HISTORY OF DAVIDSON, NORTH CAROLINA HILLSIDE INVESTIGATION

I. 2-2-84 Mecklenburg County Department of Environmental Health received a request for service from Julia Johnson of 103 Sloan Street, Davidson, North Carolina. She requested that the property around a warehouse located across the street from her residence be checked out to determine if the white material present could possibly be asbestos.

II. 2-3-84 A preliminary investigation of the area in question was made. Two separate samples of material present on top of the soil were gathered for laboratory analyses. Ms. Johnson was instructed not to allow her children to play on the hillside until the laboratory results were known.

III. 2-6-84 Duplicate samples were submitted to two separate laboratories. The laboratories used were the N.C. Occupational Health Laboratory and the Research Triangle Institute Laboratory. Both of the labs are certified to perform analytical work on bulk samples of suspected asbestos containing materials.

IV. 2-13-84 Both of the laboratories gave verbal confirmation that the samples contained approximately 20% chrysotile asbestos.

V. 2-14-84 A field visit was made to the property in question to further determine the extent of the problem. The property owner, Mr. Robert Kenyon met with Mr. Pat Curran (N.C. Occupational Health Branch) and several Mecklenburg County Department of Environmental Health employees. Over the course of the afternoon, sixty six (66) separate samples were gathered from a sampling grid. Several photographs of the area were taken. The samples were submitted to the N.C. Occupational Health Laboratory for analyses.

VI. 2-15-84 Mr. Curran called to recommend that "No Trespassing" signs be posted around the border of the property concerned.

VII. 2-16-84 Telephoned Ms. Johnson to determine a convenient date for some samples to be gathered from her home. It was also discussed that the appropriate authorities would be notified once the sample results were known and the situation could be assessed.

VIII. 2-20-84 Laboratory results of the samples collected on 2-14-84 were made available. It was also confirmed that EPA representatives would come to Charlotte, NC on Friday, February 24, 1984, to investigate the Davidson, NC asbestos site.

IX. 2-21-84 Additional photographs of the property in question were taken. A visit was made to Ms. Johnson's residence by a Mecklenburg County Department of Environmental Health representative to gather any samples of potentially contaminated material. Due to Ms. Johnson's work schedule, an air sample inside her home will have to be scheduled in the near future.

X. 2-21-84 Mecklenburg County Department of Environmental Health officially contacted Region IV EPA office in Atlanta, GA for assistance.

XI. 2-24-84 A joint meeting of officials from the CDC, EPA, N.C. Department of Human Resources, Mecklenburg County Department of Environmental Health and Mecklenburg County Health Department is scheduled to be held at the Environmental Health Department building in order to discuss the Davidson, NC asbestos situation.

Short Term response

1- Cover or seal exposed White dust immediately

2- Fence area - Woven Wire, Chainlink

3- Workers Must Meet OSHA Standards

Long Term response + Control

4 → Handle Problem of Road

Home Contamination must be identified

PLM polarized light

ground sampling

KENYON REALTY COMPANY

ROBERT E. KENYON

2411 KNOLLWOOD ROAD
CHARLOTTE, N. C. 28211

(704) 364-0643

MECK COUNTY DEPARTMENT OF
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ENVIRONMENTAL HEALTH

Davidson N.C.
Mecklinburg Co.
Feb. 14, 1984

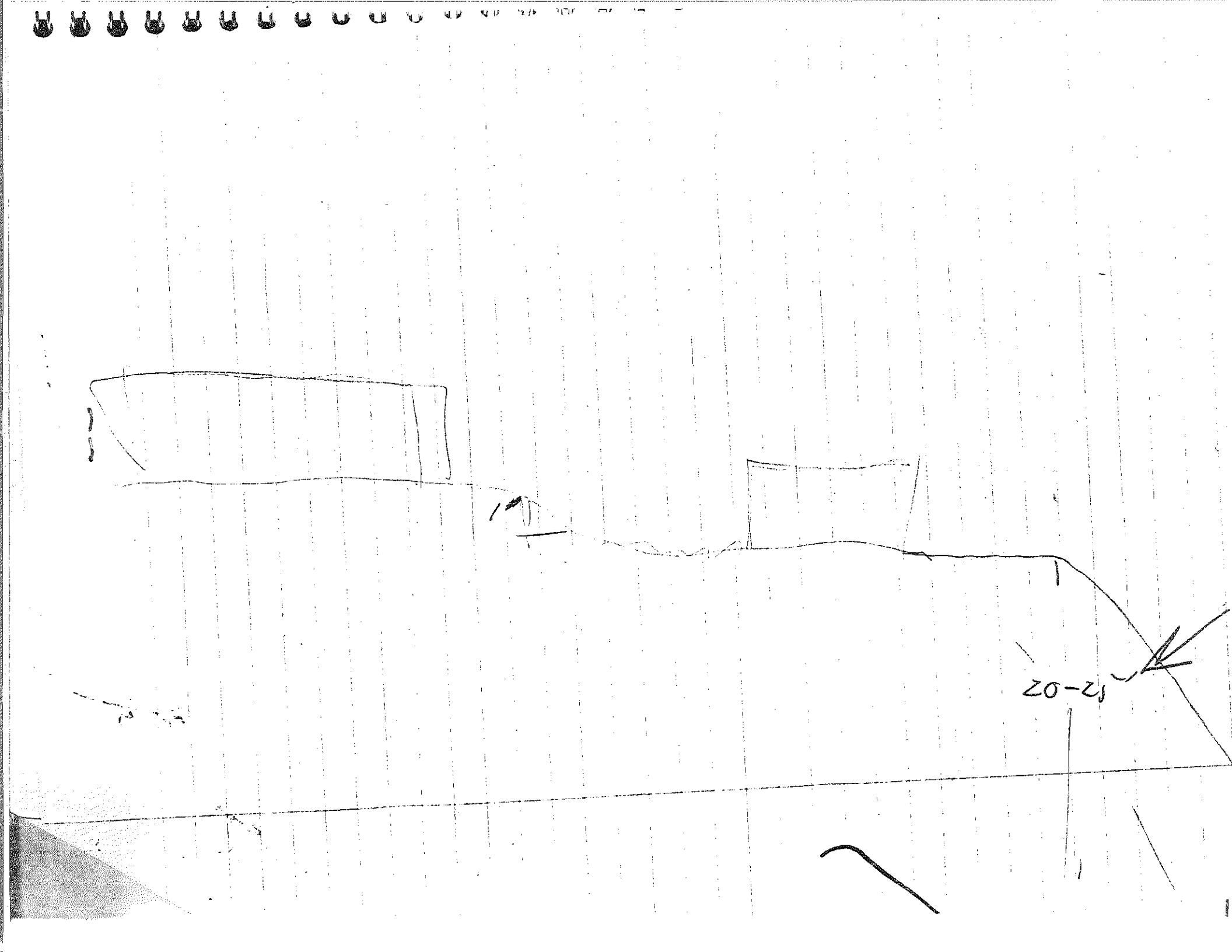
Two samples were submitted by Meck. Co. of soil behind an old abandoned asbestos Textile mill. Neighborhood children were playing on a hill behind the site and their mother became concerned about a white dust they had covering their clothes.

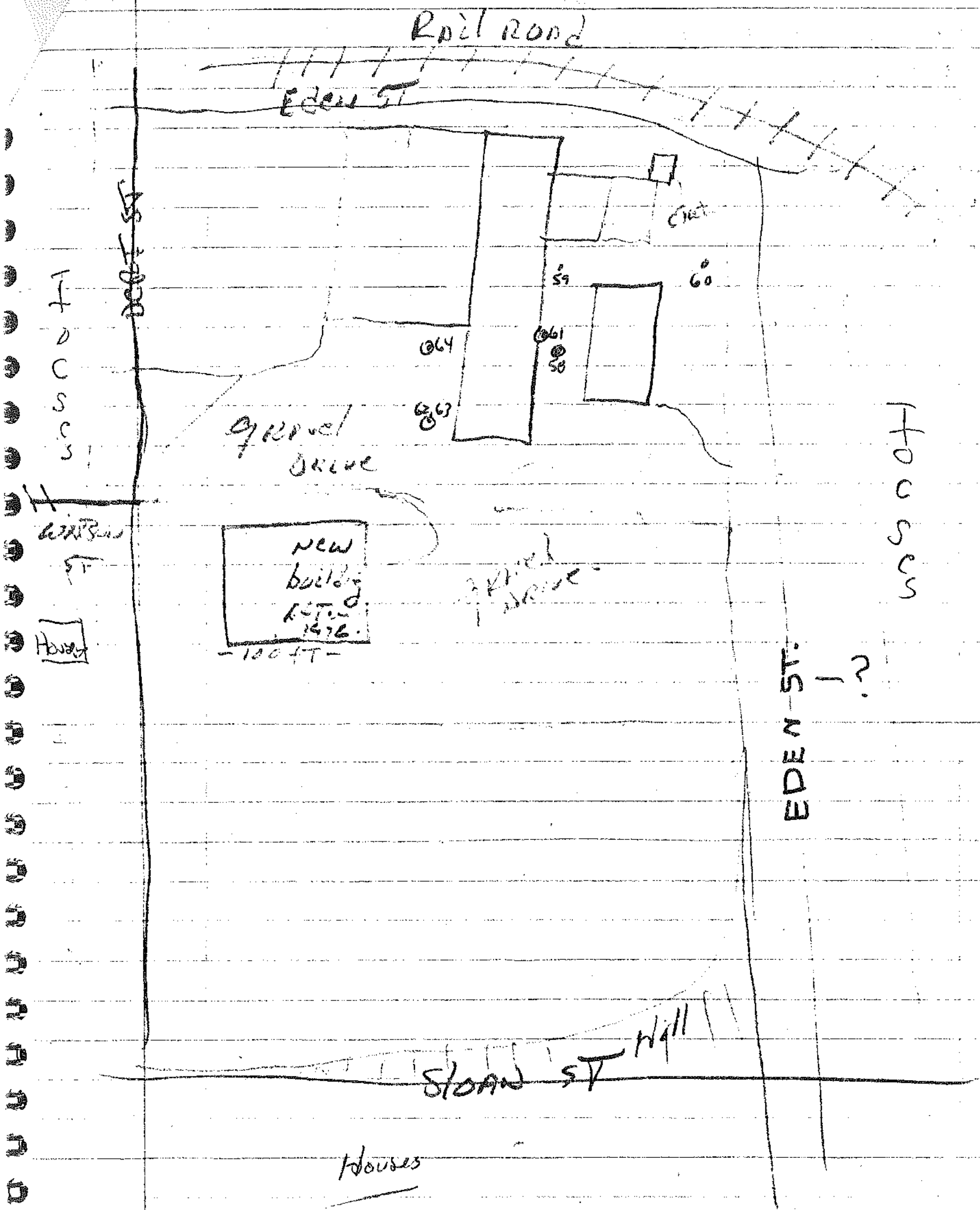
Site purchased by: Robert E. Kenyon
in 1976.
2411 Knollwood Rd.
Charlotte, N.C. 28211
: Kenyon Realty Co.
704 364-0645

Since purchase site face grading has been done a round the site and a ~~another~~ warehouse building built that was.

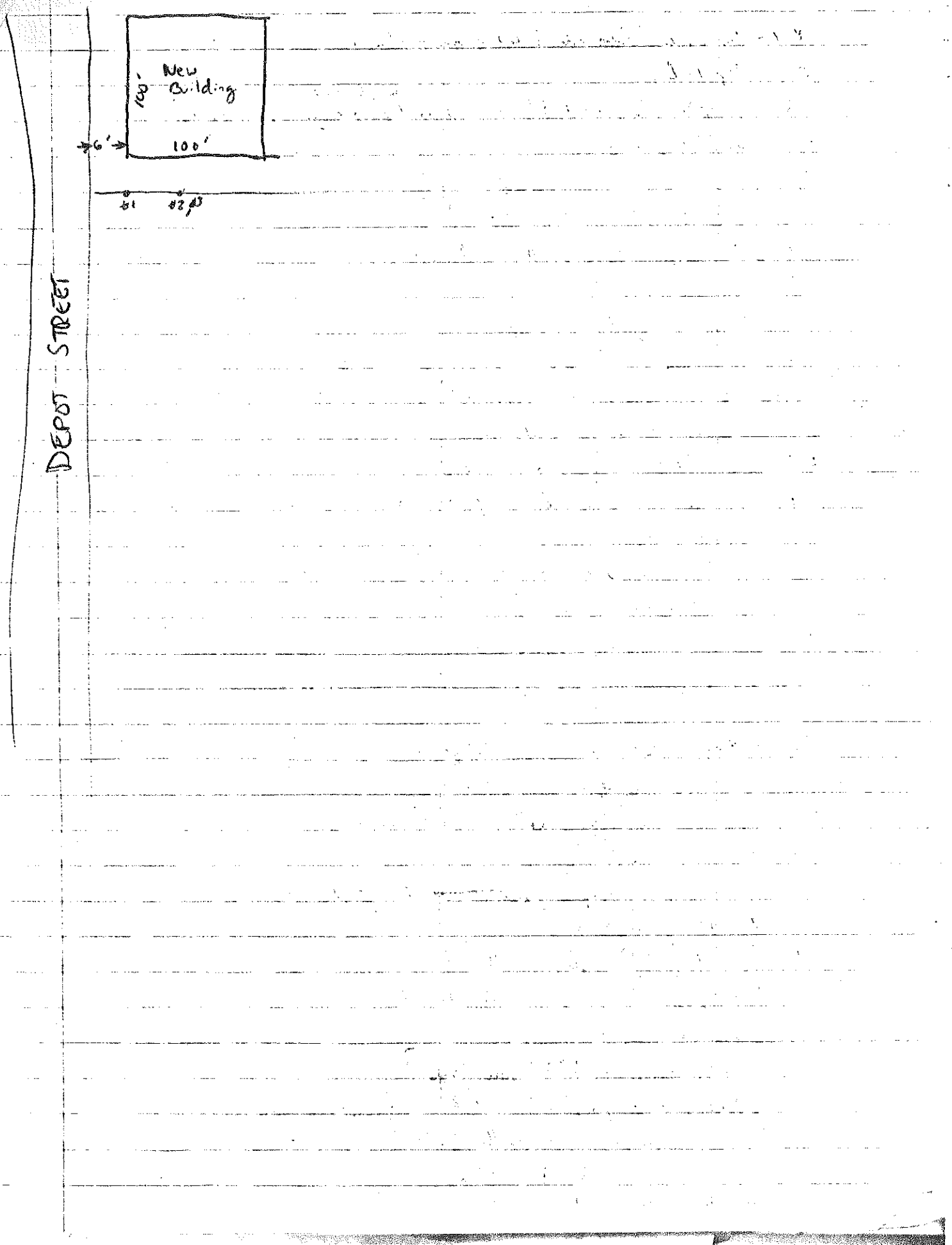
Cotton mill until 1931. Then Asbestos Textiles till mid 1960s. - Then sold to a Penn. Concern then present owner bought property in 1976.

Interview with former employee - 50 ft behind original bldg. a low creek was filled in with up to 10 ft. of Asbestos waste material

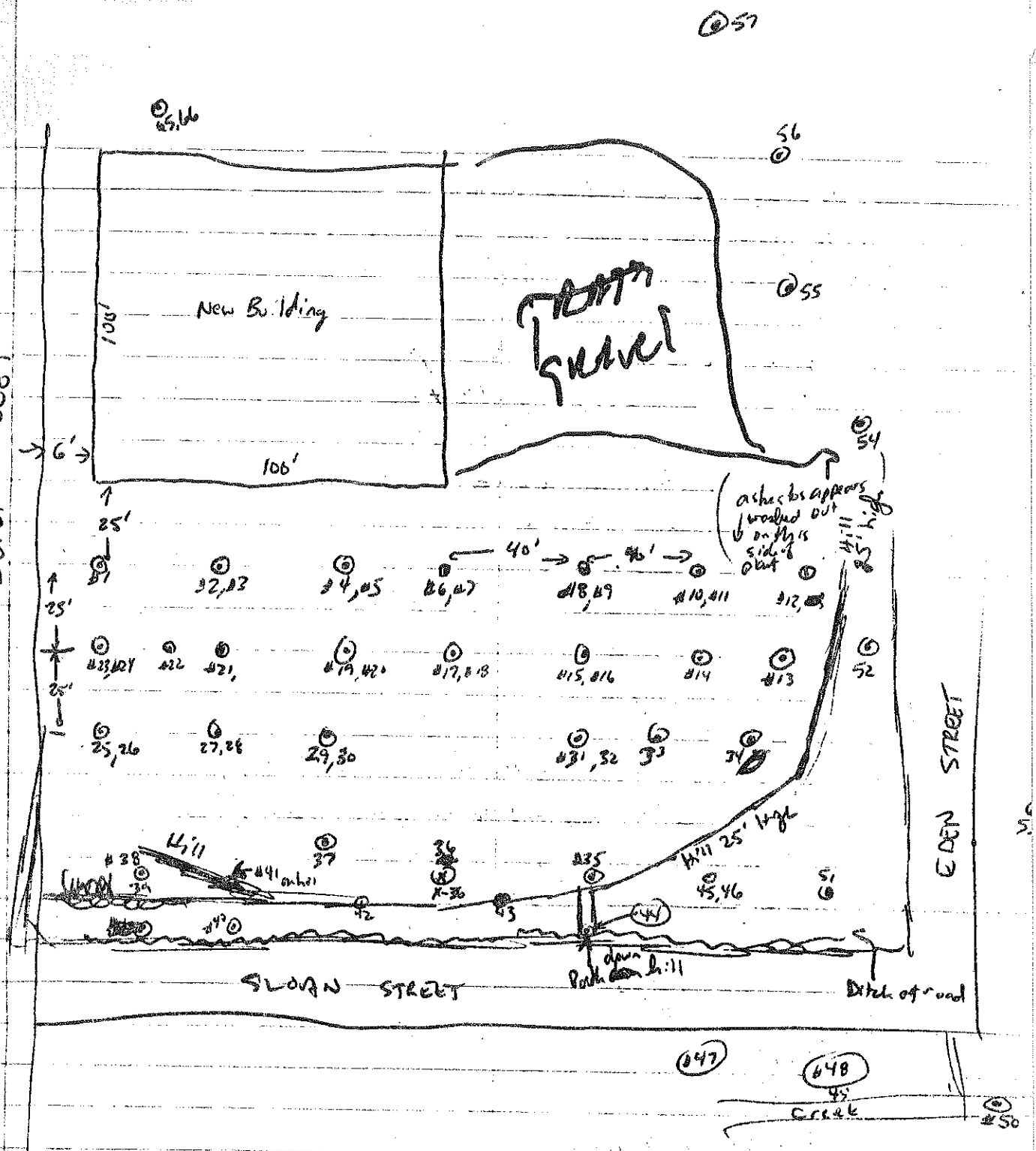

20-25


Rail Road
Eden St
59
60
61
58
64
63
Houses
Gravel Drive
New building after 1996.
-100 FT-
Gravel Drive
House
Houses
EDEN ST.
?
Wall
Sloan ST
Houses

1 - Top Inch . (Remainder looked same - clay)
2 . Top Inch
3 - Sample Silt # 2 ~~Remainder~~ From 2-3" (Remaining sample looked same) 10" total depth


New Building
100'
6'
#1
#2
#3
DEPOT - STREET

1 - Top Inch (Remainder looked same - clay)
2 - Top Inch
3 - Sample Site # 2, From 1-3" (Remainder looked same as sample # 3) Total Sample = 10"
4 - Top Inch of 3" Sample
5 - Sample Site # 4, Bottom 2" of 3" sample
6 - Top Inch, (Top 5" Same Material)
7 - 5"-6" Deep at sample site # 6 - Same for another 6"
8 - Top Inch
9 - Sample Site # 8, 2"-3" Deep
10 - Top Inch (Transition at 5½")
11 - 5½"-6½ Deep, Same Below (Sample Site # 10)
12 - Top Inch - 6" Sample Looks the Same
13 - Top Inch - 8" Sample Looks the same
14 - Top Inch - 6" Sample Looks the Same (Just Beneath Sod & brass cover
15 - Top Inch - Top 2" Same
16 - 2"-3" (Sample Site # 15, - Remaining 8" Same) 10" Total Sample } Picture Taken
17 - Top Inch (Same Through 3")
18 - 3"-4" (Sample Site # 17, Same Through rest of 8" Sample)
19 - Top Inch of 12" Sample, Transition at 10" } Picture Taken (Tape measure)
20 - 10"-11" (Sample Site 19)
21 - 9" Sample - Top Inch Same Throughout
22 - Surface Sample of Ground, White Material
23 - Top Inch, Same Through 6", 10" Total Sample
24 - 6"-7", Same Through 10" - Sample Site # 23
25 - Top Inch of 9" Sample, ~~Same Consistent Throughout~~ Change at 7"
26 - 7"-9" of Sample Site # 25
27 - Top Inch of 12" Sample, Transition at 3"
28 - 3"-4", Same Through 12", Sample Site # 27
29 - Top Inch, 12" Sample, Transition at 3"
30 - 3"-4", Sample Site # 29, Same Through 12"
31 - Top Inch, 10" Sample, Transition at 2" } Picture Taken
32 - 2"-3", Sample Site # 31, Same Through 10"
33 - Surface Sample (picture taken)
34 - Top Inch - Same Through 10"



35- Children's Park - Surface Sample

X-36 - No sample - appears to be 3' deep in asbestos

36 - Surface sample

37 - Surface sample

38 - Top Inch - Transition at 2", 12" sample

39 - 2"-3" at Site #38, same through 12"

40 - Top Inch - All same through 10"

41 - Surface sample on hill

43 - Surface Sample from midway on hill
44 - Surface sample of ditch (bottom of children's path)
45 - Top Inch, Total of 6" Sample, Transition at 2"
46 - 2"-3", Same Through 6"
47 - Top Inch from across street, Same through 8"
48 - ~~4~~ Top Inch of 10" Sample Change at 4" to 5"
49 - 4"-5" - Different Material from Site #48
50 - Surface Sample from creek bank - ~~to~~ above drainage
51 - Surface sample on hill near corner
52 - Top Inch - Same Through 6"
53 - Sample across Eden - Top Inch - Same through 12"
54 - Surface sample above ditch
55 - Top Inch - Same through 3"
56 - Top Inch - Same through 4"
57 - Top Inch - Same through 6" (30' behind old metal building
58 - Between old buildings (near bungalow) top Inch of 6" sample } Planning to put drive in this area
59 - Old foundation area top 1" of 12" sample (same)
60 - Near Eden - Top 1" of 7" Sample
61 - Shingle fragment ~~[illegible]~~ between buildings
62 - Top 1" of 6" Sample
63 - Sample Site 62 - 5"-6" Deep -
64 - Top 1"
65 - Top 1"
66 - Site #65, 2"-3" Deep -

Plans are to possibly add another building to back. - bring in fill & level. Then build building.

[illegible] "[illegible] want destroy Tax base"

MECK COUNTY DEPARTMENT OF
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North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

FEB 1984 RECEIVED

ANALYSIS REPORT

Company: Mecklinburg County Dept of Environmental Health
Address: Charlotte, N.C.
Service Requested: Asbestos I.D.
Sample Taken On: Feb. 14, 1984 By: PAT CURRAN.
Submitted To Laboratory On: Feb 15, 1984 By: PAT CURRAN.
Date of Analysis: 2/16/84 Date Reported: 2/16/84
Analyzed By: L Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
	Samples Taken from Property owned by			
	Robert E Kenyon, Davidson, N.C.			
490943	#1		3-5% Chrysotile, cellulose, quar in soil.	
490944	#2		5-8% Chrysotile, quartz, etc. in soil.	
490945	# 3		30% Chrysotile, cellulose fibers silicate minerals in basic morta	
490946	# 4		5-8% Chrysotile, quartz, cellulo fibers, in soil.	
490947	#5		45% Chrysotile, cellulose fibers silicate minerals, in basic mort	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

page 2 of 12

ANALYSIS REPORT

Company: Mecklenburg Co Dept of Envir. Mgt.

Address:

Service Requested:

Sample Taken On: Feb 14, 1984 By: Curran

Submitted To Laboratory On: Feb 15, 1984 By: Curran

Date of Analysis: 2/16/84 Date Reported: 2/16/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400948	#6		3-5% Chrysotile, quartz, cellulo in soil. Asbestos not evenly distributed.	
400949	#7		15-20% Chrysotile, cellulose, q in basic mortar and soil.	
400950	#8		25% Chrysotile, quartz, cellulo in basic mortar and soil.	
400951	#9		8-10% Chrysotile, quartz, cellu fibers, in basic mortar.	
400952	#10		Cellulose, quartz, mica, in soi No asbestos seen.	
400953	#11		8-10% Chrysotile, quartz, cellu fibers, in basic mortar.	

COMMENTS:

REPORTED BY: John L. Neal
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

Company: Mecklinburg Co. Dept. of Environ Health.

Address:

Service Requested:

Sample Taken On: Feb. 14, 1984 By: Cheeran

Submitted To Laboratory On: Feb. 15, 1984 By: Cheeran

Date of Analysis: 2/16/84 Date Reported: 2/16/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400954	#12		* 35-40% Chry., CF, Q,	in BM.
400955	#13		10-15% CHRY, CF, Q	in BM & SOIL.
400956	#14		35-40% CHRY, Q,	in BM.
400957	#15		8% CHRY, Q, CF,	in soil.
400958	#16		15-20% CHRY, Q, CF,	in BM and soi
400959	#17		15-20% CHRY, CF, Q,	In soil and B

COMMENTS: * CHRY.-- Chrysotile,
CF--Cellulose Fibers
Q-- Quartz
BM-- Basic Mortar.

These abreviations will be used for the remainder of the samples where applicable. Thanks, L. Page

REPORTED BY: John K. Read
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

Company: Mecklenburg Co. Dept. of Environ. Health

Address:

Service Requested:

Sample Taken On: Feb. 14, 1985 By: Curran

Submitted To Laboratory On: Feb. 15, 1985 By: Curran

Date of Analysis: 2/16/84 Date Reported: 2/16/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400960	#18		10-12% CHRY., CF, Q, BM in soil.	
400961	#19		<1% CHRY, CF, Q, mica, in soil.	
400962	#20		15% CHRY, CF, Q, in BM.	
400963	#21		15-20% CHRY., Q, CF, in BM and s	
400964	#22		12-15% CHRY., Q, CF, in BM.	
400965	#23		1-2% CHRY., CF, Q, in soil.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

Company: Mecklinburg Co. Dept. of Env. Health

Address:

Service Requested:

Sample Taken On: Feb. 14, 1984 By: Curran

Submitted To Laboratory On: Feb. 17, 1984 By: Curran

Date of Analysis: 2/16/84 Date Reported: 2/16/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
100966	#24		5-8% CHRY., Q, CF,	in BM and soil
100967	#25		<1% CHRY., CF, Q,	in soil.
100968	#26		20% CHRY., Q, CF,	in BM.
100969	#27		15% CHRY., Q, CF,	in BM and soil
100970	#28		20% CHRY., Q, CF,	in BM.
100971	#29		8-10% CHRY., Q, CF	IN BM and soi

COMMENTS:

REPORTED BY: John K. Neal
Chief, Occupational Health Lab

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

page 6 of 11

ANALYSIS REPORT

Company: Mecklinburg Co. Dept. of Envir Health

Address:

Service Requested:

Sample Taken On: Feb. 14 1984 By: Cureton

Submitted To Laboratory On: Feb. 15 1984 By: Cureton

Date of Analysis: 2/16/84 Date Reported: 2/16/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400972	#30		35% CHRY., Q, CF, in BM and	
400973	#31		20% Chry. Q, CF, in BM and soil.	
400974	#32		60% CHRY., Q, in BM	
400975	#33		35% CHRY., CF, Q, in BM.	
400976	#34		Same as the one above.	
400977	#35		40% CHRY., CF, Q, in BM.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

DHS Form 1440 (Rev. 2-75)
Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

page 7 of 12

Company: Mecklinburg Co. Dept. of Environ. Health

Address:

Service Requested:

Sample Taken On: Feb. 1, 1984 By: Curran

Submitted To Laboratory On: Feb 15, 1984 By: Curran

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
100978	#36		35-40% CHRY., CF, Q, in BM.	
100979	#37		25-30% CHRY., CF, Q, in BM.	
100980	#38		20-25% CHRY., CF, Q, Mica, in BM and soil.	
100981	#39		25% CHRY., CF, Q, in BM and soil	
100982	#40		20% CHRY, same as above.	
100983	#41		25-30% CHRY., CF, Q, in BM.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

page 8 of 12

ANALYSIS REPORT

Company: Mecklinburg Co. Dept. of Comm. Health.

Address:

Service Requested:

Sample Taken On: Feb. 14 1984 By: Curran

Submitted To Laboratory On: Feb. 17 1984 By: Curran

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400984	#42		25-30% CHRY., Q, CF	in BM.
400985	#43		20% Chry. same as above.	
400986	#44		25-30% CHRY., same as above.	
400987	#45		18-20% CHRY., CF, Q	, in basic m
400988	#46		35-40% CHRY., same as above.	
400989	#47		1-2% CHRY., same as the above.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

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Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

page 9 of 12

ANALYSIS REPORT

Company: Mecklenburg Co. Dept. of Envir. Hlth. Dr.

Address:

Service Requested:

Sample Taken On: Feb. 14, 1984 By: Cuerno

Submitted To Laboratory On: Feb. 15, 1984 By: Cuerno

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
100990	#48		3% CHRY., Q, CF, in	BM and soil.
100991	#49		30-35% CHRY., same	as the above.
100992	#50		1-2% CHRY. same as	the above.
100993	#51		40% CHRY., same as	the above.
100994	#52		18-20% CHRY., same	as the above.
100995	#53		<1% asbestos seen.	Clay, mica, CF

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

DHS Form 1440 (Rev. 2-75)
Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

Company: Mecklenburg Co. Dept. of Environ. Health

Address:

Service Requested:

Sample Taken On: Feb. 14, 1984 By:

Submitted To Laboratory On: Feb. 17, 1984 By:

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
400996	# 54		25% CHRY., Q, CF, in BM.	
400997	#55		15% CHRY.,Q, CF, IN soil.	
400998	#56		15% CHRY., Q, mica CF, in soil.	
400999	#57		10% CHRY., mica,CF Q, insoil.	
401000	#58		20% CHRY., CLAY, Q CF, in BM and soil.	
401001	#59		1-2% CHRY., vermiculite, Q, CF, in BM and soil.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

DHS Form 1440 (Rev. 2-75)
Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

page 11 of 12

ANALYSIS REPORT

Company: Meck Lnsbung Co Dept of Envir. Health

Address:

Service Requested:

Sample Taken On: Feb. 14 1984 By: Cannon

Submitted To Laboratory On: Feb. 15, 1984 By: Cannon

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
401002	#60		8-10% CHRY., Q, CF, mica, in BM.	
401003	#61		20-25% CHRY., Q, CF, SILICATE MINERALS, in BM.	
401004	#62		8-10% CHRY., Q, CF, mica, in BM. and soil.	
401005	#63		20% CHRY. same as the above.	
401006	#64		15-18% CHRY., Same as the above.	
401007	#65		15% CHRY. Same as the above.	

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

DHS Form 1440 (Rev. 2-75)
Occupational Health

North Carolina Department of Human Resources
Division of Health Services
Occupational Health Laboratory

ANALYSIS REPORT

page 12 of 12

Company: Mecklenburg Co Dept. of Envir. Health.

Address:

Service Requested:

Sample Taken On: Feb. 14, 1984 By: Cannon

Submitted To Laboratory On: Feb. 15, 1984 By: Cannon

Date of Analysis: 2/17/84 Date Reported: 2/17/84

Analyzed By: L. Page

LABORATORY NUMBER	SAMPLE NUMBER	DESCRIPTION	REMARKS	RESULTS IN
4u10u8	#66		15% CHRY., CF, Q, mortar. and soil.	tar, in basic

COMMENTS:

REPORTED BY: John R. Neal
Chief, Occupational Health Lab

DHS Form 1440 (Rev. 2-75)
Occupational Health

UNITED STATES GOVERNMENT

memorandum

DATE: February 29, 1984

REPLY TO ATTN OF: Rodney D. Turpin, Safety and Occupational Health Officer
Environmental Response Branch - Edison, NJ

SUBJECT: Activity Options: Davidson Asbestos Site, North Carolina

TO: Fred Stroud, On-Scene Coordinator FBS
EPA Region IV - Atlanta, GA

THRU: Joseph P. Lafornara, Chief
Analytical Support Section

MECK COUNTY DEPARTMENT OF
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ENVIRONMENTAL HEALTH

CONTAINMENT OPTIONS

In evaluating the suggested options, the following factors must be considered:

1. Proper skin/respirator equipment is required when potential asbestos conditions may be present.

2. All surfaces must be maintained regardless of option selected. The intent of the surface cover is to assure that asbestos does not migrate into the environment.

3. See Attachment No. 1 for general cost information.

A. Emergency Action

1. Slope Areas - ground cover

   a. Hydro seeding (only cost reference is the Ambler, PA estimate of approximately 5c/ft^2).

   b. Burlap cover (no cost estimate).

   c. Reduce slope via top soil backfill (this would involve closing off adjacent road).

   d. Reduce slope via landscaping techniques (e.g., railroad ties, proper surface drainage, top soil backfill).

2. Slope Areas - security

   a. Fence

   b. Security guards

3. Level Areas - ground cover

   a. Driveway areas

      (1) Seal off potential dust situations with black top, etc. Surfaces must be maintained.

   b. Non-Driveway Areas

      (1) Same as paragraph A (1) above.

      (2) Fill/top soil cover. Depth 6 inches to 2 feet. Specifics should be determined by agronomist, soil scientist, landscaper, and in accordance with local, state, and federal requirements.

      (3) Black top, etc.

      (4) Vegetation - should be selected by local expert(s). Major selection factor should include root system and maintenance requirements.

4. Level Areas - security

   a. Same as paragraph A-2 above.

B. Long Term Containment

1. Slope/level areas, in addition to expanding/refining the emergency actions mentioned above in paragraph A above, long term containment has to address:

   a. Maintaining permanent seal of ground cover.

   b. Maintaining vegetation.

   c. Meeting local, state, and federal permit, registration, etc.

2. Slope/level areas - security

   a. Same as paragraph A 2 above.

AIR MONITORING - see Attachment No. 2

Attachments

cc: Andy Zownir
Jeff Pike, EPA Reg. III, OSC

Attachment No. 1

United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington DC 20460

Office of Research and
Development
Municipal Environmental R
Laboratory
Cincinnati OH 45268

Technology Transfer

EPA

Handbook

Remedial Action at Waste Disposal Sites

Include - Cover
Stabilize
Soil Conservation Service Operation on 6" Cover
Maintenance Plan
Erosion
drying

ESTIMATED UNIT COSTS FOR SURFACE SEALING METHODS AND MATERIALS

Cover material and/or method of installation	Unit costs*	Source of cost information
Topsoil (sandy loam), hauling, spreading, and grading (within 20 miles)	$13/yd^3	Haseley Trucking Company (1980)
Clay hauling, spreading, and compaction	$8.50/yd^3	" " " "
Sand hauling, spreading, and compaction	$15/yd^3 $8,000-10,000 /acre	" " " " Universal Linings, Inc. (1980)
Cement concrete (4 to 6" layer), mixed, spread, compacted on-site	$6-10/yd^2	Tolman et al., 1979
Bituminous concrete (4 to 6" layer), including base layer	$3-5/yd^2	Tolman et al., 1979
Lime or cement, mixed into 5" cover soil	$1.50-2.10/yd^2	Tolman et al., 1979
Bentonite, material only; 2" layer, spread and compacted	$1.40/yd^2	Lutton et al., 1979
Sprayed asphalt membrane (¼" layer and soil cover), installed	$1.50-2.50/yd^2	Lutton et al., 1979
PVC membrane (20 mil), installed	$1.30-2.00/yd^2	" " " "
Chlorinated PE membrane (20-30 mil), installed	$2.40-3.20/yd^2	" " " "
Elasticized polyolefin membrane, installed	$2.70-3.60/yd^2	DuPont Elastomer Chemicals Dept. (1980)

--continued--

TABLE 3-2 (Continued)

Cover material and/or method of installation	Unit costs*	Source of cost information
Hypalon membrane, (30 mil), installed	$6.50/yd^2	DuPont Elastomer Chemicals Dept. (1980)
Neoprene membrane, installed	$5.00/yd^2	Lutton et al., 1979
Ethylene propylene rubber membrane, installed	$2.70-3.50/yd^2	" " " "
Butyl rubber membrane, installed	$2.70-3.80/yd^2	" " " "
Teflon-coated fiberglas (TFE) membrane (10 mil), installed	$20/yd^2	DuPont Elastomer Chemicals Dept. (1980)
Fly ash and/or sludge, spreading, grading, and rolling	$1.00-1.70yd^2	Tolman et al., 1979

*Note different units for volume (yd^3) vs. surface area (yd^2) costs.

Attachment No. 2

Hazardous Waste Site
Asbestos Air Monitoring Guide

DRAFT

I. ON SITE SAMPLE
   A. Type of Samples

      1. Bulk Pile Samples
         a. Sample Size - 8 oz. Sample Jar
            1. Type of Analysis
               (a) PLM (all samples)- see attached analytical method.
               (b) SEM or TEM- Select 1-4, highest positive PLM samples.

         b. Sample Location
            1. Develop site specific sampling grid. Consider real time monitor reading and site conditions.

      2. Air Samples
         a. Filter Media
            1. 25 mm - 37mm cellulose 3-stage cassette (0.45 um - 0.80 um size)

         b. Flow Rates- Liter per minute
            1. Low real-time monitor readings: 17.6
            2. Medium real-time monitor readings: 7.5
            3. High real-time monitor readings: 2.5

         c. Analytical Methods
            1. 10% of samples collected - TEM or SEM
            2. 90% of samples collected - PLM

(TEM) - Transmission Electron Microscopy
(SEM) - Scanning Electron Microscopy
(PLM) - Polarized Light Microscopy

B. Weather Conditions (see II, B.(4). Below)

II. Preliminary Ambient Air Sampling Off Site

   A. Screen area with real time aerosol or particulate instrument.

      1. RAM-1 or equivalent

   B. Sample Collection

      1. Types of Analysis- Duplicate samples (A & B) are collected at each station.

         a. Analyze all (A) samples from each station by PLM (see attached procedure)
            1. If (A) samples are positive for asbestos then analyze a minimum of 25% of the appropriate (B) samples by:

               (a) TEM with selected area electron diffraction (SAED) or
               (b) SEM with Xray dispersion analysis (EXDA)

DRAFT

B. Sample Collection (cont'd)

2. Sampling grid (Station location)
   a. Positive RAM readings
      1. Maximum 500 feet downwind from site
      2. Minimum of 1-2 samples per 1000 to 2000 feet perpendicular to wind direction adjacent to site.

   b. Background stations
      1. Minimum of 3 stations
      2. angles of 45°, 90°and 135° 500 feet to 1 mile upwind of the site

3. Sampling Methodology at at each station

   a. Media - 25mm or 37mm 3 stage cassett 0.45 to 0.8 um

   b. Flow rates
      1. Low flow pumps (per station)
         (a) 2.5 l/min for minimum of 30 minutes

      2. High flow pumps (Applicability/location) to be determined on site specific bases.
         (a) 7.45 liters/minutes for minimum of 30 minutes
         (b) 17.5 liters/minutes for minimum of 30 minutes

4. Weather Conditions

   a. Minimum of 3 days of dry weather before sampling.
   b. Wind speed minimum of 10-15 mph at time of sampling.
   c. Soil condition should be dry/non-moist at time of sampling.

III. RESIDENTIAL- Non-Commercial Buildings (IF APPLICABLE)

A. Screening- Random selection of residence to be tested.
   1. Residents directly adjacent to the disposal pile.

B. Selected areas for Settled Dust Sampling
   1. Static areas
      a. Attic (ascertain type insulation or asbestos use in attic).
      b. Rafters- ie., attic, basement, crawlspace, etc.
      c. Garage

   2. Living areas
      a. behind and/or underneath appliances, ie., refrigerators, stoves, etc.
      b. light fixtures
      c. embedded in perimeter of carpet (under tables, couch)
      d. surface areas of drapes.

DRAFT

C. Sampling Design

1. Since the emphasis is to qualitatively assess exposure, the primary effort should be directed towards identifying the presence of asbestos. This could best be achieved through the collection and analysis of settled dust. This should be accomplished by:

   a. selecting areas as defined in B. 1 and 2. These areas should be measured so as to allow determination of fiber concentration per area sample. These types of measurements may be useful for comparison purposes in this study.

D. Sample Apparatus

1. Battery operated sampling pump capable of 2.5 to 3.5 liters per minute flow rate through a cellulose ester filter with porosity of 0.8 micron and 37mm diameter.

E. Sample procedures

1. The attempt is to collect settled dust from exposed surfaces onto the filter media.

   a. The area to be selected, measured and sampled will vary depending on the amount of "free" dust on the surfaces. The person collecting the sample will need to make this assessment.

   Since the sample should not be overloaded or underloaded, the following maybe used as general guides to determine flow rate and sample area. The purpose of the two different areas is to identify the appropriate sample load if additional sampling is required:

   Heavily visible settled dust- (a) 0.5 $ft.^2$ at 3 l/min.
   (b) 1 $ft.^2$ at 3 l/min.

   Moderately visible settled dust- (a) 1.5 $ft.^2$ at 3 l/min.
   (b) 3 $ft.^2$ at 3 l/min.

   Lightly visible settled dust- (a) 1 m^2 at 3 l/min.
   (b) 2 m^2 at 3 l/min.

   No visible settled dust- (a) 2 m^2 at 3 l/min.

   b. A sample holder or cassette should be used in which the surface of the filter is at a minimum of 1/4 inch from the top of the surface.

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E. Sample Procedures (cont'd)

The sample holder or cassette should be open faced and placed in contact with the surface to be sampled (The rim of the open faced cassette that contacts the surface should be notched to allow for reduced pressure buildup on the pump).

With the pump turned on, sample holder should be moved across the surface making sure the total defined area is sampled. Depending on the filter loading, repeated sampling across the same area may be warranted. Should the investigator decide that more particulate material is needed for proper filter loading, additional areas can be defined and measured for sampling. Using the same filter and procedures these areas should be likewise sampled. All areas should be physically measured by the investigator.

F. Sample Analysis

1. Optical Microscopy
   a. Filters should be prepared and analyzed by the most current NIOSH methodology by Phase Contract Microscopy.

   b. Concentration of fibers should be determined for unit area measured.

      These fiber data should be used for comparison purposes in this study to assess extent of contamination and for making decisions for additional sampling and analysis.

2. Electron Microscopy

   a. A representative number of samples should be selected for fiber identification by either Scanning Electron Microscopy (SEM) or Transmission Electron Microscopy (TEM). These microscopy methodologies should be used for fiber count and also identification of the fibers, as well as the surrounding fiber matrix using Selected Area Electron Diffraction (SAED), TEM only, and/or Energy Dispersive X-Ray (EDX) analysis.

      This data can be used for comparison with optical fiber counts and to acertain the presence of asbestos. It may be possible to determine if asbestos contamination is the same type of fiber identified from the disposal piles.

   b. Soil surface samples should be prepared and analyzed in the same manner using Electron Microscopy.

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ORMULA: various

FIBERS
METHOD: 7400
ISSUED: 2/15/84

SHA: 0.5 asbestos fibers (> 5 μm long)/mL
IOSH: 0.1 asbestos; 3 fibrous glass (> 10 μm long, < 3.5 μm wide)
CGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos

PROPERTIES: solid, fibrous

YNONYMS: asbestos (actinolite [CAS #77536-66-4], grunerite (amosite) [CAS #12172-73-5], nthophyllite [CAS #77536-67-5], chrysotile [CAS #12001-29-5], crocidolite [CAS #12001-28-4], remolite [CAS #77536-68-6]); fibrous glass; mineral fibers.

SAMPLING

MPLER: FILTER
(cellulose ester membrane, 0.8 to 1.2 μm, 25 mm diameter)

OW RATE*: ≥ 0.5 L/min

L-MIN*: 400 L @ 0.1 fiber/mL
-MAX*: 1920 L @ 0.1 fiber/mL (DNE 1 mg total dust)

djust for 100 to 1300 fibers/mm² (step 4)

IPMENT: routine

MPLE STABILITY: indefinite

ANKS: 10% of samples (minimum 2) [1]

ACCURACY

NGE STUDIED: 80 to 100 fibers counted

S: see Evaluation of Method

RALL PRECISION: 0.115 to 0.13 [1]

MEASUREMENT

TECHNIQUE: MICROSCOPY, PHASE CONTRAST

ANALYTE: fibers (manual count)

SAMPLE PREPARATION: acetone/triacetin method

COUNTING RULES: Set A (P&CAM 239 [1,2]) or Set B (modified CRS)

EQUIPMENT: 1. phase-contrast microscope
2. Walton-Beckett graticule (100 μm diameter): A rules use Type G-22; B rules use Type G-24)
3. phase-shift test slide (HSE/NPL)

CALIBRATION: phase-shift detection limit between 3 and 4 degrees

ANALYTICAL RANGE: 100 to 1300 fibers/mm² filter area [3]

ESTIMATED LOD: 7 fibers/mm² filter area

ANALYTICAL PRECISION: 0.10 to 0.12 (A rules)[1]; 0.157 (B rules)[3]

LICABILITY: The working range is 0.02 fibers/mL (1920-L sample) to 1.25 fibers/mL (400-L ple) The method was designed to give an index of airborne asbestos fibers but may be used other materials such as fibrous glass by inserting suitable parameters into the counting es. The method does not differentiate between asbestos and other fibers. Asbestos fibers s than ca. 0.25 μm diameter will not be counted by this method [5].

ERFERENCES: Any airborne fiber may interfere; all particles meeting the counting criteria l be counted. Chain-like particles may appear fibrous. High levels of non-fibrous dust ticles may obscure fibers in the field of view and raise the detection limit.

ER METHODS: This method introduces changes for improved reproducibility and replaces AM 239 [1,2].

REAGENTS:

1. Acetone.*
2. Triacetin (glycerol triacetate) (reagent grade).

*See Special Precautions.

EQUIPMENT:

1. Sampler: field monitor, 25 mm, 3-piece cassette with 50-mm extension cowl with cellulose ester filter 0.8 to 1.2 µm pore size.
   NOTE: Analyze representative filters for fiber background before use and discard the filter lot if more than 5 fibers per 100 fields are found. Gridded filters give improved focusing capability for analysis and are recommended.
2. Personal sampling pump, $\geq$ 0.5 L/min (see step 4 for flow rate), with flexible connecting tubing.
3. Microscope, phase contrast, with green filter, 8 to 10X eyepiece, and 40 to 45X phase objective (total magnification ca. 400X), Numerical Aperture = 0.65 to 0.75.
4. Slides, glass, single-frosted, pre-cleaned, 25 x 75 mm.
5. Cover slips, 25 x 25 mm, no. 1-1/2.
6. Knife, #10 surgical steel, curved blade.
7. Tweezers.
8. Flask, Guth type, insulated neck, 250 to 500 mL (with single-holed rubber stopper and elbow-jointed glass tubing, 16 to 22 cm long).
9. Hotplate, spark-free, stirring type; or heating mantle; or infrared lamp and magnetic stirrer.
10. Syringe, hypodermic, with 22 gauge needle.
11. Graticule, Walton-Beckett type with 100 µm diameter circular field (area = 0.00785 mm^2) (Type G-22 for A rules; Type G-24 for B rules). Available from Graticules Ltd., Morley Road, Tonbridge, Kent, England TN9, 1RN.
    NOTE: The graticule is custom-made for each microscope. Specify disc diameter needed to fit exactly the ocular of the microscope and the diameter (mm) of the circular counting area (see step 11).
12. HSE/NPL phase contrast test slide, Mark II. Available from PTR Optics Ltd., 145 Newton Street, Waltham, MA 02154.
13. Telescope, phase-ring centering.
14. Stage micrometer (0.01 mm divisions).

SPECIAL PRECAUTIONS: Acetone is an extremely flammable liquid and precautions must be taken not to ignite it. The acetone must be heated in a ventilated laboratory fume hood using a flameless, spark-free heat source.

AMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line [1].
2. Fasten the sampler to the worker's lapel as close as possible to the worker's mouth. Remove the top cover from the end of the cowl extension (open face) and orient face down. Wrap the joint between the extender and monitor body with shrink tape to prevent air leaks.
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Remove the caps from the field blank cassettes and store the caps and cassettes in a clean area (bag or box) during the sampling period. Replace the caps in the cassettes when sampling is completed.
   NOTE: If a field blank yields fiber counts greater than 7 fibers/100 fields, report possible contamination of the samples.
4. Sample at 0.5 L/min or greater [6]. Do not exceed 1 mg total dust loading on the filter. Adjust sampling flow rate, Q (L/min), and time to produce a fiber density, E (fibers/mm^2), of 100 to 1300 fibers/mm^2 (3.85×10^4 to 5×10^5 fibers per 25-mm filter with 385 mm^2 effective collection area, A_c (mm^2)), for optimum counting precision. Calculate the minimum sampling time, t_{min} (minutes), at the action level (one-half the current standard), L (fibers/mL), of the fibrous aerosol being sampled:

$$t_{min} = \frac{(A_c)(E)}{(Q)(L)10^3}$$

5. Remove the field monitor at the end of sampling, replace the plastic top cover and small end caps, and store the monitor.
6. Ship the samples in a rigid container with sufficient packing material to prevent jostling or damage.

MPLE PREPARATION:

TE: The object is to produce samples with a smooth (non-grainy) background in a medium with a refractive index equal to or less than 1.46. The method below collapses the filter for easier focusing and produces permanent mounts which are useful for quality control and interlaboratory comparison. Other mounting techniques meeting the above criteria may also be used (e.g., the non-permanent field mounting technique used in P&CAM 239 [2]).

. Clean the glass slides and cover slips with acetone and set aside.

. Place 40 to 60 mL of acetone into a Guth-type flask. Stopper the flask with a single-hole rubber stopper through which a glass tube extends 5 to 8 cm into the flask. The portion of the glass tube which exits the top of the stopper (8 to 10 cm) is bent downward in an elbow which makes an angle of 20 to 30° with the horizontal.

. Place the flask on a stirring hotplate or wrap in a heating mantle. Heat the acetone gradually to its boiling temperature (ca. 58 °C).
   CAUTION: The acetone vapor must be generated in a ventilated fume hood away from all open flames and spark sources.
   NOTE: Alternate heating methods can be used, providing no open flame or sparks are present.

. Mount either the whole sample filter or a wedge cut from the sample filter on a clean glass slide.
   a. Cut wedges of ca. 25% of the filter area with a curved blade steel surgical knife using a rocking motion to prevent tearing.
   b. Place the filter or wedge, dust side up, on the clean glass slide. Static electricity will usually keep the filter on the slide until it is cleared.

c. Hold the glass slide supporting the filter wedge approximately 1 to 2 cm from the glass tube port where the acetone vapor is escaping from the heated flask. The acetone vapor stream should cause a condensation wet spot on the glass slide ca. 2 to 3 cm in diameter. By moving the glass slide gently in front of the vapor stream, the filter wedge should clear in 2 to 5 sec. If the filter wedge curls, distorts, or is otherwise rendered unusable, the vapor stream is probably not strong enough. Periodically wipe the outlet port with tissue to prevent liquid acetone dropping onto the filter.

d. Using the hypodermic syringe with a 22-gauge needle, place 1 to 2 drops of triacetin on the wedge. Gently lower a clean 25-mm square cover slip down onto the wedge at a slight angle to reduce the possibility of forming bubbles. If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours.

e. Glue the edges of the cover slip to the glass slide using a lacquer or nail polish [7].

NOTE: Counting may proceed immediately after clearing of the filter is completed. If clearing is slow, the slide preparation may be heated on a hotplate (surface temperature 50 °C) for 15 min to hasten clearing.

CALIBRATION AND QUALITY CONTROL:

1. Calibration of the Walton-Beckett graticule. Determine the diameter, d_c, of the circular counting area:

a. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.

b. Set the appropriate interpupillary distance, and if applicable, reset the binocular head adjustment so that the magnification remains constant.

c. Install the 40X or 45X phase objective.

d. Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.

e. Measure the magnified grid length, L_o (μm), using the stage micrometer.

f. Remove the graticule from the microscope and measure its actual grid length, L_a (mm). This can best be accomplished by using a stage fitted with verniers.

g. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a}{L_o} \times D$$

Example: If L_o = 108 μm, L_a = 2.93 mm and D = 100 μm, then d_c = 2.71 mm.

h. Check the circle diameter (acceptable range 100 μm ± 2 μm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (μm^2).

2. Microscope adjustments. Follow the manufacturer's instructions and:

a. Adjust the light source for even illumination across the field of view at the condenser iris.

NOTE: Köhler illumination is preferred, where available.

b. Focus on the particulate material to be examined.

c. Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.

d. Ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric.

3. Check the phase-shift detection limit of the microscope periodically.

a. Remove the HSE/NPL phase-contrast test slide from its shipping container and center it under the phase objective.

b. Bring the blocks of grooved lines into focus.

NOTE: The slide consists of 7 sets of grooves (approximately 20 grooves to each block) in descending order of visibility from set 1 to set 7. The requirements for asbestos counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least partially visible, but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements precisely has either too low or too high a resolution to be used for asbestos counting.

c. If the image quality deteriorates, clean the microscope optics and consult the microscope manufacturer.

14. Quality control of fiber counts.
    a. Prepare and count field blanks along with the field samples. Report the counts on each blank. Calculate the mean of the blank counts, and subtract this value from each sample count before reporting the results.
    b. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter).
15. Use the following test to determine whether a pair of counts on the same wedge should be rejected because of possible bias. This statistic estimates the counting repeatability at the 95% confidence level. Discard the sample if the difference between the two counts exceeds $2.77\ (F)s_r$, where F = average of the two fiber counts, and s_r = relative standard deviation, which should be derived by each laboratory based on historical in-house data.

    NOTE: If a pair of counts is rejected as a result of this test, recount the entire set of samples and test the new counts against the first counts. Discard all rejected paired counts.
16. Enroll each new counter in a training course which compares performance of counters on a variety of samples using this procedure.

    NOTE: To ensure good reproducibility, all laboratories engaged in routine asbestos counting should participate in an asbestos proficiency testing program such as the NIOSH Proficiency Analytical Testing (PAT) Program and routinely participate with other asbestos fiber counting laboratories in the exchange of field samples to compare performance of counters.

ANALYTICAL PROCEDURE

17. Place the slide on the mechanical stage of the calibrated microscope with the center of the wedge under the objective lens. Focus the microscope on the plane of the filter wedge.

    NOTE: The use of gridded filters can be very helpful in locating the proper specimen plane.
18. Regularly check phase-ring alignment and Köhler illumination [5].
19. Select one of the following sets of counting rules:

    NOTE: The two sets of rules have been demonstrated to produce equivalent mean counts on a variety of asbestos sample types [4], and must be strictly followed in order to obtain valid results. No hybridizing of the two sets of rules is permitted. The calibration of the microscope with the HSE/NPL test slide determines the minimum detectable fiber diameter (ca. 0.25 µm).

    a. A rules (same as P&CAM 239 rules [2]).

       NOTE: The A rules are required for monitoring asbestos for compliance purposes under OSHA or NIOSH standards.

       1. Count only <u>fibers</u> longer than 5 µm. Measure the length of curved fibers along the curve.

2. Count only fibers with a length-to-width ratio equal to or greater than 3:1.
3. For fibers which cross the boundary of the graticule field:
   a. Count any fiber longer than 5 µm which lies entirely within the graticule area.
   b. Count as 1/2 fiber, any fiber with only one end lying within the graticule area.
   c. Do not count any fiber which crosses the graticule boundary more than once.
   d. Reject and do not count all other fibers.
4. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber, and it meets rules a.1 and a.2.
5. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 fields regardless of fiber count.

b. B rules

NOTE: The B rules are preferred analytically because of their demonstrated ability to improve the reproducibility of fiber counts [4].

1. Count only ends of fibers. Each fiber must be longer than 5 µm and less than 3 µm diameter.
2. Count only ends of fibers with a length-to-width ratio equal to or greater than 5:1.
3. Count each fiber end which falls within the graticule area as one end, provided that the fiber meets rules b.1 and b.2.
4. Count visibly free ends which meet rules b.1 and b.2 when the fiber appears to be attached to another particle, regardless of the size of the other particle.
5. Count the free ends of fibers emanating from large clumps and bundles up to a maximum of 10 "ends" (5 fibers), provided that each segment meets rules b.1 and b.2.
6. Count enough graticule fields to yield 200 "ends." Count a minimum of 20 fields. Stop at 100 fields, regardless of the fiber count.
7. Divide the total "end" count by 2 to yield fiber count.

NOTE: Split fibers will normally be counted as more than 2 "ends" if the free ends meet the rules b.1. and b.2.

). Start counting from one end of the wedge and progress along a radial line to the other end, shift either up or down on the wedge, and continue in the reverse direction [8]. Select fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. When an agglomerate covers 1/6 or more of the field of view, reject the field and select another. Do not report rejected fields in the number of total fields counted.

NOTE: When counting a field, continuously scan a range of focal planes by moving the fine focus knob, to detect very fine fibers which have become imbedded in the filter. The small diameter fibers will be very faint but are an important contribution to the total count.

ALCULATIONS:

. Calculate and report fiber density on the filter, E (fibers/mm²), by dividing the total fiber count, F, minus the mean blank count, B, by the number of fields, n, and the field area, A_f (0.00785 mm² for a properly calibrated Walton-Beckett graticule):

$$E = \frac{(F - B)}{(n)(A_f)}, \text{ fibers/mm}^2$$

. Calculate the concentration, C (fibers/mL), of fibers in the air volume sampled, V (L), using the effective collection area of the filter, A_c (385 mm² for a 25-mm filter):

$$C = \frac{(E)(A_c)}{V \cdot 10^3}$$

NOTE: Check and adjust the value of A_c periodically, if necessary.

EVALUATION OF METHOD:

This method is a revision of NIOSH Method P&CAM 239 [1,2]. A summary of the revisions is:

A. Sampling

The change from a 37-mm to a 25-mm filter size was incorporated to reduce problems associated with non-uniform fiber loading reported on the 37-mm filters [8]. The change in flow rates allows for 2 m^3 full shift samples to be taken, providing that the filter is not overloaded with non-fibrous particulates.

B. Sample Evaluation

1. The inclusion of the Walton-Beckett graticule in the method was made to standardize the field area observed through the eyepiece [3].
2. The introduction of the HSE/NPL test slide was made to standardize microscope optics to improve reproducibility.
3. A recent international collaborative study involved 16 laboratories using prepared slides from the asbestos cement, milling, mining, textile, and friction material industries [4]. The modified CRS (NIOSH B) rules were found to be more precise than the AIA (NIOSH A)* rules. The ranges of relative standard deviations (s_r), which varied with sample type and laboratory, were:
4. Because of past inaccuracies associated with low fiber counts, the minimum loading has been increased to 100 fibers/mm^2 filter area (80 fibers total count). This level yields an overall s_r= 0.13, as indicated in Fig. 3 (revised) of P&CAM 239 [1], which corresponds to an analytical s_r= 0.12 after removal of pump error [10]. Similarly at the maximum count of 100 fibers , overall s_r= 0.115 and analytical s_r= 0.10 are obtained.

	s_r (Intralaboratory)	s_r (Interlaboratory)	s_r (Overall)
AIA (NIOSH A Rules)*	0.12 to 0.40	0.27 to 0.85	0.46
Modified CRS (NIOSH B Rules)	0.11 to 0.29	0.20 to 0.35	0.25

*Under AIA rules, only fibers having a diameter less than 3 µm are counted and fibers attached to particles larger than 3 um are not counted. NIOSH A rules are otherwise similar to the AIA rules.

The B rules have also been favorably received by analysts as less ambiguous and simpler to use; these rules also showed the least bias relative to AIA rules in the collaborative study. An independent NIOSH laboratory study using amosite fibers reported a relative standard deviation of 0.157 for the B rules [9].

Relative Levels of Count by Different Counting Rules* [4]

Sample Type	Number of Samples	Aspect Ratio > 3:1 AIA	Aspect Ratio > 3:1 Mod. CRS	Aspect Ratio > 5:1 AIA	Aspect Ratio > 5:1 Mod. CRS
Mining	10	100	127	74	92
Milling	10	100	112	84	95
Asbestos Cement	14	100	146	90	137
Textile Chrysotile	10	100	109	89	99
Friction Material	10	100	130	87	116
Others (Insulation, Amosite)	6	100	127	92	118
Mean		100	125	86	110

*Arithmetic means of counts made by different laboratories relative to the AIA (> 3:1) counts.

Sample Preparation Technique

The acetone vapor-triacetin preparation technique has been incorporated in the method as a faster and more permanent mounting technique than the dimethyl phthalate/diethyl oxalate method [2].

Evaluation of the method using the A and B counting rules will proceed on a continuing basis through the NIOSH Proficiency Analytical Testing (PAT) Program. The new PAT reporting form allows for reporting of results by either set of rules as of January, 1984.

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ETHOD REVISED BY: James W. Carter, David G. Taylor, Ph.D., CIH, and Paul A. Baron, Ph.D., NIOSH/DPSE; based on the revised Method P&CAM 239 [1].