United States Government Accountability Office

GAO

Report to the Chairman, Subcommittee on Environment and Hazardous Materials, Committee on Energy and Commerce, House of Representatives

May 2005

PERCHLORATE

A System to Track Sampling and Cleanup Results Is Needed

GAO-05-462

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Highlights

Highlights of GAO-05-462, a report to the Chairman, Subcommittee on Environment and Hazardous Materials, House Committee on Energy and Commerce

Why GAO Did This Study

Perchlorate, a primary ingredient in propellant, has been used for decades in the manufacture and firing of rockets and missiles. Other uses include fireworks, flares, and explosives. Perchlorate has been found in drinking water, groundwater, surface water, and soil in the United States. The National Academy of Sciences (NAS) reviewed studies of perchlorate's health effects and reported in January 2005 that certain levels of exposure may not adversely affect healthy adults but recommended more studies be conducted on the effects of perchlorate exposure in children and pregnant women.

GAO determined (1) the estimated extent of perchlorate in the United States, (2) what actions have been taken to address perchlorate, and (3) what studies of perchlorate's health risks have reported.

What GAO Recommends

GAO recommends that EPA work with federal agencies and the states to establish a structure to track and monitor perchlorate detections and cleanup efforts.

EPA agreed with our findings but DOD did not. Neither agency agreed with our recommendation. GAO believes its findings are sound; further, DOD's citation of sites not on EPA's list underscores the need for this recommendation.

www.gao.gov/cgi-bin/getrpt?GAO-05-462.

To view the full product, including the scope and methodology, click on the link above. For more information, contact John B. Stephenson at (202) 512-3841 or stephensonj@gao.gov.

What GAO Found

Perchlorate contamination has been found in water and soil at almost 400 sites in the United States where concentration levels ranged from a minimum reporting level of 4 parts per billion to millions of parts per billion. More than one-half of all sites were in California and Texas, and sites in Arkansas, California, Texas, Nevada, and Utah had some of the highest concentration levels. Yet, most sites had lower levels of contamination; roughly two-thirds of sites had concentration levels at or below the Environmental Protection Agency's (EPA) provisional cleanup standard of 18 parts per billion. Federal and state agencies are not required to routinely report perchlorate findings to EPA, and EPA does not centrally track or monitor perchlorate detections or the status of cleanup. As a result, a greater number of contaminated sites than we reported may already exist.

Although there is no specific federal requirement to clean up perchlorate, EPA and state agencies have used broad authorities under various environmental laws and regulations, as well as state laws and action levels, to sample and clean up and/or require the sampling and cleanup of perchlorate by responsible parties. Further, under certain federal and state environmental laws, private industry may be required to sample for contaminants, such as perchlorate. According to EPA and state officials, private industry and public water suppliers have generally complied with regulations requiring sampling and agency requests to sample. The Department of Defense (DOD) has sampled and cleaned up perchlorate in some locations when required by laws and regulations, but the department has been reluctant to sample on or near active installations under other circumstances. Except where there is a specific legal requirement, DOD's perchlorate sampling policy requires the services to sample only under certain conditions. Cleanup is planned or under way at 51 of the almost 400 perchlorate-contaminated sites identified to date.

Since 1998, EPA and DOD have sponsored a number of perchlorate health risk studies using varying study methodologies. We reviewed 90 of these studies that generally examined whether and how perchlorate affected the thyroid. About one-quarter concluded that perchlorate had an adverse effect. In January 2005, NAS reported on the potential health effects of perchlorate and concluded that a total exposure level from all sources, higher than that initially recommended by EPA (a dose equivalent to 1 part per billion in drinking water, assuming that all exposure came from drinking water) may not adversely affect a healthy adult. On the basis of NAS' report, EPA revised its reference dose to a level that is equivalent to 24.5 parts per billion in drinking water (if it is assumed that all exposure comes only from drinking water). The reference dose is not a drinking water standard; it is a scientific estimate of the total daily exposure level from all sources that is not expected to cause adverse effects in humans, including the most sensitive populations.

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Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOD	Department of Defense
EPA	Environmental Protection Agency
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act

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United States Government Accountability Office
Washington, D.C. 20548

May 20, 2005

The Honorable Paul E. Gillmor
Chairman, Subcommittee on Environment and
Hazardous Materials
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

Ammonium perchlorate (perchlorate) is a primary ingredient in solid rocket propellant and has been used for decades by the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the defense industry in the manufacturing, testing, and firing of rockets and missiles. Private industry has also used perchlorate to manufacture products such as automobile airbags, fireworks, flares, and commercial explosives. Perchlorate is a naturally occurring and manufactured salt that is easily dissolved and transported in water and has been found in groundwater, surface water, and soil across the country. Perchlorate has also been found in drinking water and food products, such as milk and lettuce. Recent health studies have shown that perchlorate can affect the thyroid gland and may cause developmental delays.

Due to questions and ongoing debate about the risks of exposing children and pregnant women to low levels of perchlorate, four federal agencies asked the National Academy of Sciences (NAS) to review and comment on recent studies of perchlorate and its health effects. In January 2005, NAS concluded that existing studies did not support a clear link between perchlorate exposure and adverse health effects. NAS recommended a perchlorate reference dose—an estimated daily exposure level from all sources that is not expected to cause adverse effects in humans, including the most sensitive populations—of 0.0007 milligrams per kilogram of body weight per day. The dose is equivalent to 2 liters of drinking water per day containing 24.5 parts per billion of perchlorate when consumed by an adult weighing 70 kilograms (or 154 pounds), assuming that all perchlorate exposure comes from drinking water. In February 2005, the Environmental Protection Agency (EPA) adopted NAS' recommended reference dose for perchlorate, but it has not established a national federal standard for perchlorate in drinking water or other regulatory requirements to clean up perchlorate in groundwater, surface water, or soil.

In this context, we identified (1) the estimated extent of perchlorate found in the United States; (2) what actions the federal government, state governments, and responsible parties have taken to clean up or eliminate the source of perchlorate; and (3) what studies of the potential health risks from perchlorate have been conducted and, where presented, the author's conclusions or findings on the health effects of perchlorate.

To provide an estimate of the extent of perchlorate found in the United States, we compiled and analyzed data on perchlorate detections from EPA, DOD, the U.S. Geological Survey, and state agencies. To identify the actions governments and responsible parties have taken to clean up and eliminate the source of the perchlorate, we (1) reviewed federal and state laws, regulations, and policies on water quality and environmental cleanup and (2) interviewed EPA officials and selected state agency officials to identify the authorities they have used to monitor and respond to instances of perchlorate. We also interviewed EPA and state agency officials on whether responsible parties have taken action to clean up perchlorate and reviewed and analyzed data from federal and state agencies to determine the status and extent of cleanup efforts. For the purposes of this report, "cleanup" refers to ongoing efforts to remove perchlorate from water and/or soil. However, our use of this term excludes pollution prevention efforts, such as the removal of perchlorate from wastewater. To identify studies of the potential health risks from perchlorate, who conducted them, and what methodologies were used, we conducted a literature search for studies of perchlorate health risks published since 1998, interviewed DOD and EPA officials on what studies they considered important in assessing perchlorate health risks, and examined the references of each study for other studies we had not obtained. We identified 125 studies on perchlorate and the thyroid, of which we reviewed 90 that were relevant to our review. A more detailed description of our scope and methodology is presented in appendix I. We conducted our work from June 2004 to March 2005 in accordance with generally accepted government auditing standards, including an assessment of data reliability and internal controls.

Results in Brief

Perchlorate has been found by federal and state agencies at almost 400 sites in groundwater, surface water, soil, or public drinking water in the United States. However, because there is not a standardized approach for reporting perchlorate data nationwide, a greater number of sites than we identified may already exist in the United States. Perchlorate has been found in 35 states, the District of Columbia, and 2 commonwealths of the United States, where the highest concentrations ranged from 4 parts per

billion to more than 3.7 million parts per billion. (At some sites, federal and state agencies detected perchlorate concentrations as low as 1 part per billion or less, yet 4 parts per billion is the minimum reporting level of the analysis method most often used.) More than one-half of all sites were found in California and Texas, and sites in Arkansas, California, Texas, Nevada, and Utah had some of the highest concentration levels. However, most sites did not have high levels of perchlorate. Roughly two-thirds of sites had concentration levels at or below 18 parts per billion, the upper limit of EPA's provisional cleanup guidance, and almost 70 percent of sites had perchlorate concentrations less than 24.5 parts per billion, the drinking water concentration calculated on the basis of EPA's recently established reference dose. At more than one-quarter of the sites, propellant manufacturing, rocket motor testing, and explosives disposal were the most likely sources of perchlorate. Public drinking water systems accounted for more than one-third of the sites where perchlorate was found. EPA sampled more than 3,700 public drinking water systems and found perchlorate in 153 systems across 26 states and 2 commonwealths of the United States. Perchlorate concentration levels found at public drinking water systems ranged from 4 to 420 parts per billion. However, only 14 of the 153 public drinking water systems had concentration levels above 24.5 parts per billion. EPA and state officials told us they had not cleaned up these public drinking water systems, principally because there was no federal drinking water standard or specific federal requirement to clean up perchlorate. Further, EPA currently does not centrally track or monitor perchlorate detections or the status of cleanup activities. In fact, several EPA regional officials told us they did not always know whether states had found perchlorate, at what levels, or what actions were taken. As a result, it is difficult to determine the extent of perchlorate in the United States or the status of cleanup actions, if any.

Although there is no specific federal requirement to clean up perchlorate or a specific perchlorate cleanup standard, EPA and state environmental agencies have investigated, sampled, and cleaned up unregulated contaminants, such as perchlorate, under various federal environmental laws and regulations. EPA and state agency officials have used their authorities under these laws and regulations, as well as under state laws and action levels, to sample and clean up and/or require the sampling and cleanup of perchlorate by responsible parties. For example, according to EPA and state officials, at least 9 states have established nonregulatory action levels or advisories, ranging from under 1 part per billion to 18 parts per billion, under which responsible parties have been required to sample and clean up perchlorate. Further, certain environmental laws and

programs require private companies to sample for contaminants, which can include unregulated substances such as perchlorate, and report to environmental agencies. According to EPA and state officials, private industry and public water suppliers have generally complied with regulations requiring sampling for contaminants and agency requests to sample or clean up perchlorate. DOD has sampled and cleaned up when required by specific environmental laws and regulations but has been reluctant to sample on or near active installations, EPA and state officials said. Where there is no specific legal requirement to sample at a particular installation, DOD's policy on perchlorate requires sampling only where a perchlorate release due to DOD activities is suspected and a complete human exposure pathway is likely to exist. Finally, EPA, state agencies, and/or responsible parties are cleaning up or planning cleanup at 51 of the almost 400 sites where perchlorate was found. The remaining sites are not being cleaned up for a variety of reasons. The reason most often cited by EPA and state officials was that they were waiting for a federal requirement to do so.

We identified and summarized 90 studies of perchlorate health risks published since 1998. EPA and DOD sponsored the majority of these studies, which used experimental, field study, and data analysis methodologies. For 26 of the 90 studies, the findings indicated that perchlorate had an adverse effect. Eighteen of these studies found adverse effects on development resulting from maternal exposure to perchlorate. Although the studies we reviewed examined whether and how perchlorate affected the thyroid, most of the studies of adult populations were unable to determine whether the thyroid was adversely affected. Adverse effects of perchlorate on the adult thyroid are difficult to evaluate because they may happen over longer time periods than can be observed in a research study. However, adverse effects of perchlorate on development can be studied and measured within study time frames. We found some studies considered the same perchlorate dose amount but found different effects. The precise cause of the differences remains unresolved but may be attributed to an individual study's design type or physical condition of the subjects, such as their age. Such unresolved questions are one of the bases for the differing conclusions among EPA, DOD, and academic studies on perchlorate dose amounts and effects.

In January 2005, NAS issued its report on the potential health effects of perchlorate. The NAS report evaluated many of the same health risk studies included in our review. NAS reported that certain levels of exposure may not adversely affect healthy adults but recommended that

more studies be conducted on the effects of perchlorate exposure in children and pregnant women. NAS also recommended a perchlorate reference dose, which is an estimated daily exposure level from all sources that is expected not to cause adverse effects in humans, including the most sensitive populations. The reference dose of 0.0007 milligrams per kilogram of body weight is equivalent to a drinking water concentration of 24.5 parts per billion, if all exposure comes from drinking water.

To ensure that EPA has more reliable information on the extent of perchlorate found, the status of cleanup efforts, and the results of investigations of perchlorate and the effectiveness of cleanup methods, we are recommending that EPA work with the states and other federal agencies to establish a formal structure to track and monitor perchlorate detections and the status of cleanup efforts in the United States and its territories.

In commenting on a draft of this report, EPA agreed with our findings and conclusions on the extent of perchlorate in the United States and also agreed that defense-related activities have been found to be associated with perchlorate detections. However, EPA did not agree with our recommendation that it establish a formal structure to centrally track and monitor perchlorate detections and the status of cleanup efforts across the federal government and state agencies. In contrast to EPA's view of our report's accuracy, DOD, in commenting on a draft of this report, stated that our report did not provide an accurate assessment of perchlorate issues and activities. DOD asserted that our report mischaracterized DOD's response to perchlorate and cited examples of where DOD has sampled and invested in cleanup technologies, even though perchlorate is currently unregulated. We disagree with DOD's position. Our report credits DOD with actions it has taken but also points out where DOD has not acted. Finally, DOD disagreed with our recommendation that EPA establish a more formal structure to centrally track and monitor perchlorate because it believes that it is not clear that such a system will provide added value. DOD stated that it will continue to share its information on perchlorate. However, in its comments on this report, DOD provided information on four locations where perchlorate has been found, in one case as long as 5 years ago, but these locations do not appear on EPA's list of perchlorate detection sites. Whether this omission occurred as a result of a DOD or an EPA oversight is unknown, but it underscores the need for a more structured and formalized system.

Background

Perchlorate is a primary ingredient in solid rocket propellant and has been used for decades by DOD, NASA, and the defense industry in the manufacturing, testing, and firing of rockets and missiles. On the basis of 1998 manufacturer data, EPA estimated that 90 percent of the perchlorate produced in the United States is manufactured for use by the military and NASA. Total typical production quantities average several million pounds per year. Private industry has used perchlorate to manufacture products such as fireworks, flares, automobile airbags, and commercial explosives. Perchlorate is a salt, both manufactured and naturally occurring, and is easily dissolved and transported in water. It has been found in drinking water, groundwater, surface water, and soil across the country. There is no national primary drinking water regulation for perchlorate. In 1992 and again in 1995, EPA established a provisional reference dose range for perchlorate of 0.0001 to 0.0005 milligrams per kilogram of body weight per day. This converts to a drinking water concentration of between 4 and 18 parts per billion. On the basis of the drinking water conversion, EPA identified a corresponding provisional cleanup level for perchlorate of between 4 and 18 parts per billion.[1]

History of Perchlorate Investigation and Study

Perchlorate was initially identified as a contaminant of concern by EPA in 1985, when it was found in wells at hazardous waste sites in California. Perchlorate became a chemical of regulatory concern in 1997 after California found perchlorate in the groundwater near Aerojet, a rocket manufacturer in Rancho Cordova. At the time, perchlorate could not reliably be detected below 400 parts per billion in water. In April 1997, a new analytical method capable of detecting perchlorate in drinking water at concentrations of 4 parts per billion became available. This development prompted several states to test drinking water, as well as groundwater and surface water, for perchlorate. Within 2 years, perchlorate had been detected in drinking water in 3 western states and groundwater and surface water in 11 states across the United States. Perchlorate in drinking water is considered a more immediate concern.

In light of emerging concerns about perchlorate, EPA published in 1998 its first draft risk assessment on the environmental risks of perchlorate

[1]Although EPA recently adopted a perchlorate reference dose of 24.5 parts per billion, EPA's provisional cleanup level for perchlorate remains between 4 and 18 parts per billion and has not been revised.

exposure. In February 1999, an external panel of independent scientists reviewed EPA's draft risk assessment and recommended additional studies and analyses to provide more data on perchlorate and its health effects. DOD and industry researchers conducted laboratory and field studies of the health effects of perchlorate and submitted them to EPA. On the basis of an analysis of these studies, EPA revised its draft perchlorate risk assessment and released it for peer review and public comment in January 2002. The revised draft risk assessment included a proposed reference dose equivalent to a concentration of 1 part per billion in drinking water,[2] if it is assumed all exposure comes only from drinking water. After a second panel peer review, and some disagreement about the proposed reference dose, EPA, DOD, NASA, and the Department of Energy asked NAS, in 2003, to review EPA's perchlorate risk assessment and key studies of the health effects of perchlorate. These and other recent health studies have shown that the consumption of perchlorate affects the human thyroid by decreasing the amount of iodine absorbed. Iodine deficiency can result in developmental delays if it occurs during pregnancy and early infancy and can result in hypothyroidism[3] if it occurs during adulthood. The purpose of the NAS study was, in part, to assess the extent to which studies have shown negative health effects from perchlorate.

In January 2005, NAS reported that existing studies did not support a clear link between perchlorate exposure and developmental effects, and NAS recommended additional research on perchlorate exposure and its effect on children and pregnant women. NAS also recommended a safe exposure level, or reference dose, for perchlorate of 0.0007 milligrams per kilogram of body weight per day. (For comparison, EPA's draft reference dose for perchlorate in its 2002 draft risk assessment, which equated to a drinking water concentration of 1 part per billion, was based on a daily dose of 0.00003 milligrams per kilogram of body weight per day.) According to NAS, the reference dose is conservative and includes safeguards to protect the most sensitive population, the fetus of the nearly iodine-deficient pregnant woman. In February 2005, EPA established a new reference dose for perchlorate on the basis of the NAS recommendation. The new reference dose is equivalent to 24.5 parts per billion in drinking water,

[2]Previously, in 1995, on the basis of a 1952 human pharmaceutical study, EPA established a provisional reference dose for perchlorate in drinking water that equated to a drinking water concentration of between 4 and 18 parts per billion.

[3]Hypothyroidism is a condition in which the thyroid gland fails to produce enough thyroid hormone, causing a variety of symptoms—such as mental and physical sluggishness.

assuming that an adult weighing 70 kilograms (or 154 pounds) consumes 2 liters of drinking water per day, and that all perchlorate ingested comes from drinking water. If EPA establishes a drinking water standard for perchlorate, however, it may be less than 24.5 parts per billion because humans may consume perchlorate from other sources, such as produce and milk.

In addition to studies of perchlorate and health effects, other federal agencies, research groups, and universities have conducted or are conducting studies of perchlorate found in food and the environment. For example, the U.S. Geological Survey collected soil samples from California and New Mexico to test for the presence of perchlorate in natural minerals and materials. In 2003, an environmental research group reported that it sampled lettuce purchased in northern California and found perchlorate above 30 parts per billion in 4 of 22 samples. In September 2003, researchers from Texas Tech University sampled 8 bottles of milk and 1 can of evaporated milk and found perchlorate concentrations up to 6 parts per billion in seven of the milk samples and more than 1 part per billion in the evaporated milk sample. In 2004, the Food and Drug Administration sampled the following items for perchlorate: lettuce, bottled water, milk, tomatoes, carrots, cantaloupe, and spinach. Produce samples were taken from areas where officials said they believed irrigation water contained perchlorate. These data are currently being evaluated, but preliminary results show perchlorate was found in some samples.

Method 314.0 is the EPA-approved method for analyzing perchlorate in drinking water under the Safe Drinking Water Act. Method 314.0 can detect perchlorate concentrations of 1 part per billion in finished (treated) drinking water but has a minimum reporting limit of 4 parts per billion. Both EPA and DOD officials have expressed concerns about using Method 314.0 to test for perchlorate in media other than drinking water, such as groundwater, surface water, and soil (where researchers mix soil with a liquid to extract the sample). According to EPA, sediment and dissolved ions commonly found in groundwater and surface water can yield false positive results if the method is not used properly. Analysis methods other than Method 314.0 are available, and EPA has approved their use to analyze specific sites for perchlorate. Further, two new methods have been developed for the analysis of perchlorate in drinking water, and another is expected to be available in the spring of 2005. These three methods have minimum reporting limits ranging from 0.02 to 0.1 parts per billion. However, Method 314.0 has been the principal method used to test and

report on the presence of perchlorate in all media, including soil, sediment, groundwater, and surface water.

Various treatment technologies to remove perchlorate from groundwater and surface water are in use or under review. Biological treatment and ion exchange systems are among the technologies currently in use. Biological treatment uses microbes to destroy perchlorate by converting the perchlorate ion to nontoxic ions, oxygen, and chloride. Ion exchange systems replace the perchlorate ion with chloride, which is an ion found in table salt.

Environmental Laws, Regulations, and Federal Policy Covering Hazardous Substances

Several federal environmental laws provide EPA, and states authorized by EPA, with broad authorities to respond to actual or threatened releases of substances that may endanger public health or the environment. For example, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, authorizes EPA to investigate the release of any hazardous substance, pollutant, or contaminant. The Resource Conservation and Recovery Act of 1976 (RCRA) gives EPA authority to order a cleanup of hazardous waste when there is an imminent and substantial endangerment to public health or the environment, and one federal court has ruled that perchlorate is a hazardous waste under RCRA. The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) provisions authorize EPA, which may, in turn, authorize states, to regulate the discharge of pollutants into waters of the United States. These pollutants may include contaminants such as perchlorate. The Safe Drinking Water Act authorizes EPA to respond to actual or threatened releases of contaminants into public water systems or underground sources of drinking water, regardless of whether the contaminant is regulated or unregulated, where there is an imminent and substantial endangerment to health and the appropriate state and local governments have not taken appropriate actions. Under certain environmental laws such as RCRA, EPA can authorize states to implement the requirements as long as the state programs are at least equivalent to the federal program and provide for adequate enforcement. A detailed summary of these and other laws and regulations is presented in appendix IV.

In addition, some states have their own environmental and water quality laws that provide state and local agencies with the authority to monitor, sample, and require cleanup of various hazardous substances, both regulated and unregulated, that pose an imminent and substantial danger to public health. For example, the California Water Code authorizes Regional

Water Control Boards to require sampling of waste discharges and to direct cleanup and abatement, if necessary, of any threat to water, which may include the release of a contaminant such as perchlorate.

DOD's September 2003 interim policy on perchlorate sampling states that the military services shall sample for perchlorate where service officials suspect the presence of perchlorate on the basis of prior or current DOD activities, and where a complete human exposure pathway is likely to exist. The policy also states that the services shall sample for perchlorate (1) as required by the Safe Drinking Water Act's Unregulated Contaminant Monitoring Regulation[4] and the Clean Water Act's NPDES program and (2) as part of cleanup conducted under DOD's Environmental Restoration Program. While DOD's policy requires it to sample where the two conditions of release and exposure are met, it does not specify whether the services may sample for perchlorate when requested by state agencies or EPA, apart from requirements under environmental laws and regulations. Further, except for at a few sites,[5] DOD has not independently directed the services to clean up perchlorate. We previously reported that DOD has cleaned up perchlorate when directed to do so by EPA or a state environmental agency under various environmental laws, or when perchlorate is found on closed ranges.[6]

Perchlorate Has Been Found at Almost 400 Sites across the United States

Various federal and state agencies have reported finding perchlorate at almost 400 sites in 35 states, the District of Columbia, and 2 commonwealths of the United States in drinking water, surface water, groundwater, and soil. Perchlorate was found at a variety of sites including public water systems, private wells, military installations, commercial manufacturers, and residential areas. The concentration levels reported ranged from 4 parts per billion to more than 3.7 million parts per billion in groundwater at 1 site, yet roughly two-thirds of sites had concentration

[4]Sampling for perchlorate was required under this regulation between 2001 and 2003 (see app. IV).

[5]Edwards Air Force Base, California, is cleaning up perchlorate. According to DOD, the cleanup is independent from, and not in response to, a requirement from a regulatory agency or environmental law.

[6]GAO, *DOD Operational Ranges: More Reliable Cleanup Cost Estimates and a Proactive Approach to Identifying Contamination Are Needed*, GAO-04-601 (Washington, D.C.: May 28, 2004).

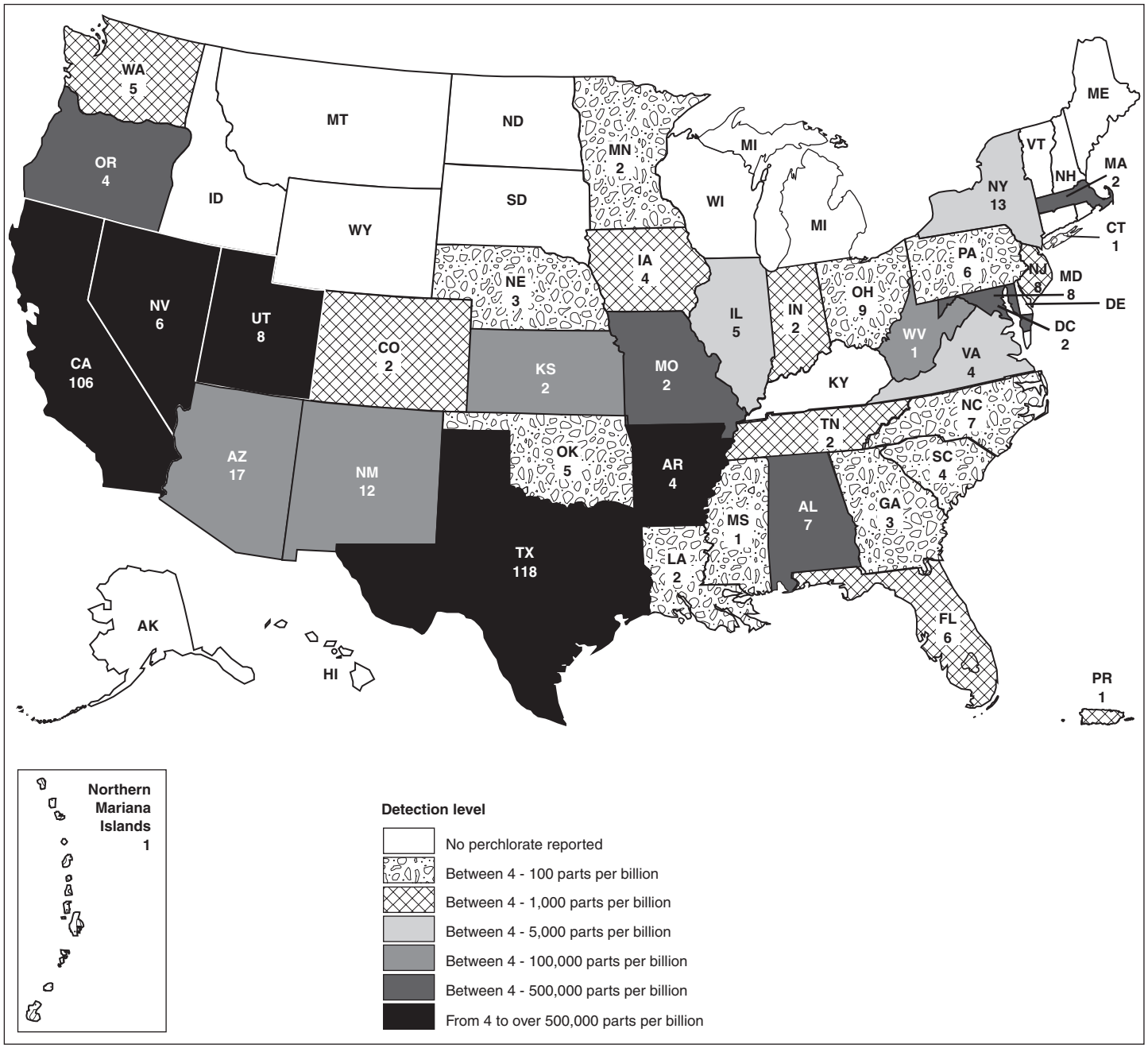
levels at or below 18 parts per billion, the upper limit of EPA's provisional cleanup guidance for perchlorate. Federal and state agencies are not required to routinely report perchlorate findings to EPA, and EPA does not currently have a formal process to centrally track or monitor perchlorate detections or the status of a cleanup. As a result, a greater number of sites may exist in the United States than is presented in this report.

The Majority of Perchlorate Was Found in California and Texas

Through discussions with federal and state environmental agency officials and a review of perchlorate sampling reports, we identified 395 sites in the United States and its commonwealths where perchlorate was found in drinking water, groundwater, surface water, sediment, or soil. A table of reported perchlorate detections in the United States and its commonwealths as of January 2005 is presented in appendix II.

Most of the sites and the highest levels of perchlorate were found in a small number of states. More than one-half of all sites, or 224, was found in Texas and California, where both states have conducted broad investigations to determine the extent of perchlorate. The highest perchlorate concentrations were found in 5 states—Arkansas, California, Nevada, Texas, and Utah—where 11 sites had concentrations exceeding 500,000 parts per billion. However, the majority of the 395 sites had lower levels of perchlorate. We found 249 sites where the highest concentration was equal to or less than 18 parts per billion, the upper limit of EPA's provisional cleanup level, and 271 sites where the highest concentration was less than 24.5 parts per billion, the drinking water concentration equivalent calculated on the basis of EPA's newly established reference dose (see fig. 1).

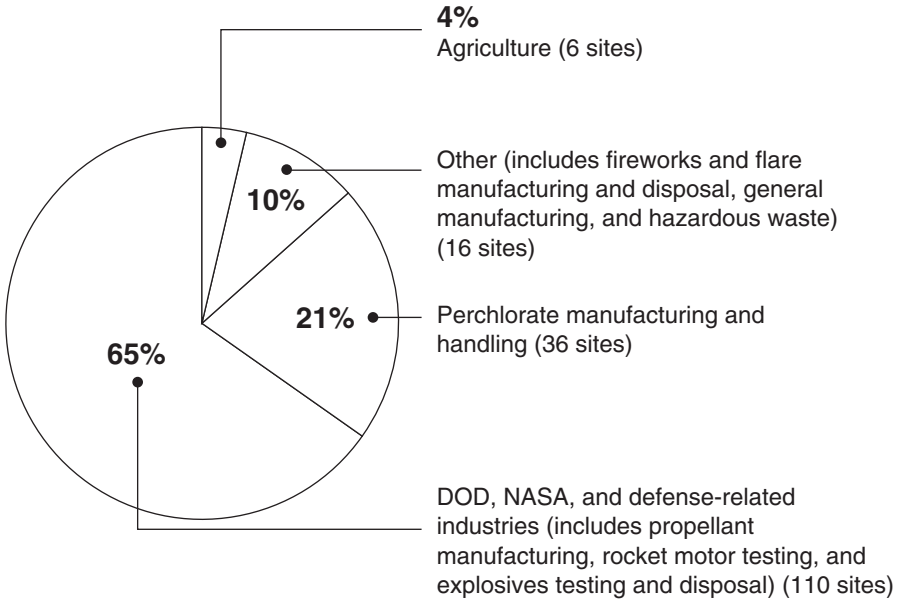
Figure 1: Maximum Perchlorate Concentrations Reported in any Media and Number of Sites, January 2005



Sources: Environmental Protection Agency, Department of Defense, U.S. Geological Survey, and state environmental agencies.

According to EPA and state agency officials, perchlorate found at 110 of the sites was due to activities related to defense and aerospace, such as propellant manufacturing, rocket motor research and test firing, or explosives disposal. At 58 sites, officials said the source of the perchlorate found was manufacturing and handling, agriculture, and a variety of commercial activities such as fireworks and flare manufacturing (see fig. 2).

Figure 2: Activities Linked to Perchlorate, by Site



Sources: Environmental Protection Agency, Department of Defense, U.S. Geological Survey, and state environmental agencies.

At the remaining 227 sites, EPA and state agency officials said the source of the perchlorate found was either undetermined or naturally occurring. Further, all 105 sites with naturally occurring perchlorate are located in the Texas high plains region where perchlorate concentrations range from 4 to 59 parts per billion.

Perchlorate Was Found in 4 Percent of Sampled Public Drinking Water Systems

As of January 2005, and as required for a 12-month period between 2001 and 2003 under the Safe Drinking Water Act's Unregulated Contaminant Monitoring Regulation, 3,722 public drinking water systems had sampled drinking water and reported the results to EPA. Of these public drinking

water systems, 153, or about 4 percent, reported finding perchlorate. Located across 26 states and 2 commonwealths, these 153 sites accounted for more than one-third of the sites we identified, where perchlorate concentrations reported ranged from 4 parts per billion to 420 parts per billion and averaged less than 10 parts per billion. Only 14 of the 153 public drinking water systems had concentration levels above 24.5 parts per billion, the drinking water equivalent calculated on the basis of EPA's revised perchlorate reference dose. California had the most public water systems with perchlorate, where 58 systems reported finding perchlorate in drinking water. The highest drinking water perchlorate concentration of 420 parts per billion was found in Puerto Rico in 2002. Subsequent sampling in Puerto Rico did not find any perchlorate, and officials said the source of the initial finding was undetermined.

Because of the proximity of these 153 public water systems to populated areas, an EPA official estimated that about 10 million people may have been exposed to perchlorate through their drinking water. EPA officials told us that they do not know the source of most of the perchlorate found in public water systems, but that perchlorate found in 32 water systems in Arizona, California, and Nevada was likely due to previous perchlorate manufacturing in Nevada. Regional EPA and state officials told us they did not plan to clean up perchlorate found at public drinking water sites pending a decision to establish a drinking water standard for perchlorate. In some cases, officials did not plan to clean up because subsequent sampling was unable to confirm that perchlorate was present.

Extent of Perchlorate and Cleanup Efforts Is Difficult to Determine Because Federal and State Agencies Are Not Generally Required to Share with EPA Information on Perchlorate Sampling or Cleanup

EPA officials said the agency does not centrally track or monitor perchlorate detections, or the status of cleanup activities, other than under the Safe Drinking Water Act where EPA collected data from public water systems for 1 year. As a result, it is difficult to determine the extent of perchlorate in the United States. EPA maintains a listing of sites known to EPA where cleanup or other response actions are under way, but the list does not include all sites because some sites have not been reported to EPA. As a result, EPA officials said they did not always know whether other federal and state agencies found perchlorate because, as is generally the case with unregulated contaminants, there is no requirement for states or other federal agencies to routinely report perchlorate findings to EPA. For example, except as required under specific environmental programs, DOD is not required to report to EPA when perchlorate is found on active installations and facilities. Consequently, EPA region officials in California said they did not know that the Department of the Navy found perchlorate

at the Naval Air Weapons Station at China Lake. Further, even where EPA has authorized states to implement the RCRA program, states are not required to routinely notify EPA about perchlorate found under the program. For example, EPA region officials in California said the Nevada state agency did not tell them perchlorate was found at Rocketdyne, an aerospace facility in Reno, or that it was being cleaned up. EPA only learned about the perchlorate finding when the facility's RCRA permit was renewed.

We also found that communication and data sharing between EPA and state agency officials varied. Because states are not required to routinely notify EPA about perchlorate, some EPA region officials told us they contacted state agencies to ask whether new sites had been found. Some EPA region and state officials told us they participated in monthly or quarterly meetings to discuss perchlorate, and most EPA and state officials told us they had good working relationships and shared information about perchlorate. Yet a few EPA region officials told us they did not always know whether states found perchlorate, at what levels, or what actions were taken. For example, an EPA region official told us he did not know what actions were taken at three RCRA sites in Utah where perchlorate was found.

EPA and State Environmental Agencies Use Federal and State Environmental Laws and Regulations to Respond to Perchlorate

Although there is no federal standard for perchlorate in drinking water or a federal cleanup standard, EPA and state environmental agencies authorized by EPA have investigated suspected sites; collected samples and analyzed for perchlorate; and, when perchlorate is found, cleaned up or limited perchlorate releases under broad authorities found in various federal environmental laws and regulations. Further, both EPA and authorized states have required responsible parties to sample and clean up perchlorate under other state laws. Most responsible parties sampled and cleaned up when required by regulation or directed by EPA or states. DOD sampled and cleaned up on the basis of its interpretation of federal and state legal requirements and its own policy. Of the 395 sites where perchlorate has been found, EPA or state environmental officials told us cleanup is under way or planned at 51 of them.

Various Environmental Laws, Regulations, and Provisional Standards Are Used by Federal and Some State Agencies to Sample and Clean Up Perchlorate

We found EPA and state environmental agencies have investigated, sampled, and cleaned up perchlorate, or have required sampling and cleanup, pursuant to general authorities contained in various federal and state environmental laws and regulations. According to EPA and state agency officials, state agencies have also established levels for sampling and cleanup, and some state environmental laws provide that other authorities are to respond to contaminant releases, including perchlorate.

Both EPA and state environmental agencies have used federal environmental laws, such as CERCLA, RCRA, and the NPDES provisions of the Clean Water Act, as authority to respond to releases of substances that may endanger public health or the environment, including perchlorate. EPA and the states have used such authority to sample and clean up as well as require the sampling and cleanup of perchlorate. For example:

- As part of a CERCLA review, EPA sampled groundwater near former government-owned grain storage facilities in Iowa and found perchlorate in residential and commercial drinking water wells at three sites. During subsequent sampling, EPA did not find perchlorate at two of the sites but confirmed perchlorate at the third site. EPA is providing bottled drinking water to certain persons until an uncontaminated drinking water supply becomes available.

- During sampling required as part of a RCRA permit, ATK Thiokol, a Utah explosives and rocket fuel manufacturer, found perchlorate. Under authority provided by RCRA, Utah required the manufacturer to install a monitoring well to determine the extent of perchlorate and take steps to prevent additional perchlorate releases.

- Under the NPDES program, Texas required the Navy to reduce perchlorate levels in wastewater discharges at the McGregor Naval Weapons Industrial Reserve Plant to 4 parts per billion, the lowest level at which perchlorate could be detected.

According to EPA and state officials, EPA and state environmental agencies have investigated and sampled groundwater and surface water areas for perchlorate, or requested that responsible parties or others do so, pursuant to agency oversight responsibilities to protect water quality and human health. For example:

- EPA plans to sample five waste disposal sites in Niagara Falls, New York, to determine whether the groundwater contains perchlorate from manufacturing that took place in the area between 1908 and 1975.

- EPA asked Patrick Air Force Base and the Cape Canaveral Air Force Station, Florida, to sample groundwater for perchlorate near rocket launch sites. Previously, both installations inventoried areas where perchlorate was suspected and conducted limited sampling. DOD officials did not find perchlorate at Patrick Air Force Base, and, according to an EPA official, the Department of the Air Force said it would not conduct additional sampling at either installation until there is a federal standard for perchlorate.

- Between 1998 and 2002, Utah sampled public drinking water systems considered at risk for the presence of perchlorate because of nearby perchlorate use and found perchlorate concentrations at more than 42 parts per billion in three wells at two sites.

- Texas contracted with Texas Tech University to sample drinking water wells for perchlorate in 54 counties after perchlorate was found in five public water systems in the high plains region of the state. The university study found perchlorate in some drinking water wells and concluded that the most likely source was natural occurrence.

When perchlorate was found, according to state and EPA officials, state agencies have taken steps to minimize human exposure or perform cleanup, or required responsible parties to do so, pursuant to the same general authorities contained in federal environmental laws and regulations. For example:

- Nevada is requiring Pepcon, a former perchlorate manufacturing site, to install a cleanup system to remove perchlorate from groundwater.

- Massachusetts closed a public well and provided bottled drinking water to students at a nearby school when perchlorate was found in a city public water system.

- At the request of California, United Technologies, a large rocket testing facility in Santa Clara County, stopped releasing perchlorate and cleaned up perchlorate found in the groundwater.

Without a federal standard for perchlorate, according to EPA and state officials, at least nine states have established nonregulatory action levels or advisories for perchlorate ranging from under 1 part per billion to 18 parts per billion. States that have sampled, or required responsible parties to sample, report, and clean up, have used these advisories as the levels at which action must be taken. For example:

- Oregon initiates in-depth site studies to determine the cause and extent of perchlorate when concentrations of 18 parts per billion or greater are found.

- Nevada required the Kerr-McGee Chemical site in Henderson to treat groundwater and reduce perchlorate concentration releases to 18 parts per billion, which is Nevada's action level for perchlorate.

- According to Utah officials, Utah does not have a written action level for perchlorate, but, if perchlorate concentrations exceed 18 parts per billion, the state may require the responsible party to clean up.

Finally, in addition to state laws enacted to allow states to assume responsibility for enforcing federal environmental laws, other state environmental laws provide authority to respond to contaminant releases, including perchlorate. For example, EPA and state officials told us that both California and Nevada state agencies have required cleanup at some sites under state water quality laws.

Parties Responsible for Perchlorate Findings Generally Have Complied with Regulations Requiring Sampling and Cleanup

According to EPA and state officials, private industry and public water suppliers have generally complied with regulations requiring sampling, such as those under (1) the RCRA and NPDES permit programs, where responsible parties have been required to sample and report hazardous releases to state environmental agencies, or (2) the Safe Drinking Water Act's Unregulated Contaminant Monitoring Regulation, which required sampling for unregulated contaminants, such as perchlorate, between 2001 and 2003. Further, according to EPA and state officials, private industry has generally responded by reducing perchlorate and cleaning up when required by regulation or directed by EPA or state agencies.

DOD's Policy Requires Sampling for Perchlorate under Certain Conditions

DOD's perchlorate sampling policy requires the military services to sample where the particular installation must do so, under laws or regulations such as the Clean Water Act's NPDES permit program, or where a reasonable basis exists to suspect that a perchlorate release has occurred as a result of DOD activities and that a complete human exposure pathway is likely to exist. However, DOD's policy on perchlorate sampling does not address cleanup. We found DOD has sampled for perchlorate on closed installations when requested by EPA or a state agency and cleaned up on active and closed installations when required by a specific environmental law, regulation, or program, such as the environmental restoration program at formerly used defense sites. For example, at EPA's request, the U.S. Army Corps of Engineers (Corps) installed monitoring wells and is sampling for perchlorate at Camp Bonneville, a closed installation near Vancouver, Washington. Utah state officials told us DOD is removing soil containing perchlorate at the former Wendover Air Force Base in Utah, where the Corps found perchlorate in 2004.

According to EPA and state officials, DOD has been reluctant to (1) sample on or near active installations because there is no specific federal regulatory standard for perchlorate or (2) sample where DOD determined the criteria to sample were not met as outlined in its policy. Except where there is a legal requirement to sample at a particular installation, DOD's perchlorate policy does not require sampling unless the two conditions of release and exposure are met. Utah state officials told us the agency asked the Department of the Army to sample for perchlorate at two active installations, Dugway Proving Grounds and Deseret Chemical Depot. Previously, in 1998, the Army reported that perchlorate had been used at Dugway for more than 20 years. According to state agency officials, the Army said there was not a clear potential for human exposure to perchlorate at these sites, and it would not sample unless a higher Army level approved the sampling. In February 2005, Utah officials told us Dugway Proving Grounds had not requested permission from Army headquarters to sample, and they did not know whether Deseret requested permission to sample.

In fiscal years 2004 and 2005, several provisions to federal law were enacted that encourage DOD to conduct health studies and evaluate perchlorate found at military sites. For example, the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 states that the Secretary of Defense should develop a plan for cleaning up perchlorate resulting from DOD activities, when the perchlorate poses a health hazard,

and continue evaluating identified sites.[7] In October 2004, DOD and California agreed to a procedure for prioritizing perchlorate sampling at DOD facilities in California. The procedure includes steps to identify and prioritize the investigation of areas on active installations and military sites (1) where the presence of perchlorate is likely based on previous and current defense-related activities and (2) near drinking water sources where perchlorate was found. Although DOD has been urged by Congress to evaluate sites where the presence of perchlorate is suspected, DOD's September 2003 perchlorate policy continues to require sampling on active installations only where there is a suspected release due to DOD activities and a likely human exposure pathway, or where required under specific laws, such as the Clean Water Act.

EPA and States Are Cleaning Up, Requiring Cleanup, or Taking Action to Clean Up 51 Sites Where Perchlorate Was Found

EPA, state agencies, and responsible parties are cleaning or planning to clean up at 51 of the 395 sites we identified. At 23 sites, EPA, states, and responsible parties are cleaning up or working to reduce perchlorate releases. For example, EPA required several defense, petroleum, and other companies to clean up perchlorate in Baldwin Park, California, a CERCLA site. The cleanup involves extracting and treating up to 26 million gallons of water per day, after which the water is distributed to several nearby communities. Texas required Longhorn Army Ammunition Plant, a closed DOD facility, to clean up by limiting perchlorate releases to a daily average concentration of 4 parts per billion (and a maximum of 13 parts per billion per day) under the NPDES program. Kerr-McGee Chemical, a former perchlorate manufacturer in Nevada, is cleaning up using an ion exchange system. According to officials, Nevada required the facility to clean up perchlorate under a state water law after perchlorate concentrations up to 3.7 million parts per billion were found in the groundwater.

At 28 sites, EPA and state agency officials told us that federal and state governments and private parties are evaluating the extent of perchlorate and potential cleanup methodologies. Unidynamics, an Arizona propellant manufacturer located at a CERCLA site, responded to EPA's concern about perchlorate at the site and is investigating perchlorate treatment methods. According to officials, after Kansas asked Slurry Explosives to clean up perchlorate under a state environmental law, the manufacturer began investigating a biological method to clean up.

[7]Pub. L. No. 108-375, § 318, 118 Stat. 1811, 1845 (2004).

The remaining 344 sites are not being cleaned up for a variety of reasons. The reason most often cited by EPA and state officials was that they were waiting for a federal requirement to do so. In some instances, officials said they would not clean up sites where perchlorate was naturally occurring or where subsequent sampling was unable to find perchlorate.

DOD and EPA Sponsored Numerous Studies of Perchlorate Exposure, but Findings about Perchlorate's Health Effects Are Inconsistent

Since 1998, EPA and DOD have sponsored a number of studies of the health risks of perchlorate using experimental, field study, and data analysis methods. We reviewed 90 of these studies and found that 44 offered conclusions or observations on whether perchlorate had a health effect. Of these, 26 studies found that perchlorate had an adverse effect. However, in some of these studies, it was unknown whether the observed adverse effects would be reversible over time. In January 2005, NAS issued its report on EPA's draft health assessment and the potential health effects of perchlorate. The NAS report considered many of the same health risk studies that we reviewed and concluded that an exposure level higher than initially recommended by EPA may not adversely affect a healthy adult, but recommended more study of the effects of perchlorate on pregnant women and children.

Study Findings Differed on the Health Effects of Perchlorate Exposure

DOD, industry, and EPA sponsored the majority of the 90 health studies we reviewed; the remaining studies were conducted by academic researchers and other federal agencies. Of these 90 studies, 49 used an experimental design methodology to determine the effects of perchlorate on humans, mammals, fish, and/or amphibians by exposing these groups to differing dose amounts of perchlorate over varied periods of time and comparing the results with other groups that were not exposed. Twelve were field studies that compared humans, mammals, fish, and/or amphibians in areas known to be contaminated with the same groups in areas known to be uncontaminated. Both methodologies have limitations; that is, the experimental studies were generally short in duration, and the field studies were generally limited by the researchers' inability to control whether, how much, or how long the population in the contaminated areas was exposed. Finally, 29 studies used a data analysis methodology where researchers reviewed several publicly available human and animal studies and used data derived from these studies to determine the process by which perchlorate affects the human thyroid and the highest exposure levels that did not adversely affect humans. The 3 remaining studies used another or

unknown methodology.[8] Appendix III provides data on these studies, including who sponsored them; what methodologies were used; and, where presented, the author's conclusions or findings on the effects of perchlorate.

Many of the studies we reviewed contained only research findings, not conclusions or observations, on the health effects of perchlorate. Only 44 studies had conclusions on whether perchlorate had an adverse effect. Of these, 29 studies evaluated the effect of perchlorate on development, and 18 found adverse effects resulting from maternal exposure to perchlorate. Adverse effects of perchlorate on the adult thyroid are difficult to evaluate because they may happen over longer time periods than can be observed in a research study. However, the adverse effects of perchlorate on development can be more easily studied and measured within study time frames. Moreover, we found different studies used the same perchlorate dose amount but observed different effects. The different effects were attributed to variables such as the study design type or age of the subjects, but the precise cause of the difference is unresolved. Such unresolved questions are one of the bases for the differing conclusions in EPA, DOD, and academic studies on perchlorate dose amounts and effects. According to EPA officials, the most sensitive population for perchlorate exposure is the fetus of a pregnant woman who is also nearly iodine-deficient. However, none of the 90 studies we reviewed considered this population. Some studies reviewed pregnant rat populations and the effect on the thyroid, but we did not find any studies that considered perchlorate's effect on nearly iodine-deficient pregnant populations and the thyroid.

The National Academy of Sciences Reported That Evidence Was Insufficient to Show Perchlorate Causes Adverse Effects

In January 2005, NAS issued its report on EPA's draft health assessment and the potential health effects of perchlorate. NAS reported that although perchlorate affects thyroid functioning, there was not enough evidence to show that perchlorate causes adverse effects at the levels found in most environmental samples. Most of the studies NAS reviewed were field studies, the report said, which are limited because they cannot control whether, how much, or how long a population in a contaminated area is exposed. NAS concluded that the studies did not support a clear link between perchlorate exposure and changes in the thyroid function in newborns and hypothyroidism or thyroid cancer in adults. In its report,

[8]The number of study types is greater than the total number of studies because 3 studies used a combination of experimental design and data analysis methodologies.

NAS noted that only 1 study examined the relationship between perchlorate exposure and adverse effects on children, and that no studies investigated the relationship between perchlorate exposure and adverse effects on vulnerable groups, such as low-birth-weight infants. NAS concluded that an exposure level higher than initially recommended by EPA may not adversely affect a healthy adult. The report did not recommend a drinking water standard; however, it did recommend that additional research be conducted on perchlorate exposure and its effect on children and pregnant women.

Conclusions

Perchlorate has been found in the groundwater, surface water, drinking water, or soil in 35 states, the District of Columbia, and 2 commonwealths of the United States where concentrations reported ranged from 4 parts per billion to millions of parts per billion. According to EPA and state environmental agency officials, a leading known cause of the perchlorate found was defense-related activities. In addition, EPA and state officials attributed the cause of the perchlorate found at more than one-half of sites to natural occurrence or undetermined sources. State and other federal agencies do not always report perchlorate detections to EPA, however, because EPA, other federal agencies, and the states do not have a standardized approach for reporting perchlorate data nationwide. As a result, a greater number of sites with perchlorate may already exist. Further, EPA does not track the status of cleanup at sites where perchlorate has been found. Without a formal system to track and monitor perchlorate findings and cleanup activities, EPA and the states do not have the most current and complete accounting of perchlorate as an emerging contaminant of concern, including the extent of perchlorate found and the extent or effectiveness of cleanup projects.

Recommendation for Executive Action

In order to ensure that EPA has reliable information on perchlorate and the status of cleanup efforts, and to better coordinate lessons learned between federal agencies and states on investigating and cleaning up perchlorate, we recommend that, in coordination with states and other federal agencies, EPA use existing authorities or seek additional authority, if necessary, to establish a formal structure to centrally track and monitor perchlorate detections and the status of cleanup efforts across the federal government and state agencies.

Agency Comments and Our Evaluation

In its April 26, 2005, letter (see app. V), EPA agreed with our findings and conclusions on the extent of perchlorate in the United States and that defense-related activities have been found to be associated with perchlorate detections. However, EPA did not agree with our recommendation that it establish a formal structure to centrally track and monitor perchlorate detections and the status of cleanup efforts across the federal government and state agencies. In its letter, EPA stated that it already had significant information and data on perchlorate concentrations in various environmental media, where much of the information was provided by other federal and state agencies as well as private parties. EPA also asserted that the development and maintenance of a new tracking system would require additional resources or the redirection of resources from other activities. To justify a tracking system, EPA would have to analyze its associated costs and benefits.

As our report explains, however, state and other federal agencies do not always report perchlorate detections to EPA. Further, without a formal system to track and monitor perchlorate findings and cleanup activities, EPA does not have the most current and complete accounting of perchlorate as an emerging contaminant of concern. To underscore our point, in commenting on a draft of this report, DOD provided a listing of four sites where it found perchlorate between 2000 and 2004. These sites were not in EPA's database. (We added these sites to our listing in app. II.) With regard to the cost benefit aspect of EPA's comments, we believe that EPA is misconstruing the extent of work necessary to implement a more formalized and structured system to track perchlorate. We are not proposing an elaborate new system but, instead, believe that EPA needs to work toward a more structured process than what is currently in place to track and monitor perchlorate routinely. Currently, EPA's regions are spending time and effort contacting their counterparts in other federal agencies and states on an ad hoc basis to obtain more current information about perchlorate. However, this is being done without any structure or consistency related to how and when contacts are made, how frequently they are made, or what specific information is collected. As a result, we found that EPA does not have complete, current, or accurate information to track the occurrence of perchlorate—the type of information that would be needed when making a determination about the need for regulation. We continue to believe that such information is necessary and that it can be obtained without an elaborate or costly undertaking.

In contrast to EPA's view of our report's accuracy, DOD said in its April 26, 2005, letter (see app. VI), that our report did not provide an accurate assessment of perchlorate issues and activities. DOD asserted that our report mischaracterized DOD's response to perchlorate and cited examples of where DOD has sampled and invested in cleanup technologies, even though perchlorate is currently unregulated. We disagree with DOD's position. Our report credits DOD with actions it has taken but also points out where DOD has not acted. For example, our report acknowledges that DOD is sampling for perchlorate as required under various environmental laws, or when certain criteria exist as specified in DOD's sampling policy; that is, where the presence of perchlorate is suspected based on prior or current DOD activities and a complete exposure pathway to humans is likely to exist. While DOD states that it has a policy that establishes an affirmative obligation to sample and not a limitation, that view is not shared by some regulators. As we point out in our report, there have been a number of instances where EPA or state agencies asked the services to sample but service officials declined because they did not believe the conditions met with DOD's sampling policy. As such, DOD has used its policy to limit testing for perchlorate that environmental regulators believed was necessary.

With regard to DOD's point that perchlorate is unregulated, we are well aware that many other contaminants, like perchlorate, are not specifically regulated, yet are being addressed and cleaned up as hazards under various environmental laws.

DOD also stated that we did not accurately summarize the findings of the NAS study and other scientific and technical data. We believe our report accurately summarizes key information from both NAS as well as 90 other studies of the potential health risks of perchlorate, as specified by the requester of this report.

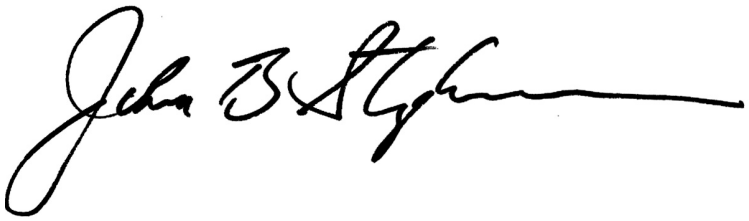
Finally, DOD disagreed with our recommendation that EPA establish a more formal structure to centrally track and monitor perchlorate because it was not clear that such a system will provide added value. DOD stated that it will continue to share its information on perchlorate. As previously noted, in commenting on this report, DOD provided information on four locations where perchlorate has been found, in one case as long as 5 years ago, and which do not appear on EPA's list of perchlorate detection sites. Whether this omission occurred as a result of a DOD or an EPA oversight is unknown, but it underscores the need for a more structured and formalized system.

Both EPA and DOD provided technical comments as enclosures to their letters, which we incorporated in our report as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees; the Administrator, Environmental Protection Agency; the Secretary of Defense; and other interested parties. We will also provide copies to others upon request. In addition, the report will be available, at no charge, on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions, please call me or Edward Zadjura at (202) 512-3841. Contributors to this report are listed in appendix VII.

Sincerely yours,



John B. Stephenson
Director, Natural Resources
and Environment

Objectives, Scope, and Methodology

We identified (1) the estimated extent of perchlorate nationwide; (2) what actions the federal government, state governments, and responsible parties have taken to clean up or eliminate the source of perchlorate found; and (3) what studies of the potential health risks from perchlorate have been conducted and, where presented, the author's conclusions or findings on the health effects of perchlorate.

To provide an estimate of the extent of perchlorate in the United States, we compiled and analyzed data on perchlorate detections from the Environmental Protection Agency (EPA), the Department of Defense (DOD), the U.S. Geological Survey, and state agencies. For each site, our review shows the highest perchlorate concentration reported for all media sampled as of January 2005, although officials may have sampled the site more than once, in varying locations and media, and found differing levels of perchlorate. We also interviewed officials from EPA headquarters and regional offices, DOD, and selected state agencies to determine the accuracy and completeness of our compiled list of perchlorate detections.

To identify what actions the government and private sector have taken to address perchlorate and the extent to which responsible parties have taken action to clean up and eliminate the source of perchlorate, we reviewed federal and state laws, regulations, and policies on water quality and environmental cleanup and interviewed EPA and state agency officials on their roles, responsibilities, and authorities to monitor and respond to instances of perchlorate found. We interviewed officials from EPA headquarters and each of its 10 regions. We also interviewed officials from state environmental agencies in California, Oregon, Texas, and Utah. We selected these states because they (1) had higher estimated numbers of sites where perchlorate was found and higher perchlorate concentration levels and/or (2) had taken steps to investigate and respond to perchlorate. During interviews with state agency officials, we discussed whether parties responsible for perchlorate had taken action to clean up and whether federal or local governments required that they stop activities causing the release of perchlorate. Finally, we reviewed and analyzed data from federal and state agencies to determine the status and extent of cleanup efforts.

To identify studies of the potential health risks from perchlorate, we conducted a literature search for studies of perchlorate health risks published since 1998. We also interviewed DOD and EPA officials to obtain a list of the studies they considered important in assessing perchlorate health risks. We examined the references for each study so that we could include any other key studies that we had not obtained through the

literature search and DOD and EPA interviews. We identified 125 studies of perchlorate and the thyroid but did not review 35 of these studies because they were not directly related to the effects of perchlorate on the thyroid. Our review of 90 studies included the title; the author and publication information; the sponsor or recipient; a description of the study subjects; the type of research design and controls; and, where presented, the author's conclusions or findings about the adverse effects of perchlorate on health.

We conducted our work from June 2004 to March 2005 in accordance with generally accepted government auditing standards, including an assessment of data reliability and internal controls.

Facilities and Sites Where Perchlorate Was Found and Concentration Levels, as of January 2005

			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
1	AL	Anniston Army Depot, Calhoun County	11	Groundwater	
2	AL	Atmore Utility Board, Escambia County	9	Drinking water	
3	AL	Daphne Utilities Board, Baldwin County	7	Drinking water	
4	AL	Fort McClellan, City of Anniston	32	Soil	
5	AL	Mobile County Water and Fire Protection Authority, Mobile County	6	Drinking water	
6	AL	Montgomery Water Works, Montgomery County	11	Drinking water	
7	AL	Redstone Army Arsenal (NASA Marshall Space Flight Center)	220,000 12,200 280	Groundwater Surface water Soil	
8	AR	Aerojet (Formerly Atlantic Research Corporation), City of East Camden	2,708,700 12,500	Soil Surface water	
9	AR	Hickory Ridge Cross County Rural Water System, Cross County	6	Drinking water	
10	AR	Hot Springs Waterworks, Garland County	7	Drinking water	
11	AR	Schumaker Naval Ammunition Depot, City of Camden	850	Groundwater	
12	AZ	Aerodyne Gila River Indian Reservation, City of Chandler	18	Groundwater	Planning
13	AZ	Apache Nitrogen Products (formerly known as Apache Powder Company), City of Benson	670	Groundwater	Planning
14	AZ	Brook Water Company, La Paz County	6	Drinking water	
15	AZ	Camp Navajo, City of Bellemont	39	Surface water	
16	AZ	Chaparral City Water Company, Maricopa County	6	Drinking water	
17	AZ	City of Mesa, Maricopa County	7	Drinking water	
18	AZ	Far West Water Company, City of Yuma	4	Drinking water	
19	AZ	Fort Huachuca, Cochise County	27,000	Soil	
20	AZ	Glendale Municipal Water Company, Maricopa County	6	Drinking water	
21	AZ	Phoenix Municipal Water System, Maricopa County	5	Drinking water	
22	AZ	Scottsdale Municipal Water, Maricopa County	7	Drinking water	
23	AZ	Tucson Water Dept Municipal, Pima County	12	Drinking water	
24	AZ	Unidynamics/Phoenix Goodyear Airport, City of Goodyear	80 30	Groundwater Drinking water	Planning

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			Highest detection reported[a]		
	State	**Facility/Site name**	**Amount (ppb)[b]**	**Media**	**Cleanup status[c]**
25	AZ	Universal Propulsion Company, Incorporated, City of Phoenix	130	Groundwater	Planning
26	AZ	Yuma Marine Corps Air Station, City of Yuma	150 4 5	Soil Drinking water Surface water	
27	AZ	Yuma Municipal Water Department, Yuma County	6	Drinking water	
28	AZ	Yuma Proving Ground, City of Yuma	5	Surface water	
29	CA	Aerojet General, City of Chino Hills	877	Groundwater	
30	CA	Aerojet General, City of Rancho Cordova	640,000 260	Groundwater Drinking water	Under way
31	CA	Air Force Research Laboratory, Edwards Air Force Base, Kern County	4,550	Groundwater	Under way
32	CA	Alpha Explosives, City of Lincoln	67,000	Groundwater	
33	CA	Azusa Light and Water, Los Angeles County	11	Drinking water	
34	CA	Beale Air Force Base, Yuba County	492	Groundwater	
35	CA	California State Polytechnical University - Pomona, Los Angeles County	6	Drinking water	
36	CA	California Water Service Company - Dominguez, Los Angeles County	9	Drinking water	
37	CA	California Water Service Company - ELA, Los Angeles County	8	Drinking water	
38	CA	California Water Service Company - Salinas, Monterey County	22	Drinking water	
39	CA	California Water Service Company - Stockton, San Joaquin County	5	Drinking water	
40	CA	California Water Service Company - Suburban Los Altos, Santa Clara County	5	Drinking water	
41	CA	Carmichael Water District, Sacramento County	4	Drinking water	
42	CA	Casmalia Resources, City of Casmalia	58	Groundwater	
43	CA	China Lake Naval Weapons Center, Kern County	921	Groundwater	
44	CA	City of Anaheim, Orange County	5	Drinking water	
45	CA	City of Bakersfield, Kern County	8	Drinking water	
46	CA	City of Brawley, Imperial County	5	Drinking water	
47	CA	City of Chino, San Bernardino County	21	Drinking water	
48	CA	City of Chino Hills, San Bernardino County	4	Drinking water	
49	CA	City of Colton, San Bernardino County	8	Drinking water	

(Continued From Previous Page)

			Highest detection reported[a]		
	State	**Facility/Site name**	**Amount (ppb)[b]**	**Media**	**Cleanup status[c]**
50	CA	City of Corona, Riverside County	12	Drinking water	
51	CA	City of Escondido, San Diego County	4	Drinking water	
52	CA	City of Garden Grove, Orange County	4	Drinking water	
53	CA	City of Hemet, Riverside County	7	Drinking water	
54	CA	City of Loma Linda, San Bernardino County	5	Drinking water	
55	CA	City of Ontario, San Bernardino County	12	Drinking water	
56	CA	City of Patterson, Stanislaus County	4	Drinking water	
57	CA	City of Pomona, Los Angeles County	10	Drinking water	
58	CA	City of Rialto, San Bernardino County	21	Drinking water	
59	CA	City of Riverside, Riverside County	42	Drinking water	
60	CA	City of San Bernardino, San Bernardino County	7	Drinking water	
61	CA	City of Santa Ana, Orange County	4	Drinking water	
62	CA	City of Stockton, San Joaquin County	19	Drinking water	
63	CA	City of Tracy, San Joaquin County	21	Drinking water	
64	CA	City of Tustin, Orange County	9	Drinking water	
65	CA	Coachella Valley Water District, Cove Community, Riverside County	6	Drinking water	
66	CA	Cucamonga Water District, San Bernardino County	9	Drinking water	
67	CA	Denova Environmental, San Bernardino County	460	Soil	
68	CA	Desert Water Agency, Riverside County	6	Drinking water	
69	CA	East Valley Water District, San Bernardino County	16	Drinking water	
70	CA	Eastern Municipal Water District, Riverside County	8	Drinking water	
71	CA	El Centro Naval Air Facility, Imperial County	5	Drinking water	
72	CA	El Toro Marine Corps Air Station, Orange County	1,600 460	Soil Groundwater	
73	CA	EMBEE, Incorporated, Orange County	1,900	Groundwater	
74	CA	Fort Ord, Monterey County	35	Soil	
75	CA	G.E. Plastics, Orange County	1,100,000	Groundwater	
76	CA	Great Oaks Water Company, Incorporated, Santa Clara County	4	Drinking water	
77	CA	Imperial Valley College, Imperial County	6	Drinking water	
78	CA	Irvine Ranch Water District, Orange County	6	Drinking water	

(Continued From Previous Page)

			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
79	CA	Jet Propulsion Laboratory, Edwards Air Force Base, Kern County	2,100,000 160,000	Soil Groundwater	
80	CA	Jurupa Community, Riverside County	5	Drinking water	
81	CA	Lawrence National Laboratories, Department of Energy Experimental Site 300, City of Tracy	84	Groundwater	Under way
82	CA	Lincoln Avenue Water Company, Los Angeles County	5	Drinking water	
83	CA	Lockheed Propulsion Company, City of Beaumont	141,000	Groundwater	Planning
84	CA	Lockheed Propulsion Company (Former), City of Redlands	87	Drinking water	Under way
85	CA	Mather Air Force Base, City of Rancho Cordova	1,900 120	Groundwater Drinking water	
86	CA	McClellan Air Force Base, Sacramento County	15	Groundwater	
87	CA	McCormick, Selph (same as TDY industries), City of Hollister	5,500	Groundwater	Under way
88	CA	McDonnell-Douglas and Aerojet Corporation, City of Rancho Cordova	32,000	Groundwater	Under way
89	CA	Metropolitan Water Dist. of Southern California, Los Angeles County	7	Drinking water	
90	CA	Monte Vista Water District, San Bernadino County	4	Drinking water	
91	CA	Morris Dam Naval Command, Control and Ocean Surveillance Center, Los Angeles County	65	Groundwater	
92	CA	MP Associates, Incorporated, City of Ione, Amador County	957,000	Soil	
93	CA	NASA, Jet Propulsion Laboratory, City of Pasadena	13,300	Drinking water	Under way
94	CA	National Semiconducter Corporation, Santa Clara County	120	Groundwater	Under way
95	CA	National Technical Systems, Los Angeles County	320	Soil	
96	CA	North Rialto Area (multiple responsible parties), City of Rialto	820	Drinking water	Under way
97	CA	OEA Aerospace (formally Universal Propulsion), Solano County	350	Groundwater	Planning
98	CA	Olin Safety Flare, City of Morgan Hill	1,000 15	Groundwater Drinking water	Under way

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	State	Facility/Site name	Highest detection reported[a] Amount (ppb)[b]	Media	Cleanup status[c]
99	CA	Pasadena Water Department, Los Angeles County	35	Drinking water	
100	CA	Purity Oil Delta Gunnite, City of Rancho Cordova	13,000	Soil	
101	CA	Pyrite Canyon, City of Glen Avon	2,100	Groundwater	
102	CA	Rancho California Water District, Riverside County	4	Drinking water	
103	CA	Redlands City Municipal Utility District-Water Division, San Bernardino County	67	Drinking water	
104	CA	Riverside Highland Water Company, San Bernardino County	5	Drinking water	
105	CA	Rubidoux Community Services District, Riverside County	10	Drinking water	Under way
106	CA	San Fernando City Water Department, Los Angeles County	9	Drinking water	
107	CA	San Fernando Valley (Area 2), City of Glendale	13	Groundwater	
108	CA	San Gabriel Valley (Area 1), El Monte Operable Unit, City of El Monte	21	Groundwater	Planning
109	CA	San Gabriel Valley (Area 2), Baldwin Park Operable Unit, City of Baldwin Park	2,180 159	Groundwater Drinking water	Under way
110	CA	San Gabriel Valley (Area 1), South El Monte Operable Unit (Includes Nike 14 Launcher Area, City of South El Monte	17	Groundwater	Under way
111	CA	San Gabriel Valley (Area 4), Puente Valley Operable Unit, City of Industry	18	Groundwater	Planning
112	CA	San Gabriel Valley Water Company, Fontana, San Bernadino County	15	Drinking water	
113	CA	San Gabriel Water District, Los Angeles County	4	Drinking water	
114	CA	Santa Clarita Site Assessment, Los Angeles County	47	Drinking water	
115	CA	Santa Clarita Water Company, Los Angeles County	4	Drinking water	
116	CA	Santa Susanna Field Laboratory, Boeing-Rocketdyne Division (Department of Energy), Los Angeles County	750	Groundwater	Under way
117	CA	Seal Beach Naval Weapons Station, Orange County	2,460	Soil	
118	CA	Sierra Army Depot, Lassen County	8	Groundwater	
119	CA	Sonoma County Site Assessment	5	Drinking water	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
120	CA	South California Water Company, Orange County	6	Drinking water	
121	CA	South Pasadena City Water Department, Los Angeles County	5	Drinking water	
122	CA	Special Devices Incorporated, City of Newhall, Los Angeles County	82	Groundwater	
123	CA	Stringfellow Superfund Site, City of Glen Avon	87,000	Groundwater	Planning
124	CA	Suburban Water Systems-San Jose, Los Angeles County	7	Drinking water	
125	CA	Trabuco Canyon Water District, Orange County	5	Drinking water	
126	CA	Tulare County Site Assessment	11	Drinking water	
127	CA	United Defense (FMC Corporation), City of Hollister	2,600	Groundwater	
128	CA	United Technologies Corporation, Santa Clara County	1,282,000	Groundwater	Under way
129	CA	United States Navy Firing Range, San Nicholas Island, Ventura County	20	Drinking water	
130	CA	Vandenburg Air Force Base	517	Groundwater	Under way
131	CA	Vernon Water Department, Los Angeles County	5	Drinking water	
132	CA	West San Bernardino County Water District (formerly West Valley Water District), San Bernardino County	8	Drinking water	
133	CA	Whittaker Bermite Ordnance, City of Santa Clarita	64,000	Groundwater	
134	CA	Whittaker Ordnance, City of Hollister	510,000	Groundwater	Under way
135	CO	Colorado Rocky Mountain Arsenal, City of Adams	14	Groundwater	Planning
136	CO	Pueblo Chemical Depot, City of Pueblo	180	Groundwater	Planning
137	CT	Naval Submarine Base New London, New London County	4	Groundwater	
138	DC	Spring Valley Superfund Site, a formerly used defense site	58	Groundwater	
139	DC	Washington Aqueduct	8	Groundwater	
140	FL	Atlantic Beach Water System, Duval County	200	Drinking water	
141	FL	Kissimmee Eastern Regional, North Bermuda, Osceola County	5	Drinking water	
142	FL	Manatee County Utilities Operations Department	30	Drinking water	

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			Highest detection reported[a]		
	State	**Facility/Site name**	**Amount (ppb)[b]**	**Media**	**Cleanup status[c]**
143	FL	Royal Palm Beach Utilities, Palm Beach County	17	Drinking water	
144	FL	Sebring Water and Sewer System, Highlands County	70	Drinking water	
145	FL	Three Worlds Camp Resort, Polk County	5	Drinking water	
146	GA	City of Watkinsville, Oconee County	38	Drinking water	
147	GA	Fayette County	5	Drinking water	
148	GA	Feagin Mill, Houston County	5	Drinking water	
149	IA	City of Ewart	29	Groundwater	
150	IA	City of Hills	372 52	Groundwater Drinking water	
151	IA	City of Napier	11	Groundwater	
152	IA	Iowa Army Ammunition Plant, Middletown	9	Groundwater	Planning
153	IL	Chanute Air Force Base, Rantoul	5	Groundwater	
154	IL	City of Joliet, Will and Kendall Counties	4	Drinking water	
155	IL	City of Rock Island, Rock Island County	8	Drinking water	
156	IL	Sangamo Electric Dump/Crab Orchard National Wildlife Refuge, City of Carterville (Department of the Interior)	1,200	Groundwater	
157	IL	Savanna Army Depot Activity, City of Savanna	12	Groundwater	
158	IN	Naval Surface Warfare Center, Crane Division, Martin County	470 67	Soil Groundwater	
159	IN	United States Army Jefferson Proving Ground, City of Madison	100	Soil	
160	KS	City of Hallowell	36,000	Surface water	Planning
161	KS	Tri-County Airport (Former Herington Army Airfield), City of Herington	9	Groundwater	
162	LA	City of Shreveport, Caddo Parrish	10	Drinking water	
163	LA	St. Charles Water District Number One	24	Drinking water	
164	MA	Clinton Water Department, Worchester County	6	Drinking water	
165	MA	Massachusetts Military Reservation, Barnstable County	134,000 500	Soil Groundwater	Under way
166	MD	Aberdeen Proving Grounds, City of Aberdeen	15,000 3,500 17	Soil Groundwater Sediment	Planning
167	MD	ATK Alliant Tech System, City of Elkton	2,020	Groundwater	Planning
168	MD	City of Aberdeen, Harford County	19	Drinking water	
169	MD	City of Chapel Hill, Harford County	20	Drinking water	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
170	MD	City of Hagerstown, Washington County	4	Drinking water	
171	MD	Fort George Meade, City of Odenton	70	Groundwater	
172	MD	Naval Surface Warfare Center, Indian Head	480,000 276,000 230 4	Soil Groundwater Sediment Surface water	
173	MD	White Oak Federal Research Center (Naval Surface Warfare Center)	1,400 880 9	Soil Groundwater Surface water	Planning
174	MN	City of New Brighton, Ramsey County	5	Drinking water	
175	MN	City of Northfield, Rice County	6	Drinking water	
176	MO	Expert Management Incorporated (formerly ICI Explosives USA Incorporated), City of Joplin	107,000	Groundwater	Planning
177	MO	Lake City Army Ammunition Plant, City of Independence	79	Groundwater	
178	MS	Hilldale Water District, Warren County	20	Drinking water	
179	NC	City of Highpoint, Guilford County	14	Drinking water	
180	NC	City of Kinston, Kinston Lenoir County	4	Drinking water	
181	NC	Cliffdale West, Cumberland County	9	Drinking water	
182	NC	Former Camp Butner, Granville and Durham Counties	10	Drinking water	
183	NC	Marine Corps Base Camp Lejeune/Marine Corps Air Station New River, Onslow County	9	Groundwater	
184	NC	New Hanover County Water System, City of Wilmington	7	Drinking water	
185	NC	Vick's Mobil Home Park, Nash County	6	Drinking water	
186	NE	City of Lewiston, Pawnee County	5	Groundwater	
187	NE	City of North Platte, Lincoln County	7	Drinking water	
188	NE	Nebraska Ordnance Plant, City of Mead	24	Groundwater	
189	NJ	Fort Dix, Pemberton Township	28	Groundwater	
190	NJ	Middlesex County	7	Drinking water	
191	NJ	Montclair Water Bureau , Essex County	5	Drinking water	
192	NJ	New Jersey American Water Company, City of Lakewood	5	Drinking water	
193	NJ	Park Ridge Water Department, City of Bergen	13	Drinking water	
194	NJ	Picatinny Arsenal, Morris County	627 500	Groundwater Soil	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
195	NJ	Township of Hammonton Water Dept, Atlantic County	4	Drinking water	
196	NJ	Vineland Water and Sewer Utility, Cumberland County	6	Drinking water	
197	NM	Cannon Air Force Base, Clovis	46 46 6	Drinking water Groundwater Soil	
198	NM	City of Deming, Luna County	20	Drinking water	
199	NM	City of Des Moines	5	Drinking water	
200	NM	Fort Wingate Depot, Gallup	3,180 2,890	Soil Groundwater	Planning
201	NM	Holloman Air Force Base, Alamogordo	16,000 7,600 7,600	Surface water Soil Sediment	
202	NM	Kirtland Air Force Base, Albuquerque	50,500 13	Soil Groundwater	
203	NM	Los Alamos National Laboratory, City of Los Alamos (Department of Energy)	1,662	Groundwater	
204	NM	Melrose Air Force Bombing Range, City of Clovis	480 41	Soil Groundwater	
205	NM	Mountain View Albuquerque, City of South Valley	5	Drinking water	
206	NM	New Mexico American Water Company, City of Clovis	7	Drinking water	
207	NM	Sandia National Labs, City of Albuquerque (Department of Energy)	1,040	Soil	
208	NM	White Sands Missile Range	32,900	Groundwater	
209	Northern Mariana Islands	Commonwealth Utilities Corporation, Saipan	14	Drinking water	
210	NV	Boeing-Rocketdyne Test Site, City of Reno	400	Groundwater	
211	NV	Henderson Water Company, Clark County	23	Drinking water	
212	NV	Kerr-McGee Chemical, City of Henderson, Clark County	3,700,000 120,000 24	Groundwater Surface water Drinking water	Under way
213	NV	Mohave Generating Station, Clark County	7	Drinking water	
214	NV	PEPCON (Former), City of Henderson, Clark County	600,000	Groundwater	Planning
215	NV	Southern Nevada Water System, Clark County	17	Drinking water	
216	NY	Bethpage Water District, Nassau County	5	Drinking water	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
217	NY	City of Glen Cove, Nassau County	4	Drinking water	
218	NY	City of Westhampton, Suffolk County	3,370 16	Groundwater Drinking water	Planning
219	NY	City of Yaphank, Suffolk County	122 26	Groundwater Drinking water	
220	NY	Garden City, Nassau County	4	Drinking water	
221	NY	Greenlawn Water District, Suffolk County	6	Drinking water	
222	NY	Hicksville Water District, Nassau County	8	Drinking water	
223	NY	Plainview Water District, Nassau County	11	Drinking water	
224	NY	South Huntington Water District, Suffolk County	5	Drinking water	
225	NY	Suffolk County Water Authority	12	Drinking water	
226	NY	Town of Hempstead Water District	9	Drinking water	
227	NY	Water Authority of Western Nassau County	6	Drinking water	
228	NY	Westbury Water District, Nassau County	14	Drinking water	
229	OH	City of Berea, Cuyahoga County	5	Drinking water	
230	OH	City of Fairfield	27	Drinking water	
231	OH	City of Loveland	7	Drinking water	
232	OH	City of Painesville, Lake County	9	Drinking water	
233	OH	City of Ravenna, Portage County	5	Drinking water	
234	OH	Defiance Water Treatment, City of Defiance	6	Drinking water	
235	OH	Hecla Water Association - Plant Public Water System, Lawrence County	32	Drinking water	
236	OH	Ravenna Army Ammunition Plant, City of Ravenna	25	Surface water	
237	OH	Wright-Patterson Air Force Base, Greene County	17	Drinking water	
238	OK	Bixby Public Works Authority, Tulsa County	11	Drinking water	
239	OK	City of Enid, Garfield County	30	Drinking water	
240	OK	City of Moore, Cleveland County	13	Drinking water	
241	OK	City of Woodward	13	Drinking water	
242	OK	Edmond Public Works Authority	13	Drinking water	
243	OR	Arkema Incorporated (formerly Atofina), City of Portland	370,000	Groundwater	Planning
244	OR	Former Boardman Air Force Range	20 14	Groundwater Surface water	
245	OR	Adjacent to the Navy Boardman Bombing Range	23	Groundwater	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
246	OR	Umatilla Ammunition Demolition Area, North Morrow, City of Hermiston	25	Groundwater	
247	PA	Ambler Boro Water Department, Montgomery County	10	Drinking water	
248	PA	Columbia Water Company, Lancaster County	12	Drinking water	
249	PA	Erie City Water Authority	5	Drinking water	
250	PA	Huntingdon Boro Water Department, Huntingdon County	7	Drinking water	
251	PA	Meadville Area Water Authority, Crawford County	33	Drinking water	
252	PA	Muhlenberg Township Municipal Authority, City of Reading	4	Drinking water	
253	PR	City of Utuado	420	Drinking water	
254	SC	Cassatt Water Company Number One, Kershaw County	5	Drinking water	
255	SC	Darlington County Water and Sewer Authority, Hartsville and Darlington Counties	7	Drinking water	
256	SC	Shaw Air Force Base, Poinsett Range, Sumter County	8	Groundwater	
257	SC	Talatha Water District, Aiken County	4	Drinking water	
258	TN	Arnold Air Force Base, City of Tullahoma	1,000	Groundwater	
259	TN	Crossville Water Department	9	Drinking water	
260	TX	Ackerly Water Supply Corporation, Dawson County	4	Groundwater	
261	TX	Acuff Steak House, Lubbock County	10	Groundwater	
262	TX	Addison private well, Terry County	23	Groundwater	
263	TX	Andrews County	24	Groundwater	
264	TX	Barr private well, Howard County	5	Groundwater	
265	TX	Blackwell private well, Midland County	4	Groundwater	
266	TX	Blair private well, Midland County	14	Groundwater	
267	TX	Bledsoe Water Service Company, Cochran County	8	Groundwater	
268	TX	Blue Nile Water Company, Midland County	6	Groundwater	
269	TX	Camp Bullis, Bexar County	424	Groundwater	Planning
270	TX	Camp Post, Garza County	8	Groundwater	
271	TX	Casselman private well, Midland County	12	Groundwater	
272	TX	Cave private well, Martin County	19	Groundwater	
273	TX	City of Amherst, Lamb County	6	Groundwater	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
274	TX	City of Andrews, Andrews County	8	Groundwater	
275	TX	City of Crane, Crane County	14	Groundwater	
276	TX	City of El Paso, El Paso County	6	Drinking water	
277	TX	City of Georgetown, Williamson County	5	Drinking water	Under way
278	TX	City of Jayton, Kent County	5	Groundwater	
279	TX	City of Kingsville	9	Drinking water	
280	TX	City of Lamesa, Dawson County	26	Groundwater	
281	TX	City of Lefors, Gray County	5	Groundwater	
282	TX	City of Levelland, Hockley County	123	Drinking water	
283	TX	City of Midland, Midland County	46	Drinking water	
284	TX	City of O'Donnell, Lynn County	6	Groundwater	
285	TX	City of Quitaque, Briscoe County	10	Groundwater	
286	TX	City of Seagraves, Gaines County	10	Groundwater	
287	TX	City of Seminole, Gaines County	25	Groundwater	
288	TX	City of Slaton, Lubbock County	5	Groundwater	
289	TX	City of Stanton, Martin County	4	Groundwater	
290	TX	City of Sudan, Lamb County	18	Groundwater	
291	TX	City of Whiteface, Cochran County	9	Groundwater	
292	TX	City of Wickett, Ward County	5	Groundwater	
293	TX	Cooper Independent School District, Lubbock County	5	Groundwater	
294	TX	Cosner private well, Midland County	6	Groundwater	
295	TX	Cotton Gin, Patricia, Dawson County	8	Groundwater	
296	TX	Cotton private well, Midland County	10	Groundwater	
297	TX	County Line Gin, Borden and Dawson County	4	Groundwater	
298	TX	County Road 404, Winkler County	8	Groundwater	
299	TX	Cranfill private well, Midland County	5	Groundwater	
300	TX	Crucher private well, Terry County	4	Groundwater	
301	TX	Cunningham private well, Midland County	7	Groundwater	
302	TX	Duke Energy Field Services Fullerton Plant, Andrews County	16	Groundwater	
303	TX	ExxonMobil Production Company, Andrews County	6	Groundwater	
304	TX	Florey Park, Andrews County	9	Groundwater	
305	TX	Flowing Wells School District One, Martin County	12	Groundwater	
306	TX	Furlow private well, Lynn County	7	Groundwater	

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			Highest detection reported[a]		
	State	Facility/Site name	Amount (ppb)[b]	Media	Cleanup status[c]
307	TX	Gaines County Golf Course, Gaines County	27	Groundwater	
308	TX	Gaines County Park, Gaines County	19	Groundwater	
309	TX	Galian private well, Midland County	5	Groundwater	
310	TX	Gardendale Country Water, Incorporated, Ector County	4	Groundwater	
311	TX	Gill private well, Lynn County	7	Groundwater	
312	TX	Girard Post Office, Kent County	9	Groundwater	
313	TX	Glosson private well, Midland County	29	Groundwater	
314	TX	Greenwood Independent School District, Midland County	8	Groundwater	
315	TX	Greenwood Terrace Mobile Home Subdivision, Midland County	5	Groundwater	
316	TX	Greenwood Ventures, Incorporated, Midland County	7	Groundwater	
317	TX	Greenwood Water Corporation, Midland County	4	Groundwater	
318	TX	Hancock private well, Midland County	5	Groundwater	
319	TX	Henry private well, Gaines County	21	Groundwater	
320	TX	Huber Gardens Estates, Ector County	5	Groundwater	
321	TX	Johns Mobile Home Park, Midland County	5	Groundwater	
322	TX	Jones private well, Andrews County	6	Groundwater	
323	TX	Jones private well, Midland County	17	Groundwater	
324	TX	Kadir private well, Midland County	5	Groundwater	
325	TX	Kent KWIK Convenience Store 312, Midland County	10	Groundwater	
326	TX	Klondike High School, Dawson County	11	Groundwater	
327	TX	Loller private well, Yokum County	6	Groundwater	
328	TX	Lone Star Army Ammunition Plant, Texarkana County	186 157 23 6	Sediment Soil Groundwater Surface water	
329	TX	Longhorn Army Ammunition Plant, Harrison County	320,000 163,000 11,000	Groundwater Soil Sediment	Under way
330	TX	Loop Water Service Company, Gaines County	6	Groundwater	
331	TX	Lubbock Public Water System, Lubbock County	9	Groundwater	
332	TX	Lucas private well, Midland County	10	Groundwater	
333	TX	Luckie private well, Midland County	6	Groundwater	

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			Highest detection reported[a]		
	State	**Facility/Site name**	**Amount (ppb)[b]**	**Media**	**Cleanup status[c]**
334	TX	Maple Water Service Company, Bailey County	8	Groundwater	
335	TX	Martin County	32	Groundwater	
336	TX	McClain private well, Midland County	7	Groundwater	
337	TX	McGregor Naval Weapons Industrial Reserve Plant, McLennan County	1,800,000 91,000 6,600 720	Soil Groundwater Surface water Sediment	Under way
338	TX	McMurries private well, Martin County	10	Groundwater	
339	TX	Minnix private well, Midland County	5	Groundwater	
340	TX	Mobile Home Park, Lubbock County	4	Groundwater	
341	TX	Nelms private well, Midland County	8	Groundwater	
342	TX	Nobels private well, Midland County	4	Groundwater	
343	TX	North State Highway 115, Winkler County	6	Groundwater	
344	TX	North University Estates, Lubbock County	5	Groundwater	
345	TX	North West Yoakum, Yoakum County	8	Groundwater	
346	TX	O'Brien private well, Dawson County	59	Groundwater	
347	TX	Offield private well, Midland County	6	Groundwater	
348	TX	Pantex Plant, City of Amarillo, Carson County (Department of Energy)	5,000 408	Soil Groundwater	
349	TX	Pecan Acres Homeowners Association, Midland County	7	Groundwater	
350	TX	Pecan Acres Water Supply Corporation, Midland County	7	Groundwater	
351	TX	Peck private well, Midland County	8	Groundwater	
352	TX	Posey private well, Howard County	26	Groundwater	
353	TX	Ray Jr. private well, Howard County	25	Groundwater	
354	TX	Red River Army Depot, Texarkana County	417 226 7	Surface water Soil Groundwater	
355	TX	Rivera private well, Midland County	4	Groundwater	
356	TX	Roosevelt Independent School District, Lubbock County	20	Groundwater	
357	TX	Sherwood Estates Manufactured Town, Midland County	10	Groundwater	
358	TX	Sid Richardson Carbon Company, Howard County	12	Groundwater	
359	TX	Small private well, Midland County	8	Groundwater	
360	TX	Southland Independent School District, Garza County	7	Groundwater	

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	State	Facility/Site name	Highest detection reported[a] Amount (ppb)[b]	Media	Cleanup status[c]
361	TX	Spade Water Supply Corporation, Lamb County	5	Groundwater	
362	TX	Spring Meadow Mobile Home Park, Midland County	4	Groundwater	
363	TX	Tahoka Public Water System, Lynn County	12	Groundwater	
364	TX	Tate private well, Martin County	10	Groundwater	
365	TX	Tellinghuisen private well, Midland County	10	Groundwater	
366	TX	Texland Great Plains Water Company, Gaines County	6	Groundwater	
367	TX	Twin Oaks Mobile Home Park, Midland County	10	Groundwater	
368	TX	Valley View Mobile Home Park, Midland County	9	Groundwater	
369	TX	Warren private well, Gaines County	30	Groundwater	
370	TX	Water Runners, Incorporated, Midland County	4	Groundwater	
371	TX	Weitzel private well, Midland County	8	Groundwater	
372	TX	Welch Water Supply Corporation, Dawson County	14	Groundwater	
373	TX	Weltie private well, Midland County	9	Groundwater	
374	TX	West Cedar Creek Municipal Utility District, Henderson County	8	Drinking water	
375	TX	West Texas Animal Clinic, Scurry County	13	Groundwater	
376	TX	Whiteface Independent School District, Cochran County	6	Groundwater	
377	TX	Yoakum County Park and Golf Course, Yoakum County	6	Groundwater	
378	UT	ATK Thiokol, Bacchus (former Bacchus Works, Alliant Tech Systems, Incorporated), City of West Valley	19,000	Groundwater	Planning
379	UT	ATK Thiokol, Promotory (former Thiokol, Promotory Point), City of Brigham	60,000	Groundwater	Planning
380	UT	Dyno Nobel, Site B (Pelican Point), City of Lehi, Utah County	1,300,000	Soil	Planning
381	UT	Dyno Nobel, Tooele Test Site, City of Topliff Hill, Tooele County	41,900	Soil	
382	UT	Hill Air Force Base, City of Layton, Davis County	70	Groundwater	Planning
383	UT	Kennecott Utah Copper (former Bacchus Works, Alliant Tech Systems, Incorporated), City of Magna	61	Drinking water	Planning
384	UT	Magna Water Company, Salt Lake County	8	Drinking water	

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			Highest detection reported[a]		
	State	**Facility/Site name**	**Amount (ppb)[b]**	**Media**	**Cleanup status[c]**
385	UT	Wendover Air Force Base, Tooele County	1,200	Soil	Under way
386	VA	Atlantic Research Corporation	17	Groundwater	Planning
387	VA	Naval Surface Warfare Center, Dahlgren	2,700 1,200 120 7	Groundwater Soil Sediment Surface water	
388	VA	Purdue Farms, Incorporated, Accomack County	4	Drinking water	
389	VA	Radford Ammunition Plant	11	Groundwater	
390	WA	Camp Bonneville, City of Vancouver	380	Groundwater	Under way
391	WA	City of Puyallup, Pierce County	8	Drinking water	
392	WA	Firgrove Mutual, Incorporated, Pierce County	6	Drinking water	
393	WA	Lacey Water Department, Thurston County	9	Drinking water	
394	WA	Lakewood Water District, Pierce County	6	Drinking water	
395	WV	Allegheny Ballistics Lab, City of Rocket Center	35,000 34,900 880 690 190	Soil Groundwater Sub-soil Surface water Sediment	

Sources: Environmental Protection Agency, Department of Defense, U.S. Geological Survey, and state environmental agencies.

Note: For the purposes of this report, a site refers to the physical location where perchlorate was found. Our listing includes both points of origin as well as locations where perchlorate was found away from the origin or source. This table lists the highest detection reported and the media in which it was found, such as groundwater or soil.

[a]In some instances, officials have not confirmed initial sampling results through subsequent tests. For example, subsequent sampling may have found lower concentrations or could not find perchlorate.

[b]Parts per billion (ppb).

[c]Data in column reflect the status of cleanup at 51 of the almost 400 sites where perchlorate was found.

Perchlorate Health Risk Studies Published Since 1998

	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
1	2000	*The Effect of Ammonium Perchlorate on Thyroids*	Mann	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	New diagnostic criteria (see original study for experimental controls)	Not identified/ Unknown.
2	2001	*Statistical Analysis of the Tumors Observed in Male F1 Rats at Week 19 in the Argus (1999) Two-Generation Reproduction Study of Ammonium Perchlorate*	Dunson	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	Established incidence probabilities (see original study for experimental controls)	Adverse effects indicated.
3	2000	*Report of the Peer Review of Thyroid Histopathology from Rodents and Rabbits Exposed to Ammonium Perchlorate in the Drinking Water*	Wolf	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	New diagnostic criteria for reviewing data (see original study for experimental controls)	Adverse effects indicated.
4	2001	*Revised Analysis of the Thyroid Hormone Data from the Mouse Immunotoxicology Study (from Keil et al., 1999)*	Crofton	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Nonadverse effects indicated. No information available on adverse effects.
5	2001	*Revised Analysis of the Thyroid Hormone Data from the Rat Developmental "effects" Study-Argus Protocol1416-003*	Crofton	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Nonadverse effects indicated. Adverse effects to development indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
6	1998	*Effects of Ammonium Perchlorate on Immunotoxicological, Hematological, and Thyroid Parameters in B6C3F1 Female Mice*	Keil, et al.	Department of Defense	Animal	Experimental design	Dose, duration, age, sex, and weight (dose levels independently verified)	Nonadverse effects indicated. Information on adverse effects is incomplete.
7	1999	*Effects of Ammonium Perchlorate on Immunotoxicological, Hematological, and Thyroid Parameters in B6C3F1 Female Mice [Final report]*	Keil, et al.	Department of Defense and Environmental Protection Agency	Animal	Experimental design	Dose, duration, age, sex, strain, and weight (dose levels independently verified)	Nonadverse effects indicated. No adverse effects indicated.
8	1998	*A 90-day Drinking Water Toxicity Study in Rats With Ammonium Perchlorate [Final Report]*	Siglin	ManTech Environmental Technology, Inc.	Animal	Experimental design	Dose, duration, sex, and weight	Nonadverse and adverse effects indicated.
9	1998	*A Neurobehavioral Developmental Study of Ammonium Perchlorate Administered Orally in Drinking Water to Rats*	York	ManTech Environmental Technology, Inc.	Animal	Experimental design	Dose and duration	Nonadverse effects and adverse developmental effects indicated.

(Continued From Previous Page)

	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
10	2001	*Hormone, Thyroid and Neurohistological Effects of Oral (drinking water) Exposure to Ammonium Perchlorate in Pregnant and Lactating Rats and in Fetuses and Nursing Pups Exposed to Ammonium Perchlorate During Gestation and Via Maternal Milk*	York	Perchlorate Study Group	Animal	Experimental design	Dose and duration	Nonadverse effects and adverse developmental effects indicated.
11	2000	*A Neurodevelopmental Study of Ammonium Perchlorate Exposure on the Motor Activity of Pre-weanling Rat Pups*	Bekkedal, et al.	Department of Defense	Animal	Experimental design	Dose and age	No developmental effects indicated.
12	2003	*An Assessment of Issues Regarding Neurotoxic Effects of Developmental Exposure to Perchlorate*	Boyes, et al.	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Adverse effects to development indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
13	2003	*Hormone, Thyroid and Neurohistological Effects of Oral (drinking water) Exposure to Ammonium Perchlorate in Pregnant and Lactating Rats and in Fetuses and Nursing Pups Exposed to Ammonium Perchlorate During Gestation and Via Maternal Milk*	Consultants in Veterinary Pathology	Review: Environmental Protection Agency/ Original study: Perchlorate Study Group	Animal	Review/ Reanalysis of studies/data	Dose, duration, and age	Adverse effects to development indicated.
14	2001	*Statistical Analysis of the Effects of Perchlorate on Neurobehavioral (motor activity) in SD Rats*	Dunson	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	Dose, duration, and age	Adverse effects to development indicated.
15	2001	*Profile Analysis of Brain Morphometry data from Argus/Primedica "Effects" Protocol 1416-003*	Gellar	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	Dose and duration	Adverse effects to development indicated.
16	2003	*Revised Brain Morphometry Analysis Incorporating Consultant in Veterinary Pathology (2003) Review of Morphometry Data from Argus 1416-003*	Gellar	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Adverse effects to development indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
17	2001	*Re: Comments on Original Experimental Design, Study Performance, and Brain Morphometry Results of Argus Research Laboratories, Inc., 14 March 2001 Study (Protocol Number 1416-003) and Supplemental Materials Provided by Dr. Robert Garman, Consultants in Veterinary Pathology, Inc.*	Harry	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Effects not studied.
18	1999	*Oral (Drinking Water) Two Generation (one Litter Per Generation) Reproduction Study of Ammonium Perchlorate*	York	Perchlorate Study Group	Animal	Experimental design	Dose, duration, and sex	Adverse effects to development indicated.
19	2000	*Oral (Drinking Water) Developmental Toxicity Study of Ammonium Perchlorate in Rats [Final report]*	York	Perchlorate Study Group	Animal	Experimental design	Dose	No adverse developmental effects indicated.
20	2000	*Ammonium Perchlorate: Effect on Immune Function*	Dourson and Dollarhide	Perchlorate Study Group	Animal	Experimental design	Dose and duration	Nonadverse and adverse effects indicated.
21	2000	*Addendum to Ammonium Perchlorate: Effect on Immune Function*	Dourson and Dollarhide	Perchlorate Study Group	Animal	Experimental design	Dose	Nonadverse and adverse effects indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
22	2000	*Ammonium Perchlorate Contamination of Colorado River Drinking Water is Associated With Abnormal Thyroid Functions in Newborns in Arizona*	Brechner, et al.	Not identified/ Unknown	Human	Field study	Dose, comparison/ control town, race/ethnicity, and age	Nonadverse effects indicated. No information available on adverse effects.
23	2002	*Health Effects Assessment for Environmental Perchlorate Contamination: The Dose Response for Inhibition of Thyroidal Radioiodine Uptake in Humans*	Greer, et al.	Perchlorate Study Group and National Institute of Health	Human	Experimental design	Dose and external data audit	Nonadverse effects indicated. No information available on adverse effects.
24	2000	*The Effect of Short-Term Low-Dose Perchlorate on Various Aspects of Thyroid Function*	Lawrence, et al.	Perchlorate Study Group, National Institute of Health, and the Thyroid Center for Excellence	Human	Experimental design	Baseline blood and urine tests, and statistical controls for time and duration	Nonadverse effects indicated. No adverse effects.
25	2003	*Estimating Human Dose-Response Functions for the Greer et al. (2000, 2002) and Merrill (2001a) Data on Thyroid Radioactive Iodide Uptake (RAIU) After Perchlorate Ingestion*	Marcus	Environmental Protection Agency	Human	Review/ Reanalysis of studies/data	Statistical controls, such as autocorrelation	Nonadverse effects indicated. No information available on adverse effects.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
26	2003	*Analysis of Dose-Response Functions for Effects of Perchlorate on Serum Hormone from Data of Greer et al. (2000, 2002) and Merrill (2001a)*	Marcus	Environmental Protection Agency	Human	Review/ Reanalysis of studies/data	Statistical controls, such as circadian rhythms, gender, dose, and duration	Nonadverse effects indicated. No information available on adverse effects.
27	2001	*Gestational Exposure to Perchlorate is Associated With Measures of Decreased Thyroid Function in a Population of California Neonates*	Schwartz	California Department of Health Services	Human	Field study	Gender, multiple birth, birth weight, blood sample, age, and ethnicity	Nonadverse effects indicated. Potential adverse developmental effects indicated.
28	2003	*Anion Selectivity by the Sodium Iodide Symporter*	Van Sande, et al.	Ministere de la Politique Scientifique, and Fonds	Cells	Experimental design	Not identified/ Unknown	Nonadverse effects indicated. No information available on adverse effects.
29	1998	*Perchlorate and the Thyroid Gland*	Wolff	Not identified/ Unknown	Not identified/ Unknown	Review/ Reanalysis of studies/data	Not identified/ Unknown	Nonadverse effects indicated. No information available on adverse effects.
30	1998	*Differences in the Electrophysiological Response To I- and the Inhibitory Anions SCN- and CIO-4 Studied in FRTL-5 Cells*	Yoshida, et al.	Not identified/ Unknown	Cells	Experimental design	Not identified/ Unknown	Effects not studied.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
31	2002	*Consultative Letter: Intravenous Kinetics of Radio Labeled Iodide and Perchlorate in Tissues of Pregnant and Lactating Spraque Dawley Female Rats Dosed With Perchlorate and/or Carrier Free $^{125}I^-$*	Yu	Environmental Protection Agency and Department of Defense	Animal	Experimental design	Dose and duration	Nonadverse effects indicated. No information available on adverse developmental effects.
32	2001	*Consultative Letter: Physiologically-Based Pharmacokinetic Model for the Kinetics of Perchlorate-Induced Inhibition of Iodide in the Pregnant Rat and Fetus*	Clewell, et al.	Environmental Protection Agency and Department of Defense	Animal	Review/ Reanalysis of studies/data	Statistical controls, such as time, body weight changes, mammary tissue, blood flow, cardiac output, and body fat	Effects not studied (model developed).
33	2001	*Consultative Letter: Physiologically-Based Pharmacokinetic Model for the Kinetics of Perchlorate-Induced Inhibition of Iodide in the Lactating and Neonatal Rat*	Clewell, et al.	Environmental Protection Agency and Department of Defense	Animal	Review/ Reanalysis of studies/data	Statistical controls, such as time, body weight changes, mammary tissue, blood flow, cardiac output, and fractional body fat	Effects not studied (model developed).
34	2001	*Consultative Letter: Audit Report for the Study of Perchlorate Pharmacokinetics and Inhibition of Radioactive Iodine Uptake (RAIU) by the Thyroid in Humans*	Merrill	Environmental Protection Agency and Department of Defense	Human	Audit of documentation from a prior study	Not identified/ Unknown	Effects not studied.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
35	2001	*Consultative Letter: PBPK Model for Perchlorate-Induced Inhibition of Radioiodide Uptake in Humans*	Merrill	Environmental Protection Agency and Department of Defense	Human	Review/ Reanalysis of studies/data	Statistical controls	Effects not studied (model developed).
36	2001	*Consultative Letter: Revision To AFRL-HE-WP-CL-2001-0010, Comparison of Internal Dosimetrics Using PBPK Models for Perchlorate-Induced Inhibition of Thyroid Iodide Uptake and Sensitivity Analysis for Male Rat Model*	Merrill	Environmental Protection Agency and Department of Defense	Animal	Review/ Reanalysis of studies/data	Statistical controls	Effects not studied (model developed).
37	2001	*Uptake and Elimination of Perchlorate in American Bullfrog Larvae, Rana Catesbeiana*	Carr, et al.	Strategic Environmental Research and Development Program	Amphibian	Experimental design	Dose and duration	Nonadverse effects indicated. No adverse developmental effects indicated.
38	2001	*Response of Native Adult and Larval Anurans in Their Natural Environment to Ammonium Perchlorate Contamination: Assessment of Reproductive and Thyroid Endpoints*	Carr, et al.	Strategic Environmental Research and Development Program	Amphibian	Field study	Dose, contaminated/ noncontaminated sites, oxygen level, temperature, conductivity, salinity, pH, and species	Adverse developmental effects indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
39	2002	*The Effects of Contaminated and Reference Surface Waters on Metamorphosis in Xenopus Laevis Using a Modified US Environmental Protection Agency Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC, US Environmental Protection Agency, 1998)- Tier 1 Tail Resorption Assay*	Carr, et al.	Strategic Environmental Research and Development Program	Amphibian	Experimental design plus field study	Dose and duration	Adverse developmental effects indicated.
40	2001	*Lethal Concentration Determination of Sodium Perchlorate and Ammonium Chloride on Xenopus Laevis Eggs and Developing Juveniles During a 5 Day Exposure*	Carr, et al.	Strategic Environmental Research and Development Program	Amphibian	Experimental design	Dose	Adverse developmental effects indicated.
41	2004	*Perchlorate Toxicity and Risk Assessment*	Klaassen	Not identified/ Unknown	Human and animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Effects not studied (reference dose developed).
42	1999	*Thyroid Health Status of Ammonium Perchlorate Workers: A Cross-Sectional Occupational Health Study*	Lamm, et al.	American Pacific Corporation, Las Vegas, NV	Human	Field study	Dose exposure level, and screening for underlying thyroid and health problems	No nonadverse or adverse effects indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
43	1998	*Genotoxicity Assays for Ammonium Perchlorate*	Sharma, et al.	Perchlorate Study Group, Toxicology Excellence for Risk Assessment, Cincinnati, OH	Animal, bacteria, and cells	Experimental design	Dose, repeated study, bacteria strain, and sex	No adverse effects indicated.
44	2000	*Consultative Letter: Hormone and Perchlorate Data from Cross-Fostering Study*	Mahle	Department of Defense	Animal	Experimental design	Dose, duration, and switched exposed/control litters with exposed/ control dams	Nonadverse effects indicated. No information available on adverse developmental effects.
45	2001	*Consultative Letter: Hormone and Perchlorate Data from Cross-Fostering Study*	Mahle	Department of Defense	Animal	Experimental design	Dose, duration, and switched exposed/ control litters with exposed/ control dams	Nonadverse effects indicated. No information available on adverse developmental effects.
46	2000	*Consultative Letter: Human PBPK Model for Perchlorate Inhibition of Iodide Uptake in the Thyroid*	Merrill	Department of Defense	Human	Review/ Reanalysis of studies/data	Statistical controls, such as body weight, urinary excretion rate constants, thyroid maximum velocities, and inhibition affinity constants	Effects not studied (model developed).
47	2000	*Consultative Letter: Hormone Data from Brabant Human Perchlorate (1.0 and 12.0 mg/kg-day) Kinetics Drinking Water Study*	Mattie	Department of Defense	Human	Experimental design	Dose and duration	Not identified/ Unknown.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
48	2002	*Uptake of Ammonium Perchlorate and Thyroid Status in Native Fish*	Theodorakis	Strategic Environmental Research and Development Program	Fish	Experimental design	Dose and duration	Nonadverse and adverse effects indicated.
49	2001	*In Situ Exposure of Fish and Amphibians for Determination of Contaminant Effects at the Longhorn Army Ammunition Plant, Jefferson County, Texas*	Theodorakis	Strategic Environmental Research and Development Program	Fish	Field study	Dose, contaminated/ clean sites, duration, pH, oxygen levels, conductivity, and temperature of test sites	Findings not used--design limitations too great.
50	2002	*Fish and Amphibians as Aquatic Sentinels for Perchlorate Exposures and Effects at the Longhorn Army Ammunition Plant, Jefferson County, Texas*	Theodorakis	Strategic Environmental Research and Development Program	Fish	Field study	Dose, contaminated/ clean sites, duration, pH, oxygen levels, conductivity, and temperature of test sites	No adverse effects indicated.
51	1998	*Stability and Concentration Verification of Ammonium Perchlorate Dosing Solutions*	Tsui, et al.	Department of Defense	Ions	Experimental design	Room temperature, light, humidity, and light/dark cycle	Effects not studied.
52	2001	*Assessment of Perchlorate in Terrestrial Mammalian Receptors: Raccoons (Procyon Lotor) and Opossums (Didelphis Virginiana)*	Smith	Strategic Environmental Research and Development Program	Animal	Field study	Dose, and contaminated areas compared with uncontaminated	No nonadverse or adverse effects indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
53	2000	*Consultative Letter: Tissue Distribution and Inhibition of Iodide Uptake in the Thyroid by Perchlorate With Corresponding Hormonal Changes in Pregnant and Lactating Rats (Drinking Water Study)*	Yu	Department of Defense	Animal	Experimental design	Dose and duration	Nonadverse effects indicated. No information available on adverse developmental effects.
54	2001	*Consultative Letter: Intravenous Kinetics of Radiolabeled Iodide in Tissues of Adult Male Sprague Dawley Rat Dosed With $^{125}I^-$ Plus Carrier*	Yu	Department of Defense	Animal	Experimental design	Time after dosing and before death	Nonadverse effects indicated. No information available on adverse developmental effects.
55	1998	*Consultative Letter: Salmonella Mutagenicity Testing of Ammonium Perchlorate*	Zeiger	Department of Health and Human Services, National Institute of Health	Animal	Experimental design	Dose	No adverse effects indicated.
56	2003	*Oral (Drinking Water) Developmental Toxicity Study of Ammonium Perchlorate in Sprague-Dawley Rats*	York, et al.	Department of Defense	Animal	Experimental design	Dose	Nonadverse effects indicated. Adverse effects to development indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
57	2003	*Consultative Letter: Review of the Thyroid Histopathology from Xenopus Laevis Exposed to Ammonium Perchlorate in the Water*	Wolf	Environmental Protection Agency	Amphibian	Review/ Reanalysis of studies/data	Dose	Adverse effects indicated.
58	2004	*Evidence for Competitive Inhibition of Iodide Uptake by Perchlorate and Translocation of Perchlorate into the Thyroid*	Clewell, et al.	Department of Defense and National Aeronautics and Space Administration	Human and animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Nonadverse effects indicated. No information available on adverse effects.
59	2000	*A 90-Day Drinking Water Toxicity Study in Rats of the Environmental Contaminant Ammonium Perchlorate*	Siglin, et al.	Not identified/ Unknown	Animal	Experimental design	Duration, dose, and recovery period	Nonadverse and adverse effects indicated.
60	2004	*A Rat Neurodevelopmental Evaluation of Offspring, Including Evaluation of Adult and Neonatal Thyroid, From Mothers Treated With Ammonium Perchlorate in Drinking Water*	York, et al.	Department of Defense and ManTech Geo-Centers Joint Venture	Animal	Experimental design	Duration and dose	Nonadverse effects indicated. Adverse developmental effects indicated.
61	2001	*Oral (Drinking Water) Developmental Toxicity Study of Ammonium Perchlorate in New Zealand White Rabbits*	York, et al.	Not identified/ Unknown	Animal	Experimental design	Dose	Nonadverse effects indicated. No adverse developmental effects indicated.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
62	2003	*Oral (Drinking Water) Developmental Toxicity Study of Ammonium Perchlorate in Sprague-Dawley Rats*	York, et al.	Not identified/ Unknown	Animal	Experimental design	Dose	Nonadverse effects indicated. No adverse developmental effects indicated.
63	2000	*Does Perchlorate in Drinking Water Affect Thyroid Function in Newborns or School-Age Children?*	Crump, et al.	Kerr-McGee Chemical, Oklahoma City Oklahoma	Human	Field study	Dose (cities with high, medium and no levels of perchlorate in water), age, sex, and urinary iodine concentration, whether living in the study city since birth or moving there in the past year	No adverse developmental effects indicated.
64	1998	*Evaluation of a Population With Occupational Exposure to Airborne Ammonium Perchlorate For Possible Acute or Chronic Effects On Thyroid Function*	Gibbs, et al.	Not identified/ Unknown	Human	Field study	Dose (high, low/control air exposure groups), dose estimation (shift and lifetime), race, gender, age, hours awake prior to shift, hours slept, time of day, and shift length	No adverse effects indicated.

(Continued From Previous Page)

	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
65	2004	*Letter To The Editor: Crump Et Al. Study Among School Children in Chile: Subsequent Urine and Serum Perchlorate Levels Are Consistent With Perchlorate in Water in Taital*	Gibbs, et al.	Not identified/ Unknown	Human	Field study	Dose (cities with high, medium and no levels of perchlorate in water), age, sex, and urinary iodine concentration, whether living in the study city since birth or moving there in the past year	Effects not studied.
66	2002	*Health Effects Assessment for Environmental Perchlorate Contamination: The Dose Response Inhibition of Thyroidal Radioiodine Uptake in Humans*	Greer, et al.	Perchlorate Study Group and National Institute of Health	Human	Experimental design	Dose and sex	Nonadverse effects indicated. No adverse effects indicated.
67	2001	*Letter To The Editor: Low Dose Perchlorate (3mg Daily) and Thyroid Function*	Lawrence, et al.	Not identified/ Unknown	Human	Experimental design	Not identified/ Unknown	No effects indicated.
68	2000	*The Effect of Short-Term Low-Dose Perchlorate on Various Aspects of Thyroid Function*	Lawrence, et al.	Perchlorate Study Group, Thyroid Center for Excellence, and National Institute of Health	Human	Experimental design	Baseline tests performed to ensure subjects had no prior thyroid problems	Nonadverse effects indicated. No information available of adverse effects.
69	2001	*Perchlorate Clinical Pharmacology and Human Health: A Review*	Soldin, et al.	Not identified/ Unknown	Human	Review/ Reanalysis of studies/data	See original study for experimental controls	Not identified/ Unknown.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
70	2003	*Predicting Fetal Perchlorate Dose and Inhibition of Iodide Kinetics During Gestation: A Physiologically-Based Pharmacokinetic Analysis of Perchlorate and Iodide Kinetics in the Rat*	Clewell, et al.	Department of Defense	Animal	Experimental design and review/ reanalysis of studies/data	Dose, duration, and model controls	Effects not studied (model developed).
71	2003	*Predicting Neonatal Perchlorate Dose and Inhibition of Iodide Uptake in the Rat During Lactation Using Physiologically-Based Pharmacokinetic Modeling*	Clewell, et al.	Department of Defense	Animal	Experimental design and review/ reanalysis of studies/data	Dose, duration, and model controls	Effects not studied (model developed).
72	2003	*PBPK Predictions of Perchlorate Distribution and its Effect on Thyroid Uptake of Radioiodide in the Male Rat*	Merrill, et al.	Department of Defense and National Aeronautics and Space Administration	Animal	Review/ Reanalysis of studies/data	Dose, duration, and model controls	Effects not studied (model developed).
73	2005	*PBPK Model for Radioactive Iodide and Perchlorate Kinetics and Perchlorate-Induced Inhibition of Iodide Uptake in Humans*	Merrill, et al.	Department of Defense and National Aeronautics and Space Administration	Animal	Review/ Reanalysis of studies/data	Dose, duration, and model controls	Effects not studied (model developed).

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
74	2002	*The Pharmacokinetics of Perchlorate and its Effect on the Hypothalamus-Pituitary-Thyroid Axis in the Male Rat*	Yu, et al.	Department of Defense and National Aeronautics and Space Administration	Animal	Experimental design	Dose, duration, and model controls	Nonadverse effects indicated. No information available on adverse effects.
75	2004	*Reference Dose for Perchlorate Based On Thyroid Hormone Change in Pregnant Women as the Critical Effect*	Strawson, et al.	Toxicology Excellence for Risk Assessment	Human	Review/ Reanalysis of studies/data	Statistical controls, such as Environmental Protection Agency protocols on Reference Dose risk assessment, and uncertainty factors	Effects not studied (reference dose developed).
76	1999	*In Vitro Mammalian Cell Gene Mutation Test (L5178Y/TK Mouse Lymphoma Assay)*	San and Clarke	Perchlorate Study Group	Animal	Experimental design	Dose, established criteria for a mutagenesis assay	No adverse effect indicated.
77	2001	*Uptake of the Perchlorate Anion Into Various Plant Species*	Anderson	Strategic Environmental and Research Development Program	Plants	Experimental design	Dose, duration, plant type, and water v. sand	Effects not studied.
78	2001	*Effects of the Perchlorate Anion on Earthworms*	Anderson	Strategic Environmental and Research Development Program	Earthworms	Experimental design	Dose, duration, and dermal v. soil contact	Effects not studied.

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	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
79	2001	*Hormone, Thyroid, and Neurohistological Effects of Oral (Drinking Water) Exposure to Ammonium Perchlorate in Pregnant and Lactating Rats and in Fetuses and Nursing Pups Exposed to Ammonium Perchlorate During Gestation or Via Maternal Milk*	Consultants in Veterinary Pathology	Perchlorate Study Group	Animal	Experimental design	Duration and dose	Adverse effect on development indicated.
80	1999	*Consultative Letter: Kinetic Data for Iodide Uptake Inhibition in the Thyroid by Perchlorate (2-Week Drinking Water Study)*	Channel	Environmental Protection Agency and Department of Defense	Animal	Experimental design	Dose	No effects indicated.
81	1999	*Consultative Letter: Summary of Human Kinetic Data on Perchlorate*	Channel	Department of Defense and National Aeronautics and Space Administration	Human	Review/ Reanalysis of studies/data	See original study for experimental controls	Effects not studied (model developed).
82	2003	*Effect of Perchlorate on Amphibian Development*	Tietge and Degitz	Environmental Protection Agency	Amphibians	Experimental design	Dose and duration	Nonadverese effects indicated. Adverse effects to development indicated.
83	1998	*Benchmark Dose Calculations on Thyroid Data from Studies Submitted for Evaluation of Perchlorate*	Geller	Environmental Protection Agency	Animal	Review/ Reanalysis of studies/data	See original study for experimental controls	Effects not studied (bechmark dose developed).

(Continued From Previous Page)

	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
84	2004	*Solid-State Proton Conduction: An Ab Initio Molecular Dynamics Investigation of Ammonium Perchlorate Doped With Neutral Ammonia*	Rosso and Tuckerman	National Science Foundation and Research Corporation Research Innovations	Ammonium Perchlorate Crystal	Experimental design	Temperature levels, and pure crystal v. neutral ammonia doped crystal	Effects not studied.
85	2002	*Community Cancer Assessment in Response to Long-Time Exposure to Perchlorate and Trichloroethylene in Drinking Water*	Morgan and Cassady	Not identified/ Unknown	Human	Field study	Incidence rates, age, sex, race/ethnicity, population size, and demographic features	No adverse effects indicated.
86	2004	*Interspecies Differences in Susceptibility to Perturbation of Thyroid Homeostasis: A Case Study With Perchlorate*	Lewandowski, et al.	Not identified/ Unknown	Human and animal	Review/ Reanalysis of studies/data	From original studies	Effects not studied.
87	2002	*In Utero and Lactational Exposure to Ammonium Perchlorate in Drinking Water: Effects on Developing Deer Mice at Postnatal Day 21*	Thuett, et al.	Strategic Environmental and Research Development Program	Animal	Experimental design	Dose and duration	Adverse effects to development indicated.

(Continued From Previous Page)

	Publication year	Study title	Author	Sponsor/ Recipient	Subject description	Design type	Design controls	Author's findings/ conclusions about the adverse effects of perchlorate on health
88	2002	*Effects of In Utero and Lactational Ammonium Perchlorate Exposure On Thyroid Gland Histology and Thyroid Sex Hormones in Developing Deer Mice (Peromyscus Maniclatus) Through Postnatal Day 21*	Thuett	Strategic Environmental and Research Development Program	Animal	Experimental design	Dose and breeding pairs (analysis with paired groups and individual pups)	Nonadverse effects indicated. Adverse effects to development indicated.
89	Since 1998 (precise year unknown)	*Iodide Transport in Xenopus Laevis Gut and Skin*	Harrison, et al.	Howard Huges Medical Institute and Texas Tech University	Amphibian	Experimental design	Dose	Effects not studied.
90	2004	*Ammonium Perchlorate Effects on Thyroid Function and Growth In Bobwhite Quail Chicks*	McNabb, et al.	Strategic Environmental Research and Development Program	Birds	Experimental design	Dose and duration	Nonadverse effects indicated. No information available on adverse developmental effects.

Source: GAO review of publicly available studies on perchlorate health effects.

Note: For the purposes of this study, we have categorized nonadverse effects as including, for example, transitional changes in thyroid hormones from perchlorate exposure. We have categorized adverse effects as including, for example, adenomas, increased thyroid or organ weights, follicular cell hypertrophy and hyperplasia, and changes in brain structure of developing subjects resulting from perchlorate exposure. (Lists are not inclusive of all criteria.)

Summary of Certain Environmental Laws and Regulations

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) was enacted as an amendment to the Solid Waste Disposal Act to create a framework for the management of hazardous and nonhazardous solid waste. It authorizes EPA to control hazardous waste from the point where waste is generated through its transportation, treatment, storage, and disposal. EPA regulations define hazardous waste to include waste specifically listed in the regulation as well as those defined as "characteristic waste." Characteristic hazardous waste is defined as waste that is ignitable, corrosive, reactive, or toxic. A federal district court in California ruled, in part, that perchlorate is a hazardous waste under RCRA because it is ignitable, under certain conditions.[1]

RCRA requires owners and operators of facilities that treat, store, and dispose of hazardous waste, including federal agencies, to obtain permits specifying how they will safely manage waste. Under RCRA's corrective action provisions, facilities seeking or holding RCRA permits can be required to clean up their hazardous waste contamination. Under RCRA, EPA has the authority to order a cleanup of hazardous waste when there is an imminent and substantial endangerment to public health or the environment. EPA may authorize states to administer their own programs in lieu of the federal program, as long as these programs are equivalent to and consistent with the federal program and provide for adequate enforcement. Under RCRA, state agencies have required RCRA permit holders to sample for and report on perchlorate detections and prevent additional releases.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, governs the cleanup of releases or threatened releases of hazardous substances, pollutants, or contaminants. CERCLA's definition of a hazardous substance includes substances regulated under various other environmental laws, including RCRA, the Clean Air Act, the Clean Water Act, and the Toxic Substances Control Act. Under section 120 of CERCLA, the federal government is

[1]*Castaic Lake Water Agency v. Whittaker Corp*, 272 F. Supp. 2d 1053 (C.D. Cal. 2003). The conclusion that perchlorate is a hazardous waste was the first step in the court's analysis of whether perchlorate is a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). (The definition of hazardous substances under CERCLA includes hazardous waste under RCRA.)

subject to and must comply with CERCLA's requirements to the same extent as any nongovernmental entity. CERCLA provides broad authority to EPA to respond to releases or threatened releases of hazardous substances or pollutants or contaminants that may endanger public health or the environment. Under these provisions, DOD has responded to perchlorate found on military installations and facilities. CERCLA establishes prohibitions and requirements for contaminated sites; provides for the liability for hazardous substances at these sites; and provides for the use of the Hazardous Substances Superfund, a trust fund to provide for cleanup, for example, when a responsible party cannot be identified. The law authorizes short-term removal—where actions may be taken to address releases or threatened releases requiring prompt response—and long-term response—where actions may be taken to permanently reduce the danger associated with a release. EPA identifies the most hazardous sites, those requiring long-term action, by listing them on the National Priorities List.

The Clean Water Act

The Clean Water Act authorizes EPA to regulate the discharge of pollutants into waters of the United States. EPA may authorize states to carry out a state program in lieu of the federal program if the state program meets the requirements of the Clean Water Act, including providing for adequate enforcement. The act defines a pollutant to include virtually all waste material. The act provides for the establishment of national discharge limitations, water quality standards, and a permit program and has provisions for addressing oil and toxic substance spills. Covered private parties as well as federal facilities must comply with the requirements of the act. According to EPA, since pollutants are defined broadly in the act to include most waste material, perchlorate would likely fall within this definition.

Under the Clean Water Act's National Pollution Discharge Elimination System (NPDES) program, facilities discharging pollutants into waters of the United States from point sources are required to obtain an NPDES permit from EPA or authorized states. NPDES permits include specific limits on the quantity of pollutants that may be discharged and require monitoring of those discharges to ensure compliance. Industrial, municipal, and other facilities must obtain permits to discharge specific pollutants if their discharges go directly to waters of the United States. Sites with NPDES permits are required to routinely sample and report to state regulatory agencies on the release of specified pollutants, which may include contaminants such as perchlorate.

The Federal Facility Compliance Act

Under section 107 of the Federal Facility Compliance Act of 1992,[2] EPA was required, in consultation with DOD and the states, to issue a rule identifying when military munitions become hazardous waste under RCRA and to provide for protective storage and transportation of that waste. Under the rule issued by EPA, used or fired military munitions become waste subject to RCRA regulation if, among other things, (1) they are transported off-range for waste management purposes or (2) they or their constituents are recovered, collected, and then disposed of by burial on or off a range.[3] Unexploded, used, and fired military munitions are known sources of perchlorate. Under RCRA, as amended by the Federal Facility Compliance Act, EPA maintains that DOD installations may be required to sample and monitor off-range for perchlorate as well as other contaminants associated with military munitions where EPA has evidence that the contaminants are creating an imminent and substantial endangerment to health or the environment.

The Safe Drinking Water Act

The Safe Drinking Water Act authorizes EPA to issue national primary drinking water regulations setting maximum contaminant-level goals and maximum contaminant levels for drinking water that must be met by public water systems.[4] EPA may authorize states to carry out primary enforcement authority for implementing the Safe Drinking Water Act if, among other things, the states adopt drinking water regulations that are no less stringent than the national primary drinking water regulations. EPA has set standards for approximately 90 contaminants in drinking water; however, most of the more than 200 chemical contaminants associated with munitions use, including perchlorate, are currently unregulated under the Safe Drinking Water Act.[5]

[2]Section 107 of the Federal Facility Compliance Act of 1992 amended RCRA by adding a new section 3004(y), codified at 42 U.S.C. § 6924(y) (2004).

[3]40 C.F.R. 266.202 (2004).

[4]A public water system is subject to the Safe Drinking Water Act if the system has at least 15 service connections or regularly serves at least 25 individuals.

[5]The Safe Drinking Water Act regulates ammonium nitrate, benzene, cadmium, chromium, and lead—constituents commonly found in munitions.

The 1996 amendments to the Safe Drinking Water Act required EPA to (1) establish criteria for a monitoring program for unregulated contaminants, where a maximum contamination level has not been established, and (2) publish a list of contaminants chosen from those not currently monitored by public water systems. EPA's regulation, referred to as the Unregulated Contaminant Monitoring Regulation, was issued in 1999 and supplemented in 2000 and 2001.[6] The purpose of the regulation was to determine whether a contaminant occurs at a frequency and in concentrations that warrant further analysis and research on its potential effects, and to possibly establish future drinking water regulations. The first step in the most recent program required public water systems serving more than 10,000 customers—and a sample of 800 small public water systems serving 10,000 or fewer customers—to monitor drinking water for perchlorate and 11 other unregulated contaminants over a consecutive 12-month period during 2001 and 2003 and to report the results to EPA. According to EPA, large public water systems provide drinking water to about 80 percent of the U.S. population served by public water systems.

[6]40 C.F.R. 141.40.

Comments from the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 26 2005

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

Mr. John Stephenson
Director
Natural Resources and Environment
Government Accountability Office
Washington, D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to review and comment on the Government Accountability Office (GAO) draft report entitled "Perchlorate: A System to Track Sampling and Cleanup Results Is Needed" (GAO-05-462). The Environmental Protection Agency (EPA) appreciates GAO's thoroughness in researching and reporting on the extent of perchlorate contamination, actions to clean up existing contamination, and studies on potential health risks of perchlorate.

EPA agrees with the report's conclusion that perchlorate contamination has been found in the groundwater, surface water, drinking water, or soil of 37 U.S. states and commonwealths. EPA also agrees with the report's finding that defense-related activities have been found to be associated with perchlorate detections. EPA does not agree with the proposed recommendation, cited on page 25, that EPA "establish a formal structure to centrally track and monitor perchlorate detections and the status of cleanup efforts across the federal government and state agencies."

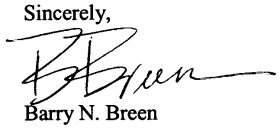
Enclosed are our comments on specific issues for GAO's consideration when preparing the final report.

EPA already has significant information and data on perchlorate concentrations in various environmental media. Much of the information is obtained from our partners in other federal agencies and States and by private parties, among others. The currently-available information indicates the extent of contamination nationally. While it's true EPA does not have all the data a tracking system could provide, as GAO recommends, its benefits are unclear.

Moreover, the development and maintenance of a new tracking system would require additional resources or the redirection of resources from other vital ongoing environmental activities. In order to justify a tracking system, EPA would have to analyze its associated costs and benefits and weight them against projects in other environmental programs. If the benefits of a new large and complex system are unclear, it is unlikely that EPA would fund it, especially when current information on perchlorate contamination is sufficient.

Thank you for this opportunity to review and comment on the draft report on perchlorate contamination.

Sincerely,



Barry N. Breen
Principal Deputy Assistant Administrator

Enclosure

Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

APR 26 2005

Mr. John Stephenson
Director, Natural Resources and Environment
U.S. General Accountability Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Stephenson:

This letter is the Department of Defense (DoD) response to the GAO draft report, "PERCHLORATE: A System to Track Sampling and Cleanup Results is Needed," dated March 31, 2005 (GAO Code 360484/GAO-05-462).

DoD finds this draft report to be factually incorrect and fundamentally flawed. It fails to provide Congress and the public with an accurate assessment of perchlorate issues and activities.

The report mischaracterizes DoD's response to perchlorate, a chemical which is unregulated by the Federal government and for which no state has promulgated standards. In an environment where no regulatory requirement exists, DoD has sampled for perchlorate at 800 sites on 101 different facilities over and above the sampling required and conducted pursuant to the Unregulated Contaminants Monitoring Rule of the Safe Drinking Water Act. Furthermore, DoD has invested over $40 million dollars in developing and demonstrating perchlorate remediation technologies and over $8 million in pollution prevention measures.

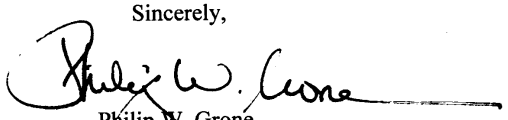
The report risks misleading Congress and the public with respect to the significance and interpretation of key health risk findings and exposure information because it inaccurately summarizes the findings of the National Academy of Sciences as well as other scientific and technical data. In so doing, the report does a serious disservice to both the complexities and nuances of those findings. DoD is disappointed that the extensive comments it twice provided (orally and in writing) to GAO staff on means to improve the accuracy and quality of text, data analysis and its presentation, were largely unheeded. If summaries of the NAS and others' studies are retained in the report, they require significant

reformulation to be accurate and informative. Enclosed are specific comments and corrections to the data and information in this report.

DoD does not concur with the report's single recommendation that "… EPA use existing authorities or seek additional authority to establish a formal structure to centrally track and monitor perchlorate detections and the status of cleanup efforts across the federal government and state agencies." DoD does not believe that EPA requires additional authority to create the proposed perchlorate data base. DoD will continue to share its information on perchlorate. It is not clear that new formal structures to track and monitor perchlorate will provide added value.

Thank you for the opportunity to review and comment on this report. Questions should be directed to DoD's primary action officer, Ms. Shannon E. Cunniff (703) 604-1529).

Sincerely,



Philip W. Grone
Principal Assistant Deputy Under Secretary of Defense
(Installations and Environment)

Enclosure:
As stated

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Staff Acknowledgments

In addition to the individuals named above, John Delicath, Christine Frye, Alan Kasdan, Karen Keegan, Roderick Moore, Edith Ngwa, James Rose, and Rebecca Shea made key contributions to this report.

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