ECONOMIC ANALYSIS OF THE FINAL RULE ON LEAD-BASED PAINT: REQUIREMENTS FOR NOTIFICATION, EVALUATION AND REDUCTION OF LEAD-BASED PAINT HAZARDS IN FEDERALLY-OWNED RESIDENTIAL PROPERTY AND HOUSING RECEIVING FEDERAL ASSISTANCE

U.S. Department of Housing and Urban Development

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Prepared by ICF Consulting for:

Office of Lead Hazard Control
U.S. Department of Housing and Urban Development

EXECUTIVE SUMMARY

This economic analysis examines the costs and benefits of the Department of Housing and Urban Development (HUD) final rule for lead-based paint (LBP) hazard evaluation and reduction activities for federally-supported housing. This document fulfills the requirements of Executive Order 12291, which requires HUD to prepare a Regulatory Impact Analysis for all major rulemakings. This economic analysis will hereafter be referred to as the Regulatory Impact Analysis (RIA).

Background

Although lead ingestion is hazardous to all humans, children under six years of age are the population at highest risk of lead poisoning. Children under age six are more vulnerable because their nervous systems are still developing. Similarly, all children of any age are more sensitive than adults. This RIA, however, only reflects monetized benefits for children under age six.

- At high levels, lead poisoning can cause coma, convulsions, and death. Such severe cases of lead poisoning are now extremely rare, but do still occur.

- At lower levels, observed adverse health effects from lead poisoning in young children include reduced intelligence, reading and learning disabilities, impaired hearing, and slowed growth.

Beginning in the 1970's, restrictions on the use of lead in gasoline and in solder for food cans greatly reduced the amount of lead being released into the environment. At the same time, the introduction of new sources of lead into the environment was limited by restricting the use of lead in paints and in pipes and solder for drinking water systems. As a result, blood lead levels for children under six declined by 75 percent over the 1980s, and declined by another 29 percent through the early 1990s. In 1991, however, the Centers for Disease Control and Prevention (CDC) lowered the blood lead intervention level for young children from 25 to 10 ug/dL. Despite the decline in blood lead levels over the past decade, recent data show that 900,000 children still have blood lead levels above 10 ug/dL. The CDC identifies the two most important remaining sources of lead hazards to be deteriorated lead-based paint in housing built before 1978 and urban soil and dust contaminated by past emissions of leaded gasoline and by paint on dwellings and other structures. These are the hazards targeted by the final rule. Chapter 1 of the RIA provides additional background on the adverse health effects of lead and the nature and extent of LBP hazards addressed by this rule.

Legislative Framework and Regulatory Options

Title X of the Housing and Community Development Act of 1992, also known as the Residential Lead-Based Paint Hazard Reduction Act of 1992 (the Act), prescribes specific lead-based paint hazard evaluation and reduction activities for federally-supported housing. The requirements of Title X as implemented in the final rule vary by housing program and by year of construction. The requirements for specific HUD programs are detailed in Subparts E through M of the final rule, and are further discussed in Chapter 5 of this RIA. In general, the rule requires the following types of hazard evaluation and reduction activities:

Hazard Evaluation:

- Risk Assessment

  - Visual assessment for deteriorated paint
  - Dust tests (window sills and floors)
  - Soil tests
  - Paint chip tests (for deteriorated LBP)

- Clearance and Reevaluation

Hazard Reduction:

- Paint stabilization
- Interim controls of LBP hazards on friction and impact surfaces
- Abatement of LBP hazards
- Cleanup
- Soil hazard cover or abatement.

Different hazard evaluation requirements are specified for different HUD programs. Some programs require a complete risk assessment, but many require only a visual assessment for deteriorated paint. Clearance testing is required after hazard reduction activities, but hazard reevaluation (in future years) is only required for Multifamily Project-Based Assistance (Subpart H), in Public Housing (Subpart L), and for HUD-owned properties held for more than one year (Subparts F and I).

Hazard reduction activities are triggered by the identification of LBP hazards. Paint stabilization or abatement is required when LBP is deteriorated or disturbed by rehab. Friction and impact surface work is required when window or floor dust levels fail the interim standards and friction or impact surface hazards (e.g., tight fitting doors or windows with LBP) are present. Cleanup is required when dust lead fails the interim standards, and work area cleanup is required after other hazard reduction activities (e.g., paint stabilization). LBP hazard abatement is only required for rehab work exceeding $25,000 per unit. Even in these cases, hazard abatement refers only to the abatement of LBP surfaces that pose hazards (e.g., deteriorated LBP surfaces). Complete abatement of LBP (including intact surfaces) is required only in public housing, but this is not a new requirement with this final rule.

The final rule reflects the prescriptive language of Title X, which limits the range of regulatory options that HUD could consider in implementing legislative requirements. Variations in the requirements under different Subparts, however, illustrate the costs and benefits associated with different options for LBP hazard evaluation and reduction.

Cost-Benefit Analysis Methodology

The analysis of net benefits in the RIA reflects costs and benefits associated with the first year of hazard evaluation and reduction activities under the final rule. These costs and benefits, however, include the present value of future costs and benefits associated with first year hazard reduction activities. For example, the costs associated with first year activities include the present value of future reevaluation costs. Similarly, the benefits of first year activities include the present value of lifetime earnings benefits for children living in or visiting the affected unit during the first year, and for children living in or visiting that unit during the second and subsequent years after hazard reduction activities.

The present value of lifetime earnings benefits is particularly sensitive to discount rate assumptions in the analysis, because these benefits reflect lifetime earnings many decades into the future. The RIA presents estimated benefits using two different discount rates for lifetime earnings -- three percent and seven percent. For all other benefit and cost estimates, the RIA uses only a seven percent rate.

Employing a three percent discount rate for the lifetime earnings estimates, the RIA concludes that benefits of first-year activities are $1,143 million, while costs are only $253 million. Thus, the estimated net benefit is $890 million. If a seven percent discount rate is used for lifetime earnings benefits, the present value of the benefits associated with first year activities is estimated to be $324 million, and estimated costs remain at $253 million. The final rule would therefore entail net benefits of $71 million using the seven percent discount rate.

While the Office of Management and Budget (OMB) specifies seven percent as the appropriate discount rate for most regulatory analyses, OMB guidance recognizes that a special social rate of time preference is appropriate when conducting intergenerational analysis. An intergenerational discount rate is applicable to the final rule because the costs will be borne by adult taxpayers, and lifetime earning benefits will be realized by the children and grandchildren of these adult taxpayers. EPA's analysis of this issue (in the 1996 RIA for the regulations implementing Sections 402(a) and 404 of the Toxic Substances Control Act) has concluded that a three percent discount rate best reflects the social rate of time preference for annualized, non-capital costs and benefits.

An intermediate approach, not quantified in the RIA, could have used a real discount rate based on the long-term borrowing costs of the Federal government. The seven percent rate used in most regulatory analyses is intended to reflect OMB's estimate of the opportunity cost of capital, based on the average real rates of return on private investments. This rate is appropriate for most regulatory analyses because most regulations impose costs on the private sector. The final rule, however, imposes costs on Federally-assisted housing. Most of these costs will be funded directly or indirectly by federal expenditures. If these expenditures increase the national debt, then the real cost of that debt to future generations will compound at the real long-term federal rate. The Internal Revenue Service's Applicable Federal Rate (AFR) measures the nominal cost of government borrowing over obligations with different maturities. The long-term AFR adjusted for the implicit price deflator results in real AFRs of approximately four to five percent over recent years. Therefore, benefits could be discounted at this real AFR rate (i.e., 4 to 5 percent).

By presenting results using both three and seven percent, HUD is providing the broadest view of costs and benefits. Additional information on the methodology and results of the cost-benefit analysis is provided below.

The methodology used in this analysis to estimate annual costs and benefits for the final rule is based on the following simple formulas:

Regulatory Costs = (unit cost) x (unit cost frequency) x (number of affected units);
and

Regulatory Benefits = (unit benefit) x (unit benefit frequency) x (number of affected units).

The unit cost estimates reflect the average costs associated with specific hazard evaluation and reduction activities in a single housing unit. The unit benefit estimates are the benefits achieved by conducting hazard reduction activities in a single housing unit. Unit cost frequencies reflect the extent of required hazard evaluation activities under the final rule, and the occurrence frequencies of different lead-based paint hazards that trigger hazard reduction requirements. Unit benefit frequencies are also determined by the occurrence frequencies of lead-based paint hazards, because benefits are realized by hazard reduction activities. The affected units, for regulatory costs and benefits, are federally assisted units affected by the final rule.

Regulatory Costs

The cost estimates used in this RIA reflect the estimated average cost per unit for LBP hazard evaluation and reduction activities in single and multifamily units affected by the final rule. In the case of rehab programs, the regulatory cost estimates for paint stabilization and LBP hazard abatement activities reflect only the incremental costs of the final rule. For example, the unit cost of stabilizing paint that would not otherwise have been repaired is significantly greater than the incremental cost of safe work practices and cleanup to reduce LBP hazards in the course of scheduled repainting. The full cost of LBP hazard abatement includes a variety of activities that are also associated with housing rehabilitation activities. Therefore, housing rehabilitation programs affected by the final rule incur only incremental costs for paint stabilization and abatement.

Under non-rehab programs, the full costs of paint stabilization are recognized as regulatory costs, but these costs are substantially offset by the market value of housing-related benefits for paint stabilization. This RIA assumes that the full market value of paint stabilization is realized whenever paint stabilization is required under the final rule. Therefore, the incremental costs of paint stabilization (e.g., safe work practices) are the only costs of these activities that are not offset by market value benefits. Although the final rule only requires hazard abatement in rehab units receiving more than $25,000 of federal assistance, the RIA anticipates that some units subject to interim control requirements will find it economical to treat friction surfaces in part by replacing old windows with new energy efficient (low-e) windows. In such cases, the RIA recognizes the market value of new windows based on the present value of estimated fuel savings (discounted at seven percent). It is possible, however, that the market value estimates for painting and window replacement may overstate the market benefits of the final rule. For example, the market value of paint stabilization required for HUD-owned housing may not be fully recovered when these repainted units are sold by HUD. Therefore, the cost-benefit analysis for non-rehab programs (in Chapter 5) explicitly separates the estimated market value benefits of the final rule from the monetized health benefits of LBP hazard reduction, to facilitate recalculations of net benefits under alternative market value assumptions. Chapter 2 details the basis for unit cost estimates and associated market values used in the RIA, and Chapter 4 explains the available data on occurrence frequencies and the number of housing units affected by the final rule.

Monetized Benefits

Although many benefits of LBP hazard reduction cannot be quantified or monetized, this RIA does provide monetized estimates of the benefits of preventing children from developing elevated blood lead levels (EBLs). Such benefits include avoiding the costs of special education and medical treatment for EBL children, as well as increasing lifetime earnings associated with higher IQs for children with lower blood lead levels. The monetized benefit of increased lifetime earnings due to lower blood lead levels accounts for 99 percent of all monetized health benefits of the rule.

The benefits quantified in this analysis reflect the benefits of preventing EBLs in children rather than the benefits of lowering the BLLs of children already affected by lead poisoning. As shown in the analysis, the benefits associated with avoiding childhood lead poisoning substantially exceed the benefits of reducing hazards for children already affected by lead poisoning. Chapter 3 details the basis for the health benefit estimates used in the RIA.

Monetized Net Benefits

The analysis of net benefits in this RIA reflects costs and benefits associated with the first year of hazard evaluation and reduction activities under the final rule. These costs and benefits, however, include the present value of future costs and benefits associated with first year hazard reduction activities. For example, the costs associated with first year activities include the present value of future reevaluation costs. Similarly, the benefits of first year activities include the present value of lifetime earnings benefits for children living in or visiting the affected unit during that first year, and for children living in or visiting that unit during the second and subsequent years after hazard reduction activities.

Exhibits ES-1a and ES-1b present a summary of the costs, benefits, and net benefits of the first year activities under the final rule, using a three percent and seven percent discount rate for lifetime earnings, respectively. The total cost of first year hazard evaluation and reduction activities is $253 million. The total benefit of first year activities is $1,143 million using a three percent discount rate, and $324 million using a seven percent discount rate. Net benefits of first year activities are therefore either $890 million or $71 million, depending on the discount rate used. Chapter 5 details the costs and benefits of the final rule by Subpart and by year of construction.

The individual rows of Exhibits ES-1a and ES-1b detail the components of hazard evaluation and reduction costs and monetized hazard reduction benefits. Although the components of hazard reduction costs and monetized benefits are often identified by the same brief descriptors (e.g., paint stabilization, soil cover, dust cleanup) the cost components are not directly comparable to the benefit components. For example, dust-cleanup costs reflect only the costs of cleanup. Cleanup benefits, however, reflect the assumption that low dust lead levels have a benefit duration of five years with paint stabilization and ten years with LBP hazard abatement.

The duration of dust removal benefits reflects the anticipated benefits over five or ten years to a new population of young children, associated with births and unit turnover. This estimated duration of benefits could not be realized without the hazard reduction activities of paint stabilization or abatement, friction/impact work, and soil cover, to the extent required by the rule.

The monetized benefits for paint stabilization and abatement reflect only the health benefits of avoided paint chip ingestion. The cost of paint stabilization includes the incremental cost for rehab programs, and the full cost for non-rehab programs. Paint stabilization market value benefits reflect the estimated market value for non-rehab programs. Subtracting paint stabilization market value benefits from paint stabilization costs yields the incremental cost of all paint stabilization required under the rule.

Exhibit ES-1a
Cost-Benefit Summary for First Year Activities Using A Three Percent Discount Rate for Lifetime Earnings ($ Millions)

Hazard Evaluation Costs	$99.5
Hazard Reduction Costs:	
Paint stabilization	$75.7
Window replacement	$4.6
Friction/impact work	$8.5
Soil cover	$2.3
Paint hazard abatement	$2.0
Dust cleanup	$60.5
Total First Year Costs	**$253.2**
Monetized Benefits:	
Paint stabilization	$71.2
Paint hazard abatement	$1.1
Soil cover	$88.0
Dust cleanup	$908.6
Paint repair market value	$70.2
Window replacement	$4.2
Total First Year Benefits	**$1,143.3**
Total First Year Net Benefits	**$890.1**

Exhibit ES-1b
Cost-Benefit Summary for First Year Activities Using A Seven Percent Discount Rate for Lifetime Earnings ($ Millions)

Hazard Evaluation Costs	$99.5
Hazard Reduction Costs:	
Paint stabilization	$75.7
Window replacement	$4.6
Friction/impact work	$8.5
Soil cover	$2.3
Paint hazard abatement	$2.0
Dust cleanup	$60.5
Total First Year Costs	**$253.2**
Monetized Benefits:	
Paint stabilization	$20.3
Paint hazard abatement	$0.3
Soil cover	$20.2
Dust cleanup	$209.0
Paint repair market value	$70.2
Window replacement	$4.2
Total First Year Benefits	**$324.2**
Total First Year Net Benefits	**$71.0**

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CHAPTER 1. BACKGROUND

Title X of the Housing and Community Development Act of 1992, also known as the Residential Lead-Based Paint Hazard Reduction Act of 1992 (the Act), prescribes (in sections 1012 and 1013) specific lead-based paint hazard evaluation and reduction activities for federally assisted housing and federally owned housing at time of sale. The United States Department of Housing and Urban Development (HUD) is preparing final regulations (24 CFR Part 35) to implement the Act. Part 35 of the rule implementing Title X will update and consolidate current lead-based paint requirements for various HUD programs. The estimated costs, benefits, and economic impacts of the rule, detailed in subsequent chapters of this Regulatory Impact Analysis (RIA) are measured against a baseline defined by current HUD regulations and practices.

This introductory chapter contains the following sections:

1.1 Data Sources and Limitations
1.2 Adverse Health Effects of Lead
1.3 Sources of Lead Poisoning
1.4 Lead-Based Paint Hazards
1.5 Pre-Title X Regulations
1.6 Title X Requirements
1.7 Executive Order 12866
1.8 RIA Analytical Structure and Unit Cost-Benefit Analysis

1.1 DATA SOURCES AND LIMITATIONS

All data sources and research studies used in this analysis are listed in the bibliography at the end of this RIA. The following data sources are referenced extensively in this introductory chapter:

HUD NATIONAL SURVEY: A HUD study conducted during 1989 and 1990 on the extent of lead-based paint (LBP) and LBP hazards in occupied housing built before 1980 (the sale of LBP was banned in 1978).

CWP: "Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing," U.S. Department of Housing and Urban Development, December 7, 1990. Summarizes data from the HUD National Survey, quantifies the costs of abatement methods, and reviews several studies investigating the effects of lead-based paint abatement on human health.

EPA RIA: "TSCA Title IV, Sections 402(a) and 404: Target Housing and Child-Occupied facilities Final Rule Regulatory Impact Analysis," Prepared by Abt Associates for U.S. Environmental Protection Agency, August, 1996.

Evaluation Data: Data on LBP hazard frequencies from the HUD Lead-Based Paint Hazard Control Grant Program (data collected through March, 1998).

NRC REPORT: "Measuring Lead Exposure in Infants, Children, and Other Sensitive Populations," Committee on Measuring Lead in Critical Populations (formed by the National Research Council), October, 1993.

NHANES III: Third National Health and Nutrition Examination Survey, as reported in "Blood Lead Levels in the U.S. Population" and "The Decline in Blood Lead Levels in the United States, " JAMA, July 27, 1994. NHANES III data, collected between 1988 and 1991, are compared to NHANES II data collected between 1976 and 1980.

NHANES III, Phase 2: Third National Health and Nutrition Examination Survey, Phase 2 (1992-1994) as reported in "Update: Blood Lead Levels – United States, 1991-1994," MMWR, February 21, 1997, p.141; with additional detail obtained by ICF Consulting Group from NHANES III data on CD-ROM.

To accurately quantify the impact of the final rule, the costs and benefits of LBP hazard reduction must be calculated relative to baseline blood lead levels and LBP hazard data that reflect the current extent and nature of the lead poisoning problem. The baseline of this RIA uses data on average blood lead levels (BLLs) from NHANES III Phase 2 (1992-1994), data on deteriorated LBP from the HUD National Survey (1989-1990), and Evaluation data on dust and soil hazards from the HUD Lead-Based Paint Hazard Control Grant Program (data collected through March, 1998).

NHANES III determined that blood lead levels declined substantially over the 1980s and NHANES III Phase 2 showed these trends continuing through the early 1990s. The effect of any continuing decline in BLLs would be to reduce the benefits of the final rule relative to projected conditions in the absence of this rule. Likewise, data from some recent studies suggest that the prevalence of dust and soil hazards may have also declined, and lower hazard occurrence frequencies would reduce the estimated costs of the rule. Recent data also suggest that dust lead levels may remain low (after hazard reduction activities) for longer than assumed in this RIA, which would increase the estimated benefits of the rule. LBP hazard evaluation and reduction costs reflected in this analysis are also lower than costs of only a few years ago, reflecting more efficient technology, and further reductions in such costs would reduce the estimated costs of the final rule.

Data on deteriorated LBP from the HUD National Survey (1989-1990) reflect a limited sample size of 227 single and 57 multifamily units, or a total of 284 units, to predict the prevalence of deteriorated lead-based paint for approximately 70 million housing units built in the United States before 1978. Evaluation data on dust and soil hazards have been weighted by year of housing construction to extrapolate these hazard occurrence frequencies to all pre-1978 housing units.

1.2 ADVERSE HEALTH EFFECTS OF LEAD

Although lead ingestion is hazardous to all humans, children under six years of age are the population at highest risk of lead poisoning. Children under age six are more vulnerable because their nervous systems are still developing. Similarly, all children of any age are more sensitive than adults.

- At high levels, lead poisoning can cause coma, convulsions, and death. Such severe cases of lead poisoning are now extremely rare, but do still occur.

- At lower levels, observed adverse health effects from lead poisoning in young children include reduced intelligence, reading and learning disabilities, impaired hearing, and slowed growth.

Children with elevated blood lead levels (EBLs) are more likely than other children to suffer decreased school performance and require special education such as reading or speech therapy or psychological assistance. Such children may suffer from a lower quality of life overall. Other health effects for young children include decreases in stature, hearing, vitamin D metabolism, and blood production.

Prenatal exposure to lead, even at low-to-moderate maternal blood lead levels, has been associated with an increased incidence of low birthweights and short gestational age, which may increase the risk of infant mortality (EPA RIA, p. 7-3). Health effects of lead poisoning in adults may include a higher rate of strokes, myocardial infarctions, and hypertension.

1.3 SOURCES OF LEAD POISONING

Sources of lead poisoning have included lead in gasoline and lead in solder for food cans, the main sources of human exposure to lead in the environment, as well as lead in paint and lead in pipes and solder for drinking water systems (JAMA, p. 284).

Beginning in the 1970's, restrictions on the use of lead in gasoline and in solder for food cans greatly reduced the amount of lead being released into the environment. At the same time, the introduction of new sources of lead into the environment was limited by restricting the use of lead in paints and in pipes and solder for drinking water systems. Exhibit 1-1 (NRC, p. 19) shows the decline in both the levels of lead used in gasoline and in average NHANES II blood lead levels from 1976 to 1980.

Substantial additional reductions in blood lead levels over the 1980s were revealed by a comparison of the NHANES II (1976-1980) and NHANES III (1988-1991) surveys. Average blood lead levels over the decade declined by 78 percent between the two surveys due to the declines in lead in gasoline and solder for food and soft drink cans (JAMA, p. 284). Average blood lead levels for children under six declined by 75 percent, from 15 ug/dL to 3.8 ug/dL. During this time, the percentage of food and soft drink cans manufactured in the United States that contained lead solder decreased from 47 percent in 1980 to .9 percent in 1990 (MMWR, August 5, 1995). Exhibit 1-2 shows that the average daily intake of lead ingested by infants aged six months or under declined by more than 90 percent over the 1980s, from 33 ug per day in 1980 to three ug per day in 1988 (NRC, p. 21). Recent data from NHANES III Phase 2 (1992-1994) shows that average blood lead levels for children under six declined by another 29 percent in the early 1990s, from 3.8 ug/dL to 2.7 ug/dL.

Exhibit 1-1
Decline in Blood Lead and Gasoline Lead Levels: 1976-1980
(Source: Annest, 1983, a shown in NRC report, p. 19)

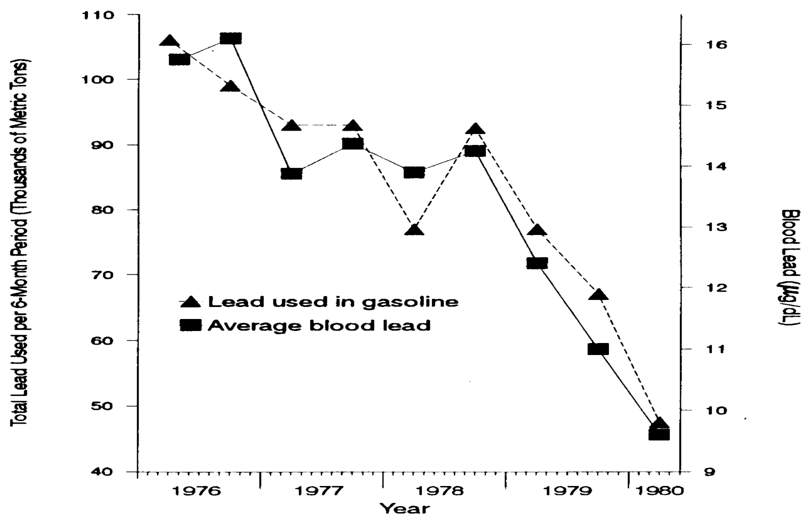
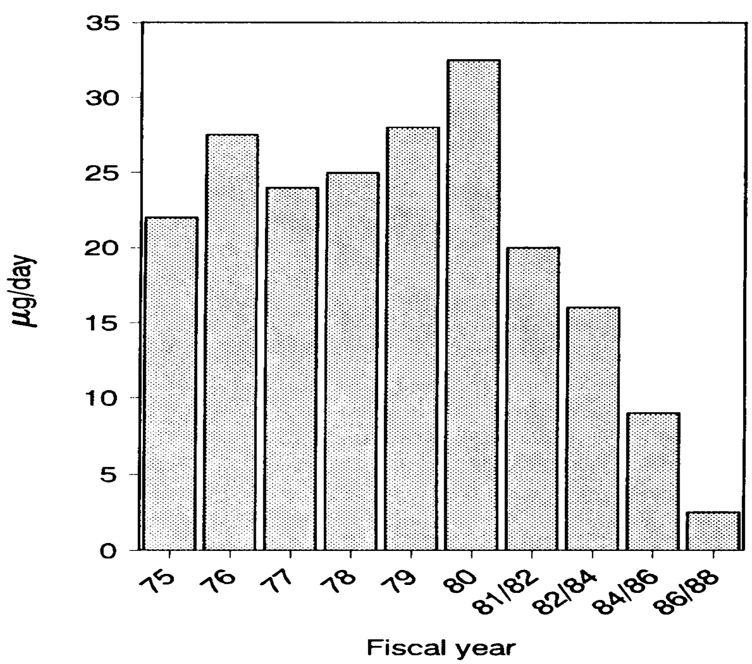


Exhibit 1-2
Average Daily Lead Intake by Infants: 1975-1988
(Source: Capor, 1991, as shown in NRC report, p. 20)



Another factor that has contributed to the decline in blood lead levels over recent years is the change in the age composition of the housing stock. Because the use of lead-based paint in housing was widespread before 1940, children living in housing units built before 1940 have a higher risk of contracting lead poisoning from LBP hazards (MMWR, August 5, 1995). The total number of occupied housing units built before 1940 was 24.2 million in 1980, and this number decreased to 20.8 million by 1989 (Pirkle, p. 290).

In 1991, the CDC lowered the blood lead level of concern for young children from 25 to 10 ug/dL. Despite the decline in blood lead levels over the past decade, NHANES III Phase 2 data show that 900,000 children still have blood lead levels above 10 ug/dL.

Although LBP hazards are recognized as the major remaining source of lead hazards, occupational exposure to lead and other less common sources of exposure constitute additional risks of lead poisoning. In surveys for occupational lead exposure in four states in 1987, 94 percent of adults with very high blood lead levels were reported to be work-related (MMWR, Sept. 22, 1989). CDC reports that 25 percent of adult EBL cases reported to state health departments are caused by exposure to lead in foundries and metal-working industries (MMWR, November 29, 1991). Some occupational exposures are also known to occur in construction industries disturbing old lead-based paint.

Occupational exposure is also likely to result in paraoccupational lead exposure, which "may occur when workers exposed to hazardous substances in their jobs carry the toxic materials home, usually on their clothing, thus exposing family members" (MMWR, May 19, 1989). A 1991 Alabama study showed that, of 46 children six months to 16 years old with blood lead levels above 15 ug/dL, 24 percent had potential for paraoccupational lead exposure (MMWR, June 11, 1993). Anecdotal evidence from CDC indicates that lead poisoning can also result from a variety of less common forms of lead exposure, including:

- Lead-contaminated bulk-delivered drinking water (MMWR, October 21, 1994);
- Traditional ethnic remedies (MMWR, July 16, 1993);
- Ceramic glaze ingestion (MMWR, June 2, 1989); and
- Lead plumbing fixtures (MMWR, October 21, 1994).

Although lead poisoning can result from sources other than lead in paint, soil, and dust, these other sources explain only a small percentage of the total number of children with elevated blood lead levels. Even in these rare cases, it is difficult to determine the main cause of lead poisoning. Although lead-contaminated bulk-delivered drinking water was considered the source of poisoning in the first example above, other possible sources of lead exposure were identified in two of the other three cases. In one case, potential sources included deteriorated lead-based paint on the exterior of the house and on one interior wall. In another case, the child's play area was found to contain lead-contaminated soil.

The Centers for Disease Control and Prevention (CDC) identifies the two most important remaining sources of lead hazards to be deteriorated lead-based paint in housing built before 1978 and urban soil and dust contaminated by past emissions of leaded gasoline and by exterior paint on dwellings and other structures (MMWR, August 5, 1994). These are the hazards targeted by the final rule.

1.4 LEAD-BASED PAINT HAZARDS

The final rule defines lead-based paint as "paint or other surface coatings that contain lead equal to or exceeding 1.0 milligram per square centimeter or 0.5 percent by weight or 5,000 parts per million by weight." Lead-based paint *hazards* include "any condition that causes exposure to lead from dust-lead hazards, soil-lead hazards, or lead-based paint that is deteriorated or present in chewable surfaces, friction surfaces, or impact surfaces, and that would result in adverse human health effects." The Consumer Product Safety Commission banned the sale of LBP in 1978, but LBP *hazards* are present in approximately 40 percent of all housing units built before 1978.

Older housing units pose the greatest likelihood for children to contract lead poisoning for several reasons:

- Older units are more likely to have LBP on at least one surface or component;
- Older units have a higher concentration of lead in LBP; and
- Older units are more likely to have deteriorated paint and associated dust and soil hazards.

Although housing built after 1959 accounts for almost half of all housing built before 1978, Exhibit 1-3 (CWP, pp. 3-9) shows that the number of units with LBP (at or above the one mg/cm^2 standard) anywhere on the structure are nearly evenly distributed between units built before 1940, from 1940 to 1959, and from 1960 to 1978. Units with lead-based paint built before 1940 account for one third of all such units, while units built from 1940 to 1959 and from 1960 to 1978 account for 29 percent and 39 percent, respectively.

Looking only at the percentage of units with any amount of lead-based paint obscures important variations in lead paint concentrations. The CWP estimated that lead concentrations in paint were highest during the first three decades of the 20th century, but "by 1919, the production of water and calcimine-based paints almost equaled those with white lead. Around 1920, a zinc-based compound . . . came into use as a supplement or replacement for white-lead pigments in interior paints. By the 1930s, titanium dioxide was introduced . . . [and its production] equaled that of leaded pigments by the late 1940s and, by the late 1950s, was five times greater." (CWP, p. 1-2)

Exhibit 1-3
Housing Units with Lead-Based Paint:
Distribution by Age of Housing

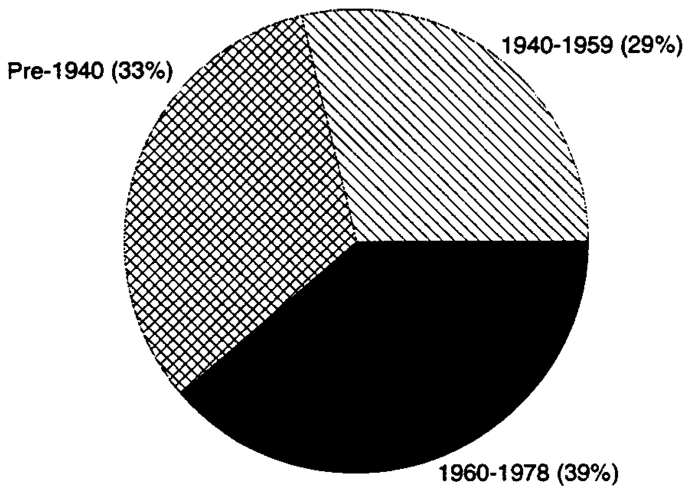
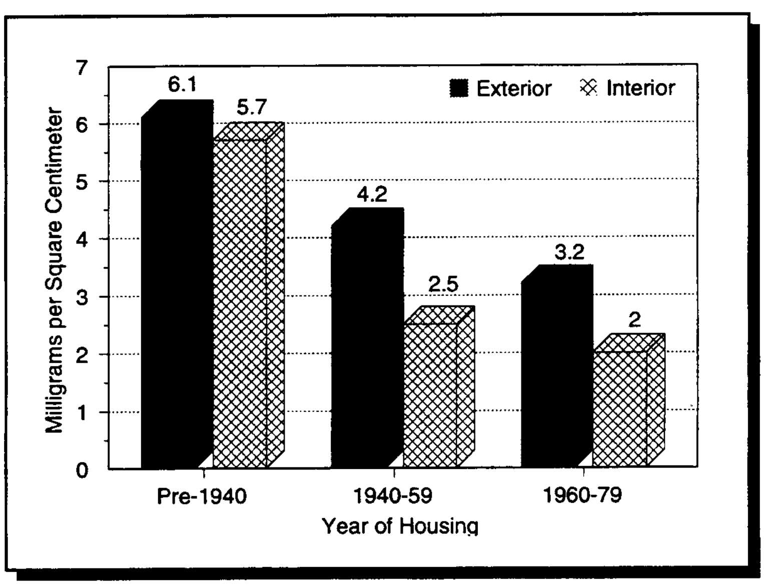
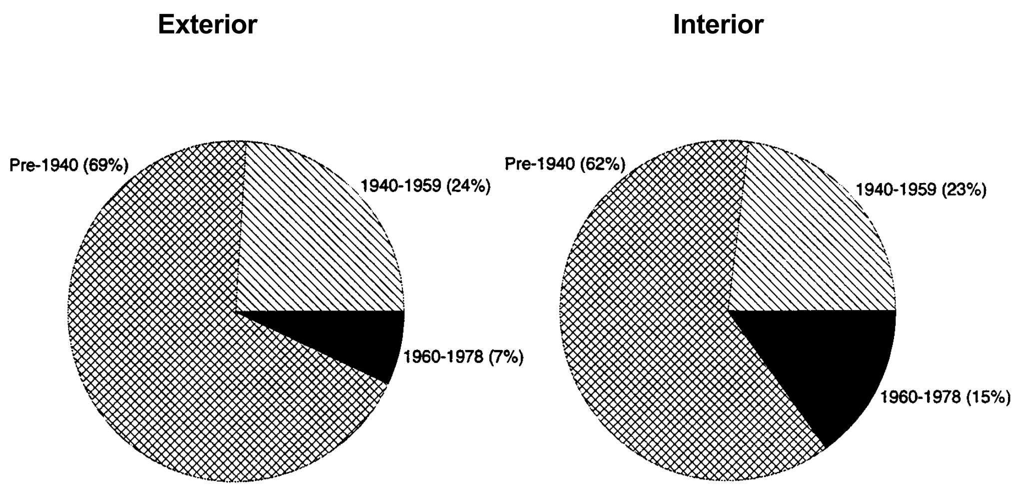


Exhibit 1-4
Average Lead Loading in LBP by Age of Housing
(average mg/cm^2 for surfaces with LBP > one mg/cm^2



National Survey data presented in Exhibit 1-4 show that the average loading of lead in LBP in pre-1940 units is two to three times the average for units built between 1960 and 1978. Other studies have reported much higher lead paint concentrations in older housing in specific locations. A 1984 Cincinnati study found that pre-1920 housing units had average lead paint concentrations about 10 times those of public housing and post-World War II units (Clark, p. 50). A study conducted in California reported that the median concentration of lead in exterior paint was about 20,000 ppm before 1920. By 1970, the average lead concentration in exterior paint had fallen to about 800 ppm. The average concentration of lead in interior paint fell from about 2,000 ppm before 1920 to about 300 ppm by 1970 (Sutton et al).

Exhibit 1-5
Percentage of Total National Surface Area of Deteriorated Lead-Based Paint by Age of Housing and Exterior versus Interior



Older housing units also have LBP on more and larger surface areas. The CWP estimates that the average pre-1940 unit has 1,193 square feet of interior surface area with LBP, whereas 1940-1959 units average 422 square feet, and 1960-1978 units average just 170 square feet. Also, the percentage of pre-1940 units with deteriorated lead-based paint is about twice the percentage for 1940-1959 units, and four times the percentage for units built between 1960 to 1978. As a result, pre-1940 units account for a substantial majority of the total. Exhibit 1-5 shows that units built before 1940 account for 69 percent of the total national surface area of exterior deteriorated LBP, and 62 percent of interior deteriorated LBP. The concentration of deteriorated LBP in pre-1940 housing results in a similar concentration of related dust and soil hazards. National Survey data also indicate that pre-1940 units account for a disproportionate share of all units with soil and dust lead hazards.

An association between elevated blood lead levels and LBP hazards in older housing has been noted in numerous studies:

- A recent comparison of blood lead levels of children in Orange County, CA and in San Francisco shows that the percentage of children with blood lead levels above 25 ug/dL was 5.5 times higher in San Francisco than in Orange County. This difference was associated with the average age of housing in each location. While only 7.5 percent of housing units in Orange County were built before 1950, 74 percent of the housing units in San Francisco were pre-1950 units (Gellert et al., 1993);

- A 1992 study of blood lead levels in the suburbs of Chicago found that the percent of children with blood lead levels above 10 ug/dL was five times higher in an area with predominantly 1940s housing, and 12 times higher in an area with 1920s housing, relative to other suburban areas with predominately 1960s housing (Binns et al., 1994);

- A 1991 to 1992 blood lead level study of children in an HMO population in the Minneapolis-St. Paul area found that 13 of the 4,678 children studied had blood lead levels above 20 ug/dL. These 13 children were all living in housing built before 1950, and were twice as likely to have peeling paint in their home as children with blood lead levels below 20 ug/dL (Nordin, 1994);

A study of children under age five in health facilities in St. Louis attributed the significant reduction in blood lead levels from 1976 to 1990 to large declines both in the older housing stock and in soil lead levels during that time (Blumenthal, 1995). The study found that average blood lead levels dropped from 34.2 ug/dL in 1976 to 15.9 in 1990 and 9.3 ug/dL in 1993. The highest blood lead levels of the children surveyed were 101 ug/dL in 1976, 65 ug/dL in 1990, and 48 ug/dL in 1993. A probable contributing factor to this decline was the demolition between 1980 and 1990 of 6,700 properties, which were most likely older properties in poor condition with a high likelihood of containing lead-based paint hazards. Researchers also related the decrease in blood lead levels to the dramatic drop in soil lead levels between 1978 and 1990. Of particular interest is the parallel in the magnitude of the percentage decreases in average blood lead and soil lead levels. While average blood lead levels decreased by 73 percent between 1976 and 1991, soil lead levels declined by about 75 percent. Researchers noted that, "in the absence of a soil abatement program in this city, the decline can only be attributed to the washing away of the superficial layers of the soil by rain and melting snow."

A study conducted by the California Department of Health Services also found that average soil lead levels in Oakland, Sacramento, and Los Angeles were highly and significantly correlated with housing unit age. While 86 percent of housing units built before 1920 had soil lead levels above 500 ppm, only 11 percent of post-1970 units were found to have soil lead levels this high (Sutton et al., 1995)

1.5 PRE-TITLE X REGULATIONS

This RIA reflects only the incremental costs of implementing the final rule. As a result, certain hazard reduction activities required by the final rule are excluded from the cost estimates for housing assistance programs that currently require equivalent actions to be taken. For example, the cost of hazard reduction activities undertaken in response to an EBL child are not considered incremental costs because regulations already require that action be taken in response to an EBL child. Also, the cost of distributing the LBP hazard pamphlet required in the final rule is excluded from the estimates of incremental costs because regulations already in effect require the distribution of a similar pamphlet. Finally, the costs of lead-based paint inspection and abatement in public housing are not estimated in this RIA because those activities are required by existing regulations.

1.6 TITLE X REQUIREMENTS

The requirements of Title X as implemented in the final rule vary by housing program and year of construction. The requirements for specific HUD programs are detailed in Subparts E through M of Part 35 of the final rule, and are further discussed in Chapter five of this RIA. In general, the rule requires the following types of hazard evaluation and reduction activities:

Hazard Evaluation:

- Risk Assessment

  - Visual assessment for deteriorated paint
  - Dust tests (window sills and floors)
  - Soil tests
  - Paint chip tests (for deteriorated LBP)

- Clearance and Reevaluation

Hazard Reduction:

- Paint stabilization
- Interim controls of LBP hazards on friction and impact surfaces
- Abatement of LBP hazards
- Cleanup
- Soil hazard cover or abatement.

Different hazard evaluation requirements are specified for different HUD programs. Some programs require a complete risk assessment, but many require only a visual assessment for deteriorated paint. Clearance testing is required after hazard reduction activities, but hazard reevaluation in future years is only required for Multifamily Project-Based Assistance (Subpart H), Public Housing (Subpart L), and HUD-owned properties held for more than one year (Subparts F and I).

Hazard reduction activities are triggered by the identification of LBP hazards. Paint stabilization is required when LBP is deteriorated or disturbed by rehab. Friction and impact surface work is required when window or floor dust lead levels fail the proposed standards and friction or impact hazards (e.g., tight fitting doors or windows with LBP) are present. Cleanup is required when dust lead fails the proposed standards. Cleanup is assumed in this RIA to be performed after hazard reduction activities (e.g., paint stabilization). LBP hazard abatement is only required for public housing and for rehab units receiving more than $25,000 per unit of federal rehabilitation assistance. In these cases, hazard abatement refers only to the abatement of LBP surfaces that pose hazards (e.g., deteriorated LBP surfaces).

1.7 EXECUTIVE ORDER 12866

On September 30, 1993, President William J. Clinton signed Executive Order 12866 to begin a "program to reform and make more efficient the regulatory process" (58 *Federal Register* 51735, October 4, 1993). This Executive Order, which revokes Executive Orders 12291 and 12498, requires HUD to provide the Office of Information and Regulatory Affairs of the Office of Management and Budget with an assessment of the costs and benefits of significant regulatory actions. A "significant regulatory action" is defined as "any regulatory action that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

HUD has determined that the final rule is a significant regulatory action because it would have an annual effect on the economy of greater than $100 million.

The cost-benefit assessment for each significant regulatory action must include the following:

- "[A] reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need" (§6(a)(3)(B)(i) of the Executive Order); and

- "An assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate and, to the extent permitted by law, promotes the President's priorities and avoids undue interference with State, local, and tribal governments in the exercise of their government functions" (§6(a)(3)(B)(ii)).

The assessment, including the underlying analysis of both costs and benefits, must be quantified to the extent feasible.

In addition, the assessment for a rulemaking that could have an annual effect on the economy of at least $100 million or have an material adverse effect must also include the following:

- An assessment of the rule's anticipated benefits and costs, such as, but not limited to, impacts on:

  - The efficient functioning of the economy and private markets (including productivity, employment, and competitiveness),

  - Health, safety, and the natural environment,

  - Discrimination or bias,

- Regulatory administrative costs, and
- Regulatory compliance costs.

The assessment shall be quantified to the extent feasible. (§6(a)(3)(C)(i)-(ii))

- "An assessment . . . of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, identified by the agencies or the public (including improving the current regulation and reasonably viable nonregulatory actions), and an explanation of why the planned regulatory action is preferable to the identified potential alternatives." (§6(a)(3)(C)(iii))

This Cost-Benefit Assessment satisfies these requirements.

1.8 RIA ANALYTICAL STRUCTURE AND UNIT COST-BENEFIT ANALYSIS

The methodology used in this analysis to estimate annual costs and benefits for the final rule is based on the following simple formulas:

Regulatory Costs = (unit cost) x (unit cost frequency) x (number of affected units); and

Regulatory Benefits = (unit benefit) x (unit benefit frequency) x (number of affected units).

This analysis focuses on the costs and benefits associated with the first year of hazard evaluation and reduction activities required by the final rule. The unit cost estimates reflect the average costs associated with specific hazard evaluation and reduction activities in a single housing unit. The unit benefit estimates are the benefits achieved by conducting hazard reduction activities in a single housing unit. Unit cost frequencies reflect the extent of required hazard evaluation activities under the final rule, and the occurrence frequencies of different lead-based paint hazards that trigger hazard reduction requirements. Unit benefit frequencies are also determined by the occurrence frequencies of lead-based paint hazards, because benefits are realized by hazard reduction activities. The affected units, for regulatory costs and benefits, are HUD-assisted units affected by the final rule.

Chapter 2 explains the average unit cost estimates used in this analysis. Separate cost estimates have been developed for different types of hazard evaluation and reduction activities, for single and multifamily units.

Chapter 3 derives the unit benefit estimates associated with specific types of hazard reduction activities. This analysis builds on published research and analysis estimating the total potential monetized benefits associated with eliminating lead poisoning, and estimates the fraction of such benefits that can be attributed to specific hazard reduction activities in a single housing unit.

Chapter 4 presents the occurrence frequency data used to estimate regulatory costs and benefits. Separate frequency estimates have been applied to housing units built before 1940, from 1940 through 1959, and from 1960 through 1978, because National Survey data and Evaluation data indicate that the age of housing units is an important determinant of LBP hazard frequencies. Chapter 4 also presents an estimate of the number of HUD-assisted units affected by the final rule. The affected units are detailed by Subpart of the final rule, and by year of construction, to reflect variations in regulatory requirements by Subpart and variations in hazard occurrence frequencies by year of construction.

Chapter 5 presents the cost-benefit analysis for the final rule. Separate tables have been developed to calculate costs, benefits, and net benefits (or costs) for each Subpart, by construction-year category. Summary tables also present the total costs, benefits, and net benefits for the rule.

Chapter 6 presents sensitivity analysis of key assumptions in the analysis, and examines regulatory alternatives. Chapter 7 examines the economic impacts of the final rule, and Chapter 8 addresses environmental justice issues associated with the final rule.

CHAPTER 2. HAZARD EVALUATION AND REDUCTION TECHNOLOGIES AND COST

This chapter presents estimates for the costs of LBP hazard evaluation and reduction activities as required under Part 35 of the final rule. This chapter is organized in six sections:

2.1 DATA SOURCES AND LIMITATIONS

All cost estimates in this chapter are presented in terms of cost per housing unit affected. These unit cost estimates are based on interviews with LBP hazard evaluation and abatement contractors, state officials, and other experts familiar with LBP hazard evaluation and reduction costs. These cost estimates are also consistent with those presented in the CWP and in the Task Force Report on LBP hazard reduction and financing (<u>Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing Supply</u>, 1995) as well as the costs reported in HUD Grant Program Evaluation data. There is considerable uncertainty, however, about a variety of factors that affect regulatory costs. In particular, the size of the housing unit and the extent of any required hazard reduction activities are variables that produce substantial variation in costs for different housing units.

The cost estimates presented in this chapter reflect the estimated "average" cost per unit for LBP hazard evaluation and reduction activities in "typical" single and multifamily units affected by the proposed rule. Exhibit 2-1 presents these unit cost estimates for LBP hazard evaluation and reduction activities. The unit cost categories in Exhibit 2-1 were defined to achieve three purposes: 1) to span the variety of activities required under the proposed rule; 2) to avoid double-counting any costs; and 3) to ensure that unit cost estimates were compatible with available data on the occurrence frequency of LBP hazards (discussed in Chapter 4). This approach reduces the complexity of the analysis and recognizes the limits of available data.

Unit cost data at a more detailed level are available, but corresponding detail on the frequency of the need for the hazard reduction activity is not available. For example, the Task Force Report provides a number of cost estimates for hazard reduction activities that could be related to floor dust lead levels, such as:

- $0.40 to $2.00 per square foot to make hard-surfaced floors smooth and cleanable;
- $35 to remove, plane, and reinstall a binding door;
- $45 to $50 if the door must be rehung; and
- $100 if the door is replaced.

To apply cost estimates at this level of detail to the analysis of the proposed rule would require data on the number of floors and doors in poor condition and the extent of work required on each floor and door. The HUD National Survey and other research, however, do not provide any systematic data at this level of detail. The National Survey does provide data on the percentage of units with floor dust lead levels that fail the final rule standards, and other data sources provide rough estimates of the average cost of some combination of friction/impact work related to floor dust lead reduction.

Exhibit 2-1
Estimated Costs per Dwelling Unit for
Hazard Evaluation and Reduction Activities

Unit Cost Activity	Cost per Single Family Unit	Cost per Multi-Family Unit
Hazard Evaluation:		
a) Visual assessment	$0	$0
b) Risk assessment (RA)	$375	$260
c) Paint testing, clearance, or hazard screen	$150	$120
d) Work site clearance (Rehab < $5,000)	$75	$60
e) Reevaluation	$271	$217
Hazard Reduction:		
a) Exterior paint stabilization	$1,000	$100
b) Interior paint stabilization	$500	$500
c) Incremental exterior paint stabilization (rehab)	$100	$10
d) Incremental interior paint stabilization (rehab)	$20	$20
e) Window work	$300	$200
f) Window replacement	$5,000	$3,000
g) Other friction/impact work	$300	$200
h) Soil cover	$200	$10
i) Exterior abatement	$5,000	$250
j) Interior abatement	$3,000	$2,000
k) Incremental exterior abatement	$1,000	$50
l) Incremental interior abatement	$600	$400
m) Unit cleanup	$350	$265
n) Work site cleanup (Rehab < $5,000)	$75	$50

Average unit cost estimates for more broadly defined types of hazard reduction avoid the issue of unknown occurrence frequencies. These average cost estimates, however, are also subject to significant uncertainty. The range of estimates provided by the limited number of experts in this field suggest that average costs may be 50 percent higher or lower than the estimates used in this analysis.

One important variable affecting average unit cost is the average size of a typical housing unit. AHS data indicate that typical pre-1978 federally-assisted multifamily units (units affected by the proposed rule) are about 800 square feet in size with four rooms, and typical single-family units are about 1,200 square feet with six rooms.

The cost estimates discussed in this chapter do not include certain one-time costs of the proposed rule, such as training Housing Quality Standards (HQS) inspectors in lead hazard evaluation. The inclusion of such costs would not materially affect this analysis when spread over all of the units affected by the proposed rule. In addition, cost estimates discussed in this chapter do not include relocation costs, which may be incurred as a result of some hazard reduction activities. Most hazard reduction activities are performed when the units are empty, and the limited extent of relocation costs is not expected to materially affect this analysis.

2.2 HAZARD EVALUATION COSTS

Hazard evaluation costs in this analysis are defined to include hazard evaluation prior to hazard reduction activities and follow-up evaluations to ensure that hazard reduction activities have been effective. For each activity, the basis for the RIA cost estimate is explained and compared to the cost estimate in the Task Force Report when appropriate.

a) Visual Assessment

A visual assessment for deteriorated paint is the only hazard evaluation requirement under several Subparts of the proposed rule. The unit cost estimates for this activity is zero because all of the applications for this unit cost under the proposed rule are in situations where an individual responsible for the visual assessment is already on-site and/or a visual assessment for deteriorated paint is already required by other regulations. The Task Force Report estimated the incremental cost of a visual assessment to be $5 to $10 per multifamily unit, assuming that the evaluation and write-up to document the assessment would not take more than 30 minutes per unit to complete. The higher estimate of $10 should also apply to single-family units because the single-family units are larger than multifamily units. Although write-up costs for single and multifamily units should be approximately the same, single-family units would also require more time for a visual assessment of exterior paint.

b) Risk Assessment

The cost of a risk assessment includes a visual assessment for deteriorated paint, friction/impact surface hazards, and bare soil, as well as dust tests for interior windowsills and floors, and preparation of a risk assessment report. Units with bare soil will also require soil testing and units with deteriorated paint or chewed paint surfaces will require paint chip testing or XRF testing to determine whether the paint is LBP. The final rule states that risk assessments shall be performed by certified risk assessors. The Task Force report estimates that the average cost of a risk assessment for a single-family property is $375, and the average cost for a multifamily unit is approximately $260.

In the case of multifamily units, the rule allows for risk assessments to be performed on a sample of similar dwelling units. Therefore, the average cost for risk assessments in multifamily buildings will be lower than the unit cost shown in Exhibit 1 when sampled unit costs are spread over all the units represented by the sample. The cost model for this analysis reflects this cost reduction from multifamily unit sampling in the cost occurrence frequency estimates (discussed in Chapter 4).

c) Paint Testing, Clearance, or Hazard Screen

Cost estimates for a complete surface-by-surface paint inspection for LBP are not included in Exhibit 2-1 because the final rule does not explicitly require a complete paint inspection under any Subpart except for public housing, where it is already required under existing regulations. The final rule does require paint testing of surfaces disturbed by rehab (although presumption of LBP is permitted), and the RIA also anticipates that federally-assisted units will generally perform paint testing of deteriorated paint to avoid other hazard reduction costs when the deteriorated paint is not LBP. Testing for LBP on a limited number of painted surfaces should be less expensive than a complete surface-by-surface inspection.

The Task Force Report estimates that the cost of a complete LBP paint inspection, performed by a certified inspector using an XRF analyzer, would be approximately $300 per multifamily unit, and could cost as much as $600 per single-family unit. These unit cost estimates are also within the range of cost estimates provided by LBP contractors and state officials familiar with LBP hazard evaluation costs. Testing for LBP on a limited number of painted surfaces, however, should be significantly less expensive. As explained below, the cost for paint testing on a limited number of surfaces should be similar to the cost of clearance testing.

Clearance testing after hazard reduction activities includes a visual assessment and dust testing. The unit cost estimates for clearance in Exhibit 2-1 reflect Task Force cost estimates for a certified risk assessor or inspector. Clearance testing costs do not include the cost of a risk assessment report or any costs for paint or soil testing after hazard reduction activities stabilize deteriorated LBP. Clearance testing does include a visual assessment to confirm that deteriorated paint has been stabilized and that any soil hazards identified in an initial risk assessment have been covered or removed.

This RIA assumes that the cost of paint testing on a limited number of surfaces should be similar to the cost of clearance testing because these two activities entail a similar level of effort and technical analysis. Both activities require a visual assessment by a certified risk assessor or inspector. Clearance also requires an analysis of the lead loading in dust samples, and paint testing requires an analysis of paint samples (either by paint chip testing or XRF analysis).

For those subparts where a risk assessment is required, the final rule also allows a more limited hazard evaluation, or hazard screen as an option to a risk assessment. The hazard screen requires only dust testing (no soil samples) and testing of deteriorated paint, but units that fail a hazard screen must complete a full risk assessment. The Task Force estimated that a hazard screen could cost as little as $150, consistent with the cost of clearance dust testing. This analysis assumes that hazard screens will only be used in single family units where it is not possible to reduce total hazard evaluation costs by performing risk assessments in a sample of similar dwellings or units.

d) Work Site Clearance

In the case of rehab activities receiving less than $5,000 of federal assistance, the final rule requires only work site cleanup and clearance in rooms where rehab has disturbed LBP. Analysis of AHS data for assisted rehab work under $5,000 indicates that these smaller rehab projects are likely to disturb paint in only one or two rooms (the AHS data on assisted rehab are discussed further under hazard reduction activities). Therefore, the cost of work site clearance is estimated to be only half the cost of unit clearance testing.

e) Reevaluation

Reevaluation requirements are essentially the same as the requirements for clearance testing. The proposed rule specifies different schedules for reevaluation depending on the types of hazards found and the extent of hazard reduction activities performed. The unit cost estimates for reevaluation in Exhibit 2-1 reflect the schedule that requires passing two sequential reevaluations at two-year intervals, beginning two years after the initial risk assessment. This schedule applies to units with interior window sill or floor dust levels that exceed the applicable standard when the hazard reduction activities performed do not include abatement of LBP. The hazard reduction costs in Exhibit 2-1 (described below) assume that the expense of complete abatement will be avoided except where required by the proposed rule. Therefore, the unit cost estimates shown for reevaluation reflect the present value of clearance costs incurred two and four years in the future, discounted at seven percent (in accordance with OMB guidelines) with no further reevaluation costs after four years.

2.3 HAZARD REDUCTION COSTS

Hazard reduction activities include paint stabilization, other interim controls, abatement, and cleanup. In the case of paint stabilization and abatement activities, an important issue in developing regulatory cost estimates is whether the rule triggers the full cost of these activities if only incremental costs are incurred relative to activities included in the regulatory baseline. For example, the unit cost of stabilizing paint that would not otherwise have been stabilized is significantly greater than the incremental cost of safe work practices and cleanup to reduce LBP hazards in the course of scheduled repainting. The full cost of LBP hazard abatement includes a variety of activities that are also associated with housing rehabilitation activities. Therefore, housing rehabilitation programs affected by the rule incur only incremental costs for paint stabilization and abatement.

Most Subparts of the rule trigger the costs of paint stabilization at times when it is not apparent that painting or rehab activities would have been performed in the absence of the proposed rule. In these cases, the costs of paint stabilization and abatement are offset by the market value of housing-related benefits associated with routine paint repair or rehab. This effectively yields a net cost that is the same as incremental costs. For non-rehab programs, however, the cost-benefit analysis (Chapter 5) separates the full costs of the final rule and the associated market benefits to facilitate recalculations of net benefits under alternative market value assumptions.

A substantial portion of incremental abatement costs are associated with OSHA and EPA rules (for worker protection and hazardous waste disposal). Therefore, the incremental abatement costs in this RIA reflect additional unit abatements required by the final rule, and not new regulatory costs for scheduled abatements.

For each hazard reduction cost listed, the basis for the RIA cost estimate is explained and sources used to evaluate the accuracy of the estimate are discussed.

a) Exterior Paint Stabilization

The full cost of exterior paint stabilization includes the cost of repairing deteriorated exterior paint plus associated cosmetic costs (i.e., repainting adjacent surfaces) and safe practices to control LBP hazards and/or exterior cleanup (e.g., to avoid soil contamination). The single-family unit cost estimate of $1,000 in Exhibit 2-1 reflects the range of cost estimates provided by LBP hazard reduction contractors for paint repair performed on one side of the exterior of a single-family unit. The occurrence frequency for this unit cost, discussed in Chapter 4, is based on the frequency of housing units with more than five square feet of deteriorated exterior LBP. Although some housing units may have extensive amounts of deteriorated LBP, and incur higher costs for paint stabilization on two or more sides of the exterior, other units may just exceed five square feet of deteriorated LBP on limited amounts of exterior trim and incur lower costs for exterior paint stabilization. The cost estimate for just one side of the housing unit is intended to approximate the average cost of paint stabilization associated with the average extent of deteriorated exterior LBP.

AHS data indicate that federally-assisted multifamily units have approximately 20 units per building, on average, and buildings of this size should have very little exterior paint, other than window and door trim. The HUD National Survey indicates that multifamily units account for only 5.4 percent of the total national amount of LBP on exterior surfaces and only 2.1 percent of deteriorated exterior LBP, even though multifamily units account for 27 percent of pre-1980 housing units. Also, the cost of repairing limited amounts of deteriorated exterior paint in multifamily units (e.g., on the trim of some windows) would be shared by all of the units in the building in the context of average unit costs for exterior paint repair. Therefore, this analysis assumes that the average cost per multifamily unit for exterior paint stabilization is $100.

b) Interior Paint Stabilization

The full cost of interior paint stabilization includes the cost of repairing deteriorated interior LBP and associated cosmetic costs (e.g., painting the rest of the room) plus safe practices to control LBP hazards. Cleanup following paint stabilization is included in a separate unit cost item to avoid double-counting cleanup costs that may also be required to reduce dust hazards. The unit cost estimate for interior paint stabilization assumes that deteriorated paint, on average, is confined to just one room. Although some units will require more extensive paint stabilization, the average unit cost estimate assumes that higher cost paint repairs are offset by lower costs in other units. The estimated average unit cost for interior paint stabilization is $500 in multifamily units, assuming that paint stabilization is confined to just one of the four rooms in a typical multifamily unit. The estimated cost for single-family units is also $500, assuming that paint repair is confined to just one of the six rooms in a typical single-family unit. Although AHS data indicate that single-family units are 50 percent larger than multifamily units, the average room size is approximately the same.

c) Incremental Interior Paint Stabilization

In estimating the incremental cost of paint stabilization associated with controlling LBP hazards, several hazard reduction contractors cited a rule-of-thumb that LBP hazards add 20 to 30 percent to the cost of paint repair. The Task Force examined this issue in some detail, however, and concluded that most of the incremental cost of interior paint repair is associated with area cleanup requirements, which is included in a separate unit cost item in this analysis. Other incremental costs of interior paint stabilization were estimated to be approximately $20 per multifamily unit. When this cost is added to the $75 cost for work area cleanup (discussed below), the total incremental cost is approximately equal to 20 percent of the full cost estimate for single-family interior paint repair ($500). The $20 incremental cost estimate for multifamily interior paint repair reflects the fact that multifamily units have an average room size that is about the same as for single-family units. Excluding the costs of area cleanup, the estimated incremental unit costs for interior paint repair amount to just four percent of the estimated full costs of interior paint repair.

d) Incremental Exterior Paint Stabilization

The estimated incremental unit cost for single-family exterior paint stabilization ($100) is equal to 10 percent of the estimated full cost of single-family exterior paint stabilization. This ratio of incremental costs to full costs is higher than the ratio for interior paint repair, because the incremental exterior paint stabilization cost estimate includes any associated exterior cleanup costs in addition to wet scraping and other safe practices associated with LBP repair (the separate unit cost for cleanup in this analysis is associated only with interior paint stabilization).

The incremental unit cost for exterior paint stabilization in multifamily units is subject to additional uncertainty related to the average extent of multifamily exterior paint. As noted above, the cost estimates in this analysis apply to multifamily buildings with approximately 20 units per building, and the cost of limited exterior paint stabilization would be shared by all of the units in the building. Therefore, this incremental cost per multifamily unit for exterior paint stabilization is estimated to be just $10. This unit cost is only incurred by units in buildings that require exterior paint stabilization.

e) Window Work

Some units with window sill dust lead in excess of regulatory standards are expected to require window work, which could be limited to the cost of covering and sealing a window sill to make it smooth and easily cleaned. The Task Force estimated this cost to be $25 per window. Therefore, in multifamily units this analysis assumes that approximately eight windows will be treated at a total cost of $200 per dwelling unit. In single-family units the cost estimate of $300 per dwelling unit reflects an assumption that 12 windows are treated. Although some units are expected to require more extensive window work at a higher unit cost, the average unit cost estimates assume that higher cost window work in some units is offset by other units that may require work on one or two windows.

f) Window Replacement

Although the final rule does not require window replacement, it is expected to be the preferred hazard reduction option in some units with window sill dust lead in excess of regulatory standards. Evaluation data from the HUD Grant Program indicates that window replacement costs are approximately $3,000 for multifamily units and $5,000 for single-family units. A substantial portion of this cost, however, may be recovered through the market value of improved energy efficiency windows. As explained in Section 2.4, the present value of energy savings that result from upgrading to high-efficiency windows (annual savings over thirty years discounted at seven percent) can offset at least 90 percent of the cost of window replacement. Therefore, the net cost of window replacement, after accounting for the market value of new windows, will be $300 in multifamily units and $500 in single-family units.

g) Other Friction/Impact and Cleanup Activity

This unit cost item includes maintenance activity to reduce friction and impact surfaces (e.g., rehanging tight-fitting doors) anticipated in some rooms with floor dust lead levels above the final rule standards. The cost of unit cleanup, which is also associated with floor dust lead, is reflected in a separate unit cost item. The cost estimates of $200 per multifamily unit and $300 per single-family unit assume that relatively limited friction/impact work will be required on doors throughout the average unit (e.g., replacing two or three doors, or removing, planing, and rehanging four to six doors, based on Task Force cost estimates cited above).

h) Soil Cover

The final regulations require soil cover when lead in bare soil exceeds 2,000 ug/g and soil abatement when soil lead exceeds 5,000 ug/g. Hazard reduction is also required when soil in play areas exceeds 400 ug/g. National Survey data indicate that only a small fraction of housing units are expected to have soil lead in excess of 5,000 ug/g (i.e., less than 3 percent of all housing units). Evaluation data from the HUD Grant Program indicate that most units with play areas that have soil lead in excess of 400 ug/g are generally units that also exceed the standard of 2,000 ug/g at the dripline. The cost estimates for this analysis are based on the 2,000 ug/g standard for soil cover because incorporating separate cost estimates and hazard frequencies for soil lead above 5,000 ug/g and play areas above 400 ug/g was not expected to materially affect the analysis. The single-family unit cost estimate for soil cover is $200, based on contractor estimates of average costs for 100 square feet of soil cover at $1.50 to $2.50 per square foot. The cost estimate for multifamily units is only $10 per unit, because the cost per building is spread over all of the units in the building, or approximately 20 units on average.

LBP Hazard Abatement Costs

LBP hazard abatement can involve a wide range of activities depending on the size of the unit, the variety of components with deteriorated LBP, and the types of surfaces with LBP hazards (e.g., wood, brick). Rather than attempting to develop separate cost estimates for each of these abatement variables, this RIA estimates the overall average abatement cost per unit for the two broad categories of interior and exterior hazard abatement. The final rule only requires hazard abatement in rehab units receiving more than $25,000 of federal assistance, and only incremental costs for abatement are incurred with rehab, but the average total cost of hazard abatement was examined as a first step in estimating incremental abatement costs.

The CWP reported abatement cost estimates based on a HUD demonstration project in 1989-1990 examining LBP abatement costs for 179 single-family units. This demonstration involved the removal or encapsulation of all LBP surfaces; not just accessible, chewable, or deteriorated LBP targeted by the proposed requirements for LBP hazard reduction. This demonstration project found that the average cost of interior abatement was $1,800 and the average cost of exterior abatement ranged from $2,800 to $4,800, with the lower cost applying to encapsulation of LBP and the higher cost applying when the removal of LBP components is required. The average abatement cost for all units with interior and/or exterior LBP was $5,500 for encapsulation and $7,700 for removal. The demonstration project also found that units with LBP hazards had a greater than average number of LBP surfaces and had abatement costs of almost $9,000 for encapsulation and $12,000 for removal.

LBP hazard reduction contractors interviewed for the RIA estimated that the average cost for interior abatement was $6,000, and the average for exterior abatement could be as high as $10,000. These contractors, however, had worked primarily on older, deteriorated units requiring extensive abatement. By contrast, the CDC has estimated that average abatement costs are just $2,100 per unit, based on abatement costs reported by New York City, St. Louis, and Boston. These data are consistent with median costs reported by the HUD demonstration project, which found that 54 percent of all units required less than $2,500 in abatement costs, but 18 percent cost more than $10,000, and almost five percent had abatement costs above $25,000. Among units with LBP hazards, only 24 percent cost less than $2,500, 29 percent cost more than $10,000, and nine percent cost more than $25,000 (CWP p. 4-11, 4-12).

The abatement cost estimates used in the RIA, as described below, are somewhat lower than the HUD demonstration costs for abatement of all LBP surfaces in units with LBP hazards, because the HUD rule does not require abatement of surfaces that are not friction or impact surfaces, do not have deteriorated LBP, and are not chewable or accessible to young children.

i) Exterior Abatement

Exterior abatement activities may involve replacement, enclosure, encapsulation, or removal of exterior LBP. The $5,000 full-cost estimate for single-family exterior abatement includes abatement activities that also provide rehabilitation benefits that would enhance the value of housing (e.g., replacement of damaged door or window sill trim).

Most LBP hazard reduction contractors and other experts interviewed for this analysis have reported very little experience with exterior abatement for multifamily units, and National Survey data confirm that the occurrence frequency of deteriorated exterior paint is relatively low for multifamily units. The multifamily exterior abatement cost estimate in Exhibit 2-1 reflects the assumption that multifamily buildings affected by this rule have only limited amounts of exterior paint, and any costs for abatement (e.g., replacement of exterior window or door trim) are spread over all of the units in the building, resulting in an average unit cost of only $250. This cost is only incurred by units in multifamily buildings with deteriorated exterior LBP.

j) Interior Abatement

Interior abatement activities may involve replacement, enclosure, encapsulation, or removal of interior LBP. The full-cost estimate for single-family interior abatement is $3,000. The sum of interior and exterior unit costs for abatement of LBP hazards in single-family units ($8,000) is 11 to 33 percent less than the average HUD demonstration cost for abatement of all LBP in units with LBP hazards (i.e., 11 percent less than the $9,000 cost for encapsulation, and 33 percent less than the $12,000 cost for removal).

The cost estimate for multifamily interior abatement ($2,000) reflects the assumption that single-family units are approximately 50 percent larger than multifamily units. Interior abatement costs for both single and multifamily units include abatement activities that are also associated with other housing rehabilitation benefits, including the energy savings benefits described above for window replacement. The sum of interior and exterior unit costs for abatement of LBP hazards in multifamily units ($2,250) is roughly consistent with the cost estimate for window replacement in multifamily units, described in Section 2.4. Window replacement may constitute complete abatement of interior and exterior LBP hazards in many multifamily units, because the interior part of the window is an accessible friction/impact surface and exterior sills and window trim may be the principal location of deteriorated exterior paint on multifamily buildings. Also, National Survey data show that interior and exterior window surfaces are among the component surfaces that are most likely to have LBP.

k) Incremental Exterior Abatement

LBP hazard abatement activities often provide other housing rehabilitation benefits. The unit cost for single-family incremental exterior abatement reflects contractor estimates that approximately 20 percent of the cost of abatement would not be incurred if similar rehabilitation activities were performed in the absence of LBP. The incremental cost estimate for multifamily units is only $50 per unit, because multifamily buildings affected by the proposed rule have only limited amounts of exterior paint, and any incremental exterior abatement costs are spread over all of the units in the building.

l) Incremental Interior Abatement

The unit cost for single-family incremental interior abatement also reflects the assumption that approximately 20 percent of the cost of abatement would not be incurred if similar activities were performed in the absence of LBP. The unit cost for multifamily incremental interior abatement also reflects the assumption that single-family units are approximately 50 percent larger than multifamily units.

m) Unit Cleanup

The Task Force estimated that specialized cleaning using a two-step protocol (HEPA vacuum followed by a wet wash with a lead-specific detergent) would cost approximately $0.30 per square foot multiplied by the size of the work area. This analysis assumes that multifamily units affected by the proposed rule are 800 square feet, and single-family units are 1,200 square feet. Therefore, unit cleanup costs based on the Task Force estimates would be $360 ($0.30 x 1,200) for single-family units, and $240 ($0.30 x 800) for multifamily units. Median unit cleanup costs reported by Evaluation data from the HUD Grant Program, after removing extreme values from one city, are $350 for single-family units and $265 for multifamily units. The cost estimates in Exhibit 2-1 are based on the Evaluation data, and are generally consistent with the Task Force estimates.

n) Work Site Cleanup

In the case of rehab activities receiving less than $5,000 of federal assistance, the final rule requires only work site cleanup and clearance in rooms where rehab has disturbed LBP. AHS data on assisted rehab work under $5,000, presented in Section 2.5, indicates that these smaller rehab projects are likely to disturb paint in only one or two rooms. Also, a portion of the cleanup activities for lead hazards would be required for routine work site cleanup after any rehab work. Therefore, the incremental cost of work site cleanup is estimated to be about 20 percent of the cost of unit cleanup.

2.4 WINDOW REPLACEMENT MARKET VALUE

The estimate that window replacement provides a market value that recovers 90 percent of its cost is based on an analysis of the energy efficiency of single-pane windows typically found in pre-1978 housing units, the cost of replacing windows with high-efficiency windows, and the present value of fuel savings from this change in the housing unit’s energy efficiency. The analysis was performed by modeling a typical federally-assisted housing unit using the DOE2 energy analysis program. To provide a range of possible climate scenarios (cold, mixed, and hot), three different cities were selected for this analysis. Cities with a high-percentage of federally-assisted housing units were selected to represent each of the three climate regions: Chicago, New York City, and Houston. Different types of windows perform more optimally in each climate region. Therefore, a different window upgrade was selected for each of the three cities. The simulated window upgrades are described in Exhibit 2-2:

Exhibit 2-2
Window Replacement Assumptions

Location	Window Type	Frame Type	U-value (center of glass)	Shading Coefficient
Houston	Double-pane, Low-e	Vinyl	0.29	0.48
Chicago	Double-pane, Low-e	Vinyl	0.30	0.86
New York	Double-pane, Low-e	Vinyl	0.31	0.65

Exhibit 2-3 outlines other modeling assumptions used in this analysis based on AHS data on key characteristics of pre-1978 federally-assisted housing units. Exhibit 2-4 presents additional assumptions necessary to perform the analysis. These assumptions were made to approximate historical construction practices in the U.S.

Exhibit 2-3
Housing Unit Characteristics Used in Energy Use Analysis of Window Replacement

Category	Housing Survey	Modeling Assumption
Number of Units/Building	78% two or more unit building (Median 6-8 units).	Ground floor apartment (in a 2 story building), one interior wall, three exterior walls.
Bedrooms	36% one bedroom, 36% two bedrooms, 20% three bedrooms, 8% other.	Two bedroom.
Size	8% Less than 500 sqft, 15% 500-749 sqft, 12% 750-999 sqft, 10% 1000-1499 sqft, 49% not reported.	800 sqft (median).
Heating	59% steam or hot water in NE, 49% furnace in MW, 55% furnace in South, 42% furnace in West.	Varied by climate region.
Heating Fuel	42% fuel oil (34% gas & 20% electric) in NE, 53% gas (35% electric) in MW, 48% electric (42% gas) in South, 55% gas (34% electric) in West.	Varied by climate region.
Window or Central Air Conditioner	45% in NE, 63% in MW, 87% in South, 44% in West.	Modeled two scenarios for each climate region (with and without air conditioning).

Source:American Housing Survey for the United States in 1995 US Dept. of Commerce, and US Dept. of Housing and Urban Development.

Exhibit 2-4
Housing Unit Assumptions Used in Energy Use Analysis of Window Replacement

Construction/System/Operation Category	Value
Shell (Envelope)	
Wall Construction	2"x4", 16" o.c.
Wall Insulation	R-6
Window Area	34 sqft per exterior wall (x3 exterior walls)
Window-to-Floor-Area Ratio	12%
Sheathing Type	½" Styrofoam (R-2)
Door R-value	R-1.8
Floor Insulation	None
Attic Insulation	N/A (adjoining apartment)
Infiltration Rate	1.0 air change per hour
Systems	
Duct Air Loss	30%
Duct Insulation	None
Heating/Cooling Capacity (size)	Autosized (sized to exactly meet the load)
Thermostat Type	Manual
Domestic Hot Water	
Fuel Type	Natural Gas
Capacity	50 gallon
Energy Factor	0.53

Exhibit 2-5 summarizes the energy cost savings resulting from replacing single pane windows with higher-performance windows.

Exhibit 2-5
Annual Cost Savings Due to Window Upgrade

	Annual Savings		
Heating Equipment	Heating	Cooling	Total
	Cold Climate - Chicago		
Gas	$195	$36	$231
Oil	$177	$36	$213
Electric	$268	$21	$289
	Mixed Climate – New York		
Gas	$159	$47	$206
Electric	$213	$32	$244
	Hot Climate – Houston		
Gas	$67	$162	$230
Electric	$53	$155	$209

Exhibit 2-5 indicates that fuel cost savings from window replacement are likely to be between $205 and $230 per year. The present value of these cost savings at a seven percent discount rate over 30 years are $2,550 and $2,850, respectively, indicating that 85 to 95 percent of the $3,000 cost for window replacement is recovered in the present value of fuel savings over the life of the new windows. The present value of fuel savings would be even higher if we anticipate any nominal inflation in fuel costs over this 30 year period.

The use of a seven percent discount rate may understate the market value of home energy efficiency because after-tax mortgage interest rates for most home buyers in the 1990s have been below seven percent. A regression analysis of AHS data indicates that the market value of energy efficiency in single-family homes over recent years actually reflects annual energy savings discounted at a five percent interest rate, consistent with the typical after-tax mortgage interest rate in recent years (Nevin and Watson, Appraisal Journal, December 1998). Therefore, the estimate of 90 percent cost recovery from window replacement with low-e windows may be conservative.

It should be noted that *Remodeling Magazine* has reported cost recovery rates for window replacement that are lower than 90 percent, based on analysis of modeled cost estimates for window replacement and survey results from real estate professionals asked to estimate how much value would be recovered at resale. In the Northeast, real estate agents recently estimated that window replacement would recover about 83 percent of its cost, and for the nation as a whole they estimated 74 percent cost recovery. Although the cost estimate used by *Remodeling Magazine* was based on low-e windows, the survey question posed to real estate agents did not mention the specific window type. Therefore, It is likely that estimates provided by real estate experts reflect their experience with double-pane windows that are not low-e, because low-e accounted for an insignificant share of the window market as recently as just a few years ago. Standard double-pane windows, typically used in new construction today, are almost twice as energy efficient as the single-pane windows commonly found in pre-1978 housing, but low-e windows are about twice as efficient as a standard double-pane window in most parts of the United States. Exhibit 2-6 presents modeled cost estimates for window replacement with standard double-pane windows and with low-e windows.

Exhibit 2-6
Window Upgrade Costs

	Standard Window			Low-e Window		
	Cost/ sqft	Total Sqft	Total Cost	Cost/ sqft	Total sqft	Total Cost
Material	$20.20	102	$2,060	$24.24	102	$2,472
Installation	$4.38	102	$447	$4.38	102	$447
Total			$2,507			$2,919

Source: Remodeling 1994 Costbook, BNI Publications, Inc. Macmillian Publishing Company, New York, NY, 1994.

Both cost estimates in Exhibit 2-6 are based on a room with approximately 100 square feet of window area, typical of a 800 square foot rental unit, and both cost estimates are roughly consistent with the $3,000 cost estimate in Exhibit 2-1 based on the HUD grant data. The difference between the upgrade cost with low-e windows versus upgrading with standard double-pane windows is approximately $412. However, the energy efficiency savings associated with low-e windows, $205 to $230, accounts for approximately 40 percent of the annual energy savings associated with window replacement. The present value of this incremental energy savings of $90 per year discounted at seven percent over 30 years is $1,116, or $704 more than the incremental cost of the low-e window. Conversely, the upgrade to standard double-pane windows would only realize annual fuel savings of about $135, and the present value of these annual savings discounted at seven percent over 30 years would be just slightly over $1,640, or about 65 percent of the upgrade cost for standard windows. This is roughly consistent with the cost recovery estimate from the *Remodeling Magazine* survey.

2.5 INCREMENTAL HAZARD REDUCTION COSTS WITH REHAB

In addition to the incremental costs for paint stabilization and abatement described above, this RIA also estimates that there are no incremental costs for window work or other friction/impact work in rehab units, based on AHS data on the types of activities performed in federally-assisted rehab units. These data are shown is Exhibits 2-7, 2-8, and 2-9 for rehab costing less than $5,000, $5,000 to $25,000, and more than $25,000, respectively

Exhibit 2-7: Subsidized, non-disaster-repair upgrades costing less than $5,000

Upgrade	Percent	Interior
Added bathroom onto home	1.2%	
Added bedroom onto home	1.1%	
Added other inside room onto home	1.1%	
Added/replaced porch	3.2%	
Added/replaced deck	2.9%	
Moved walls in bathroom	4.6%	
Added/replaced cabinets in bathroom	5.5%	
Added/replaced flooring in bathroom	14.4%	
Added/replaced counter tops in bathroom	4.5%	
Added/replaced toilet in bathroom	8.9%	
Added/replaced tub/shower in bathroom	7.6%	
Added/replaced sink in bathroom	9.5%	
Added/replaced lighting fixtures in bathroom	5.7%	
Added/replaced other electrical items in bathroom	3.0%	
Painted, papered, or wall tiled bathroom	13.8%	13.8%
Moved walls in kitchen	1.9%	
Added/replaced cabinets in kitchen	12.8%	
Added/replaced flooring in kitchen	14.0%	
Added/replaced counter tops in kitchen	11.1%	
Added/replaced other built-in appliances in kitchen	4.3%	
Added/replaced sink in kitchen	7.6%	
Added/replaced lighting fixtures in kitchen	4.7%	
Added/replaced other electrical items in kitchen	2.7%	
Painted, papered, or wall tiled kitchen	14.8%	14.8%
Bedroom created through structural changes	1.5%	
Other room created through structural changes	1.2%	
Added/replaced roof over entire home	17.5%	
Installed/added siding to home	4.4%	
Replaced/covered siding on home	8.0%	
Added internal water pipes to home	1.2%	

Replaced internal water pipes in home	7.0%	
Added electrical wiring to home	9.7%	
Completed rewired the electrical wiring in the home	3.5%	
Added/replaced fuse boxes or breaker switches	13.3%	
Added doors or windows to home	10.4%	10.4%
Replaced doors or windows in home	34.5%	34.5%
Added plumbing fixtures to home	1.3%	
Replaced plumbing fixtures in home	14.8%	
Added insulation to home	14.7%	
Replaced insulation in home	2.7%	
Added wall-to-wall carpeting over a finished floor	8.7%	
Added other types of flooring over bare subflooring	7.3%	
Replaced finished flooring with same/different type of flooring	19.9%	19.9%
Installed new paneling or ceiling tiles	0.5%	
Replaced existing paneling or ceiling tiles	2.5%	
Installed/replaced central air conditioning	7.7%	
Replaced built-in heating equipment	14.2%	
Installed new built-in heating equipment	3.7%	
Added/replaced septic tank	2.4%	
Added/replaced water heater	14.1%	
Added/replaced dishwasher	5.6%	
Added/replaced garbage disposal	5.0%	
Other major improvements or repairs inside home (up to three could be reported)	28.1%	28.1%
Added/replaced driveways or walkways	4.8%	
Added/replaced fencing or walls	12.1%	
Added/replaced patio, terrace, or detached deck	3.5%	
Other major improvements or repairs to lot or yard (up to three could be reported)	16.4%	
Total	**462.8%**	**121.4%**

Exhibit 2-8: Subsidized, non-disaster-repair upgrades costing $5,000 to $25,000

Upgrade	Percent	Interior
Created finished bathroom from unfinished space	4.5%	4.5%
Created finished bedroom from unfinished space	9.7%	9.7%
Created finished kitchen from unfinished space	1.4%	1.4%
Created finished recreation room from unfinished space	8.6%	8.6%
Created other finished inside room from unfinished space	10.8%	10.8%
Added bathroom onto home	1.6%	
Added bedroom onto home	1.7%	
Added other inside room onto home	1.7%	
Added/replaced garage	0.4%	
Added/replaced porch	3.1%	
Added/replaced deck	6.4%	
Added/replaced carport	1.5%	
Added/replaced other outside structure	3.0%	
Moved walls in bathroom	4.8%	
Added/replaced cabinets in bathroom	6.1%	
Added/replaced flooring in bathroom	18.7%	

Added/replaced counter tops in bathroom	9.5%	
Added/replaced toilet in bathroom	11.8%	
Added/replaced tub/shower in bathroom	11.7%	
Added/replaced sink in bathroom	14.1%	
Added/replaced lighting fixtures in bathroom	7.9%	
Added/replaced other electrical items in bathroom	8.2%	
Painted, papered, or wall tiled bathroom	20.6%	20.6%
Moved walls in kitchen	4.3%	
Added/replaced cabinets in kitchen	15.7%	
Added/replaced flooring in kitchen	15.2%	
Added/replaced counter tops in kitchen	13.1%	
Added/replaced other built-in appliances in kitchen	10.1%	
Added/replaced sink in kitchen	6.6%	
Added/replaced lighting fixtures in kitchen	9.4%	
Added/replaced other electrical items in kitchen	5.3%	
Painted, papered, or wall tiled kitchen	14.0%	14.0%
Bedroom created through structural changes	3.1%	3.1%
Other room created through structural changes	12.3%	12.3%
Added/replaced roof over entire home	25.9%	
Installed/added siding to home	11.1%	
Replaced/covered siding on home	17.7%	
Added internal water pipes to home	4.4%	
Replaced internal water pipes in home	8.7%	
Added electrical wiring to home	8.7%	
Completed rewired the electrical wiring in the home	2.5%	
Added/replaced fuse boxes or breaker switches	18.3%	
Added doors or windows to home	13.4%	13.4%
Replaced doors or windows in home	43.8%	43.8%
Replaced plumbing fixtures in home	5.8%	
Added insulation to home	22.0%	
Replaced insulation in home	4.8%	
Added wall-to-wall carpeting over bare sub-flooring	6.1%	
Added wall-to-wall carpeting over a finished floor	4.4%	
Added other types of flooring over bare sub-flooring	6.5%	
Replaced finished flooring with same/different type of flooring	14.4%	14.4%
Installed new paneling or ceiling tiles	1.8%	
Replaced existing paneling or ceiling tiles	7.3%	
Installed/replaced central air conditioning	14.9%	
Replaced built-in heating equipment	17.0%	
Installed new built-in heating equipment	1.7%	
Added/replaced water heater	15.9%	
Added/replaced dishwasher	5.0%	
Added/replaced garbage disposal	4.6%	
Other major improvements or repairs inside home (up to three could be reported)	32.0%	32.0%
Added/replaced driveways or walkways	13.4%	
Added/replaced fencing or walls	10.3%	
Added/replaced patio, terrace, or detached deck	4.4%	
Added/replaced swimming pool, tennis court, or other recreational structure	4.5%	
Added/replaced shed, detached garage, or other building	7.5%	
Other major improvements or repairs to lot or yard (up to three could be reported)	35.2%	
Total	**671.0%**	**188.6%**

Exhibit 2-9: Subsidized, non-disaster-repair upgrades costing more than $25,000

Upgrade	Percent	Interior
Created finished bathroom from unfinished space	18.6%	18.6%
Created finished bedroom from unfinished space	18.6%	18.6%
Created finished kitchen from unfinished space	13.0%	13.0%
Created finished recreation room from unfinished space	5.5%	5.5%
Created other finished inside room from unfinished space	44.8%	44.8%
Added bathroom onto home	13.0%	
Added kitchen onto home	13.0%	
Added bedroom onto home	13.0%	
Added/replaced garage	28.4%	
Moved walls in bathroom	12.3%	
Added/replaced cabinets in bathroom	25.2%	
Added/replaced flooring in bathroom	25.2%	
Added/replaced counter tops in bathroom	12.8%	
Added/replaced toilet in bathroom	25.2%	
Added/replaced tub/shower in bathroom	25.2%	
Added/replaced sink in bathroom	25.2%	
Added/replaced lighting fixtures in bathroom	25.2%	
Added/replaced other electrical items in bathroom	25.2%	
Painted, papered, or wall tiled bathroom	25.2%	25.2%
Moved walls in kitchen	29.1%	
Added/replaced cabinets in kitchen	38.8%	
Added/replaced flooring in kitchen	26.4%	
Added/replaced counter tops in kitchen	38.8%	
Added/replaced other built-in appliances in kitchen	26.4%	
Added/replaced sink in kitchen	66.3%	
Added/replaced lighting fixtures in kitchen	27.0%	
Painted, papered, or wall tiled kitchen	26.8%	26.8%
Bedroom created through structural changes	14.5%	14.5%
Other room created through structural changes	14.5%	14.5%
Added/replaced roof over entire home	27.3%	
Replaced/covered siding on home	14.5%	
Replaced internal water pipes in home	57.0%	
Added electrical wiring to home	13.0%	
Completed rewired the electrical wiring in the home	32.8%	
Added/replaced fuse boxes or breaker switches	45.9%	
Added doors or windows to home	24.8%	24.8%
Replaced doors or windows in home	44.6%	44.6%
Added plumbing fixtures to home	13.0%	
Replaced plumbing fixtures in home	26.3%	
Added insulation to home	44.8%	
Added wall-to-wall carpeting over bare sub-flooring	18.6%	
Added other types of flooring over bare sub-flooring	17.3%	
Installed new paneling or ceiling tiles	5.5%	
Installed/replaced central air conditioning	15.3%	
Replaced built-in heating equipment	5.5%	
Added/replaced water heater	18.4%	
Added/replaced dishwasher	17.3%	
Added/replaced garbage disposal	26.3%	

Added/replaced driveways or walkways	15.3%	
Added/replaced shed, detached garage, or other building	27.1%	
Total	**1214.0%**	**250.9%**

The “percent” column in each of these exhibits shows the percentage of rehab units in each cost category reporting specific types of upgrades. The totals for this column exceed 100 percent, indicating that the average rehab unit reports more than one type of upgrade. For example, the sum of the responses for rehabs <$5,000 is 462%, indicating that these units reported an average of 4.62 upgrades per unit. The “interior” column identifies upgrades that are likely to disturb interior paint and attempts to avoid double-counting to the extent possible (e.g., counting only the repainting upgrades for kitchen and bathroom upgrades). The totals for these interior columns also exceed 100 percent, suggesting that almost all rehab units will disturb some amount of interior paint.

Exhibits 2-7 through 2-9 also show that more than one-third of federally-assisted rehab units spending less than $5,000, and almost one-half of units spending more than $5,000, report replacing windows and doors as one of their rehab upgrades. As explained in the discussion of cost and benefit frequencies (in Section 4.2), less than one-third of federally-assisted units are expected to replace windows or perform window work or other friction impact work due to LBP hazards. Therefore, in the case of rehab units, the RIA assumes no incremental costs for windows and other friction and impact surfaces that require treatment or replacement due to LBP hazards. Rehab units do incur incremental costs for work site or unit cleanup.

These AHS data are also reflected in the RIA cost estimates for incremental interior paint stabilization for rehab units. The Task Force estimated that extensive paint repair in a larger work area (i.e., throughout the unit) could entail incremental paint repair costs of $40 per multifamily unit. This higher cost estimate would apply to rehab units if we assume that the typical rehab unit is in need of extensive repair. The AHS data in Exhibits 2-7 through 2-9, however, suggests that most paint repair is not reported as an activity in most rehab units, and where paint repair is reported it appears to be confined to just one or two rooms (especially the kitchen or bathroom) where other rehab work has also been performed. Therefore, the RIA assumes that federally-assisted rehab units will not require significantly more paint stabilization than other federally-assisted units. As discussed further in Section 4.2, these data from the AHS also suggest that LBP hazard frequencies may not be significantly higher in rehab units than in other federally-assisted units.

2.6 CONFIRMATION OF RIA COST ESTIMATES USING HUD GRANT PROGRAM EVALUATION DATA

The cost estimates described above are essentially unchanged from the cost estimates used in the 1996 RIA for HUD’s proposed hazard evaluation and reduction rule. As noted above, however, Evaluation data from the HUD Grant Program has provided additional confirmation for these cost estimates based on very recently performed hazard reduction work.

The data in Exhibit 2-10 shows Evaluation data on median hazard reduction costs per square foot by intervention strategy, calculates single and multi-family unit costs based on 1200 square foot single-family units and 800 square foot multi-family units, and compares these unit cost estimates with the RIA cost estimates.

Exhibit 2-10
Comparison of RIA Cost Estimates with Evaluation Data Hazard Reduction Costs

Evaluation Data Strategy Code Description	Evaluation Hazard Reduction Costs per square foot	Evaluation Data		RIA Estimate	
		SF 1200 sq.ft.	MF 800 sq.ft.	SF	MF
02: Cleaning, Spot Paint Stabilization	$0.57	$684	$456	$350	$265
03: Complete Paint Stabilization, Floor Treatments	$2.77	$3,324	$2,216	$500+ $300	$500+ $200
04: Window Treatments	$1.63	$1,956	$1,304	$300	$200
05: Window Replacement, Wall Enclosure/Encapsulation	$3.61	$4,332	$2,888	$5,000	$3,000

The Evaluation data intervention Strategy Codes define a hierarchy of hazard treatment activities where all of the activities in lower strategy codes are included in higher strategy codes. For example, the Strategy Code 03 reflects the activities in Strategy Code 02 (cleaning) plus paint stabilization and floor treatments. The unit costs per square foot shown in the table above for Strategy Code 03 were calculated by subtracting the median cost for Strategy Code 02 from the median cost for Strategy Code 03, to isolate the cost of paint stabilization and floor treatments. Similarly, the costs shown for Strategies 04 and 05 were calculated by subtracting the median cost for Strategy 03, to isolate the costs of window work and window replacement, respectively.

To compare the Evaluation data cost estimates with the RIA cost estimates, Exhibit 2-11 shows the percentage of rooms receiving specific lead hazard reduction treatments under each Evaluation data strategy code. This table shows that units in the Evaluation data are generally classified under a specific strategy code based on the average extent of specific treatment activities, but the strategy codes can be misleading if they are interpreted as precisely defining the limits of activities that were performed in any room. In fact, almost every treatment was used in at least some percentage of rooms under each strategy code, and the specific percentage of rooms with each treatment needs to be considered to properly interpret the median unit costs by intervention strategy code.

In the case of Strategy 03, Exhibit 2-11 shows that paint stabilization was performed in 72 percent of the rooms in these Evaluation data housing units. The paint stabilization costs of about $2,000 to $3,000 in Exhibit 2-10 are roughly consistent with the RIA estimate of $500 for painting any single room, because the average federally-assisted single-family unit has six rooms and the average multi-family unit has four rooms. Furthermore, 39 percent of the rooms in this Strategy Code also had window work, indicating that the median cost for this strategy may reflect window work in one or two rooms per unit. This window work cost would roughly offset the fact that 28 percent of the rooms did not have paint stabilization, further confirming the RIA cost estimate of $500 for paint stabilization in a single room.

Exhibit 2-11
Percentage of Evaluation Data Rooms Receiving Specific Lead Hazard Reduction Treatments, by Intervention Strategy Code

Lead Hazard Reduction Treatments	Strategy Code			
	02	**03**	**04**	**05**
No Treatment	10%	8%	13%	25%
Clean	90%	92%	88%	75%
Paint Stabilization	15%	72%	66%	60%
Encapsulate	0%	0%	0%	0%
Remove Paint	2%	7%	16%	24%
Enclose	1%	7%	14%	14%
Window Work	14%	39%	35%	18%
Replace Wall/Ceiling	0%	0%	1%	2%
Replace Floor/Stair	0%	0%	0%	0%
Replace Doors	1%	4%	10%	8%
Replace Trim	2%	7%	10%	17%
Replace Windows	1%	5%	38%	58%

Median costs for Strategy 02 are somewhat higher than the RIA estimates for unit cleanup in Exhibit 2-10, but Exhibit 2-11 shows that 15 percent of the rooms in this strategy code also performed paint stabilization, and another 14 percent had window work. Therefore, the median cost per unit in this Strategy Code may include costs for paint stabilization or window work in one room.

The median costs for Strategy Code 05 are actually lower than the RIA cost estimates for window replacement. The Evaluation data costs most likely reflect the cost of window replacement with standard double-pane windows, and the higher RIA cost estimates reflect the additional cost of more efficient Low-e windows.

Finally, Exhibit 2-11 shows that Strategy 04 does not only include cleaning, paint stabilization, and window work as hazard treatments. In particular, window replacement was reported for 38 percent of the rooms in this strategy code, doors and trim were replaced in 10 percent of the rooms, paint removal was done in 16 percent of the rooms, and enclosure in 14 percent of the rooms. This explains why the median costs for this strategy code are substantially higher than the RIA cost estimates for window work. The RIA window work cost estimate of $50 per room ($200 for multi-family units and $300 for single-family units) is indirectly confirmed by Evaluation data costs for Strategy 03, however, because 39 percent of the rooms in strategy 03 had window work done. If window work costs were significantly higher than $50 per room, then the median cost of strategy 03 would be higher.

CHAPTER 3. BENEFITS OF THE FINAL RULE

The benefits of the final rule consist of the value of any incremental reductions in lead poisoning risks achieved by hazard reduction requirements for HUD assisted housing, and the market values of paint stabilization and window replacement. This chapter presents an analysis of such benefits, organized in six sections:

3.1 Data Sources and Limitations
3.2 Potential Benefits of Preventing Lead Poisoning
3.3 Unit Benefit of Lead Dust Hazard Reduction
3.4 Unit Benefit of Paint Stabilization
3.5 Unit Benefit of Soil Hazard Reduction
3.6 Summary of the Monetized Unit Benefits of Hazard Reduction Activities.

3.1 DATA SOURCES AND LIMITATIONS

This analysis builds on a foundation of extensive academic research analyzing the risks of lead-poisoning and the benefits of LBP hazard reduction. In particular, the following data sources and research studies are referenced extensively in this chapter:

Battelle Draft Report: "Draft Report on Review of Studies Addressing Lead Abatement Effectiveness," Battelle, September 19, 1994.

CDC Report: "Strategic Plan for the Elimination of Childhood Lead Poisoning," Centers for Disease Control and Prevention, February, 1991.

EPA RIA: "TSCA Title IV, Sections 402(a) and 404: Target Housing and Child-Occupied Facilities Final Rule Regulatory Impact Analysis," Prepared by Abt Associates for U.S. Environmental Protection Agency, August, 1996.

Evaluation Data: Data on LBP hazard frequencies from the HUD Lead-Based Paint Hazard Control Grant Program (data collected through March, 1998).

Salveker: "Updated Estimates of Earnings Benefits From Reduced Exposure of Children to Environmental Lead," David S. Salveker, Environmental Research, 70, 1995.

Gulson: "Paint as a Source of Recontamination of Houses in Urban Environments and its Role in Maintaining Elevated Blood Leads in Children," Brian Gulson et al., The Science of the Total Environment, 164, 1995.

McElvaine: "Prevalence of Radiographic Evidence of Paint Chip Ingestion Among Children With Moderate to Severe Lead Poisoning, St. Louis, Missouri, 1989 through 1990," Michael McElvaine et al., Pediatrics, April 1992.

NHANES III: Third National Health and Nutrition Examination Survey, Phase 1 (1988-1991), as reported in "Blood Lead Levels in the U.S. Population" and "The Decline in Blood Lead Levels in the United States," JAMA, July 27, 1994.

NHANES III, Phase 2: Third National Health and Nutrition Examination Survey, Phase 2 (1992-1994) as reported in "Update: Blood Lead Levels – United States, 1991-1994," MMWR, February 21, 1997, p.141; with additional detail obtained by ICF Consulting Group from NHANES III data on CD-ROM.

AHS Data: 1995 American Housing Survey data on number of housing units and resident children by year of construction.

NRC Report: "Measuring Lead Exposure in Infants, Children, and Other Sensitive Populations," Committee on Measuring Lead in Critical Populations (formed by the National Research Council), October, 1993.

Rochester Study: "The Relation of Lead-Contaminated House Dust and Blood Lead Levels Among Urban Children," The University of Rochester School of Medicine, Rochester, New York, and The National Center for Lead-Safe Housing, prepared for HUD, January 15, 1995.

Schwartz: "The Societal Benefits of Reducing Lead Exposure," Joel Schwartz, Environmental Research, July 5, 1993.

Schwartz: "The Risk of Lead Toxicity in Homes With Lead Paint Hazard," Joel Schwartz and Ronnie Levin, Environmental Research, 54, pp. 1-7 (1991).

Schwartz: "Low-Level Lead Exposure and Children's IQ: A Meta-Analysis and Search for a Threshold," Joel Schwartz, Environmental Research, April, 1994.

Schwartz: "The Relationship Between Gasoline Lead and Blood Lead in the United States," Joel Schwartz and Hugh Pitcher, Journal of Official Statistics, Vol. 5 No. 4, 1989.

Staes: "Does Residential Lead-Based Paint Hazard Control Work? A Review of the Scientific Evidence," Catherine Staes and Richard Rinehart, prepared for The National Center for Lead Safe Housing, February 28, 1995.

Weitzman: "Lead-Contaminated Soil Abatement and Urban Children's Blood Lead Levels," Michael Weitzman et al., JAMA, April 7, 1993.

Data Limitations

Total potential benefits estimated in Section 3.2 are sensitive to estimated IQ points lost per one ug/dL change in childhood blood lead levels. The sensitivity analysis in Chapter 6 examines the change in estimated benefits that would result from using different research estimates for this relationship.

Benefits are also very sensitive to assumptions regarding the appropriate discount rate for this analysis. Therefore, the present value of changes in lifetime earnings associated with childhood blood lead levels is discounted at both three and seven percent. The three percent discount rate is consistent with the EPA RIA and the HUD’s view that a three percent rate best reflects the social rate of time preference for annualized, non-capital costs and benefits. The seven percent discount rate reflects OMB’s recommendation that costs and benefits should be discounted at the seven percent average real rate of return on capital. However, OMB guidance also states that a lower social rate of time preference may be appropriate when conducting intergenerational analyses in order to properly value changes in consumption across different generations. All other costs and benefits in this analysis (other than lifetime earnings) are discounted at the seven percent rate recommended by OMB.

The studies used to derive unit benefits in Sections 3.3, 3.4, and 3.5 are not always comparable for the following reasons:

- Some studies measure the decline in blood lead levels in children who have already been poisoned, while others study the benefits of preventing lead poisoning; and

- In several studies, no control group was used to measure the baseline decline.

Many benefits of the final rule are also intangible and/or cannot be monetized or otherwise quantified (e.g., the effect of neurobehavioral deficiencies and crime). For these reasons, the estimated unit benefits derived in this chapter may substantially understate the benefits of the final rule.

3.2 POTENTIAL BENEFITS OF PREVENTING LEAD POISONING

This section examines three types of benefits associated with lead hazard reduction in housing and the prevention of lead poisoning. The benefits are:

- Monetized benefits of preventing lead poisoning in young children;
- Reduced infant mortality; and
- Non-quantifiable benefits.

a) Monetized Benefits of Preventing EBLs in Young Children

The benefits of preventing elevated blood lead levels in young children have been monetized in published literature by Schwartz (1993), CDC (1991), and most recently in EPA's RIA (1996). Each of these sources identifies the following types of monetized benefits that are directly applicable to the analysis of the benefits from the final rule:

- Reductions in medical costs;
- Reductions in special education costs; and
- Increased lifetime earnings associated with higher cognitive abilities.

These monetized benefits are divided into two categories: (1) benefits achieved only for children with blood lead levels prevented from rising above 25 ug/dL; and (2) benefits achieved regardless of blood lead levels. The Schwartz, CDC, and EPA analyses included reductions in medical costs and special education costs in the first category, and increased lifetime earnings in the second.

The estimates for reduced medical and special education costs in this analysis are based on the Schwartz and CDC estimates, adjusted for inflation and to reflect NHANES III Phase 2 data on the current extent of childhood lead poisoning above 25 ug/dL. The estimate for increased lifetime earnings reflects EPA and CDC estimates, adjusted to reflect NHANES III Phase 2 data on the blood lead levels in young children.

1) Benefits Achieved Only For Children With Blood Lead Levels Prevented From Rising Above 25 ug/dL (Reductions in Medical Costs and Special Education Costs)

Medical costs for children with high blood lead levels include physician visits, laboratory testing, chelation therapy, neuropsychological testing, and follow-up testing. Schwartz and CDC estimate that preventing childhood EBLs above 25 ug/dL would reduce such medical costs by approximately $1,800 per child (based on an adjustment to 1994 dollars using a medical cost inflation index).

Children with high blood lead levels are also more likely to require speech therapy and other special education. Schwartz and CDC estimate that preventing a child's blood lead level from rising above 25 ug/dL saves, on average, approximately $4,000 in special education costs (adjusted to 1994 dollars).

Therefore, this analysis estimates the annual benefit of reduced medical and special education costs by multiplying per-child costs ($5,800) by the number of children who are prevented from developing blood lead levels above 25 ug/dL each year. This estimate may underestimate medical costs because CDC now recommends a physical examination and a detailed environmental and physical history, as well as retesting, for children consistently over 15 ug/dL. The medical cost reductions anticipated in the Schwartz and CDC analysis, however, reflect more extensive and expensive medical interventions (e.g., chelation) associated with higher blood lead levels.

2) Benefits Achieved Regardless of Blood Lead Levels (Increased Lifetime Earnings)

EPA estimates (using a three percent discount rate) that a one year old infant loses $6,442 in lifetime earnings (in current dollars) per lost IQ point. If a seven percent discount rate is used, a one-year old loses $1,480 in lifetime earnings per lost IQ point (corresponding estimates by Schwartz and CDC fall between the three and seven percent discounting estimates because each used a five percent discount rate in conducting their analyses). It is important to note that these estimates represent the sum of the following separate pathways that directly and indirectly link IQ and lifetime earnings:

- the direct link between IQ and the wage rate;
- the indirect effect of IQ on educational attainment; and
- the indirect effect of lead exposure on labor force participation.

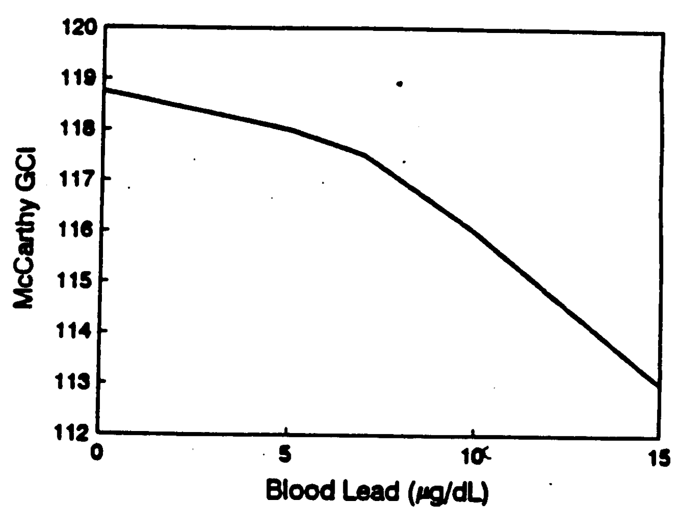
Salkever (1995) has updated the estimated present value of lifetime earnings per IQ point lost, using new data on recent trends in returns to education and cognitive skills in the labor market, and incorporating evidence that percentage earnings gains are considerably larger for females than for males. This research provides corrected estimates that imply an upward revision of 47.9 to 62.4 percent in the present value per IQ point reported by Schwartz and reflected in the EPA RIA. Applying the conservative 50 percent revision suggested by Salveker indicates that the EPA estimates should be increased to $9,663 per IQ point using a three percent discount rate, and $2,220 using a seven percent discount rate.

CDC and Schwartz estimate that 0.245 IQ points are lost, on average, for each one ug/dL increase in blood lead levels. Therefore, this analysis assumes that preventing a one ug/dL increase in a one year old child's blood lead level saves $2,367 ($9,663 x 0.245) in lifetime earnings discounted at three percent, and saves $544 ($2,220 x 0.245) in lifetime earnings discounted at seven percent.

This analysis estimates the potential benefits of increased lifetime earnings based on the total potential decline in childhood blood lead levels. NRC reports that most studies of blood lead level impacts on IQ demonstrate a relationship within the range of five-35 ug/dL (NRC, p. 59). The specific dose-response relationship assumed in the analysis (0.245 IQ points lost per one ug/dL increase in blood lead levels) is consistent with analysis by Schwartz (NRC, p. 60) based on a blood lead range of 10 to 20 ug/dL. However, Schwartz's meta-analysis (1994) indicates no threshold for the IQ relationship with blood level.

Schwartz has also reported that children with blood lead levels of three to nine ug/dL at 20 months had significantly lower McCarthy General Cognitive Index scores than children with blood lead below three ug/dL (NRC, p. 67). A graphical presentation of this relationship for blood lead levels between zero and 15 ug/dL, reproduced as Exhibit 3-1 below, indicates that the dose response relationship at blood lead levels above 10 ug/dL overstates the impact on McCarthy scores below seven ug/dL. On the other hand, the 1994 meta-analysis of this subject by Schwartz found that studies with a mean blood lead level below 15 ug/dL actually have a higher dose-response (blood lead to IQ slope) than studies at higher mean blood lead levels. Therefore, this analysis assumes that variations in the dose-response relationship at different blood lead levels may reflect only random variations across different studies, and the dose-response relationship of 0.245 IQ points per one ug/dL is assumed to apply to all blood lead levels for young children sensitive to cognitive losses.

Exhibit 3-1
Relationship Between ug/dL at 20 months and McCarthy General Cognitive Index
(Data from Bellinger et. al., 1991. Source: Schwartz, as shown in NRC Report, p. 67)



If the same blood lead to IQ relationship is applied to all young children sensitive to cognitive losses, then the potential benefit of increased earnings associated with blood lead reductions can be calculated by multiplying the potential blood lead decline for such young children by the value per unit of blood lead ($2,367 or $544 per one ug/dL, using a three percent or seven percent discount rate, respectively). The potential blood lead reduction can be calculated by multiplying the average mean blood lead for children sensitive to cognitive losses by the total number of such at-risk children.

3) At Risk Population

To quantify the benefits described above for "young children," it is necessary to specify the precise population of young children at risk for reduced lifetime earnings due to EBLs. In his meta-analysis of research on the BLL-IQ relationship, Schwartz found that most studies showed the strongest relationship for children under three, and for two year olds in particular. He also noted that this is consistent with neurotoxicological literature which suggests that "the neural network in the brain is most plastic during the first three years of life, and there is considerable evidence that basic cognitive abilities develop in that period. . . . This suggests that a measure during that period be chosen. Even if that is not the mechanism of lead toxicity, the greater plasticity of the brain in the early years suggests an emphasis on that period" (Schwartz, 1994, p. 46). A separate meta-analysis of the BLL-IQ relationship "confirms the lack of association with blood lead around birth and the inconclusiveness of the findings for the mean postnatal blood lead concentrations. However, the collective results for blood lead around two years show stronger evidence for an inverse association. . . ." (Pocock, 1994, p. 1194).

NHANES III Phase 2 data shown in Exhibit 3-2 also demonstrate that children aged one and two are more likely to have EBLs than are children aged three to five.

Exhibit 3-2
NHANES III Phase 2 Percentage of Children
Above Selected Blood Lead Levels by Age

Age	% > 25 ug/dL	% > 20 ug/dL	% > 15 ug/dL	% > 10 ug/dL
1-2	0.2	0.4	1.9	5.6
3-5	0.3	0.3	0.9	3.4

Based on the NHANES III prevalence data, and the neurotoxicological evidence and meta-analyses described above, this analysis defines the principal at-risk population for lifetime earnings benefits to be the national population of children aged one and two. The plasticity of the brain before the age of three suggests that children aged one and two are also the principal at-risk population for special education benefits.

Of course, some lesser amount of lifetime earnings and avoided special education costs will be realized by children under the age of one and ages three and older. Medical benefits will also be realized by these children. Available data used to estimate unit benefits, however, are not directly applicable to children over the age of three. Therefore, the unit benefits of avoiding EBLs in young children (discussed in Sections 3.3, 3.4, and 3.5) are initially estimated for children aged one and two residing in units during the first year following hazard reduction activities. Additional benefits are then estimated in the last section of this chapter. These additional benefits include the following:

- Benefits for children ages three and older residing in units during the first year following hazard reduction activities;

- Benefits for a new population of one year olds residing in units during the second year and subsequent years following hazard reduction activities;

- Benefits for children ages two and older who begin residing in units during the second year and subsequent years following hazard reduction activities (i.e., due to unit turnover); and

- Benefits to non-resident children who visit the unit during the years following hazard reduction activities.

These additional benefits are estimated in Section 3.5 as a percentage of the first year benefits for resident children ages one and two, where "first year" refers to the first year following hazard reduction activities. Section 3.5 also examines the likely duration of different hazard reduction benefits in order to calculate the monetized unit benefit associated with all of the years following hazard reduction activities.

4) First Year Monetized Benefits for Resident Children Aged One and Two

Medical and special education benefits of avoiding lead poisoning are $5,800 for each child aged one or two prevented from developing blood lead levels above 25 ug/dL. AHS data indicate that there were 7.6 million children aged one and two in the United States in 1995, and NHANES III Phase 2 data show that 0.2 percent of these children have blood lead levels above 25 ug/dL. Therefore, the first year medical and special education benefits of avoiding blood lead levels above 25 ug/dL in children aged one and two would be $88 million ($5,800 x 7.6 million x 0.002).

Benefits from increased earnings are $2,367 or $544 times the total blood lead decline for all one and two year old children, using a three or seven percent discount rate, respectively. NHANES III Phase 2 reported average blood lead levels of 3.0 ug/dL for one and two year olds in post-1973 housing, 4.2 ug/dL for one and two year olds in housing built between 1946 and 1973, and 5.7 ug/dL for young children in pre-1946 housing. Post-1973 housing can be characterized as virtually free of LBP hazards because lead paint was banned after 1977 and rarely used in the years just before this ban. Therefore, the NHANES III Phase 2 data suggest that eliminating LBP hazards in pre-1978 housing could reduce average blood lead levels by 1.2 ug/dL for one and two year olds in housing built between 1946 and 1973, and by 2.7 ug/dL for young children in pre-1946 housing.

AHS data show that there are 3.73 million children ages one and two living in housing built between 1940 and 1977, and 1.4 million young children in pre-1940 housing. If average blood lead for young children could be reduced to the NHANES III levels for post-1973 housing, then the benefit associated with increased earnings at a three percent discount rate would be $10.6 billion for one and two year olds in housing built between 1940 and 1978 (1.2 ug/dL change x 3.73 million children x $2,367 per child), plus $8.9 billion for one and two year olds in pre-1940 housing (2.7 ug/dL change times 1.4 million children x $2,367 per child). Summing these benefits for all children in pre-1978 housing indicates that the total lifetime earnings benefit of eliminating all LBP hazards would be $19.5 billion. At a seven percent discount rate for lifetime earnings, this total benefit would be $4.5 billion (1.2 x 3.73 million x $544 plus 2.7 x 1.4 million x $544). Section 3.6 verifies that this maximum benefit estimate is consistent with the unit benefit analyses in Sections 3.3, 3.4, and 3.5.

b) Reduced Infant Mortality

Sensitivity analysis in the EPA RIA estimated that the monetized benefits of avoided neonatal mortality are $1,163 per housing unit abated, based on the following assumptions:

- The risk of neonatal mortality decreases by .0001 for each one ug/dL reduction in maternal lead levels (based on data from the Linked Birth and Infant Death Record Project and the National Center for Health Statistics and the effect of maternal blood lead levels on gestational age from Dietrich (1987));

- Abatement prevents an increase of 2.13 ug/dL in the blood lead levels of pregnant women (adopted from CDC analysis, based on 2.13 ug/dL blood lead level difference between pregnant women in lead-contaminated 19th century housing and those in public housing (R. Bornschein, personal communication));

- On average, a pregnant woman will be living in 3.99 percent of all housing units (Census data); and

- Neonatal mortality is monetized at a value of $5.5 million per life saved (based on the mean value per life saved from 26 studies).

Schwartz (1993) and CDC (1991) adopted similar assumptions in their estimates of neonatal mortality. Schwartz noted that low birth-weight and low gestational age are strong predictors of infant mortality, and that this relationship is not limited to very-low-birth-weight infants. Therefore, he concluded that the association of maternal blood lead with reduced birth-weight supports the expectation that higher maternal blood lead levels result in increased infant mortality. However, Schwartz also noted that "the relative risk is small and impossible to detect in studies as small as the prospective lead studies."

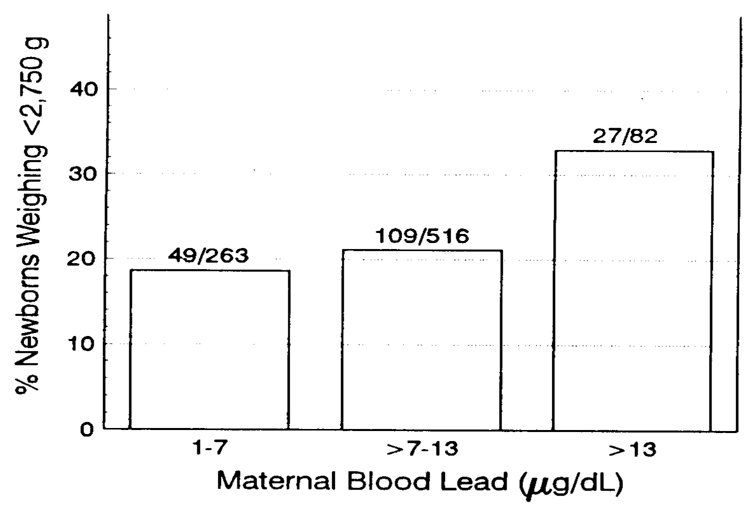
The review of the most recent NHANES data and research relating maternal blood lead levels with gestational age and birth-weight suggests that past analyses may have overstated the current risk of neonatal mortality associated with maternal blood lead levels. A survey of recent research on this subject (NRC, p. 37) notes the following:

> Women in studies in Boston (Bellinger et al., 1991b), Cleveland (Ernhart et al., 1986), Cincinnati (Bornschein et al., 1989), and Port Pirie (McMichael et al., 1986; Baghurst et al., 1987a) had average blood lead concentrations during pregnancy of 5-10 ug/dL; almost all had blood lead concentrations less than 25 ug/dL. . . . None of these studies reported an association between maternal blood lead concentrations and spontaneous abortion or stillbirth. . . . The Boston study found an increased risk of intrauterine growth retardation, low birthweight, and small-for-gestational-age deliveries at cord blood lead concentrations of 15 ug/dL or more. The Port Pirie study found that the relative risk of preterm delivery increased 2.8-fold for every 10-ug/dL increase in maternal blood lead. In the Cincinnati study,

gestational age was reduced . . . about 1.8 weeks over the entire range of observed blood concentrations. . . . However, some striking inconsistencies, yet to be explained, characterize the data on the relationship between prenatal lead exposure and fetal growth and maturation. For instance, in the large cohort (N = 907) of women residing in Kosovo (Factor-Litvak et al., 1991), no associations were seen between midpregnancy blood lead concentrations (ranging up to approximately 55 ug/dL) and either infant birthweight or length of gestation.

Even if we set aside the research inconsistencies observed by NRC, and accept the existence of a relationship between higher maternal blood lead levels and shorter gestational age which increases neonatal mortality, it is still necessary to consider the percentage of pregnant women potentially affected by this risk. Prior analyses appear to assume that the benefit of preventing neonatal mortality applies to all pregnant women exposed to LBP hazards regardless of initial blood lead levels. However, the Boston study observed this relationship at cord blood lead concentrations of 15 ug/dL or more. The NRC notes that "blood lead concentrations associated with adverse fetal development are low (10-15 ug/dL or even lower)," but NHANES III data indicate that only 0.5 percent of women aged 12 to 49 years had blood lead levels above 10 ug/dL between 1988 and 1991. Also, a graphical presentation of the relationship between maternal blood lead levels and birthweight, reproduced as Exhibit 3-3 below, indicates that the relationship is much more apparent and pronounced at maternal blood lead levels above 13 ug/dL.

Exhibit 3-3
Relationship Between Maternal Blood Lead and Newborn Weight
(Data from Dietrich (1991). Source: Schwartz (Neuro Toxicology, 1992), as shown in NRC Report, p. 72)



The review of these data and research studies suggests that neonatal mortality may not be a demonstrated or measurable risk at maternal blood lead levels below 10 ug/dL. NHANES III data indicate that only 0.5 percent of reproductive-aged females have blood lead levels above 10 ug/dL, which suggests that the monetized benefit of avoided neonatal mortality may be just $0.23 per year per housing unit abated, or 0.5 percent of EPA's $45 estimate (which applied to all pregnant women exposed to LBP hazards regardless of initial blood lead levels). Also, the small percentage of reproductive age females with BLLs above 10 ug/dL may be primarily attributable to lead risks unrelated to LBP hazards, because many studies have linked LBP hazards with the pica and mouthing behavior of young children. CDC also estimates that 94 percent of very high adult EBLs result from occupational exposure. Therefore, LBP hazard reduction is not expected to produce any significant monetized benefits associated with reduced neonatal mortality.

c) Non-Quantifiable Benefits

The ATSDR notes that there is "considerable scientific debate" about the relationship between lead poisoning and hypertension. However, the report concludes that "evidence from both occupational studies and large-scale general population studies (i.e., National Health and Nutrition Examination Survey [NHANES II], British Regional Heart Study [BRHS]) is not sufficient to conclude that such a causal relationship exists between blood lead levels and increases in blood pressure" (ATSDR, Toxicological Profile for Lead, 1993). In contrast, the NRC's evaluation of studies of the correlation between blood lead levels and blood pressure finds "overwhelming evidence for the causality of the association" (NRC, 77). The NRC further notes that "in 11 recent studies of the association between blood lead and blood pressure...positive and moderate consistent effects are seen" (NRC, 75).

The final rule may not have a significant direct impact on adult blood lead levels because LBP hazards pose the greatest risk for children with pica and mouthing behavior. Recent research, however, suggests a link between childhood BLLs and adult blood lead levels. Due to the relationship between "early skeletal accumulation [of lead] and potential later releases in late adulthood" (Mushak, 4), avoiding EBLs in preschool age children may prevent adverse cardiovascular effects when these children become adults. An accurate estimate of benefits would require data on childhood bone lead levels, and a model of bone lead contributions to blood lead over several decades. There are no available data, however, on the national distribution of childhood bone lead levels (i.e., comparable to NHANES data on blood lead levels).

Due to the complexity of quantifying benefits associated with reduced hypertension in adults, the controversy over the strength of the causal association between blood lead levels and blood pressure, and the uncertainty about the final rule's impact on adult lead poisoning, this analysis does not attempt to measure monetized benefits from reducing blood pressure in adults. However, it should be noted that omitting such benefits from the analysis will likely result in a conservative estimate of the overall benefits of the final rule.

Other non-quantifiable benefits of LBP hazard reduction include the following:

- Improving children's stature, hearing, and vitamin D metabolism;
- Reducing juvenile delinquency and the burden on the educational system;

- Avoiding the parental and family time, expenses, and emotional costs involved in caring for poisoned children; and

- Reducing personal injury claims and court cases.

Although these benefits may be substantial, they cannot be explicitly reflected in the analysis of monetized benefits. The overwhelming majority of quantifiable benefits associated with LBP hazard reduction are derived from the monetized benefits for young children. Increased lifetime earnings associated with higher IQs account for more than 98 percent of the potential first year benefit for resident children ages one and two ($19.5 or $4.5 billion, using a three percent or seven percent discount rate, respectively) and avoided medical and special education costs account for less than two percent ($88 million).

3.3 UNIT BENEFIT OF LEAD DUST HAZARD REDUCTION

The analysis under Section 3.2 concluded that the potential first year benefit of eliminating LBP hazards to one and two year old children is approximately $19.6 or $4.6 billion, using a three and seven percent discount rate, respectively. This section estimates the fraction of this potential benefit that could be realized if all housing units satisfied the HUD standard for interior window sill dust. In order to calculate the unit benefit of lead dust hazard reduction, this fraction of total benefits achieved by preventing dust lead hazards is divided by the total number of housing units that fail the HUD standard for window sill dust. Window sill dust lead is used as an indicator of lead dust removal benefits because many research studies show that window dust lead and floor dust lead are highly correlated and both types of dust lead have a strong association with blood lead levels. Therefore, the estimated unit benefit of avoiding window sill dust hazards is used in this analysis as the estimated unit benefit of removing lead dust from window sills and/or floors that fail the proposed standards.

This analysis uses Rochester study data and Evaluation data to quantify the association between lead dust hazards and elevated blood lead levels in young children. The Rochester study provides blood lead data for 208 children between the ages of 12 and 30 months, and data on dust lead levels in their homes. Children whose parents had occupational lead exposure, and children with medical interventions for lead poisoning (e.g., chelation) were excluded from the study in order to better isolate the blood lead effects of dust lead.

Several comments on the final rule questioned the extent to which the benefits analysis depended on the Rochester study to quantify the association between dust lead and blood lead levels in young children. The advantages of using the Rochester data include its focus on children ages 12 to 30 months (young enough to limit soil hazard exposure), the exclusion of children whose parents had occupational exposure (eliminating a non-LBP hazard exposure), and the exclusion of higher BLL children receiving chelation (BLLs associated with paint chip ingestion). For these reasons, the Rochester data difference in blood lead by dust lead category was expected to approximate the difference in blood lead associated with dust lead only. This would avoid double-counting the incremental benefits of avoiding blood lead impacts associated with soil hazards and paint chip ingestion, estimated separately from dust lead impacts based on other data and research (discussed in Sections 3-3 and 3-4).

Taken as a whole, the Evaluation data includes a disproportionate number of children with elevated blood lead levels because some grantees under this program targeted units in poor condition and/or units with children known to have elevated blood lead levels. As shown in Exhibit

3-4, however, a subset of Evaluation data including only one year olds with blood lead levels below 20 ug/dL is roughly comparable to the Rochester data on blood lead levels by dust lead category, except that the Rochester data shows higher blood lead levels in the highest dust lead category.

Exhibit 3-4
Comparison of Blood Lead Levels from
Rochester Study and Subset of Evaluation Data

Blood Lead by Window Sill Dust Lead		
Sill Lead	Rochester	Evaluation data for one year olds < 20 ug/dL
0-250	6.37	6.71
250-500	8.63	8.42
500-1000	8.84	9.12
1000+	11.84	9.90

The Evaluation data subset in Exhibit 3-4 includes 197 children. These data have the advantage of offering much more regional diversification than the Rochester data, but the exclusion of children with blood lead above 20 ug/dL may understate the blood lead levels associated with the highest dust lead category. In the case of the Rochester data, however, the higher blood lead level in the highest dust lead category may result from some children who ingested paint chips some weeks before their blood lead was tested, resulting in relatively high BLLs (20 to 30 ug/dL) that were not quite high enough to indicate chelation. Including higher blood lead levels associated with paint chip ingestion would double count benefits counted elsewhere in the RIA (as explained in Section 3.4). Given the strengths and weaknesses of both data sets, the RIA estimate for the average blood lead level due to dust lead, as shown in Exhibit 3-5, is based on a simple average of the change in BLL by dust lead category in the Rochester data and in the Evaluation data subset.

Exhibit 3-5
RIA Estimate for Average Increase in
Blood Lead Level Due to Dust Lead

Blood Lead Change by Window Sill Dust Lead:			
Sill Lead	Rochester	Grantee<20	Average Increase in BLL over lowest dust lead category
0-250	NA	NA	
250-500	2.26	1.71	1.98
500-1000	2.47	2.41	2.44
1000+	5.47	3.19	4.33

Analysis presented in Section 3.6 will combine the association between dust lead and blood lead described in Exhibit 3-5 with Evaluation data on dust lead hazard frequencies to calculate average blood lead levels for all one and two year olds by age of housing. These estimated blood lead impacts of dust lead, combined with the estimated blood lead impacts of paint chip ingestion and soil lead, are also shown to result in estimated average blood lead levels that are consistent with the actual average blood lead levels reported by NHANES III Phase 2 data. Also, analysis presented in Chapter 4 will show that Evaluation data on dust and soil occurrence frequencies do appear to be representative of dust and soil hazard frequencies for all pre-1978 housing.

The decrease in average blood lead associated with lower dust lead in Exhibit 3-5 is significantly greater than the actual blood lead decline reported in dust cleanup studies of children already affected by lead poisoning. This is because the "reduction" in blood lead levels associated with lower dust lead levels in Exhibit 3-5 is actually the avoided increase in blood lead levels for children that are not yet poisoned. The effect for children already poisoned is much less because the mobile component of blood lead has a half-life of up to 30 days, and endogenous releases to blood from tissue and bone lead accumulations can result in a more persistent toxicity risk of lead resorption for children already poisoned over some extended period (Mushak, 1993).

The unit benefits of removing dust lead hazards are calculated in Exhibits 3-6a and 3-6b using a three and seven percent discount rate, respectively, for lifetime earnings. AHS data indicate that about 70 percent of young children live in pre-1978 units, or approximately 5.13 million children ages one and two. Weighted average Evaluation data indicate that 16 percent of these children live in housing units in the highest window sill dust lead category (>1,000 ug/ft^2), nine percent are living in units with window sill dust lead between 500 and 999 ug/ft^2, and 17 percent live in units with window sill dust lead between 250 and 499 ug/ft^2. Exhibit 3-5 indicates that lead dust reduction could lower the average BLL in the highest category by 4.33 ug/dL, reduce the average in the 500-999 ug/ft^2 category by 2.44 ug/dL, and lower the average BLL in the 250-499 ug/ft^2 category by 1.98 ug/dL. Exhibits 3-6a and 3-6b combine these data with the present value of lifetime earnings associated with each one ug/dL in blood lead ($2,367 or $544) to calculate the unit benefit of enforcing the interim lead dust standards.

Exhibit 3-6a
Estimated Unit Benefit of Enforcing the HUD Standards for Dust Lead
(First Year Unit Benefit for Resident Children Ages One and Two
Using a <u>Three</u> Percent Discount Rate for Lifetime Earnings)

5.13 million x (0.17) x (1.98) x ($2,367)	$ 4,067 million
5.13 million x (0.09) x (2.44) x ($2,367)	$ 2,774 million
5.13 million x (0.16) x (4.33) x ($2,367)	$ 8,092 million
Monetized benefit of enforcing dust standard in all units	$ 14,933 million
42% of 70 million pre-1978 housing units failing window dust standard	29.2 million units
Monetized benefit per unit brought up to standard	$ 512 per unit

Exhibit 3-6b
Estimated Unit Benefit of Enforcing the HUD Standards for Dust Lead
(First Year Unit Benefit for Resident Children Ages One and Two
Using a <u>Seven</u> Percent Discount Rate for Lifetime Earnings)

5.13 million x (0.17) x (1.98) x ($544)	$ 935 million
5.13 million x (0.09) x (2.44) x ($544)	$ 638 million
5.13 million x (0.16) x (4.33) x ($544)	$ 1,860 million
Monetized benefit of enforcing dust standard in all units	$ 3,432 million
42% of 70 million pre-1978 housing units failing window dust standard	29.2 million units
Monetized benefit per unit brought up to standard	$ 118 per unit

The first three rows of Exhibits 3-6a and 3-6b show the monetized benefit for reducing the dust levels for children in pre-1978 housing. The first row multiplies the total number of one and two year olds in pre-1978 housing (5.13 million) by the fraction of these children living in units with dust lead of 250 to 499 ug/ft^2 (17 percent) by the average blood lead decline achieved by lead dust removal in these units (1.98) by the value of each one ug/dL decline in blood lead ($2,367 or $544). The second row shows the same calculation for the fraction of units with dust lead of 500 to 999 ug/ft^2 (nine percent) and the average blood lead decline achieved by lead dust removal in these units (2.44), and the third row reflects the fraction of units with dust lead above 1,000 ug/ft^2 (16 percent) and the average blood lead decline achieved by lead dust removal (4.33). The total benefit of enforcing the proposed dust standard in all pre-1978 units is $14.9 or $3.4 billion, depending on the discount rate used. Dividing both $15.0 and $3.4 billion by the number of units that fail the window dust standard yields the estimated unit benefits of $510 and $116, respectively.

The unit benefit calculations in Exhibits 3-6a and 3-6b reflect the weighted average occurrence frequencies for Evaluation dust hazard data, but the Evaluation data and National Survey data both indicate that children living in older housing are more likely to be exposed to lead dust hazards than children in newer units. To measure how the frequency and severity of lead dust hazards can affect unit benefits for older housing relative to newer housing, the benefits calculations in Exhibits 3-6a and 3-6b are repeated below for pre-1940 units, units built from 1940 through 1959, and those built from 1960 through 1977. The results are illustrated in Exhibits 3-6c through 3-6h, respectively.

AHS data indicate that approximately 1.4 million children ages one and two live in pre-1940 housing units, 1.55 million live in units built from 1940 through 1959, and 2.18 million live in units built from 1960 through 1977. Weighted average Evaluation data indicate that children in pre-1940 units are more likely to be exposed to dust hazards than children in units built from 1940 through 1959, but the proportion of units with children ages one and two is higher in units built from 1940 through 1959. The net effect of these factors, shown in Exhibits 3-6c through 3-6f, is that the average unit benefit of dust hazard removal in all units built before 1960 is $577 using a three percent discount rate, and $133 using a seven percent discount rate. By contrast, children in units built from 1960 through 1977 are much less likely to be exposed to lead dust loadings above the 250 ug/ft^2 HUD standard, and none of the post-1960 units in the HUD grant data are above 1000 ug/ft^2. The lower frequency and severity of lead dust hazards in post-1959 housing results in a lower average unit benefit for lead dust removal. As shown in Exhibits 3-6g and 3-6h, the unit benefit for housing built from 1960 through 1977 is $341 using a three percent discount rate, and $78 using a seven percent discount rate.

Exhibit 3-6c
Unit Benefit of Enforcing the HUD Standards for Dust Lead in Pre-1940 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a <u>Three</u> Percent Discount Rate for Lifetime Earnings)

1.4 million x (0.14) x (1.98) x ($2,367)	$ 905 million
1.4 million x (0.13) x (2.44) x ($2,367)	$ 1,051 million
1.4 million x (0.32) x (4.33) x ($2,367)	$ 4,592 million
Monetized benefit of enforcing dust standard in all units	$ 6,548 million
59% of 19 million pre-1940 housing units failing window dust standard	11.4 million units
Monetized benefit per unit brought up to standard	$577 per unit

Exhibit 3-6d
Unit Benefit of Enforcing the HUD Standards for Dust Lead in Pre-1940 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a Seven Percent Discount Rate for Lifetime Earnings)

1.4 million x (0.14) x (1.98) x ($544)	$ 208 million
1.4 million x (0.13) x (2.44) x ($544)	$ 242 million
1.4 million x (0.32) x (4.33) x ($544)	$ 1,055 million
Monetized benefit of enforcing dust standard in all units	$ 1,505 million
59% of 19 million pre-1940 housing units failing window dust standard	11.4 million units
Monetized benefit per unit brought up to standard	$133 per unit

Exhibit 3-6e
Unit Benefit of Enforcing the HUD Standards for Dust Lead in 1940-1959 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a Three Percent Discount Rate for Lifetime Earnings)

1.55 million x (0.14) x (1.98) x ($2,367)	$ 1,017 million
1.55 million x (0.15) x (2.44) x ($2,367)	$ 1,343 million
1.55 million x (0.22) x (4.33) x ($2,367)	$ 3,495 million
Monetized benefit of enforcing dust standard in all units	$ 5,855 million
51% of 20 million 1940-1959 housing units failing window dust standard	10.1 million units
Monetized benefit per unit brought up to standard	$577 per unit

Exhibit 3-6f
Unit Benefit of Enforcing the HUD Standards for Dust Lead in 1940-1959 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a Seven Percent Discount Rate for Lifetime Earnings)

1.55 million x (0.14) x (1.98) x ($544)	$ 234 million
1.55 million x (0.15) x (2.44) x ($544)	$ 309 million
1.55 million x (0.22) x (4.33) x ($544)	$ 803 million
Monetized benefit of enforcing dust standard in all units	$ 1,346 million
51% of 20 million 1940-1959 housing units failing window dust standard	10.1million units
Monetized benefit per unit brought up to standard	$ 133 per unit

Exhibit 3-6g
Unit Benefit of Enforcing the HUD Standards for Dust Lead in 1960-1977 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a Three Percent Discount Rate for Lifetime Earnings)

2.18 million x (0.21) x (1.98) x ($2,367)	$ 2,146 million
2.18 million x (0.03) x (2.44) x ($2,367)	$ 378 million
2.18 million x (0.00) x (4.33) x ($2,367)	$ -
Monetized benefit of enforcing dust standard in all units	$ 2,523 million
24% of 31 million 1960-1977 housing units failing window dust standard	7.4 million units
Monetized benefit per unit brought up to standard	$341 per unit

Exhibit 3-6h
Unit Benefit of Enforcing the HUD Standards for Dust Lead in 1960-1977 Units
(First Year Unit Benefit for Resident Children Ages One and Two
Using a Seven Percent Discount Rate for Lifetime Earnings)

2.18 million x (0.21) x (1.98) x ($544)	$ 493 million
2.18 million x (0.03) x (2.44) x ($544)	$ 87 million
2.18 million x (0.00) x (4.33) x ($544)	$ -
Monetized benefit of enforcing dust standard in all units	$ 580 million
21% of 31 million 1960-1977 housing units failing window dust standard	7.4 million units
Monetized benefit per unit brought up to standard	$78 per unit

The sum of the total monetized benefits reflected in Exhibits 3-6c through 3-6h are the same as the total monetized benefits for all pre-1978 housing units presented in Exhibits 3-6a and 3-6b (except for rounding error). The estimates in Exhibits 3-6c through 3-6h are used to calculate the benefits of the final rule in Chapter 5, in order to recognize variations in unit benefits by age of housing.

3.4 UNIT BENEFIT OF PAINT STABILIZATION

Exhibit 3-7 presents a summary of recent studies of LBP hazard reduction benefits, as measured by reductions in childhood EBLs. These studies are presented to illustrate why the subsequent analysis of paint stabilization distinguishes between the direct benefit of avoided paint chip ingestion and the indirect benefit of lead dust hazards associated with interior deteriorated LBP.

Exhibit 3-7
LBP Hazard Reduction Research Studies

Intervention Study Title	Year Data Collected	Method of Intervention	Duration (months)	Initial BLLs Average (range)	Percent Decline
Baltimore Dust Control	1981	IC - no DC IC - bimonthly DC	12 12	38.5 38.6	-1.8% -18%
Boston Retrospective Study	1984-1985	IC	8	35.7	-29%
Boston Three-City Study	1989-1990	PR, DC, SA PR, DC PR	11 11 11	13.1 (7 to 24) 12.4 (7 to 24) 12 (7 to 24)	-19% -7.1% -5.6%
St. Louis Retrospective Study	1990	IC/DC	10-14 10-14	(>35) (25-34)	-22% -1%
Worcester Retrospective Study	1987-1990	IC No DC or clearance	1-12	25.9 (20 to 29) 16.7 (Under 20)	-18.5% +15%

Key to Abbreviations:

BLL: Blood Lead Level in ug/dL
IC: Interim Controls
DC: Dust Control
PR: Paint Stabilization

The studies included in Exhibit 3-7 were selected for this analysis because they offered at least one of the following attributes:

Current Data: NHANES data show that blood lead levels have declined substantially over the past 10 years. Many older studies provide data on EBLs above 30 ug/dL, which may not apply to this analysis because the monetized benefits are primarily derived from preventing lower levels of childhood blood lead.

Minimize Seasonal Variations: Studies with post-intervention blood lead level measurements taken approximately one year after the original intervention were selected to better isolate the effect of intervention procedures rather than the confounding effect of seasonal variations in blood lead levels.

Distinguish Between Incremental Benefits: Studies that distinguish between the benefits of lead dust reduction and paint stabilization were selected to isolate the incremental benefit of each hazard reduction activity.

The results of these studies may be not be entirely applicable to the final rule, however, for three reasons:

(1) These research studies reflect the benefits of reducing EBLs for children who have already been poisoned, not the benefits associated with preventing lead poisoning from occurring in the first place;

(2) Several of these studies combine limited abatement activities and paint stabilization, and the available research does not clearly distinguish between the benefits of abatement and stabilization; and

(3) Cleanup activities following paint stabilization (especially in older studies) may not reflect the more stringent requirements of the final rule.

The 1981 Baltimore Dust Control Study is included in Exhibit 3-7 because it is one of the only studies that clearly separates the benefit of dust control from the benefits of paint stabilization. The study examined 49 children aged 15 to 72 months with blood lead levels between 30 and 49 ug/dL. Treatment of their residences included removal of any deteriorated or peeling LBP and removal of intact LBP on chewable surfaces. No extensive cleanup was performed in the units that treated only paint hazards, and dust measurements were not collected in these units in order to avoid drawing attention to dust as a potential source of lead exposure. The dust control units were visited every two weeks by a dust control team, which wet mopped floors and window sills above specified dust lead levels. The child's caretaker was also advised to wet mop these areas on a regular basis, to wash the child's hands, and in some cases to limit the child's access to high-lead areas. Study results showed that interventions with subsequent cleaning procedures reduced EBLs by an average of 18 percent, whereas the blood lead levels of children in units that treated only paint hazards barely declined by a statistically insignificant 1.8 percent.

The data in Exhibit 3-7 on the Boston Retrospective study was gathered from 59 children under the age of six with blood lead levels above 25 ug/dL, none of whom received chelation therapy. Treatment of the children's residences included dry scraping or permanent cover of deteriorated LBP and intact LBP on chewable surfaces. In the Boston study, however, the benefits attributed to treatment may have been overstated because the families of EBL children were educated about de-leading procedures, the importance of removing children during the abatement process, and cleaning up by washing surfaces with tri-sodium phosphate. Although cleanup procedures were not uniformly followed, the 29 percent decrease in blood lead levels may be partially attributable to lead dust hazard education rather than entirely due to the effects of paint stabilization. Seasonal variations also may have distorted the results of this study because post-abatement blood lead level measurements were taken eight months after abatement.

In the Boston Three-City study, the effects of paint stabilization (removal of peeling interior paint), dust control (HEPA vacuuming, wiping floors and windows with a wet cloth, and cleaning furniture with an oil-treated rag), and soil abatement were compared for children with initial blood lead levels between seven and 24 ug/dL. In the group undergoing paint stabilization alone, the decline in blood lead levels after 11 months was just 5.6 percent. In units with paint stabilization and dust control (a one-time cleanup after paint stabilization) the decline in BLLs was 7.1 percent. In units with paint stabilization, cleanup, and soil abatement, BLLs declined by 19 percent. Families in all of the units were provided education about lead poisoning, "and since educational efforts were identical among the groups, this may have resulted in decreased group differences." (Weitzman, p. 1653)

Several studies in Exhibit 3-7 suggest that paint stabilization is especially effective in reducing relatively high EBLs. The Boston Retrospective study reported a 29 percent decline in blood lead levels after paint stabilization, but the average initial EBL in that study was 35.7 ug/dL. The St. Louis Retrospective study of paint stabilization and minimal hazard education reported a

23 percent overall decline in EBLs, and a 13 percent net intervention effect decline relative to a 12 percent decline for a control group that received only minimal hazard education. The net decline in blood lead levels for children with initial EBLs above 35 ug/dl was 22 percent, while the net decline for children with initial EBLs between 25 and 34 ug/dL was only one percent. Likewise, in the Worcester Retrospective study, interim controls resulted in an 18 percent reduction in the blood lead levels of children with higher initial EBLs between 20 and 29 ug/dL. However, the blood lead levels of children initially under 20 ug/dL actually increased by an average of 15 percent after abatement and interim controls.

The limited effectiveness of paint stabilization in reducing EBLs below 25 ug/dL in many studies appears to contradict National Survey and Rochester data that show a clear correlation between window sill and floor dust lead levels and deteriorated interior LBP. One likely explanation is that many of the research studies reflect paint stabilization activities that were not followed by adequate cleanup. For example, the Worcester study included "no formal mandates regarding dust control, cleanup procedures and clearance" (Staes, 1995, p. 79). The CWP also cited several studies indicating that "sanding, scraping, and repainting can result in increased dust lead and elevated blood lead levels" (CWP, p. 2-21).

If elevated dust lead levels after paint stabilization explain the lack of blood lead level declines below 25 ug/dL in many research studies, then the clearly apparent declines above 25 ug/dL may be largely attributable to reductions in paint chip ingestion. Therefore, the direct benefit of reduced paint chip ingestion and the indirect effect of lower lead dust levels (with proper cleanup) are examined separately below.

a) Benefits of Avoiding Paint Chip Ingestion

The ASTDR noted that, "evidence has long been available to show radio-opaque (lead) paint chips in the abdomens of children who had both high Pb-B levels and severe poisoning and who had not been in contact with any other source of lead" (ATSDR, 1988, p. VI-10). Other experts agree that "clinical lead poisoning is most frequently associated with ingestion of lead-bearing paint" (CWP, p. 2-17).

At high levels, lead paint chip ingestion can cause coma, convulsions, and death. Although rare, one such case occurred in 1990 when a 28-month-old child was fatally poisoned after living in a two-story nonresidential structure built in 1923. The structure had badly deteriorating lead-based paint, with paint chips on floors, window sills, and stairs. The paint chips contained an average lead concentration of nine mg/cm^2 (MMWR, March 29, 1991).

Although the frequency of high EBL children has declined, recent research indicates that paint chip ingestion is still a significant factor in the prevalence of very high EBL children. Indirect evidence for this conclusion is provided by a Schwartz analysis (1991) of EBL children in Chicago. Schwartz determined that children in units with interior LBP concentrations greater than two mg/sq cm were almost 10 times more likely to have EBLs above 30 after controlling for the effect of leaded gas on blood lead levels.[1] Although the data available for analysis did not specify the

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[1] After performing a regression analysis to remove the effect of leaded gas on EBL children, Schwartz found that an increased percentage of children with lead toxicity could be attributed to paint lead. Further, he found that the relative risk of high EBLs attributable to lead paint is 5.7 during the winter and fall, 12.81 in the spring, and 15.8 in the summer. Summing these relative risks (39.01) and dividing by

condition of the LBP, National Survey data indicate that interior LBP greater than two mg\sq cm and deteriorated LBP are both heavily concentrated in pre-1940 housing.

National Survey data in Exhibit 3-8 indicate that pre-1940 housing units account for 61 percent of housing units with interior LBP concentrations greater than two mg/sq cm. Data in Exhibit 3-9 for LBP with lead concentrations greater than one mg/sq cm show that pre-1940 units account for 62 percent of the total amount of deteriorated interior LBP and 69 percent of deteriorated exterior LBP (CWP, pp. B-2 and B-4).

Exhibit 3-8
Estimated National Total of Units with LBP Concentrations Greater than two mg/sq cm

Construction Year	% units interior paint > two mg/sq cm	# of units (millions)	# units > two mg/sq cm (millions)	% all units > two mg/sq cm
1960-1979	7%	35.7	2.5	**15%**
1940-1959	20%	20.5	4.1	**24%**
pre-1940	50%	21.	10.5	**61%**

Exhibit 3-9
Estimated National Total of Deteriorated LBP on Exterior and Interior Surfaces

Construction Year	Interior (million sq. ft.)	% Interior Deteriorated LBP	Exterior (million sq. ft.)	% Exterior Deteriorated LBP
1960-1979	455	**23%**	562	**7%**
1940-1959	301	**15%**	1,982	**24%**
pre-1940	1250	**62%**	5,568	**69%**

More direct evidence of the link between paint chip ingestion and the presence of high EBL children comes from a McElvaine (1992) study of severely lead poisoned St. Louis children. This study examined data on 90 children found to have very high blood lead levels over a two year period. The mean age was 2.5 years and the mean blood lead level was 56 ug/dL. Abdominal radiographs revealed evidence of paint chip ingestion for 13 of these children, all with blood lead levels over 50 ug/dL. The 13 children with radiographic evidence of paint chip ingestion represented only a small percentage of the 1460 St. Louis children with EBLs above 25 ug/dL during the two year period. However, the article notes the transit time of ingested material through a child's gastrointestinal tract ranges from several hours to several days, and other research indicates that the half-life of lead in blood is 30 days. Therefore, radiographs will only reveal the small percentage of EBLs due to very recent paint chip ingestion.

If the half-life of lead in blood is 30 days, and the children with evidence of paint chip ingestion all had blood lead levels above 50 ug/dL, then those children would likely have BLLs above 25 ug/dL for 30 days. Conversely, if the average transit time for paint chips through the children's gastrointestinal tracts is assumed to be 24 hours (one day), then the children with radiographic evidence of paint chip ingestion may account for only one-thirtieth of all children with BLLs above 25 ug/dL due to paint chip ingestion (i.e., children who ingested paint chips one to 30 days prior to testing). Multiplying 13 by 30 suggests that 390 St. Louis children may have had

four to get the average across seasons, indicates that children are 9.75 times more likely to have EBLs if they live in units with interior LBP concentrations greater than two mg/sq cm.

EBLs greater than 25 ug/dL during this period due to paint chip ingestion. Dividing 390 by the total number of St. Louis children with EBLs greater than 25 ug/dL during this period (1,460) suggests that approximately one-fourth of all childhood EBLs above 25 ug/dL may be attributable to paint chip ingestion (390 divided by 1,460 = .267).

b) Unit Benefit of Paint Stabilization Preventing Paint Chip Ingestion

The average blood lead level for the St. Louis children with radiographic evidence of paint chip ingestion was 63 ug/dL. If we assume that blood lead levels decline more rapidly immediately after an increase due to paint chip ingestion, and then continue to decline at a slower rate (consistent with the 30 day half-life for blood lead), then the average blood lead for all children above 25 ug/dL due to paint chip ingestion may be approximately 40 ug/dL above the Rochester mean of 6.37 ug/dL. If paint stabilization were performed in all units with deteriorated LBP, then this population of one and two year olds could realize a 40 ug/dL decline in average blood lead due to avoided paint chip ingestion alone (in addition to blood lead declines realized from lead dust removal associated with cleanup after paint stabilization).

NHANES III data show that 0.6 percent of all children ages one and two had blood lead levels above 25 ug/dL during Phase 1 (1988-1991) but only 0.2 percent had BLLs this high during Phase 2 (1992-1994). The radiographic evidence from St. Louis, collected during the same time period as NHANES III Phase 1, suggests that paint chip ingestion may have been responsible for 25 percent of the Phase 1 BLLs above 25 ug/dL. The continuing decline in BLLs above 25 ug/dL, as reflected in the NHANES III Phase 2 data, suggests that paint chip ingestion may now account for an even larger proportion of the declining number of high BLLs, because there could not have been a proportionate decline in the amount of deteriorated LBP over such a short period of time. Furthermore, the Phase 2 data show that children in pre-1946 housing account for 63 percent of all children ages one through five with BLLs greater than 15 ug/dL, which is very similar to National Survey data on the pre-1940 housing share of both interior and exterior deteriorated LBP. By comparison, children in pre-1946 housing account for only 32 percent of children with BLLs between 10 and 15 ug/dL, which is closer to the pre-1940 share of all housing units with lead dust above the HUD standard (39 percent based on weighted Evaluation data). The stronger correlation between higher EBLs and the presence of deteriorated LBP suggests that paint chip ingestion may now account for approximately half of all BLLs above 25 ug/dL among children ages one and two.

Exhibits 3-10a and 3-10b show the estimated first year unit benefit, for resident children ages one and two, of avoided paint chip ingestion due to paint stabilization of deteriorated LBP using a three and a seven percent discount rate, respectively. The first rows multiply the total number of one and two year olds in pre-1978 housing (5.13 million) by the estimated fraction of these children with very high EBLs due to paint chip ingestion (0.1 percent, or half of all one and two year olds with BLLs above 25 ug/dL) by the average blood lead decline achieved by repairing deteriorated LBP (40 ug/dL) by the lifetime earnings benefit achieved by each one ug/dL decline in blood lead ($2,367 or $544, depending on the discount rate).

Exhibit 3-10a
Estimated Unit Benefit of Paint Stabilization Due to Avoided LBP Paint Chip Ingestion
(First Year Benefit for Resident Children Ages One and Two
Using a Three Percent Discount Rate for Lifetime Earnings)

5.13 million x (0.001) x (40) x $2,367	$486 million
50% of $88 million medical and special education benefits	$ 44 million
Total Benefit of avoided paint chip ingestion	$530 million
18% of 70 million pre-78 units with deteriorated LBP	12.6 million units
Monetized benefit per unit with LBP repair	$42 per unit

Exhibit 3-10b
Estimated Unit Benefit of Paint Stabilization Due to Avoided LBP Paint Chip Ingestion
(First Year Benefit for Resident Children Ages One and Two
Using a Seven Percent Discount Rate for Lifetime Earnings)

$5.13 million x (0.001) x (40) x $544	$112 million
50% of $88 million medical and special education benefits	$ 44 million
Total Benefit of avoided paint chip ingestion	$156 million
18% of 70 million pre-78 units with deteriorated LBP	12.6 million units
Monetized benefit per unit with LBP repair	$12 per unit

The second rows of Exhibits 3-10a and 3-10b show 50 percent of the total potential benefit of avoided medical and special education costs for young children with EBLs above 25 ug/dL (0.5 x $88 million) because paint chip ingestion is now estimated to account for half of these high EBLs. The third rows show that the total benefit of repairing all deteriorated LBP, the sum of the first two rows, is either $530 or $156 million, depending on the discount rate used in the added components.

National Survey data indicate that about seven percent of all pre-1978 units have deteriorated interior LBP and 11 percent have deteriorated exterior LBP. The radiographic evidence of paint chip ingestion in St. Louis revealed that 10 of the 13 positive radiographs were taken during warmer months (from May through September) when children are more likely to be outdoors, suggesting that exterior deteriorated LBP poses at least as much risk of paint ingestion as interior deteriorated LBP. Therefore, this analysis adds the frequencies of interior and exterior LBP and assigns the same unit benefit to the repair of interior or exterior deteriorated LBP. The fourth rows of Exhibits 3-10a and 3-10b show that the benefit of avoided paint chip ingestion is spread over 12.6 million units (seven percent of the interiors and eleven percent of the exteriors of 70 million pre-1978 units). Dividing the total benefits of $530 million and $156 million by 14 million units yields the unit benefit of $38 and $11, respectively.

This analysis assumes that the estimated lifetime earnings benefit of avoided paint chip ingestion does not double count the estimated benefits for dust reduction because the subset of Evaluation data and the Rochester data both excluded children with medical interventions for very high EBLs (the highest EBL in the Rochester study was just over 30 ug/dL, and only six children had blood lead levels above 20 ug/dL). Therefore, the data used to estimate blood lead levels by dust lead categories probably excluded children recovering from paint chip ingestion.

c) Dust Hazard Reduction Benefit of Paint Stabilization With Cleanup

The HUD rule always requires cleanup after LBP stabilization, with clearance testing following cleanup. Therefore, the benefits of avoided lead dust hazards are also realized under this rule whenever deteriorated LBP is stabilized.

3.5 UNIT BENEFIT OF SOIL HAZARD REDUCTION

The estimated unit benefit of soil cover is based on the Boston study (Aschengrau, 1994), which tested the hypothesis that a reduction of lead in soil accessible to children would result in a decrease in blood lead levels. One important feature of this study is that it attempted to isolate the decrease in blood lead levels attributable exclusively to soil abatement with paint stabilization and cleanup, relative to a control group that received only paint stabilization and cleanup. Another feature of this study that makes it particularly applicable to analyzing the benefits of the final rule is that it used 2,000 ppm as the initial lead soil threshold (the same threshold as the final rule). Also, the blood lead levels of the children in this study were in the range of levels measured in recent NHANES III data.

In the Boston study, the mean blood lead level of children whose homes received soil hazard reduction plus paint stabilization and dust removal declined by approximately 2.5 ug/dL more than when their homes just received dust removal and paint stabilization. Exhibits 3-11a and 3-11b show the unit benefit of soil cover associated with this incremental decline in blood lead levels using a three and a seven percent discount rate, respectively. The first rows multiply the total number of one and two year olds in pre-1978 housing (5.13 million) by the fraction of such units that fail the proposed soil standard (13 percent) by the average blood lead decline achieved by soil cover (2.5 ug/dL) by the value of a one ug/dL decline in blood lead ($2,367 or $544). The calculated total benefit of covering all soil that fails the standard is $3,946 million using a three percent discount rate, and $907 million using a seven percent discount rate. Dividing both totals by the 9.1 million units that fail the soil standard yields unit benefits of $434 and $100, respectively.

Exhibit 3-11a
Estimated Unit Benefit of Soil Cover
(Using a <u>Three</u> Percent Discount Rate for Lifetime Benefits)

5.13 x (0.13) x 2.5 x $2,367 in Lifetime Earnings	$3,946 million
13 Percent of 70 Million Units Fail Soil Standard	9.1 million units
Benefit per Unit With Soil Cover	$434/unit

Exhibit 3-11b
Estimated Unit Benefit of Soil Cover
(Using a <u>Seven</u> Percent Discount Rate for Lifetime Benefits)

5.13 x (0.13) x 2.5 x $544- In Lifetime Earnings	$907 million
13 Percent of 70 Million Units Fail Soil Standard	9.1 million units
Benefit per Unit With Soil Cover	$100/unit

3.6 SUMMARY OF MONETIZED UNIT BENEFITS OF HAZARD REDUCTION ACTIVITIES

Exhibits 3-12a and 3-12b demonstrate that the monetized unit benefit calculations in Sections 3.3, 3.4, and 3.5 are consistent with the total potential monetized benefit of eliminating LBP hazards based on data from NHANES III Phase 2. Section 3.2 concluded that total potential first-year benefits from eliminating LBP hazards for children ages one and two are approximately $19.6 billion or $4.6 billion, using a three and seven percent discount rate, respectively. These estimates were based on the monetized benefits of reducing average blood lead levels for young children in all pre-1978 housing to the average reported by NHANES III Phase for post-1973 housing. Exhibits 3-6a and 3-6b showed that eliminating lead dust hazards in all pre-1978 housing units could realize either $14.9 or $3.4 billion of these potential benefits. Exhibits 3-10a and 3-10b showed that avoiding paint chip ingestion could realize $0.5 or 0.2 billion, and Exhibits 3-11a and 3-11b showed that enforcing the proposed soil standards could realize $3.9 or $0.9 billion, respectively. Exhibits 3-12a and 3-12b show that the sum of these benefit estimates for specific types of LBP hazards is entirely consistent with the total potential benefit estimate based on NHANES III Phase 2 blood lead data. The unit benefits derived for each type of LBP hazard are the basis for estimating the benefits of the HUD rule. Of course, the HUD rule will only apply to federally-assisted housing units, so the benefits from this will be substantially less than the total benefit of eliminating all LBP hazards.

Exhibit 3-12a
Reconciliation of RIA Unit Benefit Estimates with Maximum Potential First-Year Benefits for Children Ages One and Two Based on NHANES III Phase 2 Blood Lead Data by Year of Housing Construction
(three percent discount rate for lifetime earnings)

NHANES III Phase 2 Average	**Post-73**	**1946-1973**	**Pre-46**
ug/dL for Children Ages One and Two	3.00	4.20	5.68
Potential Change		1.20	2.68
Number of Children Ages 1&2		3.73 million	1.4 million
Total Potential ug/dL Change to Post-73 Average		4.48 million	3.75 million
IQ Benefit per ug/dL		$2,367	$2,367
Total Potential IQ Benefit		$10.6 billion	$8.9 billion
NHANES First-Year Benefit of Eliminating LBP Hazards		**$19.6 billion**	
RIA: Dust Hazard Removal		$14.9 billion	
RIA: Soil Hazard Removal		$3.9 billion	
RIA: Avoided Paint Chip Ingestion		$0.5 billion	
RIA First-Year Benefit of Eliminating LBP Hazards		**$19.3 billion**	

Exhibit 3-12b
Reconciliation of RIA Unit Benefit Estimates with Maximum Potential First-Year Benefits for Children Ages One and Two Based on NHANES III Phase 2 Blood Lead Data by Year of Housing Construction (seven percent discount rate for lifetime earnings)

NHANES III Phase 2 Average ug/dL for Children Ages One and Two	**Post-73**	**1946-1973**	**Pre-46**
	3.00	4.20	5.68
Potential Change		1.20	2.68
Number of Children Ages 1&2		3.73 million	1.4 million
Total Potential ug/dL Change to Post-73 Average		4.48 million	3.75 million
IQ Benefit per ug/dL		$544	$544
Total Potential IQ Benefit		$2.5 billion	$2.0 billion
NHANES First-Year Benefit of Eliminating LBP Hazards		**$4.6 billion**	
RIA: Dust Hazard Removal		$3.4 billion	
RIA: Soil Hazard Removal		$0.9 billion	
RIA: Avoided Paint Chip Ingestion		$0.2 billion	
RIA First-Year Benefit of Eliminating LBP Hazards		**$4.5 billion**	

Exhibits 3-13 shows that the correspondence between RIA benefit estimates and the estimate based on NHANES III Phase 2 data results from the estimated relationship between dust lead and blood lead described in Exhibit 3-5 combined with Evaluation data on dust hazard frequencies and with the estimated blood lead impacts of paint chip ingestion and soil lead discussed in Section 3.4 and 3.5, respectively. The top half of Exhibit 3-13 shows the weighted average estimated impact of dust lead on blood lead for children ages one and two, based on the relationship between dust lead and blood lead described in Exhibit 3-5 and Evaluation data on dust hazard frequencies by year of housing construction. The lower half of Exhibit 3-13 shows the baseline blood lead level from NHANES III data on young children in post-1973 housing, the weighted average incremental blood lead from dust lead for the periods of housing construction reported by NHANES, and the estimated blood lead impacts of paint chip ingestion and soil lead discussed for those age of housing categories, based on the analysis presented in Section 3.4 and 3.5, and on the occurrence frequencies for deteriorated LBP and soil hazards by year of construction. The sum of these incremental blood lead impacts is very close to the average blood lead levels reported by NHANES III Phase 2 by age of housing.

a) Duration of Dust Removal Benefits

The unit benefit estimates derived above for lead dust and soil hazard reduction and for paint stabilization are first year benefits, almost entirely attributable to the present value of increased lifetime earnings associated with higher IQs resulting from the prevention of childhood lead poisoning among resident children ages one and two. This present value represents only the first year benefit because additional benefits would accrue to a new population of one year olds each year and to children older than one who move into units in years after hazard reduction activities are performed. Therefore, a critical issue in assigning total unit benefits to hazard reduction activities is the expected duration of risk reductions associated with those activities.

Exhibit 3-13
Reconciliation of NHANES III Phase 2 Blood Lead Data with Estimated Impacts of Dust Lead, Soil Lead, and Paint Chip Ingestion on Blood Lead Levels for Children Ages One and Two

Sill dust Loading	Blood Lead Attributed in RIA to Lead Dust	Percent of Units by Sill Dust Loading		
		60-77	**40-59**	**pre-40**
0-250	0.00	76%	49%	41%
250-500	1.98	21%	14%	14%
500-1000	2.44	3%	15%	13%
1000+	4.33	0%	22%	32%
Incremental Blood Lead from Dust		**0.49**	**1.60**	**1.97**
		1946-1973		pre-46
Baseline Blood Lead (NHANES Post-73)		3.00		3.00
Incremental Blood Lead from dust		0.95		1.97
Incremental Blood Lead from soil		0.14		0.66
Incremental Blood Lead from LBP Ingestion		0.02		0.09
RIA Estimated Average Blood Lead		**4.11**		**5.72**
NHANES III Phase 2 Average Blood Lead		**4.20**		**5.68**

The first year benefits calculated for resident one and two year olds also do not include any benefits for infants under age one, or for children over age three. Furthermore, these estimates do not include any benefits for other children who may visit units where hazard reduction activities are performed, because first year benefits were calculated only for children living in units with LBP hazards. Some estimate of these additional benefits must also be reflected in the total unit benefit estimate.

The 1996 RIA for the proposed HUD rule cited limited research with contradictory findings on the duration of benefits associated with LBP hazard abatement. A study conducted in Sydney, Australia found that houses previously decontaminated by their owners were recontaminated with dust lead over varying periods as short as six months (Gulson, 1994). The source of recontamination was adjacent units with thoroughly deteriorated LBP. The houses in this study were all more than 80 years old, however, and the "open air living" conditions of these houses is not comparable to older housing in the United States. By contrast, a study conducted in Baltimore found that extensive abatement had significant and lasting effects on dust lead levels (Staes, 1995). Post-abatement dust lead levels immediately after cleanup were 14 ug/ft^2 for floors and 13 ug/ft^2 on window sills. After 1.5 to 3.5 years, dust lead levels had only increased to 41 ug/ft^2 for floors and 103 ug/ft^2 for window sills. Subtracting immediate post-abatement levels from subsequent measurements indicates a total accumulation of 27 ug/ft^2 for floors and 90 ug/ft^2 for window sills. Dividing these accumulations by an average duration of 2.5 years between measurements yields an annual accumulation rate of 11 ug/ft^2 per year for floors and 36 ug/ft^2 for window sills.

One possible explanation for the longevity of the benefits found in the Baltimore study is the extensive nature of the hazard reduction activities, which included treating all lead painted surfaces primarily by using replacement and enclosure methods, installing vinyl replacement windows, making floors smooth and easily cleanable, and performing cleanup with wet washing and HEPA vacuums. Floors were also sealed with polyurethane, deck enamel, or vinyl tile. The extent of the activities actually exceed the abatement requirements under the final rule, which requires only abatement of LBP hazards, as opposed to abatement (e.g., replacement or enclosure) of LBP that is not deteriorated.

The dust accumulation rates reported in the abated Baltimore houses are consistent with unpublished data on dust accumulation in Cincinnati housing that was extensively rehabilitated (removing most LBP in the process) about two decades prior to hazard reduction activities that included soil abatement and interior lead dust removal. The subsequent accumulation rate for dust lead was 10 ug/ft^2 per year for floors and 20 ug/ft^2 for window sills.

Accumulation rates in both the Cincinnati and Baltimore studies may have been affected by resident education about lead dust hazards. It may be appropriate, however, to reflect an increased awareness of such hazards in the baseline for the final rule, due to ongoing education efforts by public health programs. Also, the removal of lead from gasoline has substantially reduced the ambient air lead source for lead dust accumulation, and soil lead declines reported in St. Louis suggest that other exterior sources of lead dust have also declined. Therefore, older research studies showing a relatively rapid accumulation of lead dust (Charney et al., 1983) do not reflect the baseline for the final rule.

Exhibit 3-14 shows Evaluation data on floor dust accumulation rates, by intervention strategy for Evaluation units that exceeded the final rule standard of 40 ug/ft^2. As explained in Chapter 2, housing units in the Evaluation data are classified under a specific Strategy Code based on the average extent of specific treatment activities. Strategy Code 02 refers to cleaning and spot stabilization. Strategy Code 03 generally refers to paint stabilization plus cleaning. Strategy Code 04 includes friction and impact work plus paint stabilization and cleaning, and Strategy Code 05 includes window replacement plus paint stabilization and cleanup.

Exhibit 3-14 shows that about half of the units in every strategy code would have failed a clearance standard of 40 ug/ft^2. Most of the Evaluation work, however, was done with a clearance standard of 100 or 200, not 40. Exhibit 3-14 also indicates that routine cleaning by residents reduced floor dust lead levels below the levels achieved by unit cleanup prior to clearance, because the levels immediately after clearance were actually higher than the levels measured one year later. This decline in floor dust lead over the first year may simply reflect measurement error, but it is surprising that these data show no evidence of floor dust lead accumulation in the year after clearance.

Exhibit 3-14
Evaluation Data on Floor Dust Lead Accumulation Rates by Intervention Strategy for Housing Units with Initial Floor Dust > 40 ug/ft^2

Unit Floor Dust (ug/ft^2)	Strategy 02	Strategy 03	Strategy 04	Strategy 05
Clearance % > 40	49%	58%	66%	54%
Post Clearance Median	40	46	58	45
One-Year Median	40	47	50	30
Accumulation per Year	0	1	-8	-15

Exhibit 3-15 shows the Evaluation data for window sill dust accumulation rates by intervention strategy for units that exceeded the final rule clearance standard of 250 ug/ft^2. These data are more consistent with the lead dust accumulation data discussed above and cited in the proposed HUD rule RIA. The window sill data on clearance failure rates does have some of the same problems as the floor dust data, because most evaluation units were cleaned to meet a clearance standard of 500 on window sills. Therefore, one could expect that the percentage of units over 250 at clearance would be lower if unit cleanup were performed to meet a clearance standard of 250 ug/ft^2.

To estimate the duration of first year unit benefits developed in Sections 3.2, 3.3, and 3.4, Exhibit 3-15 uses the sill dust accumulation rates from the Evaluation data to calculate the estimated length of time before median sill dust lead levels return to their initial pre-intervention levels. Of course, unit benefits equivalent to first year benefits would not be realized over this entire length of time because the unit benefit would diminish each year as lead dust gradually rises back to its pre-intervention levels. If the percentage of first year benefits achieved each year declines in a linear fashion, however, then the equivalent duration of full first year benefits can be approximated by simply dividing in half the length of time it would take to return to the initial dust lead levels.

Exhibit 3-15
Evaluation Data on Sill Dust Lead Accumulation Rates by Intervention Strategy for Housing Units with Initial Sill Dust > 250 ug/ft^2

Unit Sill Dust (ug/ft^2)	**Strategy 02**	**Strategy 03**	**Strategy 04**	**Strategy 05**
Initial (Pre-Intervention) Median	1090	836	1114	1180
Clearance % >250	43%	26%	34%	19%
Post Clearance Median	113	119	98	53
Six Month Median	338	255	183	164
One Year Median	283	266	202	108
First Year Accumulation Rate	170	147	104	55
Years to Initial Median	5.7	4.9	9.8	20.5
Duration of Full Unit Benefit (Years)	**2.9**	**2.4**	**4.9**	**10.2**
2nd Half-Year Accumulation Rate/yr.	-110	22	38	-112
Years to Initial median	NA	27.4	25.5	NA
Duration of Full Unit Benefit (Years)	**NA**	**13.7**	**12.8**	**NA**

The Evaluation data in Exhibit 3-15 show that sill dust accumulates 104 to 170 ug/ft^2 over the first year after clearance under strategies 02, 03, and 04, and at 55 ug/ft^2 under strategy 05. During the second half of that first year, however, Exhibit 3-15 shows that sill dust accumulated at an annual rate of just 22 to 38 ug/ft^2 under Strategies 03 and 04, and actually declined under Strategies 02 and 05.

At the rate of accumulation over the entire first year, the median sill dust lead would return to its initial pre-intervention median in 5.7 years under strategy 02, 4.9 years under Strategy 03, 9.8 years under Strategy 04, and 20.5 years under Strategy 05. These rates of accumulation over the entire first year would result in unit benefit duration estimates of 2.9 years under Strategy 02, 2.5 years under Strategy 03, 4.9 years under Strategy 04, and 10.2 years under Strategy 05. On the other hand, the accumulation rates over the second half of the first year support unit benefit duration estimates of 25 to 27 years for Strategies 03 and 04, and the duration of unit benefits would actually be infinite for Strategies 02 and 05 due to negative dust lead accumulation rates.

Chapter 2 noted that the general descriptions of Evaluation data Strategy Codes can be misleading if they are interpreted as precisely defining the limits of activities performed in each room. Therefore, the analysis in Exhibit 3-15 is repeated in Exhibit 3-16 to compare window sill dust accumulation rates for each room where specific intervention activities were performed. Based on the rate of sill dust accumulation over the first year after clearance, Exhibit 3-16 shows unit benefit duration estimates of: 2.8 years for rooms where only cleanup is done; 6.3 years for rooms with paint stabilization and cleanup; 2.4 years for rooms with window work, paint stabilization, and cleanup; and 80.9 years for rooms with window replacement, paint stabilization, and cleanup. Accumulation rates over the second half of the first year support unit benefit duration estimates of 3.5 years for rooms with window work and an infinite duration of benefits for all other rooms due to negative dust lead accumulation rates.

Exhibit 3-16
Evaluation Data on Sill Dust Lead Accumulation Rates by Intervention Strategy for Rooms with Initial Sill Dust > 250 ug/ft^2

Room Dust (ug/ft^2)	**Cleanup Only**	**Paint Stabilization & Cleanup**	**Window Work, P.S. & Cleanup**	**Window Replacement, P.S., & Cleanup**
Initial (Pre-Intervention) Median	689	464	1050	1666
Clearance % >250	21%	4%	13%	10%
Post Clearance Median	92	33	62	49
Six Month Median	278	67	202	127
One Year Median	197	67	272	59
First Year Accumulation Rate	105	34	210	10
Years to Initial Median	5.7	12.7	4.7	161.7
Duration of Full Benefit (Years)	**2.8**	**6.3**	**2.4**	**80.9**
2nd Half-Year Accumulation Rate/yr.	-162	0	140	-136
Years to Initial median	NA	NA	7.1	NA
Duration of Full Benefit (Years)	**NA**	**NA**	**3.5**	**NA**
RIA Benefit Duration Estimate	**5 years**			**10 years**

The RIA for the proposed HUD rule assumed that interim controls would result in unit dust benefits for four years, and abatement would result in unit dust benefits for eight years. The Evaluation data on dust accumulation rates for Strategy 05 units in Exhibit 15 and for rooms with window replacement in Exhibit 3-16 indicate that 10 years is a very conservative estimate of the unit benefit duration for units with window replacement and other types of LBP hazard abatement. For units with interim controls, the Evaluation data in Exhibits 15 and 16 indicate that a 4 year unit benefit duration may be somewhat optimistic based on accumulation rates over the entire first year after clearance, but a four year duration seems extremely conservative based on accumulation rates over the second half of the first year. Therefore, dust benefit duration estimates used in this RIA for the final rule are 10 years for abatement, including units with window replacement, and five years for units with interim controls. The five year estimate for interim controls is also consistent with the benefit duration estimate for paint stabilization with interim controls.

b) Duration of Benefits for Paint Stabilization and LBP Hazard Abatement

This analysis assumes that unit benefits of avoided paint chip ingestion are realized for five years because paint stabilization should provide approximately five years of protection against significant amounts of deteriorated LBP. As in the case of lead dust reduction, out-year benefits are discounted at seven percent.

In those cases where the final rule requires complete LBP hazard abatement (rehab units receiving more than $25,000 of federal assistance), this analysis assumes that abatement of deteriorated LBP provides 20 years of benefits from avoiding paint chip ingestion. The final rule's definition of LBP hazard abatement involves an expected design life of 20 years. Assuming 20 years of avoided paint chip ingestion may overstate benefits for some units because abatement is only required for surfaces that pose a hazard when the unit is evaluated and other lead paint surfaces could become deteriorated and pose hazards in future years. However, building component replacement provides a permanent ongoing benefit because the paint has been permanently and completely removed. Similarly, enclosures should last at least 40 years. Therefore, an average abatement benefit of 20 years will understate the duration of benefits in units where hazard abatement includes all or a substantial majority of all LBP surfaces.

c) Duration of Soil Cover Benefits

The annual unit benefit for soil cover is assumed to provide five years of benefits because the final rule requires repair of any deteriorated exterior LBP whenever soil cover is required. Therefore, the soil benefits are assumed to last for five years because exterior paint stabilization should provide approximately five years of protection from the most important source of soil recontamination (deteriorated exterior LBP). This assumption reflects National Survey data indicating a very high correlation between exterior deteriorated LBP and soil hazards.

d) Total Monetized Unit Benefits of Hazard Reduction

Exhibits 3-17a and 3-17b, using a three and seven percent discount rate, respectively, summarize the total monetized unit benefits of LBP hazard reduction activities, based on the assumptions described above and rough estimates for additional benefits realized by children other than the one and two year olds actually residing in targeted units. The first rows of Exhibits 3-17a and 3-17b show the first-year benefit for resident one and two year olds for each type of LBP hazard reduction activity. As explained above, the paint stabilization and paint hazard abatement benefits reflect only the benefit of avoided paint chip ingestion. Abated units will also realize the ten year unit dust reduction benefit, and paint stabilization units will realize the five year unit dust reduction benefit associated with unit cleanup.

The second rows of Exhibits 3-17a and 3-17b show the estimated additional first-year benefits for resident children ages three and older and for other children visiting the targeted unit. This analysis assumes that the sum of these other benefits is 50 percent of the benefits realized by one and two year olds.

In Exhibits 3-17a and 3-17b, the third lines show the second-year benefit for a new population of one year olds and the fourth lines show the estimated second-year benefit for children visiting the unit and for new residents. This analysis assumes that second-year benefits for these other children are 20 percent of the benefit for the new population of one year olds in the targeted units. This percentage is lower than the "other benefit" assumption for the first year, because any new population of resident children over the age of one would be limited to units with new residents (i.e., resulting from unit turnover). The benefits for years three through 20 are calculated using the same assumptions as applied to year two, reflecting the anticipated average duration of each unit benefit.

Exhibit 3-17a
Summary Table of Monetized Unit Benefits ($/unit)
Using a Three Percent Discount Rate for Lifetime Earnings

Source of Benefits	Pre-60 Dust **5 Year**	**Pre-60 Dust 10 Year**	Post-59 Dust **5 Year**	**Post-59 Dust 10 Year**	**Paint Stabi-lization**	**Paint Hazard Abatement**	**Soil Cover**
1st Year, One and Two Year Olds	577	577	341	341	42	42	434
1st Year, Other	289	289	171	171	21	21	217
2nd Year, One Year Olds	270	270	159	159	20	20	203
2nd Year, Other	54	54	32	32	4	4	41
3rd and 4th Year, One Year Olds	487	487	288	288	35	35	367
3rd and 4th Year, Other	97	97	58	58	7	7	73
5th Year, One Year Olds	220	220	130	130	16	16	166
5th Year, Other	44	44	26	26	3	3	33
Years 6-10, One Year Olds		902		533		66	
Years 6-10, Other		180		107		13	
Years 11-20, One Year Olds						80	
Years 11-20, Other						16	
TOTAL	2038	3121	1205	1845	148	323	1533
Tenant-Based Assistance	12323	18871	7283	11153	897	1956	9269
Public Housing	4922	7537	2909	4454	358	781	3702
Project Based Assistance	2402	3679	1420	2174	175	381	1807
Rehab Units	3,059	4,684	1,808	2,768	223	485	2,301
Resident Children Aged 1 & 2	75%	78%	75%	78%	76%	80%	(76%)
Other Children	25%	22%	25%	22%	24%	20%	(24%)

The hazard reduction benefits in the total unit benefit row are average monetized unit benefit estimates for all housing units, when hazard reduction activities do not explicitly target units with young children. Monetized benefits, however, are entirely realized by young children, and average unit benefits reflect the average percentage of housing units with young children. Therefore, the unit benefit of hazard reduction activities is much higher for HUD programs that apply to housing units with an above average number of units with young children. In order to adjust unit benefit estimates for this factor, AHS data for all occupied units were compared to AHS data relating to four HUD programs: (1) Public Housing; (2) Project-Based Assistance; (3) Assisted Rehab; and (4) Tenant-Based Rental Assistance. Unit benefits for each of these programs were adjusted upward to reflect the proportion of regulated units with young children relative to the proportion of all occupied units with young children. The proportion of “regulated” units with young children was estimated after excluding units with only elderly residents (no residents under age 65) to approximate the exclusion for assisted units reserved for the elderly. In the case of Tenant-Based Assistance, the high unit benefit estimates reflect the fact that the final rule requirements only apply to units with young children. The unit benefits for project-based assistance are used in the cost-benefit analysis for other federally assisted housing units affected by the final rule because the proportion of units with young children in project-based units was similar to the proportion for all housing units except for the adjustment to exclude housing units with only elderly residents.

The last two lines of Exhibits 3-17a and 3-17b show that approximately three-fourths of all monetized health benefits are associated with resident children ages one and two. The other one-fourth of monetized benefits reflect rough estimates of the additional benefits realized by older children during the first year and benefits associated with unit turnover and visiting children. The uncertainty associated with this benefit for "other children" is explicitly presented in the cost benefit analysis, with separate estimates provided for the monetized benefits for resident children ages one and two, and for "other" children (based on the percentages in Exhibits 3-17a and 3-17b).

Exhibit 3-17b
Summary Table of Monetized Unit Benefits ($/unit)
Using a Seven Percent Discount Rate for Lifetime Earnings

Source of Benefits	Pre-60 Dust **5 year**	**Pre-60 Dust 10 year**	Post-59 Dust **5 year**	**Post-59 Dust 10 year**	**Paint Stabili-zation**	**Paint Hazard Abatement**	**Soil Cover**
1st Year, One and Two Year Olds	133	133	78	78	12	12	100
1st Year, Other	66	66	39	39	6	6	50
2nd Year, One Year Olds	62	62	37	37	6	6	47
2nd Year, Other	12	12	7	7	1	1	9
3rd and 4th Year, One Year Olds	112	112	66	66	10	10	84
3rd and 4th Year, Other	22	22	13	13	2	2	17
5th Year, One Year Olds	51	51	30	30	5	5	38
5th Year, Other	10	10	6	6	1	1	8
Years 6-10, One Year Olds		208		123		19	
Years 6-10, Other		42		25		4	
Years 11-20, One Year Olds						23	
Years 11-20, Other						5	
TOTAL	469	718	277	424	42	92	353
Tenant-Based Assistance	2834	4340	1675	2565	256	559	2132
Public Housing	1132	1733	669	1024	102	223	851
Project Based Assistance	553	846	327	500	50	109	416
Rehab Units	703	1,077	416	637	64	139	529
Resident Children Aged 1 & 2	75%	78%	75%	78%	76%	80%	(76%)
Other Children	25%	22%	25%	22%	24%	20%	(24%)

In addition to the monetized health benefits in Exhibits 3-17a and 3-17b, this RIA also recognizes market value benefits for paint stabilization and for window replacement. In the case of paint stabilization, market values are assumed to equal the difference between full and incremental costs in Exhibit 2-1. The market value of interior paint stabilization is $480 per unit ($500-$20), the assigned value for multi-family exterior paint stabilization is $90 per unit ($100-$10), and the single-family exterior value is $900 ($1000-$100). Window replacement market values are estimated to be 90 percent of the cost of window replacement, based on the present value of future fuel savings discounted at seven percent (as explained in Chapter 2).

CHAPTER 4. HOUSING STOCK AFFECTED

This chapter describes the housing stock affected by the final rule, and the occurrence frequency of specific unit costs and benefits. This chapter is organized in three sections:

4.1 Data Sources and Limitations;
4.2 Cost and Benefit Frequencies; and
4.3 HUD-Assisted Units

4.1 DATA SOURCES AND LIMITATIONS

Occurrence frequency estimates in this analysis reflect National Survey data on damaged paint and deteriorated LBP and Evaluation data on dust and soil hazards. The number of affected units under each Subpart of the final rule reflect HUD estimates and data on assisted units from the 1995 American Housing Survey (AHS).

A review of HQS data on deteriorated interior paint in all occupied units in HUD-assisted units under Public Housing, Tenant-Based Assistance, and Project-Based Assistance suggests that National Survey data on the extent of damaged paint and deteriorated LBP should provide a reasonable estimate of the occurrence frequencies for deteriorated LBP hazards in federally assisted housing. Although the National Survey data were collected in 1989 and 1990, there is no reason to expect that the occurrence frequencies for deteriorated paint and LBP in pre-1978 housing has changed to any significant extent since the time of the National Survey. Evaluation data on deteriorated LBP showed much higher occurrence frequencies for this hazard. These frequencies are not representative of the national housing stock.

Although the Evaluation data include a high percentage of units with deteriorated LBP and a high percentage of children with elevated blood lead levels, the data in Exhibit 4-1 show that the weighted average occurrence frequencies of soil and dust hazards in pre-1940 and post-1960 Evaluation data units are not substantially different from the dust and soil hazard frequencies reported in National Survey data. As explained in Chapter 3, Evaluation data on dust and soil hazards in pre-1920 housing and in 1920 to 1940 housing were weighted by the proportion of all housing units in these age categories (from AHS data) to develop weighted average data on dust and soil hazards in pre-1940 housing. Evaluation data on 1940 to 1960 units, and 1960 to 1977 units were then combined with the weighted data on pre-1940 units and with AHS data on the proportion of all housing units in each age category to develop weighted average frequencies for dust and soil hazards in all pre-1978 housing.

Exhibit 4-1 shows that the occurrence frequencies for very high window sill dust lead levels are actually higher in the National Survey data than in the Evaluation data for units built before 1940 and between 1960 and 1977. The Evaluation data soil hazard frequencies are somewhat higher than in the National Survey, but well within the 95 percent confidence interval reported for the National Survey Estimates.

Exhibit 4-1
Comparison of Hazard Frequencies from Weighted Evaluation Data and National Survey

LBP Hazard	Pre-1940	1940-1959	1960-1977	Pre-1978
Window Sill Dust (ug/ft^2):				
Evaluation Data > 1000	32%	22%	0%	16%
National Survey > 1000	49%	13%	7%	20%
Evaluation Data > 250	59%	51%	24%	42%
National Survey > 250	63%	26%	15%	31%
Floor Dust (ug/ft^2):				
Evaluation Data > 100	33%	21%	0%	15%
National Survey > 100	36%	17%	4%	17%
Evaluation Data > 40	51%	36%	3%	26%
National Survey > 50	43%	29%	10%	24%
Soil Lead > 2000 ug/g:				
Evaluation Data	27%	18%	0%	13%
National Survey	21%	4%	0%	8%

When collecting dust samples, the National Survey used a method that is now known to underestimate actual dust lead levels anticipated with the dust-wipe sample collection methods required by the final rule. This problem was corrected by using a conversion factor to approximate the results that would have been obtained using the sampling method specified in the final rule. However, the conversion factor used depends upon two studies that have conducted side-by-side comparisons of the two sampling methods, which depend on the surface sampled and vary from study to study. The National Survey also found fewer housing units with soil hazards in large cities, whereas other studies have found that soil hazards are much more common in large cities. The soil collection method used in the National Survey, based on core samples rather than surface scrapings, may have understated soil hazard frequencies in large cities that had no unpaved surfaces suitable for core sampling. As explained in Chapter 3, the Evaluation data on dust and soil hazard frequencies also result in predicted average blood lead levels by year of construction that are consistent with the actual blood lead data reported by NHANES III Phase 2. Therefore, the dust and soil hazards from the Evaluation data, weighted by AHS data on the age distribution of the housing stock, appear to be the best basis for estimating the occurrence frequencies of these hazards for this RIA.

4.2 ESTIMATED OCCURRENCE FREQUENCIES

The estimated occurrence frequencies used in this analysis are presented in Exhibit 4-2. This section explains the specific basis for these estimates.

Exhibit 4-2
Cost and Benefit Occurrence Frequencies

Unit Cost Occurrence Trigger	Freq. (% of all units)		
	Pre-1940	**1940-1959**	**1960-1977**
Multifamily Sample Testing:			
Risk assessment	16%	16%	16%
Paint inspection	39%	39%	39%
Deteriorated Paint:			
Interior and/or exterior deteriorated paint >5 sq. ft	55%	36%	18%
Rehab < $5,000 work site deteriorated paint	23%	14%	5.5%
Dust and Soil Hazards:			
Window sill dust > 250 ug/sq. ft	59%	51%	24%
Window work	27%	19%	10%
Window Replacement	3%	1%	0%
Floor dust > 40	51%	36%	3%
Other friction / impact work	10%	7%	1%
Bare soil > 2000 ug/g	27%	18%	0%
Deteriorated LBP:			
Interior LBP > 2 sq. ft	16%	6%	3%
Single family deteriorated exterior LBP > 5 sq. ft	28%	12%	5%
Multifamily deteriorated exterior LBP > 5 sq. ft	14%	6%	3%
Single family deteriorated interior plus exterior LBP	44%	18%	8%
Multifamily deteriorated interior plus exterior LBP	30%	12%	6%
Combined and Partial Hazards:			
Sill and/or floor dust	76%	66%	24%
Rehab < $5,000 work site area deteriorated LBP	8%	3%	2%
Interior deteriorated paint with sill and/or lead floor dust	35%	18%	3%
Rehab < $5,000 work site area dust	38%	33%	12%

Multifamily Testing

The final rule allows risk assessment and paint inspection sampling for multifamily units and for single family units that are part of a larger project of similar dwellings. Although multifamily buildings are assumed to have 20 units, on average, many of these buildings may be located together, with units in multiple buildings qualifying as "similar dwellings."

To quantify the cost of risk assessments and paint inspections for multifamily programs, the percentage of units required to undergo such activities must be determined for the average multifamily property. The 1991 Residential Finance Survey (RFS) reports that the average multifamily property has only 25 units. However, the RFS average is 140 units for properties with 50 or more units per structure, and the RFS reports that these larger properties account for 58 percent of all multifamily units. By contrast, the Assessment of the HUD-Insured Multifamily Housing Stock (September, 1993) reports that properties with more than 50 units account for 81 percent of HUD-insured multifamily housing units. HUD-insured properties have an average of 112 units per property, and HUD-insured properties that receive project-based assistance have an average of 102 units per property. HUD estimates that HUD-owned and mortgagee-in-possession multifamily properties are even larger, with an average of 120 units per property.

The sampling provisions of the final rule require risk assessments in 17 units for properties with 76 to 125 units. This 17-unit sampling requirement comprises 15 percent of the average number of units (112) for HUD-insured properties and 17 percent of the average number (102) for HUD-assisted properties. Therefore, this analysis assumes that risk assessments are required in 16 percent of the units in all multifamily properties.

The sampling provisions for paint inspections allow inspections in 47 units in properties with 120 to 138 units. For properties with approximately 120 units per property, Exhibit 4-2 shows that paint inspections could be done on a sample of 39 percent of HUD-owned multifamily units (47/120 = .39). The final rule does not explicitly require paint inspections, however, and the RIA anticipates that it will generally be more economical to perform risk assessments.

Deteriorated Paint

The occurrence frequencies for deteriorated interior and/or exterior paint reflect National Survey data. These frequencies determine the extent of paint testing under Subparts that require a visual assessment and paint testing for LBP (unless all deteriorated paint is repaired according the requirements for deteriorated LBP).

Deteriorated Paint and LBP Disturbed by Rehabilitation

The final rule assumed that housing units targeted for rehabilitation would have a higher than average frequency of deteriorated paint. The AHS data presented in Chapter 2, however, shows that most assisted rehab units are performing upgrades that do not appear to indicate that the condition of paint in these units is significantly worse than in typical housing units. Therefore, the occurrence frequencies for deteriorated paint in the National Survey are also applied to rehab units receiving more than $5,000 of federal assistance. For rehab projects receiving less than $5,000, the AHS data in Chapter 2 suggests that the work area will generally be limited to just one to three rooms. Our analysis assumes that the frequencies of deteriorated paint in these work area rooms are about one-half the National Survey occurrence frequencies for deteriorated paint anywhere in a housing unit.

Dust and Soil Hazards

As explained above, the occurrence frequencies for dust and soil hazards reflect weighted average Evaluation data. Among Evaluation data rooms with initial window sill dust levels above 250, approximately one-third performed window work, one-third replaced windows, and one-third performed only paint stabilization and/or cleanup, but most of these units were built before 1930 and were in poor condition. The estimated percentage of units performing window work or replacing windows under the final rule reflects the assumption that hazard interventions by regulated units will be less aggressive than the work performed under the HUD Grant Program. These data assume that about one-half of pre-1940 units, and 60 percent of post-1940 units with sill dust above the final rule standard will perform cleanup only, with paint stabilization as required for deteriorated LBP. The RIA also assumes that only a small percentage of older units will choose to replace windows (3 percent of pre-1940 units, and 1 percent of 1940 to 1960 units). The data on other friction and impact work assumes that 80 percent of units with floor dust above the standard will perform cleanup only, with other interim controls only as required by other provisions of the final rule. Any occurrence of bare soil hazards will trigger soil cover costs and benefits.

Deteriorated LBP

The occurrence frequencies for deteriorated LBP reflect National Survey Data. These frequencies determine paint stabilization costs in units that do paint testing including units that do paint testing as part of a risk assessment. The combined frequencies for interior plus exterior deteriorated LBP determine the paint stabilization benefits associated with preventing paint chip ingestion.

Combined and Partial Hazards

Combined and partial hazards were calculated to avoid double-counting costs or benefits under specific combinations of final rule requirements. For example, the combined frequencies for window sill and/or floor dust (from Evaluation data) determine the extent of dust removal benefits, avoiding the double-counting of benefits for units that fail both standards. Window sill and/or floor dust frequencies also determine the frequencies for unit cleanup, clearance, and reevaluation in units where risk assessments are performed.

For Subparts that require only a visual assessment for deteriorated paint, the RIA anticipates that it is generally economical to perform paint testing and to do hazard reduction only when there is deteriorated LBP. In this case, the unit cost frequencies for painting, cleanup, and clearance all reflect the frequency of deteriorated LBP, as does the health benefit frequency for paint stabilization. The dust removal benefit also reflects the fraction of units with deteriorated LBP because cleanup under these Subparts only occurs in units with deteriorated LBP and virtually all units with deteriorated LBP are expected to have lead dust above the final rule standards.

For rehab projects receiving less than $5,000, the AHS data in Chapter 2 suggests that the work area will generally be limited to just one to three rooms. Our analysis assumes that the frequencies of deteriorated LBP in these work area rooms are about one-half the National Survey occurrence frequencies for deteriorated LPB anywhere in a housing unit, and the frequencies for sill and/or floor dust are about one-half the unit frequencies from the Evaluation data.

4.3 HUD-ASSISTED UNITS

Exhibit 4-3 presents the estimated annual number of HUD-assisted units affected by the final rule. Most of these estimates reflect an annual flow of units under HUD programs (e.g., insurance and rehabilitation programs). In the case of Project-Based Assistance, however, the "annual" units shown reflect a stock, or inventory, of affected units under this program, divided by the number of years allowed under the final rule for the completion of required hazard evaluation and reduction activities. This same concept applies to Public Housing units. The annual number of Public Housing units and pre-1960 Project-Based units reflect one-half of the total number of units covered by these programs, because the rule requires hazard evaluation and reduction activities in these units to be completed within two years. The annual number of units under 1960 to 1978 Project-Based Assistance reflects one-fourth of the total number of units in this category, because the rule requires hazard evaluation and reduction activities in these units to be completed within four years.

Exhibit 4-3
Annual Number of Federally Assisted Housing Units Subject to the Final Rule

Subparts (Cost-Benefit Tables)	Number of Units			Total
	Pre-1940	1940-1959	1960-1977	
HUD-Owned Single Family Housing (F)	9,190	5,170	7,507	21,867
Multifamily Insured Housing (G)	1,875	1,875	11,250	15,000
Multifamily Housing with Project-Based Assistance > $5K/unit (Hm1)	4,040	4,040	27,670	35,750
Multifamily Housing with Project-Based Assistance < $5K/unit (Hm2)	72,700	72,700	263,290	408,690
Single Family Housing with Project Based Assistance (Hs)	20,020	20,020	94,240	134,280
HUD-Owned Multifamily Mortgagee-in-Possession (I)	190	560	3,000	3,750
Single Family Rehab < $5,000 (J1s)	21,040	19,316	26,480	66,836
Single Family Rehab $5,000 - $25,000 (J2s)	14,752	13,790	20,456	48,998
Single Family Rehab > $25,000 (J3s)	1,007	3,160	1,650	5,817
Multifamily Rehab < $5,000 (J1m)	2,370	2,335	3,129	7,834
Multifamily Rehab $5,000 - $25,000 (J2m)	3,895	3,839	8,143	15,877
Multifamily Rehab > $25,000 (J3m)	2,210	2,178	2,918	7,306
Single Family Acquisition, Leasing, Operating, & Support (Ks)	1,190	1,585	2,318	5,093
Multifamily Acquisition , Leasing, Operating, & Support (Km)	1,998	1,514	2,591	6,103
Multifamily Public Housing (Lm)	13,118	52,480	65,599	131,197
Single Family Public Housing (Ls)	3,283	13,118	16,401	32,803
Single Family Tenant-Based Rental Assistance (Ms)	31,460	38,840	64,200	134,500
Multifamily Tenant-Based Rental Assistance (Mm)	48,430	59,790	98,830	207,050
Total Number of Units	252,768	316,310	719,672	1,288,751

The estimated number of units by year of construction under Subparts F (HUD-Owned Single Family Housing), G (Multifamily Insured Housing), I (HUD-Owned Multifamily Housing), and K (Acquisition, Leasing, Operating, and Support) reflect HUD estimates. The estimated number under Subparts H (Project-Based), L (Public Housing), and M (Tenant-Based) reflect HUD data on the total number of units in each program, multiplied by AHS data on the percentage distribution of single and multifamily and by year of construction. Units with Tenant-Based assistance were reduced to account for the exemption from the rule for units with no resident children under the age of six. The total units under Public Housing were also reduced to account for the number of units excluded from the final rule because they have performed paint inspections and found no LBP or abated any LBP surfaces. For Subpart J, Assisted Rehab, the total number of units reflect HUD and AHS data on the number of single and multifamily federally assisted upgrade units by year of construction and by total upgrade cost. AHS data were also used to estimate the percentage of units with only elderly residents, which were excluded from the estimate of affected units to approximate the exclusion for housing reserved for the elderly.

CHAPTER 5. COST-BENEFIT ANALYSIS

This chapter presents the comparison of costs and benefits for each Subpart under the final rule. This chapter is organized in two sections:

5.1 Total Regulatory Costs, Benefits, and Net Benefits (Costs); and
5.2 Regulatory Cost and Benefit Calculations by Subpart.

The analysis presented in this chapter reflects costs and benefits associated with the first year of hazard evaluation and reduction activities under the final rule. These costs and benefits, however, include the present value of future costs and benefits associated with first year hazard reduction activities. For example, the costs associated with first year activities include the present value of future reevaluation costs, where required. Similarly, the benefits of first year activities include the present value of lifetime earnings benefits for children living in or visiting the affected unit during that first year, and for children living in or visiting that unit during the second and subsequent years after hazard reduction activities.

5.1 TOTAL REGULATORY COSTS, BENEFITS, AND NET BENEFITS (COSTS)

Exhibits 5-1a and 5-1b present summaries of the costs, benefits, and net benefits of the first year activities under the final rule. Exhibit 5-1a presents summaries of costs and benefits using a three percent discount rate, while Exhibit 5-1b presents summaries of costs and benefits using a seven percent discount rate. The total cost of first year hazard evaluation and reduction activities is $253 million. The total benefit of first year activities is $1,143 million using a three percent discount rate, and $324 million using a seven percent discount rate. Net benefits of first year activities are $890 million using a three percent discount rate, and 71 million using a seven percent discount rate.

The individual rows of Exhibits 5-1a and 5-1b detail the components of hazard evaluation and reduction costs and monetized hazard reduction benefits. Although the components of hazard reduction costs and monetized benefits are often identified by the same brief descriptors (e.g., paint stabilization, soil cover, dust cleanup) the cost components are not directly comparable to the benefit components. For example, dust-cleanup costs reflect only the costs of cleanup. Cleanup benefits, however, reflect the assumption that low dust lead levels have a benefit duration of five years with paint stabilization and ten years with window replacement and other LBP hazard abatement (i.e., a new population of young children associated with births and unit turnover realize lead dust removal benefits for five or ten years). This estimated duration of benefits could not be realized without the hazard reduction activities of paint stabilization or abatement, friction/impact work, and soil cover, to the extent required by the final rule. The monetized benefits for paint stabilization and abatement reflect only the health benefits of avoided paint chip ingestion. The cost of paint stabilization includes the incremental cost for rehab programs, and the full cost for non-rehab programs. Paint stabilization market value benefits reflect the estimated market value for non-rehab programs. Subtracting paint stabilization market value benefits from paint stabilization costs yields the incremental cost of all paint stabilization required under the final rule. Finally, window replacement market value reflects the present value of future fuel expenditure savings discounted at seven percent.

Exhibit 5-1a
Cost-Benefit Summary for First Year Activities Using A Three Percent Discount Rate for Lifetime Earnings ($ Millions)

Hazard Evaluation Costs	$99.5
Hazard Reduction Costs:	
Paint stabilization	$75.7
Window replacement	$4.6
Friction/impact work	$8.5
Soil cover	$2.3
Paint hazard abatement	$2.0
Dust cleanup	$60.5
Total First Year Costs	**$253.2**
Monetized Benefits:	
Paint stabilization	$71.2
Paint hazard abatement	$1.1
Soil cover	$88.0
Dust cleanup	$908.6
Paint repair market value	$70.2
Window replacement	$4.2
Total First Year Benefits	**$1,143.3**
Total First Year Net Benefits	**$890.1**

Exhibit 5-1b
Cost-Benefit Summary for First Year Activities Using A Seven Percent Discount Rate for Lifetime Earnings ($ Millions)

Hazard Evaluation Costs	$99.5
Hazard Reduction Costs:	
Paint stabilization	$75.7
Window replacement	$4.6
Friction/impact work	$8.5
Soil cover	$2.3
Paint hazard abatement	$2.0
Dust cleanup	$60.5
Total First Year Costs	**$253.2**
Monetized Benefits:	
Paint stabilization	$20.3
Paint hazard abatement	$0.3
Soil cover	$20.2
Dust cleanup	$209.0
Paint repair market value	$70.2
Window replacement	$4.2
Total First Year Benefits	**$324.2**
Total First Year Net Benefits	**$71.0**

Exhibits 5-2, 5-3a, 5-3b, 5-4a, 5-4b, 5-5a, and 5-5b present costs, benefits, net benefits (costs), and net benefits (costs) per unit, by construction-year period, for each HUD program. Exhibits 5-3a, 5-4a, and 5-5a present costs and benefits using a three percent discount rate, while Exhibits 5-3b, 5-4b, and 5-5b present costs and benefits using a seven percent discount rate. Variations in the total costs, benefits, and net benefits associated with each Subpart often reflect variations in the number of units affected under each Subpart of the final rule. For example, variations in net benefits (costs) per unit in Exhibit 5-5a illustrate that net benefits tend to be higher in multifamily units and in pre-1960 units. Multifamily units have higher net benefits because hazard evaluation costs per unit are reduced by sampling procedures for similar dwellings, and because unit cleanup costs are reduced by the smaller size of multifamily units. Pre-1960 units have higher net benefits because they have higher unit dust benefits, and because

LBP hazards are more common in older housing units, which increases benefits more than costs because hazard evaluation costs are not increased by hazard reduction activities.

Exhibit 5-2. Total Cost by Program

Subparts (Tables)	Program Cost			Total for Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	$5,812,675	$1,581,867	$1,073,501	$8,468,043
Multifamily Insured Housing (G)	$1,115,438	$779,063	$0	$1,894,500
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$2,543,665	$1,818,889	$5,761,447	$10,124,001
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	$16,110,320	$7,437,210	$13,335,639	$36,883,169
Single Family Housing With Project-Based Assistance (Hs)	$10,460,450	$4,684,680	$10,083,680	$25,228,810
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	$119,628	$252,123	$624,660	$996,411
Single Family Rehab <5K (J1s)	$3,252,784	$2,951,485	$4,001,128	$10,205,397
Single Family Rehab 5K-25K (J2s)	$11,730,790	$9,469,593	$7,018,454	$28,218,837
Single Family Rehab >25K (J3s)	$1,232,568	$2,886,660	$738,375	$4,857,603
Multifamily Rehab <5K (J1m)	$271,602	$263,388	$347,632	$882,622
Multifamily Rehab 5K-25K (J2m)	$1,330,143	$1,149,013	$1,098,084	$3,577,239
Multifamily Rehab >25K (J3m)	$1,025,219	$828,729	$511,380	$2,365,328
Single Family Acquisition, Leasing, Operating, and Support (Ks)	$621,775	$370,890	$248,026	$1,240,691
Multifamily Acquisition, Leasing, Operating, and Support (Km)	$442,757	$154,882	$131,234	$728,873
Multifamily Public Housing (Lm)	$8,231,159	$23,513,781	$13,516,611	$45,261,551
Single Family Public Housing (Ls)	$3,927,306	$10,301,903	$5,892,990	$20,122,200
Single Family Tenant-Based Rental Assistance (Ms)	$16,437,850	$9,088,560	$6,869,400	$32,395,810
Multifamily Tenant-Based Rental Assistance (Mm)	$10,344,648	$6,116,517	$3,251,730	$19,712,895
Total Cost by Program	$95,010,776	$83,649,233	$74,503,969	$253,163,978
Average Cost per Unit	$376	$264	$104	$196

Exhibit 5-3a. Total Benefit by Program (three percent discount rate for lifetime earnings)

Subparts (Tables)	Program Benefit			Total for Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	$6,617,024	$1,477,077	$806,050	$8,900,151
Multifamily Insured Housing (G)	$4,827,961	$3,760,899	$0	$8,588,860
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$10,402,646	$8,103,483	$10,156,965	$28,663,095
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	$38,260,920	$14,492,336	$18,134,099	$70,887,355
Single Family Housing With Project-Based Assistance (Hs)	$15,819,504	$6,255,136	$10,931,840	$33,006,480
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	$341,294	$803,583	$941,563	$2,086,440
Single Family Rehab <5K (J1s)	$29,958,504	$22,764,800	$7,104,716	$59,828,020
Single Family Rehab 5K-25K (J2s)	$52,096,341	$38,584,869	$11,204,979	$101,886,189
Single Family Rehab >25K (J3s)	$4,425,072	$11,353,083	$1,160,148	$16,938,303
Multifamily Rehab <5K (J1m)	$3,374,603	$2,751,906	$839,526	$6,966,035
Multifamily Rehab 5K-25K (J2m)	$13,633,499	$10,690,281	$4,415,012	$28,738,793
Multifamily Rehab >25K (J3m)	$9,561,370	$7,761,625	$2,016,323	$19,339,318
Single Family Acquisition, Leasing, Operating, and Support (Ks)	$940,320	$495,224	$268,888	$1,704,432
Multifamily Acquisition, Leasing, Operating, and Support (Km)	$1,051,517	$301,807	$178,455	$1,531,780
Multifamily Public Housing (Lm)	$66,854,173	$212,278,624	$48,182,239	$327,315,036
Single Family Public Housing (Ls)	$17,857,941	$54,926,910	$12,894,708	$85,679,559
Single Family Tenant-Based Rental Assistance (Ms)	$84,792,021	$40,302,996	$22,447,530	$147,542,547
Multifamily Tenant-Based Rental Assistance (Mm)	$112,854,138	$52,689,774	$28,114,664	$193,658,576
Total Benefit by Program	$473,668,848	$489,794,415	$179,797,707	$1,143,260,969
Average Benefit per Unit	$1,874	$1,548	$250	$887

Exhibit 5-3b. Total Benefit by Program (seven percent discount rate for lifetime earnings)

Subparts (Tables)	Program Benefit			Total for Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	$3,884,834	$892,599	$533,898	$5,311,331
Multifamily Insured Housing (G)	$1,362,128	$955,690	$0	$2,317,817
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$2,934,931	$2,059,193	$2,708,340	$7,702,464
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	$14,017,182	$5,332,778	$7,690,701	$27,040,661
Single Family Housing With Project-Based Assistance (Hs)	$8,792,955	$3,582,643	$6,899,310	$19,274,909
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	$103,938	$211,816	$255,765	$571,519
Single Family Rehab <5K (J1s)	$6,911,849	$5,243,269	$1,639,906	$13,795,025
Single Family Rehab 5K-25K (J2s)	$12,063,742	$8,905,498	$2,599,139	$23,568,379
Single Family Rehab >25K (J3s)	$1,029,867	$2,626,692	$270,600	$3,927,158
Multifamily Rehab <5K (J1m)	$778,569	$633,829	$193,779	$1,606,176
Multifamily Rehab 5K-25K (J2m)	$3,150,315	$2,464,461	$1,021,621	$6,636,396
Multifamily Rehab >25K (J3m)	$2,217,177	$1,792,258	$468,412	$4,477,847
Single Family Acquisition, Leasing, Operating, and Support (Ks)	$522,658	$283,641	$169,701	$976,000
Multifamily Acquisition, Leasing, Operating, and Support (Km)	$385,231	$111,057	$75,683	$571,971
Multifamily Public Housing (Lm)	$17,173,446	$51,416,629	$11,992,753	$80,582,828
Single Family Public Housing (Ls)	$5,307,718	$14,514,923	$3,741,466	$23,564,107
Single Family Tenant-Based Rental Assistance (Ms)	$28,154,911	$13,708,332	$8,354,346	$50,217,589
Multifamily Tenant-Based Rental Assistance (Mm)	$30,012,222	$14,049,674	$8,003,253	$52,065,149
Total Benefit by Program	$138,803,671	$128,784,981	$56,618,674	$324,207,326
Average Benefit per Unit	$549	$407	$79	$252

Exhibit 5-4a. Net Benefit (Cost) by Program (three percent discount rate for lifetime earnings)

Subparts (Tables)	Net Program Benefit (Cost)			Total for Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	$804,349	($104,790)	($267,451)	$432,108
Multifamily Insured Housing (G)	$3,712,523	$2,981,836	$0	$6,694,360
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$7,858,982	$6,284,595	$4,395,518	$18,539,094
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	$22,150,600	$7,055,126	$4,798,460	$34,004,186
Single Family Housing With Project-Based Assistance (Hs)	$5,359,054	$1,570,456	$848,160	$7,777,670
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	$221,666	$551,460	$316,903	$1,090,029
Single Family Rehab <5K (J1s)	$26,705,720	$19,813,315	$3,103,588	$49,622,624
Single Family Rehab 5K-25K (J2s)	$40,365,551	$29,115,276	$4,186,525	$73,667,352
Single Family Rehab >25K (J3s)	$3,192,504	$8,466,423	$421,773	$12,080,700
Multifamily Rehab <5K (J1m)	$3,103,001	$2,488,518	$491,894	$6,083,413
Multifamily Rehab 5K-25K (J2m)	$12,303,357	$9,541,269	$3,316,929	$25,161,554
Multifamily Rehab >25K (J3m)	$8,536,151	$6,932,896	$1,504,944	$16,973,991
Single Family Acquisition, Leasing, Operating, and Support (Ks)	$318,545	$124,334	$20,862	$463,741
Multifamily Acquisition, Leasing, Operating, and Support (Km)	$608,761	$146,925	$47,221	$802,907
Multifamily Public Housing (Lm)	$58,623,013	$188,764,843	$34,665,629	$282,053,485
Single Family Public Housing (Ls)	$13,930,634	$44,625,006	$7,001,718	$65,557,359
Single Family Tenant-Based Rental Assistance (Ms)	$68,354,171	$31,214,436	$15,578,130	$115,146,737
Multifamily Tenant-Based Rental Assistance (Mm)	$102,509,490	$46,573,257	$24,862,934	$173,945,681
Total Net Benefit	$378,658,072	$406,145,182	$105,293,738	$890,096,991

Exhibit 5-4b. Net Benefit (Cost) by Program (seven percent discount rate for lifetime earnings)

Subparts (Tables)	Net Program Benefit (Cost)			Total for Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	($1,927,841)	($689,268)	($539,603)	($3,156,712)
Multifamily Insured Housing (G)	$246,690	$176,627	$0	$423,317
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$391,267	$240,304	($3,053,108)	($2,421,537)
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	($2,093,138)	($2,104,432)	($5,644,938)	($9,842,508)
Single Family Housing With Project-Based Assistance (Hs)	($1,667,495)	($1,102,037)	($3,184,370)	($5,953,901)
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	($15,690)	($40,308)	($368,895)	($424,892)
Single Family Rehab <5K (J1s)	$3,659,065	$2,291,784	($2,361,222)	$3,589,628
Single Family Rehab 5K-25K (J2s)	$332,951	($564,095)	($4,419,314)	($4,650,458)
Single Family Rehab >25K (J3s)	($202,701)	($259,968)	($467,775)	($930,445)
Multifamily Rehab <5K (J1m)	$506,967	$370,441	($153,853)	$723,554
Multifamily Rehab 5K-25K (J2m)	$1,820,172	$1,315,448	($76,463)	$3,059,158
Multifamily Rehab >25K (J3m)	$1,191,958	$963,529	($42,968)	$2,112,520
Single Family Acquisition, Leasing, Operating, and Support (Ks)	($99,117)	($87,249)	($78,325)	($264,691)
Multifamily Acquisition, Leasing, Operating, and Support (Km)	($57,525)	($43,825)	($55,551)	($156,902)
Multifamily Public Housing (Lm)	$8,942,287	$27,902,848	($1,523,858)	$35,321,277
Single Family Public Housing (Ls)	$1,380,411	$4,213,020	($2,151,524)	$3,441,908
Single Family Tenant-Based Rental Assistance (Ms)	$11,717,061	$4,619,772	$1,484,946	$17,821,779
Multifamily Tenant-Based Rental Assistance (Mm)	$19,667,574	$7,933,157	$4,751,523	$32,352,254
Total Net Benefit	$43,792,895	$45,135,748	($17,885,295)	$71,043,348

Exhibit 5-5a. Net Benefit (Cost) per Unit by Program (three percent discount rate for lifetime earnings)

Subparts (Tables)	Net Program Benefit (Cost)			Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	$88	($20)	($36)	$20
Multifamily Insured Housing (G)	$1,980	$1,590	$0	$446
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$1,945	$1,556	$159	$519
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	$305	$97	$18	$83
Single Family Housing with Project-Based Assistance (Hs)	$268	$78	$9	$58
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	$1,167	$985	$106	$291
Single Family Rehab <5K (J1s)	$1,269	$1,026	$117	$742
Single Family Rehab 5K-25K (J2s)	$2,736	$2,111	$205	$1,503
Single Family Rehab >25K (J3s)	$3,170	$2,679	$256	$2,512
Multifamily Rehab <5K (J1m)	$1,309	$1,066	$157	$777
Multifamily Rehab 5K-25K (J2m)	$3,159	$2,485	$407	$1,585
Multifamily Rehab >25K (J3m)	$3,863	$3,183	$516	$2,323
Single Family Acquisition, Leasing, Operating, and Support (Ks)	$268	$78	$9	$91
Multifamily Acquisition, Leasing, Operating, and Support (Km)	$305	$97	$18	$132
Multifamily Public Housing (Lm)	$4,469	$3,597	$528	$2,150
Single Family Public Housing (Ls)	$4,243	$3,402	$427	$1,999
Single Family Tenant-Based Rental Assistance (Ms)	$2,173	$804	$243	$856
Multifamily Tenant-Based Rental Assistance (Mm)	$2,117	$779	$252	$840

Exhibit 5-5b. Net Benefit (Cost) per Unit by Program (seven percent discount rate for lifetime earnings)

Subparts (Tables)	Net Program Benefit (Cost)			Subpart
	Pre-1940	1940-1959	1960-1977	
Single Family Insured Housing (E)	$0	$0	$0	$0
HUD-Owned Single Family Housing (F)	($210)	($133)	($72)	($144)
Multifamily Insured Housing (G)	$132	$94	$0	$28
Multifamily Housing With Project-Based Assistance > $5K (Hm1)	$97	$59	($110)	($68)
Multifamily Housing With Project-Based Assistance < $5K (Hm2)	($29)	($29)	($21)	($24)
Single Family Housing with Project-Based Assistance (Hs)	($83)	($55)	($34)	($44)
HUD-Owned and Mortgagee-in-Possession Multifamily Housing (I)	($83)	($72)	($123)	($113)
Single Family Rehab <5K (J1s)	$174	$119	($89)	$54
Single Family Rehab 5K-25K (J2s)	$23	($41)	($216)	($95)
Single Family Rehab >25K (J3s)	($201)	($82)	($284)	($193)
Multifamily Rehab <5K (J1m)	$214	$159	($49)	$92
Multifamily Rehab 5K-25K (J2m)	$467	$343	($9)	$193
Multifamily Rehab >25K (J3m)	$539	$442	($15)	$289
Single Family Acquisition, Leasing, Operating, and Support (Ks)	($83)	($55)	($34)	($52)
Multifamily Acquisition, Leasing, Operating, and Support (Km)	($29)	($29)	($21)	($26)
Multifamily Public Housing (Lm)	$682	$532	($23)	$269
Single Family Public Housing (Ls)	$420	$321	($131)	$105
Single Family Tenant-Based Rental Assistance (Ms)	$372	$119	$23	$133
Multifamily Tenant-Based Rental Assistance (Mm)	$406	$133	$48	$156

5.2 REGULATORY COST AND BENEFIT CALCULATIONS BY SUBPART

The calculations for costs and benefits under each Subpart are presented in Tables F through M, labeled to correspond with the Subparts F through M of the final rule. No cost-benefit tables are presented for Subpart E, Single Family Insured Housing, because the final rule does not impose any new requirements on these units. Each of these tables combines unit cost estimates (from Chapter 2) and unit benefit estimates (from Chapter 3) with estimated occurrence frequencies and number of affected units (from Chapter 4) to calculate regulatory costs and benefits associated with each Subpart.

In the case of rehab programs, the regulatory cost estimates for paint stabilization and LBP hazard abatement activities reflect only the incremental costs of the final rule. Under non-rehab programs, the full costs of paint stabilization and window replacement are recognized as costs, but these costs are substantially offset by the full market value of paint stabilization and the present value of fuel savings from window replacement. Therefore, the incremental costs of paint stabilization (e.g., safe work practices) are the only costs of these activities that are not offset by market value benefits. Although window replacement is not required under any Subparts, the cost-benefit analysis assumes that some affected units will choose window replacement as their most economical hazard reduction option. It is possible, however, that the full market values of painting and the present value of fuel savings from window replacement may overstate the market benefits of the final rule. For example, the market value of paint stabilization required for HUD-owned housing may not be fully recovered when these repainted units are sold by HUD. Therefore, the cost-benefit analysis for non-rehab programs (in Section 5.2) explicitly separates the estimated market value benefits of the rule from the monetized health benefits of LBP hazard reduction, to facilitate recalculations of net benefits under alternative market value assumptions. The analysis also separates monetized benefits for resident children aged one and two, and for "other" children.

For subparts where paint stabilization and cleanup are only required for deteriorated LBP, the RIA assumes that units with deteriorated paint will conduct paint testing. Although paint testing is not explicitly required for these subparts (units with deteriorated paint can assume that the paint is LBP, and perform stabilization and cleanup accordingly), paint testing will generally minimize total costs.

Tables F(a) and F(b). HUD-Owned Single Family Housing

Under Subpart F, HUD-Owned Single Family Housing, the final rule requires a visual assessment for deteriorated paint, paint stabilization, unit cleanup, and clearance. Paint testing is an option. If deteriorated paint is not lead-based paint, paint stabilization and clearance are not required.

Assumptions Reflected in Cost-Benefit Analysis

Single family unit cost estimates are used for this Subpart, and the analysis assumes that paint testing is done in all units with deteriorated interior and/or exterior paint. Therefore, the frequencies for interior paint stabilization, cleanup, and clearance, the 5-year dust benefit frequency, and the market value of interior paint stabilization are equal to the frequency of deteriorated interior LBP. The frequency of exterior paint stabilization and associated market value equals the frequency of deteriorated exterior LBP. The health benefit frequency for LBP repair is the frequency of deteriorated interior and exterior LBP. The analysis also recognizes holding costs incurred by HUD, which reflects the financing costs associated with delaying the sale of these units while hazard reduction work is performed.

Results of Cost-Benefit Analysis

Tables F(a) and F(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. Pre-1940 units realize net benefits with a three percent discount rate for lifetime earnings, but post-1940 units incur net costs, as do all units when net benefits reflect a seven percent discount rate.

Table F(a). HUD-Owned Single Family Housing (three percent discount rate for lifetime earnings

Activity	Unit Cost	Pre-1940 Units/Yr: 9,190		1940-1959 Units/Yr: 5,170		1960-1977 Units/Yr: 7,507		Total Units: 21,867
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Paint testing	$150	55%	$758,175	36%	$279,153	18%	$202,689	$1,240,017
Interior LBP stabilization	$500	16%	$735,200	6%	$155,085	3.0%	$112,605	$1,002,890
Exterior LBP stabilization	$1,000	28%	$2,573,200	12%	$620,340	5.0%	$375,350	$3,568,890
Holding Cost	$200	55%	$1,010,900	36%	$372,204	18%	$270,252	$1,653,356
Unit cleanup	$350	16%	$514,640	6%	$108,560	3.0%	$78,824	$702,023
Clearance	$150	16%	$220,560	6%	$46,526	3.0%	$33,782	$300,867
Hazard Evaluation Costs			$1,989,635		$697,883		$506,723	$3,194,240
Hazard Reduction Costs			$3,823,040		$883,985		$566,779	$5,273,803
Total Program Cost			$5,812,675		$1,581,867		$1,073,501	$8,468,043
Average Cost/Unit			$633		$306		$143	$387

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 9,190		1940-1959 Units/Yr: 5,170		1960-1977 Units/Yr: 7,507		Total Units: 21,867
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
LBP stabilization	$148	$148	$148	44%	$598,453	18%	$137,715	8.0%	$88,883	$825,051
Unit dust - 5 years	$2,038	$2,038	$1,205	16%	$2,996,899	6%	$632,174	3.0%	$271,251	$3,900,324
Total Program Health Benefits					$3,595,352		$769,889		$360,134	$4,725,375
Resident children ages 1&2					$2,702,499		$578,794		$270,989	$3,552,282
Other children					$892,854		$191,095		$89,145	$1,173,093
Interior LBP stabilization market value	$480	$480	$480	16%	$705,792	6%	$148,882	3.0%	$108,101	$962,774
Exterior LBP stabilization market value	$900	$900	$900	28%	$2,315,880	12%	$558,306	5.0%	$337,815	$3,212,001
Total Program Benefits					$6,617,024		$1,477,077		$806,050	$8,900,151

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$804,349	($104,790)	($267,451)	$432,108
Net benefit (cost) per unit	$88	($20)	($36)	$20

Table F(b). HUD-Owned Single Family Housing (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 9,190		1940-1959 Units/Yr: 5,170		1960-1977 Units/Yr: 7,507		Total Units: 21,867
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Paint testing	$150	55%	$758,175	36%	$279,153	18%	$202,689	$1,240,017
Interior LBP stabilization	$500	16%	$735,200	6%	$155,085	3.0%	$112,605	$1,002,890
Exterior LBP stabilization	$1,000	28%	$2,573,200	12%	$620,340	5.0%	$375,350	$3,568,890
Holding Cost	$200	55%	$1,010,900	36%	$372,204	18%	$270,252	$1,653,356
Unit cleanup	$350	16%	$514,640	6%	$108,560	3.0%	$78,824	$702,023
Clearance	$150	16%	$220,560	6%	$46,526	3.0%	$33,782	$300,867
Hazard Evaluation Costs			$1,989,635		$697,883		$506,723	$3,194,240
Hazard Reduction Costs			$3,823,040		$883,985		$566,779	$5,273,803
Total Program Cost			$5,812,675		$1,581,867		$1,073,501	$8,468,043
Average Cost/Unit			$633		$306		$143	$387

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 9,190		1940-1959 Units/Yr: 5,170		1960-1977 Units/Yr: 7,507		Total Units: 21,867
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
LBP stabilization	$43	$43	$43	44%	$173,875	18%	$40,012	8.0%	$25,824	$239,711
Unit dust - 5 years	$469	$469	$1,675	16%	$689,287	6%	$145,400	3.0%	$62,158	$896,845
Total Program Health Benefits					$863,162		$185,412		$87,982	$1,136,556
Resident children ages 1&2					$649,110		$139,459		$66,245	$854,814
Other children					$214,052		$45,953		$21,737	$281,742
Interior LBP stabilization market value	$480	$480	$480	16%	$705,792	6%	$148,882	3.0%	$108,101	$962,774
Exterior LBP stabilization market value	$900	$900	$900	28%	$2,315,880	12%	$558,306	5.0%	$337,815	$3,212,001
Total Program Benefits					$3,884,834		$892,599		$533,898	$5,311,331

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	($1,927,841)	($689,268)	($539,603)	($3,156,712)
Net benefit (cost) per unit	($210)	($133)	($72)	($144)

Tables G(a) and G(b). Multifamily Insured Housing

Under Subpart G, Multifamily Insured Housing, the final rule requires a risk assessment and interim controls for pre-60 housing, and maintenance for post-59 housing. Interim controls for units with LBP hazards include repair of deteriorated LBP using safe practices for LBP (e.g., wet scraping), window work (or replacement) and other friction and impact work associated with dust hazards, soil cover for soil hazards, unit cleanup, and clearance testing.

Assumptions Reflected in Cost-Benefit Analysis

Multifamily unit cost estimates are used for this Subpart. Maintenance for post-59 housing is assumed to entail no incremental costs or benefits over existing regulations. The Risk Assessment frequency reflects the effect of sampling for multifamily dwellings. Interior and exterior LBP repair and associated paint stabilization market values reflect the frequencies of deteriorated interior and exterior LBP, and the health benefit of LBP repair reflects the sum of interior and exterior deteriorated LBP. The frequency of window work, window replacement, and other friction and impact work reflect the assumptions discussed in Chapter 4. Soil cover costs and benefits reflect the frequency of soil lead above the final rule standard. Cleanup and clearance activity reflects the frequencies for sill and/or floor dust above the final rule standard. Window replacement market value and 10-year dust benefits reflect the frequency of window replacement, and 5-year dust benefits reflect the frequency of sill and/or floor dust above the standard minus the frequency of 10-year benefits for window replacement.

Results of Cost-Benefit Analysis

Tables G(a) and G(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. There are net benefits at either discount rate for lifetime earnings for pre-1960 units and no costs or benefits for post-59 units.

Table G(a). Multifamily Insured Housing (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,875 Freq.	Cost	1940-1959 Units/Yr: 1,875 Freq.	Cost	1960-1977 Units/Yr: 11,250 Freq.	Cost	Total Units: 15,000 Total Cost
Risk assessment	$260	16%	$78,000	16%	$78,000	0%	$0	$156,000
Interior LBP stabilization	$500	16%	$150,000	6%	$56,250	0%	$0	$206,250
Exterior LBP stabilization	$100	14%	$26,250	6%	$11,250	0%	$0	$37,500
Window work	$200	27%	$101,250	19%	$71,250	0%	$0	$172,500
Window replacement	$3,000	3%	$168,750	1%	$56,250	0%	$0	$225,000
Other friction/impact work	$200	10%	$37,500	7%	$26,250	0%	$0	$63,750
Soil cover	$10	27%	$5,063	18%	$3,375	0%	$0	$8,438
Unit cleanup	$265	76%	$377,625	66%	$327,938	0%	$0	$705,563
Clearance	$120	76%	$171,000	66%	$148,500	0%	$0	$319,500
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Hazard Evaluation Costs			$249,000		$226,500		$0	$475,500
Hazard Reduction Costs			$866,438		$552,563		$0	$1,419,000
Total Program Cost			$1,115,438		$779,063		$0	$1,894,500
Average Cost/Unit			$595		$416		$0	$126

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 1,875 Freq.	Benefit	1940-1959 Units/Yr: 1,875 Freq.	Benefit	1960-1977 Units/Yr: 11,250 Freq.	Benefit	Total Units: 15,000 Total Benefit
LBP stabilization	$175	$175	$175	30%	$98,438	12%	$39,375	0%	$0	$137,813
Unit dust - 5 years	$2,402	$2,402	$1,420	73%	$3,288,294	65%	$2,927,933	0%	$0	$6,216,226
Unit dust - 10 years	$3,679	$3,679	$2,174	3%	$206,936	1%	$68,979	0%	$0	$275,915
Soil	$1,807	$1,807	$1,807	27%	$914,794	18%	$609,863	0%	$0	$1,524,656
Total Program Health Benefits					$4,508,461		$3,646,149		$0	$8,154,610
Resident children ages 1&2					$3,397,686		$2,743,173		$0	$6,140,859
Other children					$1,110,775		$902,975		$0	$2,013,750
Window replacement market value	$2,700	$2,700	$2,700	3%	$151,875	1%	$50,625	0%	$0	$202,500
Interior paint stabilization market value	$480	$480	$480	16%	$144,000	6%	$54,000	0%	$0	$198,000
Exterior paint stabilization market value	$90	$90	$90	14%	$23,625	6%	$10,125	0%	$0	$33,750
Total Program Benefits					$4,827,961		$3,760,899		$0	$8,588,860

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$3,712,523	$2,981,836	$0	$6,694,360
Net benefit (cost) per unit	$1,980	$1,590	$0	$446

Table G(b). Multifamily Insured Housing (seven percent discount rate for lifetime earnings)

		Pre-1940 Units/Yr: 1,875		1940-1959 Units/Yr: 1,875		1960-1977 Units/Yr: 11,250		Total Units: 15,000
Activity	**Unit Cost**	**Freq.**	**Cost**	**Freq.**	**Cost**	**Freq.**	**Cost**	**Total Cost**
Risk assessment	$260	16%	$78,000	16%	$78,000	0%	$0	$156,000
Interior LBP stabilization	$500	16%	$150,000	6%	$56,250	0%	$0	$206,250
Exterior LBP stabilization	$100	14%	$26,250	6%	$11,250	0%	$0	$37,500
Window work	$200	27%	$101,250	19%	$71,250	0%	$0	$172,500
Window replacement	$3,000	3%	$168,750	1%	$56,250	0%	$0	$225,000
Other friction/impact work	$200	10%	$37,500	7%	$26,250	0%	$0	$63,750
Soil cover	$10	27%	$5,063	18%	$3,375	0%	$0	$8,438
Unit cleanup	$265	76%	$377,625	66%	$327,938	0%	$0	$705,563
Clearance	$120	76%	$171,000	66%	$148,500	0%	$0	$319,500
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Hazard Evaluation Costs			$249,000		$226,500		$0	$475,500
Hazard Reduction Costs			$866,438		$552,563		$0	$1,419,000
Total Program Cost			$1,115,438		$779,063		$0	$1,894,500
Average Cost/Unit			$595		$416		$0	$126

	Unit Benefit			Pre-1940 Units/Yr: 1,875		1940-1959 Units/Yr: 1,875		1960-1977 Units/Yr: 11,250		Total Units: 15,000
Hazard Removal	**Pre-1940**	**1940-1959**	**1960-1977**	**Freq.**	**Benefit**	**Freq.**	**Benefit**	**Freq.**	**Benefit**	**Total Benefit**
LBP stabilization	$50	$50	$50	30%	$28,125	12%	$11,250	0%	$0	$39,375
Unit dust - 5 years	$553	$553	$327	73%	$756,308	65%	$673,425	0%	$0	$1,429,732
Unit dust - 10 years	$846	$846	$500	3%	$47,595	1%	$15,865	0%	$0	$63,460
Soil	$416	$416	$416	27%	$210,600	18%	$140,400	0%	$0	$351,000
Total Program Health Benefits					$1,042,628		$840,940		$0	$1,883,567
Resident children ages 1&2					$785,786		$632,697		$0	$1,418,483
Other children					$256,842		$208,242		$0	$465,084
Window replacement market value	$2,700	$2,700	$2,700	3%	$151,875	1%	$50,625	0%	$0	$202,500
Interior paint stabilization market value	$480	$480	$480	16%	$144,000	6%	$54,000	0%	$0	$198,000
Exterior paint stabilization market value	$90	$90	$90	14%	$23,625	6%	$10,125	0%	$0	$33,750
Total Program Benefits					$1,362,128		$955,690		$0	$2,317,817

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$246,690	$176,627	$0	$423,317
Net benefit (cost) per unit	$132	$94	$0	$28

Tables Hm1(a) and Hm1(b). Multifamily Project-Based Assistance (greater than $5,000 per unit)

Under Subpart H, Multifamily Housing Project-Based Assistance)greater than $5,000 per unit), the final rule requires a risk assessment, stabilization of deteriorated LBP using safe practices (e.g., wet scraping), window work (or replacement) and other friction and impact work as needed, soil cover for contaminated bare soil, unit cleanup, clearance, and reevaluation. Safe practices and area cleanup are required only for LBP repair because paint chip testing during the risk assessment will determine the lead content of deteriorated paint.

Assumptions Reflected in Cost-Benefit Analysis

Multifamily unit cost estimates are used for this Subpart. The Risk Assessment and reevaluation frequencies reflect the effect of sampling for multifamily dwellings. Interior and exterior LBP repair and associated paint stabilization market values reflect the frequencies of deteriorated interior and exterior LBP. The health benefit of LBP repair reflects the sum of interior and exterior deteriorated LBP. The frequency of window work, window replacement, and other friction and impact work reflect the assumptions discussed in Chapter 4. Soil cover costs and benefits reflect the frequency of soil lead above the final rule standard. Cleanup and clearance activity reflects the frequencies for sill and/or floor dust above the final rule standard. Window replacement market value and 10-year dust benefits reflect the frequency of window replacement, and 5-year dust benefits reflect the frequency of sill and/or floor dust above the standard minus the frequency of 10-year benefits for window replacement.

Results of Cost-Benefit Analysis

Tables Hm1(a) and Hm1(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. There are net benefits in all years at a three percent discount rate for lifetime earnings, and net benefits at a seven percent discount rate for pre-1960 units, but net costs at a seven percent rate for post-59 units.

Table Hm1(a). Multifamily Housing With Project-Based Assistance > $5,000/unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 4,040		1940-1959 Units/Yr: 4,040		1960-1977 Units/Yr: 27,670		Total Units: 35,750
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$260	16%	$168,064	16%	$168,064	16%	$1,151,072	$1,487,200
Interior LBP stabilization	$500	16%	$323,200	6%	$121,200	3%	$415,050	$859,450
Exterior LBP stabilization	$100	14%	$56,560	6%	$24,240	3%	$69,175	$149,975
Window work	$200	27%	$218,160	19%	$153,520	10%	$553,400	$925,080
Window replacement	$3,000	3%	$363,600	1%	$121,200	0%	$0	$484,800
Other friction/impact work	$200	10%	$80,800	7%	$56,560	1%	$55,340	$192,700
Soil cover	$10	27%	$10,908	18%	$7,272	0%	$0	$18,180
Unit cleanup	$265	76%	$813,656	66%	$706,596	24%	$1,759,812	$3,280,064
Clearance	$120	76%	$368,448	66%	$319,968	24%	$796,896	$1,485,312
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	16%	$140,269	16%	$140,269	16%	$960,702	$1,241,240
Hazard Evaluation Costs			$676,781		$628,301		$2,908,670	$4,213,752
Hazard Reduction Costs			$1,866,884		$1,190,588		$2,852,777	$5,910,249
Total Program Cost			$2,543,665		$1,818,889		$5,761,447	$10,124,001
Average Cost/Unit			$630		$450		$208	$283

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 4,040		1940-1959 Units/Yr: 4,040		1960-1977 Units/Yr: 27,670		Total Units: 35,750
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
LBP stabilization	$175	$175	$175	30%	$212,100	12%	$84,840	6%	$266,324	$563,264
Unit dust - 5 years	$2,402	$2,402	$1,420	73%	$7,085,177	65%	$6,308,719	24%	$9,429,936	$22,823,831
Unit dust - 10 years	$3,679	$3,679	$2,174	3%	$445,878	1%	$148,626	0%	$0	$594,504
Soil	$1,807	$1,807	$1,807	27%	$1,971,076	18%	$1,314,050	0%	$0	$3,285,126
Total Program Health Benefits					$9,714,230		$7,856,235		$9,696,260	$27,266,726
Resident children ages 1&2					$7,320,881		$5,910,624		$7,274,858	$20,506,363
Other children					$2,393,350		$1,945,611		$2,421,402	$6,760,362
Window replacement market value	$2,700	$2,700	$2,700	3%	$327,240	1%	$109,080	0%	$0	$436,320
Interior paint stabilization market value	$480	$480	$480	16%	$310,272	6%	$116,352	3%	$398,448	$825,072
Exterior paint stabilization market value	$90	$90	$90	14%	$50,904	6%	$21,816	3%	$62,258	$134,978
Total Program Benefits					$10,402,646		$8,103,483		$10,156,965	$28,663,095

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$7,858,982	$6,284,595	$4,395,518	$18,539,094
Net benefit (cost) per unit	$1,945	$1,556	$159	$519

Table Hm1(b). Multifamily Housing With Project-Based Assistance > $5,000/unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 4,040 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 4,040 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 27,670 Freq.	1960-1977 Cost	Total Units: 35,750 Total Cost
Risk assessment	$260	16%	$168,064	16%	$168,064	16%	$1,151,072	$1,487,200
Interior LBP stabilization	$500	16%	$323,200	6%	$121,200	3%	$415,050	$859,450
Exterior LBP stabilization	$100	14%	$56,560	6%	$24,240	3%	$69,175	$149,975
Window work	$200	27%	$218,160	19%	$153,520	10%	$553,400	$925,080
Window replacement	$3,000	3%	$363,600	1%	$121,200	0%	$0	$484,800
Other friction/impact work	$200	10%	$80,800	7%	$56,560	1%	$55,340	$192,700
Soil cover	$10	27%	$10,908	18%	$7,272	0%	$0	$18,180
Unit cleanup	$265	76%	$813,656	66%	$706,596	24%	$1,759,812	$3,280,064
Clearance	$120	76%	$368,448	66%	$319,968	24%	$796,896	$1,485,312
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	16%	$140,269	16%	$140,269	16%	$960,702	$1,241,240
Hazard Evaluation Costs			$676,781		$628,301		$2,908,670	$4,213,752
Hazard Reduction Costs			$1,866,884		$1,190,588		$2,852,777	$5,910,249
Total Program Cost			$2,543,665		$1,818,889		$5,761,447	$10,124,001
Average Cost/Unit			$630		$450		$208	$283

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 4,040 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 4,040 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 27,670 Freq.	1960-1977 Benefit	Total Units: 35,750 Total Benefit
LBP stabilization	$50	$50	$50	30%	$60,600	12%	$24,240	6%	$76,093	$160,933
Unit dust - 5 years	$553	$553	$327	73%	$1,629,591	65%	$1,451,005	24%	$2,171,542	$5,252,138
Unit dust - 10 years	$846	$846	$500	3%	$102,552	1%	$34,184	0%	$0	$136,736
Soil	$416	$416	$416	27%	$453,773	18%	$302,515	0%	$0	$756,288
Total Program Health Benefits					$2,246,515		$1,811,945		$2,247,634	$6,306,094
Resident children ages 1&2					$1,693,107		$1,363,251		$1,686,487	$4,742,845
Other children					$553,409		$448,693		$561,148	$1,563,249
Window replacement market value	$2,700	$2,700	$2,700	3%	$327,240	1%	$109,080	0%	$0	$436,320
Interior paint stabilization market value	$480	$480	$480	16%	$310,272	6%	$116,352	3%	$398,448	$825,072
Exterior paint stabilization market value	$90	$90	$90	14%	$50,904	6%	$21,816	3%	$62,258	$134,978
Total Program Benefits					$2,934,931		$2,059,193		$2,708,340	$7,702,464

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$391,267	$240,304	($3,053,108)	($2,421,537)
Net benefit (cost) per unit	$97	$59	($110)	($68)

Tables Hm2(a) and Hm2(b). Multifamily Project-Based Assistance (less than $5,000 per unit)

The requirements under Subpart H for Multifamily Housing receiving less than $5,000 per unit in Project-Based Assistance are a visual assessment for deteriorated paint, paint testing for LBP if paint is deteriorated and/or paint stabilization, unit cleanup, and clearance.

Assumptions Reflected in Cost-Benefit Analysis

Multifamily unit cost estimates are used in Tables Hm2(a) and Hm2(b). The analysis assumes that paint testing is done in all units with detriorated paint. Therefore, the frequencies for interior paint stabilization, cleanup, and clearance, the 5-year dust benefit frequency, and the market value of interior paint stabilization are equal to the frequency of deteriorated interior LBP. The frequency of exterior paint stabilization and associated market value equals the frequency of deteriorated exterior LBP. The health benefit frequency for LBP repair is the frequency of deteriorated interior and exterior LBP.

Results of Cost-Benefit Analysis

Tables Hm2(a) and Hm2(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. Net benefits are realized for all units at a three percent discount rate, and net costs are incurred for all units at a seven percent discount rate for lifetime earnings.

Table Hm2(a). Multifamily Housing With Project-Based Assistance < $5,000/unit (three percent discount rate for lifetime earnings)

		Pre-1940 Units/Yr: 72,700		1940-1959 Units/Yr: 72,700		1960-1977 Units/Yr. 263,290		Total Units: 408,690
Activity	**Unit Cost**	**Freq.**	**Cost**	**Freq.**	**Cost**	**Freq.**	**Cost**	**Total Cost**
Paint testing	$120	55%	$4,798,200	36%	$3,140,640	18%	$5,687,064	$13,625,904
Interior LBP stabilization	$500	16%	$5,816,000	6%	$2,181,000	3%	$3,949,350	$11,946,350
Exterior LBP stabilization	$100	14%	$1,017,800	6%	$436,200	3%	$658,225	$2,112,225
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$265	16%	$3,082,480	6%	$1,155,930	3%	$2,093,156	$6,331,566
Clearance	$120	16%	$1,395,840	6%	$523,440	3%	$947,844	$2,867,124
Hazard Evaluation Costs			$6,194,040		$3,664,080		$6,634,908	$16,493,028
Hazard Reduction Costs			$9,916,280		$3,773,130		$6,700,731	$20,390,141
Total Program Cost			$16,110,320		$7,437,210		$13,335,639	$36,883,169
Average Cost/Unit			$222		$102		$51	$90

	Unit Benefit			Pre-1940 Units/Yr: 72,700		1940-1959 Units/Yr: 72,700		1960-1977 Units/Yr: 263,290		Total Units: 408,690
Hazard Removal	**Pre-1940**	**1940-1959**	**1960-1979**	**Freq.**	**Benefit**	**Freq.**	**Benefit**	**Freq.**	**Benefit**	**Total Benefit**
Paint stabilization	$175	$175	$175	30%	$3,816,750	12%	$1,526,700	6%	$2,534,166	$7,877,616
Unit dust - 5 years	$2,402	$2,402	$1,420	16%	$27,944,790	6%	$10,479,296	3%	$11,216,154	$49,640,240
Total Program Health Benefits					$31,761,540		$12,005,996		$13,750,320	$57,517,856
Resident children ages 1&2					$23,859,322.25		$9,019,764.09		$10,338,081.85	$43,217,168
Other children					$7,902,217.42		$2,986,232.03		$3,412,238.40	$14,300,688
Interior paint stabilization market value	$480	$480	$480	16%	$5,583,360	6%	$2,093,760	3%	$3,791,376	$11,468,496
Exterior paint stabilization market value	$90	$90	$90	14%	$916,020	6%	$392,580	3%	$592,403	$1,901,003
Total Program Benefits					$38,260,920		$14,492,336		$18,134,099	$70,887,355

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$22,150,600	$7,055,126	$4,798,460	$34,004,186
Net benefit (cost) per unit	$305	$97	$18	$83

Table Hm2(b). Multifamily Housing With Project-Based Assistance < $5,000/unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 72,700		1940-1959 Units/Yr: 72,700		1960-1977 Units/Yr. 263,290		Total Units: 408,690
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Paint testing	$120	55%	$4,798,200	36%	$3,140,640	18%	$5,687,064	$13,625,904
Interior LBP stabilization	$500	16%	$5,816,000	6%	$2,181,000	3%	$3,949,350	$11,946,350
Exterior LBP stabilization	$100	14%	$1,017,800	6%	$436,200	3%	$658,225	$2,112,225
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$265	16%	$3,082,480	6%	$1,155,930	3%	$2,093,156	$6,331,566
Clearance	$120	16%	$1,395,840	6%	$523,440	3%	$947,844	$2,867,124
Hazard Evaluation Costs			$6,194,040		$3,664,080		$6,634,908	$16,493,028
Hazard Reduction Costs			$9,916,280		$3,773,130		$6,700,731	$20,390,141
Total Program Cost			$16,110,320		$7,437,210		$13,335,639	$36,883,169
Average Cost/Unit			$222		$102		$51	$90

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 72,700		1940-1959 Units/Yr: 72,700		1960-1977 Units/Yr: 263,290		Total Units: 408,690
	Pre-1940	1940-1959	1960-1979	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint stabilization	$50	$50	$50	30%	$1,090,500	12%	$436,200	6%	$724,048	$2,250,748
Unit dust - 5 years	$553	$553	$327	16%	$6,427,302	6%	$2,410,238	3%	$2,582,875	$11,420,415
Total Program Health Benefits					$7,517,802		$2,846,438		$3,306,922	$13,671,162
Resident children ages 1&2					$5,649,256.22		$2,139,190.58		$2,487,432.28	$10,275,879
Other children					$1,868,545.41		$707,247.53		$819,490.13	$3,395,283
Interior paint stabilization market value	$480	$480	$480	16%	$5,583,360	6%	$2,093,760	3%	$3,791,376	$11,468,496
Exterior paint stabilization market value	$90	$90	$90	14%	$916,020	6%	$392,580	3%	$592,403	$1,901,003
Total Program Benefits					$14,017,182		$5,332,778		$7,690,701	$27,040,661

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	($2,093,138)	($2,104,432)	($5,644,938)	($9,842,508)
Net benefit (cost) per unit	($29)	($29)	($21)	($24)

Tables Hs(a) and Hs(b) Single Family Project-Based Assistance

The requirements under Subpart H for Single Family Housing with Project-Based Assistance are a visual assessment for deteriorated paint, paint testing for LBP if paint is deteriorated and/or paint stabilization, unit cleanup, and clearance.

Assumptions Reflected in Cost-Benefit Analysis

Single family unit cost estimates are used for this Subpart. The analysis assumes that paint testing is done in all units with deteriorated paint. Therefore, the frequencies for interior paint stabilization, cleanup, and clearance, the 5-year dust benefit frequency, and the market value of interior paint stabilization are equal to the frequency of deteriorated interior LBP. The frequency of exterior paint stabilization and paint repair market value equals the frequency of deteriorated exterior LBP. The health benefit frequency for LBP repair is the frequency of deteriorated interior and exterior LBP. The value of unit benefits reflects the high proportion of young children in affected units.

Results of Cost-Benefit Analysis

Tables Hs(a) and Hs(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. Net benefits are realized for all units at a three percent discount rate, and net costs are incurred for all units at a seven percent discount rate for lifetime earnings.

Table Hs(a). Single Family Housing With Project-Based Assistance (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 20,020 Freq.	Cost	1940-1959 Units/Yr: 20,020 Freq.	Cost	1960-1977 Units/Yr: 94,240 Freq.	Cost	Total Units: 134,280 Total Cost
Paint testing	$150	55%	$1,651,650	36%	$1,081,080	18%	$2,544,480	$5,277,210
Interior LBP stabilization	$500	16%	$1,601,600	6%	$600,600	3%	$1,413,600	$3,615,800
Exterior LBP stabilization	$1,000	28%	$5,605,600	12%	$2,402,400	5%	$4,712,000	$12,720,000
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$1,121,120	6%	$420,420	3%	$989,520	$2,531,060
Clearance	$150	16%	$480,480	6%	$180,180	3%	$424,080	$1,084,740
Hazard Evaluation Costs			$2,132,130		$1,261,260		$2,968,560	$6,361,950
Hazard Reduction Costs			$8,328,320		$3,423,420		$7,115,120	$18,866,860
Total Program Cost			$10,460,450		$4,684,680		$10,083,680	$25,228,810
Average Cost/Unit			$523		$234		$107	$188

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 20,020 Freq.	Benefit	1940-1959 Units/Yr: 20,020 Freq.	Benefit	1960-1977 Units/Yr: 94,240 Freq.	Benefit	Total Units: 134,280 Total Benefit
LBP stabilization	$175	$175	$175	44%	$1,541,540	18%	$630,630	8%	$1,319,360	$3,491,530
Unit dust - 5 year	$2,402	$2,402	$1,420	16%	$7,695,388	6%	$2,885,770	3%	$4,014,624	$14,595,782
Total Program Health Benefits					$9,236,928		$3,516,400		$5,333,984	$18,087,312
Resident children ages 1&2					$6,943,111		$2,643,607		$4,013,682	$13,600,399
Other children					$2,293,817		$872,794		$1,320,302	$4,486,913
Interior LBP stabilization market value	$480	$480	$480	16%	$1,537,536	6%	$576,576	3%	$1,357,056	$3,471,168
Exterior LBP stabilization market value	$900	$900	$900	28%	$5,045,040	12%	$2,162,160	5%	$4,240,800	$11,448,000
Total Program Benefits					$15,819,504		$6,255,136		$10,931,840	$33,006,480

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$5,359,054	$1,570,456	$848,160	$7,777,670
Net benefit (cost) per unit	$268	$78	$9	$58

Table Hs(b). Single Family Housing With Project-Based Assistance (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 20,020 Freq.	Cost	1940-1959 Units/Yr: 20,020 Freq.	Cost	1960-1977 Units/Yr: 94,240 Freq.	Cost	Total Units: 134,280 Total Cost
Paint testing	$150	55%	$1,651,650	36%	$1,081,080	18%	$2,544,480	$5,277,210
Interior LBP stabilization	$500	16%	$1,601,600	6%	$600,600	3%	$1,413,600	$3,615,800
Exterior LBP stabilization	$1,000	28%	$5,605,600	12%	$2,402,400	5%	$4,712,000	$12,720,000
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$1,121,120	6%	$420,420	3%	$989,520	$2,531,060
Clearance	$150	16%	$480,480	6%	$180,180	3%	$424,080	$1,084,740
Hazard Evaluation Costs			$2,132,130		$1,261,260		$2,968,560	$6,361,950
Hazard Reduction Costs			$8,328,320		$3,423,420		$7,115,120	$18,866,860
Total Program Cost			$10,460,450		$4,684,680		$10,083,680	$25,228,810
Average Cost/Unit			$523		$234		$107	$188

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 20,020 Freq.	Benefit	1940-1959 Units/Yr: 20,020 Freq.	Benefit	1960-1977 Units/Yr: 94,240 Freq.	Benefit	Total Units: 134,280 Total Benefit
LBP stabilization	$50	$50	$50	44%	$440,440	18%	$180,180	8%	$376,960	$997,580
Unit dust - 5 year	$553	$553	$327	16%	$1,769,939	6%	$663,727	3%	$924,494	$3,358,161
Total Program Health Benefits					$2,210,379		$843,907		$1,301,454	$4,355,741
Resident children ages 1&2					$1,662,189		$634,732		$979,860	$3,276,781
Other children					$548,190		$209,175		$321,594	$1,078,959
Interior LBP stabilization market value	$480	$480	$480	16%	$1,537,536	6%	$576,576	3%	$1,357,056	$3,471,168
Exterior LBP stabilization market value	$900	$900	$900	28%	$5,045,040	12%	$2,162,160	5%	$4,240,800	$11,448,000
Total Program Benefits					$8,792,955		$3,582,643		$6,899,310	$19,274,909

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	($1,667,495)	($1,102,037)	($3,184,370)	($5,953,901)
Net benefit (cost) per unit	($83)	($55)	($34)	($44)

Tables I(a) and I(b). HUD-Owned and Mortgagee-in-Possession Multifamily Housing

Under Subpart I, HUD-Owned and Mortgagee-in-Possession Multifamily Housing, the final rule requires a risk assessment, repair of deteriorated LBP using safe practices (e.g., wet scraping), window work (or replacement) and other friction and impact work as needed, soil cover for contaminated bare soil, unit cleanup, clearance, and reevaluation. Safe practices and area cleanup are required only for LBP repair because paint chip testing during the risk assessment will determine the lead content of deteriorated paint.

Assumptions Reflected in Cost-Benefit Analysis

Multifamily unit cost estimates are used for this Subpart. The Risk Assessment and reevaluation frequencies reflect the effect of sampling for multifamily dwellings. Interior and exterior LBP repair and associated paint stabilization market values reflect the frequencies of deteriorated interior and exterior LBP. The health benefit of LBP repair reflects the sum of interior and exterior deteriorated LBP. The frequency of window work, window replacement, and other friction and impact work reflect the assumptions discussed in Chapter 4. Soil cover costs and benefits reflect the frequency of soil lead above the final rule standard. Cleanup and clearance activity reflects the frequencies for sill and/or floor dust above the final rule standard. Window replacement market value and 10-year dust benefits reflect the frequency of window replacement, and 5-year dust benefits reflect the frequency of sill and/or floor dust above the standard minus the frequency of 10-year benefits for window replacement.

Results of Cost-Benefit Analysis

Tables I(a) and I(b) present the results of the cost-benefit analysis using a three and seven percent discount rate, respectively. There are net benefits in all years at a three percent discount rate for lifetime earnings, but net costs are incurred in all years at seven percent rate.

Table I(a). HUD-Owned and Mortgagee-in-Possession Multifamily Housing (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 190 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 560 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 3,000 Freq.	1960-1977 Cost	Total Units: 3,750 Total Cost
Risk assessment	$260	16%	$7,904	16%	$23,296	16%	$124,800	$156,000
Interior LBP stabilization	$500	16%	$15,200	6%	$16,800	3%	$45,000	$77,000
Exterior LBP stabilization	$100	14%	$2,660	6%	$3,360	3%	$7,500	$13,520
Window work	$200	27%	$10,260	19%	$21,280	10%	$60,000	$91,540
Window replacement	$3,000	3%	$17,100	1%	$16,800	0%	$0	$33,900
Other friction/impact work	$200	10%	$3,800	7%	$7,840	1%	$6,000	$17,640
Soil cover	$10	27%	$513	18%	$1,008	0%	$0	$1,521
Unit cleanup	$265	76%	$38,266	66%	$97,944	24%	$190,800	$327,010
Clearance	$120	76%	$17,328	66%	$44,352	24%	$86,400	$148,080
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	16%	$6,597	16%	$19,443	16%	$104,160	$130,200
Hazard Evaluation Costs			$31,829		$87,091		$315,360	$434,280
Hazard Reduction Costs			$87,799		$165,032		$309,300	$562,131
Total Program Cost			$119,628		$252,123		$624,660	$996,411
Average Cost/Unit			$630		$450		$208	$266

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 190 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 560 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 3,000 Freq.	1960-1977 Benefit	Total Units: 3,750 Total Benefit
LBP stabilization	$148	$148	$148	30%	$8,436	12%	$9,946	6%	$24,420	$42,802
Unit dust - 5 years	$2,038	$2,038	$1,204	73%	$282,692	65%	$741,888	24%	$867,193	$1,891,773
Unit dust - 10 years	$3,121	$3,121	$1,845	3%	$17,790	1%	$17,478	0%	$0	$35,268
Total Program Health Benefits					$308,918		$769,311		$891,613	$1,969,842
Resident children ages 1&2					$232,306		$577,607		$668,954	$1,478,868
Other children					$76,611		$191,704		$222,659	$490,975
Window replacement	$2,700	$2,700	$2,700	3%	$15,390	1%	$15,120	0%	$0	$30,510
Interior paint stabilization market value	$480	$480	$480	16%	$14,592	6%	$16,128	3%	$43,200	$73,920
Exterior paint stabilization market value	$90	$90	$90	14%	$2,394	6%	$3,024	3%	$6,750	$12,168
Total Program Benefits					$341,294		$803,583		$941,563	$2,086,440

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$221,666	$551,460	$316,903	$1,090,029
Net benefit (cost) per unit	$1,167	$985	$106	$291

Table I(b). HUD-Owned and Mortgagee-in-Possession Multifamily Housing (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 190 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 560 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 3,000 Freq.	1960-1977 Cost	Total Units: 3,750 Total Cost
Risk assessment	$260	16%	$7,904	16%	$23,296	16%	$124,800	$156,000
Interior LBP stabilization	$500	16%	$15,200	6%	$16,800	3%	$45,000	$77,000
Exterior LBP stabilization	$100	14%	$2,660	6%	$3,360	3%	$7,500	$13,520
Window work	$200	27%	$10,260	19%	$21,280	10%	$60,000	$91,540
Window replacement	$3,000	3%	$17,100	1%	$16,800	0%	$0	$33,900
Other friction/impact work	$200	10%	$3,800	7%	$7,840	1%	$6,000	$17,640
Soil cover	$10	27%	$513	18%	$1,008	0%	$0	$1,521
Unit cleanup	$265	76%	$38,266	66%	$97,944	24%	$190,800	$327,010
Clearance	$120	76%	$17,328	66%	$44,352	24%	$86,400	$148,080
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	16%	$6,597	16%	$19,443	16%	$104,160	$130,200
Hazard Evaluation Costs			$31,829		$87,091		$315,360	$434,280
Hazard Reduction Costs			$87,799		$165,032		$309,300	$562,131
Total Program Cost			$119,628		$252,123		$624,660	$996,411
Average Cost/Unit			$630		$450		$208	$266

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 190 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 560 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 3,000 Freq.	1960-1977 Benefit	Total Units: 3,750 Total Benefit
LBP stabilization	$43	$43	$43	30%	$2,451	12%	$2,890	6%	$7,095	$12,436
Unit dust - 5 years	$469	$469	$276	73%	$65,019	65%	$170,634	24%	$198,720	$434,373
Unit dust - 10 years	$718	$718	$424	3%	$4,092	1%	$4,020	0%	$0	$8,112
Total Program Health Benefits					$71,562		$177,544		$205,815	$454,921
Resident children ages 1&2					$53,819		$133,307		$154,432	$341,558
Other children					$17,743		$44,236		$51,383	$113,362
Window replacement	$2,700	$2,700	$2,700	3%	$15,390	1%	$15,120	0%	$0	$30,510
Interior paint stabilization market value	$480	$480	$480	16%	$14,592	6%	$16,128	3%	$43,200	$73,920
Exterior paint stabilization market value	$90	$90	$90	14%	$2,394	6%	$3,024	3%	$6,750	$12,168
Total Program Benefits					$103,938		$211,816		$255,765	$571,519

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	($15,690)	($40,308)	($368,895)	($424,892)
Net benefit (cost) per unit	($83)	($72)	($123)	($113)

Tables J1s(a), J1s(b), J1m(a), and J1m(b). Federally-Assisted Rehabilitation: Under $5,000 per Unit

For units with rehabilitation costs less than $5,000 under Subpart L, Federally-Assisted Rehabilitation, the final rule requires repair of paint disturbed by rehab and work area cleanup and clearance testing. Safe practices and area cleanup costs can be avoided in units where disturbed paint is tested for lead content and is not LBP.

Assumptions Reflected in Cost-Benefit Analysis

The AHS data presented in Chapter 2 indicates that most rehab units will disturb some amount of interior paint, so work site cleanup and clearance are incurred by all units. The nature of rehab upgrades suggest that these units may not have higher LBP hazard frequencies than other assisted housing units, and in rehab units receiving less than $5,000 per unit of assistance, the work area appears to be limited to just one to three rooms, so the frequency of deteriorated paint in the work area is assumed to be about half the frequency of deteriorated paint anywhere in a typical assisted unit. The cost for paint stabilization reflects incremental costs because the AHS data suggest that painting is often done in rooms where other upgrades are reported (especially the kitchen and bathrooms). There are no paint stabilization market benefits with the use of incremental paint stabilization costs, but health benefits of work site area LBP repair are assumed to be about half the frequency of deteriorated LBP in other assisted units. A significant percentage of these units report replacing windows and doors, so the frequency of window replacement is assumed to be at least as high as in other units, but there are no incremental costs or market benefits for window replacement. A 10-year dust benefit is realized, however, in units with window replacement, because the rule will require cleanup and clearance testing in the work area. A 5-year dust benefit is realized by the frequency of sill and/or floor dust minus the frequency of 10-year dust benefits. The only difference between single and multifamily units is that different cost estimates apply for work site cleanup and clearance.

Results of Cost-Benefit Analysis

Table J1s(a), Table J1s(b), J1m(a), and J1m(b) show that there are net benefits for all ages of single and multifamily rehab units receiving less than $5,000 of federal assistance, at a three percent discount rate for lifetime earnings, and for pre-1960 units at 7 percent discount rate, but net costs are incurred for post-60 units at a 7 percent discount rate.

Table J1s(a). Federally-Assisted Single Family Rehabilitation: Under $5,000 per Unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 21,040 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 19,316 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 26,480 Freq.	1960-1977 Cost	Total Units: 66,836 Total Cost
Visual assessment	$0	100%	$0	100%	$0	100%	$0	$0
Incremental interior paint stabilization	$20	23%	$96,784	14%	$54,085	6%	$29,128	$179,997
Window replacement	$0	15%	$0	10%	$0	5%	$0	$0
Worksite cleanup	$75	100%	$1,578,000	100%	$1,448,700	100%	$1,986,000	$5,012,700
Clearance	$75	100%	$1,578,000	100%	$1,448,700	100%	$1,986,000	$5,012,700
Hazard Evaluation Costs			$1,578,000		$1,448,700		$1,986,000	$5,012,700
Hazard Reduction Costs			$1,674,784		$1,502,785		$2,015,128	$5,192,697
Total Program Cost			$3,252,784		$2,951,485		$4,001,128	$10,205,397
Average Cost/Unit			$155		$153		$151	$153

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 21,040 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 19,316 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 26,480 Freq.	1960-1977 Benefit	Total Units: 66,836 Total Benefit
Rehab < 5,000 worksite area deteriorated LBP	$223	$223	$223	8%	$375,354	3%	$129,224	2%	$88,576	$593,153
Worksite dust - 5 years	$3,059	$3,059	$1,808	23%	$14,801,269	23%	$13,588,466	7%	$3,351,309	$31,741,044
Worksite dust - 10 years	$4,684	$4,684	$2,768	15%	$14,781,881	10%	$9,047,110	5%	$3,664,832	$27,493,823
Total Program Health Benefits					$29,958,504		$22,764,800		$7,104,716	$59,828,020
Resident children ages 1&2					$22,916,088		$17,346,306		$5,439,368	$45,701,761
Other children					$7,042,416		$5,418,495		$1,665,348	$14,126,259
Total Program Benefits					$29,958,504		$22,764,800		$7,104,716	$59,828,020

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$26,705,720	$19,813,315	$3,103,588	$49,622,624
Net benefit (cost) per unit	$1,269	$1,026	$117	$742

Table J1s(b). Federally-Assisted Single Family Rehabilitation: Under $5,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 21,040 Freq.	Cost	1940-1959 Units/Yr: 19,316 Freq.	Cost	1960-1977 Units/Yr: 26,480 Freq.	Cost	Total Units: 66,836 Total Cost
Visual assessment	$0	100%	$0	100%	$0	100%	$0	$0
Incremental interior paint stabilization	$20	23%	$96,784	14%	$54,085	6%	$29,128	$179,997
Window replacement	$0	15%	$0	10%	$0	5%	$0	$0
Worksite cleanup	$75	100%	$1,578,000	100%	$1,448,700	100%	$1,986,000	$5,012,700
Clearance	$75	100%	$1,578,000	100%	$1,448,700	100%	$1,986,000	$5,012,700
Hazard Evaluation Costs			$1,578,000		$1,448,700		$1,986,000	$5,012,700
Hazard Reduction Costs			$1,674,784		$1,502,785		$2,015,128	$5,192,697
Total Program Cost			$3,252,784		$2,951,485		$4,001,128	$10,205,397
Average Cost/Unit			$155		$153		$151	$153

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 21,040 Freq.	Benefit	1940-1959 Units/Yr: 19,316 Freq.	Benefit	1960-1977 Units/Yr: 26,480 Freq.	Benefit	Total Units: 66,836 Total Benefit
Rehab < 5,000 worksite area deteriorated LBP	$64	$64	$64	8%	$107,725	3%	$37,087	2%	$25,421	$170,232
Worksite dust - 5 years	$703	$703	$416	23%	$3,404,292	23%	$3,125,347	7%	$771,098	$7,300,737
Worksite dust - 10 years	$1,077	$1,077	$637	15%	$3,399,833	10%	$2,080,835	5%	$843,388	$6,324,056
Total Program Health Benefits					$6,911,849		$5,243,269		$1,639,906	$13,795,025
Resident children ages 1&2					$5,286,959		$3,995,248		$1,255,486	$10,537,693
Other children					$1,624,890		$1,248,021		$384,421	$3,257,332
Total Program Benefits					$6,911,849		$5,243,269		$1,639,906	$13,795,025

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$3,659,065	$2,291,784	($2,361,222)	$3,589,628
Net benefit (cost) per unit	$174	$119	($89)	$54

Table J1m(a). Federally-Assisted Multifamily Rehabilitation: Under $5,000 per Unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 2,370		1940-1959 Units/Yr: 2,335		1960-1977 Units/Yr: 3,129		Total Units: 7,834
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Visual assessment	$0	100%	$0	100%	$0	100%	$0	$0
Incremental interior paint stabilization	$20	23%	$10,902	14%	$6,538	6%	$3,442	$20,882
Window replacement	$0	15%	$0	10%	$0	5%	$0	$0
Worksite cleanup	$50	100%	$118,500	100%	$116,750	100%	$156,450	$391,700
Worksite clearance	$60	100%	$142,200	100%	$140,100	100%	$187,740	$470,040
Hazard Evaluation Costs			$142,200		$140,100		$187,740	$470,040
Hazard Reduction Costs			$129,402		$123,288		$159,892	$412,582
Total Program Cost			$271,602		$263,388		$347,632	$882,622
Average Cost/Unit			$115		$113		$111	$113

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 2,370		1940-1959 Units/Yr: 2,335		1960-1977 Units/Yr: 3,129		Total Units: 7,834
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Rehab < 5,000 worksite area deteriorated LBP	$223	$223	$223	8%	$42,281	3%	$15,621	2%	$10,467	$68,368
Worksite unit dust - 5 years	$3,059	$3,059	$1,808	23%	$1,667,253	23%	$1,642,631	7%	$396,006	$3,705,891
Worksite dust - 10 year	$4,684	$4,684	$2,768	15%	$1,665,069	10%	$1,093,653	5%	$433,054	$3,191,776
Total Program Health Benefits					$3,374,603		$2,751,906		$839,526	$6,966,035
Resident children ages 1&2					$2,581,327		$2,096,895		$642,741	$5,320,963
Other children					$793,276		$655,011		$196,785	$1,645,072
Total Program Benefits					$3,374,603		$2,751,906		$839,526	$6,966,035

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$3,103,001	$2,488,518	$491,894	$6,083,413
Net benefit (cost) per unit	$1,309	$1,066	$157	$777

Table J1m(b). Federally-Assisted Multifamily Rehabilitation: Under $5,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 2,370 Freq.	Cost	1940-1959 Units/Yr: 2,335 Freq.	Cost	1960-1977 Units/Yr: 3,129 Freq.	Cost	Total Units: 7,834 Total Cost
Visual assessment	$0	100%	$0	100%	$0	100%	$0	$0
Incremental interior paint stabilization	$20	23%	$10,902	14%	$6,538	6%	$3,442	$20,882
Window replacement	$0	15%	$0	10%	$0	5%	$0	$0
Worksite cleanup	$50	100%	$118,500	100%	$116,750	100%	$156,450	$391,700
Worksite clearance	$60	100%	$142,200	100%	$140,100	100%	$187,740	$470,040
Hazard Evaluation Costs			$142,200		$140,100		$187,740	$470,040
Hazard Reduction Costs			$129,402		$123,288		$159,892	$412,582
Total Program Cost			$271,602		$263,388		$347,632	$882,622
Average Cost/Unit			$115		$113		$111	$113

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 2,370 Freq.	Benefit	1940-1959 Units/Yr: 2,335 Freq.	Benefit	1960-1977 Units/Yr: 3,129 Freq.	Benefit	Total Units: 7,834 Total Benefit
Rehab < 5,000 worksite area deteriorated LBP	$64	$64	$64	8%	$12,134	3%	$4,483	2%	$3,004	$19,621
Worksite unit dust - 5 years	$703	$703	$416	23%	$383,468	23%	$377,805	7%	$91,116	$852,390
Worksite dust - 10 year	$1,077	$1,077	$637	15%	$382,966	10%	$251,540	5%	$99,659	$734,165
Total Program Health Benefits					$778,569		$633,829		$193,779	$1,606,176
Resident children ages 1&2					$595,537		$482,963		$148,354	$1,226,853
Other children					$183,032		$150,866		$45,425	$379,323
Total Program Benefits					$778,569		$633,829		$193,779	$1,606,176

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$506,967	$370,441	($153,853)	$723,554
Net benefit (cost) per unit	$214	$159	($49)	$92

Tables J2s(a), J2s(b), J2m(a), and J2m(b). Federally-Assisted Rehabilitation: $5,000-$25,000 per Unit

For units with rehabilitation costs between $5,000 and $25,000 under Subpart J, Federally-Assisted Rehabilitation, the final rule requires a risk assessment, and interim controls for LBP hazards and for LBP that is disturbed by rehab. Interim controls include LBP repair friction/impact work as needed, soil cover for contaminated bare soil, unit cleanup for dust hazards, and clearance.

Assumptions Reflected in Cost-Benefit Analysis

Risk assessments or hazard screens are performed for all single family units, and for a sample of units in multifamily buildings. The analysis assumes that the percentage of units that perform hazard screens is approximately equal to the percentage of units that are expected to find no sill or floor dust hazards. The AHS data presented in Chapter 2 indicate that rehab units may not have higher LBP hazard frequencies than other assisted housing units, so the frequency of deteriorated LBP, dust and soil hazards are the same as in other assisted units. The cost for paint stabilization reflects incremental costs, however, and there are no incremental costs for window replacement, window work, or other friction impact work because AHS data show that a substantial percentage of rehab units receiving more than $5,000 of federal assistance already report replacing windows and doors. There are no paint stabilization or window replacement market benefits with the use of incremental costs, but health benefits of LBP repair are realized for the percentage of interior plus exterior LBP repair. The frequency of window replacement is assumed to be at least as high as window work in other units, and a 10-year dust benefit is realized in units with window replacement because the rule requires unit cleanup and clearance for dust hazards. A 5-year dust benefit is realized for the frequency of sill and/or floor dust minus the frequency of 10-year dust benefits. The only difference between single and multifamily units are the use of applicable unit costs and the sampling provisions for multifamily risk assessment.

Results of Cost-Benefit Analysis

Table J2s(a), J2s(b), J2m(a), and J2m(b) show that these multifamily rehab units realize net benefits for all ages of housing at a three percent discount rate for lifetime earnings, and realize net benefits for pre-1960 units at a seven percent discount rate, but incur net costs for post-1960 units at a seven percent discount rate. Single family rehab units only realize net benefits for all ages of housing at a three percent discount rate for lifetime earnings but only for pre-40 housing at a seven percent discount rate.

Table J2s(a). Federally-Assisted Single Family Rehabilitation: $5,000-$25,000 per Unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 14,752		1940-1959 Units/Yr: 13,790		1960-1977 Units/Yr: 20,456		Total Units: 48,998
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$375	80%	$4,425,600	70%	$3,619,875	30%	$2,301,300	$10,346,775
Hazard screen	$150	20%	$442,560	30%	$620,550	70%	$2,147,880	$3,210,990
Incremental interior LBP stabilization	$20	16%	$47,206	6%	$16,548	3%	$12,274	$76,028
Incremental exterior LBP stabilization	$100	28%	$413,056	12%	$165,480	5%	$102,280	$680,816
Incremental friction/impact work	$0	51%	$0	36%	$0	3%	$0	$0
Incremental window replacement	$0	30%	$0	20%	$0	10%	$0	$0
Soil cover	$200	27%	$796,608	18%	$496,440	0%	$0	$1,293,048
Unit cleanup	$350	76%	$3,924,032	66%	$3,185,490	24%	$1,718,304	$8,827,826
Clearance	$150	76%	$1,681,728	66%	$1,365,210	24%	$736,416	$3,783,354
Hazard Evaluation Costs			$6,549,888		$5,605,635		$5,185,596	$17,341,119
Hazard Reduction Costs			$5,180,902		$3,863,958		$1,832,858	$10,877,718
Total Program Cost			$11,730,790		$9,469,593		$7,018,454	$28,218,837
Average Cost/Unit			$795		$687		$343	$576

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 14,752 Freq.	Benefit	1940-1959 Units/Yr: 13,790 Freq.	Benefit	1960-1977 Units/Yr: 20,456 Freq.	Benefit	Total Units: 48,998 Total Benefit
Interior and exterior LBP stabilization	$223	$223	$223	44%	$1,447,466	18%	$553,531	8%	$364,935	$2,365,932
Unit dust - 5 years	$3,059	$3,059	$1,808	46%	$20,755,544	46%	$19,402,044	14%	$5,177,823	$45,335,411
Unit dust - 10 years	$4,684	$4,684	$2,768	30%	$20,728,356	20%	$12,917,752	10%	$5,662,221	$39,308,329
Soil	$2,301	$2,301	$2,301	27%	$9,164,975	18%	$5,711,542	0%	$0	$14,876,517
Total Program Health Benefits					$52,096,341		$38,584,869		$11,204,979	$101,886,189
Resident children ages 1&2					$39,800,231		$29,388,835		$8,577,250	$77,766,316
Other children					$12,296,110		$9,196,034		$2,627,729	$24,119,873
Total Program Benefits					$52,096,341		$38,584,869		$11,204,979	$101,886,189

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$40,365,551	$29,115,276	$4,186,525	$73,667,352
Net benefit (cost) per unit	$2,736	$2,111	$205	$1,503

Table J2s(b). Federally-Assisted Single Family Rehabilitation: $5,000-$25,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 14,752 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 13,790 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 20,456 Freq.	1960-1977 Cost	Total Units: 48,998 Total Cost
Risk assessment	$375	80%	$4,425,600	70%	$3,619,875	30%	$2,301,300	$10,346,775
Hazard screen	$150	20%	$442,560	30%	$620,550	70%	$2,147,880	$3,210,990
Incremental interior LBP stabilization	$20	16%	$47,206	6%	$16,548	3%	$12,274	$76,028
Incremental exterior LBP stabilization	$100	28%	$413,056	12%	$165,480	5%	$102,280	$680,816
Incremental friction/impact work	$0	51%	$0	36%	$0	3%	$0	$0
Incremental window replacement	$0	30%	$0	20%	$0	10%	$0	$0
Soil cover	$200	27%	$796,608	18%	$496,440	0%	$0	$1,293,048
Unit cleanup	$350	76%	$3,924,032	66%	$3,185,490	24%	$1,718,304	$8,827,826
Clearance	$150	76%	$1,681,728	66%	$1,365,210	24%	$736,416	$3,783,354
Hazard Evaluation Costs			$6,549,888		$5,605,635		$5,185,596	$17,341,119
Hazard Reduction Costs			$5,180,902		$3,863,958		$1,832,858	$10,877,718
Total Program Cost			$11,730,790		$9,469,593		$7,018,454	$28,218,837
Average Cost/Unit			$795		$687		$343	$576

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 14,752 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 13,790 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 20,456 Freq.	1960-1977 Benefit	Total Units: 48,998 Total Benefit
Interior and exterior LBP stabilization	$64	$64	$64	44%	$415,416	18%	$158,861	8%	$104,735	$679,012
Unit dust - 5 years	$703	$703	$416	46%	$4,773,775	46%	$4,462,470	14%	$1,191,357	$10,427,603
Unit dust - 10 years	$1,077	$1,077	$637	30%	$4,767,522	20%	$2,971,083	10%	$1,303,047	$9,041,652
Soil	$529	$529	$529	27%	$2,107,028	18%	$1,313,084	0%	$0	$3,420,112
Total Program Health Benefits					$12,063,742		$8,905,498		$2,599,139	$23,568,379
Resident children ages 1&2					$9,216,056		$6,782,975		$1,989,493	$17,988,525
Other children					$2,847,685		$2,122,523		$609,646	$5,579,854
Total Program Benefits					$12,063,742		$8,905,498		$2,599,139	$23,568,379

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$332,951	($564,095)	($4,419,314)	($4,650,458)
Net benefit (cost) per unit	$23	($41)	($216)	($95)

Table J2m(a). Federally-Assisted Multifamily Rehabilitation: $5,000-$25,000 per Unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 3,895 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 3,839 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 8,143 Freq.	1960-1977 Cost	Total Units: 15,877 Total Cost
Risk assessment	$260	16%	$162,032	16%	$159,702	16%	$338,749	$660,483
Incremental interior LBP stabilization	$20	16%	$12,464	6%	$4,607	3%	$4,886	$21,957
Incremental exterior LBP stabilization	$10	14%	$5,453	6%	$2,303	3%	$2,036	$9,792
Incremental friction/impact work	$0	10%	$0	7%	$0	1%	$0	$0
Incremental window replacement	$0	30%	$0	20%	$0	10%	$0	$0
Soil cover	$10	27%	$10,517	18%	$6,910	0%	$0	$17,427
Unit cleanup	$265	76%	$784,453	66%	$671,441	24%	$517,895	$1,973,789
Clearance	$120	76%	$355,224	66%	$304,049	24%	$234,518	$893,791
Hazard Evaluation Costs			$517,256		$463,751		$573,267	$1,554,274
Hazard Reduction Costs			$812,887		$685,262		$524,816	$2,022,964
Total Program Cost			$1,330,143		$1,149,013		$1,098,084	$3,577,239
Average Cost/Unit			$342		$299		$135	$225

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 3,895 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 3,839 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 8,143 Freq.	1960-1977 Benefit	Total Units: 15,877 Total Benefit
LBP stabilization	$223	$223	$223	30%	$260,576	12%	$102,732	6%	$99,874	$463,181
Unit dust - 5 years	$3,059	$3,059	$1,808	46%	$5,480,128	46%	$5,401,338	14%	$2,061,156	$12,942,622
Unit dust - 10 years	$4,684	$4,684	$2,768	30%	$5,472,949	20%	$3,596,175	10%	$2,253,982	$11,323,106
Soil	$2,301	$2,301	$2,301	27%	$2,419,847	18%	$1,590,037	0%	$0	$4,009,884
Total Program Health Benefits					$13,633,499		$10,690,281		$4,415,012	$28,738,793
Resident children ages 1&2					$10,416,117		$8,142,524		$3,379,878	$21,938,518
Other children					$3,217,382		$2,547,757		$1,035,135	$6,800,274
Total Program Benefits					$13,633,499		$10,690,281		$4,415,012	$28,738,793

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$12,303,357	$9,541,269	$3,316,929	$25,161,554
Net benefit (cost) per unit	$3,159	$2,485	$407	$1,585

Table J2m(b). Federally-Assisted Multifamily Rehabilitation: $5,000-$25,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 3,895		1940-1959 Units/Yr: 3,839		1960-1977 Units/Yr: 8,143		Total Units: 15,877
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$260	16%	$162,032	16%	$159,702	16%	$338,749	$660,483
Incremental interior LBP stabilization	$20	16%	$12,464	6%	$4,607	3%	$4,886	$21,957
Incremental exterior LBP stabilization	$10	14%	$5,453	6%	$2,303	3%	$2,036	$9,792
Incremental friction/impact work	$0	10%	$0	7%	$0	1%	$0	$0
Incremental window replacement	$0	30%	$0	20%	$0	10%	$0	$0
Soil cover	$10	27%	$10,517	18%	$6,910	0%	$0	$17,427
Unit cleanup	$265	76%	$784,453	66%	$671,441	24%	$517,895	$1,973,789
Clearance	$120	76%	$355,224	66%	$304,049	24%	$234,518	$893,791
Hazard Evaluation Costs			$517,256		$463,751		$573,267	$1,554,274
Hazard Reduction Costs			$812,887		$685,262		$524,816	$2,022,964
Total Program Cost			$1,330,143		$1,149,013		$1,098,084	$3,577,239
Average Cost/Unit			$342		$299		$135	$225

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 3,895		1940-1959 Units/Yr: 3,839		1960-1977 Units/Yr: 8,143		Total Units: 15,877
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
LBP stabilization	$64	$64	$64	30%	$74,784	12%	$29,484	6%	$28,663	$132,931
Unit dust - 5 years	$703	$703	$416	46%	$1,260,429	46%	$1,242,308	14%	$474,248	$2,976,985
Unit dust - 10 years	$1,077	$1,077	$637	30%	$1,258,778	20%	$827,120	10%	$518,709	$2,604,608
Soil	$529	$529	$529	27%	$556,323	18%	$365,550	0%	$0	$921,872
Total Program Health Benefits					$3,150,315		$2,464,461		$1,021,621	$6,636,396
Resident children ages 1&2					$2,406,810		$1,877,110		$782,063	$5,065,984
Other children					$743,504		$587,351		$239,557	$1,570,413
Total Program Benefits					$3,150,315		$2,464,461		$1,021,621	$6,636,396

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$1,820,172	$1,315,448	($76,463)	$3,059,158
Net benefit (cost) per unit	$467	$343	($9)	$193

Tables J3s(a), J3s((b), J3m(a), and L3m(b). Federally-Assisted Rehabilitation: Over $25,000 per Unit

For rehab units with federal assistance of more than $25,000, Subpart L requires a risk assessment, abatement of hazards, unit cleanup and clearance, and soil cover for contaminated bare soil.

Assumptions Reflected in Cost-Benefit Analysis

Risk assessments or hazard screens are performed for all single family units, and the cost-benefit model assumes that sampling applies to multifamily buildings. The analysis assumes that the percentage of units that perform hazard screens is approximately equal to the percentage of units that are expected to find no sill or floor dust hazards. The AHS data presented in Chapter 2 indicate that rehab units reporting over $25,000 may not have higher LBP hazard frequencies than other assisted housing units, so the frequency of deteriorated LBP, dust and soil hazards are the same as in other assisted units. Incremental costs are used for interior and exterior abatement because the AHS data also show that about 45 percent of these assisted rehab units are replacing windows and/or doors, and almost 15 percent are adding or replacing exterior siding. The frequency of exterior abatement is assumed to equal to frequency of deteriorated exterior LBP, and the frequencies of soil cover costs and benefits are the frequencies for bare soil above the HUD standard. The frequencies of interior abatement, cleanup, clearance, and 10-year dust benefits all reflect the sill and/or floor dust above the final rule standards. The frequency of paint hazard abatement health benefits reflects the frequency of interior plus exterior deteriorated LBP. The only difference between the single and multi-family units is the use of applicable unit costs and the sampling provisions for multifamily risk assessment. AHS data on assisted rehab units, however, do not show any multifamily rehab units affected by the requirements for units receiving more than $25,000 of federal assistance.

Results of Cost-Benefit Analysis

Table J3s(a), J3s(b), J3m(a), and J3m(b) show that these single family rehab units realize net benefits for all ages of housing at a three discount rate for lifetime earnings, but incur net costs at a seven percent discount rate. Multifamily units receiving more than $25,000 of federal assistance realize net benefits for all units at a three percent discount rate, and for pre-1960 units at a seven percent discount rate, but incur net costs for post-1960 units at a seven percent discount rate.

Table J3s. Federally-Assisted Single Family Rehabilitation: Over $25,000 per Unit

Activity	Unit Cost	Pre-1940 Units/Yr: 1,007 Freq.	Cost	1940-1959 Units/Yr: 3,160 Freq.	Cost	1960-1977 Units/Yr: 1,650 Freq.	Cost	Total Units: 5,817 Total Cost
Risk assessment	$375	80%	$302,100	70%	$829,500	30%	$185,625	$1,317,225
Hazard Screen	$150	20%	$30,210	30%	$142,200	70%	$173,250	$345,660
Incremental exterior abatement	$1,000	28%	$281,960	12%	$379,200	5%	$82,500	$743,660
Soil cover	$200	27%	$54,378	18%	$113,760	0%	$0	$168,138
Incremental interior abatement	$600	30%	$181,260	20%	$379,200	10%	$99,000	$659,460
Unit cleanup	$350	76%	$267,862	66%	$729,960	24%	$138,600	$1,136,422
Clearance	$150	76%	$114,798	66%	$312,840	24%	$59,400	$487,038
Hazard Evaluation Costs			$447,108		$1,284,540		$418,275	$2,149,923
Hazard Reduction Costs			$785,460		$1,602,120		$320,100	$2,707,680
Total Program Cost			$1,232,568		$2,886,660		$738,375	$4,857,603
Average Cost/Unit			$1,224		$914		$448	$835

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 1,007 Freq.	Benefit	1940-1959 Units/Yr: 3,160 Freq.	Benefit	1960-1977 Units/Yr: 1,650 Freq.	Benefit	Total Units: 5,817 Total Benefit
Paint hazard abatement	$485	$485	$485	44%	$214,894	18%	$275,868	8%	$64,020	$554,782
Unit dust - 10 years	$4,684	$4,684	$2,768	76%	$3,584,559	66%	$9,768,406	24%	$1,096,128	$14,449,093
Soil	$2,301	$2,301	$2,301	27%	$625,619	18%	$1,308,809	0%	$0	$1,934,428
Total Program Health Benefits					$4,425,072		$11,353,083		$1,160,148	$16,938,303
Resident children ages 1&2					$3,443,342		$8,834,746		$906,196	$13,184,283
Other children					$981,730		$2,518,337		$253,952	$3,754,020
Total Program Benefits					$4,425,072		$11,353,083		$1,160,148	$16,938,303

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$3,192,504	$8,466,423	$421,773	$12,080,700
Net benefit (cost) per unit	$3,170	$2,679	$256	$2,512

Table J3s(b). Federally-Assisted Single Family Rehabilitation: Over $25,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,007		1940-1959 Units/Yr: 3,160		1960-1977 Units/Yr: 1,650		Total Units: 5,817
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$375	80%	$302,100	70%	$829,500	30%	$185,625	$1,317,225
Hazard Screen	$150	20%	$30,210	30%	$142,200	70%	$173,250	$345,660
Incremental exterior abatement	$1,000	28%	$281,960	12%	$379,200	5%	$82,500	$743,660
Soil cover	$200	27%	$54,378	18%	$113,760	0%	$0	$168,138
Incremental interior abatement	$600	30%	$181,260	20%	$379,200	10%	$99,000	$659,460
Unit cleanup	$350	76%	$267,862	66%	$729,960	24%	$138,600	$1,136,422
Clearance	$150	76%	$114,798	66%	$312,840	24%	$59,400	$487,038
Hazard Evaluation Costs			$447,108		$1,284,540		$418,275	$2,149,923
Hazard Reduction Costs			$785,460		$1,602,120		$320,100	$2,707,680
Total Program Cost			$1,232,568		$2,886,660		$738,375	$4,857,603
Average Cost/Unit			$1,224		$914		$448	$835

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 1,007		1940-1959 Units/Yr: 3,160		1960-1977 Units/Yr: 1,650		Total Units: 5,817
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint hazard abatement	$139	$139	$139	44%	$61,588	18%	$79,063	8%	$18,348	$158,999
Unit dust - 10 years	$1,077	$1,077	$637	76%	$824,449	66%	$2,246,733	24%	$252,252	$3,323,434
Soil	$529	$529	$529	27%	$143,830	18%	$300,895	0%	$0	$444,725
Total Program Health Benefits					$1,029,867		$2,626,692		$270,600	$3,927,158
Resident children ages 1&2					$801,651		$2,044,383		$211,435	$3,057,469
Other children					$228,215		$582,309		$59,165	$869,689
Total Program Benefits					$1,029,867		$2,626,692		$270,600	$3,927,158

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	($202,701)	($259,968)	($467,775)	($930,445)
Net benefit (cost) per unit	($201)	($82)	($284)	($193)

Table J3m(a). Federally-Assisted Multifamily Rehabilitation: Over $25,000 per Unit (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 2,210 Freq.	Cost	1940-1959 Units/Yr: 2,178 Freq.	Cost	1960-1977 Units/Yr: 2,918 Freq.	Cost	Total Units: 7,306 Total Cost
Risk assessment	$260	16%	$91,936	16%	$90,605	16%	$121,389	$303,930
Incremental exterior abatement	$50	14%	$15,470	6%	$6,534	3%	$3,648	$25,652
Soil cover	$10	27%	$5,967	18%	$3,920	0%	$0	$9,887
Incremental interior abatement	$400	30%	$265,200	20%	$174,240	10%	$116,720	$556,160
Unit cleanup	$265	76%	$445,094	66%	$380,932	24%	$185,585	$1,011,611
Clearance	$120	76%	$201,552	66%	$172,498	24%	$84,038	$458,088
Hazard Evaluation Costs			$293,488		$263,102		$205,427	$762,018
Hazard Reduction Costs			$731,731		$565,627		$305,952	$1,603,310
Total Program Cost			$1,025,219		$828,729		$511,380	$2,365,328
Average Cost/Unit			$464		$381		$175	$324

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 2,210 Freq.	Benefit	1940-1959 Units/Yr: 2,178 Freq.	Benefit	1960-1977 Units/Yr: 2,918 Freq.	Benefit	Total Units: 7,306 Total Benefit
Paint hazard abatement	$485	$485	$485	30%	$321,555	12%	$126,760	6%	$77,838	$526,152
Unit dust - 10 years	$4,684	$4,684	$2,768	76%	$7,866,808	66%	$6,732,781	24%	$1,938,486	$16,538,075
Soil	$2,301	$2,301	$2,301	27%	$1,373,007	18%	$902,084	0%	$0	$2,275,091
Total Program Health Benefits					$9,561,370		$7,761,625		$2,016,323	$19,339,318
Resident children ages 1&2					$7,436,839		$6,038,561		$1,574,289	$15,049,689
Other children					$2,124,530		$1,723,064		$442,034	$4,289,629
Total Program Benefits					$9,561,370		$7,761,625		$2,016,323	$19,339,318

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$8,536,151	$6,932,896	$1,504,944	$16,973,991
Net benefit (cost) per unit	$3,863	$3,183	$516	$2,323

Table J3m(b). Federally-Assisted Multifamily Rehabilitation: Over $25,000 per Unit (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 2,210 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 2,178 Freq.	1940-1959 Cost	1960-1977 Units/Yr: 2,918 Freq.	1960-1977 Cost	Total Units: 7,306 Total Cost
Risk assessment	$260	16%	$91,936	16%	$90,605	16%	$121,389	$303,930
Incremental exterior abatement	$50	14%	$15,470	6%	$6,534	3%	$3,648	$25,652
Soil cover	$10	27%	$5,967	18%	$3,920	0%	$0	$9,887
Incremental interior abatement	$400	30%	$265,200	20%	$174,240	10%	$116,720	$556,160
Unit cleanup	$265	76%	$445,094	66%	$380,932	24%	$185,585	$1,011,611
Clearance	$120	76%	$201,552	66%	$172,498	24%	$84,038	$458,088
Hazard Evaluation Costs			$293,488		$263,102		$205,427	$762,018
Hazard Reduction Costs			$731,731		$565,627		$305,952	$1,603,310
Total Program Cost			$1,025,219		$828,729		$511,380	$2,365,328
Average Cost/Unit			$464		$381		$175	$324

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 2,210 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 2,178 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 2,918 Freq.	1960-1977 Benefit	Total Units: 7,306 Total Benefit
Paint hazard abatement	$139	$139	$139	30%	$92,157	12%	$36,329	6%	$22,308	$150,794
Unit dust - 10 years	$1,077	$1,077	$637	76%	$1,809,366	66%	$1,548,540	24%	$446,104	$3,804,009
Soil	$529	$529	$529	27%	$315,654	18%	$207,389	0%	$0	$523,043
Total Program Health Benefits					$2,217,177		$1,792,258		$468,412	$4,477,847
Resident children ages 1&2					$1,724,928		$1,394,540		$365,807	$3,485,276
Other children					$492,249		$397,718		$102,604	$992,571
Total Program Benefits					$2,217,177		$1,792,258		$468,412	$4,477,847

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$1,191,958	$963,529	($42,968)	$2,112,520
Net benefit (cost) per unit	$539	$442	($15)	$289

Tables Ks(a), Ks(b), Km(a) , and Km(b). Acquisition, Leasing, Operating, and Support

For Acquisition, Leasing, Operating, and Support units, Subpart K requires a visual assessment for deteriorated paint, repair of deteriorated paint using safe practices for LBP (e.g., wet scraping), and unit cleanup and clearance testing in all units where there is LBP repair. Safe practices and area cleanup costs can be avoided in units where deteriorated paint is tested for lead content and is not LBP.

Assumptions Reflected in Cost-Benefit Analysis

The analysis assumes that paint testing is done for all units with deteriorated paint. The frequencies for interior paint stabilization, cleanup, and clearance, the 5-year dust benefit frequency, and the market value of interior paint stabilization are equal to the frequency of deteriorated interior LBP. The frequency of exterior paint stabilization and its associated market value equals the frequency of deteriorated exterior LBP. The health benefit frequency for LBP repair is the frequency of interior plus exterior deteriorated LBP.

Results of Cost-Benefit Analysis

Tables Ks(a), Ks(b), Km(a), and Km(b) show that all single and multifamily units realize net benefits with a three percent discount rate for lifetime earnings, but incur net costs with a seven percent discount rate.

Table Ks(a). Single Family Acquisition, Leasing, Operating, and Support (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,190		1940-1959 Units/Yr: 1,585		1960-1977 Units/Yr. 2,318		Total Units: 5,093
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Paint testing	$150	55%	$98,175	36%	$85,590	18%	$62,586	$246,351
Interior LBP stabilization	$500	16%	$95,200	6%	$47,550	3%	$34,770	$177,520
Exterior LBP stabilization	$1,000	28%	$333,200	12%	$190,200	5%	$115,900	$639,300
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$66,640	6%	$33,285	3%	$24,339	$124,264
Clearance	$150	16%	$28,560	6%	$14,265	3%	$10,431	$53,256
Hazard Evaluation Costs			$126,735		$99,855		$73,017	$299,607
Hazard Reduction Costs			$495,040		$271,035		$175,009	$941,084
Total Program Cost			$621,775		$370,890		$248,026	$1,240,691
Average Cost/Unit			$523		$234		$107	$244

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 1,190		1940-1959 Units/Yr: 1,585		1960-1977 Units/Yr: 2,318		Total Units: 5,093
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint stabilization	$175	$175	$175	44%	$91,630	18%	$49,928	8%	$32,452	$174,010
Unit dust - 5 years	$2,402	$2,402	$1,420	16%	$457,418	6%	$228,469	3%	$98,747	$784,634
Total Program Health Benefits					$549,048		$278,396		$131,199	$958,643
Resident children ages 1&2					$412,702		$209,297		$98,724	$720,723
Other children					$136,346		$69,100		$32,475	$237,921
Interior LBP stabilization market value	$480	$480	$480	16%	$91,392	6%	$45,648	3%	$33,379	$170,419
Exterior LBP stabilization market value	$900	$900	$900	28%	$299,880	12%	$171,180	5%	$104,310	$575,370
Total Program Benefits					$940,320		$495,224		$268,888	$1,704,432

Cost-Effectiveness	Pre-1940	1940-1959	1960-1977	Total
Net program benefit (cost)	$318,545	$124,334	$20,862	$463,741
Net benefit (cost) per unit	$268	$78	$9	$91

Table Ks(b). Single Family Acquisition, Leasing, Operating, and Support (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,190 Freq.	Cost	1940-1959 Units/Yr: 1,585 Freq.	Cost	1960-1977 Units/Yr. 2,318 Freq.	Cost	Total Units: 5,093 Total Cost
Paint testing	$150	55%	$98,175	36%	$85,590	18%	$62,586	$246,351
Interior LBP stabilization	$500	16%	$95,200	6%	$47,550	3%	$34,770	$177,520
Exterior LBP stabilization	$1,000	28%	$333,200	12%	$190,200	5%	$115,900	$639,300
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$66,640	6%	$33,285	3%	$24,339	$124,264
Clearance	$150	16%	$28,560	6%	$14,265	3%	$10,431	$53,256
Hazard Evaluation Costs			$126,735		$99,855		$73,017	$299,607
Hazard Reduction Costs			$495,040		$271,035		$175,009	$941,084
Total Program Cost			$621,775		$370,890		$248,026	$1,240,691
Average Cost/Unit			$523		$234		$107	$244

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 1,190 Freq.	Benefit	1940-1959 Units/Yr: 1,585 Freq.	Benefit	1960-1977 Units/Yr. 2,318 Freq.	Benefit	Total Units: 5,093 Total Benefit
Paint stabilization	$50	$50	$50	44%	$26,180	18%	$14,265	8%	$9,272	$49,717
Unit dust - 5 years	$553	$553	$327	16%	$105,206	6%	$52,548	3%	$22,740	$180,494
Total Program Health Benefits					$131,386		$66,813		$32,012	$230,211
Resident children ages 1&2					$98,801		$50,252		$24,101	$173,155
Other children					$32,585		$16,561		$7,910	$57,055
Interior LBP stabilization market value	$480	$480	$480	16%	$91,392	6%	$45,648	3%	$33,379	$170,419
Exterior LBP stabilization market value	$900	$900	$900	28%	$299,880	12%	$171,180	5%	$104,310	$575,370
Total Program Benefits					$522,658		$283,641		$169,701	$976,000

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	($99,117)	($87,249)	($78,325)	($264,691)
Net benefit (cost) per unit	($83)	($55)	($34)	($52)

Table Km(a). Multifamily Acquisition, Leasing, Operating, and Support (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,998 Freq.	Cost	1940-1959 Units/Yr: 1,514 Freq.	Cost	1960-1977 Units/Yr. 2,591 Freq.	Cost	Total Units: 6,103 Total Cost
Paint testing	$120	55%	$131,868	36%	$65,405	18%	$55,966	$253,238
Interior LBP stabilization	$500	16%	$159,840	6%	$45,420	3%	$38,865	$244,125
Exterior LBP stabilization	$100	14%	$27,972	6%	$9,084	3%	$6,478	$43,534
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$265	16%	$84,715	6%	$24,073	3%	$20,598	$129,386
Clearance	$120	16%	$38,362	6%	$10,901	3%	$9,328	$58,590
Hazard Evaluation Costs			$170,230		$76,306		$65,293	$311,828
Hazard Reduction Costs			$272,527		$78,577		$65,941	$417,045
Total Program Cost			$442,757		$154,882		$131,234	$728,873
Average Cost/Unit			$222		$102		$51	$119

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 1,998 Freq.	Benefit	1940-1959 Units/Yr: 1,514 Freq.	Benefit	1960-1977 Units/Yr: 2,591 Freq.	Benefit	Total Units: 6,103 Total Benefit
Paint stabilization	$175	$175	$175	30%	$104,895	12%	$31,794	6%	$24,938	$161,627
Unit dust - 5 years	$2,402	$2,402	$1,420	16%	$768,001	6%	$218,235	3%	$110,377	$1,096,612
Total Program Health Benefits					$872,896		$250,029		$135,315	$1,258,240
Resident children ages 1&2					$655,721		$187,839		$101,736	$945,296
Other children					$217,175		$62,189		$33,579	$312,944
Interior paint stabilization market value	$480	$480	$480	16%	$153,446	6%	$43,603	3%	$37,310	$234,360
Exterior paint stabilization market value	$90	$90	$90	14%	$25,175	6%	$8,176	3%	$5,830	$39,180
Total Program Benefits					$1,051,517		$301,807		$178,455	$1,531,780

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$608,761	$146,925	$47,221	$802,907
Net benefit (cost) per unit	$305	$97	$18	$132

Table Km(b). Multifamily Acquisition, Leasing, Operating, and Support (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 1,998 Freq.	Cost	1940-1959 Units/Yr: 1,514 Freq.	Cost	1960-1977 Units/Yr. 2,591 Freq.	Cost	Total Units: 6,103 Total Cost
Paint testing	$120	55%	$131,868	36%	$65,405	18%	$55,966	$253,238
Interior LBP stabilization	$500	16%	$159,840	6%	$45,420	3%	$38,865	$244,125
Exterior LBP stabilization	$100	14%	$27,972	6%	$9,084	3%	$6,478	$43,534
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$265	16%	$84,715	6%	$24,073	3%	$20,598	$129,386
Clearance	$120	16%	$38,362	6%	$10,901	3%	$9,328	$58,590
Hazard Evaluation Costs			$170,230		$76,306		$65,293	$311,828
Hazard Reduction Costs			$272,527		$78,577		$65,941	$417,045
Total Program Cost			$442,757		$154,882		$131,234	$728,873
Average Cost/Unit			$222		$102		$51	$119

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 1,998 Freq.	Benefit	1940-1959 Units/Yr: 1,514 Freq.	Benefit	1960-1977 Units/Yr: 2,591 Freq.	Benefit	Total Units: 6,103 Total Benefit
Paint stabilization	$50	$50	$50	30%	$29,970	12%	$9,084	6%	$7,125	$46,179
Unit dust - 5 years	$553	$553	$327	16%	$176,640	6%	$50,194	3%	$25,418	$252,252
Total Program Health Benefits					$206,610		$59,278		$32,543	$298,431
Resident children ages 1&2					$155,257		$44,549		$24,478	$224,285
Other children					$51,353		$14,729		$8,064	$74,146
Interior paint stabilization market value	$480	$480	$480	16%	$153,446	6%	$43,603	3%	$37,310	$234,360
Exterior paint stabilization market value	$90	$90	$90	14%	$25,175	6%	$8,176	3%	$5,830	$39,180
Total Program Benefits					$385,231		$111,057		$75,683	$571,971

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	($57,525)	($43,825)	($55,551)	($156,902)
Net benefit (cost) per unit	($29)	($29)	($21)	($26)

Tables Ls(a), Ls(b), Lm(a), and Lm(b). Public Housing

Under Subpart L, Public Housing units must perform a risk assessment, stabilization of deteriorated LBP using safe practices (e.g., wet scraping), window work (or replacement) and other friction and impact work as needed, soil cover for contaminated bare soil, unit cleanup, clearance, and reevaluation. Safe practices and area cleanup are required only for LBP repair because paint chip testing during the risk assessment will determine the lead content of deteriorated paint. Units that have performed paint inspections and found no LBP are excluded.

Assumptions Reflected in Cost-Benefit Analysis

The Risk Assessment and reevaluation frequencies reflect the effect of sampling for similar dwellings. Interior and exterior LBP repair and associated paint stabilization market values reflect the frequencies of deteriorated interior and exterior LBP. The health benefit of LBP repair reflects the sum of interior and exterior deteriorated LBP. The frequency of window work, window replacement, and other friction and impact work reflect the assumptions discussed in Chapter 4. Soil cover costs and benefits reflect the frequency of soil lead above the final rule standard. Cleanup and clearance activity reflects the frequencies for sill and/or floor dust above the final rule standard. Window replacement market value and 10-year dust benefits reflect the frequency of window replacement, and 5-year dust benefits reflect the frequency of sill and/or floor dust above the standard minus the frequency of 10-year benefits for window replacement. The only key difference between single and multifamily public housing is the applicable unit cost estimates.

Results of Cost-Benefit Analysis

Tables Lm(a), Lm(b), Ls(a), and Ls(b) show net benefits for all pre-1960 units with either a three or seven percent discount rate for lifetime earnings. Post-59 units show net benefits at a three percent discount rate, but incur net costs at a seven percent discount rate.

Table Lm(a). Multifamily Public Housing (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 13,118		1940-1959 Units/Yr: 52,480		1960-1977 Units/Yr: 65,599		Total Units: 131,197
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$260	16%	$545,727	16%	$2,183,179	16%	$2,728,906	$5,457,811
Interior LBP stabilization	$500	16%	$1,049,474	6%	$1,574,408	3%	$983,980	$3,607,863
Exterior LBP stabilization	$100	14%	$183,658	6%	$314,882	3%	$163,997	$662,536
Window work	$200	27%	$708,395	19%	$1,994,250	10%	$1,311,974	$4,014,619
Window replacement	$3,000	3%	$1,180,659	1%	$1,574,408	0%	$0	$2,755,067
Other friction/impact work	$200	10%	$262,369	7%	$734,724	1%	$131,197	$1,128,290
Soil cover	$10	27%	$35,420	18%	$94,464	0%	$0	$129,884
Unit cleanup	$265	76%	$2,642,052	66%	$9,178,798	24%	$4,172,077	$15,992,926
Clearance	$120	76%	$1,196,401	66%	$4,156,437	24%	$1,889,242	$7,242,080
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	15%	$427,005	15%	$1,708,233	15%	$2,135,237	$4,270,475
Hazard Evaluation Costs			$2,169,132		$8,047,848		$6,753,385	$16,970,366
Hazard Reduction Costs			$6,062,027		$15,465,933		$6,763,225	$28,291,185
Total Program Cost			$8,231,159		$23,513,781		$13,516,611	$45,261,551
Average Cost/Unit			$627		$448		$206	$345

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 13,118		1940-1959 Units/Yr: 52,480		1960-1977 Units/Yr: 65,599		Total Units: 131,197
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint stabilization	$358	$358	$358	30%	$1,408,919	12%	$2,254,552	6%	$1,291,638	$4,955,110
Unit dust - 5 years	$4,922	$4,922	$2,909	73%	$47,131,441	65%	$167,886,325	24%	$45,798,383	$260,816,149
Unit dust - 10 years	$7,537	$7,537	$4,454	3%	$2,966,036	1%	$3,955,207	0%	$0	$6,921,243
Soil	$3,702	$3,702	$3,702	27%	$13,112,396	18%	$34,970,747	0%	$0	$48,083,143
Total Program Health Benefits					$64,618,792		$209,066,832		$47,090,021	$320,775,645
Resident children ages 1&2					$48,698,288		$157,291,033		$35,330,432	$241,319,754
Other children					$15,920,504		$51,775,799		$11,759,589	$79,455,891
Window replacement market value	$2,700	$2,700	$2,700	3%	$1,062,593	1%	$1,416,967	0%	$0	$2,479,560
Interior LBP stabilization market value	$480	$480	$480	16%	$1,007,495	6%	$1,511,432	3%	$944,621	$3,463,548
Exterior LBP stabilization market value	$90	$90	$90	14%	$165,292	6%	$283,393	3%	$147,597	$596,283
Total Program Benefits					$66,854,173		$212,278,624		$48,182,239	$327,315,036

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$58,623,013	$188,764,843	$34,665,629	$282,053,485
Net benefit (cost) per unit	$4,469	$3,597	$528	$2,150

Table Lm(b). Multifamily Public Housing (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 13,118		1940-1959 Units/Yr: 52,480		1960-1977 Units/Yr: 65,599		Total Units: 131,197
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$260	16%	$545,727	16%	$2,183,179	16%	$2,728,906	$5,457,811
Interior LBP stabilization	$500	16%	$1,049,474	6%	$1,574,408	3%	$983,980	$3,607,863
Exterior LBP stabilization	$100	14%	$183,658	6%	$314,882	3%	$163,997	$662,536
Window work	$200	27%	$708,395	19%	$1,994,250	10%	$1,311,974	$4,014,619
Window replacement	$3,000	3%	$1,180,659	1%	$1,574,408	0%	$0	$2,755,067
Other friction/impact work	$200	10%	$262,369	7%	$734,724	1%	$131,197	$1,128,290
Soil cover	$10	27%	$35,420	18%	$94,464	0%	$0	$129,884
Unit cleanup	$265	76%	$2,642,052	66%	$9,178,798	24%	$4,172,077	$15,992,926
Clearance	$120	76%	$1,196,401	66%	$4,156,437	24%	$1,889,242	$7,242,080
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$217	15%	$427,005	15%	$1,708,233	15%	$2,135,237	$4,270,475
Hazard Evaluation Costs			$2,169,132		$8,047,848		$6,753,385	$16,970,366
Hazard Reduction Costs			$6,062,027		$15,465,933		$6,763,225	$28,291,185
Total Program Cost			$8,231,159		$23,513,781		$13,516,611	$45,261,551
Average Cost/Unit			$627		$448		$206	$345

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 13,118		1940-1959 Units/Yr: 52,480		1960-1977 Units/Yr: 65,599		Total Units: 131,197
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint stabilization	$102	$102	$102	30%	$401,424	12%	$642,358	6%	$368,009	$1,411,791
Unit dust - 5 years	$1,132	$1,132	$669	73%	$10,840,231	65%	$38,613,855	24%	$10,532,526	$59,986,612
Unit dust - 10 years	$1,733	$1,733	$1,024	3%	$682,188	1%	$909,698	0%	$0	$1,591,886
Soil	$851	$851	$851	27%	$3,014,222	18%	$8,038,926	0%	$0	$11,053,148
Total Program Health Benefits					$14,938,065		$48,204,837		$10,900,535	$74,043,437
Resident children ages 1&2					$11,258,171		$36,267,732		$8,179,081	$55,704,984
Other children					$3,679,894		$11,937,106		$2,721,454	$18,338,453
Window replacement market value	$2,700	$2,700	$2,700	3%	$1,062,593	1%	$1,416,967	0%	$0	$2,479,560
Interior LBP stabilization market value	$480	$480	$480	16%	$1,007,495	6%	$1,511,432	3%	$944,621	$3,463,548
Exterior LBP stabilization market value	$90	$90	$90	14%	$165,292	6%	$283,393	3%	$147,597	$596,283
Total Program Benefits					$17,173,446		$51,416,629		$11,992,753	$80,582,828

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$8,942,287	$27,902,848	($1,523,858)	$35,321,277
Net benefit (cost) per unit	$682	$532	($23)	$269

Table Ls(a). Single Family Public Housing (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 3,283 Freq.	Cost	1940-1959 Units/Yr: 13,118 Freq.	Cost	1960-1977 Units/Yr: 16,401 Freq.	Cost	Total Units: 32,803 Total Cost
Risk assessment	$375	16%	$196,973	16%	$787,106	16%	$984,078	$1,968,157
Interior paint stabilization	$500	16%	$262,630	6%	$393,553	3%	$246,020	$902,203
Exterior paint stabilization	$1,000	28%	$919,206	12%	$1,574,212	5%	$820,065	$3,313,483
Window work	$300	27%	$265,913	19%	$747,751	10%	$492,039	$1,505,703
Window replacement	$5,000	3%	$492,432	1%	$655,922	0%	$0	$1,148,353
Other friction/impact work	$300	10%	$98,486	7%	$275,487	1%	$49,204	$423,177
Soil cover	$200	27%	$177,275	18%	$472,263	0%	$0	$649,539
Unit cleanup	$350	76%	$873,245	66%	$3,030,357	24%	$1,377,710	$5,281,313
Clearance	$150	76%	$374,248	66%	$1,298,725	24%	$590,447	$2,263,420
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$271	30%	$266,898	30%	$1,066,528	30%	$1,333,426	$2,666,853
Hazard Evaluation Costs			$838,119		$3,152,359		$2,907,952	$6,898,429
Hazard Reduction Costs			$3,089,188		$7,149,545		$2,985,038	$13,223,770
Total Program Cost			$3,927,306		$10,301,903		$5,892,990	$20,122,200
Average Cost/Unit			$1,196		$785		$359	$613

Hazard Removal	Unit Benefit Pre-1940	1940-1959	1960-1977	Pre-1940 Units/Yr: 3,283 Freq.	Benefit	1940-1959 Units/Yr: 13,118 Freq.	Benefit	1960-1977 Units/Yr: 16,401 Freq.	Benefit	Total Units: 32,803 Total Benefit
Paint stabilization	$358	$358	$358	44%	$517,119	18%	$845,352	8%	$469,733	$1,832,204
Unit dust - 5 years	$4,922	$4,922	$2,909	73%	$11,794,608	65%	$41,966,351	24%	$11,450,737	$65,211,696
Unit dust - 10 years	$7,537	$7,537	$4,454	3%	$742,248	1%	$988,679	0%	$0	$1,730,927
Soil	$3,702	$3,702	$3,702	27%	$3,281,367	18%	$8,741,597	0%	$0	$12,022,965
Total Program Health Benefits					$16,335,342		$52,541,979		$11,920,471	$80,797,792
Resident children ages 1&2					$12,311,759		$39,532,014		$8,945,050	$60,788,823
Other children					$4,023,583		$13,009,965		$2,975,420	$20,008,968
Window replacement market value	$4,500	$4,500	$4,500	3%	$443,188	1%	$590,329	0%	$0	$1,033,518
Interior paint stabilization market value	$480	$480	$480	16%	$252,125	6%	$377,811	3%	$236,179	$866,115
Exterior paint stabilization market value	$900	$900	$900	28%	$827,285	12%	$1,416,790	5%	$738,059	$2,982,134
Total Program Benefits					$17,857,941		$54,926,910		$12,894,708	$85,679,559

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$13,930,634	$44,625,006	$7,001,718	$65,557,359
Net benefit (cost) per unit	$4,243	$3,402	$427	$1,999

Table Ls(b). Single Family Public Housing (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 3,283		1940-1959 Units/Yr: 13,118		1960-1977 Units/Yr: 16,401		Total Units: 32,803
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Risk assessment	$375	16%	$196,973	16%	$787,106	16%	$984,078	$1,968,157
Interior paint stabilization	$500	16%	$262,630	6%	$393,553	3%	$246,020	$902,203
Exterior paint stabilization	$1,000	28%	$919,206	12%	$1,574,212	5%	$820,065	$3,313,483
Window work	$300	27%	$265,913	19%	$747,751	10%	$492,039	$1,505,703
Window replacement	$5,000	3%	$492,432	1%	$655,922	0%	$0	$1,148,353
Other friction/impact work	$300	10%	$98,486	7%	$275,487	1%	$49,204	$423,177
Soil cover	$200	27%	$177,275	18%	$472,263	0%	$0	$649,539
Unit cleanup	$350	76%	$873,245	66%	$3,030,357	24%	$1,377,710	$5,281,313
Clearance	$150	76%	$374,248	66%	$1,298,725	24%	$590,447	$2,263,420
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Reevaluation	$271	30%	$266,898	30%	$1,066,528	30%	$1,333,426	$2,666,853
Hazard Evaluation Costs			$838,119		$3,152,359		$2,907,952	$6,898,429
Hazard Reduction Costs			$3,089,188		$7,149,545		$2,985,038	$13,223,770
Total Program Cost			$3,927,306		$10,301,903		$5,892,990	$20,122,200
Average Cost/Unit			$1,196		$785		$359	$613

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 3,283		1940-1959 Units/Yr: 13,118		1960-1977 Units/Yr: 16,401		Total Units: 32,803
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
Paint stabilization	$102	$102	$102	44%	$147,336	18%	$240,854	8%	$133,835	$522,025
Unit dust - 5 years	$1,132	$1,132	$669	73%	$2,712,760	65%	$9,652,261	24%	$2,633,394	$14,998,415
Unit dust - 10 years	$1,733	$1,733	$1,024	3%	$170,717	1%	$227,396	0%	$0	$398,113
Soil	$851	$851	$851	27%	$754,307	18%	$2,009,481	0%	$0	$2,763,788
Total Program Health Benefits					$3,785,119		$12,129,992		$2,767,229	$18,682,340
Resident children ages 1&2					$2,852,977		$9,126,820		$2,076,760	$14,056,557
Other children					$932,142		$3,003,173		$690,469	$4,625,784
Window replacement market value	$4,500	$4,500	$4,500	3%	$443,188	1%	$590,329	0%	$0	$1,033,518
Interior paint stabilization market value	$480	$480	$480	16%	$252,125	6%	$377,811	3%	$236,179	$866,115
Exterior paint stabilization market value	$900	$900	$900	28%	$827,285	12%	$1,416,790	5%	$738,059	$2,982,134
Total Program Benefits					$5,307,718		$14,514,923		$3,741,466	$23,564,107

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$1,380,411	$4,213,020	($2,151,524)	$3,441,908
Net benefit (cost) per unit	$420	$321	($131)	$105

Tables Ms(a), Ms(b), Mm(a), and Mm(b). Tenant-Based Rental Assistance

Under Subpart M, Tenant-Based Rental Assistance units must perform a visual assessment for deteriorated paint, repair of deteriorated paint using safe practices for LBP (e.g., wet scraping), and unit cleanup and clearance testing in all units where there is LBP repair. Safe practices and area cleanup costs can be avoided in units where deteriorated paint is tested for lead content and is not LBP. This Subpart only applies to units with children under the age of six.

Assumptions Reflected in Cost-Benefit Analysis

The analysis assumes that paint testing is done in all units with deteriorated paint. The frequencies for interior paint stabilization, cleanup, and clearance, the 5-year dust benefit frequency, and the market value of interior paint stabilization are equal to the frequency of deteriorated interior LBP. The frequency of exterior paint stabilization and its associated market value equals the frequency of deteriorated exterior LBP. The health benefit frequency for LBP repair is the frequency of interior plus exterior deteriorated LBP.

Results of Cost-Benefit Analysis

Tables Ms(a), Ms(b), Mm(a), and Mm(b) show substantial net benefits for single and multifamily units at either a three or seven percent discount rate for lifetime earnings. The high net benefits under this Subpart result from the higher unit benefits associated with targeting only units with children under six years of age.

Table Ms(a). Single Family Tenant-Based Rental Assistance (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 31,460		1940-1959 Units/Yr: 38,840		1960-1977 Units/Yr. 64,200		Total Units: 134,500
		Freq.	Cost	Freq.	Cost	Freq.	Cost	Total Cost
Paint testing	$150	55%	$2,595,450	36%	$2,097,360	18%	$1,733,400	$6,426,210
Interior LBP stabilization	$500	16%	$2,516,800	6%	$1,165,200	3%	$963,000	$4,645,000
Exterior LBP stabilization	$1,000	28%	$8,808,800	12%	$4,660,800	5%	$3,210,000	$16,679,600
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$1,761,760	6%	$815,640	3%	$674,100	$3,251,500
Clearance	$150	16%	$755,040	6%	$349,560	3%	$288,900	$1,393,500
Hazard Evaluation Costs			$3,350,490		$2,446,920		$2,022,300	$7,819,710
Hazard Reduction Costs			$13,087,360		$6,641,640		$4,847,100	$24,576,100
Total Program Cost			$16,437,850		$9,088,560		$6,869,400	$32,395,810
Average Cost/Unit			$523		$234		$107	$241

Hazard Removal	Unit Benefit			Pre-1940 Units/Yr: 31,460		1940-1959 Units/Yr: 38,840		1960-1977 Units/Yr: 64,200		Total Units: 134,500
	Pre-1940	1940-1959	1960-1977	Freq.	Benefit	Freq.	Benefit	Freq.	Benefit	Total Benefit
LBP stabilization	$897	$897	$897	44%	$12,416,633	18%	$6,271,106	8%	$4,606,992	$23,294,731
Unit dust - 5 year	$12,323	$12,323	$7,283	16%	$62,031,340	6%	$28,718,578	3%	$14,027,058	$104,776,976
Total Program Health Benefits					$74,447,973		$34,989,684		$18,634,050	$128,071,707
Resident children ages 1&2					$55,960,146		$26,304,974		$14,021,607	$96,286,728
Other children					$18,487,827		$8,684,710		$4,612,443	$31,784,979
Interior LBP stabilization market value	$480	$480	$480	16%	$2,416,128	6%	$1,118,592	3%	$924,480	$4,459,200
Exterior LBP stabilization market value	$900	$900	$900	28%	$7,927,920	12%	$4,194,720	5%	$2,889,000	$15,011,640
Total Program Benefits					$84,792,021		$40,302,996		$22,447,530	$147,542,547

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$68,354,171	$31,214,436	$15,578,130	$115,146,737
Net benefit (cost) per unit	$2,173	$804	$243	$856

Table Ms(b). Single Family Tenant-Based Rental Assistance (seven percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 31,460 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 38,840 Freq.	1940-1959 Cost	1960-1977 Units/Yr. 64,200 Freq.	1960-1977 Cost	Total Units: 134,500 Total Cost
Paint testing	$150	55%	$2,595,450	36%	$2,097,360	18%	$1,733,400	$6,426,210
Interior LBP stabilization	$500	16%	$2,516,800	6%	$1,165,200	3%	$963,000	$4,645,000
Exterior LBP stabilization	$1,000	28%	$8,808,800	12%	$4,660,800	5%	$3,210,000	$16,679,600
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Unit cleanup	$350	16%	$1,761,760	6%	$815,640	3%	$674,100	$3,251,500
Clearance	$150	16%	$755,040	6%	$349,560	3%	$288,900	$1,393,500
Hazard Evaluation Costs			$3,350,490		$2,446,920		$2,022,300	$7,819,710
Hazard Reduction Costs			$13,087,360		$6,641,640		$4,847,100	$24,576,100
Total Program Cost			$16,437,850		$9,088,560		$6,869,400	$32,395,810
Average Cost/Unit			$523		$234		$107	$241

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 31,460 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 38,840 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 64,200 Freq.	1960-1977 Benefit	Total Units: 134,500 Total Benefit
LBP stabilization	$256	$256	$256	44%	$3,543,654	18%	$1,789,747	8%	$1,314,816	$6,648,218
Unit dust - 5 year	$2,834	$2,834	$1,675	16%	$14,267,208	6%	$6,605,273	3%	$3,226,050	$24,098,531
Total Program Health Benefits					$17,810,863		$8,395,020		$4,540,866	$30,746,749
Resident children ages 1&2					$13,393,583		$6,314,163		$3,418,798	$23,126,544
Other children					$4,417,279		$2,080,858		$1,122,068	$7,620,205
Interior LBP stabilization market value	$480	$480	$480	16%	$2,416,128	6%	$1,118,592	3%	$924,480	$4,459,200
Exterior LBP stabilization market value	$900	$900	$900	28%	$7,927,920	12%	$4,194,720	5%	$2,889,000	$15,011,640
Total Program Benefits					$28,154,911		$13,708,332		$8,354,346	$50,217,589

Cost-Effectiveness	**Pre-1940**	**1940-1959**	**1960-1977**	**Total**
Net program benefit (cost)	$11,717,061	$4,619,772	$1,484,946	$17,821,779
Net benefit (cost) per unit	$372	$119	$23	$133

Table Mm(a). Multifamily Tenant-Based Rental Assistance (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 48,430 Freq.	Pre-1940 Cost	1940-1959 Units/Yr: 59,790 Freq.	1940-1959 Cost	1960-1977 Units/Yr. 98,830 Freq.	1960-1977 Cost	Total Units: 207,050 Total Cost
Paint testing	$120	55%	$3,196,380	36%	$2,582,928	18%	$1,386,720	$7,166,028
Interior LBP stabilization	$500	16%	$3,874,400	6%	$1,793,700	3%	$963,000	$6,631,100
Exterior LBP stabilization	$100	6%	$290,580	6%	$358,740	3%	$160,500	$809,820
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Clearance	$120	16%	$929,856	6%	$430,488	3%	$231,120	$1,591,464
Unit cleanup	$265	16%	$2,053,432	6%	$950,661	3%	$510,390	$3,514,483
Hazard Evaluation Costs			$6,179,668		$3,964,077		$2,128,230	$12,271,975
Hazard Reduction Costs			$4,164,980		$2,152,440		$1,123,500	$7,440,920
Total Program Cost			$10,344,648		$6,116,517		$3,251,730	$19,712,895
Average Cost/Unit			$214		$102		$33	$95

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 48,430 Freq.	Pre-1940 Benefit	1940-1959 Units/Yr: 59,790 Freq.	1940-1959 Benefit	1960-1977 Units/Yr: 98,830 Freq.	1960-1977 Benefit	Total Units: 207,050 Total Benefit
Paint stabilization	$897	$897	$897	30%	$13,032,513	12%	$6,435,796	6%	$4,875,778	$24,344,087
Unit dust - 5 year	$12,323	$12,323	$7,283	16%	$95,491,983	6%	$44,209,160	3%	$21,593,367	$161,294,510
Total Program Health Benefits					$108,524,496		$50,644,956		$26,469,145	$185,638,597
Resident children ages 1&2					$81,523,697		$38,048,075		$19,900,616	$139,472,388
Other children					$27,000,799		$12,596,881		$6,568,528	$46,166,208
Interior LBP stabilization market value	$480	$480	$480	16%	$3,719,424	6%	$1,721,952	3%	$1,423,152	$6,864,528
Exterior LBP stabilization market value	$90	$90	$90	14%	$610,218	6%	$322,866	3%	$222,368	$1,155,452
Total Program Benefits					$112,854,138		$52,689,774		$28,114,664	$193,658,576

Cost-Effectiveness	**Pre-1940**		**1940-1959**		**1960-1977**	**Total**
Net program benefit (cost)	$102,509,490		$46,573,257		$24,862,934	$173,945,681
Net benefit (cost) per unit	$2,117		$779		$252	$840

Table Mm(b). Multifamily Tenant-Based Rental Assistance (three percent discount rate for lifetime earnings)

Activity	Unit Cost	Pre-1940 Units/Yr: 48,430 Freq.	Cost	1940-1959 Units/Yr: 59,790 Freq.	Cost	1960-1977 Units/Yr: 98,830 Freq.	Cost	Total Units: 207,050 Total Cost
Paint testing	$120	55%	$3,196,380	36%	$2,582,928	18%	$1,386,720	$7,166,028
Interior LBP stabilization	$500	16%	$3,874,400	6%	$1,793,700	3%	$963,000	$6,631,100
Exterior LBP stabilization	$100	6%	$290,580	6%	$358,740	3%	$160,500	$809,820
Maintenance	$0	100%	$0	100%	$0	100%	$0	$0
Clearance	$120	16%	$929,856	6%	$430,488	3%	$231,120	$1,591,464
Unit cleanup	$265	16%	$2,053,432	6%	$950,661	3%	$510,390	$3,514,483
Hazard Evaluation Costs			$6,179,668		$3,964,077		$2,128,230	$12,271,975
Hazard Reduction Costs			$4,164,980		$2,152,440		$1,123,500	$7,440,920
Total Program Cost			$10,344,648		$6,116,517		$3,251,730	$19,712,895
Average Cost/Unit			$214		$102		$33	$95

Hazard Removal	Unit Benefit Pre-1940	Unit Benefit 1940-1959	Unit Benefit 1960-1977	Pre-1940 Units/Yr: 48,430 Freq.	Benefit	1940-1959 Units/Yr: 59,790 Freq.	Benefit	1960-1977 Units/Yr: 98,830 Freq.	Benefit	Total Units: 207,050 Total Benefit
Paint stabilization	$256	$256	$256	30%	$3,719,424	12%	$1,836,749	6%	$1,391,526	$6,947,699
Unit dust - 5 year	$2,834	$2,834	$1,675	16%	$21,963,156	6%	$10,168,107	3%	$4,966,208	$37,097,470
Total Program Health Benefits					$25,682,580		$12,004,856		$6,357,734	$44,045,170
Resident children ages 1&2					$19,299,129		$9,022,009		$4,782,216	$33,103,354
Other children					$6,383,451		$2,982,846		$1,575,518	$10,941,815
Interior LBP stabilization market value	$480	$480	$480	16%	$3,719,424	6%	$1,721,952	3%	$1,423,152	$6,864,528
Exterior LBP stabilization market value	$90	$90	$90	14%	$610,218	6%	$322,866	3%	$222,368	$1,155,452
Total Program Benefits					$30,012,222		$14,049,674		$8,003,253	$52,065,149

Cost-Effectiveness	Pre-1940		1940-1959		1960-1977	Total
Net program benefit (cost)	$19,667,574		$7,933,157		$4,751,523	$32,352,254
Net benefit (cost) per unit	$406		$133		$48	$156

CHAPTER 6. SENSITIVITY ANALYSIS AND REGULATORY ALTERNATIVES

This chapter examines the sensitivity of the analysis to key assumptions, and examines alternative regulatory approaches. The chapter is organized in four sections:

6.1 Continuing Declines in Blood Lead Levels;
6.2 Sensitivity Analysis of Lifetime Earnings Benefits;
6.3 Baseline Costs for Paint stabilization and Abatement; and
6.4 Hazard Education.

6.1 CONTINUING DECLINES IN BLOOD LEAD LEVELS

Comparisons of NHANES II and NHANES III data show that average BLLs for children under six declined from 15.0 to 3.6 between the two surveys. Data from NHANES III Phase 2 show an additional 29 percent decline in the early 1990s.

The change in net benefits of the final rule associated with any continuing decline in blood lead levels is impossible to quantify because the magnitude of any such decline cannot be quantified from available data, and because there are no systematic data on any associated potential declines in LBP hazards (which would reduce the costs of the final rule). It is probable that any continuing decline in blood lead levels would reflect a continuing decline in LBP hazards (e.g., soil and dust lead levels). Therefore, hazard reduction costs could decline to an extent that might be roughly proportionate to any decline in hazards reduction benefits.

Exhibit 5-1a showed that hazard evaluation costs account for $112 million of the $300 million in total hazard evaluation and reduction costs, and hazard reduction costs account for $188 million (holding costs of less than $2 million are included in the $112 million shown for hazard evaluation costs). Total hazard reduction benefits were $1,36 million (using a three percent discount rate). Therefore, the net impact of even a substantial percentage reduction in both blood lead levels and hazard reduction cost would still yield net benefits under the final rule. For example, if hazard reduction benefits declined by 50 percent (e.g., $680 million using a three percent discount rate) and hazard reduction costs declined by 50 percent ($94 million), then the final rule would still yield net benefits of $474 million (with a three percent discount rate).

6.2 SENSITIVITY ANALYSIS OF LIFETIME EARNINGS BENEFITS

The monetized benefits of preventing elevated blood lead levels derived in Chapter 3 are almost entirely attributable to the benefits from increased lifetime earnings associated with the higher cognitive abilities of children who are prevented from being lead poisoned. Increased lifetime earnings are quantified by multiplying the amount of lifetime earnings lost per IQ point by the average amount of IQ points lost per each one ug/dL increase in blood lead levels. This RIA uses EPA's estimate of lifetime earnings lost for each one point decline in IQ, and the Schwartz estimate that each one ug/dL increase in blood lead levels causes a .245 point decrease in IQ. Therefore, these benefits are sensitive to the dollar estimate of lifetime earnings per IQ point lost and to the estimated amount of IQ points lost per one ug/dL increase in blood lead levels.

Benefits Limited to Resident Children Ages One and Two

Exhibits 3-12a and 3-12b showed that resident children ages one and two account for about three-fourths of total monetized unit benefits. Therefore, if there were no benefits realized by "other" children, the first-year benefits would decline by $340 million, and the final rule would still realize net benefits of $720 million, based on a three percent discount rate for lifetime earnings. Conversely, if the estimated benefit for other children were doubled, then the final rule would realize net benefits of $1.4 billion.

Lower IQ to Blood Lead Relationship

The estimated .245 decrease in IQ per each increase of one ug/dL in blood lead levels is a composite measure resulting from an analysis of eight studies on the effect of increased blood lead levels on IQ (Schwartz, 1993). Alternative estimates, however, suggest different possible IQ to blood lead relationships. Schwartz's more recent meta-analysis (1994) estimated .257 IQ points lost per one ug/dL increase in blood lead levels, but the estimated IQ losses were found to be .185 per one ug/dL increase for populations that were socially disadvantaged and .289 per one ug/dL increase for populations that were not disadvantaged.

The fact that the final rule targets disadvantaged populations (as discussed in Chapter 8) suggests that the .185 figure could be substituted for the .245 estimate in the RIA benefit analysis. Using this estimate would reduce the total benefits derived from increased lifetime earnings by 27 percent (because .185 is 73 percent of .245).

A lower estimate is also supported by a meta-analysis by Pocock (1994), which derived different estimates for the blood-lead relationship using prospective and cross-sectional studies. The prospective studies supported an estimate of .185 IQ points per one ug/dL increase in blood lead levels. By contrast, the cross-sectional studies supported an estimate of .253 IQ points per one ug/dL increase in blood lead levels, but the removal of one extreme value reduced this estimate to .175 per one ug/dL.

A 27 percent reduction in monetized health benefits, associated with a lower value for the IQ to blood lead relationship, would reduce the first year health benefits of the final rule to $367 million, using a three percent discount rate. In this case, the final rule would still yield first year net benefits of $693 million.

Higher IQ to Blood Lead Relationship

Although the Schwartz meta-analysis reported a lower slope for the I.Q. to blood lead relationship in socially disadvantaged populations, he also reported a lower slope associated with higher blood lead levels. Specifically, his analysis concluded that the size effect was .323 IQ points in studies with mean blood lead below 15 ug/dL, and .232 IQ points in studies with mean blood lead above 15 ug/dL. The Bellinger study was the only study in the Schwartz meta-analysis with a mean blood lead well below 10, at 6.5 ug/dL, and it reported a slope of .58 IQ points per ug/dL. Schwartz notes that "there are toxicological effects that show saturation phenomenon" consistent with the finding that the IQ to blood lead slope increases at lower blood lead levels.

It is quite possible that the lower slope associated with socially disadvantaged populations is simply the result of confounding variables, because the studies of socially disadvantaged populations also tend to report higher blood lead levels. The problem of confounding variables has been extensively discussed in the research literature, with some researchers suggesting that the IQ to blood lead relationship is still highly uncertain because blood lead levels are very strongly correlated with family income, parental education, maternal IQ, and many other factors affecting a child's IQ. Many research studies, however, support the IQ to blood lead relationship after controlling for confounding variables.

The dramatic decline in blood lead levels over the past two decades provides a new perspective on the IQ to blood lead relationship and the role of confounding variables. If IQ levels have shown any significant increase over this period of decline in blood lead levels, then this change in cognitive abilities may be largely attributed to lower blood lead levels, because there is no reason to assume any corresponding change in other variables known to affect a child's IQ.

To test this hypothesis, ICF obtained norm comparisons for the Cognitive Abilities Test (CogAT) given to a representative national sample of children between the ages of nine and 18. The CogAT test has evolved over more than forty years with its predecessor, the *Lorge-Thorndike Intelligence Tests*. Norm comparisons are done when the CogAT is updated, approximately every seven years, establishing a new set of scores to define the IQ normal distribution. In particular, when the CogAT switched from Form 4, first used in 1984, to "Form 5" in 1992, both tests were administered to 3,119 students in 23 schools in 10 school districts. The published results of the norm comparisons are explained as follows: "lower scores on Form 5 indicate that the 1992 norm is "easier" than the 1984-85 norm at that score level *or* that the age group on which the norms are based had higher ability in 1992 than in 1984-85." The latter interpretation may be especially relevant to estimating the IQ to blood lead relationship, because the CogAT norm comparison between 1984 and 1992 should reflect the substantial decline in blood lead levels reported between NHANES II and NHANES III Phase 1.

The analysis presented below compares the 1984 to 1992 CogAT norm comparisons for children ages nine and ten with the decline in blood lead levels for children under the age of six between NHANES II (conducted from 1976 through 1980) and NHANES III Phase 1 (conducted from 1988 through 1991). This time lag was chosen because the research literature shows that children are most vulnerable to cognitive losses from lead poisoning at ages under six. The nine and ten year olds taking the CogAT test in 1984 would have been under age six during the NHANES II period, and the nine and ten year olds taking the CogAT test in 1992 would have been under age six in the years during and just prior to the NHANES III Phase 1 survey period.

To the extent IQ losses are specifically associated with average blood lead levels at the age of one or two, the average blood lead for children under five during NHANES II will understate the average blood lead at age one and two for children age nine and ten during 1984. These children would have been one and two during 1976 to 1978, the first half of the NHANES II study period, and Annest has shown that blood lead levels dropped throughout the length of the NHANES II study period. Also, the average blood lead levels from NHANES III Phase 1 may also understate the average blood lead levels at ages one and two for children age nine and ten during the 1992, because these children would have been ages one and two during 1983 to 1985, and data from NHANES III phase 1 (1988-1991) and phase 2 (1992-1994) show that blood lead levels continued to drop throughout the 1980s and at least through the first few years of the 1990s. Taken together, however, these offsetting errors suggest that the decline in average blood lead levels for children under six between NHANES II and NHANES III Phase 1 should approximate the decline at ages one and two for children ages nine and ten in the 1984 and 1992 CogAT norm comparison.

Exhibit 6-1 compares the change in the 25th percentile, median, and 75th percentile blood lead levels for children under six between NHANES II and NHANES III phase 1. Over this period of time, the 25th percentile blood lead level for children under six declined by 9.8 ug/dL, the median declined by 11.3 ug/dL, and the 75th percentile declined by 13.1 ug/dL. The 75th percentile was at 19 ug/dL during NHANES II, and at this initial blood lead level the Schwartz analysis suggests a gain of .232 IQ points per ug/dL decline. This would result in an increase of 3.04 IQ points for children who were in the 75th percentile of blood lead during NHANES III Phase 1 relative to children in the 75th percentile under NHANES II. The median blood lead under NHANES II was 15 ug/dL, and at this blood lead level the Schwartz analysis suggests a gain of .323 IQ points per ug/dL decline in young children with blood lead levels below 15 ug/dL, resulting in an increase of 5.03 IQ points for children at the median blood lead during NHANES III Phase 1 relative to children at the median under NHANES II. Finally, the 25th percentile was at 12 ug/dL during NHANES II. At this initial blood lead level the Schwartz analysis suggests a gain of at least .323 IQ points per ug/dL, and the Bellinger study suggests that the IQ gain for children at such a relatively low initial blood lead level could be as high .58 IQ points per ug/dL. The Schwartz estimate for children under 15 ug/dL would result in an increase of 3.17 IQ points, and the Bellinger estimate would result in an increase of 5.68 IQ points for children in the 25th percentile of blood lead during NHANES III Phase 1 relative to children in the 25th percentile under NHANES II.

Exhibit 6-1: Predicted IQ Change from Blood Lead Decline Between NHANES II and NHANES III Phase 1

	NHANES II (1976-80)	NHANES III Phase 1 (1988-91)	Change (ug/dL)	IQ points per ug/dL	Expected IQ change
25th Percentile	12.0	2.2	9.8	.323 .580	3.17 5.68
Median	15.0	3.7	11.3	.323	3.65
75th Percentile	19.0	5.9	13.1	.232	3.04

The CogAT norm comparisons give us some indication of whether IQ levels actually changed for children who were around the age of two during NHANES III Phase 1 relative to the IQ levels of children who were around age two during NHANES II. Exhibit 6-2 shows the norm comparisons for nine and ten year olds in 1992 with Standard Age Scores (SAS) of 110 (75th percentile), 100 (median), and 90 (25th percentile) based on the Form 5 scores in 1992. The norm comparison with verbal (V), quantitative (Q), and non-verbal (NV) SAS scores on Form 4 indicate that a nine year old child with a Form 5 (1992) SAS of 110 on all three test batteries would have had an average SAS of 115.7 on the SAS distribution established for Form 4 in 1984-85. A ten-year-old child with a Form 5 SAS of 110 on all three test batteries would have had an average SAS of 116.7 on the SAS distribution established for Form 4 in 1984-85. A nine year old child with a Form 5 SAS of 100 on all three test batteries would have had an average SAS of 104 on the SAS distribution established for Form 4 in 1984-85, and a ten year old child with a Form 5 SAS of 100 would have had an average SAS of 105.3 on the Form 4 distribution established in 1984-85. Finally, children age nine or ten with a Form 5 SAS of 90 on all three test batteries would have had an average SAS of 93 on the SAS distribution established for Form 4 in 1984-85.

Exhibit 6-2: Actual IQ Change from CogAT Norm Comparison for Children Affected by Blood Lead Decline Between NHANES II and NHANES III Phase 1

	Form 5 SAS (1992)	Form 4 SAS (1984-85)								Change in IQ	
		9 year olds (N=852)				10 year olds (N=459)				9 yr olds	10 yr olds
		V	Q	NV	Avg.	V	Q	NV	Avg.		
25th Percentile	110	117	114	116	115.7	115	118	117	116.7	5.7	6.7
Median	100	105	103	104	104.0	105	105	106	105.3	4.0	5.3
75th Percentile	90	93	93	93	93.0	93	93	93	93.0	3.0	3.0

Exhibit 6-3 compares the predicted change in IQ based on changes in blood lead quartiles for children under six between NHANES II and NHANES III Phase 1, versus the actual change in quartile IQ indicated by the CogAT norm comparisons for children who were under six during these two NHANES studies. The CogAT norm comparisons clearly support the IQ to blood lead relationship, and the relative magnitude of the increase in IQ specifically supports the Schwartz conclusion that the slope is higher in children with lower average blood lead. In fact, the change in IQ for the 25th percentile is consistent with the higher slope suggested by Bellinger's research.

Exhibit 6-3: Predicted IQ Change from Blood Lead Decline Versus Actual CogAT IQ Change

	Change in ug/dL	IQ points per ug/dL	Predicted IQ Change	Actual CogAT IQ Change	
				9 year olds	10 year olds
25th Percentile	9.8	.323 .580	3.17 5.68	5.7	6.7
Median	11.3	.323	3.65	4.0	5.3
75th Percentile	13.1	.232	3.04	3.0	3.0

The comparison shown in Exhibit 6-3 assumes that the IQ quartiles in the CogAT norm comparisons are representative of their respective blood lead quartiles when these children were around the age of two. The strongest support for this assumption comes from the critics of published prospective and cross sectional studies of the IQ to blood lead relationship, who point out that blood lead is very strongly correlated with other factors that are recognized determinants of IQ. The correlation between blood lead and these confounding variables supports the assumption that children in the 25th percentile of blood lead are likely to fall near the 25th percentile of IQ in later life, if not because of their blood lead then because of their family income, parental education, and other variables that correlated with both blood lead and IQ. Similarly, children at the median of population blood lead levels are likely to fall near the median IQ in later life, and children in the 75th percentile of blood lead are likely to fall near the 25th percentile of IQ in later life. If there were no clear trends between NHANES II and NHANES III Phase 1 relating to population changes in parental education, family income, or any other confounding variable related to IQ, then it is reasonable to conclude that the reported change in IQ levels results from the decline in blood lead levels, especially because the absolute magnitude of the IQ change is completely consistent with the measured decline in childhood blood levels and the estimated slopes for the IQ to blood lead relationship reported in the Schwartz analysis.

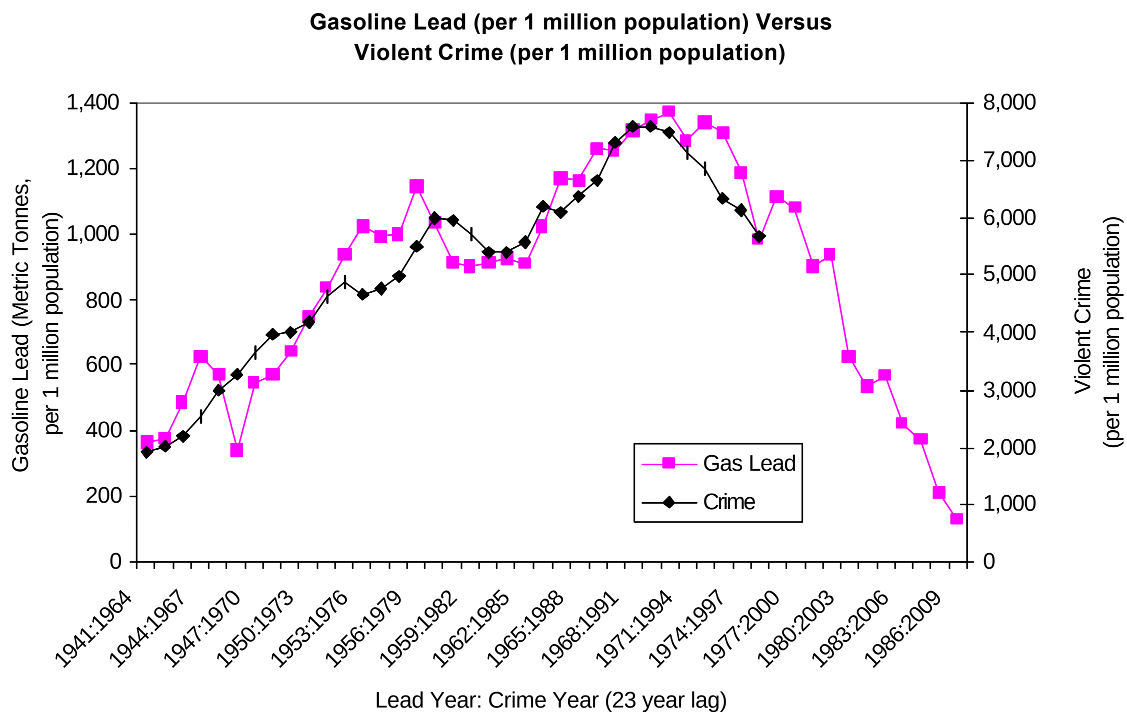
The analysis presented above indicates that the IQ to blood lead slope is higher at lower blood lead levels, and specifically suggests that the Bellinger estimate of .58 IQ points per one ug/dL may be applicable to the relative low blood lead levels today. Using this estimate would increase the total benefits derived from increased lifetime earnings by 237 percent (because .58 is 237 percent of .245). A 237 percent increase in monetized health benefits, associated with a higher value for the IQ to blood lead relationship, would increase the first year health benefits of the proposed rule to $2,012 million, using a three percent discount rate. In this case, the proposed rule would yield first year net benefits of $3,173 million.

Other Macro-Trends Consistent with Blood Lead Research

The monetized benefits reflected in this RIA reflect only the lifetime earnings (and a comparatively small amount of avoided medical costs) for the children who avoid higher blood lead levels. Recent research literature, however, suggests that lead poisoning imposes additional societal costs, especially in the form of crime. Any benefits from avoided crime have been excluded from the cost-benefit analysis in Chapter five because the research in this area is still controversial, and because the benefit of avoided crime would be difficult to monetize even if the relationship were clearly established. Exhibit 6-4, however, does present a graphical indication of the potential magnitude of this benefit from avoided lead poisoning.

There are no systematic data on childhood blood lead levels prior to NHANES II, and no data showing year by year changes in blood lead between NHANES II and NHANES III. However, Nriagu has compiled detailed year by year data on gasoline lead emissions, and the lead in gasoline RIA and other work by Schwartz and others clearly show that gasoline lead was the major principal determinant of blood lead in young children when leaded gas was in extensive use. Therefore, Exhibit 6-4 uses gasoline lead as a proxy for childhood blood lead levels in order to examine the potential impact of blood lead on crime. This graph shows a time series comparison for gasoline lead per million population versus violent crime per million population 23 years later. The 23-year lag reflects a median age of 24 for individuals arrested for violent crime in 1996, where children are most affected by lead during their first few years of life. The fit between these two graphs provides striking visual support for the findings from recent studies showing a relationship between bone lead and violent behavior.

Exhibit 6-4



6.3 MARKET VALUE FOR PAINT STABILIZATION

Exhibit 5-1a showed that the market value of paint stabilization accounts for about 7 percent, or $74.4 million of the $1.06 billion in net benefits associated with first year hazard reduction activities under the final rule, using a three percent discount rate. The full costs of paint stabilization are shown to be approximately 27 percent of total first-year costs. If the cost-benefit analysis reflected no benefits for the market value of paint stabilization associated with first year activities, then the final rule would still yield net benefits of $1,286 million for first year activities.

6.4 HAZARD EDUCATION

The discussion of paint stabilization benefits in Chapter 3 noted that many hazard reduction studies also reflect some amount of lead hazard education for residents, and it is difficult to separate the benefits of hazard reduction from the benefits of hazard education. Chapter 3 also noted that the estimated duration of dust removal benefits assumes that the baseline for this analysis includes increased resident education about lead hazards, which reduces the reaccumulation of lead dust. This section examines the limited data available on the additional benefits that might be achieved through hazard education.

Exhibit 6-5 presents data on some of the hazard reduction studies discussed in Chapter 3, plus available research studies of lead hazard education. The 1981 Baltimore Dust Control study found ongoing dust control was necessary in order to achieve an 18 percent reduction in EBLs. The authors of the St. Louis Retrospective study assumed that education or other interventions initiated after the initial discovery of lead poisoning could reduce blood lead levels in the absence of hazard controls, and the 12 percent decline in the control group for this study seems to support that conclusion. The Boston Three-City study authors noted that "study staff also regularly visited all participating families and provided education about lead poisoning, and since education was identical among the groups, this may have resulted in decreased group differences" (Weitzman, 1993).

Exhibit 6-5
Lead Hazard Reduction and Hazard Education Studies

Intervention Study Title	Year Data Collected	Method of Intervention	Duration (months)	Initial BLLs Average (range)	Percent Decline
Baltimore Dust Control	1981	PS - no DC	12	38.5	-1.8%
		PS and bimonthly DC	12	38.6	-18%
St. Louis Retrospective Study	1990	IC, DC, ED	10-14	33.6	-23%
		ED only	10-14	35.1	-12%
Boston Three-City Study	1989-1990	PS, DC, SA, ED	11	13.1 (7 to 24)	-19%
		PS, DC, ED	11	12.4 (7 to 24)	-7.1%
		PS, ED	11	12 (7 to 24)	-5.6%
Milwaukee Retrospective Study	1990-1993	ED	3-12	20-24	-18%
		Control Group	3-12	20-24	-5%
		ED and nurse visit	2-6	25-40	-18%
Granite City Study	1991	ED	4	15	-48%
			12	15	-40%
				*All Initial BLLs > 10	
Rochester Study	1995	ED	7	6.7	None

Key to Abbreviations:

BLL: Blood Lead Level in ug/dL
PS: Paint stabilization
DC: Dust Control
ED: Education
SA: Soil Abatement
IC: Interim Controls

The results from Granite City are consistent with the Milwaukee study finding that lead hazard education can be very effective in reducing initial blood lead levels. The Granite City results also suggest that more extensive educational measures combined with hazard reduction result in a larger percentage decline in blood lead levels. By contrast, a limited education study in Rochester revealed no reduction in blood lead levels when residents received instructions and cleaning supplies. The Rochester findings suggest that distribution of a lead hazard pamphlet, or other written materials, may not have any measurable impact on blood lead levels.

It is important to note that lead hazard education should not imply any criticism of the household's current housekeeping practices. National Survey data show that dust lead loadings are relatively low on floors, but much higher on window sills and extremely high in window troughs, where even fastidious housekeepers would not routinely clean. A Seattle study also found that dust lead levels were 95 percent lower in homes where residents were asked to remove their shoes before they entered their homes, relative to homes where residents used vacuum cleaners.

Additional research is needed to determine the types of hazard education that are most effective, and whether education should be viewed as a supplement to hazard reduction in some units, and as an alternative strategy in other units. Education efforts may be most effective when they target units that are in good condition. Hazard education for children living in units with deteriorated LBP would probably not prevent the ingestion of paint chips because most parents are already well aware of paint chip hazards. Also, adequate removal of lead dust on floors and windows may not be possible when these surfaces are not smooth and cleanable. In such cases, however, hazard education might be an important supplement to hazard reduction, potentially extending the benefits of dust removal for many years, and substantially increasing associated benefits. In units that are already in good condition, hazard education may offer a cost-effective means of reducing blood lead levels without any hazard reduction activities.

CHAPTER 7. ECONOMIC IMPACTS

Economic impact analyses estimate the extent to which specific groups, such as industries or consumers, bear costs or receive benefits from an environmental regulation. This information is important for evaluating the fairness of the distribution of benefits and costs, in determining whether it is important to mitigate such effects, and in assessing the social costs or benefits of regulation.

This chapter presents the economic impacts of the proposed requirements for HUD programs. The exhibit below shows the annual number, percentage, and cumulative percentage of units subject to the final rule under four categories of HUD programs: project based and tenant based rental assistance, rehabilitation, and Public housing programs. Although the final rule organizes housing programs into a larger number of categories, this section combines the programs into four broader categories to simplify the economic impact analysis while still covering 96 percent of the total number of units affected by the final rule (see Exhibit 7-1 below).

Exhibit 7-1
Housing Units by Type of Assistance

Type of Assistance	Number of Units	Percentage of Units	Cumulative Percentage of Units
Project Based and Tenant Based Rental Assistance	920,270	71%	71%
Rehabilitation	152,668	12%	83%
Public Housing	164,000	13%	96%
Other	51,813	4%	100%
Total	1,288,751	100%	100%

For each of the three types of assistance programs named above, the economic impact analysis discusses who will bear the cost of LBP hazard evaluation and reduction activities. It then explains the methodology used to evaluate the economic impacts of the proposed regulations for each program and describes these impacts.

Project Based and Tenant Based Rental Assistance

For project based and tenant based assistance programs, the final rule states that the owner is responsible for hazard evaluation and reduction, but it may be possible for owners to raise the contract rent to finance these costs. Although this option is not explicitly stated in the final rule, it is reasonable to expect that property owners will try to recover regulatory costs, and income-based limits on tenant-paid rents under this program suggest that HUD would pay the cost of any rent increase. For purposes of this analysis, it is assumed that HUD will directly or indirectly pay the incremental costs of the final rule for tenant based assistance programs and for project based assistance programs.

If HUD is directly or indirectly paying the costs of the final rule for rental assistance programs, then the economic impact for these Subparts can be measured in terms of the number of households or units that HUD would be unable to assist each year with the funds that are expended on LBP hazard evaluation and reduction. The total annual cost of the final rule for project- and tenant-based assistance is $124 million. The annual per-household cost of tenant-based assistance is less than $7,000 per unit. Therefore, with the funds expended on LBP hazard evaluation and reduction for project and tenant based assistance programs, HUD could provide rental assistance to more than 17,714 families. This represents less than two percent of the total number of households presently receiving tenant based rental assistance.

Rehabilitation Programs

In the case of rehabilitation programs, there is no explicit acknowledgement in the final rule that HUD will finance the additional costs of LBP hazard evaluation and reduction, which suggests that the recipients of federal funds are responsible for funding these activities. These recipients, however, are receiving HUD assistance for rehabilitation. Therefore, it is reasonable to assume that the costs of the final rule will reduce the amount of rehab work that the recipients can finance. In this case, the economic impact of the final rule can be measured by determining the number of rehabilitation projects that would not be funded due to the recipients' inability to finance these additional costs. Dividing the total cost of the final rule for rehabilitation programs ($50 million) by an average cost of $15,000 per unit for rehabilitation work indicates that the final rule could cause a loss of financing for more than 3,333 units in need of rehabilitation each year, or about two percent of all units receiving federal assistance for rehab work.

Public Housing

For Public and Indian housing programs, the relevant Housing Authority is responsible for implementing the final rule with funds that otherwise would have been available for maintenance and repairs. Therefore, the economic impact of the final rule on Public and Indian housing programs can be measured by the amount by which annual maintenance and repair services would be reduced for each unit. Based on the average incremental cost per unit of the final rule, multifamily public housing programs would have to reduce annual maintenance and repair expenditures by $345 per unit. Single family public housing programs would have to reduce such expenditures by $613 per unit.

CHAPTER 8. ENVIRONMENTAL JUSTICE

On February 11, 1994, President William J. Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, and an accompanying Presidential Memorandum to focus federal attention on the environmental and human health conditions in minority and low-income communities with the goal of achieving environmental justice. The Executive Order was also intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low-income communities access to public information and an opportunity for public participation concerning matters relating to human health.

As part of HUD's goal to incorporate environmental justice into its policies and programs, the Department has examined the impacts of the final rule on low-income populations and minority populations. In summary, the final rule promotes environmental justice in the following ways:

- Conducting lead-based paint evaluation and control activities in federally assisted housing will disproportionately benefit low-income and minority populations because low-income and minority families are more likely to have EBL children, and because low-income families are more likely to live in federally assisted housing.

- The final rule facilitates safe and effective lead-based paint hazard evaluation and control to the benefit of low-income and minority populations.

- In developing the final rule, the Department provided ample opportunity for public participation.

- Provisions within the final rule ensure that low-income and minority populations will have access to public information about lead-based paint hazards.

The following sections discuss each of these environmental justice benefits in further detail.

8.1 POPULATIONS BENEFITTING FROM THE FINAL RULE

Lead poisoning affects children across all socioeconomic strata and in all regions of the country. Because lead-based paint hazards are most severe in older housing in disrepair, however, lead poisoning disproportionately affects the poor in inner cities. In the Report of the Task Force on Lead-Based Paint Hazard Reduction and Financing, minority and low-income populations are identified as the populations with the greatest proportion of EBL children (children with elevated blood lead levels, or blood lead levels above 10 ug/dL). Using data from NHANES III-Phase 2, the Task Force reports that:

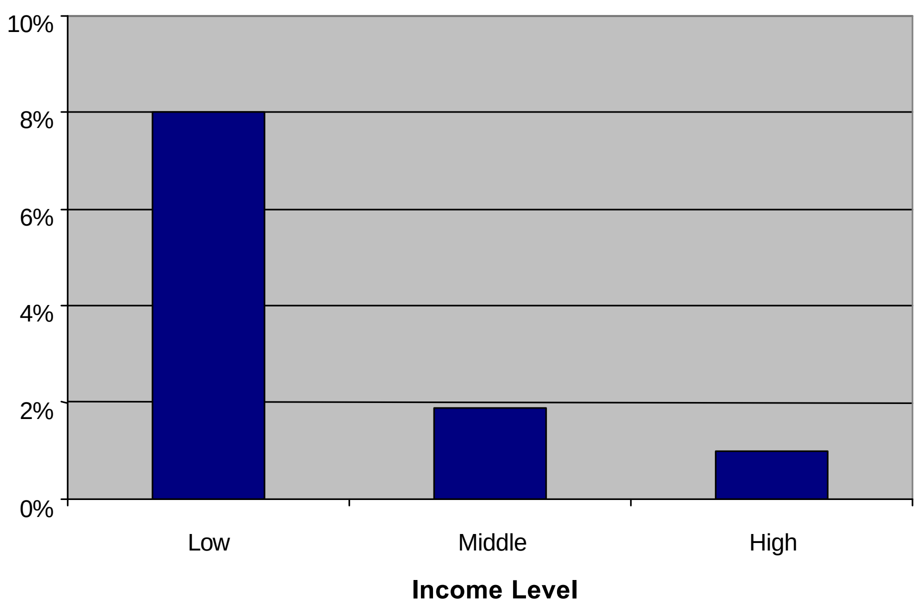
- Children aged one to five in lower income families are four and five times more likely than children in middle- and high-income families, respectively, to have blood lead levels at or above 10 ug/dL;[5]

- Eleven percent of African American children from ages one to five have blood lead levels at or above 10 ug/dL – almost five times the rate of White children; and

- Children living in central cities are more than one and one-half times more likely to have elevated blood lead levels than those outside of central cities. Populations with multiple risk factors have the highest prevalence rates: 37 percent of Black children living in central cities have blood lead levels at or above 10 ug/dL.[6]

Exhibits 8-1 and 8-2 compare the proportion of EBL children between one and five years of age by both race and income level.

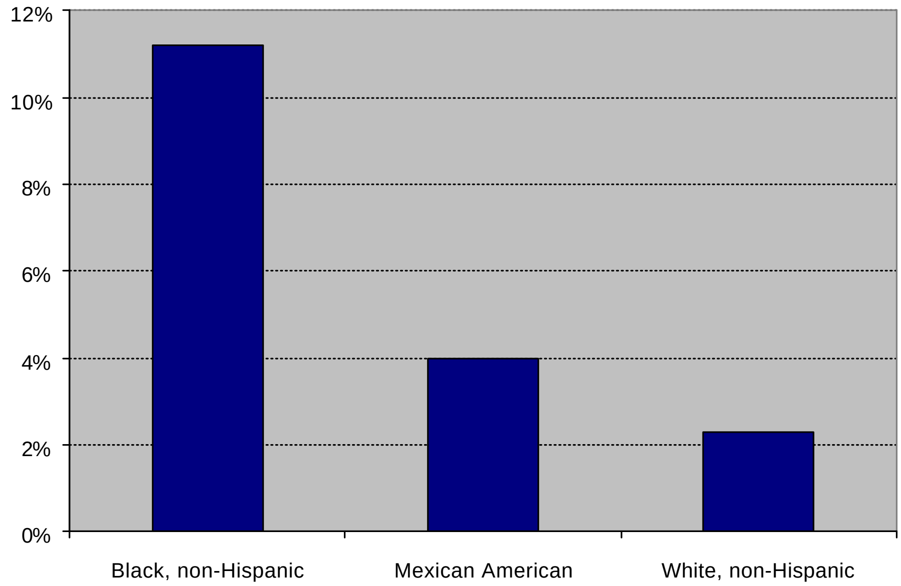
Exhibit 8-1
Percentage of Children Ages One to Five Years with EBLs by Income Level



[5] Income level was defined by the poverty-income ratio (PIR): the total family income divided by a poverty threshold. Low income was defined as having a PIR greater than zero and less than 1.300, middle income was defined as having a PIR greater than or equal to 1.301 and less than 3.500, and high income was defined as having a PIR greater than or equal to 3.501.

[6] "Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing," Report of the Lead-Based Paint Hazard Reduction and Financing Task Force, U.S. Department of Housing and Urban Development, Washington, D.C., 1995, p. 35.

Exhibit 8-2
Percentage of Children Ages One to Five Years with EBLs by Race



The above data show that children most at risk of developing EBLs are those from African American and low-income populations. Therefore, any effort to address lead-based paint hazards disproportionately benefits African American populations, as well as low-income populations in general.

By targeting housing assisted by HUD, the benefits of the final rule are further concentrated among low-income populations. Of the 1.4 million housing units that will be affected by Title X each year, 85 percent belong to either the public housing or project or tenant-based rental assistance programs. Because these programs require means testing for eligibility, the majority of benefits from the final rule will accrue to low-income communities.

8.2 ENVIRONMENTAL BENEFITS OF THE FINAL RULE

In the past several years, lead-based paint remediation technologies and the scientific and medical communities' understanding of the causes of childhood lead poisoning have substantially advanced. As a result, the existing regulations no longer reflect the most up-to-date methods for evaluating and reducing lead-based paint hazards. In addition, the current regulations do not offer a consolidated, uniform approach to addressing lead-based paint hazards. Each individual HUD program has a separate set of lead-based paint requirements incorporated into its program regulations. These widely scattered, program-specific requirements are inconsistent and sometimes vague regarding acceptable methods for evaluating and reducing lead-based paint hazards.

The final rule will replace the numerous lead-based paint regulations that currently apply to various HUD programs. Together with 24 CFR Part 38, these rules will consolidate HUD's regulatory requirements for lead-based paint hazard reduction and evaluation. In addition, the final rule organizes the requirements according to the type of assistance received rather than according to each specific HUD program. This organization avoids conflicting regulations for properties receiving more than one type of public assistance, and will allow the regulations to continue to apply as HUD's current programs are combined into performance-based funds. Moreover, the final regulations use a clear and consistent set of terms to specify hazard evaluation and reduction requirements and include guidelines for the safe implementation of these actions.

By offering a more consistent and streamlined approach to addressing lead-based paint hazards in federally assisted housing, the provisions in the final rule increase the effectiveness of lead-based paint hazard evaluation and control and thereby lower human exposure to lead in the environment. As discussed in the previous section, effectively addressing lead-based paint hazards disproportionately benefits minority and low-income families, who are more likely to have children with EBLs and more likely to live in federally assisted housing.

8.3 PUBLIC INVOLVEMENT IN THE RULEMAKING

Because of the magnitude of changes required in HUD's lead-based paint regulations and the potential impact of these changes, public involvement was crucial to developing the rulemaking. HUD used three main avenues to involve the public in developing the final rule. First, the Department held three meetings with HUD clients on the potential implications of Title X on HUD programs. The meetings involved HUD constituents, grantees, and field staff of the Offices of Public and Indian Housing, Community Planning and Development, and Housing, as well as advocacy and tenant representatives.

The Department also invited housing, public health, and environmental professionals with broad experience in lead hazard evaluation and reduction to develop HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.[7] These Guidelines form the basis for many of the lead hazard evaluation and reduction methods described in Part 37 of the final rule, and are intended to help property owners, government agencies, and private contractors sharply reduce children's exposure to lead.

Finally, the Department created the Title X Task Force on Lead-Based Paint Hazard Reduction and Financing to address sensitive issues related to lead hazards in private housing, including standards of hazard evaluation and reduction, financing hazard reduction activities, and liability and insurance for rental property owners and hazard control contractors. Members of the Task Force included representatives from federal agencies, the secondary mortgage, building, and construction industries, landlords, tenants, parents of poisoned children, single and multifamily real estate interests, nonprofit housing developers, property liability insurers, public housing agencies, low-income housing advocacy organizations, lead-poisoning prevention advocates, and community-based organizations serving communities at high risk for childhood lead poisoning. The Department used the Task Force recommendations to guide the development of the lead-based paint requirements, particularly for Section 8 tenant-based rental assistance programs.

[7] Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, U.S. Department of Housing and Urban Development, June 1995.

8.4 PUBLIC ACCESS TO INFORMATION

Through two primary provisions, the final rule ensures that the public, particularly minority and low-income populations, will have access to information regarding the hazards of lead-based paint. First, the final rule requires that the lead hazard information pamphlet developed by the Environmental Protection Agency (EPA) be distributed to existing owner-occupants and tenants residing in residential dwelling units covered by the final rule. Forthcoming Section 1018 requirements to be established in Part 38 will require new purchasers and new tenants of target housing to receive the EPA lead hazard information pamphlet.

The EPA pamphlet (available in both English and Spanish) provides information about: the health risks associated with exposure to lead; the possible presence of lead-based paint hazards in the unit; the risks of renovating housing with lead-based paint; approved methods of lead-based paint hazard evaluation and reduction; obtaining a list of certified evaluation and reduction contractors; conducting a risk assessment or inspection prior to purchase, lease, or renovation; and federal, state, and local agencies that provide further information about lead-based paint laws and financing.

Second, the final rule requires that occupants of rental housing receiving Federal assistance or federally owned housing be provided written notice of risk assessments, paint inspections, or hazard reduction activities required by this regulation and undertaken at the property. The notification must be easy to read, and provided in the tenants' primary language, if possible. The tenant notification requirements established by the final rule will provide tenants of rental housing with important information that can help them protect their families from exposure to lead-based paint hazards.

These two provisions in the final rule promote environmental justice by increasing public awareness of lead-based paint hazards, actions to prevent lead poisoning, and hazard evaluation and reduction activities undertaken as a result of the regulations. Increased public awareness of these issues will help reduce human exposure to lead in the environment by encouraging the public to take measures that reduce the risk of lead poisoning.

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