



RISK BULLETIN

Perchlorate: An Emerging Environmental Contaminant

INTRODUCTION

This fact sheet provides an overview of technical information and issues associated with this emerging environmental contaminant. Management of sites with suspected or known perchlorate contamination presents a challenge because site investigation and remediation standards are still being evaluated by federal, state, and local regulatory agencies.

PERCHLORATE – WHAT IS IT?

The perchlorate ion (ClO_4^-), in its purest form, is a white or colorless powder. It is found naturally in the environment or as a manufactured product. Perchlorate and its salts (e.g., ammonium perchlorate) are used in solid propellant for rockets, missiles, and fireworks. Perchlorate has a number of industrial uses and is used in matches, flares, pyrotechnics, ordnance, explosives, air bag initiators, paints and enamels, leather tanning, engine oil testing, electropolishing and electroplating.



Perchlorate readily dissolves in water and easily moves from surface to groundwater. Once present in groundwater, perchlorate can persist for many decades. At this time, perchlorate contamination has been found in groundwater in over 35 states, most notably in Arizona, Arkansas, California, Maryland, Massachusetts, Nevada, New York, Texas and Utah.

HEALTH CONCERNS

Perchlorate interferes with iodide uptake into the thyroid gland. Because iodide is an essential component of thyroid hormones, perchlorate disrupts how the thyroid functions. In adults, the thyroid helps to regulate the metabolism. In children, the thyroid plays a major role in proper development, in addition to metabolism. Impairment of thyroid function in pregnant mothers may impact the fetus and result in effects such as changes in behavior, delayed development and decreased learning capability. Drinking water contaminated with perchlorate is the most likely way that perchlorate can be ingested.

EXPOSURE POTENTIAL

Perchlorate regulation is an emerging issue that could lead to potential environmental claims and regulatory re-openers for sites previously issued a formal closure approval by a federal, state or local oversight agency. Concerned parties should continually track regulatory monitoring requirements for groundwater and soil cleanup standards governed by the agencies in their respective states. In particular, California and Massachusetts have been aggressive in developing MCLs and cleanup standards for perchlorate. A rising concern in California is the requirement for all Superfund sites and active remediation sites to sample for emergent chemicals in groundwater. Perchlorate is included as a chemical on this list. Furthermore, all former and active DOD, US Army, and US Air Force sites in California are required to sample for perchlorate in groundwater. This increases the potential for regulatory re-openers in California for sites that have been issued closure approval. The California RWQCB has been active in requiring

active remediation sites in the Los Angeles region to expand their chemical analysis to include perchlorate in their quarterly or semi-annual groundwater monitoring requirements. The discovery of perchlorate for active remediation systems can potentially increase overall remediation costs due to design changes or unforeseen sampling/monitoring expenses.

REGULATORY UPDATE

In 1998, the United States Environmental Protection Agency (USEPA) released an “Interim Assessment Guidance for Perchlorate,” which was then subject to peer review in 1999. The document “Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization,” (November 2002) responded to the recommendations emanating from the peer review. The National Research Council of the National Academies published its technical review in “Health Implications of Perchlorate Ingestion” (January 2005).

From this review, the USEPA has established an official human reference dose (RfD) of **0.0007 mg/kg/day** of perchlorate effective February 2005. A reference dose is a scientific estimate of a daily exposure level that is not expected to cause adverse health effects in humans. The 0.007 mg/kg/D RfD equates to a drinking water equivalent level (DWEL) of **24.5 ppb**. The DWEL is calculated using the RfD multiplied by an adult body weight of 70 kg, and divided by a conservative tap water consumption value of 2 L/day. USEPA has considered this level as a recommended remediation goal for cleaning up perchlorate contamination. Consistent with current practice, final cleanup level determinations should take site-specific information into consideration. A DWEL assumes that all of the contaminant exposure is derived from drinking water and is the concentration of a contaminant in drinking water that will have no adverse effect

with a margin of safety. DWELs are not an enforceable standard.

Establishing drinking water advisory levels and enforceable maximum contaminant levels (MCLs) is the responsibility of federal and state agencies. Prior to 2007, USEPA had not established a perchlorate MCL and only Massachusetts had established a state MCL (2ug/l). States that have developed advisory levels for perchlorate include:

AZ – 14 ug/l

CA – 6 ug/l*

MD – 1 ug/l

NM – 1 ug/l

NY – 5/18 ug/l (5 ug/l for water planning level & 18 ug/l for public notification)

NV – 18 ug/l

TX – 17/51 ug/l (17 ug/l for residential cleanup & 51 ug/l for commercial/industrial)

**In August 2006, California Department of Health Services (DHS) established 6 ug/l as a Public Health Goal (PHG) and proposed a state MCL. Consumer notification is required at concentrations greater than 6 ug/l. Once the standard is adopted, drinking water sources exceeding this limit must be removed from service.*

Other countries have also begun to address perchlorate and Health Canada recommends a drinking water guidance value of 6 ug/l.

FATE IN THE ENVIRONMENT

Much of the focus of perchlorate contamination deals with soil migration and its presence in groundwater. Since perchlorate is highly soluble in water, any precipitation in the form of rainfall or snow melt quickly depletes the ground surface contaminant mass (source) in soils. Perchlorate does not adhere to soil particles; however, dis-

solved perchlorate can be trapped within soil by capillary forces. Dissolved perchlorate can be held between soil particles as a result of retention capacity of the soil matrix. Retention capacity ranges from 0.01% for granite, 3% for sand, to 48% for clay. Retention capacity can provide a general indicator as to whether perchlorate can be retained within the soil column.

SAMPLING AND TESTING FOR PERCHLORATE

Analytical requirements for perchlorate testing vary depending on the regulatory drivers. Use of EPA Method 314.0 ion chromatography (IC) is the current acceptable standard for analysis of



perchlorate in drinking water. The target reporting limit for drinking water using Method 314.0 is 4 ug/l. For US Department of Defense (DOD)-owned drinking water systems, USEPA Method 331.0 liquid chromatography/mass spectrometry (LC/MS) is recommended for analysis of drinking water.

The LC/MS method has a target reporting limit as low as 0.1 ug/l. For soil matrix samples, USEPA Methods 6850 and 6860 using IC/MS are recommended by DOD. The soil target reporting limit for these methods are 2 ug/kg.

REMEDIATION TECHNOLOGIES

Treatment of perchlorate contamination in water is complicated because conventional filtration, sedimentation, and air stripping technologies cannot remove the perchlorate anion. Since 1997, much progress has been made in perchlorate treatment technologies. However, no single treatment technique is effective in every case and the best solution may be a combination of treatment technologies. The following are the most effective treatment technologies available:

1. **Ion Exchange** – Can use water softening process or deionization. Ion exchange has been successful in reducing perchlorate concentrations in water from 75 ppb to less than detectable levels at the San Gabriel Valley Superfund site.
2. **Reverse Osmosis/Nanofiltration** – RO and NF can be costly due to energy use and perchlorate disposal.
3. **Biological** – Effective and fast reaction treatment has been successful in reducing concentrations in water from 75 ppb to less than detectable levels at the Aerojet site. Biological fluidized bed reactors use naturally occurring microorganisms to destroy perchlorate molecules while attached to a fluidized bed of activated carbon media.

CASE STUDY

Olin Corp./Standard Fusee was identified as a source of widespread perchlorate groundwater contamination in the San Martin/San Jose, CA area. Nearly 1,000 private wells and 5 municipal wells were impacted. The San Francisco Bay Area Regional Water Quality Control Board (RWQCB) issued several Cleanup and Abatement Orders to Olin to assess and remediate the contamination. In addition, over 100 citizen lawsuits were filed against Olin. Olin ceased operations in 1997 and was ordered to supply replacement (bottled) water to private well owners with >4 ug/l of perchlorate. Olin petitioned the State of California Water Board to overturn the regional order which required bottled water for over 1,000 residents. The State Water Board recently agreed to overturn the regional order to provide replacement water for private wells containing perchlorate above the detection limit of 4 ug/l. Under the new ruling, Olin will only be required to provide replacement water for private wells containing perchlorate above the California DHS Public Health Goal level of 6 ug/l.

PERTINENT WEB LINKS FOR PERCHLORATE

www.waterboards.ca.gov/cwphome/perchlorate/
www.dhs.ca.gov/ps/ddwem/chemicals/perchlindex.htm
www.epa.gov/safewater/ccl/perchlorate.perchlorate.html
www.swrcb.ca.gov/rwqcb4/html/perchlorate.html
www.epa.gov/fedfac/documents/perchlorate_links.htm
www.clu-in.org/contaminantfocus/default.focus/sec/perchlorate/cat/Overview/
www.navylabs.navy.mil/Perchlorate.htm
www.denix.osd.mil/denix/Public/Library/Water/Perchlorate/perchlorate.html
www.dodperchlorateinfo.net

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