

NATIONAL BUREAU OF STANDARDS REPORT

10 680

INTERIM REPORT: LEAD PAINT DETECTION
IN RESIDENTIAL DWELLINGS; A COST ANALYSIS

Not for publication
or for reference



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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² Located at Boulder, Colorado 80302.

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INTERIM REPORT: LEAD PAINT DETECTION IN RESIDENTIAL DWELLINGS; A COST ANALYSIS

Milestone 8a

by

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ABSTRACT

A major step in the process of the elimination of lead paint poisoning is the detection of the lead hazard. The National Bureau of Standards is investigating twelve methods for the detection of lead in building materials. The total cost associated with each method is dependent on the type of equipment used, the skills required and other pertinent considerations. This report describes the factors that influence the cost of each lead detection method and presents tentative data for the costs of each method under various conditions.

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INTERIM REPORT: LEAD PAINT DETECTION IN RESIDENTIAL DWELLINGS; A COST ANALYSES

I. INTRODUCTION

The hazardous nature of lead painted surfaces in dwelling units is an established fact. Detoxification by means of removing, covering or otherwise preventing humans from ingesting available chips or segments of a leaded wall, ceiling, or moldings depends first on the detection of the presence of lead in painted surfaces. A program goal of lead detection in old paint has been established by the U.S. Department of Housing and Urban Development. That goal specifies detection capability when lead concentrations equal or exceed 1% by dried weight of the paint.

The Analytical Chemistry Division (ACD) of the National Bureau of Standards, is identifying and analyzing various methods and equipment useful for lead detection at the 1% level. In support of the ACD, the Building Economics Group, Building Research Division, NBS, is determining the expected costs when using the various methods to detect lead content in old residential painted surfaces.

"One" best method for detection is not recommended in this report. Rather, tabulation will be provided of information describing costs, life, time, utilization profiles and so on. It is necessarily a decision of the using municipality, state or other legal body, to determine adoption of a particular methodology, rate of use, and the machinery needed. Hopefully, the tabulated data will aid in decision making.

II. THE PROBLEM

There are ten basic lead paint detection methods under consideration by analytical chemists at the National Bureau of Standards. Two of

these methods have two options based on the type of equipment required. Thus, there are a total of twelve procedures being examined by the NBS chemists to detect lead by weight of dried solids at the 1% level.

The following attributes of a lead detection test method have cost significance:

- 1) Type of equipment employed.
- 2) Useful equipment life.
- 3) Amount of expendable material used.
- 4) Personnel skills required.
- 5) The number of samples that can be analyzed per unit time.

Each detection method is different. Initial investment costs and the operating and maintenance costs are also different for each method. Furthermore, the present value (discounted cost) of each method will vary, depending on the magnitude of:

- 1) Program duration.
- 2) Wage rate.
- 3) Discount rate.
- 4) Utilization rates of the capital equipment.

III. DATA REQUIREMENTS

Preliminary cost data regarding the various lead detection methods under consideration by NBS have been provided by the Analytical Chemistry Division. Those cost data provided by ACD were converted to annual costs for purposes of analysis. Data included for each detection method are:

- 1) Equipment First Cost.
- 2) Accessory First Cost.
- 3) Life (years).

- 4) Time Required For Analysis.
- 5) Number of Samples that can be Tested Per Day.
- 6) Was the method destructive or non-destructive.
- 7) Test Site (laboratory or field).
- 8) Operator Skill Level.

Table 1 displays those data used for analyses.

IV. A COST MODEL

A simple model has been constructed to permit rapid evaluation of detection costs while varying conditions for detection. The model permits parametric variation in certain cost influencing factors while holding all other factors constant.

Basic input data to the model is found in Table 1. For analysis the following influence factors have been considered:

- 1) Depreciation.
- 2) Discount rate.
- 3) Utilization.
- 4) Wage rate.
- 5) Program length.

For preliminary analysis the following assumptions have been made:

- 1) Depreciation follows a straight line computation, i.e., investment minus salvage value divided by years of life equals annual depreciation.
- 2) The Government Discount Rate shall be permitted to vary up to 50% of the current maximum borrowing rate.
- 3) Equipment utilization shall be based on an 8 hour, 5 day week being equal to 100%.

- 4) Wage rates shall be selected as representative of the skills employed and shall be an estimated value.
- 5) Program length in months or years shall recognize policy decisions to "clean up" the lead paint within reasonable time periods.

V. RATIONALE

A particular detection method may have a lower initial investment (first cost) when compared with other methods, but it may require two or three times the expendable materials and maintenance per year to perform the chemical analysis. Dependent upon the length of the lead detection program, the total detection cost might be considerably less if one chose a higher first cost method having lower annual operating and maintenance costs. Thus, total program length is an important consideration. The decision maker is in a better position to decide on an approach to detection methods when costs are presented on a common datum.

Varying wage rates will determine the cost sensitivity of particular methods to labor skills and future cost escalation.

Utilization rates (percentage of time a machine is being used) are an important determinant of total cost. For example, consider a detection method that requires an expensive machine. If utilization rates are considered it might be more effective to purchase lower cost equipment. This will be dependent on a city's lead program. The lead detection method that would be best suited for a particular city depends on the magnitude of the lead poisoning problem and the resources available in that city.

The discount rate is used to equalize the initial investment cost of the base year with future cost streams, such as operating and maintenance costs, that occur over time. A dollar to be received one year from now or two years in the future, doesn't have the same value as a dollar received today. There is an opportunity cost of receiving that dollar today rather than in the future. For example, one can earn a 4½ interest payment in one year at the local bank (\$1.045). Hence people, firms or governments are not indifferent between having to spend money today as against future monetary outlays.

VI. CALCULATION OF PRESENT WORTH OF LEAD DETECTION COSTS PER SAMPLE

It was assumed that the O & M cost per year for each method would be a constant amount for all years of a given lead paint detection program. Therefore the appropriate formula for calculating the present worth of a uniform series of payments is:

$$P = R \left[\frac{(1 + i)^N - 1}{i(1 + i)^N} \right]$$

where:

P = Present worth of the future O & M costs.

N = program length of a given lead detection program in years.

i = discount rate.

R = the annual operations and maintenance costs including labor, depreciation and expendables.

The cost per sample for each detection method was computed by summing the initial investment cost in equipment and accessories (from Table 1) with the present worth of the operations and maintenance costs (O & M)

associated with each method (Tables 5-7), and dividing by the number of samples per year that each method is capable of analyzing. To this sum must be added the cost of sample collection (Tables 5-7) for those methods where it is required.

Thus the formula for computation of total cost per sample is:

$$\left(\frac{I + P}{S}\right) + C$$

where: I = Initial investment cost in equipment and accessories.

P = present worth of the O & M costs.

S = number of samples per year per lead detection method.

C = per sample cost of collection of lead paint chips.

VII. RESULTS BASED ON PRELIMINARY DATA

For each lead detection method there exists a set of present value costs determined by varying wage rates, program length, utilization rates, and discount rates. These results, classified by detection method, present an array of likely alternatives and the costs associated with each. Each critical factor (discount rate, wage rate, utilization rate, and program length) is varied while the others are held constant. The decision maker simply considers those possibilities relevant to his particular needs and budget constraints. Table 2 shows a sample output matrix.

Progress on Analysis

The values selected for the first model run were:

Factor	Units	Low	Mid	High
Wage Rate	\$/Hour	2.50	5.00	10.00
Discount Rate	%	10	15	20
Program Length	Years	3	5	10
Utilization Rate	%	100	75	50

These values were selected to represent realistic magnitudes of a low intensity, medium intensity and high intensity lead paint poisoning program. A range of options were considered dependent on the effort involved.

A computerized cost model has been developed. The program logic is presented in Table 3. This is a relatively simple program using Fortran V for batch use and Basic Language for time shared application. The computations are performed by the computer. Thus, when refined and updated cost data are received, they can be fed into the model and new lead detection method cost estimates can be immediately computed.

Typical output for a 3-year, 5-year and 10-year lead paint program are presented in Tables 5, 6, and 7.

VIII. FUTURE RESEARCH

The model has been run with preliminary cost data for this interim report. During the course of the study, efforts will be made to obtain refined and updated cost data. To insure that the sensitivity cost analysis for the final report on lead detection methods is based upon the most reliable and accurate cost data obtainable, the cost model is set up for rapid use once new cost inputs become available. The cost model will be improved and new output reports to display the cost analysis may be designed.

IX. EXAMPLES OF USE--DETERMINATION OF DETECTION COSTS PER DWELLING UNIT

To compute detection cost per dwelling unit (D.U.), one begins by entering tables 5-7 and determining the cost per sample for a particular combination of discount rate, utilization rate, and time frame for the method under consideration. As an example, select Method 2, Atomic Absorption Spectroscopy I. Assume a 75% utilization rate, 10% discount

rate and a 3-year program length. Table 5 indicates a cost per sample of \$0.62 based on the assumptions. Assuming that 20 samples are required for analysis per D.U. at \$0.62 per sample, the total cost is \$12.40. To this amount must be added the field costs to collect 20 samples. Based on survey data, it costs approximately \$40 for sample collection, including cost of equipment and transportation. Thus the total cost per D.U. for Method 2 at 75% utilization for a 3-year program would be \$52.40. For a five-year program, a 75% utilization rate and a 10% discount rate, the cost per D.U. for Method 2 would be (from Table 6): $\$0.52 \times 20 = \$10.40 + \$40.00 = \50.40 . Similarly a 10-year program at a 75% utilization rate, and 10% discount rate would cost $\$0.40 \times 20 = \$8.00 + \$40.00 = \48.00 cost per D.U. In sum, we have detection costs at 75% utilization rate, 10% discount rate, using Method 2:

3-yr. program \$52.40 cost/D.U.

5-yr. program \$50.40 cost/D.U.

10-yr. program \$48.00 cost/D.U.

Following the above procedure, one could derive the cost per D.U. for any of the 12 detection methods based upon that data provided in Tables 5-7 and in Appendix B.

Table 1: COST MATRIX--LEAD PAINT DETECTION METHODS

Testing Method	Destruc- tive or Non- Destruc- tive	Time Required for Analysis	No. of Samples Per Year	Investment Life (Years)	Initial Investment Cost	Expend- ables Per Year Cost	Test Site
1. Spectrophotometry	D	2 hrs.	1000	10 yrs.	\$ 1,600	\$ 60	Lab
2. Atomic Absorption Spectroscopy I	D	15 min.	8000	10 yrs.	4,200	1,650	Lab
3. Atomic Absorption Spectroscopy V (Includes Flameless Sample Holder)	D	10 min.	12000	10 yrs.	6,700	1,600	Lab
4. Optical Emission Spectrography	D	25 min.	5000	20 yrs.	21,000	1,500	Lab
5. X-Ray Fluorescence Analysis I	ND	1.5-2 min.	40000	10 yrs.	6,000	0	Field
6. X-Ray Fluorescence Analysis II	D	20 min.	6000	15 yrs.	16,000	2,040	Lab
7. Potentiometric Method	D	20 min.	5000	10 yrs.	1,200	300	Lab
8. Polarographic Method	D	20 min.	5000	15 yrs.	3,200	240	Lab
9. Electrolytic Method: Electrogravimetry	D	2 hrs.	1000	15 yrs.	1,900	240	Lab
10. Chemical Spot Tests	D	1.5-2 min.	40000	10 yrs.	1,100	500	Field
11. Wet Chemical Analysis: Gravimetry and Titrimetry	D	2 hrs.	1000	10 yrs.	1,400	250	Lab
12. Miniprobe	ND	20 min.	6000	15 yrs.	27,000	0	Lab

Table 2: SAMPLE PRINTOUT OF LEAD DETECTION COST ANALYSIS

Method

Spectrophotometry

u = utilization rate;

w = wage rate; i = discount rate;

n = program length years

Discounted Cost

1. \$xxxx.xx

u = 100%, w = \$2.50, i = .10, n = 3 yrs.

\$xxxx.xx

u = 100%, w = \$5.00, i = .10, n = 3 yrs.

\$xxxx.xx

u = 100%, w = \$10.00, i = .10, n = 3 yrs.

.

.

.

.

.

27. \$xxxx.xx

u = 50%, w = \$10.00, i = .20, n = 10 yrs.

Table 3: LEAD PAINT DETECTION METHODS COST ANALYSIS COMPUTER PROGRAM

```

RPS1      10:42      11/10/71

100 DIM A(3),N(3),F(3)
110 IL=0
120 READ M,S,D,F
130
140 PRINT "METHOD",M, "NUMBER OF SAMPLES PER YEAR",S, "ANNUAL DEPRECIATION",D, "FIRST COST",F
145 PRINT
150 MAT READ A(3)
160 MAT READ N(3)
170 MAT READ R(3)
180 FOR I=1 TO 3
190 FOR J=1 TO 3
200 FOR K=1 TO 3
210 PRINT "DISCOUNT RATE",A(K),"TIME(YPS)",N(J),"O&M COST",R(I)
220 R1=R(I)-D
230 P=(1+A(K))↑N(J)
240 P1=R1*(P-1)/(A(K)*P)
250 P0=P1+F
260 P2=.5:P0
270 P3=.75:P0
280 P4=P0/(S*N(J))
290 P5=P2/(S*N(J))
300 P6=P3/(S*N(J))
310 PRINT "DISCOUNTED COST @ 100% UTILIZATION" P0
320 PRINT "DISCOUNTED COST @ 75% UTILIZATION" P3
330 PRINT "DISCOUNTED COST @ 50% UTILIZATION" P2
340 PRINT
350 PRINT "COST PER SAMPLE @ 100% UTILIZATION" P4
360 PRINT "COST PER SAMPLE @ 75% UTILIZATION" P5
370 PRINT "COST PER SAMPLE @ 50% UTILIZATION" P6
380 PRINT
390 NEXT K
400 NEXT J
410 NEXT I
420 IL=IL+1
425 PRINT
430 IF IL< 12 GO TO 120
440
450 DATA 1,1000,160,1600,.10,.15,.20,3,5,10,5060,10060,20060
460 DATA 2,8000,420,4200,.10,.15,.20,3,5,10,6650,11650,21650
470 DATA 3,12000,670,6700,.10,.15,.20,3,5,10,6600,11600,21600
480 DATA 4,5000,1050,21000,.10,.15,.20,3,5,10,6500,11500,21500
490 DATA 5,40000,600,6000,.10,.15,.20,3,5,10,5000,10000,20000
500 DATA 6,6000,1067,16000,.10,.15,.20,3,5,10,7040,12040,22040
510 DATA 7,5000,120,1200,.10,.15,.20,3,5,10,10300,20300,40300
520 DATA 8,5000,213,3200,.10,.15,.20,3,5,10,5240,10240,20240
530 DATA 9,1000,127,1000,.10,.15,.20,3,5,10,5240,10240,20240
540 DATA 10,40000,110,1100,.10,.15,.20,3,5,10,5500,10500,20500
550 DATA 11,1000,140,1400,.10,.15,.20,3,5,10,5250,10250,20250
560 DATA 12,6000,1800,27000,.10,.15,.20,3,5,10,5000,10000,20000
600 END
PFADY

```


Table 4: LEAD DETECTION METHODS, KEY TO COST ANALYSIS
TABLES TESTING METHOD

1. SPECTROPHOTOMETRY
2. ATOMIC ABSORPTION SPECTROSCOPY I
3. ATOMIC ABSORPTION SPECTROSCOPY II
(Includes Flameless Sample Holder)
4. OPTICAL EMISSION SPECTROGRAPHY
5. X-RAY FLUORESCENCE ANALYSIS I
6. X-RAY FLUORESCENCE ANALYSIS II
7. POTENTIOMETRIC METHOD
8. POLAROGRAPHIC METHOD
9. ELECTROLYTIC METHOD: ELECTROGRAVIMETRY
10. CHEMICAL SPOT TESTS
11. WET CHEMICAL ANALYSIS:
GRAVIMETRY AND TITRIMETRY
12. MINIPROBE

Table 5: HIGH INTENSITY PROGRAM

Cost Analysis for a 3-Year Lead Detection Program @ 10% Discount Rate

Program Duration: 3 yrs.
Discount Rate: 10%

METHOD

	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
PRESENT WORTH:												
<u>Utilization</u>												
100% \$13785	19692	21447	59422	16942	43288	26516	28135	14615	14504	51410	47392	
75% \$10339	14769	16085	44566	12706	32466	19887	21101	10961	10878	38557	35544	
50% \$6893	9846	10723	29711	8471	21644	13258	14067	7307	7252	25705	23696	
Hourly Labor Rate	\$2.50	2.50	2.50	7.50	2.50	5.00	5.00	2.50	2.50	10.00	5.00	
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	1000	40000	1000	6000	
Cost Per Sample 100%	\$4.59	0.82	0.60	3.96	0.14	2.40	1.77	1.88	4.87	0.12	17.14	2.63
75%	\$3.45	0.62	0.45	2.97	0.11	1.80	1.33	1.41	3.65	0.09	12.85	1.97
50%	\$2.30	0.41	0.30	1.98	0.07	1.20	0.88	0.94	2.44	0.06	8.57	1.32

Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 per sample. Therefore, a \$2 add-on should be made for methods indicated ().

Table 6: MEDIUM INTENSITY PROGRAM

Cost Analysis for a 5-Year Lead Detection Program @ 10% Discount Rate

Program Duration: 5 yrs.

Discount Rate: 10%

	METHOD											
	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11	12*
PRESENT WORTH:												
<u>Utilization</u>												
100%	\$20175	27816	29179	79567	22679	57596	39790	41210	21282	21532	77633	58084
75%	\$15131	20862	21884	59675	17009	43197	29842	30908	15962	16149	58224	43563
50%	\$10087	13908	14589	39783	11339	28798	19895	20605	10641	10766	38816	29042
Hourly Labor Rate	\$2.50	2.50	2.50	7.50	2.50	5.00	2.50	5.00	2.50	2.50	10.00	5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$4.04	0.70	0.49	3.18	0.11	1.92	1.59	1.65	4.26	0.11	15.53	1.94
75%	\$3.03	0.52	0.36	2.39	0.09	1.44	1.19	1.60	3.19	0.08	11.64	1.45
50%	\$2.02	0.35	0.24	1.59	0.06	0.96	0.80	0.82	2.13	0.05	7.76	0.97

Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 per sample. Therefore, a \$2 add-on should be made for the methods indicated ().

Table 7: LOW INTENSITY PROGRAM

Cost Analysis for a 10-Year Lead Detection Program @ 15% and 20% Discount Rate

Program Duration: 10 yrs.

Discount Rate: 10%

	METHOD											
	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
PRESENT WORTH:												
<u>Utilization</u>												
100%	\$31708	42481	43137	115933	33036	83424	63751	64812	33317	34219	124967	77385
75%	\$23781	31860	32353	86950	24777	62568	47813	48609	24988	25664	93725	58039
50%	\$15854	21240	21568	57966	16518	41712	31875	32406	16658	17110	62483	38693
Hourly Labor Rate	\$2.50	2.50	2.50	7.50	2.50	5.00	2.50	2.50	2.50	2.50	10.00	5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$3.17	0.53	0.36	2.32	0.08	1.39	1.28	1.30	3.33	0.09	12.50	1.29
75%	\$2.38	0.40	0.27	1.74	0.06	1.04	0.96	0.97	2.50	0.06	9.40	0.97
50%	\$1.59	0.27	0.18	1.16	0.04	0.70	0.64	0.65	1.67	0.04	6.20	0.64

Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit; or approximately \$2 per sample. Therefore, a \$2 add-on should be made for the methods indicated ().

Figure 1

LOGIC FLOW

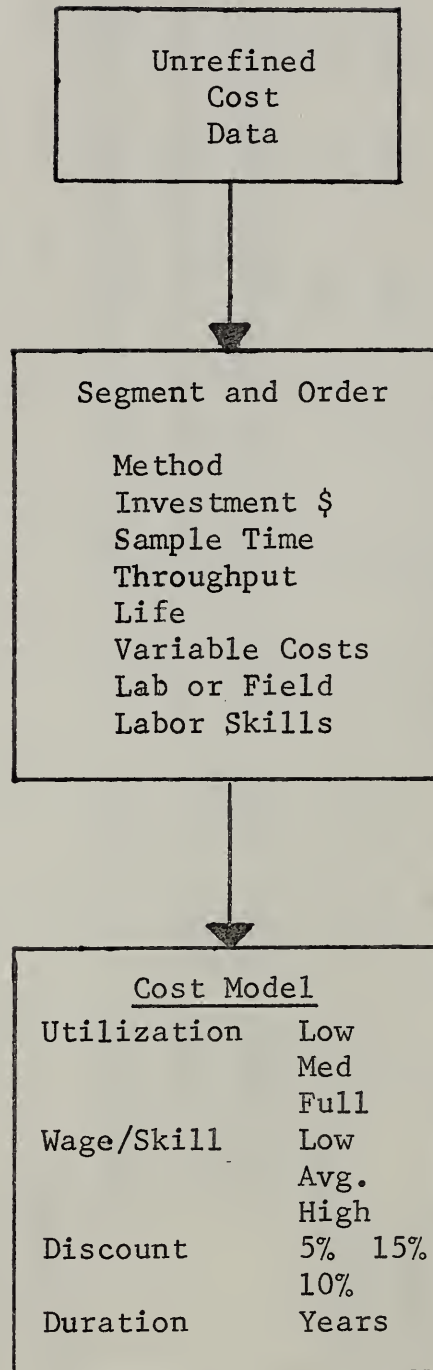


Figure 1 (Cont.)

OUTPUT				
Sensitivity				
Method	U	W	D	P
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Low Utilization

Med. Utilization

High Utilization

Figure 1 (Cont.)

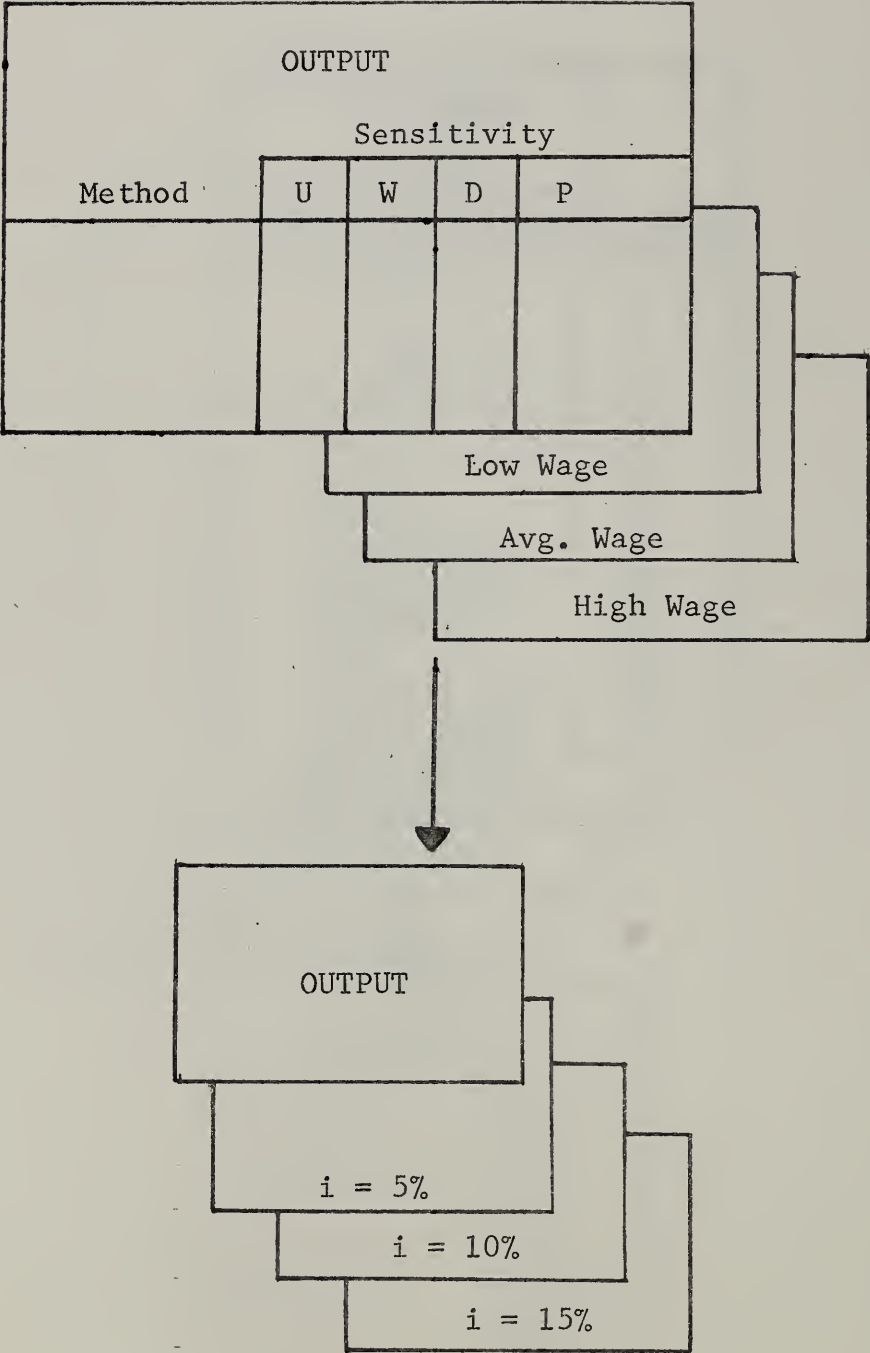
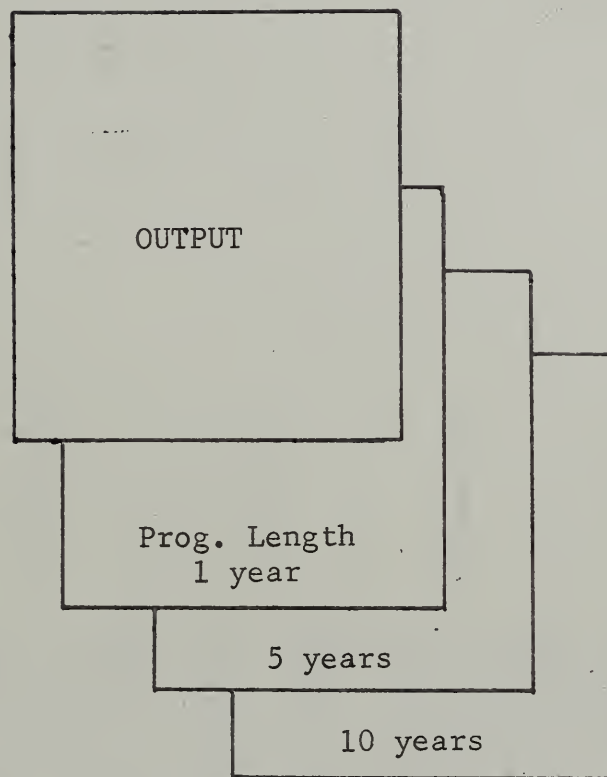


Figure 1 (Cont.)



RUN	10:46	11/10/71	METHOD 1	NUMBER OF SAMPLES PER YEAR 1000	ANNUAL DEPRECIATION 100	FIRST COST 1000
RBS1	10:46	11/10/71				
			DISCOUNT RATE .1	TIME(YRS) 3		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	13785.6		
			DISCOUNTED COST @ 75% UTILIZATION	10339.2		
			DISCOUNTED COST @ 50% UTILIZATION	6892.79		
			COST PER SAMPLE @ 100% UTILIZATION	4.59519		
			COST PER SAMPLE @ 75% UTILIZATION	3.44639		
			COST PER SAMPLE @ 50% UTILIZATION	2.2976		
			DISCOUNT RATE .15	TIME(YRS) 3		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	12787.8		
			DISCOUNTED COST @ 75% UTILIZATION	9500.85		
			DISCOUNTED COST @ 50% UTILIZATION	6393.9		
			COST PER SAMPLE @ 100% UTILIZATION	4.2626		
			COST PER SAMPLE @ 75% UTILIZATION	3.10695		
			COST PER SAMPLE @ 50% UTILIZATION	2.1313		
			DISCOUNT RATE .2	TIME(YRS) 3		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	11921.8		
			DISCOUNTED COST @ 75% UTILIZATION	8941.32		
			DISCOUNTED COST @ 50% UTILIZATION	5960.88		
			COST PER SAMPLE @ 100% UTILIZATION	3.97392		
			COST PER SAMPLE @ 75% UTILIZATION	2.98044		
			COST PER SAMPLE @ 50% UTILIZATION	1.98606		
			DISCOUNT RATE .1	TIME(YRS) 5		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	20174.9		
			DISCOUNTED COST @ 75% UTILIZATION	15131.1		
			DISCOUNTED COST @ 50% UTILIZATION	10087.4		
			COST PER SAMPLE @ 100% UTILIZATION	4.03497		
			COST PER SAMPLE @ 75% UTILIZATION	3.02623		
			COST PER SAMPLE @ 50% UTILIZATION	2.01749		
			DISCOUNT RATE .15	TIME(YRS) 5		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	18025.6		
			DISCOUNTED COST @ 75% UTILIZATION	13519.2		
			DISCOUNTED COST @ 50% UTILIZATION	9012.78		
			COST PER SAMPLE @ 100% UTILIZATION	3.60511		
			COST PER SAMPLE @ 75% UTILIZATION	2.70283		
			COST PER SAMPLE @ 50% UTILIZATION	1.80256		
			DISCOUNT RATE .2	TIME(YRS) 5		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	16254.		
			DISCOUNTED COST @ 75% UTILIZATION	12100.5		
			DISCOUNTED COST @ 50% UTILIZATION	8127.		
			COST PER SAMPLE @ 100% UTILIZATION	3.2509		
			COST PER SAMPLE @ 75% UTILIZATION	2.4381		
			COST PER SAMPLE @ 50% UTILIZATION	1.6254		
			DISCOUNT RATE .1	TIME(YRS) 10		08M COST 5000
			DISCOUNTED COST @ 100% UTILIZATION	31709.4		
			DISCOUNTED COST @ 75% UTILIZATION	23791.3		
			DISCOUNTED COST @ 50% UTILIZATION	16054.2		

COST PER SAMPLE @ 100% UTILIZATION 3.17004			
COST PER SAMPLE @ 75% UTILIZATION 2.27003			
COST PER SAMPLE @ 50% UTILIZATION 1.57002			
DISCOUNT RATE .15 TIME(YRS) 10			
DISCOUNTED COST @ 100% UTILIZATION 2.61000			
DISCOUNTED COST @ 75% UTILIZATION 1.66000			
DISCOUNTED COST @ 50% UTILIZATION 1.00000			
COST PER SAMPLE @ 100% UTILIZATION 2.61002			
COST PER SAMPLE @ 75% UTILIZATION 1.66004			
COST PER SAMPLE @ 50% UTILIZATION 1.30000			
DISCOUNT RATE .2 TIME(YRS) 10			
DISCOUNTED COST @ 100% UTILIZATION 2.21003			
DISCOUNTED COST @ 75% UTILIZATION 1.60073			
DISCOUNTED COST @ 50% UTILIZATION 1.07100			
COST PER SAMPLE @ 100% UTILIZATION 2.21431			
COST PER SAMPLE @ 75% UTILIZATION 1.60073			
COST PER SAMPLE @ 50% UTILIZATION 1.10710			
DISCOUNT RATE .1 TIME(YRS) 3			
DISCOUNTED COST @ 100% UTILIZATION 2.6219.8			
DISCOUNTED COST @ 75% UTILIZATION 1.9664.0			
DISCOUNTED COST @ 50% UTILIZATION 1.3100.9			
COST PER SAMPLE @ 100% UTILIZATION 8.73004			
COST PER SAMPLE @ 75% UTILIZATION 6.55496			
COST PER SAMPLE @ 50% UTILIZATION 4.36007			
DISCOUNT RATE .15 TIME(YRS) 3			
DISCOUNTED COST @ 100% UTILIZATION 24203.0			
DISCOUNTED COST @ 75% UTILIZATION 18152.9			
DISCOUNTED COST @ 50% UTILIZATION 12102.0			
COST PER SAMPLE @ 100% UTILIZATION 8.06708			
COST PER SAMPLE @ 75% UTILIZATION 6.05008			
COST PER SAMPLE @ 50% UTILIZATION 4.03309			
DISCOUNT RATE .2 TIME(YRS) 3			
DISCOUNTED COST @ 100% UTILIZATION 22454.2			
DISCOUNTED COST @ 75% UTILIZATION 16840.6			
DISCOUNTED COST @ 50% UTILIZATION 11227.1			
COST PER SAMPLE @ 100% UTILIZATION 7.48472			
COST PER SAMPLE @ 75% UTILIZATION 5.61354			
COST PER SAMPLE @ 50% UTILIZATION 3.74230			
DISCOUNT RATE .1 TIME(YRS) 5			
DISCOUNTED COST @ 100% UTILIZATION 39128.8			
DISCOUNTED COST @ 75% UTILIZATION 29346.6			
DISCOUNTED COST @ 50% UTILIZATION 19564.4			
COST PER SAMPLE @ 100% UTILIZATION 7.82570			
COST PER SAMPLE @ 75% UTILIZATION 5.86022			
COST PER SAMPLE @ 50% UTILIZATION 3.91288			
DISCOUNT RATE .15 TIME(YRS) 5			
DISCOUNTED COST @ 100% UTILIZATION 34730.3			
DISCOUNTED COST @ 75% UTILIZATION 26000.7			
DISCOUNTED COST @ 50% UTILIZATION 17000.0			

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DISCOUNTED COST @ 100% UTILIZATION 77036.7
 DISCOUNTED COST @ 75% UTILIZATION 57777.5
 DISCOUNTED COST @ 50% UTILIZATION 38518.3
 COST PER SAMPLE @ 100% UTILIZATION 15.4073
 COST PER SAMPLE @ 75% UTILIZATION 11.5555
 COST PER SAMPLE @ 50% UTILIZATION 7.70366

08M COST 20060

DISCOUNT RATE .15
 TIME(YRS) 5
 DISCOUNTED COST @ 100% UTILIZATION 68307.9
 DISCOUNTED COST @ 75% UTILIZATION 51230.9
 DISCOUNTED COST @ 50% UTILIZATION 34153.9
 COST PER SAMPLE @ 100% UTILIZATION 13.6616
 COST PER SAMPLE @ 75% UTILIZATION 10.2462
 COST PER SAMPLE @ 50% UTILIZATION 6.83079

08M COST 20060

DISCOUNT RATE .2
 TIME(YRS) 5
 DISCOUNTED COST @ 100% UTILIZATION 61113.2
 DISCOUNTED COST @ 75% UTILIZATION 45334.9
 DISCOUNTED COST @ 50% UTILIZATION 30556.6
 COST PER SAMPLE @ 100% UTILIZATION 12.2226
 COST PER SAMPLE @ 75% UTILIZATION 9.16698
 COST PER SAMPLE @ 50% UTILIZATION 6.11132

08M COST 20060

DISCOUNT RATE .1
 TIME(YRS) 10
 DISCOUNTED COST @ 100% UTILIZATION 123877.
 DISCOUNTED COST @ 75% UTILIZATION 92907.7
 DISCOUNTED COST @ 50% UTILIZATION 61938.4
 COST PER SAMPLE @ 100% UTILIZATION 12.3877
 COST PER SAMPLE @ 75% UTILIZATION 9.29077
 COST PER SAMPLE @ 50% UTILIZATION 6.19384

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08M COST 20060

DISCOUNT RATE .15
 TIME(YRS) 10
 DISCOUNTED COST @ 100% UTILIZATION 101473.
 DISCOUNTED COST @ 75% UTILIZATION 76105.1
 DISCOUNTED COST @ 50% UTILIZATION 50736.7
 COST PER SAMPLE @ 100% UTILIZATION 10.1473
 COST PER SAMPLE @ 75% UTILIZATION 7.61051
 COST PER SAMPLE @ 50% UTILIZATION 5.07367

08M COST 20060

DISCOUNT RATE .2
 TIME(YRS) 10
 DISCOUNTED COST @ 100% UTILIZATION 85030.2
 DISCOUNTED COST @ 75% UTILIZATION 63772.6
 DISCOUNTED COST @ 50% UTILIZATION 42515.1
 COST PER SAMPLE @ 100% UTILIZATION 8.50302
 COST PER SAMPLE @ 75% UTILIZATION 6.37726
 COST PER SAMPLE @ 50% UTILIZATION 4.25151

FIRST COST 4200

ANNUAL DEPRECIATION 420

METHOD 2 NUMBER OF SAMPLES PER YEAR 8000

08M COST 6650

DISCOUNT RATE .1
 TIME(YRS) 3
 DISCOUNTED COST @ 100% UTILIZATION 19693.1
 DISCOUNTED COST @ 75% UTILIZATION 14760.8
 DISCOUNTED COST @ 50% UTILIZATION 9846.54
 COST PER SAMPLE @ 100% UTILIZATION 8.20546
 COST PER SAMPLE @ 75% UTILIZATION 6.15400
 COST PER SAMPLE @ 50% UTILIZATION 4.19273

DISCOUNT RATE .15
 TIME(YRS) 3
 08M COST 6650

DISCOUNTED COST @ 100% UTILIZATION	13424.5	
DISCOUNTED COST @ 75% UTILIZATION	13918.4	
DISCOUNTED COST @ 50% UTILIZATION	9212.25	
COST PER SAMPLE @ 100% UTILIZATION	.767687	
COST PER SAMPLE @ 75% UTILIZATION	.575765	
COST PER SAMPLE @ 50% UTILIZATION	.383844	
DISCOUNT RATE .2	TIME(YRS) 3	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	17323.4	
DISCOUNTED COST @ 75% UTILIZATION	12992.5	
DISCOUNTED COST @ 50% UTILIZATION	8661.69	
COST PER SAMPLE @ 100% UTILIZATION	.721807	
COST PER SAMPLE @ 75% UTILIZATION	.541356	
COST PER SAMPLE @ 50% UTILIZATION	.360904	
DISCOUNT RATE .1	TIME(YRS) 5	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	27816.6	
DISCOUNTED COST @ 75% UTILIZATION	20862.4	
DISCOUNTED COST @ 50% UTILIZATION	13908.3	
COST PER SAMPLE @ 100% UTILIZATION	.695415	
COST PER SAMPLE @ 75% UTILIZATION	.521561	
COST PER SAMPLE @ 50% UTILIZATION	.347707	
DISCOUNT RATE .15	TIME(YRS) 5	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	25083.9	
DISCOUNTED COST @ 75% UTILIZATION	18812.9	
DISCOUNTED COST @ 50% UTILIZATION	12542.	
COST PER SAMPLE @ 100% UTILIZATION	.627098	
COST PER SAMPLE @ 75% UTILIZATION	.470324	
COST PER SAMPLE @ 50% UTILIZATION	.313549	
DISCOUNT RATE .2	TIME(YRS) 5	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	22831.5	
DISCOUNTED COST @ 75% UTILIZATION	17123.6	
DISCOUNTED COST @ 50% UTILIZATION	11415.8	
COST PER SAMPLE @ 100% UTILIZATION	.570788	
COST PER SAMPLE @ 75% UTILIZATION	.428091	
COST PER SAMPLE @ 50% UTILIZATION	.285394	
DISCOUNT RATE .1	TIME(YRS) 10	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	42480.7	
DISCOUNTED COST @ 75% UTILIZATION	31860.5	
DISCOUNTED COST @ 50% UTILIZATION	21240.3	
COST PER SAMPLE @ 100% UTILIZATION	.531008	
COST PER SAMPLE @ 75% UTILIZATION	.398256	
COST PER SAMPLE @ 50% UTILIZATION	.265504	
DISCOUNT RATE .15	TIME(YRS) 10	08M COST 6650
DISCOUNTED COST @ 100% UTILIZATION	35466.9	
DISCOUNTED COST @ 75% UTILIZATION	26600.2	
DISCOUNTED COST @ 50% UTILIZATION	17733.5	
COST PER SAMPLE @ 100% UTILIZATION	.443337	
COST PER SAMPLE @ 75% UTILIZATION	.443337	
COST PER SAMPLE @ 50% UTILIZATION	.443337	

Appendix B. Cost Analysis of 3, 5 and 10 Year Lead
Detection Programs @ 15% and 20% Discount Rates

Table B-1

Program Duration: 3 yrs.
Discount Rate: 15%

	METHOD											
	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
PRESENT WORTH:												
Utilization												
100%	\$12787	18425	20240	56276	16046	41054	24443	26094	13574	13407	47316	45722
75%	\$9590	13818	15180	42207	12035	30790	18332	19570	10181	10055	35487	34292
50%	\$6393	9213	10120	28138	8023	20527	12222	13047	6787	6703	23658	22861
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$5.00	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$4.26	0.77	0.56	3.75	0.13	2.28	1.63	1.74	4.52	0.11	15.77	2.54
75%	\$3.19	0.58	0.42	2.81	0.10	1.71	1.22	1.30	3.39	0.08	11.83	1.91
50%	\$2.13	0.38	0.28	1.88	0.07	1.14	0.81	0.87	2.26	0.06	7.89	1.27

*Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

Table B-2

Program Duration: 5 yrs.
Discount Rate: 15%

	METHOD											
	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
PRESENT WORTH:												
Utilization												
100%	\$18025	25084	26578	72791	20750	52783	35324	36812	19040	19168	68812	54488
75%	\$13519	18813	19934	54593	15562	39587	26494	27609	14280	14376	51609	40866
50%	\$9012	12542	13289	36395	10375	26392	17663	18406	9520	9584	34406	27244
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$5.00	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$3.61	0.63	0.44	2.91	0.10	1.76	1.41	1.47	3.81	0.10	13.76	1.82
75%	\$2.70	0.47	0.33	2.18	0.08	1.32	1.06	1.10	2.86	0.07	10.32	1.36
50%	\$1.80	0.31	0.22	1.46	0.05	0.88	0.71	0.74	1.90	0.05	6.88	0.91

*Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

Table B-3

Program Duration: 10 yrs.
Discount Rate: 15%

	METHOD											
	1	2	3	4	5	6	7	8	9	10	11	12
PRESENT WORTH:												
Utilization												
100%	\$26192	35467	36461	98540	28083	71071	52291	53523	27561	28151	102327	68154
75%	\$19644	26600	27346	73905	21062	53303	39218	40142	20671	21113	76746	51115
50%	\$13096	17733	18231	49270	14041	35536	26146	26762	13781	14076	51164	34077
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$5.00	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$2.62	0.44	0.30	1.97	0.07	1.18	1.05	1.07	2.76	0.07	10.23	1.14
75%	\$1.96	0.33	0.23	1.48	0.05	0.89	0.78	0.80	2.07	0.05	7.67	0.85
50%	\$1.31	0.22	0.15	0.99	0.04	0.59	0.52	0.54	1.38	0.04	5.11	0.57

* Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

Table B-4

Program Duration: 3 yrs.
Discount Rate: 20%.

	METHOD											
	1	2	3	4	5	6	7	8*	9*	10	11*	12*
PRESENT WORTH:												
Utilization												
100%	\$11922	17323	19191	53545	15269	39114	22644	24322	12670	12454	43761	44273
75%	\$8941	12992	14394	40159	11451	29336	16983	18241	9503	9340	32821	33205
50%	\$5960	8662	9596	26773	7634	19557	11322	12161	6335	6229	21881	22137
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$5.00	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00
Annual Throughput	1000	8000	12000	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$3.97	0.72	0.53	3.57	0.13	2.17	1.51	1.62	4.22	0.10	14.59	2.46
75%	\$2.98	0.54	0.40	2.68	0.10	1.63	1.13	1.22	3.17	0.08	10.94	1.84
50%	\$1.99	0.36	0.27	1.78	0.06	1.09	0.75	0.81	2.11	0.05	7.29	1.23

* Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

Table B-5

Program Duration: 5 yrs.
Discount Rate: 20%

	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
PRESENT WORTH:												
Utilization												
100% \$16254	22832	24437	67205	19159	48816	31644	33187	17191	17219	61541	51523	
75% \$12191	17124	18326	50404	14369	36612	23733	24890	12893	12915	46156	38642	
50% \$8127	11416	12217	33603	9579	24408	15822	16593	8396	8610	30771	25762	
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00	
Annual Throughput	1000	8000	12000	5000	40000	5000	5000	1000	40000	1000	6000	
Cost Per Sample 100%	\$3.25	0.57	0.41	2.69	0.10	1.63	1.27	1.33	3.44	0.09	12.31	1.72
75%	\$2.44	0.42	0.31	2.02	0.07	1.22	0.95	1.00	2.58	0.06	9.23	1.29
50%	\$1.63	0.29	0.20	1.34	0.05	0.81	0.63	0.66	1.72	0.04	6.15	0.86

* Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

Table B-6

Program Duration: 10 yrs.
Discount Rate: 20%

	METHOD											
	1*	2*	3*	4*	5	6*	7*	8*	9*	10	11*	12*
Utilization												
100%	\$22143	30319	31561	85774	24447	62004	43879	45238	23336	23697	85711	61378
75%	\$16607	22739	23671	64330	18335	46503	32910	33928	17502	17773	64283	46034
50%	\$11071	15157	15781	42887	12223	31002	21940	22619	11668	11849	42855	30689
Hourly Labor Rate	\$2.50	\$2.50	\$2.50	\$7.50	\$2.50	\$5.00	\$2.50	\$5.00	\$2.50	\$2.50	\$10.00	\$5.00
Annual Throughput	1000	8000	1 00	5000	40000	6000	5000	5000	1000	40000	1000	6000
Cost Per Sample 100%	\$2.21	0.38	0.26	1.72	0.06	1.03	0.88	0.90	2.33	0.06	8.57	1.02
75%	\$1.66	0.28	0.20	1.29	0.05	0.78	0.66	0.68	1.75	0.04	6.43	0.77
50%	\$1.11	0.19	0.13	0.86	0.03	0.52	0.44	0.45	1.17	0.03	4.23	0.51

PRESENT WORTH:

*Requires field gathering of paint chips or samples. A survey of a using city indicates sampling costs of \$35 to \$45 per dwelling unit, or approximately \$2 add-on should be made for the indicated methods.

