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Field Demonstration of Lead-Based Paint Removal and Inorganic Stabilization Technologies

by

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Disclaimer

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Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threatens human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

Abstract

Today the most widespread source of lead exposure in the environment of U.S. children is lead-based paint that was applied to residential buildings before 1978. Exposure to lead in paint can come from the paint chips themselves, from dust caused by abrasion on friction surfaces, or from chalking of exterior paint. A study was conducted to demonstrate the effectiveness of a wet abrasive blasting technology to remove lead-based paint from exterior wood siding and brick substrates, and the effectiveness of two Best Demonstrated Available Technologies (BDAT) to stabilize the resultant blasting media (coal slag and mineral sand) paint debris to reduce the leachable lead content. The average lead loading of the paint coating on the wood and brick substrates was 6.9 and 51.9 mg/cm^2, respectively. The effectiveness of the lead-based paint removal technology was determined using an X-ray fluorescence (XRF) spectrum analyzer (L&K shell). The XRF measurements were corroborated by analysis of substrate samples using inductively-coupled plasma atomic emission spectroscopy (ICP-AES). The effectiveness of the technologies to stabilize the debris was evaluated through the Toxicity Characteristic Leaching Procedure (TCLP). Aerodynamic particle size distributions of lead particulate generated during paint removal were measured using a multi-stage personal cascade impactor. Personal and area air samples were collected to evaluate the potential of the wet abrasive blasting technology to generate exposure levels of lead above the OSHA Permissible Exposure Limit (PEL) of 50 $\mu g/m^3$, 8 hour time-weighted average.

Wet abrasive blasting effectively removed the lead-based paint coating from both the wood and brick substrates to below the U.S. Department of Housing and Urban Development Guideline (1 mg/cm^2) with minimal or no damage to the underlying substrates ($p<0.0001$). The mean area air levels of lead-containing particulate generated during paint removal were significantly below the PEL ($p<0.001$), whereas the mean personal breathing zone lead levels were approximately three times higher than the PEL. Neither of the two stabilization technologies consistently stabilized the abrasive media paint debris to achieve a leachable lead content below the RCRA regulatory threshold (< 5 mg/L).

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We also acknowledge the suppliers of the technologies including Keizer Technologies of Americas, Inc. for providing the Torbo® Wet Abrasive Blasting System; TDJ Group, Inc. for providing the Blastox® abrasive additive; and NexTec, Inc., for providing the PreTox 2000 Fast Dry surface preparation coating lead-stabilizer.

This document was written by John R. Kominsky, CIH, CSP, CHMM of Environmental Quality Management, Inc. The abatement technology cost analysis was prepared by Vincent F. Hock and Susan A. Drozdz of USACERL. The laboratory control sample charts were prepared by Chris Gibson of DataChem Laboratories.

Chapter 1
Introduction

Background

Today the most widespread source of lead exposure in the environment of U.S. children is lead-based paint that was applied to residential buildings before the 1978 ban on residential leaded paint by the Consumer Product Safety Commission. Lead was a major ingredient in most interior and exterior oil paints prior to 1960, with some paints containing as much as 50 percent lead in dry weight. Lead was widely used as pigment because its different forms could produce a wide variety of colors, and it improved the physical properties of the paint. Exposure to lead in paint can come from the paint chips themselves, from dust caused by abrasion of paint on friction surfaces, or from chalking of exterior paint. The U.S. Department of Housing and Urban Development (HUD) estimates that 83 percent of pre-1980 residential housing structures contain some lead-based paint.[1] The likelihood, extent, and concentration of lead-based paint vary with the age of the building.

The Lead-Based Paint Poisoning Prevention Act of 1971, as amended by the Housing and Community Development Act of 1987, established 1.0 milligram of lead per square centimeter of surface area (mg/cm^2) as the federal threshold requiring abatement of lead-based paint on architectural components in public and Indian housing developments nationwide. The Residential Lead-Based Paint Hazard Reduction Act of 1992 (commonly referred to as "Title X") mandated the evaluation and reduction of lead-based paint hazards in the nation's existing housing. Title X also established 0.5 percent lead by weight as an alternative to the 1.0 mg/cm^2 threshold. An U.S. Environmental Protection Agency (EPA) study[2] found that a level of 1.0 mg/cm^2 was roughly equivalent to 1.0 percent by weight and a level of 0.5 percent by weight was roughly equivalent to 0.5 mg/cm^2.

The management of wastes generated from lead-based paint abatement activities are governed by the Resource Conservation and Recovery Act (RCRA) of 1976 and provisions contained in 40 CFR Parts 260-268. RCRA classifies any waste that leaches 5 milligrams per liter (mg/L) of lead or more (as determined by a Toxicity Characteristic Leaching Procedure[3]) a hazardous waste. The leachability of lead is affected by various factors, including speciation of the metal, pH of the leachate, particle size, acid flux through the waste, and time of contact with the leachant. The U.S. Environmental Protection Agency (EPA) has promulgated a list of Best Demonstrated

Available Technologies (BDAT) for the inorganic stabilization of hazardous wastes including lead-containing wastes.[4] Stabilization includes those techniques that limit the solubility of hazardous constituents in the waste.[4] Much of the inorganic stabilization that occurs in the United States is based on the chemistry of lime or ordinary Portland cement.

EPA is sponsoring a program aimed toward the reduction of lead emissions in the environment from demolition and renovation projects in commercial buildings, nonindustrial structures, and residential dwellings. As part of this program, the U.S. Army Construction Engineering Research Laboratories (USACERL) and EPA's National Risk Management Research Laboratory (NRMRL) conducted this study to evaluate a paint removal technology combined with two lead-based paint waste stabilization technologies.

Objective

The overall objective of this study was to demonstrate the effectiveness of a wet abrasive blasting technology combined with an inorganic-based stabilization technology to remove lead-based paint from exterior substrates (wood and brick) and to generate a non-hazardous waste for disposal. The specific objectives of this study are:

- Evaluate the effectiveness of wet abrasive blasting (Torbo®) with an abrasive lead-stabilizer additive (Blastox®) and wet abrasive blasting (Torbo®) on a surface preparation coating lead-stabilizer (PreTox 2000 Fast Dry) to remove lead-based paint from exterior brick and wood substrates to achieve a lead loading (i.e., mass of lead in a given surface area on the substrate) of <1 mg/cm^2.

- Evaluate the effectiveness of an abrasive additive (Blastox®) and surface preparation coating (PreTox 2000 Fast Dry) to stabilize the lead in paint abrasive media waste to reduce the leachable lead to below the RCRA regulatory threshold of 5 mg/L.

- Evaluate the potential for each technology combination (e.g., Torbo® with Blastox®) to generate airborne lead particulate levels in excess of the Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL) of 50 μg/m^3, 8-hour time-weighted average (TWA).

- Develop estimates of the cost of lead-based paint removal and disposal using these technologies.

Chapter 2
Conclusions and Recommendations

Conclusions

1. Wet abrasive blasting effectively removed the lead-based paint from both exterior wood siding and brick masonry with minimal or no damage to the underlying substrates (only light sanding of the wood was required prior to painting or tuck pointing of the mortar joints). The residual lead levels were significantly below the HUD Guideline of 1 mg/cm^2 ($p<0.0001$). The average paint removal rates were 76.4 and 119.8 ft^2/hr on wood and brick, respectively.

2. The lead concentrations determined by ICP-AES analysis and determined by XRF measurements before paint removal on wood were not significantly different ($p=0.1055$); however, these determinations before paint removal on brick were significantly different ($p=0.0001$). The lead concentrations determined by ICP-AES analysis and determined by XRF measurements after paint removal on wood were significantly different ($p=0.0331$); however, these determinations after paint removal on brick were not significantly different ($p=0.5504$).

3. The wet abrasive slurry-mixture appears to reduce the fugitive emissions of lead-containing particulate, which serves to enhance the level of environmental protection as well as worker health and safety. The mean area air levels of lead-containing particulate generated during paint removal were significantly below the OSHA PEL of 50 $\mu g/m^3$ ($p<0.001$), whereas the mean personal breathing zone levels of lead were approximately three times higher than the PEL. The personal breathing zone levels of lead did not vary significantly with substrate ($p=0.6396$); the area samples showed higher levels of lead during removal of paint from brick than for paint removal from wood ($p=0.0463$).

4. Neither of the two stabilization technologies (Blastox® and PreTox 2000) consistently stabilized the abrasive media lead-based paint waste to reduce the leachable lead content. The 80 percent upper confidence interval for the mean leachable lead concentration in the debris consistently exceeded the RCRA regulatory threshold (5 mg/L). Failure of the technologies to stabilize the lead most likely was due to an inadequate chemical stabilizer-abrasive blend ratio or

insufficient application mil thickness of the pre-paint removal coating treatment in the case of Blastox® and PreTox 2000, respectively.

Recommendations

1. Although wet abrasive blasting reduces fugitive emissions of lead-containing particulate generated during removal of paint film from exterior wood or brick masonry, it should be conducted in at least a Class 4 Containment System as specified in SSPC Guide 6, "*Guide for Containing Debris Generated During Paint Removal Operations.*"[3] Air monitoring should be conducted at the perimeter work area to determine the extent that lead-containing particulate are escaping from the work area.

2. To maximize the performance of these technologies the user should understand the various factors that may affect the effectiveness of the product to reduce the leachable lead content of the debris. Included are paint film lead content, paint film thickness, paint film condition, type of substrate (e.g., wood, brick, metal), variant particle size, and other potentially significant factors.

   PreTox 2000–The user of this technology should follow the application optimization procedure specified in the technical guidance provided by the manufacturer. This will ensure that the optimum mil thickness application rate of PreTox 2000 is applied to the lead-based paint coating to be abated.

   Blastox®–Subsequent to completing this study, the manufacturer of Blastox® revised their technical guidance regarding the proper blend ratios of abrasive to chemical-stabilizer. The user of this technology should verify that the blend ratio provided by the material supplier is consistent with the recommended blend ratio for a given lead-based paint coating to be abated.

3. Due to the inability of these technologies to consistently reduce the leachable lead content in the abrasive media paint debris during this demonstration, all debris should be tested by TCLP prior to disposal. The sampling strategy should be consistent with Chapter 9 "*Sampling Plan*" of SW-846 "*Test Methods of Environmental Testing of Solid Wastes.*"[8]

Chapter 3
Study Design and Methods

Study Design

This study evaluated the effectiveness of a wet abrasive blasting technology (Torbo®) combined with two inorganic-based stabilization technologies (Blastox® and PreTox 2000 Fast Dry) to remove lead-based paint from exterior substrates (brick and wood) and to generate a non-hazardous waste for disposal. Each technology combination (e.g., Torbo® with PreTox 2000 Fast Dry) was demonstrated on the two substrates (brick and wood) to yield two treatments. Each treatment was replicated three times to yield six experiments per technology combination. The study design is summarized in Table 1.

Table 1. Study Design for Lead-Based Paint Removal from Brick and Wood

Substrate	Number of Experiments		
	Torbo® with Blastox®	Torbo® with PreTox 2000	Total
Brick	3	3	6
Wood	3	3	6
Total	6	6	12

Brick -- A single building wall (approximately 28' H x 157' L) was used as the exterior painted brick substrate. This expanse of wall reportedly had the same construction and painting history. The lead loading (i.e., mass of lead in a given surface area on the substrate) on the brick ranged from 1.5 to 15.2 mg/cm^2 (average 6.9 mg/cm^2, std. dev. 3.2 mg/cm^2) using a NITON Model 703-A X-ray fluorescence (XRF) spectrum analyzer (K & L Shell Combined). The masonry wall was divided into six areas that ranged from 556 to 756 ft^2 (average 627 ft^2). The differences in surface area are due to the presence of varying numbers of windows on the wall; the respective areas were subtracted from each of the test areas. Each technology combination was assigned at random to the six test areas.

Wood -- Five buildings (two houses and three storage buildings with 4-inch poplar wood siding) were used as the exterior painted wood substrate. The buildings were located on the same property, had an identical architectural design, and reportedly had similar painting histories. The lead loading on the wood siding ranged from 13.1 to 51.9 mg/cm^2 (average 33.3 mg/cm^2, std. dev. = 10.1 mg/cm^2) using a NITON Model 703-A XRF spectrum analyzer (K & L Shell Combined).

Two test areas were selected from one of the two houses, and one test area was selected from each of the remaining four buildings (i.e., one house and three storage sheds), yielding a total of six test areas. The six test areas ranged from 294 to 431 ft^2 (average 363 ft^2). The technology combinations were randomly assigned to the test areas, but assignments were controlled to ensure that each technology combination was tested on a house.

Table 2 presents a summary of the sampling design for the environmental measurements. Table 3 presents a summary of the environmental sampling strategy.

Technologies Evaluated

Torbo® Wet Abrasive Blasting System

The Torbo® Wet Abrasive System is manufactured by Keizer Technologies of Americas, Inc. in Euless, Texas. The system uses conventional blasting abrasives mixed with water (80% abrasive to 20% water) in a pressure vessel. During this study, mineral slag was used to remove the paint from the brick and coal slag (Black Beauty®) was used to remove the paint from the wood.

The system combines the abrasive media and water to create a slurry-mixture that is fed to a blast nozzle much like a conventional blasting system. In concept, each particle of the abrasive is encased in a thin layer of water. It utilizes this coating to both reduce the heat generated by friction and form a cohesive bond for the dust created by the blasting process that reduces the fugitive particulate emissions.

Water pressure (175 psi) from a system piston pump forces the slurry-mixture from the vessel to a compressor-generated airstream (185 cfm minimum flow rate), where it is accelerated toward the blasting nozzle. The blast media consumption (0.01-0.23 cfm) and water consumption (0.03 - 0.42 gal/min) are both adjustable during operation. The paint coating is removed by the kinetic energy and mechanical abrasion of the blast media striking the surface. After the abrasive blasting of the brick or wood substrates was completed, power water rinsing (60 psi for wood and 95 psi for brick substrates) was performed on the surface to ensure that all of the abrasive-mixture was removed. The rinse option used approximately 5 gallons of water per minute. The water expended during the rinse cycle either evaporated or was absorbed by the abrasive on the polyethylene sheeting ground cover to form a sludge.

Table 2. Summary of Sampling Design for Environmental Measurements

Technology Combination	Substrate	Environmental Data to be Collected		
		Paint Removal Effectiveness	Work Area Contamination	Site Control
Torbo® with Blastox®	Exterior Wood Siding	° XRF[a]: pre/post removal ° ICP-AES[b]: paint chip/bare substrate chip: pre/post removal ° Visual surface evaluations: post removal	° Air lead: during removal ° Air lead particle size: during removal ° Blasting debris: post removal	° Area air lead: during removal ° Soil lead: pre/post removal
	Exterior Brick	° XRF: pre/post removal ° ICP-AES: paint chip/bare substrate chip: pre/post removal ° Visual surface evaluations: post removal	° Air lead: during removal ° Air lead particle size: during removal ° Blasting debris: post removal	° Area air lead: during removal ° Soil lead: pre/post removal
Torbo® with PreTox 2000 Fast Dry	Exterior Wood Siding	° XRF: pre/post removal ° ICP-AES: paint chip/bare substrate chip: pre/post removal ° Visual surface evaluations: post removal	° Air lead: during removal ° Air lead particle size: during removal ° Blasting debris: post removal	° Area air lead: during removal ° Soil lead: pre/post removal
	Exterior Brick	° XRF: pre/post removal ° ICP-AES: paint chip/bare substrate chip: pre/post removal ° Visual surface evaluations: post removal	° Air lead: during removal ° Air lead particle size: during removal ° Blasting debris: post removal	° Area air lead: during removal ° Soil lead: pre/post removal

[a] Denotes X-ray fluorescence.

[b] Denotes inductively-coupled plasma atomic emission spectroscopy.

Table 3. Environmental Sampling Strategy Matrix

Technology Combination	Substrate	Experiments per Substrate per Technology Combination	Sample Type	No. of Samples per Experiment	No. of Samples Collected per Substrate per Technology Combination[a]
Torbo® with Blastox®	Exterior Wood Siding or Exterior Brick	3	XRF	5/25[b]	15/75
			Air Lead	1-2/2-6[c]	3-6/6-18
			Air Lead Particle Size	1[d]	1
			Soil	1 pair[e]	3 pair
			Paint Chip/Bare Substrate Chip[f]	3/5[f]	9/15
			Blasting Debris	2	6
Torbo® with PreTox 2000 Fast Dry	Exterior Wood Siding or Exterior Brick	3	XRF	5/25[b]	15/75
			Air Lead[a]	1-2/2-6[c]	3-6/6-18
			Air Lead Particle Size[b]	1[d]	1
			Soil	1 pair[e]	3 pair
			Paint Chip/Substrate Chip[f]	3/5[f]	9/15
			Blasting Debris	2	6

[a] Excludes QA/QC samples.
[b] Includes five measurements before and 25 measurements after application of a paint removal technology.
[c] One to two personal samples were collected on the technology operator and/or helper. Two to six area air samples were collected depending on the site configuration.
[d] Personal sample was collected on the technology operator.
[e] Pair refers to one 3-part composite sample before and one 3-part composite sample after application of a paint removal technology.
[f] A 1¼" x 1¼" paint chip sample was collected before and a 1¼" x 1¼" bare substrate chip sample was collected after application of a technology.

Blastox®

Blastox® is manufactured by TDJ Group Inc. in Cary, Illinois. Blastox®, an abrasive additive, is a di- and tri-calcium silicate-based material similar in chemical composition to Type I cement. Typically, for lead-based paint removal, it is added at a 20-25 weight percent ratio to the non-recyclable blasting media such as mineral sand or coal slag. For this study, the supplier of the abrasive reportedly premixed the Blastox® additive at a 20 and 15 percent weight ratio to the abrasive (mineral sand or coal slag) for paint removal from the wood and brick substrates, respectively.

A U.S. Army Corps of Engineers study[5] concluded that Blastox® stabilizes lead-containing paint blast media wastes (i.e., reduces the leachability of lead) by a series of simultaneous reactions that result in an encapsulated lead silicate compound, which is insoluble at all pH levels. The first reaction is a pH adjustment that simultaneously stabilizes the lead by adjusting the pH range (8.0-11.5) where there is limited leachability for lead. Secondly, the chemical form of the lead is changed from a lead oxide, carbonate, or hydroxide, to a lead silicate, which is insoluble. A U.S. EPA study[6] concluded that Blastox® appears to stabilize the lead through an immobilization mechanism, rather than by chemical reaction of lead oxide, to form a lead silicate. Lastly, hydration reactions encapsulate the waste into a cementitious material, which limits the gravitational flow of water through the waste.

PreTox 2000 Fast Dry

PreTox 2000 Fast Dry (hereafter referred to as PreTox 2000) is manufactured by NexTec, Inc. in Dubuque, Iowa. PreTox 2000 is a cementitious paint-like mixture (i.e., treatment layer) designed to be applied to lead-based paint surfaces and allowed to cure and adhere to the paint coating; it then is removed in conjunction with the underlying lead-based paint coating using abrasive blasting or other standard techniques. PreTox 2000 is composed of materials from the compounds of sodium and potassium silicates, sodium and potassium phosphate, and calcium silicate, iron and aluminum sulfates, and an alkali metal salt.[7] It also contains toluene, acetone, and VM&P naptha as carrier solvents. Typically, PreTox 2000 is designed to be applied to a 10- to 60-mil (wet) thickness depending on substrate and paint condition; the average application is 40-mil (wet) thickness. For this study, the manufacturer's representative used an airless sprayer to apply PreTox 2000 to a surface of 40 mil (wet) thickness.

The manufacturer reports that the PreTox 2000 system stabilizes the lead through two mechanisms. The first mechanism is chemical stabilization through pH adjustment, which instantaneously stabilizes the lead by adjusting the pH range (8.0-11.5) where there is limited leachability for lead. The second is chemical fixation that changes the soluble ionic form of lead to an insoluble metallic form. Test data provided by NexTec, Inc. showed that PreTox 2000 successfully stabilized lead-based paint debris, yielding a leachable lead content of <5 mg/L using both the TCLP and Multiple Extraction Procedure (MEP).

Data Collection Approach

Study Objective 1

The first study objective was to *evaluate the effectiveness of wet abrasive blasting with an abrasive lead-stabilizer additive (Blastox®) and wet abrasive blasting on a lead-stabilizing surface preparation coating (Torbo®) to remove lead-based paint from exterior wood and brick substrates to a lead loading of <1 mg/cm^2.*

An effective removal technology is one that can render the substrate as "free of lead-based paint," defined as a lead loading of <1 mg/cm^2. In addition, the technology must remove the lead-based paint down to the "bare" wood or brick substrate with minimal or no damage to the underlying substrate. Therefore, a measure of effectiveness must include an assessment of lead removal and abated surface condition. Both of these measures were included to achieve this objective.

One difficulty in comparing the effectiveness of these technologies under real world conditions was that they could not each be applied to the same surface area. Thus, a surface cannot receive a lead-based paint abatement treatment more than once. Under ideal conditions, comparisons of different technologies would best be conducted on the same surfaces. Since abatement can only be done once, however, different surfaces were selected for removal by each technology. The approach for this study was to minimize the potential differences between these surfaces selected for removal by each technology. To minimize these potential differences, a single expanse of painted brick wall was selected with the same painting history and five buildings (two houses and three storage sheds) on the same property with wood siding having similar architectural characteristics and painting histories.

The study approach to achieve Study Objective 1 included the following:

- Lead-based paint removal effectiveness was evaluated by measuring the lead loading before and after application of each technology using multiple lead in paint measurements on the substrates (wood or brick) with an X-ray fluorescence (XRF) spectrum analyzer.

- The surface condition was assessed by observing the physical appearance of the abated surfaces. A set of standardized terminology (such as lifted or feathered wood grain or pitted wood surface; spalled brick; or dislodged mortar from joints) was used for assessing the condition of the surfaces.

- The effects of changing operational parameters were minimized by attempting to hold operational parameters constant between the different experimental replicates for each technology. In addition, the abrasive/Blastox® blend was premixed by the supplier of the abrasives; the PreTox 2000 surface coating preparation was applied by the same manufacturer's representative; and the same two Torbo® employees (operator and helper) conducted the wet abrasive blasting.

Study Objective 2

The second study objective was to *evaluate the effectiveness of the abrasive lead-stabilizer additive (*Blastox®*) and the surface preparation coating (*PreTox 2000*) to stabilize the lead in paint abrasive media waste to below the RCRA regulatory threshold of 5 mg/L in leachate.*

The study approach to achieve Study Objective 2 included the following:

- The effectiveness of Blastox® and PreTox 2000 to stabilize the lead in residual paint abrasive media waste was evaluated by collecting samples of abrasive media debris after each technology. The leachable lead content of the waste was determined by TCLP.[3]

Study Objective 3

The third study objective was to *evaluate the potential for each technology combination (e.g.,* Torbo® *with* Blastox®*) to generate airborne lead particulate above the OSHA Permissible Exposure Limit (PEL) of 50 μg/m^3, 8-hour time weighted average (TWA).*

The study approach to achieve Study Objective 3 included the following:

- The assessment of airborne lead particulate generated within the breathing zone of both the technology operator and a helper was performed by collecting personal air samples from the workers during application of each technology combination. The samples were collected and analyzed in accordance with NIOSH Method 7300.

Study Objective 4

The fourth study objective was to *develop comparative estimates of the cost of paint removal and disposal using the two technology combinations.*

The study approach to achieve Study Objective 4 included the following:

- The cost estimates that were developed consisted of five components: (1) direct labor cost of lead-based paint abatement; (2) indirect labor cost of lead-based paint abatement (i.e., equipment related to the technology and associated materials, consumables, and utilities); (3) indirect materials cost (i.e., polyethylene sheeting, tape, and materials to construct each work area containment, disposable protective clothing, respiratory protection, and associated support materials); (4) environmental testing for worker safety and waste characterization; and (5) transportation and disposal of waste. The estimated costs are reported for each technology combination and each substrate (wood and masonry) on a per-square-foot-basis.

Preparation of Worker Safety Plans

Prior to commencement of the work, the following documents were submitted for approval by the USACERL Contracting Officer's Representative:

- Hazard Communication Program
- Lead Paint Removal/Abatement Plan
- Respirator Protection Program
- Waste Collection and Disposal Plan
- Worker Protection Plan

Approval was granted on all of these referenced documents prior to the commencement of the technology demonstration. All work was performed in accordance with guidelines contained in these documents.

Site Preparation

The potential environmental hazards from removal of lead-based paint coatings are reduced by minimizing or eliminating the airborne particulate, and by containing and collecting the debris. Hence, the purpose of containment is to prevent or minimize the debris generated during removal of the lead-based paint coating from the substrate from entering the environment (air, soil, or water) and to facilitate the controlled collection of the debris for disposal. The level and type of containment needed is dependent on various considerations such as size, elevation, and location of the structure, and the surface preparation (i.e., paint removal) method used.

Wood -- The initial containment that was constructed for removal of the lead-based paint coating from the wood siding was consistent with an SSPC-Guide 6 Class 2A design[8] -- i.e., air impenetrable walls and ceiling, fully sealed joints, partially sealed entryway, forced airflow mechanical ventilation, and water impermeable floors. Because of the lack of visibility inside the containment due to the high relative humidity levels generated during wet abrasive blasting, however, the containment was reduced to water-impermeable ground cover consisting of 10-mil nylon-reinforced flame-resistant polyethylene sheeting. (A limited evaluation of the Torbo® wet abrasive blasting system by the Department of the Navy under open blasting conditions showed that the fugitive airborne lead-particulate emissions were consistently below the OSHA PEL.) The polyethylene sheeting was fastened to the base of the building to prevent further contamination of the soil. The outer edge of the polyethylene was weighted. The spent abrasive and paint debris was removed from the ground cover using brooms and shovels. The materials were placed in 55-gallon open-top DOT-approved drums.

Brick -- The containment for the removal of the lead-based paint coating from the brick consisted of an SSPC-Guide 6 Type B2 air penetrable woven polypropylene opacity screen (85% opacity) weighing 0.75 oz/ft^2. The air was able to pass through the containment material. The screen (35-ft by 50-ft) was draped over the side of the building at each of the test areas. The perimeter of the screen was anchored to the roof of the building using 50-pound bags of sand. The ground was covered with water-impermeable ground cover consisting of 10-mil nylon-reinforced flame-resistant polyethylene sheeting. The polyethylene sheeting was fastened to the base of the building to prevent further contamination of the soil. The outer edge of the polyethylene was weighted with sandbags. The spent abrasive and paint debris was removed from the ground cover using brooms and shovels. The materials were placed in 55-gallon open-top DOT-approved drums.

Sampling and Analytical Methods

Thickness of Dry Paint Film

Locations selected to measure the paint film thickness were representative of the paint over the entire area of the building wall to be abated. Because of the relatively large surface areas (average of 495 ft^2 per test panel), five measurements of the paint film thickness were made for each of the 12 test panels, yielding a total of 60 measurements. The thickness measurements were made at the approximate center point of each equally dimensioned grid square of a six-part grid system created over each test panel.

The measurement of dry film thickness of the paint was made using ASTM Method D 4138-88.[9] This in-field method measures the dry film thickness of coating films by microscopical observation of precision-cut angular grooves in the coating film. The range of thickness measurement is 0 to 50 mils (0 to 1.3 mm).

Lead in Dry Paint Film

Lead in paint measurements (XRF and ICP-AES) were made before paint removal to establish the lead loading on the test panel. The measurements were made at approximately the same five locations as the paint film thickness measurements. The measurements were made in accordance with Chapter 7 *"Lead-Based Paint Inspection"* (1997 Revision) of the HUD Guidelines.[10]

XRF Measurements

A NITON XRF Spectrum Analyzer (Model 703-A) running software Version 5.1 was used to determine the lead loading on the brick and wood substrates. The instrument was operated in the variable-time paint test mode "*K & L + Spectra*" using the "*Combined Lead Reading*" with the instrument display of a 95% confident (2-sigma) positive or negative determination versus the threshold-level (1 mg/cm^2) as the stopping point of the measurement. There is no inconclusive classification when using the threshold for this instrument running software version 5.1.[11] Results are classified as positive (i.e., $\geq$ 1.0 mg/cm^2), if greater than or equal to the threshold, or negative (i.e., $<$ 1.0 mg/cm^2) if less than the threshold. The instrument reads until a 95% confident reading of "Positive" or "Negative" versus the threshold (1 mg/cm^2) is achieved.

The Depth Index displayed by the instrument was also recorded with each measurement. The Depth Index is a numerical indication of the amount of non-leaded paint covering the lead detected by the instrument. A Depth Index less than 1.5 indicates lead very near the surface layer of paint. A Depth Index between 1.5 and 4.0 indicates moderately covered lead. A Depth Index greater than 4 indicates deeply buried lead.

In addition to the manufacturer's recommended warmup and quality control procedures, the XRF instrument operator performed the calibration check readings in accordance with the HUD Guidelines.[10] The calibration checks were taken using the Red (1.02 mg/cm^2) National Institute of Standards and Technology (NIST) Standard Reference Material (SRM No. 2579) paint film. In all cases, the instrument displayed a value between the calibration check limits (0.9 to 1.2 mg/cm^2) specified in the Performance Characteristic Sheet[11] and indicated *Surface Lead*. Because all of the lead loadings measured in the paint film before paint removal exceed the calibration standard, the corresponding measurements should be interpreted as approximate or minimum values.

In order to minimize the contribution of variability originating from the XRF instrument and operator during the measurement process, the same XRF instrument and operator were used for all XRF measurements.

Paint Chip Sampling

A paint chip sample for ICP-AES analysis was obtained at approximately the same location as three of the five XRF measurements. Each sample was obtained from a 1¼-inch by 1¼-inch (approximately 3.17-cm by 3.17-cm) square area. The outline of the sample area was marked with an indelible ink pen. One edge of a 5-inch by 7-inch aluminum tray was taped immediately below the sample area and formed to accommodate complete collection of the sample.

Ideally, the goal was to remove <u>all</u> layers of paint equally, but <u>none</u> of the substrate. However, inclusion of small amounts of substrate material in the paint sample would result in minimal error because the primary unit of measure is mass to area (mg/cm^2). That is, the entire sample was extracted by the laboratory, and mass of lead present was divided by the area of sample. A new 1¼-inch-wide wood chisel was used to remove the paint film sample from the wood siding. The sample was removed by shaving the paint film surface in a direction parallel to the grain of the wood. To facilitate collection of the paint film sample from the brick, a heat gun was used to soften the paint before removal to minimize the amount of substrate in the sample. The sample area was heated until it became soft and supple. The paint was scraped off the substrate with a clean 1¼-inch-wide metal paint scraper. All paint was removed from wood and brick to bare substrate. The exact dimensions (to the nearest millimeter) of the sample collection area were recorded. The paint sample was transferred from the aluminum tray into a labeled centrifuge tube with screw cap for shipment to the laboratory. The hard-shelled container was used to facilitate analysis of the entire sample.

The samples were prepared for analysis in accordance with EPA SW-846 Method 3050 and analyzed by ICP-AES in accordance with EPA SW-846 Method 6010. The analytical limit of detection was reported as 5 µg/sample.

Lead on Bare Substrate

Lead on bare substrate measurements (XRF and ICP-AES) were made after paint removal to establish the residual lead loading in the test area. The six wood siding test areas and the six brick wall test areas were each equally dimensioned into 25 areas (i.e., grid squares). The measurements were made at the approximate center point of each grid square. An XRF measurement was made in each of the 25 grid squares. A bare substrate sample for ICP-AES analysis was collected from five of the 25 squares; the test locations were randomly selected.

XRF Measurements on Bare Substrate

A Niton XRF Spectrum Analyzer (Model 703-A) was used to determine the lead loading on the substrate after paint removal.

Bare Substrate Chip

Bare substrate chip samples for ICP-AES analysis were collected to verify the lead loading on the test area determined by the XRF Spectrum Analyzer. The samples were obtained from a 1¼-inch by 1¼-inch (approximately 3.17 cm by 3.17 cm) square area. The outline of the sample area was marked with an indelible ink pen. One edge of an aluminum tray was taped immediately below the sample area and formed to accommodate complete collection of the sample.

A sharp 1¼-inch-wide wood chisel and hammer were used to remove the sample of wood substrate. The sample was removed by shaving the wood surface in a direction parallel to the grain of the wood. A new 1¼-inch brick chisel and hammer were used to scrape/chip the brick surface to obtain the substrate sample. The depth of each sample was approximately $\leq$ 2 millimeters. The exact dimensions (to the nearest millimeter) of the sample collection area were recorded. The substrate sample was then transferred from the aluminum collection tray into a labeled centrifuge tube with screw cap for shipment to the laboratory. The hard-shelled container was used to facilitate analysis of the entire sample.

The samples were prepared for analysis in accordance with EPA SW-846 Method 3050 and analyzed by ICP-AES in accordance with EPA SW-846 Method 6010. The analytical limit of detection was reported as 5 µg/sample.

Lead in Airborne Particulate

Personal Breathing Zone Samples

Personal breathing zone samples were collected on the technology operator and helper during each technology demonstration, i.e., each worker wore a personal sampling pump with the filter assembly positioned in the workers' breathing zone area. The sampling assembly was worn by each worker for the duration of the technology demonstration. The samples were collected on closed-face, 37-mm-diameter, 0.8-µm pore size mixed-cellulose-ester (MCE) membrane filters contained in a three-piece cassette. The filter assembly was attached to a constant-flow, battery-powered vacuum pump operating at a flow rate of approximately 2 liters per minute. The sampling pumps were calibrated with a precision rotameter both immediately before and after sampling. The precision rotameter is a secondary standard, and thus was calibrated with a primary airflow standard (a bubble tube) before, at the midpoint, and after each field demonstration (i.e., wood and brick substrates) study.

The samples were collected and prepared for analysis by ICP-AES in accordance with NIOSH Method 7300. The analytical limit of detection was reported as 0.2 µg/sample.

Area Air Samples

During each technology demonstration, area air samples were collected to determine the extent of lead-particulate emissions from the site. The samples were collected during the same period as the personal breathing zone samples. The samples were collected on closed-face, 37-mm-diameter, 0.8-um pore size MCE membrane filters contained in a three-piece cassette positioned on tripods at a height of 4 to 5 feet. The filter assembly was attached to an electric-powered vacuum pump operating at a flow rate of approximately 5 liters per minute. The sampling pumps were calibrated as described for the personal breathing zone samples.

The samples were collected and prepared for analysis by ICP-AES in accordance with NIOSH Method 7300. The analytical limit of detection was reported as 0.2 µg/sample.

Lead Particulate Aerodynamic Particle Size Distribution

An eight-stage Marple Personal Cascade Impactor (Model 298) was used to determine the aerodynamic particle size distribution of the lead particulate generated by the technology. The cascade impactor physically separates particles by size. Table 4 presents the experimentally determined cut-points at the design flow rate of 2 liters/min (Lpm).[12] The collection substrates for Stages 1 through 8 consisted of 34-mm-diameter slotted-mylar substrates. The backup filter consisted of a 34-mm-diameter, 5-µm polyvinyl chloride filter.

Table 4. Cascade Impactor Model 298 Cut-Points at 2 Lpm

Impactor Stage No.	Cut-Point[a] D_p (µm)
1	21
2	15
3	10
4	6.0
5	3.5
6	2.0
7	0.9
8	0.5
Backup Filter	0.00

[a] Aerodynamic equivalent particle-size diameter for spherical particles of unit mass density in air at 25° C and 1 atm.

The personal sampler was worn by the technology operator for the duration of the technology demonstration, i.e., during the period of paint removal. The sampler was attached to a constant-flow, battery-powered vacuum pump operating at a flowrate of 2 liters per minute. The sampling pumps were calibrated as described for the personal breathing zone samples.

The samples were collected and prepared for analysis by ICP-AES in accordance with NIOSH Method 7300. The analytical limit of detection was reported as 0.2 µg/sample.

Characterization of Abrasive Media Paint Debris

Representative samples of the abrasive media paint debris (spent abrasive, stabilization product, paint chips/particles) were collected to determine whether the material generated from a technology combination was a RCRA (40 CFR Part 261) hazardous waste based on the Toxicity Characteristic Leaching Procedure (TCLP). The TCLP is designed to simulate the leaching a waste will undergo in a sanitary landfill. If the leachable lead concentration is equal to or greater than 5 mg/L, the material is a hazardous waste. The samples were extracted in accordance with EPA SW-846 Method 1311, digested in accordance with EPA SW-846 Method 3015, and analyzed in accordance with EPA SW-846 Method 6010.

Wood Substrate

Initially, six and nine representative samples were obtained from the abrasive media paint debris generated from the Torbo®-Blastox® and Torbo®-PreTox 2000 technology combination demonstrations, respectively. That is, two and three samples, respectively, were collected during each of the three replicate demonstrations. Each of these samples consisted of four subsamples that represented a "W" pattern of the abrasive media paint debris that had deposited on the ground cover around the structure.

Re-sampling of Debris from Wood Substrates

Due to a concern that this sampling strategy may not have yielded representative samples of the debris, the material which was subsequently deposited in 55-gallon drums for disposal was re-sampled. The re-sampling involved removing a 5-gallon container of the Torbo®- Blastox® generated debris from each of four 55-gallon drums; re-sampling was done in the same manner for the Torbo®-PreTox 2000 generated debris. The material from one of the 5-gallon containers was deposited on a hard-flat surface and thoroughly mixed using a shovel. The pile was then divided into four quarters with a shovel. A subsample was then collected from each quarter and combined as a single sample. This procedure was repeated for each 5-gallon container, yielding a total of four samples for each technology combination.

In addition to the re-sampling of the debris, three 5-gallon containers were obtained from the Torbo®-Blastox® generated debris and three from the Torbo®-PreTox 2000 generated debris and then treated with additional amounts of Blastox® or PreTox 2000. The debris was treated with additional amounts of the stabilization products to achieve the optimal blend ratio or mil application thickness, respectively. Additional amounts of dry Blastox® were added to achieve a blend ratio of 30 percent. Additional amounts of dry PreTox 2000 were added to simulate a 60 wet mil application thickness. Retrospectively, these turned out to be the formulations that the respective manufacturers should have used for the demonstration involving the wood substrates.

Representatives from both TDJ Group, Inc. (Blastox®) and NexTex, Inc. (PreTox 2000) participated in selection of the debris for re-testing, mixing of the debris with and without the additional amounts of the stabilization products, and sampling of the debris.

Brick Substrate

Six representative samples were obtained of the abrasive media paint debris generated from the Torbo®-Blastox® technology combination demonstrations, and six were obtained from the Torbo®-PreTox 2000 technology combination demonstrations. Prior to collecting the samples, the resultant abrasive media paint debris that had deposited on the ground cover was culled into a large pile. The pile was thoroughly mixed and divided into four quarters with shovel. A subsample was then collected from each quarter and combined as a single sample. This procedure was repeated for a second sample.

Statistical Methods

All comparisons of two sample means were made using a standard two-sample t-test. If the distributional assumption of normality was not reasonable, then the corresponding nonparametric distribution-free method was used (i.e., Wilcoxon Rank Sum Test). All one-sample comparisons to a regulatory action level (1 mg/cm^2) were made using a standard one-tailed t-test. Again, if the distributional assumption of normality was not reasonable, then the corresponding nonparametric method was used (i.e., Signed Rank Test). All of these statistical comparisons were made at the 0.05 level of significance.

The upper limit of the 80 percent confidence interval for the mean concentration of leachable lead in the abrasive media paint debris was calculated to determine if the material was a RCRA hazardous waste.[13] If the mean concentration of leachable lead plus the 80 percent confidence interval is greater than the regulatory threshold (5 mg/L), the material was considered to be a hazardous waste.

Calculation of 8-hour Time-Weighted Average

The personal breathing zone concentrations of airborne lead were converted to an 8-hour time-weighted average (8-hr TWA) exposure concentration using the following formula:

$$\mathbf{E = (C_aT_a + C_bT_b + ... + C_nT_n)/8\ hours}$$

where: **E** is the equivalent exposure for the working shift
C is the concentration ($\mu g/m^3$) during any period of time T
T is the duration (hours) of the exposure at concentration C.

The 8-hr TWA concentrations associated with the measured airborne levels of lead were calculated assuming zero exposure beyond that which was measured during technology application. That is, the 8-hr TWAs were calculated by multiplying the sample duration (hours) by the measured concentration of lead ($\mu g/m^3$) and dividing the product by 8 hours. It should be noted that this approach yielded 8-hr TWA exposure concentrations that most likely would be lower than the exposure measured for a worker using the technology during an actual abatement project due to the longer exposure period.

Chapter 4
Quality Assurance

Sample Chain of Custody

During the study, sample chain-of-custody procedures were an integral part of both the sampling and analytical activities and were followed for all samples collected for laboratory analysis. The final custody procedures documented each sample from the time of its collection until its receipt by the analytical laboratory. Internal laboratory records then documented the custody of the sample through its final disposition.

Standard sample chain-of-custody procedures were used. Each sample was labeled with a unique project identification number that was recorded on a sample data sheet along with other information such as sampling date, location of the sample, size of the sample (volume or area), sampling flow rate, sampling start/stop time, and conditions (environmental and operational) of sampling.

Sample Analysis

Specific quality assurance procedures were followed including those pertaining to the analysis of field blank samples, laboratory method blanks, laboratory control samples, and replicate sample analysis.

Field Blank Samples

A field blank sample is a non-exposed sample of the medium being used for testing (e.g., mixed cellulose ester membrane filter) that is analyzed for lead as an assessment of potential lead contamination resulting from field collection and sample transport activities. The field blanks were limited to the air samples. The field blank samples for the air samples were collected by removing the colored plugs from both the top and bottom sides of the cassette for approximately 15 to 30 seconds and then replacing the plugs. The seven field blank samples did not show detectable levels of lead at a detection limit of 0.2 µg/sample.

Laboratory Control Samples

Laboratory control samples (i.e., matrix spiked with known concentration of lead) were analyzed for each sample matrix (e.g., paint chip, wood chip, brick substrate, mixed cellulose ester filter, etc.). Each laboratory control sample (LCS) consisted of each matrix spiked with a certified reference material. The LCS spiking material references and the corresponding matrix were: paint chips - NIST Standard Reference

Material 2589, air sampling filters - Fisher Scientific Lot # 973670-24, TCLP extracts - High Purity Standards Lot # 726120, and soil - Environmental Resource Associates Inorganic Trace Metals Lot # 235. The laboratory control samples were analyzed with each sample set processed to verify that the accuracy and bias of the analytical process were within control limits.

The analytical data generated with the laboratory control samples fall within the specified laboratory control limits; hence, were generated while the laboratory was in control. Table 5 presents a summary of the laboratory control sample results. Appendix A contains the individual laboratory control sample results and the corresponding control charts.

Replicate Sample Analysis

Replicate sample analyses were performed on the field samples to determine the precision of the analytical method on each matrix (e.g., abrasive media debris, wood, brick, paint, etc.). A replicate analysis was defined in this study as a second analysis of the digestate. The precision of the analysis was estimated by the relative percent difference (RPD). The acceptance criteria for replicate analysis was <20 percent.[14, 15] All replicate analyses of the samples were <20 percent. Table 5 presents a summary of the replicate sample analysis results.

Method Blanks

A method blank sample was analyzed with each batch of samples to document any contamination resulting from the analytical process. The acceptance criteria were that the concentration of lead in the method blank should not be higher than the method detection limit. All method blanks showed non-detectable concentrations of lead. Table 5 presents a summary of the method blank sample results.

Table 5. Summary of Laboratory QA/QC Analyses by Sample Set and Matrix

Date	Sample Set ID	Matrix	Method Blank	Laboratory Control Samples (LCS)			Replicate Sample Analysis		
				% Recovery			µg/sample or ppm		Replicate RPD
				LCS 1	LCS 2	LCS RPD[a]	Replicate 1	Replicate 2	
4/29/98	98-S-2526	MCE Filter	ND[b]	98	99	1.2	98	98	0.0
4/29/98	98-S-2526	MCE Filter	ND	101	101	0.0	35	35	0.0
4/29/98	98-S-2526	MCE Filter	-	-	-	-	10	10	0.0
5/1/98	98-S-2528	TCLP Extract	ND	90	97	7.9	3.7	3.8	2.7
5/1/98	98-S-2528	TCLP Extract	-	-	-	-	32	30	6.5
4/29/98	98-S-2530	Wood Chip	ND	97	98	0.3	3000	3100	3.3
4/29/98	98-S-2530	Wood Chip	ND	101	100	1.2	970	960	1.0
4/29/98	98-S-2530	Wood Chip	-	-	-	-	5200	5100	1.9
4/30/98	98-S-2432	Paint Chip	ND	102	102	0.2	200000	190000	5.1
4/30/98	98-S-2432	Paint Chip	-	-	-	-	400000	400000	0.0
5/7/98	98-S-2746	Wood Chip	ND	100	102	2.3	1500	1500	0.0
5/7/98	98-S-2746	Wood Chip	-	-	-	-	43	41	4.8
6/11/98	98-S-3452	MCE Filter	ND	104	105	1.0	0.3	<0.2	NA[c]
6/11/98	98-S-3452	MCE Filter							

(continued)

Table 5 (continued)

Date	Sample Set ID	Matrix	Method Blank	Laboratory Control Samples (LCS) % Recovery LCS 1	LCS 2	LCS RPD[a]	Replicate Sample Analysis µg/sample or ppm Replicate 1	Replicate 2	Replicate RPD
6/12/98	98-S-3453	Paint Chip	ND	97	98	0.5	3500	3500	0.0
6/22/98	98-S-3454	Brick Chip	ND	103	103	0.2	30	30	0/0
6/22/98	98-S-3454	Brick Chip	ND	96	95	0.1	150	150	0.0
6/22/98	98-S-3454	Brick Chip	-	-	-	-	46	46	0.0
6/18/98	98-S-3455	MCE Filter	ND	101	101	0.0	13	13	0.0
6/18/98	98-S-3455	MCE Filter	ND	101	98	3.4	5.1	5.1	0.0
6/18/98	98-S-3455	MCE Filter	ND	100	100	0.3	68	69	1.5
6/18/98	98-S-3455	MCE Filter	-	-	-	-	160	160	0.0
7/8/98	98-S-3457	TCLP Extract	ND	96	109	13.1	2	2	0.0
7/8/98	98-S-3457	TCLP Extract	-	-	-		76	75	1.3
7/2/98	98-S-3802	TCLP Extract	ND	91	90	1.0	21	21	0.0
7/2/98	98-S-3802	TCLP Extract	ND	88	88	1.2	1.7	1.7	0.0
7/2/98	98-S-3802	TCLP Extract	-	-	-	-	7	7	0.0

[a] Denotes relative percent difference.
[b] Denotes none detected.
[c] Denotes not applicable.

Both samples should contain concentrations of analyte above the detection limit.

Chapter 5
Results and Discussion

Effectiveness of Paint Removal

XRF Measurements Before and After Paint Removal

Tables 6 and 7 present descriptive statistics for the XRF measurements obtained before and after paint removal on wood and brick substrates, respectively, for each technology combination. The descriptive statistics include the number of samples, arithmetic mean and standard deviation, and the minimum and maximum lead concentrations. Appendix B presents the individual XRF measurements on wood and brick substrates before paint removal. Appendix C presents the individual XRF measurements on wood and brick substrates after paint removal.

Table 6. Descriptive Statistics for XRF Measurements (K & L Shell Combined) Collected Before and After Paint Removal on Exterior Wood Siding

Technology Combination	Lead Concentration (mg/cm^2)				
	N	Mean	Std. Dev.	Minimum	Maximum
Before Paint Removal					
Torbo® with Blastox®	15	36.9	9.52	15.5	51.9
Torbo® with PreTox 2000	15	29.7	9.66	13.1	41.4
After Paint Removal					
Torbo® with Blastox®	75	0.24	0.22	0	1.1
Torbo® with PreTox 2000	75	0.16	0.16	0	0.70

A one-tailed t-test was used to determine whether the mean lead concentration after paint removal was significantly less than 1 mg/cm^2 both by substrate (i.e., wood and brick) and overall for each technology combination. In every case, both by substrate and overall, the results show that both Torbo®-Blastox® and Torbo®-PreTox 2000 reduced lead concentrations on wood and brick to a level significantly below 1 mg/cm^2. Table 8 presents the results of the t-test comparisons.

Table 7. Descriptive Statistics for XRF Measurements (K & L Shell Combined) Collected Before and After Paint Removal on Exterior Brick

Technology Combination	Lead Concentration (mg/cm^2)				
	N	Mean	Std. Dev.	Minimum	Maximum
Before Paint Removal					
Torbo® with Blastox®	15	5.59	1.78	1.5	9.7
Torbo® with PreTox 2000	15	8.18	3.71	3.9	15.2
After Paint Removal					
Torbo® with Blastox®	75	0.14	0.09	0	0.4
Torbo® with PreTox 2000	75	0.11	0.14	0	1.1

Table 8. Effectiveness of Paint Removal from Exterior Wood Siding and Brick

Technology Combination	Substrate	Site	N	Mean (mg/cm^2)	t statistic	p-value
Torbo® with Blastox®	Wood	1	25	0.10	-40.2	<0.0001
		2	25	0.37	-16.9	<0.0001
		5	25	0.24	-14.9	<0.0001
		Overall	75	0.24	-30.0	<0.0001
	Brick	2	25	0.12	-57.6	<0.0001
		4	25	0.17	-44.0	<0.0001
		6	25	0.12	-52.7	<0.0001
		Overall	75	0.14	-86.2	<0.0001
Torbo® with PreTox 2000	Wood	3	25	0.13	-26.9	<0.0001
		4	25	0.18	-23.7	<0.0001
		6	26	0.15	-29.8	<0.0001
		Overall	76	0.16	-46.2	<0.0001
	Brick	1	25	0.07	-55.1	<0.0001
		3	25	0.09	-64.6	<0.0001
		5	25	0.16	-19.4	<0.0001
		Overall	75	0.11	-54.0	<0.0001

The one-tailed t-test requires a distributional assumption that the data be normally distributed. Although the XRF data (Appendix C) were not reasonably described by a normal distribution, the results of the t-tests were so highly significant (<<0.0001) that a violation of this distributional assumption is not consequential. However, these data were also analyzed using a non-parametric Sign Rank Test which does not require that the data follow a normal distribution (i.e., a distribution-free method). The results of the Signed Rank Tests were also highly significant and agreed with the respective parametric t-test in every case.

Comparison of XRF Measurements and ICP-AES Analysis

Tables 9 and 10 present descriptive statistics for the XRF measurements obtained before and after paint removal on wood and brick substrates, respectively, for each technology combination. The descriptive statistics include the number of samples, arithmetic mean and standard deviation, and minimum and maximum lead concentrations. Appendix D presents the individual ICP-AES sample analyses on wood and brick substrates before paint removal. Appendix E presents the individual ICP-AES sample analyses on wood and brick substrates after paint removal. The individual sample concentrations are presented as both mg/cm^2 and µg/g.

The Wilcoxon Rank Sum Test was used to compare lead concentrations measured by XRF and ICP-AES on the wood and brick substrates both before and after paint removal. The Wilcoxon test does not require the distributional assumption of normality. The lead concentrations determined by ICP-AES and XRF measurements before paint removal on wood were not significantly different ($p=0.1055$); however, the measurements before paint removal on brick were significantly different ($p=0.0001$). The lead concentrations determined by ICP-AES and XRF measurements after paint removal on wood were significantly different ($p=0.0331$); however, the measurements after paint removal on brick were not significantly different ($p=0.5504$).

Table 9. Lead Concentrations in Paint and on Wood Measured by ICP-AES and XRF (K & L Shell Combined)

Method of Measurement	Lead Concentration (mg/cm^2)				
	N	Mean	Std. Dev.	Minimum	Maximum
Before Paint Removal					
ICP-AES	18	28.2	12.8	9.1	51.6
XRF (L & K Shell)	30	33.3	10.1	13.1	51.9
After Paint Removal					
ICP-AES	30	0.37	0.50	0.01	2.68
XRF (L & K Shell)	150	0.20	0.20	0	1.10

Table 10. Lead Concentrations in Paint and on Brick Measured by ICP-AES and XRF (K & L Shell Combined)

Method of Measurement	Lead Concentration (mg/cm^2)				
	N	Mean	Std. Dev.	Minimum	Maximum
Before Paint Removal					
ICP-AES	18	2.93	2.11	0.20	9.1
XRF (L & K Shell)	30	6.89	3.15	1.5	15.2
After Paint Removal					
ICP-AES	30	0.20	0.30	0.005	1.39
XRF (L & K Shell)	150	0.13	0.12	0	1.10

Condition of Abated Surface

The physical appearance of the abated wood and brick substrates was assessed by visual examination to determine the extent of damage and degree of repair required prior to painting of the surface. The wood surfaces were examined to determine whether the woodgrain was lifted or feathered, the edges of the boards were rounded, or the surface was pitted or grooved, as well as the general evenness of the surface. The brick surfaces were examined to determine whether the surface was spalled and the extent that the mortar in the joints was dislodged.

Wood Surfaces

Overall, there did not appear to be a noticeable difference in the appearance of the abated wood substrate between the two technology combinations. Both technology combinations effectively removed the paint coating to bare substrate with minimal damage to the underlying substrate. Overall, <10 percent of the surfaces were slightly grooved or pitted; none of the surfaces displayed lifted or feathered woodgrain. Thus, the resultant substrate would require light sanding prior to painting. An evaluation was not conducted to measure the potential exposures to airborne lead during this activity. Hence, users of this technology should be cautioned that sanding of the abated substrate could result in elevated exposures to lead particulate. In the absence of actual exposure monitoring data, appropriate respiratory protection and personal protective clothing should be worn.

It should be noted that the initial wet abrasive blasting of the wood siding at Site 1 resulted in rounding of the edges of the boards. This apparently was due to the sharpness of the coal slag particles. Hence, mineral sand or other abrasive media would have been a more appropriate material.

Brick Surfaces

Overall, there did not appear to be a noticeable difference in the appearance of the abated brick substrate between the two technology combinations. Both technology combinations effectively removed the paint coating to bare substrate with no apparent damage to the underlying substrate (i.e., the surface was not spalled). Overall, approximately 25 percent of the mortar joints may require tuck pointing. A mineral sand abrasive was used for these demonstrations.

Paint Removal Rates

Table 11 presents the paint removal rates for wood and brick substrates for both technology combinations. The removal rates represent the average of the three replicate demonstrations per technology combination per substrate. The higher removal rates from brick may be attributed to the removal from a single expanse of wall versus the multiple wood wall surfaces, as well as the time required to exercise more care not to damage the softer wood substrate.

Table 11. Average Paint Removal Rates from Wood and Brick Substrates

Technology Combination	Substrate	Paint Removal (ft^2)	Removal Time (Hours)	Removal Rate (ft^2/hr)
Torbo® with Blastox®	Wood	354.3	4.26	83.2
Torbo® with PreTox 2000		370.1	5.23	70.8
Overall		362.2	4.74	76.4
Torbo® with Blastox®	Brick	646.3	5.45	118.6
Torbo® with PreTox 2000		609.3	5.02	121.4
Overall		627.8	5.24	119.8

Characterization of Abrasive Media Paint Debris

Coal Slag Paint Debris from Wood Substrate

Table 12 presents descriptive statistics for the TCLP analysis of coal slag paint debris from wet abrasive blasting of the wood siding. The descriptive statistics include the number of samples, arithmetic mean and standard deviation, and the minimum and maximum lead concentrations. Appendix F presents the individual TCLP sample results.

The 80 percent confidence interval was used to determine whether the mean leachable lead level in the coal slag paint debris was significantly greater than the RCRA regulatory threshold of 5 mg/L. If the upper limit of the 80 percent confidence interval for the mean is $\geq$ 5 mg/L, the material is considered to be a RCRA hazardous waste. Table 13 presents the mean leachable lead levels and corresponding upper confidence limits for the abrasive paint debris by site and overall for both technology combinations. Overall, the abrasive paint debris from both technology combinations was determined to be a hazardous waste. If examined on a site-by-site basis, the debris is also determined to be a hazardous waste. Another field demonstration of the Torbo®-Blastox® technology combination showed similar lead stabilization results.[16]

The mean leachable lead levels in abrasive media debris generated from the removal of paint from wood by the two technology combinations were compared by using a standard two-sample t-test. The mean leachable lead level in the debris generated from the Torbo®-Blastox® combination (21.3 mg/L) was not significantly different (p=0.4459) from the mean leachable lead level in the debris generated from the Torbo®-PreTox 2000 combination (14.8 mg/L).

Table 12. Descriptive Statistics for Leachable Lead (TCLP) Measured in Coal Slag Paint Debris from Wood Substrates

Technology Combination	Leachable Lead Concentration (mg/L)				
	N	Mean	Std. Dev.	Minimum	Maximum
Torbo®-Blastox®	6	21.3	17.6	3.7	52.0
Torbo®-PreTox 2000	9	14.8	14.1	0.3	37.0

Table 13. Characterization of Coal Slag Paint Debris from Wood Substrates

Technology Combination	Substrate	Site	N	Leachable Lead Level	
				Mean (mg/L)	80% UCL for Mean
Torbo®-Blastox®	Wood	1	2	12.4	39.0
		2	2	15.5	47.9
		5	2	36.0	85.2
		Overall	6	21.3	31.9
Torbo®-PreTox 2000	Wood	3	3	7.7	20.2
		4	3	29.7	39.2
		6	3	7.1	17.5
		Overall	9	14.8	21.4

The debris was re-sampled due to a concern that the initial sampling data (Table 13) may not have been representative of the true concentration of leachable lead in the coal slag paint debris. The sampling strategy was consistent with the ASTM Quartering

Method.[17] Table 14 presents the mean leachable lead levels and corresponding upper confidence limits for the abrasive paint debris for both technology combinations. Appendix F presents the individual TCLP sample results. The mean leachable lead levels from the initial sampling (Table 13) were compared to those from the re-sampling (Table 14) using a standard two-sample t-test. The initial mean leachable lead level in the debris generated from the Torbo®-Blastox® combination (21.3 mg/L) was not significantly different ($p=0.2721$) from the mean leachable lead level in the re-sampled debris (12.5 mg/L). Similarly, the initial mean leachable lead level in the debris generated from the Torbo®-PreTox 2000 combination (14.8 mg/L) was not significantly different ($p=0.7742$) from the mean leachable lead level in the re-sampled debris (13.0 mg/L). Hence, these data confirm that the mean leachable lead level determined by the initial sampling strategy was representative.

Table 14. Leachable Lead Levels in Re-sampled Debris from Abrasive Blasting of Wood Substrates

Technology Combination	N	Mean (mg/L)	80% UCL for Mean
Torbo®-Blastox®	8	12.5	18.0
Torbo®-PreTox 2000	8	13.0	19.0

In addition to the re-sampling of the abrasive media paint debris, the leachable lead content was also determined for the debris that had been treated with additional amounts of Blastox® or PreTox 2000 to achieve the blend ratio or simulate the mil application thickness, respectively, based on the paint film thickness (average 71 mil). Table 15 presents the mean leachable lead levels and corresponding upper confidence limits for the treated debris. Appendix F presents the individual TCLP sample results. The abrasive media paint debris treated with additional amounts of PreTox 2000 were determined to be a non-hazardous waste (i.e., the 80% UCL (mg/L) was <5 mg/L). The abrasive media paint debris treated with additional amounts of Blastox®, however, remained as a hazardous waste (i.e., the 80% UCL (mg/L) was >5 mg/L).

Table 15. Leachable Lead Levels in Abrasive Media Paint Debris from Wood Substrates Treated with Additional Blastox® or PreTox 2000

Technology Combination	N	Mean (mg/L)	80% UCL for Mean
Torbo®-Blastox®	2	21.1	41.9
Torbo®-PreTox 2000	2	0.1	NA[a]

[a] Not applicable. The individual values were all 0.1 mg/L.

Mineral Sand Paint Debris from Brick Substrate

Table 16 presents descriptive statistics for the TCLP analysis of mineral sand paint debris from wet abrasive blasting of the brick wall. The descriptive statistics include the number of samples, arithmetic mean and standard deviation, and the minimum and maximum lead concentrations. Appendix G presents the individual TCLP sample results.

Table 16. Descriptive Statistics for Leachable Lead (TCLP) Measured in Mineral Sand Paint Debris from Brick Substrates

Technology Combination	Leachable Lead Concentration (mg/L)				
	N	Mean	Std. Dev.	Minimum	Maximum
Torbo®-Blastox®	6	7.8	2.1	3.9	10.0
Torbo® -PreTox 2000	6	8.1	9.0	0.2	20.0

Table 17 presents the mean leachable lead levels and corresponding upper confidence limits for the abrasive paint debris by site and overall for both technology combinations. Overall, the abrasive paint debris from both technology combinations was determined to be a hazardous waste. If examined on a site-by-site basis, the debris is also determined to be a hazardous waste, with one exception. The two samples collected from debris at Site 1 (Torbo®-Blastox®) showed an 80% UCL of 3.9, which by itself would not be classified as a hazardous waste.

Table 17. Characterization of Mineral Sand Paint Debris from Brick Substrates

Technology Combination	Substrate	Site	N	Leachable Lead Level	
				Mean (mg/L)	80% UCL for Mean
Torbo®-Blastox®	Brick	2	2	1.1	3.9
		4	2	19.5	21.0
		6	2	3.6	9.6
		Overall	6	8.1	13.5
Torbo®-PreTox 2000	Brick	1	2	9.4	11.4
		3	2	5.9	11.9
		5	2	8.3	9.5
		Overall	6	7.8	9.1

The mean leachable lead levels in abrasive media debris generated from the removal of paint from brick by the two technology combinations were compared by using a standard two-sample t-test. The mean leachable lead level in the debris generated from the Torbo®-Blastox® combination (8.1 mg/L) was not significantly different (p=0.9555) from the mean leachable lead level in the debris generated from the Torbo®-PreTox 2000 combination (7.8 mg/L).

Overall, the abrasive media paint debris characterization results (Tables 12-17) are somewhat surprising. The leachablility of lead is affected by many factors including, type of lead in paint, resins used in the paint, age of the paint, particle size, and others.[18-19] The manufacturers of the stabilization technologies postulate that the ineffectiveness of their respective products in this study was due to insufficient product added or applied to stabilize the concentration of lead present in the paint. The reason(s) why these stabilization technologies were ineffective under the conditions of this study is equivocal.

Blastox®--The material supplier provided a 20% and 15% blend ratio of Blastox® with the coal slag and mineral sand abrasives for use on the wood and brick substrates, respectively. A 30% and 20% blend ratio of Blastox® with the respective abrasives would have been preferred by the manufacturer. Hence, the optimum blend ratio was not used in the demonstration. Mis-communication between the manufacturer and the abrasive supplier resulted in the incorrect blending ratio of Blastox® with the abrasive. Subsequently, the manufacturer issued a technical bulletin to minimize the probability of this blending error occurring in the future.[20]

PreTox 2000--The manufacturer of PreTox 2000 recommends a 10-40 mil (wet) thickness application; a 40 mil (wet) thickness was applied to both the wood and brick substrates. A 60 mil (wet) thickness application for the wood substrates would have been preferred by the manufacturer. Hence, the optimum application mil thickness was not used in the demonstration.

Air Measurements

Personal and Area Air Measurements

Tables 18 and 19 present descriptive statistics for the airborne lead concentrations measured in the personal breathing zone samples collected on the operator and helper and in the perimeter areas (outside of the containment) during paint removal from the wood and brick substrates, respectively. The descriptive statistics include the number of samples, arithmetic mean, the minimum and maximum concentrations measured during the actual period of sampling, and the same parameters for the corresponding 8-hour time-weighted average (TWA) exposure concentrations. Appendix H presents individual air sampling results.

Table 18. Descriptive Statistics for Personal Zone and Area Air Concentrations of Lead Measured During Removal of Paint from Wood

Technology Combination	N	Lead Concentration (µg/m³)					
		Measured During Sampling Period			8-hour TWA		
		Mean	Minimum	Maximum	Mean	Minimum	Maximum
Personal Breathing Zone Samples							
Torbo®-Blastox®	3	149	37.0	230	70.9	25.1	101.5
Torbo®-PreTox 2000	3	94.3	48.0	170	55.1	34.5	86.7
Area Air Samples							
Torbo®-Blastox®	9	39.1	8.5	82.0	20.5	5.4	41.5
Torbo®-PreTox 2000	12	40.2	9.8	67.0	26.9	7.6	52.0
OSHA Permissible Exposure Limit					50		

Table 19. Descriptive Statistics for Personal Zone and Area Air Concentrations of Lead Measured During Removal of Paint from Brick

Technology Combination	N	Lead Concentration (µg/m³)					
		Measured During Sampling Period			8-hour TWA		
		Mean	Minimum	Maximum	Mean	Minimum	Maximum
Personal Breathing Zone Samples							
Torbo®-Blastox®	6	101	38.0	170	68.4	20.1	147.1
Torbo®-PreTox 2000	6	203	120	560	81.5	69.1	100.6
Area Air Samples							
Torbo®-Blastox®	18	30.0	0.76	150	21.2	0.48	144
Torbo®-PreTox 2000	16	41.3	1.4	130	24.9	0.81	79.1
OSHA Permissible Exposure Limit					50		

A standard one-tailed t-test was used to determine whether mean airborne lead levels were significantly less than the OSHA Permissible Exposure Limit of 50 µg/m³ 8-hour time-weighted average (TWA). The results of the t-tests are presented in Table 20. The mean airborne lead levels measured on area samples during paint removal from wood and brick were significantly less than the 50 µg/m³ 8-hour TWA ($p<0.001$). In all cases, the mean airborne lead levels measured by the personal breathing zone samples were significantly greater than the 50 µg/m³ 8-hour TWA.

Table 20. Comparisons of Personal and Area Air Concentrations to OSHA PEL

Technology Combination	Substrate	Type of Sample	N	Mean 8-hr TWA ($\mu g/m^3$)	t statistic	p-value
Torbo® with Blastox®	Wood	Personal	3	70.9	0.8958	0.7675
		Area	9	20.5	-6.40	0.0001
	Brick	Personal	6	68.4	1.03	0.8257
		Area	18	21.2	-3.36	0.0018
Torbo® with PreTox 2000	Wood	Personal	3	55.1	0.3163	0.6091
		Area	12	26.9	-6.53	0.0001
	Brick	Personal	6	81.5	5.63	0.9975
		Area	16	24.9	-3.60	0.0013

The Wilcoxon Rank Sum Test was used to compare the average personal breathing zone concentrations of lead-containing particulate measured during paint removal from the brick (74.6 $\mu g/m^3$) and wood (63.0 $\mu g/m^3$) substrates. The personal breathing zone levels of lead did not vary significantly with substrate (p=0.6396). The same comparison was performed for the samples collected in the perimeter of the work area during paint removal from the brick (22.9 $\mu g/m^3$) and wood (24.2 $\mu g/m^3$) substrates. The area samples showed higher levels of lead during removal of paint from wood than from brick (p=0.0463).

Lead Particulate Aerodynamic Particle Size Distribution

One sample at each of Sites 1 and 2 were collected on the operator using a multistage cascade impactor during wet abrasive blasting of the brick wall. The brick was treated with a 40 mil (wet) thickness application of PreTox 2000. Appendix I presents the individual concentrations of lead measured.

Figure 1 shows the average differential lead particle size distribution for the two samples. This graph provides the particle mass concentration ($\triangle C_i$) in each particle-size band versus the geometric mean diameter (GMD_i), where $GMD_i = \sqrt{D_i \times D_{i-1}}$. The lead particles generated by the wet abrasive blasting of the surface coating covers a wide-size spectrum, where the larger particles account for the greatest mass of lead.

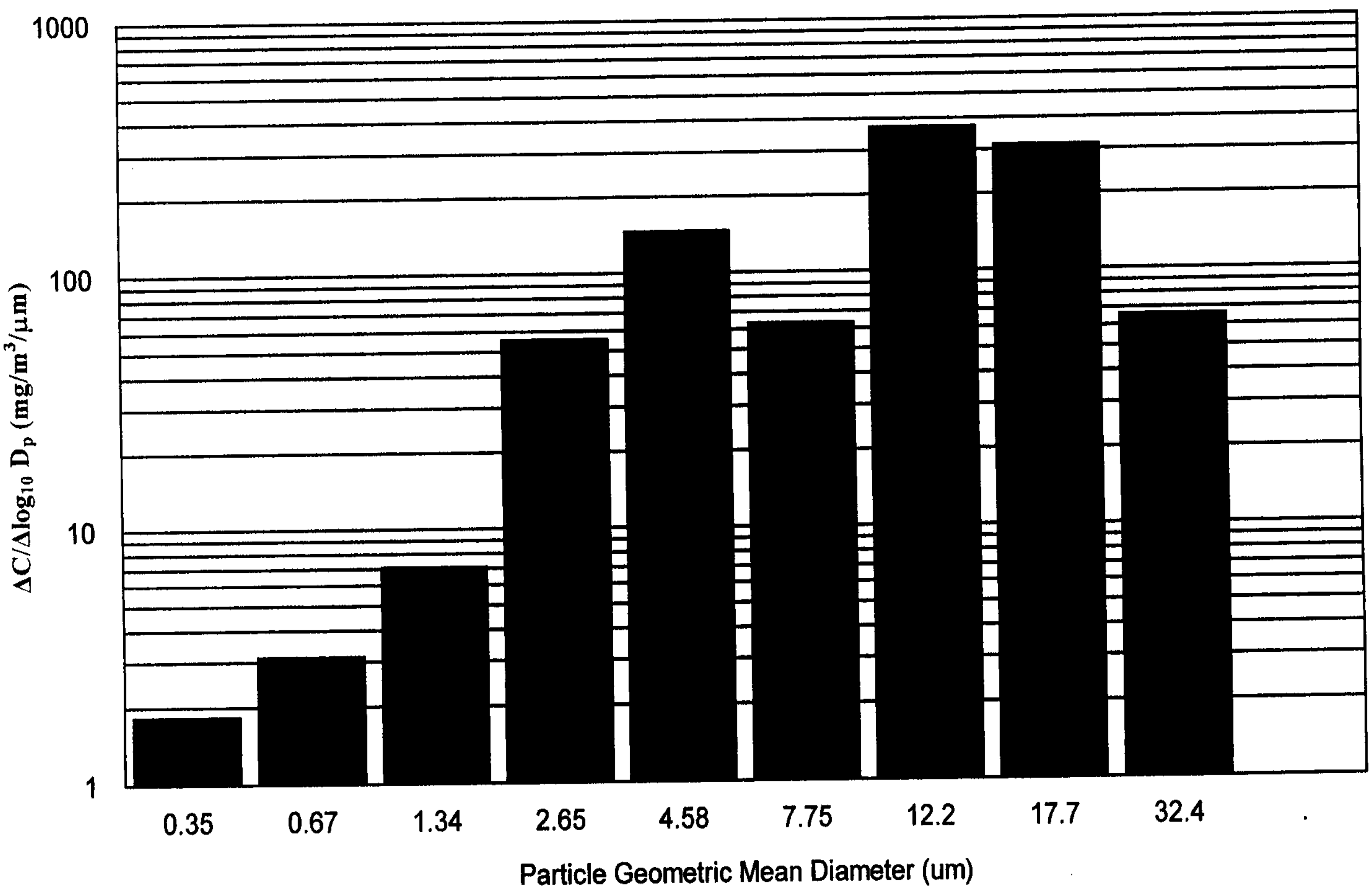


Figure 1. Differential Lead Particle Size Distribution During Wet Abrasive Blasting of Brick.

Figure 2 shows the corresponding cumulative particle size distribution for the lead particles generated during wet abrasive blasting of the surface coating. The lead particle sizes are approximately lognormally distributed; i.e., a straight line reasonably fits the data (r^2=0.9746). The mass median aerodynamic diameter (MMD) is approximately 8.3 µm. That is, 50% of the mass is represented by particles larger than the MMD and 50% of the mass is represented by particles smaller than the MMD. The geometric standard deviation (i.e., measure of the spread of the particle size distribution) was 3.4. By comparison, a geometric standard deviation of 1 represents a monodisperse aerosol (all particles are of the same size).

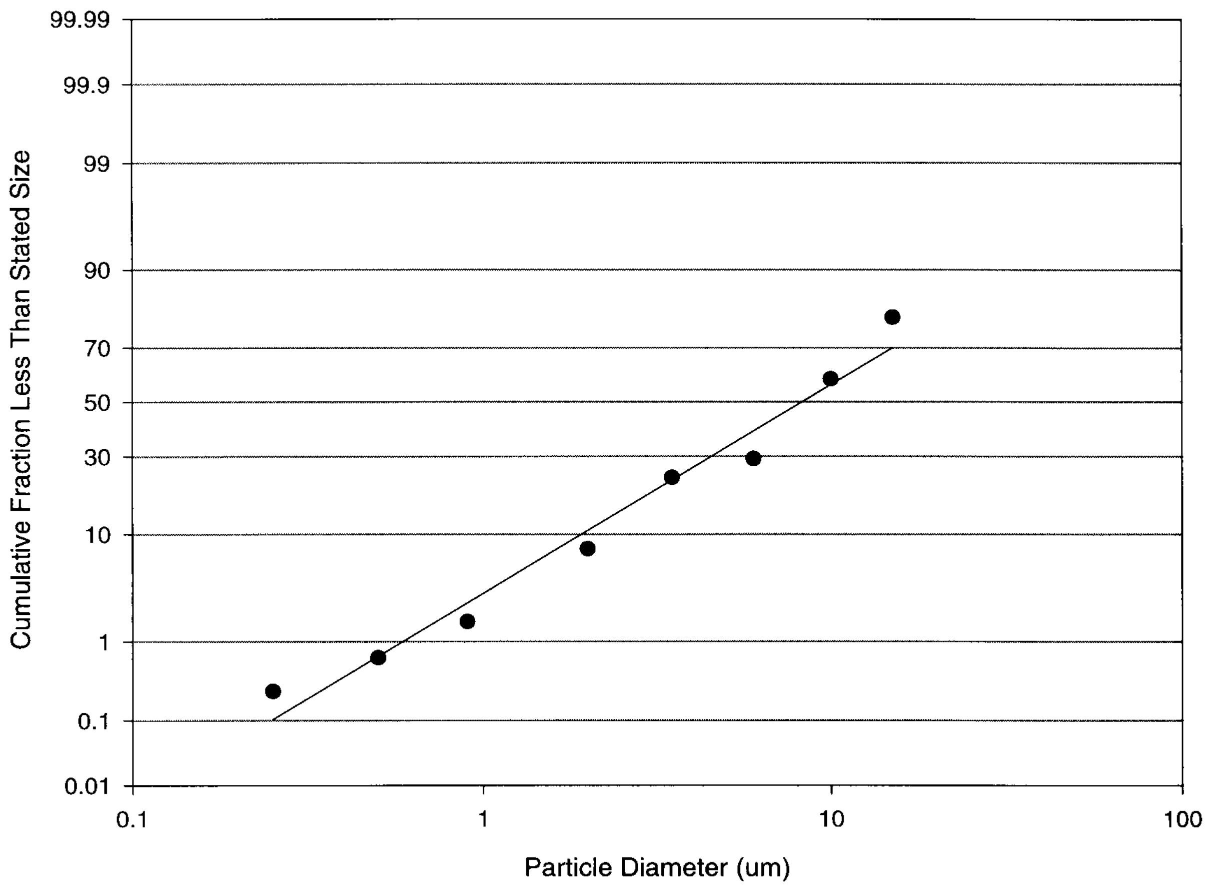


Figure 2. Lead particle size distribution cumulative probability plot.

Chapter 6
Cost Analysis

A cost analysis of the use of Torbo®-Blastox® and Torbo®-PreTox 2000 technology combinations to remove lead-based paint from wood and brick substrates is based on field data from the actual test demonstrations. The cost analysis is limited to the determination of present value savings (i.e., in immediate real dollar terms).

Tables 21 and 22 present summary data from the separate cost analyses of the wood and brick substrates. Different equipment is required for the various structures (one-story wood structures vs. 28-ft-high brick wall), thereby affecting contractor overhead and the type of access equipment used. Furthermore, both the amount of blast media per square foot and the rate of removal (ft^2/hour) vary depending on the type of substrate.

Cost factors presented in the tables are based on actual contractor cost and are compared to actual government estimates from site-specific lead-based paint abatement projects. Note that these cost are highly variable and depend on local conditions; the data in Tables 21 and 22 are intended to be taken as a guide. The term "capital facilities" refers to the capital investment in the technology (Torbo® blasting system). Labor is quoted from actual contractor costs or derived from government estimate sheets. Consumables include the blast media, blast media additive (Blastox®), surface coating preparation (PreTox 2000), personal protective clothing and equipment, tarps and covers, and packaging required for disposal as a hazardous or non-hazardous waste. Environmental testing includes required tests such as air monitoring (personal and site), XRF testing, and TCLP waste characterization.

Table 21. Cost Analysis for Removal of Lead-Based Paint from Wood Substrate

Cost Factors	Torbo® without Stabilization Technology	Torbo® with Stabilization Technology	
		Blastox® (30 % Blend)	PreTox 2000 (40-mil wet thickness)
Capital Facilities[a]	$7.14/site hour	$7.14/site hour	$7.14/site hour
Equipment Rental[b]	$30.00/site hour	$30.00/site hour	$30.00/site hour
Labor[c]	$46.00/site hour	$46.00/site hour	$46.00/site hour
Consumables[d]	$13.62/site hour	$13.72/site hour	$14.09/site hour
Environmental Testing[e]	$49.00/site hour	$49.00/site hour	$49.00/site hour
Subtotal	$145.76/site hour	$145.87/site hour	$146.27/site hour
Removal Rate	83 ft^2/hour	83 ft^2/hour	71 ft^2/hour
Removal Cost	$1.76 /$ft^2$	$1.76 /$ft^2$	$2.06/$ft^2$
Disposal Cost[f]	$0.29/$ft^2$ ($250/ton)	$0.29/$ft^2$ ($250/ton)	$0.29/$ft^2$ ($250/ton)
Total Cost	$2.05/$ft^2$	$2.05/$ft^2$	$2.35/$ft^2$
Non-Hazardous Disposal	N/A	$0.04/$ft^2$ ($35/ton)	$0.04/$ft^2$ ($35/ton)
Non-Hazardous Total Cost	N/A	$1.80 /$ft^2$	$2.10 /$ft^2$

[a] Capital rates of recovery are from actual contractor costs and DEH government cost estimate detail sheets. Costs for investment are amortized over 7 years for depreciation, and assume a 2000-hour site year.

[b] Includes construction fork lifts for handling of materials, man lifts for site access, and PreTox 2000 spray application equipment (as applicable).

[c] Site personnel labor cost. Labor is quoted from actual contractor costs or derived from government estimate sheets.

[d] Consumables are based on items used up in the demonstration. Blastox®: 29 (100-lb) bags of abrasive (coal slag and 20% Blastox® additive) were used resulting in 2.72 lb of abrasive mixture per ft^2 of surface area blasted. PreTox 2000: 38 (100-lb) bags of abrasive (coal slag) were used to remove 40-mil (wet) thickness application of PreTox 2000 resulting in 3.42 lb of abrasive per ft^2 of surface area blasted. The application of 40-mil (wet) thickness on 1,112 ft^2 required six 5-gallon containers of PreTox 2000.

[e] Environmental testing includes air monitoring (6 personal and 23 site perimeter), TCLP (12 abrasive media debris), and XRF ($50/site hour).

[f] Actual transportation and disposal costs.

Table 22. Cost Analysis for Removal of Lead-Based Paint from Brick Substrate

Cost Factors	Torbo® without Stabilization Technology	Torbo® with Stabilization Technology	
		Blastox® (30% Blend)	PreTox 2000 (40-mil wet thickness)
Capital Facilities[a]	$7.14/site hour	$7.14/site hour	$7.14/site hour
Equipment Rental[b]	$30.00/site hour	$30.00/site hour	$30.00/site hour
Labor[c]	$46.00/site hour	$46.00/site hour	$46.00/site hour
Consumables[d]	$16.28/site hour	$16.38/site hour	$16.75/site hour
Environmental Testing[e]	$49.00/site hour	$49.00/site hour	$49.00/site hour
Subtotal	$148.42/site hour	$148.52/site hour	$148.93/site hour
Removal Rate	119 ft^2/hour	119 ft^2/hour	121 ft^2/hour
Removal Cost	$1.25/ft^2$	$1.25/ft^2$	$1.23/ft^2$
Disposal Cost[f]	$0.29/ft^2$ ($250/ton)	$0.29/ft^2$ ($250/ton)	$0.29/ft^2$ ($250/ton)
Total Cost	$1.54/sq ft	$1.54/sq ft	$1.52/sq ft
Non-Hazardous Disposal	N/A	$0.04/ft^2$ ($35/ton)	$0.04/ft^2$ ($35/ton)
Non-Hazardous Total Cost	N/A	$1.29/ft^2$	$1.27/ft^2$

[a] Capital rates of recovery are from actual contractor costs and DEH government cost estimate detail sheets. Costs for investment are amortized over 7 years for depreciation, and assume a 2000 hour site year.

[b] Includes construction fork lifts for handling of materials, man lifts for site access, and PreTox 2000 spray application equipment (as applicable).

[c] Site personnel labor cost. Labor is quoted from actual contractor costs or derived from government estimate sheets.

[d] Consumables are based on items used up in the demonstration. Blastox®: 46 (100-lb) bags of abrasive (mineral sand and 15% Blastox® additive) were used resulting in 2.33 lb of abrasive mixture per ft^2 of surface area blasted. PreTox 2000: 46 (100-lb) bags of abrasive (mineral sand) were used to remove 40 mil (wet) thickness application of PreTox 2000 resulting in 2.56 lb of abrasive per ft^2 of surface area blasted. The application of 40 mil (wet) thickness on 1,1796 ft^2 required ten 5-gallon containers of PreTox 2000.

[e] Environmental testing includes air monitoring (11 personal and 34 site perimeter), TCLP (12 abrasive media debris), and XRF ($50/site hour).

[f] Actual transportation and disposal costs.

Appendix A Laboratory Control Samples

Table A-1. Paint/Bulk Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-S-1877, 1876, 1880, 2081	6010	4/8/98	100600	100000	100.60	100.25	85.23	90.24	110.26	115.27
98-S-1884, 1883	6010	4/9/98	104100	100000	104.10	100.25	85.23	90.24	110.26	115.27
98-S-2229, 2196, 2190, 2191, 2199	6010	4/13/98	99550	100000	99.55	100.25	85.23	90.24	110.26	115.27
98-S-2220	6010	4/14/98	102300	100000	102.30	100.25	85.23	90.24	110.26	115.27
98-S-2272	6010	4/16/98	101600	100000	101.60	100.25	85.23	90.24	110.26	115.27
98-S-2314, 2315	6010	4/20/98	99930	100000	99.93	100.25	85.23	90.24	110.26	115.27
98-S-2313, 2319	6010	4/21/98	103000	100000	103.00	100.25	85.23	90.24	110.26	115.27
98-S-2472, 2468	6010	4/24/98	105302	100000	105.30	100.25	85.23	90.24	110.26	115.27
98-S-2524, 2521, 2520	6010	4/27/98	101000	100000	101.00	100.25	85.23	90.24	110.26	115.27
98-S-2439, 2440, 2441, 2442	6010	4/27/98	100500	100000	100.50	100.25	85.23	90.24	110.26	115.27
98-S-2530	6010	4/29/98	97150	100000	97.15	100.25	85.23	90.24	110.26	115.27
98-S-2530	6010	4/29/98	97530	100000	97.53	100.25	85.23	90.24	110.26	115.27
98-S-2530	6010	4/29/98	101200	100000	101.20	100.25	85.23	90.24	110.26	115.27
98-S-2530	6010	4/29/98	100000	100000	100.00	100.25	85.23	90.24	110.26	115.27
98-S-2443/2451/2447/2446/2445/2444	6010	4/29/98	96630	100000	96.63	100.25	85.23	90.24	110.26	115.27
98-S-2532	6010	4/30/98	101700	100000	101.70	100.25	85.23	90.24	110.26	115.27
98-S-2532	6010	4/30/98	101500	100000	101.50	100.25	85.23	90.24	110.26	115.27
98-S-2627/2656	6010	5/1/98	91.57	82	111.40	100.25	85.23	90.24	110.26	115.27
98-S-2629/26930	6010	5/1/98	104400	100000	104.40	100.25	85.23	90.24	110.26	115.27
98-S-2629/2930	6010	5/1/98	104400	100000	104.40	100.25	85.23	90.24	110.26	115.27

Chart A-1. Paint/Bulk Laboratory Control Samples for Lead

Method: SW-846 6010
Analyte: Lead
Matrix: Paint Chip

Central Line=Mean Recovery
WL = +/-2 SD
CL = +/- 3SD

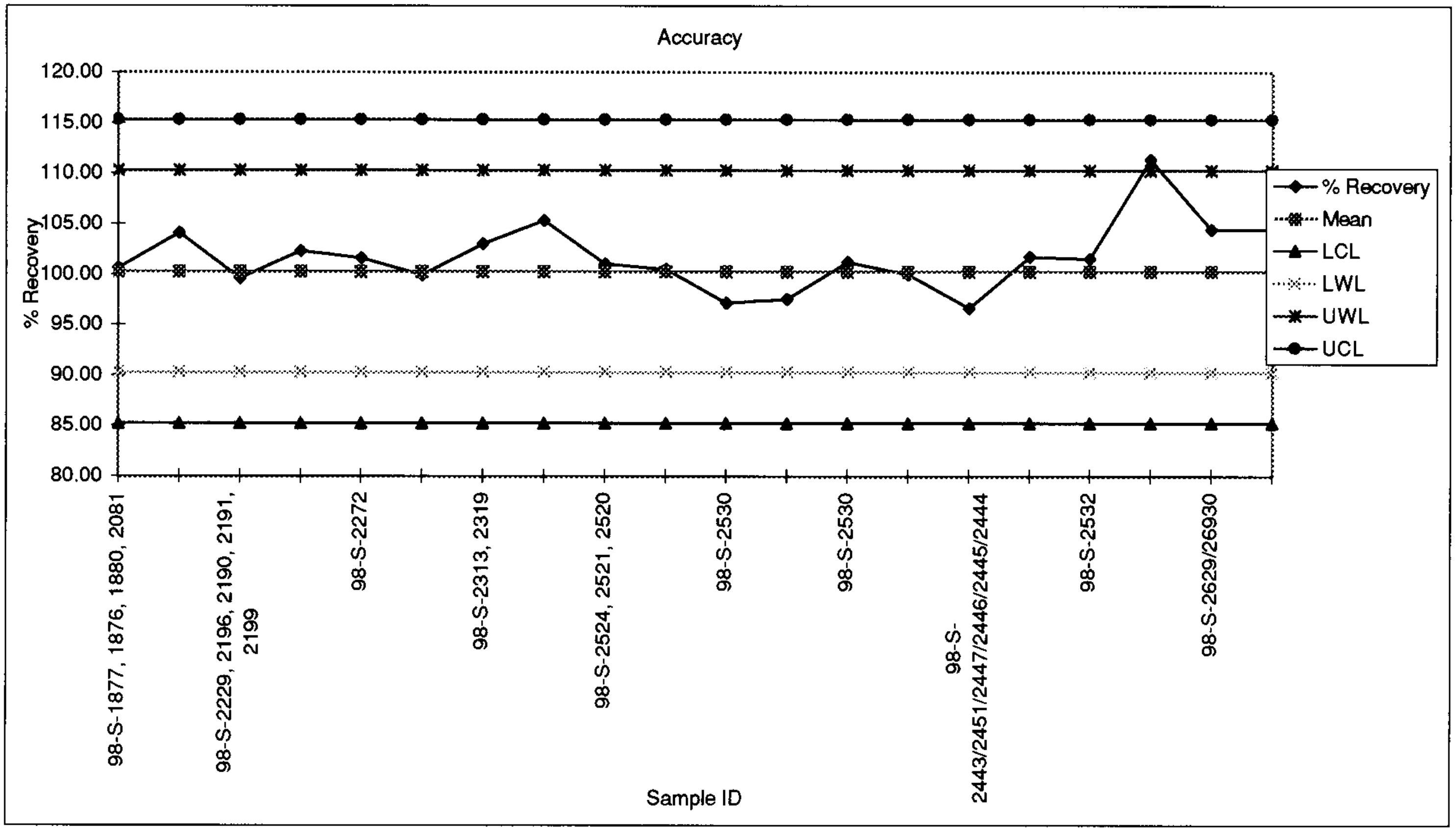


Table A-2. Paint/Bulk Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-s-2593, 2452, 2450, 2448	6010	5/4/98	104300	100000	104	100.17	92.72	95.20	105.14	107.63
98-S-2683/2662/2622/2449	6010	5/5/98	99110	100000	99	100.17	92.72	95.20	105.14	107.63
98-S-2737/2718/2725/2728	6010	5/6/98	95330	100000	95	100.17	92.72	95.20	105.14	107.63
98-S-2737/2718/2725/2728	6010	5/6/98	95330	100000	95	100.17	92.72	95.20	105.14	107.63
98-S-2783	6010	5/6/98	98970	100000	99	100.17	92.72	95.20	105.14	107.63
98-s-2730/2729/2661/2726	6010	5/6/98	98780	100000	99	100.17	92.72	95.20	105.14	107.63
98-S-2746	6010	5/7/98	102300	100000	102	100.17	92.72	95.20	105.14	107.63
98-S-2746	6010	5/7/98	100000	100000	100	100.17	92.72	95.20	105.14	107.63
98-S-2831/2747	6010	5/8/98	103800	100000	104	100.17	92.72	95.20	105.14	107.63
98-s-2720/2723/2824/2834	6010	5/11/98	99820	100000	100	100.17	92.72	95.20	105.14	107.63
98-S-2721/2835/2841/2854/2755	6010	5/13/98	103300	100000	103	100.17	92.72	95.20	105.14	107.63
98-S-2719/2910/2722/2724/2727	6010	5/14/98	100400	100000	100	100.17	92.72	95.20	105.14	107.63
98-S-2739	6010	5/14/98	104400	100000	104	100.17	92.72	95.20	105.14	107.63
98-S-3053	6010	5/18/98	99330	100000	99	100.17	92.72	95.20	105.14	107.63
98-s-2823/3047/3056/3057/3058/3059/3060/3062	6010	5/19/98	99950	100000	100	100.17	92.72	95.20	105.14	107.63
98-s-2823/3047/3056/3057/3058/3059/3060/3062	6010	5/19/98	99950	100000	100	100.17	92.72	95.20	105.14	107.63
98-S-3048/3049/3055/3061	6010	5/20/98	99130	100000	99	100.17	92.72	95.20	105.14	107.63
98-S-3048/3049/3055/3061	6010	5/20/98	99130	100000	99	100.17	92.72	95.20	105.14	107.63
98-S-3126	6010	5/20/98	100500	100000	101	100.17	92.72	95.20	105.14	107.63
98-S-3131	6010	5/20/98	99620	100000	100	100.17	92.72	95.20	105.14	107.63

Chart A-2. Paint/Bulk Laboratory Control Samples for Lead

Method: EPA SW-846 6010
Analyte: Lead
Matrix: Paint Chip

Central Line=Mean Recovery
WL = +/- 2 SD
Cl = +/- 3 SD

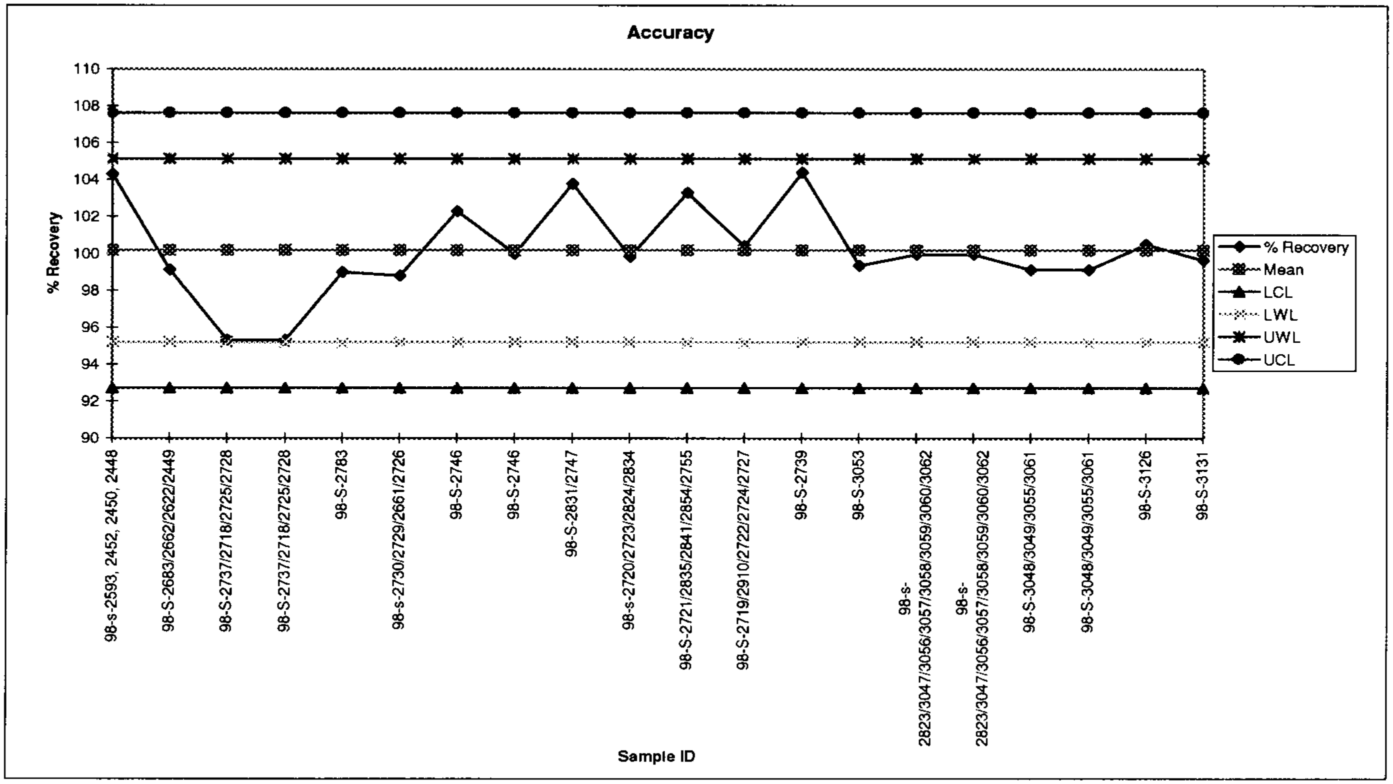


Table A-3. Paint/Bulk Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-S-3131	6010	5/20/98	99620	100000	100	101.35	93.98	96.44	106.27	108.72
98-S-3143/3156/3157	6010	5/25/98	105100	100000	105	101.35	93.98	96.44	106.27	108.72
98-S-3207	6010	5/26/98	100900	100000	101	101.35	93.98	96.44	106.27	108.72
98-S-3325	6010	6/2/98	102700	100000	103	101.35	93.98	96.44	106.27	108.72
98-S-3221/3263	6010	6/2/98	99170	100000	99	101.35	93.98	96.44	106.27	108.72
98-S-3370/3375/3376	6010	6/4/98	100700	100000	101	101.35	93.98	96.44	106.27	108.72
98-S-3403	6010	6/4/98	99840	100000	100	101.35	93.98	96.44	106.27	108.72
98-S-3416	6010	6/5/98	105900	100000	106	101.35	93.98	96.44	106.27	108.72
98-S-3458	6010	6/8/98	103300	100000	103	101.35	93.98	96.44	106.27	108.72
98-S-3352/3495/3496/3498	6010	6/9/98	103000	100000	103	101.35	93.98	96.44	106.27	108.72
98-S-3451/3493/3491/3492/3497/3494	6010	6/9/98	98430	100000	98	101.35	93.98	96.44	106.27	108.72
98-S-3534	6010	6/10/98	105600	100000	106	101.35	93.98	96.44	106.27	108.72
98-S-3453	6010	6/11/98	98800	100000	99	101.35	93.98	96.44	106.27	108.72
98-s-3453	6010	6/11/98	97410	100000	97	101.35	93.98	96.44	106.27	108.72
98-S-3313	6010	6/15/98	102236	100000	102	101.35	93.98	96.44	106.27	108.72
98-s-3454	6010	6/16/98	102500	100000	103	101.35	93.98	96.44	106.27	108.72
98-s-3454	6010	6/16/98	102700	100000	103	101.35	93.98	96.44	106.27	108.72
98-S-3454/3610/3611/3612	6010	6/16/98	99750	100000	100	101.35	93.98	96.44	106.27	108.72
98-S-3715	6010	6/17/98	99295	100000	99	101.35	93.98	96.44	106.27	108.72
98-S-3781/3783	6010	6/19/98	100100	100000	100	101.35	93.98	96.44	106.27	108.72

Chart A-3. Paint/Bulk Laboratory Control Samples for Lead

Method: EPA Sw-846 6010
Analyte: Lead
Matrix: Paint Chip

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

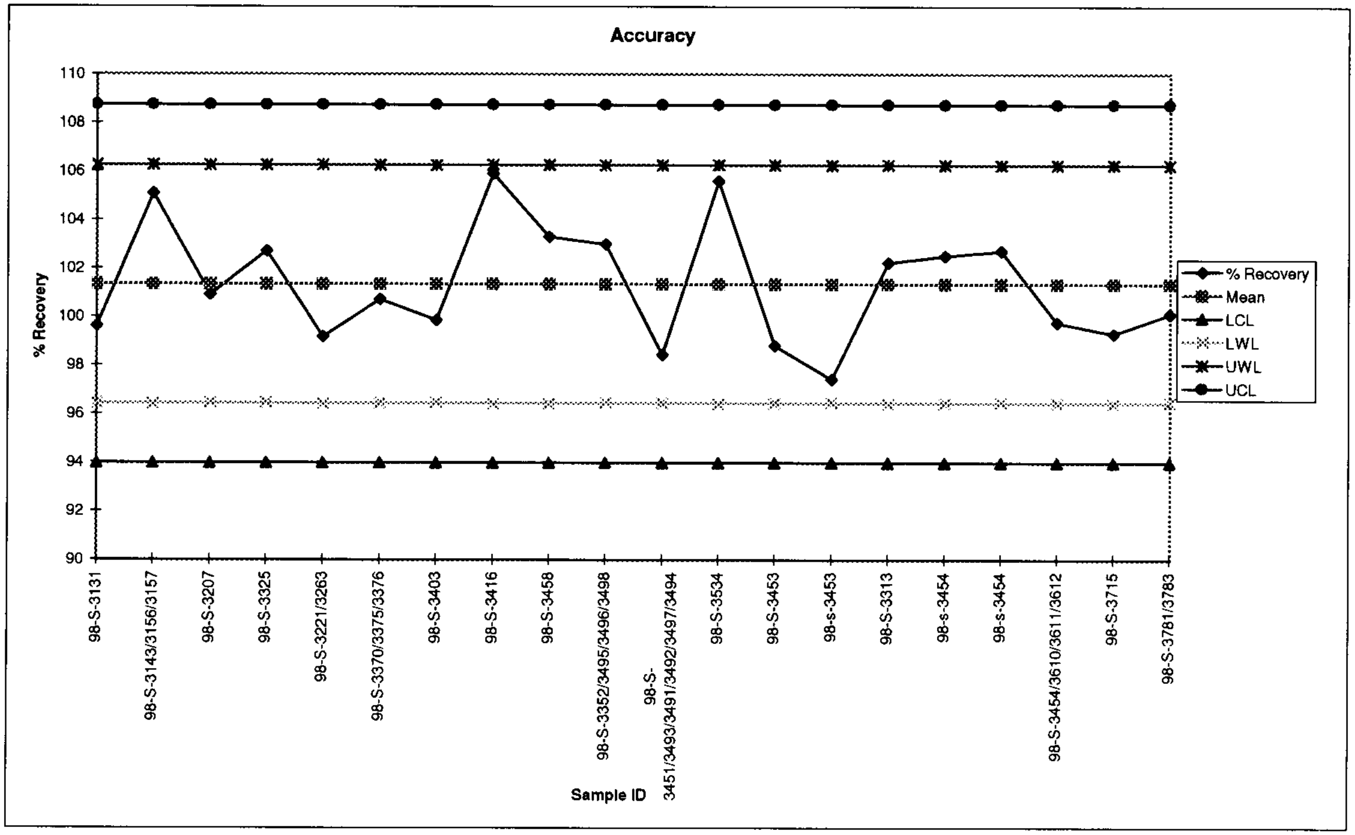


Table A-4. Paint/Bulk Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-s-4456	6010	7/20/98	100899	100000	100.90	100.32	85.14	90.20	110.44	115.50
98-s-4298/4327/4334/4335/4336/4337/4338/4424	6010	7/20/98	99171	100000	99.17	100.32	85.14	90.20	110.44	115.50
98-S-4329/4300/4276/4330/4331/4332	6010	7/20/98	97130	100000	97.13	100.32	85.14	90.20	110.44	115.50
98-S-4425/4422/4328/4421/4333/4423	6010	7/21/98	96520	100000	96.52	100.32	85.14	90.20	110.44	115.50
98-S-4524	6010	7/22/98	101800	100000	101.80	100.32	85.14	90.20	110.44	115.50
98-S-4588	6010	7/24/98	82624	100000	82.62	100.32	85.14	90.20	110.44	115.50
98-S-4653	6010	7/30/98	101700	100000	101.70	100.32	85.14	90.20	110.44	115.50
98-S-4653	6010	7/30/98	101700	100000	101.70	100.32	85.14	90.20	110.44	115.50
98-S-3453	6010	7/31/98	97120	100000	97.12	100.32	85.14	90.20	110.44	115.50
98-S-3453	6010	7/31/98	97590	100000	97.59	100.32	85.14	90.20	110.44	115.50
98-S-3454	6010	7/31/98	95510	100000	95.51	100.32	85.14	90.20	110.44	115.50
98-S-3454	6010	7/31/98	95400	100000	95.40	100.32	85.14	90.20	110.44	115.50
98-S-3454	6010	7/31/98	97410	100000	97.41	100.32	85.14	90.20	110.44	115.50
98-S-3454	6010	7/31/98	97720	100000	97.72	100.32	85.14	90.20	110.44	115.50
98-S-4745	6010	8/3/98	99190	100000	99.19	100.32	85.14	90.20	110.44	115.50
98-S-4607/4657/4660/4661/4662	6010	8/4/98	98020	100000	98.02	100.32	85.14	90.20	110.44	115.50
98-S-4656/4665/4666	6010	8/4/98	97710	100000	97.71	100.32	85.14	90.20	110.44	115.50
98-S-4619	6010	8/4/98	100100	100000	100.10	100.32	85.14	90.20	110.44	115.50
98-S-4659/4663/4668/4658	6010	8/5/98	96620	100000	96.62	100.32	85.14	90.20	110.44	115.50
98-S-4834/4664/4667/4669/4798	6010	8/6/98	101900	100000	101.90	100.32	85.14	90.20	110.44	115.50

Chart A-4. Paint/Bulk Laboratory Control Samples for Lead

Method: EPA SW-846 6010
Analyte: Lead
Matrix: Bulk/Paint

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

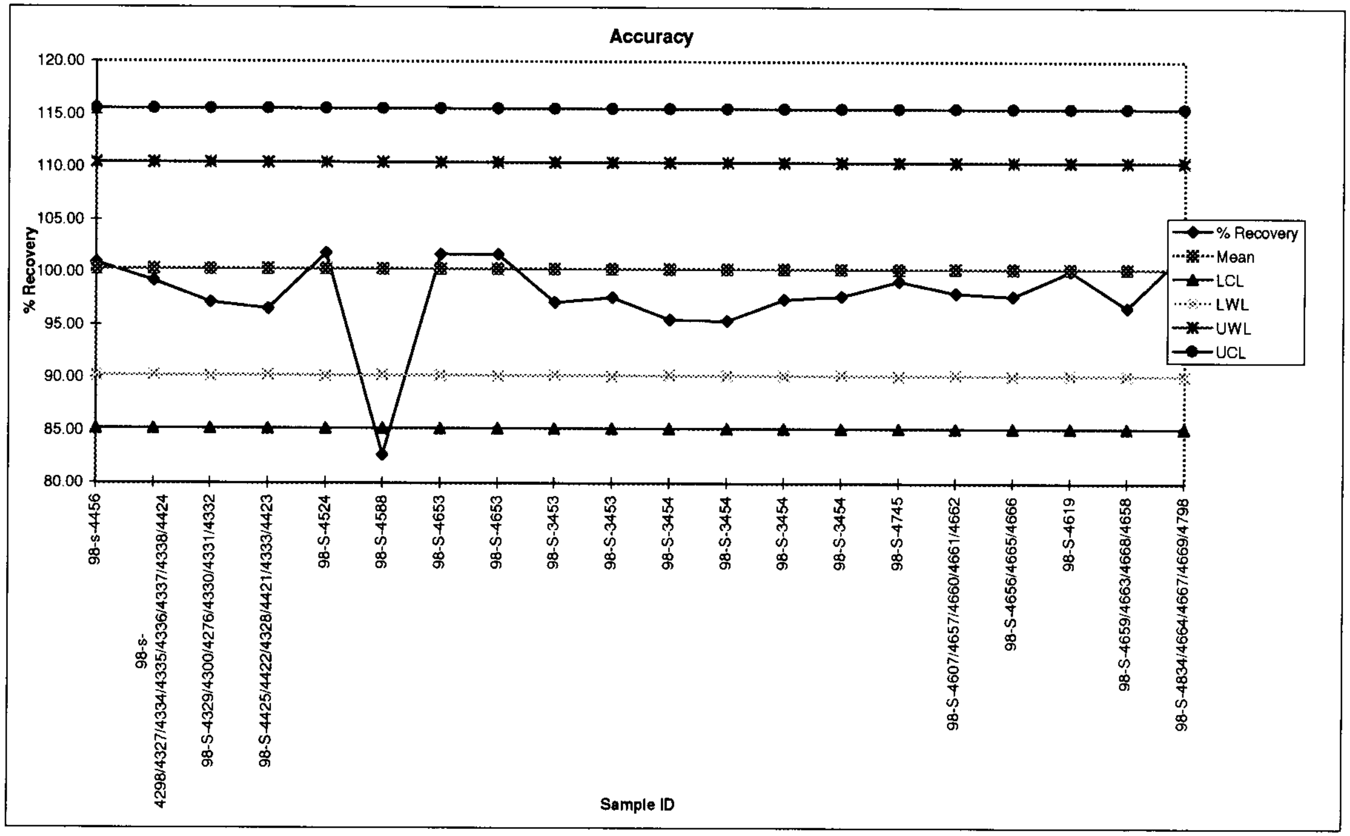


Table A-5. TCLP Extract Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-S-2275 TCLP	3015/6010	4/17/98	9.79	10	98	100.69	78.47	85.87	115.51	122.92
98-s-2257	3015/6010	4/21/98	9.9	10	99	100.69	78.47	85.87	115.51	122.92
98-S-2354	3015/6010	4/21/98	9.99	10	100	100.69	78.47	85.87	115.51	122.92
98-S-2463	3015/6010	4/24/98	10.1	10	101	100.69	78.47	85.87	115.51	122.92
98-S-2398	3015/6010	4/24/98	9.68	10	97	100.69	78.47	85.87	115.51	122.92
98-S-2585/2552/2549/2592/2599	3015/6010	4/29/98	0.504	0.5	101	100.69	78.47	85.87	115.51	122.92
98-S-2528	3015/6010	5/1/98	8.96	10	90	100.69	78.47	85.87	115.51	122.92
98-S-2528	3015/6010	5/1/98	9.7	10	97	100.69	78.47	85.87	115.51	122.92
98-S-2657	3015/6010	5/4/98	8.8	10	88	100.69	78.47	85.87	115.51	122.92
98-s-2675	3015/6010	5/4/98	9.53	10	95	100.69	78.47	85.87	115.51	122.92
98-S-2800/2786/2752	3015/6010	5/7/98	9.14	10	91	100.69	78.47	85.87	115.51	122.92
98-S-2796	3015/6010	5/7/98	0.499	0.5	100	100.69	78.47	85.87	115.51	122.92
98-S-2747	3015/6010	5/8/98	9.56	10	96	100.69	78.47	85.87	115.51	122.92
98-S-2747	3015/6010	5/8/98	9.49	10	95	100.69	78.47	85.87	115.51	122.92
98-S-2848	3015/6010	5/12/98	0.453	0.5	91	100.69	78.47	85.87	115.51	122.92
98-S-2880/2878/2863/2930	3015/6010	5/13/98	9.64	10	96	100.69	78.47	85.87	115.51	122.92
98-S-2850	3015/6010	5/13/98	10.7	10	107	100.69	78.47	85.87	115.51	122.92
98-S-2624/2663/2664	3015/6010	5/14/98	10.1	10	101	100.69	78.47	85.87	115.51	122.92
98-S-2881	3015/6010	5/14/98	0.543	0.5	109	100.69	78.47	85.87	115.51	122.92
98-S-2881/2893	3015/6010	5/14/98	0.562	0.5	112	100.69	78.47	85.87	115.51	122.92

Chart A-5. TCLP Extract Laboratory Control Samples for Lead

Method: EPA SW-846 6010
Analyte: Lead
Matrix: Liquid

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

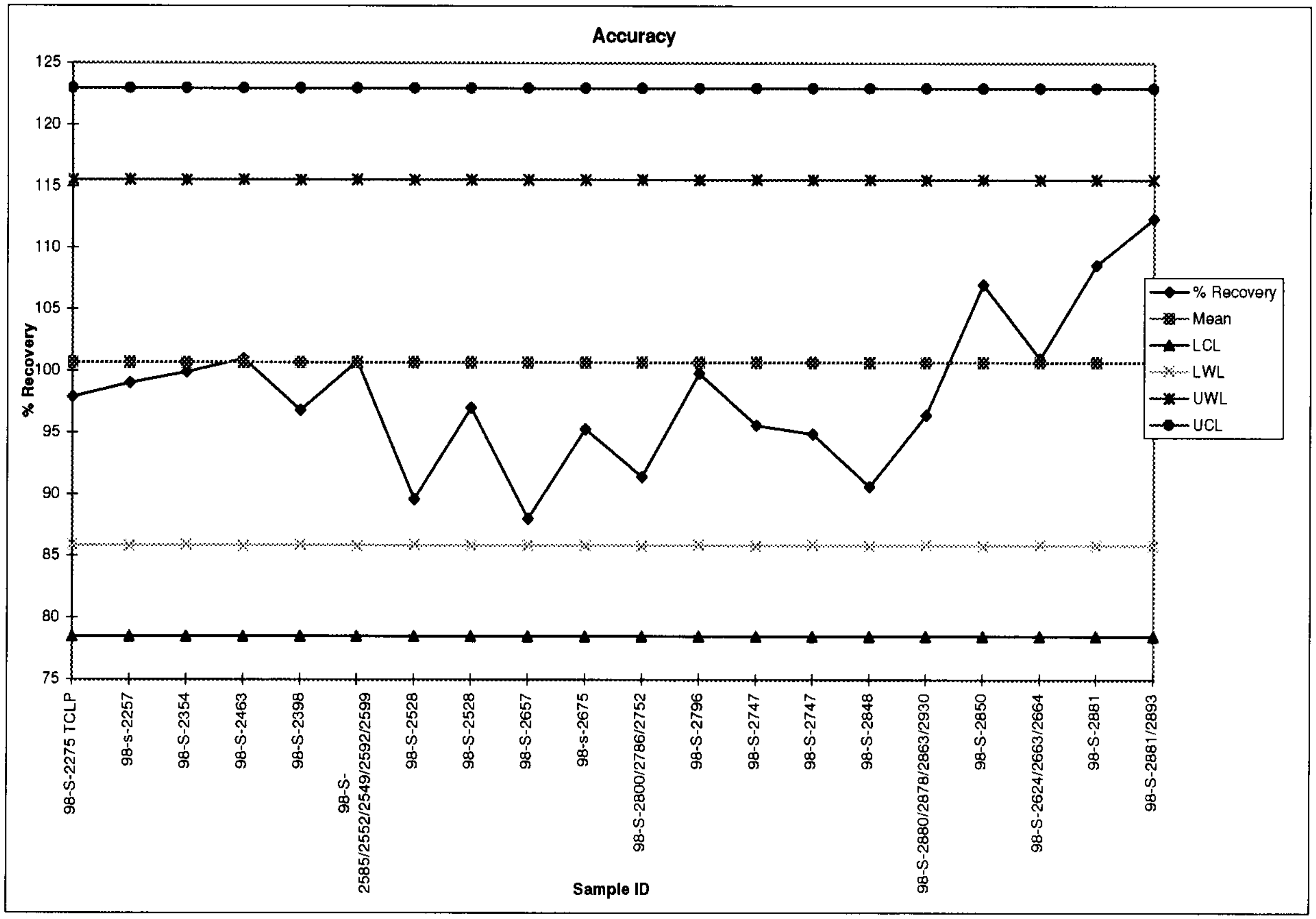


Table A-6. TCLP Extract Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-S-2991/2934	3015/6010	5/19/98	0.473	0.5	95	99.39	77.26	84.64	114.14	121.51
98-S-3145/3172/3188/3189	3015/6010	5/27/98	9.94	10	99	99.39	77.26	84.64	114.14	121.51
98-S-3229/3069	3015/6010	5/28/98	0.508	0.5	102	99.39	77.26	84.64	114.14	121.51
98-S-3146/3220/3253	3015/6010	5/29/98	0.558	0.5	112	99.39	77.26	84.64	114.14	121.51
98-S-3243/3277/3298/3345	3015/6010	6/3/98	0.492	0.5	98	99.39	77.26	84.64	114.14	121.51
98-S-3436/3350/3435	3015/6010	6/8/98	0.499	0.5	100	99.39	77.26	84.64	114.14	121.51
98-S-3513	3015/6010	6/10/98	0.489	0.5	98	99.39	77.26	84.64	114.14	121.51
98-S-3514	3015/6010	6/11/98	0.5	0.5	100	99.39	77.26	84.64	114.14	121.51
98-S-3315/3353/3363/3566	3015/6010	6/12/98	0.458	0.5	92	99.39	77.26	84.64	114.14	121.51
98-S-2528	3015/6010	6/12/98	9.02	10	90	99.39	77.26	84.64	114.14	121.51
98-S-3579/3679	3015/6010	6/16/98	9.45	10	95	99.39	77.26	84.64	114.14	121.51
98-S-3624	3015/6010	6/18/98	11.3	10	113	99.39	77.26	84.64	114.14	121.51
98-S-3875/3762/3723	3015/6010	6/24/98	0.491	0.5	98	99.39	77.26	84.64	114.14	121.51
98-S-3807/3790/3831/3772	3015/6010	6/26/98	9.66	10	97	99.39	77.26	84.64	114.14	121.51
98-S-3693	3015/6010	6/30/98	0.482	0.5	96	99.39	77.26	84.64	114.14	121.51
98-S-3802	3015/6010	7/2/98	8.96	10	90	99.39	77.26	84.64	114.14	121.51
98-S-3802	3015/6010	7/2/98	8.75	10	88	99.39	77.26	84.64	114.14	121.51
98-S-3802	3015/6010	7/2/98	9.05	10	91	99.39	77.26	84.64	114.14	121.51
98-S-3802	3015/6010	7/2/98	8.86	10	89	99.39	77.26	84.64	114.14	121.51
98-S-3457	3015/6010	7/8/98	9.56	10	96	99.39	77.26	84.64	114.14	121.51

Chart A-6. TCLP Extract Laboratory Control Samples for Lead

Method: EPA SW 846 6010
Analyte: Lead
Matrix: Liquid

Central Line=Mean Recovery
WL = /- 2 SD
CL = +/- 3 SD

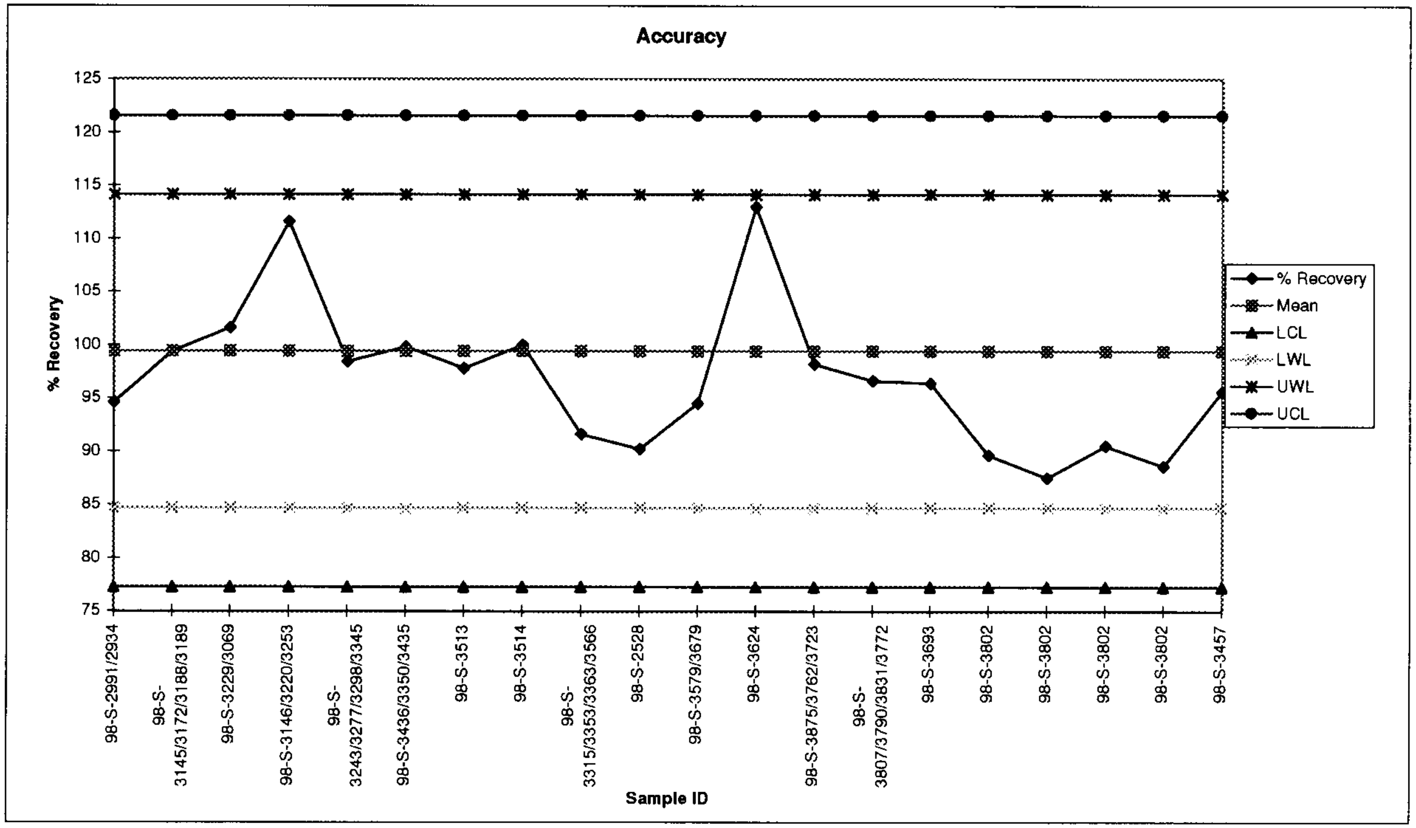


Table A-7. TCLP Extract Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
98-S-3457	3015/6010	7/8/98	10.92	10	109	99.37	78.36	85.36	113.37	120.37
98-S-4198	3015/6010	7/8/98	9.58	10	96	99.37	78.36	85.36	113.37	120.37
98-S-4145	3015/6010	7/9/98	9.74	10	97	99.37	78.36	85.36	113.37	120.37
98-s-4197/4154	3015/6010	7/10/98	0.521	0.5	104	99.37	78.36	85.36	113.37	120.37
98-S-4263	3015/6010	7/13/98	0.466	0.5	93	99.37	78.36	85.36	113.37	120.37
98-S-4027/4261	3015/6010	7/13/98	0.509	0.5	102	99.37	78.36	85.36	113.37	120.37
98-s-4309/4596/4605/4618	3015/6010	7/30/98	0.497	0.5	99	99.37	78.36	85.36	113.37	120.37
98-S-4772/4818/4853/4888	3015/6010	8/7/98	0.457	0.5	91	99.37	78.36	85.36	113.37	120.37
98-S-4765	3015/6010	8/11/98	0.537	0.5	107	99.37	78.36	85.36	113.37	120.37
98-S-4766	3015/6010	8/11/98	0.537	0.5	107	99.37	78.36	85.36	113.37	120.37
98-S-4869	3015/6010	8/11/98	0.518	0.5	104	99.37	78.36	85.36	113.37	120.37
98-S-5036	3015/6010	8/13/98	9.43	10	94	99.37	78.36	85.36	113.37	120.37
98-S-4899/4930	3015/6010	8/17/98	0.48	0.5	96	99.37	78.36	85.36	113.37	120.37
98-S-4900/5086/5087/5115	3015/6010	8/19/98	0.473	0.5	95	99.37	78.36	85.36	113.37	120.37
98-S-5089/5098/5099/5057	3015/6010	8/19/98	9.6	10	96	99.37	78.36	85.36	113.37	120.37
98-S-5345	3015/6010	8/25/98	9.69	10	97	99.37	78.36	85.36	113.37	120.37
						99.37	78.36	85.36	113.37	120.37
						99.37	78.36	85.36	113.37	120.37
						99.37	78.36	85.36	113.37	120.37
						99.37	78.36	85.36	113.37	120.37

Chart A-7. TCLP Extract Laboratory Control Samples for Lead

Method: EPA SW-846 3015/6010
Analyte: Lead
Matrix: Liquid

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

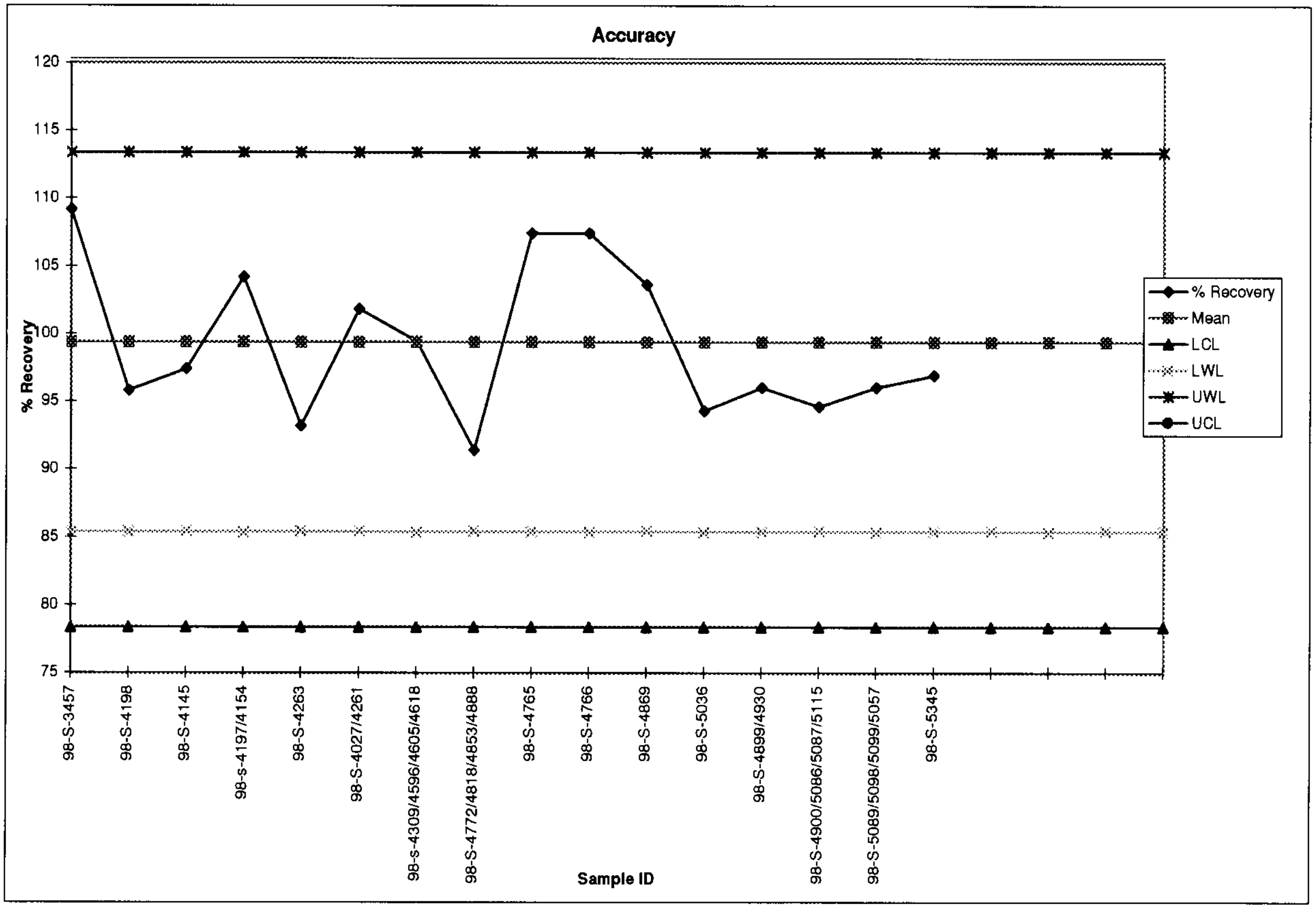


Table A-8. Air Filter Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
6833	7300	4/15/98	102	100	102	101.95	90.09	94.04	109.86	113.81
6834	7300	4/15/98	98.3	100	98.3	101.95	90.09	94.04	109.86	113.81
6835	7300	4/15/98	100	100	100	101.95	90.09	94.04	109.86	113.81
6832	7300	4/16/98	101	100	101	101.95	90.09	94.04	109.86	113.81
6865	7300	4/16/98	102	100	102	101.95	90.09	94.04	109.86	113.81
6433	7300	4/20/98	103	100	103	101.95	90.09	94.04	109.86	113.81
6866	7300	4/20/98	103	100	103	101.95	90.09	94.04	109.86	113.81
6831	7300	4/21/98	110	100	110	101.95	90.09	94.04	109.86	113.81
6868	7300	4/22/98	104	100	104	101.95	90.09	94.04	109.86	113.81
6830	7300	4/23/98	104	100	104	101.95	90.09	94.04	109.86	113.81
7292	7300	4/23/98	10.2	10	102	101.95	90.09	94.04	109.86	113.81
6867	7300	4/24/98	106	100	106	101.95	90.09	94.04	109.86	113.81
7274	7300	4/28/98	9.93	10	99.3	101.95	90.09	94.04	109.86	113.81
7287	7300	4/28/98	9.72	10	97.2	101.95	90.09	94.04	109.86	113.81
7288	7300	4/29/98	10.7	10	107	101.95	90.09	94.04	109.86	113.81
7470	7300	4/29/98	98.7	100	98.7	101.95	90.09	94.04	109.86	113.81
7471	7300	4/29/98	99.3	100	99.3	101.95	90.09	94.04	109.86	113.81
7472	7300	4/29/98	100.6	100	100.6	101.95	90.09	94.04	109.86	113.81
7473	7300	4/29/98	101	100	101	101.95	90.09	94.04	109.86	113.81
7491	7300	4/29/98	101	100	101	101.95	90.09	94.04	109.86	113.81

Chart A-8. Air Filter Laboratory Control Samples for Lead

Method: NIOSH 7300
Analyte: Lead
Matrix: Filter

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

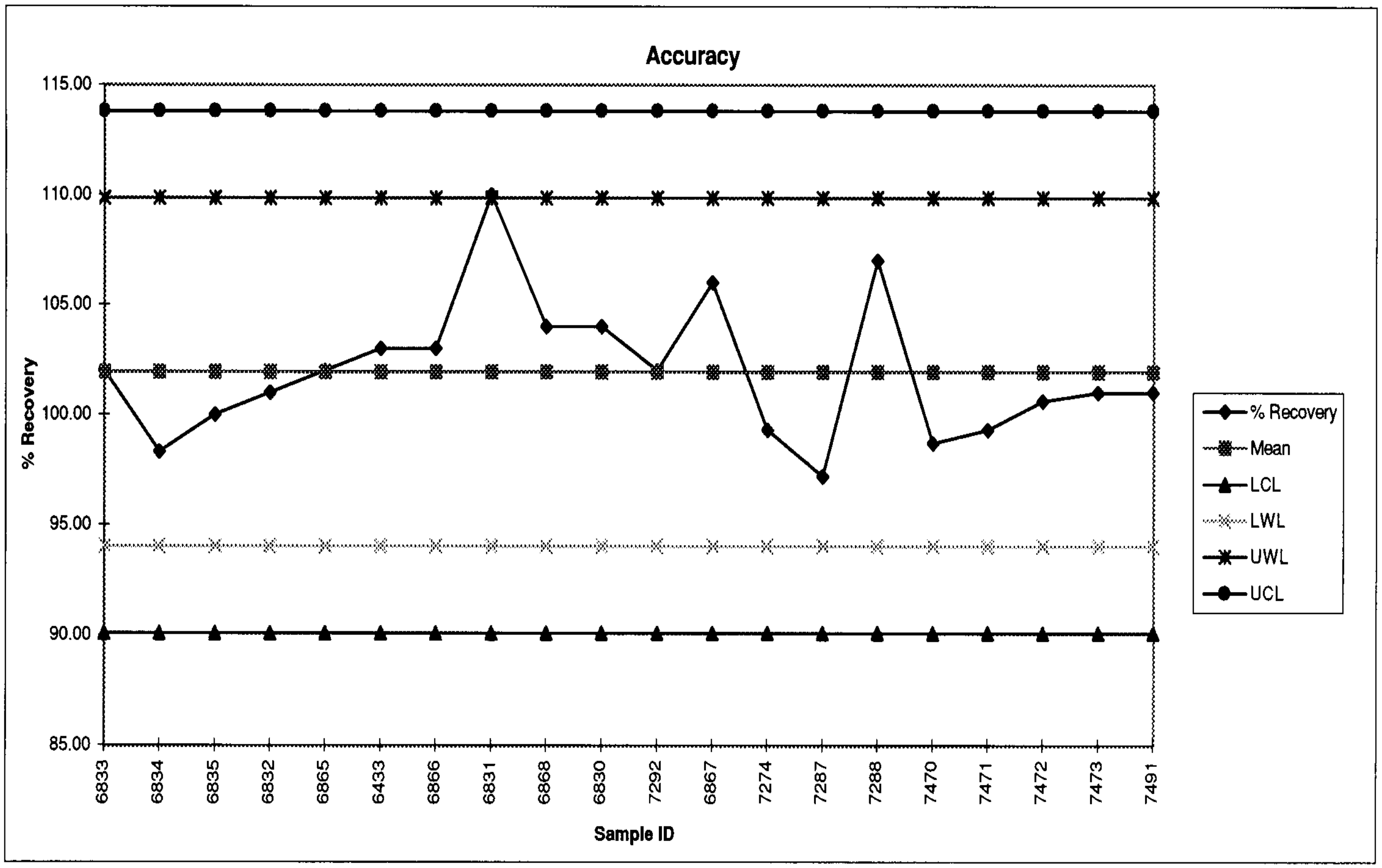


Table A-9. Air Filter Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
7474	7300	4/30/98	100	100	100	100.39	90.03	93.48	107.29	110.74
7492	7300	5/4/98	96.6	100	96.6	100.39	90.03	93.48	107.29	110.74
7493	7300	5/8/98	94.6	100	94.6	100.39	90.03	93.48	107.29	110.74
7494	7300	5/8/98	96.6	100	96.6	100.39	90.03	93.48	107.29	110.74
7506	7300	5/13/98	10.7	10	107	100.39	90.03	93.48	107.29	110.74
7483	7300	5/15/98	104.4	100	104.4	100.39	90.03	93.48	107.29	110.74
7484	7300	5/19/98	98.3	100	98.3	100.39	90.03	93.48	107.29	110.74
7495	7300	5/21/98	9.79	10	97.9	100.39	90.03	93.48	107.29	110.74
7485	7300	5/26/98	101	100	101	100.39	90.03	93.48	107.29	110.74
7486	7300	5/26/98	99.8	100	99.8	100.39	90.03	93.48	107.29	110.74
7487	7300	5/26/98	99.9	100	99.9	100.39	90.03	93.48	107.29	110.74
7488	7300	5/26/98	105	100	105	100.39	90.03	93.48	107.29	110.74
7476	7300	5/27/98	99.4	100	99.4	100.39	90.03	93.48	107.29	110.74
7477	7300	5/29/98	101	100	101	100.39	90.03	93.48	107.29	110.74
7481	7300	6/8/98	96.8	100	96.8	100.39	90.03	93.48	107.29	110.74
7489	7300	6/9/98	98.5	100	98.5	100.39	90.03	93.48	107.29	110.74
7475	7300	6/11/98	104	100	104	100.39	90.03	93.48	107.29	110.74
7479	7300	6/11/98	105	100	105	100.39	90.03	93.48	107.29	110.74
7480	7300	6/11/98	97.9	100	97.9	100.39	90.03	93.48	107.29	110.74
7482	7300	6/11/98	104	100	104	100.39	90.03	93.48	107.29	110.74

Chart A-9. Air Filter Laboratory Control Samples for Lead

Method: NIOSH 7300
Analyte: Lead
Matrix: Filter

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD

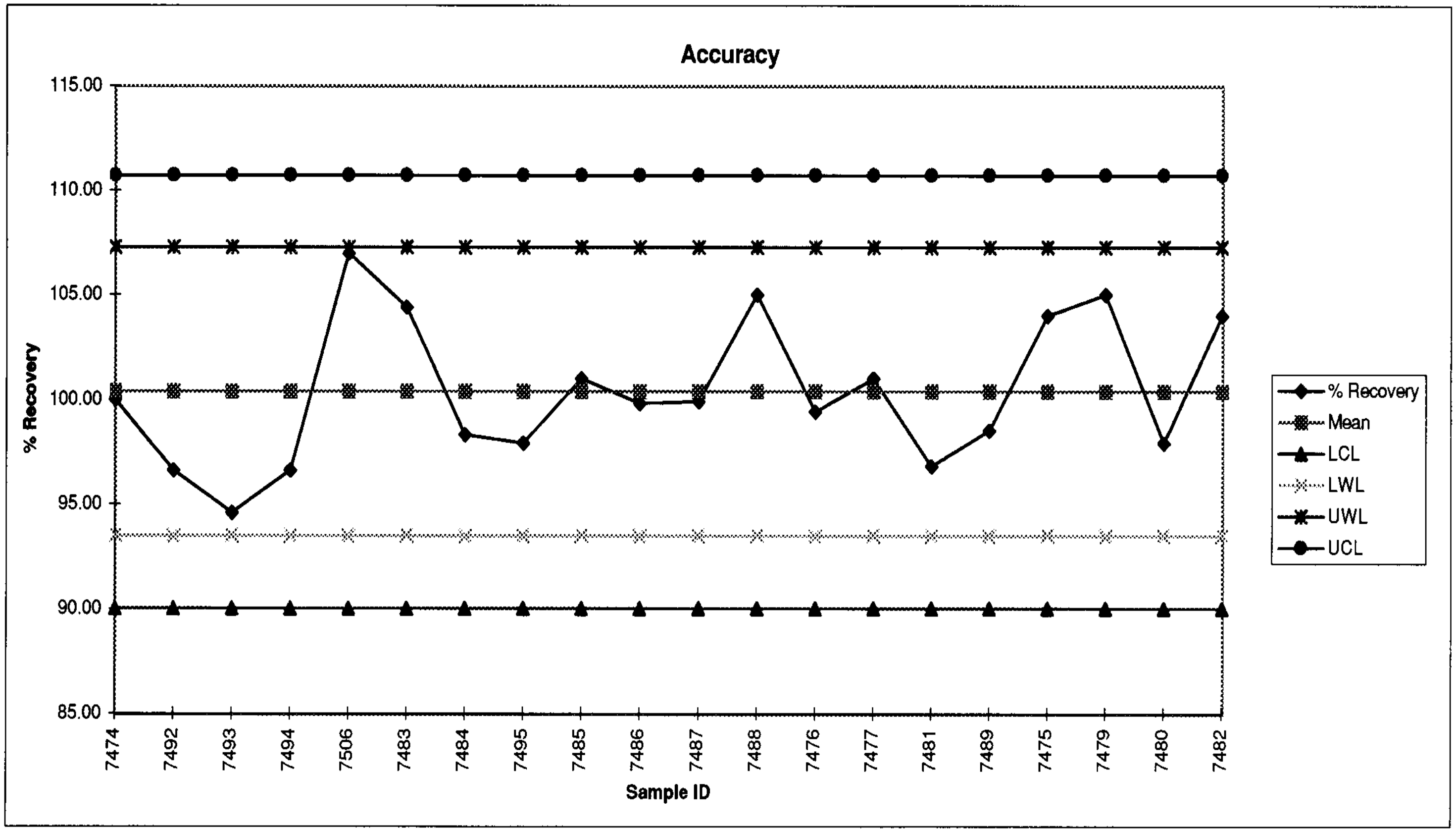


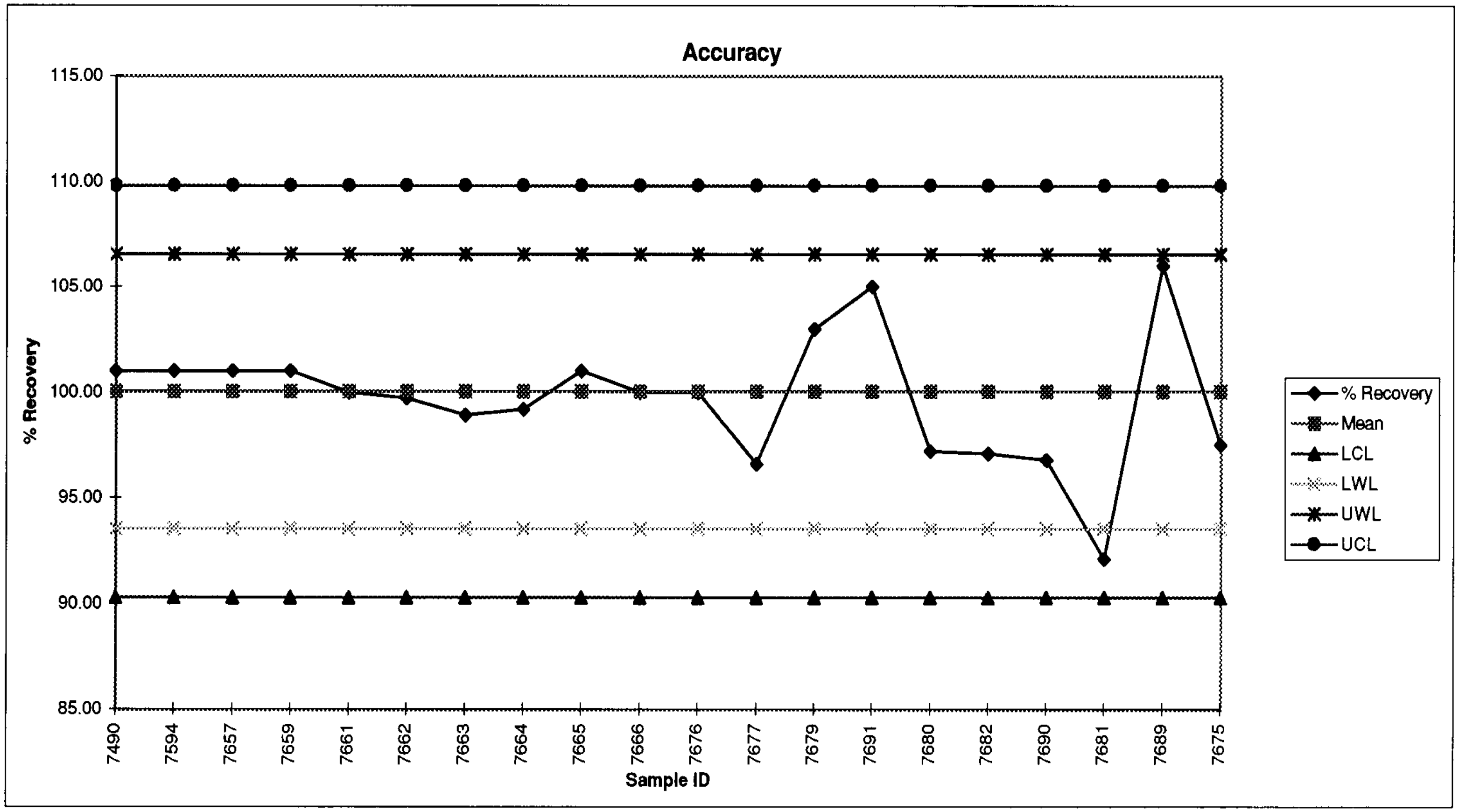
Table A-10. Air Filter Laboratory Control Samples for Lead

QC Number	Method	Date	Found	Target	% Recovery	Mean	LCL	LWL	UWL	UCL
7490	7300	6/11/98	101	100	101	100.05	90.28	93.54	106.55	109.81
7594	7300	6/11/98	10.1	10	101	100.05	90.28	93.54	106.55	109.81
7657	7300	6/18/98	101	100	101	100.05	90.28	93.54	106.55	109.81
7659	7300	6/18/98	101	100	101	100.05	90.28	93.54	106.55	109.81
7661	7300	6/18/98	100	100	100	100.05	90.28	93.54	106.55	109.81
7662	7300	6/18/98	99.7	100	99.7	100.05	90.28	93.54	106.55	109.81
7663	7300	6/18/98	98.9	100	98.9	100.05	90.28	93.54	106.55	109.81
7664	7300	6/18/98	99.2	100	99.2	100.05	90.28	93.54	106.55	109.81
7665	7300	6/18/98	101	100	101	100.05	90.28	93.54	106.55	109.81
7666	7300	6/18/98	100	100	100	100.05	90.28	93.54	106.55	109.81
7676	7300	6/23/98	100	100	100	100.05	90.28	93.54	106.55	109.81
7677	7300	6/23/98	96.6	100	96.6	100.05	90.28	93.54	106.55	109.81
7679	7300	6/25/98	103	100	103	100.05	90.28	93.54	106.55	109.81
7691	7300	6/25/98	105	100	105	100.05	90.28	93.54	106.55	109.81
7680	7300	7/1/98	97.2	100	97.2	100.05	90.28	93.54	106.55	109.81
7682	7300	7/1/98	97.1	100	97.1	100.05	90.28	93.54	106.55	109.81
7690	7300	7/1/98	96.8	100	96.8	100.05	90.28	93.54	106.55	109.81
7681	7300	7/798	92.1	100	92.1	100.05	90.28	93.54	106.55	109.81
7689	7300	7/9/98	106	100	106	100.05	90.28	93.54	106.55	109.81
7675	7300	7/13/98	97.5	100	97.5	100.05	90.28	93.54	106.55	109.81

Chart A-10. Air Filter Laboratory Control Samples for Lead

Method: NIOSH 7300
Analyte: Lead
Matrix: Filter

Central Line=Mean Recovery
WL = +/- 2 SD
CL = +/- 3 SD



Appendix B
XRF Measurements of Lead on Wood and Brick Before Paint Removal Using a Niton Model 703-A (Variable-Time Mode, "Combined Lead Reading")

Site Location	Date Tested	Substrate	Technology	Paint Film Thickness (mil)	Lead (mg/cm^2)	Classification	Depth Index
1-A	4/18/98	Wood	Torbo/Blastox	110	29.5	Positive	3.4
1-B	4/18/98	Wood	Torbo/Blastox	100	23.1	Positive	2.5
1-C	4/18/98	Wood	Torbo/Blastox	70	51.9	Positive	2.9
1-C	4/18/98	Wood	Torbo/Blastox	80	42.3	Positive	2.6
1-C	4/18/98	Wood	Torbo/Blastox	50	44.5	Positive	2.6
2	4/18/98	Wood	Torbo/Blastox	80	40.6	Positive	2.7
2	4/18/98	Wood	Torbo/Blastox	60	42.4	Positive	3.7
2	4/18/98	Wood	Torbo/Blastox	80	40.5	Positive	3.5
2	4/18/98	Wood	Torbo/Blastox	90	45.6	Positive	2.9
2	4/18/98	Wood	Torbo/Blastox	80	41.2	Positive	2.8
3-A	4/18/98	Wood	Torbo/Pre-Tox	90	23.9	Positive	2.3
3-B	4/18/98	Wood	Torbo/Pre-Tox	70	20.1	Positive	2.4
3-C	4/18/98	Wood	Torbo/Pre-Tox	60	32.8	Positive	2.3
3-C-1	4/18/98	Wood	Torbo/Pre-Tox	60	22.7	Positive	2.3
3-C-2	4/18/98	Wood	Torbo/Pre-Tox	70	29.4	Positive	2.4
4-A	4/18/98	Wood	Torbo/Pre-Tox	60	13.1	Positive	3.1
4-B	4/18/98	Wood	Torbo/Pre-Tox	50	40.9	Positive	3.5
4-C	4/18/98	Wood	Torbo/Pre-Tox	60	38.6	Positive	5.4
4-D	4/18/98	Wood	Torbo/Pre-Tox	70	38.9	Positive	3.8
4-D-1	4/18/98	Wood	Torbo/Pre-Tox	70	19.0	Positive	5.5
5-A	4/18/98	Wood	Torbo/Blastox	70	15.5	Positive	3.9
5-B	4/18/98	Wood	Torbo/Blastox	60	33.8	Positive	4.7
5-C	4/18/98	Wood	Torbo/Blastox	70	28.6	Positive	5.4
5-D	4/18/98	Wood	Torbo/Blastox	70	33.5	Positive	5.9
5-D-1	4/18/98	Wood	Torbo/Blastox	70	40.6	Positive	3.9
6-A	4/18/98	Wood	Torbo/Pre-Tox	70	28.9	Positive	4.1
6-B	4/18/98	Wood	Torbo/Pre-Tox	50	41.4	Positive	5.3
6-C	4/18/98	Wood	Torbo/Pre-Tox	70	18.0	Positive	3.9
6-D	4/18/98	Wood	Torbo/Pre-Tox	60	40.2	Positive	5.0
6-D-1	4/18/98	Wood	Torbo/Pre-Tox	70	37.3	Positive	4.1
1	5/29/98	Brick	Torbo-Pre-Tox	24	8.3	Positive	5.4
1	5/29/98	Brick	Torbo-PreTox	30	6.3	Positive	5.1
1	5/29/98	Brick	Torbo-PreTox	25	8.3	Positive	6.3
1	5/29/98	Brick	Torbo-PreTox	26	4.1	Positive	7.2
1	5/29/98	Brick	Torbo-PreTox	29	3.9	Positive	6.1
2	5/29/98	Brick	Torbo-Blastox	14	9.7	Positive	4.9
2	5/29/98	Brick	Torbo-Blastox	25	7.2	Positive	4.7
2	5/29/98	Brick	Torbo-Blastox	24	6.2	Positive	6.3
2	5/29/98	Brick	Torbo-Blastox	27	5.7	Positive	4.6
2	5/29/98	Brick	Torbo-Blastox	25	6.0	Positive	6.8
3	5/29/98	Brick	Torbo-PreTox	17	13.2	Positive	4.7
3	5/29/98	Brick	Torbo-PreTox	26	15.2	Positive	5

(continued)

APPENDIX B (continued)

Site Location	Date Tested	Substrate	Technology	Paint Film Thickness (mil)	Lead (mg/cm^2)	Classification	Depth Index
3	5/29/98	Brick	Torbo-PreTox	22	12.8	Positive	4.3
3	5/29/98	Brick	Torbo-PreTox	20	12.8	Positive	4.3
3	5/29/98	Brick	Torbo-PreTox	24	6.7	Positive	2.4
4	5/29/98	Brick	Torbo-Blastox	18	5.4	Positive	4.1
4	5/29/98	Brick	Torbo-Blastox	17	5.3	Positive	4
4	5/29/98	Brick	Torbo-Blastox	21	1.5	Positive	7.3
4	5/29/98	Brick	Torbo-Blastox	20	4.5	Positive	6.1
4	5/29/98	Brick	Torbo-Blastox	18	3.7	Positive	3.7
5	5/29/98	Brick	Torbo-PreTox	20	7.4	Positive	6
5	5/29/98	Brick	Torbo-PreTox	18	9.1	Positive	4
5	5/29/98	Brick	Torbo-PreTox	19	4.8	Positive	3.5
5	5/29/98	Brick	Torbo-PreTox	21	4.4	Positive	3.3
5	5/29/98	Brick	Torbo-PreTox	17	5.4	Positive	9.3
6	5/29/98	Brick	Torbo-Blastox	26	6.2	Positive	4.2
6	5/29/98	Brick	Torbo-Blastox	22	5.5	Positive	4.9
6	5/29/98	Brick	Torbo-Blastox	21	5.5	Positive	4.9
6	5/29/98	Brick	Torbo-Blastox	24	6.8	Positive	4.3
6	5/29/98	Brick	Torbo-Blastox	20	4.7	Positive	9.8

Appendix C
XRF Measurements of Lead on Wood and Brick After Paint Removal
Using a Niton Model 703-A (Variable-Time Mode, "Combined Lead Reading")

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
1-A	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-A	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.0
1-A	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-A	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.4
1-A	4/21/98	Wood	Torbo-Blastox	0.2	Negative	1.1
1-A	4/21/98	Wood	Torbo-Blastox	0.2	Negative	1.2
1-A	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.0
1-A	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.8
1-B	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-B	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-B	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.3
1-B	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.0
1-B	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.0
1-B	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.0
1-B	4/21/98	Wood	Torbo-Blastox	0.2	Negative	1.2
1-B	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-C	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.3
1-C	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-C	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-C	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.1
1-C	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.5
1-C	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.1
1-C	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.3
1-C	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
1-C	4/21/98	Wood	Torbo-Blastox	0.0	Negative	1.0
2	4/21/98	Wood	Torbo-Blastox	0.5	Negative	6.2
2	4/21/98	Wood	Torbo-Blastox	0.5	Negative	3.3
2	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.9
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.5
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.6
2	4/21/98	Wood	Torbo-Blastox	0.5	Negative	1.6
2	4/21/98	Wood	Torbo-Blastox	0.6	Negative	2.2
2	4/21/98	Wood	Torbo-Blastox	0.9	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.1
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	2.3
2	4/21/98	Wood	Torbo-Blastox	0.3	Negative	1.5
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.3	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.2	Negative	1.3
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.6	Negative	2.3
2	4/21/98	Wood	Torbo-Blastox	0.3	Negative	1.8
2	4/21/98	Wood	Torbo-Blastox	0.5	Negative	2.6

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
2	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1
2	4/21/98	Wood	Torbo-Blastox	0.3	Negative	1.7
2	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.1	Negative	1.4
2	4/21/98	Wood	Torbo-Blastox	0.2	Negative	1.1
2	4/21/98	Wood	Torbo-Blastox	0.3	Negative	1.1
2	4/21/98	Wood	Torbo-Blastox	0.4	Negative	2.3
3-A	4/22/98	Wood	Torbo-PreTox	0.1	Negative	7.5
3-A	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-A	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-A	4/22/98	Wood	Torbo-PreTox	0.5	Negative	2.6
3-A	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-B	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.5
3-B	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-B	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.3
3-B	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-B	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.3
3-C	4/22/98	Wood	Torbo-PreTox	0.1	Negative	2.7
3-C	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.3
3-C	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-C	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.2
3-C	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.6
3-C1	4/22/98	Wood	Torbo-PreTox	0.1	Negative	2.1
3-C1	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
3-C1	4/22/98	Wood	Torbo-PreTox	0.6	Negative	2.9
3-C1	4/22/98	Wood	Torbo-PreTox	0.3	Negative	1.4
3-C1	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.0
3-C2	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.0
3-C2	4/22/98	Wood	Torbo-PreTox	0.2	Negative	1.2
3-C2	4/22/98	Wood	Torbo-PreTox	0.3	Negative	1.2
3-C2	4/22/98	Wood	Torbo-PreTox	0.3	Negative	2.1
3-C2	4/22/98	Wood	Torbo-PreTox	0.2	Negative	1.0
4-A	4/22/98	Wood	Torbo-PreTox	0.1	Negative	2.8
4-A	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.9
4-A	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.6
4-A	4/22/98	Wood	Torbo-PreTox	0.2	Negative	2.7
4-A	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
4-B	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.0
4-B	4/22/98	Wood	Torbo-PreTox	0.6	Negative	1.3
4-B	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.3
4-B	4/22/98	Wood	Torbo-PreTox	0.3	Negative	1.7
4-B	4/22/98	Wood	Torbo-PreTox	0.2	Negative	1.0
4-C	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.1
4-C	4/22/98	Wood	Torbo-PreTox	0.2	Negative	1.0
4-C	4/22/98	Wood	Torbo-PreTox	0.2	Negative	2.6

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
4-C	4/22/98	Wood	Torbo-PreTox	0.2	Negative	2.0
4-C	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.0
4-D	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.2
4-D	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.1
4-D	4/22/98	Wood	Torbo-PreTox	0.4	Negative	2.1
4-D	4/22/98	Wood	Torbo-PreTox	0.2	Negative	2.0
4-D	4/22/98	Wood	Torbo-PreTox	0.1	Negative	1.2
4-D-1	4/22/98	Wood	Torbo-PreTox	0.7	Negative	2.0
4-D-1	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
4-D-1	4/22/98	Wood	Torbo-PreTox	0.3	Negative	1.2
4-D-1	4/22/98	Wood	Torbo-PreTox	0.0	Negative	1.0
4-D-1	4/22/98	Wood	Torbo-PreTox	0.2	Negative	1.0
5-A	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.0
5-A	4/22/98	Wood	Torbo-Blastox	0.0	Negative	1.0
5-A	4/22/98	Wood	Torbo-Blastox	0.1	Negative	5.4
5-A	4/22/98	Wood	Torbo-Blastox	0.2	Negative	4.8
5-A	4/22/98	Wood	Torbo-Blastox	0.0	Negative	1.0
5-B	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.0
5-B	4/22/98	Wood	Torbo-Blastox	0.2	Negative	2.2
5-B	4/22/98	Wood	Torbo-Blastox	0.4	Negative	1.0
5-B	4/22/98	Wood	Torbo-Blastox	0.1	Negative	1.6
5-B	4/22/98	Wood	Torbo-Blastox	0.1	Negative	1.6
5-C	4/22/98	Wood	Torbo-Blastox	0.1	Negative	1.0
5-C	4/22/98	Wood	Torbo-Blastox	0.0	Negative	1.0
5-C	4/22/98	Wood	Torbo-Blastox	0.2	Negative	2.8
5-C	4/22/98	Wood	Torbo-Blastox	0.0	Negative	1.0
5-C	4/22/98	Wood	Torbo-Blastox	0.0	Negative	1.1
5-D	4/22/98	Wood	Torbo-Blastox	1.1	Negative	1.3
5-D	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.7
5-D	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.0
5-D	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.0
5-D	4/22/98	Wood	Torbo-Blastox	0.3	Negative	1.1
5-D-1	4/22/98	Wood	Torbo-Blastox	0.4	Negative	1.8
5-D-1	4/22/98	Wood	Torbo-Blastox	0.2	Negative	1.5
5-D-1	4/22/98	Wood	Torbo-Blastox	0.8	Negative	2.2
5-D-1	4/22/98	Wood	Torbo-Blastox	0.3	Negative	2.1
5-D-1	4/22/98	Wood	Torbo-Blastox	0.5	Negative	2.8
6-A	4/24/98	Wood	Torbo-PreTox	0.0	Negative	1.0
6-A	4/24/98	Wood	Torbo-PreTox	0.1	Negative	7.7
6-A	4/24/98	Wood	Torbo-PreTox	0.4	Negative	4.9
6-A	4/24/98	Wood	Torbo-PreTox	0.0	Negative	1.0
6-A	4/24/98	Wood	Torbo-PreTox	0.1	Negative	6.7
6-B	4/24/98	Wood	Torbo-PreTox	0.0	Negative	1.0
6-B	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0
6-B	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
6-B	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0
6-B	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0
6-C	4/24/98	Wood	Torbo-PreTox	0.0	Negative	1.0
6-C	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.5
6-C	4/24/98	Wood	Torbo-PreTox	0.1	Negative	2.1
6-C	4/24/98	Wood	Torbo-PreTox	0.5	Negative	2.5
6-C	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.2
6-D	4/24/98	Wood	Torbo-Pre-Tox	0.2	Negative	2.9
6-D	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.4
6-D	4/24/98	Wood	Torbo-PreTox	0.4	Negative	1.5
6-D	4/24/98	Wood	Torbo-PreTox	0.2	Negative	1.0
6-D	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.1
6-D-1	4/24/98	Wood	Torbo-Pre-Tox	0.4	Negative	2.4
6-D-1	4/24/98	Wood	Torbo-PreTox	0.4	Negative	2.2
6-D-1	4/24/98	Wood	Torbo-PreTox	0.2	Negative	1.0
6-D-1	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0
6-D-1	4/24/98	Wood	Torbo-PreTox	0.1	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	3.7
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.9
1	6/2/98	Brick	Torbo-PreTox	0.3	Negative	5.2
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.6
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.1
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.1
1	6/2/98	Brick	Torbo-PreTox	0.2	Negative	3.6
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.2
1	6/2/98	Brick	Torbo-PreTox	0.2	Negative	2.5
1	6/2/98	Brick	Torbo-PreTox	0.1	Negative	3.3
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
1	6/2/98	Brick	Torbo-PreTox	0.2	Negative	2.2
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	2.0
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.8
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.6
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.1
1	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
2	5/30/98	Brick	Torbo-Blastox	0.2	Negative	2.8
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.3
2	5/30/98	Brick	Torbo-Blastox	0.2	Negative	3.5

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.4
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.7
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.3
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.5
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	2.9
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.5
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.8
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	3.1
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	2.5
2	5/30/98	Brick	Torbo-Blastox	0.2	Negative	6.5
2	5/30/98	Brick	Torbo-Blastox	0.0	Negative	1.8
2	5/30/98	Brick	Torbo-Blastox	0.0	Negative	1.8
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	3.1
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	2.8
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.8
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.9
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	2.3
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	2.5
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.9
2	5/30/98	Brick	Torbo-Blastox	0.1	Negative	1.8
2	5/30/98	Brick	Torbo-Blastox	0.2	Negative	1.9
2	5/30/98	Brick	Torbo-Blastox	0.4	Negative	5.7
3	6/2/98	Brick	Torbo-PreTox	0.2	Negative	2.6
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.2
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.0
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	4.6
3	6/2/98	Brick	Torbo-PreTox	0.2	Negative	2.3
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.6
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.3
3	6/2/98	Brick	Torbo-PreTox	0.3	Negative	1.3
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.8
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	3.1
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	1.0
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	3.5
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.7
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.5
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.5
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.4
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	3.4
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.1
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.3
3	6/2/98	Brick	Torbo-PreTox	0.0	Negative	1.0

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.6
3	6/2/98	Brick	Torbo-PreTox	0.1	Negative	2.0
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	3.0
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	2.8
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	2.1
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	3.1
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	2.1
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	3.1
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	1.9
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	1.2
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	1.6
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	7.8
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	4.7
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	2.1
4	6/2/98	Brick	Torbo-Blastox	0	Negative	1.2
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	1.7
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	2.1
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	3.1
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	1.4
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	4.6
4	6/2/98	Brick	Torbo-Blastox	0.1	Negative	2.2
4	6/2/98	Brick	Torbo-Blastox	0	Negative	1.5
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	1.5
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	2.2
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	1.9
4	6/2/98	Brick	Torbo-Blastox	0.2	Negative	1.4
4	6/2/98	Brick	Torbo-Blastox	0.3	Negative	1.5
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.4
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.3
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.0
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	3.7
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	1.5
5	6/1/98	Brick	Torbo-PreTox	0.3	Negative	5.7
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	1.3
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	2.1
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	2.6
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	1.3
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.0
5	6/1/98	Brick	Torbo-PreTox	1.1	Negative	10.0
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	2.7
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	2.2
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	3.8
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	6.1
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	2.2
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	3.7

(continued)

APPENDIX C (continued)

Site Location	Date Tested	Substrate	Technology	Lead (mg/cm^2)	Classification	Depth Index
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.0
5	6/1/98	Brick	Torbo-PreTox	0.3	Negative	2.0
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	1.8
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	3.6
5	6/1/98	Brick	Torbo-PreTox	0.1	Negative	2.1
5	6/1/98	Brick	Torbo-PreTox	0.0	Negative	1.1
5	6/1/98	Brick	Torbo-PreTox	0.2	Negative	2.7
6	6/1/98	Brick	Torbo-Blastox	0.0	Negative	1.3
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	2.3
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	2.9
6	6/1/98	Brick	Torbo-Blastox	0.3	Negative	1.6
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.5
6	6/1/98	Brick	Torbo-Blastox	0.0	Negative	1.7
6	6/1/98	Brick	Torbo-Blastox	0.0	Negative	1.0
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.5
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.5
6	6/1/98	Brick	Torbo-Blastox	0.0	Negative	1.1
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	4.1
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	2.7
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	2.7
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.8
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	2.4
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	2.3
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	1.6
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.3
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.7
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	2.3
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.6
6	6/1/98	Brick	Torbo-Blastox	0.1	Negative	1.6
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	2.4
6	6/1/98	Brick	Torbo-Blastox	0.2	Negative	3.5
6	6/1/98	Brick	Torbo-Blastox	0.3	Negative	1.8

Appendix D
Lead Content of Dry Paint Film Samples Before Paint Removal by ICP-AES

Site Location	Date Sampled	Sample Number	Substrate	Technology	Lead Content	
					µg/g	mg/cm^2
1-A	4/19/98	1-PC-A-01	Wood	Torbo/Blastox	170,000	19.8
1-B	4/19/98	1-PC-B-02	Wood	Torbo/Blastox	180,000	16.9
1-C	4/19/98	1-PC-C-03	Wood	Torbo/Blastox	310,000	25.8
2	4/19/98	2-PC-A-01	Wood	Torbo/Blastox	260,000	34.7
2	4/19/98	2-PC-A-02	Wood	Torbo/Blastox	260,000	39.7
2	4/19/98	2-PC-A-03	Wood	Torbo/Blastox	260,000	51.6
3-A	4/19/98	3-PC-A-01	Wood	Torbo/PreTox	150,000	23.8
3-B	4/19/98	3-PC-B-02	Wood	Torbo/PreTox	150,000	19.8
3-C	4/19/98	3-PC-C-03	Wood	Torbo/PreTox	200,000	25.8
4-A	4/19/98	4-PC-1-01	Wood	Torbo/PreTox	170,000	11.9
4-B	4/19/98	4-PC-3-03	Wood	Torbo/PreTox	230,000	39.7
4-C	4/19/98	4-PC-4-02	Wood	Torbo/PreTox	330,000	31.7
5-A	4/19/98	5-PC-2-01	Wood	Torbo/Blastox	210,000	34.7
5-B	4/19/98	5-PC-1-02	Wood	Torbo/Blastox	140,000	17.9
5-C	4/19/98	5-PC-4-03	Wood	Torbo/Blastox	210,000	40.7
6-A	4/19/98	6-PC-1-01	Wood	Torbo/PreTox	180,000	13.9
6-B	4/19/98	6-PC-2-02	Wood	Torbo/PreTox	280,000	49.6
6-C	4/19/98	6-PC-2-03	Wood	Torbo/PreTox	200,000	9.1
1	4/28/98	PC-PT-1-01	Brick	Torbo/PreTox	56,000	2.0
1	4/28/98	PC-PT-1-02	Brick	Torbo/PreTox	62,000	3.2
1	4/28/98	PC-PT-1-03	Brick	Torbo/PreTox	45,000	2.7
2	4/28/98	PC-B-2-01	Brick	Torbo/Blastox	74,000	3.8
2	4/28/98	PC-B-2-02	Brick	Torbo/Blastox	20,000	1.3
2	4/28/98	PC-B-2-03	Brick	Torbo/Blastox	28,000	1.8
3	4/28/98	PC-PT-3-01	Brick	Torbo/PreTox	63,000	3.8
3	4/28/98	PC-PT-3-02	Brick	Torbo/PreTox	130,000	5.9
3	4/28/98	PC-PT-3-03	Brick	Torbo/PreTox	130,000	9.1
4	4/28/98	PC-B-4-01	Brick	Torbo/Blastox	94,000	0.4
4	4/28/98	PC-B-4-02	Brick	Torbo/Blastox	4,300	0.2
4	4/28/98	PC-B-4-03	Brick	Torbo/Blastox	60,000	2.8
5	4/28/98	PC-PT-5-01	Brick	Torbo/PreTox	77,000	4.9
5	4/28/98	PC-PT-5-02	Brick	Torbo/PreTox	24,000	1.7
5	4/28/98	PC-PT-5-03	Brick	Torbo/PreTox	59,000	1.8
6	4/28/98	PC-B-6-01	Brick	Torbo/Blastox	35,000	3.1
6	4/28/98	PC-B-6-02	Brick	Torbo/Blastox	29,000	1.5
6	4/28/98	PC-B-6-03	Brick	Torbo/Blastox	62,000	2.7

Appendix E
Lead Content of Wood and Brick Substrates After Paint Removal by ICP-AES

Site Location	Date Sampled	Sample Number	Substrate	Technology	Lead Content µg/g	Lead Content mg/cm^2
1-A	4/19/98	1-BS-A-01	Wood	Torbo/Blastox	6,000	0.30
1-B	4/19/98	1-BS-B-02	Wood	Torbo/Blastox	1,400	0.08
1-C	4/19/98	1-BS-C-03	Wood	Torbo/Blastox	5,100	0.53
1-C	4/19/98	1-BS-C-04	Wood	Torbo/Blastox	3,900	0.26
1-C	4/19/98	1-BS-C-05	Wood	Torbo/Blastox	7,900	0.38
2	4/19/98	2-BS-A-01	Wood	Torbo/Blastox	7,000	0.60
2	4/19/98	2-BS-A-02	Wood	Torbo/Blastox	15,000	0.85
2	4/19/98	2-BS-A-03	Wood	Torbo/Blastox	2,200	0.28
2	4/19/98	2-BS-A-04	Wood	Torbo/Blastox	490	0.05
2	4/19/98	2-BS-A-05	Wood	Torbo/Blastox	12,000	0.69
3-A	4/19/98	3-BS-A-01	Wood	Torbo/PreTox	2,500	0.21
3-B	4/19/98	3-BS-A-02	Wood	Torbo/PreTox	1,300	0.10
3-C	4/19/98	3-BS-A-03	Wood	Torbo/PreTox	140	0.01
3-C	4/19/98	3-BS-C1-04	Wood	Torbo/PreTox	2,700	0.27
3-C	4/19/98	3-BS-C2-05	Wood	Torbo/PreTox	2,100	0.18
4-A	4/19/98	4-BS-1-01	Wood	Torbo/PreTox	2,500	0.24
4-B	4/19/98	4-BS-4-02	Wood	Torbo/PreTox	12,000	0.76
4-C	4/19/98	4-BS-4-03	Wood	Torbo/PreTox	1,200	0.10
4-C	4/19/98	4-BS-1-04	Wood	Torbo/PreTox	2,000	0.16
4-C	4/19/98	4-BS-2-05	Wood	Torbo/PreTox	4,600	0.39
5-A	4/19/98	5-BS-2-01	Wood	Torbo/Blastox	7,900	0.52
5-B	4/19/98	5-BS-1-02	Wood	Torbo/Blastox	920	0.07
5-C	4/19/98	5-BS-4-03	Wood	Torbo/Blastox	1,500	0.07
5-C	4/19/98	5-BS-3-04	Wood	Torbo/Blastox	860	0.04
5-C	4/19/98	5-BS-4-05	Wood	Torbo/Blastox	210	0.02
6-A	4/19/98	6-BS-4-01	Wood	Torbo/PreTox	3,100	0.22
6-B	4/19/98	6-BS-3-02	Wood	Torbo/PreTox	1,800	0.07
6-C	4/19/98	6-BS-2-03	Wood	Torbo/PreTox	2,400	0.25
6-C	4/19/98	6-BS-1-04	Wood	Torbo/PreTox	45,000	2.68
6-C	4/19/98	6-BS-4-05	Wood	Torbo/PreTox	9000	0.61
1	6/2/98	BS-PT-1-01	Brick	Torbo/PreTox	190	0.04
1	6/2/98	BS-PT-1-02	Brick	Torbo/PreTox	20	0.005
1	6/2/98	BS-PT-1-03	Brick	Torbo/PreTox	290	0.05
1	6/2/98	BS-PT-1-04	Brick	Torbo/PreTox	4,300	1.39
1	6/2/98	BS-PT-1-05	Brick	Torbo/PreTox	220	0.04
5	6/2/98	BS-PT-5-01	Brick	Torbo/PreTox	170	0.04
5	6/2/98	BS-PT-5-02	Brick	Torbo/PreTox	2,300	0.58
5	6/2/98	BS-PT-5-03	Brick	Torbo/PreTox	6,000	0.74
5	6/2/98	BS-PT-5-04	Brick	Torbo/PreTox	63	0.02
5	6/2/98	BS-PT-5-05	Brick	Torbo/PreTox	180	0.06
3	6/2/98	BS-PT-3-01	Brick	Torbo/PreTox	240	0.04
3	6/2/98	BS-PT-3-02	Brick	Torbo/PreTox	88	0.02
3	6/2/98	BS-PT-3-03	Brick	Torbo/PreTox	1,300	0.36
3	6/2/98	BS-PT-3-04	Brick	Torbo/PreTox	250	0.05

(continued)

APPENDIX E (continued)

Site Location	Date Sampled	Sample Number	Substrate	Technology	Lead Content µg/g	Lead Content mg/cm^2
3	6/2/98	BS-PT-3-05	Brick	Torbo/PreTox	1,600	0.42
6	6/2/98	BS-B-6-01	Brick	Torbo/Blastox	260	0.04
6	6/2/98	BS-B-6-02	Brick	Torbo/Blastox	320	0.07
6	6/2/98	BS-B-6-03	Brick	Torbo/Blastox	150	0.04
6	6/2/98	BS-B-6-04	Brick	Torbo/Blastox	1,400	0.30
6	6/2/98	BS-B-6-05	Brick	Torbo/Blastox	1,800	0.15
4	6/2/98	BS-B-4-01	Brick	Torbo/Blastox	130	0.03
4	6/2/98	BS-B-4-02	Brick	Torbo/Blastox	92	0.02
4	6/2/98	BS-B-4-03	Brick	Torbo/Blastox	540	0.09
4	6/2/98	BS-B-4-04	Brick	Torbo/Blastox	450	0.06
4	6/2/98	BS-B-4-05	Brick	Torbo/Blastox	1,400	0.59
2	6/2/98	BS-B-2-01	Brick	Torbo/Blastox	2,800	0.28
2	6/2/98	BS-B-2-02	Brick	Torbo/Blastox	320	0.04
2	6/2/98	BS-B-2-03	Brick	Torbo/Blastox	490	0.11
2	6/2/98	BS-B-2-04	Brick	Torbo/Blastox	510	0.08
2	6/2/98	BS-B-2-05	Brick	Torbo/Blastox	1,300	0.15

Appendix F
TCLP for Lead in Abrasive Media Debris from Removal of Lead-Based Paint from Wood

					Leachable Lead	Extract Solution	
Site Location	Date Sampled	Sample Number	Substrate	Technology	mg/L	pH 1	pH 2
1	4/19/98	1-BD-B-01	Wood	Torbo/Blastox	3.7	NR[a]	NR
1	4/19/98	1-BD-B-02	Wood	Torbo/Blastox	21.0	NR	NR
2	4/20/98	2-BD-B-01	Wood	Torbo/Blastox	26.0	NR	NR
2	4/20/98	2-BD-B-02	Wood	Torbo/Blastox	4.9	NR	NR
5	4/20/98	5-BD-B-01	Wood	Torbo/Blastox	20.0	NR	NR
5	4/20/98	5-BD-B-02	Wood	Torbo/Blastox	52.0	NR	NR
3	4/21/98	3-BD-PT-01	Wood	Torbo/PreTox	1.0	NR	NR
3	4/21/98	3-BD-PT-02	Wood	Torbo/PreTox	21.0	NR	NR
3	4/21/98	3-BD-PT-03	Wood	Torbo/PreTox	1.2	NR	NR
4	4/22/98	4-BD-PT-01	Wood	Torbo/PreTox	37.0	NR	NR
4	4/22/98	4-BD-PT-02	Wood	Torbo/PreTox	32.0	NR	NR
4	4/22/98	4-BD-PT-03	Wood	Torbo/PreTox	20.0	NR	NR
6	4/22/98	6-BD-PT-01	Wood	Torbo/PreTox	3.0	NR	NR
6	4/22/98	6-BD-PT-02	Wood	Torbo/PreTox	18.0	NR	NR
6	4/22/98	6-BD-PT-03	Wood	Torbo/PreTox	0.3	NR	NR
3, 4, 6	6/11/98	D1-PT-WOT-1	Wood	Torbo/PreTox	21.0	9.85	3.77
3, 4, 6	6/11/98	D1-PT-WOT-2	Wood	Torbo/PreTox	21.0	10.39	1.90
3, 4, 6	6/11/98	D1-PT-WT-1	Wood	Torbo/PreTox	0.1	11.14	9,95
3, 4, 6	6/11/98	D2-PT-WOT-1	Wood	Torbo/PreTox	26.0	10.49	1.94
3, 4, 6	6/11/98	D2-PT-WOT-2	Wood	Torbo/PreTox	28.0	10.56	1.88
3, 4, 6	6/11/98	D2-PT-WT-1	Wood	Torbo/PreTox	0.1	11.16	2.60
3, 4, 6	6/11/98	D3-PT-WOT-1	Wood	Torbo/PreTox	1.1	10.42	2.01
3, 4, 6	6/11/98	D3-PT-WOT-2	Wood	Torbo/PreTox	1.5	10.40	1.96
3, 4, 6	6/11/98	D3-PT-WT-1	Wood	Torbo/PreTox	<0.1	11.03	2.36
3, 4, 6	6/11/98	D4-PT-WOT-1	Wood	Torbo/PreTox	3.4	10.18	1.91
3, 4, 6	6/11/98	D4-PT-WOT-2	Wood	Torbo/PreTox	1.7	10.31	2.40
1, 2, 5	6/11/98	D1-B-WOT-1	Wood	Torbo/Blastox	24.0	10.23	1.83
1, 2, 5	6/11/98	D1-B-WOT-2	Wood	Torbo/Blastox	16.0	10.35	1.88
1, 2, 5	6/11/98	D1-B-WT-1	Wood	Torbo/Blastox	25.0	11.19	3.99
1, 2, 5	6/11/98	D2-B-WOT-1	Wood	Torbo/Blastox	29.0	10.54	1.92
1, 2, 5	6/11/98	D2-B-WOT-2	Wood	Torbo/Blastox	18.0	10.56	1.85
1, 2, 5	6/11/98	D2-B-WT-1	Wood	Torbo/Blastox	38.0	11.30	2.66
1, 2, 5	6/11/98	D3-B-WOT-1	Wood	Torbo/Blastox	<0.1	11.07	1.95
1, 2, 5	6/11/98	D3-B-WOT-2	Wood	Torbo/Blastox	0.3	10.77	1.81
1, 2, 5	6/11/98	D3-B-WT-1	Wood	Torbo/Blastox	0.2	11.40	5.89
1, 2, 5	6/11/98	D4-B-WOT-1	Wood	Torbo/Blastox	7.0	10.78	2.77
1, 2, 5	6/11/98	D4-B-WOT-2	Wood	Torbo/Blastox	5.9	10.35	2.19

a NR denotes that the pH of the extract solution was not reported.

Appendix G
TCLP for Lead in Abrasive Media Debris from Removal of Lead-Based Paint from Brick

Site Location	Date Sampled	Sample Number	Substrate	Technology	Leachable Lead mg/L	Extract Solution pH 1	pH 2
1	6/2/98	BD-1-PT-1	Brick	Torbo/PreTox	0.2	10.30	3.53
1	6/2/98	BD-1-PT-2	Brick	Torbo/PreTox	2.0	10.40	7.15
2	5/29/98	BD-2-B-1	Brick	Torbo/Blastox	10.0	10.37	2.11
2	5/29/98	BD-2-B-2	Brick	Torbo/Blastox	8.7	10.38	2.00
3	6/1/98	BD-3-PT-1	Brick	Torbo/PreTox	19.0	10.34	2.24
3	6/1/98	BD-3-PT-2	Brick	Torbo/PreTox	20.0	10.33	2.33
4	5/30/98	BD-4-B-1	Brick	Torbo/Blastox	7.8	10.66	2.04
4	5/30/98	BD-4-B-2	Brick	Torbo/Blastox	3.9	10.58	1.86
5	6/1/98	BD-5-PT-1	Brick	Torbo/PreTox	1.6	10.48	5.54
5	6/1/98	BD-5-PT-2	Brick	Torbo/PreTox	5.5	10.47	5.20
6	5/31/98	BD-6-B-1	Brick	Torbo/Blastox	7.9	10.71	2.38
6	5/31/98	BD-6-B-2	Brick	Torbo/Blastox	8.7	10.73	2.32

Appendix H
Personal and Area Air Concentrations of Lead Measured During Removal of Lead-Based Paint from Wood and Brick Substrates

Site	Date	Sample Number	Sample Type	Substrate	Technology	Sample Period (Hours)	Sample Volume (Liters)	Air Level (µg/m^3)	8-hr TWA (µg/m^3)
1	4/19/98	1-OP-01	Personal	Wood	Torbo/Blastox	3.53	424	230	101
1	4/19/98	1-OA-01	Area	Wood	Torbo/Blastox	4.05	486	82	42
1	4/19/98	1-OA-02	Area	Wood	Torbo/Blastox	4.08	490	63	32
2	4/20/98	2-OP-2	Personal	Wood	Torbo/Blastox	3.83	460	180	86
2	4/20/98	2-OA-03	Area	Wood	Torbo/Blastox	3.67	440	41	19
2	4/20/98	2-OA-04	Area	Wood	Torbo/Blastox	3.67	440	16	7
2	4/20/98	2-OA-05	Area	Wood	Torbo/Blastox	3.67	440	64	29
3	4/22/98	3-OP-01	Personal	Wood	Torbo/PreTox	4.08	490	170	87
3	4/22/98	3-OA-01	Area	Wood	Torbo/PreTox	4.67	560	41	24
3	4/22/98	3-OA-02	Area	Wood	Torbo/PreTox	4.67	560	59	34
3	4/22/98	3-OA-03	Area	Wood	Torbo/PreTox	4.67	560	63	37
3	4/22/98	3-OA-04	Area	Wood	Torbo/PreTox	4.67	560	32	19
4	4/21/98	4-OP-01	Personal	Wood	Torbo/PreTox	5.75	690	48	35
4	4/21/98	4-OA-01	Area	Wood	Torbo/PreTox	6.20	744	19	15
4	4/21/98	4-OA-02	Area	Wood	Torbo/PreTox	6.20	744	67	52
4	4/21/98	4-OA-03	Area	Wood	Torbo/PreTox	6.20	744	50	39
4	4/21/98	4-OA-04	Area	Wood	Torbo/PreTox	6.20	744	9.8	8
5	4/20/98	5-OP-01	Personal	Wood	Torbo/Blastox	5.42	650	37	25
5	4/20/98	5-OA-01	Area	Wood	Torbo/Blastox	5.25	630	10	7
5	4/20/98	5-OA-02	Area	Wood	Torbo/Blastox	5.25	630	51	33
5	4/20/98	5-OA-03	Area	Wood	Torbo/Blastox	5.25	630	16	11
5	4/20/98	5-OA-04	Area	Wood	Torbo/Blastox	5.08	610	8.5	5
6	4/22/98	6-OP-01	Personal	Wood	Torbo/PreTox	5.42	650	65	44
6	4/22/98	6-OA-01	Area	Wood	Torbo/PreTox	5.42	650	38	26
6	4/22/98	6-OA-02	Area	Wood	Torbo/PreTox	5.42	650	32	22
6	4/22/98	6-OA-03	Area	Wood	Torbo/PreTox	5.42	650	46	31
6	4/22/98	6-OA-04	Area	Wood	Torbo/PreTox	5.42	650	26	18
1	6/2/98	P-OP-1-01	Personal	Brick	Torbo/PreTox	4.67	585	140	82
1	6/2/98	P-HP-1-02	Personal	Brick	Torbo/PreTox	3.95	488	140	69
1	6/2/98	A-R-1-01	Area	Brick	Torbo/PreTox	4.80	1,492	8.7	5
1	6/2/98	A-R-1-03	Area	Brick	Torbo/PreTox	4.80	1492	4.7	3
1	6/2/98	A-G-1-01	Area	Brick	Torbo/PreTox	4.77	1,481	68	41
1	6/2/98	A-G-1-02	Area	Brick	Torbo/PreTox	4.75	1476	11	7
1	6/2/98	A-G-1-03	Area	Brick	Torbo/PreTox	4.63	1,440	90	52
2	5/29/98	P-OP-2-01	Personal	Brick	Torbo/Blastox	5.33	640	66	44
2	5/29/98	P-HP-2-02	Personal	Brick	Torbo/Blastox	4.37	640	38	21
2	5/29/98	A-R-2-01	Area	Brick	Torbo/Blastox	5.08	1,580	1.5	1
2	5/29/98	A-R-2-02	Area	Brick	Torbo/Blastox	5.10	1,585	0.76	0
2	5/29/98	A-R-2-03	Area	Brick	Torbo/Blastox	5.12	1,590	3.2	2
2	5/29/98	A-G-2-01	Area	Brick	Torbo/Blastox	5.03	1,594	77	48
2	5/29/98	A-G-2-02	Area	Brick	Torbo/Blastox	5.05	1,570	31	20
2	5/29/98	A-G-2-03	Area	Brick	Torbo/Blastox	5.07	1,575	76	48

(continued)

APPENDIX H (continued)

Site	Date	Sample Number	Sample Type	Substrate	Technology	Sample Period (Hours)	Sample Volume (Liters)	Air Level (μg/m^3)	8-hr TWA (μg/m^3)
3	6/1/98	P-OP-3-01	Personal	Brick	Torbo/PreTox	4.77	586	120	72
3	6/1/98	A-R-3-01	Area	Brick	Torbo/PreTox	4.67	1,450	4.3	3
3	6/1/98	A-R-3-03	Area	Brick	Torbo/PreTox	4.67	1,450	1.4	1
3	6/1/98	A-G-3-01	Area	Brick	Torbo/PreTox	4.42	1,373	130	72
3	6/1/98	A-G-3-02	Area	Brick	Torbo/PreTox	4.40	1,368	50	28
3	6/1/98	A-G-3-03	Area	Brick	Torbo/PreTox	4.38	1,362	120	66
4	5/30/98	P-OP-4-01	Personal	Brick	Torbo/Blastox	4.10	492	96	49
4	5/30/98	P-HP-4-02	Personal	Brick	Torbo/Blastox	4.10	492	150	77
4	5/30/98	A-R-4-01	Area	Brick	Torbo/Blastox	4.10	1,274	1.3	1
4	5/30/98	A-R-4-02	Area	Brick	Torbo/Blastox	4.12	1,279	1.1	1
4	5/30/98	A-R-4-03	Area	Brick	Torbo/Blastox	4.15	1,290	4.4	2
4	5/30/98	A-G-4-01	Area	Brick	Torbo/Blastox	4.05	1,259	21	11
4	5/30/98	A-G-4-02	Area	Brick	Torbo/Blastox	4.02	1,248	16	8
4	5/30/98	A-G-4-03	Area	Brick	Torbo/Blastox	4.00	1,243	130	65
5	6/1/98	P-OP-5-01	Personal	Brick	Torbo/PreTox	5.75	683	120	86
5	6/1/98	P-OP-5-02	Personal	Brick	Torbo/PreTox	5.75	697	140	101
5	6/1/98	A-R-5-01	Area	Brick	Torbo/PreTox	5.28	1,642	2.6	2
5	6/1/98	A-R-5-02	Area	Brick	Torbo/PreTox	5.30	1,647	9.1	6
5	6/1/98	A-R-5-03	Area	Brick	Torbo/PreTox	5.32	1.652	3.3	2
5	6/1/98	A-G-5-01	Area	Brick	Torbo/PreTox	5.70	1,772	31	22
5	6/1/98	A-G-5-02	Area	Brick	Torbo/PreTox	5.72	1,777	16	11
5	6/1/98	A-G-5-03	Area	Brick	Torbo/PreTox	5.75	1,787	110	79
6	5/31/98	P-OP-6-01	Personal	Brick	Torbo/Blastox	6.92	834	84	73
6	5/31/98	P-OP-6-02	Personal	Brick	Torbo/Blastox	6.92	838	170	147
6	5/31/98	A-R-6-01	Area	Brick	Torbo/Blastox	7.85	2,440	2	2
6	5/31/98	A-R-6-02	Area	Brick	Torbo/Blastox	7.87	2,445	1.6	2
6	5/31/98	A-R-6-03	Area	Brick	Torbo/Blastox	7.87	2,445	13	13
6	5/31/98	A-G-6-01	Area	Brick	Torbo/Blastox	7.68	2,388	150	144
6	5/31/98	A-G-6-02	Area	Brick	Torbo/Blastox	7.7	2,393	9.2	9
6	5/31/98	A-G-6-03	Area	Brick	Torbo/Blastox	7.7	2,393	6.3	6

Appendix I
Particle Size Distribution of Lead Particulate Measured
Using a Cascade Impactor on Operator During Paint Removal from Brick

Site	Date Sampled	Sample Number	Impactor Stage	Air Volume (Liters)	Lead Level (µg/m^{3})
1	6/2/98	CI-1-1	One	510	45
1	6/2/98	CI-1-2	Two	510	39
1	6/2/98	CI-1-3	Three	510	69
1	6/2/98	CI-1-4	Four	510	1
1	6/2/98	CI-1-5	Five	510	41
1	6/2/98	CI-1-6	Six	510	11
1	6/2/98	CI-1-7	Seven	510	2
1	6/2/98	CI-1-8	Eight	510	0.6
1	6/2/98	CI-1-F	Final	510	0.6
3	6/1/98	CI-1-1	One	561	4.6
3	6/1/98	CI-1-2	Two	561	52
3	6/1/98	CI-1-3	Three	561	62
3	6/1/98	CI-1-4	Four	561	27
3	6/1/98	CI-1-5	Five	561	27
3	6/1/98	CI-1-6	Six	561	16
3	6/1/98	CI-1-7	Seven	561	2.9
3	6/1/98	CI-1-8	Eight	561	1
3	6/1/98	CI-1-F	Final	561	0.5

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