

# Perchlorate and Children's Health

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The Case for a Strong  
Cleanup Standard for  
Rocket Fuel in Drinking Water

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# Update:

## Perchlorate Developments from Early 2005

In the following pages, Environment California Research & Policy Center offers a detailed case for a comprehensive cleanup of perchlorate from California's drinking water, based on the best available science. However, since the first release of this report in January 2005, several new developments have shed additional light on the extent of the perchlorate problem and the need for action.

In January, the National Academy of Sciences released a long-awaited review of the state of scientific knowledge on perchlorate. The U.S. EPA, following the recommendation of the National Academy, then issued a revised "safe level" of perchlorate intake. Finally, researchers at Texas Tech University published a first-of-its-kind study of perchlorate levels in breast milk, demonstrating widespread infant exposure to unsafe amounts of perchlorate, amounts that exceed the National Academy and EPA recommendation. In fact, the study shows that some infants are exposed to perchlorate in levels shown to harm brain development in infant rats.

Taken together, these developments highlight the need to aggressively implement a cleanup plan that will protect the health of California's children, and of children nationwide. Infants are smaller and more vulnerable than adults. Infants are also exposed to contaminants through breast milk and a variety of other sources. As a result, they need special consideration when setting drinking water standards for developmental toxins. The new information brought to light strengthens the case for protecting California's children and infants by reducing perchlorate contamination in drinking water to one part per billion (ppb) or less.

### National Academy of Sciences Releases Perchlorate Review

On January 10, 2005, the National Research Council of the National Academy of Sciences (the Academy) released a report entitled *Health Implications of Perchlorate Ingestion*. The report summarizes an

## The Difference Between A Drinking Water Standard and a “Safe Dose”

The Academy calculated a “safe dose,” or an amount an individual could consume in a day and theoretically suffer no harm. Translating the dose into a drinking water standard requires adjustments to ensure that no one is exposed to more perchlorate than considered safe. Adjustments are made for exposure to perchlorate from additional sources including food, and for body weight and drinking water intake.

18-month review of the health risks of perchlorate exposure. The review was requested by the Department of Defense and NASA to resolve concerns voiced by perchlorate users over the scientific certainty of an earlier U.S. EPA recommended “safe level” of perchlorate intake.

Press coverage focused on the Academy’s conclusion that perchlorate was not quite as hazardous as the EPA estimated earlier. However, some articles mistakenly implied that the report would lead to a weaker drinking water standard or would prevent cleanup of some contaminated areas. Actually, the Academy report supports the conclusion that California’s drinking water standard for perchlorate should be set no higher than one part per billion in order to protect infants, as argued in the following pages.

The Academy calculated a “safe dose,” but refrained from recommending a level for an enforceable drinking water standard (see “The Difference Between a Drinking Water Standard and a “Safe Dose”). Members of the National Academy panel made a point of emphasizing that any eventual drinking water standard should take into account the contribution of food and other sources to overall exposure.<sup>1</sup> The Academy panel also made it clear that a drinking water standard should take into account the body weight

of the class of individuals it is meant to protect, to ensure that the most vulnerable are kept safe.<sup>2</sup>

In other words, the Academy recognized that agencies setting enforceable standards for perchlorate in drinking water have additional decisions to make. First, agencies must decide which population of people the standard is meant to protect. Second, agencies must take into account additional exposure sources beyond drinking water to ensure overall safety. In the case of perchlorate exposure:

- Infants are most vulnerable to harm. Infants are less able to compensate for the toxic effects of perchlorate, are at a critical stage in growth and development, and also consume more water per kilogram of body weight than an adult.
- Infant exposure to perchlorate from food and breast milk (via a mother’s exposure to perchlorate-laced food and water) must be considered in addition to water.

In mid-February 2005 the U.S. EPA issued an updated recommendation for the maximum “safe dose” of perchlorate. Essentially, the EPA revised its earlier calculation based on the advice of the

National Academy of Sciences. Press coverage of this action almost uniformly confused the “safe dose” with a drinking water standard. The EPA has not yet issued an enforceable drinking water standard.

## Perchlorate Found in Breast Milk at High Levels

On February 23, Andrea Kirk and her colleagues in the Dasgupta lab at Texas Tech University published a study showing that unsafe levels of perchlorate are commonplace in the breast milk of women across the country.<sup>3</sup> According to the study, breast-fed babies ingest more than twice as much perchlorate on average than the National Academy of Sciences’ recommended “safe dose.”<sup>4</sup>

The Texas Tech researchers found perchlorate in the breast milk of every one of 36 women tested across the country, at an average level of 10.5 ppb, ranging up to 92 ppb. The high levels suggest that women may concentrate perchlorate in their breast tissue to some extent. Infants exposed to the highest levels of contamination would receive a dose large enough to interfere with normal brain development in infant rats, as determined from laboratory tests.

Sources of the contamination likely include food tainted by perchlorate-laced irrigation water. In November 2004, the U.S. Food and Drug Administration released the results of a survey of perchlorate levels in common food items across the country. Perchlorate was detected in most or all samples of lettuce and milk from supermarket shelves, including 38 of 38 milk samples and 67 of 78 lettuce samples from California.<sup>5</sup> The levels were higher than many experts anticipated, reaching a maximum level of 9.9 ppb in milk and 52 ppb in lettuce, with average levels at 5.7 ppb and 9.4 ppb, respectively.

## Implications for California’s Perchlorate Health Goal

In light of the new developments of the first two months of 2005, California officials should take immediate action to reduce the health threat posed to infants by perchlorate contamination. Appropriate steps include:

- Maintaining a focus on infants as the most vulnerable population;
- Revising the public health goal downward to one part per billion or less;
- Issuing an emergency enforceable drinking water standard to begin the cleanup process;
- Taking aggressive steps to clean the Colorado River.

California officials should maintain a focus on infants as the most vulnerable population. Assembly Bill 2342, signed by Governor Schwarzenegger in 2004, requires California EPA to specifically consider the health of infants and children when setting a public health goal.

Given the new developments of early 2005, California EPA will need to adjust its public health goal for perchlorate in drinking water. In particular, in deriving the public health goal, California EPA inappropriately reduced the margin of safety when calculating the “safe” drinking water level for infants and underestimated infant exposure to perchlorate from sources other than drinking water.

As described in the following pages, California EPA applied a margin of safety of ten-fold to protect the most vulnerable adults. However, it *reduced* the margin of safety to three-fold when calculating a safe level of perchlorate in drinking water for infants. The National Research Council made it clear that this approach was unwarranted.<sup>6</sup>

In light of new data on perchlorate levels in breast milk and food, California EPA underestimated the amount of perchlorate that could be ingested outside of drinking water, especially for infants. California EPA assumed that 100 percent of infant perchlorate exposure would come from drinking water. However, many infants are breastfed during their first year of life, and from this source alone are exposed to already dangerous levels of perchlorate. California EPA should fully account for all additional sources of perchlorate ingestion in infants, using newly available data.

With a full uncertainty factor of 10 or more to protect infant children from rocket fuel in drinking water, and a more accurate accounting of infant perchlorate exposure from all sources, California EPA should revise its public health goal

to a more protective level of one part per billion or less.

While the process of revising the public health goal moves forward, state officials should issue an emergency drinking water standard for perchlorate to kick-start the cleanup effort. In particular, removing perchlorate from the Colorado River, a source of irrigation water and drinking water for much of Southern California, should be prioritized.

For further information, please contact Sujatha Jahagirdar, Clean Water Advocate, at (213) 251-3688.

(Copies of *Health Implications of Perchlorate Ingestion* are available online at [www.nap.edu](http://www.nap.edu); the results of FDA monitoring of food for perchlorate are available at [www.fda.gov](http://www.fda.gov); and the Texas Tech breast milk study is available at [pubs.acs.org/journals/esthag](http://pubs.acs.org/journals/esthag).)

## Update Notes:

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1. During a public briefing given on 11 January 2005, the National Academy Panel clarified that the result presented in their report was a reference dose, or an amount of perchlorate safe to ingest, corrected for body weight, and not a drinking water standard. In order to obtain a drinking water standard, the reference dose must be corrected for drinking water intake, perchlorate ingestion from other sources than drinking water, and infant body weight. A committee member said, "The committee recognizes that its recommendations would lead to a reference dose of 0.0007 milligrams per kilogram per day. Now that's a dose. That's not a content in water. That's a total amount, whatever the source is – food, milk, water – that we felt would be a safe limit, a safe and health protective limit." Statement by NAS committee member at "Health Implications of Perchlorate Ingestion," public briefing held on 11 January 2005 at 2 PM EST, available online at [www.visualwebcaster.com/event.asp?id=26586](http://www.visualwebcaster.com/event.asp?id=26586), at time 25:28.

2. (Referring to the safe dosage) "This 0.0007 milligram per kilogram – adjusted for body weight – so if it's a three kilogram baby, you adjust it down. If its an 80 kilogram adult, you

adjust it up. It's based on a per kilogram." Ibid, at time 26:30.

3. Andrea Kirk et al, "Perchlorate and Iodide in Dairy and Breast Milk," *Environmental Science and Technology*, ASAP Article 10.1021/es048118tS0013-936X(04)08118-0, 22 February 2005.

4. For calculation, see Peter Waldman, "Perchlorate in Human Milk Exceeds Regulator's 'Safe Dose'" *Wall Street Journal*, 23 February 2005.

5. U.S. Food and Drug Administration, *Exploratory Data on Perchlorate in Food*, downloaded from [www.cfsan.fda.gov](http://www.cfsan.fda.gov), 26 November 2004.

6. A committee member said, "I'll just conclude, before we open for questions, by pointing out where the committee stopped. We stopped at a dosage – what we felt would be a safe limit to the amount, whatever the source, of perchlorate that an individual might take in. This is 0.0007 mg/kg-day – adjusted for body weight – so if it's a 3 kilogram baby, you adjust it down." In this statement, the panel makes it clear that the reference dose must be adjusted for body weight without changing the margin of safety applied to protect vulnerable groups, such as pregnant women, infants, and people with hypothyroidism. See note 1, at time 38:25.

# Executive Summary

In order to protect expecting mothers, their developing fetuses and their infant children, the California Department of Health Services (DHS) should set a final health standard for perchlorate in drinking water at one part per billion or less.

Perchlorate, the primary ingredient in solid rocket fuel, is emerging as a major contaminant of California's food and water supplies. The U.S. Food and Drug Administration recently documented widespread contamination in milk and lettuce from grocery stores in California and across the country. Many water suppliers in California have detected perchlorate in their wells at levels suggested by the U.S. Environmental Protection Agency (EPA) as unsafe.

- State agencies have discovered perchlorate pollution in more than 350 water sources, including the Colorado River and hundreds of municipal wells.
- The bulk of the contamination was caused by the military, aerospace contractors and other users and manufacturers of explosive chemicals.

- Communities with contaminated water supplies include Riverside, Loma Linda, San Bernardino, Pasadena, Rancho Cordova, West Orange County, and Otay.

Perchlorate exposure threatens expecting mothers, developing fetuses and infant children.

- Perchlorate affects the thyroid hormone system at very low levels of exposure. It acts by preventing uptake of iodine into the thyroid gland, reducing the gland's ability to produce enough hormone.
- Thyroid hormone and iodine are critical for normal brain development in fetuses and young infants. Children born to mothers with thyroid problems or iodine deficiency can have lower IQ, impaired learning, hyperactive behavior, delayed growth, or can suffer a range of serious neurodevelopmental problems, including mental retardation.
- Exposure to perchlorate during specific and important windows of



time during the growth and development of a child increases the risk of neurodevelopmental disability.

Neurodevelopmental disabilities, like attention deficit and hyperactivity disorder (ADHD), are a serious and growing problem in California.

- Learning-disabled students increased 65 percent faster than the general school population from 1985 to 1999.
- Perchlorate exposure could be contributing to this trend in combination with exposure to a variety of other chemicals polluting the environment such as toxic flame retardants, lead, mercury, and polychlorinated biphenyls (PCBs).

The evidence of perchlorate's toxicity warrants a strong drinking water standard of one part per billion or less.

- Exposure to low levels of perchlorate *in utero* leads to changes in brain structure and behavior in infant rats.
- Humans are as sensitive as rats to iodine uptake inhibition by perchlorate.

After evaluating the full spectrum of available science on perchlorate, the U.S. Environmental Protection Agency and the states of Massachusetts, Maryland and New Mexico have recommended preliminary drinking water health guidelines of one part per billion or less to provide a margin of safety for developing fetuses and infants. Accounting for widespread exposure to perchlorate in the food supply and for the combined effects of other thyroid toxicants in addition to perchlorate would justify an even lower standard.

However, the state of California is unofficially moving forward with a final drinking water standard equivalent to the

public health goal of six parts per billion issued in March 2004. The process used to arrive at the public health goal did not live up to the criteria established by California law, and a standard set at this level would be inadequate for several reasons:

- California EPA chose a single scientific study as the main basis for calculating a safe level. The study examined the effect of perchlorate on healthy adults exposed for a short period of time, as opposed to including other research involving fetal and newborn rats with long-term perchlorate exposure.
- California EPA applied an atypically small margin of safety to ensure protection of especially vulnerable people. Almost all established public health goals in California use a larger margin of safety.
- California EPA failed to consider how perchlorate may be interacting with other thyroid toxicants (like toxic flame retardants, nitrates, PCBs and other common environmental contaminants) to contribute to neurodevelopmental problems in children.
- A final standard of six parts per billion could leave the contamination of the Colorado River and nearly one-third of the polluted wells in California unaddressed.

In setting a final perchlorate standard, the state should use the weight of scientific evidence, including experiments showing neurobehavioral damage to infant rats exposed to small amounts of perchlorate in the womb, as well as considering the possible interaction of perchlorate with other toxicants. In addition, the state should set larger margins of safety to account for uncertainties in the vulnerability of fetuses and infants to

long-term exposure to low levels of perchlorate. After taking these steps, the state should arrive at a drinking water standard for perchlorate of 1 part per billion or

less, ensuring a comprehensive cleanup and providing a margin of safety for pregnant women, their developing babies and their infant children.

## POLICY RECOMMENDATIONS

- **The California Department of Health Services should set the drinking water standard for perchlorate at one part per billion or less.**
- In addition, the State of California, local governments, and water suppliers should hold responsible parties fully liable for cleanup and for supplying replacement drinking water to affected communities. Congress should not exempt the Department of Defense.
- Congress should reinstate Superfund fees for polluting industries to ensure that contamination caused by now-bankrupt companies will be cleaned up.
- Federal and state agencies should require American Pacific, Kerr-McGee Chemical and other responsible parties to accelerate clean up of perchlorate contamination currently leaking into the Colorado River and local aquifers.

# Introduction

Governments have a responsibility to protect their citizens from threats to their health and well-being, especially those threats beyond individual control. Take, for example, toxic contamination in public food or water supplies. To protect the public, governments often set health standards to limit public exposure, minimize risk, set a threshold for cleanup, and allow cost recovery from those responsible for spilling dangerous waste.

California law requires a comprehensive approach to setting health standards for toxic chemicals. In setting a standard, officials must:

- Protect the most vulnerable people from known or anticipated threats to their health and well-being;
- Ensure an adequate margin of safety to ensure that uncertainties in the science today do not cause public health problems in the future;
- Explicitly consider the many sources of exposure to a toxicant, including food and milk, and how the toxicant might interact with other harmful

substances in the environment to have a more dangerous effect; and

- Place emphasis on public health when considering cost and feasibility.<sup>1</sup>

In practice, however, the implementation of these requirements is often hindered. Companies with a potential liability for toxic spills can—and often do—attempt to protect their financial interests by pushing for public health standards that are weaker than sound science would dictate.

The debate around perchlorate in drinking water is a case in point. Perchlorate manufacturers and users, including the Department of Defense and its contractors, have attempted to focus the health debate around the needs of healthy adults in an effort to set a weak standard and thus limit their financial liability for contaminating much of California's drinking water supply.

But the real threat of perchlorate is to the health and development of young children. Exposure to small amounts of perchlorate, whether in the womb or during the sensitive first few years of life,

has the potential to set children back in their mental development.

The choice in setting a health standard for perchlorate is a choice between protecting the financial interests of a handful of companies and government agencies, or protecting California's children.

California's children are the future of

our society. They need protection from threats to their health and well-being in order to have the greatest possible opportunity to grow into their full potential. Establishing a reasonable perchlorate standard based on the weight of the scientific evidence would be in their best interest.

# Perchlorate Contamination Plagues California's Drinking Water Supplies

**P**erchlorate, the major ingredient in solid rocket fuel, contaminates the drinking water supply of 16 million Californians.

The vast majority of perchlorate in the United States is synthetic.<sup>2</sup> It is manufactured by chemical companies and then sold to producers and users of rockets, flares and other related technologies. The U.S. Environmental Protection Agency estimates that the Department of Defense and NASA use about 90% of the perchlorate produced in the United States.<sup>3</sup>

Perchlorate travels easily in water, allowing spills to easily enter water supplies, and persists for many decades underground.<sup>4</sup> Through careless handling, use, storage and disposal of perchlorate over the last six decades, the military and its contractors have extensively polluted California's drinking water sources. State agencies have discovered perchlorate pollution in more than 350 California water sources, including the Colorado River and hundreds of municipal wells.

## The Colorado River

Beginning in the 1950s, large amounts of perchlorate were made at factories owned by American Pacific and Kerr-McGee corporations outside Las Vegas, in an area draining into Lake Mead and the Colorado River.<sup>5</sup> Dumping, spills and explosions left the area around these factories heavily contaminated. Professor Jacimaria Batista at the University of Nevada estimates that sediments downstream from the perchlorate factories hold more than 20 million pounds of the chemical.<sup>6</sup> Wastewater from the city of Las Vegas carries the perchlorate downstream to Lake Mead. In 2004, 200 to 300 pounds of perchlorate leached into Lake Mead every day.<sup>7</sup>

The contaminated water then travels down the Colorado River, which is used as a municipal water supply for millions of people in Arizona and Southern California and as a source of irrigation water for much of the nation's winter produce.

Figure 1: Perchlorate Contamination in the Lower Colorado River<sup>12</sup>



Table 1: Number of Perchlorate Contaminated Wells by County<sup>14</sup>

County	Number of Contaminated Wells
Los Angeles	138
San Bernardino	82
Riverside	68
Orange	34
Sacramento	15
Santa Clara	9
Tulare	8
Ventura	4
San Diego	1
Sonoma	1
Stanislaus	1

Since 1998, over 1.4 million pounds of perchlorate have leaked into the Colorado River.<sup>8</sup> Near Lake Mead, perchlorate levels have been measured as high as 24 parts per billion.<sup>9</sup> Water taken from the river by the Metropolitan Water District of Southern California contains up to six parts per billion perchlorate (Figure 1).<sup>10</sup>

At the current pace of cleanup and with natural flushing of the river, Dr. Batista and her colleagues estimate that the lower Colorado River will remain contaminated with perchlorate for the next 50 years.<sup>11</sup>

Figure 2: Peak Perchlorate Levels Measured in Selected Southern California Water Systems, 2003<sup>18</sup>



Perchlorate can be found in the drinking water supplies of many communities in Southern California. Metropolitan Water District distributes Colorado River water, contaminated with perchlorate from a chemical plant in Nevada, to communities across the south coast. Other communities face perchlorate contamination in their aquifers, from spills as well as using Colorado River water for recharge.

## Aquifers and Wells

Perchlorate users have also contaminated many underground water systems across the state. The contamination extends into more than 10 counties, including San Bernardino, Sacramento, Los Angeles, Riverside, Ventura, Tulare, Orange, Santa Clara, Sonoma and San Diego (Table 1).<sup>13</sup> Southern California communities in Los Angeles and the Inland Valley have

been hard-hit (Figure 2), as well as Northern California communities such as Rancho Cordova outside of Sacramento.

Underground water contamination has come from both direct spills of perchlorate, as well as the use of polluted Colorado River water to recharge aquifers in Orange County and across southern California. In all, perchlorate has been found in at least 350 major California water sources.

## Contamination in Food

The impact of perchlorate is not limited to drinking water. Perchlorate also concentrates in leafy vegetables like lettuce, which creates a concern for consumers of Imperial Valley crops irrigated with Colorado River water. Tests by scientists and advocacy organizations like the Environmental Working Group have confirmed that plants, especially broad-leaf varieties, concentrate perchlorate from the environment.<sup>15</sup> Scientists have found perchlorate in plant tissues at levels up to 100

times higher than in nearby water sources.<sup>16</sup>

In November 2004, the Food and Drug Administration released the results of an initial nationwide food screening. They found perchlorate in 90 percent of 128 lettuce samples and in all but three of 104 milk samples, with average levels ranging from six parts per billion in milk to 12 parts per billion in Romaine lettuce.<sup>17</sup> These results raise the possibility that perchlorate contamination is much more widespread than regulators currently know, and that exposure is widespread across the country.



# Perchlorate Threatens Developing Fetuses and Infant Children

**P**erchlorate poses the greatest threat to developing fetuses and infant children. Exposure to perchlorate during key windows of time in the growth and development of a baby could lead to impaired brain development, causing lowered IQ, reduced learning ability, attention deficits and hyperactivity.

Perchlorate poses a threat because it affects the thyroid hormone system. It acts by preventing uptake of iodine into the thyroid gland, reducing the gland's ability to produce enough hormone. Expecting mothers need healthy thyroids to properly direct brain development in their developing fetuses. Children born to mothers with thyroid problems often have lower IQ, impaired learning, hyperactive behavior and delayed growth, and can suffer a range of serious problems, including mental retardation. Thyroid problems in infants after birth can also cause similar harm.

Despite claims by perchlorate users and manufacturers that perchlorate does not cause health problems, experiments with humans and animals clearly show that perchlorate interferes with iodine uptake into the thyroid gland. In rats

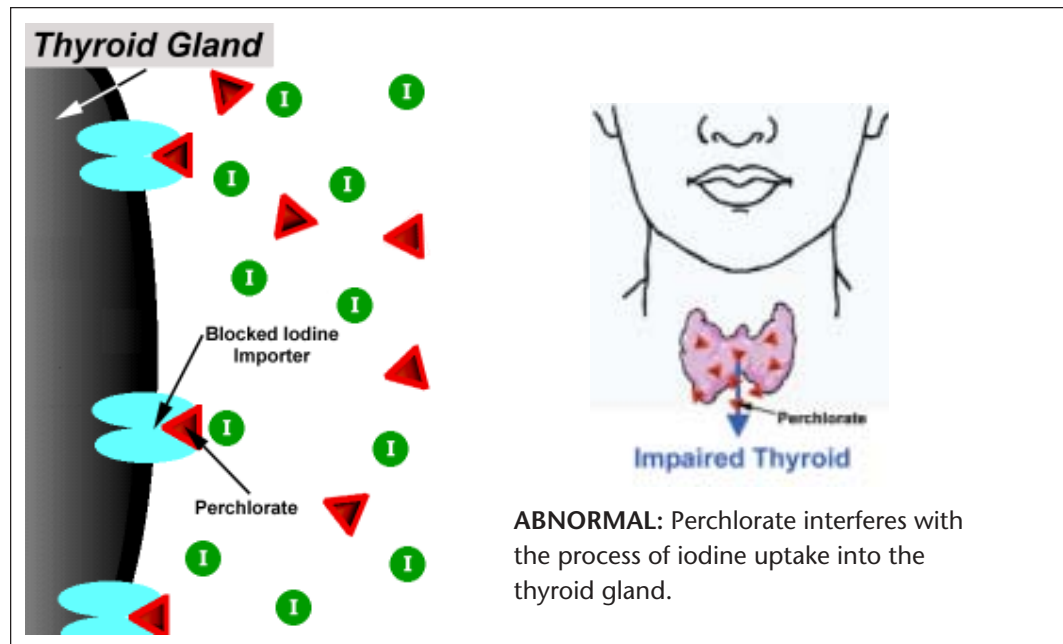
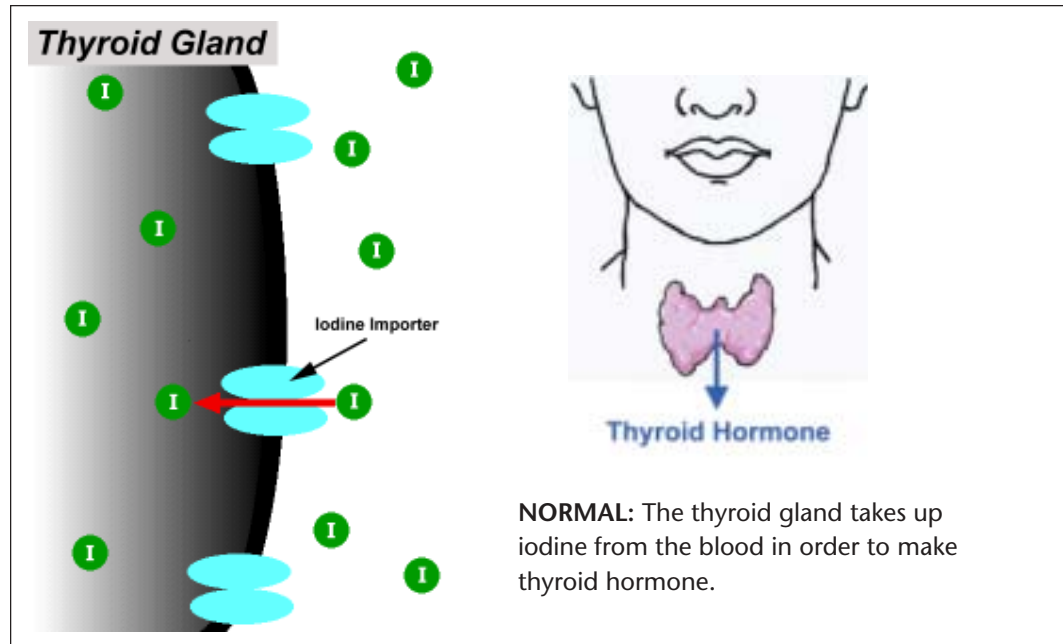
exposed in the womb, perchlorate causes changes in the shape of the brain and leads to impaired behavior. Human infants, who have no extra stores of thyroid hormone, are especially vulnerable thyroid toxicants like perchlorate.

These facts are all the more alarming when the increasing trends in neuro-developmental and mental health disabilities in California are considered. The number of students in public schools suffering from a variety of learning disabilities, including Attention Deficit Hyperactivity Disorder (ADHD), increased 65 percent faster than the general school population from 1985 to 1999. While no one factor has been implicated, perchlorate could be contributing to this trend in combination with toxic flame retardants, pesticides and the well-established culprits of lead, mercury, dioxin and polychlorinated biphenyls (PCBs).

## Perchlorate Impairs the Thyroid Hormone System

Perchlorate primarily affects the thyroid hormone system. In the body, perchlorate

Figure 3: Perchlorate Impairs the Production of Thyroid Hormone by Preventing Iodine Uptake Into the Thyroid Gland



Under normal circumstances, the thyroid gland is able to take up iodine and use it to make thyroid hormone, important for regulating metabolism in adults, and critical for normal brain development in fetuses and infant children. However, perchlorate inhibits iodine uptake into the thyroid gland, impairing the ability of the gland to produce the appropriate amount of hormone. In expectant mothers, this can have serious consequences for the child, including reduced IQ, and impaired attention and behavior as the child grows up.

acts to reduce the levels of circulating thyroid hormones. It inhibits the uptake of iodine into the thyroid gland, required for the production of thyroid hormone (Figure 3).<sup>19</sup> Scientists discovered this property over 50 years ago, and physicians have used perchlorate to treat diseases involving an over-active thyroid gland, such as Grave's disease.<sup>20</sup>

## Impaired Thyroid Function Leads to Problems in Brain Development, Learning, and Behavior

When the thyroid hormone system malfunctions, children can end up with serious behavioral and learning problems. The thyroid hormone system plays a critical role in the complex process of brain development. It provides important signals that help direct the growth of brain tissue into the structures that give children the capabilities to perceive and organize information, learn, remember, and grow into fully functional adults.<sup>21</sup>

Most of the cognitive capability of the brain develops between the eighth week of pregnancy and the second year of life.<sup>22</sup> During this period, the developing brain is most vulnerable to damage.

Scientists know that disruptions in maternal thyroid levels as early as week eight in the womb can impair a child's intelligence and coordination. Too little thyroid hormone delivered from mother to fetus during brain development can decrease the number of cells in the mature brain, impairing neurological development, with consequences including learning disabilities, speech and memory problems, poor coordination and balance, or—in severe cases—mental retardation.<sup>23</sup>

Mothers with thyroid problems caused by iodine deficiency also have children more likely to suffer from neuro-

Reduced thyroid levels in the first few weeks of life for pre-term and low birth-weight babies are associated with increased risk of neurological disorders, including the need for special education by age nine.

developmental birth defects. In areas with chronically low iodine levels in the food supply, mothers have symptoms of hypothyroidism and give birth to children with impaired physical and mental development.<sup>24</sup> On average, children of iodine-deficient mothers have 5 to 13 fewer IQ points compared to children of mothers with iodine-sufficient diets.<sup>25</sup> Children of mothers with severe iodine deficiency are more likely to have congenital defects, mental retardation, impaired physical growth and a variety of severe disabilities and neurological disorders including deafness.<sup>26</sup>

Newborns in particular are likely to be much more vulnerable to perchlorate than adults. They have no thyroid hormone stored in their glands, they have a very small body weight, and thyroid hormone in their blood recycles more quickly than in adults.<sup>27</sup> Reduced thyroid levels in the first few weeks of life for pre-term and low birth-weight babies are associated with increased risk of neurological disorders, including the need for special education by age nine.<sup>28</sup>

Because perchlorate interferes with the thyroid hormone system, perchlorate exposure is likely to cause the same problems as iodine deficiency and hypothyroidism, with potentially severe and lifelong consequences for the developing child.

## Thyroid Disruption and ADHD

Evidence exists that changes in thyroid hormone levels may be part of the cause of Attention Deficit Hyperactivity Disorder (ADHD). Dr. Peter Hauser at the National Institutes of Health found that families with a genetic problem that reduces the function of the thyroid hormone system were more likely to have symptoms of ADHD. In the study, 70 percent of children from families with genetic thyroid problems had ADHD, while the disorder affected 20 percent of children in normal families.<sup>29</sup> In another experiment, Dr. Michael McDonald at the National Institute of Mental Health showed that mice with the same genetic defect in their thyroid hormone systems developed symptoms of ADHD, including hyperactivity and impaired learning ability.<sup>30</sup>

### Direct Evidence of Perchlorate's Effects

The strongest evidence that perchlorate exposure is likely to cause effects similar to iodine deficiency or thyroid imbalance in expectant mothers and newborns comes from experiments in which mammals were intentionally and directly exposed. Most of the recent research has been funded by the Department of Defense, an agency with a financial interest in avoiding cleanup of perchlorate contamination. Despite this potential bias, the Department of Defense-funded studies provide more than enough evidence of perchlorate's toxicity to warrant a comprehensive cleanup effort.

On average, children of iodine-deficient mothers have 5 to 13 fewer IQ points compared to children of mothers with iodine-sufficient diets.

These studies support the picture of the potential health effects of perchlorate presented in the previous section. They demonstrate that perchlorate exposure changes thyroid hormone levels and can affect the brain structure and behavior of rat pups exposed while in the womb and after birth, and that perchlorate alters the function of the thyroid gland in humans.

Specifically, the direct perchlorate exposure studies demonstrated:

- inhibition of iodide uptake into the thyroid gland in humans and animals,<sup>31</sup>
- perchlorate-induced changes in thyroid hormone production,<sup>32</sup>
- physical changes (including tumors) in the thyroid gland of rats exposed to perchlorate *in utero* and through mother's milk,<sup>33</sup>
- perchlorate-induced changes in brain structure and behavior in rat pups exposed *in utero* and after birth.<sup>34</sup>

- Additionally, researchers at the University of Wisconsin found that exposure to perchlorate interfered with the maturation of the reproductive system in female rats. After exposure to perchlorate in the womb, rats developed fewer follicles in their ovaries.<sup>35</sup>

In the context of the debate around how much perchlorate is dangerous, one direct exposure-response study has received particularly extensive attention. In this study, Dr. Monte Greer and his colleagues gave differing amounts of perchlorate to healthy adult human volunteers over the course of two weeks, and measured the inhibition of iodine uptake into the thyroid gland.<sup>36</sup> This study found a clear and direct relationship between the amount of perchlorate exposure and the degree of iodine uptake inhibition in the human thyroid. When compared with similar experiments carried out in rats, it shows that humans are as sensitive as rats to iodine uptake inhibition by perchlorate.

The Greer study has been used by many regulatory agencies in the process of deriving health recommendations, because of the high quality of the data. However, the study also has limitations that are important to consider in the process of setting a health standard. For example, the study did not directly address the effects of perchlorate on vulnerable individuals (such a study would be ethically intolerable), the study involved short-term perchlorate exposure as opposed to long-term exposure of the type likely caused by contaminated drinking water, and the study had a small number of subjects, limiting its ability to detect iodine uptake inhibition at low exposure levels. These issues are explored more fully in the section on California's Public Health Goal (See page 25). Despite these limitations, the Greer study does offer

solid support for the idea that perchlorate exposure increases the risk of brain development problems in human infants by interfering with the thyroid gland.

### **Studies Used by Industry to Argue that Perchlorate Isn't Dangerous**

Scientists have also looked for evidence of perchlorate-caused harm in communities with water contamination. Many of these studies have been funded by perchlorate manufacturers or users (see “Major Polluters and Their Public Relations Consultants” on page 19), and have been used in public relations campaigns as evidence that perchlorate is not harmful in small doses. However, by their nature, these types of studies—known as ecological studies—are prone to ambiguity. There are many possible influences that could cloud the results, including diet, nutritional status, exposure to other chemicals, natural changes in thyroid status with age and air temperature, and more. It is much more difficult to draw conclusions when past perchlorate exposure cannot be directly measured. Most ecological studies involve no more than two exposure categories: exposed and not exposed, with great potential for misclassification. Health outcomes are also more difficult to measure—especially subtle neuro-developmental deficits that are likely not detectable by commonly-used hormone status tests. Because of these issues, ecological studies are less likely to discover a connection between chemical exposure and health effects, even when one actually exists.

The studies regularly cited by the perchlorate industry include:

- Five studies of neonatal thyroid hormone status in areas with contaminated drinking water.<sup>37</sup> (Funded by members of the Perchlorate Study Group and carried out by Consultants

in Epidemiology and Occupational Health, Inc., and Exponent, Inc.)

- A study of the general population, looking for differences in thyroid disease prevalence in areas with perchlorate in the water and without.<sup>38</sup> (Funded by American Pacific Corporation and carried out by Consultants in Epidemiology and Occupational Health, Inc.)
- A study of ADHD and autism in Nevada, looking for evidence that areas with perchlorate in the water had higher prevalence of these diseases.<sup>39</sup> (Funded by American Pacific Corporation and carried out by Consultants in Epidemiology and Occupational Health, Inc.)
- A study of school-age children from three different cities in Chile, looking for connections between perchlorate exposure and thyroid hormone status,<sup>40</sup> (Funded by the Kerr-McGee Chemical Corporation and carried out by ICF Consulting). (This study yielded complicated results, including some positive findings and strange anomalies in the data. However, industry characterizes its findings as negative.)

The EPA thoroughly reviewed all but the most recent of these studies, and discusses their weaknesses in detail in a 2002 report on perchlorate and in a document responding to the comments of peer reviewers.<sup>41</sup> In summary, the EPA concluded that these studies “offer little help beyond indicating that clinical thyroid disease is not greatly increased in populations with sustained drinking water contamination as high as 15 micrograms per liter [15 parts per billion] in the past,” failing to answer any questions about perchlorate and neurobehavioral

disease.<sup>42</sup> In fact, one of the peer reviewers noted that studies with this type of design are prone to flaws; for example, one of the largest ecological studies of radioactive radon gas found a negative association between exposure and incidence of lung cancer—a result that directly contradicts many laboratory studies, as well as common sense.<sup>43</sup> Ecological studies of perchlorate could be giving similarly confusing results.

Two additional studies of infant thyroid health in areas with contaminated drinking water demonstrated a positive link between perchlorate exposure and impaired thyroid status. First, the Arizona Department of Health Services found differences in thyroid hormone levels among infants whose mothers were exposed to perchlorate-contaminated drinking water from the Colorado River and those who had not been exposed to perchlorate while pregnant.<sup>44</sup> Second, Jackie Schwartz, then a public health graduate student at U.C. Berkeley, found that infant thyroid hormone levels were significantly lowered when mothers were exposed to drinking water contaminated with perchlorate at levels as low as one to two parts per billion, with stronger effects at higher doses.<sup>45</sup> These studies also suffer from the same sources of uncertainty as the industry-funded studies discussed above. However, the EPA considers the Schwartz study the most convincing of the whole set because of its relatively detailed exposure classifications, variety of controls, and strong statistical analysis. The two studies that found a positive perchlorate effect are the only two studies not funded by members of the Perchlorate Study Group.

Because of limitations associated with the ecological studies involving perchlorate, the U.S. EPA and state environmental agencies uniformly decided against using them in the development of any quantitative health standards.



## Major Polluters and Their Public Relations Consultants

### **The Department of Defense**

The Department of Defense is the largest user of perchlorate in the country. Along with NASA, it is responsible for roughly 90 percent of all perchlorate used in the U.S. The Department of Defense works with a group of aerospace contractors and chemical companies that supply perchlorate and perchlorate-containing products. As a federal agency, the Department of Defense, is in a position of influence over the standard-setting process for perchlorate cleanup at the U.S. EPA.

### **Major Aerospace Contractors and Perchlorate Manufacturers**

The Department of Defense and NASA contract out a large amount of aerospace work to companies like Lockheed-Martin. All of these entities have purchased and continue to purchase perchlorate from chemical manufacturers including American Pacific and Kerr-McGee. These contractors and chemical companies have spilled perchlorate at thousands of sites across the nation and are aggressively working to limit their liability. For example, in 2002 Kerr-McGee teamed up with Lockheed-Martin to sue California health authorities over the state's new provisional drinking water standard for perchlorate.<sup>46</sup> The move forced the state to reconsider the standard and significantly delayed the cleanup process.

### **The Perchlorate Study Group**

The Perchlorate Study Group is a collaboration between eight perchlorate manufacturers or users, including Lockheed-Martin, AeroJet, Kerr-McGee Chemical, and American Pacific—all of whom face financial liability for perchlorate cleanup. They supply the Department of Defense, NASA and other entities with perchlorate and perchlorate-containing products. The Perchlorate Study Group funds research into the health effects of perchlorate. However, the results of such research generally are used as public relations material to argue for weak perchlorate standards. Research funded by companies with a financial interest in vindicating their products tends to be less reliable than research without such conflicts of interest.<sup>47</sup>

### **The Council on Water Quality**

A public-relations effort funded by a subset of the member companies of the Perchlorate Study Group. The council is focused on making any potential cleanup standards for perchlorate as weak as possible. The council advocates for cleanup standards more than 200 times higher than recommended by the U.S. EPA—standards that would effectively negate the need for any cleanup to happen at all.

### **Consultants in Epidemiology and Occupational Health, Inc.**

Consultants in Epidemiology and Occupational Health, Inc. is a company that contracts with chemical manufacturers to provide technical support on health issues. Their services include helping clients avoid costs associated with regulation and liability. The organization has worked with the perchlorate manufacturer American Pacific for about 10 years.<sup>48</sup> The group has also worked with other industrial clients, including the American Wood Preservers Institute, an organization that promotes dangerous arsenic-treated wood products used in playgrounds. Dr. Steven H. Lamm is the director of this organization. He is the primary investigator for four of the six studies used by the perchlorate industry when arguing for a weak health standard. His studies regularly conclude that there is no link between low levels of perchlorate and human health impacts, or between thyroid hormone disruptions and neurobehavioral disease.<sup>49</sup>

### **Exponent, Inc.**

Exponent is a scientific consulting firm that, among other services, helps companies navigate the technical aspects of regulation. In some cases, they help clients to dilute cleanup standards or weaken regulations. According to a case study listed under the company's description of risk analysis services, "based on consideration of realistic scenarios of human exposure and chemical migration, Exponent can

often demonstrate that substantially higher cleanup goals are more appropriate than the originally proposed cleanup targets."<sup>50</sup> In other words, Exponent can earn its keep by promoting less costly outcomes for companies facing expensive cleanup liability.

### **TERA—Toxicology and Excellence in Risk Assessment**

TERA is another consulting firm that uses the tools of risk assessment to promote less costly outcomes for its corporate clients. Their most recent publication in the perchlorate field argues for a weak perchlorate health standard using an ecological study rejected by the EPA as scientifically flawed and ignoring critical issues to yield a misleading result.<sup>51</sup>

### **Gradient Corporation**

Gradient Corporation is a consulting firm that, like Exponent and TERA, performs risk analyses for corporate clients facing cleanup liabilities or challenges to the unhindered use of chemical products. Gradient has produced analyses of dozens of chemicals, from lead to arsenic, including a risk analysis of ethylene oxide paid for by the Ethylene Oxide Industry Council.<sup>52</sup> Gradient recently published a paper claiming that the rat is "more sensitive than humans" to perchlorate, overlooking major issues that undermine their conclusion.<sup>53</sup> This research was a part of Gradient's testimony in court on behalf of Lockheed-Martin.



## Learning Disabilities Are a Serious and Growing Problem in California

The potential for perchlorate to interfere with normal brain development is cause for concern, especially considering that mental health birth defects are a serious

and growing problem in California—in particular, learning disabilities like attention deficit hyperactivity disorder (ADHD).

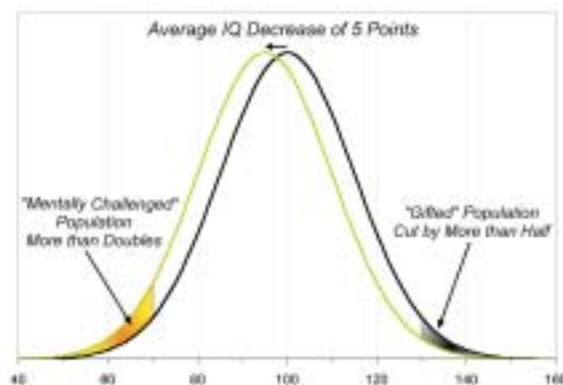
Although perchlorate exposure alone likely cannot explain this trend, it could be making children more vulnerable to other environmental insults, including

### Consequences of a Small Shift in Average IQ in California

What would be the significance of a five-point drop in average IQ across California society? It doesn't sound like much, and for the average individual, the loss of five IQ points might not be noticeable. However, a drop in the average IQ across millions of people would lead to a significant loss of intellectual capacity, reduced productivity, and greatly increased needs for special education and related services (Figure 5).

If 35 million people in California have an average IQ of 100, about 800,000 people would be gifted (IQ more than 130), and 800,000 would be mentally challenged (IQ less than 70). However, if the average IQ dropped just five points, the number of gifted people would drop by more than half to 340,000 people, and the number of mentally challenged people would more than double to 1.7 million. Clearly, widespread exposure to a chemical that could impair mental development has profound implications for the overall health and productivity of society.

**Figure 5: Consequences of a Society-Wide Reduction in Average Intelligence**



toxic flame retardants, pesticides and the well-established culprits of lead, mercury, dioxin, and PCBs.

### Learning Disabilities Are Growing More Frequent

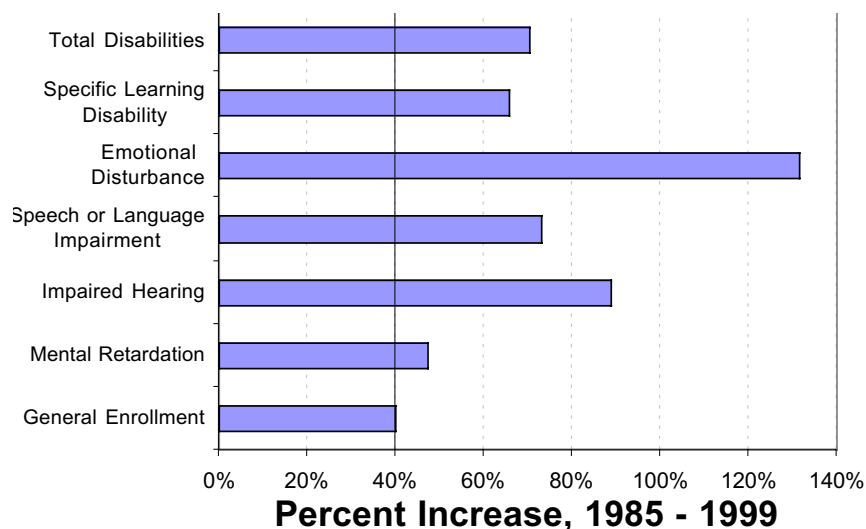
Learning disabilities have been increasing in California schools. The enrollment of children with specific learning disabilities has increased faster than the general student population during the last two decades (Figure 4). From 1985 to 1999, the number of learning disabled students increased 65 percent faster than the general student population in public schools. Students with learning disabilities now make up roughly six percent of all students in the state.<sup>54</sup> In addition to learning disabilities, enrollment of children with emotional disturbance, speech or language disorders, and hearing impairment increased faster than general enrollment.

No one really knows what is causing these trends. However, there is evidence that exposure to toxic chemicals in the

environment could be playing a key role.<sup>56</sup> Chemicals including toxic flame retardants (polybrominated diphenyl ethers or PBDEs), pesticides and the well-established culprits of lead, mercury, dioxin and PCBs all could be causing neurodevelopmental problems in children. In particular, toxic flame retardants, dioxin, and PCBs are all known to affect the thyroid hormone system.<sup>57</sup> These chemicals are bioaccumulative and present in significant amounts in California citizens.<sup>58</sup> The presence of perchlorate in drinking water could be aggravating injury caused by these chemicals, making children more vulnerable to toxicants that disrupt the thyroid system.

Given this context, caution is warranted. The social cost of erring on the wrong side would be considerable. The economic cost of widespread injury to neurological development, even if it represents a societal drop in average IQ of only a few points, would have wide-ranging impacts on the productivity of society (See “Consequences of a Small Shift” on page 21).

Figure 4: Change in Enrollment in California Schools by Type of Disability, 1985-1999<sup>55</sup>



# Regulatory Action: Setting a Cleanup Standard That Will Protect Children

The California Department of Health Services (DHS) now faces the task of setting a final standard for perchlorate in drinking water—a standard that will protect expecting mothers, developing fetuses, infants and other vulnerable individuals from harm.

Regulatory action by the state of California to date has been inadequate. In March 2004, The California Environmental Protection Agency (California EPA), the agency charged with identifying a safe level for perchlorate in water, established a public health goal for perchlorate. California EPA set the goal at six parts per billion, six times weaker than recommendations from scientists at the U.S. EPA and the states of Massachusetts, Maryland, and New Mexico. Unofficially, DHS is moving forward with a final drinking water standard equivalent to the public health goal.

A final standard of six parts per billion would be inadequate for several reasons. California EPA chose a single scientific study as the main basis for calculating the public health goal. The study they chose for their calculations, known as the Greer study, looked only at the effect of

perchlorate on iodine uptake into the thyroids of healthy adults exposed for a short period of time—while the health goal is meant to protect vulnerable fetuses and infant children exposed to perchlorate over long periods of time. The public health goal applied an atypically small margin of safety and failed to consider how other thyroid toxicants might be adding to the effect of perchlorate, lessening the probability that the standard would actually protect the most vulnerable children. In addition, a final standard of six parts per billion could leave the contamination of the Colorado River and nearly one-third of the polluted wells in California unaddressed.

## Recommendations of One Part Per Billion

Scientists at the U.S. EPA and the environmental agencies of Massachusetts, Maryland, and New Mexico have issued recommendations that expectant mothers, infants and children should not be exposed to perchlorate at levels greater than one part per billion in drinking water.

California EPA set the (public health) goal at six parts per billion, six times weaker than recommendations from scientists at the U.S. EPA and the states of Massachusetts, Maryland, and New Mexico.

Health scientists in these agencies looked at the full weight of scientific evidence to determine how much perchlorate is dangerous or causes an unacceptable risk. First, agency scientists looked at experimental data to determine what dose would have no effect on a vulnerable individual. Second, they reduced this dose by a factor designed to ensure that uncertainties in the science today do not cause public health problems in the future. (For example, when establishing a public health goal for diethylhexyl phthalate (DEHP) in drinking water, California EPA applied a safety factor of 1,000 to account for the possibility that humans are more sensitive than experimental animals, the variety in chemical sensitivities among people, and the serious and irreversible problems DEHP could cause for human development and reproduction.)

### The U.S. EPA

Based on evidence available in the late 1990s, the EPA developed an initial recommended maximum for perchlorate of 18 parts per billion.<sup>59</sup> However, as more evidence became available, especially studies of the effects of perchlorate on pregnant rats and their pups, the EPA revised its recommendation downward to one part per billion in 2002.<sup>60</sup>

The EPA based its determination on:

- Laboratory data showing that rats exposed *in utero* to perchlorate at levels as low as 10 micrograms per

kilogram body weight per day show changes in thyroid hormone levels and thyroid gland structure associated with measurable changes in brain structure and behavior patterns.<sup>61</sup>

- Experiments with healthy people showing that humans were as sensitive as rats to iodine uptake inhibition by perchlorate, with uptake measurably impaired at doses as small as seven micrograms per kilogram body weight per day.

With the application of a margin of safety to ensure that exposure levels would not pose a threat to vulnerable individuals and to account for remaining scientific uncertainty, the EPA developed a one part per billion perchlorate recommendation. With the application of factors to account for the possibility of ingesting perchlorate through the diet, the agency noted it could support a maximum contaminant level as low as 0.2 to 0.8 ppb in water.

### The State of Massachusetts

As soon as perchlorate was discovered in drinking water sources in Massachusetts, the state Department of Environmental Protection began work on its own public health guideline for the maximum allowable level of perchlorate in drinking water. State scientists evaluated the entire body of available data on perchlorate toxicity, including results from studies on biological responses to perchlorate in animals and the effects of perchlorate on the developing fetus and nursing newborn. Based on this evidence, and accounting for uncertainties in the science, the scientists recommended that drinking water contain no more than one part per billion perchlorate to protect all members of the population from harm.<sup>62</sup> Their work was extensively peer-reviewed by qualified experts and released in May 2004.

Although Massachusetts scientists used slightly different assumptions and methods from the EPA scientists, they reached a similar conclusion.

## California's Public Health Goal: Six Times Weaker

Using the same basic set of data, but a narrower approach, the state of California issued a recommendation of six parts per billion, six times weaker than the recommendations of the U.S. EPA and Massachusetts.<sup>63</sup> This recommendation, known as a public health goal, is a preliminary step toward setting an official and legally-binding health standard.

The process used to arrive at the public health goal did not fulfill the intent of the statutes guiding the process. Under California law,

- A public health goal should be set at a level “at which no known or anticipated adverse effects on health occur, with an adequate margin of safety.”<sup>64</sup>
- The goal should include consideration of:
  - o Potential additive or interactive effects with other contaminants present in the environment.
  - o The increased vulnerability of “infants, children, pregnant women, the elderly, individuals with a history of serious illness” and other sensitive groups.
  - o The additive effect of additional exposure to the contaminant in food, air, or other sources beyond drinking water.<sup>65</sup>

In deriving the public health goal, California EPA did not rely on the full weight of scientific evidence, set an atypically small margin of safety to protect the most

vulnerable people, and failed to consider how other thyroid toxicants in the environment could be increasing vulnerability to perchlorate. As a result, the final public health goal was set at a level that would leave much of the contamination in California unaddressed.

## Narrow Consideration of Available Research

California EPA scientists focused primarily on one single study of healthy adult volunteers given perchlorate for a brief period of 14 days, the Greer study. This study involved a relatively small number of people, did not directly address the risk to the most vulnerable populations (expecting mothers, fetuses, and infants), and did not address the possible effects of long-term exposure associated with low-level contamination of drinking water. While studies involving pregnant human volunteers would be ethically intolerable, research involving rats was available as an informative substitute.

## Inadequate Margin of Safety to Protect Vulnerable Individuals

California EPA scientists set a smaller margin of safety for perchlorate than warranted by uncertainties in the science, smaller than those typically used in public health goals for other chemicals (Table 2). Only four chemicals of more than 70 with a public health goal have a margin of safety set at 10 or lower—lead, nitrates, fluoride, and perchlorate.<sup>66</sup> Perchlorate is the least studied of the four. A search of the National Library of Medicine shows that 75 times more studies address lead than perchlorate.<sup>67</sup> There are over 32,000 studies on fluoride, and over 19,000 studies on nitrates, while there are just over 2,200 studies that address perchlorate in some way. In addition, perchlorate is the only one of the four which does not have

direct scientific evidence of effects on the most vulnerable human populations.

California EPA used a single safety factor of 10 to account for differences in the sensitivity of individuals to perchlorate. In the case of infants, California EPA used a safety factor of only 3, arguing that only minor perchlorate absorption differences exist between adults and infants. However, limitations in the Greer study, and in general knowledge of how perchlorate affects infants, warranted larger safety factors to ensure protection of vulnerable individuals. Scientists at both the Massachusetts DEP and the U.S. EPA set larger margins of safety to account for limitations in perchlorate science (Table 3). They each chose a safety factor of 300.

California EPA should have accounted for the fact that the Greer study had a very small sample size, and thus was less likely to detect small differences in iodine uptake at the lowest dose levels. Scientists at the U.S. EPA determined that the group given the smallest dose had only one-tenth of the statistical power to detect changes in iodine uptake as the group given the largest dose, making it difficult to conclude that the smallest dose tested had no effect, and also difficult to estimate the variability in sensitivity to perchlorate across the population.<sup>72</sup> To account for this limitation, the U.S. EPA and Massachusetts DEP began with an estimate of a dose expected to have no effect on a healthy individual two-fold lower than the California EPA, and used a safety factor of an additional 10-fold.

California EPA should have used a larger safety factor for infants. California EPA extrapolated data from the Greer study, involving healthy adults, to a level designed to protect infants using an atypically small safety factor. Newborns in particular are likely to be much more vulnerable to perchlorate than adults. They have no thyroid hormone stored in their glands, and thyroid hormone in

**Table 2: Comparison of Safety Factors Used in Selected California Public Health Goals<sup>68</sup>**

Chemical	Safety Factor (Non-Cancer Effects)
Perchlorate (infants)	3
Perchlorate (adults)	10
Lead <sup>69</sup>	3
Fluoride <sup>70</sup>	1
Nitrates <sup>71</sup>	1
1,1-Dichloroethane	1,000
Alachlor	1,000
Atrazine	100
Carbofuran	300
Carbon Tetrachloride	1,000
Chlordane	10,000
Dalapon	300
Dichloromethane	100
Diethylhexylphthalate (DEHP)	1,000
Endrin	100
Ethylene dibromide	1,000
Heptachlor	100 to 1,000
Hexachlorobenzene	1,000
Lindane	1,000
Methoxychlor	1,000
Methyl tertiary butyl ether (MTBE)	10,000
Pentachlorophenol	1,000
Tetrachloroethylene	30 to 100
Toxaphene	1,000
Trichloroethylene	100
Vinyl Chloride	100

their blood recycles more quickly than in adults.<sup>73</sup> Infants may also be more sensitive to the effects of perchlorate. And, infants may each have a different sensitivity to perchlorate because of differences in dietary iodine intake or in their genetic makeup. An infant safety factor of three most likely does not account for the full scope of individual variability.

California EPA should have assigned



a safety factor to account for the possibility of effects at lower exposure levels lasting for a longer period of time. The Greer study examined the effects of short-term perchlorate exposure and did not evaluate longer-term effects, which could be greater or happen at smaller doses. In fact, U.S. EPA scientists evaluated the raw data from the Greer study and noticed that perchlorate effects became greater over time, suggesting that chronic exposure to perchlorate could cause problems at lower levels than heretofore detected.<sup>74</sup>

Finally, California EPA should have assigned a safety factor to account for uncertainty caused by remaining unanswered questions in perchlorate toxicity. Experiments to date have not examined neurodevelopmental outcomes, subtle and time-sensitive changes in thyroid function during development, and other, more direct ways to detect potentially subtle effects of perchlorate exposure. As these questions are answered, the effects of perchlorate may become apparent at lower exposure levels.

In summary, the Massachusetts DEP concluded that “the Greer study results themselves support a lower interim exposure guidance value for sensitive individuals than that adopted by California EPA.”<sup>75</sup> If California EPA scientists had applied the margin of safety used in Massachusetts or by the U.S. EPA, they would have arrived at a public health goal of one part per billion or less.<sup>76</sup>

### No Consideration of Potentially Additive Effects with Other Contaminants in the Environment

California EPA scientists also failed to consider how perchlorate may add to the ill-effects of other dangerous chemicals that harm the thyroid gland and put infant children at risk of neuro-developmental defects. In particular, California women have measurable amounts of thyroid toxicants like toxic flame retardants (PBDEs), PCBs and dioxin in their bodies. Just as a pregnant woman with iodine

**Table 3: Comparison of Safety Factors Used by the U.S. EPA, Massachusetts DEP, and California EPA**

Source of Uncertainty	SAFETY FACTOR		
	U.S EPA <sup>77</sup> (Weight of Evidence)	MADEP <sup>78</sup> (Weight of Evidence)	Cal/EPA <sup>79</sup> (Greer Study)
Variability Among People	3	10	10
Short-Term Exposure Study, Not Chronic	3	—	—
Low Statistical Resolution to Detect Effects at Smallest Exposure Level	10	10	—
Extrapolation of Animal Data to Human	—	3	—
Remaining Unanswered Questions in Perchlorate Science	3	—	—
<b>Total Safety Factor</b>	<b>300</b>	<b>300</b>	<b>10</b>

deficiency or hypothyroidism would be more vulnerable to perchlorate, a pregnant woman with potentially dangerous levels of other thyroid toxicants in her body would be more vulnerable to perchlorate. Other contaminants in water, such as nitrates from fertilizer or factory farms, can also block iodine uptake into the thyroid. Other chemicals, including a toxicant found in cigarette smoke, can have a similar effect. Yet the California EPA scientists failed to consider the cumulative effects of these other pollutants. The effects of multiple chemicals that disrupt the function of the thyroid hormone system could simply be additive, or they could be worse in combination with each other than any one alone. Accounting for the possibility of these interactions would require a lower public health goal.

## **Leaving Contamination Unaddressed**

If California implemented a final standard based on the public health goal of six parts per billion, it could allow polluters to leave much contamination unaddressed. Much of the water drawn from the Colorado River would technically require no treatment. If this water continues to serve as irrigation for crops in Southern California, it could expose massive numbers of people to unacceptable levels of perchlorate through their diets. A final standard of six parts per billion would also effectively exclude nearly one-third of the polluted wells in California from the cleanup effort. More than 110 wells have a maximum detected contaminant level of six parts per billion or less and would be left without mandatory cleanup.<sup>80</sup>



# Policy Recommendations

The state has an obligation to protect the health of its most vulnerable citizens. The bottom line is that expectant mothers, fetuses and infants should not have to face the threat of perchlorate in their drinking water. Rocket fuel is not a natural part of California's water supply.

The weight of scientific evidence supports a stronger health standard for perchlorate in drinking water than advocated by the perchlorate industry, and stronger than the current public health goal. DHS should help create the healthiest possible conditions for parents to help their children grow into their full potential by setting a standard that is both scientifically supportable and reflective of legal requirements and community values in providing protection for those who need it most.

DHS should immediately establish a health-protective drinking water standard for perchlorate of one part per billion or less, providing an adequate margin of

safety for pregnant women, their developing babies and infants. These young and future citizens need our protection and nurturing in order to reach their full potential.



**Addressing the problem of perchlorate contamination will require action on the state, local and national level.**

**California Department of Health Services**

- **The California Department of Health Services should set the drinking water standard for perchlorate at one part per billion or less.**

*In addition:*

**Congress**

- Congress should re-establish fees for polluting industries under the Superfund program to ensure cleanup funding for sites like the Inland Empire, where some responsible parties have gone bankrupt.
- Congress should hold the Department of Defense liable for cleanup.
- Congress should require the Department of Defense to fund regular testing for perchlorate contamination on its lands, and to respond promptly to requests for information from state and federal environmental agencies—requests the Department of Defense has a history of resisting.

**U.S. EPA, California EPA, and Nevada DEP**

- State and federal agencies should require American Pacific, Kerr-McGee Chemical and other responsible parties to accelerate clean up of perchlorate contamination currently leaking into the Colorado River.
- California EPA should label perchlorate as hazardous under proposition 65, which would require warnings for perchlorate-contaminated food.

**The State of California Attorney General's Office**

- The Attorney General's Office should pursue responsible parties to ensure full recovery of cleanup costs.
- The Attorney General's Office should assist local governments and water suppliers in cases against polluters.

**Regional Water Quality Control Boards**

- Regional Water Quality Control Boards, including the Santa Ana Regional Water Quality Control Board, should require all responsible parties to provide impacted communities with immediate replacement drinking water.

**Local Water Utilities**

- Local utilities should endorse a one part per billion perchlorate standard to protect customers.
- Local utilities should provide a summary of the health risks of perchlorate exposure in a variety of languages to customers along with water bills.

# Notes

1 California Code of Regulations, Health and Safety Code section 116365, part C.

2 The major perchlorate hot-spots are all associated with defense, aerospace, or other major producers and users of the chemical. Some small levels of perchlorate in Texas have appeared in wells not clearly associated with any perchlorate use. The ultimate source of this contamination is still up for debate. Perchlorate does occur naturally in a mineral deposit in Chile. The perchlorate industry often claims that fertilizer made from this mineral deposit could be a significant source of perchlorate contamination. However, analysis by the EPA indicates that the amounts of fertilizer imported and the minimal perchlorate content of the fertilizer make it impossible to conclude that it is a major source of contamination: U.S. Environmental Protection Agency, Office of Research and Development, *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization (External Review Draft)* Washington, D.C., NCEA-1-0503, 2002.

3 U.S. Government Accountability Office, *DOD Operational Ranges: More Reliable Cleanup Cost Estimates and a Proactive Approach to Identifying Contamination Are Needed*, GAO-04-601, 29 June 2004; U.S. Environmental Protection Agency, Office of Research and Development, *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization (External Review Draft)* Washington, D.C., NCEA-1-0503, 2002.

4 U.S. Environmental Protection Agency, Office of Research and Development, *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization (External Review Draft)* Washington, D.C., NCEA-1-0503, 2002.

5 Environmental Working Group, *Rocket Science: Perchlorate and the Toxic Legacy of the Cold War*, 16 July 2001.

6 Cheryl Hogue, "Rocket-Fueled River: Lower Colorado Carries Perchlorate to Millions Who Drink its Water, to Those Who Eat Lettuce Irrigated With its Water, and Into a Tribal Well," *Chemical and Engineering News* 81, 37-46, 18 August 2003.

7 Nevada Division of Environmental Protection, Monitoring Data from USGS Gage # 09419790 (LV Wash BLW Lake Las Vegas BLW Henderson, NV), January 1998 through October 2004.

8 Estimated by extrapolating average lb/day perchlorate discharge data: Nevada Division of Environmental Protection, Monitoring Data from USGS Gage # 09419790 (LV Wash BLW Lake Las Vegas BLW Henderson, NV), January 1998 through October 2004.

9 American Rivers, *Colorado River "Most Endangered:" Colorado #1 on Annual List Released Today*, Press Release, 14 April 2004.

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