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ABSTRACT

In response to California's 1992 Lead-Safe Schools Protection Act, the state's Department of Health Services conducted a study of the extent of lead contamination in paint, soil, and water in California schools. Data were collected in the field between 1995 and 1997. This report presents the study findings to the state legislature and makes recommendations for ensuring that all California schools are lead-safe schools. Findings and recommendations are as follows: (1) as is the case with housing in California and across the nation, lead-containing paint is present in most California public elementary schools and childcare facilities, yet with proper training, resources, and support, it can be managed safely as part of standard maintenance and operations practices; (2) if lead-safe work practices are instituted and continued over time, they are safer, more efficient, and more cost effective than wholesale removal of lead-containing paint; (3) the lead content of bare soil may be elevated if the soil is close to painted exterior walls, but simple steps can eliminate potential exposure hazards; (4) lead may be present in drinking water in about 18 percent of schools and childcare facilities. A testing, remediation, and replacement program will identify and eliminate this potential source of exposure. The report concludes with the Department of Health Services' action plan and several recommendations. (EV)

Lead Hazards in California's Public Elementary Schools and Child Care Facilities

Report to the California State Legislature

California Department of Health Services

April 15, 1998

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List of Abbreviations

Cal/OSHA	California Occupational Safety and Health Program
CDC	United States Centers for Disease Control and Prevention
CDE	California Department of Education
CLPPB	Childhood Lead Poisoning Prevention Branch
DHS	California Department of Health Services\par
HUD	United States Department of Housing and Urban Development
LAUSD	Los Angeles Unified School District
LSSPA	Lead-Safe Schools Protection Act

California Department of Health Services

California Department of Health Services
Childhood Lead Poisoning Prevention Branch
Report to the Legislature:
Lead Hazards in California's Public Elementary Schools and Child Care Facilities

I. INTRODUCTION

Purpose of this Report

In 1992 the California State Legislature approved *The Lead-Safe Schools Protection Act (LSSPA)* in response to concerns about the presence of lead hazards in schools. At that time whether California schools contain lead hazards had not been evaluated systematically, and there were no specific guidelines or standards which schools could use to safely and cost-effectively manage and prevent lead hazards. The Act required the California Department of Health Services (DHS) to conduct a study to determine the prevalence of lead and lead hazards in California's public elementary schools and childcare facilities; to report individual findings to participating schools; to make recommendations on the feasibility and necessity of conducting statewide lead testing in schools; to develop standards; to evaluate technologies; and to work with the California Department of Education (DOE) to develop guidelines for schools.

As a first step, DHS conducted a study of the extent of lead contamination in paint, soil and water in California schools. The study began in 1994. Data were collected in the field between 1995 and 1997. This report presents the study findings to the State Legislature and makes recommendations for ensuring that all California schools are lead-safe schools.

II. BACKGROUND

A. Health Effects of Lead

Although it is entirely preventable, lead poisoning is the most common environmental health problem for California's children (Coye, 1992). Approximately 239,000 children in California have high enough levels of lead in their blood to put them at risk of adverse health effects (DHS, 1997).

Lead is a highly toxic heavy metal that adversely affects virtually every organ system in the body. Fetuses and young children are particularly susceptible to the effects of lead. The US Centers for Disease Control and Prevention (CDC) has found that "lead poisoning remains the most common and societally devastating environmental disease of young children (CDC, 1997)." Most children with lead poisoning have no overt symptoms. Instead, they silently suffer permanent neurological deficits and behavioral problems, those most notably being loss of IQ and attention deficit disorder. Childhood lead poisoning results in significant medical and special education costs and reduces the lifetime earning potential of poisoned children (Schwartz, 1994).

Although all children are at some risk of lead poisoning (CDC, 1991), most school-age children are at less risk than those five years of age and under. Those under two years of age and those with developmental disabilities are at greatest risk. Young children tend to explore their environment with their hands and mouths, which increases their chance of ingesting lead contaminated paint chips, soil or dust (Menton, et al., 1995). A child's body absorbs up to four times more lead than that of an adult and undernourished children have an even higher rate of lead absorption (Jacobs, 1995). According to the CDC and the American Academy of Pediatrics, a child is at risk of adverse health effects with a blood lead level of 10 micrograms of lead per deciliter of whole blood (g/dL) or more (CDC, 1997).

B. Environmental Sources and Exposure Pathways

1. Sources

Lead is pervasive in industrial environments. It is found in paint pigments, industrial air emissions, soil, food, plumbing fixtures, water and some hobby materials (Menton et al., 1995). Although recent legislation has eliminated lead in gasoline and greatly reduced lead in manufactured products, widespread contamination of the environment continues to cause elevated blood lead levels in children. Three potential sources of exposure are lead-containing paint, contaminated soil, and contaminated drinking water.

a. Lead in Paint

Lead used in the manufacturing of paint is a major source of environmental lead (Jacobs, 1995). Paint that is chalking, flaking or peeling releases lead-contaminated paint chips and dust into the environment. The disturbance of **lead paint**[1^] during ordinary maintenance and repainting activities, or as the result of improper abatement practices, can increase the potential for lead contamination by spreading lead dust.

Lead levels in paint have been lowered by legislation and voluntary industry guidelines since the 1940's. Prior to 1950 lead was a major ingredient in many interior and exterior house paints. Some paints contained up to 50 percent lead by dry weight (HUD, 1995). During the 1940s, some reduction in the amount of lead in interior residential paint occurred titanium dioxide began to be used to replace lead pigments. In 1955, the paint industry adopted a voluntary one percent (10,000 parts lead per million parts of paint (ppm) limit on lead concentration in interior paints. In 1978, the Consumer Products Safety Commission (CPSC) banned the manufacture of most paints containing more than 0.06 percent (600 ppm) lead. As a result, the year in which a building was constructed is generally recognized to be the best predictor of lead presence in and around that building. Many buildings constructed after 1978 may also contain lead paint, especially if older surplus paint has been used on the building (CDC, 1997).

b. Lead in Soil

Paint chips and paint dust generated during repainting activities often settle into nearby soil. Leaded gasoline emissions also settles into soil. In some urban areas, lead presence in soil is high enough to poison children who ingest it (Menton, et al., 1995). The use of lead as an additive to gasoline was phased out during the 1970s and 1980s. Prior to that time, an estimated 668,023 tons of lead was emitted in vehicle exhaust and distributed throughout the United States. As a result, high lead levels are found in soil near freeways, where fallout from emissions has accumulated.

c. Lead in Water

Lead may occur in drinking water either by contamination of the source water system, or by corrosion of lead plumbing or fixtures. Plumbing installed before 1930 is considered most likely to contain lead. However, newer plumbing is often connected with lead solder, which was in common use until leaded plumbing solder was banned by a 1984 amendment to the federal Safe Drinking Water Act. Lead in solder tends to leach into water more significantly from recently installed plumbing, before mineral deposits coat the inside of the pipes and form a physical barrier between the solder and the water.

2. Exposure Pathways

In the United States, lead-containing paint is the primary exposure pathway in young children (Marcus and Elias, 1995; CDC, 1991). As lead paint normally deteriorates or is disturbed by unsafe maintenance or repainting methods, it creates lead-laden dust. A child who walks, crawls or plays in the area may pick up and ingest paint chips or lead dust through normal hand-to-mouth behavior or occasionally through pica behavior, that is, the eating of non-food items. The lead then enters the intestinal tract where 50% or more is transferred to the blood stream (CDC, 1997).

Most children with elevated blood lead levels are exposed to multiple sources of lead at more than one location (CDC, 1997). Besides ingestion of dust from lead-based paint, exposure pathways for children also include ingestion of contaminated soil or water, consumption of food which has been stored in lead soldered cans or prepared and served in lead-glazed ceramics, and ingestion of lead-containing traditional remedies.

Since 1987, DHS has been tracking childhood lead poisoning through laboratory-based surveillance of children with elevated blood lead levels. Eighty-five percent of the 8156 children identified as lead poisoned to date are under five years of age. When a child with high blood lead levels is identified, local public health and environmental health staff investigate possible sources of lead exposure. Nearly always, lead sources in the home environment are identified. Lead hazards at school have not been found to be the primary source of lead in any childhood lead poisoning case in the DHS lead poisoning surveillance system.

C. Current Legislation

1. Federal Statutes Governing Lead-based Paint

The most comprehensive legislation governing lead-based paint is *The Residential Lead-based Paint Hazard Reduction Act of 1992* and Title X of *The Housing and Community Development Act*. In part, Title X mandated the U.S. Environmental Protection Agency (USEPA) to set standards for work practices, training programs and certification of workers; to accredit laboratories for lead analysis; to develop performance standards for testing and abatement products; and to require disclosure of lead-based paint upon sale or rental of pre-1978 housing. These guidelines describe methods for conducting risk assessments and inspections, performing interim controls, and abating lead paint hazards. Title X also requires the U.S. Department of Housing and Urban Development (HUD) to develop detailed guidelines specifying methods for inspecting and controlling lead in federally-owned and federally-financed housing.

2. California Legislation Governing Lead Hazards

Nine California statutes govern lead hazard reduction and lead poisoning prevention. Appendix I contains the complete text of these codes. Summaries are provided below.

a. Legislation Related to Childhood Lead Poisoning Prevention

In 1986 (Health and Safety Code, §§ 124125-124125) the Legislature declared childhood lead exposure to be the most significant childhood environmental health problem in California. A Statewide Childhood Lead Poisoning Prevention Program within DHS was established to compile information concerning prevalence, causes, and geographic occurrence of childhood lead poisoning; to identify and target areas with significant lead exposure; to develop and implement a program for medical and environmental abatement follow-up that will "reduce the incidence of excessive childhood lead exposures in California." As a result, medical laboratories were required to report elevated blood lead levels to DHS. Through legislation in 1989 (Health and Safety Code, §§ 124150-124165), DHS established programs which support local health department lead poisoning prevention activities and educate health care providers. DHS was also required to adopt regulations governing the abatement of residential lead paint. As a result, DHS conducted targeted studies (see Section II, G.1.c for a summary of findings) and developed a strong surveillance program. DHS also developed a regulatory proposal package governing abatement of residential lead paint which is currently under legislative review.

The *Childhood Lead Poisoning Prevention Act of 1991* (Health and Safety Code, §§ 105275-105310) required DHS to develop medical standards of care consistent with the CDC and to ensure appropriate case management of lead poisoned children. The Act also gave DHS broad regulatory authority to perform the following activities: write and distribute screening and case management protocols; designate qualified laboratories and procedures for laboratory reporting of blood lead levels; reimburse screening and case management activities; and notify parents and guardians of reported elevated blood lead levels. The Act also established the Childhood Lead Poisoning Prevention Fund and authorized DHS to establish regulatory fees to support the program, to be assessed on "manufacturers and other parties formerly, presently, or both formerly and presently engaged in the stream of commerce of lead or products containing lead." Additionally, Health and Safety Code, §§ 1367.3-1367.35 (1992) set standards for comprehensive preventive care of children, including screening for blood lead levels. In response, DHS developed regulations for fee collection[2]. DHS has also established a Blood Lead Proficiency program within the Environmental Health Laboratory Branch; contracted with 55 of 61 local health departments to provide case management services to lead poisoned children; coordinated with the Child Health and Disabilities Branch to assure blood lead screening for children; developed protocols for screening and case management; established a Medi-Cal Lead Program; and developed a strong outreach and education program.

In 1993 the Legislature established further protections for children by requiring DHS to adopt regulations and implement a program to achieve status as a USEPA Authorized State Lead Program (Health and Safety Code, §§ 105250). In order to become a state authorized program, DHS must set standards for lead-related work practices; and establish a program to accredit private lead-related construction training providers, and certify lead-related construction workers. Additionally, USEPA requires DHS to develop a formal enforcement and compliance program to assure that children are not poisoned as the result of lead-related construction activities. This program was implemented in 1994 and has enabled local and State agencies to obtain over $65 million in HUD funding to reduce lead hazards in privately-owned low and moderate income housing. This is the only public source of such funding in the State.

b. Legislation Related to Occupational Lead Poisoning Prevention

Workers who disturb or remove lead paint may inhale or ingest lead paint dust and may poison their children if they bring lead dust home on their work clothes. Additional state laws protect workers from the threat of lead poisoning as described below.

In 1991 the Legislature established an occupational lead poisoning prevention program (Health and Safety Code, §§ 105185 to 105195) to monitor adult lead poisoning, create an occupational blood lead registry, follow up and investigate occupational lead poisoning cases (including take-home exposures that may involve children), and conduct education and training. These activities were to be funded through fees collected from employers in industries where lead poisoning has been documented. In response to this legislation DHS established the Occupational Lead Poisoning Prevention Program. In 1993 (Labor Code §§ 6726 to 6717), the Department of Industrial Relations began developing a standard for protecting workers who perform lead-related construction work, which was approved by the California Occupational Safety and Health (Cal/OSHA) Standards Board in 1993. Revisions to the Cal/OSHA Standard in 1997 required workers and their supervisors engaged in construction work in residences and public access buildings to receive training by DHS-approved training providers and to be certified by DHS.

c. Legislation Related to Products and Real Estate Sales

Health and Safety Codes §§ 108550 to 108580 prohibit the manufacture, sale or exchange of toys containing lead in excess of the amount permitted by federal regulations and empower DHS to embargo any toy found to be in violations of this article.

Sections §§ 1102 to 1102.6 of the California Civil Code require the disclosure of known lead-based paint upon sale of property.

The Safe Drinking Water and Toxic Enforcement Act of 1986 (Health and Safety Code Section 25249.5 et seq.), also known as Proposition 65, requires the Governor to publish a list of chemicals known to the State to cause cancer or reproductive toxicity. The list of chemicals and regulations pertaining to the Act are published in the California Code of Regulations Title 22 beginning with Section 12000. Although lead is listed as a carcinogen and as a reproductive toxicant under Proposition 65, the primary health concern for children is its neurological effects.

d. Legislation Affecting Schools

The Lead-safe Schools Protection Act (LSSPA) of 1992 (Education Code, §§ 32240 to 32245) required DHS to do the following:

- Conduct a survey of public elementary schools and public day care facilities for the purpose of predicting lead contamination in paint, soil and drinking water;
- Provide each participating school with the results of environmental testing for lead;
- Recommend Statewide standards for control of lead hazards in California public schools and daycare facilities;
- Consider the feasibility of Statewide lead testing or other lead-related activities in schools and evaluate lead abatement technologies; and
- In cooperation with CDE, develop voluntary guidelines to minimize lead hazards in the course of

repair and maintenance and abatement procedures.

The Act also required public elementary schools and day care facilities to do the following:

- Notify teachers, staff, and parents of the results of environmental testing for lead if they participated in the DHS school survey (described above);
- Use DHS-certified lead-related construction personnel when abating lead hazards; and
- Prohibit use of lead paint, lead plumbing and solders, or other potential sources of lead contamination in new construction and modernization or renovation projects.

The Legislature stipulated funding for these activities through the Child Health and Safety Fund, but resources in this fund were inadequate to provide the necessary support. As a result, the Lead Hazards in Schools Study was primarily funded by USEPA, under a cooperative agreement to develop and implement a comprehensive state lead program. A smaller grant from the Public Health Foundation/Public Health Trust was used specifically to examine the lead content of drinking water.

e. Other Standards

Cal/OSHA regulations require employers who use hazardous materials (including lead) to develop and provide worker protection training programs, to supply workers with Material Safety Data Sheets that contain information about the chemicals they work with; and to develop a compliance effort that insures adherence to these rules. Cal/OSHA also requires that written, safe worksite procedures be kept on site. In some cases, lead is considered a hazardous waste and must be disposed of in accordance with state and local regulations.

D. Standards for Lead Content in Paint, Soil And Water

1. Lead Content of Paint

a. Painting History

Exteriors and interiors of buildings are often painted on different schedules and with different kinds and colors of paint (including varnish and shellac). Trim components such as window sashes, door jambs, and baseboards also may have paint histories which differ from that of wall surfaces. Studies have found higher lead content in trim paint than in wall paint and more lead in exterior paint than interior paint (Sutton et al, 1992; HUD, 1997). Since windows, doors and trim components are often subject to impact or friction, they are often sources of lead in dust. Interior walls in schools were often painted with lead-containing enamel paint for durability and washability.

b. Lead Paint Action Levels

Several state and federal regulatory agencies either recommend or require specific actions when paint containing lead at various levels is present. Table 1 summarizes the action levels for lead in paint that have been established by USEPA, HUD, CPSC and Cal/OSHA. These levels are used to categorize lead content of paint in the findings that follow in Section IV.

Table 1

Action Levels for Lead in Paint

Agency	Lead Level	Explanation
USEPA/HUD	5,000 ppm or above	The Title X statutory definition of "lead-based paint." USEPA and HUD consider deteriorated, chipping or chalking paint at or above 5,000 ppm to be a lead hazard.
CPSC	600 ppm or above	Legal limit for lead content in household paint sold to consumers, set by the CPSC in 1978. Lead-containing paint is still allowed for marine and industrial use.
Cal/OSHA	Any detectable amount of lead	Level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. Referred to in this report as "lead-containing paint."

c. Lead Paint Hazards: Definition

The presence of lead paint alone does not in itself constitute a hazard. When lead-containing paint is in poor condition and accessible to children, it becomes hazardous. Assessments of lead-based paint hazards seek to answer four questions: First, is lead present? Second, is the lead paint in deteriorated condition? Third, is the area easily accessible to children and are children present? Finally, are activities which cause lead to be released into the environment curtailed, or allowed to occur? USEPA and HUD use the answers to these questions to define a lead-based paint hazard. The Cal/OSHA Lead in Construction Standard requires that any worker performing a "trigger task" (where lead may be present at any detectable level) must be given adequate protection and training, and assessed for airborne lead exposure. Trigger tasks that are typically performed during school maintenance and operations work include: manual demolition of structures; manually scraping or sanding; power sanding or grinding; and use of a heat gun to remove old paint.

2. Lead Content of Soil

Both USEPA and HUD define lead-contaminated soil as bare soil containing lead at or above 400 ppm, especially in playgrounds and areas where children have contact with the soil. If the soil is covered or inaccessible to children it is not considered a hazard. Studies have demonstrated a direct relationship between proximity of soil to buildings with lead paint and increased lead content. California has no equivalent standard for lead in soil as a hazard to children; however, state regulation defines soil containing lead at 1000 ppm or more to be a hazardous waste. If soil containing lead above 1000 ppm is removed from a site, it must be transported and disposed of according to state and local hazardous waste regulations.

3. Lead Content of Water

USEPA considers drinking water containing lead concentrations at or above 15 parts lead per billion parts water (ppb) to be unsafe and recommends that such outlets be removed from service immediately until the level of lead contamination is reduced to below 15 ppb. In 1986, the Safe Drinking Water Act of 1974 was amended to ban all future use of lead pipe and lead solder.

Refrigerated water fountains were identified by the USEPA in 1987 as another potential source of lead contamination. The Lead Contamination and Control Act was approved in 1988 to address this concern. The Act required that water coolers with lead-lined tanks be repaired or removed; banned the manufacture and sale of water coolers that were not lead free, and required that lead problems in schools' drinking water be identified and resolved. To comply with the Act of 1988, the CDE released three advisories in December, 1987; March, 1988 and June 1989 to alert school superintendents to the potential hazard of lead in refrigerated water fountains. The advisories describe methods for testing drinking water and for reducing the threat of lead contamination (Appendix II).

E. Lead-safe Maintenance Practices
Lead in paint enters the environment through the deterioration of paint due to normal aging, friction or weather damage; and as a result of repainting and maintenance methods that generate large quantities of paint dust (Bornshein, 1985; Bellinger, 1986). Over the past decade, national consensus has developed regarding maintenance and operations for the safe removal and replacement of deteriorated lead-containing paint. Studies assessing their effectiveness have found that blood lead levels in children are likely to decline after these interventions (Chisolm, 1985; Weitzman, 1993).

1. Recommended Practices
Lead-safe practices for managing lead-containing paint and soil have not been developed specifically for public schools. However, USEPA has published guidance for schools regarding lead in drinking water.

a. Safe Work Practices When Paint Will be Disturbed
Immediate removal of lead-containing paint is not usually the safest way to prevent exposure (HUD, 1995). Safe methods for addressing lead paint hazards (deteriorated paint and friction/impact surfaces) include wet scraping or sanding to remove loose paint; followed by repainting; using power tools (such as sanders) with a HEPA filtration system; enclosing lead-containing paint with drywall or other coverings; encapsulating paint using a 20 year rated encapsulant; or replacement of windows, doors, or trim with new components.

When paint removal is found to be the best option, abatement activities must be performed by DHS certified lead in construction supervisors and workers (LSSPA).

Intact paint, regardless of lead level, does not release lead into the environment. However, paint disturbed by friction (such as that caused by opening and closing windows), or in a deteriorated condition (such as the chalking, chipping and peeling that occur as paint ages) contributes to increased dust lead levels (Beard and Iske, 1995). Furthermore, environmental lead levels increase substantially with dust generation during preparation for repainting (such as by dry sanding or scraping) or with improper cleanup following paint removal (Staes, et al., 1995; USEPA, 1995). Renovation or remodeling activities have also been shown to produce lead dust at levels that exceeded current USEPA hazard levels (USEPA, 1997).

Lead-safe maintenance and operations procedures focus on keeping paint intact, using work practices that confine lead dust to a contained area and removing young children from areas with high levels of lead. Safe work practices include placing a tarp or plastic beneath paint removal operations to collect old paint debris, dampening paint before removing it with a scraper ("wet scraping"), cleaning nearby surfaces with a wet mop or cloth to control dust after the job is completed, using a High Efficiency Particulate Air (HEPA) attachment on power sanders, and conducting cleanup with HEPA vacuums to remove lead dust. HUD also recommends prioritizing paint maintenance so that areas where young children are present are maintained before other areas. Some of the most dangerous practices include power sanding without HEPA attachments, the removal of paint with a torch or open flame, and sanding or scraping paint from a surface without first wetting it ("dry sanding or scraping") (HUD, 1995).

b. Safe Practices for Soil
HUD recommends that soil with lead content above 5000 ppm be paved over or replaced, and that access to soil be restricted when soil lead levels are at or above 400 ppm. Surface coverings for soil may include grass, other plantings, concrete or asphalt. Land use controls include: placing barrier fencing and warning signs, creating alternate play areas, and planting thorny bushes (HUD, 1995).

c. Safe Practices for Water

USEPA has developed specific recommendations for school drinking water with lead concentrations at or above the action level. This includes: the daily "flushing" of plumbing by allowing water to run for at least 30 seconds from all affected taps; the reduction of lead concentrations in the source water; the installation of a corrosion control device at school point-of-entry; the use of cold tap water for drinking and cooking; or the use of bottled water (USEPA, 1989).

2. Published Resources

Each resource described below was designed to meet specific needs. Combined, they can be extremely useful in public school settings.

HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*, (1995) are considered to be the national standard for lead hazard reduction techniques pertaining to paint and soil, and provide a working manual of best practices for lead hazard reduction (HUD, 1995). Guidelines for lead in drinking water are contained in the USEPA booklet *Lead in School Drinking Water* (USEPA, 1989).

Several additional guidelines also describe "best practices" for lead-based paint removal and maintenance in specific situations. The National Institute of Building Sciences (NIBS) publication, *Lead-Based Paint Operations & Maintenance Work Practices Manual for Homes and Buildings*, is a detailed guide for the safe management of lead-based paint for owners of single family residences and small apartment buildings, as well as owners and managers of residential or public and commercial buildings. The manual describes how to control lead dust during maintenance activities, clean up thoroughly, and provide worker protection (NIBS, 1995).

The Lead-Based Paint Maintenance Training Program was developed for USEPA and HUD by the National Environmental Training Association (NETA). This program guides trainers and supervisors on methods for training maintenance personnel on safe maintenance procedures for dwellings that contain lead-based paint. The training program provides basic instruction on proper and prohibited lead paint maintenance and control measures (NETA, 1997).

The Occupational Lead Poisoning Prevention Program (OLPPP/CDNS) developed a manual entitled "Painting Contractors Guide to Lead Safety" (OLPPP, 1996) to assist residential and commercial painting contractors in how to properly manage a lead paint job. The manual provides guidance on work practices, OSHA regulations, and worker health and safety.

A variety of pamphlets about lead related construction work and safety have been assembled by OLPPP for widespread distribution. "Lead Safety for Construction Workers" (OLPPP) is available in English, Spanish and Chinese for short, supervisor-taught field training.

Some California school districts have developed written programs that meet specific needs. For example, the Los Angeles Unified School District has an environmental lead management program that describes potential sources of lead in schools, lists procedures for protecting workers, and requires specific abatement and in-place management strategies (Los Angeles Unified School District, 1996).

The Self-Insured Schools of California (SISC), has developed a manual entitled *Lead-Based Operations and Maintenance Work Training Manual* which contains simple rules and instructions for workers conducting routine maintenance operations that involve lead (SISC, n.d.).

The *Tools for Schools Resource Kit* is available from USEPA. The materials in this kit focus mainly on indoor air quality. A very limited section on lead hazard prevention is included (USEPA, 1995).

F. California Accreditation and Certification Programs for Lead-Related Construction

CLPPB operates the State's programs for certifying lead-related construction workers and accrediting the training providers who offer courses required for certification. The program is mandated by California Health and Safety Code Section 105250, which was amended by statute in 1993. The program began when regulations took effect in 1994.

To become certified to perform lead work, individuals must complete State-approved training, and have relevant experience and education. Individuals can become certified in five disciplines, including Inspector/Assessor, Project Monitor, Project Designer, Supervisor, and Worker. Each certificate has different training, education, and experience requirements. Certificates are granted to individuals, not to companies or businesses. They are non-transferrable and must be renewed annually. Appendix III contains DHS fact sheets about the lead related construction certification program.

The training courses required to become certified in lead related construction disciplines are offered by training providers who have been accredited by DHS. To become accredited, training providers must have qualified instructors, approved curricula, and adequate training facilities. Their courses must provide information about the health effects of lead poisoning, sources of lead, how to identify and reduce lead hazards, as well as work practice information specific to each certificate discipline. Appendix II contains DHS fact sheets about the lead related construction accreditation program.

To date, twenty-four training providers in Northern and Southern California have been accredited to teach 65 courses. Additionally, 3340 individuals have been certified in one or more disciplines, resulting in over 4500 certificates issued statewide across the five lead related construction disciplines.

G. The Role of Public Awareness in Reducing Childhood Exposure to Lead

Recent concerns about environmental contaminants in schools have sparked several regulatory initiatives at the federal level (Ornstein, 1994). National policies and program development to address asbestos hazards, radon gas emissions and indoor air quality in public schools have all been undertaken with varying degrees of success and public health benefit. Many of these undertakings have been quite costly.

In the case of asbestos, for instance, researchers found that in 1989, per student expenditures for schools in seven states averaged $71 for instructional materials, and $406 for asbestos control (Fisher et al, 1993). Furthermore, there is evidence that much of asbestos clean-up was done incorrectly and may have created hazards where none previously existed (Ornstein, 1994). The perceived failure of asbestos policy has focused attention on the role of public awareness and education in reducing exposure to environmental hazards, including lead hazards in schools.

The CDC considers public awareness of the nature of lead hazards to be key to preventing exposure (CDC, 1997). The USEPA reviewed three studies of the effectiveness of educational efforts aimed at reducing blood lead content and concluded that such intervention had an impact on reducing children's blood lead levels (USEPA, 1995).

One assessment of USEPA-initiated risk management programs for public schools found that schools tend to respond best to guidance about reducing environmental dangers when that guidance includes an active state-level component which distributes materials and provides training and financial support (Fisher et al, 1993).

H. Overview of Previous Research

1. Lead in Housing

Although no previous studies of lead in California schools exist, studies of housing in California, nationwide, and in other countries provide some background on potential lead hazards in schools.

a. National Housing Studies

In 1989 and 1990, HUD performed a nationwide study of lead levels in housing. The HUD results revealed a high prevalence of lead-based paint in housing. Seventy-four percent of houses built before 1980 contained lead-based paint somewhere in the building. The study also found that damaged lead-based paint was associated with excessive lead levels in dust. More than five square feet of damaged lead-based paint were present in 18 percent of pre-1980 housing stock (HUD, 1995).

b. Other Housing Studies

Prior to the HUD National Housing Study, numerous studies established a strong connection between damaged lead paint and excessive dust lead levels. A New Zealand study of lead paint and home age and type found that, in homes with interior lead paint, 45 percent of the total lead content in dust was made up of lead from paint (Fergusson and Schroeder, 1985 in Beard, et al.). A 1985 study in Cincinnati, Ohio examined the effect of house age, paint lead content and condition on the amount of lead in external dust. Higher levels of lead were found in housing in poor condition (Clark et al., 1985 in Beard, et al.)

Soil is also contaminated by lead based paint. A study in Detroit, Michigan of soil lead and distance from buildings determined that soil taken two feet from a corresponding building had lead levels five times higher than samples taken ten feet away (Ter Haar and Aronow, 1974).

Five studies in the United States between 1983 and 1987 analyzed house dust lead and child blood lead levels during and after lead paint removal. The results, taken together, indicate that dust from paint removal has a substantial negative effect on child blood lead levels (Beard, et al.,1995).

c. California Housing Studies

Childhood Lead Poisoning in California: Extent, Causes, and Prevention (DHS, 1992) is the report of targeted studies that was mandated by the Legislature in 1986. It assessed environmental lead contamination in the homes of children in three urban locations. Paint, soil and dust lead levels, as well as children's blood lead levels, were measured, and a questionnaire was administered. Applying survey results to the state as a whole, an estimated three million homes in California (27 percent) may have exterior paint lead levels at or above the USEPA/HUD action level of 5000 ppm and 1.3 million homes (12 percent) may have interior paint lead levels at or above 5000 ppm. Age of housing was found to be the best predictor of lead in soil and dust; homes built before 1920 were ten times more likely to have soil lead levels above 5000 ppm. This study confirmed the need for additional examination of lead hazards to children.

2. Lead in Schools

The California Lead Hazards in Schools study is the first to examine the presence of lead in schools in the three media of paint, soil and water. A search of literature on lead in schools disclosed seven studies

(USGAO, 1993; Weisman, et al, 1995; Fisher, et al, 1993; Hamilton, 1992; Gnaedinger, 1993; Berkowitz, 1995; Odell, 1991), four of which looked only at levels of lead in school drinking water. None of these studies were focused on schools in California.

A study by the General Accounting Office of federal, state, and local activities focused on lead in child care facilities and schools. *Toxic Substances: The Extent of Lead Hazards in Child Care Facilities and Schools is Unknown* concluded that data was not sufficient to determine the extent of lead hazards in the nation's child care facilities and schools or to assess whether these hazards are being adequately addressed (US GAO, 1993).

Many studies have evaluated lead contamination in school drinking water. The only California-based study of this subject was conducted by the Los Angeles Unified School District (LAUSD) in 1988. In this study, LAUSD found that half of its refrigerated units dispensed water containing 20 ppb lead or more, whereas the same lead levels were found at only about 12 percent of non-refrigerated units (LAUSD, 1988).

An examination of water in 22 of Tennessee's schools revealed relatively high concentrations of dissolved lead, along with other minerals. Lead concentrations above Tennessee's Primary Standard for Drinking Water were found, and corrective measures were taken where necessary (Hamilton, 1992).

In response to the Lead Contamination Control Act of 1988, Missouri established a program to assist schools and day care centers in identifying potential lead contamination problems in their buildings and implementing remedies. Many of the schools and day care centers tested water outlets for lead, even though it was not required by the legislation. The testing revealed that 5.7 percent of all outlets in the schools tested were above the State action level of 20 ppb. In day care centers, 2.4 percent of the outlets exceeded the lead action level (Gnaedinger, 1993).

The New Jersey Department of Health issued a *Survey of New Jersey Schools and Day Care Centers for Lead in Plumbing Solder* to determine if schools and child care centers were in compliance with a 1987 State ban on lead solder for use in drinking water plumbing systems. Samples from 24 percent of facilities constructed or renovated just after this ban tested positive for lead content. The percentage of samples that tested positive for lead content declined in facilities constructed or renovated in the period from 1989 to 1992 (Berkowitz, 1995).

The findings of a study of lead levels in drinking water in the Seattle School District were presented in *Reducing Lead in School Drinking Water: A Case Study*. This article described the steps taken to identify lead levels in water and implement corrective measures (Odell, 1991).

The study *Schools Respond to Risk Management Programs for Asbestos, Lead in Drinking Water and Radon* evaluated USEPA's public school risk management programs in Colorado, Idaho, Illinois, New York, Ohio, Pennsylvania, South Carolina, Tennessee and Texas in 1989. The authors found that state agency involvement is an important factor in the success of public school risk management programs (Fisher, Chestnut and Chapman, 1993).

One study correlated lead in paint, soil and dust at day care centers with children's blood lead levels. In *Elevated Environmental Lead Levels in a Day Care Setting*, the blood lead levels of children attending six Midwestern university day care centers were measured and a questionnaire identified risk factors of lead exposure. Lead samples from paint, dust and soil were also analyzed. Although all centers had elevated levels of lead in paint, all but one of the 155 children tested had blood lead levels below 10 μg/dL3^. The authors concluded that children attending day care centers with high environmental lead burdens should be evaluated for elevated blood lead levels, at-risk behaviors, and lead exposure risks in the home (Weisman, et al.,1995).

[1]Throughout this report, lead paint denotes the presence of an unspecified amount of lead in paint; lead-containing paint denotes lead in paint at or greater than the level of detection; lead-based paint denotes lead in paint at a greater than the USEPA action level of 5000 parts of lead per million parts of paint.

[2] These fees were the subject of recent legal challenge. In June 1997 the California Supreme Court found the fees to be legal regulatory fees.

[3] CDC considers blood lead levels of 10 g lead per deciliter whole blood to be elevated.

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III. METHODS

A. Introduction

This study has two separate but related aims: (1) to estimate the extent to which lead is a contaminant of water, soil, and paint in California's public elementary schools, and (2) to describe operations and maintenance practices as they may contribute to (or protect against) the generation of lead hazards on public school grounds. To address the first aim, the Childhood Lead Poisoning Prevention Branch (CLPPB) of DHS conducted a survey of paint, soil and water in a representative sample of California's public elementary schools and day care facilities properties (the "Schools Survey"). To address the second aim, the CLPPB administered a questionnaire regarding maintenance and operations practices to public schools facilities managers (the "Current Practices Survey").

B. Preliminary Steps

1. Joint DHS/CDE Interim Advisory

Because the study would require several years to complete, DHS and the CDE jointly developed an interim advisory (Appendix IV) that was distributed to every public school district in California in May, 1994. This non-binding guidance document informed schools that DHS would be conducting a study of lead hazards in schools, and also provided guidance on environmental lead and its health effects, likely sources of lead in schools, and briefly outlined safe and unsafe maintenance practices. The Advisory referenced three previously issued advisories on lead in school drinking water, which are included in Appendix II.

2. Consultations with Experts and Stakeholders

Throughout the course of the study, the Lead Hazards in Schools Project has consulted with key experts and stakeholders, including school maintenance and facilities managers and workers, teachers, childcare experts, administrators, school district personnel, labor, local health officers and State personnel from DHS, Cal/OSHA, CDE and the Governor's Office of Child Development and Education. These experts and stakeholders provided invaluable assistance in enlisting schools, developing data collection instruments and procedures, fostering collaboration, and communicating results to each participating school.

Many of the experts and stakeholders who assisted the project were involved in the asbestos removal program during the 1980's and contributed valuable information from lessons learned during that effort. One of the key general lessons is that it is more important to control exposure than to completely remove all lead-containing materials. The experts and stakeholders stressed that this approach would allow resources to be directed toward the effective protection of children's health.

C. The Schools Survey

1. Recruiting and Communicating

a. Recruiting

Recruiting schools to participate in the study required intense collaboration among DHS, DOE, local health departments, local offices of education, local school districts, staff of selected schools, and directors of childcare programs that are located on school grounds. (See Appendix V for sample correspondence from DHS to these entities). Full participation was important because replacing schools that refused to participate would be costly, time-consuming and could threaten the study's scientific integrity.

Local school districts had ultimate authority to decide whether or not schools in their jurisdiction could be approached about participating in the study. Many districts were initially hesitant, fearing that the study would identify problems and leave individual schools and districts to cope with the results alone and without support. Establishing a relationship of trust with both districts and schools occurred through a slow, careful, and productive process: every single school that was selected actually participated (a rare accomplishment in survey research).

b. Communicating

The LSSPA required that written reports of findings be issued to each of the participating schools within 60 days of on-site data collection (Appendix VI). These individual reports included the results of laboratory analyses for lead in all soil, paint, and water samples, information on data collection locations, and suggestions for managing any lead hazards that may have been identified. Supporting materials accompanied the report, and included a Parent Question and Answer sheet about the study (Appendix VII). (Once participating schools had been given their survey results, all data that would allow specific participating schools to be identified was removed.)

The legislation also required that schools inform parents and staff of the report's findings within 45 days after the school had received a report from DHS. When requested to do so by schools or districts, DHS staff provided communications advice and additional informational materials for distribution to the public. Parents and staff responded very favorably to this approach. No major concerns about the school's ability to provide a lead-safe environment were raised at any participating school, even at schools where lead hazards were found.

2. Choosing a Representative Sample of Schools

In 1995, when the school sample selection methods were being developed, California had 5,041 public elementary schools, and only a sample could be effectively included in the School Survey. A representative sample of 200 of these schools were invited to participate. This sample included schools with both public and private pre-kindergarten and childcare programs located on school grounds.

Because year of construction is the best predictor for presence of lead based paint in buildings, it was the most important variable to consider in selecting schools for the study. Since no enumeration of California's schools by year of construction exists, DHS surveyed staff at a random sample of 629 schools by telephone to determine year of construction. Estimates based on this survey indicate that a relatively small proportion (22 percent) of California's schools were built before 1940 or after 1979. Therefore, a simple random sample of 200 schools would be unlikely to include sufficient numbers of schools built before the lead content of paint first began to be reduced (pre-1940), and after the CPSC household paint lead standard took effect (post-1979) to conduct reliable analyses of the impacts of these practices and legislation.

A mixed sampling strategy was implemented to assure that statistically sufficient numbers of schools built before 1940 and after 1979 would be included. One hundred fifty schools were chosen by simple random sampling from among all schools; an additional 18 schools were randomly selected from among those reportedly built before 1940 and another 32 were randomly selected from schools reportedly built after 1979. Original year of construction was verified when schools were surveyed. The final sample included 37 schools originally built before 1940 (18.5 percent), 125 schools (62.5 percent) built between 1940 and 1979, and 38 schools (19 percent) built between 1980 and 1994.

Table 2 and Figure 1 compare the distribution of selected schools, by age, to the estimated distribution, by age, of all public elementary schools in California. Applications of this study's findings to all California public elementary schools were derived by mathematically weighting this stratified sample so that results for schools from the various age categories were given significance equal to their occurrence in California's schools overall. (See Section III, 7, below for details on the method for sample weighting employed for analysis).

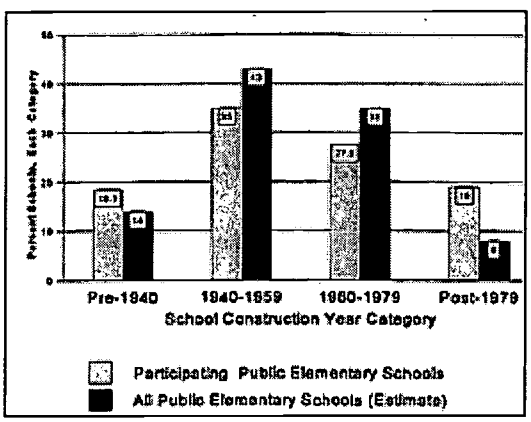
Table 2

Year of Construction: Actual Frequencies of Participating California Public Elementary Schools and Estimated Frequencies for All California Public Elementary Schools

Year Constructed	Participating Schools	All Schools (Estimated)
Pre-1940	37 (18.5%)	706 (14%)
1940-1959	71 (35%)	2168 (43%)
1960-1979	54 (27%)	1764 (35%)
1980-1994	38 (19.5%)	403 (8%)
Total	2000 (100%)	5041 (100%)

Actual year of construction for participating schools was obtained from schools at time of testing. Estimated year of construction for all schools is based on the results of a telephone survey of a sample of 629 schools of the 5041 public elementary schools which were in California when participating schools were selected. California Lead Hazards in Schools Study, 1998

FIGURE 1



Actual year of construction for participating schools was obtained from schools at time of testing. Estimated year of construction for all schools is based on the results of a telephone survey of a sample of 629 schools of the 5041 public elementary schools which were in California when participating schools were selected.
California Lead Hazards in Schools Study, 1998

The selection process also yielded a geographically representative sample. Figure 2, a map of California, shows the location of participating schools. As expected, they represent all areas of the State, and are more densely concentrated in urban areas.

Recognized risk factors for lead poisoning include residence in housing stock built before 1950, presence of children under the age of six, and low income status. The rates of these risk factors in the vicinity of the study schools are similar to those of the entire state (Table 3), according to a comparison of 1990 U.S. Census data.

FIGURE 2

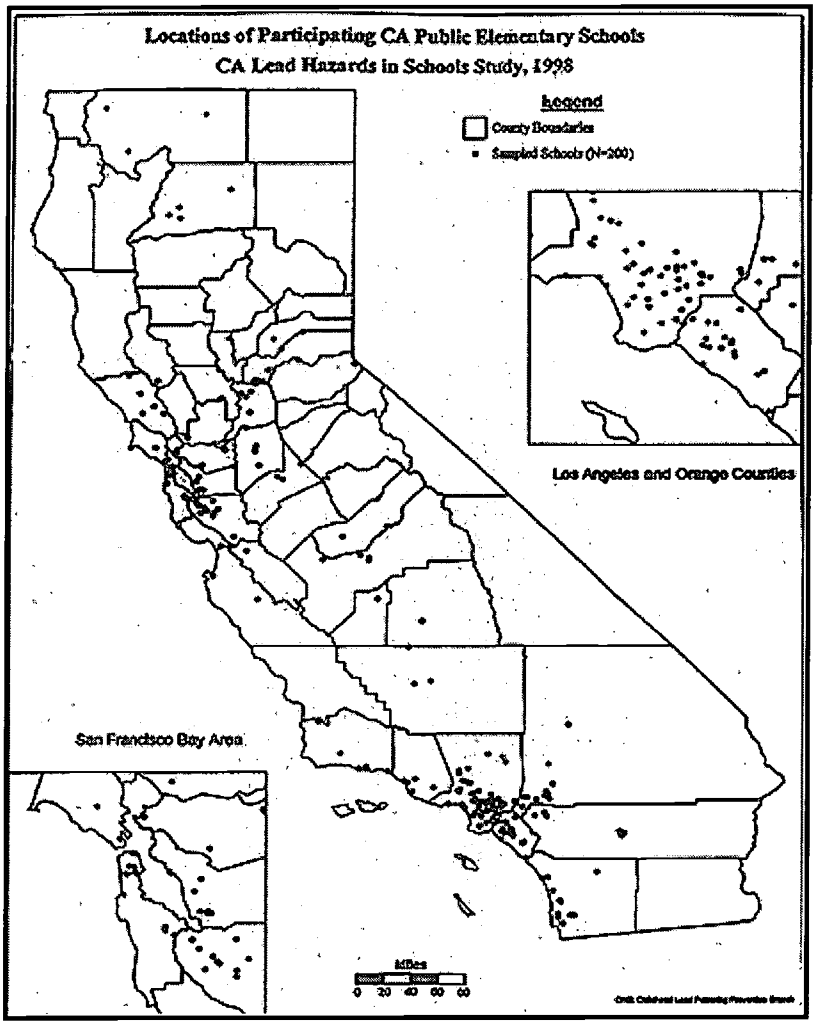


Table 3
Risk Factors for Childhood Lead Poisoning in ZIP Code Areas of Participating Public Elementary Schools and For California As a Whole

Risk Factors	Participating Schools' ZIP Codes	California
Housing built before 1950	17.7%	19.8%
Children under six years of age	10.2%	9.6%
Population at or below	17.2	16.6%

Source: U.S. 1990 Census, STF-3A, Tape 3 California Lead Hazards in Schools Study, 1998

3. Data Collection Protocols, Training, and Standards

A standard protocol was developed to ensure that all field staff collected samples in a consistent manner at all locations (See Appendix VIII). All data collection personnel were required to attend several training sessions to acquaint them with the protocol and the procedures were tested in a pilot study of five schools in the San Francisco Bay Area. Upon completion of the pilot study, standard data collection instruments were developed for use throughout the study (Appendix IX). One of three research supervisors oversaw testing at each of the 200 schools. The three supervisors regularly conducted testing together to ensure consistency of environmental sample selection and collection methods. Samples from paint, soil and water were collected, packaged, identified and stored in the same fashion at every location. Research supervisors conducted regular field inspections to ensure compliance with the protocols throughout the study period.

4. Collecting Data

Paint, water and soil samples were collected at each school. Paint and soil samples were obtained from the oldest building (which was assumed to be most likely to contain lead hazards), and from the youngest children's classroom. At most schools (153 schools or 76.5 percent), the oldest building also contained the youngest children's classrooms and in those cases only that building was sampled. At schools where these two areas were different, paint and soil samples were collected at both buildings. Water samples were always collected at the oldest building, unless that building had no inside water outlet. In that case, water was taken from the next oldest building on campus. In this report, results from the oldest buildings were used to characterize schools.

a. Paint Sampling

The number of painted surfaces varied from school to school. In some schools, all walls, trim, and doors were painted. In others (usually those of more recent construction), only some surfaces (such as doors or windows) were painted while other surfaces (such as walls) might be made with pre-fabricated materials that did not require painting. As a result, the number of paint specimens that field teams collected varied from school to school. A maximum of four interior and seven exterior paint chip samples were collected, following protocols described above. Wherever possible, paint chip samples were obtained from areas where the paint was visibly deteriorated. If no deterioration was present, samples were taken from intact paint. Using a clean paint scraper, one-square inch sized paint chips were removed through all layers of paint and placed in a lead-free whirl-pak plastic bag supplied by the analytical laboratory. Difficult to remove paint was softened with a low-setting heat gun.

To estimate the extent of paint deterioration (a probable contributor to lead in dust and soil), field staff assessed the overall condition of the painted surface from which samples were taken. Interior walls, interior trim, exterior walls and exterior trim were rated from 0 (all walls or trim in poor condition) to 8 (all walls or trim in good condition). Researchers were trained to recognize standardized paint conditions. Unpainted surfaces were considered to be in "good" condition.

c. Soil Sampling

Soil specimens were collected from within five feet of painted walls or windows, play areas, and from a location on the school grounds which was as far away from any buildings as possible. At schools where one building was tested, a maximum of four soil samples were taken; for two-building schools, researchers took up to seven samples. Researchers took more soil samples from older schools than newer ones, since newer schools had smaller areas of bare soil. Visible paint chip, rocks or organic material were removed from the soil prior to sample collection, and the samples were immediately identified and sealed in plastic bags.

d. Drinking Water Sampling

Four water samples were collected from each school; two from an inside outlet and two from an outside outlet. The first sample was taken immediately after the water outlet was opened and the second after the water was allowed to run for 30 seconds. Wherever possible, samples were collected from the oldest building. Water was collected in sterile lead-free 250 ml plastic bottles. A total of 346 drinking fountains were sampled as were 52 other water outlets, such as hose bibs. There was one refrigerated water outlet among all tested areas. Samples were collected as close to noontime as possible. Other information recorded included time of day, hours since last use, and type of water outlet.

5. Laboratory Analysis and Quality Control

Paint, soil, and water samples were analyzed at a commercial laboratory with documented experience in reliably analyzing lead-contaminated environmental specimens. This laboratory is accredited by both the National Lead Laboratory Accreditation Program (NLLAP) and the American Industrial Hygiene Association (AIHA) as proficient in the analysis of lead in paint chips, soil and water. Samples from all three media were analyzed using flame atomic absorption spectroscopy (FLAA).

The laboratory employed a strict Quality Assurance/Quality Control protocol. In addition, approximately 10 percent of unanalyzed samples were resubmitted for blind analysis. Finally, for approximately two percent of all schools tested, secondary samples immediately adjacent to the actual paint and soil samples were collected and analyzed by the DHS Environmental Health Laboratory for comparison of results. Results obtained by the contract laboratory from the blind samples and the side-by-side samples demonstrated a high level of agreement, indicating that the analytical method was reliable and that the sampling technique did not introduce unacceptable sampling variance.

In all three media, the lead content in some of the environmental samples was below the detection limit. For paint and soil, the detection limit varied with the weight of the sample; for water the detection limit was a constant 5 ppb. For statistical analysis, all samples reported to have a lead content below the detection limit were treated as if they had a value of one-half the detection limit.

6. Data Management

Data collected in the field and laboratory analysis results were entered from standardized data collection forms into a computerized database program written in Microsoft Access®, Version 2.0. All data were double-entered by different data entry operators. Microsoft Access ® was used to write a program which compared all data points and resolved data entry discrepancies. The resulting data set was cleaned and examined in SAS ® statistical software, Version 6.12.

7. Statistical methods

To obtain the results that would maximize the ability to predict lead presence and amount, the environmental sample with the highest lead content within each medium (paint, soil, and water) was chosen to represent each school. In this report geometric mean is used to express the central tendency of lead content (IE, average lead content) because it normalizes the data, which tends to be heavily skewed toward higher lead levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample. Geometric mean of lead content and other descriptive statistics were calculated for each medium (paint, soil, water) stratified by four year categories (before 1940, 1940 to 1959, 1960 to 1979, and 1980 to 1995). Differences in lead content for year of construction category were compared by employing a Chi-square test. Two specific statistical issues encountered in the data analysis and the methods employed to resolve them are described below.

a. Sample Weighting

In order to apply stratified sample survey results to all California public elementary schools, a recognized statistical sample weighting method was used (Levy, et al, 1980). This method weighted values according to age-of-school categories in proportion to their occurrence in the actual population of California's schools. This method was used to estimate proportions and standard error for data on all schools combined. (For the equation used to compute proportions and standard error, see Appendix X).

b. Uneven Numbers of Samples

Field technicians took more paint and soil samples from older schools than newer ones, since newer schools had fewer painted surfaces and less accessible soil. Two separate statistical analyses were used to evaluate the effect of an uneven number of samples on the relationship between year of construction and lead content for both media. One analysis employed a regression model using year to predict lead content in which the number of samples collected was a covariant. In another, the number of samples was used as a weighting variable in models which included year of construction to predict lead content. In both tests, only minimal effects were found. Accordingly, results are presented here assuming that the varied number of environmental samples had no impact on the results.

D. The Current Practices Survey

The Lead Maintenance and Operations Practices Questionnaire (Appendix XI) was devised to determine the extent to which facilities managers in local school districts were aware of safe and unsafe work practices and the extent to which such practices were employed. Knowledge about and attitudes toward lead as an environmental contaminant were also measured. It was administered to volunteers at the 1997 Annual Meeting of the California Association of School Business Officials. Most of the respondents (86 percent) reported that they were managers of school physical plants or of maintenance and operations activities.

Survey results were entered into Microsoft FoxPro ® database software. All data were double-entered by different operators and a program written in Microsoft FoxPro ® was used to compare all data points and resolve data entry discrepancies. The resulting data set was cleaned and examined in SPSS ® statistical software, Release 7.5.

Frequency distributions for all variables were evaluated. Since the sample was not intended to estimate practices of the state-wide population of school facilities managers, no inferential statistical methods were employed.

IV. FINDINGS

A. Lead Content of Paint in Schools

1. Study Schools

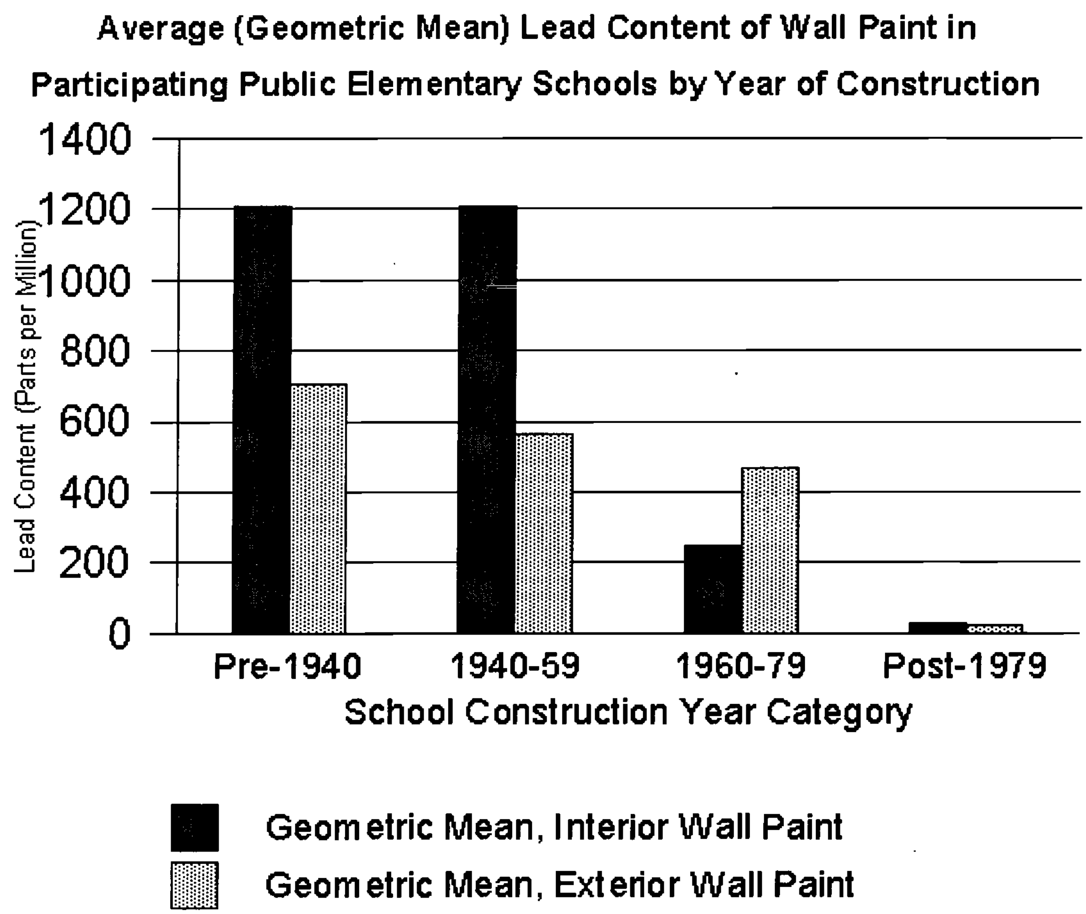
a. Lead Content by Type of Surface

In general, samples from the building exteriors tended to have substantially more lead than interior samples, with a geometric mean nearly double that of interior samples. However, among schools built before 1960, interior wall paint had higher average lead levels than exterior wall paint. (Descriptive statistics for paint lead levels by building age and surface type are found in Appendix XII.)

Lead content in trim paint was consistently higher than in wall paint, both inside and outside schools. These differences were statistically significant. ($p<0.05$). The geometric mean for exterior trim was more than five times that of exterior walls, while the interior trim geometric mean was slightly more than twice that of interior wall paint samples.

Figure 3 presents average (geometric mean) wall paint lead levels by year of building construction. Results are presented for schools built before 1980. Average (geometric mean) trim paint lead levels by year of building construction are presented in Figure 4.

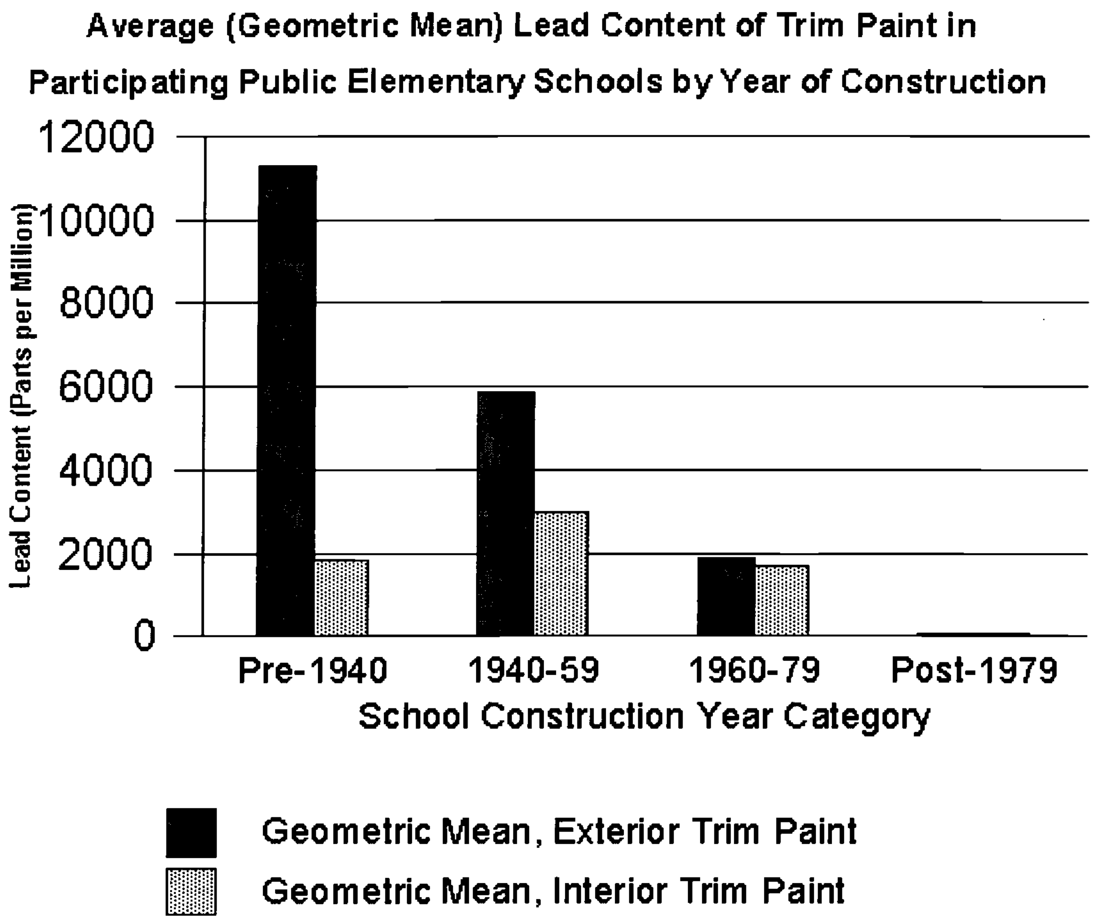
FIGURE 3



Geometric mean is used to express the central tendency (average) of lead content in this report because it normalizes data such as this which is heavily skewed toward higher levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample.

Lead Hazards in Schools Study, 1998

FIGURE 4

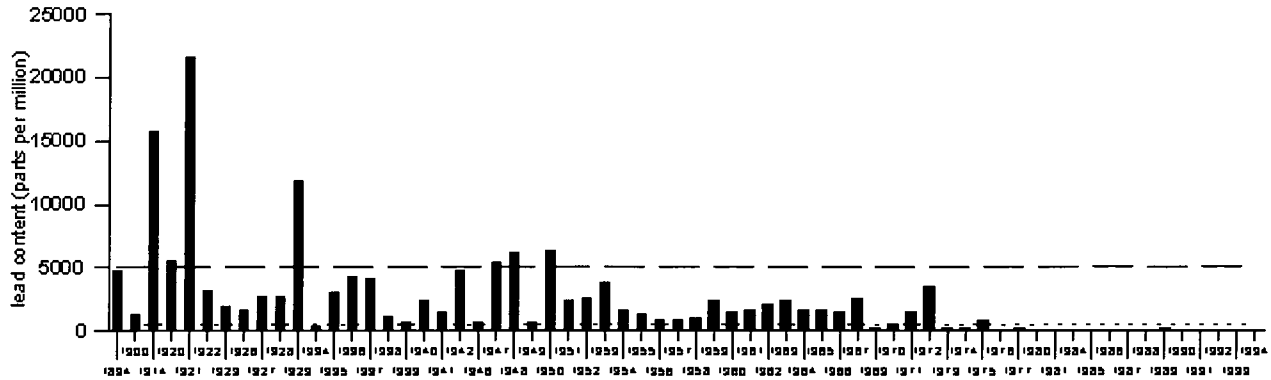


Geometric mean is used to express the central tendency (average) of lead content in this report because it normalizes data such as this which are heavily skewed toward higher levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample. Post-1979 values are too low to be visible on this graph.

California Lead Hazards in Schools Study, 1998

FIGURE 5

Average (Geometric Mean) Lead Content of Paint of Participating Public Elementary Schools By Year Built



Geometric Mean, Lead Content of All Paint Samples from All Participating Schools Built in Year

5000 parts per million (USEPA Action Level for Lead in Paint)

600 parts per million (CPSC consumer paint standard = 600 ppm)

Data for each year includes data for all schools built in that year. Years within which no participating schools were built are not shown. Geometric mean is to express the central tendency (average) of lead content in this report because it normalizes data such as this which is heavily skewed toward higher levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample. Ppm=parts per million part pain. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. "600 ppm" is limit for lead content in consumer paint, set by the Consumer Products Safety Commission in 1978. "5000 ppm" is The regulatory definition of "lead-based paint", and the level at which USEPA and HUD recommend paint can be either abated or contained through interim measures.
California Lead Hazards in Schools Study, 1998

c. Building Age and Lead Content

The geometric mean of lead levels in paint declined substantially over time. The year 1950 was the latest year to have an average (geometric mean) lead level of above 5000 ppm , and all years after 1975 averaged lead levels below 600 ppm (Figure 5). There were substantial variations in these averages prior to 1950. Each participating school was classified into paint lead concentration categories that correspond to current State or federal standards. So that results would be most protective of children, the paint sample with the highest lead content was chosen to represent each school for this analysis. Table 4 presents the distribution of schools' paint lead concentrations in standard categories by school construction year category.

Lead content in paint was significantly dependent upon school age (X2=213.2, df=12, p<.001). The most dramatic decline in lead content was observed in schools built after the CPSC limit was instituted in 1979. While every school built before 1980 contributed at least one paint sample with some detectable lead, we found no lead at all in the paint of more than half (55.3 percent) of schools built after that year. A review of the participating schools built between 1992 and 1995 showed that none of these newest schools contributed paint samples containing lead above the CPSC level of 600 ppm. However, the number of schools in that small sampling was too few for statistical reliability.

Table 4

Number of Participating Public Elementary Schools With Lead in Paint Above Regulatory Standards by School Construction Year Category

Year Built	Lead Concentration				
	Not Detectable	Detectable- 599 ppm (CAl/ OSHA)	600-4999 ppm	5000 ppm or above (USEPA)	TOTAL
Before 1940	0	0	2 5.4%	35 94.6%	37 100%
1940-1959	0	0	6 8.5%	65 91.5%	71 100%
1960-1979	0	3 5.5%	13 24.1%	38 70.4%	54 100%
1980-1995	21 55.3%	11 28.9%	5 13.2%	1 2.6%	38 100%

N=200. Row percentages may not total 100% due to rounding. The paint sample with the highest lead content was used to represent each school. A school is only represented in one lead content category. Ppm=parts lead per million parts paint. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. "600 ppm" is limit for lead content in consumer paint, set by the Consumer Products Safety Commission in 1978. “5000 ppm” is the regulatory definition of “lead-based paint”, and the level at which USEPA and HUD recommend paint be either abated or contained through interim measures.

California Lead Hazards in Schools Study, 1998

d. Paint Condition

To estimate the degree to which lead-containing paint was in need of current or near-term maintenance, paint condition was evaluated. Results are presented in Table 5.

Table 5

Number of Participating Public Elementary Schools With Lead in Paint Above Regulatory Standards in Deteriorated Paint Environments, by School Construction Year Category

Year Built	Lead Concentration				
	Undetectable Lead, And/Or No Deterioration	Detectable- 599 ppm and Some Deterioration	600-4999 ppm and Some Deterioration	5000 ppm or Above and Some Deterioration	**TOTAL**
Before 1940	10 27.8%	0	3 8.3%	23 63.9%	36 100%
1940-1959	36 53.7%	0	3 4.5%	28 41.8%	67 100%
1960-1979	35 79.6%	1 2.3%	2 4.6%	6 13.6%	44 100%
1980-1995	31 96.9%	0	1 3.1%	0	32 100%

N=179. At 21 schools, complete paint condition data were not available. Row percentages may not total 100% due to rounding. The paint sample with the highest lead content was used to represent each school. "Deteriorated Paint Environment" means that wall and/or trim paint in a room or on the exterior of a building from which a paint sample was taken was in "fair" or "poor" condition. A school can only be represented in one lead content category. Ppm=parts lead per million parts paint. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. "600 ppm" is limit for lead content in consumer paint, set by the Consumer Products Safety Commission in 1978. "5000 ppm" is the regulatory definition of "lead-based paint", and the level at which USEPA and HUD recommend paint be either abated or contained through interim measures.

California Lead Hazards in Schools Study, 1998

Schools built before 1960, and especially before 1940, were more likely to have the two conditions which can constitute a lead-based paint hazard: paint with a high lead content and paint in need of maintenance. This relationship was strong and highly significant (X2=65.81, df=12, p=<.001).

2. Application of Findings: Lead Content of Paint at California Public Elementary Schools

An estimated 77.7 percent of California's public elementary schools have paint with lead content that exceeds the USEPA/HUD action level of 5000 ppm, 91.6 percent have paint with lead content that exceeds the CPSC limit of 600 ppm, and 95.8 percent have paint that contains detectable levels of lead. The estimated number of schools with at least some lead-containing paint is presented in Table 6 and Figure 6. These population estimates were derived by weighting our stratified sample.

Table 6

Percent of All California Public Elementary Schools with Lead in Paint Above Regulatory Standards, Estimated from Study Findings (95% Confidence Intervals)

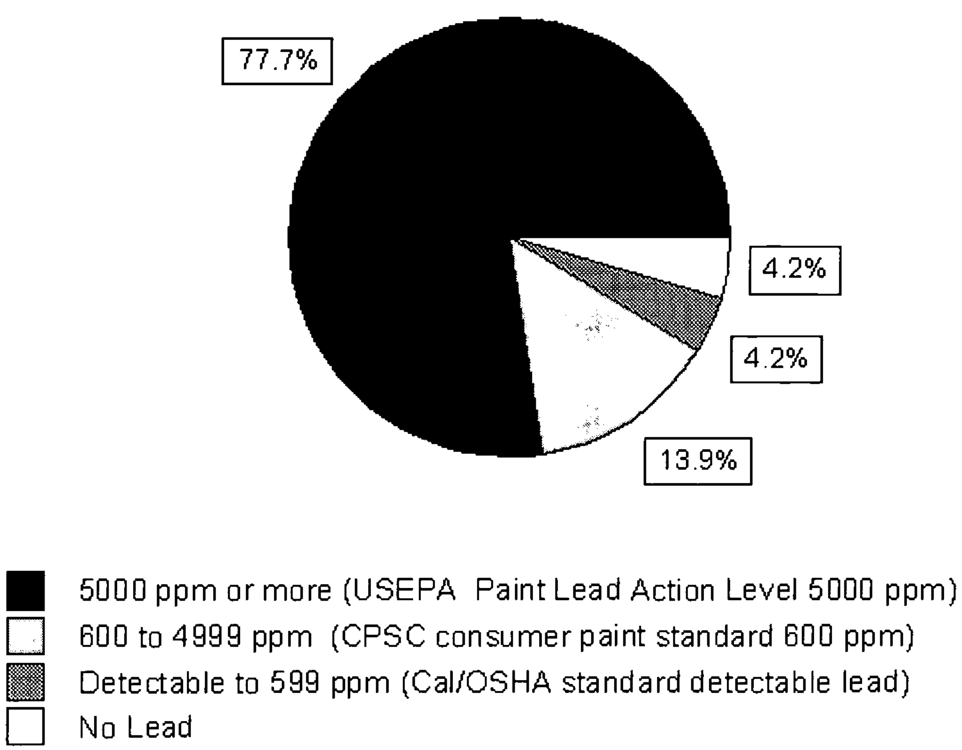
Lead Levels	Percent of Schools Estimated to Have Lead in Paint at Regulatory Levels (95% Confidence Intervals)	Number of Public Elementary Schools Estimated to Have Lead in Paint at Regulatory Levels
At or Above 5000 ppm	77.7% (73.2, 82.3)	3917 schools
At or Above 600 ppm	91.6% (89.7, 93.5)	4618 schools
Any Detectable Lead	95.8% (95.2, 96.3)	4829 schools

Based on a sample of 200 schools out of the 5041 public elementary schools in California at the time of the study. The paint sample with the highest lead content was used to represent each school. "Ppm"=parts lead per million parts paint. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. "600 ppm" is limit for lead content in consumer paint, set by the Consumer Products Safety Commission in 1978 "5000 ppm" is the regulatory definition of "lead-based paint", and the level at which USEPA and HUD recommend paint be either abated or contained through interim measures.

California Lead Hazards in Schools Study, 1998

FIGURE 6

Percent of All Public Elementary Schools with Lead in Paint Above Regulatory Standards, Estimated from Study Findings



Based on a sample of 200 schools out of the 5041 public elementary schools in California at the time of the study. "Ppm"=parts lead per million parts paint. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard. "600 ppm" is limit for lead content in consumer paint, set by the Consumer Products Safety Commission in 1978. "5000 ppm" is the regulatory definition of "lead-based paint", and the level at which

USEPA and HUD recommend paint be either abated or contained through interim measures.
California Lead Hazards in Schools Study, 1998

Lead-based paint (paint containing 5000 ppm or more lead) in California's elementary schools appears to be slightly more prevalent than in the nation's housing stock of similar age. The construction periods used in this report are comparable to the periods examined in a report on the lead content in housing that was published by HUD, A Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing: A Report to Congress (HUD, 1990b), (Table 7).

Table 7

Presence of Lead-based Paint in US Homes and Study Findings in California's Public Elementary Schools

	Lead Concentration	
Year Built	**HUD Study: Percent of Homes with Lead-based Paint (5000 ppm or greater)**	**Schools Study: Percent of Public Elementary Schools with Lead-based Paint (5000 ppm or greater)**
Before 1940	90%	94.6%
1940-1959	80%	91.5%
1960-1979	62%	70.4%

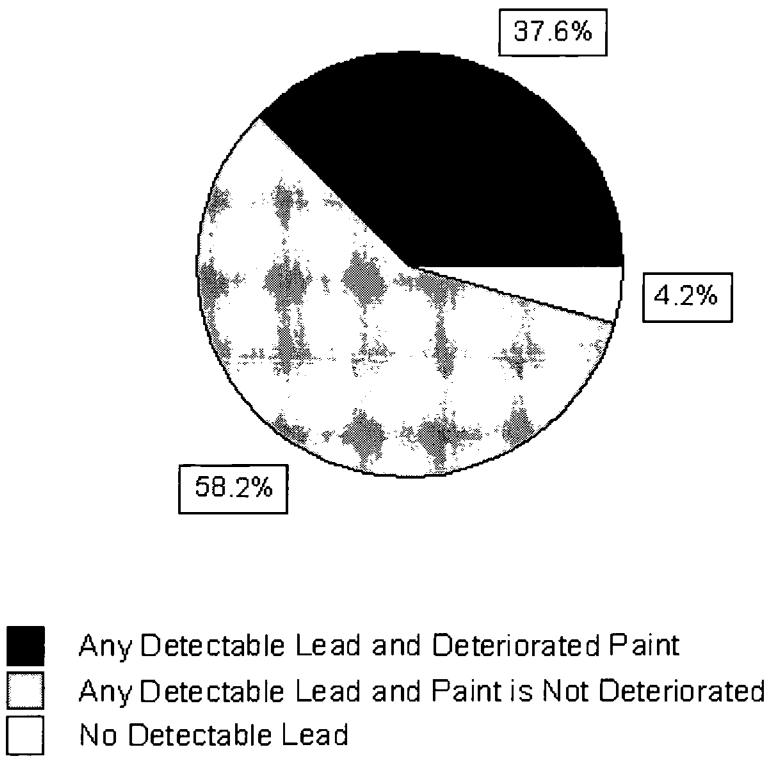
"5000 ppm" is the regulatory definition of "lead-based paint", and the level at which USEPA and HUD recommend paint be either abated or contained through interim measures. "Ppm"=parts lead per million parts paint. The paint sample with the highest lead content was used to represent each school in both studies.
California Lead Hazards in Schools Study, 1998 and HUD, "A Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing: A Report to Congress", 1990b

A study of housing stock in three California cities found lead-based paint (at or above 5000 ppm) at 71 percent of homes built before 1950 (Sutton et al., 1995).

An estimated 37.6 percent of California's public elementary schools are likely to have deteriorated lead-containing paint (Figure 7). This proportion is derived from a weighted sample analysis.

FIGURE 7

Estimated Percent of Public Elementary Schools with No Lead in Paint, Lead in Intact Paint, and Lead in Deteriorated Paint



Based on a sample of 179 schools out of the 5041 public elementary schools in California at the time of the study. At 21 schools, complete paint condition data were not available. "Deteriorated Paint Environment" means that wall and/or trim paint in a room or on the exterior of a building from which a paint sample was taken was in "fair" or "poor" condition. A school can only be represented in one lead content category. Ppm=parts lead per million parts paint. "Detectable lead" is the level of lead (in any product) at which Cal/OSHA requires worker protection under the Lead in Construction Standard.
California Lead Hazards in Schools Study, 1998

B. Soil

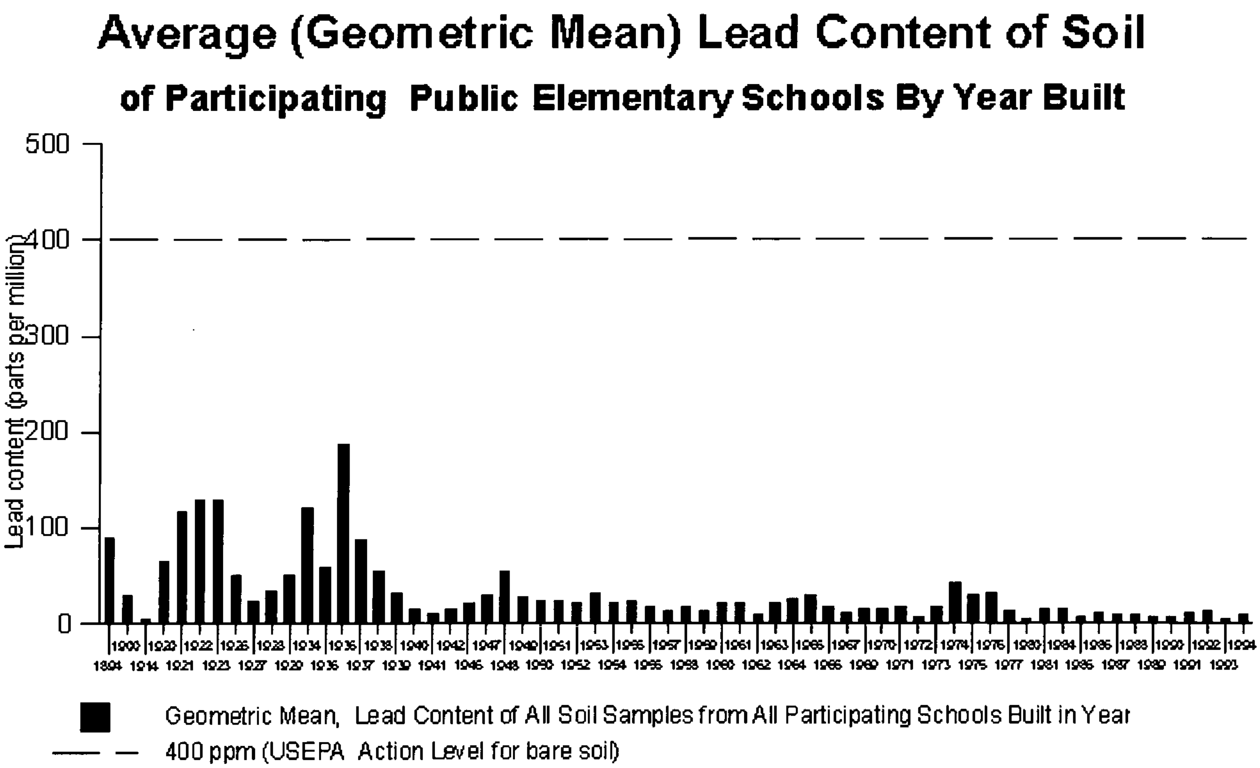
Soil lead concentrations ranged from non-detectable to a high of 6906 ppm. Descriptive statistics for soil lead levels are found in Appendix XII.

Soil lead levels were highest closer to school buildings. The geometric mean lead content of soil samples obtained within five feet of school buildings was 52.4 ppm, more than five times that of samples taken further away from buildings. Lead content of soil within five feet of buildings ranged from 2.4 ppm to 6906 ppm, compared to a range of non-detectable to 532 ppm for all other samples. At nineteen schools (9.5 percent) at least one soil sample within five feet of a building had a lead content of over 400 ppm. Only one school had a soil sample taken more than five feet from a structure with a lead content of over 400 ppm.

1. Building Age and Lead Content

The geometric mean lead level in soil samples for all years of construction fell below the USEPA action level of 400 ppm[4]. (Figure 8).

FIGURE 8



Data for each year includes data for all schools built in that year. Years within which no participating schools were built are not shown. Geometric mean is used to express the central tendency (average) of lead content in this report because it normalizes data such as this which is heavily skewed toward higher levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample. Ppm=parts lead per million parts soil. USEPA and HUD define lead-contaminated soil as bare soil containing lead at or above 400 ppm, especially in playgrounds and areas where children have contact wit the soil.
California Lead Hazards in Schools Study, 1998

Schools built before 1940 were more likely to have soil with a lead content at or above the USEPA recommended 400 ppm (Table 8). The relationship between year of construction and lead content was statistically significant (X2=73.5, df=6, p<.001).

Table 8

Number of Participating Schools with Lead in Soil Above Federal Guidelines By Year of Construction

Year Built	**Lead Concentration**			
	Not Detectable	Detectable- 399.99 ppm	400 ppm or Above (USEPA Guidelines)	**TOTAL**
Before 1940	0	26 70.3%	11 29.7%	37 100%
1940-1959	4	65 91.6%	2 2.8%	71 100%
1960-1979	5.6%	50 92.6%	1 1.8%	54 100%
1980-1995	15 39.5%	23 60.5%	0	38 100%

N=200. Row percentages may not total 100% due to rounding. The soil sample with the highest lead content was used to represent each school. A school is only represented in one lead content category. Ppm=parts lead per million parts soil. USEPA and HUD define lead-contaminated soil as bare soil containing lead at or above 400 ppm, especially in playgrounds and areas where children have contact with the soil.

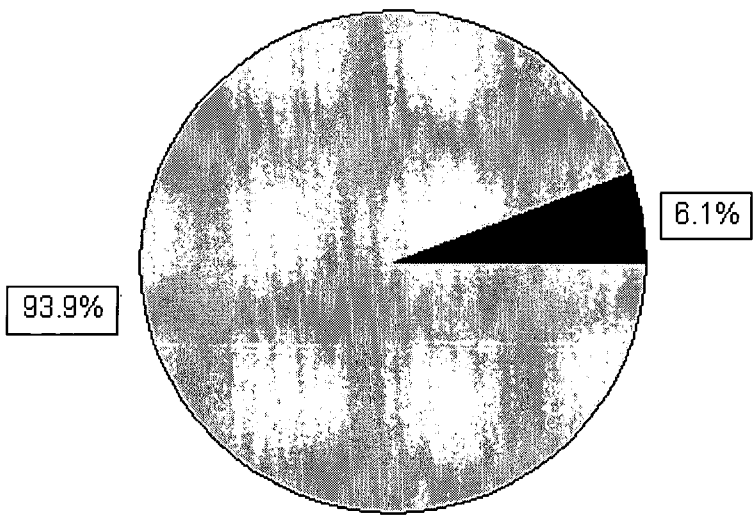
California Lead Hazards in Schools Study, 1998

3. Application of Findings: Lead Content of Soils at California Public Elementary Schools

An estimated 6.1 percent (307) of public elementary schools may have some soil that exceeds the USEPA recommended high of 400 ppm for areas in which children play. This estimate is derived from a weighted analysis of our stratified sample (Figure 9 and Table 9).

FIGURE 9

Percentage of All Public Elementary Schools with Lead in Soil Above Federal Guidelines, Estimated from Study Findings



Based on a sample of 200 schools out of the 5041 public elementary schools in California at the time of the study. "Ppm"=parts lead per million parts soil. USEPA and HUD define lead-contaminated soil as bare soil containing lead at or above 400 ppm, especially in playgrounds and areas where children have contact with the soil.
California Lead Hazards in Schools Study, 1998

Table 9

Percent of All California Public Elementary Schools with Lead in Soil above Regulatory Standards, Estimated from Study Findings (95% Confidence Intervals)

Lead Levels	Percent of Schools Estimated to Have Lead in Soil at Regulatory Levels (95% Confidence Intervals)	Number of Public Elementary Schools Estimated to Have Lead in Soil at Regulatory Levels
At or Above 400 ppm	6.1% (3.7%, 8.6%)	307
Any Detectable	92.6% (89.8%, 95.4%)	4668

Based on a sample of 200 schools out of the 5041 public elementary schools in California at the time of the study. The paint sample with the highest lead content was used to represent each school. "Ppm"=parts lead per million parts soil. USEPA and HUD define lead-contaminated soil as bare soil containing lead at or above 400 ppm, especially in playgrounds and areas where children have contact with the soil.
California Lead Hazards in Schools Study, 1998

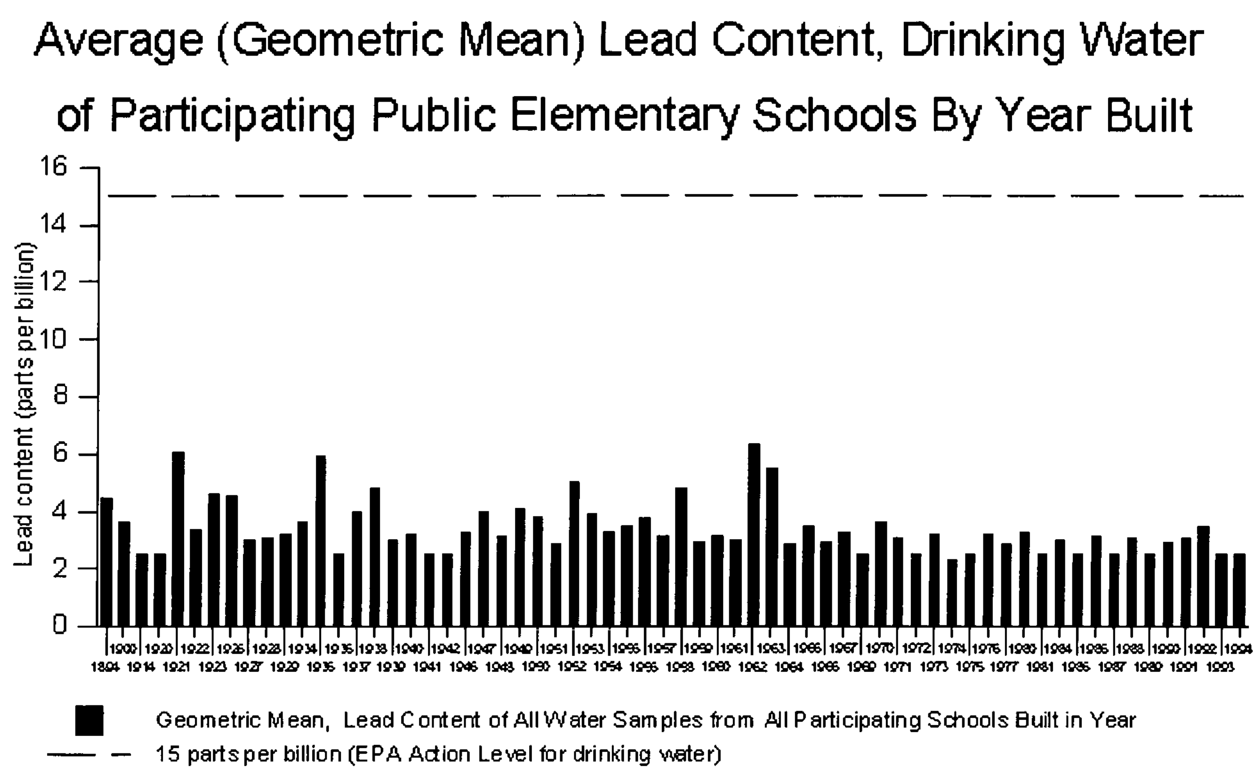
C. Water

Lead concentrations in water samples ranged from non-detectable levels to a high of 166 ppb. A table of descriptive statistics for lead levels in water can be found in Appendix XII.

1. Year of Construction

Average (geometric mean) lead levels were well below 15 ppb for all years tested. The highest geometric mean value (6.34 ppb) was calculated for schools built in 1963 (Figure 10).

FIGURE 10



Data for each year includes data for all schools built in that year. Years within which no participating schools were built are not shown. Geometric mean is used to express the central tendency (average) of lead content in this report because it normalizes data such as this which is heavily skewed toward higher levels. Had a simple arithmetic mean or median been used, the resulting value would have been much larger, thereby misrepresenting the average school or environmental sample. Ppm=parts lead per million parts soil. USEPA considers drinking water containing lead concentrations above 15 parts per billion (ppb) to be unsafe.
California Lead Hazards in Schools Study, 1998

Although the lead content of drinking water is highest in schools built before 1940 and lowest in schools built after 1980, the relationship was not statistically significant (X2=7.52, df=6, p>.05). Schools in all age categories contributed water samples with a lead content above the USEPA action level of 15 ppb. Table 10 presents the levels of lead in drinking water by age of school building for all participating schools.

Table 10

Number of Participating Schools with Lead in Drinking Water Above Regulatory Standards By Year of Construction

Year Built	Lead Concentration			
	Not Detectable	Detectable- 14 ppb	15 ppb or Above (USEPA Standard)	TOTAL
Before 1940	11 31.4%	13 37.1%	11 31.4%	35 100%
1940-1959	33 47.1%	26 37.1%	11 15.7%	70 100%
1960-1979	26 48.1%	19 35.2%	9 16.7%	54 100%
1980-1995	22 57.9%	11 28.9%	5 13.2%	38 100%

N = 197 schools. At three participating schools, drinking water was not available for sampling at the time data were obtained. Row percentages may not total 100% due to rounding. The water sample with the highest lead content was used to represent each school. A school is only represented in one lead content category. Ppb=parts lead per billion parts water. USEPA considers drinking water containing lead concentrations below 15 parts per billion (ppb) to be safe.

California Lead Hazards in Schools Study, 1998

2. First and Second Draw Water Samples

a. Lead Content of First Draw Water Samples

First draw samples (taken immediately upon opening the tap) had higher average lead levels than second draw samples (taken thirty seconds after opening the tap), with a geometric mean of 3.9 ppb and a range from non-detectable to 166 ppb (n=389 samples).

The likelihood of finding lead in first draw samples at both detectable and unsafe levels increased significantly when drinking water outlets (including fountains and spigots) were not used for 24 hours or more. Four percent of first draw samples taken from taps used within 24 hours of sampling had lead content above 15 ppb. Nearly twenty percent of samples from taps not used for 24 hours or longer contained lead above 15 ppb.

b. Lead Content of Second Draw Water Samples

For second draw samples, the geometric mean lead content was 2.9 ppb and samples ranged from non-detectable to to 63.6 (n=389 samples).

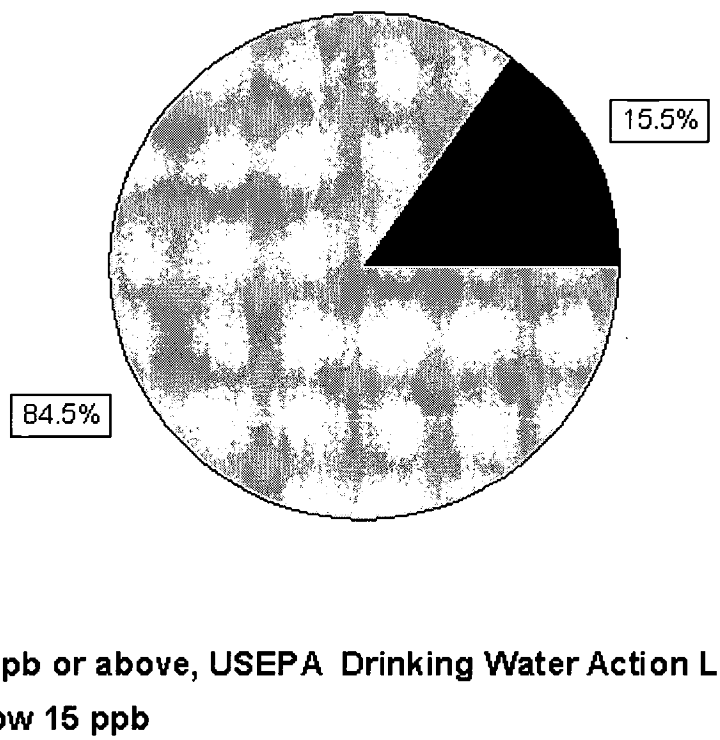
c. Comparison of First and Second Draw Lead Content

USEPA recommends flushing drinking water pipes by running water for at least 30 seconds to reduce lead content. To estimate flushing effects, a difference of means test was conducted on first and second draw sample pairs. Among samples which had a detectable level of lead upon first draw, lead levels decreased an average of 9.1 ppb upon second draw. This difference was statistically significant ($p<.05$).

Although flushing did not always decrease lead content to below the USEPA Action Level, the probability that flushing would increase lead content was slight. Of 389 pairs of samples, 21 pairs (5.4 percent) showed an increase in lead from first draw to second draw. Of the 34 total pairs with first draw samples at or above 15 ppb, 26 (76.5 percent) second draw samples were below that level. Six of 355 pairs (1.7 percent) with lead levels initially below 15 ppb were increased to more than 15 ppb after flushing. Figure 11 presents the distribution of schools with at least one first-draw sample at or above the USEPA action level of 15 ppb and Figure 12 displays schools with second draw samples above the action level. The number of schools above the USEPA limit on the second draw (13 schools) was less than half the number of schools above the USEPA limit on the first draw (31 schools).

FIGURE 11

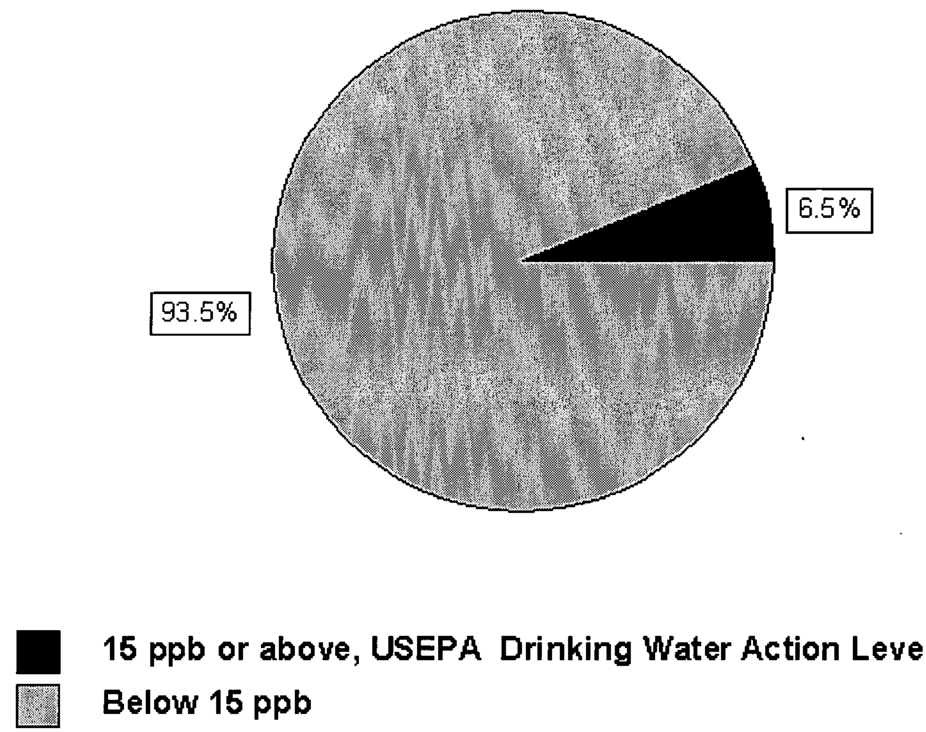
Percent Participating Public Elementary Schools With Lead In Drinking Water Above Regulatory Standards - 1st Draw



N= 197 schools. At three participating schools, drinking water was not available for sampling at the time data were obtained. The water sample with the highest lead content was used to represent each school. First draw samples were collected immediately upon opening the tap. Ppb=parts lead per billion parts water. USEPA considers drinking water containing lead concentrations below 15 parts per billion (ppb) to be safe.
California Lead Hazards in Schools Study, 1998

FIGURE 12

Percent Participating Public Elementary Schools With Lead In Drinking Water Above Regulatory Standards - 2nd Draw



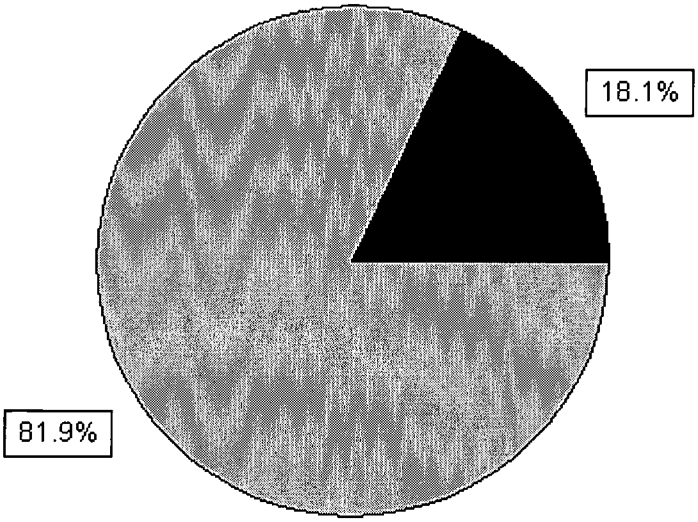
N= 197 schools. At three participating schools, drinking water was not available for sampling at the time data were obtained. The water sample with the highest lead content was used to represent each school. Second draw samples were collected 30 seconds after opening the tap. Ppb=parts lead per billion parts water. USEPA considers drinking water containing lead concentrations below 15 parts per billion (ppb) to be safe.
California Lead Hazards in Schools Study, 1998

4. Application of Findings: Lead Content in Drinking Water at All California Public Elementary Schools

Weighted sample analysis indicates that 18.1 percent of schools (912 schools) may have some water outlets with lead content that exceeds the USEPA Action Level (Figure 13). Water outlets that have been used within 24 hours are less likely to contain lead at or above the USEPA Action Level. Weighted sample analysis indicates that 10.5 percent of schools (529 schools) may have outlets in daily use (used within the past 24 hours) with lead content that exceeds the USEPA Action Level. Table 11 presents estimated prevalence of schools with lead in drinking water and confidence intervals at the 95 percent level of confidence.

FIGURE 13

Percent All Public Elementary Schools with Lead in Drinking Water Above Regulatory Standards, Estimated from Study Findings



15 ppb or above, USEPA Drinking Water Action Level
Below 15 ppb

Based on a sample of 197 schools out of the 5041 public elementary schools in California at the time of the study. At three participating schools, drinking water was not available for sampling at the time data were obtained. The water sample with the highest lead content was used to represent each school. Ppb=parts lead per billion parts water. USEPA considers drinking water containing lead concentrations below 15 parts per billion (ppb) to be safe.

California Lead Hazards in Schools Study, 1998

Table 11

Percent of All California Public Elementary Schools with Lead in Drinking Water Above Regulatory Standards, Estimated from Study Findings (95% Confidence Intervals)

Lead Levels	**Estimated Percent of Schools, All Water Outlets**	**Estimated Number of Schools, All Water Outlets**	**Estimated Percent of Schools, Water Outlets in Daily Use**	**Estimated Number of Schools, Water Outlets in Daily Use**
At or Above 15 ppb	18.1% (13.3, 22.9)	912 schools	10.5% (5.7, 15.4)	529 schools
Any Detectable	53.9% (47.7, 60.2)	2717 schools	42% (33.7, 50.3)	2117 schools

Based on a sample of 197 schools out of the 5041 public elementary schools in California at the time of the study. At three participating schools, drinking water was not available for sampling at the time data were obtained. The water sample with the highest lead content was used to represent each school. "Daily use" means tested water outlet had been used within 24 hours of

sampling. Ppb=parts lead per billion parts water. USEPA considers drinking water containing lead concentrations above 15 parts per billion (ppb) to be unsafe.
California Lead Hazards in Schools Study, 1998

D. Current Practices

1. Safe and Unsafe Maintenance Practices

Guidelines published by federal agencies and other organizations consistently recommend a number of "safe" maintenance practices for managing lead-containing paint, including: maintaining painted surfaces in good condition, containing the work area with tarpaulins or plastic, wet cleaning after a painted surface has been disturbed, misting surfaces before sanding or scraping, and using a HEPA vacuum to clean up when a job is finished. Additionally, guidelines recommend avoidance of other practices, including dry sanding and scraping of a painted surface, use of open flame burning to remove old paint, and power sanding without use of a HEPA vacuum containment system.

Only 14 percent of respondents reported that they prioritize paint maintenance in areas frequented by kindergarten and pre-kindergarten aged children. Fifty-three percent reported that their schools put down a tarpaulin as a standard practice when painted surfaces are sanded or scraped. Less than half (49 percent) said they wet mop and wipe surfaces to control dust after a job is completed as a standard practice. Fifty-five percent of respondents said their districts never use a HEPA vacuum during clean-up.

Use of unsafe practices follows a similar pattern. Eighty-four percent of respondents reported occasional dry scraping to remove paint. Twelve percent reported occasional use of the extremely dangerous practice of open flame burning to remove paint. Sixty-one percent reported occasional power sanding of painted surfaces without a HEPA attachment.

2. Lead Paint Hazard Awareness

Eleven percent of respondents reported that their schools had any kind of a lead hazard control program in place. Thirty-eight percent said they were not familiar with the Cal/OSHA Lead in Construction Standard. Seventeen percent reported that they have attended a DHS-accredited lead-related construction training course, and an additional five percent reported that they attended any training course that discussed lead paint hazards; fifty-two percent reported that none of their maintenance staff had been trained in lead-safe work practices and hazard control.

Sixty-four percent of respondents reported that they believe that lead hazards in schools are either a very significant or somewhat significant problem, and sixty-three percent believed their districts should do more to control lead hazards. When asked about factors limiting their district's lead hazard control activities, seventy percent reported that they felt insufficient funding was a "somewhat or very significant" factor, and seventy-seven percent felt that insufficient information about lead hazard control practices was a "somewhat or very significant factor. Finally, seventy-four percent thought that training in how to practice lead-safe maintenance and operations activities would be "extremely useful" for their district.

E. Summary of Findings

1. Paint

Paint meeting USEPA's definition of lead based paint (5000 ppm) is estimated to be present in 2917 schools (77.7 percent). Lead concentrations which require worker protection under Cal/OSHA regulations (any detectable level) are likely to be found at an estimated 95.8 percent (4829 schools) of California elementary schools. The lead content of paint is significantly and inversely related to school age. Only one paint sample (taken from an interior door) above 5000 ppm was found at any school built after passage of the CPSC limit in 1978. No samples above the CPSC limit of 600 were found at any school built after the 1992 enactment of the LSSPA. On surfaces where paint deterioration was observed, less than 37 percent of sampled schools had any lead-containing paint. Exterior trim paint tended to have the highest average lead content, followed by (in descending order of lead content) interior trim, interior wall and exterior wall paint.

2. Soil

Characterizing soils at any location requires a more detailed sampling protocol than this study could employ, and state-wide applications of study results are limited: soils that contain lead at or above the USEPA reference value of 400 ppm are likely to be located close to school buildings and more likely to occur at schools built before 1940.

3. Water

An estimated 18.1 percent of all California schools have lead in drinking water at or above the 15 ppb USEPA action level while lead exceeding the federal action level was found at 10.5% of schools where the sampled outlet had been used within 24 hours of testing. Schools in all age categories contributed samples above 15 ppb.

4. Maintenance and Operations

Facilities managers had a relatively poor understanding of lead hazard control techniques for maintenance of surfaces covered with lead-containing paint, and this was reflected in reported frequency of unsafe practices. Respondents felt that sufficient funding and training would be key to implementing those safe practices and would like more information about lead-safe work practices.

[2] The USEPA action level applies to bare soil which is accessible to children.

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V. CONCLUSIONS

A. Lead in Paint

1. As is the case with housing in California and across the nation, lead containing paint is present in most California public elementary schools and child care facilities. With proper training, resources, and support, it can be managed safely as part of standard maintenance and operations practices.

Lead in paint at schools was found at about the same frequency as has been found in California homes of similar age. Most California elementary schools contain paint with a lead content that is above federal action levels, and in one-third of these schools lead-containing paint is deteriorated and poses a potential hazard to children. Age of building is a major but incomplete predictor of the lead content of paint. By identifying deteriorated paint that contains lead and employing lead-safe work practices, schools can reduce the hazards that exist now, and can reduce the probability that new hazards will develop in the future. Most maintenance and operations and facilities managers are open to training, and to instituting lead-safe work practice programs.

2. If lead-safe work practices are instituted and continued over time, they are safer, more efficient, and more cost effective than wholesale removal of lead containing paint.

The presence of lead in paint does not in and of itself constitute a lead hazard. Hazards to children are produced when the paint is allowed to deteriorate, when it is mishandled during routine maintenance and operations activities, or when it is removed by untrained individuals using unsafe removal techniques. Removing lead-containing paint incorrectly can actually increase the risk of exposure to children. Management in place is the safest alternative.

B. Lead in Soil

The lead content of bare soil may be elevated if the soil is close to painted exterior walls. Simple steps can eliminate potential exposure hazards.

Six percent of California public elementary schools have bare soils with lead levels that exceed the USEPA recommended level for bare soil areas where children play. Since these soils tend to be located near painted exterior building walls, limiting access to these areas or permanently covering them will prevent exposure to children.

C. Lead in Drinking Water

Lead may be present in drinking water in about eighteen percent of California public elementary schools and child care facilities. A testing, remediation and replacement program will identify and eliminate this potential source of exposure.

Lead above federal action levels may be present in drinking water at as many as 18.1% of California's public elementary schools and child care centers, while water exceeding the federal action level for lead content was found at 10.5% of schools where the sampled outlet had been used within 24 hours of testing.

USEPA currently recommends flushing drinking water outlets where lead contamination is found by running them for a minimum of 30 seconds prior to use. If flushing does not reduce lead content to below the action level of 15 ppb, USEPA recommends removing the outlet from service immediately until lead contamination is reduced to below the action level. In this study, a 30-second flush reduced lead content to below the action level in 76.5% of cases where a first draw sample was above the action level. There are multiple potential sources of lead contamination within a school's drinking water supply and plumbing system. As a result, in this study age of plumbing predicted lead content of water under most, but not all, circumstances. A drinking water testing program, implementation of flushing procedures and the use of alternative drinking water outlets where flushing is not effective can eliminate this potential hazard until lead sources are permanently removed. Many of the 200 schools contacted for this study had already begun such a program.

The USEPA standard of 15 ppb has a safety factor built into it. Thus it is very unlikely that a child who drinks tap water with the exceedances which were found in this study would develop significantly elevated blood lead levels from this source alone.

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VI. DEPARTMENT OF HEALTH SERVICES ACTION PLAN

DHS has created a multi-year action plan to address the potential lead hazards in public elementary schools and child care facilities that have been identified in this study.

A. California Lead-safe Schools Program

The Department of Health Services will develop, implement, and support a California Lead-Safe Schools Program (LSSP) to promote safe and cost-effective lead-safe work practices among Local Education Agencies (LEA). The program will concentrate on lead-based paint maintenance practices that will decrease childhood exposures to lead. It will include the following key elements:

- Voluntary lead-safe work practice guidelines for schools;
- Identification of high risk tasks and occupational groups;
- Training programs aimed at reducing exposure risks to children and staff;
- A time-limited technical assistance and support program and;
- Evaluation.

Each program component is discussed below:

Component 1: Voluntary Lead-safe Work Practice Guidelines For Schools

Building on the experience of two excellent California programs for lead-safe work practices in public schools (Los Angeles Unified School District and the Self-Insured Schools of California), the Child Care Lead Poisoning Prevention Project, and the US USEPA Tools for Schools project, a uniform set of voluntary guidelines for lead awareness and safe work practices will be developed and distributed to all districts throughout the State. An important adjunct will be multi-language, culturally sensitive materials for communicating with public, parents, staff, and teachers.

Component 2: High Risk Tasks And Occupational Groups

A variety of tasks are required to operate and maintain public school facilities, and many of the tasks can increase children's risk of exposure to lead. Large schools and complex districts may have a variety of occupational groups performing these tasks, such as custodians, maintenance workers, painters, carpenters, and others, while small districts may employ a single individual. Identifying high risk work by both task and occupation will allow local school districts to craft programs that meet their specific needs and circumstances. Working with LEAs and local schools facilities experts, DHS will survey public school operations and maintenance tasks for their potential to increase the risk of childhood exposures and examine job classifications that are likely to perform these tasks. High risk tasks (such as deferred maintenance on deteriorated older painted surfaces) and occupational classifications will be identified and used to develop task- and occupation-specific lead-safe training guidance.

Component 3: Training Programs

Once high risk tasks have been identified, training programs will be tailored to address lead-safe work practices within the context of local training needs. Two kinds of training programs will be developed: 1) task- and occupation-specific training that can be offered by the LEA to its own operations and maintenance staff, and 2) a "train the trainer" component that will teach LEA representatives how to provide the task- and occupation-specific training program, including how to modify the program to local needs. DHS will provide "train the trainer" training free of charge to all LEAs. Each two-day session will provide intensive hands-on training for six to ten individuals who will then become the lead-safe work practices trainer for an LEA. Training materials and training programs have been developed by a variety of agencies and organizations, including a course for residential maintenance workers developed for HUD and USEPA by the National Environmental Training Association (NETA), a course for painters (DHS Occupational Lead Poisoning Prevention Program), and a lead awareness course for child care facilities operators (The Child Care Lead Poisoning Prevention Project, co-sponsored by DHS and the California Child Care Health Program). Sources for these training courses are attached in Appendix XIX. To conserve costs, DHS will employ existing training materials whenever they fit California's public school needs for lead-safe training.

Component 4: Technical Assistance And Support Program

Although lead-safe work practices and activities are not complex, LEAs will require significant technical assistance and support over a period of several years. During this time, DHS will provide on-site and telephone consultation to LEAs, parents, and the public.

Component 5: Evaluation

Finally, the program will include an evaluation component that will examine the extent to which voluntary programs have been instituted in local schools, and the effectiveness of such programs in reducing and eliminating lead hazards in public elementary schools and child care facilities. A report will be prepared and distributed to CDE and the Legislature.

B. Timeline

DHS will develop and implement the Lead-safe Schools Program over a period of four years. In year one, the following activities will take place: development of guidelines, identification of high risks tasks and occupations, evaluation of existing training courses, development and evaluation of new courses (or modifications of existing ones), field tests of training courses and the "train the trainer" program, publishing training materials, and technical assistance. Years two and three will focus on conducting "train the trainer" sessions with LEAs and providing technical assistance. During the final year of the project, DHS will continue to offer "train the trainer" programs and technical assistance, evaluate program performance, and report to CDE and the Legislature.

Work will begin in July, 1998. A timeline is attached as Appendix XIII. Additionally, during the current fiscal year DHS will provide technical support to interested LEAs.

VII. RECOMMENDATIONS

These recommendations are designed specifically to address the needs of public elementary schools and child care facilities that are located on public elementary school grounds. They incorporate existing lead-safe procedures considered by HUD and USEPA to be the "best practices" in the construction and maintenance industries. (See Section II, E of this report for an overview of these practices.) Their utility is not limited to schools: they may be applicable in other settings where young children are present on a regular basis.

A. Evaluate the lead content of school drinking water at the outlet following current USEPA protocols, at schools that have not already done so.

There is no sure way to know the lead content of school drinking water except by evaluating drinking water outlets for lead. USEPA has issued a document which provides guidance for evaluating lead content of drinking water in schools (Appendix VIII). Schools should adhere to these guidelines when conducting evaluations. If a school finds lead exceeding the USEPA action level of 15 ppb in the first draw water sample, the guidelines recommend evaluating a second, fully flushed water sample. If the second sample does not exceed the USEPA action level, that outlet should be flushed thoroughly each day before use, following USEPA flushing guidelines, until a plan for remediation of lead contamination can be implemented. If both samples from any outlet exceed the action level, LEAs should make that outlet inoperable and supply alternative sources of drinking water until a plan for remediation of lead contamination can be implemented. In general, USEPA guidelines recommend that schools evaluate drinking water for lead during the active school year, rather than during a period when water may have been stagnant for a long period of time. Water samples should be collected using standard USEPA sampling techniques and should be analyzed only by laboratories that are certified by the Department of Health Services Environmental Laboratory Accreditation Program. A list of approved laboratories are attached as Appendix XIV.

B. Prioritize deferred maintenance activities to classrooms that house the most vulnerable children.

Deteriorated paint that contains lead presents the greatest opportunity for exposing young children to lead hazards. The most vulnerable children in public schools settings are those in pre-kindergarten through grade 2, and those with developmental disabilities. Targeting their classrooms is the surest way to reduce opportunities for exposure to lead-but only if the deferred maintenance activities are conducted when children are not present and if the work area is thoroughly cleaned afterwards. In the absence of guidelines, a simple dust wipe test can be performed to assure that any lead contamination has been removed. The dust wipe should be collected using recognized procedures, and should be analyzed only by a laboratories that meet USEPA standards for conducting analysis of environmental samples. Dust wipe collection methods are attached in Appendix XVII and a list of laboratories approved to analyze dust, paint and soil samples for lead are attached as Appendix XVI.

C. Assume that surfaces painted prior to 1992 contain lead and use lead-safe work practices.

Almost all California schools have lead on surfaces painted prior to the LSSPA of 1992. It is prudent to assume that disturbing these painted surfaces may create lead hazards. Lead-safe work practices minimize the production of lead dust and paint chips, minimize contamination of the environment, and keep children away from potentially contaminated work areas. These practices are briefly described in Appendix XVIII.•tc "Almost all California schools have lead on surfaces painted prior to the LSSPA of 1992. It is prudent to assume that disturbing these painted surfaces may create lead hazards. Lead-safe work practices minimize the production of lead dust and paint chips, minimize contamination of the environment, and keep children away from potentially contaminated work areas. These practices are briefly described in Appendix XVIII.

D. Assure that workers are properly trained.

Between the time of the release of this report and the time when DHS can issue standardized voluntary safe work practices guidelines, LEAs should use existing guidance and materials to assure that workers who may disturb lead in paint are identified, trained, and (if necessary) DHS-Certified. OLPPP has prepared a set of training handouts entitled, "Lead Safety for Construction Workers", and a guide for painters, *Painting Contractor's Guide to Lead Safety*. Los Angeles Unified School District and the Self-Insured Schools of California have designed programs that specifically address situations in public schools. Additionally, Chapters 4 ("Lead-Based Paint and Housing Renovation") and 17 ("Routine building Maintenance and Lead-Based Paint") of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* (HUD, 1995) contain information that is directly applicable to public school settings.

A training curriculum for maintenance workers is available from the National Environmental Training Association (NETA), and OLPPP has developed a course for painters (DHS Occupational Lead Poisoning Prevention Program). The Child Care Lead Poisoning Prevention Project has a general lead awareness curriculum for child care facilities, and the USEPA *Tools for Schools* project may also be helpful.

Appendix XIX describes how to obtain these resources.

E. Use the expertise of DHS Certified Lead-Related Construction personnel.

The Lead-safe Schools Protection Act of 1992 requires that LEAs use DHS Certified Lead-Related Construction personnel for abating lead hazards. DHS interprets this to mean that inspections before work is done must be conducted by certified Inspector/Assessors, who must also conduct follow up inspections to assure that the work area has been cleaned to existing standards, while the actual work must be conducted by certified Workers who are supervised by a certified Supervisor. LEAs may choose to train and certify their own employees, or they may choose to obtain the services of private consultants.

The only Lead-Related Construction professional categories that meet this standard are: Inspector/Assessor, Supervisor, Worker, Project Monitor, and Project Designer. They must be certified by the Department of Health Services, Childhood Lead Poisoning Prevention Branch. Each Lead-Related Construction professional who is properly certified has received a photo identification card from the Department of Health Services. The identification card lists the categories in which the individual is certified, along with expiration dates. *This DHS Lead-Related Construction identification card is the only proof of certification that public schools or the public at large should accept.* **A paper "certificate" issued by a training program is NOT a DHS Lead-Related Construction Certificate and should not be accepted in place of the identification card. Always verify certification.** DHS maintains an Internet site that lists individuals who are DHS Certified in Lead Related Construction. It is updated weekly. This site also provides lists of DHS Accredited training providers who offer the specialized training that is a necessary requirement for certification.

F. Comply with State and federal mandates for worker health and safety

Practices that protect the health and safety of lead workers are also helpful in protecting children from exposure to lead hazards. State and federal mandates are described in Section II of this report.

G. Fence off or cover bare soils adjacent to painted exterior walls of buildings constructed prior to 1940.

USEPA recommends that children not be exposed to soils that have a lead content of 400 ppm or higher. In this study, only soils immediately adjacent to painted exterior walls of older buildings were found to contain lead at levels that exceeded the USEPA recommendations for areas of bare soil in which children play. Schools should assume lead is present within five feet of older buildings and implement interim measures. Interim measures include using dense plantings or fencing to restrict children's access to these areas. Soils adjacent to painted exterior walls are not appropriate to use for` children's demonstration gardens, rainbow gardens, or other educational activities. These areas should never be used as children's play areas.

Soil testing is recommended only when children cannot be protected from areas with bare soil adjacent to the painted walls of older buildings. However, soil testing strategies are complex and are best conducted by a DHS Certified Inspector/Assessor.

H. Adopt and support the voluntary Lead-safe Schools Program.

The DHS Lead-safe Schools Program will protect children and staff, prevent costly and unnecessary over spending, bring schools and school districts into compliance with current lead regulations, increase lead awareness and knowledge among parents, teachers and staff, and demonstrate to the public that hazards are being addressed. Program activities should be fully integrated into daily practices so that they become a standard part of regular work activities.

California Department of Health Services

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