United States
Environmental Protection
Agency

EPA/600/R-19/001 | February 2019
www.epa.gov/homeland-security-research

Evaluation of Low-Tech Outdoor Decontamination Methods Following Wide Area Radiological/Nuclear Incidents

Office of Research and Development
Homeland Security Research Program

This page left intentionally blank

EPA/600/R-19/001
February 2019

Technology Evaluation Report

Evaluation of Low-Tech Outdoor Decontamination Methods Following Wide Area Radiological/Nuclear Incidents

U.S. Environmental Protection Agency
Cincinnati, OH 45268

Disclaimer

The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development's National Homeland Security Research Center, funded and managed this evaluation. The document was prepared by Battelle Memorial Institute under EPA Contract Number EP-C-15-002; Task Order 12. This document was reviewed in accordance with EPA policy prior to publication. Note that approval for publication does not signify that the contents necessarily reflect the views of the Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use of a specific product.

Questions concerning this document or its application should be addressed to:

Dr. Sang Don Lee
U.S. EPA
109 T.W. Alexander Drive
Mail Code: E343-06
Research Triangle Park, NC 27709
Lee.Sangdon@epa.gov
919-541-4531

Contents

Executive Summary vii
1.0 Introduction 1
under the selected contamination conditions. 1
2.0 Experimental Details 3
2.1 Experimental Preparation 3
2.1.1 Surfaces 3
2.1.2 Surface Contamination 7
2.1.3 Measurement of Activity on Coupon Surface 8
2.2 Decontamination Methods 9
2.3 Decontamination Conditions 11
3.0 Quality Assurance/Quality Control 13
3.1 *InSpector^{TM} 1000* 13
3.2 Audits 13
3.2.1 Technical System Audit 13
3.2.2 Data Quality Audit 13
3.3 QA/QC Reporting 14
4.0 Evaluation Results and Performance Summary 15
4.1 Decontamination Efficacy 15
4.2 Operational and Deployment Factors 23
4.3 Performance Summary 27
5.0 References 29

FIGURES

Figure 2-1. Roofing surfaces: asphalt roofing, asphalt shingles, clay tiles (top row) and gutter, metal roofing, and wood shingles (bottom row). 5
Figure 2-2. Siding and other surfaces: vinyl (representative of aluminum and steel as well), composite fence, stucco (top row), wood siding, window, and plastic slide.. 5
Figure 2-3. Hardscape surfaces: brick pavers, asphalt drive, concrete pavers (top row), stained wood deck and sidewalk concrete (bottom row). 5
Figure 2-4. Mock wall setup with asphalt shingles, vinyl siding, gutter and downspout. 6
Figure 2-5. Containment tent used for all experiments 6
Figure 2-6. Contamination of asphalt shingles with a heavy SFM loading on squares (left). Light SFM loading on asphalt drive (center), and ASFM applicator (right). 8
Figure 2-7. InSpectorTM 1000, Digital Hand-Held MCA with shielding support to facilitate repeatable geometry 9
Figure 2-8. Pass 1 pattern (left) and Pass 2 pattern (right) with decontamination approaches 10

TABLES

Table 2-1. Description of Surface Materials 4
Table 2-2. Summary of Contamination Experimental Conditions 7
Table 2-3. Low-Tech Remediation Methods Used for the Evaluation 11
Table 2-4. Test Matrix of Decontamination Methods for Roofing Surfaces 12
Table 2-5. Test Matrix of Decontamination Methods for Siding and Other Surfaces 12
Table 2-6. Test Matrix of Decontamination Methods for Hardscape Surfaces 12
Table 4-1a. Decontamination Efficacy for Roofing Surfaces by Method 16
Table 4-1b. Decontamination Efficacy for Roofing Materials by Surface 17
Table 4-2. Decontamination Efficacy for Siding and other Outdoor Surfaces 18
Table 4-3. Decontamination Efficacy for Hardscape Surfaces 20
Table 4-4. Decontamination Efficacy for Mock Wall Spraying 21
Table 4-5. Efficacy Observations of Each Surface Type 22
Table 4-6. Operational Summary of Each Low-tech Remediation Method 24
Table 4-7. Accessories for each Low-tech Remediation Method by Deposition Method 25
Table 4-8. Estimated Waste from Decontamination of Typical Home (Heavy SFM) 26
Table 4-9. Estimated Waste from Decontamination of Typical Home (Light SFM) 26
Table 4-10. Estimated Waste Stream from Decontamination of Typical Home 26
Table 4-11. Estimated Waste Stream as a Function of Deposition Method 26

Abbreviations/Acronyms

%R	percent(s) removal
ASFM	aqueous simulated fallout material
ARD	Arizona Road Dust
BG	background
CBRN	chemical, biological, radioactive, and nuclear
cm	centimeter(s)
Cs	cesium
DAC	derived air concentration
EPA	U.S. Environmental Protection Agency
ft	foot/feet
g	gram(s)
HEPA	high efficiency particle air
HSRP	Homeland Security Research Program
kg	kilogram(s)
L	liter(s)
low-tech	low technology
MCA	multichannel analyzer
mCi	millicurie(s)
mg	milligram(s)
mm	millimeter(s)
mL	milliliter(s)
m	meter(s)
µm	micron(s)
µCi	microcurie(s)
PPE	personal protective equipment
QA	quality assurance
QC	quality control
Rad/Nuc	radiological or nuclear
Rb	rubidium
RPD	relative percent difference
SFM	simulated fallout material
T&E	Testing and Evaluation

Acknowledgments

This document was developed by the EPA's Homeland Security Research Program (HSRP) within EPA's Office of Research and Development. Dr. Sang Don Lee was the project lead for this document. Contributions of the following individuals and organizations to the development of this document are acknowledged.

United States Environmental Protection Agency

John Archer, National Homeland Security Research Center
Timothy Boe, National Homeland Security Research Center
Kathy Hall, National Homeland Security Research Center
Scott Hudson, Office of Emergency Management
Mario Ierardi, Office of Resource Conservation and Recovery
Paul Lemieux, National Homeland Security Research Center
Matthew Magnuson, National Homeland Security Research Center
Anne Mikelonis, National Homeland Security Research Center
Jim Mitchell, EPA Region 5
Terry Stilman, EPA Region 4

State of Illinois

Mark Hannant

Battelle Memorial Institute

Ryan James
Zachary Willenberg

Booze Allen Hamilton

Katrina McConkey

Executive Summary

The U.S. Environmental Protection Agency's (EPA's) Homeland Security Research Program (HSRP) is helping to protect human health and the environment from adverse impacts resulting from intentional or unintentional releases of chemical, biological, radiological, and nuclear (CBRN) contamination. One way the HSRP helps to protect human health and the environment is by performance testing technologies for remediating CBRN contamination from various surface types and locations. The objective of the work described here is to collect information and experimental data about low-tech outdoor radiological decontamination methods available in the United States.

This technology evaluation included use of low technology (low-tech) decontamination methods on surfaces common to outdoor residential environments. Tests were performed to evaluate decontamination with respect to technology efficacy for varying particle sizes and wet and dry applications and method constraints. In addition, the technology's deployment and operational factors were evaluated including safety concerns, feasibility, waste generation, potential exposure, and cost. Prior to pilot-scale testing, literature containing pertinent information related to common outdoor cleaning and maintenance activities within the United States was compiled into a summary compendium including relevant information about multiple low-tech cleaning methods from the results of the literature search. Through discussion and prioritization, an EPA project team, made up of several EPA scientists and emergency responders, focused the information into a list of 10 outdoor cleaning activities (e.g., vacuuming, sweeping, wet wiping) for decontamination evaluation testing which could be performed by untrained homeowners with guidance. These types of activities are collectively referred to as "low-tech" decontamination methods because of the comparatively simple tools, equipment, and operations involved. Additionally, 20 common outdoor surfaces (including roofing material, siding, hardscape surfaces, etc.) were chosen that were contaminated using three different contamination conditions. These outdoor surfaces were selected because of their prevalence around personal residences and commercial office buildings and because of the inconvenience associated with removing and replacing relatively expensive items (compared to grass, mulch, etc.). The low-tech decontamination methods were selected based on ease of use and availability in the aftermath of a radiological incident.

This method evaluation included use of multiple common surfaces at a pilot scale (0.7 square meters [m^2]) for decontamination testing. Testing included deposition and measurement of the radioactive contaminant on the surface; the method for application of the decontamination; and subsequent measurement of residual contamination to determine a quantitative decontamination efficacy (i.e., effectiveness of radionuclide removal) attained by each method. Semi-quantitative and quantitative information pertaining to each method was collected. This type of information included number of wipes/sponge pads used, relative level of contamination on the wipes/sponge pads, and level of contamination on the components of a decontamination tool (e.g., handle, support end, and sponge end). The results presented here include cesium-137 and rubidium-86 tagged to particles and cesium-137 as an aqueous application. Efficacies of decontamination technologies may differ with different radionuclides.

A summary of the evaluation results for these low-tech decontamination methods is presented below, and a discussion of the observed performance can be found in Section 4 of this report.

Decontamination: The results indicated that the aqueous simulated fallout material (ASFM) was much more difficult to remove than the simulated fallout material (SFM), and particle size was usually not a factor in SFM removal. In particular, the porous surfaces such as asphalt shingles, asphalt roofing, wood shingles, wood siding, stucco, or concrete exhibited extremely low percent removals (%Rs) for the ASFM. Also, when wiping methods such as pre-wet wipes, sponges, or mold wash were used on surfaces that were rough, the %Rs were decreased compared to smooth surfaces. The amount of waste is driven by the surface density of the fallout material as well as the weight of the tools used. The data from this project show that vacuums are effective tools and that, depending on the surface, wipes and cloths were rather effective. Lastly, the mockup of one side of a house (mock wall) and pump sprayer (power washing, water hosing) hardscape experiments demonstrated that water rinsing can be an effective decontamination approach.

Decontamination Efficacy Summary

	Roofing
Asphalt roofing	• SFM %R 10-78%, removal variable among broom, wipe, and sponge methods; • highest ASFM %R 8%; • wall spray in mock-up setup %R >97% for SFM and 15% for ASFM
Asphalt shingles	• SFM %R 22-61% for broom, wipe, and sponge methods; vacuum %R >97% • ASFM %R 1-4%; • mock wall spray %R near 100% for SFM and 10-20% for ASFM
Clay tiles	• SFM %R near 100% for wipe and sponge (only methods used), • ASFM %R 27-37%; • mock wall spray %R near 100% for SFM and 52% for ASFM
Gutter	• SFM %R near 100% for all methods used; • ASFM %R 18% for vacuum, but 91% for wipes and 100% for sponge
Metal roofing	• SFM %R near 100% for all methods used; • ASFM %R 42% for broom, but 99% for wipes and sponge; • mock wall spray %R near 100% for SFM and 99% for ASFM
Wood shingles	• SFM %R 67-87% for broom and sponge methods, vacuum %R >97%; • ASFM %R were between 0-10%; • mock wall spray %R 98% for SFM and 38% for ASFM (Highly fibrous surface)
Siding and Other Surfaces	
Aluminum siding	• SFM %R >96% for all methods, • ASFM 75%, 87%, and 100% for sponge, wipes, and mold wash
Composite fence	• SFM %R 80%-96%, • ASFM 69% and 82%; wipes and sponge (only methods used)
Plastic slide	• SFM and ASFM %R all near 100%, wipes and sponge (only methods used)
Steel siding	• SFM %R >93% for all methods, • ASFM %R all near 100%
Stucco	• SFM %R 62%-98% with mold wash being highest, • ASFM %R 0-4%
Vinyl siding	• SFM %R >94% for all methods, • ASFM %R all near 100%; • mock wall spray %R >91% for ASFM (fan sprayer setting most effective)
Window	• SFM and ASFM %R all near 100%; • mock wall spray %R >96% for ASFM using cone and fan settings and 88% for stream setting

Wood siding	• SFM %R >88% for all methods with heavier loading having higher %Rs, • ASFM %R 12-20%; • mock wall spray %R 32% for ASFM
	Hardscape
Asphalt drive	• SFM %R 29-100% with mop and vacuum being highest and squeegee the lowest; • ASFM %R 0-23% with the mop being the highest
Brick pavers	• SFM %R 27-100% with vacuum being highest and squeegee the lowest; • ASFM %R 0-6%; lighter particle load removed less well than heavier with push broom
Concrete pavers	• SFM %R 22-100% with vacuum being highest and squeegee the lowest; • ASFM %R 2-3%; lighter particle load removed less well than heavier with push broom
Sidewalk concrete	• SFM %R >90% for all methods with exception of squeegee which was 53-83% and light loaded mop (86%); • ASFM removals 0-5%
Stained wood deck	• SFM %R >90% for all methods; • ASFM %R 2-7% for the vacuum and push broom, %R 47% for the deck wash, and 49% for the spray removal

Deployment and Operational Factors: Section 4 provides an operational summary of the various low-tech decontamination methods that were employed during testing by presenting observations made by the operators using each low-tech decontamination method. Examples include information on deployment of wipes and cloths which can conveniently be transported between sites (in new packaging), and can possibly be disposed of at each site more efficiently than attempting to transport powered equipment that would have become contaminated.

In addition, Section 4 describes the fate of the SFM (containing radiological activity) following decontamination. The determination of the fate of the SFM was done by performing a qualitative radiological survey of the tools used for decontamination. After every decontamination experiment, the operators were surveyed from head to toe to determine if they had received any contamination on their personal protective equipment (PPE) including powered air purifying respirators (with HEPA filters). None of those surveys resulted in activity measurements above background levels, as evidenced by little to no contamination on the gloves of the decontamination workers and the high activity found on the low-tech decontamination tools. Furthermore, almost all of the activity was isolated on the item that was in contact with the surface being decontaminated.

Based on the results of the decontamination experiments described above, the amount (and types) of radiological waste that would be generated from the decontamination of the exteriors of a typical house (using the most effective decontamination methods) was estimated. For this example, the exterior of a two-story house assumed to be 186 square meters (2,000 square feet) was used. The total solid waste generated was estimated to be 181 kilograms (kg). The level of activity in the waste will be dependent on the initial contamination levels, which will then, in turn, affect waste management activities. If water rinsing is used, the technology generates large amounts of runoff that may likely to be collected to reduce any secondary contamination. This runoff may be liquid waste that will either be disposed of as solidified liquid or directly as liquid waste.

Several air samplers were positioned throughout the testing to measure the potential inhalation dose for the decontamination worker. The air sampler filters never exceeded 0.2% of the derived air concentration, which is the average atmospheric concentration of the radionuclide that would lead to the annual occupational limit of intake of the radionuclide if working in that environment for a 2,000 hour working year.

The project described in this report focused on the low-tech radiological decontamination method efficacy of outdoor surfaces; an early report provided information on the low-tech radiological method decontamination efficacy on indoor surfaces(1). The combined results of which indicate that there are some decontamination methods that are readily available, inexpensive, can be conducted by untrained people, that are effective at decontamination and are able to be accomplished without personal contamination or significant dose received. Results indicate that vacuum removal is an extremely effective low-tech decontamination technology for particle contamination onto hard surfaces with minimal pores. In addition, pre-wet wipes are also a very effective low-tech removal technology for particle and aqueous contamination for hard, smooth, non-porous surfaces. Several other technologies also provide consistent decontamination, but these two technologies stand out as very consistent decontamination methods.

1.0 Introduction

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for environmental cleanup after the release of chemical, biological, radioactive, and nuclear (CBRN) contaminants. EPA's Homeland Security Research Program (HSRP) is tasked to perform scientific studies and develop strategies and guidance that can be deployed during a CBRN incident. For wide area radiological or nuclear (Rad/Nuc) incidents (e.g., nuclear power plant accident, discharge of a radiological dispersal device or improvised nuclear device); there may be outdoor areas around personal residences, office buildings, or critical infrastructure like firehouses and hospital emergency rooms that may be impacted with Rad/Nuc material and require cleanup. However, the radiological activity in these areas may not be high enough to warrant the evacuation of residents. These homeowners, contractors, office workers, firefighters, hospital workers, and/or others may want or need to take action themselves to reduce the potential radioactive dose to those living or working in these areas. Early government-funded cleanup efforts will most likely focus mainly on restoring/decontaminating critical infrastructure in areas where radioactive contamination levels are high enough to warrant evacuation. Following the Fukushima Nuclear Power Plant incident, the Japanese national government developed guidance[(2)] for decontamination strategies specifically focused on residential structures. This guidance outlined which areas required decontamination, which technologies were applicable for the affected areas, and in what order these areas should be decontaminated. The document also provided guidance for on-site waste management. The objective of the work described here is to collect information and experimental data on decontamination efficacy, potential exposure from, and waste generated by low-tech outdoor radiological decontamination methods available in the United States for possible use by homeowners, contractors hired by homeowners, or first responders to reduce exposure.

This technology evaluation included use of low technology (low-tech) decontamination methods on surfaces common to outdoor residential environments and included evaluating the decontamination efficacy, method constraints, safety concerns, feasibility, waste generation, potential exposure, and cost. Prior to pilot scale testing; a literature review was conducted to identify, collect, evaluate, and summarize available articles, reports, guidance documents, and other pertinent information related to common housekeeping activities within the United States. This literature review resulted in a summary compendium including relevant information about multiple low-tech cleaning methods from the literature search results. Through discussion and prioritization, an EPA project team, made up of several EPA scientists and emergency responders, focused the information into a list of 10 outdoor cleaning activities (e.g., vacuuming, sweeping, wet wiping) for decontamination evaluation testing. These types of activities are collectively referred to as "low-tech" decontamination methods because of the comparatively simple tools, equipment, and operations involved. Additionally, 20 common outdoor surfaces (including roofing material, siding, hardscape surfaces, etc.) were chosen that were contaminated using three different contamination conditions. Seventy-three combinations of methods and surfaces were chosen for testing under the selected contamination conditions.

Pilot scale decontamination testing was performed using several common outdoor surfaces (paved surfaces, roofing, walls, decking, etc.) with an area of approximately 0.7 square meters (m^2). Testing included deposition and measurement of the radioactive contaminant on the surface, application of the decontamination method, and subsequent measurement of residual contamination to determine a quantitative decontamination efficacy (i.e., effectiveness of radionuclide removal) attained by each method. Semi-quantitative and quantitative information pertaining to each method was collected. This type of information included number of wipes, sponge pads, etc., used, relative level of contamination on decontamination accessories, and level of contamination on the components of a low-tech decontamination tool (e.g., handle, support end, and sponge end). Qualitative information on operational ease and appearance of the surfaces after decontamination was also collected. The results presented here include cesium-137 and rubidium-86 tagged to particles and cesium-137 as an aqueous application. Efficacies of decontamination technologies may differ with different radionuclides.

2.0 Experimental Details

This technology evaluation included use of low-tech decontamination methods on surfaces common to outdoor residential environments and included evaluating the decontamination efficacy, method constraints, safety concerns, feasibility, waste generation, potential exposure, and cost. This evaluation included the radiological contaminants cesium (Cs)-137, with a half-life of 30 years, added to Arizona Road Dust (ARD) with particle size greater than 250 micrometers (µm) and rubidium (Rb)-86 added to ARD particles between 1 and 10 µm to generate simulated fallout material (SFM) as dry deposition. Rubidium, with a half-life of 19 days, was chosen as a shorter-lived surrogate for Cs, and it possesses chemical properties similar to cesium[3].

The dry deposition of particles was conducted using a heavy and a light loading onto the surfaces for two distinct contamination conditions. For the heavy loading experiments, high activity material was applied to each of the 4 individual test squares (15x15 cm marked subsections) on each 0.7 m^2 or the item's common size surface (test coupon), and low activity material was applied to the remainder of the surface. For the light loading experiments, fine grained material was applied to only the test squares. An aqueous solution of Cs-137 (as cesium chloride) was applied to each surface to simulate a contamination event where the SFM had initially been wet due to precipitation or some other source of water and then dried. This contamination approach will hereafter be referred to as aqueous SFM (ASFM). For each surface sample, the SFM or ASFM was deposited on the surface, a pre-decontamination measurement of activity was performed, the low-tech decontamination method was applied, and lastly, a post-decontamination measurement of activity was conducted. All of the radiological work was conducted in a 4 m × 2.6 m × 2.1 m contamination control tent located in a high bay area.

2.1 Experimental Preparation

2.1.1 Surfaces

This technology evaluation included use of low-tech decontamination methods on surfaces found around a home or commercial buildings (industrial plants, shopping areas, hospitals, schools, etc.) where people live, work, traverse, and/or visit. Surface types chosen for this evaluation included a variety of materials used for roofing, walls, decking, driveways, sidewalks, etc. The material samples were large enough to be considered pilot scale, i.e., a scale large enough to simulate use of the decontamination methods on surfaces that are relatively inconvenient and/or expensive to remove and replace. The surfaces were divided into several classes summarized in Table 2-1.

Table 2-1. Description of Surface Materials

Surface Types	Source Information
	Roofing
Asphalt roofing	Shasta White Rolled Roofing, Owens Corning, Toledo, OH
Asphalt shingles	Royal Sovereign Charcoal 3-Tab Shingles, GAF, Parsippany, NJ
Clay tiles	Spanish Field Tile, Ludowici, New Lexington, OH
Gutter	K-Style White Aluminum Gutter, Gibraltar Brands, Skokie, IL
Metal roofing	Classic Rib Steel Roof Panel, Metal Sales Manufacturing Corp., Louisville, KY
Wood shingles	Red Cedar Shake, Roofing Wholesale, Columbus, OH
	Siding and Other Surfaces
Aluminum siding	Textured Gray Aluminum Siding, Sell Even Building Products, Appleton, WI
Composite fence	Enhance 8-ft Saddle Composite Deck Board, Trex, Winchester, VA
Plastic slide	1st Slide, Little Tikes, Hudson, OH
Steel siding	Beige Steel Siding, Midwest Manufacturing, Eau Claire, WI
Stucco	Rapid Set Stucco Mix, CTS Cement Manufacturing Corp., Cypress, CA
Vinyl siding	Khaki Vinyl Dutch Lap Siding, Ply Gem, Cary, NC
Window	V1000 Single Hung Thermostar, Pella Windows, Pella, IA
Wood siding	Smooth Log Siding, Meadow Valley Log Homes and Siding, Mather, WI
	Hardscapes
Asphalt drive	Used parking lot asphalt, Columbus Ohio Asphalt, Columbus, OH
Brick pavers	Clay Brick Flats (Alamo Sunrise), Brickweb, Old Mill Brick, Inc., Salt Lake City, UT
Concrete pavers	Square Gray Patio Stone, Lowes, Mooresville, NC
Sidewalk concrete	Quikrete, Quikrete Companies, Atlanta, GA
Stained wood deck	Prime Ground Contact Pressure-Treated Lumber, Home Depot, Atlanta, GA Cedar Naturaltone Semi-Transparent Stain and Sealer, Behr, Santa Ana, CA

Surface materials were positioned in the evaluation based on how they are typically installed in the outdoor environment and whether the materials are cleaned by hand or using a handled device such as a broom or vacuum. Paved surfaces were positioned and decontaminated on the floor, and the other surfaces were positioned and decontaminated on a table top. For all surfaces, the test coupon size was approximately 0.7 m^2 or a common size of the item itself (e.g., gutter, window). All surfaces (except the asphalt drive surface) were purchased new, so the surfaces were clean and undamaged. Newly purchased surfaces were staged and put through the evaluation steps in an indoor location containing a radiological containment tent, minimizing differences in conditions during use of the various methods over the course of the evaluation testing. Older or weathered surfaces found on homes and commercial buildings may not present the same results due to the surface aging and weathering. Figures 2-1 through 2-3 are pictures of the roofing, siding and other surfaces, and hardscapes, respectively. Figure 2-4 is a picture of the mock wall setup used for spray decontamination experiments of roofing and siding surfaces.

Figure 2-1. Roofing surfaces: asphalt roofing, asphalt shingles, clay tiles (top row left to right), gutter, metal roofing, and wood shingles (bottom row left to right).

Figure 2-2. Siding and other surfaces: vinyl (representative of aluminum and steel as well), composite fence, stucco (top row left to right), wood siding, window, and plastic slide (bottom row left to right).

Figure 2-3. Hardscape surfaces: brick pavers, asphalt drive, concrete pavers (top row left to right**), stained wood deck, and sidewalk concrete (bottom row left to right).**

Figure 2-4. Mock wall setup with asphalt shingles, vinyl siding, gutter, and downspout.

All the radiological work was conducted in the tent shown in Figure 2-5 (Dual Chamber Tent, LANCS Industries, Kirkland, WA), which was located in an indoor high bay area (Building JS-23 in West Jefferson, OH). The evaluation tent measured approximately 4 m × 2.6 m × 2.1 m with separate rooms for donning PPE (protective coveralls, hoods, booties, shoe covers, gloves) and performing the experiments. Decontamination technicians wore respiratory protection (powered air purifying respirators with HEPA filters) while performing the experimental procedures. The tent was connected to a high efficiency particle air (HEPA) filtration system, and two air samples were run outside the tent confirming function of the HEPA filter.

Figure 2-5. Containment tent used for all experiments.

2.1.2 Surface Contamination

Three contaminant deposition approaches (heavy SFM loading, light SFM loading, and ASFM) were used to evaluate the decontamination methods and are described in Table 2-2. In an actual fallout event, the level of material loading would vary greatly depending on the height of a possible explosion, ground characteristics below a possible explosion, distance from radiological release, meteorological conditions, ventilation of residences or offices, etc. Previous fallout decontamination research[4-5] (mostly outdoor) has used surface densities of approximately 20 milligrams (mg)/square centimeter (cm^2), so this density was used as the heavy SFM loading. This relatively high level served as a severe contamination case scenario for decontamination, possible worker contamination, and waste handling. An SFM density of 2 mg/cm^2 was used as a light SFM loading to simulate a less heavy loading that may be more representative of more actual scenarios. Regardless of approach, each outdoor surface material was marked with four numbered squares using permanent marker. The test squares were 15 cm × 15 cm and used to define the areas of quantitative decontamination evaluation and to ensure that the pre- and post-decontamination gamma measurements were taken from the same locations.

Table 2-2. Summary of Contamination Experimental Conditions

Deposition Approach	Contaminant	Loading on Surface
Heavy SFM Loading	Cs-137 tagged to >250 µm ARD Rb-86 tagged to 1-10 µm ARD	4 g 1:1 high activity (2 µCi Cs-137 and (20 µCi Rb-86) particle size mixture on test square (20 mg/cm^2) 20 mg/cm^2 1:1 low activity (0.1 µCi Cs-137 and (1 µCi Rb-86) particle size mixture on remaining test coupon surface
Light SFM Loading	Cs-137 tagged to 1-10 µm ARD	0.5 g ARD (2 µCi Cs-137) deposited on each test square
Aqueous SFM	Cs-137 in deionized water	Sprayed on test squares and allowed to dry (2 µCi Cs-137)

Heavy SFM loading. The first contaminant deposition approach included a heavy SFM loading consisting of ARD in two particle size ranges. This approach has been used during previous EPA radiological decontamination technology evaluations[1]. Cs-137 was tagged to ARD particles that were greater than 250 µm in diameter (12203-250 Test Dust, Powder Technology, Inc., Arden Hills, MN) at an activity concentration level of 1 microcurie (µCi)/gram (g), and Rb-86 was tagged to ARD particles that ranged from 1 to 10 µm (ISO 12103-1 A1 Ultrafine Test Dust, Powder Technology, Inc., Arden Hills, MN) at an activity concentration level of 10 µCi/g. The Cs-137 (#8137, Eckert & Ziegler Analytics, Atlanta, GA) used for tagging was obtained as 5 milliliter (mL) volumes of 20 µCi/mL in 0.1 molar aqueous hydrochloric acid, and the Rb-86 (N9300145, Perkin Elmer, Waltham, MA) was obtained as 1 millicurie (mCi) in microliter volumes of water. For both particle types, SFM was made by adding dilute aqueous radionuclide to a fixed amount of the substrate, mixed to be thoroughly damp, and then allowed to dry. Approximately 2 g of each particle size was measured into a salt shaker (166A Tablecraft, Shenzhen, China) and rotated to mix well. For particle application, one shaker was emptied onto each surface square corresponding to 10 mg/cm^2 of each SFM for a total particle density of 20 mg/cm^2 and 2 µCi of Cs-137 and 20 µCi of Rb-86 on each square. The remaining surface was then covered at the same particle density and size, but with a lower activity (0.1 µCi/g Cs-137 and 1 µCi/g Rb-86) particle mixture to mimic a more actual event and for minimization of worker dose.

Light SFM loading. The second deposition method consisted of a lighter particle load and included only 1 to 10 µm ARD tagged with Cs-137 at an activity concentration level of 8 µCi/g. Only 0.5 g of these particles was sprinkled onto each square so that the particles were just above the visible threshold (see middle photo below) for an extremely light loading, resulting in a total of 2 µCi of Cs-137 on each square. The SFM was prepared in a similar manner, adjusting the amount of Cs-137 and mass of particles accordingly.

Aqueous Contamination. The third application included 2.5 mL of an aqueous mist of Cs-137 at a concentration of 0.8 µCi/mL (diluted from the source standard with deionized water) for a total addition of 2 µCi per square. A similar contamination approach has been used during several EPA radiological decontamination studies[8-14]. The ASFM mist was delivered manually to each surface using a calibrated sprayer (11 pumps correspond to approximately 2.5 mL). Exact calibration of this sprayer was not required as the gamma radiation measurement for each surface before decontamination (not the volume of radionuclide applied) is the critical measurement for determination of applied radionuclide. A small amount of pooling on the surface being contaminated occurred as expected during the application of the liquid aerosol, so the surface was air dried prior to gamma radiation measurement. A uniform application of solution was applied to each surface. The uniformity of application was based only on observance by the experimental staff during spray application. Figure 2-6 shows the three different approaches used for contaminating the surfaces.

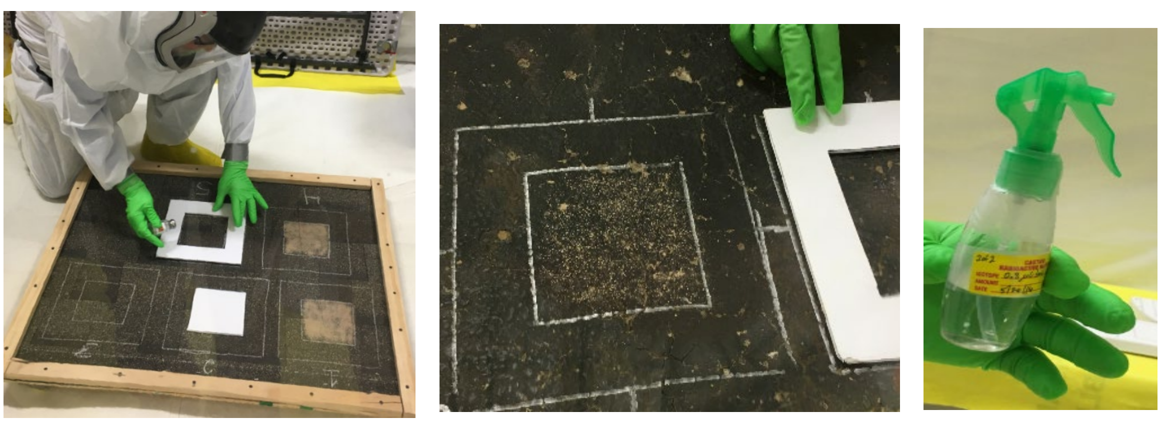


Figure 2-6. Contamination of asphalt shingles with a heavy SFM loading on squares (left). Light SFM loading on asphalt drive (center), and ASFM applicator (right).

2.1.3 Measurement of Activity on Test Coupon Surface

Following surface contamination, the Cs-137 and/or Rb-86 gamma radiation was measured (in the channels of interest only) by placing the spectrometer approximately 2.5 cm above the contaminated test square on the surface. The activity measurements were made using an InSpector^{TM} 1000 Digital Hand-Held multichannel analyzer (MCA) (Canberra Industries, Inc., Meriden, CT). The pre-decontamination counts were collected over a 100-second measurement period, and the post-decontamination counts were taken over a 300-second (five-minute) measurement period (counts were normalized by pre- and post- decontamination counting times).

Because of the variable geometries of contaminant application, no activity calculations were performed.

The measurement of gamma radiation from the surfaces is a non-destructive measurement technique; surfaces that had been contaminated with SFM or ASFM and had the gamma radiation measured were then decontaminated using the low-tech method. Following application of the decontamination method, the residual activity on the surface was measured again to calculate the percent removal (%R). Careful positioning of the gamma spectrometer above the contaminated squares was performed to account for any differences in geometry of the surfaces that could confound the gamma measurements. Reproducible positioning was done by attaching a support stand around the detector face. The support stand allowed the detector to be set down on top of each 15 x 15 test square in a location that was labeled ahead of time with a permanent marker. This feature facilitated repeatable geometry due to the consistent position of the detector face with respect to the surface and location because of the ease of positioning onto the pre-marked surface.

Figure 2-7. InSpector™ 1000, Digital Hand-Held MCA with support to facilitate repeatable geometry.

2.2 Decontamination Methods

Throughout the course of this evaluation, the evaluation tent was staged separately with the contaminated surfaces given in Table 2-1 (a total of 62 outdoor wall surfaces corresponding to over 180 separate surface decontamination experiments) with various surfaces for application of the decontamination methods evaluated. In most cases, four replicate surface measurements (the 4 test squares on each test coupon) were included for each surface. Once contaminated with a heavy SFM loading, an initial pass for a decontamination method in a single direction or standard “sweeping action” where particles were collected at one end of the surface was performed. Then, the same decontamination method was applied to the staged surface in a way that resulted in two complete passes over the entire surface as presented in Figure 2-8. The first pass took place in one direction, implementing an “S” pattern (or back and forth) across the surface, covering the entire surface, then a second pass (using the same pattern) occurred in the perpendicular direction, so the entire surface had been treated a second time. There were also 11 experiments performed on a mock-up of one side of a house (mock wall) that used only the pump sprayer on the roof and walls. A similar spray pattern (0.2 m from the surface at 1-5 pounds per square inch pressure) was followed as for the wipe pattern described above. For hardscape pump sprayer applications, the surfaces were placed in a ground containment and sprayed following a similar pattern (0.1 m from the surface at 1-5 pounds per square inch pressure). The low-tech methods used in this evaluation are presented in Table 2-3.

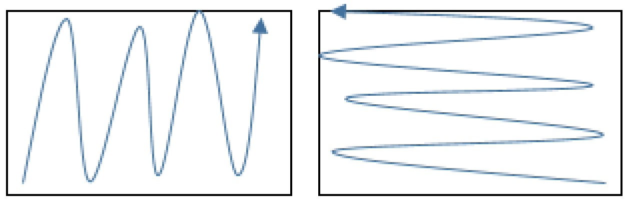


Figure 2-8. Pass 1 pattern (left) and Pass 2 pattern (right) with decontamination approaches.

In addition to the evaluation of the decontamination method efficacy, the potential for resuspension of radiological material was measured using low volume air particulate samplers positioned 0.25 m and 0.5 m from the surfaces during application of each low-tech method. Radiological air sampling and analysis was performed daily (per a Battelle standard operating procedure) to collect suspended particles and to measure potential dose during the method evaluation. Air particulate samples were collected inside and outside the radiological containment area (area samples) as well as from within the breathing zone (personal samples) of the decontamination technicians. Air sampling pumps operating at 2-3 liters per minute were connected to holders containing round quartz fiber filters (60 millimeters (mm) in diameter) and operated for the duration of the time that the decontamination technicians were working within the radiological containment area. The activity on the filters was counted daily to document air concentrations.

Potential dermal exposure to users of low-tech decontamination methods was monitored by conducting qualitative radiological surveys of the PPE of the workers after decontamination activities. The focus was on the hands (covered by PPE) of the workers and other areas that were likely to have been exposed to the SFM or ASFM. All gloves used by the workers were collected and surveyed together using a qualitative survey instrument (Ludlum Model 3 with 44-9 probe, Ludlum Measurements, Inc., Sweetwater, TX), and the locations of contamination were documented on a data collection form. In addition, other items such as wipes and towels were counted and surveyed to determine the approximate amounts of activity and magnitude of waste streams generated by use of these decontamination methods.

Table 2-3. Low-Tech Decontamination Methods Used for the Evaluation[1]

Surface	Decontamination Method	Source	Method Comments
Roofing	Vacuum	2.25 Horsepower, Shop-Vac®, Williamsport, PA	Used flat 4-inch attachment and then used hose only for final pass.
	Kitchen broom	Precision Angle Broom, Libman, Arcola, IL	Swept particles into a pile on surface and used vacuum for disposal.
	Push broom	18" Multi-Surface Commercial Push Broom, Libman, Arcola, IL	Swept particles into a pile on surface and used vacuum for disposal.
	Pre-wet wipes	Disinfecting Wipes, Clorox® Company, Oakland, CA	Collected particles in wipes until surface visibly clean and no more improvement was visible.
	Sponge	Ocelo Cellulose Sponge (4 in x 6 in), 3M, St. Paul, MN	Collected particles in water-wetted sponges until surface visibly clean.
Siding and Other Surfaces	Mold wash with terry towels	Liquid Mold Remover, Wet and Forget, Chicago, IL; HDX, Model 7-660, Home Depot, Atlanta, GA	Sprayed mold wash on particles and then used terry towels to wipe surface. Repeated until visibly clean or until no more improvement was visible.
	Pre-wet wipes	Disinfecting Wipes, Clorox® Company, Oakland, CA	Same as pre-wet wipe description above.
	Sponge	Same as sponge description above.	Same as sponge description above.
	Squeegee water rinse	Metal Handle General-Duty Squeegee, Unisan, Los Angeles, CA	Wetted particles with a water bottle of water and squeegeed the surface until no more improvement was visible.
Hardscapes	Deck wash	Biodegradable Deck Cleaner, Olympic, Pittsburgh, PA	Sprayed deck wash on particles and then used damp sponge to wipe surface. Repeated until visibly clean or until no more improvement was visible.
	Vacuum	Same as vacuum description above.	Same as vacuum description above.
	Squeegee water rinse	Same as squeegee water rinse description above.	Same as squeegee water rinse description above.
	Mop	Blend Mop Head, Rubbermaid Commercial Products, Atlanta, GA	Thoroughly wetted mop and then cleaned surface until no more improvement was visible.
	Push broom	Same as push broom description above.	Same as push broom description above.
	Pump Sprayer	Multi-Purpose Sprayer (All-in-one Nozzle), Scotts, Marysville, OH	Used all nozzle settings. Pumped 10 times and when pressure noticeably decreased, pumped 10 more times. For roofing, ~0.2 m from surface; for hardscapes, ~0.1 m from surface.

1 Photographs and video of technologies can be found in Appendix A.

2.3 Decontamination Conditions

The evaluation was performed over the course of approximately four months from May through September 2017 and approximately 1.5 months during January and February 2018. During the evaluation, the temperature in the tent averaged 23.9 ± 1.6 degrees Celsius and the relative humidity averaged 63% ± 5%. Tables 2-4 through 2-6 present the combinations of decontamination methods and surfaces tested during this study. All three contamination deposition approaches were used with these test combinations. For the mock wall spray experiments, SFM and ASFM were applied to the roofing while only ASFM was applied to the siding.

Table 2-4. Test Matrix of Decontamination Methods for Roofing Surfaces

	Decontamination Methods				
Surfaces	Vacuum	Broom	Pre-wet Wipes	Sponge	Mock Wall Spray
Asphalt roofing		×	×	×	×
Asphalt shingles	×	×		×	×
Clay tiles			×	×	×
Gutter	×		×	×	
Metal roofing		×	×	×	×
Wood shingles	×	×		×	×

Table 2-5. Test Matrix of Decontamination Methods for Siding and Other Surfaces

	Decontamination Methods				
Surfaces	Mold Wash	Pre-wet Wipes	Sponge	Squeegee	Mock Wall Spray
Aluminum siding	×	×	×		×
Composite fence		×	×		
Concrete siding					×
Plastic slide		×	×		
Steel siding	×	×	×		
Stucco	×	×	×		×
Vinyl siding	×	×	×		×
Window		×	×	×	×
Wood siding	×	×	×		×

Table 2-6. Test Matrix of Decontamination Methods for Hardscape Surfaces

	Decontamination Methods					
Surfaces	Deck Wash	Vacuum	Squeegee	Mop	Push Broom	Pump Sprayer
Asphalt drive		×	×	×	×	
Brick pavers		×	×	×	×	×
Concrete paver		×	×	×	×	×
Sidewalk concrete		×	×	×	×	×
Stained wood deck	×	×			×	×

3.0 Quality Assurance/Quality Control

This evaluation was conducted at Battelle's West Jefferson Campus, in West Jefferson, Ohio. Quality Assurance (QA)/quality control (QC) procedures were performed in accordance with the project-specific Quality Assurance Project Plan for this evaluation. Before contaminating each surface, the background activities of the surfaces were determined by a five-minute data acquisition. Per quality requirements, two audits were conducted: a technical systems audit and an audit of data quality on the results from the evaluation. The background measurements fluctuated daily due to the contents in the tent at the time of gamma measurement. The measurement results were corrected for the background levels measured on the respective testing days. Typical background activity levels were on average 1%±2% of the pre-decontamination activity levels.

3.1 *InSpector™ 1000*

The InSpector™ 1000 was set up to monitor for Cs-137 and Rb-86. A positive control coupon (15 cm × 15 cm cardboard coupon sealed/contained with duct tape) was contaminated with the ASFM Cs-137 and allowed to dry. This coupon was measured at the beginning and end of each testing day using a 100-second acquisition to ensure the instrument was performing consistently throughout the day. The relative percent difference (RPD) was calculated for 62 paired positive control measurements and ranged from 0% to 5%. In addition, the raw gamma counts collected daily throughout the course of the 2017 and 2018 testing operations had relative standard deviations of 1% and 2%, respectively, indicating very consistent instrument performance. A duplicate measurement was taken on one of the replicate contaminated squares from each experiment to provide duplicate measurements to further evaluate the repeatability of the instrument. The average and standard deviation for the RPDs determined for this instrument were 3% ± 5% (N=154). There were two results that exceeded the 25% RPD requirement. The results were reported as one instance had low counts post-decontamination, thus increasing the percent difference even though the absolute difference in counts was small, and the other surface had inconsistent geometry making exact placement of the sensor more difficult.

3.2 Audits

3.2.1 Technical System Audit

A technical systems audit was performed on June 12, 2017, to confirm compliance with project quality requirements. The audit report was completed, and no findings or observations were reported.

3.2.2 Data Quality Audit

At least 10% of the data acquired during the evaluation were audited. The QA officer traced the data from the initial acquisition, through reduction and statistical analysis, to final reporting, to ensure the integrity of the reported results. All calculations performed on the audited data were checked for accuracy. The audit revealed a %R formula error that was corrected in the report and data spreadsheets.

3.3 QA/QC Reporting

Each assessment and audit was documented in accordance with project quality requirements. Once the assessment report was prepared by the QA officer, the report was routed to the task order leader and Testing and Evaluation II (T&E II) program manager for review and approval.

4.0 Evaluation Results and Performance Summary

4.1 Decontamination Efficacy

The decontamination efficacy was determined for each contaminated test coupon in terms of %R:

%R = 1-(A_f-BG)/(A_o-BG) × 100%

or

$$\%R = 1 - \frac{(A_f - BG)}{A_0 - BG} \times 100\%$$

where A_o is the radiological activity from the surface of the test coupon before application of the decontamination technologies, A_f is the radiological activity from the surface of the coupon after decontamination, and BG is the background before contamination. As discussed in Section 2.1.2, approximately 2 µCi of Cs-137 and 20 µCi of Rb-86 was added to each heavy loading SFM test square, approximately 2 µCi of Cs-137 to the light loading SFM test square, and approximately 2 µCi of Cs-137 to each ASFM test square. Because of the variability in particle application geometry and because of the time it would take to perform an instrument calibration regularly, the raw counts for each radionuclide were used to calculate %R. The background activity was, on average, 1%±2% of the pre-decontamination counts. Therefore, a 100%R shown in the results may not be distinguishable from 97%R because the magnitude of the background. The term 'significantly different' is defined as a difference exceeding the standard deviation of the average %R (derived from the replicate results) of the conditions being compared.

Roofing. Table 4-1(a and b) gives the average %R for each low-tech decontamination method used on roofing materials categorized by the contaminant deposition techniques. Each %R is given with the standard deviation over four replicates. If the %R is reported with a 'greater than' sign (>), the average %R exceeded 100% and is reported as having %R greater than the lower limit of the average minus the standard deviation.

Observations about the heavy loading SFM roofing material decontamination efficacy data include:

- Particle Size:
  - Efficacy at each particle size was significantly different (lower %R for larger particles) for only wood shingles (kitchen broom), asphalt roofing (pre-wet wipes and wet sponge), and asphalt shingles (wet sponge).
  - In 14 of 34 instances (across both particle sizes), the average %R was less than 90% and in six of those instances, the averages were less than 50%R.
  - In 20 of 34 instances (across both particle sizes), the average %R was 95% or above.
  - The largest standard deviation was 9%.
- Technology:
  - Use of the pre-wet wipes on the asphalt roofing provided the lowest average %R, which was 10% for the large particle size.

- Using a kitchen broom on the asphalt roofing resulted in the next lowest average %R with 23% and 22% for the large and small particle sizes, respectively.

Observations about the light loading SFM (roofing material) decontamination efficacy data include:

- 10 out of 17 average %R values were 98% and above; in the seven instances where the light load SFM %R was less than 98%, the heavy load %R was also below 98% at a similar magnitude.

Observations about the ASFM (roofing material) decontamination efficacy data include:

- Only four of 18 instances (wet sponges and pre-wet wipes on metal roofs and gutters) had average %R exceeding 90% (ranging 91%-100%);
- No other instance exceeded 48% (kitchen broom on metal roofing).
- Several material/method combinations had little or no removal
  - vacuum/asphalt and wood shingles, (%R of 1- 2%)
  - kitchen broom/asphalt shingles, (%R of 1%)
  - pre-wet wipes/asphalt roofing, (%R of 0%)
  - push broom/wood shingles, (%R of 1%)
  - wet sponge/asphalt roofing and shingles and wood shingles. (%R of 1- 4%)

Table 4-1a. Decontamination Efficacy for Roofing Materials by Method

Method	Surface	% Removal for Each Contamination Deposition Approach			
		Cs-137, >250 µm Heavy Load SFM	Rb-86, <10 µm Heavy Load SFM	Cs-137, <10 µm Light Load SFM	Cs-137 ASFM
Vacuum	Asphalt Shingles	97% ± 0%	97% ± 0%	98% ± 1%	2% ± 1%
	Gutter	100% ± 0%	100% ± 0%	100% ± 0%	18% ± 5%
	Wood Shingles	99% ± 0%	99% ± 1%	98% ± 0%	0% ± 2%
Kitchen Broom	Asphalt Shingles	23% ± 6%	22% ± 8%	25% ± 3%	1% ± 1%
	Metal Roofing	>100% ± 1%	100% ± 0%	98% ± 1%	42% ± 4%
	Wood Shingles	87% ± 3%	74% ± 4%	71% ± 9%	10% ± 16%
Prewet Wipes	Asphalt Roofing	10% ± 5%	47% ± 1%	52% ± 8%	0% ± 1%
	Clay Tiles	97% ± 1%	100% ± 1%	99% ± 1%	27% ± 3%
	Gutter	100% ± 0%	100% ± 0%	99% ± 1%	91%[a] ± 1%
	Metal Roofing	98% ± 1%	99% ± 1%	99% ± 0%	99% ± 0%
Push Broom	Asphalt Roofing	41% ± 10%	63% ± 11%	53% ± 17%	3% ± 13%
	Wood Shingles[b]				1% ± 2%
Wet Sponge	Asphalt Roofing	50% ± 5%	67% ± 2%	78% ± 3%	8% ± 4%
	Asphalt Shingles	27% ± 9%	47% ± 8%	61% ± 3%	4% ± 1%
	Clay Tiles	100% ± 0%	100% ± 0%	99% ± 0%	37% ± 3%
	Gutter	99% ± 1%	99% ± 1%	100% ± 2%	100% ± 2%
	Metal Roofing	99% ± 0%	100% ± 0%	99% ± 0%	99% ± 1%
	Wood Shingles	81% ± 4%	81% ± 5%	67% ± 17%	10% ± 2%

[a] Initial testing %R result was 76%, repeated as seemed unexpectedly low, no explanation for initial result.
[b] Blackened cells were not tested because the decontamination approach was not applicable to the surface.

Table 4-1b. Decontamination Efficacy for Roofing Materials by Surface

Surface	Method	% Removal for Each Contamination Deposition Approach			
		Cs-137, >250 µm Heavy Load SFM	Rb-86, <10 µm Heavy Load SFM	Cs-137, <10 µm Light Load SFM	Cs-137 ASFM
Asphalt Roofing	Wet Sponge	50% ± 5%	67% ± 2%	78% ± 3%	8% ± 4%
Asphalt Shingles	Vacuum	97% ± 0%	97% ± 0%	98% ± 1%	2% ± 1%
	Push Broom	41% ± 10%	63% ± 11%	53% ± 17%	3% ± 13%
	Wet Sponge	27% ± 9%	47% ± 8%	61% ± 3%	4% ± 1%
	Kitchen Broom	23% ± 6%	22% ± 8%	25% ± 3%	1% ± 1%
	Prewet Wipes	10% ± 5%	47% ± 1%	52% ± 8%	0% ± 1%
Wood Shingles	Vacuum	99% ± 0%	99% ± 1%	98% ± 0%	0% ± 2%
	Kitchen Broom	87% ± 3%	74% ± 4%	71% ± 9%	10% ± 16%
	Wet Sponge	81% ± 4%	81% ± 5%	67% ± 17%	10% ± 2%
	Push Broom[b]				1% ± 2%
Clay Tiles	Wet Sponge	100% ± 0%	100% ± 0%	99% ± 0%	37% ± 3%
	Prewet Wipes	97% ± 1%	100% ± 1%	99% ± 1%	27% ± 3%
Metal Roofing	Kitchen Broom	>100% ± 1%	100% ± 0%	98% ± 1%	42% ± 4%
	Wet Sponge	99% ± 0%	100% ± 0%	99% ± 0%	99% ± 1%
	Prewet Wipes	98% ± 1%	99% ± 1%	99% ± 0%	99% ± 0%
Gutter	Vacuum	100% ± 0%	100% ± 0%	100% ± 0%	18% ± 5%
	Prewet Wipes	100% ± 0%	100% ± 0%	99% ± 1%	91%[a] ± 1%
	Wet Sponge	99% ± 1%	99% ± 1%	100% ± 2%	100% ± 2%

[a] Initial testing %R result was 76%, repeated as seemed unexpectedly low, no explanation for initial result.
[b] Blackened cells were not tested because the decontamination approach was not applicable to the surface.

Siding and other outdoor surfaces. Table 4-2 gives the average %R for each low-tech decontamination method and each of the three contaminant deposition techniques for siding and other outdoor surfaces.

Observations about the heavy loading SFM (on siding and other outdoor surfaces) decontamination efficacy data include:

- Efficacy for each particle size was significantly different for only composite fence (pre-wet wipes) with a difference of only 6% and stucco (wet sponge) with a difference of 10%.
- In 38 of 42 instances (across both particle sizes), the average %R was 94% or greater.
- In 16 of 42 instances, the average %R plus or minus the standard deviation included 100%.
- The largest standard deviation was 17% and 9% for pre-wet wipes on stucco; no other standard deviation was greater than 6%.
- Pre-wet wipes on stucco provided the lowest average %R, 62% and 83% for the large and small particle sizes, respectively. As noted above, this surface also generated less precise results, likely due to the rough, inconsistent surface.

Table 4-2. Decontamination Efficacy for Siding and other Outdoor Surfaces

Method	Surface	% Removal for Each Contamination Deposition Approach: Cs-137 >250 µm Heavy Load SFM			Rb-86 < 10 µm Heavy Load SFM			Cs-137 < 10 µm Light Load SFM			Cs-137 ASFM		
Mold Wash	Aluminum Siding	96%	±	3%	98%	±	3%	99%	±	1%	>100%		
	Stucco	96%	±	2%	98%	±	0%	98%	±	1%	4%	±	1%
	Vinyl Siding	98%	±	1%	98%	±	2%	100%	±	0%	96%	±	1%
	Steel Siding	98%	±	1%	99%	±	2%	100%	±	0%	100%	±	0%
	Wood Siding	97%	±	1%	99%	±	1%	94%	±	0%	12%	±	2%
Prewet Wipes	Aluminum Siding	97%	±	1%	100%	±	0%	93%	±	3%	87%	±	4%
	Composite Fence	89%	±	3%	95%	±	2%	82%	±	5%	69%	±	12%
	Plastic slide	100%	±	0%	99%	±	2%	99%	±	0%	>100%		
	Steel Siding	96%	±	3%	97%	±	3%	100%	±	1%	87%	±	4%
	Stucco	62%	±	17%	83%	±	9%	85%	±	3%	0%	±	1%
	Vinyl Siding	95%	±	3%	95%	±	2%	98%	±	0%	94%	±	1%
	Window	100%	±	0%	100%	±	0%	100%	±	0%	99%	±	0%
	Wood Siding	97%	±	0%	98%	±	2%	88%	±	3%	20%	±	3%
Sponge	Aluminum Siding	96%	±	3%	96%	±	3%	96%	±	2%	75%	±	5%
	Composite Fence	96%	±	1%	96%	±	2%	80%	±	4%	82%	±	3%
	Plastic slide	100%	±	0%	100%	±	0%	99%	±	0%	98%	±	1%
	Steel Siding	93%	±	2%	96%	±	2%	99%	±	0%	98%	±	0%
	Stucco	85%	±	4%	95%	±	1%	90%	±	0%	2%	±	1%
	Vinyl Siding	94%	±	4%	94%	±	6%	99%	±	0%	95%	±	1%
	Window	100%	±	0%	100%	±	0%	100%	±	0%	97%	±	1%
	Wood Siding	98%	±	0%	100%	±	1%	91%	±	2%	13%	±	3%
Squeegee	Window	99%	±	0%	100%	±	1%	100%	±	0%	96%	±	2%

Observations about the light loading SFM (on siding and other outdoor surfaces) decontamination efficacy data include:

- 15 out of 21 instances were 93% or above, lowest %R was 80% for composite fence with wet sponge.

Observations about the ASFM (on siding and other outdoor surfaces) decontamination efficacy data include:

- 10 of 21 instances had average %R exceeding 90%;
- In six instances, the average %R did not exceed 20%; the method/surface combinations were the mold wash, pre-wet wipes, and sponge, all with stucco and wood siding;
- Stucco had no greater removal than 4%;
- Mold wash/aluminum and steel siding, pre-wet wipes/plastic slide, and squeegee/window had %R of 100%; and

- For the three nonporous sidings (vinyl, steel, and aluminum), the mold wash exhibited removals greater than 96% while there was more variability with other methods.

Hardscape surfaces. Table 4-3 gives the average %R for each low-tech decontamination method and each of the three contaminant deposition techniques for hardscape surfaces.

Observations about the heavy loading SFM (hardscape surfaces) decontamination efficacy data include:

- Efficacy for each particle size differed on average by more than 6% for asphalt drive (squeegee) and concrete pavers (pump sprayer). All others were very similar;
- Vacuum removed all particles with %R of 99% or 100%;
- Only three of eight squeegee particle removal scenarios resulted in %R of greater than 50%; the rest ranged from 22% to 47%;
- Three of six mop particle removal scenarios resulted in %R greater than 90%; the rest ranged from 81% to 86%;
- Push broom removed the heavy load of mixed sized particles better than the lighter load of small particles; and
- Using the pump sprayer resulted in a range of %R from 87% to 98%, except for the smaller particles on the concrete pavers for which %R was 54%.

Observations about the light loading SFM (on hardscape surfaces) decontamination efficacy data include:

- Except for the push broom decontamination, the light loading was removed at similar magnitudes as the heavy loaded particles.

Observations about the ASFM (on hardscape surfaces) decontamination efficacy data include:

- 18 of 21 instances had average %R below 10%. The three exceptions were use of the deck wash and sprayer for the stained wood deck (47% and 49%) and the mop on the asphalt drive (23%).

Table 4-3. Decontamination Efficacy for Hardscape Surfaces

Method	Surface	% Removal for Each Contamination Deposition Approach			
		Cs-137 >250 µm Heavy Load SFM	Rb-86 < 10 µm Heavy Load SFM	Cs-137 < 10 µm Light Load SFM	Cs-137 ASFM
Deck Wash	Stained Wood Deck	99% ± 0%	100% ± 1%	99% ± 1%	47% ± 12%
Vacuum	Asphalt Drive	100% ± 0%	100% ± 1%	99% ± 1%	0% ± 2%
	Brick Pavers	100% ± 0%	100% ± 0%	99% ± 0%	4% ± 1%
	Concrete Paver	99% ± 0%	99% ± 1%	100% ± 1%	2% ± 1%
	Sidewalk Concrete	99% ± 0%	100% ± 0%	100% ± 0%	1% ± 2%
	Stained Wood Deck	99% ± 0%	99% ± 1%	99% ± 0%	2% ± 1%
Squeegee	Asphalt Drive	36% ± 13%	58% ± 7%	29% ± 8%	9% ± 3%
	Brick Pavers	27% ± 7%	37% ± 6%	47% ± 4%	6% ± 1%
	Concrete Paver	34% ± 5%	38% ± 5%	22% ± 4%	3% ± 2%
	Sidewalk Concrete	77% ± 2%	83% ± 3%	53% ± 6%	3% ± 0%
Mop	Asphalt Drive	88% ± 9%	94% ± 5%	85% ± 5%	23% ± 1%
	Brick Paver	91% ± 4%	95% ± 3%	89% ± 2%	12% ± 2%
	Concrete Paver	81% ± 5%	88% ± 3%	66% ± 13%	2% ± 1%
	Sidewalk Concrete	94% ± 1%	93% ± 3%	86% ± 2%	1% ± 1%
Push Broom	Asphalt Drive	85% ± 7%	84% ± 6%	63% ± 18%	2% ± 3%
	Brick Pavers	92% ± 4%	94% ± 2%	68% ± 16%	2% ± 3%
	Concrete Paver	91% ± 0%	81% ± 3%	61% ± 7%	3% ± 2%
	Sidewalk Concrete	96% ± 1%	96% ± 1%	90% ± 4%	-1% ± 2%
	Stained Wood Deck	99% ± 0%	98% ± 1%	91% ± 3%	7% ± 4%
Pump Sprayer	Concrete Paver	88% ± 4%	54% ± 4%		3% ± 4%
	Brick Pavers	92% ± 4%	87% ± 3%		-5% ± 5%
	Stained Wood Deck	98% ± 0%	98% ± 1%		49% ± 3%
	Sidewalk concrete	97% ± 2%	94% ± 3%		5% ± 3%

Mock wall spray removal. Table 4-4 gives the average %R for each low-tech decontamination method and each of the three contaminant deposition techniques for the mock wall spray removal. Observations about the sprayer removal from mock wall decontamination efficacy data include:

- Sprayer removed all particles with %R of greater than 96%;

Table 4-4. Decontamination Efficacy for Mock Wall Spraying

Surface	Spray Pattern	Cs ASFM, Cs-137 Lt	Average %R ± SD	Volume (L)
Roofing				
Asphalt Roofing	Fan	Cs-137	98% ± 0%	1.5
	Fan	Rb-86	99% ± 0%	1.5
	Fan	Cs ASFM	15% ± 3%	1.5
Asphalt Shingles	Cone	Cs-137 Lt	96% ± 1%	0.6
	Fan	Cs-137 Lt	98% ± 1%	1.1
	Stream	Cs-137 Lt	100% ± 0%	1.4
	Cone	Cs ASFM	9% NA	0.9
	Fan[a]	Cs ASFM	15% NA	0.63
	Stream	Cs ASFM	19% NA	0.9
Clay Tile	Fan	Cs-137	>100%	1.1
	Fan	Rb-86	98% ± 1%	1.1
	Fan	Cs ASFM	52% ± 6%	1.1
Metal Roof	Cone	Cs-137 Lt	>100%	0.6
	Fan	Cs-137 Lt	98% ± 1%	0.4
	Stream	Cs-137 Lt	99% ± 0%	0.6
	Cone	Cs ASFM	99% NA	0.1
	Fan	Cs ASFM	99% NA	0.1
	Stream	Cs ASFM	99% NA	0.3
Wood Shingles	Fan	Cs-137	98% ± 1%	1.5
	Fan	Rb-86	98% ± 0%	1.5
	Fan	Cs ASFM	38% ± 7%	1.5
Siding				
Concrete Siding	Fan	Cs ASFM	15% ± 4%	1.5
Stucco	Fan	Cs ASFM	4% ± 2%	2.3
Vinyl Siding	Cone	Cs ASFM	93% ± 1%	0.3
	Fan	Cs ASFM	97% ± 1%	0.35
	Stream	Cs ASFM	92% ± 3%	1
Al Siding	Fan	Cs ASFM	96% ± 3%	2.3
Wood Siding	Fan	Cs ASFM	32% ± 7%	1.1
Window	Cone	Cs ASFM	97% ± 1%	0.3
	Fan	Cs ASFM	96% ± 2%	0.35
	Stream	Cs ASFM	88% ± 2%	1

[a]Single experiment suggested that tripling the rinse volume could up to double the removal.

- ASFM removal was widely varied depending on surface; asphalt shingles ranged from 10-20% for the various spray settings; metal roof was removed at 99% for all three spray settings; asphalt roofing exhibited removal of 15%; for wood shingles, 38% and clay tile, 52%;

- Contamination was removed from vinyl siding and window at greater than 96% for the fan setting. The other two settings are slightly more variable;
- Stucco, wood, and concrete siding removals ranged from 4% to 32%, all performed with the fan spray setting;
- Average volume used per surface was 1 liter (L), and the average spray flow was 0.5 L/minute, which was variable as it is the nature of this type of sprayer to have decreasing flow as the initial pressure bleeds down during use after the sprayer is initially pumped to pressurize; and
- As the footnote indicates, a single experiment on the aqueous contaminated surface indicated that increases in rinse volume would (not surprisingly) increase the removal of the aqueous contamination; additional experimentation would be required to further define this result.

Fate of mock wall contamination. For the mock wall experiments, the fate of the activity-laden particles and water was monitored using frisk surveys. When particles were applied and decontaminated from the roofing material, most of the particles were rinsed into the gutter. This allocation of the particles was confirmed through visual inspection as well as the frisk surveys exhibiting minimal activity in the collection bucket. Rather than the particles flowing with the rinse water down the downspout and into the collection bucket, the particles settled at the bottom of the gutter and had to be removed manually with a wet cloth. Conversely, when ASFM was applied and then removed (for surfaces where removal occurred), the activity stayed with the water as it flowed into the collection vessel.

Table 4-5 provides observations of the efficacy data by surface type.

Table 4-5. Efficacy Observations for Each Surface Type

Surface	Efficacy Summary
	Roofing
Asphalt roofing	• SFM %R 10-78%, removal variable among broom, wipe, and sponge methods; • highest ASFM %R 8%; • spray on mock wall setup %R >97% for SFM and 15% for ASFM
Asphalt shingles	• SFM %R 22-61% for broom, wipe, and sponge methods; vacuum %R >97% • ASFM %R 1-4%; • spray on mock wall setup %R near 100% for SFM and 10-20% for ASFM
Clay tiles	• SFM %R near 100% for wipe and sponge (only methods used), • ASFM %R 27-37%; • spray on mock wall setup %R near 100% for SFM and 52% for ASFM
Gutter	• SFM %R near 100% for all methods used; • ASFM %R 18% for vacuum, but 91% for wipes and 100% for sponge
Metal roofing	• SFM %R near 100% for all methods used; • ASFM %R 42% for broom, but 99% for wipes and sponge; • spray on mock wall setup %R near 100% for SFM and 99% for ASFM
Wood shingles	• SFM %R 67-87% for broom and sponge methods, vacuum %R >97%; • ASFM %R were between 0-10%; • spray on mock wall setup %R 98% for SFM and 38% for ASFM (Highly fibrous surface)

Siding and Other Surfaces	
Aluminum siding	• SFM %R >96% for all methods, • ASFM 75%, 87%, and 100% for sponge, wipes, and mold wash
Composite fence	• SFM %R 80%-96%, • ASFM 69% and 82%; wipes and sponge (only methods used)
Plastic slide	• SFM and ASFM %R all near 100%, wipes and sponge (only methods used)
Steel siding	• SFM %R >93% for all methods, • ASFM %R all near 100%
Stucco	• SFM %R 62%-98% with mold wash being highest, • ASFM %R 0-4%
Vinyl siding	• SFM %R >94% for all methods, • ASFM %R all near 100%; • spray on mock wall setup %R >91% for ASFM (fan sprayer setting most effective)
Window	• SFM and ASFM %R all near 100%; • spray on mock wall setup %R >96% for ASFM using cone and fan settings and 88% for stream setting
Wood siding	• SFM %R >88% for all methods with heavier loading having higher %Rs, • ASFM %R 12-20%; • spray on mock wall setup %R 32% for ASFM
Hardscape	
Asphalt drive	• SFM %R 29-100% with mop and vacuum being highest and squeegee the lowest; • ASFM %R 0-23% with the mop being the highest
Brick pavers	• SFM %R 27-100% with vacuum being highest and squeegee the lowest; • ASFM %R 0-6%; lighter particle load removed less well than heavier with push broom
Concrete pavers	• SFM %R 22-100% with vacuum being highest and squeegee the lowest; • ASFM %R 2-3%; lighter particle load removed less well than heavier with push broom
Sidewalk concrete	• SFM %R >90% for all methods with exception of squeegee which was 53-83% and light loaded mop (86%); • ASFM removals 0-5%
Stained wood deck	• SFM %R >90% for all methods; • ASFM %R 2-7% for the vacuum and push broom, %R 47% for the deck wash, and 49% for the spray removal

4.2 Operational and Deployment Factors

Operator observations and decontamination method waste stream. Table 4-6 provides an operational summary of the various low-tech decontamination methods that were employed during testing by summarizing observations made by the operators using each low-tech decontamination method focusing on method constraints, safety concerns, and feasibility. In addition, the table gives the activity level according to each component or tool used for decontamination. For example, if a broom was used, the activity on the broom handle and broom head was measured as the low-tech decontamination tools were being placed in radiological waste.

Table 4-6. Operational Summary of Each Low-tech Decontamination Method

Low-tech Method	Operational Summary	Waste Stream Summary
	Roofing	
Vacuum	Particles accumulated in vacuum attachment causing concern over containment when moving vacuum; removal of vacuum head and using hose only removed a few more particles, but only increased %R by 1%; dark color roofing still looked dirty even though removals were high.	SFM: activity goes with particles into waste as there was minimal but measurable activity on attachment; ASFM: No activity measured.
Kitchen Broom	Operationally better than push broom when surface uneven (like shingles) as the tines are longer and softer; did not remove particles well from non-metal surfaces.	Background (BG) activity on gloves and handle, at times activity on broom head
Push Broom	Operationally preferable to kitchen broom on even surfaces (asphalt roofing), however, tines do get caught on aggregate and does not push easily.	BG activity on gloves and handle, sometimes measurable activity on broom head
Pre-wet wipes	Difficult to wipe across surfaces with roughness, at times they started to tear apart, smooth surfaces worked very well.	1-4% activity on gloves, >95% on wipes
Sponge	Sponge was easier to wipe across rough surfaces than wipes because there was more to hold on to. However, at times they started to come apart; smooth surfaces worked very well.	SFM: 12% activity on gloves, 88% on sponges ASFM: 99% on sponges
	Siding and Other Surfaces	
Mold wash	Mold wash sprayed on surfaces and terry cloths used for wiping; they were rugged in that they held up under use on a variety of surfaces and removed particles well	1-3% activity on gloves, >97% on cloths
Pre-wet wipes	Wipes function well on the smooth siding surfaces, at times they began to fall apart on the stucco, which is quite rough.	2% of activity on gloves, >97% on wipes
Sponge	Sponges function even better than wipes on the smooth siding surfaces as there is more material to handle, at times they began to fall apart on the stucco, which is quite rough.	SFM: often 10-25% and up to 60% activity on gloves, rest on sponges. ASFM: 99% on sponges
Squeegee	Squeegee only used on windows which is what it is designed for (consistent with it working very well).	Activity on gloves, >99% on squeegee
	Hardscapes	
Vacuum	Vacuum attachment collected particles which risked contamination	BG activity on gloves, minimal activity on attachment
Squeegee	Squeegee tended to just drag wet particles around the surfaces, not really removing any particles; it made sticky particle mud and was the least effective decon method	BG activity on gloves, >99% on squeegee head
Mop	Once mop was loaded with particles, it was difficult to maneuver without contaminating surrounding floor, etc. Particle removal was satisfactory, but rinsing mop for large areas would be difficult without cross contamination.	BG activity on gloves, >99% on mop head
Deck wash	Only used on stained wood decking. Sprayed deck wash on contaminated surfaces, let sit for 5 minutes, then rinsed with damp sponge.	SFM: often 5% activity on gloves, rest on sponges ASFM: 99% on sponges
Push broom	Push broom functioned well on all the hardscape surfaces, no special difficulties were noted, but removal efficacy was moderate.	BG activity on gloves and handle, sometimes activity on broom head
Pump sprayer	Sprayed surfaces with handheld garden sprayer using fan setting. There were no functional difficulties to note. Volumes noted with efficacy data.	BG activity on gloves, particles collected in gutter water flushed to waste (water flow rate of 1.5 L per m^2 surface), surface had minimal activity

Based on the results of the decontamination experiments described above, Table 4-7 reports the number of low-tech decontamination method accessories (wipes, brooms, pads, etc.) that were required to accomplish decontamination of the surfaces (using each type of deposition) within this project.

Table 4-7. Accessories for Each Low-tech Decontamination Method by Deposition Method

Low-tech Method	Number of Accessories (wipes, pads, etc.)		
	Heavy Loading	**Light Loading**	**ASFM**
Roofing (0.7 m²)			
Vacuum	1 vacuum across all surfaces[a]		
Kitchen Broom	1 broom for each surface[a]		
Push Broom	1 broom for each surface[a]		
Pre-wet wipes	Asphalt roofing: 28 Clay Tiles: 12 Gutter: 12 Metal roofing: 20	Asphalt roofing: 16 Clay Tiles: 6 Gutter: 4 Metal roofing: 8	Asphalt roofing: 14 Clay Tiles: 8 Gutter: 8 Metal roofing: 4
Sponge	Asphalt roofing: 3 Asphalt shingles: 4 Clay Tiles: 3 Gutter: 3 Metal roofing: 4 Wood Shingles: 3	Asphalt roofing: 4 Asphalt shingles: 3 Clay Tiles: 2 Gutter: 2 Metal roofing: 4 Wood Shingles: 4	Asphalt roofing: 2 Asphalt shingles: 3 Clay Tiles: 2 Gutter: 2 Metal roofing: 2 Wood Shingles: 2
Siding and Other Surfaces (0.7 m²)			
Mold wash (towels)	Aluminum siding: 2 Stucco: 4 Vinyl siding: 4 Steel siding: 3 Wood siding: 5	Aluminum siding: 2 Stucco: 3 Vinyl siding:3 Steel siding: 2 Wood siding: 3	Aluminum siding: 2 Stucco: 2 Vinyl siding: 3 Steel siding: 2 Wood siding: 3
Pre-wet wipes/Sponge	Aluminum siding: 20/3 Composite fence: 26/8 Plastic slide: 14/4 Steel siding: 24/4 Stucco: 24/6 Vinyl siding: 24/4 Window: 20/4 Wood siding: 20/6	Aluminum siding: 10/3 Composite fence: 12/2 Plastic slide: 8/4 Steel siding: 8/3 Stucco: 8/2 Vinyl siding: 8/2 Window: 8/2 Wood siding: 10/4	Aluminum siding: 6/2 Composite fence: 8/3 Plastic slide: 6/2 Steel siding: 4/2 Stucco: 10/2 Vinyl siding: 6/3 Window: 8/3 Wood siding: 8/2
Hardscapes (0.7m²)			
Vacuum	1 vacuum across all surfaces		
Squeegee	1 squeegee for each surface (for experimental contamination containment, not due to wear)		
Mop	1 mop for each surface (for experimental contamination containment, not due to wear)		
Deck wash	Sprayed deck wash on contaminated surfaces and then rinsed with damp sponges, used 3 sponges for the heavy SFM, 2 for the SFM light, and 4 for ASFM.		
Push broom	1 broom for each surface (for experimental contamination containment, not due to wear)		
Pump sprayer	1 pump sprayer across all surfaces		

[a]One vacuum and broom was used for each surface to contain the contamination, not because the equipment could not have been used further; it is possible that in a real event the decontamination tools may be able to be used in multiple locations, thus lowering the cost and waste stream.

Waste stream from typical house. Table 4-8 through Table 4-11 expands on the accessory use data and provides an estimate of how much radiological waste (and what types, including the accessories mentioned above and SFM) would be generated from the decontamination of a representative two-story house under three types of depositions. This estimate was made by extrapolating the number of accessories and amount of SFM relative to the amount of surface area in the home. For this example, a two-story house is assumed to equal 186 m^2 (2,000 square feet). As shown in Table 4-9, an estimated 45.5 kilograms (kg) of solid waste would be generated under heavy loading conditions and no liquid waste was generated from the decontamination efforts.

Table 4-8. Estimated Waste from Decontamination of Typical Home (Heavy SFM Loading)

Surface	Surface Area	Method	Number of items	Potential %R
Asphalt shingles and gutter	160 m^2	Vacuum	1 vacuum with 20 mg/cm^2 SFM	97%
Vinyl siding	150 m^2	Mold wash	857 terry towels with 20 mg/cm^2 SFM	100%
Windows	10 m^2	Pre-wet wipes	286 wipes with 20 mg/cm^2 SFM	100%
Sidewalk Concrete	80 m^2	Vacuum	1 vacuum with 20 mg/cm^2 SFM	99%
Stained wood deck	13 m^2	Vacuum	1 vacuum with 20 mg/cm^2 SFM	99%

Table 4-9. Estimated Waste from Decontamination of Typical Home (Light SFM Loading)

Surface	Surface Area	Method	Number of items	Potential %R
Asphalt shingles and gutter	160 m^2	Vacuum	1 vacuum with 2 mg/cm^2 SFM	98%
Vinyl siding	150 m^2	Mold wash	640 terry towels with 20 mg/cm^2 SFM	100%
Windows	10 m^2	Pre-wet wipes	114 wipes with 2 mg/cm^2 SFM	100%
Sidewalk Concrete	80 m^2	Vacuum	1 vacuum with 2 mg/cm^2 SFM	100%
Stained wood deck	13 m^2	Vacuum	1 vacuum with 2 mg/cm^2 SFM	99%

Table 4-10. Estimated Waste Stream from Decontamination of Typical Home (ASFM)

Surface	Surface Area	Method	Amount of items	Potential %R
Asphalt shingles and gutter	160 m^2	Sponges	914 sponges	4%
Wall vinyl siding	150 m^2	Pump sprayer rinse	220 L water	97%
Windows	10 m^2	Pre-wet wipes	114 wipes	99%
Sidewalk Concrete	80 m^2	Pump sprayer rinse	120 L water	5%
Stained wood deck	13 m^2	Pump sprayer rinse	20 L water	49%

Table 4-11. Estimated Waste Stream as a Function of Deposition Method

	Estimated Waste Volume		
Surface	**Heavy SFM Loading**	**Light SFM Loading**	**ASFM**
Asphalt shingles and gutter	1 vacuum (6 kg), 32 kg SFM	1 vacuum (6 kg), 3 kg SFM	16 kg sponges, 40 kg water in sponges
Vinyl siding	51 kg terry towels and 40 kg of mold wash saturated in towels, 30 kg SFM	39 kg terry towels and 31 kg of mold wash saturated in towels, 3 kg SFM	220 L rinse water
Windows	1 kg in wipes; 2 kg SFM	0.5 kg in wipes; 200 g SFM	0.5 kg in wipes

Sidewalk Concrete	1 vacuum (6 kg), 16 kg SFM	1 vacuum (6 kg), 2 kg SFM	120 L rinse water
Stained wood deck	1 vacuum (6 kg), 3 kg SFM	1 vacuum (6 kg), 300 g SFM	20 L rinse water
Estimate of total mass, volume, and activity	181 kg into ten 0.2 m^3 bags- (only 1 vacuum disposed) If initial fallout had activity of 0.5 µCi/g, then 91 mCi.	85 kg into five 0.2 m^3 bags – 1 vacuum disposed If initial fallout had activity of 0.5 µCi/g, then 43 mCi	56 kg into three 0.2 m^3 bags; 360 L of liquid in two waste drums If initial activity of 0.01 mCi/m^2, then 4 mCi

Potential operator exposure. Throughout the evaluation, project decontamination technicians were required to use full PPE including powered air purifying respirators (with HEPA filters) because the work was performed in a radiological enclosure using unsealed radiological material of various particle sizes. However, to estimate the potential airborne exposure of the project decontamination workers to radiological material, four sets of particle air sample filters were collected during each decontamination experiment. One of these air samplers was placed in the breathing zone of the decontamination worker, and the sample was collected only during surface decontamination. The other three air samplers were placed in the common area within the radiological containment tent. One was placed adjacent to the decontamination work area, and the other two were placed near the outflow to the tent HEPA filtration system to capture the airflow of particles through the tent (even if they were being vented). During the testing, the activity concentrations of the air sampler filters never exceeded 0.2% of the derived air concentration (DAC). The DAC is the average atmospheric concentration of the radionuclide that would lead to the annual occupational limit of intake of the radionuclide if working in that environment for a 2,000-hour work year. The low filter concentration suggests that the potential particle inhalation exposure and resulting dose due to the experimental conditions was minimal. Performance of these same low-tech decontamination methods in other settings under variable conditions may produce different levels of personal exposure to particles containing radiological activity.

In addition to air sampling, the operators were surveyed from head to toe after every decontamination experiment to determine if they had received any contamination on their PPE. None of the surveys resulted in activity measurements above background levels, consistent with the waste stream results shown in Table 4-6, where even the decontamination worker's gloves had little or no contamination and almost all the activity was isolated on the item that was in contact with the surface being cleaned.

Any time radiological material was handled, PPE (as described above) was required. Additionally, any waste (e.g., from use of low-tech decontamination methods and post-decontamination surfaces) was considered low level radioactive waste (unless surveyed for free release). The requirement for this level of PPE was not driven by the use of the low-tech decontamination technologies (which only have the hazards described on their product labels), but rather by the presence of Cs-137.

4.3 Performance Summary

The primary objective of the work described here was to collect information and experimental data about low-tech outdoor radiological decontamination methods available in the United

States. This technology evaluation included use of low-tech decontamination methods on surfaces common to outdoor residential environments and included evaluating the decontamination efficacy, method constraints, safety concerns, feasibility, waste generation, potential exposure, and cost. Fourteen different low-tech decontamination methods were evaluated on eight different surfaces (not all methods were used on every surface). In total, 62 different combinations of non-mock wall low-tech decontamination methods and surfaces were evaluated using three different radiological contamination deposition methods (heavy loading, light loading, and ASFM) for a total of over 180 different experiments. There were also 11 mock wall surface experiments. Overall, the results indicated that ASFM was much more difficult to remove than SFM, and particle size was usually not a factor in SFM removal. Most of the %Rs for the SFM using vacuums were greater than 95%, and several of the methods were less effective for SFM. All the surfaces used during this study (with the exception of the paved surfaces) were purchased new and had not experienced any outdoor conditions such as one may expect in the case of an actual outdoor contamination event. Decontamination of weathered surfaces may result in different levels of decontamination efficacy.

Secondary objectives included the observation of the likelihood of decontamination technician contamination while performing these low-tech methods as well as estimating the waste stream following implementation of low-tech decontamination. To accomplish these objectives, whole body surveys were completed after every decontamination test, and multiple air samples were collected. None of these surveys or air samples indicated technician contamination, even during the heavy loading portions of the evaluation. The type, weight, and volume of the waste stream from a personal residence was estimated based on typical surface areas of various types as well as the amount of low-tech decontamination accessories (wipes, sponges, etc.) used during this evaluation on relatively smaller total surface area. Radiological activity was estimated based on what the starting activity of the fallout may have been. Overall, the amount of waste is driven by the surface density of the fallout material as well as the weight of the tools used. The data from this project show that vacuums are very effective although they are heavy and bulky to dispose of. Wipes and cloths were rather effective, can be conveniently transported between sites (in new packaging), and can possibly be disposed of at each site more efficiently than attempting to transport powered equipment that would have become contaminated.

Over the past 10 years, EPA has performed multiple radiological decontamination projects [1, 6-14] to test the decontamination efficacies of many methods (physical removal, strippable coatings, chemical decontamination, low-tech on multiple indoor (flooring, laminate, countertop, carpet, etc.) and outdoor surfaces (concrete, brick, marble, granite, limestone, etc.)), and these EPA radiological decontamination projects have furthered this area of science greatly. Other research to complement this work could include: 1) determination of the efficacy of low-tech decontamination of outdoor surfaces using weathered surfaces, 2) the determination of efficacy of salt rinse solutions on fixed radiological contamination, 3) an evaluation of general homeowner/novice decontamination technician dose (experiments performed in the containment tent) when performing decontamination of material at various activity levels, 4) track-in studies for people living and working in fallout zones, 5) ventilation and PPE effectiveness research for decontamination workers, and 6) the development of a comprehensive guidance document to make this material available to the public in the event it is needed.

5.0 References

1. U.S. EPA. Evaluation of Low-Tech Indoor Remediation Methods Following Wide Area Radiological/Nuclear Incidents. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-17/021, 2017.

2. Decontamination Guidelines, 2nd Edition, Japanese Ministry of the Environment, 2013.

3. O. Paz Tal, R. Bar Ziv, R. Hakmon, E. J. C. Borojovich, A. Nikoloski, T. Ohaion, R. (Yanosh) Levi, I. Yaar, Study of Cleanup Procedures for Contaminated Areas: Examination of Rubidium as a Surrogate to Cesium, Conference of the Nuclear Societies in Israel; Dead Sea (Israel); 11-13 Feb 2014, p 27.

4. Wiltshire, L. L.; Owen, W. L. *Three Tests of Fire Hosing Technique and Equipment for the Removal of Fallout from Asphalt Streets and Roofing Materials*; USNRDL-TR-1048; U.S. Naval Radiological Defense Laboratory: San Francisco, California, 1966.

5. D. E. Clark,; W. C. Cobbin. *Removal Effectiveness of Simulated Dry Fallout from Paved Areas by Motorized and Vacuumized Street Sweepers*; USNRDL-TR-746; U.S. Naval Radiological Defense Laboratory: San Francisco, California, 1963.

6. U.S. EPA. Technology Evaluation Report, River Technologies LLC 3-Way Decontamination System for Radiological Decontamination. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-11/015, 2011.

7. U.S. EPA. CS Unitec ETR180 Circular Sander for Radiological Decontamination. Technology Evaluation Report. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-11/018, 2011.

8. U.S. EPA. Empire Abrasive Blast N'Vac for Radiological Decontamination. Technology Evaluation Report. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-11/014, 2011.

9. U.S. EPA. Industrial Contractors Supplies, Inc. Surface Dust Guard with DiamondWheel for Radiological Decontamination. Technology Evaluation Report. U.S. Environmental Protection Agency. Washington, D.C. EPA/600/R-11/013, 2011.

10. U.S. EPA. Industrial Contractors Supplies, Inc. Surface Dust Guard with Wire Brush for Radiological Decontamination. Technology Evaluation Report. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-11/016, 2011.

11. U.S. EPA. Decontamination of Concrete and Granite Contaminated with Cobalt-60 and Strontium-85. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-13/002, 2012.

12. U.S. EPA. Decontamination of Concrete with Aged and Recent Cesium Contamination. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-13/001, 2013.

13. U.S. EPA. Technology Evaluation Report Bartlett Services, Inc. Stripcoat TLC Free Radiological Decontamination of Americium. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-13/005, 2013.

14. U.S. EPA. Evaluation of Chemical-Based Technologies for Removal of Radiological Contamination from Building Material Surfaces. U.S. Environmental Protection Agency, Washington, DC, EPA/600/S-15/155, 2015.

Appendix A

Decontamination Method Operational Summary Tables

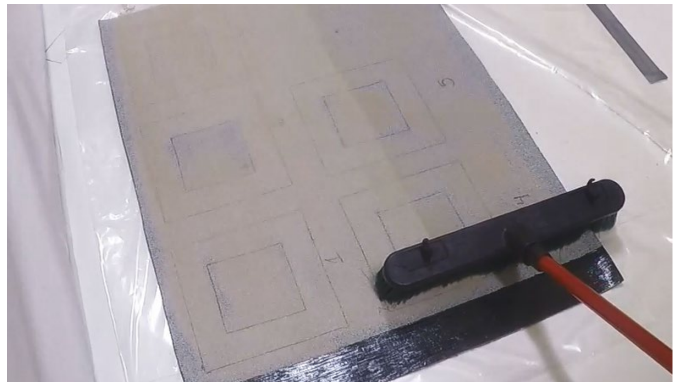
The following pages include example pictures and video clips of the decontamination methods being tested in a controlled experimental setting as well as tables containing information pertaining to the testing of each low-tech decontamination technology. The video clips can be used as training aids for people wanting to learn how to safely (and with the prospect of efficacy similar to the experimental results) decontaminate radiological fallout material. The source of the information in the table (experimentally measured, observed, or calculated based on assumptions) is explained in the template table shown below. These results and estimates may vary depending on the rate of work, equipment, surface conditions, and method application being conducted at an actual contaminated property. In addition, the cost and waste stream could be impacted by the degree of cross contamination that may be observed between job sites. For example, to control cross contamination, contractors assisting homeowners or homeowners assisting neighbors may choose to use all new equipment at each contaminated property (like a new vacuum for each), thus increasing the overall amount of waste generated. The waste generation estimates assume no surface materials would be disposed, only the decontamination equipment and simulated fallout material. The information in the appendix tables may be used to develop guidance, but EPA does not formally recommend any one method. Note that decontamination efficacies labeled as 100%R represent removals below the background activity and may not be distinguishable from 97%R due to the uncertainty of the background activity.

Decontamination Method Information Appendix Template (explaining source of information)

Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm[a]	< 10 µm[a]	< 10 µm Light[a]	ASFM[b]	
Surface types	Measured decontamination efficacy data.				Calculated based on experimentally observed decontamination rate using project surfaces (~0.7 m^2)
Method Summary	Description of method application as used during this project.				
Efficacy observations	Summary observations about each low-tech radiological decontamination method				
Equipment	Equipment used to accomplish low-tech radiological decontamination method				
PPE	PPE used during project, not necessarily what would be required onsite as the technician contamination and dose was insignificant throughout the experimental testing. Based on the results obtained during testing, less PPE could be considered.				
Waste	Waste types generated as result of low-tech radiological decontamination method, amounts were actual amounts based on experimental waste generation by decontamination methods				
Fate of activity	Detailed location of activity after use of low-tech decontamination tools (broom handles and heads, wipes, sponges, gloves, etc.)				
Method cost (non-labor)	Estimate of cost considering only the low-tech radiological decontamination tools used during the experimental decontamination testing				
Operational notes	Functional observations by decontamination technicians and project manager pertaining to efficacy, PPE used, air particulate samples results, training requirements.				

[a]Radiologically tagged particles were applied at 20 mg/cm^2 or 2 mg/cm^2 (light) using a shaker
[b]ASFM – Aqueous simulated fallout material that was applied to the surfaces as a spray

Decontamination Method: Push Broom



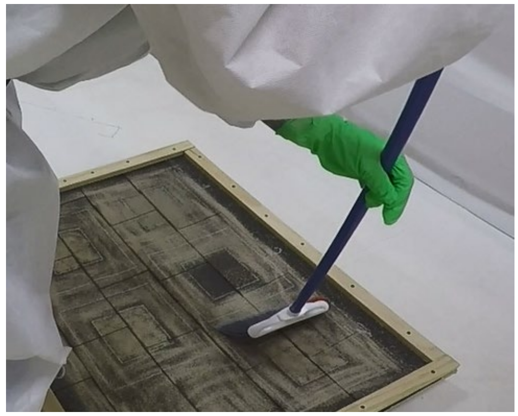
Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Roofing	61%	75%	53%	3%	168-336
Asphalt Drive	83%	84%	62%	2%	168-336
Brick Pavers	90%	94%	68%	2%	168-336
Paver Concrete	90%	81%	60%	3%	336
Sidewalk Concrete	95%	96%	88%	0%	112-336
Stained Wood Deck	98%	98%	88%	7%	336
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; surfaces were broomed in both directions until no additional visual removal.				
Efficacy observations	Light SFM application was removed to a lesser extent than the heavier application,likely due to higher proportion of SFM getting lodged in pores; almost no ASFM removed				
Equipment	18-inch push broom				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and broom (10-70 kg/day)				
Fate of activity	SFM: Almost no activity transferred to gloves, >99% on broom head; ASFM: No detectble activity on broom parts				
Method cost (non-labor)	<$20 per 1 person day (if one broom can be used across locations)				
Operational notes	- Push broom used on flat, even surfaces; kitchen broom (results not shown here) used on more uneven surfaces as more conducive to longer, softer, broom tines - If surface had any degree of roughness, surface still looks dirty after brooming, even if %R is >75% - No appreciable contamination, dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

1 AsphaltDrive_PushBroom.mp4

2 AsphaltRoofing_PushBroom.mp4

Decontamination Method: Kitchen Broom

Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Shingles	23%	22%	25%	1%	168
Metal Roofing	100%	100%	98%	42%	168
Wood Shingles	87%	74%	71%	10%	112-336
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; surfaces were broomed in both directions until no additional visual removal.				
Efficacy observations	Operationally better than push broom when surface uneven as the tines are longer and softer; did not remove particles well from non-metal surfaces (especially poor for asphalt shingles);almost no ASFM removed				
Equipment	9-10 inch kitchen broom				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and broom (10-70 kg/day)				
Fate of activity	SFM: Almost no activity transferred to gloves, >99% on broom head; ASFM: No activity measured.				
Method cost (non-labor)	<$20 per 1 person day (if one broom can be used across locations)				
Operational notes	- Kitchen broom used on more uneven surfaces as more conducive to longer, softer, broom tines - If surface had any degree of roughness, surface still looks dirty after brooming, even if %R is >75% - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

3 WoodShingles_Broom.mp4

4 AsphaltShingles_Broom.mp4

Decontamination Method: Vacuum

Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Shingles	97%	97%	98%	2%	168
Gutter	100%	100%	100%	18%	168
Wood Shingles	99%	99%	98%	0%	168-336
Asphalt Drive	100%	100%	99%	0%	48-84
Brick Pavers	100%	100%	99%	4%	112-336
Concrete Paver	99%	99%	100%	2%	112-336
Sidewalk Concrete	99%	100%	100%	1%	67-168
Stained Wood Deck	99%	99%	99%	2%	42-112
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; used flat 4 inch attachment then used hose only for final pass or non-smooth surfaces, until no increased removal observed.				
Efficacy observations	Particles removed very well; ASFM was not removed.				
Equipment	2.25 Horsepower, Shop-Vac®				
PPE	disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and vacuum (10-70 kg/day)				
Fate of activity	SFM: activity goes with particles into waste as there was minimal, but measurable activity on attachment; ASFM: No activity measured.				
Method cost (non-labor)	$45 per vacuum				
Operational notes	- Particles accumulated in vacuum attachment causing concern over containment when moving vacuum end to different locations; removal of vacuum head and using hose removed a few more particles, but only increased %R by 1%; dark color roofing still looked dirty even though removal percentages were high. - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Even with inexpensive vacuum, particulate concentration and therefore, worker exposure to radiological particles, was minimal - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

5 SidewalkConcrete_DryVac.mp4

6 WoodShingles_DryVac.mp4

Decontamination Method: Pre-wet Wipes

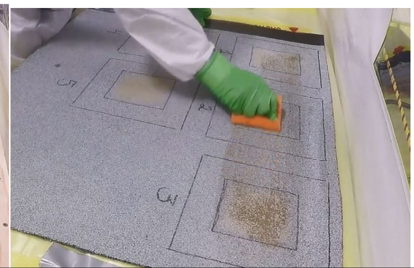
Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Roofing	10%	47%	52%	0%	31-84
Clay Tiles	97%	100%	99%	27%	42-168
Gutter	100%	100%	99%	91%	84-168
Metal Roofing	98%	99%	99%	99%	20-168
Aluminum Siding	97%	100%	93%	87%	56-336
Composite Fence	89%	95%	93%	69%	112-168
Plastic slide	100%	99%	99%	100%	84-112
Steel Siding	96%	97%	100%	87%	112-168
Stucco	62%	83%	85%	0%	31-56
Vinyl Siding	95%	95%	98%	94%	48-168
Window	100%	100%	100%	99%	31-168
Wood Siding	97%	98%	88%	20%	112-336
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; wiped surfaces in "S" shaped pattern until no additional visual removal.				
Efficacy observations	Particles removed very well except for asphalt roofing and stucco; ASFM removed well from smooth surfaces.				
Equipment	Disinfecting Wipes, Clorox® Company				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and wipes (10-20 kg/day)				
Fate of activity	1-4% activity on gloves, >95% on wipes				
Method cost (non-labor)	$15-$200 of wipes per 1 person day (depending on surface)				
Operational notes	- Difficult to wipe across surfaces with roughness, at times they started to tear apart, smooth surfaces worked very well. - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

7 Plastic_PrewetWipes.mp4

8 ClayTiles_PrewetWipes.mp4

Decontamination Method: Sponge and Water



Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Roofing	50%	67%	78%	8%	28-168
Asphalt Shingles	27%	47%	61%	4%	67-84
Clay Tiles	100%	100%	99%	37%	84-112
Gutter	99%	99%	100%	100%	168-336
Metal Roofing	99%	100%	99%	99%	28-84
Wood Shingles	81%	81%	67%	10%	56-336
Aluminum Siding	96%	96%	96%	75%	67-112
Composite Fence	96%	96%	80%	82%	22-168
Plastic slide	100%	100%	99%	98%	48-168
Steel Siding	93%	96%	99%	98%	37-168
Stucco	85%	95%	90%	2%	28-112
Vinyl Siding	94%	94%	99%	95%	28-112
Window	100%	100%	100%	97%	34-168
Wood Siding	98%	100%	91%	13%	56-168
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; wiped surfaces with water wetted sponge in "S" shaped pattern until no additional visual removal.				
Efficacy observations	Particles removed well except asphalt/wood shingles and asphalt roofing and stucco; ASFM removed well from smooth non-porous surfaces.				
Equipment	Ocelo Cellulose Sponge, 3M				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and sponges (10-50 kg/day)				
Fate of activity	SFM: 10-25% and up to 60% activity on gloves, rest on sponges ASFM: 99% on sponges				
Method cost (non-labor)	$5 pack of 6 sponges 3-4 sponges per m^2				
Operational notes	- Sponge was easier to wipe across rough surfaces than wipes because there was more to hold on to, however at times they started to come apart; smooth surfaces worked very well. - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

9 AsphaltShingles_Sponge.mp4

10 AsphaltRoofing_Sponge.mp4

Decontamination Method: Mold Wash and Terry Towels

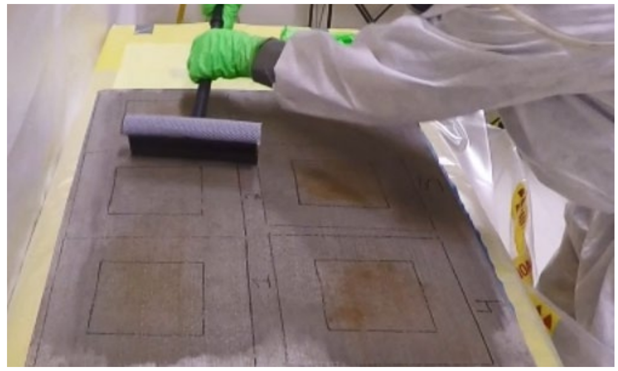
Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Aluminum Siding	96%	98%	99%	100%	56-168
Stucco	96%	98%	98%	4%	42-67
Vinyl Siding	98%	98%	100%	96%	20-112
Steel Siding	98%	99%	100%	100%	56-168
Wood Siding	97%	99%	94%	12%	31-84
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; saturated surface with mold wash with bottle sprayer and then wipe surfaces with terry cloths in "S" shaped pattern until no additional visual removal.				
Efficacy observations	Particles removed well; ASFM removed well from smooth non-porous surfaces.				
Equipment	Liquid Mold Remover, Wet and Forget; HDX, Model 7-660, Home Depot				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and cloths (30-50 kg/day)				
Fate of activity	1-3% activity on gloves, >97% on cloths				
Method cost (non-labor)	$20 per pack of 60 terry cloths, 3-5 cloths per m^2; 500 mL mold wash per m^2 (~$4/$m^2$)				
Operational notes	- Terry cloths were rugged in that they held up under use on a variety of surfaces and removed particles well - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

11 SteelSiding_MoldWash.mp4

12 WoodSiding_MoldWash.mp4

Decontamination Method: Squeegee and Water



Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Window	99%	100%	98%	100%	22-84
Asphalt Drive	36%	58%	29%	9%	37-84
Brick Pavers	27%	37%	47%	6%	24-84
Concrete Paver	34%	38%	22%	3%	34-84
Sidewalk Concrete	77%	83%	53%	3%	48-84
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; saturated surface with water with bottle sprayer and squeegeed surfaces in two directions until no additional visual removal.				
Efficacy observations	Aside from window surfaces, the squeegee did not facilitate effective removals of particles or ASFM removed.				
Equipment	Metal Handle General-Duty Squeegee, Unisan				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and squeegee (10-20 kg/day)				
Fate of activity	Measurable activity on gloves, >99% on squeegee				
Method cost (non-labor)	$5 per handheld squeegee				
Operational notes	- Squeegee tended to just drag wet particles around the surfaces, not really removing any particles, made sticky particle mud, least effective decon method - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

13 AsphaltDrive_Squeegee.mp4

14 SidewalkConcrete_Squeegee.mp4

Decontamination Method: Mop and Water

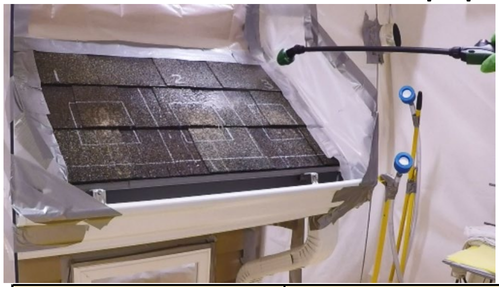
Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m^2/person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Asphalt Drive	88%	94%	85%	23%	336
Concrete Paver	81%	88%	82%	2%	168-336
Sidewalk Concrete	94%	93%	86%	1%	37-336
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m^2 of these surfaces; saturated mop with water and mopped surfaces in "S" pattern until no additional visual removal.				
Efficacy observations	Mopping generated particle removals greater than 80%, but no removals greater than 95%.				
Equipment	Blend Mop Head, Rubbermaid Commercial Products				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and mop (20-90 kg/day)				
Fate of activity	BG activity on gloves, >99% on mop head				
Method cost (non-labor)	$8 per mop head				
Operational notes	- Once mop was loaded with particles, it was difficult to maneuver without contaminating surrounding floor, etc. Particle removal seemed to be ok,but rinsing mop for large areas would be difficult without cross contamination. - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

15 PaverConcrete_Mop.mp4

16 AsphaltDrive_Mop.mp4

Decontamination Method: Pump Sprayer and Water

Surface	Decontamination Efficacy (% Removal)				Area Decontaminated (m²/1 person day)
	> 250 µm	< 10 µm	< 10 µm Light	ASFM	
Concrete Paver	88%	54%		3%	112
Brick Pavers	92%	87%		0%	84-112
Stained Wood Deck	98%	98%		49%	168-336
Sidewalk concrete	97%	94%		5%	67-112
Asphalt Roofing	98%	99%		15%	67-84
Asphalt Shingles	98%			15%	112
Clay Tile Roof	100%	98%		52%	84
Metal Roof			98%	99%	112
Wood Shingles	98%	98%		38%	84-112
Concrete Siding				15%	112
Stucco Siding				4%	67
Vinyl Siding				97%	112
Aluminum Siding				96%	67
Wood Siding				32%	84
Window				96%	67-112
Method Summary	Simulated fallout material (particles and aqueous) was added to 0.7 m² of these surfaces; hardscape surfaces were sprayed off with a fan pattern sprayer, driving the SFM off off the surface. Mock wall application was similar, but SFM captured in gutter. Pumped sprayer 10 times and when pressure noticeably decreased, pumped 10 more times. For roofing, ~0.2 m from surface; for hardscapes, ~0.1 m from surface.				
Efficacy observations	Most particles were removed well from hardscapes and roofing material, ASFM removed well from non-porous siding surfaces, but not removed well from rough, porous surfaces.				
Equipment	Multi-Purpose Sprayer (All-in-one Nozzle), Scotts				
PPE	Disposable coveralls, booties, gloves, powered air purifying respirator				
Waste	SFM, PPE, and rinse water (20 kg/day solid and 90-450L rinse water)				
Fate of activity	BG activity on gloves, particles collected in gutter water flushed to waste at a rate of 1.4L/m², surface had minimal activity				
Method cost (non-labor)	$18 per sprayer				
Operational notes	- Average volume used per surface was 1 L at 0.5L/min at ~1 psi. - No appreciable contamination or dose to decon technician - Airborne radiological particulate concentration below allowed levels - Appropriate for homeowner use as no training required except a tutorial on minimizing radiological dose and contamination during cleanup				

Example videos:

17 MockWall_AsphaltShingles.mp4

18 StainedWood_PumpSprayer.mp4

Appendix B
Evaluation Results by Decontamination Method

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Deck Wash	Stained Wood Deck	Cs ASFM	463	256	9	46%	47%	12%
Deck Wash	Stained Wood Deck	Cs ASFM	496	350	9	30%		
Deck Wash	Stained Wood Deck	Cs ASFM	561	240	9	58%		
Deck Wash	Stained Wood Deck	Cs ASFM	604	284	9	54%		
Deck Wash	Stained Wood Deck	Cs-137	638	14	7	99%	99%	0%
Deck Wash	Stained Wood Deck	Cs-137	626	16	7	98%		
Deck Wash	Stained Wood Deck	Cs-137	651	12	7	99%		
Deck Wash	Stained Wood Deck	Cs-137	697	10	7	99%		
Deck Wash	Stained Wood Deck	Rb-86	42	0	0	100%	100%	1%
Deck Wash	Stained Wood Deck	Rb-86	52	0	0	100%		
Deck Wash	Stained Wood Deck	Rb-86	40	0	0	99%		
Deck Wash	Stained Wood Deck	Rb-86	40	0	0	100%		
Deck Wash	Stained Wood Deck	Cs-137 Lt	313	11	11	100%	99%	1%
Deck Wash	Stained Wood Deck	Cs-137 Lt	348	11	11	100%		
Deck Wash	Stained Wood Deck	Cs-137 Lt	512	19	11	99%		
Deck Wash	Stained Wood Deck	Cs-137 Lt	320	19	11	97%		
Hand held squeegee	Asphalt Drive	Cs ASFM	930	820	7	12%	9%	3%
Hand held squeegee	Asphalt Drive	Cs ASFM	676	599	7	12%		
Hand held squeegee	Asphalt Drive	Cs ASFM	528	492	7	7%		
Hand held squeegee	Asphalt Drive	Cs ASFM	624	587	7	6%		
Hand held squeegee	Asphalt Drive	Cs-137 Lt	402	289	36	31%	29%	8%
Hand held squeegee	Asphalt Drive	Cs-137 Lt	470	379	39	21%		
Hand held squeegee	Asphalt Drive	Cs-137 Lt	425	330	34	24%		
Hand held squeegee	Asphalt Drive	Cs-137 Lt	413	260	26	39%		
Hand held squeegee	Asphalt Drive	Cs-137	773	529	219	44%	36%	13%
Hand held squeegee	Asphalt Drive	Cs-137	554	368	31	36%		
Hand held squeegee	Asphalt Drive	Cs-137	475	398	45	18%		
Hand held squeegee	Asphalt Drive	Cs-137	642	362	46	47%		
Hand held squeegee	Asphalt Drive	Rb-86	40	16	0	59%	58%	7%
Hand held squeegee	Asphalt Drive	Rb-86	42	16	0	62%		
Hand held squeegee	Asphalt Drive	Rb-86	37	19	0	48%		
Hand held squeegee	Asphalt Drive	Rb-86	42	16	2	64%		
Hand held squeegee	Brick Wall	Cs ASFM	276	257	21	7%	6%	1%
Hand held squeegee	Brick Wall	Cs ASFM	313	297	20	6%		
Hand held squeegee	Brick Wall	Cs ASFM	345	322	18	7%		
Hand held squeegee	Brick Wall	Cs ASFM	313	296	17	6%		
Hand held squeegee	Brick Wall	Cs-137	534	436	7	19%	27%	7%
Hand held squeegee	Brick Wall	Cs-137	640	431	7	33%		
Hand held squeegee	Brick Wall	Cs-137	607	467	7	23%		
Hand held squeegee	Brick Wall	Cs-137	562	391	7	31%		
Hand held squeegee	Brick Wall	Rb-86	48	35	0	28%	37%	6%
Hand held squeegee	Brick Wall	Rb-86	51	30	0	41%		
Hand held squeegee	Brick Wall	Rb-86	53	32	0	41%		
Hand held squeegee	Brick Wall	Rb-86	37	23	0	38%		
Hand held squeegee	Paver Concrete	Cs ASFM	354	337	6	5%	3%	2%
Hand held squeegee	Paver Concrete	Cs ASFM	491	472	6	4%		
Hand held squeegee	Paver Concrete	Cs ASFM	364	360	6	1%		
Hand held squeegee	Paver Concrete	Cs ASFM	332	327	6	2%		
Hand held squeegee	Paver Concrete	Cs-137	650	389	7	41%	34%	5%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Hand held squeegee	Paver Concrete	Cs-137	637	421	7	34%		
Hand held squeegee	Paver Concrete	Cs-137	661	471	7	29%		
Hand held squeegee	Paver Concrete	Cs-137	715	480	7	33%		
Hand held squeegee	Paver Concrete	Rb-86	79	46	0	42%	38%	5%
Hand held squeegee	Paver Concrete	Rb-86	54	38	0	30%		
Hand held squeegee	Paver Concrete	Rb-86	83	51	0	38%		
Hand held squeegee	Paver Concrete	Rb-86	86	51	0	41%		
Hand held squeegee	Paver Concrete	Cs-137 Lt	304	243	8	21%	22%	4%
Hand held squeegee	Paver Concrete	Cs-137 Lt	426	317	8	26%		
Hand held squeegee	Paver Concrete	Cs-137 Lt	300	232	8	23%		
Hand held squeegee	Paver Concrete	Cs-137 Lt	317	263	8	18%		
Hand held squeegee	Sidewalk Concrete	Cs ASFM	419	404	15	4%	3%	0%
Hand held squeegee	Sidewalk Concrete	Cs ASFM	408	397	15	3%		
Hand held squeegee	Sidewalk Concrete	Cs ASFM	429	418	15	3%		
Hand held squeegee	Sidewalk Concrete	Cs ASFM	437	426	15	3%		
Hand held squeegee	Sidewalk Concrete	Cs-137	635	528	5	17%	13%	4%
Hand held squeegee	Sidewalk Concrete	Cs-137	694	593	5	15%		
Hand held squeegee	Sidewalk Concrete	Cs-137	661	584	5	12%		
Hand held squeegee	Sidewalk Concrete	Cs-137	607	554	5	9%		
Hand held squeegee	Sidewalk Concrete	Rb-86	72	39	0	45%	45%	2%
Hand held squeegee	Sidewalk Concrete	Rb-86	86	48	0	45%		
Hand held squeegee	Sidewalk Concrete	Rb-86	64	33	0	48%		
Hand held squeegee	Sidewalk Concrete	Rb-86	69	39	0	44%		
Hand held squeegee	Sidewalk Concrete	Cs-137 Lt	274	139	9	51%	53%	6%
Hand held squeegee	Sidewalk Concrete	Cs-137 Lt	344	139	9	61%		
Hand held squeegee	Sidewalk Concrete	Cs-137 Lt	362	171	9	54%		
Hand held squeegee	Sidewalk Concrete	Cs-137 Lt	482	262	9	46%		
Hand held squeegee	Window	Cs ASFM	173	12	6	97%	96%	2%
Hand held squeegee	Window	Cs ASFM	184	11	6	98%		
Hand held squeegee	Window	Cs ASFM	176	15	6	95%		
Hand held squeegee	Window	Cs ASFM	155	15	6	94%		
Hand held squeegee	Window	Cs-137	637	9	6	100%	99%	0%
Hand held squeegee	Window	Cs-137	582	9	6	99%		
Hand held squeegee	Window	Cs-137	660	9	6	100%		
Hand held squeegee	Window	Cs-137	694	10	6	99%		
Hand held squeegee	Window	Rb-86	57	1	0	99%	100%	1%
Hand held squeegee	Window	Rb-86	59	0	0	100%		
Hand held squeegee	Window	Rb-86	71	0	0	100%		
Hand held squeegee	Window	Rb-86	69	0	0	100%		
Hand held squeegee	window	Cs-137 Lt	356	9	9	100%	100%	0%
Hand held squeegee	window	Cs-137 Lt	362	8	9	100%		
Hand held squeegee	window	Cs-137 Lt	429	10	9	100%		
Hand held squeegee	window	Cs-137 Lt	460	9	9	100%		
Kitchen Broom	Asphalt Shingles	Cs-137	608	460	5	25%	23%	6%
Kitchen Broom	Asphalt Shingles	Cs-137	623	536	5	14%		
Kitchen Broom	Asphalt Shingles	Cs-137	600	450	5	25%		
Kitchen Broom	Asphalt Shingles	Cs-137	683	495	5	28%		
Kitchen Broom	Asphalt Shingles	Rb-86	94	63	0	34%	22%	8%
Kitchen Broom	Asphalt Shingles	Rb-86	107	88	0	18%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Kitchen Broom	Asphalt Shingles	Rb-86	116	98	0	15%		
Kitchen Broom	Asphalt Shingles	Rb-86	99	79	0	21%		
Kitchen Broom	Asphalt Shingles	Cs ASFM	463	463	3	0%	1%	1%
Kitchen Broom	Asphalt Shingles	Cs ASFM	504	493	3	2%		
Kitchen Broom	Asphalt Shingles	Cs ASFM	365	361	3	1%		
Kitchen Broom	Asphalt Shingles	Cs ASFM	349	343	3	2%		
Kitchen Broom	Asphalt Shingles	Cs-137 Lt	420	320	12	25%	25%	3%
Kitchen Broom	Asphalt Shingles	Cs-137 Lt	544	404	12	26%		
Kitchen Broom	Asphalt Shingles	Cs-137 Lt	336	270	12	20%		
Kitchen Broom	Asphalt Shingles	Cs-137 Lt	611	447	12	27%		
Kitchen Broom	Metal Roofing	Cs-137	379	4	22	105%	104%	1%
Kitchen Broom	Metal Roofing	Cs-137	443	5	22	104%		
Kitchen Broom	Metal Roofing	Cs-137	450	5	22	104%		
Kitchen Broom	Metal Roofing	Cs-137	471	4	22	104%		
Kitchen Broom	Metal Roofing	Rb-86	70	0	0	100%	100%	0%
Kitchen Broom	Metal Roofing	Rb-86	71	0	0	100%		
Kitchen Broom	Metal Roofing	Rb-86	74	0	0	100%		
Kitchen Broom	Metal Roofing	Rb-86	59	0	0	100%		
Kitchen Broom	Metal Roofing	Cs ASFM	162	93	4	44%	42%	4%
Kitchen Broom	Metal Roofing	Cs ASFM	166	100	4	41%		
Kitchen Broom	Metal Roofing	Cs ASFM	207	129	4	38%		
Kitchen Broom	Metal Roofing	Cs ASFM	147	80	4	47%		
Kitchen Broom	metal roofing	Cs-137 Lt	279	16	11	98%	98%	0%
Kitchen Broom	metal roofing	Cs-137 Lt	306	18	11	98%		
Kitchen Broom	metal roofing	Cs-137 Lt	312	15	11	99%		
Kitchen Broom	metal roofing	Cs-137 Lt	324	16	11	98%		
Kitchen Broom	Wood Shingles	Cs-137	532	68	12	89%	87%	3%
Kitchen Broom	Wood Shingles	Cs-137	638	77	12	90%		
Kitchen Broom	Wood Shingles	Cs-137	535	92	12	85%		
Kitchen Broom	Wood Shingles	Cs-137	510	95	12	83%		
Kitchen Broom	Wood Shingles	Rb-86	49	10	0	80%	74%	4%
Kitchen Broom	Wood Shingles	Rb-86	54	15	0	72%		
Kitchen Broom	Wood Shingles	Rb-86	49	14	0	72%		
Kitchen Broom	Wood Shingles	Rb-86	61	18	0	71%		
Kitchen Broom	Wood Shingles	Cs-137 Lt	407	161	15	63%	71%	9%
Kitchen Broom	Wood Shingles	Cs-137 Lt	532	203	15	64%		
Kitchen Broom	Wood Shingles	Cs-137 Lt	606	139	15	79%		
Kitchen Broom	Wood Shingles	Cs-137 Lt	565	130	15	79%		
Kitchen Broom	Wood Shingles	Cs ASFM	781	790	40	-1%	10%	16%
Kitchen Broom	Wood Shingles	Cs ASFM	967	934	40	4%		
Kitchen Broom	Wood Shingles	Cs ASFM	605	936	40			
Kitchen Broom	Wood Shingles	Cs ASFM	834	610	40	28%		
Mock Wall Cone	Mock Wall Asphalt Shingles	Cs-137 Lt	597	28	15	98%		
Mock Wall Cone	Mock Wall Asphalt Shingles	Cs-137 Lt	664	43	17	96%	96%	1%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Mock Wall Cone	Mock Wall Asphalt Shingles	Cs-137 Lt	666	47	31	97%		
Mock Wall Cone	Mock Wall Asphalt Shingles	Cs-137 Lt	465	34	15	96%		
Mock Wall Cone	Mock Wall Asphalt Shingles	ASFM	666	603	11	10%		
Mock Wall Cone	Mock Wall siding	Cs ASFM	617	61	26	94%	93%	1%
Mock Wall Cone	Mock Wall siding	Cs ASFM	395	50	23	93%		
Mock Wall Cone	Mock Wall steel roof	Cs-137 Lt	210	20	23	101%	101%	1%
Mock Wall Cone	Mock Wall steel roof	Cs-137 Lt	213	22	22	100%		
Mock Wall Cone	Mock Wall steel roof	Cs-137 Lt	181	22	24	101%		
Mock Wall Cone	Mock Wall steel roof	ASFM	334	25	22	99%		
Mock Wall Cone	Mock Wall window	Cs ASFM	405	41	29	97%	97%	1%
Mock Wall Cone	Mock Wall window	Cs ASFM	383	42	35	98%		
Mock Wall Fan	Mock Wall Asphalt Shingles	Cs-137 Lt	444	16	15	100%		
Mock Wall Fan	Mock Wall Asphalt Shingles	Cs-137 Lt	554	43	34	98%	98%	1%
Mock Wall Fan	Mock Wall Asphalt Shingles	Cs-137 Lt	441	47	34	97%		
Mock Wall Fan	Mock Wall Asphalt Shingles	Cs-137 Lt	427	36	34	99%		
Mock Wall Fan	Mock Wall Asphalt Shingles	ASFM	622	531	34	15%		
Mock Wall Fan	Mock Wall steel roof	Cs-137 Lt	175	23	18	97%	98%	1%
Mock Wall Fan	Mock Wall steel roof	Cs-137 Lt	181	22	20	99%		
Mock Wall Fan	Mock Wall steel roof	Cs-137 Lt	205	24	21	98%		
Mock Wall Fan	Mock Wall steel roof	ASFM	330	25	22	99%		
Mock Wall Fan	Mock Wall vinyl siding	Cs ASFM	360	39	26	96%	97%	1%
Mock Wall Fan	Mock Wall vinyl siding	Cs ASFM	452	36	23	97%		
Mock Wall Fan	Mock Wall window	Cs ASFM	207	37	29	95%	96%	2%
Mock Wall Fan	Mock Wall window	Cs ASFM	225	40	35	98%		
Mock Wall Stream	Mock Wall Asphalt Shingles	Cs-137 Lt	601	19	17	100%		
Mock Wall Stream	Mock Wall Asphalt Shingles	Cs-137 Lt	587	17	19	100%	100%	0%
Mock Wall Stream	Mock Wall Asphalt Shingles	Cs-137 Lt	663	31	29	100%		
Mock Wall Stream	Mock Wall Asphalt Shingles	Cs-137 Lt	507	15	11	99%		
Mock Wall Stream	Mock Wall Asphalt Shingles	ASFM	682	553	34	20%		
Mock Wall Stream	Mock Wall siding	Cs ASFM	346	71	54	94%	92%	3%
Mock Wall Stream	Mock Wall siding	Cs ASFM	350	74	44	90%		
Mock Wall Stream	Mock Wall steel roof	Cs-137 Lt	123	18	18	99%	99%	0%
Mock Wall Stream	Mock Wall steel roof	Cs-137 Lt	148	20	19	99%		
Mock Wall Stream	Mock Wall steel roof	Cs-137 Lt	129	21	19	99%		
Mock Wall Stream	Mock Wall steel roof	ASFM	341	24	20	99%		
Mock Wall Stream	Mock Wall window	Cs ASFM	253	65	37	87%	88%	2%
Mock Wall Stream	Mock Wall window	Cs ASFM	260	61	40	90%		
Mock Wall Stream	Mock Wall window	Cs ASFM	329	91	30	80%	85%	7%
Mock Wall Stream	Mock Wall window	Cs ASFM	384	72	38	90%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Mold Wash	Aluminum siding	Cs-137	573	46	18	95%	96%	3%
Mold Wash	Aluminum siding	Cs-137	592	56	18	93%		
Mold Wash	Aluminum siding	Cs-137	547	26	18	98%		
Mold Wash	Aluminum siding	Cs-137	577	27	18	98%		
Mold Wash	Aluminum siding	Rb-86	27	1	0	96%	98%	3%
Mold Wash	Aluminum siding	Rb-86	19	1	0	95%		
Mold Wash	Aluminum siding	Rb-86	21	0	0	100%		
Mold Wash	Aluminum siding	Rb-86	18	0	0	100%		
Mold Wash	Aluminum Siding	Cs ASFM	351	15	17	101%	101%	0%
Mold Wash	Aluminum Siding	Cs ASFM	265	14	17	101%		
Mold Wash	Aluminum Siding	Cs ASFM	245	14	17	101%		
Mold Wash	Aluminum Siding	Cs ASFM	268	13	17	101%		
Mold Wash	Aluminum Siding	Cs-137 Lt	376	18	15	99%	99%	1%
Mold Wash	Aluminum Siding	Cs-137 Lt	382	15	15	100%		
Mold Wash	Aluminum Siding	Cs-137 Lt	149	16	15	99%		
Mold Wash	Aluminum Siding	Cs-137 Lt	210	20	15	97%		
Mold Wash	steel siding	Cs-137	499	28	15	97%	98%	1%
Mold Wash	steel siding	Cs-137	621	26	15	98%		
Mold Wash	steel siding	Cs-137	401	20	15	99%		
Mold Wash	steel siding	Cs-137	603	18	15	100%		
Mold Wash	steel siding	Rb-86	27	1	0	97%	99%	2%
Mold Wash	steel siding	Rb-86	23	0	0	100%		
Mold Wash	steel siding	Rb-86	21	0	0	100%		
Mold Wash	steel siding	Rb-86	28	0	0	100%		
Mold Wash	Steel Siding	Cs ASFM	143	14	13	99%	100%	0%
Mold Wash	Steel Siding	Cs ASFM	146	13	13	100%		
Mold Wash	Steel Siding	Cs ASFM	179	13	13	100%		
Mold Wash	Steel Siding	Cs ASFM	129	13	13	100%		
Mold Wash	Steel Siding	Cs-137 Lt	369	14	15	100%	100%	0%
Mold Wash	Steel Siding	Cs-137 Lt	373	16	15	100%		
Mold Wash	Steel Siding	Cs-137 Lt	180	15	15	100%		
Mold Wash	Steel Siding	Cs-137 Lt	277	16	15	100%		
Mold Wash	Stucco	Cs ASFM	640	603	12	6%	4%	1%
Mold Wash	Stucco	Cs ASFM	459	439	12	5%		
Mold Wash	Stucco	Cs ASFM	419	407	12	3%		
Mold Wash	Stucco	Cs ASFM	463	445	12	4%		
Mold Wash	stucco	Cs-137	726	26	7	97%	96%	2%
Mold Wash	stucco	Cs-137	618	23	7	97%		
Mold Wash	stucco	Cs-137	667	44	7	94%		
Mold Wash	stucco	Cs-137	631	43	7	94%		
Mold Wash	stucco	Rb-86	69	1	0	98%	98%	0%
Mold Wash	stucco	Rb-86	71	1	0	99%		
Mold Wash	stucco	Rb-86	79	1	0	98%		
Mold Wash	stucco	Rb-86	78	2	0	98%		
Mold Wash	stucco	Cs-137 Lt	740	23	7	98%	98%	1%
Mold Wash	stucco	Cs-137 Lt	679	28	7	97%		
Mold Wash	stucco	Cs-137 Lt	763	23	7	98%		
Mold Wash	stucco	Cs-137 Lt	865	24	7	98%		
Mold Wash	Vinyl Siding	Cs ASFM	406	20	5	96%	96%	1%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Mold Wash	Vinyl Siding	Cs ASFM	256	18	5	95%		
Mold Wash	Vinyl Siding	Cs ASFM	370	19	5	96%		
Mold Wash	Vinyl Siding	Cs ASFM	366	18	5	96%		
Mold Wash	Vinyl Siding	Cs-137	531	24	5	96%	98%	1%
Mold Wash	Vinyl Siding	Cs-137	612	23	5	97%		
Mold Wash	Vinyl Siding	Cs-137	579	17	5	98%		
Mold Wash	Vinyl Siding	Cs-137	622	13	5	99%		
Mold Wash	Vinyl Siding	Rb-86	34	1	0	97%	98%	2%
Mold Wash	Vinyl Siding	Rb-86	33	1	0	96%		
Mold Wash	Vinyl Siding	Rb-86	44	0	0	100%		
Mold Wash	Vinyl Siding	Rb-86	38	1	0	98%		
Mold Wash	vinyl siding	Cs-137 Lt	281	10	8	99%	100%	0%
Mold Wash	vinyl siding	Cs-137 Lt	273	10	8	99%		
Mold Wash	vinyl siding	Cs-137 Lt	326	8	8	100%		
Mold Wash	vinyl siding	Cs-137 Lt	335	8	8	100%		
Mold wash	wood siding	Cs-137	924	34	9	97%	97%	1%
Mold wash	wood siding	Cs-137	797	25	9	98%		
Mold wash	wood siding	Cs-137	687	30	9	97%		
Mold wash	wood siding	Cs-137	449	25	9	96%		
Mold wash	wood siding	Rb-86	55	0	0	99%	99%	1%
Mold wash	wood siding	Rb-86	37	0	0	99%		
Mold wash	wood siding	Rb-86	37	1	0	98%		
Mold wash	wood siding	Rb-86	22	0	0	100%		
Mold Wash	Wood Siding	Cs ASFM	309	267	17	14%	12%	2%
Mold Wash	Wood Siding	Cs ASFM	453	411	17	10%		
Mold Wash	Wood Siding	Cs ASFM	390	344	17	12%		
Mold Wash	Wood Siding	Cs ASFM	437	391	17	11%		
Mold Wash	Wood Siding	Cs-137 Lt	261	30	16	94%	94%	0%
Mold Wash	Wood Siding	Cs-137 Lt	282	33	16	94%		
Mold Wash	Wood Siding	Cs-137 Lt	339	33	16	95%		
Mold Wash	Wood Siding	Cs-137 Lt	352	35	16	94%		
Mop	Asphalt Drive	Cs ASFM	804	649	131	23%	23%	1%
Mop	Asphalt Drive	Cs ASFM	680	554	131	23%		
Mop	Asphalt Drive	Cs ASFM	828	666	131	23%		
Mop	Asphalt Drive	Cs ASFM	784	624	131	25%		
Mop	Asphalt Drive	Cs-137 Lt	268	36	6	88%	85%	5%
Mop	Asphalt Drive	Cs-137 Lt	233	40	6	85%		
Mop	Asphalt Drive	Cs-137 Lt	204	48	6	79%		
Mop	Asphalt Drive	Cs-137 Lt	207	26	6	90%		
Mop	Asphalt Drive	Cs-137	731	104	66	94%	88%	9%
Mop	Asphalt Drive	Cs-137	704	106	58	92%		
Mop	Asphalt Drive	Cs-137	693	214	50	74%		
Mop	Asphalt Drive	Cs-137	477	82	42	91%		
Mop	Asphalt Drive	Rb-86	26	0	0	100%	94%	5%
Mop	Asphalt Drive	Rb-86	27	1	0	95%		
Mop	Asphalt Drive	Rb-86	27	4	0	87%		
Mop	Asphalt Drive	Rb-86	18	1	0	94%		
Mop	Brick Paver	Cs-137 Lt	281	35	13	92%	89%	2%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Mop	Brick Paver	Cs-137 Lt	231	38	13	88%		
Mop	Brick Paver	Cs-137 Lt	288	39	13	91%		
Mop	Brick Paver	Cs-137 Lt	221	40	13	87%		
Mop	Brick Paver	Cs ASFM	436	397	18	9%	12%	2%
Mop	Brick Paver	Cs ASFM	397	349	18	13%		
Mop	Brick Paver	Cs ASFM	509	448	18	12%		
Mop	Brick Paver	Cs ASFM	415	360	18	14%		
Mop	Brick Wall	Cs-137	540	48	15	94%	91%	4%
Mop	Brick Wall	Cs-137	617	61	15	92%		
Mop	Brick Wall	Cs-137	638	55	15	94%		
Mop	Brick Wall	Cs-137	633	106	15	85%		
Mop	Brick Wall	Rb-86	242	23	15	97%	95%	3%
Mop	Brick Wall	Rb-86	284	26	15	96%		
Mop	Brick Wall	Rb-86	260	23	15	97%		
Mop	Brick Wall	Rb-86	281	39	15	91%		
Mop	Paver Concrete	Cs ASFM	337	334	6	1%	2%	1%
Mop	Paver Concrete	Cs ASFM	472	466	6	1%		
Mop	Paver Concrete	Cs ASFM	360	353	6	2%		
Mop	Paver Concrete	Cs ASFM	327	316	6	3%		
Mop	Paver Concrete	Cs-137	597	139	8	78%	81%	5%
Mop	Paver Concrete	Cs-137	566	144	8	76%		
Mop	Paver Concrete	Cs-137	618	104	8	84%		
Mop	Paver Concrete	Cs-137	608	90	8	86%		
Mop	Paver Concrete	Rb-86	104	16	0	85%	88%	3%
Mop	Paver Concrete	Rb-86	98	14	0	86%		
Mop	Paver Concrete	Rb-86	92	8	0	91%		
Mop	Paver Concrete	Rb-86	92	10	0	89%		
Mop	Paver Concrete	Cs-137 Lt	449	141	10	70%	66%	13%
Mop	Paver Concrete	Cs-137 Lt	371	70	10	84%		
Mop	Paver Concrete	Cs-137 Lt	487	227	10	54%		
Mop	Paver Concrete	Cs-137 Lt	365	163	10	57%		
Mop	Paver Concrete	Cs-137 Lt	313	92	16	74%	82%	6%
Mop	Paver Concrete	Cs-137 Lt	563	89	16	87%		
Mop	Paver Concrete	Cs-137 Lt	693	145	16	81%		
Mop	Paver Concrete	Cs-137 Lt	747	112	16	87%		
Mop	Sidewalk Concrete	Cs ASFM	417	419	15	-1%	1%	1%
Mop	Sidewalk Concrete	Cs ASFM	411	408	15	1%		
Mop	Sidewalk Concrete	Cs ASFM	440	429	15	3%		
Mop	Sidewalk Concrete	Cs ASFM	444	437	15	2%		
Mop	Sidewalk Concrete	Cs-137	551	37	5	94%	94%	1%
Mop	Sidewalk Concrete	Cs-137	570	37	5	94%		
Mop	Sidewalk Concrete	Cs-137	685	38	5	95%		
Mop	Sidewalk Concrete	Cs-137	599	40	5	94%		
Mop	Sidewalk Concrete	Rb-86	43	5	0	88%	93%	3%
Mop	Sidewalk Concrete	Rb-86	50	2	0	96%		
Mop	Sidewalk Concrete	Rb-86	55	4	0	92%		
Mop	Sidewalk Concrete	Rb-86	50	3	0	94%		
Mop	Sidewalk Concrete	Cs-137 Lt	482	71	10	87%	86%	2%
Mop	Sidewalk Concrete	Cs-137 Lt	482	82	10	85%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Mop	Sidewalk Concrete	Cs-137 Lt	512	68	10	89%		
Mop	Sidewalk Concrete	Cs-137 Lt	512	89	10	84%		
Prewet Wipes	Aluminum siding	Cs-137	519	31	11	96%	97%	1%
Prewet Wipes	Aluminum siding	Cs-137	487	32	11	96%		
Prewet Wipes	Aluminum siding	Cs-137	583	30	11	97%		
Prewet Wipes	Aluminum siding	Cs-137	518	20	11	98%		
Prewet Wipes	Aluminum siding	Rb-86	18	0	0	99%	100%	0%
Prewet Wipes	Aluminum siding	Rb-86	12	0	0	100%		
Prewet Wipes	Aluminum siding	Rb-86	22	0	0	100%		
Prewet Wipes	Aluminum siding	Rb-86	17	0	0	100%		
Prewet Wipes	Aluminum Siding	Cs ASFM	242	38	14	90%	87%	4%
Prewet Wipes	Aluminum Siding	Cs ASFM	132	25	14	90%		
Prewet Wipes	Aluminum Siding	Cs ASFM	148	32	14	86%		
Prewet Wipes	Aluminum Siding	Cs ASFM	150	39	14	81%		
Prewet Wipes	Aluminum Siding	Cs-137 Lt	423	42	16	94%	93%	3%
Prewet Wipes	Aluminum Siding	Cs-137 Lt	393	24	16	98%		
Prewet Wipes	Aluminum Siding	Cs-137 Lt	447	55	16	91%		
Prewet Wipes	Aluminum Siding	Cs-137 Lt	405	47	16	92%		
Prewet Wipes	Asphalt Roofing	Cs-137	781	664	14	15%	10%	5%
Prewet Wipes	Asphalt Roofing	Cs-137	689	656	14	5%		
Prewet Wipes	Asphalt Roofing	Cs-137	775	679	14	13%		
Prewet Wipes	Asphalt Roofing	Cs-137	837	777	14	7%		
Prewet Wipes	Asphalt Roofing	Rb-86	81	41	0	49%	47%	1%
Prewet Wipes	Asphalt Roofing	Rb-86	84	45	0	46%		
Prewet Wipes	Asphalt Roofing	Rb-86	73	39	0	47%		
Prewet Wipes	Asphalt Roofing	Rb-86	84	44	0	48%		
Prewet Wipes	Asphalt Roofing	Cs ASFM	725	708	13	2%	0%	1%
Prewet Wipes	Asphalt Roofing	Cs ASFM	598	595	13	0%		
Prewet Wipes	Asphalt Roofing	Cs ASFM	573	573	13	0%		
Prewet Wipes	Asphalt Roofing	Cs ASFM	583	588	13	-1%		
Prewet Wipes	Asphalt Roofing	Cs-137 Lt	918	399	11	57%	52%	8%
Prewet Wipes	Asphalt Roofing	Cs-137 Lt	857	517	11	40%		
Prewet Wipes	Asphalt Roofing	Cs-137 Lt	1353	601	11	56%		
Prewet Wipes	Asphalt Roofing	Cs-137 Lt	1764	840	11	53%		
Prewet Wipes	Clay Tiles	Cs-137	263	11	6	98%	97%	1%
Prewet Wipes	Clay Tiles	Cs-137	268	14	6	97%		
Prewet Wipes	Clay Tiles	Cs-137	286	19	6	95%		
Prewet Wipes	Clay Tiles	Cs-137	373	16	6	97%		
Prewet Wipes	Clay Tiles	Rb-86	20	0	0	100%	100%	1%
Prewet Wipes	Clay Tiles	Rb-86	16	0	0	98%		
Prewet Wipes	Clay Tiles	Rb-86	33	0	0	100%		
Prewet Wipes	Clay Tiles	Rb-86	29	0	0	100%		
Prewet Wipes	Clay Tiles	Cs ASFM	178	123	3	31%	27%	3%
Prewet Wipes	Clay Tiles	Cs ASFM	177	131	3	26%		
Prewet Wipes	Clay Tiles	Cs ASFM	154	115	3	26%		
Prewet Wipes	Clay Tiles	Cs ASFM	168	125	3	26%		
Prewet Wipes	Clay tiles	Cs-137 Lt	330	14	13	100%	99%	1%
Prewet Wipes	Clay tiles	Cs-137 Lt	554	14	13	100%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Prewet Wipes	Clay tiles	Cs-137 Lt	486	22	13	98%		
Prewet Wipes	Clay tiles	Cs-137 Lt	661	23	13	99%		
Prewet Wipes	Composite Fencing	Cs-137	551	79	3	86%	89%	3%
Prewet Wipes	Composite Fencing	Cs-137	529	63	3	89%		
Prewet Wipes	Composite Fencing	Cs-137	614	66	3	90%		
Prewet Wipes	Composite Fencing	Cs-137	626	47	3	93%		
Prewet Wipes	Composite Fencing	Rb-86	68	5	0	93%	95%	2%
Prewet Wipes	Composite Fencing	Rb-86	87	5	0	95%		
Prewet Wipes	Composite Fencing	Rb-86	95	5	0	95%		
Prewet Wipes	Composite Fencing	Rb-86	94	3	0	96%		
Prewet Wipes	Composite Fencing	Cs ASFM	464	228	7	52%	69%	12%
Prewet Wipes	Composite Fencing	Cs ASFM	450	134	7	71%		
Prewet Wipes	Composite Fencing	Cs ASFM	466	107	7	78%		
Prewet Wipes	Composite Fencing	Cs ASFM	445	111	7	76%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	244	58	12	80%	85%	4%
Prewet Wipes	Composite Fencing	Cs-137 Lt	460	58	12	90%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	349	70	12	83%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	579	93	12	86%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	516	32	17	97%	93%	4%
Prewet Wipes	Composite Fencing	Cs-137 Lt	704	61	17	94%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	334	59	17	87%		
Prewet Wipes	Composite Fencing	Cs-137 Lt	674	62	17	93%		
Prewet Wipes	Gutter	Cs ASFM	540	52	10	92%	91%	1%
Prewet Wipes	Gutter	Cs ASFM	324	38	10	91%		
Prewet Wipes	Gutter	Cs ASFM	494	54	10	91%		
Prewet Wipes	Gutter	Cs ASFM	504	59	10	90%		
Prewet Wipes	Metal Roofing	Cs-137	336	13	7	98%	98%	1%
Prewet Wipes	Metal Roofing	Cs-137	504	10	7	99%		
Prewet Wipes	Metal Roofing	Cs-137	432	13	7	99%		
Prewet Wipes	Metal Roofing	Cs-137	319	13	7	98%		
Prewet Wipes	Metal Roofing	Rb-86	60	0	0	100%	99%	1%
Prewet Wipes	Metal Roofing	Rb-86	65	1	0	99%		
Prewet Wipes	Metal Roofing	Rb-86	68	0	0	99%		
Prewet Wipes	Metal Roofing	Rb-86	55	1	0	97%		
Prewet Wipes	Metal Roofing	Cs ASFM	252	11	8	99%	99%	0%
Prewet Wipes	Metal Roofing	Cs ASFM	287	11	8	99%		
Prewet Wipes	Metal Roofing	Cs ASFM	266	9	8	99%		
Prewet Wipes	Metal Roofing	Cs ASFM	326	11	8	99%		
Prewet Wipes	metal roofing	Cs-137 Lt	351	11	9	100%	99%	0%
Prewet Wipes	metal roofing	Cs-137 Lt	273	12	9	99%		
Prewet Wipes	metal roofing	Cs-137 Lt	382	14	9	99%		
Prewet Wipes	metal roofing	Cs-137 Lt	376	13	9	99%		
Prewet Wipes	Gutter	Cs ASFM	284	67	13	80%	76%	5%
Prewet Wipes	Gutter	Cs ASFM	261	62	13	80%		
Prewet Wipes	Gutter	Cs ASFM	271	82	13	73%		
Prewet Wipes	Gutter	Cs ASFM	213	70	13	71%		
Prewet Wipes	Gutter	Cs-137	592	10	8	100%	100%	0%
Prewet Wipes	Gutter	Cs-137	594	9	8	100%		
Prewet Wipes	Gutter	Cs-137	615	12	8	99%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Prewet Wipes	Gutter	Cs-137	570	11	8	99%		
Prewet Wipes	Gutter	Rb-86	69	0	0	100%	100%	0%
Prewet Wipes	Gutter	Rb-86	59	0	0	100%		
Prewet Wipes	Gutter	Rb-86	87	0	0	100%		
Prewet Wipes	Gutter	Rb-86	73	0	0	100%		
Prewet Wipes	Gutter	Cs-137 Lt	424	20	8	97%	99%	1%
Prewet Wipes	Gutter	Cs-137 Lt	326	9	8	100%		
Prewet Wipes	Gutter	Cs-137 Lt	449	10	8	100%		
Prewet Wipes	Gutter	Cs-137 Lt	408	15	8	98%		
Prewet Wipes	Plastic slide	Cs ASFM	299	3	6	101%	101%	0%
Prewet Wipes	Plastic slide	Cs ASFM	206	3	6	102%		
Prewet Wipes	Plastic slide	Cs ASFM	222	3	6	101%		
Prewet Wipes	Plastic slide	Cs ASFM	224	4	6	101%		
Prewet Wipes	Plastic slide	Cs-137	354	3	5	100%	100%	0%
Prewet Wipes	Plastic slide	Cs-137	302	3	5	100%		
Prewet Wipes	Plastic slide	Cs-137	197	5	5	100%		
Prewet Wipes	Plastic slide	Cs-137	556	4	5	100%		
Prewet Wipes	Plastic slide	Rb-86	22	0	0	100%	99%	2%
Prewet Wipes	Plastic slide	Rb-86	24	0	0	100%		
Prewet Wipes	Plastic slide	Rb-86	15	1	0	96%		
Prewet Wipes	Plastic slide	Rb-86	55	0	0	100%		
Prewet Wipes	Plastic slide	Cs-137 Lt	331	9	7	99%	99%	0%
Prewet Wipes	Plastic slide	Cs-137 Lt	335	9	7	99%		
Prewet Wipes	Plastic slide	Cs-137 Lt	372	8	7	100%		
Prewet Wipes	Plastic slide	Cs-137 Lt	355	9	7	99%		
Prewet Wipes	Steel siding	Cs-137	566	28	10	97%	96%	3%
Prewet Wipes	Steel siding	Cs-137	574	16	10	99%		
Prewet Wipes	Steel siding	Cs-137	607	61	10	91%		
Prewet Wipes	Steel siding	Cs-137	570	28	10	97%		
Prewet Wipes	Steel siding	Rb-86	48	0	0	99%	97%	3%
Prewet Wipes	Steel siding	Rb-86	51	1	0	98%		
Prewet Wipes	Steel siding	Rb-86	55	4	0	93%		
Prewet Wipes	Steel siding	Rb-86	54	1	0	98%		
Prewet Wipes	Steel siding	Cs ASFM	449	85	15	84%	87%	4%
Prewet Wipes	Steel siding	Cs ASFM	351	47	15	90%		
Prewet Wipes	Steel siding	Cs ASFM	376	46	15	91%		
Prewet Wipes	Steel siding	Cs ASFM	201	45	15	84%		
Prewet Wipes	Steel siding	Cs-137 Lt	340	24	20	99%	100%	1%
Prewet Wipes	Steel siding	Cs-137 Lt	330	18	20	101%		
Prewet Wipes	Steel siding	Cs-137 Lt	399	24	20	99%		
Prewet Wipes	Steel siding	Cs-137 Lt	469	21	20	100%		
Prewet Wipes	Stucco	Cs ASFM	651	646	7	1%	0%	1%
Prewet Wipes	Stucco	Cs ASFM	470	468	7	0%		
Prewet Wipes	Stucco	Cs ASFM	429	435	7	-2%		
Prewet Wipes	Stucco	Cs ASFM	476	470	7	1%		
Prewet Wipes	Stucco	Cs-137	597	166	5	73%	62%	17%
Prewet Wipes	Stucco	Cs-137	519	107	5	80%		
Prewet Wipes	Stucco	Cs-137	627	316	5	50%		
Prewet Wipes	Stucco	Cs-137	674	371	5	45%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Prewet Wipes	Stucco	Rb-86	102	13	0	87%	83%	9%
Prewet Wipes	Stucco	Rb-86	110	6	0	94%		
Prewet Wipes	Stucco	Rb-86	90	23	0	75%		
Prewet Wipes	Stucco	Rb-86	110	25	0	78%		
Prewet Wipes	stucco	Cs-137 Lt	456	62	6	88%	85%	3%
Prewet Wipes	stucco	Cs-137 Lt	477	87	6	83%		
Prewet Wipes	stucco	Cs-137 Lt	471	64	6	88%		
Prewet Wipes	stucco	Cs-137 Lt	433	79	6	83%		
Prewet Wipes	Vinyl Siding	Cs-137	324	37	8	91%	95%	3%
Prewet Wipes	Vinyl Siding	Cs-137	399	28	8	95%		
Prewet Wipes	Vinyl Siding	Cs-137	541	31	8	96%		
Prewet Wipes	Vinyl Siding	Cs-137	498	23	8	97%		
Prewet Wipes	Vinyl Siding	Rb-86	73	4	0	94%	95%	2%
Prewet Wipes	Vinyl Siding	Rb-86	82	4	0	95%		
Prewet Wipes	Vinyl Siding	Rb-86	89	5	0	95%		
Prewet Wipes	Vinyl Siding	Rb-86	92	2	0	98%		
Prewet Wipes	Vinyl Siding	Cs ASFM	375	25	5	94%	94%	1%
Prewet Wipes	Vinyl Siding	Cs ASFM	291	26	5	92%		
Prewet Wipes	Vinyl Siding	Cs ASFM	323	24	5	94%		
Prewet Wipes	Vinyl Siding	Cs ASFM	340	20	5	95%		
Prewet Wipes	vinyl siding	Cs-137 Lt	353	14	7	98%	98%	0%
Prewet Wipes	vinyl siding	Cs-137 Lt	455	13	7	99%		
Prewet Wipes	vinyl siding	Cs-137 Lt	476	15	7	98%		
Prewet Wipes	vinyl siding	Cs-137 Lt	448	13	7	99%		
Prewet Wipes	Window	Cs ASFM	229	9	6	99%	99%	0%
Prewet Wipes	Window	Cs ASFM	175	8	6	99%		
Prewet Wipes	Window	Cs ASFM	187	9	6	98%		
Prewet Wipes	Window	Cs ASFM	166	9	6	98%		
Prewet Wipes	Window	Cs-137	656	8	9	100%	100%	0%
Prewet Wipes	Window	Cs-137	616	8	9	100%		
Prewet Wipes	Window	Cs-137	665	6	9	100%		
Prewet Wipes	Window	Cs-137	665	6	9	100%		
Prewet Wipes	Window	Rb-86	90	0	0	100%	100%	0%
Prewet Wipes	Window	Rb-86	98	0	0	100%		
Prewet Wipes	Window	Rb-86	79	0	0	100%		
Prewet Wipes	Window	Rb-86	91	0	0	100%		
Prewet Wipes	window	Cs-137 Lt	326	10	8	99%	100%	0%
Prewet Wipes	window	Cs-137 Lt	345	8	8	100%		
Prewet Wipes	window	Cs-137 Lt	305	9	8	99%		
Prewet Wipes	window	Cs-137 Lt	326	9	8	100%		
Prewet Wipes	Wood Siding	Cs-137	871	41	16	97%	97%	0%
Prewet Wipes	Wood Siding	Cs-137	794	43	16	97%		
Prewet Wipes	Wood Siding	Cs-137	924	46	16	97%		
Prewet Wipes	Wood Siding	Cs-137	792	47	16	96%		
Prewet Wipes	Wood Siding	Rb-86	42	0	0	100%	98%	2%
Prewet Wipes	Wood Siding	Rb-86	40	0	0	99%		
Prewet Wipes	Wood Siding	Rb-86	49	2	0	96%		
Prewet Wipes	Wood Siding	Rb-86	50	1	0	97%		
Prewet Wipes	Wood Siding	Cs-137 Lt	371	87	37	85%	88%	3%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Prewet Wipes	Wood Siding	Cs-137 Lt	408	69	37	91%		
Prewet Wipes	Wood Siding	Cs-137 Lt	550	108	37	86%		
Prewet Wipes	Wood Siding	Cs-137 Lt	498	85	37	90%		
Prewet Wipes	Wood Siding	Cs ASFM	261	208	21	22%	20%	3%
Prewet Wipes	Wood Siding	Cs ASFM	293	230	21	23%		
Prewet Wipes	Wood Siding	Cs ASFM	295	241	21	20%		
Prewet Wipes	Wood Siding	Cs ASFM	262	225	21	15%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs-137	545	23	15	98%	98%	0%
Pump Sprayer	Asphalt Roofing (mock wall)	Cs-137	490	24	15	98%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs-137	617	27	15	98%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs-137	543	26	15	98%		
Pump Sprayer	Asphalt Roofing (mock wall)	Rb-86	115	2	0	98%	99%	0%
Pump Sprayer	Asphalt Roofing (mock wall)	Rb-86	131	2	0	98%		
Pump Sprayer	Asphalt Roofing (mock wall)	Rb-86	141	2	0	99%		
Pump Sprayer	Asphalt Roofing (mock wall)	Rb-86	128	1	0	99%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs ASFM	388	327	23	17%	15%	3%
Pump Sprayer	Asphalt Roofing (mock wall)	Cs ASFM	398	336	23	17%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs ASFM	394	336	23	16%		
Pump Sprayer	Asphalt Roofing (mock wall)	Cs ASFM	380	341	23	11%		
Pump Sprayer	Brick Wall	Cs ASFM	275	289	37	-6%	-5%	5%
Pump Sprayer	Brick Wall	Cs ASFM	298	320	37	-9%		
Pump Sprayer	Brick Wall	Cs ASFM	306	324	37	-7%		
Pump Sprayer	Brick Wall	Cs ASFM	329	323	37	2%		
Pump Sprayer	Brick Wall	Cs-137	395	37	19	95%	92%	4%
Pump Sprayer	Brick Wall	Cs-137	441	76	19	87%		
Pump Sprayer	Brick Wall	Cs-137	512	43	19	95%		
Pump Sprayer	Brick Wall	Cs-137	484	70	19	89%		
Pump Sprayer	Brick Wall	Rb-86	184	18	0	90%	87%	3%
Pump Sprayer	Brick Wall	Rb-86	169	26	0	85%		
Pump Sprayer	Brick Wall	Rb-86	209	20	0	90%		
Pump Sprayer	Brick Wall	Rb-86	212	32	0	85%		
Pump Sprayer	Clay Tile (mock wall)	Cs-137	236	15	18	101%	102%	3%
Pump Sprayer	Clay Tile (mock wall)	Cs-137	162	9	18	106%		
Pump Sprayer	Clay Tile (mock wall)	Cs-137	165	18	18	100%		
Pump Sprayer	Clay Tile (mock wall)	Cs-137	208	12	18	103%		
Pump Sprayer	Clay Tile (mock wall)	Rb-86	28	1	0	97%	98%	1%
Pump Sprayer	Clay Tile (mock wall)	Rb-86	22	0	0	99%		
Pump Sprayer	Clay Tile (mock wall)	Rb-86	25	1	0	98%		
Pump Sprayer	Clay Tile (mock wall)	Rb-86	31	1	0	98%		
Pump Sprayer	Clay Tile (mock wall)	Cs ASFM	152	68	8	58%	52%	6%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Pump Sprayer	Clay Tile (mock wall)	Cs ASFM	160	74	8	56%		
Pump Sprayer	Clay Tile (mock wall)	Cs ASFM	172	96	8	46%		
Pump Sprayer	Clay Tile (mock wall)	Cs ASFM	213	113	8	49%		
Pump Sprayer	Concrete Paver	Cs-137	631	90	17	88%	88%	4%
Pump Sprayer	Concrete Paver	Cs-137	571	118	17	82%		
Pump Sprayer	Concrete Paver	Cs-137	607	71	17	91%		
Pump Sprayer	Concrete Paver	Cs-137	694	89	17	89%		
Pump Sprayer	Concrete Paver	Rb-86	219	110	0	50%	54%	4%
Pump Sprayer	Concrete Paver	Rb-86	213	98	0	54%		
Pump Sprayer	Concrete Paver	Rb-86	311	125	0	60%		
Pump Sprayer	Concrete Paver	Rb-86	292	139	0	52%		
Pump Sprayer	Concrete Siding	Cs ASFM	947	856	17	10%	15%	4%
Pump Sprayer	Concrete Siding	Cs ASFM	837	724	17	14%		
Pump Sprayer	Concrete Siding	Cs ASFM	664	542	17	19%		
Pump Sprayer	Concrete Siding	Cs ASFM	809	677	17	17%		
Pump Sprayer	Paver Concrete	Cs ASFM	706	667	118	7%	3%	4%
Pump Sprayer	Paver Concrete	Cs ASFM	738	704	118	6%		
Pump Sprayer	Paver Concrete	Cs ASFM	634	645	118	-2%		
Pump Sprayer	Paver Concrete	Cs ASFM	1077	1070	118	1%		
Pump Sprayer	Sidewalk Concrete	Cs-137	650	53	15	94%	97%	2%
Pump Sprayer	Sidewalk Concrete	Cs-137	731	43	15	96%		
Pump Sprayer	Sidewalk Concrete	Cs-137	658	24	15	99%		
Pump Sprayer	Sidewalk Concrete	Cs-137	600	19	15	99%		
Pump Sprayer	Sidewalk Concrete	Rb-86	214	22	0	90%	94%	3%
Pump Sprayer	Sidewalk Concrete	Rb-86	189	10	0	95%		
Pump Sprayer	Sidewalk Concrete	Rb-86	197	15	0	93%		
Pump Sprayer	Sidewalk Concrete	Rb-86	245	5	0	98%		
Pump Sprayer	Sidewalk Concrete	Cs ASFM	302	298	53	2%	5%	3%
Pump Sprayer	Sidewalk Concrete	Cs ASFM	280	260	53	9%		
Pump Sprayer	Sidewalk Concrete	Cs ASFM	241	227	53	7%		
Pump Sprayer	Sidewalk Concrete	Cs ASFM	319	311	53	3%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	930	24	13	99%	96%	3%
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	932	38	13	97%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	915	22	13	99%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	817	34	13	97%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	619	29	13	97%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	636	30	13	97%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	783	61	13	94%		
Pump Sprayer	Siding with Window (mock wal)	Cs ASFM	872	90	13	91%		
Pump Sprayer	Stained Wood Deck	Cs-137	756	28	16	98%	98%	0%
Pump Sprayer	Stained Wood Deck	Cs-137	560	22	16	99%		
Pump Sprayer	Stained Wood Deck	Cs-137	623	29	16	98%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Pump Sprayer	Stained Wood Deck	Cs-137	530	26	16	98%		
Pump Sprayer	Stained Wood Deck	Rb-86	178	4	0	98%	98%	1%
Pump Sprayer	Stained Wood Deck	Rb-86	220	1	0	99%		
Pump Sprayer	Stained Wood Deck	Rb-86	147	4	0	98%		
Pump Sprayer	Stained Wood Deck	Rb-86	172	2	0	99%		
Pump Sprayer	Stained Wood Deck	Cs ASFM	458	252	20	47%	49%	3%
Pump Sprayer	Stained Wood Deck	Cs ASFM	532	289	20	47%		
Pump Sprayer	Stained Wood Deck	Cs ASFM	427	210	20	53%		
Pump Sprayer	Stained Wood Deck	Cs ASFM	562	291	20	50%		
Pump Sprayer	Stucco (mock wall)	Cs ASFM	1499	1480	13	1%	4%	2%
Pump Sprayer	Stucco (mock wall)	Cs ASFM	1100	1062	13	3%		
Pump Sprayer	Stucco (mock wall)	Cs ASFM	1235	1198	13	3%		
Pump Sprayer	Stucco (mock wall)	Cs ASFM	1279	1189	13	7%		
Pump Sprayer	Wood Shingles (mock wall)	Cs-137	381	20	15	99%	98%	1%
Pump Sprayer	Wood Shingles (mock wall)	Cs-137	399	17	15	99%		
Pump Sprayer	Wood Shingles (mock wall)	Cs-137	434	23	15	98%		
Pump Sprayer	Wood Shingles (mock wall)	Cs-137	452	24	15	98%		
Pump Sprayer	Wood Shingles (mock wall)	Rb-86	120	2	0	98%	98%	0%
Pump Sprayer	Wood Shingles (mock wall)	Rb-86	128	2	0	98%		
Pump Sprayer	Wood Shingles (mock wall)	Rb-86	130	4	0	97%		
Pump Sprayer	Wood Shingles (mock wall)	Rb-86	186	3	0	98%		
Pump Sprayer	Wood Shingles (mock wall)	Cs ASFM	257	148	17	45%	38%	7%
Pump Sprayer	Wood Shingles (mock wall)	Cs ASFM	287	177	17	41%		
Pump Sprayer	Wood Shingles (mock wall)	Cs ASFM	256	184	17	30%		
Pump Sprayer	Wood Shingles (mock wall)	Cs ASFM	301	203	17	35%		
Pump Sprayer	Wood Siding (mock wall)	Cs ASFM	733	555	14	25%	32%	7%
Pump Sprayer	Wood Siding (mock wall)	Cs ASFM	632	391	14	39%		
Pump Sprayer	Wood Siding (mock wall)	Cs ASFM	590	427	14	28%		
Pump Sprayer	Wood Siding (mock wall)	Cs ASFM	554	364	14	35%		
Push Broom	Asphalt Drive	Cs ASFM	894	731	7	18%	12%	8%
Push Broom	Asphalt Drive	Cs ASFM	1074	865	7	20%		
Push Broom	Asphalt Drive	Cs ASFM	644	628	7	2%		
Push Broom	Asphalt Drive	Cs ASFM	642	598	7	7%		
Push Broom	Asphalt Drive	Cs ASFM	783	747	8	5%	2%	3%
Push Broom	Asphalt Drive	Cs ASFM	967	931	8	4%		
Push Broom	Asphalt Drive	Cs ASFM	694	701	8	-1%		
Push Broom	Asphalt Drive	Cs ASFM	635	626	8	1%		
Push Broom	Asphalt Drive	Cs-137 Lt	412	105	6	76%	63%	18%
Push Broom	Asphalt Drive	Cs-137 Lt	210	122	6	43%		
Push Broom	Asphalt Drive	Cs-137 Lt	271	132	6	53%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Push Broom	Asphalt Drive	Cs-137 Lt	316	63	6	82%		
Push Broom	Asphalt Drive	Cs-137	679	92	11	88%	85%	7%
Push Broom	Asphalt Drive	Cs-137	684	72	11	91%		
Push Broom	Asphalt Drive	Cs-137	591	98	11	85%		
Push Broom	Asphalt Drive	Cs-137	565	147	11	75%		
Push Broom	Asphalt Drive	Rb-86	55	7	0	88%	84%	6%
Push Broom	Asphalt Drive	Rb-86	63	8	0	87%		
Push Broom	Asphalt Drive	Rb-86	54	8	0	86%		
Push Broom	Asphalt Drive	Rb-86	62	15	0	75%		
Push Broom	Asphalt Roofing	Cs-137	799	480	10	40%	41%	10%
Push Broom	Asphalt Roofing	Cs-137	766	424	10	45%		
Push Broom	Asphalt Roofing	Cs-137	782	396	10	50%		
Push Broom	Asphalt Roofing	Cs-137	698	515	10	27%		
Push Broom	Asphalt Roofing	Rb-86	113	33	0	71%	63%	11%
Push Broom	Asphalt Roofing	Rb-86	85	31	0	64%		
Push Broom	Asphalt Roofing	Rb-86	93	28	0	70%		
Push Broom	Asphalt Roofing	Rb-86	87	45	0	48%		
Push Broom	Asphalt Roofing	Cs ASFM	482	511	13	-6%	3%	13%
Push Broom	Asphalt Roofing	Cs ASFM	259	272	13	-5%		
Push Broom	Asphalt Roofing	Cs ASFM	432	344	13	21%		
Push Broom	Asphalt Roofing	Cs ASFM	301	291	13	3%		
Push Broom	Asphalt Roofing	Cs-137 Lt	221	162	16	29%	53%	17%
Push Broom	Asphalt Roofing	Cs-137 Lt	345	120	16	68%		
Push Broom	Asphalt Roofing	Cs-137 Lt	190	102	16	51%		
Push Broom	Asphalt Roofing	Cs-137 Lt	181	79	16	62%		
Push Broom	Asphalt Roofing	Cs-137	655	304	12	55%	61%	5%
Push Broom	Asphalt Roofing	Cs-137	417	178	12	59%		
Push Broom	Asphalt Roofing	Cs-137	568	228	12	61%		
Push Broom	Asphalt Roofing	Cs-137	622	212	12	67%		
Push Broom	Asphalt Roofing	Rb-86	228	88	12	65%	75%	7%
Push Broom	Asphalt Roofing	Rb-86	154	50	12	73%		
Push Broom	Asphalt Roofing	Rb-86	227	58	12	79%		
Push Broom	Asphalt Roofing	Rb-86	279	63	12	81%		
Push Broom	Brick Paver	Cs-137 Lt	359	196	15	47%	68%	16%
Push Broom	Brick Paver	Cs-137 Lt	557	122	15	80%		
Push Broom	Brick Paver	Cs-137 Lt	495	187	15	64%		
Push Broom	Brick Paver	Cs-137 Lt	480	100	15	82%		
Push Broom	Brick Wall	Cs-137	649	104	16	86%	92%	4%
Push Broom	Brick Wall	Cs-137	749	47	14	96%		
Push Broom	Brick Wall	Cs-137	796	63	14	94%		
Push Broom	Brick Wall	Cs-137	741	65	11	93%		
Push Broom	Brick Wall	Rb-86	76	7	0	91%	94%	2%
Push Broom	Brick Wall	Rb-86	81	4	0	95%		
Push Broom	Brick Wall	Rb-86	96	6	0	94%		
Push Broom	Brick Wall	Rb-86	70	4	0	95%		
Push Broom	Brick Wall	Cs ASFM	454	453	0	0%	2%	3%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Push Broom	Brick Wall	Cs ASFM	645	656	0	-2%		
Push Broom	Brick Wall	Cs ASFM	868	836	0	4%		
Push Broom	Brick Wall	Cs ASFM	515	488	0	5%		
Push Broom	Paver Concrete	Cs ASFM	447	443	6	1%	3%	2%
Push Broom	Paver Concrete	Cs ASFM	352	339	6	4%		
Push Broom	Paver Concrete	Cs ASFM	322	316	6	2%		
Push Broom	Paver Concrete	Cs ASFM	323	309	6	4%		
Push Broom	Paver Concrete	Cs-137	571	56	2	91%	91%	0%
Push Broom	Paver Concrete	Cs-137	718	69	2	91%		
Push Broom	Paver Concrete	Cs-137	615	57	2	91%		
Push Broom	Paver Concrete	Cs-137	617	60	2	91%		
Push Broom	Paver Concrete	Rb-86	74	15	0	79%	81%	3%
Push Broom	Paver Concrete	Rb-86	102	23	0	78%		
Push Broom	Paver Concrete	Rb-86	97	17	0	82%		
Push Broom	Paver Concrete	Rb-86	94	15	0	84%		
Push Broom	Paver Concrete	Cs-137 Lt	266	130	6	52%	61%	7%
Push Broom	Paver Concrete	Cs-137 Lt	287	124	6	58%		
Push Broom	Paver Concrete	Cs-137 Lt	391	129	6	68%		
Push Broom	Paver Concrete	Cs-137 Lt	337	117	6	67%		
Push Broom	Sidewalk Concrete	Cs ASFM	413	423	15	-3%	-1%	2%
Push Broom	Sidewalk Concrete	Cs ASFM	413	418	15	-1%		
Push Broom	Sidewalk Concrete	Cs ASFM	438	433	15	1%		
Push Broom	Sidewalk Concrete	Cs ASFM	438	449	15	-2%		
Push Broom	Sidewalk Concrete	Cs-137	704	28	6	97%	96%	1%
Push Broom	Sidewalk Concrete	Cs-137	594	33	6	95%		
Push Broom	Sidewalk Concrete	Cs-137	722	47	6	94%		
Push Broom	Sidewalk Concrete	Cs-137	632	32	6	96%		
Push Broom	Sidewalk Concrete	Rb-86	86	3	0	97%	96%	1%
Push Broom	Sidewalk Concrete	Rb-86	73	3	0	95%		
Push Broom	Sidewalk Concrete	Rb-86	84	3	0	97%		
Push Broom	Sidewalk Concrete	Rb-86	81	4	0	95%		
Push Broom	Sidewalk Concrete	Cs-137 Lt	496	42	12	94%	90%	4%
Push Broom	Sidewalk Concrete	Cs-137 Lt	504	86	12	85%		
Push Broom	Sidewalk Concrete	Cs-137 Lt	457	48	12	92%		
Push Broom	Sidewalk Concrete	Cs-137 Lt	430	59	12	89%		
Push Broom	Stained Wood Deck	Cs ASFM	377	333	5	12%	7%	4%
Push Broom	Stained Wood Deck	Cs ASFM	442	405	5	8%		
Push Broom	Stained Wood Deck	Cs ASFM	464	442	5	5%		
Push Broom	Stained Wood Deck	Cs ASFM	458	444	5	3%		
Push Broom	Stained Wood Deck	Cs-137	753	14	6	99%	99%	0%
Push Broom	Stained Wood Deck	Cs-137	598	13	6	99%		
Push Broom	Stained Wood Deck	Cs-137	684	14	6	99%		
Push Broom	Stained Wood Deck	Cs-137	760	12	6	99%		
Push Broom	Stained Wood Deck	Rb-86	43	1	0	97%	98%	1%
Push Broom	Stained Wood Deck	Rb-86	37	1	0	97%		
Push Broom	Stained Wood Deck	Rb-86	38	1	0	98%		
Push Broom	Stained Wood Deck	Rb-86	52	0	0	99%		
Push Broom	Stained Wood Deck	Cs-137 Lt	496	36	9	95%	91%	3%
Push Broom	Stained Wood Deck	Cs-137 Lt	259	37	9	89%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Push Broom	Stained Wood Deck	Cs-137 Lt	349	37	9	92%		
Push Broom	Stained Wood Deck	Cs-137 Lt	262	37	9	89%		
Push Broom	Wood Shingles	Cs ASFM	258	259	11	0%	1%	2%
Push Broom	Wood Shingles	Cs ASFM	257	254	11	1%		
Push Broom	Wood Shingles	Cs ASFM	240	240	11	0%		
Push Broom	Wood Shingles	Cs ASFM	216	209	11	4%		
Sponge	Aluminum Siding	Cs ASFM	362	130	19	68%	75%	5%
Sponge	Aluminum Siding	Cs ASFM	268	77	19	77%		
Sponge	Aluminum Siding	Cs ASFM	368	94	19	78%		
Sponge	Aluminum Siding	Cs ASFM	332	92	19	77%		
Sponge	Aluminum Siding	Cs-137 Lt	412	27	15	97%	96%	2%
Sponge	Aluminum Siding	Cs-137 Lt	501	23	15	98%		
Sponge	Aluminum Siding	Cs-137 Lt	455	41	15	94%		
Sponge	Aluminum Siding	Cs-137 Lt	400	40	15	94%		
Sponge	Asphalt Roofing	Cs-137 Lt	247	75	20	76%	78%	3%
Sponge	Asphalt Roofing	Cs-137 Lt	296	91	20	74%		
Sponge	Asphalt Roofing	Cs-137 Lt	208	58	20	80%		
Sponge	Asphalt Roofing	Cs-137 Lt	258	66	20	81%		
Sponge	Steel Siding	Cs ASFM	506	29	19	98%	98%	0%
Sponge	Steel Siding	Cs ASFM	363	25	19	98%		
Sponge	Steel Siding	Cs ASFM	424	27	19	98%		
Sponge	Steel Siding	Cs ASFM	428	28	19	98%		
Sponge	Steel Siding	Cs-137 Lt	309	16	15	100%	99%	0%
Sponge	Steel Siding	Cs-137 Lt	344	18	15	99%		
Sponge	Steel Siding	Cs-137 Lt	419	19	15	99%		
Sponge	Steel Siding	Cs-137 Lt	284	19	15	99%		
Sponge	Wood Shingles	Cs-137 Lt	481	120	13	77%	67%	17%
Sponge	Wood Shingles	Cs-137 Lt	274	93	13	69%		
Sponge	Wood Shingles	Cs-137 Lt	188	113	13	43%		
Sponge	Wood Shingles	Cs-137 Lt	296	67	13	81%		
Sponge	Wood Siding	Cs-137 Lt	258	45	15	88%	91%	2%
Sponge	Wood Siding	Cs-137 Lt	306	40	15	91%		
Sponge	Wood Siding	Cs-137 Lt	366	49	15	90%		
Sponge	Wood Siding	Cs-137 Lt	337	37	15	93%		
Squeegee	Brick Paver	Cs-137 Lt	423	226	14	48%	47%	4%
Squeegee	Brick Paver	Cs-137 Lt	429	248	14	44%		
Squeegee	Brick Paver	Cs-137 Lt	632	363	14	43%		
Squeegee	Brick Paver	Cs-137 Lt	592	293	14	52%		
Squeegee	Sidewalk Concrete	Cs-137	484	137	14	74%	77%	2%
Squeegee	Sidewalk Concrete	Cs-137	553	143	14	76%		
Squeegee	Sidewalk Concrete	Cs-137	682	159	14	78%		
Squeegee	Sidewalk Concrete	Cs-137	690	154	14	79%		
Squeegee	Sidewalk Concrete	Rb-86	196	33	0	83%	83%	3%
Squeegee	Sidewalk Concrete	Rb-86	197	38	0	80%		
Squeegee	Sidewalk Concrete	Rb-86	224	31	0	86%		
Squeegee	Sidewalk Concrete	Rb-86	193	39	0	80%		
Vacuum	Asphalt Drive	Cs ASFM	769	762	8	1%	0%	2%
Vacuum	Asphalt Drive	Cs ASFM	688	680	8	1%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Vacuum	Asphalt Drive	Cs ASFM	799	828	8	-4%		
Vacuum	Asphalt Drive	Cs ASFM	788	784	8	1%		
Vacuum	Asphalt Drive	Cs-137 Lt	336	4	4	100%	99%	1%
Vacuum	Asphalt Drive	Cs-137 Lt	299	7	4	99%		
Vacuum	Asphalt Drive	Cs-137 Lt	254	5	4	99%		
Vacuum	Asphalt Drive	Cs-137 Lt	241	7	4	99%		
Vacuum	Asphalt Drive	Cs-137	705	9	12	100%	100%	0%
Vacuum	Asphalt Drive	Cs-137	728	10	12	100%		
Vacuum	Asphalt Drive	Cs-137	731	13	12	100%		
Vacuum	Asphalt Drive	Cs-137	731	9	12	100%		
Vacuum	Asphalt Drive	Rb-86	84	0	0	100%	100%	1%
Vacuum	Asphalt Drive	Rb-86	121	0	0	100%		
Vacuum	Asphalt Drive	Rb-86	108	2	0	99%		
Vacuum	Asphalt Drive	Rb-86	87	0	0	100%		
Vacuum	Asphalt Shingles	Cs-137	460	43	5	92%	92%	1%
Vacuum	Asphalt Shingles	Cs-137	536	40	5	93%		
Vacuum	Asphalt Shingles	Cs-137	450	39	5	92%		
Vacuum	Asphalt Shingles	Cs-137	495	49	5	91%		
Vacuum	Asphalt Shingles	Rb-86	63	12	0	81%	85%	3%
Vacuum	Asphalt Shingles	Rb-86	88	10	0	89%		
Vacuum	Asphalt Shingles	Rb-86	98	14	0	86%		
Vacuum	Asphalt Shingles	Rb-86	79	13	0	84%		
Vacuum	Asphalt Shingles	Cs ASFM	538	538	12	0%	2%	1%
Vacuum	Asphalt Shingles	Cs ASFM	550	537	12	2%		
Vacuum	Asphalt Shingles	Cs ASFM	526	519	12	1%		
Vacuum	Asphalt Shingles	Cs ASFM	619	600	12	3%		
Vacuum	Asphalt Shingles	Cs-137	568	24	5	97%	97%	0%
Vacuum	Asphalt Shingles	Cs-137	518	23	5	97%		
Vacuum	Asphalt Shingles	Cs-137	547	22	5	97%		
Vacuum	Asphalt Shingles	Cs-137	613	23	5	97%		
Vacuum	Asphalt Shingles	Rb-86	53	1	0	97%	97%	0%
Vacuum	Asphalt Shingles	Rb-86	42	1	0	97%		
Vacuum	Asphalt Shingles	Rb-86	51	1	0	97%		
Vacuum	Asphalt Shingles	Rb-86	52	2	0	97%		
Vacuum	Asphalt Shingles	Cs-137 Lt	640	21	12	99%	98%	0%
Vacuum	Asphalt Shingles	Cs-137 Lt	257	16	12	98%		
Vacuum	Asphalt Shingles	Cs-137 Lt	282	18	12	98%		
Vacuum	Asphalt Shingles	Cs-137 Lt	254	15	12	99%		
Vacuum	Brick Wall	Cs-137	693	16	14	100%	100%	0%
Vacuum	Brick Wall	Cs-137	589	14	14	100%		
Vacuum	Brick Wall	Cs-137	643	14	14	100%		
Vacuum	Brick Wall	Cs-137	693	11	14	100%		
Vacuum	Brick Wall	Rb-86	63	0	0	100%	100%	0%
Vacuum	Brick Wall	Rb-86	66	0	0	100%		
Vacuum	Brick Wall	Rb-86	60	0	0	100%		
Vacuum	Brick Wall	Rb-86	58	0	0	100%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Vacuum	Brick Wall	Cs ASFM	453	437	18	4%	4%	1%
Vacuum	Brick Wall	Cs ASFM	656	627	18	4%		
Vacuum	Brick Wall	Cs ASFM	836	808	18	3%		
Vacuum	Brick Wall	Cs ASFM	488	474	18	3%		
Vacuum	Brick Wall	Cs-137 Lt	435	16	12	99%	99%	0%
Vacuum	Brick Wall	Cs-137 Lt	634	15	12	100%		
Vacuum	Brick Wall	Cs-137 Lt	720	16	12	100%		
Vacuum	Brick Wall	Cs-137 Lt	474	15	12	99%		
Vacuum	Open Gutter	Cs ASFM	272	208	12	25%	18%	5%
Vacuum	Open Gutter	Cs ASFM	288	241	12	17%		
Vacuum	Open Gutter	Cs ASFM	195	165	12	16%		
Vacuum	Open Gutter	Cs ASFM	279	244	12	13%		
Vacuum	Open Gutter	Cs-137	731	12	9	100%	100%	0%
Vacuum	Open Gutter	Cs-137	710	10	9	100%		
Vacuum	Open Gutter	Cs-137	603	10	9	100%		
Vacuum	Open Gutter	Cs-137	668	15	9	99%		
Vacuum	Open Gutter	Rb-86	81	0	0	100%	100%	0%
Vacuum	Open Gutter	Rb-86	45	0	0	100%		
Vacuum	Open Gutter	Rb-86	74	0	0	100%		
Vacuum	Open Gutter	Rb-86	98	0	0	100%		
Vacuum	Open Gutter	Cs-137 Lt	270	9	8	100%	100%	0%
Vacuum	Open Gutter	Cs-137 Lt	421	9	8	100%		
Vacuum	Open Gutter	Cs-137 Lt	371	9	8	100%		
Vacuum	Open Gutter	Cs-137 Lt	449	10	8	99%		
Vacuum	Paver Concrete	Cs ASFM	463	447	8	3%	2%	1%
Vacuum	Paver Concrete	Cs ASFM	356	352	8	1%		
Vacuum	Paver Concrete	Cs ASFM	327	322	8	2%		
Vacuum	Paver Concrete	Cs ASFM	334	323	8	3%		
Vacuum	Paver Concrete	Cs-137	610	14	4	98%	99%	0%
Vacuum	Paver Concrete	Cs-137	683	12	4	99%		
Vacuum	Paver Concrete	Cs-137	627	8	4	99%		
Vacuum	Paver Concrete	Cs-137	667	9	4	99%		
Vacuum	Paver Concrete	Rb-86	68	2	0	97%	99%	1%
Vacuum	Paver Concrete	Rb-86	63	1	0	99%		
Vacuum	Paver Concrete	Rb-86	82	0	0	100%		
Vacuum	Paver Concrete	Rb-86	77	1	0	99%		
Vacuum	Paver Concrete	Cs-137 Lt	308	9	11	101%	100%	1%
Vacuum	Paver Concrete	Cs-137 Lt	327	14	11	99%		
Vacuum	Paver Concrete	Cs-137 Lt	265	14	11	99%		
Vacuum	Paver Concrete	Cs-137 Lt	434	12	11	100%		
Vacuum	Sidewalk Concrete	Cs ASFM	423	417	15	2%	1%	2%
Vacuum	Sidewalk Concrete	Cs ASFM	418	411	15	2%		
Vacuum	Sidewalk Concrete	Cs ASFM	433	440	15	-2%		
Vacuum	Sidewalk Concrete	Cs ASFM	449	444	15	1%		
Vacuum	Sidewalk Concrete	Cs-137	627	9	4	99%	99%	0%
Vacuum	Sidewalk Concrete	Cs-137	586	11	4	99%		
Vacuum	Sidewalk Concrete	Cs-137	716	12	4	99%		
Vacuum	Sidewalk Concrete	Cs-137	704	12	4	99%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Vacuum	Sidewalk Concrete	Rb-86	86	0	0	100%	100%	0%
Vacuum	Sidewalk Concrete	Rb-86	110	0	0	100%		
Vacuum	Sidewalk Concrete	Rb-86	105	1	0	99%		
Vacuum	Sidewalk Concrete	Rb-86	94	0	0	100%		
Vacuum	Sidewalk Concrete	Cs-137 Lt	300	10	13	101%	100%	0%
Vacuum	Sidewalk Concrete	Cs-137 Lt	397	13	13	100%		
Vacuum	Sidewalk Concrete	Cs-137 Lt	333	11	13	100%		
Vacuum	Sidewalk Concrete	Cs-137 Lt	346	12	13	100%		
Vacuum	Stained Wood Deck	Cs-137	550	9	2	99%	99%	0%
Vacuum	Stained Wood Deck	Cs-137	755	9	2	99%		
Vacuum	Stained Wood Deck	Cs-137	490	8	2	99%		
Vacuum	Stained Wood Deck	Cs-137	529	8	2	99%		
Vacuum	Stained Wood Deck	Rb-86	78	0	0	100%	99%	1%
Vacuum	Stained Wood Deck	Rb-86	88	2	0	98%		
Vacuum	Stained Wood Deck	Rb-86	69	0	0	100%		
Vacuum	Stained Wood Deck	Rb-86	125	1	0	100%		
Vacuum	Stained Wood Deck	Cs ASFM	386	373	5	4%	2%	1%
Vacuum	Stained Wood Deck	Cs ASFM	446	441	5	1%		
Vacuum	Stained Wood Deck	Cs ASFM	458	457	5	0%		
Vacuum	Stained Wood Deck	Cs ASFM	466	455	5	2%		
Vacuum	Stained Wood Deck	Cs-137 Lt	289	13	7	98%	99%	0%
Vacuum	Stained Wood Deck	Cs-137 Lt	360	11	7	99%		
Vacuum	Stained Wood Deck	Cs-137 Lt	368	12	7	99%		
Vacuum	Stained Wood Deck	Cs-137 Lt	465	12	7	99%		
Vacuum	Wood Shingles	Cs-137	618	13	8	99%	99%	0%
Vacuum	Wood Shingles	Cs-137	578	11	8	99%		
Vacuum	Wood Shingles	Cs-137	379	11	8	99%		
Vacuum	Wood Shingles	Cs-137	481	12	8	99%		
Vacuum	Wood Shingles	Rb-86	63	0	0	99%	99%	1%
Vacuum	Wood Shingles	Rb-86	65	0	0	100%		
Vacuum	Wood Shingles	Rb-86	45	0	0	100%		
Vacuum	Wood Shingles	Rb-86	42	1	0	98%		
Vacuum	Wood Shingles	Cs ASFM	260	258	11	1%	0%	2%
Vacuum	Wood Shingles	Cs ASFM	256	257	11	0%		
Vacuum	Wood Shingles	Cs ASFM	246	240	11	2%		
Vacuum	Wood Shingles	Cs ASFM	210	216	11	-3%		
Vacuum	Wood Shingles	Cs-137 Lt	510	19	10	98%	98%	0%
Vacuum	Wood Shingles	Cs-137 Lt	175	13	10	98%		
Vacuum	Wood Shingles	Cs-137 Lt	338	16	10	98%		
Vacuum	Wood Shingles	Cs-137 Lt	277	17	10	98%		
Wet Sponge	Aluminum Siding	Cs-137	620	55	10	93%	96%	3%
Wet Sponge	Aluminum Siding	Cs-137	607	40	10	95%		
Wet Sponge	Aluminum Siding	Cs-137	585	20	10	98%		
Wet Sponge	Aluminum Siding	Cs-137	652	17	10	99%		
Wet Sponge	Aluminum Siding	Rb-86	54	4	0	93%	96%	3%
Wet Sponge	Aluminum Siding	Rb-86	56	3	0	94%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Wet Sponge	Aluminum Siding	Rb-86	71	1	0	99%		
Wet Sponge	Aluminum Siding	Rb-86	70	1	0	98%		
Wet Sponge	Asphalt Roofing	Cs-137	590	337	14	44%	50%	5%
Wet Sponge	Asphalt Roofing	Cs-137	839	441	14	48%		
Wet Sponge	Asphalt Roofing	Cs-137	815	368	14	56%		
Wet Sponge	Asphalt Roofing	Cs-137	787	392	14	51%		
Wet Sponge	Asphalt Roofing	Rb-86	82	27	0	67%	67%	2%
Wet Sponge	Asphalt Roofing	Rb-86	89	32	0	64%		
Wet Sponge	Asphalt Roofing	Rb-86	80	25	0	69%		
Wet Sponge	Asphalt Roofing	Rb-86	87	29	0	67%		
Wet Sponge	Asphalt Roofing	Cs ASFM	511	449	13	12%	8%	4%
Wet Sponge	Asphalt Roofing	Cs ASFM	272	248	13	9%		
Wet Sponge	Asphalt Roofing	Cs ASFM	344	328	13	5%		
Wet Sponge	Asphalt Roofing	Cs ASFM	291	276	13	5%		
Wet Sponge	Asphalt Shingles	Cs ASFM	261	248	7	5%	4%	1%
Wet Sponge	Asphalt Shingles	Cs ASFM	229	219	7	5%		
Wet Sponge	Asphalt Shingles	Cs ASFM	277	265	7	5%		
Wet Sponge	Asphalt Shingles	Cs ASFM	284	276	7	3%		
Wet Sponge	Asphalt Shingles	Cs-137	615	380	5	39%	27%	9%
Wet Sponge	Asphalt Shingles	Cs-137	599	419	5	30%		
Wet Sponge	Asphalt Shingles	Cs-137	580	486	5	16%		
Wet Sponge	Asphalt Shingles	Cs-137	535	404	5	25%		
Wet Sponge	Asphalt Shingles	Rb-86	57	24	0	57%	47%	8%
Wet Sponge	Asphalt Shingles	Rb-86	51	28	0	44%		
Wet Sponge	Asphalt Shingles	Rb-86	59	37	0	38%		
Wet Sponge	Asphalt Shingles	Rb-86	55	29	0	48%		
Wet Sponge	Asphalt Shingles	Cs-137 Lt	444	168	10	64%	61%	3%
Wet Sponge	Asphalt Shingles	Cs-137 Lt	597	245	10	60%		
Wet Sponge	Asphalt Shingles	Cs-137 Lt	483	207	10	58%		
Wet Sponge	Asphalt Shingles	Cs-137 Lt	597	222	10	64%		
Wet Sponge	Clay Tiles	Cs ASFM	167	99	3	41%	37%	3%
Wet Sponge	Clay Tiles	Cs ASFM	201	127	3	37%		
Wet Sponge	Clay Tiles	Cs ASFM	200	127	3	37%		
Wet Sponge	Clay Tiles	Cs ASFM	191	128	3	34%		
Wet Sponge	Clay Tiles	Cs-137	432	5	3	99%	100%	0%
Wet Sponge	Clay Tiles	Cs-137	545	6	3	99%		
Wet Sponge	Clay Tiles	Cs-137	581	5	3	100%		
Wet Sponge	Clay Tiles	Cs-137	594	6	3	99%		
Wet Sponge	Clay Tiles	Rb-86	29	0	0	100%	100%	0%
Wet Sponge	Clay Tiles	Rb-86	23	0	0	100%		
Wet Sponge	Clay Tiles	Rb-86	30	0	0	100%		
Wet Sponge	Clay Tiles	Rb-86	37	0	0	100%		
Wet Sponge	Clay tiles	Cs-137 Lt	460	10	10	100%	99%	0%
Wet Sponge	Clay tiles	Cs-137 Lt	652	15	10	99%		
Wet Sponge	Clay tiles	Cs-137 Lt	422	14	10	99%		
Wet Sponge	Clay tiles	Cs-137 Lt	468	14	10	99%		
Wet Sponge	Composite Fencing	Cs-137	651	25	3	97%	96%	1%

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Wet Sponge	Composite Fencing	Cs-137	664	23	3	97%		
Wet Sponge	Composite Fencing	Cs-137	513	28	3	95%		
Wet Sponge	Composite Fencing	Cs-137	488	32	3	94%		
Wet Sponge	Composite Fencing	Rb-86	93	3	0	96%	96%	2%
Wet Sponge	Composite Fencing	Rb-86	115	2	0	98%		
Wet Sponge	Composite Fencing	Rb-86	64	4	0	94%		
Wet Sponge	Composite Fencing	Rb-86	112	5	0	95%		
Wet Sponge	Composite Fencing	Cs ASFM	257	47	4	83%	82%	3%
Wet Sponge	Composite Fencing	Cs ASFM	248	54	4	80%		
Wet Sponge	Composite Fencing	Cs ASFM	260	40	4	86%		
Wet Sponge	Composite Fencing	Cs ASFM	189	39	4	81%		
Wet Sponge	Composite Fencing	Cs-137 Lt	394	68	11	85%	80%	4%
Wet Sponge	Composite Fencing	Cs-137 Lt	326	84	11	77%		
Wet Sponge	Composite Fencing	Cs-137 Lt	305	81	11	76%		
Wet Sponge	Composite Fencing	Cs-137 Lt	510	106	11	81%		
Wet Sponge	Metal Roofing	Cs-137	459	9	4	99%	99%	0%
Wet Sponge	Metal Roofing	Cs-137	521	7	4	99%		
Wet Sponge	Metal Roofing	Cs-137	439	8	4	99%		
Wet Sponge	Metal Roofing	Cs-137	402	7	4	99%		
Wet Sponge	Metal Roofing	Rb-86	76	0	0	100%	100%	0%
Wet Sponge	Metal Roofing	Rb-86	81	1	0	99%		
Wet Sponge	Metal Roofing	Rb-86	63	0	0	100%		
Wet Sponge	Metal Roofing	Rb-86	57	1	0	99%		
Wet Sponge	Metal Roofing	Cs ASFM	209	10	7	99%	99%	1%
Wet Sponge	Metal Roofing	Cs ASFM	222	8	7	100%		
Wet Sponge	Metal Roofing	Cs ASFM	222	9	7	99%		
Wet Sponge	Metal Roofing	Cs ASFM	240	8	7	100%		
Wet Sponge	metal roofing	Cs-137 Lt	483	14	9	99%	99%	0%
Wet Sponge	metal roofing	Cs-137 Lt	392	12	9	99%		
Wet Sponge	metal roofing	Cs-137 Lt	437	14	9	99%		
Wet Sponge	metal roofing	Cs-137 Lt	375	14	9	99%		
Wet Sponge	Open Gutter	Cs-137	673	15	6	99%	99%	1%
Wet Sponge	Open Gutter	Cs-137	626	7	6	100%		
Wet Sponge	Open Gutter	Cs-137	692	7	6	100%		
Wet Sponge	Open Gutter	Cs-137	599	9	6	99%		
Wet Sponge	Open Gutter	Rb-86	68	1	0	98%	99%	1%
Wet Sponge	Open Gutter	Rb-86	60	1	0	99%		
Wet Sponge	Open Gutter	Rb-86	63	0	0	100%		
Wet Sponge	Open Gutter	Rb-86	68	0	0	100%		
Wet Sponge	Open Gutter	Cs ASFM	247	25	20	98%	100%	2%
Wet Sponge	Open Gutter	Cs ASFM	252	24	20	98%		
Wet Sponge	Open Gutter	Cs ASFM	295	17	20	101%		
Wet Sponge	Open Gutter	Cs ASFM	250	16	20	102%		
Wet Sponge	Open Gutter	Cs-137 Lt	392	23	13	97%	100%	2%
Wet Sponge	Open Gutter	Cs-137 Lt	303	9	13	101%		
Wet Sponge	Open Gutter	Cs-137 Lt	302	9	13	101%		
Wet Sponge	Open Gutter	Cs-137 Lt	355	9	13	101%		
Wet Sponge	plastic	Cs ASFM	253	6	4	99%	98%	1%
Wet Sponge	plastic	Cs ASFM	255	6	4	99%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Wet Sponge	plastic	Cs ASFM	287	14	4	97%		
Wet Sponge	plastic	Cs ASFM	273	12	4	97%		
Wet Sponge	plastic	Cs-137	617	6	6	100%	100%	0%
Wet Sponge	plastic	Cs-137	550	4	6	100%		
Wet Sponge	plastic	Cs-137	646	6	6	100%		
Wet Sponge	plastic	Cs-137	633	5	6	100%		
Wet Sponge	plastic	Rb-86	49	0	0	100%	100%	0%
Wet Sponge	plastic	Rb-86	61	0	0	100%		
Wet Sponge	plastic	Rb-86	57	0	0	100%		
Wet Sponge	plastic	Rb-86	60	0	0	100%		
Wet Sponge	Plastic	Cs-137 Lt	435	8	7	100%	99%	0%
Wet Sponge	Plastic	Cs-137 Lt	317	8	7	100%		
Wet Sponge	Plastic	Cs-137 Lt	394	11	7	99%		
Wet Sponge	Plastic	Cs-137 Lt	436	12	7	99%		
Wet sponge	steel siding	Cs-137	558	35	11	96%	93%	2%
Wet sponge	steel siding	Cs-137	591	59	11	92%		
Wet sponge	steel siding	Cs-137	588	43	11	94%		
Wet sponge	steel siding	Cs-137	564	58	11	92%		
Wet sponge	steel siding	Rb-86	27	1	0	97%	96%	2%
Wet sponge	steel siding	Rb-86	31	1	0	98%		
Wet sponge	steel siding	Rb-86	23	1	0	94%		
Wet sponge	steel siding	Rb-86	24	1	0	95%		
Wet Sponge	Stucco	Cs ASFM	646	640	7	1%	2%	1%
Wet Sponge	Stucco	Cs ASFM	468	459	7	2%		
Wet Sponge	Stucco	Cs ASFM	435	419	7	4%		
Wet Sponge	Stucco	Cs ASFM	470	463	7	2%		
Wet Sponge	Stucco	Cs-137	612	77	8	89%	85%	4%
Wet Sponge	Stucco	Cs-137	625	93	8	86%		
Wet Sponge	Stucco	Cs-137	533	118	8	79%		
Wet Sponge	Stucco	Cs-137	556	90	8	85%		
Wet Sponge	Stucco	Rb-86	103	4	0	96%	95%	1%
Wet Sponge	Stucco	Rb-86	108	4	0	96%		
Wet Sponge	Stucco	Rb-86	85	5	0	94%		
Wet Sponge	Stucco	Rb-86	108	6	0	95%		
Wet Sponge	Stucco	Cs-137 Lt	412	45	10	91%	90%	1%
Wet Sponge	Stucco	Cs-137 Lt	443	56	10	89%		
Wet Sponge	Stucco	Cs-137 Lt	480	55	10	90%		
Wet Sponge	Stucco	Cs-137 Lt	484	58	10	90%		
Wet Sponge	Vinyl Siding	Cs-137	422	15	4	97%	94%	4%
Wet Sponge	Vinyl Siding	Cs-137	523	20	4	97%		
Wet Sponge	Vinyl Siding	Cs-137	582	39	4	94%		
Wet Sponge	Vinyl Siding	Cs-137	541	59	4	90%		
Wet Sponge	Vinyl Siding	Rb-86	27	0	0	99%	94%	6%
Wet Sponge	Vinyl Siding	Rb-86	29	0	0	99%		
Wet Sponge	Vinyl Siding	Rb-86	38	3	0	93%		
Wet Sponge	Vinyl Siding	Rb-86	34	5	0	87%		
Wet Sponge	Vinyl Siding	Cs ASFM	192	17	10	96%	95%	1%
Wet Sponge	Vinyl Siding	Cs ASFM	186	19	10	95%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Wet Sponge	Vinyl Siding	Cs ASFM	210	23	10	93%		
Wet Sponge	Vinyl Siding	Cs ASFM	232	22	10	95%		
Wet Sponge	vinyl siding	Cs-137 Lt	335	13	9	99%	99%	0%
Wet Sponge	vinyl siding	Cs-137 Lt	320	11	9	99%		
Wet Sponge	vinyl siding	Cs-137 Lt	326	10	9	100%		
Wet Sponge	vinyl siding	Cs-137 Lt	314	11	9	99%		
Wet Sponge	Window	Cs-137	660	7	7	100%	100%	0%
Wet Sponge	Window	Cs-137	619	5	7	100%		
Wet Sponge	Window	Cs-137	622	5	7	100%		
Wet Sponge	Window	Cs-137	622	6	7	100%		
Wet Sponge	Window	Rb-86	74	0	0	100%	100%	0%
Wet Sponge	Window	Rb-86	88	0	0	100%		
Wet Sponge	Window	Rb-86	76	0	0	99%		
Wet Sponge	Window	Rb-86	99	0	0	100%		
Wet Sponge	Window	Cs ASFM	273	20	9	96%	97%	1%
Wet Sponge	Window	Cs ASFM	302	18	9	97%		
Wet Sponge	Window	Cs ASFM	119	12	9	97%		
Wet Sponge	Window	Cs ASFM	211	15	9	97%		
Wet Sponge	window	Cs-137 Lt	344	12	11	100%	100%	0%
Wet Sponge	window	Cs-137 Lt	297	13	11	99%		
Wet Sponge	window	Cs-137 Lt	374	11	11	100%		
Wet Sponge	window	Cs-137 Lt	407	14	11	99%		
Wet Sponge	Wood Shingles	Cs-137	490	117	9	78%	81%	4%
Wet Sponge	Wood Shingles	Cs-137	473	106	9	79%		
Wet Sponge	Wood Shingles	Cs-137	596	84	9	87%		
Wet Sponge	Wood Shingles	Cs-137	567	117	9	81%		
Wet Sponge	Wood Shingles	Rb-86	46	12	0	75%	81%	5%
Wet Sponge	Wood Shingles	Rb-86	53	7	0	86%		
Wet Sponge	Wood Shingles	Rb-86	53	8	0	84%		
Wet Sponge	Wood Shingles	Rb-86	52	10	0	81%		
Wet Sponge	Wood Shingles	Cs ASFM	259	238	13	8%	10%	2%
Wet Sponge	Wood Shingles	Cs ASFM	254	222	13	13%		
Wet Sponge	Wood Shingles	Cs ASFM	240	218	13	10%		
Wet Sponge	Wood Shingles	Cs ASFM	209	191	13	9%		
Wet Sponge	wood siding	Cs-137	804	25	13	99%	98%	0%
Wet Sponge	wood siding	Cs-137	942	23	13	99%		
Wet Sponge	wood siding	Cs-137	888	32	13	98%		
Wet Sponge	wood siding	Cs-137	863	29	13	98%		
Wet Sponge	wood siding	Rb-86	33	0	0	99%	100%	1%
Wet Sponge	wood siding	Rb-86	50	0	0	100%		
Wet Sponge	wood siding	Rb-86	48	0	0	100%		
Wet Sponge	wood siding	Rb-86	44	0	0	99%		
Wet Sponge	Wood Siding	Cs ASFM	344	288	11	17%	13%	3%
Wet Sponge	Wood Siding	Cs ASFM	343	294	11	15%		

Method	Surface	Cs-137, Rb-86, Cs ASFM Cs-137 Lt	Pre Decon (cps)	Post Decon (cps)	Background (cps)	%R	Avg. %R	Standard Deviation
Wet Sponge	Wood Siding	Cs ASFM	362	321	11	12%		
Wet Sponge	Wood Siding	Cs ASFM	393	355	11	10%		

SCIENCE

United States
Environmental Protection
Agency

PRESORTED STANDARD
POSTAGE & FEES PAID
EPA
PERMIT NO. G-35

Office of Research and Development (8101R)
Washington, DC 20460

Official Business
Penalty for Private Use
$300