

Stormwater Runoff Water Quality Science/Engineering Newsletter
Devoted to Urban/Rural Stormwater Runoff
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This issue of the Stormwater Runoff Water Quality Science/Engineering Newsletter is devoted to providing information on **unrecognized pollutants** and a recent US EPA workshop devoted to **Pharmaceuticals in the Environment**. Included in this Newsletter is a section on unrecognized pollutants authored by Drs. Anne Jones-Lee and G. Fred Lee that was published in the **Water Encyclopedia**. (This discussion of unrecognized pollutants is adapted from NL 7-3, published in March 2004.) Also included in this Newsletter are several announcements of meetings, conference proceedings and other materials that may be of interest to readers of this Newsletter.

Announcements

The **California Lake Management Society** will hold its 20th annual CALMS conference on October 13 and 14, 2005, at North Lake Tahoe, California. This conference will be devoted to Lake Tahoe: Research and Development. Lake Tahoe is an example of how watershed development can adversely impact a waterbody's water quality. Additional information on this conference and CALMS is available at <http://www.nalms.org/calms/>.

US EPA NPS News-Notes Issue 76 is Now Online at www.epa.gov/newsnotes. This newsletter contains information on several issues related to nonpoint source water quality monitoring and management. Notification of NPS News-Notes can be received electronically, by joining the News-Notes Notification Listserv online at the above address.

The **California Nonpoint Source Encyclopedia** (NPS Encyclopedia) has been updated. To access the August 2005 NPS Encyclopedia, visit the website at <http://www.waterboards.ca.gov/nps/encyclopedia.html>.

“The NPS Encyclopedia is a condensed, quick-reference guide that provides an entry point to information on nonpoint source management practices in California. It includes a brief discussion of the main elements and intent of the 61 nonpoint source management measures for each of the six nonpoint source categories (agriculture; forestry; urban areas; marinas and recreational boating; hydromodification; and wetlands, riparian areas, and vegetated treatment systems). It also includes descriptions of management practices and how they can be used to meet each management measure, as well as their applicability to various situations in California and their cost-effectiveness in different climatic and land use settings. The information in the NPS Encyclopedia is intended to assist state agencies, regional boards, local agencies, and nonpoint source practitioners in identifying and implementing practices to protect high-quality waters and restore impaired waters.”

For further information on the California NPS Encyclopedia contact Diane Edwards at dedwards@waterboards.ca.gov. More information on California's Nonpoint Source Program (reducing polluted runoff to our state's waters), is available at <http://www.waterboards.ca.gov/nps/index.html>.

The **California Third Annual NPS Pollution Conference** will be held November 7-9, 2005, in Sacramento, California. Information on this conference is available at <http://www.swrcb.ca.gov/nps/fall2005.html>.

“The California Nonpoint Source Conference will bring together leaders from the agriculture, urban, forestry, marinas and other NPS categories, scientists and technical people, including managers, consultants, and industry staff, as well as policy makers and agency representatives and others to exchange ideas, successes, and lessons learned to improve future water quality programs and related watershed projects. This event will build on the successful 2003 NPS Conference, which was attended by more than 200 people. Conference participants will be able to learn from speakers who are implementing on-the-ground NPS projects throughout California with federal and/or state funds (e.g., CWA Section 319, and Propositions 13, 40, and 50). The conference will focus on the importance of designing projects to achieve measurable water quality improvements, and on techniques for monitoring results.”

The 4th national **Nonpoint Source and Stormwater Pollution Education Programs** conference will be held October 17-20, 2005, in Chicago, Illinois. The conference is sponsored by the Chicago Botanic Garden and the US EPA. Information on the conference is available at www.chicagobotanic.org/aquatics/nonpoint.

The **2005 National Forum on Contaminants in Fish** will be held in Baltimore, Maryland, September 18-21, 2005. Information on the conference is available at <http://epa.gov/waterscience/fish/forum/2005/>.

“The general sessions for the 2005 Forum include

- *Updates from EPA and FDA on their activities related to risks and benefits of fish consumption;*
- *Special session on Mercury;*
- *Health risks and benefits of consuming fish;*
- *Risk communication;*
- *Federal and state monitoring programs;*
- *Updates on selected chemicals of concern including PBDEs, Mercury, and PCBs.”*

The proceedings will be posted on the US EPA website about three months after the conference at <http://www.epa.gov/waterscience/fish/>.

The US EPA **EMAP 2004 Symposium** abstracts and PowerPoint presentations have been posted at <http://www.epa.gov/emap/html/pubs/docs/groupdocs/symposia/symp2004/>.

This symposium included several presentations on

- *“Monitoring the Condition of Aquatic Resources;*

- *Methods to Integrate Monitoring and Assessment for Clean Water Act [305(b)/303(d)] Reporting;*
- *Monitoring to Establish Aquatic Life Uses, Develop Criteria, and Evaluate Use Attainment;*
- *Wetlands;*
- *Implementing EPA's Guidance to States Pursuant to Section 303(d) & Section 305(b) of the Clean Water Act;*
- *Criteria for Aquatic Life Use, Attainment and Reference Condition Assessment;*
- *Cross Media;*
- *Design Based approaches for estimating approaches to 305(b)/303(d) information;*
- *Physical Criteria;*
- *Lakes;*
- *Nutrient Criteria;*
- *Landscape characterization and model based approaches for estimating conditions or impairment of waterbodies.”*

Other Stormwater Newsletters. Steve Rosenbaum of Foley Lardner LLP, San Diego, California, periodically releases *Stormwater News*, which is available at no cost via email from srosenbaum@foley.com. “*This newsletter is a source of recent regulatory and policy information on stormwater and other water-related news.*” The August 29, 2005, *Stormwater News* contains information on the California Water Resources Control Board’s convening a panel of stormwater experts to consider numeric discharge limits for stormwater permits. This panel will meet on September 14, 2005, and the meeting will be open to the public.

“The specific questions the State Water Board has asked the panel to answer are:

- *Is it technically feasible to establish numeric effluent limitations, or some other objective criteria, for inclusion in storm water permits?*
- *How would such limitations or criteria be established, and what information and data would be required?*

The answer should address industrial general permits, construction general permits, and area-wide municipal permits. In evaluating establishment of any objective criteria, the panel should address all of the following:

- *The ability of the Water Board to establish appropriate objective limitations or criteria;*
- *How compliance determinations would be made;*
- *The ability of dischargers and inspectors to monitor for compliance; and*
- *The technical and financial ability of dischargers to comply with the limitations or criteria.*

The panel’s response should address each of the types of permits (industrial, construction, and municipal).”

The agenda for this meeting is posted at <http://www.waterboards.ca.gov/stormwtr/index.html>.

The issue of application of water quality criteria/standards has been discussed in detail in NL 1-2, 1-3, 1-5, 1-6/7, 2-2, 5-4, 6-8, 6-9, 7-2, 7-3, 7-5, 7-6/7 and 8-4. These are available at <http://www.gfredlee.com/newsindex.htm>. Based on serving as a member of the US EPA peer

review panel that developed the current approach for establishing the water quality criteria and state standards based on these criteria, the author (G. Fred Lee) has pointed out that the current US EPA water quality criteria were not developed for application to urban, highway and agricultural stormwater runoff. The application of these criteria to stormwater runoff, where there can be no more than one exceedance every three years, will overregulate stormwater-runoff-associated constituents. This will lead to massive expenditures by the public on the order of \$5 to \$10 per person per day by the populations served by the municipal stormwater sewer system for the development and operation of stormwater runoff advanced wastewater treatment processes. Several years ago the US EPA recommended wet weather criteria to more appropriately regulate urban and highway stormwater-runoff-associated potential pollutants. It will be of interest to examine the results of the State Water Board Expert Panel deliberations on the issue of establishing water criteria/standards/objectives for NPDES permitted stormwater runoff.

California Department of Transportation, Division of Environmental Analysis, Office of Storm Water Policy periodically releases via email its *Water Quality NewsFlash*. This newsletter is developed by Fred Kreiger. To be added to the email list, contact fkrieger@msn.com. The Caltrans contact for this newsletter is Betty Sanchez (Betty_Sanchez@dot.ca.gov). Her telephone number is (916) 653-2115. These newsletters are posted online at <http://www.dot.ca.gov/hq/env/stormwater/publicat/newsflash/index.htm>.

The September/October 2005 issue of *Stormwater* contains an article, “**Urban Stormwater Runoff Aquatic Life Toxicity: An Update,**” by Lee and Jones-Lee. This article is adapted from NL 8-1/2, February 2005. *Stormwater* is published by Forester Communications, Santa Barbara, CA (www.forester.net). *Stormwater* is published seven times a year and is distributed at no cost to over 21,000 subscribers. Those interested in receiving a copy of *Stormwater* may subscribe online at www.forester.net/sw_subscribe.html.

Pharmaceuticals in the Environment

The US EPA recently held a 2.5-day workshop on Pharmaceuticals in the Environment. The agenda for this meeting is at <http://www.scgcorp.com/pharmaceuticals/agenda.asp>. According to the meeting announcement the “overall goals for the workshop” were to

- *“Provide an opportunity for STAR grantees to present the results of their research. (Summaries of the grantees' projects can be accessed at <http://epa.gov/nerlesd1/chemistry/pharma/star.htm>.)*
- *Identify research “gaps” important to addressing decisions and/or policy-making issues associated with pharmaceuticals in the environment.*
- *Provide an opportunity for information sharing among scientists and policy-makers from EPA’s program offices, regions, and the Office of Research and Development, as well as from States, local agencies, research entities and stakeholders, about the state-of-the science regarding the presence, fate, and effects of pharmaceuticals in the environment and techniques and tools for Regions’ and/or States’ monitoring programs.*
- *To the extent there is a problem, identify ways that EPA can be part of the solution by improving the understanding of “institutional barriers” and discussing programmatic approaches (headquarters and Regions).*

- *Explore the use of voluntary, collaborative approaches to reducing pharmaceuticals in the environment that include Regions and Program Offices, States, Tribes, other federal agencies, and stakeholders.”*

Based on the presentations made at this workshop, it has been well established that domestic and some other wastewaters and stormwater runoff from urban and some agricultural areas contain pharmaceuticals and other chemicals at concentrations that are a potential threat to domestic water supply water quality and surface water and groundwater quality. The sources of these chemicals include domestic wastewater excretion by individuals taking the pharmaceuticals and individuals discarding pharmaceuticals in their wastewaters, confined animal feeding operations, dairies, landfill leachate (through leakage from the landfill and leachate management at POTWs), stormwater runoff from urban areas and agricultural areas where sewage sludge (biosolids) and animal manure are managed, where the animals and/or animal feed has been treated with pharmaceuticals.

Several papers at the workshop provided information on the concentrations of various pharmaceuticals found from various sources and on the fate/persistence of the pharmaceuticals in wastewater collection and treatment and in ambient waters. Studies are being conducted on the ability of domestic wastewater treatment plants to remove pharmaceuticals. There is increasing evidence that some fish taken from near domestic wastewater discharges/outfalls experience feminization of male fish. The significance of this to the fish populations in those areas is not known.

Further, there is concern about the finding that acute/chronic toxicity ratios for aquatic life for some pharmaceuticals are on the order of 50,000 to 150,000. Typically, for the currently regulated pollutants, the ratio of the acute toxicity concentration to the chronic safe concentration is on the order of 10 to 100. In general, pharmaceuticals are developed to have biological effects (in man and/or animals) at low concentrations without causing toxicity to the treated organism. There is too little data on the chronic toxicity of many pharmaceuticals to aquatic life to know how common very high acute/chronic ratios are. There is also concern that some pharmaceuticals, while not toxic in the classical sense, cause behavioral changes in some aquatic life that would in the long term affect aquatic life populations in the area where the pharmaceuticals are found.

At the workshop Al Alwan of the US EPA Region 5 presented his views (not necessarily those of the US EPA) on “*Managing Emerging Contaminants: A Practical Approach.*” His presentation included a summary of the major issues on emerging contaminant issues. Two of his PowerPoint slides presented a summary of the current situation in investigating and managing pharmaceuticals and personal care products (PPCPs) in the environment. These slides are presented below:

“Quick Review of emerging contaminants Issues

- *The characteristics of many emerging contaminants are (low levels, multiple sources, long-term not emergency issue)*
- *Create a concern about possible estrogenic and other effects, both to wildlife and humans*
- *No standardized biological test available*

- *EPA does not have approved chemistry methods to detect many of these chemicals*
- *Enter aquatic environment from point and non-point sources*
- *The environment fate and transportation information are lacking*
- *Policies to address these contaminants are complicated by differing mandates of agencies (EPA, FDA, others)*
- *We need new tools to help us address this issue thus our approach.”*

Mr. Alwan’s presentation includes information on these and related issues. The complete set of his abstract and PowerPoint slides will be available in the workshop proceedings. It is the author’s (G. Fred Lee’s) assessment that Mr. Alwan’s summary correctly presents the current situation on investigating/managing emerging chemicals in wastewaters, landfill leachate and ambient waters.

The abstracts and PowerPoint slides of the workshop presentations are to be made available in about a month at <http://es.epa.gov/ncer/publications>.

The PowerPoint presentation at the workshop by Dr. Christian Daughton, Chief of the Environmental Chemistry Branch, National Exposure Research Laboratory, Office of Research and Development, US EPA, Las Vegas, Nevada, “Overview of Science Involved with Pharmaceuticals,” is available from gfredlee@aol.com upon request. Background information on Pharmaceuticals and Personal Care Products (PPCPs) as Environmental Pollutants is available at

<http://www.epa.gov/nerlesd1/chemistry/pharma/>


and at

<http://www.epa.gov/nerlesd1/chemistry/ecb-posters.htm>.

Unrecognized Environmental Pollutants¹

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Abstract

The US water pollution control program focuses on the current 126 Priority Pollutants originally selected without peer review in the mid-1970s through a litigation settlement. That notwithstanding, they remain the focal point of water quality investigations. Limited attention is given to the many thousands of potential pollutants that are in municipal and industrial liquid and solid wastes. Periodically, unregulated chemicals that are in use are discovered to be widespread pollutants, posing a significant threat to public health and/or the environment. One example is the pharmaceuticals and personal care products (PPCPs) used in homes and in agriculture, which are being found in domestic and agricultural waste waters and solid wastes. Another is perchlorate found in highway accident flares. That chemical is being found in surface and groundwaters in concentrations that are a threat to human health. Polybrominated diphenyl ethers (PBDEs) that are used as flame retardants on furniture and other materials are now being found in human breast milk and in some aquatic organisms. Those chemicals pose significant environmental concerns but are not regulated with respect to water quality impacts. Many of these unrecognized pollutant chemicals are not new chemicals but rather have been in the environment for decades. There is need to significantly change the approach used to evaluate the potential for the vast array of chemicals that are in commerce today to cause public health and environmental impacts.

Key Words:

Priority Pollutants, pollutants, Polybrominated diphenyl ethers (PBDEs), Pharmaceuticals and personal care products (PPCPs), perchlorate

Introduction

The US water pollution control program focuses on the control of a limited group of chemicals, the 126 current "Priority Pollutants." The chemicals included on the list of "Priority Pollutants" were originally selected in the mid-1970s through a litigation settlement. The list did not receive appropriate peer review for its representation of the chemical contaminants of most pressing importance to public health and environmental quality. That notwithstanding, the Priority Pollutants remain the focal point of water quality investigation and management. Limited attention is given to the evaluation and regulation of the many thousands of other potential

¹ Reference as **Error! Main Document Only.** Lee, G. F. and Jones-Lee, A., "Unrecognized Environmental Pollutants," *Water Encyclopedia: Surface and Agricultural Water*, Wiley, Hoboken, NJ, pp 371-373 (2005).
<http://www.members.aol.com/annejlee/WileyUnrecognizedPollutants.pdf>

Adapted from Lee, G. F., "Unrecognized Environmental Pollutants," *Stormwater Runoff Science/Engineering Newsletter* 7(3), March (2004).

pollutants that are in municipal and industrial liquid and solid wastes, even in light of the myriad other chemicals currently in commercial and personal household use, and those that come into use annually.

Daughton (2004) highlighted the growing concern about unrecognized, unregulated pollutants, indicating that there are over 22 million organic and inorganic substances, with nearly 6 million commercially available. The current water quality regulatory approach addresses fewer than 200 of these chemicals. He also noted,

“Since the 1970s, the impact of chemical pollution has focused almost exclusively on conventional ‘priority pollutants,’ especially on those collectively referred to as ‘persistent, bioaccumulative, toxic’ (PBT) pollutants, ‘persistent organic pollutants’ (POPs), or ‘bioaccumulative chemicals of concern’ (BCCs).

The ‘dirty dozen’ is a ubiquitous, notorious subset of these, comprising highly halogenated organics (e.g., DDT, PCBs).

The conventional priority pollutants, however, are only one piece of the larger risk puzzle.”

“Regulated pollutants compose but a very small piece of the universe of chemical stressors to which organisms can be exposed on a continual basis.”

Similarly, Dr. K. Hooper of the Hazardous Materials Laboratory, California EPA Department of Toxic Substances Control recently noted (Hooper, 2003),

“Over the past 25 years, tens of thousands of new chemicals (7 chemicals per day) are introduced into commerce after evaluation by USEPA. Few (100-200) of the 85,000 chemicals presently in commerce are regulated. We have reasons to believe that a much larger number than 200 adversely affect human health and the environment.”

Periodically, unregulated chemicals that are in use are discovered to be widespread pollutants, posing a significant threat to public health and or the environment. Examples of such findings and illustration of the need to address the broader issue of previously unrecognized pollutants are presented below.

Examples of Previously Unrecognized Pollutants

Pharmaceuticals and Personal Care Products (PPCPs). Increasing attention is being given to pharmaceuticals and personal care products (PPCPs) as environmental pollutants. At the California Bay Delta Authority (CBDA) Contaminant Stressors Workshop, Dr. Christian Daughton, Chief, Environmental Chemistry Branch, US EPA National Exposure Research Laboratory, addressed this issue in his presentation entitled, *“Ubiquitous Pollution from Health and Cosmetic Care: Significance, Concern, Solutions, Stewardship – Pollution from Personal Actions.”* (Contact Daughton at daughton.christian@epa.gov.)

Daughton (2004) pointed out that a wide variety of chemicals that are introduced into domestic wastewaters are being found in the environment. Various chemicals (pharmaceuticals) used by individuals and to treat pets, outdated medications disposed of into sewerage systems, and treated and untreated hospital wastes discharged to domestic sewerage systems end up in receiving waters for domestic wastewater treatment plant effluents. Further, transfer of sewage solids (“biosolids”) to land, industrial waste streams, landfill leachate, releases from aquaculture of medicated feeds, etc., also introduce these chemicals into the environment. Many of these chemicals are not new and have been present in wastewaters for some time. However, they are only now beginning to be recognized as potentially significant water pollutants and are largely unregulated as water pollutants.

According to Daughton (2004),

“PPCPs [Pharmaceuticals and Personal Care Products] are a diverse group of chemicals comprising all human and veterinary drugs (available by prescription or over-the-counter; including the new genre of ‘biologics’), diagnostic agents (e.g., X-ray contrast media), ‘nutraceuticals’ (bioactive food supplements such as huperzine A), and other consumer chemicals, such as fragrances (e.g., musks) and sun-screen agents (e.g., methylbenzylidene camphor); also included are ‘excipients’ (so-called ‘inert’ ingredients used in PPCP manufacturing and formulation).”

While the full range of impacts of PPCPs is just beginning to be investigated, PPCPs are being found to have adverse impacts on aquatic ecosystems. For example, Daughton (2004) discussed the relationship between PPCPs and endocrine disrupters, which are believed to be responsible for causing sex changes in fish. In addition, in a feature article in *Environmental Science and Technology* Eggen *et al.* (2004) reviewed a number of the issues pertinent to understanding the impacts of PPCPs and other chemicals that can cause endocrine disruption, DNA damage/mutagenesis, deficiencies in immune system and neurological effects in fish and other aquatic life. (Additional information on PPCPs is available at www.epa.gov/nerlesd1/chemistry/pharma/index.htm.)

Perchlorate. Perchlorate (ClO_4^-), used in highway safety flares and other applications, is another example of a chemical that is now being found in surface and groundwaters in sufficient concentrations to pose a threat to human health. Perchlorate is derived from several sources. Silva (2003) of the Santa Clara Valley (CA) Water District, noted the potential for highway safety flares to be a significant source of perchlorate contamination to water, even when the flares are 100-percent burned. According to him, one fully burned flare can leach up to almost 2,000 μg of perchlorate, and

“A single unburned 20-minute flare can potentially contaminate up to 2.2 acre-feet [726,000 gallons] of drinking water to just above the California Department of Health Services’ current Action Level of 4 $\mu\text{g}/\text{L}$ [for perchlorate].”

Silva also pointed out that more than 40 metric tons of flares were used/burned in 2002 alone in Santa Clara County. California’s Office of Environmental Health Hazard Assessment (OEHHA, 2004) recently conducted an evaluation of the hazards of perchlorate in drinking water. The 4

µg/L action level for perchlorate in drinking water was based on the detection limit; it has been revised to 6 µg/L based on the recent OEHHA evaluation.

Polybrominated diphenyl ethers (PBDE). Another unrecognized, unregulated pollutant is the polybrominated diphenyl ethers (PBDEs) used as a flame retardant on furniture and other materials. Hooper (2003) recently discussed finding PBDE in human breast milk and in San Francisco Bay seals, and the fact that archived human breast milk shows that this contamination has been occurring for over 20 years. According to McDonald (2003) of the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment,

“Approximately 75 million pounds of PBDEs are used each year in the U.S. as flame retardant additives for plastics in computers, televisions, appliances, building materials and vehicle parts; and foams for furniture. PBDEs migrate out of these products and into the environment, where they bioaccumulate. PBDEs are now ubiquitous in the environment and have been measured in indoor and outdoor air, house dust, food, streams and lakes, terrestrial and aquatic biota, and human tissues. Concentrations of PBDE measured in fish, marine mammals and people from the San Francisco Bay region are among the highest in the world, and these levels appear to be increasing with each passing year.”

PBDEs are similar to PCBs and are considered carcinogens. Some of the PBDEs are being banned in the US and in other countries.

Pesticides. Another example of unidentified pollutants was given by Kuivila (2000). She discussed the fact that there are approximately 150 pesticides used in California’s Central Valley that are a threat to cause water quality problems in the Delta and its tributaries. The current pesticide water quality regulation program considers only about half a dozen of those.

Conclusions and Recommendations

The presence of untold, unregulated pollutants in environmental systems, as illustrated above with the examples of PPCPs and others, is not unexpected based on the approach that is normally used to define constituents of concern in water pollution control programs. Based on the vast array of chemicals that are used in commerce, many of which are or could be introduced into aquatic systems from wastewater and stormwater runoff, it is likely that many other chemicals will be discovered in the future that are a threat to public health or aquatic ecosystems. There is a pressing need to significantly expand water quality monitoring programs to specifically search for new, previously unrecognized water pollutants. As demonstrated by the perchlorate and PBDE situations, monitoring programs that focus on Priority Pollutants stand to be significantly deficient in properly defining constituents of concern with respect to impairing the beneficial uses of waters.

References

Daughton, C. G., “Pharmaceuticals and Personal Care Products (PPCPs) as Environmental Pollutants: Pollution from Personal Actions,” Presentation at the California Bay-Delta Authority

Contaminant Stressor Workshop, Sacramento, CA, February (2004). Contact Daughton at daughton.christian@epa.gov. Also see <http://search.epa.gov/s97is.vts> and <http://www.epa.gov/esd/chemistry/pharma/tracers.htm>.

Eggen, R. I. L.; Behra, R.; Burkhardt-Holm, P.; Escher, B. I., "Challenges in Ecotoxicology: Mechanistic Understanding Will Help Overcome the Newest Challenges," *Environmental Science and Technology* 38(3):58A-64A, February 1 (2004).

Hooper, K., "Lessons from the PBDEs – The Value of Monitoring Community Body Burdens Using Breast Milk," In: 6th Biennial State of the Estuary Conference, *The San Francisco Bay-Delta Estuary: Changes and Challenges*, San Francisco Estuary Project, Oakland, CA (2003).

Kuivila, K., "Pesticides in the Sacramento-San Joaquin Delta: State of Our Knowledge," Abstracts from the CALFED Bay-Delta Program Science Conference 2000, Sacramento, CA (2000).

McDonald, T. A., "The Risk Posed by the PBDEs, A Class of Flame Retardants," In: 6th Biennial State of the Estuary Conference, *The San Francisco Bay-Delta Estuary: Changes and Challenges*, San Francisco Estuary Project, Oakland, CA (2003).

OEHHA, "OEHHA Announces Health Goal for Perchlorate in Drinking Water," Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA (2004). http://www.oehha.ca.gov/public_info/press/perchloratepress.html

Silva, M. A., "Safety Flares Threaten Water Quality with Perchlorate," Report of Santa Clara Valley Water District (2003). http://www.valleywater.org/Water/Water_Quality/Protecting_your_water/_Lustop/Perchlorate.shtm