in the 100 to 150 pounds per day range**, a decrease of about 85% from pre-control amounts. **NDEP and EPA are considering whether to have McGinley and Associates refine their 2003 perchlorate modeling efforts to provide a better predictive tool that includes the effect of two more years of operation of the Tronox Athens Road extraction wells, as well as the AMPAC extraction wells which are scheduled to begin operation in February 2006.**

4. Monitoring Locations

There are eleven monitoring locations referenced within this report that extend from **Tronox's** property in Henderson, Nevada to the Colorado River Aqueduct near Parker Dam on the Lower Colorado River. The monitoring locations are indicated below and are shown on the three maps in **Appendix A**.

- Groundwater on **Tronox** Property Above Slurry Wall (**collected by Tronox**)
- Groundwater on **Tronox** Property Below Slurry Wall (M-100) (**collected by Tronox**)
- Groundwater at Athens Road Wells (ART-8) (**collected by Tronox**)
- Groundwater Below Athens Road Wells (ARP-3) (**collected by Tronox**)
- Groundwater at Seep Area (PC-97) (**collected by Tronox**)
- Las Vegas Wash Downstream of Seep Area (LW 5.3) (**collected by SNWA**)
- Las Vegas Wash at North Shore Road (**collected by NDEP**)
- Lake Mead at Las Vegas Bay (LVB 2.7/LVB 3.5) (**collected by SNWA**)
- Lake Mead at Saddle Island (AMSWTF Raw Water) (**collected by SNWA**)
- Colorado River Below Hoover Dam (Willow Beach) (**collected by NDEP**)
- Colorado River at Colorado River Aqueduct at Lake Havasu (**collected by MWD**)

5. Perchlorate Monitoring Trends for 2005 at Each Monitoring Location

The following summaries are based solely on 2005 data; they do not reflect any changes that may have occurred in 2006.

A. Mass Loading in Las Vegas Wash at North Shore Road

- Has declined slightly in 2005 to about 120 lbs/day.
- Has ranged from 100-160 lbs/day from April through December 2005.
- Further declines to less than 100 lbs/day may occur in 2006.
- Annual average declined by 16% from 170 lbs/day in 2004 to 142 lbs/day in 2005.

B. Ground Water on Tronox Property Above Slurry Wall

- Has declined slightly from 1,500,000 - 1,800,000 ppb (1500 - 1800 ppm) to 1,200,000 -

1,500,000 ppb (1200 - 1500 ppm).

-Monitoring location reflects perchlorate source area; not likely to decrease significantly for many years

C. Ground Water on Tronox Property Below Slurry Wall (M-100)

-Has declined about 85% since slurry wall installed in October 2001

-Currently about 130,000 to 180,000 ppb (130 to 180 ppm); has been relatively steady at this level for the last two years.

D. Ground Water at Athens Road Wells (ART-8)

-Steady at about 400,000 ppb (400 ppm), as expected

-Not likely to decrease for many years

E. Ground Water Below Athens Road Wells (ARP-3)

-Has declined about 80% since Athens Road Wells began continuous operation in October 2002

-Results somewhat erratic; there could be a “stagnant zone”(a nearly flat gradient with low flows) just below Athens Road Wells

-Currently about 70,000 to 120,000 ppb (70 to 120 ppm)

F. Ground Water at Seep Area (PC-97)

-Has declined more than 95% since Athens Road Wells began continuous operation in October 2002

-Currently about 2,000 ppb (2 ppm)

G. Las Vegas Wash Downstream of Seep Area (LW 5.3)

-Has declined about 75% to 80% since Athens Road Wells began continuous operation in October 2002

-Currently about 60 to 100 ppb

H. Las Vegas Wash at North Shore Road

-Perchlorate concentrations declined about 50% in 2004 to about 140 ppb; concentrations remained at 130 to 140 ppb in 2005.

-Further declines to less than 100 ppb may occur in 2006

I. Lake Mead at Las Vegas Bay (LVB 2.7/LVB 3.5)

-Seasonal variation from 10 - 100 ppb over the last six years; peaks in spring/summer; valleys in fall/winter; range for 2005 was 7 to 24 ppb.

- On 12/16/03 sampling location moved to LVB 3.5 due to low water elevations in Lake Mead
- No clear trend (except seasonal variation) from 2000 to 2003; summer time peaks in 2004 and 2005 show decreases of about 65% and 75%, respectively, compared to 2002.

J. Lake Mead at Saddle Island (AMSWTF Raw Water)

- Concentrations began to decline in late 2003; declines continued in 2004 and 2005.
- Monthly average concentrations ranged from 2.4 ppb to 3.9 ppb from May through November 2005, the seven lowest values in more than 6 years of data.
- November and December 2003 monthly average peaks were both 10.5 ppb, about 35% lower than previous 3 year's peaks (2000, 2001 and 2002).
- November and December 2005 monthly averages were 2.6 and 6.3 ppb, respectively. The two month average (4.5 ppb) is 57% lower than the November/December 2003 average of 10.5 ppb.
- 2005 annual average was 3.8 ppb, a decrease of 60% from the 2003 annual average of 9.8 ppb, and a decrease of 70% from the 2000 annual average of 13.1 ppb.
- On June 29, 2004 the intake depth was lowered from 1050 feet to 1000 feet, which would be expected to decrease perchlorate concentrations.

K. Colorado River Below Hoover Dam (Willow Beach)

- Peak concentrations have gradually declined from about 10 ppb to about 4 ppb since seep capture began in November 1999
- Concentrations declined to 1.8 ppb in July, 1.9 ppb in August and 1.9 ppb in September 2005, the 3 lowest values ever measured at this location.
- Annual average concentrations have declined from 6.5 ppb in 2000 to 2.4 ppb in 2005 (a 63 % decrease); further declines are expected in 2006.
- Modeling conducted for MWD predicted that concentrations would reach 2 ppb by the end of 2005; the average for the last 6 months of 2005 was 2.1 ppb.

L. Colorado River at Colorado River Aqueduct

- Peak concentrations have gradually declined from 9 ppb to less than 4 ppb since seep capture began in November 1999
- In 2005 all twelve monthly samples were less than 4 ppb.
- Annual average concentrations have declined from 6.4 ppb in 2000 to less than 4 ppb in 2004 and 2005 (about a 50% decrease).
- Modeling conducted for MWD predicted that concentrations would reach 2 ppb by the end of 2005; in November and December 2005 the concentrations were 2 ppb and non-detect, respectively (method detection limit = 2 ppb).

II MONITORING DATA

1. Total Perchlorate Mass Removal by **Tronox**

Table 1. : **Perchlorate Removed by Tronox (formerly Kerr McGee), Henderson, Nevada.**

	1. Seep Area (near LVW) (lbs/day)	2. Athens Road Wells (midpoint) (lbs/day)	3. On Site CTL Wells (lbs/day)	4. Total (lbs/day)	Total Tons Removed per/month
October 2002*	495	331	1402	2228	34.5
November 2002	422	1001	1146	2569	38.5
December 2002	208	1164	1292	2664	41.3
January 2003	335	1074	1467	2876	44.6
February 2003	570	783	1060	2413	33.8
March 2003**	485	806	1067	2358	36.5
April 2003	713	713	1033	2460	36.9
May 2003	703	729	1148	2581	40.0
June 2003	686	907	1098	2691	40.4
July 2003***	594	755	1034	2383	36.9
August 2003	463	741	921	2125	32.9
Septem- ber 2003	416	770	937	2123	31.8
October 2003	370	769	1003	2142	33.1

November 2003	337	713	949	1999	30.0
December 2003	317	735	915	1967	30.5
January 2004	305	689	953	1947	30.2
February 2004	312	630	894	1836	26.6
March 2004	221	743	932	1895	29.4
April 2004	151	733	849	1733	26.0
May 2004	122	740	835	1697	26.3
June 2004	157	755	1053	1965	29.5
July 2004	195	794	968	1958	30.4
August 2004	201	767	914	1882	29.2
September 2004	169	835	974	1978	29.7
October 2004	262	799	1026	2088	32.4
November 2004	167	814	1032	2013	30.2
December 2004	123	811	901	1835	28.4
January 2005	142	775	1008	1926	29.8
February 2005	143	648	991	1782	25.0
March 2005	157	781	979	1917	29.7

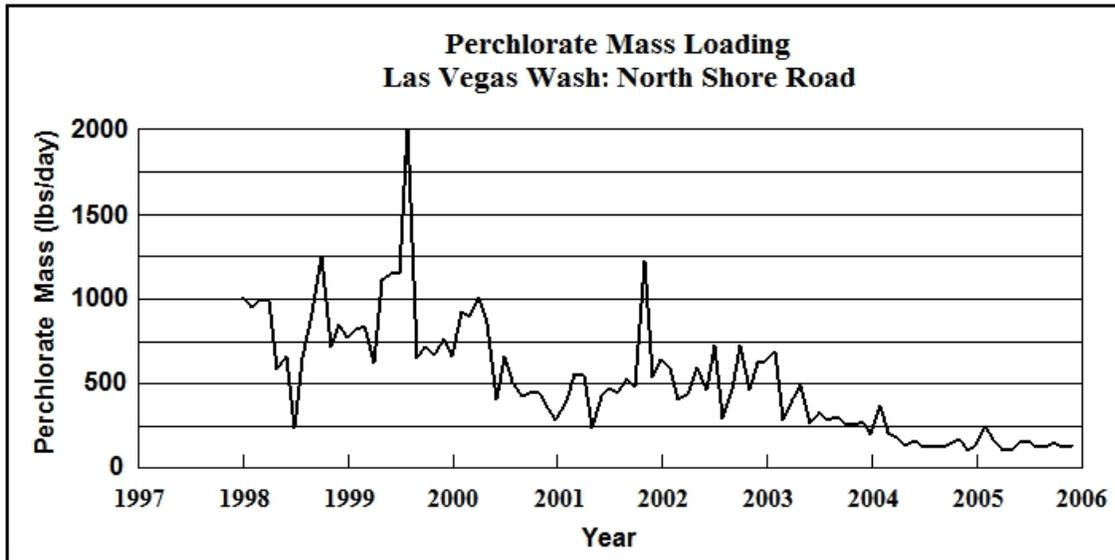
April 2005	145	787	987	1919	28.8
May 2005	152	756	982	1890	29.3
June 2005	151	793	985	1929	28.9
July 2005	154	769	1077	2000	31.0
August 2005	135	800	1109	2044	31.7
September 2005	85	807	1140	2032	30.5
October 2005	99	797	1077	1973	30.6
November 2005	111	773	1089	1973	29.6
December 2005	121	725	1137	1984	30.8

*Athens Road Extraction Wells begin full time operation on 10/22/02.

**Five new seep area extraction wells begin operation on 3/24/03.

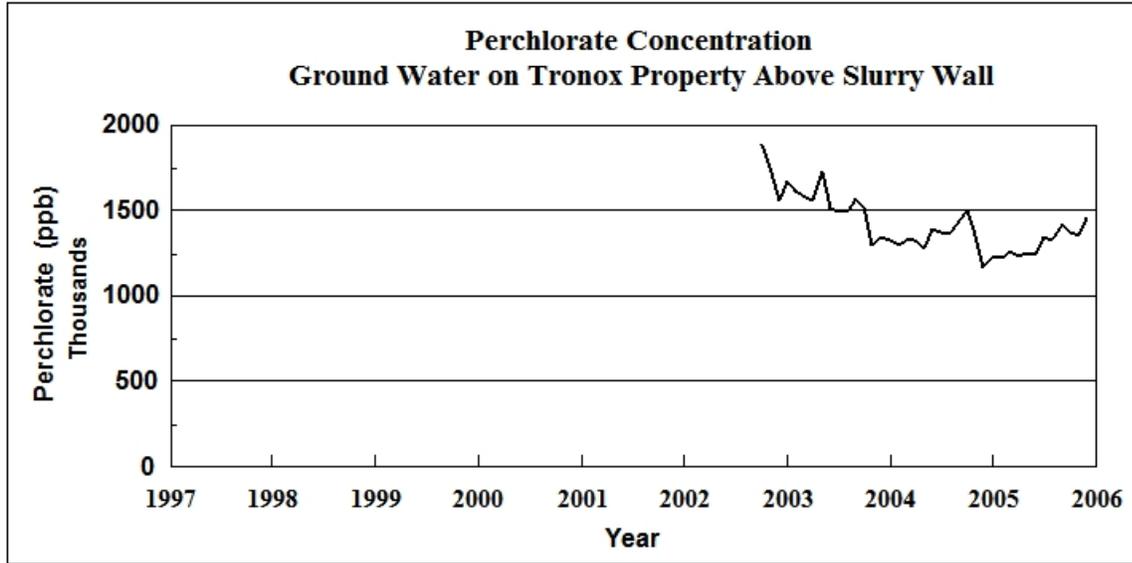
***As expected, Seep Area mass capture began to decline in July 2003 as a result of Athens Road mass capture. These declines are expected to continue throughout **2006**.

2. Perchlorate Mass Loading in Las Vegas Wash at North Shore Road



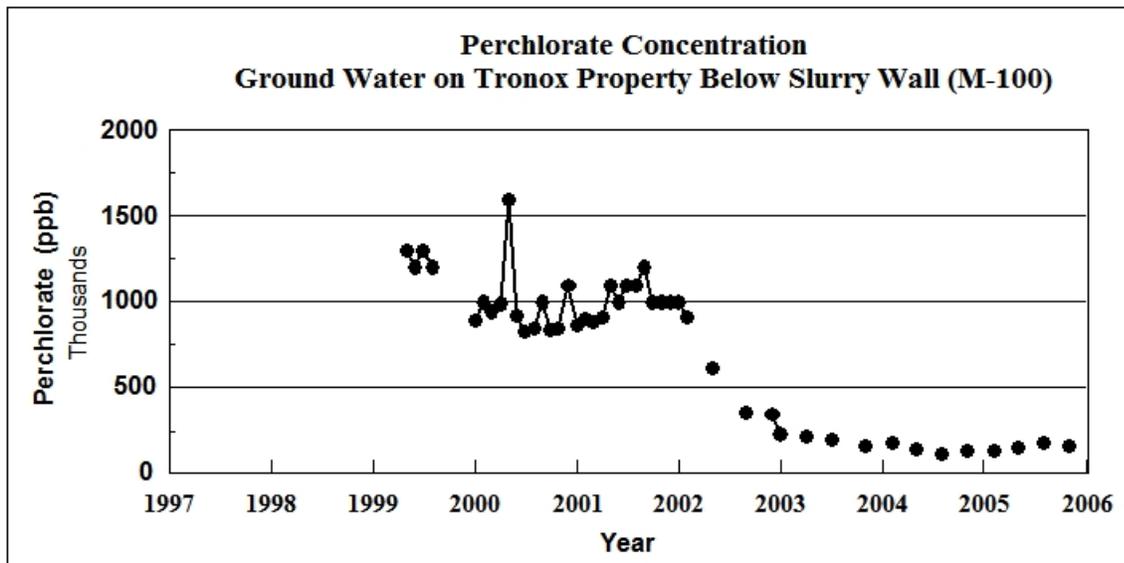
- Measures total perchlorate load in Las Vegas Wash entering Lake Mead; measures overall effectiveness of perchlorate remediation efforts in Henderson, Nevada.
- Mass loading declined in 2000 after seep capture began in November 1999, and declined further in 2003, 2004 and **2005** after Athens Road Wells began operation **in October 2002**.
- During the last seven months of 2003 mass loadings ranged from 250 to 325 lbs/day, a substantial decrease from amounts in 2002 and early 2003.
- **During the last nine months of 2005 mass loadings ranged from 100 to 160 lbs/day.**
- Further declines **may occur in 2006.**

3. Groundwater on Tronox Property Above Slurry Wall



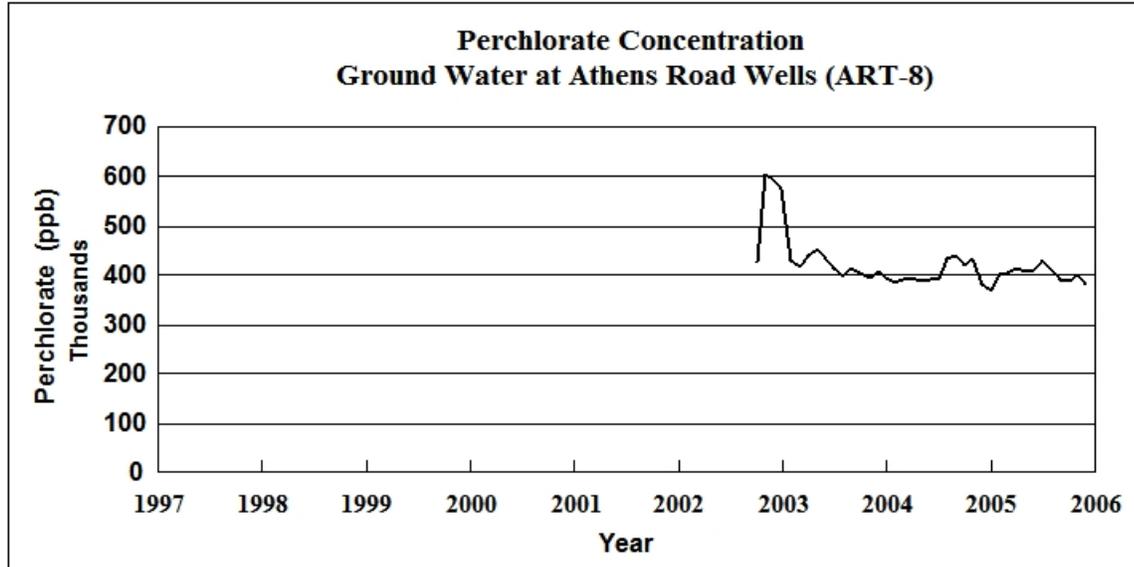
- Measures perchlorate source concentrations
- Concentrations show gradual declining trend since October 2002

4. Groundwater on Tronox Property Below Slurry Wall (M-100)



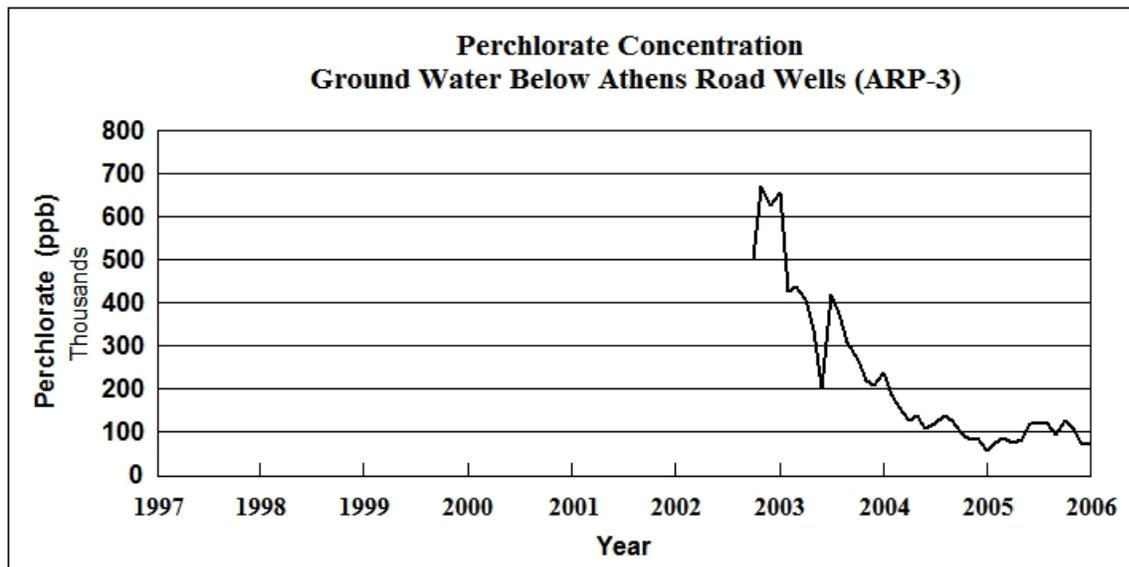
- Measures effectiveness of slurry wall/extraction well capture system.
- Extraction wells began operating in January 1999; slurry wall completed in September 2001.
- **Concentrations declined about 85% after September 2001; concentrations have been in the 130-180 ppm range for the last two years.**

5. Groundwater at Athens Road Wells (ART-8)



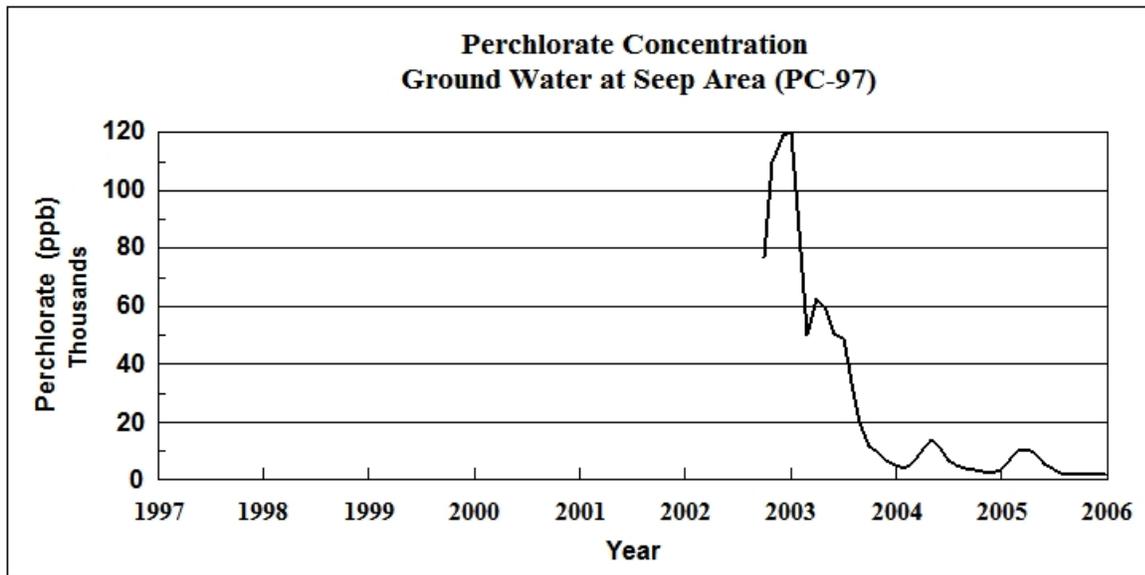
- Measures plume concentrations at Athens Road, about midway between the **Tronox** plant site and Las Vegas Wash
- This groundwater is being extracted and treated; the goal is “virtually complete capture.”

6. Groundwater Below Athens Road Wells (ARP - 3)



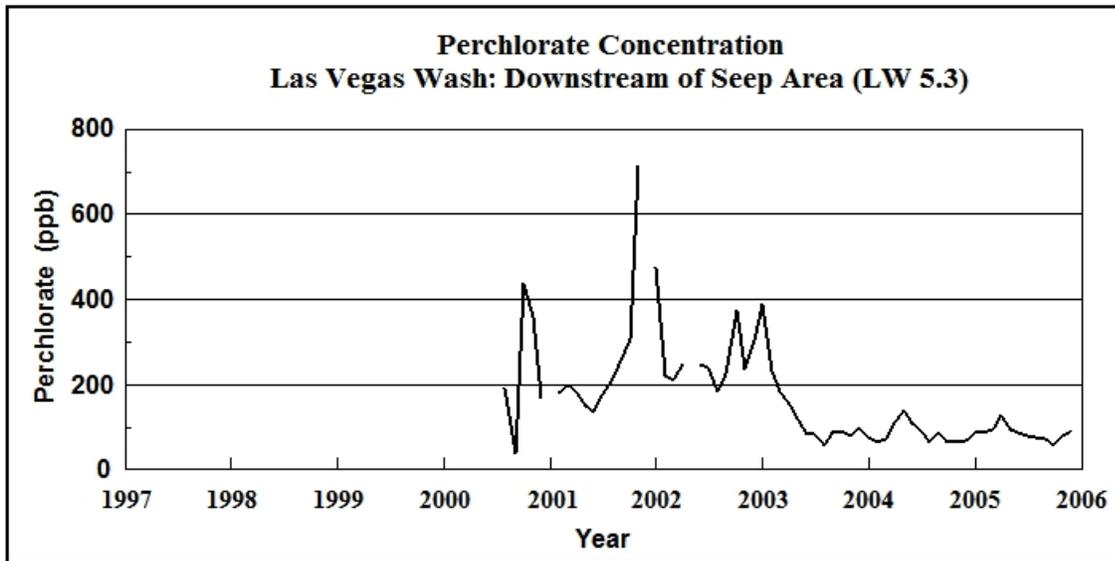
- Measures effectiveness of Athens Road extraction well capture system and downstream effects.
- Concentrations **have declined about 80%** since October 2002.

7. Groundwater at Seep Area (PC-97)



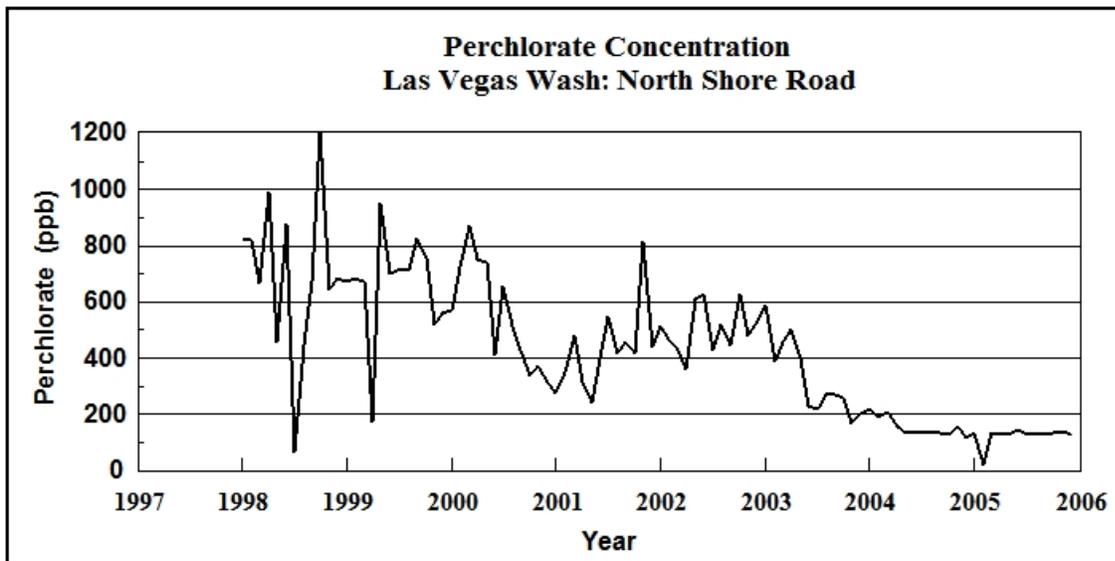
- Measures plume concentrations at seep area.
- Shows combined effect of Athens Road and seep area extraction wells.
- Concentrations have declined **more than 95%** since October 2002.

8. Las Vegas Wash Downstream of Seep Area (LW 5.3)



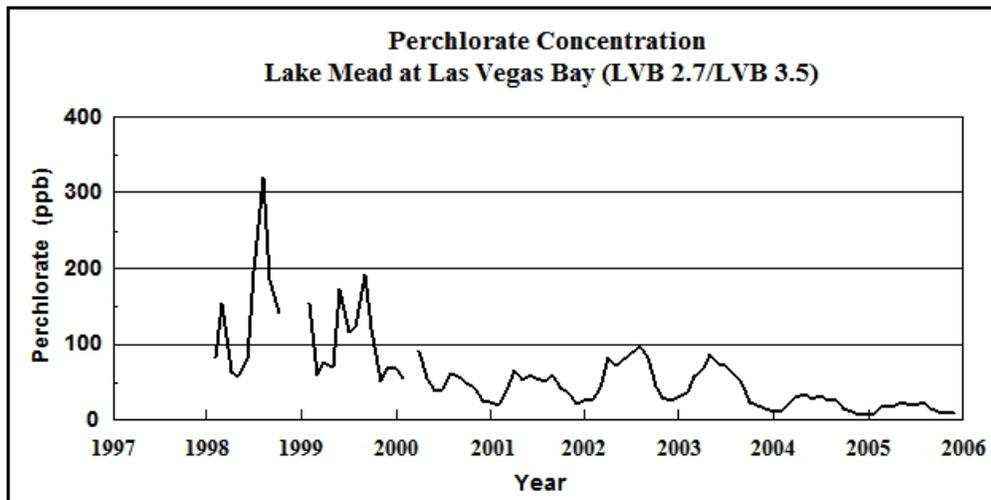
- Measures perchlorate “daylighting” from Las Vegas Wash gravels, **near Historic Lateral**.
- Concentrations **may** decline further in 2006.

9. Las Vegas Wash at North Shore Road



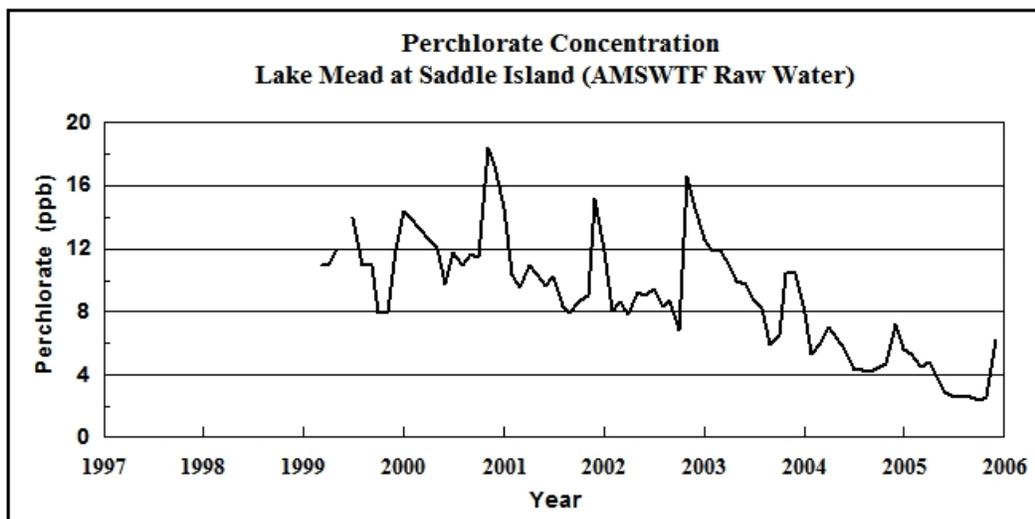
- Measures total perchlorate concentration in Las Vegas Wash entering Lake Mead.
- Concentrations declined in 2000 after seep capture began in November 1999, and declined further in 2003, 2004 **and 2005** after Athens Road Wells began operation in **October 2002**.
- Further declines **may occur** in 2006.

10. Lake Mead at Las Vegas Bay (LVB 2.7/LVB 3.5)



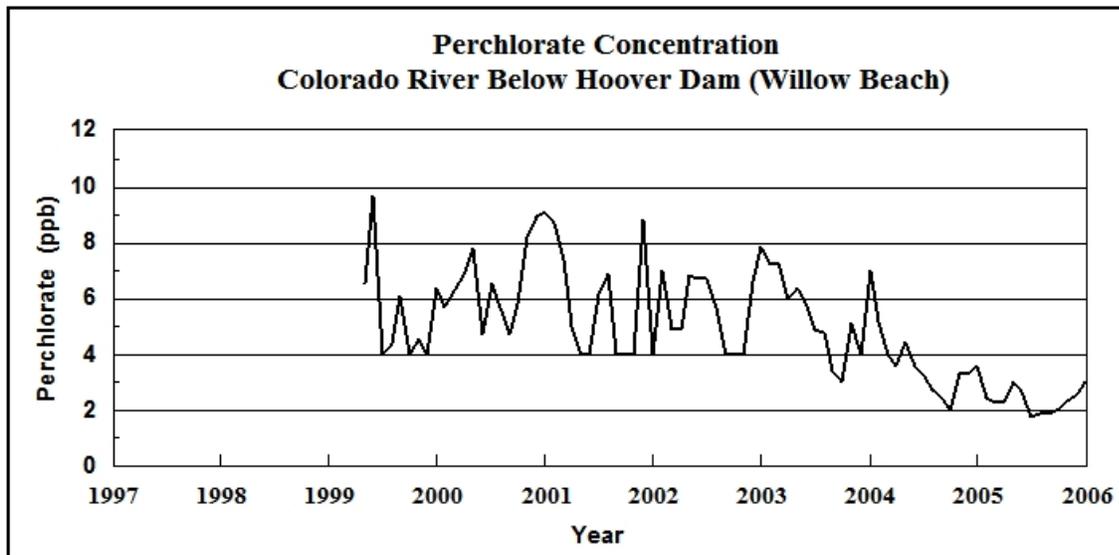
- Measures perchlorate concentrations in Las Vegas Bay; sampling location moved to LVB 3.5 in December 2003 due to declining water levels in Lake Mead.
- Concentrations began to decline in 2000 after seep capture began in November 1999.
- Declining Lake Mead surface elevations (years 2000 to 2004) may have resulted in increased perchlorate concentrations.

11. Lake Mead at Saddle Island (AMSWTF Raw Water)



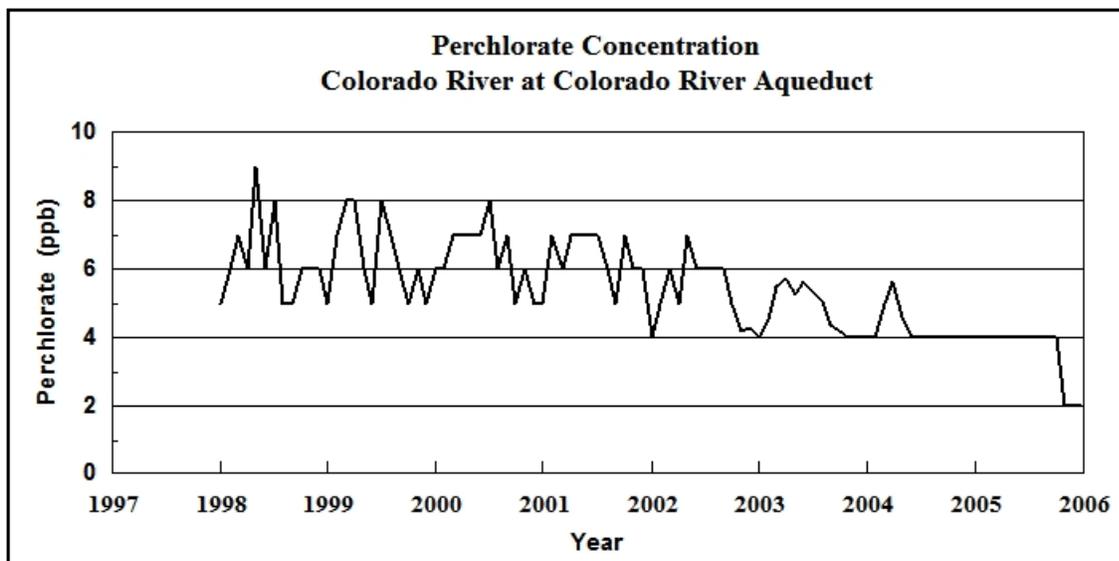
- Measures perchlorate concentrations in Las Vegas Valley drinking water supply.
- Concentrations began to decline in 2000 after seep capture began in November 1999.
- Destratification of water in Lake Mead in November/December each year causes seasonal peaks in perchlorate concentrations; 2003 seasonal peak was about 35% lower than in previous three years.
- Declining Lake Mead surface elevations (years 2000 to 2004) may have resulted in increased perchlorate concentrations
- Intake depth lowered from 1050 feet to 1000 feet on June 29, 2004.
- Method Detection Limit = 0.2 ppb beginning in May 2005 (MDL = 4 ppb previously).

12. Colorado River Below Hoover Dam (Willow Beach)



- Measures perchlorate concentrations in water entering Lower Colorado River
- Concentrations **have declined more than 60%** since seep capture began in November 1999.
- Concentrations **declined to less than 2 ppb in July, August and September 2005.**
- Method Detection Limit (MDL) = 1 ppb beginning in November 2004 (MDL = 4 ppb prior to December 2002; 2 ppb from December 2002 to October 2004)

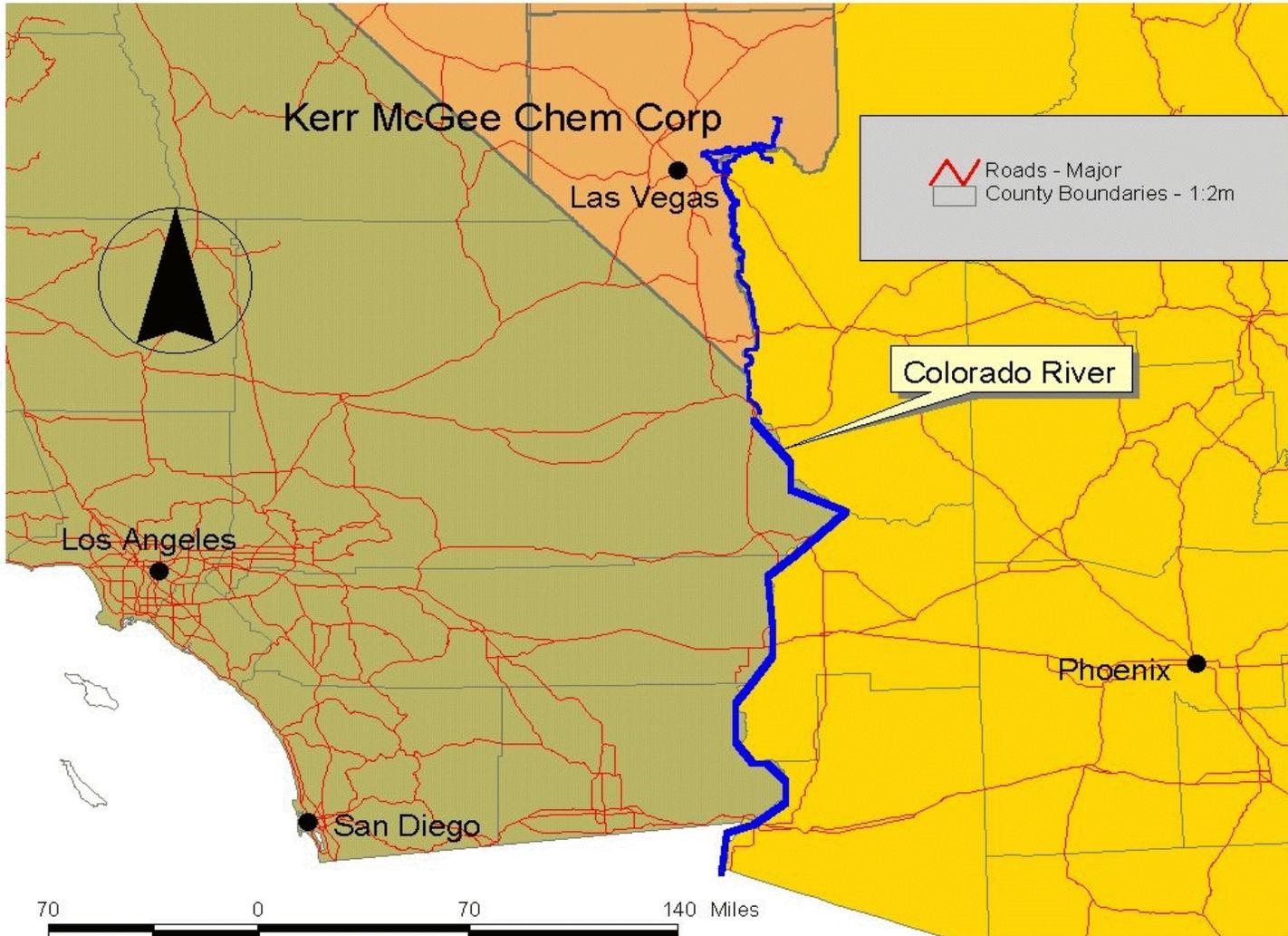
13. Colorado River at the Colorado River Aqueduct at Lake Havasu



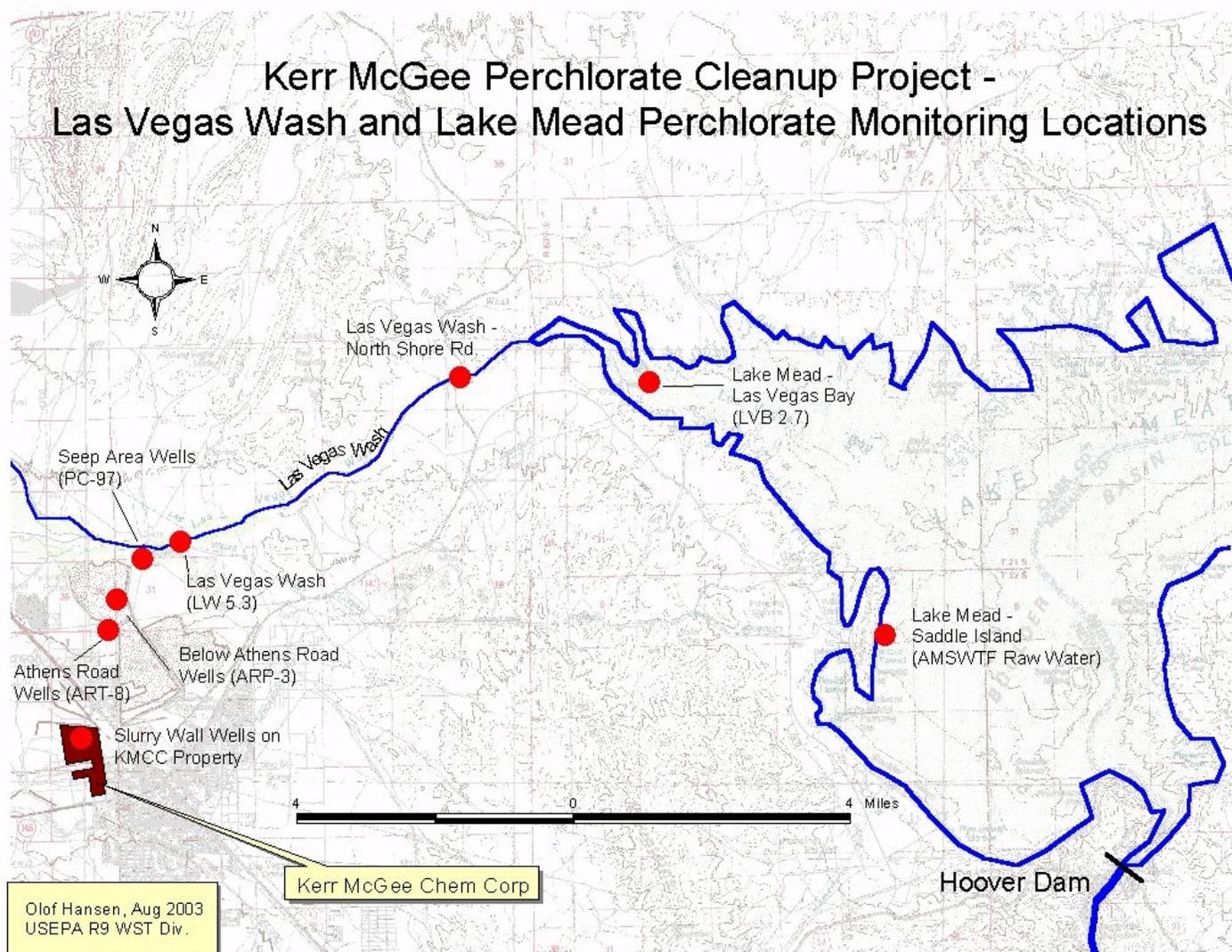
- Measures perchlorate concentrations at Southern California drinking water supply.
- Peak concentrations have shown gradual decline since seep capture began in November 1999.
- **In 2005, 11 of the 12 monthly samples were non-detect; all concentrations less than 4 ppb.**
- Method Detection Limit (MDL) = 2 ppb since Nov. 2005; non-detect samples graphed at MDL.
- **California Public Health Goal (PHG) = 6 ppb.**

APPENDIX A: MAPS

1. Southern California, Southern Nevada and Western Arizona



2. Las Vegas Wash and Lake Mead Perchlorate Monitoring Locations



3. Lake Mead and Lower Colorado River Perchlorate Monitoring Locations



APPENDIX B: BACKGROUND

1. Discovery and Magnitude of the Perchlorate Problem

- In mid - 1997 the Metropolitan Water District of Southern California discovered perchlorate in the lower Colorado River due to a more sensitive test method, and traced the contamination to Lake Mead and the Las Vegas Wash. Ultimately, the source of the perchlorate was traced to the Kerr McGee (**now Tronox**) Chemical Plant in Henderson, Nevada.
- Since 1997 the Nevada Division of Environmental Protection and the US Environmental Protection Agency have been working closely with Kerr McGee/**Tronox** to achieve source control and reduce perchlorate releases to Las Vegas Wash as quickly as possible.
- Kerr McGee Chemical Company (KMCC) - perchlorate production was initiated in 1945; full commercial production of ammonium perchlorate began in 1951 under prior owners/operators; Kerr McGee acquired the property in 1967; **name changed to Tronox in November 2005.**
- Perchlorate contaminated ground water from the Kerr McGee/**Tronox** plume flows north about 3 miles from **Tronox** to Las Vegas Wash. **Tronox** is the most significant source of perchlorate entering LVW; prior to controls, the **Tronox** plume released about 900 to 1000 pounds per day (average) to Las Vegas Wash (LVW).
- These perchlorate releases to Lake Mead and the Lower Colorado River have impacted the drinking water supply of 15 to 20 million people in Arizona, southern California, southern Nevada, Tribal nations and Mexico.
- In the last 2 years, concentrations of perchlorate at Saddle Island (AMSWTF Raw Water) in Lake Mead have ranged from **2 to 8 ppb** which is below the recently adopted US EPA reference dose drinking water equivalent level (DWEL) of 24.5 ppb, but at times greater than California's Public Health Goal of 6 ppb.
- In the last 2 years, concentrations of perchlorate at the Colorado River Aqueduct near Parker Dam have ranged from non-detect (ND = **2 ppb**) to **5.6 ppb**, which is below the recently adopted US EPA reference dose drinking water equivalent level (DWEL) of 24.5 ppb. Since June 2002, all of the monthly samples have been at or below California's Public Health Goal of 6 ppb. In 2004 nine of the twelve monthly samples were non-detect (ND = 4 ppb). **In 2005 all twelve monthly samples were less than 4 ppb.**
- This report addresses only the perchlorate releases from **Tronox and AMPAC** in Henderson, Nevada and their impacts on Las Vegas Wash, Lake Mead and the lower Colorado River. There are many other perchlorate releases throughout the United States which have created their own separate and distinct perchlorate plumes. This report does not address any of these other releases.

2. Status of Applicable Perchlorate Standards

- In 1992 EPA adopted a federal provisional reference dose drinking water equivalent level (DWEL) of 4-18 ppb.
- In January 2002 EPA proposed a new reference dose for perchlorate of 0.00003 mg/kg, with an associated drinking water equivalent level of 1 ppb, but this reference dose was never finalized. **In order to resolve disagreements about how to interpret the health effects**

data, the National Academy of Sciences (NAS) reviewed these data for perchlorate and issued their report to EPA on January 10, 2005. The NAS recommended a reference dose of 0.0007 mg/kg.

- On February 18, 2005 EPA adopted a perchlorate reference dose of 0.0007 mg/kg/day, **which can be used to calculate** a drinking water equivalent level (DWEL) of 24.5 ppb, assuming that all perchlorate exposure comes from drinking water, **and using standard adult body weight and water consumption estimates.**
- **On January 26, 2006 “Assessment Guidance for Perchlorate” was issued by EPA’s Office of Solid Waste and Emergency Response (OSWER), which recommends using 24.5 ppb as a starting point for evaluation of federal cleanup sites.**
- **EPA is currently working to determine whether or not a national drinking water regulation for perchlorate would present a meaningful opportunity for health risk reduction.**
- In November 2002 the state of California proposed a Public Health Goal (PHG) for perchlorate of 2-6 ppb and adopted a final PHG of 6 ppb on March 11, 2004.
- California expects to adopt a drinking water standard for perchlorate in 2006.
- The state of Nevada uses a perchlorate “provisional **action** level” of 18 ppb.

3. Tronox Control Strategy and Current Status

- Control Strategy: capture and treat perchlorate at three locations:
 - On **Tronox** property where perchlorate is most concentrated,
 - At Athens Road about midway between **Tronox** and Las Vegas Wash where there is a narrow subsurface channel that makes effective capture possible, and
 - Near Las Vegas Wash where capture will have the most immediate impact on reducing releases to Las Vegas Wash.
- Current Status:
 - On **Tronox** property - source control achieved in October 2001; slurry wall (1700 feet long & 60 feet deep) and 22 extraction wells captured an average of 1050 pounds per day in 2003, **940** in 2004 and **1050 pounds per day in 2005** (“virtually complete capture”).
 - At Athens Road - 8 extraction wells began regular operation in October 2002; they captured an average of 790 pounds per day in 2003, 760 in 2004 and **770 pounds per day in 2005** (an estimated 90 - 98% of the mass flow).
 - Near Las Vegas Wash - seep and 10 extraction wells capture an estimated 70 - 90% of the mass flow. As expected, mass removal rates at this location have decreased **significantly** due to perchlorate removal by the upstream wells at Athens Road (from about 700 lbs/day in April/May/June 2003 to about **85 - 135 lbs/day in August through December 2005**).
- Water Treatment - A total of 1000 gpm of water captured from the three locations is treated using a biologically-based fluidized-bed reactor (FBR), then discharged back to LVW. The FBR treatment plant was in startup/shakedown mode for most of 2004, but successfully completed a 30-Day Performance Test in October/November, and is now fully operational. It has a treatment capacity of about 1000 gpm and removes about 99.99% of the perchlorate. The perchlorate concentrations in the treatment plant effluent are less than 18 ppb (1000 gpm at 18 ppb equates to about **0.21** pounds per day of perchlorate to Las Vegas Wash). The FBR

has replaced the previously used ion exchange treatment units.

- Summary - engineered controls are in place and removing 1700-2000 pounds (almost 1 ton) per day of perchlorate from the **Tronox** plume that flows towards Las Vegas Wash. As of **December 31, 2005**, these control systems have removed more than **1800** tons of perchlorate from the environment.

4. AMPAC's Control Strategy and Current Status

The former **AMPAC** perchlorate plant also has a plume of perchlorate, but it is smaller and much less concentrated than the **Tronox** plume. However, the **AMPAC** plume is being investigated and will be remediated.

- **AMPAC** conducted an In-Situ Bioremediation Pilot Study from December 2002 to April 2003; the pilot was successful, reducing perchlorate concentrations from about 500 ppm to less than 2 ppb. During 2003 and 2004 **AMPAC** conducted additional investigation of the nature and extent of their perchlorate plume.
- Nevada Division of Environmental Protection (NDEP) is requiring that **AMPAC** install a remediation system at the leading edge of its plume by **February 2006**.
- The next step would be to install a full scale system at the middle or source of the plume in **2007**.

5. Estimated Travel Times and Flushing Times

It takes time for ground water and surface water to travel from one point to the next (travel time). Even after a source of perchlorate is reduced or eliminated, it takes time for clean water to flush out the contaminated ground water or surface water (flushing time).

- Athens Road to Las Vegas Wash - travel time is estimated to be 7 months; flushing time to reach 4 ppm is estimated to take **28 to 49** months (**4 to 7** travel times)
- Las Vegas Wash Gravels - travel time is estimated to be 6 months; flushing time is estimated to take 18 to **42** months (**3 to 7** travel times)
- Lake Mead - flushing time is likely to be several years; the average residence time of Boulder Basin (the lower part of Lake Mead) is about 10 months.
- Lower Colorado River (below Hoover Dam) - travel time from Hoover Dam to Colorado River Aqueduct intake is estimated to be 3 months; flushing time estimated to be about 1 year; MWD had a contractor investigate this issue - their final report of flushing time estimates was issued on March 25, 2004.
- In late 2003 Flow Science conducted a perchlorate modeling effort for the Metropolitan Water District of Southern California to estimate how long it would take Colorado River perchlorate concentrations to reach target levels under various perchlorate control strategies and hydrological conditions. Their final report was dated March 25, 2004. Assuming 90% capture of all perchlorate sources to Las Vegas Wash (and based on the modeling results from the October 20, 2003 McGinley and Associates report prepared for the Nevada Division of Environmental Protection), the modeling predicts that perchlorate concentrations at the Colorado River Aqueduct intake will reach 4 ppb by mid 2004 and 2 ppb by mid to late 2005. The 2004 and 2005 annual average concentrations at this location were less than 4 ppb. **In November 2005 the method detection limit (MDL) for this sampling location was**

changed from 4 ppb to 2 ppb.

6. Perchlorate Monitoring Trends for 2004 at Each Monitoring Location

The following summaries are based solely on 2004 data; they do not reflect any changes that may have occurred in 2005.

A. Mass Loading in Las Vegas Wash at North Shore Road

- Has declined about 50% in 2004 to about 130 lbs/day
- Has ranged from 110-170 lbs/day between May through December 2004
- Further declines to less than 100 lbs/day expected in 2005
- Annual average declined by more than 50% from 374 lbs/day in 2003 to 170 lbs/day in 2004.

B. Ground Water on Kerr McGee Property Above Slurry Wall

- Has declined slightly from 1,500,000 - 1,800,000 ppb (1500 - 1800 ppm) to 1,300,000 - 1,500,000 ppb (1300 - 1500 ppm).
- Monitoring location reflects perchlorate source area; not likely to decrease significantly for many years

C. Ground Water on Kerr McGee Property Below Slurry Wall (M-100)

- Has declined almost 90% since slurry wall installed in October 2001
- Currently about 110,000 to 130,000 ppb (110 to 130 ppm)

D. Ground Water at Athens Road Wells (ART-8)

- Steady at about 400,000 ppb (400 ppm), as expected
- Not likely to decrease for many years

E. Ground Water Below Athens Road Wells (ARP-3)

- Has declined about 80% since Athens Road Wells began continuous operation in October 2002
- Results somewhat erratic; there could be a “stagnant zone” (a nearly flat gradient with low flows) just below Athens Road Wells
- Currently about 90,000 ppb (90 ppm)

F. Ground Water at Seep Area (PC-97)

- Has declined about 95% since Athens Road Wells began continuous operation in October 2002
- Currently about 3,000 ppb (3 ppm)

G. Las Vegas Wash Downstream of Seep Area (LW 5.3)

- Has declined about 75% to 80% since Athens Road Wells began continuous operation in October 2002
- Currently about 60 to 90 ppb

H. Las Vegas Wash at North Shore Road

- Perchlorate concentrations have declined about 50% in 2004 to about 140 ppb
- Further declines to less than 100 ppb expected in 2005

I. Lake Mead at Las Vegas Bay (LVB 2.7/LVB 3.5)

- Seasonal variation from 10 - 100 ppb over the last five years; peaks in spring/summer; valleys in fall/winter
- On 12/16/03 sampling location moved to LVB 3.5 due to low water elevations in Lake Mead
- No clear trend (except seasonal variation) from 2000 to 2003; summer time peak in 2004 shows a decrease of about 60% compared to 2002 and 2003.

J. Lake Mead at Saddle Island

- Concentrations began to decline in late 2003; declines continued in 2004
- Monthly average concentrations ranged from 4.2 ppb to 4.7 ppb between July through November 2004, the five lowest values in more than 5 years of data
- November and December 2003 monthly average peaks were both 10.5 ppb, about 35% lower than previous 3 year's peaks (2000, 2001 and 2002)
- November and December 2004 monthly averages were 4.7 and 7.2 ppb, respectively. The two month average (6.0 ppb) is more than 40% lower than the November/December 2003 average of 10.5 ppb.
- 2004 annual average was 5.6 ppb, a decrease of about 40% from the 2003 annual average of 9.8 ppb, and a decrease of almost 60% from the 2000 annual average of 13.1 ppb.
- On June 29, 2004 the intake depth was lowered from 1050 feet to 1000 feet, which would be expected to decrease perchlorate concentrations.

K. Colorado River Below Hoover Dam (Willow Beach)

- Peak concentrations have gradually declined from about 10 ppb to about 6 ppb since seep capture began in November 1999
- Concentrations declined to 2.8 ppb in August, 2.5 ppb in September and 2.0 ppb in October 2004; the 3 lowest values ever measured at this location
- Annual average concentrations have declined from 6.5 ppb in 2000 to 3.8 ppb in 2004 (about a 40% decrease).
- Further declines expected in 2005

L. Colorado River at Colorado River Aqueduct

- Peak concentrations have gradually declined from 9 ppb to less than 6 ppb since seep capture began in November 1999
- In 2004 nine of the twelve monthly samples were non-detect (ND = 4 ppb)
- Annual average concentrations have declined from 6.4 ppb in 2000 to less than 4 ppb in 2004 (about a 50% decrease)
- Modeling conducted for MWD predicts that concentrations will reach 2 ppb by the end of 2005.

7. 2003 Perchlorate Monitoring Trends at Each Monitoring Location

The following summaries are based solely on 2003 data; they do not reflect any changes that occurred in 2004.

A. Mass Loading in Las Vegas Wash at North Shore Road

- Has declined about 50% in 2003 to about 275 lbs/day
- Has “leveled off” at 250-280 lbs/day in October/November/December 2003
- Further declines to about 100 lbs/day expected in 2004

B. Ground Water on Kerr McGee Property Above Slurry Wall

- Steady at 1,500,000 - 1,800,000 ppb (1500 - 1800 ppm), as expected
- Monitoring location reflects perchlorate source area; not likely to decrease for many years

C. Ground Water on Kerr McGee Property Below Slurry Wall (M-100)

- Has declined about 80% since slurry wall installed in October 2001
- Currently about 160,000 ppb (160 ppm)

D. Ground Water at Athens Road Wells (ART-8)

- Steady at 400,000 - 450,000 ppb (400 - 450 ppm), as expected
- Not likely to decrease for many years

E. Ground Water Below Athens Road Wells (ARP-3)

- Has declined 50% - 60% since Athens Road Wells began continuous operation in October 2002
- Results erratic; there could be a nearly flat gradient with low flows just below Athens Road Wells
- Currently about 220,000 ppb (220 ppm)

F. Ground Water at Seep Area (PC-97)

- Has declined about 90% since Athens Road Wells began continuous operation in October 2002
- Currently about 10,000 ppb (10 ppm)

G. Las Vegas Wash Downstream of Seep Area (LW 5.3)

- Has declined about 75% since Athens Road Wells began continuous operation in October 2002
- Currently about 80 to 90 ppb

H. Las Vegas Wash at North Shore Road

- Perchlorate concentrations have declined about 50% to 60% in 2003 to about 200 - 270 ppb
- Further declines to about 100 ppb expected in 2004

I. Lake Mead at Las Vegas Bay (LVB 2.7)

- Seasonal variation from 20 - 100 ppb; “peaks” in spring/summer; “valleys” in fall/winter
- No clear trend (except seasonal variation) during last 3 years
- On 12/16/03 sampling location moved to LVB 3.5 due to low water elevations in Lake Mead

J. Lake Mead at Saddle Island

- Concentrations appear to be declining in late 2003; further declines expected in 2004
- Monthly average concentrations declined to 5.9 ppb in September and 6.6 ppb in October 2003, the 2 lowest values in more than 4 years of data
- November and December monthly average peaks were both 10.5 ppb, about 35% lower than previous 3 years peaks (2000, 2001 and 2002)
- 2003 annual average was 9.8 ppb, about the same as 2001 (10.4 ppb) and 2002 (9.9 ppb); lower lake levels have likely prevented decreases in annual average concentrations

K. Colorado River Below Hoover Dam (Willow Beach)

- Peak concentrations have gradually declined from about 10 ppb to about 7 ppb since seep capture began in November 1999
- Concentrations declined to 3.4 ppb in September and 3.0 ppb in October 2003; the 2 lowest values ever measured at this location
- Further declines expected in 2004

L. Colorado River at Colorado River Aqueduct

- Peak concentrations have gradually declined from 9 ppb to less than 6 ppb since seep capture began in November 1999
- Recent concentrations have ranged from non-detect (ND = 4 ppb) to 6 ppb

- Annual average concentration has declined from 6.4 ppb in 2000 to 4.8 ppb in 2003 (a 25% decrease)
- Further declines expected in 2004