UNCLASSIFIED

STONEMAN II TEST OF RECLAMATION PERFORMANCE

VOLUME III

PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES

Research and Development Technical Report USNRDL-TR-336
NY 320-001-9
U.S. Army

6 June 1959

by

H. Lee
J.D. Sartor
W.H. Van Horn

Special Distribution

Technical Objective
AW-5c

Technical Developments Branch
C.F. Miller, Head

Chemical Technology Division
E.R. Tompkins, Head

Scientific Director
P. C. Tompkins

Commanding Officer and Director
Captain J.H. McQuilkin, USN

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
San Francisco 24, California

UNCLASSIFIED

ABSTRACT

The basic decontamination procedures (firehosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water. Since it was recognized that in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three procedures for "waterless" decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

SUMMARY

The Problem

To develop and evaluate reclamation techniques for land targets with emphasis on waterless decontamination procedures such as motorized sweeping, vacuumized sweeping, etc.

Findings

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three procedures for "waterless" decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

ADMINISTRATIVE INFORMATION

This investigation was sponsored by the Department of the Army as part of Program B-3, Problem 3, described in this Laboratory's *Technical Program for Fiscal Year 1959*, revised 1 January 1959.

The main objective was to determine cost and performance of reclamation measures for land-based construction. This report presents results for sub-objective 2: to provide information on new reclamation techniques for land targets with emphasis on waterless decontamination procedures. The other reports in this series include

Vol. I	The Production, Dispersal and Measurement of Synthetic Fallout Material
Vol. II	Performance Characteristics of Wet Decontamination Procedures
Vol. IV	Performance Characteristics of Land Reclamation Methods
Vol. V	Contaminability Characteristics of Personnel Exposed to Contact Beta Radiation

ACKNOWLEDGEMENTS

The objectives of this test could not have been fulfilled without the whole-hearted assistance and cooperation of many organizations and personnel therefrom. The performance of the 50th Chemical Service Platoon, U.S. Army, assigned to support the test was outstanding in every respect. The services of the personnel from the Mobile Construction Battallion Five, Port Hueneme, California proved invaluable in the operation of heavy equipment assigned to the project. In addition the authors wish to acknowledge the invaluable aid from the following organizations: Headquarters, Sixth U.S. Army, Presidio of San Francisco, California; Post Engineer, Camp Stoneman, California; Research Directorate, Air Force Special Weapons Center, Kirtland Air Force Base, New Mexico; U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

CONTENTS

CONTENTS (Cont'd)

TABLES

TABLES (Cont'd)

FIGURES

FIGURES (Cont'd)

CHAPTER 1

INTRODUCTION

1.1 OBJECTIVE

This report is Volume III in a series of reports describing the results of the Stoneman II Land Target Tests. In this volume, results of objective (b),

> "To develop and evaluate new reclamation techniques for Land Targets with emphasis on waterless decontamination procedures such as motorized sweeping, vacuumized sweeping, etc." are submitted.

1.2 BACKGROUND

The first experimental work on the decontamination of paved areas utilizing waterless decontamination procedures was carried out in 1948.[1,2] In Operation Streetsweep[1] an investigation was made to determine the efficiency of removal of large and small sized metallic particles from various types of road surfaces using a mechanized street sweeper and a standard firehose. It was found that the street sweeper removed the coarser particles more completely than the fine particles. Firehosing was found to be the best method of removal. In Operation Supersweep[2] a study was made of the efficiency of removal of three different particle size ranges of radio-tantalum metal from macadam and concrete test samples by hand sweeping and hosing. Again it was found that the smaller the particle size the more difficult it is to remove this material and that hosing is far more efficient than sweeping. At Operation JANGLE[3] in the winter of 1951, experiments were carried out on an asphalt road in the fallout field. Various decontamination methods were evaluated including waterless decontamination methods such as, dry sweeping with a towed rotary broom, vacuum cleaning and air hosing. Of the dry methods evaluated, high pressure air hosing was found to be the most effective and vacuum cleaning the least effective.

In 1956, the basic decontamination procedures (firehosing, motorized flushing and scrubbing) were evaluated at a field test[4] at Camp Stoneman utilizing tagged soils to simulate dry fallout. Although the tests were primarily conducted to determine the performance of wet methods, limited test with a motorized sweeper were conducted on small (10 x 50 ft) asphaltic and concrete test areas using the dry synthetic fallout material dispersed at an initial mass level of 250 gms/ft^2. The procedure was found to remove 87 to 90 percent of the mass of the material present on test surfaces.

The basic decontamination procedures evaluated during the field test required the use of large quantities of water. For instance, an average firehosing operation required 800 gallons per 1,000 ft^2 and motorized flushing 500 gallons per 1,000 ft^2. These large quantities of water may be somewhat reduced by increasing the rate of operation without any decrease in decontamination effectiveness. However, in many situations there may not be adequate water supplies for use in large scale decontamination operations. Moreover under emergency conditions, water systems may be damaged or otherwise depleted. Furthermore during cold weather, decontamination procedures using water may not be practicable. In view of these anticipated difficulties, it appears desirable to develop and/or exploit decontamination methods that do not require the use of water or use it in limited quantities only.

1.3 BASIC PRINCIPLES OF DECONTAMINATION OPERATIONS

Decontamination of paved areas covered with fallout from land surface bursts consist of two processes: (a) loosening and/or removal of the debris from the surface; and (b) disposal of the debris.

For solid particulate fallout typical of land surface bursts, gravity is one of the chief forces holding the larger particles to the surface; for small particles other surface attractive forces may also be important. For this type of fallout most of the effort in decontamination is expended in the removal of the debris from the surface. Dry decontamination methods normally use mechanical erosion to either move the contaminant across the surface to a collection point, or else pick it up and transfer it to a container. The collected material must then be transferred to a disposal site; in situations in which a high fallout deposit is found and the areas to be decontaminated are large, the problems involved in disposal of the collected debris may be considerable. Certain techniques such as blowing the contaminant off the surface, combine the two processes, removal and disposal. However such techniques are limited to special usages.

There are available at present a number of techniques that can be categorized as waterless or near-waterless decontamination methods for paved areas. The techniques studied were limited primarily to those which make use of readily available equipment.

Because of their universal availability primary consideration was directed towards the testing of standard street sweepers. Generally all commercial street sweepers have the same operating characteristics. A powered rotary broom is used to dislodge the debris on streets and to sweep it onto a conveyor system which in turn carries the debris into a hopper. Thus a removal bulk transport system is inherent in the design.

The present pickup brooms that come as standard equipment on street sweepers utilize stiff, large fiber brooms made from split hickory or palmyra stalk or of african bass.

During the sweeping process, a quantity of dust is generated. Most sweepers utilize a fine water spray to dampen the surface ahead of the pickup broom to limit dust generation. The use of a water spray previous to brushing may reduce the effectiveness, particulary when removing small amounts of dry fallout because the combination of the water spray and sweeping action creates a slurry which then becomes difficult to remove. Since some sort of dust suppression may be considered desirable, a vacuum system operating in conjunction with the pickup broom would provide this feature.

Another technique of dry fallout removal utilizes air to blow the material from the surface. The air supplied by a conventional air compressor is delivered to a nozzle manifold mounted on a vehicle. The removal of heavy deposits would produce a large dust cloud and the procedure probably could be used only when the situation is such that contamination of areas downwind from the area being decontaminated can be tolerated, or if the aerosol produced is of lesser importance than the emergency.

1.4 SCOPE OF TEST

The tests conducted were limited to the evaluation of the following procedures: (1) Motorized sweeping; (2) "Vacuumized" sweeping, and (3) Air Broom sweeping.

Each procedure was evaluated on asphaltic concrete test surfaces. Due to the limited availability of suitable portland cement concrete surfaces only motorized sweeping was evaluated on both types of surfaces.

One contaminating condition was considered; a dry synthetic fallout material simulating the fallout resulting from a high-yield (MT) land surface burst. Three nominal mass levels were investigated; 10 grams/ft^2, 33 grams/ft^2 and 100 grams/ft^2. These mass levels could correspond to dose rates of approximately 300 r/hr, 1,000 r/hr and 3,000 r/hr all at one hour after burst.[5]

1.5 SELECTION OF TEST SITE

Camp Stoneman, a deactivated Army Camp near Pittsburg, California was selected as the test site. A description of the test site and test surfaces can be found in Volume I[6] of this series of reports.

CHAPTER 2

DESCRIPTION OF TEST PROCEDURES AND MEASUREMENTS

2.1 DECONTAMINATION PROCEDURES

The decontamination procedures evaluated, as stated in Section 1.4 were:

(a) Motorized Sweeping
(b) "Vacuumized" Sweeping
(c) Air Broom Sweeping

2.1.1 Motorized Sweeping (Figure 2.1)

The motorized sweeping was carried out with a standard Wayne* Model 450 street sweeper. This machine utilizes a 58" wide palmyra main broom. The material picked up is deposited on a conveyer system which transports the material to a 3 cubic yard hopper. Dust suppression, when desired, is accomplished through the use of a water spray system. The sweeper can be used with either one or two 45" diameter, wire filled, gutter brooms, or, as in these tests, without any gutter brooms.

Prior to the full scale field test, preliminary studies were conducted to:

(a) Establish for the motorized sweeper the range of operating rates for various initial masses of fallout material.
(b) To determine the effect of pretreatment agents such as sand on the pickup efficiency of the motorized sweeper.
(c) To determine the effect of gutter brooms on the pickup efficiency of the motorized sweeper.

The preliminary tests were conducted on an asphaltic concrete street located in the San Francisco Naval Shipyard. Before each test the street was thoroughly cleaned. Dry soil of the type used in the synthetic fallout material was dispersed on the streets in the amounts to be evaluated

---

* Wayne Manufacturing Co., Newark, New Jersey.

Fig. 2.1 Motorized Sweeping (Wayne Model 450) on Portland Cement Concrete.

Fig. 2.2 Vacuumized Sweeping (Tennant Model 100) on Asphaltic Concrete.

during the field test (10 grams/ft^2 and 100 grams/ft^2). No radioactive tracer was used; to determine quantitatively the pickup efficiency a material balance of the soil dispersed and subsequently picked up was utilized.

Sand was dispersed over the dry soil in the same amounts as the dispersed soil to determine the effect of sand as a pretreatment agent. The water spray system in the sweeper was used to moisten the sand before sweeping.

From observations of the preliminary sweeping tests the following operating speeds were recommended for use during the full scale tests.

Mass Loading	Procedure	Speed
10 grams/ft^2	Dry Sweep only	7 ft/sec
10 grams/ft^2	Sand pretreatment	5 ft/sec
100 grams/ft^2	Dry Sweep only	4 ft/sec
100 grams/ft^2	Sand pretreatment	2 ft/sec

It was found that by removing the gutter broom from the sweeper the pick-up efficiency of the equipment was appreciably increased. It appeared that the gutter broom, in revolving, created air currents which re-distributed the fallout material before it could be picked up by the main broom. For this reason the gutter broom was completely removed and not used in the full scale tests.

The full scale motorized sweeping tests were conducted on asphaltic concrete and Portland cement concrete test areas. Test areas, prior to each test, were either cleaned with the Wayne 450 or flushed with a motorized street flusher, depending on prior usage. The operating rates used are listed in Appendix A. Radiation measurements were taken before and after each cycle; a complete cycle included the coverage of the entire area at least once. The number of individual passes per cycle was subjectively determined for each cycle based upon the apparent contamination remaining on the surface. Upon completion of each cycle the hopper was emptied at a predesignated waste disposal area.

2.1.2 "Vacuumized" Sweeping (Figures 2.2 and 2.3)

The vacuumized sweeping tests were carried out with two recently developed vacuumized sweepers. A Tennant Model 100* (designed for street and open area use) was made available for evaluation by the Air Force Special Weapons Center, Kirtland Air Force Base, New Mexico. Also evaluated was a Tennant Model

---

* G.H. Tennant Co., Minneapolis, Minnesota.

Fig. 2.3 Vacuumized Sweeping (Tennant Model 80) on Asphaltic Concrete.

Fig. 2.4 Air Broom Sweeping on Asphaltic Concrete.

evaluated was a Tennant Model 80*, a smaller industrial power sweeper, that was designed for sweeping small areas. The Model 80 was made available for evaluation by the Naval Civil Engineering Laboratory, Port Hueneme, California.

The Model 100 utilizes a 48" wide african bass filled, main pickup broom and two 32" diameter nylon bristle gutter brooms. The broom system was enclosed in a vacuum equipped housing. The aerosol generated by the sweeping process is filtered by a series of cloth filter bags. The material picked up by the brooms and the dust trapped by the filters is cast or dropped into a 1-3/4 yd hopper mounted in the rear of the unit.

The Model 80 utilizes a 42" wide fiber main brush and a 24" diameter side brush. The main brush is enclosed and a high volume low pressure fan draws the generated dust from the brush enclosure into a heavy fabric bag. A 12 cu ft hopper mounted in front of the brush enclosure receives the material picked up by the main broom.

The vacuumized sweeping tests were conducted on asphaltic concrete test areas. The operating rates used were those recommended for maximum decontamination effectiveness by a manufacturer's representative who was present. The equipment was not available prior to the full scale tests so no preliminary test was conducted. This equipment was evaluated in the same manner used for the motorized sweeper.

2.1.3 Air Broom Sweeping (Figure 2.4)

An air broom, consisting of a nozzle manifold mounted on a compressor truck and positioned near the surface to blow the contaminant to one side, was evaluated. Nine nozzles, spaced 8" apart along the manifold and designed to deliver compressed air at supersonic velocities were supplied by a 210 cfm, 100 psi compressor.

Prior to the full scale field tests preliminary tests were conducted on an asphaltic concrete test area in the San Francisco Naval Shipyard to determine the feasibility of the air broom in removing dry soil dispersed in the mass levels of interest (10 grams/ft^2 - 100 grams/ft^2).

The tests indicated that the proposed system would remove dry soil up to initial deposits of 100 grams/ft^2 satisfactorily. The full scale evaluation tests were then conducted on asphaltic concrete test areas. The system was also evaluated when used in conjunction with motorized sweeping. This evaluation consisted of a final air broom pass after several cleaning cycles with the motorized sweeper.

---

* G.H. Tennant Co., Minneapolis, Minnesota.

2.2 PRODUCTION OF SYNTHETIC FALLOUT

The design and preparation of the synthetic fallout material is described in detail in Volume I[6] of this series of reports. A brief resumé of the general procedures and techniques used during the operation follows:

The dry fallout simulant was prepared by combining a radioactive tracer in solution and a bulk carrier material in the mixing drum of a modified Jaeger 3-1/2 cubic-yard transit-mix truck (Fig. 2.5). The solution was fed to an air nozzle located in the head end of the rotating drum where it was atomized onto the bulk carrier materials.

The mix for each day was obtained by blending three size fractions of the bulk carrier material so that a standard final mix resulted. Distribution curves for each day's batch are presented in Volume I.[6] The mix used for each test is indicated in Appendix B.

2.2.1 Selection of Radioisotope

The radionuclide La^{140} was used as the radioactive tracer in the synthetic fallout. Experiments[7] performed prior to the land target tests[4] conducted in 1956, demonstrated that trivalent La^{140} was strongly adsorbed to the carrier material and would not desorb under wet decontamination procedures. The half life, 40.2 hours, of La^{140} was such that natural decay reduced the radioactivity at the test site to negligible amounts within a short time after the completion of the tests.

The facilities at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico were used to supply the necessary quantities of La^{140}.

2.2.2 Bulk Carrier Material

Soil (Ambrose Clay Loam) obtained from the test site at Camp Stoneman, Calif. was used as the bulk carrier material in the synthetic fallout material. To obtain acceptable physical properties, the soil was processed through a crushing, burning and sieving operation by a commercial materials processing plant.

2.3 DISPERSAL OF SYNTHETIC FALLOUT

The amount of synthetic fallout material dispersed depended upon the radiation levels to be simulated. As stated in Section 1.4, radiation levels of 300 r/hr, 1,000 r/hr and 3,000 r/hr at 1 hour after burst were selected as levels of primary interest, and weights deposited for these standard dose rates were approximately 10 gms/ft^2, 33 gms/ft^2 and 100 gms/ft^2 respectively.

Fig. 2.5 Transit Mix Truck for Mixing Dry Synthetic Fallout.

Fig. 2.6 Dump Truck for Dispersing Dry Synthetic Fallout on Paved Areas.

The layer of material simulating 300 r/hr at 1 hour would be approximately .004 inches deep; for 1,000 r/hr at 1 hour, .012 inches deep; and for 3,000 r/hr at 1 hour, .04 inches deep (based on soil density of 1840 lbs/yd3).

2.3.1 Paved Areas

The dry synthetic fallout material was dispersed over the paved areas from a modified Burch Hydron Spreader mounted on the rear of a 2-1/2 yd^3 dump truck (Fig. 2.6). An aluminum hopper was installed on the truck to contain the synthetic fallout material and feed it directly into the spreader when the truck bed was raised. The dimensions and locations of the test areas are shown in Appendix A.

2.3.2 Sampling Pans

To determine the actual quantity of material dispersed, sampling pans (Fig. 2.6) were placed on the test areas prior to the dispersing of the synthetic fallout material. These pans were collected immediately after the disperser had passed over them, placed in plastic bags and weighed.

The total activity of the sample in the pan was determined in a large sample counter (LSC). The LSC consisted of a chamber 26" wide by 28" deep by 52" high, covered with 2" lead sheet and lined with 3/4" plywood, into which the pan was placed. A 1-1/2" sodium iodide-thallium activated crystal, attached to an appropriate scaler, was used for determining the radioactivity in the sample. Next a portion of the material in each pan was removed for the determination of specific activity in the 4-pi ion chamber.[8]

2.4 MEASUREMENT TECHNIQUES

To determine the effectiveness of the various procedures evaluated, measurements were taken of the radiation levels present on the test areas just prior to contamination (background), after contamination, and after decontamination. The measurements were obtained with a mobile shielded gamma scintillation detector unit (Fig. 2.7). The detecting element of this instrument consisted of a one inch NaI (Tl) Scintillation Crystal on a photomultiplier tube. The crystal and PM tube were mounted within a lead shield having a wall thickness of 6". The shield is so mounted as to place the center of the detector one meter above ground plane. A collimated aperature subtending a solid angle of 50° permits entrance of radiation into the sensitive volume. Due to the geometry of this system approximately 98 percent of the total radiation flux measured by the system from an ideal plane will fall within a circle having a radius of six feet. A complete description of the unit and method of calibration is given in Volume I[6] of this series of reports. The method used to convert these radiation measurements to mass units is summarized in Appendix B.

Fig. 2.7 Mobile Shielded Gamma Scintillation Detector Unit.

Appendix A presents the measurements obtained at each location on the test areas. The data presented have been corrected to a common time to account for radioactive decay and also corrected for background.

Each decontamination operation was timed to obtain necessary information on rate and effort. Motion pictures were also obtained of the various operations; this allowed subsequent viewing and evaluation of the operations.

CHAPTER 3

RESULTS

3.1 DECONTAMINATION OF PAVED AREAS

The results for the three types of dry decontamination methods, motorized sweeping, vacuumized sweeping and air broom sweeping, are summarized in Tables 3.1, 3.2 and 3.3. Two surfaces were tested, asphaltic concrete (A-C) and portland cement (P-C). No great individual variation in surface characteristics was noted and it was assumed that all surfaces of a given type were identical. The average initial mass level (M_o) and average final mass level (M), in grams per square foot, are computed as shown in Appendix B from the raw data of Appendix A. The average percent remaining ($\overline{F}_m$) is obtained from:

$$\overline{F}_m = \frac{M}{M_o} \times 100. \qquad (1)$$

It should be noted that $\overline{F}$ can also be obtained by substituting the average final and initial radiation readings, I_R and R_R, for M and M_o. Effort (E) is a measure of time per unit area, normally expressed as man-min/ft^2 or equipment-min/ft^2; in this case the two terms are equivalent since one man could operate each machine. For convenience E is given in terms of man-min/10^4 ft^2. The raw data for computing E, given in Appendix A, consists of the size of the test area and the total time that the decontamination equipment spent on the area for each cycle. This time does not include turn-around time or dump time.

3.1.1 Motorized Sweeping

A Wayne Model 450 motorized street sweeper was tested on asphaltic concrete, portland cement, and on a sand-treated asphaltic concrete surface. In the latter case, after the contaminant had been dispersed, sand was uniformly spread over the top of it in the following amounts:

Test B13	90 g/ft^2
Test B14	120 g/ft^2
Test B15	150 g/ft^2

To minimize operational differences, the same operator was used on all tests. The average speed of the test equipment was 7.4 ft/sec with significant variations occurring only in tests B5 and B6.

3.1.2 "Vacuumized" Sweeping

Two vacuumized sweepers, a Tennant Model 80 and a Tennant Model 100, were tested on asphaltic concrete streets at three mass levels. The operator, the same one used on the Wayne 450, maintained an average speed of 6.0 ft/sec for the Model 80 and 3.9 ft/sec for the Model 100. In test B9, after the first cycle, the speed of the Model 100 was intentionally doubled to test the effect of rate on performance.

3.1.3 Air Broom Sweeping

The prototype air broom was tested on asphaltic concrete (Tests B16, B17, B18). Tests were scheduled such that low wind speeds (1-3 knots) were encountered and the wind direction was 75-90° to that of the test section, causing the dust generated by the air broom to move slowly downwind. Air pressure at the air outlets was maintained constant but the speed of the equipment was varied from pass to pass as well as from forward to reverse.

The air broom was also tested as a follow-up method to conventional street sweeping, being applied after two or three passes of the street sweeper. The wind direction varied from 75°-110° to that of the road; the speed was moderate (4-6 knots).

3.2 Time and Motion Studies

Extensive film footage was taken of most of the tests. Efforts to obtain quantitative time information from viewing these films were generally unsuccessful because sufficient detail was not visible. However much qualitative information was obtained from these films and proved useful in evaluating the operational characteristics of the equipment tested.

TABLE 3.1

Decontamination Results for a Conventional Motorized Sweeper on Various Test Surfaces

Test No.	Cycle No.	Surface	Method	M_o g/ft^2	M g/ft^2	$\bar{F}_m$%	Effort, man-min/10^4 ft^2 Per Cycle	Cumulative
B1	1	A-C	Wayne Model 450	27.6	2.44	8.8	7.8	7.8
	2	A-C		27.6	1.49	5.4	5.2	13.0
	3	A-C		27.6	.97	3.5	7.0	20.0
B2	1	A-C	Wayne Model 450	59.2	4.97	8.4	8.1	8.1
	2	A-C		59.2	2.16	3.6	8.1	16.2
	3	A-C		59.2	1.55	2.6	8.1	24.3
B3	1	A-C	Wayne Model 450	120.9	3.83	3.2	11.5	11.5
	2	A-C		120.9	2.02	1.7	8.3	19.8
B4	1	P-C	Wayne Model 450	16.8	1.69	10.1	11.4	11.4
	2	P-C		16.8	1.43	8.5	5.4	16.8
	3	P-C		16.8	1.03	6.1	5.4	22.2
B5	1	P-C	Wayne Model 450	34.1	4.97	14.6	5.1	5.1
	2	P-C		34.1	2.50	7.3	5.3	10.4
	3	P-C		34.1	1.23	3.6	3.9	14.3
B6	1	P-C	Wayne Model 450	118.6	2.38	2.0	15.8	15.8
	2	P-C		118.6	2.09	1.8	9.3	25.1
B13	1	A-C	Sand Pre-treatment Wayne Model 450	23.8	4.66	19.6	7.5	7.5
	2	A-C		23.8	2.83	11.9	6.5	14.0
	3	A-C		23.8	1.88	7.9	6.5	20.5
B14	1	A-C	Sand Pre-treatment Wayne Model 450	71.5	5.25	7.3	12.5	12.5
	2	A-C		71.5	2.51	3.5	8.3	20.8
	3	A-C		71.5	1.58	2.2	8.3	29.1
B15	1	A-C	Sand-Pre treatment Wayne Model 450	137.9	18.9	13.7	10.0	10.0
	2	A-C		137.9	8.50	6.2	10.0	20.0
	3	A-C		137.9	5.20	3.8	10.0	30.0

TABLE 3.2

Decontamination Results for Vacuumized Type Sweepers

Test No.	Cycle No.	Surface	Method	M_o g/ft^2	M g/ft^2	$\overline{F}_m$%	Effort, man-min/10^4 ft^2 Per Cycle	Cumulative
B7	1	A-C	Tennant	21.6	1.00	4.6	14.4	14.4
	2	A-C	100	21.6	.40	1.9	14.4	28.8
	3	A-C		21.6	.27	1.3	18.0	46.8
B8	1	A-C	Tennant	67.6	.79	1.2	18.9	18.9
	2	A-C	100	67.6	.39	.58	15.2	34.1
	3	A-C		67.6	.31	.46	18.2	52.3
B9	1	A-C	Tennant	177.7	3.60	2.0	19.7	19.7
	2	A-C	100	177.7	1.72	.97	7.3	27.0
	3	A-C		177.7	1.28	.72	6.7	33.7
B10	1	A-C	Tennant	18.5	3.98	21.5	15.2	15.2
	2	A-C	80	18.5	2.24	12.1	14.5	29.7
	3	A-C		18.5	1.65	8.9	14.5	44.2
B11	1	A-C	Tennant	33.5	7.82	23.4	15.2	15.2
	2	A-C	80	33.5	4.51	13.5	11.3	26.5
	3	A-C		33.5	3.22	9.6	11.3	37.8
B12	1	A-C	Tennant	174.9	10.24	5.9	27.3	27.3
	2	A-C	80	174.9	7.46	4.3	11.3	38.6
	3	A-C		174.9	5.87	3.4	11.3	49.9

TABLE 3.3

Decontamination Results for Air Broom Sweeping

Test No.	Cycle No.	Surface	Method	M_o g/ft^2	M g/ft^2	$\bar{F}_m$%	Effort, man-min/10^4 ft^2 Per Cycle	Cumulative
B1	4	A-C	Combination Method[a]	.97	.19	19.6	11.1	31.1[b]
B2	4	A-C	Combination Method[a]	1.55	.25	16.1	17.4	41.7[b]
B3	3	A-C	Combination Method[a]	2.02	.14	6.9	12.5	32.3[b]
B6	3	P-C	Combination Method[a]	2.09	.24	11.5	13.0	38.1[b]
B14	4	A-C	Combination Method[a]	1.58	.28	17.7	20.8	49.9[b]
B16	1	A-C	Air Broom	16.1	.21	1.3	20.3	20.3
B17	1	A-C	Air Broom	62.9	.57	.81	24.1	24.1
	2	A-C	Air Broom	62.9	.40	.64	24.1	48.2
B18	1	A-C	Air Broom	148.7	.92	.62	36.2	36.2

a. Combination method consists of street sweeper followed by air broom.

b. Cumulative effort includes effort expended by the motorized sweeping procedures.

CHAPTER 4

DISCUSSION OF RESULTS

4.1 PARAMETERS EFFECTING DECONTAMINATION EFFECTIVENESS

The effectiveness of the decontamination methods can best be expressed as the residual mass levels obtainable at given initial mass levels for a specified expenditure of effort. However, test conditions varied widely with respect to both initial mass levels and effort applied so that a direct comparison between tests was not practical.

Equation (2) below, developed by Miller[9] accounts for variations in initial mass level but assumes an infinite amount of effort expended.

$$M^{*} = M_{o}^{*}\,(1-e^{-\alpha M_{o}}) \qquad (2)$$

where M^{*} = residual mass level at an infinite effort level g/ft^2

M_o = initial mass level, g/ft^2

M_o^{*} = the limiting upper value for M^{*}, a constant for a given surface-method combination, g/ft^2

α = spreading coefficient dependent upon the surface-method combination, the particle size and density of the fallout material, ft^2/g

Since the above equation did not make provisions for the differences in the amount of effort applied, an extension of the theory developed by Miller was necessary to account for effort.#

Upon the expenditure of effort by a given surface-method combination, the mass available for removal will decrease and in accordance with equation (2) will approach M^{*}. This decrease in mass level (amount removed) per unit of applied effort is proportional to the removable mass present; in mathematical terms, this relation is

---

See Minvielle's report now in preparation.

$$-\frac{dM}{dE} = K\ (M - M^*) \qquad (3)$$

in which K is a constant depending mainly on the method and surface and E is the effort expended. The constant K is the effort efficiency factor for the method and surface combination - i.e. the efficiency for removing a mass of particles from the surface.

Integrating between the limits of initial mass level at zero effort and a residual mass level (M) at a given level of effort gives

$$\int_{M_o}^{M} \frac{dM}{(M - M^*)} = -K \int_{o}^{E} dE \qquad (4)$$

or $$M = M^* + (M_o - M^*)\ e^{-KE} \qquad (5)$$

The term e^{-KE} gives the fraction of the removable mass remaining after expending the effort, E.

This derivation assumes a permanent, non-changing surface; actually surfaces such as asphaltic concrete erode while being decontaminated but this factor is unimportant in the range of practical interest.

Equation (5) was solved using test data for values of M, M_o and E and making successive approximations for M* and K to obtain satisfactory curves through the data points when plotting M vs E.

To further correlate the derived values of M*, the constants for equation (2) were similarly derived as follows. Using the M* values from equation (5) with the corresponding M_o values, successive approximation for M_o^* and α were made until satisfactory curves were obtained through the M* values when plotting M* vs M_o. The resulting curves are presented in Fig. 4.1.1.New values of M were then obtained, using the derived values of M*, from equation (5). The resulting curves are presented in Figs. 4.1.2 through 4.1.6. The actual data points for each test including one standard deviation are also presented. The derived values of M*, K, M_o^* and α are presented in Table 4.1.

The correlation between the test data and the curves was considered satisfactory in every case except tests B13-15. The sand pretreatment in these tests masked the initial mass level; because of the generally poor results obtained with this particular procedure no intensive attempt was made to adapt equation (5) to fit these conditions. In lieu of r[illegible]resentation by equation, lines were plotted through the data points by visual interpolation, as shown in Fig. 4.1.7.

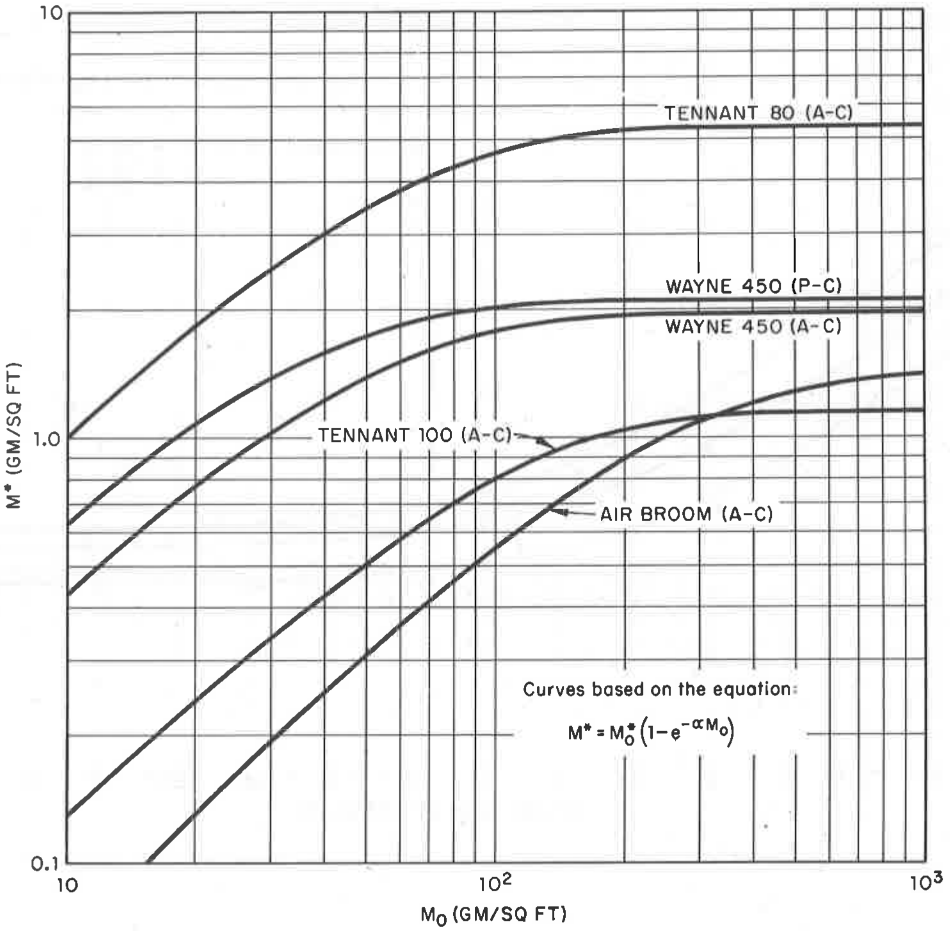


Fig. 4.1.1 The Variation of Decontamination Effectiveness As Measured by M* With Initial Mass Level.

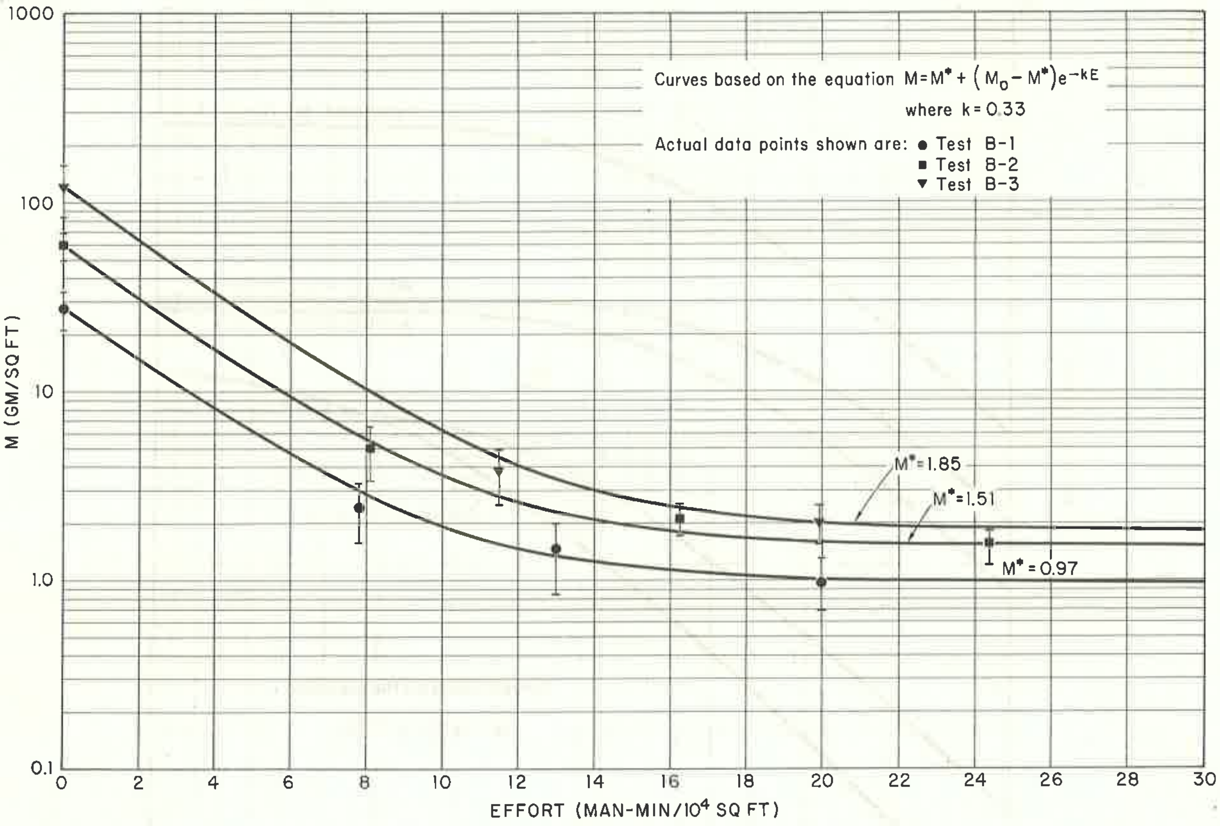


Fig. 4.1.2 Effectiveness of the Wayne 450 on Asphaltic Concrete.

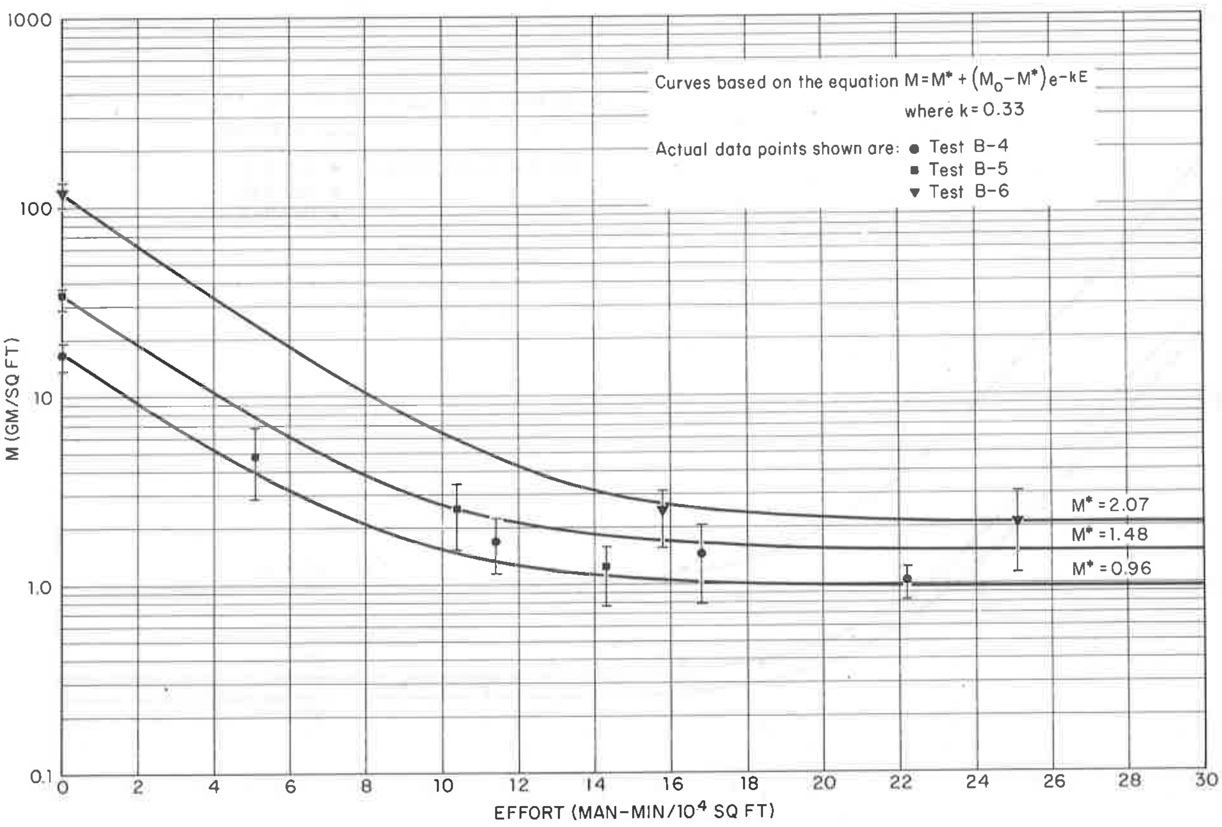


Fig. 4.1.3 Effectiveness of the Wayne 450 on Portland Cement Concrete.

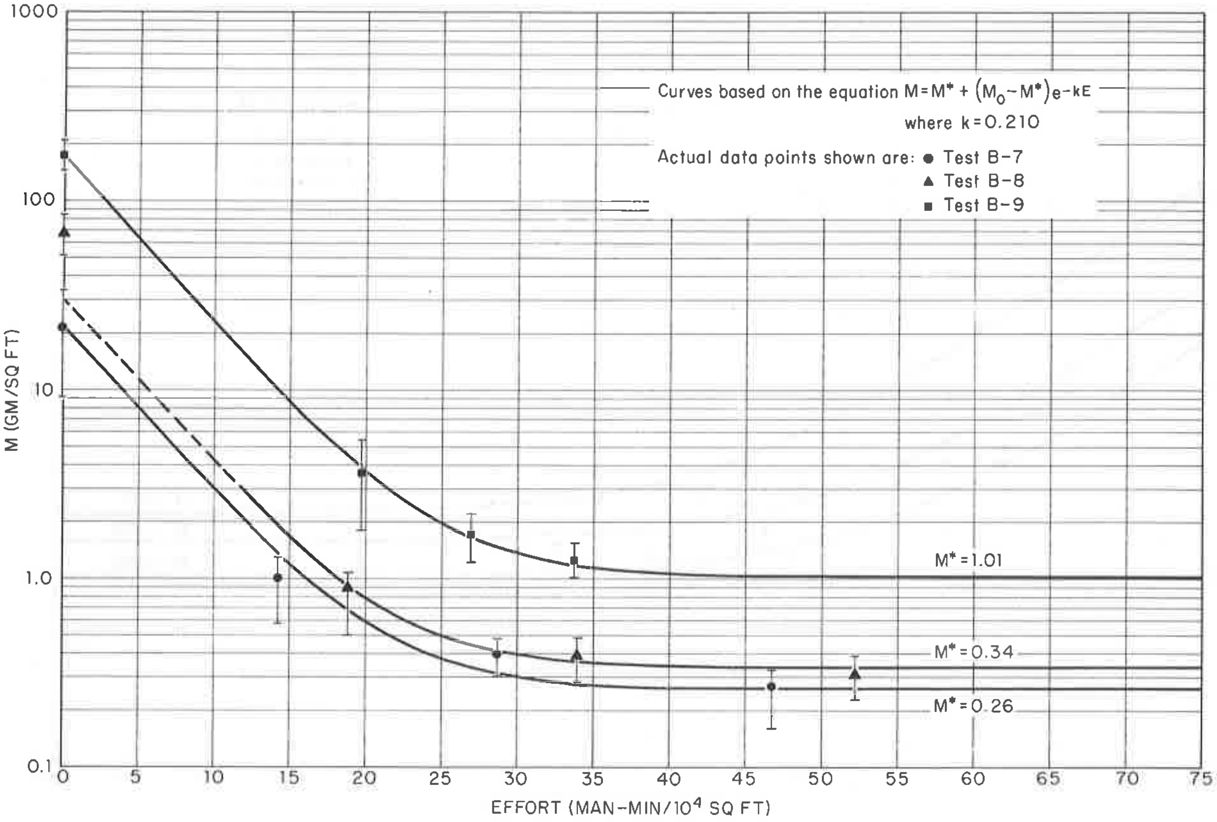


Fig. 4.1.4 Effectiveness of the Tennant 100 Vacuumized Sweeper on Asphaltic Concrete.

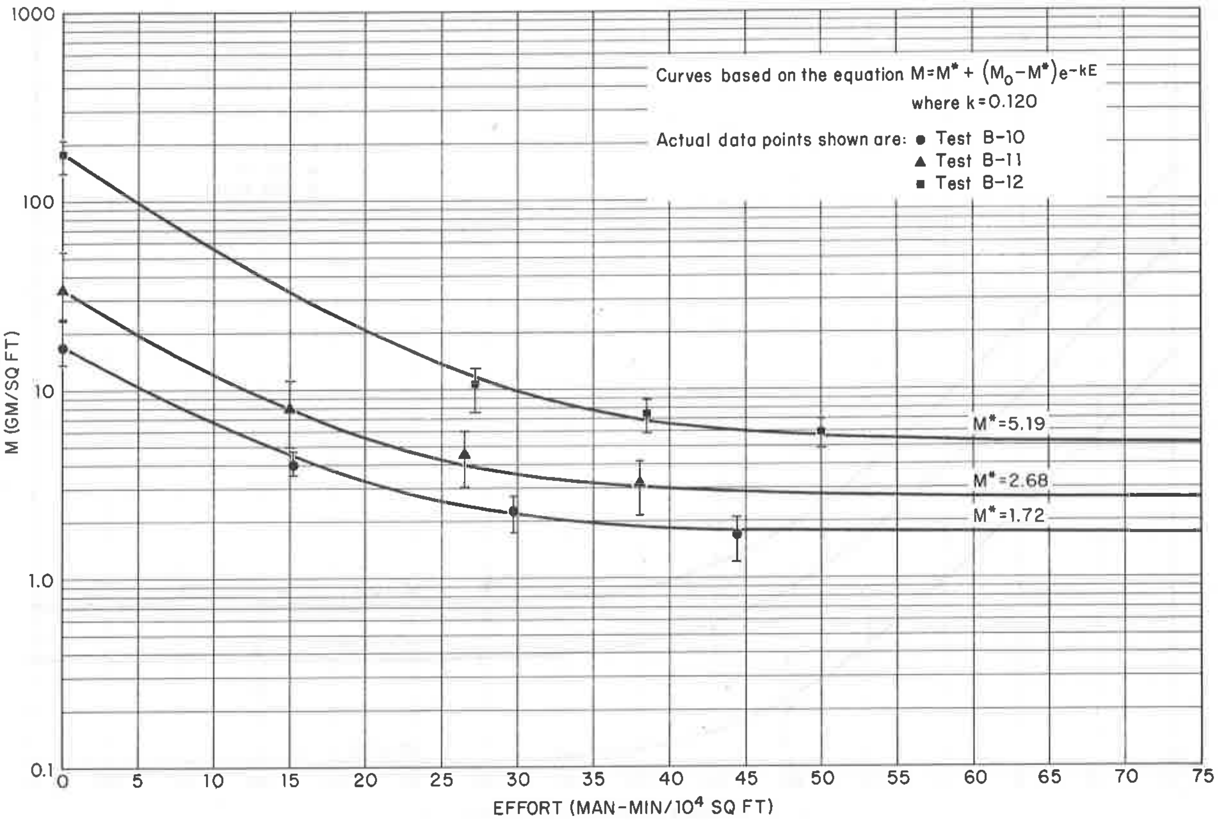


Fig. 4.1.5 Effectiveness of the Tennant 80 Vacuumized Sweeper on Asphaltic Concrete.

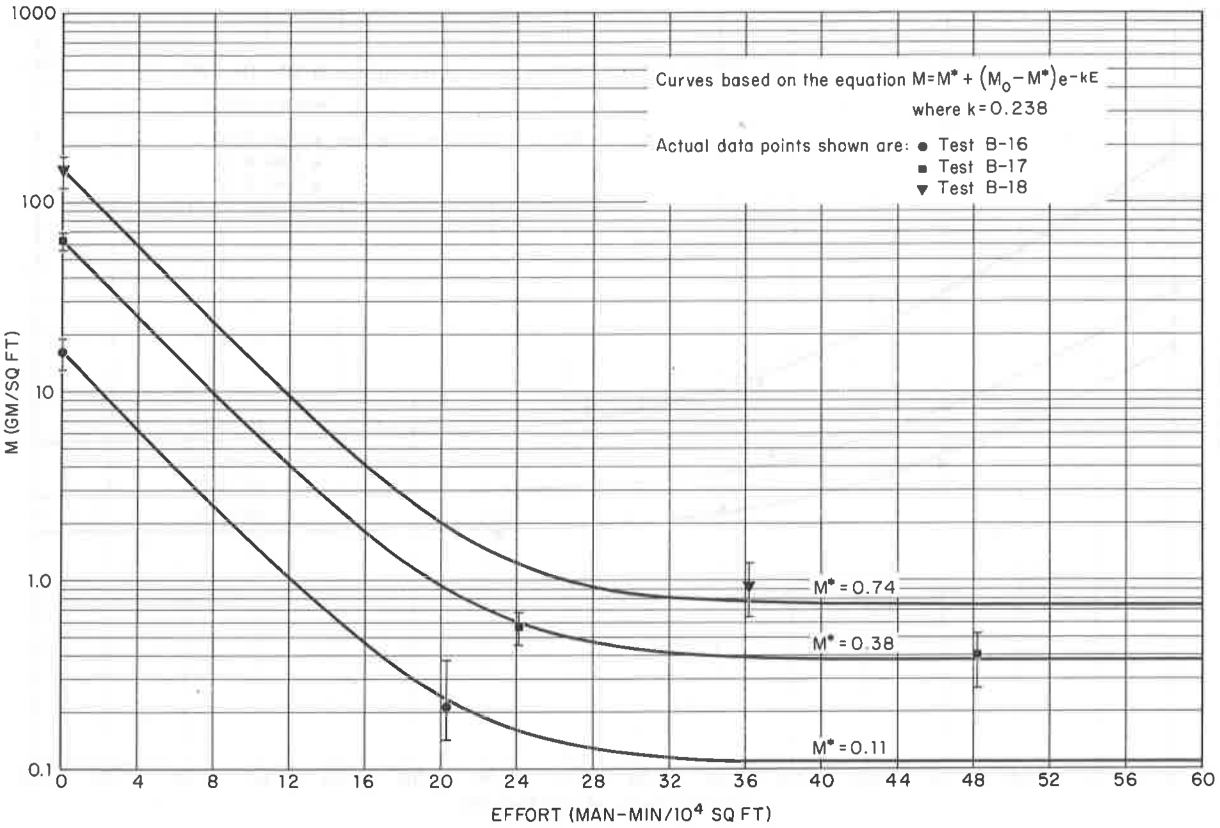


Fig. 4.1.6 Effectiveness of Air Broom Sweeping on Asphaltic Concrete.

TABLE 4.1

Derived Values of M*, M_0^*, K, and α

Test No.	Method-Surface	M_o g/ft^2	M* g/ft^2	K ft^2/ man-min	M_0^* g/ft^2	α ft^2/g
B-1	Wayne 450 Asphaltic Conc.	27.6	0.97	0.330	1.95	.025
B-2	Wayne 450 Asphaltic Conc.	59.2	1.51	0.330	1.95	.025
B-3	Wayne 450 Asphaltic Conc.	120.9	1.85	0.330	1.95	.025
B-4	Wayne 450 Portland Cement	16.8	0.96	0.330	2.10	.036
B-5	Wayne 450 Portland Cement	34.1	1.48	0.330	2.10	.036
B-6	Wayne 450 Portland Cement	118.6	2.07	0.330	2.10	.036
B-7	Tennant 100 Asphaltic Conc.	21.6	0.26	0.210	1.14	.012
B-8	Tennant 100 Asphaltic Conc.	30.0	0.34	0.210	1.14	.012
B-9	Tennant 100 Asphaltic Conc.	177.7	1.01	0.210	1.14	.012
B-10	Tennant 80 Asphaltic Conc.	18.5	1.72	0.120	5.32	.021
B-11	Tennant 80 Asphaltic Conc.	33.5	2.68	0.120	5.32	.021
B-12	Tennant 80 Asphaltic Conc.	174.9	5.19	0.120	5.32	.021
B-16	Air Broom-Asphaltic Conc.	16.1	0.11	0.238	1.40	.005
B-17	Air Broom-Asphaltic Conc.	62.9	0.38	0.238	1.40	.005
B-18	Air Broom-Asphaltic Conc.	148.7	0.74	0.238	1.40	.005

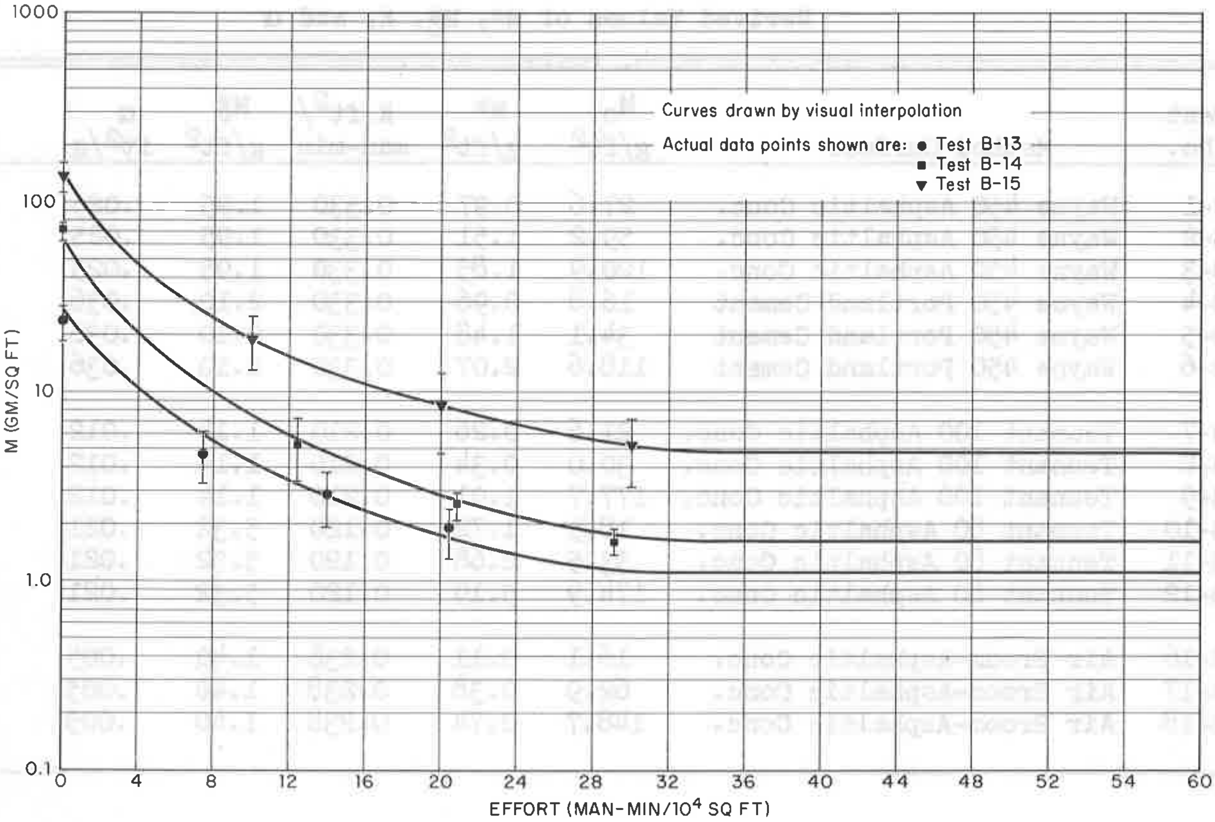


Fig. 4.1.7 Effectiveness of the Wayne 450 on Sand Pre-Treated Asphaltic Concrete.

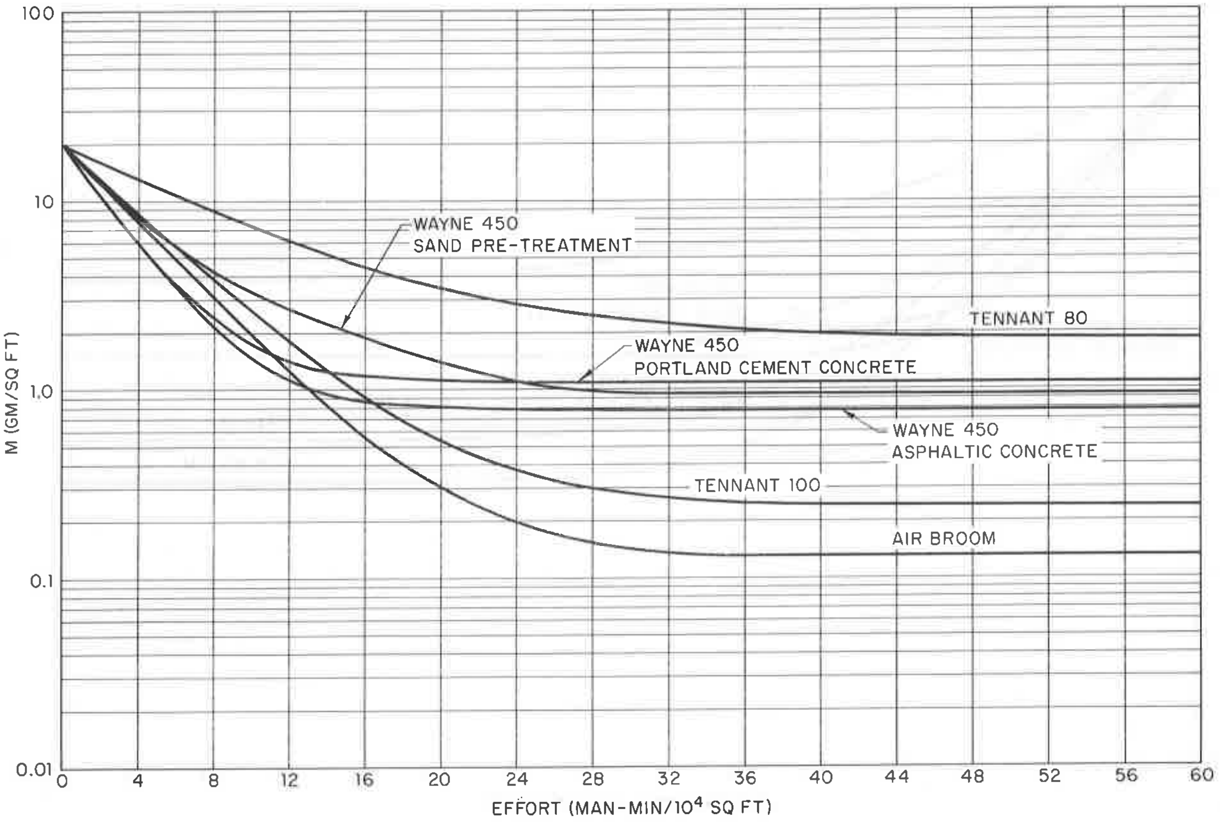


Fig. 4.2.1 Comparative Effectiveness of Dry Decontamination Methods on Paved Areas at an Initial Mass Level of 20 g/ft^2.

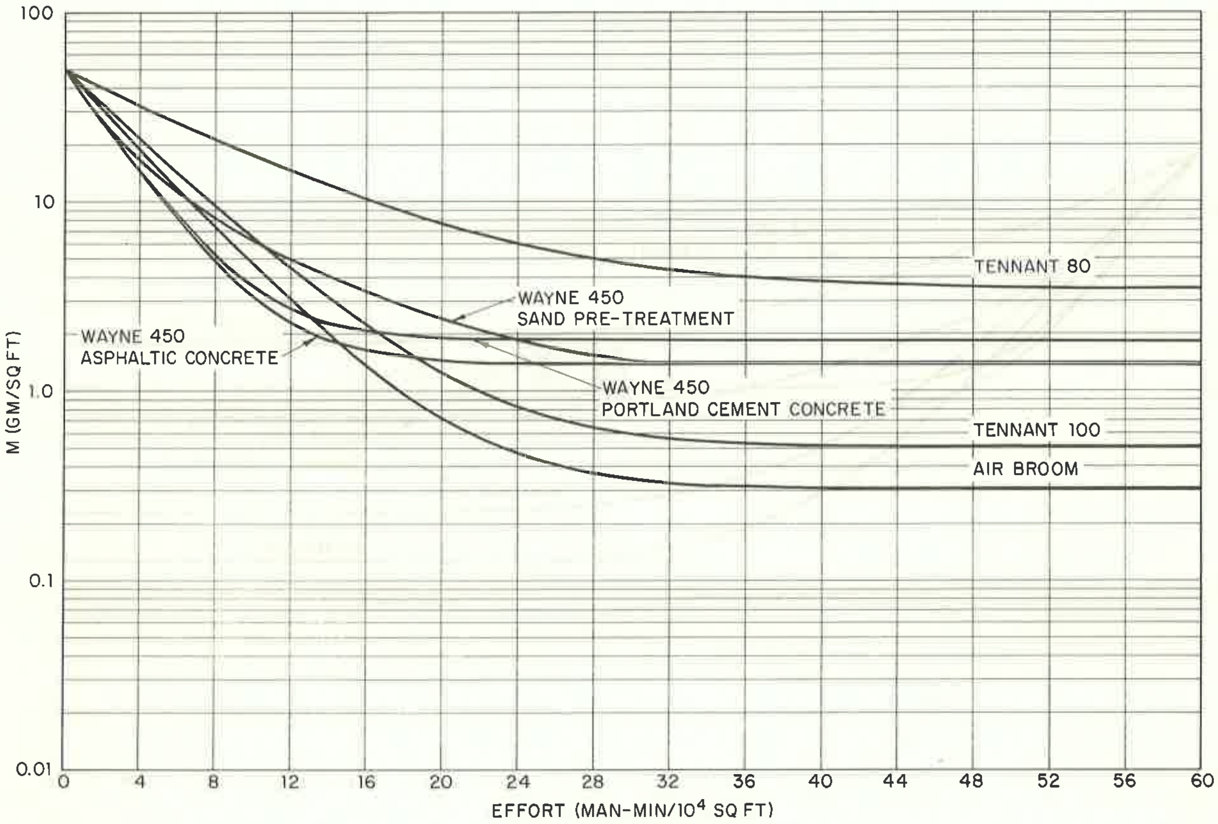


Fig. 4.2.2 Comparative Effectiveness of Dry Decontamination Methods on Paved Areas at an Initial Mass Level of 50 g/ft^2.

The curve plotted for test B^8, Fig. 4.1.3 was derived from equation (5) using a value of 30 g/ft^2 for M_0 instead of the value 67.6 g/ft^2, which was computed from the initial radiation measurements. When using the measured M_0, the resulting curve did not satisfy the test data points. This difference could be attributed to the effect of the wind which redistributed and removed a large percentage of the synthetic fallout material prior to the first decontamination cycle. (Due to the high wind on that particular test day, no other tests were performed).

The air broom was unique in that it was used as both a primary decontamination method and as a secondary method following decontamination by a conventional street sweeper. Equation (5) with suitable constants was found to fit the data for the primary usage satisfactorily.

4.2 COMPARISON OF DECONTAMINATION METHODS

Two criteria by which a decontamination method may be evaluated are the effort expended and the residual mass level attained. These two parameters are shown in Figs. 4.2.1, 4.2.2, and 4.2.3 for three different initial mass levels. These curves, except for the Wayne 450 on sand-treated asphaltic concrete, were obtained from equation (5) of Section 4.1.

All the methods tested were found to have some potential usefulness in decontamination operations but only two, conventional sweeping with the Wayne 450 and vacuumized sweeping with the Tennant 100, have the characteristics necessary for general usage. Although the Tennant 100 ultimately cleaned to a much lower residual mass level than conventional sweeping with the Wayne 450, the latter had a more rapid initial removal rate. The cross-over, or point of equal effectiveness, was dependent upon the initial mass loading and occurred at effort levels of 12 to 16 man-min/10^4 ft^2.

The use of a sand pre-treatment prior to conventional street sweeping with the Wayne 450 proved to be detrimental, in most cases, to the efficient operation of the equipment. It is believed that much of the effort normally expended on the contaminant was instead used on the sand cover, decreasing the overall effectiveness of the equipment. Interestingly, at low initial mass levels (< 60 g/ft^2) the final residual mass level (M^*) was as low or lower than with conventional sweeping. These results suggest that perhaps sand spread in small quantities over the surface after partial decontamination would act as a scouring agent, loosening the more tightly held contaminant.

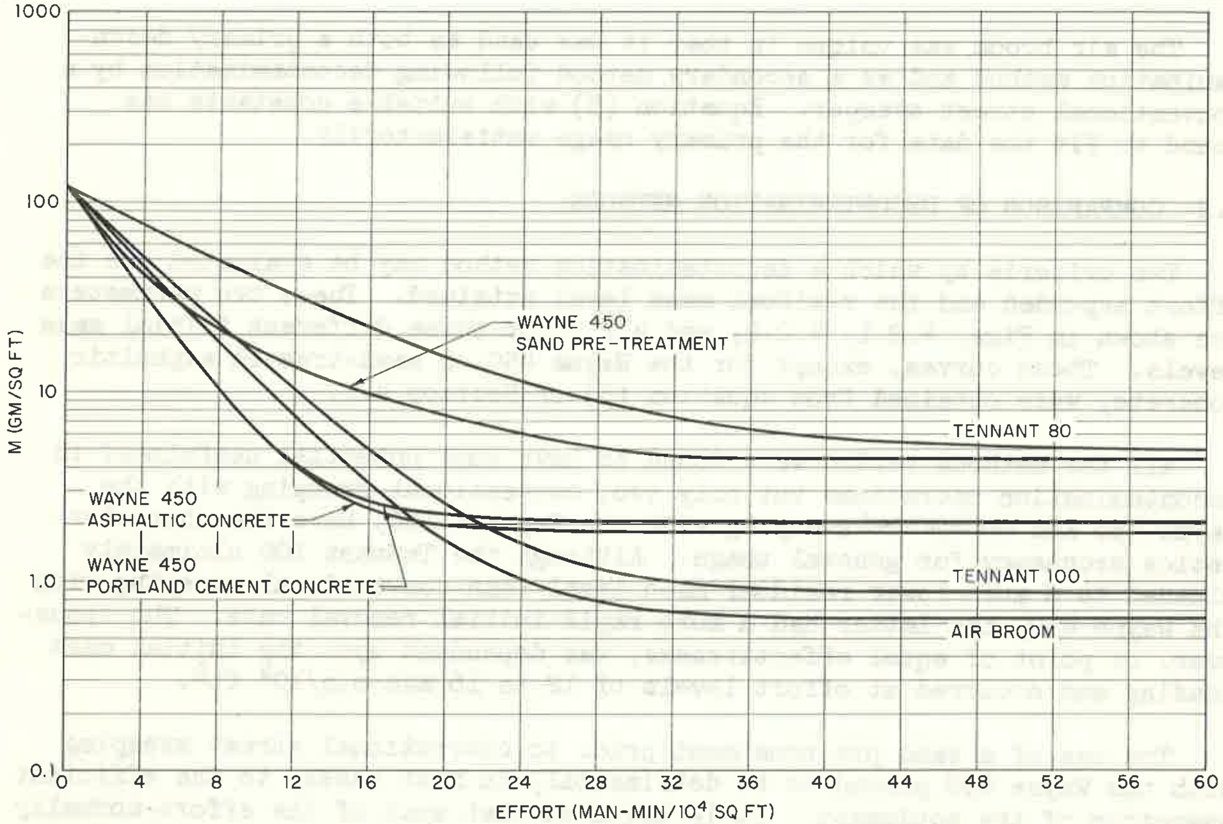


Fig. 4.2.3 Comparative Effectiveness of Dry Decontamination Methods on Paved Areas at an Initial Mass Level of 120 g/ft^2.

The Tennant 80 is not comparable to the large sweepers but is rather a specialized item for use in close quarters and on small areas. None-the-less the performance of this vacuumized sweeper was disappointing, being both slow and relatively ineffective in removal of contaminant. At best the Tennant 80 can be considered only as an adjunct to hand sweeping.

The air broom gave the lowest M* value of any of the methods tested; it also proved to be a most useful supplementary treatment following conventional methods. However, the air broom does not collect resuspended material, and is therefore a (see Sec. 4.7.3) tool which can be used only under select conditions, namely, the ratio of the breadth to length of the contaminated area is small; a cross wind is blowing across the contaminated area; and no possibility exists of hazard to personnel downwind. The adherence to these conditions becomes less critical as the initial mass decreases; accordingly the most promising application of the air broom lies in its use as a follow-up method. The incorporation of the air broom principle into a vacuumized sweeper, such as the Tennant 100, would perhaps constitute a synergistic combination.

4.3 COMBINATION OF METHODS

The use of a combination of methods in which one is more efficient in removal of heavy deposits and the other more efficient at low mass levels should offer a means of obtaining the lowest possible level of remaining mass with a given total effort or of reducing the initial mass deposit to a given level with the least effort. Such a combination of methods seemingly occurs for two methods such as the Wayne 450 and the air broom. In Fig. 4.2.2, for example, curves for these two methods start at the same initial mass level, then diverge, and finally cross-over at an effort level of 14 man-min/10^4 ft^2. From these curves it might appear that the path of least effort would be attained by following the curve for the Wayne 450 to this crossover point and thereafter following the curve for the air broom. However, from the slope of the mass-effort curves given by Eq. (5) it may be noted that the most efficient utilization of the applied effort is at the low values of effort and that the efficiency decreases with increasing effort. Thus the path for most efficient mass removal should be the path of steepest descent on the mass-effort curve; in other words, the desirable cross-over from one method to another would be at the point where the slope of the mass-effort curve for the second method is equal to that of the first. For the two mentioned methods this path consists of determining a curve for the air broom that is tangent to the curve for the Wayne 450

(Fig. 4.3.1).# The path of least effort then follows the Wayne 450 curve from the origin to the point of tangency and thereafter follows the curve for the air broom. (It will be noted that although the initial mass level for the Wayne 450 is 50 g/ft^2, the comparable value for the air broom is 32 g/ft^2.)

Limited data were obtained on the use of the air broom following several cycles with the Wayne 450. Of these tests, B1 and B2, were found to provide suitable data for analysis. The data points for Test B2, are shown in Fig. 4.3.2; the curve for the Wayne 450, determined by equation (5), is shown as a solid line. Using equation (5) with constants for the air broom, attempts to fit a curve through points W-3 and AB-1 were unsuccessful when the assumed initial mass level was 59 g/ft^2 (point w-o) or greater.

Finally, using the path of least effort described above, a curve, shown by a dotted line, was derived from equation (5), using the air broom constants; this combination of data gave the best fit for the datum point (AB-1). A similar procedure for Test B1 showed that only a curve through the point of tangency would fit the observed datum. In this case the observed value was 0.19 g/ft^2 and the calculated value 0.13 g/ft^2.

Further studies designed to test the validity of the method for obtaining the path of least effort to obtain a given residual mass are needed but, based upon the present limited results, it would appear that maximum usefulness of manpower and equipment can be obtained by using the concept of a path of least effort.

4.4 EFFECT OF INITIAL MASS LEVEL AND EFFORT ON RESIDUAL MASS LEVEL

The relationships expressed in equations (2) and (5) were derived using the hypothesis that the residual mass level is a function of the initial mass level and effort expended. The two equations can be combined giving

---

\# The point of tangency can be approximated by differentiating equation (6), equating them, and reducing to the case for large values of M_o. The resulting equation for the value of M at which the two slopes, (dM/dE), are equal is

$$M = \frac{K_1 M_1^* - K_2 M_2^*}{K_1 - K_2} \quad (g/ft^2)$$

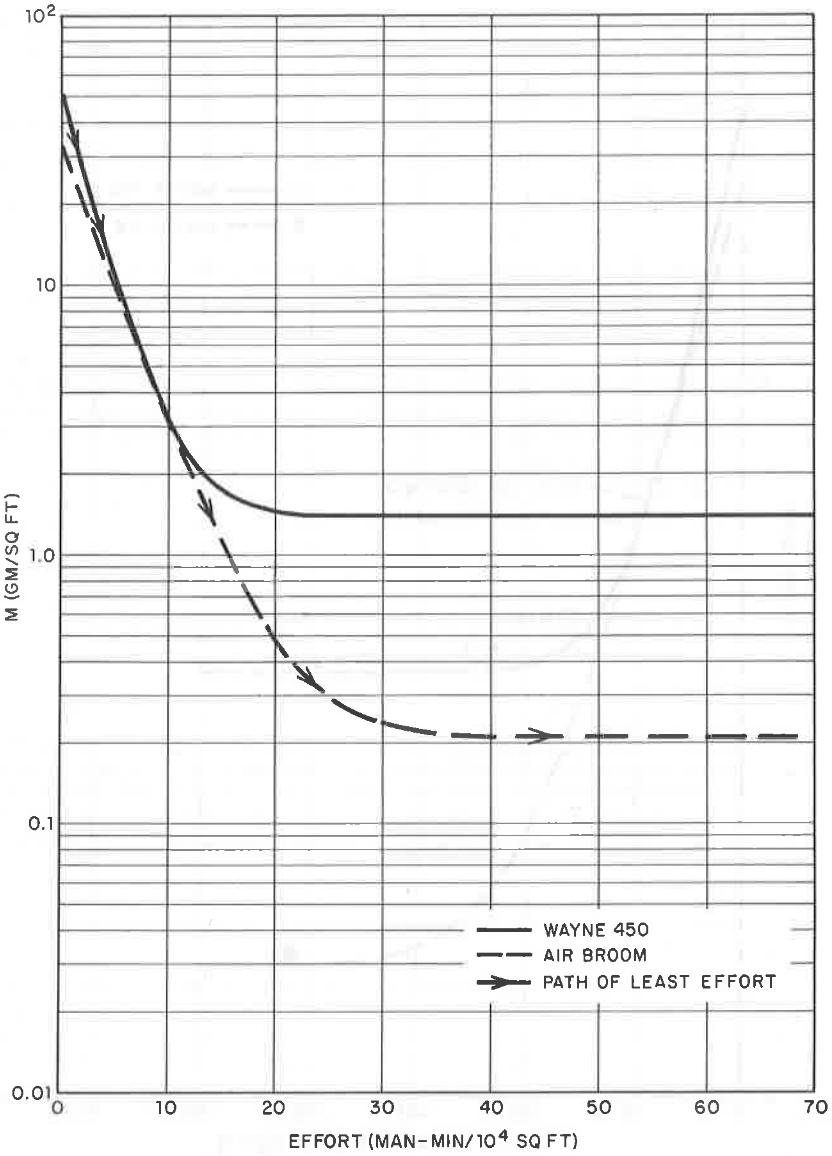


Fig. 4.3.1 Path of Least Effort for a Combination of Two Methods.

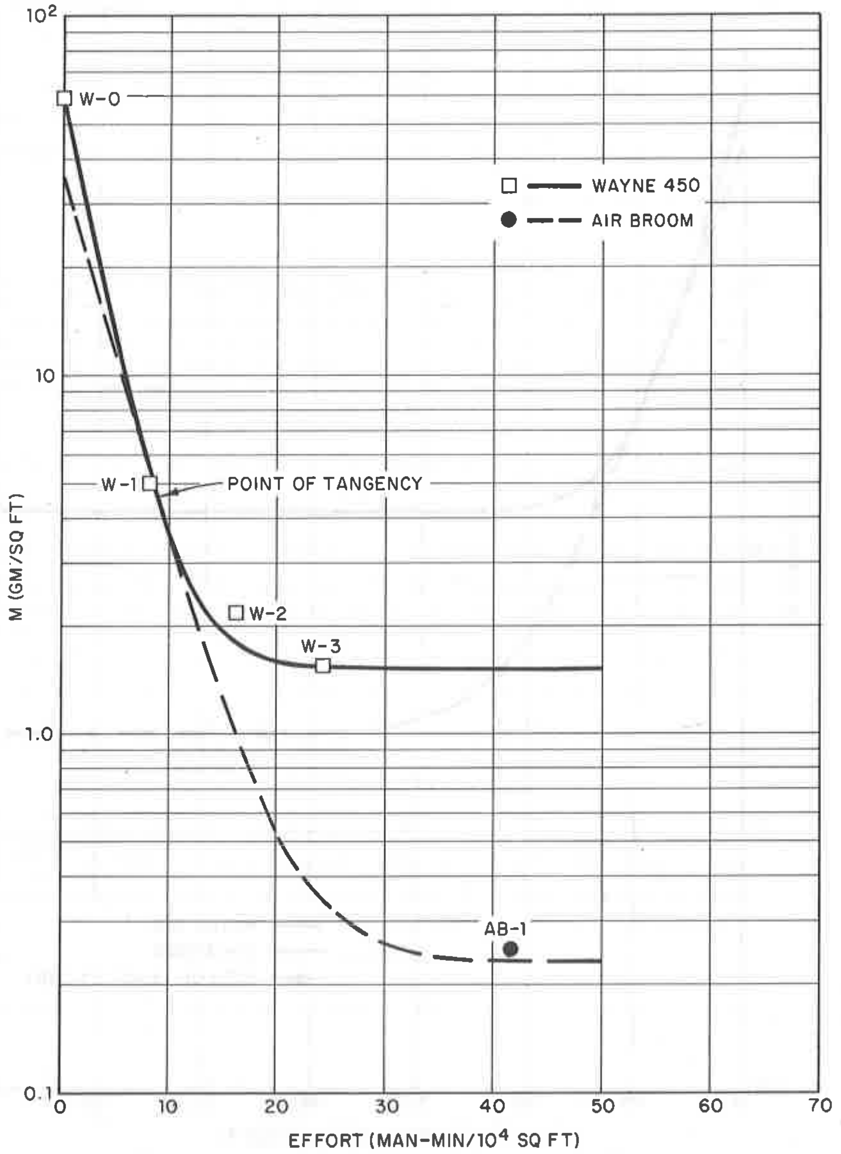


Fig. 4.3.2 Determination of the Path on Least Effort From Experimental Values for the Wayne 450 and the Air Broom (Test B-2).

$$M = M_o^* (1-e^{\alpha M_o}) + M_o - M_o^* (1-e^{\alpha M_o}) \quad e^{-KE} \qquad (6)$$

From a mathematical treatment of equation (6) one can derive the following relationships between residual mass level, initial mass level and effort.

(1) For small M_o, small E, $M \longrightarrow M_o(1-KE)$

(2) For small M_o, large E, $M \longrightarrow M_o M_o^* \alpha$

(3) For large M_o, small E, $M \longrightarrow M_o^* + M_o(1-KE)$

(4) For large M_o, large E, $M \longrightarrow M_o^*$

Figures 4.4.1-4.4.6 show graphically these stated relationships for each of the surface-method combinations evaluated.

These curves can be utilized to determine what level of effort is needed to produce a required residual mass level for any given fallout condition.

4.5 EFFECT OF SURFACE ON RESIDUAL MASS LEVEL

As indicated in Section 1.4, only the motorized sweeping operation with the Wayne 450 was evaluated on both portland cement concrete and asphaltic concrete. One can compare the effect of surface by examining the curves for the Wayne 450 in Figs. 4.2.1-4.2.3. It can be seen that for each initial mass level investigated, the differences are relatively small. No surface roughness measurements were made of the two types of surfaces but visual inspection revealed no gross differences in surface irregularities.

The Portland cement concrete data analyzed did not include the radiation measurements taken over or near form lines. As indicated in Appendix A, (Tables A-5 - A-6)radiation measurements taken over a seam or form line in Test B-5 and B-6, were 5-10 times greater than adjacent readings. The differences in readings were not apparent until after the completion of the first cycle. The sweeper was not able to remove the dry contaminant from the seams.

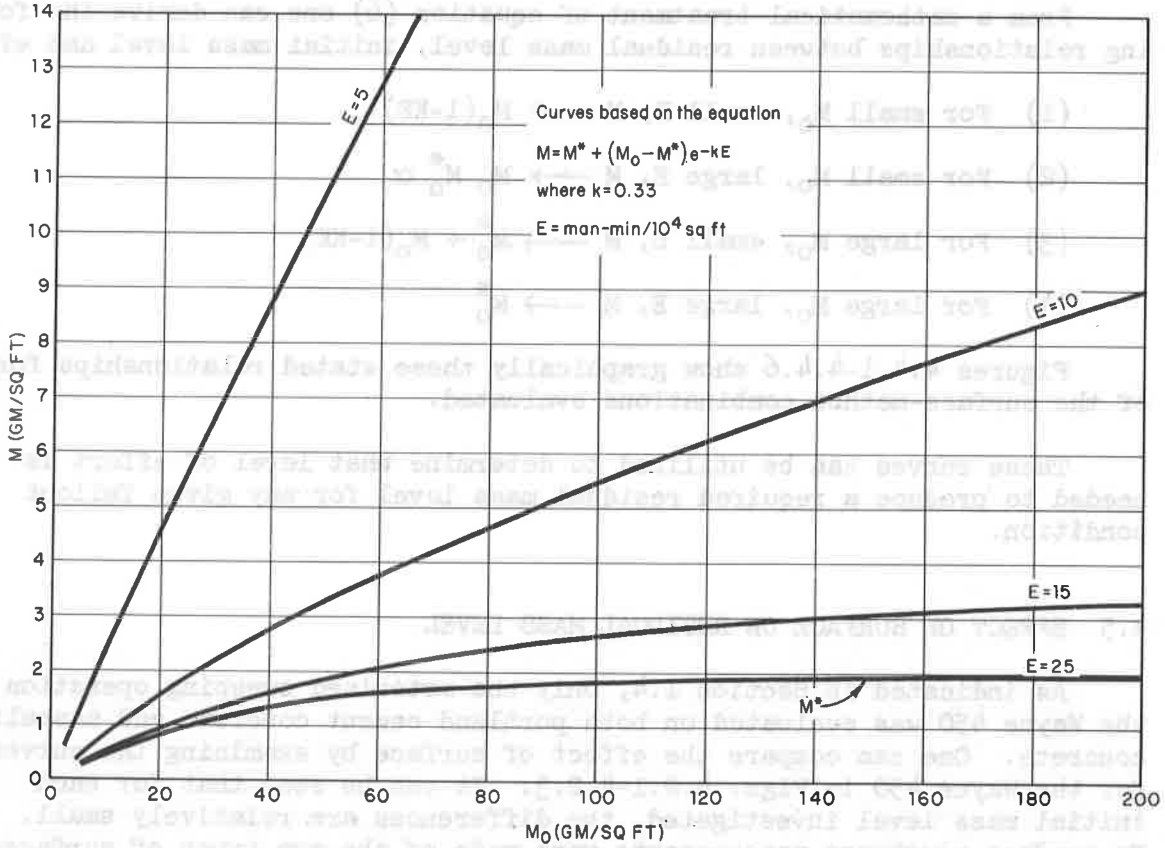


Fig. 4.4.1 **Residual Mass vs Initial Mass Wayne 450 on Asphalt Concrete.**

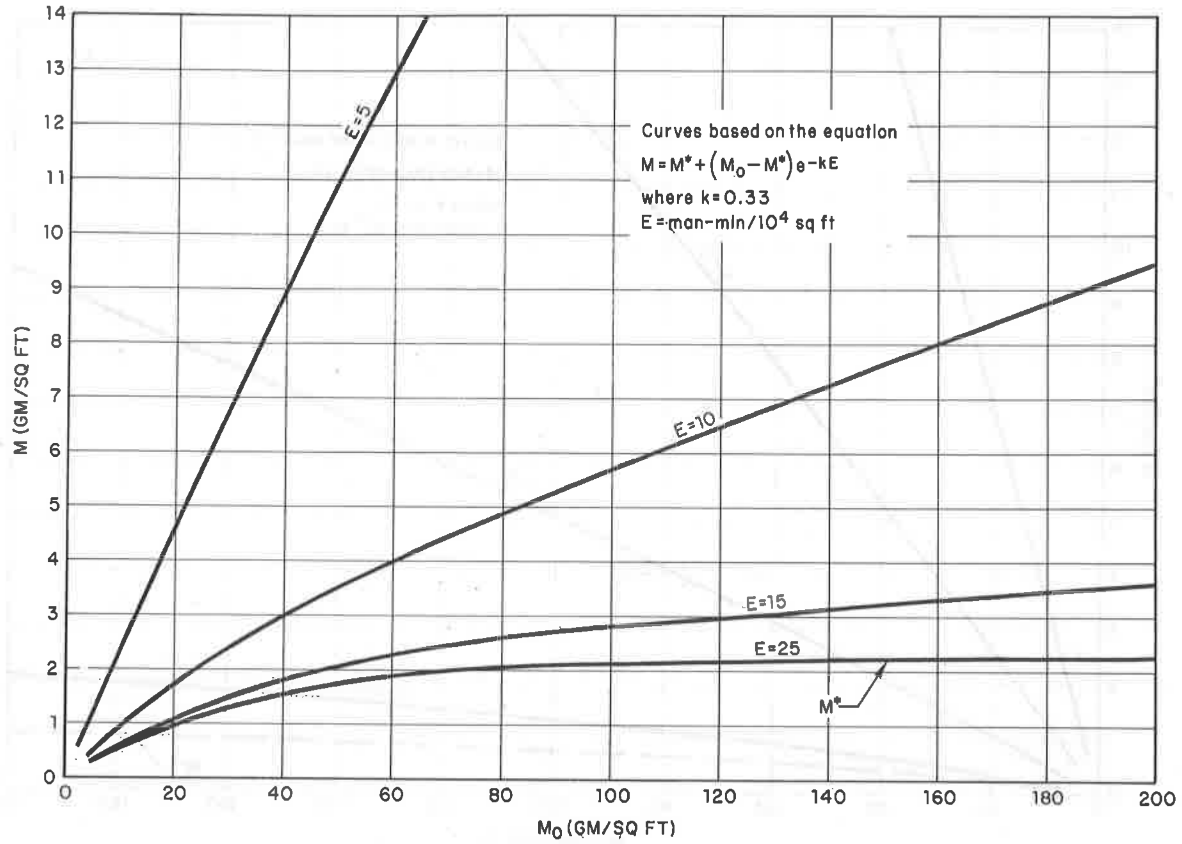


Fig. 4.4.2 Residual Mass vs Initial Mass - Wayne 450 on Portland Cement Concrete.

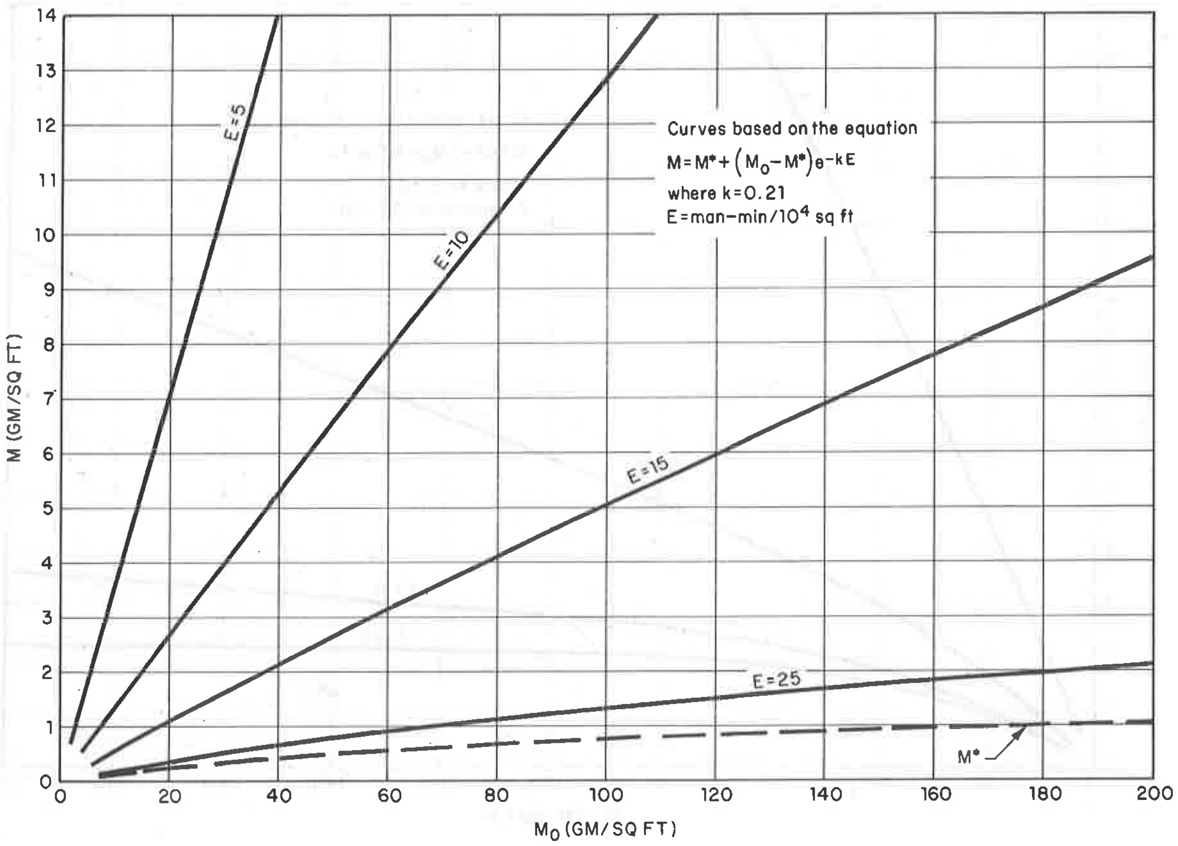


Fig. 4.4.3 Residual Mass vs Initial Mass - Tennant 100 Vacuumized Sweeping on Asphaltic Concrete.

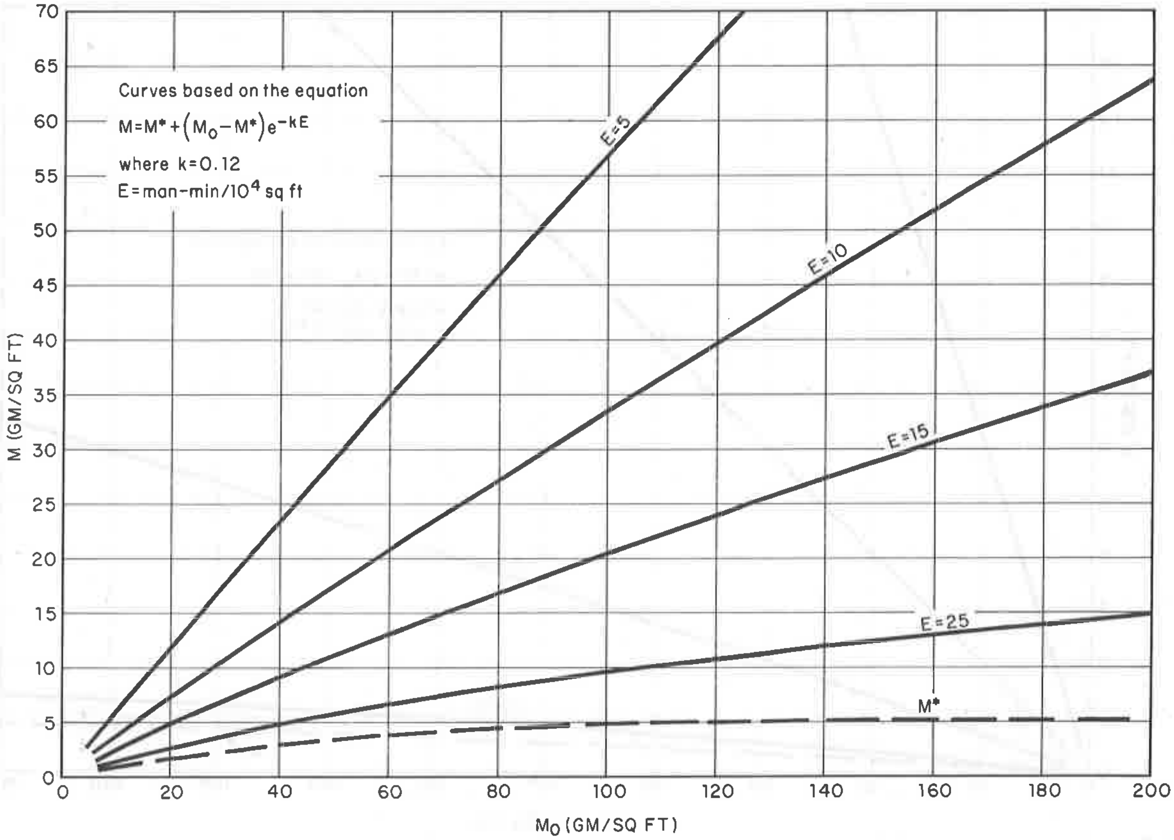


Fig. 4.4.4 Residual Mass vs Initial Mass - Tennant 80 Vacuumized Sweeping on Asphaltic Concrete.

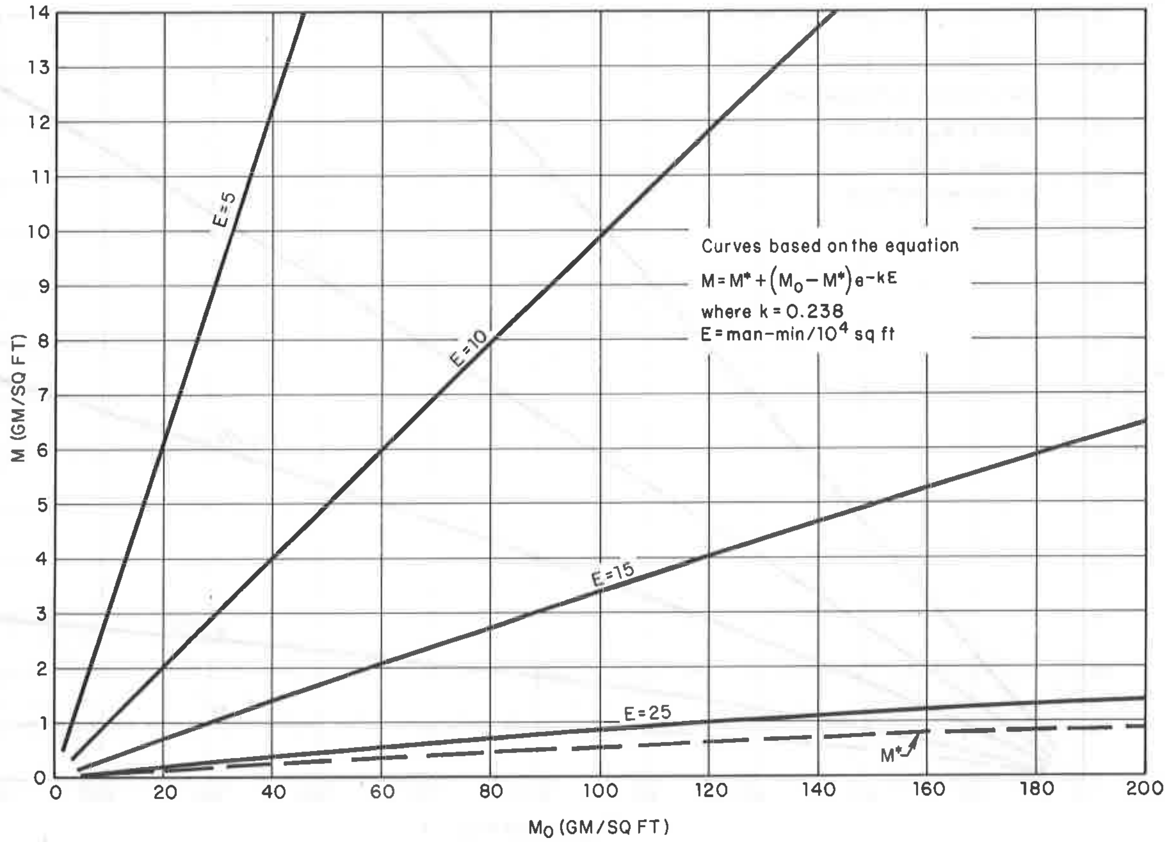
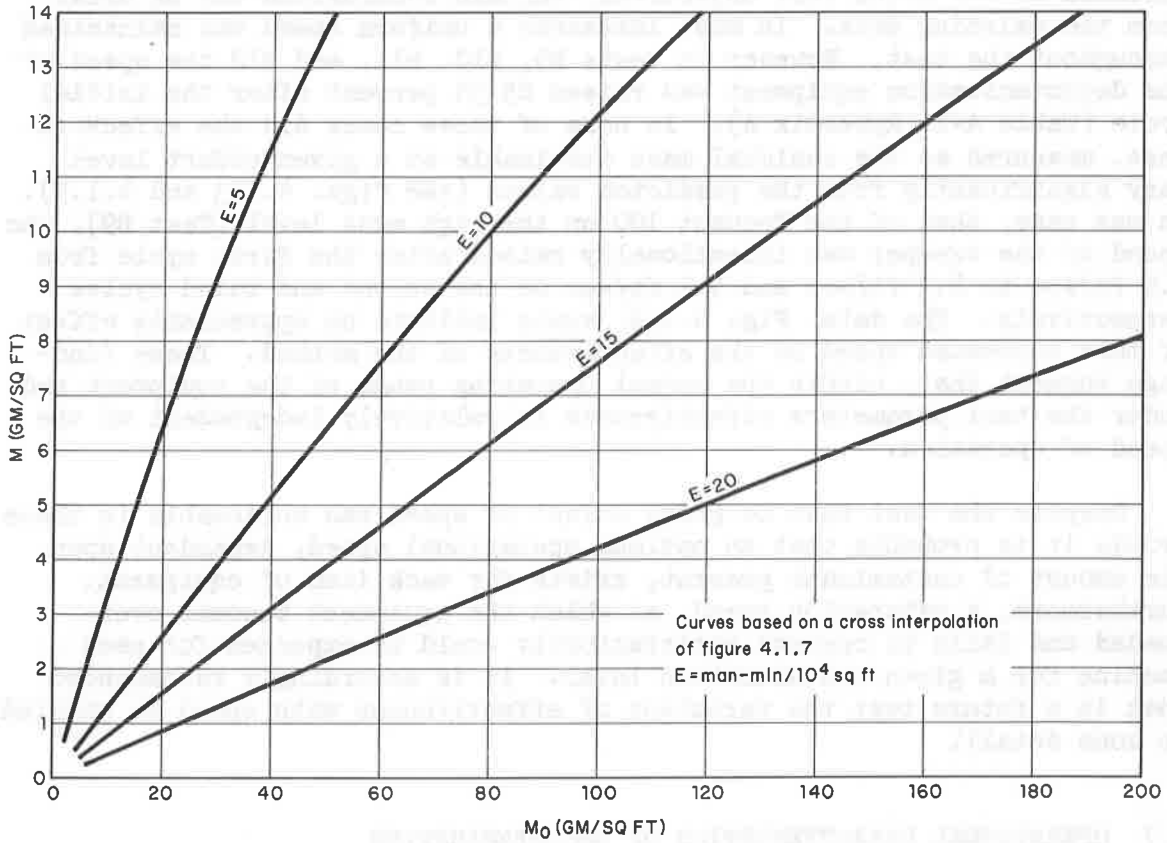


Fig. 4.4.5 Residual Mass vs Initial Mass - Air Broom Sweeping on Asphaltic Concrete.



Curves based on a cross interpolation of figure 4.1.7
E=man-min/10^4 sq ft

Fig. 4.4.6 Residual Mass vs Initial Mass - Wayne 450 on Sand Pre-Treated Asphaltic Concrete.

4.6 EFFECT OF EQUIPMENT SPEED

Although the effect of speed on decontamination effectiveness was not included as one of the test objectives, certain conclusions can be drawn from the existing data. In most instances a uniform speed was maintained throughout the test. However in tests B5, B10, B11, and B12 the speed of the decontamination equipment was raised 25-35 percent after the initial cycle (Table A-1, Appendix A). In none of these cases did the effectiveness, measured as the residual mass obtainable at a given effort level vary significantly from the predicted values (see Figs. 4.1.3 and 4.1.5). In one case, that of the Tennant 100 on the high mass level (Test B9), the speed of the sweeper was intentionally raised after the first cycle from 3.9 ft/sec to 8.3 ft/sec and 9.1 ft/sec on the second and third cycles respectively. The data, Fig. 4.1.4, again indicate no appreciable effect of this increased speed on the effectiveness of the method. These findings suggest that, within the normal operating range of the equipment and under the test parameters effectiveness is relatively independent of the speed of operation.

Despite the fact that no gross effect of speed was noticeable in these trials it is probable that an optimum operational speed, dependent upon the amount of contaminant present, exists for each item of equipment. Furthermore, a saturation speed, at which the equipment becomes overloaded and fails to operate satisfactorily would be expected for each machine for a given contamination level. It is accordingly recommended that in a future test the variation of effectiveness with speed be studied in some detail.

4.7 OPERATIONAL CHARACTERISTICS OF DECONTAMINATION EQUIPMENT

There are certain operational factors that must be considered when dry fallout material is removed from paved areas and streets by the "waterless" decontamination procedures evaluated. Factors such as effort, equipment availability, and mode of operation will be discussed.

4.7.1 Motorized Sweeping

Today approximately 4,000 motorized street sweepers are in operation on city streets in this country.[10] Table 4.6 lists the availability of motorized sweepers in cities of various sizes. The table does not include sweepers that belong to military activities, state highway departments, etc. On the average, a motorized sweeper can clean 20 gutter miles per day. Assuming an eight foot wide pass, the total coverage amounts to 845,000 ft^2 day. Using an average of 5 actual sweeping hours/day, this would be equal to approximately 169,000 ft^2/hr or in the units of effort,

TABLE 4.6

Effort Required to Achieve Residual Mass Levels

M_o (g/ft^2)	M (g/ft^2)	E (equip min/10^4 ft^2)	Increase over Normal (3.5)
20	1.0	15	4.3
	2.0	8.5	2.4
	5.0	5	1.4
50	2.0	13.5	3.9
	5.0	8	2.3
120	2.0	20	5.7
	5.0	11	3.2

TABLE 4.7

Motorized Sweeper Ownership in the United States

Population Range	No. of Cities Surveyed	Average Miles of Streets	Average Sweepers per City	Miles of Streets per Sweeper
Over 100,000	31	570	12.5	46
50,000 to 100,000	25	147	2.7	53
25,000 to 50,000	47	76	1.6	42
15,000 to 25,000	49	42	1.2	31
5,000 to 15,000	87	19.1	0.8	23
Under 5,000	39	3.9	0.3	13

$3.5 \; \frac{\text{equip - min.}}{10^4 \text{ ft}^2}$. Table 4.6 extracted from Figs. 4.2.1-4.2.3, compares the effort required to achieve different degrees of effectiveness at several initial mass levels, for the Wayne Model 450 motorized sweeper on asphaltic concrete.

It can readily be seen that the amount of effort required to obtain effectiveness in the range that may be required is several times the effort normally expended in sweeping operations.

Application of the data in Tables 4.6 and 4.7 to demonstrate the time involved in the decontamination of streets in a typical city follows:

Given: Initial fallout mass level - 20 g/ft^2
City has 50 miles of streets per sweeper
Average width of street - 60 ft

Required: Time to obtain a residual mass level of 1 g/ft^2
(Residual Number# = 0.05)

From Table 4.6, an effort level of 15 equip-min/10^4 ft^2 is required to achieve a residual mass level of 1 g/ft^2. There the time involved will be

$$t = \frac{50 \text{ miles}}{\text{equip}} \times \frac{5280 \text{ ft}}{\text{mile}} \times 60 \text{ ft} \times \frac{15 \text{ equip min}}{10^4 \text{ ft}^2} \times \frac{1 \text{ hr}}{60 \text{ min}}$$

$$t = 396 \text{ hours or } 49.5 \text{ - eight hr working days}$$

If the initial mass level was 120 g/ft^2, and a residual mass level of 2 g/ft^2 would be required, (residual number = 0.017) it would take a total of 66 - eight hr working days.

A suggested technique for the use of the motorized sweeper is to combine a "wet" decontamination procedure with the sweeping operation. One test of this nature is reported in Volume II[11] of this series of reports. The motorized sweeper would be utilized to remove the bulk of the fallout material and the "wet" decontamination procedure to remove the remaining material. This technique would be most successful when the initial mass levels are high. The rate of operation and water requirements for a "wet" procedure decreases significantly with a decrease in mass level.

\# The residual number is defined as the decimal fraction of the potential dose that would be received after a countermeasure has been applied. The more effective the countermeasure, the smaller the residual number.

It was also found that considerable hopper leakage occurred as the hopper approached full capacity. The fine fallout material would spill out around the closure seams and recontaminate the area being decontaminated. It may be necessary to empty the hopper more often when removing dry fallout material. Dumping areas could be established close to but outside the area being reclaimed or alternately, auxiliary equipment such as a front-end loader and a dump truck could haul the collected material to a waste-disposal area further away.

It was pointed out in Section 2.1.1 that the gutter broom decreased the overall effectiveness of the sweeping operation when sweeping curbless areas. When sweeping gutters, the gutter broom must be used, otherwise the material against the curb cannot be reached.

4.7.2 "Vacuumized" Sweeper

The two vacuumized sweepers evaluated in this operation were not true vacuum sweepers in that a large broom was utilized for sweeping and picking up the material from the surface. In principle their operation was similar to a motorized sweeper with an additional vacuum system for controlling the dust cloud created by the sweeping process.

The effort required to obtain a high degree of effectiveness when removing dry fallout material with the Tennant 100 is several times larger than that required for normal sweeping operations.

The Tennant 100 at present is the only large sweeper that incorporates a vacuum system for dust control and it is presently not as widely available as the standard motorized sweeper.

The Tennant 80 is primarily an industrial type sweeper used for driveways, walks and the interior of industrial buildings. Its usefulness would be limited on large paved areas and streets.

In recent years the development of large scale airport sweepers has been accelerated by the advent of jet aircraft which require clean runways. Due to the large size of runways and the necessity of frequent cleaning, these sweepers have been designed to clean up to a 1,000,000 ft^2/hr at speeds of 20 to 25 mph. The sweeping is accomplished with a recirculating air stream-vacuum combination system. The primary concern is the removal of relatively large objects which may cause considerable damage if they are drawn into the air intake of the jet engine. The separation of the picked-up material from the air stream is accomplished by a rotating screen separator. Consequently, a large percentage of the fine material picked up is exhausted with the bleed-off air.

Preliminary investigations[12] of the pickup and retention efficiency of a machine of this type have been conducted with dry Stoneman soil similar to that used in this operation. It was found that approximately 58% of the picked-up material was collected in the hopper and 42% left the sweeper with the bleed-off air. Sufficient filtering capacity requirements to retain most of this fine material would involve extensive redesign and modification of the existing system.

4.7.3 Air Broom Sweeping

Within the limitations indicated in Section 4.2, the air broom proved to be the most effective "dry" decontamination method tested at high values of effort. Air compressors generally are available from Public Works Departments, military activities, or private contractors. These compressors are generally trailer mounted or truck mounted. The addition of a manifold nozzle system to the trailer or prime mover makes available a useable "dry" decontamination technique.

The air broom was found to have certain limitations on the quantity of material it could move effectively. Fig. 4.6 illustrates the ridges of dry fallout material left on the surface by the air broom when removing an initial mass of approximately 150 gms/ft^2. The air broom is most effectively used at low initial mass levels, i.e., 50 gms/ft^2 or less, or in conjunction with motorized sweeping, when the sweeper is used to remove the bulk of the material.

Another limitation of the air broom is obviously the fact that the material blown off the surface is not collected but is resuspended and, depending on wind conditions, is deposited nearby or at some distance downwind.

4.8 SOURCES OF ERROR

Error in the results come from two major areas, namely the determination of the mass level on the surface and the performance of the decontamination equipment. The sources of error in the performance data are quite limited and fairly unimportant. Possible sources of error include: total time consumed, equipment variability such as brush condition and speed of brush rotation, and operator variability, due primarily to increasing experience.

The main sources of mass level error include the following areas: synthetic fallout composition; instrumentation; distribution and redistribution of the synthetic fallout; and surface condition. Considerable variation in composition existed between individual batches of the synthetic fallout material (see Vol. I of this series of reports for further details). Although there is presently insufficient information available

Fig. 4.6 Ridges of dry synthetic fallout material left on surface after one pass of the air broom. Initial mass of 147 gms/ft^2.

to determine the importance of these variations upon the results, it has been assumed to be relatively unimportant when comparing the various methods. The primary source of instrumentation error was from the mobile shielded detector; it is estimated that timing variations and change of response in the crystal caused a total error of approximately + 12.5%. The 4-pi gamma ionization chamber and the large sample counter, being laboratory instruments, have an inherent error of less than 2%. Redistribution by wind of the synthetic fallout during or after spreading was the largest unknown factor in the data. Even a low wind blowing during the spreading operation could fractionate the synthetic fallout by carrying away the fine particles while allowing coarser material to settle on the surface. This fractionation, although occurring before surface readings were taken with the mobile shielded detector, could cause a variation in the specific activity of the contaminant, producing anomalous readings. The most important wind effects, however, were those produced by a moderately strong wind blowing across the test strip after the initial reading (I_r) had been taken but prior to decontamination. In such cases the calculated initial mass level could be in error by as much as a factor of two. The two major sources of errors, wind effects and instrument error, are largely cancelled out by using the calibration factor K (see Appendix B). The variation in the individual readings, expressed as one standard deviation, are shown on Figs. 4.1.2 and 4.1.7.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Two parameters, derived from the test data, and used for the comparison of methods, were K which is an expression of rate of removal and M_0^* which is an expression for the ultimate level obtainable at very high effort levels and high initial mass levels. The derived values of K, M_0^* and M_{120}^*, the value at an initial mass level of 120 g/ft^2 are shown below.

Method-Surface	K	M_{120}^*	M_0^*
Wayne 450 - Asphaltic Concrete	.330	1.84	1.96
Wayne 450 - Portland Concrete	.330	2.06	2.09
Air Broom - Asphaltic Concrete	.238	0.64	1.40
Tennant 100 - Asphaltic Concrete	.210	0.88	1.14
Tennant 80 - Asphaltic Concrete	.120	4.90	5.32

The ideal method would be one which had a high K value and a low M_0^* value. Since none of the methods qualified in both respect the sequential use of two methods, one having a high K value, and the other a low M_0^* value would result in producing the maximum return for effort expended. In instances where a large expenditure of effort can be tolerated one would choose the method producing the lowest M_0^* value.

The removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

The smaller of the two vacuumized sweepers evaluated, the Tennant 80, was found to have limited value in removing dry fallout material from large paved areas and streets. This machine or others similar in size, could probably be used, however, for removing dry fallout from sidewalks or other relatively inaccessible paved areas.

The residual mass level obtainable by any given method-surface-combination evaluated was found to be dependent upon the initial mass level and the effort expended.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

Within the normal operating range of the equipment and under the test conditions, overall performance appear to be independent of the speed of operation.

At all initial mass levels tested, it was easier to decontaminate the asphaltic concrete surface than the Portland cement concrete surfaces. The joints and form lines in the Portland cement concrete areas further complicate the difficulty of decontaminating this type surface.

5.2 RECOMMENDATIONS

It is recommended that dry decontamination methods be considered for incorporation in the passive defense plans as: (1) a supplement to wet methods and (2) in areas of critical water supply, as the primary decontamination method for paved areas.

The following lines of further investigation are suggested for inclusion in future developments of dry decontamination procedures for land targets:

a. Determine if an optimum speed and/or a limiting range of speeds exists for each surface-method combination.

b. Evaluate the two equations used at very high and low effort levels.

c. Determine the feasibility of incorporating the removal action of the air broom with the retention features of the vacuumized sweeper.

d. Further evaluate the sequential use of two methods.

Approved by:

E. R. Tompkins

E. R. TOMPKINS
Head, Chemical Technology Division

For the Scientific Director

REFERENCES

1. F.R. Holden, R.A. Laughlin, et al. Operation Supersweep. ADZ-42, Oct. 4, 1948. U.S. Naval Radiological Defense Laboratory Report. (Out of print.)

2. R.A. Laughlin, J. Howell, et al. Operation Streetsweep. ADX-39, Dec. 2,1948. U.S. Naval Radiological Defense Laboratory Report. (Out of print.)

3. W. Strope, et al. Protection and Decontamination of Land Targets and Vehicles. Operation JANGLE, Project 6.2, WT-400. 11 June 1952. (Classified.)

4. J.D. Sartor, H.B. Curtis, et al. Cost and Effectiveness of Decontamination Procedures for Land Targets. U.S. Naval Radiological Defense Laboratory Report, USNRDL-TR-196, 27 December 1957.

5. C.F. Miller. Estimated Effectiveness of Common Radiological Decontamination Methods for Paved Areas and Building Surfaces. U.S. Naval Radiological Defense Laboratory Report, USNRDL-TR-140, March 1957 (Classified).

6. J.D. Sartor, W.B. Lane. The Production, Dispersal and Measurement of Synthetic Fallout Material. Vol. I. U.S. Naval Radiological Defense Laboratory Report in preparation.

7. L.L. Wiltshire, R.K. Fuller, et al. The Adsorption of La^{140} on Ambrose Clay Loam. U.S.Naval Radiological Defense Laboratory Technical Memorandum, USNRDL-TM-67, 3 January 1957. (Limited Intra-Laboratory Distribution)

8. C.F. Miller. Response Curves for USNRDL 4-pi Ionization Chamber. U.S. Naval Radiological Defense Laboratory Report, USNRDL-TR-155, 17 May 1957.

9. C.F. Miller. Theory of Decontamination. Part 1. U.S. Naval Radiological Defense Laboratory Report, USNRDL 460, 15 July 1958.

10. W.S. Foster. Modern Trends in Street Sanitation. The American City. March 1957.

11. J.D. Sartor, W.H. Van Horn, W.L. Owen. Performance Characteristics of Wet Decontamination Procedures, Vol. II. U.S. Naval Radiological Defense Laboratory Report in preparation.

12. J.T. Barnett, et al. Airfield Vacuum Cleaner Decontamination Feasibility Study Report, 10 March 1958. Coleman Engineering Co., Los Angeles 16, Calif.

APPENDIX A

A.1 Raw Data

The following tables present for each test the radiation measurements obtained at the monitoring locations on the test areas. The measurements have been background-corrected and decayed to the mid-time of the initial readings. All measurements were taken with the Mobile Shielded Gamma Detector Unit described in Volume I of this series of reports. Table A.1 presents the raw data utilized to obtain the effort required for each surface-method combination.

A map of Camp Stoneman indicating the various test areas is shown in Fig. A.1.

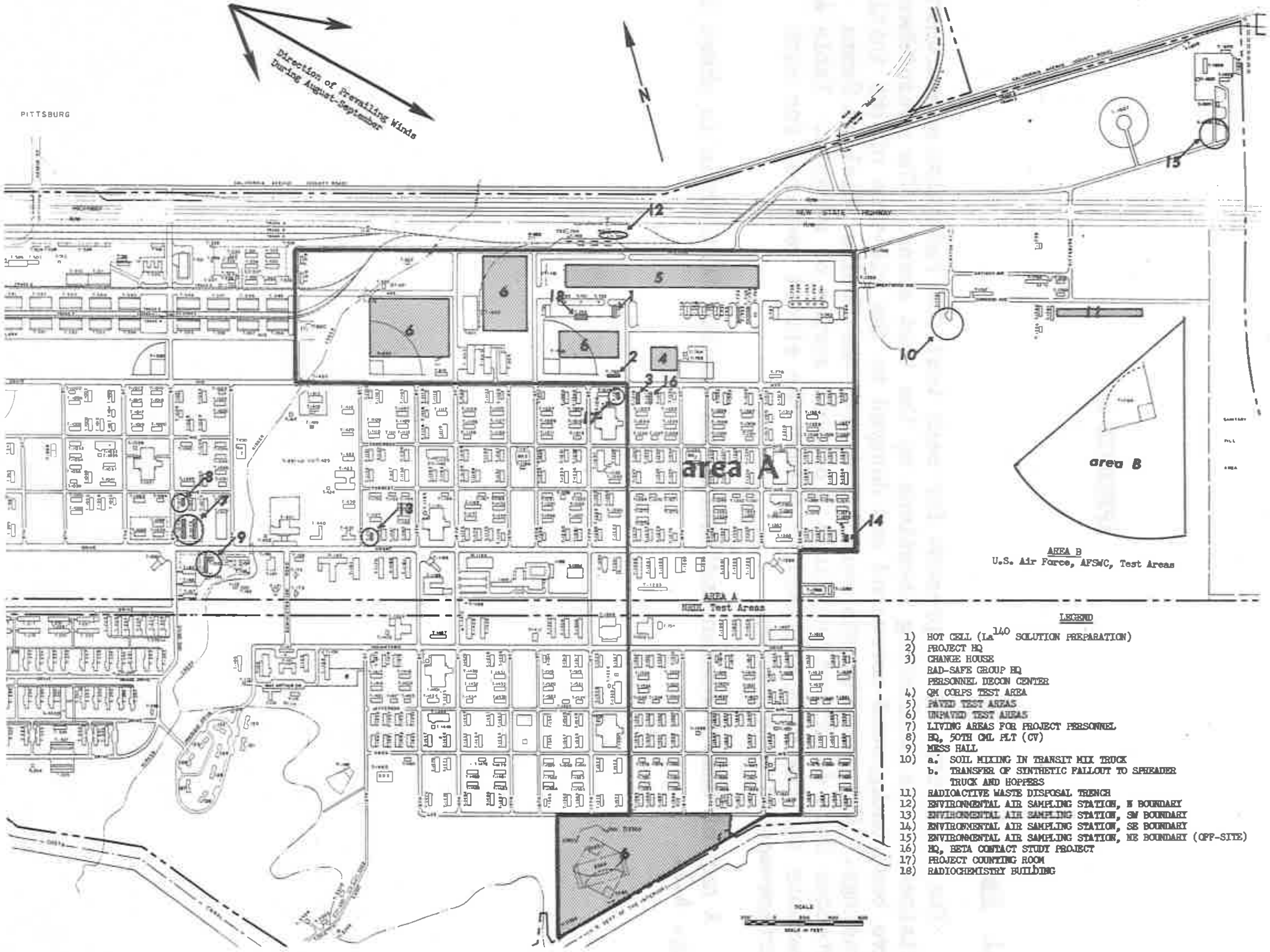

Direction of Prevailing Winds During August-September
N
PITTSBURG
CALIFORNIA AVENUE COUNTY ROAD
NEW STATE HIGHWAY
SANITARY FILL AREA
area A
area B
AREA B
U.S. Air Force, AFSWC, Test Areas
AREA A
NRDL Test Areas
1
2
3
4
5
6
8
9
10
11
12
13
14
15
16
17
18
LEGEND
1) HOT CELL (La140 SOLUTION PREPARATION)
2) PROJECT HQ
3) CHANGE HOUSE
RAD-SAFE GROUP HQ
PERSONNEL DECON CENTER
4) QM CORPS TEST AREA
5) PAVED TEST AREAS
6) UNPAVED TEST AREAS
7) LIVING AREAS FOR PROJECT PERSONNEL
8) HQ, 50TH CML PLT (CV)
9) MESS HALL
10) a. SOIL MIXING IN TRANSIT MIX TRUCK
b. TRANSFER OF SYNTHETIC FALLOUT TO SPREADER TRUCK AND HOPPERS
11) RADIOACTIVE WASTE DISPOSAL TRENCH
12) ENVIRONMENTAL AIR SAMPLING STATION, N BOUNDARY
13) ENVIRONMENTAL AIR SAMPLING STATION, SW BOUNDARY
14) ENVIRONMENTAL AIR SAMPLING STATION, SE BOUNDARY
15) ENVIRONMENTAL AIR SAMPLING STATION, NE BOUNDARY (OFF-SITE)
16) HQ, BETA CONTACT STUDY PROJECT
17) PROJECT COUNTING ROOM
18) RADIOCHEMISTRY BUILDING
SCALE
SCALE IN FEET

Fig. A-1

TABLE A.1

Raw Data for Decontamination Effort

Test	Cycle	Area ft^2	No. of Passes	Time, sec	Speed[a] ft/sec	Rate ft^2/min
B1	1	2400	9	112.5	8.0	1280
	2		6	75	8.0	1920
	3		8	100	8.0	1440
	4 (AB)		8	160	2.5/6.7[b]	900
B2	1	2400	10	117	7.7	1230
	2		10	117	7.7	1230
	3		10	117	7.7	1230
	4 (AB)		10	250	0.91/7.7[b]	580
B3	1	2400	11	165	6.7	870
	2		8	120	6.7	1200
	3 (AB)		7	180	2.2/6.7[b]	800
B4	1	4000	21	273	7.7	880
	2		10	130	7.7	1850
	3		10	130	7.7	1850
B5	1	4480	8	136	8.2	1970
	2		8	144	7.8	1880
	3		8	104	10.7	2580
B6	1	4480	17	425	5.6	630
	2		10	250	5.6	1070
	3		5	350	2.0	770
B7	1	2400	8	208	3.9	690
	2		8	208	3.9	690
	3		10	260	3.9	550
B8	1	2200	10	250	4.0	530
	2		8	200	4.0	660
	3		8	240	3.3	550
B9	1	2200	10	260	3.9	510
	2		8	96	8.3	1380
	3		8	88	9.1	1500

Continued

a. Computed
b. Forward/Reverse AB = Air Broom

TABLE A.1 (Cont'd)

Raw Data for Decontamination Effort

Test	Cycle	Area ft^2	No. of Passes	Time, sec	Speed(a) ft/sec	Rate ft^2/min
B10	1	1100	10	100	5.0	660
	2		12	96	6.2	690
	3		12	96	6.2	690
B11	1	1100	10	100	5.0	660
	2		10	75	6.7	880
	3		10	75	6.7	880
B12	1	1100	18	180	5.0	370
	2		10	75	6.7	880
	3		10	75	6.7	880
B13	1	2000	6	90	6.7	1330
	2		6	78	7.7	1540
	3		6	78	7.7	1540
B14	1	2400	12	180	6.7	800
	2		8	120	6.7	1200
	3		88	120	6.7	1200
	4 (AB)		10	300	1.7/6.7(b)	480
B15	1	2000	8	120	6.7	1000
	2		8	120	6.7	1000
	3		8	120	6.7	1000
B16	1	1380	8	168	2.9/2.9(b)	490
B17	1	1380	10	200	2.0/6.0(b)	410
	2		10	200	2.0/6.0(b)	410
B18	1	1380	10	300	2.7/1.6(b)	280

a. Computed.
b. Forward/Reverse AB = Air Broom

TABLE A-2

TEST NO. B - 1

DATE 8/27/58

PROCEDURE Motorized Sweeping
Wayne Model 450

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 15

AREA SIZE 20' x 100'

INITIAL READINGS

7333	6286	5695	5451	5588	5520	6504	3942
7680	8065	8415	5060	7054	7753	9140	3753

PASS NO. 1

1815	1190	627	676	470	460	577	254
585	512	623	645	636	418	363	495

PASS NO. 2

1005	712	397	345	296	224	221	216
362	319	337	405	506	313	274	294

PASS NO. 3

1205	428	201	273	234	247	253	194
188	182	212	205	238	159	161	225

PASS NO. 4 Air Broom Sweeping

905	59	42	64	41	34	45	33
36	46	65	36	43	39	43	51

TABLE A-3

TEST NO. B - 2
DATE 8/27/58
PROCEDURE Motorized Sweeping
Wayne Model 450
SURFACE TYPE Asphaltic Concrete
AREA NO. B - 13
AREA SIZE 20' x 100'

INITIAL READINGS

10412	10211	12085	11845	13814	13118	11810	9962
10081	11414	13067	11944	14788	12250	11374	6632

PASS NO. 1

989.7	683.5	758.1	788.1	760.3	619.9	658.2	752.6
937.8	1124.3	1403.1	1583.3	1544.5	1401.2	1108.3	827.9

PASS NO. 2

396.1	381.9	397.1	385.9	318.9	317.8	364.4	543.9
438.4	408.4	441.1	539.3	560.2	547.9	462.9	410.3

PASS NO. 3

279.9	237.0	292.3	265.2	239.9	248.6	308.9	335.9
323.6	270.9	339.4	335.9	356.6	414.8	378.1	350.3

PASS NO. 4 Air Broom Sweeping

45.4	43.5	44.3	47.5	41.4	48.2	54.4	54.6
40.6	41.6	46.5	51.1	60.6	56.1	63.0	70.7

TABLE A-4

TEST NO. B - 3

DATE 8/26/58

PROCEDURE Motorized Sweeping
Wayne Model 450

SURFACE TYPE Asphaltic Concrete

AREA NO.

AREA SIZE 20' x 100'

INITIAL READINGS

2278	9771	9835	7589	9987	7509	9924	7374
▲	▲	▲	▲	▲	▲	▲	▲
8125	7541	5654	8483	5259	6274	8752	6574
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

228.0	188.1	234.2	175.4	232.9	208.0	244.4	218.6
▲	▲	▲	▲	▲	▲	▲	▲
289.1	417.3	303.6	200.8	379.3	290.4	227.0	168.9
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

134.2	123.9	142.4	99.5	135.0	118.8	133.3	129.5
▲	▲	▲	▲	▲	▲	▲	▲
130.2	173.4	147.6	77.0	207.1	161.7	110.7	90.1
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3 Air Broom Sweeping

7.6	9.3	18.8	7.4	8.1	5.8	5.2	6.2
▲	▲	▲	▲	▲	▲	▲	▲
10.1	10.7	11.5	9.7	9.8	10.3	7.0	6.8
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-5

DATE 8/30/58

PROCEDURE Motorized Sweeping
Wayne Model 450

AREA NO. A - 29

AREA SIZE 40' x 100'

INITIAL READINGS

2396 ▲	3357 ▲	3243 ▲	2900 ▲	2828 ▲	3240 ▲	3116 ▲	3401 ▲
▲	▲	▲	▲	▲	▲	▲	▲
3015 ▲	2686 ▲	3548 ▲	3606 ▲	4118 ▲	4365 ▲	4046 ▲	2900 ▲

PASS NO. 1

412.3 ▲	338.0 ▲	278.9 ▲	301.6 ▲	321.2 ▲	653.4 ▲	357.7 ▲	232.4 ▲
▲	▲	▲	▲	▲	▲	▲	▲
348.3 ▲	202.8 ▲	249.0 ▲	251.8 ▲	210.4 ▲	456.4 ▲	322.5 ▲	396.2 ▲

PASS NO. 2

465.2 ▲	152.6 ▲	184.9 ▲	278.5 ▲	231.2 ▲	652.6 ▲	257.2 ▲	305.9 ▲
▲	▲	▲	▲	▲	▲	▲	▲
413.5 ▲	241.5 ▲	238.0 ▲	227.9 ▲	214.7 ▲	210.2 ▲	225.7 ▲	220.9 ▲

PASS NO. 3

233.2 ▲	132.4 ▲	177.0 ▲	151.7 ▲	203.6 ▲	230.6 ▲	205.9 ▲	290.8 ▲
▲	▲	▲	▲	▲	▲	▲	▲
238.4 ▲	202.8 ▲	187.2 ▲	172.8 ▲	166.1 ▲	155.2 ▲	215.8 ▲	281.3 ▲

TABLE A-6

TEST NO. B - 5

DATE 9/3/58

PROCEDURE Motorized Sweeping
Wayne Model 450

SURFACE TYPE Portland Cement Concrete

AREA NO. A - 30

AREA SIZE 32' x 140'

INITIAL READINGS

	6174	7605	6586	9909	8349	7164	8595	7670	9125	7715
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	7235	6802	6859	6787	7013	7200	7609	6489	6563	6841
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 1

2055.5	1632.9	1683.3	1365.0	1412.0	1458.5	1143.7	1084.2	1173.0	1146.7	1245.6
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
515.4	420.6	490.2	543.6	971.3	748.4	782.6	2239.1	1023.7	939.0	853.3
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 2

714.5	927.6	823.4	652.0	598.0	705.8	648.6	1782.0	571.8	699.0	824.4
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
335.9	210.9	246.2	346.0	669.6	459.5	394.0	3966.0	387.1	428.8	234.0
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 3

241.5	382.7	411.4	340.0	297.3	310.5	274.3	1084.0	311.1	377.3	921.0
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
234.6	142.5	129.4	178.8	417.9	235.9	188.9	1266.0	177.3	154.6	132.4
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-7

TEST NO.	B - 6	SURFACE TYPE	Portland Cement Concrete
DATE	8/26/58	AREA NO.	A - 30
PROCEDURE	Motorized Sweeping Wayne Model 450	AREA SIZE	32' x 140'

INITIAL READINGS

	8184	9970	7061	9965	10397	8397	11920	10322	9195	10079
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	7572	6337	8242	8883	8153	10496	8718	6997	7746	3023
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 1

	276.5	301.1	236.7	204.9	244.6	186.2	1549.7	191.0	196.9	219.9
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	88.7	89.4	113.4	188.8	124.8	134.2	1364.8	147.3	140.5	122.9
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 2

	262.3	161.1	174.8	181.9	236.2	219.4	1729.1	213.5	274.9	259.2
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	48.3	81.0	81.5	109.1	87.9	87.3	600.5	107.1	113.0	113.3
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

seam

PASS NO. 3 Air Broom Sweeping

	50.6	25.6	15.3	13.3	12.1	13.8	37.1	13.2	10.7	14.1
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	47.7	15.2	19.7	13.4	12.9	11.2	339.3	11.4	9.7	12.6
▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-8

TEST NO. B - 7

DATE 9/12/58

PROCEDURE Vacuumized Sweeping
Tennant Model 100

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 7

AREA SIZE 20' x 100'

INITIAL READINGS

4024	3343	2829	8893	8940	7208	4211	
▲	▲	▲	▲	▲	▲	▲	▲
1444	3319	1887	2471	3030	2719	3580	
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

161	188	225	304	240	237	204	
▲	▲	▲	▲	▲	▲	▲	▲
97	125	114	179	165	181	261	
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

88	92	84	102	105	88	89	
▲	▲	▲	▲	▲	▲	▲	▲
39	58	44	69	64	66	68	
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

62	62	68	81	84	63	63	
▲	▲	▲	▲	▲	▲	▲	▲
22	21	44	30	49	43	39	
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-9

TEST NO.	B - 8	SURFACE TYPE	Asphaltic Concrete
DATE	9/11/58	AREA NO.	B - 8
PROCEDURE	Vacuumized Sweeping Tennant Model 100	AREA SIZE	20' x 100'

INITIAL READINGS

12435	12673	11530	9353	10093	12287	8789	10270
▲	▲	▲	▲	▲	▲	▲	▲
15200	19974	15043	14916	16189	18103	19135	15357
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

106.0	104.5	176.3	199.2	135.2	131.3	118.8	128.2
▲	▲	▲	▲	▲	▲	▲	▲
70.7	144.0	156.4	177.7	207.1	229.1	213.6	282.9
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

76.6	61.9	76.5	65.9	67.6	67.4	58.0	70.3
▲	▲	▲	▲	▲	▲	▲	▲
61.9	62.9	74.2	85.6	102.3	104.7	107.7	132.8
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

63.4	56.7	58.1	51.2	60.3	57.2	56.3	34.8
▲	▲	▲	▲	▲	▲	▲	▲
50.4	62.6	60.6	69.4	71.5	86.0	78.6	111.7
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-10

TEST NO. B - 9

DATE 9/10/58

PROCEDURE Vacuumized Sweeping Tennant Model 100

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 9

AREA SIZE 20' x 100'

INITIAL READINGS

13767	17535	15512	15676	16953	15203	12762	15044
▲	▲	▲	▲	▲	▲	▲	▲
18100	14453	15334	18017	20797	20379	24041	19148
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

135.2	518.6	321.3	269.1	315.6	312.9	286.3	252.2
▲	▲	▲	▲	▲	▲	▲	▲
166.2	241.8	232.9	296.7	269.9	477.1	643.6	792.3
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

96.7	273.7	185.4	206.1	203.2	171.4	153.6	142.3
▲	▲	▲	▲	▲	▲	▲	▲
80.1	135.7	134.7	161.7	137.0	144.5	187.2	219.4
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

88.7	142.5	129.5	141.9	150.1	145.4	129.3	88.0
▲	▲	▲	▲	▲	▲	▲	▲
81.3	111.9	96.7	129.9	115.0	112.7	139.7	163.3
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-11

TEST NO.	B - 10	SURFACE TYPE	Asphaltic Concrete
DATE	9/15/58	AREA NO.	B - 11
PROCEDURE	Vacuumized Sweeping Tennant Model 80	AREA SIZE	20' x 50'

INITIAL READINGS

3830	4122	3517	4141				
▲	▲	▲	▲	▲	▲	▲	▲
1853	2763	2341	3583				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

80.9	64.8	71.4	84.3				
▲	▲	▲	▲	▲	▲	▲	▲
64.8	72.8	67.5	89.7				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

38.5	31.9	32.4	43.2				
▲	▲	▲	▲	▲	▲	▲	▲
38.2	47.6	43.6	60.4				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

28.9	21.6	20.3	30.3				
▲	▲	▲	▲	▲	▲	▲	▲
29.5	35.8	33.3	47.6				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-12

TEST NO.	B - 11	SURFACE TYPE	Asphaltic Concrete
DATE	9/12/58	AREA NO.	B - 10
PROCEDURE	Vacuumized Sweeping Tennant Model 80	AREA SIZE	20' x 50'

INITIAL READINGS

4011	10298	9499	9710				
▲	▲	▲	▲	▲	▲	▲	▲
6408	5375	7500	5340				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

1322.5	2240.6	1455.8	2923.3				
▲	▲	▲	▲	▲	▲	▲	▲
1289.3	932.6	1129.7	1398.4				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

772.6	1193.2	779.4	1522.9				
▲	▲	▲	▲	▲	▲	▲	▲
767.2	589.5	783.3	865.7				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

541.1	880.4	546.8	1083.2				
▲	▲	▲	▲	▲	▲	▲	▲
593.6	441.8	496.3	615.9				
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-13

TEST NO. B - 12

DATE 9/10/58

PROCEDURE Vacuumized Sweeping
Tennant Model 80

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 12

AREA SIZE 20' x 50'

INITIAL READINGS

14537 ▲	20125 ▲	17225 ▲	12219 ▲	▲	▲	▲	▲
21077 ▲	19048 ▲	20940 ▲	23371 ▲	▲	▲	▲	▲

PASS NO. 1

1336.6 ▲	1592.2 ▲	670.8 ▲	1075.4 ▲	▲	▲	▲	▲
841.2 ▲	1004.8 ▲	1086.9 ▲	1086.7 ▲	▲	▲	▲	▲

PASS NO. 2

833.3 ▲	1065.7 ▲	495.5 ▲	772.0 ▲	▲	▲	▲	▲
780.0 ▲	754.9 ▲	794.3 ▲	837.1 ▲	▲	▲	▲	▲

PASS NO. 3

688.9 ▲	827.9 ▲	419.2 ▲	585.4 ▲	▲	▲	▲	▲
602.6 ▲	623.6 ▲	619.6 ▲	617.3 ▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-14

TEST NO.	B - 13	SURFACE TYPE	Asphaltic Concrete
DATE	9/5/58	AREA NO.	B - 3
PROCEDURE	Motorized Sweeping w/sand pretreatment Wayne Model 450	AREA SIZE	20' x 100'

INITIAL READINGS

2103	2604	3867	3519	3437	3278	3775	4553
▲	▲	▲	▲	▲	▲	▲	▲
5203	5181	4809	4712	5293	5143	4673	4590
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

1246.8	870.0	1104.6	1103.0	1133.9	883.8	783.6	860.2
▲	▲	▲	▲	▲	▲	▲	▲
417.9	532.3	544.6	529.6	690.5	769.1	713.2	876.6
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

765.8	614.8	647.9	686.5	724.1	544.8	538.5	467.8
▲	▲	▲	▲	▲	▲	▲	▲
218.9	311.9	352.5	365.1	404.9	427.5	399.2	468.5
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

546.2	398.6	420.8	422.5	446.4	420.4	345.3	338.7
▲	▲	▲	▲	▲	▲	▲	▲
153.5	171.6	210.7	241.2	263.2	290.5	284.0	317.1
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-15

TEST NO.	B - 14	**SURFACE TYPE**	Asphaltic Concrete
DATE	8/29/58	**AREA NO.**	B - 7
PROCEDURE	Motorized Sweeping w/sand pretreatment Wayne Model 450	**AREA SIZE**	20' x 100'

INITIAL READINGS

14911	14048	12255	12253	8876	8203	7162	6372
▲	▲	▲	▲	▲	▲	▲	▲
12395	14493	14889	13398	16215	16022	15325	13716
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

981.5	833.2	682.4	775.9	582.4	676.8	579.3	520.2
▲	▲	▲	▲	▲	▲	▲	▲
719.9	766.9	776.2	1200.3	1141.8	1333.8	1618.4	1538.3
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

472.5	434.6	336.7	357.1	359.6	368.1	414.3	421.2
▲	▲	▲	▲	▲	▲	▲	▲
436.4	467.2	390.0	454.7	525.7	520.2	617.2	460.0
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

273.8	278.2	226.1	263.7	241.8	340.5	285.7	227.6
▲	▲	▲	▲	▲	▲	▲	▲
220.2	251.8	262.3	345.9	316.8	316.8	328.5	237.9
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4 Air Broom Sweeping

48.6	43.2	48.7	49.4	35.7	41.1	42.3	41.4
▲	▲	▲	▲	▲	▲	▲	▲
44.9	51.4	52.8	49.8	52.5	63.2	58.8	53.4
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-16

TEST NO. B - 16

DATE 9/1/58

PROCEDURE Motorized Sweeping w/sand pretreatment Wayne Model 450

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 9

AREA SIZE 20' x 100'

INITIAL READINGS

11460	13662	11075	13017	13017	11231	12040	10936
▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

2093.3	2350.6	1284.3	1842.4	2202.5	12229.7	1188.6	993.3
▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

796.6	976.0	609.8	874.5	1402.6	477.7	426.6	377.4
▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

548.8	630.3	391.8	563.8	676.9	275.7	267.9	278.8
▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-17

TEST NO.	B - 16	SURFACE TYPE.	Asphaltic Concrete
DATE	8/30/58	AREA NO.	B - 24
PROCEDURE	Air Broom Sweeping	AREA SIZE	20' x 60'

INITIAL READINGS

3707	3142	3377	3835	3680				
▲	▲	▲	▲	▲	▲	▲	▲	
2382	2888	2450	2387	3097				
▲	▲	▲	▲	▲	▲	▲	▲	

PASS NO. 1

52.6	50.2	54.8	57.7	39.0			
▲	▲	▲	▲	▲	▲	▲	▲
29.3	31.0	33.6	23.6	25.6			
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-18

TEST NO. B - 17

DATE 8/29/58

PROCEDURE Air Broom Sweeping

SURFACE TYPE Asphaltic Concrete

AREA NO. B - 18

AREA SIZE 20' x 60'

INITIAL READINGS

11540	11935	11695	13209	9451				
▲	▲	▲	▲	▲	▲	▲	▲	▲
11729	11855	12613	11739	11176				
▲	▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

90.3	104.4	105.5	86.8	71.8				
▲	▲	▲	▲	▲	▲	▲	▲	▲
106.1	136.9	137.4	135.5	112.3				
▲	▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

51.9	48.7	56.5	60.8	52.3				
▲	▲	▲	▲	▲	▲	▲	▲	▲
89.9	102.6	105.7	104.5	78.2				
▲	▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

▲	▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲	▲

TABLE A-19

TEST NO.	B - 18	SURFACE TYPE	Asphaltic Concrete
DATE	9/2/58	AREA NO.	B - 22
PROCEDURE	Air Broom Sweeping	AREA SIZE	20' x 60'

INITIAL READINGS

14172	15534	11964	14154	16537			
▲	▲	▲	▲	▲	▲	▲	▲
13294	11442	16064	14044	8272			
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 1

94.2	77.0	62.1	59.8	107.1			
▲	▲	▲	▲	▲	▲	▲	▲
141.5	101.0	86.0	67.5	43.4			
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 2

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 3

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

PASS NO. 4

▲	▲	▲	▲	▲	▲	▲	▲
▲	▲	▲	▲	▲	▲	▲	▲

APPENDIX B

CONVERSION OF RADIATION MEASUREMENTS TO MASS UNITS

B.1 A calibration factor for the mobile shielded detector was determined for each surface; this calibration factor was then used to determine a conversion factor for determining mass levels. The complete derivation of these factors is discussed in detail in Vol. I of these series of reports.

$$K = \frac{I_r}{M_D \times S} \tag{1}$$

where K = calibration factor, counts per disintegration per square foot ($c/d/ft^2$), accounting for surface roughness and backscattering

I_r = average initial intensity of contaminated surface, in counts per minute (c/m) obtained with mobile shielded detector

M_D = average weight of contaminant, in grams per square foot (g/ft^2) determined by 1.22 ft^2 pan samples

S = specific activity, in disintegrations per second per gram $\frac{d/s}{g}$ measured in a 4-pi ionization chamber.*

As can be seen from Table B.1 a considerable variation in the value of K was found. This variation is attributed primarily to instrument error or variability and to rearrangement of the contaminant by the wind between successive measurements. A K of constant value, denoted as K_o, was determined for each surface by a simple average of all suitable values. To determine mass levels using K_o

$$K_o \times S = C \tag{2}$$

$$\frac{Ir}{C} = M_o \tag{3}$$

$$\frac{Rr}{C} = M \tag{4}$$

---

*The calibration factor used for converting the readings from the 4-pi ion chamber from milliamperes to disintegrations per second is:

$$3.30 \times 10^{-15} \frac{ma}{d/m}$$ [8] .

where C = a conversion factor, $\frac{c/s}{g/ft^2}$

M_o = calculated initial mass, g/ft^2

R_r = average residual intensity of decontaminated surface, in c/m

M = calculated residual mass, g/ft^2

TABLE B.1

Compilation of Basic and Extracted Test Data

Test	Area	Date	Mix(a) Number	(1) Time	(2) Wind Speed, Knots	(3) M_D g/ft^2	(4) Pan Count c/m/ft^2	(5) S d/s/gx10^5	(6) c/d x10^{-4}
B1	B15	8/27/58	2.3	1347	-	23.0	80775	3.978	1.45
B2	B13	8/28/58	2.4	0830	7	65.7	194160	3.416	1.43
B3	B2	8/26/58	2.2	1405	6	109.9	103386	1.12(b)	1.24
B4	A29	8/30/58	2.6	1120	4	15.0	39267	3.129	1.39
B5	A30	9/3/58	3.3	0847	5	41.4	125396	3.453	1.46
B6	A30	8/26/58	2.2	0950	2	104.5	110648	1.190	1.49
B7	B7	9/12/58	4.5	1747	9	15.8	39987	3.26(b)	1.47
B8	B8	9/11/58	4.4	1120	10	63.2	186297	3.489	1.41
B9	B9	9/10/58	4.3	1547	10	210.9	298516	1.634	1.44
B10	B10	9/15/58	5.1	0955	1	22.1	61013	3.197	1.45
B11	B11	9/12/58	4.5	1505	5	32.2	97336	3.437	1.46
B12	B12	9/10/58	4.3	0925	2	180.3	282039	1.809	1.43
B13	B3	9/5/58	3.5	0842	1	19.8	52912	2.986	1.49
B14	B7	8/29/58	2.5	1057	5	54.9	107893	2.986	1.45
B15	B9	9/1/58	3.1	0805	2	178.9	238367	1.489	1.49
B16	B24	8/30/58	2.6	0737	4	10.0	29190	3.282	1.46
B17	B18	8/29/58	2.5	0727	1	61.8	172521	3.236	1.43
B18	B22	9/2/58	3.2	0900	3	131.0	175316	1.552	1.43

Continued

a. First numeral refers to week; second numeral to day.

b. Extrapolated value.

c. These values not used for obtaining K_o.

TABLE B.1 (Cont'd)

Compilation of Basic and Extracted Test Data

Test	(7) K c/d/ft^2	(8) K_o x 10^{-4}	(9) C c/s x ft^2/g	(10) I_r c/s	(11) M_o g/ft^2	(12) R_r-1 c/s	(13) R_r-2 c/s	(14) R_r-3 c/s	(15) R_r-4 c/s
B1	7.040	5.870	233.51	6,452	27.63	568.7	348.1	226.7	45.1
B2	5.293	5.870	200.52	11,878	59.23	996.3	432.2	311.0	50.6
B3	6.455(c)	5.870	65.45	7,910	120.86	250.4	132.2	9.0	-
B4	7.027	6.290	196.81	3,298	16.76	333.3	282.5	202.8	-
B5	5.191	6.290	217.19	7,414	34.14	1048	543.8	268.0	-
B6	7.134	6.290	74.85	8,875	118.57	181.4	156.2	17.9	-
B7	8.053(c)	5.870	191.36	4,136	21.61	192	75.8	52.2	-
B8	6.279	5.870	204.80	13,834	67.55	161.3	79.8	64.3	-
B9	4.947	5.870	95.92	17,045	177.70	345.7	164.6	122.9	-
B10	4.913	5.870	187.66	3,471	18.50	746	420	309	-
B11	6.112	5.870	201.75	6,766	33.54	1270	909	650	-
B12	5.693	5.870	106.19	18,568	174.86	1087	792	623	-
B13	7.074	5.870	175.28	4,171	23.80	816	496	329	-
B14	7.651	5.870	175.28	12,533	71.50	920	440	276	48.6
B15	4.524(c)	5.870	87.40	12,055	137.93	1648	743	454	-
B16	9.430(c)	5.870	192.65	3,095	16.07	39.7	-	-	-
BI7	5.974	5.870	189.95	11,943	62.87	108.7	75.1	-	-
B18	6.666	5.870	91.10	13,548	148.72	84.0	-	-	-

a. First numeral refers to week; second numeral to day.
b. Extrapolated value.
c. These values not used for obtaining K_o.

Explanation of Table B.1

(1) Time. Time that initial reading was taken; all radiation data have been decayed to this time.

(2) Wind Speed. Wind speed at time (1) obtained with a hand held anemometer.

(3) M_D. The average weight of the contaminant deposited per square foot by the dispersal device. The contaminant was collected in 1.22 ft^2 pans placed approximately every 500 ft^2 in the contamination pattern.

(4) Pan Count. The average one minute count determined in a large scale counter for the pan sample (normalized to 1 ft^2).

(5) S. Specific activity determined by 4-pi ion chamber on a sample taken from pan (3) above.

(6) c/d. The ratio of $\frac{(4)/60}{(3) \times (5)}$; c/d should be a constant value for all cases.

(7) K. Calculated value. $K = \frac{(10)}{(3) \times (5)}$; K should be a constant value for all like surfaces.

(8) K_o. Average value of K.

(9) C. A conversion factor dependent upon specific activity (5) and K_o(8).

(10) I_r. Average initial count of the test area taken with the mobile shielded detector.

(11) M_o. Average initial mass level; the ratio of (10)/(9).

(12) - (15) R_r-1, etc. Average residual count on the test area taken with the mobile shielded detector. Values given are for successive cycles of the decontamination procedure. These values can be converted to M by the use of conversion factor C.

$$M = \frac{Rr}{C}$$

APPENDIX C

c.1 **The operating characteristics of the three street sweepers evaluated are given in the following tables. The information listed was obtained from manufacturer's information brochures describing the equipment.**

TABLE C-1

Operating Characteristics of Wayne Model 450

---

1. Type

Manufacture	Wayne Manufacturing Co., Newark 5, New Jersey
Model No.	Wayne 450

2. Sweeping Speeds

Maximum	6 - 8 mph (Travel 20 -25 mph)
Minimum	2 - 4 mph

3. Sweeping Path

Pickup Broom	4' 10"
With one gutter broom	7' 6"
With two gutter brooms	10' 0"

4. Broom Characteristics

Main (Pickup) Broom

Diameter	36"
Length	58"
Broom Material	Palmyra Stalk
Drive	Chain Drive
Mounting	Full Floating - Spring Suspended
Control (Lift)	Hydraulic
Reversible	Yes
Speeds	2 Fwd, 1 Reverse

Side Brooms (Gutter)

Diameter	45"
Broom Material	Standard 26" Steel Wire
Drive	Direct Drive
Mounting	Free Floating
Control (Lift)	Hydraulic
Speeds	2 Fwd, 1 Reverse

TABLE C-1 (Cont'd)

Operating Characteristics of Wayne Model 450

---

5. Conveyor System

Type	Ladder Type - Rubber
Drive	Rubber Chain
Speeds	2 Fwd, 1 Reverse

6. Dirt Hopper

Capacity	3 cubic yards (Located Forward)
Dump Controls	Hydraulic
Dump Doors	Clam Type

7. Water Spraying System

Tank Capacity	170 Gallons
Nozzles	Brass Atomizing Nozzles
Pump	Centrifugal
Operating Controls	At Drivers Position

8. Physical Dimensions

Wheel Base	9'- 1"
Length Overall	15'- 8"
Height	6'-11"
Width Overall	8'- 8"
Weight	10,000 lbs.
Turning Radius	14'

TABLE C-2

Operating Characteristics of Tennant Model 100

---

1. **Type**

Manufacture	G. H. Tennant Co., Minneapolis, Minnesota
Model No.	Model 100

2. **Sweeping Speeds**

Maximum	15.0 mph
Minimum	2.3 mph

3. **Sweeping Path**

Pickup Broom	4' 0"
With two gutter brooms	7' 4"

4. **Broom Characteristics:**

Main (Pickup) Broom

Diameter	29"
Length	48"
Broom Material	Plastic Filled
Drive	Engine Driven - Gears
Mounting	Free Floating
Control (Lift)	Hydraulic
Reversible	No
Speeds	2 Fwd.

Side Brooms (Gutter)

Diameter	32"
Broom Material	Flat Wire Bristles
Engine	Engine Driven - Gears
Mounting	Free Floating
Control (Lift)	Hydraulic
Speeds	2

TABLE C-2 (Cont'd)

Operating Characteristics of Tennant Model 100

---

5. Vacuum System

Type	Suction Type Dust Collection Through Bags
Material	Cloth Bags - 540 ft^2
Air Flow	2200 cfm

6. Dirt Hopper

Capacity	1-3/4 cubic yards
Dump Controls	Hydraulic
Dump Doors	Rear Lift

7. Physical Dimensions

Wheel Base	4'-4"
Length Overall	9'-9-1/4"
Height	7'-2"
Width Overall	7'-4"
Weight	7600 lbs
Turning Radius	9'-2"

TABLE C-3

Operating Characteristics of Tennant Model 80

1. Type

Manufacture	G. H. Tennant Co., Minneapolis, Minnesota
Model No.	Model 80

2. Sweeping Speeds

Maximum	8 mph
Minimum	2 mph

3. Sweeping Path

Pickup Broom	42"
With one gutter broom	53"

4. Broom Characteristics:

Main (Pickup) Broom

Diameter	14"
Length	42"
Broom Material	Fiber Bristles
Drive	V Belt
Mounting	Free Floating
Control (Lift)	Hydraulic
Reversible	No
Speeds	2 Fwd.

Side Brooms (Gutter)

Diameter	21"
Broom Material	Wire Bristles
Drive	V Belt
Mounting	Free Floating
Control (Lift)	Hydraulic
Speeds	2

TABLE C-3 (Cont'd)

Operating Characteristics of Tennant Model 80

---

5. Vacuum System

Type	Suction Type Dust Collector Through Bag
Material	Heavy Fabric Bag - 4200 in^2 Area
Air Flow	700 cfm

6. Dirt Hopper

Capacity	12 cubic feet
Dump Controls	Hydraulic
Dump Doors	Front Lift

7. Physical Dimensions

Wheel Base	
Length Overall	83"
Height	55"
Width Overall	55-1/2"
Weight	1410 lbs
Turning Radius	65"

DISTRIBUTION

Copies	
	NAVY
1-3	Chief, Bureau of Ships (Code 335)
4-5	Chief, Bureau of Ships (Code 341)
6	Chief, Bureau of Aeronautics (Code AE40)
7-16	Chief, Bureau of Yards and Docks (D-440)
17	Chief of Naval Operations (Op-75)
18	Chief of Naval Operations (Op-OE3G)
19	Chief, Bureau of Supplies and Accounts (Code SS)
20-22	Director, Naval Research Laboratory (Code 2021)
23-25	CO, U.S. Naval Civil Engineering Laboratory
26	U.S. Naval School (CEC Officers)
27	CO, Naval Schools Command, Treasure Island
28	CO, Naval Damage Control Training Center, Philadelphia
29	U.S. Naval Postgraduate School, Monterey
30	Commandant, 12th Naval District
31	Office of Patent Counsel, San Diego
32	CO, Nuclear Weapons Training Center, Atlantic
33	CO, Nuclear Weapons Training Center, Pacific
34	President, Naval War College
35	CinC, Pacific Fleet
36	CinC, Atlantic Fleet
37	CinC, Naval Forces, Eastern Atl. and Med.
38	Commander Amphibious Force, Pacific Fleet
39	Commander Amphibious Force, Atlantic Fleet
40	Commander Service Force, Pacific Fleet
41	Commander Service Force, Atlantic Fleet
42	Commandant, U.S. Marine Corps
43	Commandant, Marine Corps Schools, Quantico (Library)
44	Commandant, Marine Corps Schools, Quantico (Dev. Center)
45	CO, Naval Medical Field Research Lab., Camp Lejeune
	ARMY
46-47	Chief of Research and Development (Atomic Div.)
48	Deputy Chief of Staff for Military Operations
49	Chief of Engineers (ENGEB)
50	Chief of Engineers (ENGNB)
51	Chief of Transportation (TC Technical Committee)
52	Chief of Ordnance (ORDTN-RE)
53	Ballistic Research Laboratories

54	Chief Chemical Officer
55	Assistant Chief Chemical Officer for Planning and Doctrine
56	The Quartermaster General
57	CG, Chemical Corps Res. and Dev. Command
58	Hq., Chemical Corps Materiel Command
59	President, Chemical Corps Board
60-62	CO, BW Laboratories
63	CO, Chemical Corps Training Command (Library)
64	CO, Chemical Corps Field Requirements Agency
65-66	CO, Chemical Warfare Laboratories
67	CG, Aberdeen Proving Ground
68	Office of Chief Signal Officer (SIGRD-8B)
69	CG, Continental Army Command, Fort Monroe (ATDEV-1)
70	CG, Quartermaster Res. and Eng. Command
71	CO, Army Artillery and Missile Center, Fort Sill
72	Director Operations Research Office (Librarian)
73	CO, Dugway Proving Ground
74-76	CG, Sixth U.S. Army, Presidio, San Francisco
77	CG, Engineer Res. and Dev. Lab. (Library)
78	CG, Engineer Res. and Dev. Lab., (Special Projects Branch)
79	CO, Transportation Res. and Dev. Command, Fort Eustis
80	President, Board No. 6, CONARC, Fort Rucker
81	Director, Office of Special Weapons Development, Fort Bliss
82	CO, Ordnance Materials Research Office, Watertown
83	CG, Redstone Arsenal
84	CO, Picatinny Arsenal (ORDBB-TW6)
85	CO, U.S. Army Nuclear Medicine Research Detach., Europe
86	CG, Quartermaster Board, Fort Lee
87	Surgeon General (MEDNE)
88	CO, Army Signal Res. and Dev. Lab.
89	CO, Waterways Experiment Station
90	CO, Ordnance Tank-Automotive Command
91	Commandant, Provost Marshal Generals School, Fort Gordon
92	CO, Army Research Office, Arlington
93	Hq., Army Military District, Washington (for Booz-Allen)

AIR FORCE

94	Assistant Chief of Staff, Intelligence (AFCIN-3B)
95	Commander, Air Materiel Command (MCMTC)
96-99	Commander, Wright Air Development Center (WCACT)
100	Commander, Air Res. and Dev. Command (RDTW)
101	Directorate of Installations (AFOIE-ES)
102	Director, USAF Project RAND (WEAPD)
103	CG, Strategic Air Command (Operations Analysis Office)
104-105	Commander, Special Weapons Center, Kirtland AFB
106	Director, Air University Library, Maxwell AFB
107-108	Commander, Technical Training Wing, 3415th TTG
109	CG, Cambridge Research Center (CRTZ)

OTHER DOD ACTIVITIES

110	Chief, Defense Atomic Support Agency
111	Commander, FC/DASA, Sandia Base (FCTG Library)
112-113	Commander, FC/DASA, Sandia Base (FCDV)
114	Assistant Secretary of Defense (Res. and Eng.)
115-124	Armed Services Technical Information Agency
125	U.S. Military Representative, NATO

OCDM

126-127	Office of Civilian and Defense Mobilization, Battle Creek

AEC ACTIVITIES AND OTHERS

128	AEC, Military Applications Division
129	AEC, Civil Effects Test Group
130	Los Alamos Scientific Laboratory (Library)
131	Sandia Corporation (Document Room)

USNRDL

132-175	USNRDL, Technical Information Division

DATE ISSUED: 13 October, 1959

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes - Decontaminating effects.
2. Pavements - Contamination.
3. Radiological contamination - Safety measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes - Decontaminating effects.
2. Pavements - Contamination.
3. Radiological contamination - Safety measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes - Decontaminating effects.
2. Pavements - Contamination.
3. Radiological contamination - Safety measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes - Decontaminating effects.
2. Pavements - Contamination.
3. Radiological contamination - Safety measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes -
   Decontaminating effects.
2. Pavements -
   Contamination.
3. Radiological
   contamination - Safety
   measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes -
   Decontaminating effects.
2. Pavements -
   Contamination.
3. Radiological
   contamination - Safety
   measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes -
   Decontaminating effects.
2. Pavements -
   Contamination.
3. Radiological
   contamination - Safety
   measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III. PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES, H. Lee, J.D. Sartor, and W.H. Van Horn, 6 June 1959, 97 p., tables, illus., 12 refs. UNCLASSIFIED

The basic decontamination procedures (fire-hosing, motorized flushing, scrubbing) evaluated during the field test conducted at Camp Stoneman in 1956 required the use of large quantities of water.

(over)

1. Brushes -
   Decontaminating effects.
2. Pavements -
   Contamination.
3. Radiological
   contamination - Safety
   measures.

I. Lee, H.
II. Sartor, J.D.
III. Van Horn, W.H.
IV. Title.
V. NY 320-001-9.

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Since it was recognized in many situations adequate water supplies will not be available for use in large scale decontamination operations, and under emergency conditions water systems may be damaged or otherwise depleted, it appeared desirable to develop and/or exploit decontamination methods that do not require the use of water.

A series of tests were therefore conducted to develop and evaluate new reclamation techniques for land targets with emphasis on waterless decontamination methods. The tests conducted were limited to the evaluation, on asphaltic concrete and portland cement concrete, of the following procedures: (1) Motorized Sweeping, (2) Vacuumized Sweeping, and (3) Air Broom Sweeping.

Using synthetic fallout to simulate dry fallout from nuclear weapons detonated on a land surface, effectiveness and rate of removal data were obtained for the evaluation of three

(continued on next card)

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED

Naval Radiological Defense Laboratory
USNRDL-TR-336 (card 2)
STONEMAN II TEST OF RECLAMATION PERFORMANCE. VOLUME III.
PERFORMANCE CHARACTERISTICS OF DRY DECONTAMINATION PROCEDURES
(continued)

procedures for waterless decontamination of large paved areas, namely motorized sweeping, vacuumized sweeping and air broom sweeping.

The highest degree of effectiveness was obtained with the air broom and the highest rate of removal was obtained with motorized sweeping using the Wayne 450. However the removal of heavy deposits by the air broom produces a large dust cloud and the procedure could probably be used only when the situation is such that contamination of downwind areas can be tolerated.

A mathematical model, based upon theoretical considerations, has been developed for the comparative evaluation of decontamination methods. Using this model it is possible to accurately evaluate dry decontamination methods and to predict the effect of various environmental parameters.

UNCLASSIFIED