

P R E L I M I N A R Y D R A F T

AIR MONITORING METHODOLOGY

FOR THE

DULUTH ASBESTOS STUDY

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DULUTH ASBESTOS STUDY TEAM

Air Monitoring Program

1.0 INTRODUCTION

The air monitoring program was designed to answer specific questions regarding the presence of asbestos fibers originating from several sources, including:

- (1) The Reserve Mining Company (RMC) processing plant at Silver Bay, Minnesota.
- (2) The land disposal areas of the Erie Mining Company (EMC) at Hoyt Lakes, Minnesota.
- (3) The ore loading dock area within Duluth, Minnesota.
- (4) The RMC coarse crushing and mining operation near Babbitt, Minnesota.

An additional area monitored included residential areas within Duluth.

Specific processes or sites were selected for sampling in each source area. Meteorological data was also concurrently collected to verify the emission source. The primary reason for sampling was to detect the presence of airborne asbestos fibers in the taconite mining, processing, and ore handling areas.

Monitoring sites at the RMC, Silver Bay, Minnesota were located in a semi-circular network due to the interference of the adjoining lake. The purpose was to measure airborne asbestos emissions from the crushing, concentrating, pellet forming and taconite

pellet loading processes. A background station was also selected. This company was also surveyed for possible stack testing.

Monitoring at EMC was designed to measure airborne asbestos particles from the tailings disposal area. A second site was located to evaluate process emissions, particularly from the pellet forming process. Finally, a background site was selected for comparison. This company was also surveyed for possible stack tests.

Airborne particulates from the ore loading docks within the Duluth Harbor were monitored to determine the presence of asbestos. The significance of this data is that the ore and taconite pellets loaded on ore boats at Duluth originate from mining and processing areas west of the RMC and EMC mining area...and this material may also contain asbestos fibers.

The fourth area of concern was the RMC coarse crushing process and mine near Babbitt. Asbestos fibers could affect the health of mine workers, and families residing in Babbitt and in surrounding areas.

Finally, residential areas within Duluth were monitored. This data would be used to define background levels existing in residential areas. Consideration would be given to airborne asbestos levels originating from the water supply, including laundry facilities and furnace humidifiers.

1.1 RESOURCES

The EPA, Region V office provided personnel to operate the collection of air samples under chain of custody procedures.

Region V also provided the air sampling program coordinator.

The NERC-RTP provided technical assistance in sampling network design and in installation, operation, and maintenance of air monitoring and meteorological instrumentation. A meteorologist was also provided to assist in sampling site selection and interpretation of meteorological data. NERC-RTP was responsible for all air sample analyses. The St. Louis County Civil Defense Agency supplied power generators to operate the monitoring instruments, and vehicles as necessary. Generators were also rented from local rental agencies.

The National Water Quality Laboratory (NWQL) was the base of operations, providing logistical support including necessary vehicles, supplies, and other miscellaneous equipment. These resources were combined and utilized to complete the air monitoring effort.

1.2 SAMPLING SCHEDULE

The following air monitoring schedule was developed:

- (1) Region V air coordinator on-site June 16, 1973.
- (2) NERC-RTP technical assistance on-site June 18, 1973.
- (3) NERC-RTP meteorological support on-site June 19, 1973.
- (4) NERC-RTP air monitoring equipment and maintenance personnel on-site June 20, 1973.

- (5) Region V, ASB personnel to operate equipment on-site June 21, 1973.
- (6) RMC, Silver Bay process monitoring started June 21, 1973, completed June 23, 1973.
- (7) EMC, Hoyt Lakes process and tailing monitoring started June 23, 1973, completed June 25, 1973.
- (8) RMC, Babbitt process and mine monitoring started June 25, 1973, completed June 28, 1973.
- (9) Duluth ore loading docks monitoring started June 23, 1973, completed June 27, 1973.
- (10) Duluth, NWQL "inside" laboratory evaluation started June 26, 1973, completed July 5, 1973.
- (11) Duluth, NWQL "outside" monitoring for background started June 27, 1973, completed June 29, 1973.
- (12) Duluth, residential areas started June 28, 1973, completed July 5, 1973.
- (13) RMC, Silver Bay pre-stack test survey completed June 25, 1973.
- (14) EMC, Hoyt Lakes pre-stack test survey completed June 26, 1973.

1.3 PROCEDURES

The sets of procedures utilized in the air monitoring program included site selection, sampling handling procedures, and monitoring strategy. The steps in each procedure follow:

A. Monitoring Site Selection.

1. Definition of the data needed.

2. Location of the source on topographic maps.
3. Location of possible monitoring sites on maps.
4. Preliminary survey of the source.
5. Selection of the sampling date(s).
6. Collection of meteorological forecast data.
7. Selection of the sampling site based on existing site topography, process source, wind speed, and wind direction.

The air coordinator and the meteorologist jointly determined final site definition.

B. Sample Handling.

A chain of custody procedure was used to verify sample status at all times. After completing the sampling and recording procedural parameters in the log book, the operator retains the sample until it is transferred to the field coordinator. The transfer operation was then recorded in the sample log book. Additional transfers of samples were recorded on a duplicate form with the original remaining with the sample and the carbon remaining with the transferring party.

Responsible individuals and their functions are listed in Table 1.1.

1. Monitor Operator responsible for the recording of data; filter change during his shift; and maintaining the filter until transfer to the field coordinator.
2. Field Coordinator responsible for verification of the data recording including the return of any filter record

card with missing information; filter transfer using the transfer form from the operator to a locked or sealed container, and maintenance of the locked or sealed file until transfer to a courier.

3. Courier responsible for custody and transportation from Duluth to Columbus, Ohio of the locked or sealed file until exchange with contractor.
4. Contractor responsible for the receipt of the locked or sealed file. Chain of custody must be maintained within the contractor's laboratory.

C. Monitoring Strategy.

1. Six areas were selected for monitoring including:
 - a. Duluth - ore loading
 - b. Duluth - NWQL
 - c. Duluth residence
 - d. RMC - Silver Bay, Minnesota
 - e. EMC - Hoyt Lakes, Minnesota
 - f. RMC - Babbitt, Minnesota
2. Duplicate samples were collected except on RMC and EMC property where triplicate samples were collected. The third set was signed over to the mining companies before EPA field personnel left the mine property.
3. Sampling in each area included approximately three 8-hour runs, except for background sampling at the NWQL and residential areas within Duluth. These were continuous runs for 24 hours.

4. All samples except for filters run in private residences were handled under chain of custody procedures. Personnel continuously observed the monitors during operation. Filters collected in the Duluth ore loading dock and on the roof of the NWQL were collected within locked or sealed areas to maintain chain of custody.
5. All sampling networks included monitoring locations upwind, downwind and background for each source.
6. Portable meteorological measurements including wind velocity and wind direction were recorded at each site.

TABLE 1.1 - Responsible Personnel

1. Air Coordinator - Dr. Richard P. Trautner, Region V, S&A , Air Surveillance Branch.
2. Field Coordinator - Kenneth Shih, Region V, S&A, Air Surveillance Branch.
3. Couriers - Robert Kay and Peggy Harris - Region V, S&A, Federal Activities Branch.
4. Meteorologist - Paul Humphrey, Meteorology Laboratory, NERC-RTP.
5. Sample Custodian - Kay Kamalick, Region V, S&A, Air Surveillance Branch.
6. Monitor Operators - Region V, S&A, Air Surveillance Branch :
 - a. David Hogleund
 - b. Charles Miller
 - c. Edward Klappenbach
 - d. Edwin Fox
 - e. Barry Bolka
 - f. Walter Kocal
 - g. Kenneth Malmberg
 - h. Paul de Percin
 - i. Eugene Moran ,
7. Secretarial Support - Roberta Fairley, Region V, S&A, Air Surveillance Branch.
8. Maintenance Support - NERC-RTP, QAEML:
 - a. Frank McElroy
 - b. Jack Bower
 - c. Jim Thompson
 - d. Bobby Edmonds
 - e. Vernon Daughtridge

2.0 INSTRUMENTATION

The standard high volume air sampler with fiber glass filters could not be used due to interference of asbestos in the fiber filters. Membrane filters and a membrane particulate sampler were selected.

2.1 AMBIENT AIR SAMPLERS

The samplers used in the Duluth Study were total particulate membrane samplers equipped with 4" sampling heads. This unit has a limiting orifice to maintain constant flow and is designed to operate with membrane filters between 0.2 and 5.0 micron membrane. Schematics of the unit are presented in Illustrations 2.1-2.4. The pump shelter and internal layout are described in Illustrations 2.1 and 2.2, pages 12-13. The physical design of the filter holder and components of the sampling train are presented in Illustrations 2.3 and 2.4, pages 14-15.

2.2 FILTER MEDIA

The collecting media consisted of a membrane filter of a copolymer of acrylonitrile and polyvinyl chloride coated onto a nylon web. The pore size used was 0.45 micron over a 3 5/8" diameter effective area.

2.3 METEOROLOGICAL EQUIPMENT

Wind speed and directions measurements were taken at all monitoring areas except EMC. The U.S. EPA meteorological equipment consisted of Climet #C1-26 units mounted on 15 foot masts. A battery powered

strip chart recorder gave a continuous record of both wind speed and direction. At EMC, meteorological data was collected by a Bendix aerovane operated by EMC, which was mounted on a 20 foot mast. A xeroxed copy of the strip chart recording was provided to EPA by EMC. The meteorological station locations are listed in Table 2.1, page 16. ✓

2.4 CORRECTION OF AIR FLOWS TO REFERENCE CONDITIONS

Hourly temperature and pressure reading at the National Weather Service Office, Duluth Municipal Airport, were used to correct all Duluth flow rates to reference conditions of 25°C and 1 atmosphere. It was determined that the maximum variation occurred for samples A95 and A96 collected on June 22, 1973 between 0000-0800 hours at Silver Bay. In this instance the measured flow rate was 2.9% less than the actual flow rate.

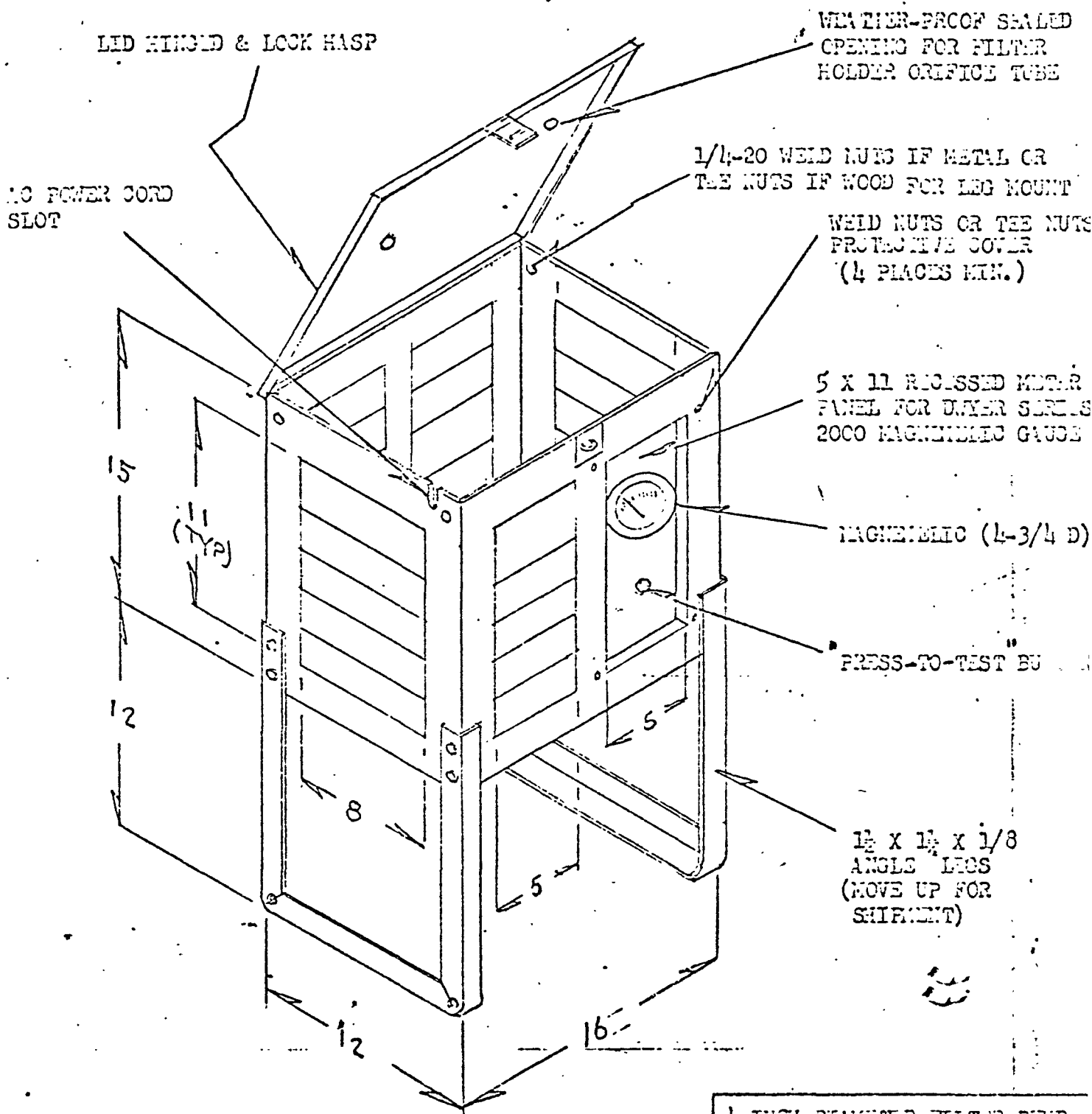
2.5 DULUTH WIND PATTERN DATA

A comparison was made of the frequencies of wind direction at Duluth during part of the sampling period of June 21 through June 30, 1973. This was compared to the 10 year frequencies for June, 1951 through 1960. Calm conditions and wind directions from the NW quadrant (W-NNW) had significantly greater frequencies during the 1973 sampling period than during the 10 year period (1951-1960).

The frequency of wind directions from 3 quadrants was below normal. From the NE quadrant (N-ESE), the 1973 value was only a tenth the 10 year frequency. Wind from the SE quadrant (E-SSE) during the 1973 sampling period was almost one-third less than the 10 year frequency.

The SW quadrant (S-WSW) during the 1973 sampling period had a ratio of roughly on²-half the 10 year directional frequency. However, the NW quadrant (W-NNW) had a ratio in 1973 2.22 times greater than the 10 year June frequency. During calm conditions the ratio of the 1973 test period was 2.93 times greater than the 10 year frequency. It can be concluded from these facts that the wind pattern during our sampling period (June 21-30, 1973) was quite inconsistent with the 10 year wind pattern (see Tables 2.1 and 2.2).

TOTAL PARTICULATE MEMBRANE SAMPLER PUMP SHELTER



NOTES:

1. MATERIAL: 18 GAUGE METAL, EXTERIOR ENAMEL
2. VENTILATION LOUVERS 8 X 11 AREA EACH, 5 X 11 FRONT AND EACH. (2 INCH CLEARANCE TO CASE EDGES) MAYBE SLIT & FORCED IN CASE OR ADDED.

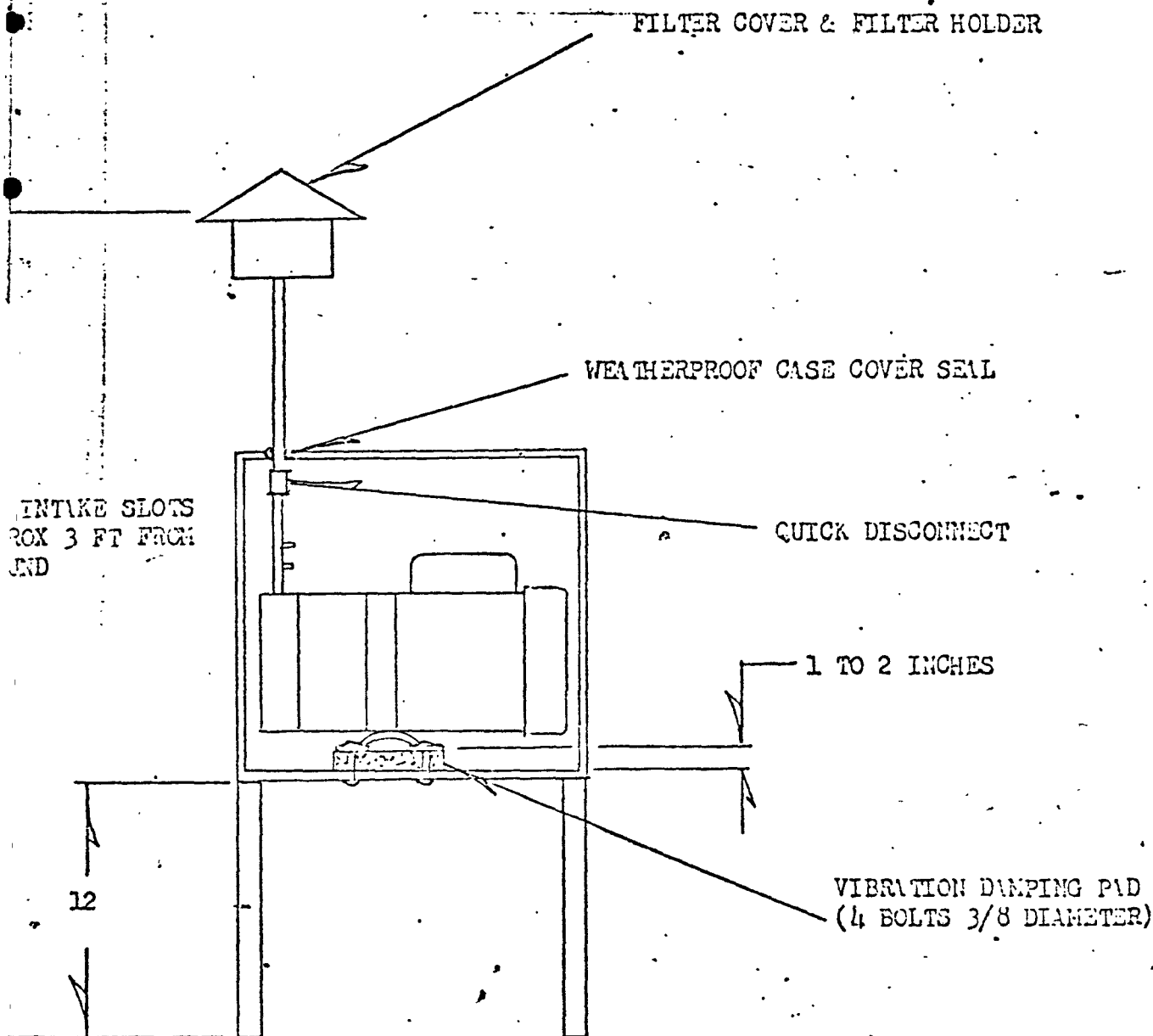
4 INCH DIAMETER FILTER PUMP
SHELTER GAST MODEL 0822 UNIT

DATE 8-21-68 BY RP

SCALE 1:0 ENG. NO. AF-1

ILLUSTRATION 2.2

TOTAL PARTICULATE MEMBRANE SAMPLER - SIDE VIEW



4 INCH DIAMETER FILTER HOLDER

ASSEMBLY DIMENSIONS OF UNIT

DATE 8-29-68 BY RP

SCALE 1:8 DWG. NO. RF-3

TOTAL PARTICULATE MEMBRANE SAMPLER FILTER HOLDER

WEATHERPROOF COVER LOWER EDGE
MUST OVER-LAP INTAKE SLOT LOWER
EDGE (PREVENT CROSS-WIND FROM
WETTING FILTER DURING RAINS)

1/2 X 3-1/4 SLOTS (4 PLACED EVENLY
SPACED ON SAME CIRCUMFERENCE LINE OF
SIX-INCH DIAMETER PIPE)

FILTER COVER MUST BE EASILY
REMOVED AND APPLIED WITH A STOP-
ARRANGEMENT TO MAINTAIN A 1/2
INCH SPACING BETWEEN THE LOWER
EDGE OF THE INTAKE SLOT AND THE
PLANE OF THE MEMBRANE FILTER
PLACED IN THE HOLDER.

1/8 TO 1/4 DIAMETER X 5.750 I.D.
"O" RING SEALS (2 PLACES APPROX.
1/2 INCH FROM CASE ENDS)

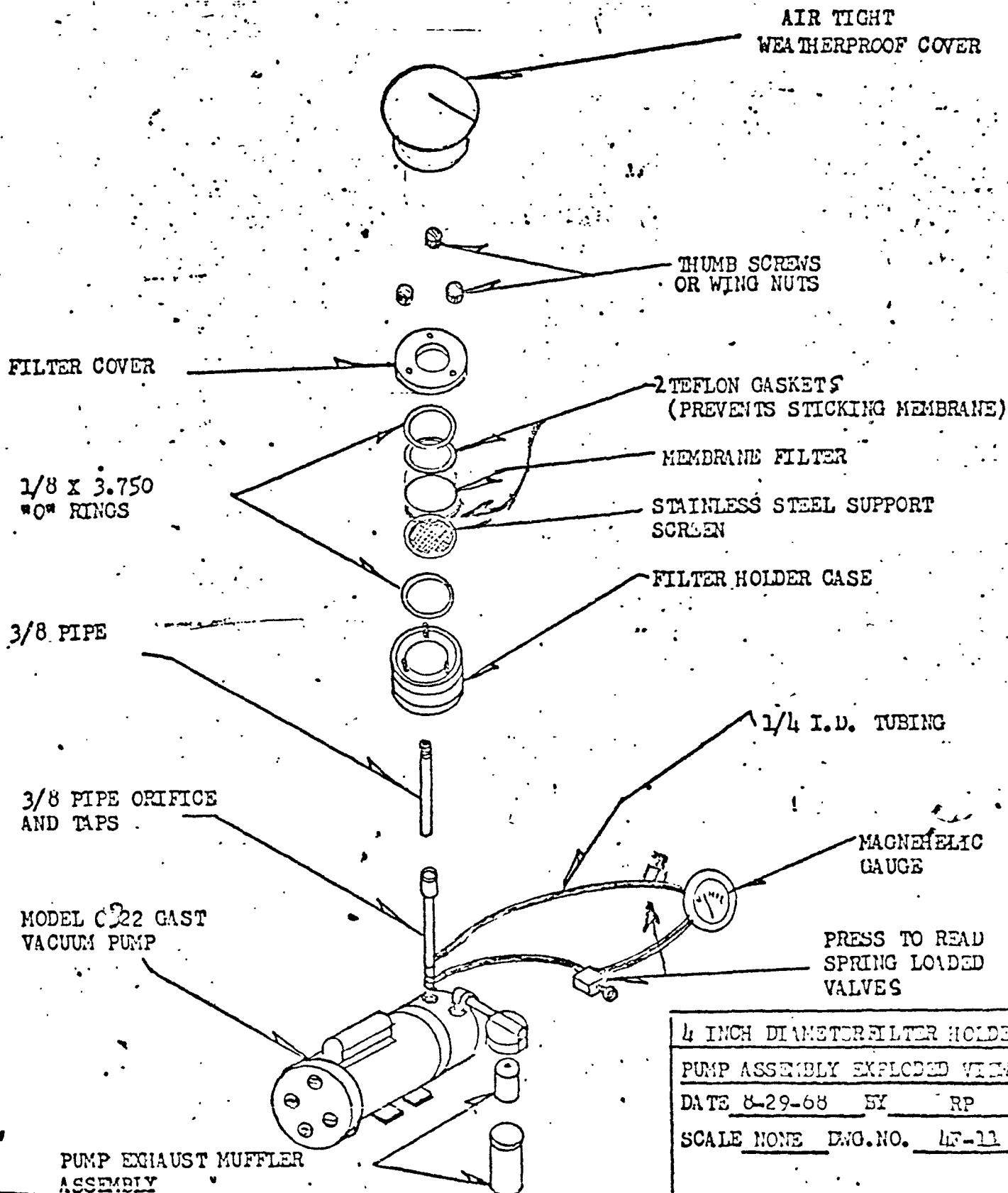
MUST MAINTAIN 1/2 INCH
MINIMUM AIR ACCESS TO
INTAKE SLOTS

MATERIAL: 24 GAUGE (.0239)
MINIMUM CRS OR
ALUMINUM
FINISH: WEATHERPROOF

4 INCH DIAMETER FILTER HOLDER
WEATHERPROOF COVER
DATE 8-29-68 BY RP
REQUIRED EACH UNIT 1
SCALE 1:2 Dwg. NO. 4F-4

ILLUSTRATION 2.4

TOTAL PARTICULATE MEMBRANE SAMPLER - PUMP ASSEMBLY

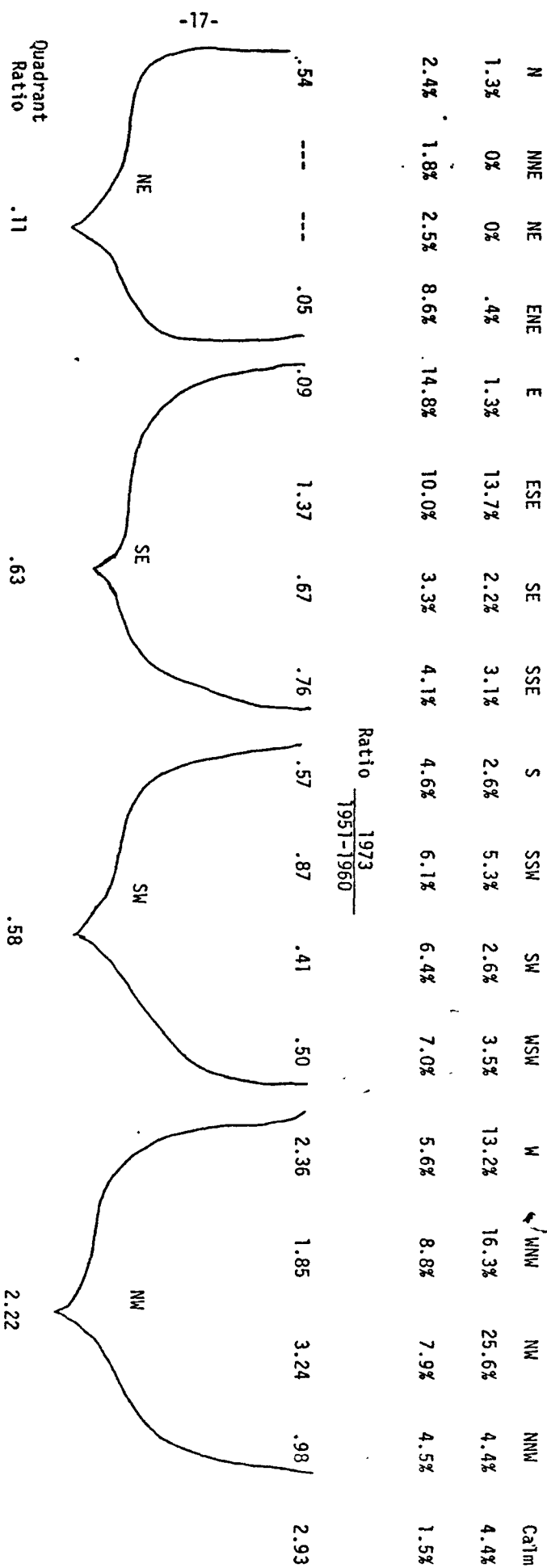


4 INCH DIAMETER FILTER HOLDER		
PUMP ASSEMBLY EXPLODED VIEW		
DATE 8-29-68	BY	RP
SCALE NONE	ENG. NO.	4F-11

TABLE 2.1 - DULUTH ASBESTOS STUDY MONITORING STATION DEFINITION

NUMBER	LOCATION	ADDRESS	TYPE	SAMPLING HEIGHT	UTM COOD.	REMARKS
D-1	Duluth, Minnesota	37th & Oneoft St.	Ore Loading	12.5	N. 5187690; E. 565620	W.D. & W.S. at 21.5' above ground
D-2	Duluth, Minnesota	6201 Congdon Rd.	Lab. background (241)	3	N. 5187460; E. 576040	
D-3	"	"	Lab. background (121)	3	"	
D-4	"	"	Roof MWQL-background	41.6	"	W.D. & W.S. at 47.6' above ground level.
D-5	"	6015 London Rd.	Resident	3	N. 5187390; E. 575730	
D-6	"	9901 North Shore Rd.	"	3	N. 519400; E. 58400	
D-7	"	1910 Hartley Rd.	"	3	N. 518600; E. 570310	
D-8	"	2702 E. 1st. St.	"	3	N. 5184650; E. 57310	
D-9	"	143 Occidental Ave.	"	3	N. 5187620; E. 575620	
D-10	"	6201 Congdon Rd.	Lab background (230)	3	N. 5187460; E. 576040	
S-1	RMC-Silver Bay, Minn.	N. of Plant Site	Background Site	8	N. 5241000; E. 632540	W.D. & W.S. 17' above ground level.
S-3	"	West of Plant Site	Process Site	8	N. 5238570; E. 631140	W.D. only 17' above ground level.
S-4	"	S.W. of Plant Site	Process Site	8	N. 5237140; E. 630430	W.D. only 17' above ground level.
B-1	RMC-Babbitt, Minn.	N. of mine area	Process + background	8	N. 5280690; E. 582000	W.D. only 17' above ground level.
B-2	"	S. of mine area	Background	8	N. 5276920; E. 581310	W.D. & W.S. 17' above ground level.
B-3	"	SE of mine area	Process	8	N. 5279620; E. 583150	
B-4	"	SE of Crusher #1	Process	8	N. 5280230; E. 58400	
E-1	EMC-Hoyt Lakes, Minn.	N. of tailing area	Process	8	N. 5275650; E. 565530	
E-2	"	N. of taconite process	Process	8	N. 5271690; E. 564690	
E-3	"	S. of mine area	Background	8	N. 5268080; E. 563080	
EMC Met. tower	"	NE. of E-2	Met. Station	20	N. 5272150; E. 565040	Met. Station of E.M.C. (W.D. & W.S.)

TABLE 2.2 - A Comparison of Wind Direction
Frequencies for Duluth, Minnesota
(June, 1973 vs. the 10 yr. Standard 1951 - 1960)



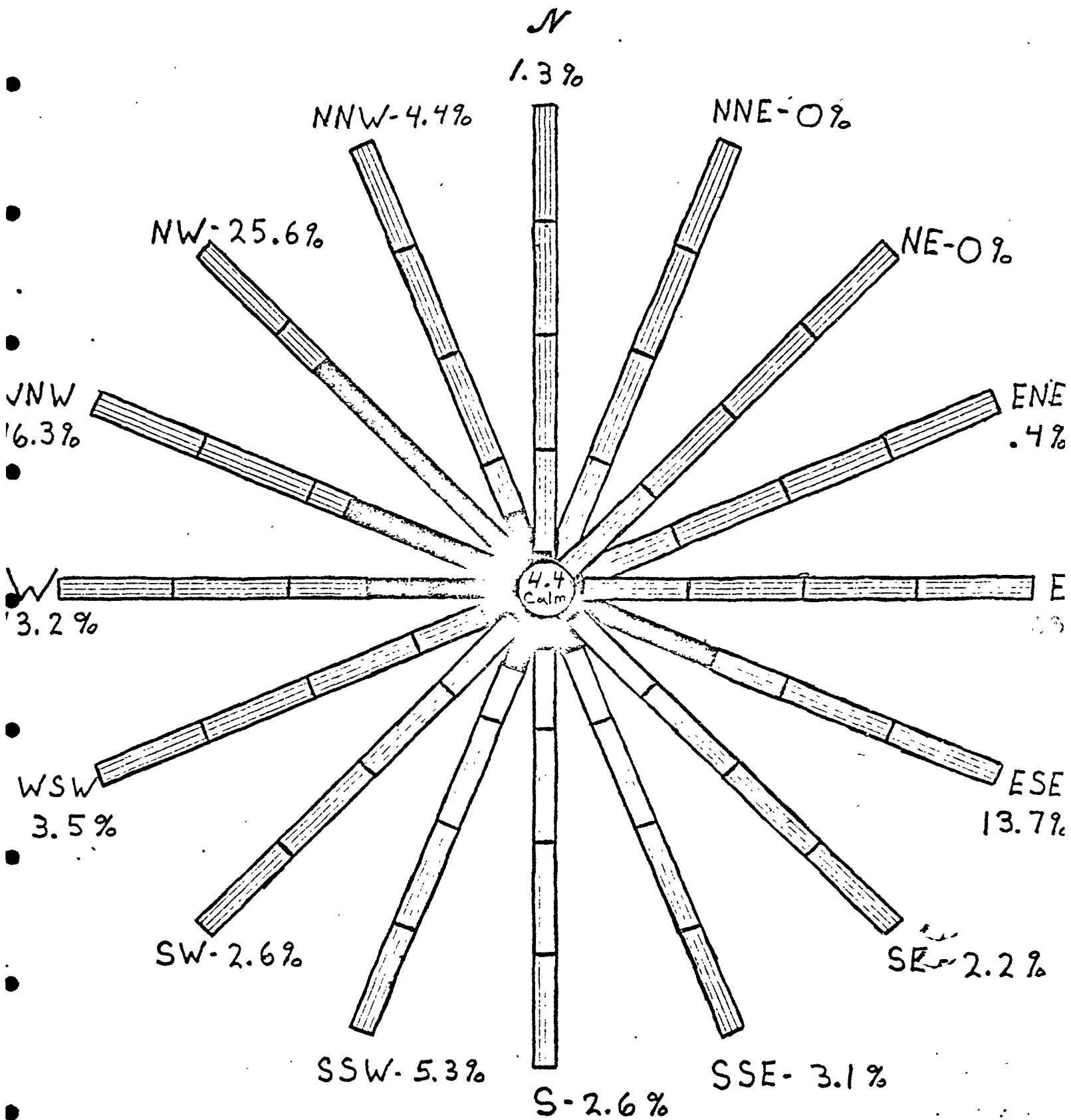


CHART 2.1
DULUTH WIND ROSE
6/21/73 - 6/30/73 11:00 a.m.

PER CENT

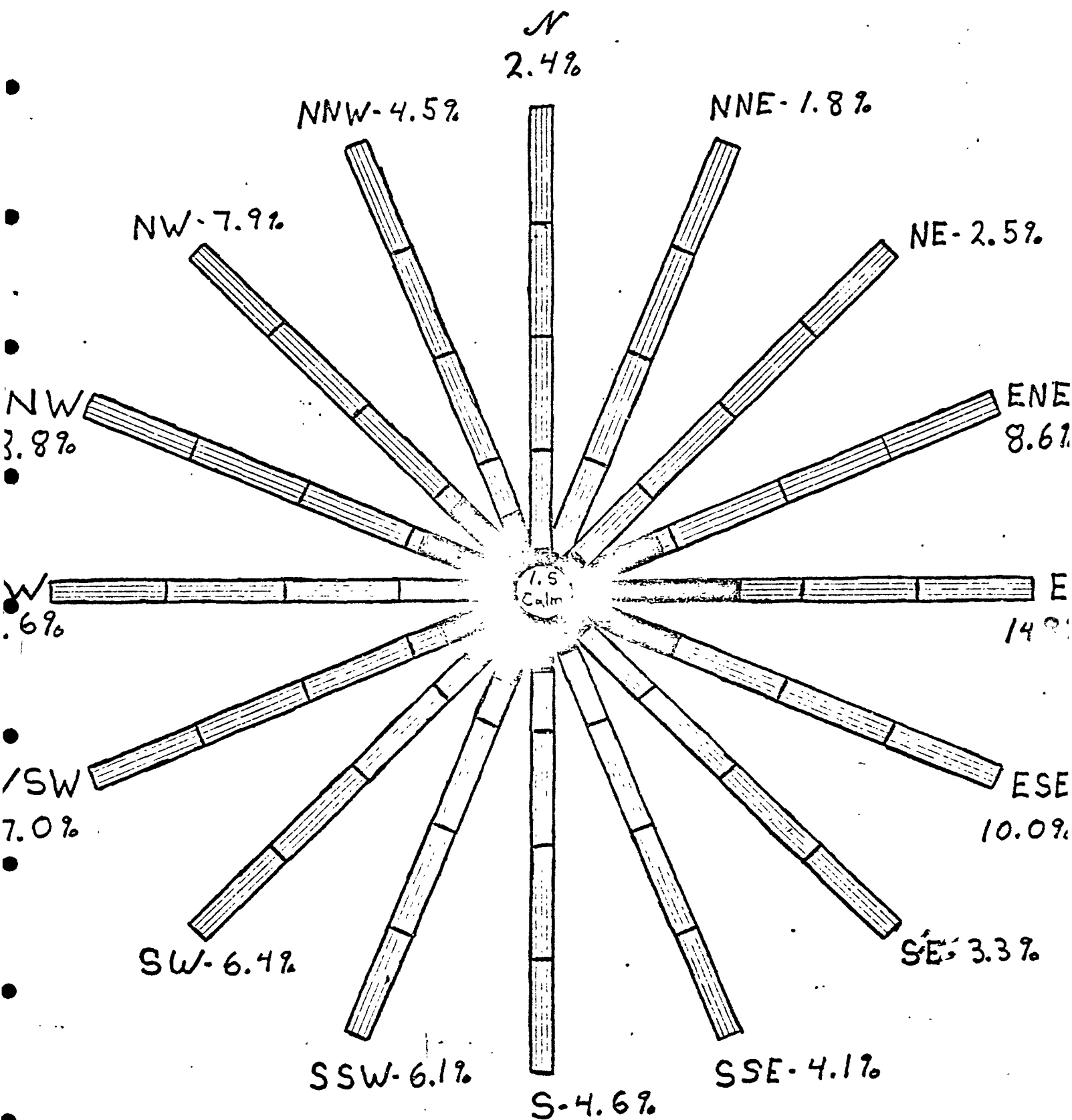


CHART 2.2
DULUTH WIND ROSE
June 1951 - 1960

PERCENT



3.0 SUMMARY OF SAMPLING BY SITE

Monitoring sites were assigned numbers in the following manner:

- | | | | | | |
|-------------------|---|------|---|------|--------|
| 1. RMC-Silver Bay | S | plus | a | site | number |
| 2. Duluth | D | " | " | " | " |
| 3. EMC-Hoyt Lake | E | " | " | " | " |
| 4. RMC-Babbitt | B | " | " | " | " |

All stations conducting air monitoring are listed and described in Table 3.1 - 3.4, pages 28-31. Maps are provided to show locations and distances from sites to the source being monitored.

1. Depending on wind direction, samples were classified by sampling efficiency.
2. For each site, a wind sector was defined. It included all possible wind directions that would blow emissions from the source to the sampling site.
3. The amount of time the wind blew from within this sector, compared to the total sampling time, yields the sampling efficiency in percent.
4. Sites were broken into two categories:
 - a. Background Sites - 100% sampling efficiency means the wind blew from the sampler toward the source 100% of the time. No emissions collected could have come from the source.
 - b. Process Sites - 100% sampling efficiency means the wind blew from the source toward the sampler 100% of the time. All emissions collected could have come from the source being monitored.

5. The percent figure was then grouped into one of three categories:

- a. Best 75% - 100%
- b. Fair 25% - 74%
- c. Poor 0 - 24%

3.1 RMC, SILVER BAY, MINNESOTA: JUNE 21-23, 1973; Sites S-1 to S-4; 22 FILTERS; (See TABLE 3.1, pages 32-33.)

S-1 Background Site, June 21-23.

Site S-1 was located north of the source on Ski Hill Road. No portion of the RMC facility was visible from the sampling site, which was located in a hilly, wooded terrain. All winds except S to SW would generate Best results.

Four 8-hour samples were collected at this site. Filters A65, A66, and A67 were classified as Best.

S-2 No sampling due to meteorological interference.

S-3 Process Site, June 21-23.

Site S-3 was located 60 feet northwest of the Car Dumper and Barney House, fine crusher, and concentrator. It was on a bluff 20 feet above the dumper. All winds except ENE to SSW would generate Best results.

Five sets of duplicate 8-hour samples were collected. Filters A97, A98, A101 and A102 were classified Best.

S-4 Process Site, June 21-23.

Site S-4 was located on a gravel turnaround 75 feet from U.S. 61. The site was south-southwest of the pellet storage area, the pelletizing plant, and the concentrator. Small bushes surrounded the site. Only winds from NNE to E could be used to obtain Best results.

Four sets of duplicate 8-hour samples were taken. One filter, A82 was unusable because the filter support collapsed. Only filter A84 could be classified Best.

3.2 DULUTH; June 24-July 5, 1973; Sites D1-D10; 36 FILTERS, (See Table 3.2, pages 34-35).

D-1 Sewage Pumphouse, Process Site, 37th and Oneoto Streets, June 24-26.

Site D-1 was selected to define asbestos levels in the ore dock loading area. The samplers were placed on top of the pumphouse, 12.5 feet above grade. All winds from S to NE in a counterclockwise direction would result in Best.

D-2 NWQL, Congdon, Background Site, June 26.

Site D-2 was in room #241 of the NWQL. This site would provide background data on working areas inside NWQL.

Duplicate samples were collected for a 24-hour period.

D-3 NWQL, Background Site, June 27.

Site D-3 was in the scope room in laboratory #121 of NWQL. Duplicate samples were collected for a 24-hour period.

D-4 NWQL, Background Site, June 27-28.

Site D-4 was located on the roof of NWQL. It was selected as a background site, but an offshore wind may cause this site to indicate airborne asbestos from Lake Superior.

Duplicate 24-hour samples were collected.

D-5 6015 London Road, Duluth, Background Site, June 28.

Site D-5 was located inside the Allen Batterman residence. One sampler was positioned in the living room, near the front door with stairs nearby. The other was located in the basement, near a clothes washer and dryer. This is an older home with exposed pipes and wires in the basement. At least 3 individuals carried on normal activity during the sampling period.

Duplicate 24-hour samples were obtained. Sampling efficiency was not computed.

D-6 9901 North Shore Drive, Duluth, Background Site, June 28.

Site D-6 was located in the basement of the John McCormick residence. The samplers were placed near a washer, dryer, and hot air furnace. All utilities were operated during the sampling period. This residence has private well water, and a family of four live there.

Duplicate 24-hour samplers were collected. Sampling efficiency was not computed.

D-7 1910 Hartely Road, Duluth, Background Site, June 29.

Site D-7 was located in the basement of the William Brungs residence. The samplers were located in a recreation room between a dehumidifier and a hot air furnace. A washer, dryer, television set, and workshop

were also situated nearby. Four individuals engaged in normal activity during the sampling period.

Duplicate 24-hour samples were taken. Sampling efficiency was not computed.

D-8 2702 E. 1st Street, Duluth, Background Site, June 29.

Site D-8 was located in the basement of the Dr. Philip Cook duplex. The samplers were positioned near a washer, dryer, furnace, and hot water heater. This is an older home with exposed pipes and wires in the basement. Activity was somewhat less than normal, because the family was away the last 8 hours of the sampling period.

Duplicate 24-hour samples were collected. Sampling efficiency was not computed.

D-9 143 Occidental Blvd., Duluth, Background Site, June 29.

Site D-9 was located in the basement of the Dr. Gary Glass home. The samplers were located on either side of a hot air furnace, near a washer-dryer, dehumidifier, and freezer. Four people engaged in normal activity during the sampling period.

Duplicate 24-hour samples were taken. Sampling efficiency was not computed.

D-10 NWQL, Background Site, July 5.

Site D-10 was located in the tailings laboratory, room #230.

Duplicate 24-hour samples were collected.

3.3 EMC-HOYT LAKES; JUNE 23-24, 1973; SITES E1-E3; 36 FILTERS, 12 GIVEN TO EMC; METEOROLOGICAL DATA SUPPLIED BY EMC. (SEE TABLE 3.3, pages 36-37).

E-1 Process Site, June 23-25.

Site E-1 was located at the north end of the tailing basin, with a forest to the north. The site's purpose was to evaluate tailing disposal as a source of airborne asbestos. Winds from all directions except WSW clockwise to ESE generated Best results.

Four triplicate 8-hour samples were taken at this site, with one from each set going to EMC. Filters A103-A105, A109-A114, and A215-A217 were classified as Best.

E-2 Process Site, June 23-25.

Site E-2 was located 875 feet south of coarse crusher #1. It was in the immediate vicinity of the major crushing plant, on an unpaved road. Winds from any direction except NW to ENE generated Best results.

Four triplicate 8-hour samples were taken, with one from each set going to EMC. All the samples from this site were classified as Best.

E-3 Background Site, June 23-25.

Site E-3 was located 10 to 20 feet off to the side of Company Road, a small paved road. It was selected as a background site, and was surrounded by trees, grass and bushes. All winds except N to NE generated Best results.

Four triplicate 8-hour samples were collected, with one from each set going to EMC. Filters A69-A75, A220, and A221 were classified as Best.

3.4 RMC, BABBITT, MINNESOTA; June 25-28, 1973; SITES B1-B4; 42 FILTERS, 14 Given to RMC; (See Table 3.4, pages 38-40).

B-1 Background + Process Site, June 25-28.

Site B-1 was located on the north side of the mine and south of Argo Lake. The site was beside a narrow gravel road, with occasional grass, shrubs, and trees (mostly to the north). Due to shifting winds, one set of filters monitored RMC emissions, the rest monitored the background level of asbestos. Winds from W to NE in a clockwise direction generated background readings.

Four triplicate samples were obtained, with one from each set going to RMC. All the samplers from this site were classified as Best.

B-2 Background Site, June 25.

Site B-2 was located in vegetation 80 feet from an asphalt road, with a stockpile of low grade ore visible to the north. Sampling was terminated after 2 hours due to violent thunderstorms flooding the generators.

Triplicate samples were collected, with one going to RMC. All were classified as Best.

B-3 Process Site, June 25-28.

Site B-3 was located about 250 feet from an unpaved road that company trucks used to haul ore from the mine to crusher #1. It was about 0.5 miles west of crusher #1. All winds would generate Best results except NE to E.

Six triplicate samples were taken at this site, with one from each set going to RMC. All the samples were classified as Best.

B-4 Process Site, June 25-28.

Site B-4 was located near the loading bins for crusher #1 and a single railroad track going to crusher #1. All winds except SSW to WSW would generate Best results.

Three triplicate samples were taken at this site, with one from each set going to RMC. All the samples were classified as Best.

In summary, a total of 137 filters were collected in the Duluth air quality sampling. EMC received 12 samples, and RMC received 14.

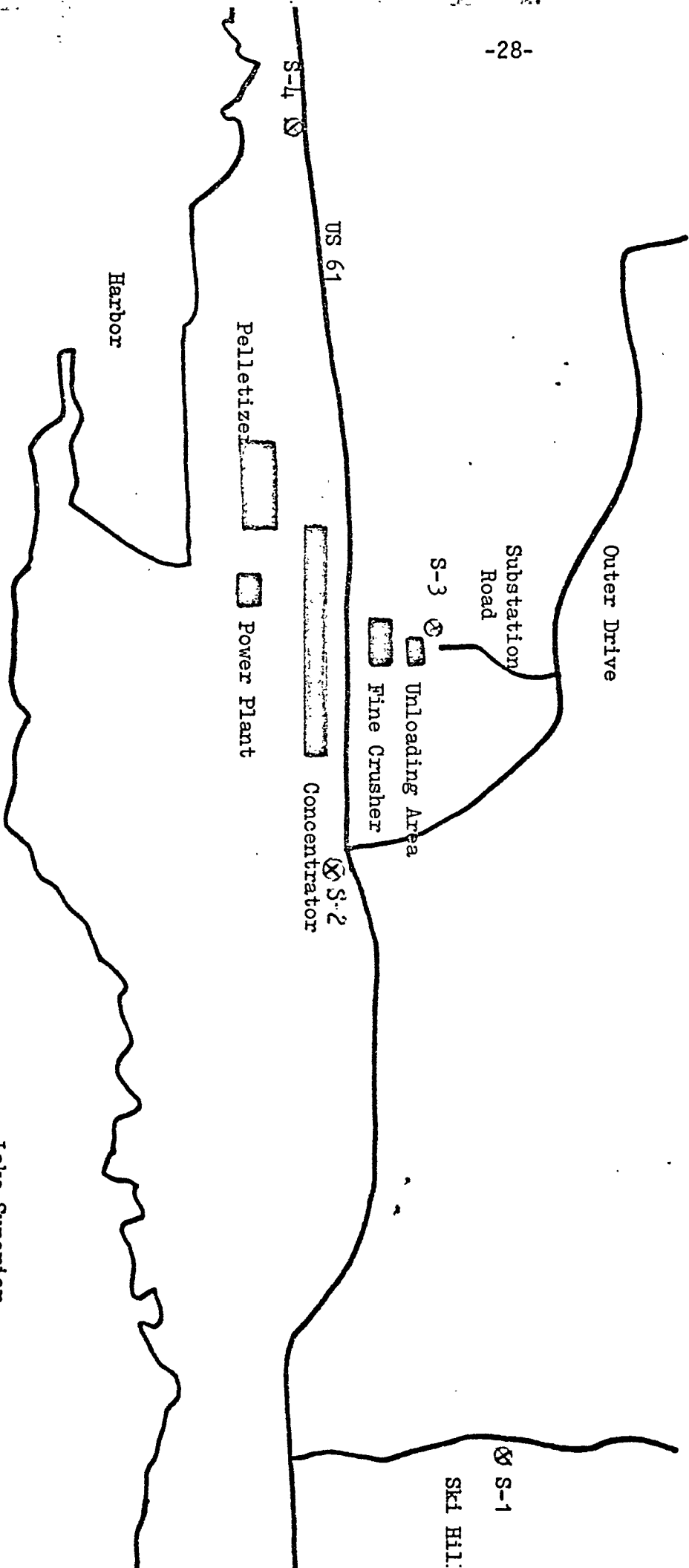
Eighty-nine of the 137 samples were classified as Best on the basis of wind direction. Only 4 samples had to be classified as Poor.

Asbestos Study Air Monitoring Site Location Reserve Mining Company, Silver Bay Minn.

500 feet
Monitoring site

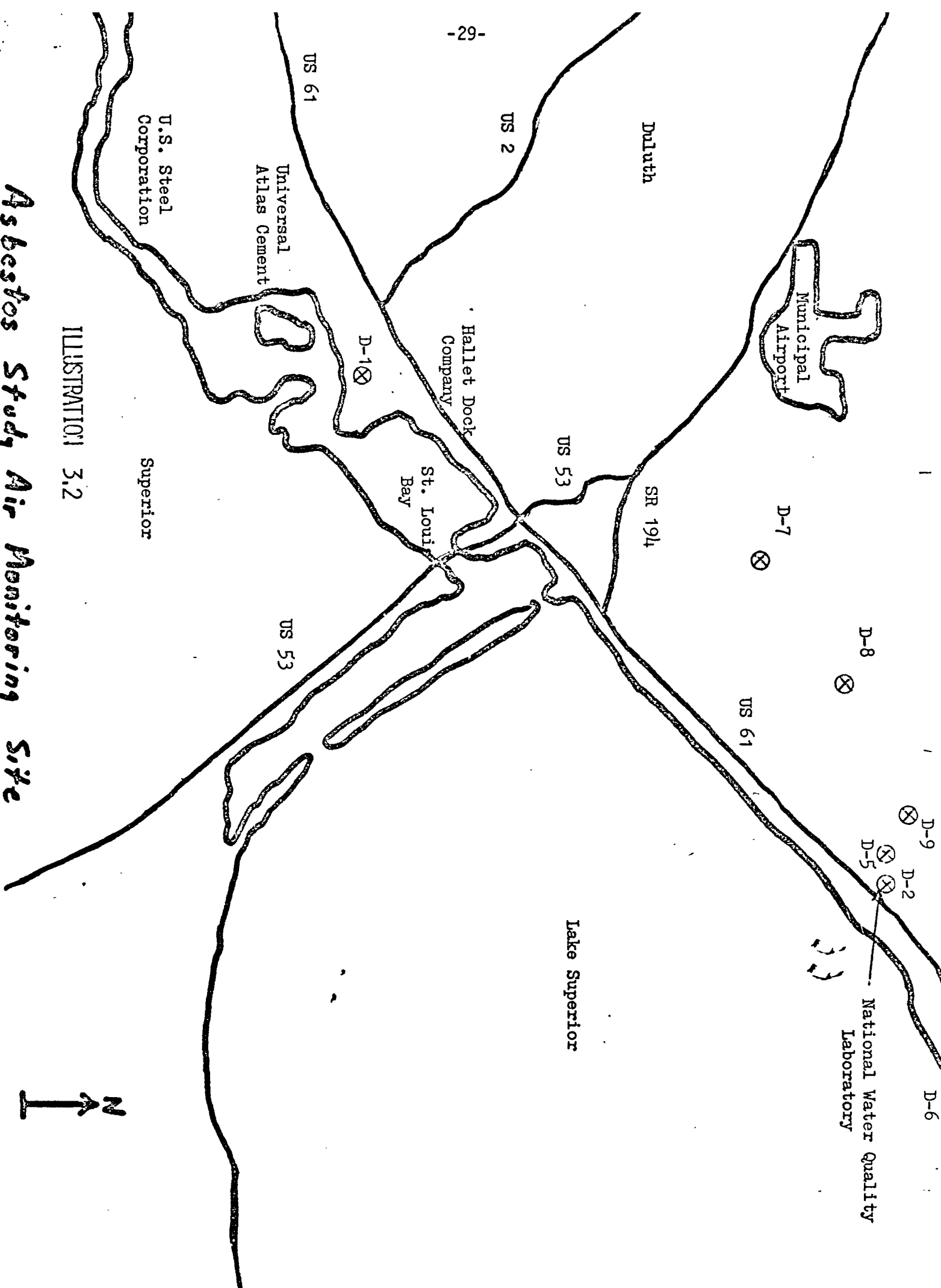


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Asbestos Study Air Monitoring Site

ILLUSTRATION 3.2



*Asbestos Study Air Monitoring Site Location
Erie Mining Company, Hoyt Lakes Minn.*

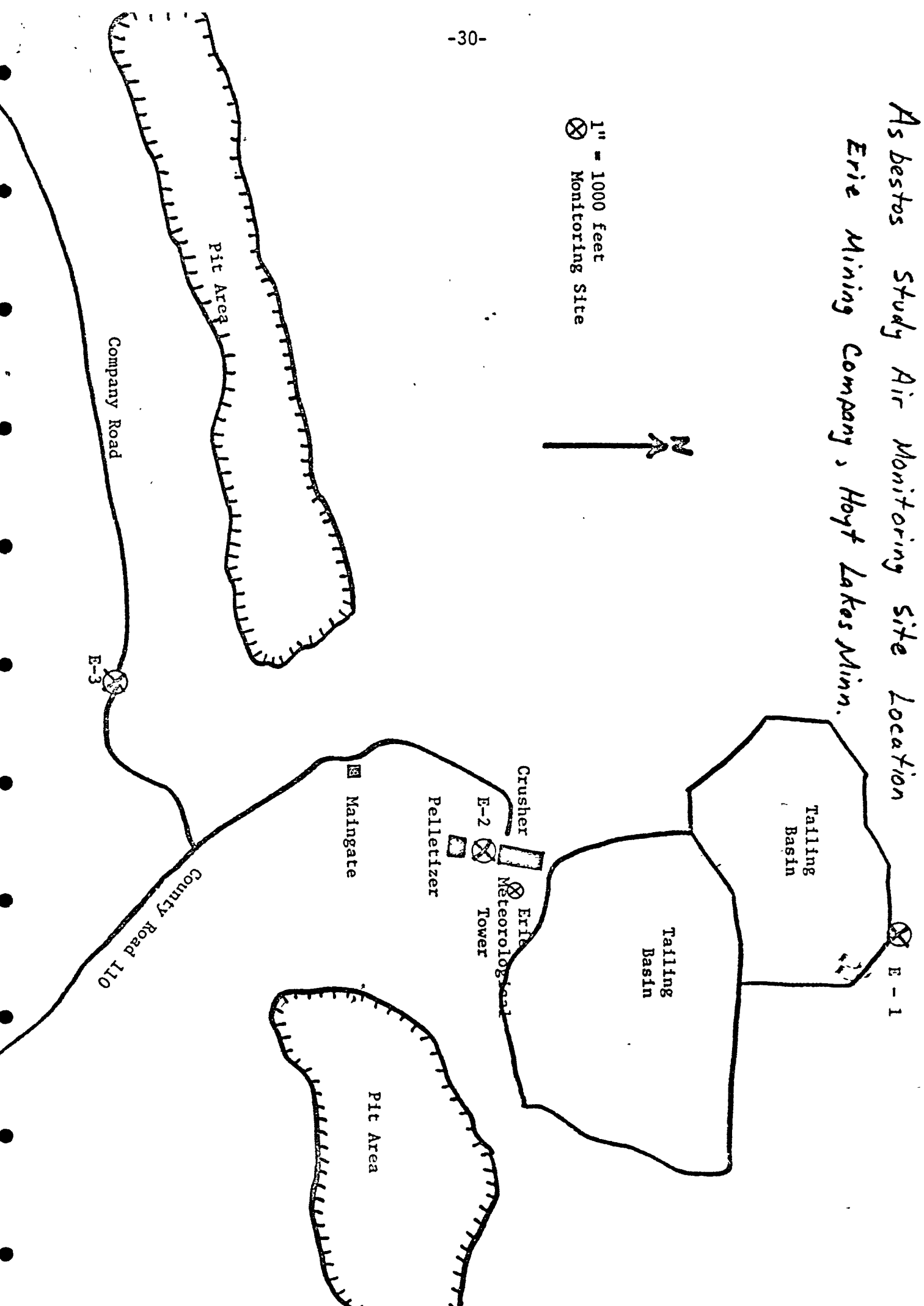


ILLUSTRATION 3.4

Asbestos Study Air Monitoring Site Location

Reserve Mining Company, Babbitt Minn.

1" = 5000 feet
⊗ Monitoring site

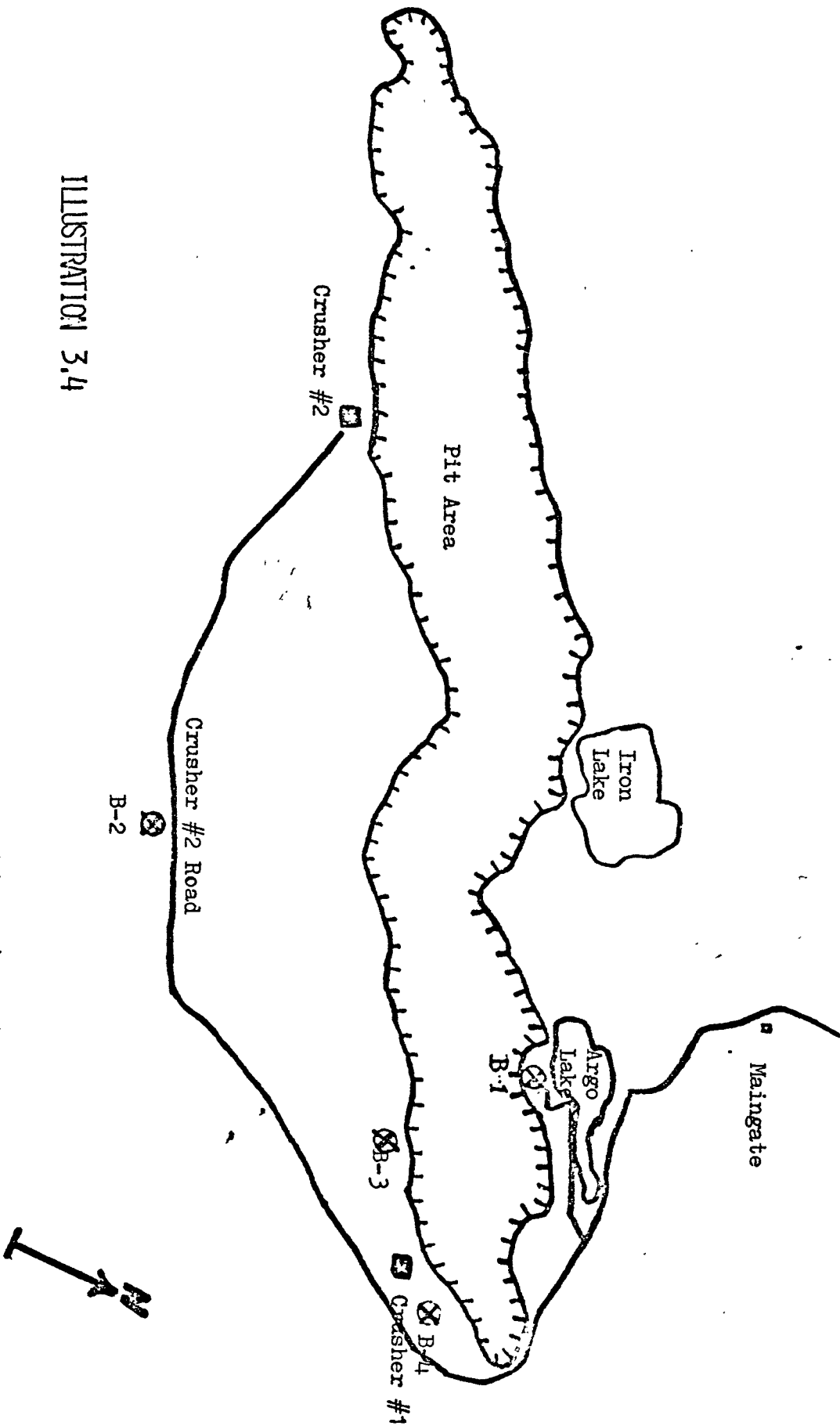


TABLE 3.1- DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR RESERVE MINING CO., SILVER BAY, MINNESOTA (June 21-23, 1973)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	Prevailing Wind	Wind Variability	Sampling Efficiency
RMC - Silver Bay, Minnesota, Site S-1 (Background Site)								
A65	2200	535	72.0	NNW	5.8G17.5	NW	NW-NE	100%
A66	0845	480	64.6	ESE	3.6	ENE	ENE-SE	100%
A67	1700	480	63.9	NNE	4.4G11.5	NE	N-ENE	100%
A68	0100	405	53.9	Var.	2.0	WNW/NE	NNE-SSE-NW	37%
RMC - Silver Bay, Minnesota, Site S-3 (Process Site)								
A93	1300	660	68.8	NW	6.5G17.5	NW	W-NNW	0%
A94	1300	660	65.8	"	"	"	"	"
A95	0000	480	61.1	N	5.1G14.5	NNE	NW-NE	0%
A96	0000	480	58.5	"	"	"	"	"
A97	0800	480	59.5	E	3.6	ENE	ENE-SE	100%
A98	0800	480	58.5	"	"	"	"	"
A99	1624	456	58.1	NE	4.6G11.5	NNE	N-ENE	25%
A100	1625	455	54.6	"	"	"	"	"
A101	0000	480	59.8	Var.	2.0	NE	NNE-SSE-NW	75%
A102	0000	480	56.4	"	"	"	"	"

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.1 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR RESERVE MINING
CO., SILVER BAY, MINNESOTA (June 21-23, 1973) (Cont'd)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	3** Prevailing Wind	4** Wind Variability	5** Sampling Efficiency
RMC - Silver Bay, Minnesota, Site S-4 (Process Site)								
A79	1940	735	96.8	N	5.9G17.5	NNW	NW-E	38%
A80	1940	740	-	"	"	"	"	"
A81	0800	480	62.5	ESE	3.6	E	E-SE	50%
A82	0805	67	29.2	E	2.5	E	E-ESE	67%
A83	1130	270	35.9	ESE	4.3	ESE	E-SE	40%
A84	1600	420	54.7	ENE	4.6G17.5	ENE	E-ENE	100%
A85	1600	400	52.1	"	"	"	"	"
A86	0040	428	55.1	S	2.0	SSW	ENE-S-WSW	25%
A87	0047	434	57.8	"	"	"	"	"

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.2 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR DULUTH, MINNESOTA
(June 24 - July 5, 1973)

Duluth, Minnesota, Site D-1, Sewage Pump House									
Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	Prevailing Wind	Wind Variability	Sampling Efficiency	
A1	1500	480	58.5	ENE	5.2G7.0	ENE	ENE-ESE	100%	-34-
A2	1500	480	61.2	ENE	5.2G7.0	ENE	ENE-ESE	"	
A3	2300	470	57.2	ENE	4.9G17.5	NE	NE-SE	"	
A4	2300	470	58.3	ENE	4.9G17.5	NE	NE-SE	"	
A5	0700	460	57.0	SE	4.2G10.0	E	NE-NW-WSW-E	"	
A6	0700	460	54.5	SE	4.26G10.0	E	NE-NW-WSW-E	"	
A7	1500	450	57.3	E	7.0G11.5	ENE	ENE-SE	"	
A8	1500	450	55.8	E	7.0G11.5	ENE	ENE-SE	"	
A9	2300	480	60.5	NE	3.1	ENE	WNW-NE-ESE	"	
A10	2300	480	59.5	NE	3.1	ENE	WNW-NE-ESE	"	
A47	0700	480	60.5	SSE	8.1G20.0	ESE	E-S-WNW	"	
A48	0700	480	59.5	SSE	8.1G20.0	ESE	E-S-WNW	70%	
A51	1500	470	59.2	NNE	7.3G20.0	ENE	W-ENE-E	70%	
A52	1500	470	59.2	NNE	7.3G20.0	ENE	W-ENE-E	"	
A53	2300	480	61.2	NNE	4.6G14.0	NW	SSE-E-NW-WSW	"	
A54	2300	480	61.2	NNE	4.6G14.0	NW	SSE-E-NW-WSW	"	
Duluth, Minnesota, Site D-2; Room 241, NWQL									
A49	1600	1440	191.7	NE	5.5-20.0	ENE	WSW-NW-E-SSE		
A50	1600	1440	175.4	NE	5.5-20.0	ENE	WSW-NW-E-SSE		
Duluth, Minnesota, Site D-3; Room 121, NWQL									
A57	1600	1440	170.5	SE	7.7-19.0	SE	E-SSE		
A58	1600	1440	186.3	SE	7.7-19.0	SE	E-SSE		
Duluth, Minnesota, Site D-4; Roof, NWQL									
A55	1100	1440	183.5	SE	6.8-19.0	SE	E-S		
A56	1100	1440	183.5	SE	6.8-19.0	SE	E-S		

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.2 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR DULUTH, MINNESOTA
(June 24 - July 5, 1973) (cont'd)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M ³)	Wind Direction	Wind Speed	Prevailing Wind	Wind ^{4**} Variability	Sampling ^{5**} Efficiency
A59	1100	1355	172.6	ESE	7.0G17.5	ESE	E-S	
A60	1100	1355	172.6	ESE	7.0G17.5	ESE	E-S	
<u>Duluth, Minnesota, Site D-5, Batterman</u>								
A61	1515	1290	171.7	ESE	6.9G17.5	SE	ESE-S	
A62	1515	1295	174.2	ESE	6.9G17.5	SE	ESE-S	
<u>Duluth, Minnesota, Site D-6, McCormick</u>								
A63	1630	1290	174.8	ESE	6.5G17.0	SE	ESE-S	
A64	1630	1290	161.3	ESE	6.5G17.0	SE	ESE-S	
<u>Duluth, Minnesota, Site D-7, Brungs</u>								
A226	1045	1410	171.7					
A227	1500	1410	177.7					
<u>Duluth, Minnesota, Site D-8, Cook</u>								
A230	1600	1410	187.7					
A231	1600	1410	171.7					
<u>Duluth, Minnesota, Site D-9, Glass</u>								
A228	1400	1380	175.8					
A229	1400	1380	179.4					
<u>Duluth, Minnesota, Site D-10, Room 230, NWQL</u>								
A232	1430	1290	160.0					
A233	1430	1290	160.0					

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.3 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR ERIE MINING CO., Hoyt Lakes, Minnesota (June 23-24, 1973)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	Prevailing Wind	Wind Variability	Sampling Efficiency
EMC - Hoyt Lakes, Minnesota, Site E-1 (Tailing Site)								
A109	1747	373	47.5	ESE	6.1GN	S	N-SSE-S	57%
A110*	1752	373	42.3	"	"	"	"	"
A111	1757	373	49.1	"	"	"	"	"
A112*	0025	420	52.3	S	9.6GN	S	S	100%
A113	0025	420	48.2	"	"	"	"	"
A114	0025	420	55.3	"	"	"	"	"
A103	0800	480	59.8	SSW	10.0G24.0	S	S-WSW	88%
A104	0800	480	55.1	"	"	"	"	"
A105*	0800	480	63.2	"	"	"	"	"
A215	1610	480	57.8	S	11.4G21.5	S	S	100%
A216*	1610	480	53.7	"	"	"	"	"
A217	1600	480	62.5	"	"	"	"	"
EMC - Hoyt Lakes, Minnesota, Site E-2 (Process Site)								
A186	1905	295	36.3	SE	6.5GN	S	N-SSE-S	80%
A187	2000	160	22.2	"	"	"	"	"
A188*	1905	295	35.1	"	"	"	"	"
A189	0030	450	54.8	S	9.6GN	S	S	100%
A190	0030	450	61.2	"	"	"	"	"
A191*	0030	450	52.2	"	"	"	"	"
A192*	0800	480	57.1	SSW	10.0G24.0	S	S-WSW	63%
A193	0800	480	63.2	"	"	"	"	"
A194	0800	480	54.4	"	"	"	"	"

* These filters were randomly selected and kept by EMC before EPA left the mine area.
 **Footnotes 1 through 5 defined on separate sheet.

TABLE 3.3 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR ERIE MINING CO., HOYT LAKES, MINNESOTA (June 23-24, 1973) (Cont'd)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	Prevailing Wind	3** Wind Variability	4** Wind Variability	5** Sampling Efficiency
A195	1615	465		S	11.4G21.5	S	S	S	100%
A196*	1615	465	54.0	"	"	"	"	"	"
A197	1615	465	52.7	"	"	"	"	"	"
EMC - Hoyt Lakes, Minnesota, Site E-3 (Background Site)									
A76*	1555	485	63.2	ESE	5.7GN	N	N-SSE-S	N-SSE-S	50%
A77	1555	485	63.9	"	"	"	"	"	"
A78	1555	485	61.8	"	"	"	"	"	"
A73	0000	480	63.9	S	9.6GN	S	S	S	100%
A74*	0000	480	62.5	"	"	"	"	"	"
A75	0000	480	59.8	"	"	"	"	"	"
A70	0800	478	71.7	SSW	10.0G24.0	S	S-SW	S-SW	100%
A71	0800	360	45.9	"	"	"	"	"	"
A72*	0800	460	57.3	"	"	"	"	"	"
A69	1610	470	57.2	S	11.4G21.5	S	S	S	100%
A220	1621	459	73.4	"	"	"	"	"	"
A221*	1635	445	56.1	"	"	"	"	"	"

*These filters were randomly selected and kept by EMC before EPA left the mine area.
 **Footnotes 1 through 5 defined on separate sheet.

TABLE 3.4-DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR RESERVE MINING CO.,
BABBITT, MINNESOTA (June 25-28, 1973)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	1&2**			3** Prevailing Wind	4** Wind Variability	5** Sampling Efficiency
RMC - Babbitt, Minnesota, Site B-1 (Both a Background and Process Site)											
A168	1400	450	56.7	SW	7.5G19				SW	NNE-SSE-WSW	86%
A169*	1400	450	56.7	"	"				"	" (Process)	"
A170	"	"	"	"	"				"	"	"
A210	0910	410	51.1	NNW	12.7GN				NNW	NW-NNW	100%
A211*	"	"	"	"	"				"	" (Background)	"
A212	"	"	"	"	"				"	"	"
A151	1615	185	22.3	NNW	11.2GN				NNW	NNW-N	100%
A152	"	465	61.2	"	"				"	" (Background)	"
A153*	"	185	22.0	"	"				"	"	"
A154*	0020	380	45.7	N	10.GN				N	NNW-N	100%
A155	"	"	46.3	"	"				"	" (Background)	"
A156	"	"	50.0	"	"				"	"	"
RMC - Babbitt, Minnesota, Site B-2 (Background Site)											
A198	1705	115	15.0	SW	No Data				SW	None	100%
A199	"	"	13.7	"	"				"	"	"
A200*	"	"	13.0	"	"				"	"	"
RMC - Babbitt, Minnesota Site B-3 (Process Site)											
A182*	0905	415	52.9	WSW	No Data				W	SW-W	100%
A183	"	"	"	"	"				"	"	"
A184	"	"	"	"	"				"	"	"

*These filters were randomly selected and kept by RMC before EPA left the mine area.

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.4 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR RESERVE MINING CO.,
BABBITT, MINNESOTA (June 25-28, 1973) (Cont'd)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	1&2**	Prevailing Wind	3**	4** Wind Variability	5** Sampling Efficiency
A179	1612	468	58.0	WNW	No Data		W		WSW-NW	100%
A180	1609	471	"	"	"		"		"	"
A181*	1605	475	59.0	"	"		"		"	"
A171*	0000	480		NNW	No Data		NNW		NNW-NW	100%
A172	0003	477	60.8	"	"		"		"	"
A173	0006	474	"	"	"		"		"	"
A174*	0840	440	57.3	NNW	12.7GN		NNW		NNW-NW	100%
A175	"	"	"	"	"		"		"	"
A176	"	"	"	"	"		"		"	"
A177	1605	475	60.5	NNW	11.2GN		NNW		N-NW	100%
A132	1609	471	60.0	"	"		"		"	"
A178*	1600	480	62.5	"	"		"		"	"
A133	0005	475	60.5	N	9.9GN		N		NNW-N	100%
A134*	0010	470	59.9	"	"		"		"	"
A135	0015	465	61.9	"	"		"		"	"
RMC - Babbitt, Minnesota, Site B-4 (Process Site)										
A201	1015	345	39.1	W	No Data		W		WSW-W	100%
A202*	1008	352	41.9	"	"		"		"	"
A203	"	"	46.5	"	"		"		"	"
A204	1610	380	55.3	WNW	No Data		NNW		WSW-NW	100%
A205	1615	455	54.1	"	"		"		"	"
A206	1620	450	58.6	"	"		"		"	"

*These filters were randomly selected and kept by RMC before EPA left the mine area.

**Footnotes 1 through 5 defined on separate sheet.

TABLE 3.4 - DULUTH ASBESTOS STUDY AIR SAMPLING SUMMARY FOR RESERVE MINING CO.,
BABBITT, MINNESOTA (June 25-28, 1973) (Cont'd)

Filter No.	Start Time	Total Time (Min.)	Total Flow (M3)	Wind Direction	Wind Speed	1&2**	Prevailing Wind	Wind Variability	Sampling Efficiency
A207*	0010	470	55.9	NNW	No Data		NNW	NW-NNW	100%
A208	0010	470	62.6	"	"		"	"	"
A209	0100	420	48.8	"	"		"	"	"

*These filters were randomly selected and kept by RMC before EPA left the mine area.
**Footnotes 1 through 5 defined on separate sheet.

Date Due

Department of Protection Agency
Department of
Department of
City of

TABLE 3.5

FOOTNOTES

1. Wind Speed is measured in miles per hour (mph).
2. G - The maximum instantaneous wind speed (Gust) if greater than 10.0 mph recorded during a specified period.
3. Prevailing Wind - That direction of wind which, at a given place, occurs more frequently than any other during a specified period.
4. Wind Variability - The range of directions from which the wind blows during a specified period.
5. Sampling Efficiency is defined as selecting a sector of wind and calculating the number of hours of wind originating from the direction within the sector compared to total hours during sampling. 100% at Background Site means the wind was blowing from sampler toward the source 100% of the time. 100% at Process Site means the wind was blowing from source toward the sampler 100% of the time.