Final Draft

Health Consultation

Perchlorate in the Colorado River

Below Hoover Dam, Mohave County, AZ

Prepared by

Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services

Summary

INTRODUCTION

In the *Perchlorate in the Colorado River*, the Arizona Department of Health Services' (ADHS') top priority is to ensure that the community and residents have the best information possible to safeguard their health.

This report was written in response to a request from the Director of the Arizona Department of Health Services (ADHS) who is concerned about the level of perchlorate detected in the Colorado River. The Environmental Toxicology Program was asked to evaluate the public health risks due to exposure to perchlorate in Colorado River water.

CONCLUSIONS

ADHS concludes that: The detected levels of perchlorate are not expected to harm the health of people. Therefore, ADHS does not consider that there is a health threat to people who are exposed to perchlorate in Colorado River water.

BASIS FOR DECISION

The estimated 95% upper confidence limit (UCL) of the arithmetic mean is lower than the EPA's Interim Health Advisory and Arizona's Health Based Guidance Level.

NEXT STEPS

ADHS will continue to review and evaluate water monitoring results from the site when data are acquired by the agencies overseeing the site. ADHS will attend public meetings, make presentations, and develop educational information on the public health implications of perchlorate when requested by the community or other agencies.

FOR MORE INFORMATION

If you have concerns about your health, you should contact your health care provider. Please call ADHS at 602-364-3128 and ask for more information on the Perchlorate site.

Purpose

Low levels of perchlorate have been found in some drinking water supplies which use Colorado River water as source water. Elevated levels of perchlorate can cause inhibition of iodine uptake from the thyroid, which may lead to decreased production of thyroid hormone. Because thyroid hormones perform important functions throughout the body, many normal body activities also are affected by the lower hormone levels. Therefore, ADHS' Director asked the Environmental Toxicology Program to evaluate the perchlorate water monitoring results from Colorado River to see if they are at levels harmful to people's health.

Background and Statement of Issues

In 1997, perchlorate was discovered in the lower Colorado River as a result of a new and more sensitive method. It was found that the contaminants originated from manufacturing operations at the Kerr McGee Chemical Company (KMCC) in Henderson, Nevada. The previous owner began production of perchlorate in the early 1950s. KMCC (currently Tronox LLC) purchased the property and continued the production until 1967. Perchlorate-containing water was discharged into unlined evaporation ponds and contaminated the aquifer. The perchlorate-containing water leached into the Las Vegas Wash, Lake Mead and ultimately the Colorado River, affecting the drinking water supply of 15 to 20 million people in Arizona, southern California, southern Nevada, Tribal nations and Mexico (US EPA 2010).

Perchlorate can affect the iodine uptake ability of the thyroid gland. Iodine is required for the production of thyroid hormone which regulates many body functions after they are released into the blood. Based on the study conducted by Greer et al (2002), the National Research Council (NRC) considered that 7 micrograms per kilogram per day (µg/kg/day) is the No-Observed–Effect Level[1] (NOEL) for perchlorate-induced inhibition of iodine uptake from the thyroid (NRC 2005). US Environmental Protection Agency's (US EPA's) Integrated Risk Information System (IRIS) established a Reference Dose[2] (RfD) for perchlorate by applying an uncertainty factor of 10 to account for the differences in sensitivity among the population. US EPA also determined that perchlorate is not likely to be carcinogenic to humans at the level below those affecting the thyroid function (US EPA 2005). Currently, there is no federal drinking water standard for perchlorate. In 2009, EPA issued an Interim Health Advisory level of 15 micrograms per liter of water (µg/L) for perchlorate (US EPA 2008). Arizona lowered the previous Health Based Guidance Level[3] (HBGL) for perchlorate in drinking water to 11 µg/L based on the RfD of 0.7 µg/kg/day and child exposure assumptions.

ADHS' Director asked the Environmental Toxicology Program to evaluate the water monitoring results to see if they are at levels harmful to people's health because low levels of perchlorate have been found in some drinking water supplies which use Colorado River water as source

[1] No-Observed-Effect-Level (NOEL): An exposure level which does not cause observable harm between the exposed population and its appropriate control.
[2] Reference Dose (RfD): A numerical estimate of a daily oral exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime.
[3] Health Based Guidance Level (HBGL): Concentrations of contaminants in drinking water that are protective of public health during long-term exposure.

water. Perchlorate concentrations are monitored at Lake Mead and the Lower Colorado to measure the remediation efforts in Henderson, Nevada. The water samples collected from the location below Hoover Dam, at Willow Beach, were used in this evaluation report. The samples are intended to measure perchlorate concentrations in water entering the Colorado River. In addition, the previous studies indicated that the perchlorate concentrations are consistent along the Colorado River in the Arizona region (personal communication with Mr. Kevin Mayer, US EPA Region 9.)

Discussion

General Assessment Methodology

ADHS generally follows a three-step methodology to assess public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, ADHS identifies exposure pathways, and then uses health-based comparison values to find those contaminants that do not have a realistic possibility of causing adverse health effects. For the remaining contaminants, ADHS reviews recent scientific studies to determine if the extent of environmental contamination indicates a public health hazard.

Environmental Data

From 1999 to 2010, forty-three water samples were sampled by the US Geological Survey (USGS) and analyzed for perchlorate by US EPA Region 9 Laboratory. The concentration of perchlorate was determined by iron chromatography and the detection limit was 2 parts per billion (ppb). The detected concentrations ranged from 1.3 to 9 µg/L (Table 2).

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation because adverse health impacts can only happen if people are exposed to contaminants. The presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant. Exposure pathways have been divided into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways: (1) a source of contamination, (2) a media such as soil or ground water through which the contaminant is transported, (3) a point of exposure where people can contact the contaminant, (4) a route of exposure by which the contaminant enters or contacts the body, and (5) a receptor population. Completed pathways exist when all five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring presently. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. ADHS generally evaluates completed and potential pathways to determine if there are potential public health impacts. In eliminated pathways, at least one of the five elements is or was missing, and will never be present.

Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

The most likely human exposures are by consuming perchlorate-containing water through drinking or cooking. Residents can also be exposed to the perchlorate-containing water via dermal contact during bathing/showering or other household activities. However, it is unlikely that dermal absorption of perchlorate would pose a concern for human health and will not be considered in this health consultation. Inhalation is also not a significant exposure pathway. People are not likely to breathe in dangerous levels of perchlorate due to its low vapor pressure.

Table 1. Exposure pathway evaluation

Exposure Pathway Elements					Time Frame	Type of Exposure Pathway
Source	Media	Point of Exposure	Route of Exposure	Estimated Exposed Population		
Manufacturing wastes	Water	Residences	Ingestion, dermal contact	Residents	Past	Completed
					Current	Completed
					Future	Potential

Comparison to environmental and health-based comparison values

The environmental and health-based comparison values (CVs) are screening tools used with environmental data relevant to the exposure pathways. The environmental and health-based CVs are concentrations of contaminants that the current public health literature suggest are "safe" or "harmless." These comparison values are quite conservative, because they include ample safety factors that account for the most sensitive populations. ADHS typically uses comparison values as follows: if a contaminant is never found at levels greater than its CV, ADHS concludes the levels of corresponding contamination are "safe" or "harmless." If, however, a contaminant is found at levels greater than its comparison value, ADHS designates the pollutant as a *contaminant of interest* and examines potential human exposures in greater detail.

Comparison values are based on extremely conservative assumptions. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels greater than the comparison value may or may not lead to a health effect. Therefore, the comparison values should not be used to predict the occurrence of adverse health effects.

ADHS used the 95% upper confidence limit (UCL)[4] of the arithmetic mean as the exposure point concentration as recommended by EPA (USEPA 1992). The 95% UCL is used as an estimate of the average perchlorate concentration. It is used because it is a conservative (protective) way to estimate the average concentration of contaminants someone might be exposed to. The statistical software ProUCL was used to estimate the 95% UCL. The result shows that the measured concentrations were below the current recommended levels by EPA (15 µg/L) and ADHS (11 µg/L). Therefore, residents are not likely to experience adverse health effects from consuming contaminated water.

Table 2. Summary of the perchlorate concentration in water samples collected from November 30, 1999 to March 1, 2010.

Chemical	Number of samples	Range of detected concentrations (µg/L)	95% UCL of the Average Concentration[1] (µg/L)	Health-based comparison values (CVs) (µg/L)		Number of samples exceeded CV	Is it a contaminant of interest?
Perchlorate	43	1.3 - 9	4.6	11	HBGL[2]	0	No

1. 95% upper confidence limit (UCL) of the arithmetic mean
2. HBGL: Arizona Health Based Guidance Level for drinking water

Child Health Considerations

ADHS considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. In general, ADHS assumes that children are more susceptible to chemical exposures than are adults. Children six years old or younger may be more sensitive to the effects of pollutants than adults because their organ systems are not fully developed, and they consume more food on a per mass basis as compared with adults.
If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. The CVs used in this health consultation were developed to be protective of susceptible populations such as children.

Conclusions

The detected levels of perchlorate in water samples collected from the lower Colorado River are not expected to harm the health of people. The estimated 95% upper confidence limit (UCL) of the arithmetic mean is lower than the EPA's Interim Health Advisory and Arizona's Health Based Guidance Level. Therefore, ADHS does not consider that there is a health threat to people who are exposed to perchlorate in the Colorado River water.

[4] A confidence interval is bounded by the lower and upper confidence limits (UCLs). A confidence interval of the arithmetic mean gives an estimated range of averages which is likely to include the true average of the sampled population (*population mean*), and the estimated range is calculated from a given set of samples (*sample mean*). The 95% confidence interval is the region about the *sample mean* that is likely to contain the underlying *population mean* (representing the whole site itself) with a probability of 95%.

Recommendations

- Continue to monitor the perchlorate level for the protection of public health

Public Health Action Plan

- ADHS will continue to review and evaluate water monitoring results from the site when data are acquired by the agencies overseeing the site.
- ADHS will attend public meetings, make presentations, and develop educational information on the public health implications of perchlorate when requested by the community or other agencies.

References/Information Sources

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US EPA (Environmental Protection Agency). 2010. ProUCL Version 4.00.05: User Guide (draft). EPA/600/R-07/038, May 2010

Prepared by

Hsin-I Lin, ScD

Office of Environmental Health
Bureau of Epidemiology and Disease Control
Arizona Department of Health Services

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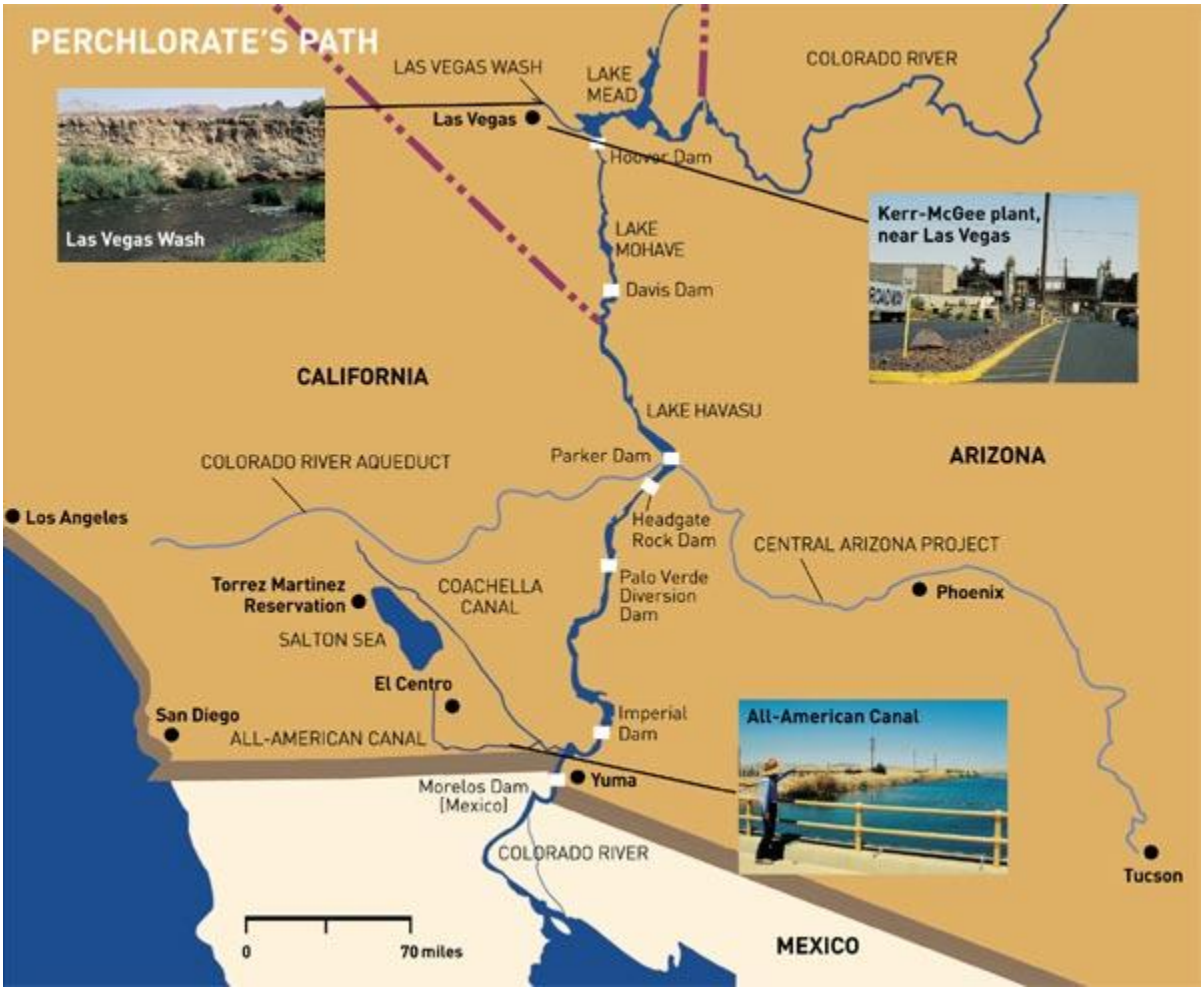
Appendix A



Map to show the location of Kerr McGee plant and perchlorate's path. The map is adapted from: http://www.epa.gov/region9/toxic/perchlorate/per_nv.html