

S B

4 8

Notice of hearing published Jan 25

Jan 31 - Asked Senator Ferguson - Mike Scott  
for bill back-up

Feb 1 - Ferguson/Scott brought mtg by. -

Steve Gilbertson or Teague - 15 minutes  
3 communities and Arctic haze

Info from Mike Scott 2/1/85 - all contacted

DEC Stan Hungerford 3648 Clean Air  
7660

Dr. Lena Shaw Univ of Ak  
Geophysical Institute

call Steve Gilbertson C/Boro Juneau

Ak Environ Lobby Steve Higheman  
Juneau  
586-2345

SB 48

Feb 6 - Spoke w/ Hungerford - he will testify  
DEC - State

FNSB - Heather Stockard, Envia Seves Dir.  
Linda Anderson -- 586-1608 - Lobbyist for Fai.

Glen Shaw

Dr. ~~Stan Hungerford~~ - Arctic Haze

will speak 8 to 10 minutes

Muni's need to spend more money for research

Dr. Gunther Weller - did not reach

Jay Nelson - At Envia. Lobby will be  
present - doesn't desire to testify

Leonard Verrelli

U. of A  
Geophysical  
ph 474-7558

STATE OF ALASKA  
THE LEGISLATURE

POUCH Y - STATE CAPITOL  
JUNEAU, ALASKA 99811  
907-465-3800

LEGISLATIVE AFFAIRS AGENCY  
LEGISLATIVE REFERENCE LIBRARY

May, 1988

Copies of minutes listed below were originally included in this file. The minutes are available on the STAIRS database CMPR. In order to save space copies of minutes have not been left in the files.

Mary Van Nimwegen

PRA

2-7-85- 3:34pm

# STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

## DEPT. OF ENVIRONMENTAL CONSERVATION

OFFICE OF THE COMMISSIONER  
POUCH O, JUNEAU, ALASKA 99811

Telephone: (907)  
Address:

465-2100

March 1, 1985

The Honorable Edna Armstrong-DeVries  
Chair, Senate Committee on  
Community and Regional Affairs  
Pouch V  
Juneau, Alaska 99811

Dear Senator Armstrong-DeVries:

Thank you for the opportunity to comment on SB 48 related to grants for community air quality monitoring and abatement programs. Mr. Stan Hungerford reported to me about the hearing you held February 7th. Since it is apparent that a letter of intent and/or modifications to the act may be necessary, I offer the following comments for your review and consideration:

- 1) Specify that the department promulgate regulations similar to the language in AS 46.06.130 referring to the Litter Program grant authority.
- 2) Define the types of projects eligible for funding similar to the language in AS 46.06.120 referring to the Litter Program grants, or AS 46.03.03(b) referring to water supply, sewerage, and solid waste facilities grants.
- 3) Insert language in what is currently line 14, indicating that the department may enter into contractual agreements with an appropriate consulting firm on behalf of a community whose project merited funding in those cases where a community was unable to manage a contract of this technical nature, or has requested the department manage it for them, similar to that in AS 46.07.040 related to the Village Safe Water facilities grant program.
- 4) Limit or prohibit the use of funding, such as use of project funds to pay routine community administrative costs, similar to that in AS 46.03.030(d), related to construction grants.
- 5) Limit the amount of funds to be awarded to any one project or community.

February 21, 1985

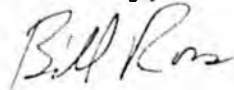
- 6) Indicate how to allocate the total funds. For example, the following range of distribution would give the department guidance on how the legislature would like air quality problems addressed.

- 30-40% air quality and meteorological monitoring where risk of human health has a high potential
- 10-20% monitoring for potential environmental damages
- 10-20% basic research in atmospheric sciences applicable to high latitudes
- 10-20% to develop control strategies
- 20-30% to implement a local control strategy
- 10-20% to support staffing of an approved local program
- 10-20% development of innovative control technologies.

We would be glad to work with you to establish such allocation levels if you desire.

- 7) If funding for staffing a local program is desired, specify the financial commitment required of the community, such as "matching" a specific percentage or budgeting to assure continuation of the program after the grant period ends, similar to that in 46.03.030(e) related to construction grants.

Sincerely,



Bill Ross  
Commissioner

SWH6/sm

cc: Senator Arliss Sturgulewski  
Senator Vic Fischer  
Senator John Coghill  
Senator Frank Ferguson

Rec'd 2/21/85

Ford  
2/21/85 ✓

Original sponsors: Ferguson, Kelly,  
Sturgulewski and Coghill

Funding Information

General Fund	\$10,000,000
Other Funds	- 0 -
	<u>\$10,000,000</u>

1 IN THE SENATE

BY THE COMMUNITY AND REGIONAL  
AFFAIRS COMMITTEE

2 CS FOR SENATE BILL NO. 48 (C&RA)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 FOURTEENTH LEGISLATURE - FIRST SESSION

5 A BILL

6 For an Act entitled: "An Act making a special appropriation to the Depart-  
7 ment of Environmental Conservation for payment as  
8 grants to municipalities and unincorporated communi-  
9 ties for clean air studies, abatement of air pollu-  
10 tion, [and development of technology to reduce air  
11 pollution;] and providing for an effective date."

12 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

13 \* Section 1. The sum of \$10,000,000 is appropriated from the general  
14 fund to the Department of Environmental Conservation for payment as grants  
15 to municipalities and unincorporated communities for clean air studies,  
16 abatement of air pollution, [and development of technology to reduce air  
17 pollution.]

18 \* Sec. 2. The appropriation made by this Act shall be disbursed in  
19 accordance with AS 37.05.315 - 37.05.325.

20 \* Sec. 3. This Act takes effect immediately in accordance with AS 01.-  
21 10.070(c).



CITY/BOROUGH OF JUNEAU  
★ ALASKA'S CAPITAL CITY

January 28, 1985

Honorable Senator Edna Armstrong-DeVries  
Senate Community and Regional Affairs Committee  
Pouch V  
Capital Room 427  
Juneau, Alaska 99801

Dear Senator Armstrong-DeVries:

The City and Borough of Juneau has noted with great interest the introduction of Senate Bill Number 48 which provides for grants to municipalities for clean air studies and air pollution abatement.

Perhaps one of the most serious health problems which exists in the Juneau area is the high level of winter-time air pollution in the Mendenhall Valley. Rising fuel prices have caused a significant and unprecedented increase in the installation and use of wood stoves. This, combined with the unique topography of the Mendenhall Valley, has caused reoccurring smoke pollution conditions which are detrimental to the health of the people of Juneau, especially young children and older persons with respiratory problems.

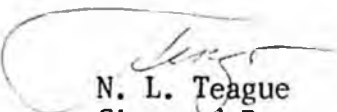
In October 1983, the Assembly of the City and Borough of Juneau adopted regulations which imposed restrictions on wood burning in the Mendenhall Valley. The heart of the regulations is the authority for the City Manager to declare an air emergency when air pollution levels are expected to exceed state and federal air standards. All wood burning is prohibited during an air emergency.

The current regulations place local government in the position of reacting to air pollution problems which develop rather than trying to prevent them from developing. We see a real need for a comprehensive program which will include education of people as to the proper burning techniques and research into types of devices such as catalytic combustors which can reduce the amount of wood stove emissions.

Senator Armstrong-DeVries  
January 28, 1985  
Page 2

The City and Borough of Juneau would welcome the opportunity to offer testimony to the Community and Regional Affairs Committee when Senate Bill Number 48 is being discussed. Please advise us as to the time and place of the hearing.

Sincerely,



N. L. Teague  
City and Borough Manager

NLT:SG:sj  
cc: Senator Ferguson

CITY AND BOROUGH OF JUNEAU  
MENDENHALL VALLEY AIR POLLUTION PROGRAM BUDGET

FY85-86

BUDGET ITEM

Manpower

<u>Position</u>	<u>Salaries</u>
Full-time program coordinator	\$36,000
Seasonal environmental officer	15,000
Seasonal environmental officer	15,000
Benefits	<u>21,000</u>
TOTAL MANPOWER BUDGET	<u>\$87,000</u>

Equipment

Nephelometer for measuring woodsmoke levels	\$17,000
Monitoring station	5,000
Dicot sampler	<u>5,000</u>
TOTAL EQUIPMENT	<u>\$27,000</u>

Contractual Services

Wind regime study of the Mendenhall Valley to develop a model of air circulation for refined control strategy	<u>\$80,000</u>
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Public Information

Development and distribution of public education materials concerning wood burning and air pollution	<u>\$15,000</u>
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<u>TOTAL PROGRAM BUDGET</u>	<u>\$209,000</u>
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# MEMORANDUM

# State of Alaska

TO: Bill Ross  
Commissioner  
Department of Environmental  
Conservation

DATE: February 7, 1985

FILE NO: 366-348-85

TELEPHONE NO: 465-3600

FROM: Norman C. Gorsuch  
Attorney General

SUBJECT: ADEC authority to  
administer clean  
air grants

By: Thomas M. Jahnke *TJM*  
Assistant Attorney General  
Natural Resources-Juneau

Former Commissioner Neve' wrote us on January 31, 1985 concerning SB 48, an act making appropriations to the Department of Community and Regional Affairs for grants to municipalities for clean air studies and abatement of air pollution. The commissioner asked whether the Department of Environmental Conservation has the statutory authority to administer a program of such studies and abatement activities. The answer is a clear "yes."

AS 46.03.020 provides that the department may:

(1) enter into contracts necessary or convenient to carry out the functions, powers, and duties of the department;

\* \* \* \*

(5) undertake studies, inquiries, surveys or analyses it may consider essential to the accomplishment of the purposes of the department; these activities may be carried out by the personnel of the department or in cooperation with public or private agencies, including educational, civic and research organizations, colleges, universities, institutes and foundations;

(6) at reasonable times enter and inspect with the consent of the owner or occupier any property or premises to investigate either actual or suspected sources of pollution or contamination or to ascertain compliance or noncompliance with a regulation which may be promulgated under AS 46.03.020--46.03.040; information relating to secret processes or methods of manufacture discovered during investigation is confidential;

(7) conduct investigations and hold hearings and compel the attendance of witnesses and the

production of accounts, books and documents by the issuance of a subpoena;

(8) advise and cooperate with municipal, regional and other local agencies and officials in the state, to carry out the purposes of this chapter;

(9) act as the official agency of the state in all matters affecting the purposes of the department under federal laws now or hereafter enacted;

(10) adopt regulations necessary to effectuate the purposes of this chapter, including, by way of example and not limitation, regulations providing for

(A) control, prevention and abatement of air, water, or land or subsurface land pollution ...

Subsection 5 is the most pertinent, but even in its absence a court would hold that, unless specifically denied in statute, the agency has a sufficiently broad mission and attendant powers to administer the studies and abatement efforts:

[Administrative agencies] possess the [implied] powers reasonably necessary and fairly appropriate to make effective the express powers granted to, or duties imposed on them, and to accomplish the purposes of the legislation which established them.

73 C.J.S. Public Administrative Law and Procedure, §51, p. 503 (1983).

The agency mission and statutory powers are set out in various statutes. Besides the provisions quoted above, specific grants of power to regulate air pollution are found in AS 46.03.140 et seq. The power to study air pollution is necessarily implied from the power to regulate pollution by prevention, abatement, or control. AS 46.03.140. The power to grant variances under AS 46.03.170 necessarily implies the power to undertake the investigation necessary to support the required factual findings precedent to the grant of a variance. Finally, the department has the power and duty to closely oversee local air pollution control programs, AS 46.03.210--46.03.220; the department cannot meet its responsibility without the data necessary to verify compliance with pollution standards. See, e.g., AS 46.03.210(a)(4) and (d).

Bill Ross, Commissioner  
Department of Environmental Conservation  
366-348-85

February 7, 1985  
Page 3

For these reasons, there is no doubt that the Department of Environmental Conservation has the power to administer the research and abatement efforts.

TMS:jf

# Alaska State Legislature

## Senate

Senator Edna DeVries, Chairman

Members:

Senator Ferguson, Vice Chairman

Senator Coghill

Senator Sturgulewski

Senator V. Fischer



Official Business

## Committee on Community and Regional Affairs

Pouch V  
Juneau, Alaska 99811

2/7/85

Summary info -- SB 48

This bill would appropriate \$10 million dollars for clean air studies and abatement of air pollution.

The money could be disbursed by the Dept of Community & Regional Affairs to a named recipient that is not a municipality; the department could request proposals to provide the goods or services and if money is disbursed to other than the named recipient, the basis for taking the action must be stated in writing and a copy sent to Leg Budget and Audit; and the money may be disbursed to a non profit corporation organized by a community if there is no qualified incorporated entity. (see attached section from Title 37 of the statutes.

There is a legal opinion from Leg Counsel to Senator Ferguson that discusses the award of grant monies under this bill.

Anchorage, Fairbanks, and Juneau have submitted examples of how their money would be spent under this legislation.

Anchorage does not plan to have a witness testify, Juneau will have either Steve Gilbertson or Mr. Teague (Borough/City Manager testify). Fairbanks does not plan to have anyone testify, although their lobbyist (Linda Anderson) will be present. Anchorage person present will be Suzanne Tryck.

There is material in the file that corroborates the air pollution problems in Anchorage, Fairbanks, Juneau, Sitka, and Kenai. There is also material on Arctic Haze. The authority on arctic haze is Dr. Glen Shaw from the University of Alaska Geophysical Institute. Dr. Shaw will be present today to testify.

Arctic haze is the pollution that affects Ferguson's election district....it is the one I presume he would want money for.... it is a relatively new phenomenon -- air pollution in the other urban areas is considered to be more of an immediate problem.

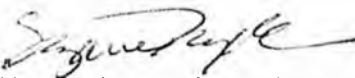
Stan Hungerford from the Department of Environmental Conservation, Chief, Air and Hazardous Waste Management Section, will testify.

I called the Alaska Environmental Lobby but they said they probably would not testify.

MUNICIPALITY OF  
ANCHORAGE

MEMORANDUM

TO: Senate Community and Regional Affairs Committee

FROM: Suzanne Tryck   
Staff to the Municipality of Anchorage

DATE: February 20, 1985

RE: SB 48

This is the written response to the question asked during the last committee meeting on SB 48. During that meeting, Senator DeVries asked the Municipality whether any of the money in this piece of legislation would be used to study the effects of the burning of McKenzie point on Anchorage.

I have been informed that if the state does not study the effects of the burning on McKenzie point then yes, the Municipality of Anchorage will use some of the dollars appropriated to the Municipality in SB 48 for that purpose.

Thank you for your consideration of this piece of legislation. If we can be of further assistance, please let me know (586-2401).

# Municipality of Anchorage



P.O. BOX 6-650  
ANCHORAGE, ALASKA 99502-0650  
(907) 264-4960 / Juneau 586 2401

TONY KNOWLES  
MAYOR

## INTERGOVERNMENTAL AFFAIRS

February 5, 1985

### MUNICIPALITY OF ANCHORAGE SUGGESTED USES OF AIR POLLUTION FUNDS (SB 48)

9074653700;# 2

→

XEROX TELECOPIER 495; 8-11-84; 3:18

TOPIC	LOCATION	PURPOSE	EXPENDITURES	COST EST
Indoor Air Pollution Program	Statewide	To answer air quality concerns in the home. This is an area not covered by EPA, ADEC, ADOL, or US DOL.	Workshop program development Personnel Equipment Training	\$ 100,000
Meteorological Tower Monitoring	Anchorage	More precise measurements of atmospheric stability to answer questions about high CO concentrations in Anchorage.	Meteorological instrumentation Telemetry equipment Tower	\$ 200,000
Transit Subsidies	Anchorage	Develop the Municipality of Anchorage transit system to make it more attractive to potential riders.	Heated shelters More buses "Feeder" routes	\$2,000,000
Hazardous Materials Detection	Anchorage	Develop a hazardous materials team that can react quickly to spills and protect the public. Coordinate with meteorological tower monitoring (above).	Equipment Manpower Training	\$ 100,000
Carbon Monoxide Exposure Study	Anchorage Fairbanks	To determine actual exposures to carbon monoxide from indoor and outdoor sources. - Determine whether outside CO measurements accurately reflect health impacts.	Monitoring equipment Manpower	\$ 300,000
Acid Rain and Snow	Statewide	As a result of future in state use of coal, a baseline for acid deposition should be taken now.	Monitoring equipment Manpower	\$1,000,000
Mobile Laboratory	Anchorage	To be used for air monitoring throughout the municipality.	Vehicle or trailer Air monitoring analyzer Meteorological equipment	\$ 200,000
Wood Stoves	Statewide	To abate residential wood combustion pollutants.	To provide low interest loans for retrofitting or purchasing or low polluting wood stoves.	\$1,500,000
Plug-in Cars (Ighred)	Municipal garages	To prevent or abate cold starts.	To provide low interest loans or subsidies.	\$1,000,000



# Fairbanks North Star Borough

Mayor: B.B. Allen

February 1, 1985

Ms. Linda Anderson  
130 Seward, #304  
Juneau, Alaska 99811

Dear Linda:

Attached is a list of possible projects in the area of clean air studies and abatement of air pollution. These are the types of projects which we feel could be funded under the terms of Senate Bill 48.

Please give me a call if you have any questions.

Sincerely,

A handwritten signature in cursive script that reads "Heather".

Heather T. Stockard  
Environmental Services Director

HTS/mnb  
Attachment

hts1-36



# Fairbanks North Star Borough

Mayor: B.B. Allen

## Suggested SB 48 Projects

*Projects are listed in priority order*

### CLEAN AIR STUDIES

\$ 45,000

1. Data acquisition and meteorological equipment for the Fairbanks North Star Borough. Allow for more efficient and accurate collection of ambient air quality data.

\$ 170,000.

2. Non-areawide air quality monitoring in the Fairbanks North Star Borough. Use existing mobile air monitoring equipment and purchase supplemental equipment to investigate current carbon monoxide levels within the federally-designated non-attainment area. Collect evidence needed to shrink the boundaries of the designated non-attainment area.

\$ 100,000. ← 2a. → *Ice log research*

\$ 75,000. → 3.

3. Carbon monoxide exposure studies in Fairbanks and Anchorage. Determine average individual levels of exposure to carbon monoxide by residents of the non-attainment areas in Fairbanks and Anchorage.

\$ 100,000.

4. Indoor Air Pollution -- Statewide: Determine levels of various pollutants in residences statewide. This is of special concern in super-insulated airtight houses and is an area which is not regulated by EPA, ADEC, OSHA, or municipalities.

### AIR POLLUTION ABATEMENT PROJECTS

250,000 cars  
in HNC & Fair.  
30% will need  
repairs -- perhaps  
low interest loans

1. Vehicle Inspection/Maintenance (I/M) Program in Fairbanks and Anchorage: Provide I/M program funding to reduce or eliminate cost to individuals as a result of program implementation. Provide subsidies, grants, or low cost loans for repairs needed in order for vehicles to meet program standards.

Economic in-  
centives --

\$ 400,000 to  
\$ 500,000

2. Wood-chipping facilities: Provide subsidies, grants, or low-cost loans to a company willing to establish a portable wood-chipping facility in the Fairbanks North Star Borough. This would allow farmers to clear their agricultural lands without violating the provisions of the proposed ADEC open burning regulations.

Suggested SB 48 Projects

2/1/85

page 2

- 15-20,000 families affected -- low interest loans*
3. Wood Stove upgrade program -- Statewide: Provide subsidies or low-cost loans to individuals who retrofit existing wood stoves with catalytic converters or replace existing wood stoves with certified low emissions stoves.

HTS/mnb  
attachment

# STATE OF ALASKA THE LEGISLATURE

POUCH Y STATE CAPITOL  
JUNEAU ALASKA 99811  
907 465 3800

## LEGISLATIVE AFFAIRS AGENCY

M E M O R A N D U M

January 31, 1985

SUBJECT: Senate Bill 48 Municipal and  
unincorporated community grants

TO: Senator Frank Ferguson

FROM: Mike F. Ford  
Legislative Counsel

You have asked for an explanation of the requirements governing grants to municipalities and unincorporated communities. Specifically, grants to municipalities are governed by AS 37.05.315, which sets forth the specifics for disbursement of the grant, which is by law through the Department of Administration. Grants to unincorporated communities are controlled by AS 37.05.317, which requires the Department of Community and Regional Affairs to disburse the funds to the grant recipient. Grants to a specific named recipient, not a municipality, can be disbursed through any Department which has statutory authority to perform functions in the area for which the grant is made. This requirement is set forth in AS 37.05.316.

Regarding appropriations to named recipients, there may be more than one agency that could receive an appropriation as a grant and have the statutory authority to perform functions in the area of the grant. In some cases the statutory authority of a Department can overlap with that of another Department, in effect giving the legislature a choice of which Department to use to disburse an appropriation. For example, the Department of Commerce and Economic Development has the primary responsibility for programs in relation to economic development and planning for the state, pursuant to AS 44.33.020. However the Department of Community and Regional Affairs has general authority to advise and assist local governments, and to conduct studies and projects for developing solutions to community and regional problems pursuant to AS 44.47.050. Assuming the existence of an appropriation for community economic

Senator Frank Ferguson  
January 31, 1985  
Page 2

development, either Department would have broad authority to disburse grant funds to a named recipient without violating statutory requirements, under AS 37.05.316.

In conclusion, SB 48 was drafted to disburse funds through the Department of Community and Regional Affairs because AS 37.05.317 requires that grant funds to unincorporated communities be disbursed by that department. Grant funds for a named recipient which is not a municipality, should be appropriated to the Department with the authority to act in the area, as required by AS 37.05.316.

MFF:ojb  
J11/045

Notes taken 2/7/85 at hearing

1

Dr. Shaw - Arctic Haze - air pollutants  
that affect the upper air

Arctic haze - L.H. Smog - 2 opposite ends of  
a spectrum

Smog - associated w/warm air and acid rain

opposite air chemistry at the high latitude  
in Alaska

90% of study pertains to L.A. style pollution  
almost known on arctic air chemistry

Source of Arctic pollution affecting Ak is  
Central Eurasia (Russia)

Arctic affects - Canada - all the circumpolar nations

Symposium next year at Cambridge on Arctic Haze.

Intl. law aspects - State responsibility  
Ak has organized and put the Sympos together  
put us on the map.

What has been found has application to industry

Do need to do research so that will know what  
industry must do in order to avoid ~~having~~ having

to close down some innocent industry that is totally unaware of the harm of Arctic haze

basic vs acid -- sodium vs. vinegar  
Arctic envire  $\rightarrow$  to chemical processes that create chemical transformations

Smelter chemicals from Russia  $\rightarrow$  to Alaska

Steve Gilbertson -- Juneau City Boro. - supports \$200,000

1979- DEC  $\rightarrow$  monitoring wood burning pollution  
Now Boro has regs against open burning - can declare air emergency

very complex issue -  
Would buy monitoring eqpt - educational mtl  
Budget \$200,000 could have a full time program coordinator, eqpt to measure, do a study of micro-climate of Mendenhall Valley educa mtl - public information

Stan Hungerford - DEC  
Monitoring C - must conform to siting standards of Feds  
serve as Fed Envir Prot agent in Ak.  
stringency of data base

Control pollution in a regulatory program

fully support concept & - local area causes pollution - local agency should regulate

Difference in reqs for Tesoro and North Slope refineries  
Tes must remove all sulphur from oil before processing it  
Mareo - distillation process - total pollutants is greater than at Tesoro - but concentration is lower.  
Tesoro burns cleaned-up gas

~~scribble~~  
Suzanne Tryck - Murr of Airc - supports comprehensive statewide approach

burning at Pt McKenzie

will provide info on Pt McKenzie burning

Fischer - level of funding to do "arctic haze research"  
\$300,000/yr that would result in academic research

Fischer is ice fog of P research

Ice fog-- Shaw & studied to death

Fisher well can we now do something about it

Shaw-- entrepreneurs could do something if some of this money went to them

Use the money broadly  
not all to cities  
not all to ice fog

~~Dr. Arkles - Markowski Arctic~~

\$400,000 cold climate research money from Feds --  
as to who gets money

Line 15 delete and

Shud have a letter of intent

ferge wanted money to go to DEC - AG said  
I couldn't

Hungerford - AG's opinion - it can be done

OFFICE OF THE COMMISSIONER  
POUCH O, JUNEAU, AK 99811

465-2666

February 2, 1984

The Honorable Jerry Ward  
Representative  
Alaska State Legislature  
Pouch V  
Juneau, AK 99811

Dear Representative Ward:

Alaska is currently in compliance with state and federal ambient air quality standards for all pollutants except carbon monoxide (CO). Since the early 1970s, CO levels in Anchorage and Fairbanks have exceeded health standards. Although airplanes, house heating units, power plants, and other industries also produce CO, motor vehicles generate 90-95% of the CO in these communities.

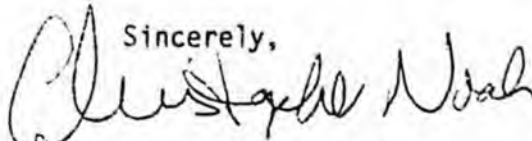
The Municipality of Anchorage and the Fairbanks North Star Borough have established local air pollution control agencies that have worked closely with the department to reduce public exposure to CO. Some improvements in air quality have occurred through automotive emission controls and implementation of local programs to reduce traffic congestion. However, this has been somewhat of a losing battle because both population and reliance on personal vehicles have increased, and are expected to continue to do so.

Enclosed is a brief summary of the CO violations in Anchorage and Fairbanks. Although the data on the magnitude of the violations have not been included, please be aware that Anchorage's violations are frequently more than double the national and state CO standard of 9ppm and are frequently higher than CO violations in New York City. So far, this year's high CO values are higher than last year's. Also, this winter season is the first year in which violations occurred in the month of October and is the first year violations occurred at a representative residential site in the month of November. From January 1 through January 23, 1984, there have been a total of 8 violations at three of the monitoring sites. This would bring the total violations for this CO season to approximately 53 for all states.

I have also included some information on the "whys" and "wherefores" of an Inspection and Maintenance program (I/M). Questions 3, 4, and 5 specifically address alternative approaches and consequences of not

implementing the I/M program. This information was put together by the staff of Dr. Rodman Wilson, Director, Department of Health and Environmental Protection, for the Municipality of Anchorage in their efforts to correct the violations of the carbon monoxide standard. He and his staff are actively involved in all aspects of the carbon monoxide problems, transportation control programs and I/M program planning in Anchorage. I am sure he would be very willing to discuss this topic and provide additional materials needed for your sub-committee hearings. If I can be of any further help, please do not hesitate to contact me.

Sincerely,



For: Richard A. Neve  
Commissioner

RAN/DK/ne

cc: Dr. Rodman Wilson

## Attachment 1

Historical CO Violations

	Calendar Year	# Violations (over 9ppm) in an 8 hour period
<u>Anchorage</u>		
7th and C	1975	47
	1976	15
	1977	14
	1978	12
	1979	4
	1980	18
	1981	2
	1982	2
	1983	n.o.*
Spenard and Benson	1978	5
	1979	63
	1980	73
	1981	32
	1982	57
	1983	49
Garden**	1981	7
	1982	24
	1983	26
Sand Lake	1980	51 (construction-traffic rerouting)
	1981	6
	1982	6
	1983	6
<u>Fairbanks</u>		
2nd and Cushman	1975	61
	1976	100
	1977	105
	1978	68
Borough Bldg	1975	114
	1976	118
	1977	74
	1978	9
	1979	32
SOB	1975	65
	1976	77
	1977	65
	1978	49
	1979	42
	1980	32

\* not operational

\*\* residential location

OFFICE OF THE COMMISSIONER  
POUCH O, JUNEAU, ALASKA 99811

465-2600

January 3, 1985

Mr. Pat Teague  
City Manager  
City & Borough of Juneau  
155 South Seward Street  
Juneau, Alaska 99801

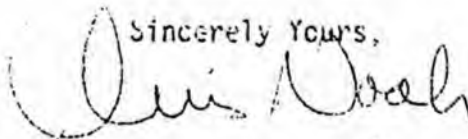
Dear Mr. Teague:

During the last woodsmoke episode it was evident that the valley residents are becoming complacent regarding burning. Numerous violators were warned and cited. Enforcement is the key to the success of reducing pollution in the Valley. Without proper and adequate enforcement we will most assuredly violate State and Federal Standards and be declared a non-attainment area by the federal government.

Four members of the ADEC staff spent 49 man-hours helping enforce the woodsmoke ban. Without this added support to the city staff, additional exceedances to the TSP standard would have been realized.

I feel a meeting is needed to discuss the ramifications of minimum enforcement and the eventual declaration of non-attainment by the federal government. Please have your Land and Resource manager, Steve Gilbertson, contact Tom Chapple of my air staff for establishment of a meeting on this subject.

Sincerely Yours,



Richard A. Neve  
Commissioner

RAN/LV/sd

OFFICE OF THE COMMISSIONER  
POUCH O, JUNEAU, ALASKA 99811

465-2600

April 9, 1984

The Honorable Fran Ulmer, Mayor  
City and Borough of Juneau  
155 S. Seward  
Juneau, AK 99801

Dear Mayor Ulmer:

I wish to express my gratitude to the City and Borough of Juneau for its positive actions to improve the air quality of the Mendenhall Valley. The joint program between city and state this past winter demonstrated that air pollution can be checked while also allowing personal firewood to be a continued component of the local energy balance.

Wood smoke in Juneau was the fastest growing air quality problem within the state. The health of approximately 10,000 people are affected to some extent during these wood smoke episodes. Unfortunately, those individuals who are least able to make their opinions and concerns known are the most readily affected. The children, the sick and the elderly are almost always the first to suffer the deleterious affects of air pollution.

As Juneau continues to grow, the city government through your direction must be prepared to respond to this and other escalating environmental problems. The recommendations presently before you and the assembly as drafted by the Air Quality Advisory Committee responsibly address these problems. It is apparent that a great deal of research, debate and forethought is encompassed in the recommendations. Each point is well founded and in unison they provide the integrated approach that is necessary to abate the problem. The establishment of an environmental health staff and the enactment of specific pollution emission standards for newly purchased stoves are the major cornerstones of an effective management program when coupled with enforcement of existing ordinances.

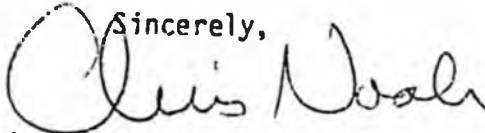
Mayor Fran Ulmer

-2-

April 9, 1984

In summary, I urge you to adopt and implement the recommendations of your committee and I offer the resources of my staff to assist in the detailed development of each of the program components.

Sincerely,



Richard A. Neve

Richard A. Neve  
Commissioner

RAN/TC/ne

cc: N.L. Teague - City Manager  
Keith Kelton  
Deena Henkins

# MEMORANDUM

THE CITY AND BOROUGH OF JUNEAU

CAPITAL OF ALASKA

155 SOUTH SEWARD ST. JUNEAU, ALASKA 99801

TO: N. L. Teague,  
City Manager

DATE: February 24, 1984

FILE NO.

SUBJECT: Air Quality Advisory  
Committee Recommendations

FROM: Air Quality Advisory Committee  
Bob Jacobson, Chairman  
Larry Armstrong  
Dr. Dennis Batey  
Mark Burger  
Karleen Grummett  
Verdell Jackson, Co-Chairman  
Martha Kohler  
Ann McFarlane  
Shannon Shields  
Larry Woodall  
Steve Gilbertson, Staff Liason

RECEIVED

MAR 07

DEPARTMENT  
ENVIRONMENTAL

The City and Borough of Juneau (CBJ) Air Pollution Advisory Committee has been holding monthly meetings since the enactment of the Wood Smoke Ordinance last fall. We have been getting updates from the Alaska Department of Environmental Conservation (DEC) and the CBJ staff on the effects of the ordinance and have been working with those agencies on methods of educating the public in all facets of the pollution problem. In January, the CBJ manager requested that our committee make recommendations to the Assembly regarding a moratorium on wood-burning devices in the Mendenhall Valley and on building code modifications concerning residential heating requirements. As we have been discussing other topics during our deliberations, we have taken this opportunity to include recommendations on several other topics as well.

1. The issue of a moratorium on wood-burning devices in new residential construction was debated long and hard within our committee. Based on the feelings of an overwhelming majority of its members, our committee recommends that the Assembly enact an ordinance placing a moratorium on the installation of all wood-burning devices in new residential construction in any Wood Smoke hazard Area found within the City and Borough limits until January 1, 1985. By that date, the CBJ staff will be charged with developing emission standards and a certification program for wood-burning devices. All wood-burning heating devices sold in the CBJ or installed under conditions requiring a CBJ Building Permit from that date forth would be required to meet or exceed the standards set by the certification program. We also recommend that this program be reviewed annually because of the rapid changes in wood-burning technology. Such an ordinance can be easily enforced by building inspectors within the building permit system.
2. We find it incongruous that the current CBJ building code allows residences to be built with wood-burning devices as a major source of heat especially in the Mendenhall Valley. We, therefore, recommend that the Assembly amend this building code such that, in new

residential construction within any Wood Smoke Hazard Area contained in the CBJ limits, all heating requirements be met by other than wood-burning devices. As such, residences would be adequately heated if an extended ban on wood-burning devices was required.

3. The pollution problem, so evident in the Mendenhall Valley, can be seen to some extent throughout the entire CBJ. Open burning, in particular, has produced smoke that locally is quite obnoxious. We, therefore, recommend that the Assembly enact a limited borough-wide ban on all open burning from November 1 to March 31. This ban could be lifted on a day-by-day basis as determined by the CBJ Manager. (All open burning would, in the Wood Smoke Hazard Area, continue to be totally banned during that time.) We also recommend that the CBJ investigate and pursue the purchase and construction of a Waste-to-Energy Plant for the disposing of all solid, burnable wastes. When such a system becomes operational, we recommend all open burning in the CBJ be banned totally.
4. At the present time, there is no method by which a polluter outside of the Wood Smoke Hazard Area can be stopped. We feel that such a tool is necessary to protect those affected by careless burners. We, therefore, recommend the 50 percent opacity standard presently in place in the Wood Smoke Hazard Area be implemented throughout the CBJ.
5. As presently written, the Wood Smoke Ordinance allows people to burn newspapers and coal in wood-burning devices. This can possibly subvert the intent of the ordinance. We, therefore, recommend that Paragraph 26.40.050(a) of Ordinance 83-63 be amended changing, ". . . no person may burn wood in any manner . . ." to, ". . . no person may burn wood, wood products, or coal in any manner . . ."
6. Although no exact criteria for calling Air Emergencies was included in the Wood Smoke Ordinance, state and federal standards do give the City Manager some limits. Based on input from local U.S. Environmental Protection Agency (EPA) personnel, our committee publicly recommends that the City Manager use a 24-hour average particulate count of 150  $\mu\text{g}/\text{m}^3$  as the standard in the Wood Smoke Hazard Area. This complies not only with current EPA and DEC standards, but also with proposed EPA limits.
7. Although wood smoke is the most obvious form of pollution in Juneau and especially in the Mendenhall Valley, it is not the only one. The smoke is obvious because it can be seen and smelled. However, our committee, with input from DEC, believes that there is beginnings to be a problem with automobile emissions in the Mendenhall Valley. Conditions that are conducive to holding wood smoke near the earth's surface do the same with carbon monoxide, nitrous oxide, sulfur dioxide, and other pollutants which cars produce.

N. L. Teague  
February 24, 1984  
Page 3

As more and more people move into the valley, this problem will become larger. It is possible that EPA standards for these emissions have already been violated in isolated instances, especially near the Mendenhall Mall.

Also, upon looking at the wood smoke episodes, we are convinced that the problem is not completely confined to the valley. It is likely that the Lemon Creek Valley will soon be subject to the same wood-burning restrictions as those in the Mendenhall Valley. Also, smoke from these sources has been drifting over the downtown area and down the Gastineau Channel.

Our committee feels that there is a critical need for a CBJ department to be charged with monitoring and dealing with all of the various environmental health concerns of the municipality. This would encompass not only air pollution but also water pollution and the various forms of waste disposal. The state is unable to adequately handle these affairs. In addition, these are City and Borough problems and the City and Borough should manage them.

As such, the CBJ Air Quality Advisory Committee recommends that the Assembly cause an Environmental Health Unit to be established with the current governmental structure. This should be done before the 1984-1985 wood smoke season.

We feel these seven proposals would tighten up the already enacted ordinance and would help make not only the Mendenhall Valley but the entire City and Borough more livable. We also feel that an Environmental Health Unit is especially important. We urge the Assembly to adopt and implement these recommendations

BJ:sj:61

# STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

## DEPT. OF ENVIRONMENTAL CONSERVATION

Telephone: (907) 465-2666  
Address: Pouch 0  
Juneau 99811

*Sitka  
Wood Smoke  
Assessed study currently under way  
JEC*

July 20, 1983

Mr. Rocky Gutierrez  
City Manager  
City & Borough of Sitka  
P.O. Box 79  
Sitka, Alaska 99835

Dear Mr. Gutierrez:

The Department of Environmental Conservation in conjunction with the Sitka Community High School proposes to undertake an air quality monitoring program to measure exposures of total suspended particulate matter (TSP) in Sitka.

Particulate matter can be generated from a number of sources, including windblown soils, fuel burning and industrial processes, residential wood burning and marine salt water spray. Due to the observed build-up of wood smoke pollution on a few days in Sitka last winter, the Department desires to assess the potential existence of unhealthy pollution levels.

Mr. Bill Foster of the Sitka High School has indicated an interest in performing the monitoring project. Students working directly under his supervision with initial training by Department personnel would perform the daily operational aspects of the monitoring.

During this past May, Lester Leatherberry and I assessed several potential monitoring locations in consideration of Lester's knowledge and observation of residential districts prone to smoke build-up. In establishing monitoring sites, it is imperative to select a site which will collect a sample representative of the overall air quality. For this particular type of project, it is often difficult to find a location which will not, at times, collect air parcels directly from a smoke plume emanating from a nearby house. Upon determining the residential area north and east of Swan Lake as the area of study, the small spit on the eastern shore of Swan Lake (see attached map) was found to be the only acceptable location for the sampler. This location should provide samples free of direct source impacts while also describing the overall condition of the area's air quality.

Since this site is the property of the City and Borough of Sitka, the Department requests permission to install and operate air quality and meteorological monitors for a period of two years.

Mr. Rocky Gutierrez

-2-

July 20, 1983

A small wooden platform will be needed for the instruments. A preliminary sketch of the platform is enclosed for your review, in addition to some information on the proposed instruments. It will also be necessary to supply electrical power to the site. Although the platform has not been designed in detail, maximum considerations will be made to ensure the platform and equipment are compatible with existing site usage. The ground surface at the site will be disturbed only for the location of four cement footings and possibly to bury electrical cable from a nearby powerline.

If approval is granted, we would desire to begin equipment installation during September of this year. Should you desire some additional clarification on this request, please contact me.

Sincerely,

  
Tom Chapple  
Air Quality Engineer

Enclosures

cc: Lester Leatherberry - Sitka DO  
Deena Henkins - SERO  
Bill Foster - Sitka High School  
Tom Tribble - Lab

Thomas R. Hanna  
Section Chief  
Air and Solid Waste Management

March 28, 1980

Stanley W. Hungerford  
Environmental Engineer IV

Public Hearing  
Tesoro Variance Request

On March 19, 1980 I held a public hearing at the Kenai Borough Building in Soldotna to receive testimony on Tesoro Alaska Petroleum's request for a variance from emission regulations and/or the circumvention regulation for sulfur dioxide emissions from a proposed sulfur recovery plant. Ten persons attended the hearing, two Tesoro representatives testified, and one individual asked a number of questions and expressed concerns about the cumulative effects of continued industrial growth. We also received written comments from two persons and two others requested copies of the variance application and other information.

Mr. Grantham, Tesoro project engineer, described the sulfur plant project, its relationship to the already permitted refinery modifications, and the company's efforts to find a vendor that might guarantee compliance with existing State emission standards without the use of dilution air. He also discussed the estimated change in air quality due to the sulfur dioxide emissions, and presented some general information from studies of sulfur dioxide impacts on human health, conifers and laboratory animals.

Mr. Jakubas commented that he didn't particularly object to the SO<sub>2</sub> emissions so long as they weren't offensive. However, he did express considerable concern for the increasing amount of NO<sub>x</sub> emissions in the Kenai area, and the possible acidification of poorly buffered lakes from acid rain and/or dry (nitrate) deposition. He also had a number of questions about the BACT alternatives presented in the PSD application, seasonal variations in meteorology and seasonal changes in patterns of "areas of influence" to which Mr. Grantham responded.

Mr. Pat Thomas, Tesoro's legal representative, briefly discussed socio-economic aspects of the project -- less air pollution due to the increase in un-leaded gasoline production, more petroleum products available for use in Alaska enhancing the economy, and the temporary increase in construction jobs available to Kenai residents.

Mr. Charles F. Bailey, Assistant Trust Officer of National Bank of Alaska in Anchorage, in written comments, expressed concern that objectionable odors might be evident on the property held in trust, and if such were the case, his client had instructed him to enter an objection to the request for a variance.

Mr. James E. Frates, Refuge Manager of the Kenai National Moose Range, submitted a lengthy list of concerns and questions many of which related to acid rain etc. A number of his questions pertained to the PSD review. Two questions were about the reason for the State's regulations and one about field surveillance activities.

Based on my review of the Variance application and testimony submitted, I have concluded that we should amend the permit and grant a variance to Tesoro which allows them to operate the H<sub>2</sub>S incinerator and dilute the exhaust to comply with the SO<sub>2</sub> emission limitation.

STATE  
of ALASKA

## MEMORANDUM

TO:  Stanley W. Hungerford  
Environmental Engineer IV

DATE: April 2, 1980

FILE NO:

TELEPHONE NO:

FROM: T.C. Tribble *T.C.T.*  
Chief, EQM&LO

SUBJECT: Tesoro-Alaska  
Kenai Refinery;  
Suggestions for  
Monitoring

I have reviewed Mr. Frates' letter regarding the Tesoro-Alaska Kenai refinery. The following are my suggestions and comments.

Generally speaking, the many concerns expressed by Mr. Frates represent hypothetical situations rather than actual or anticipated conditions. There is no point in my trying to address Mr. Frates' concerns individually since I presume that you will be doing that in your letter.

However, there are some actions that we can take in order to provide you with factual information regarding environmental conditions.

We can develop an ambient air monitoring strategy for the area of concern considering siting requirements, instrument selection and performance testing, calibration, maintenance and data reduction. District office personnel must operate the equipment, however. We might want to establish SO<sub>2</sub>, O<sub>3</sub>, Oxides of Nitrogen and TSP sites at one or two locations.

We can develop a program for monitoring water quality of nearby lakes and streams evaluating parameters such as TKN, NO<sub>3</sub>-NO<sub>2</sub>, sulfate, pH, carbonate alkalinity and perhaps even hydrocarbons. Again district office support would be required to collect samples and measure pH as well as carbonate alkalinity. EQM&LO can provide the required laboratory support.

In order for you to decide how far you wish to go with this problem, I have included in the following an estimate of new equipment costs.

I AMBIENT AIR MONITORINGA Sulfur Dioxide

1. TECO Model 43 SO <sub>2</sub> analyzer	8,500
2. METRONICS Dynacalibrator	5,350
3. SUPERSCRIBE strip chart recorder	1,600
4. MONITOR LABS signal averager	1,100
5. Miscellaneous commodities	250
	<u>16,800</u> per site

B Ozone

1. SUPERSCRIBE Model 1003-RS Ozone analyzer	5,750
2. SUPERSCRIBE strip chart recorder	1,600
3. MONITOR LABS signal averager	1,100
4. Miscellaneous commodities	250
	<u>8,700</u> per site

C Oxides of Nitrogen

1. MONITOR LABS Model 844-E NO(X) analyzer	10,000
2. CSI Gas phase titration calibrator	9,000
3. SUPERSCRIBE strip chart recorder	1,600
4. MONITOR LABS signal averager	1,100
5. Miscellaneous commodities	<u>250</u>
	21,950 per site

Total equipment costs per site for ambient air monitoring are \$47,450. I recommend a back-up strip chart recorder and signal averager for an additional \$2,700 and a total of \$50,150.

II WATER QUALITY MONITORINGA Non-conservative Parameters

1. ORION pH meter, probe and buffer solutions, alkalinity gear 950

B Conservative Parameters

1. All required water chemistry can be incorporated into the existing program.

I have included one of these sites in our request for additional ambient air monitoring equipment. Please advise me how you want to go with this problem.

Tom Tribble  
Chief, EQM & LO

April 9, 1980

Stanley W. Hungerford *Stan*  
Environmental Engineer IV

Kenai Air/Water  
Monitoring Program

Tom, your suggestions for a multi-parameter monitoring program for obtaining "background" air and water quality data in the Kenai area looks good to me. Please obtain the equipment (via Tom Hanna's grant funds) and arrange to set up a monitoring station somewhere in the vicinity of the Collier-Phillips-Tesoro industrial complex about 10 miles north of Kenai. Enclosed is a map from Tesoro's PSD application which indicates calculated pollutant concentrations in the area, and another map showing locations of major facilities.

I hope you can get the program started while I am on leave, but if not, we should get together as soon as I return. Here are the names of company officials who might be able to help you site the instruments and obtain power:

Union Chemicals --

Mr. George Ford, Plant Manager (776-8121)  
Mr. Bill Switzer, Environment Engineer

Phillips Petroleum --

Mr. J. F. Settle (776-8166)

Tesoro Alaska Refining --

Mr. Mark Necessary (776-8191)  
Mr. Ray Measles, Laboratory Supervisor

Chevron USA (refinery) --

Mr. George E. Day, Manager (776-8161)

Chugach Electric Ass'n --

Mr. L. J. Schultz, General Manager (276-3500)  
Mr. Larry Marley, Manager, Environmental

EA-50

Summary Information  
Alaska Arctic Air Pollution Planning Symposium

The purpose of the symposium is to assemble experts from a wide variety of disciplines to discuss the issues and ramifications of Arctic air pollution and to lay the ground work for a follow-up international meeting.

This symposium is convened by the University of Alaska and funded by the State Legislature at the request of the Honorable F. R. Ferguson, Alaska State Senator.

A major objective of the meetings is to determine, at the request of Senator Ferguson's office, whether growing air pollution in the remote Arctic regions constitutes any threat to health or environment and, if so, to assess the situation and make recommendations for a plan of action.

Arctic air pollution is a phenomenon which has come to the attention of scientists only recently. The pollution affects large portions of the northern polar cap of the planet; it is remarkable because of its aerial extent.

After a decade of research, mainly in the North American and Scandinavian Arctic, we have learned that the "Arctic Haze" is the results of industrial air pollution. In Alaska the haze pollution is thickest on the North Slope of the Brook's Range and extends eastward at least to Norway, or roughly half way around the circumference of the Arctic, and probably further. The pollutants sometimes extend up to 18,000 feet, but usually are contained in layers close to the ground. In late winter months the pollution can become quite dense.

A research group at the University of Rhode Island (under the directorship of Kenneth Rahn) has developed a system of chemical tracers that can reveal where a given sample of polluted Arctic air comes from. The work has shown quite clearly that the major source of pollutants in the American Arctic is the Soviet Union. After the USSR, Europe and, we think, the United Kingdom are the next largest sources. North America contributes very little pollution to the Arctic, primarily because of air flow patterns and location.

In 1983, instrumented aircraft from the United States, Norway and the Federal Republic of Germany flew into the high Arctic and sampled the air; pollution by-products were found in higher than expected concentration and all the way to the North Pole.

Arctic air pollution is sampled at Geophysical Institute's field stations in central Alaska and at a U.S. Department of Commerce station near Barrow. When air is drawn through white filters, the filters sometimes turn dark gray in color. According to Hal Rosen at the Livermore Laboratory in California, the discoloration is caused by carbon particles. Scientists are concerned that the black light-absorbing carbon particles over the reflecting polar ice might disturb the climate.

It is believed that a dialogue between health experts, government and industrial representatives, and scientists in symposia like these may help set the stage for a rational future policy.

Glenn Shaw  
Geophysical Institute  
University of Alaska



*See p 5*  
ARCTIC HAZE

APPLIED RESEARCH OF  
THE GEOPHYSICAL INSTITUTE  
VOLUME 15, NUMBER 3  
FALL 1983

applied science & technology in the north

**THE NORTHERN ENGINEER**

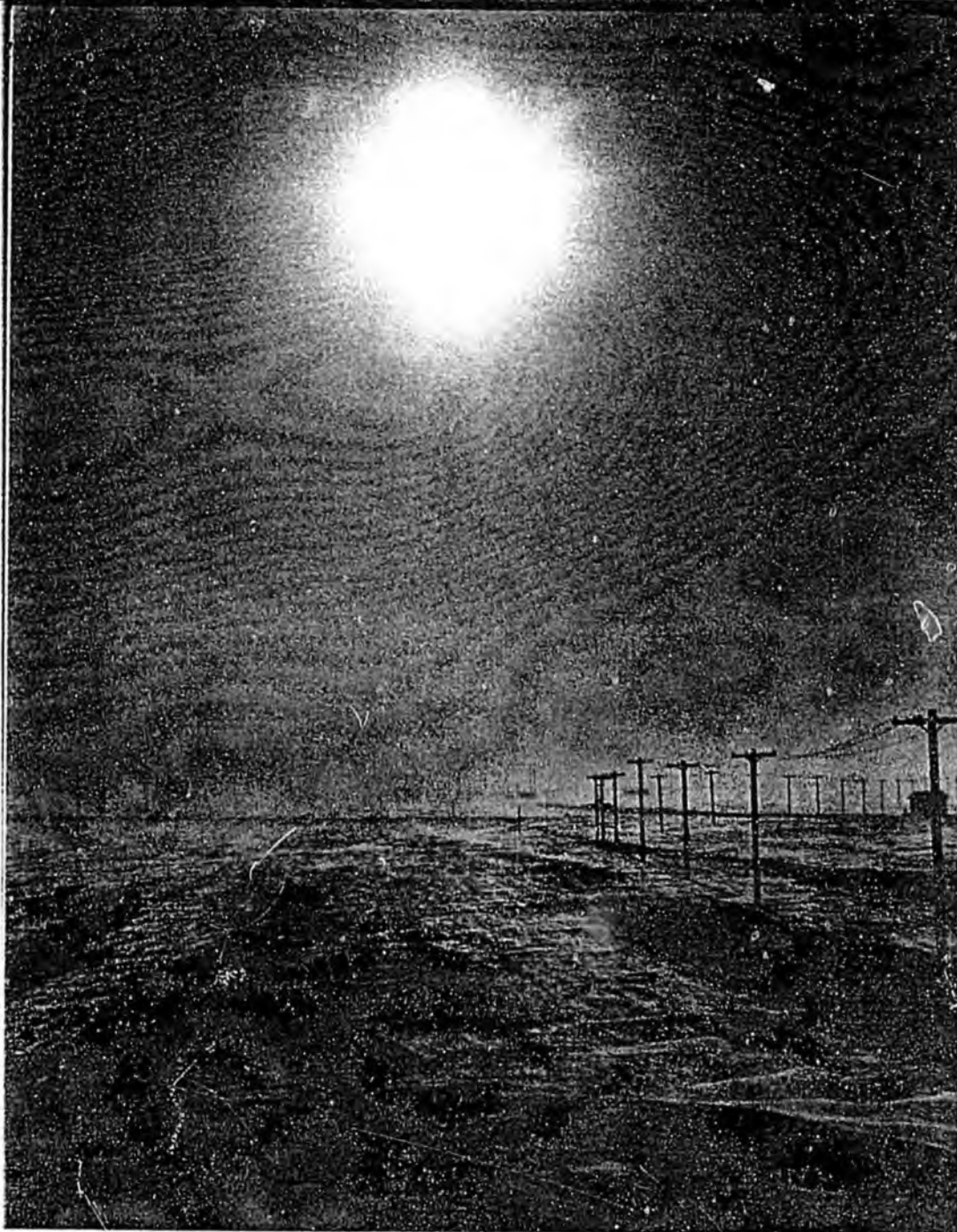


Figure 1. Arctic haze as photographed near Barrow, Alaska, in April, 1978.

# ARCTIC HAZE

by Glenn E. Shaw

## INTRODUCTION

The great clarity of polar air is legendary; polar explorers have frequently commented on it. Indeed, it should come as no surprise that polar air is frequently clear; there is no dust, there is no local air pollution to speak of, and the polar oceans and land masses are covered with ice and snow most of the time.

Nevertheless, something started going awry, apparently around the end of World War II. People began reporting the existence of haze at high-latitude locations in the Scandinavian and Alaskan Arctic. At first it was believed, as was often in fact the case, that the observers were reporting visibility reductions caused by blowing snow or precipitations of ice crystals. But

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*Dr. Glenn E. Shaw is a professor of geophysics at the Geophysical Institute, University of Alaska, Fairbanks. He has been studying the arctic haze phenomenon since the mid-1970s and has published numerous articles on the subject.*

in 1956 J.M. Mitchell, who was then a young weather officer stationed in Alaska (and now is a noted climatologist), flew on a B-29 USAF "Ptarmigan" weather reconnaissance flight and took a close look at the haze which was being reported by the pilots. Mitchell had a good eye for detail and he surmised from the color and the way it scattered light that the haze was composed of submicron-sized particles; there was no way that ice crystals or blowing snow could cause such effects. Mitchell published his interesting observations, but his paper apparently attracted little attention and was soon buried in the literature and forgotten.<sup>1</sup>

In the early 1970s turbidity at several arctic stations was found to be higher than expected and to have a seasonal variation opposite to that at midlatitudes.<sup>2,3</sup> (Turbidity as used here refers to the haziness of the atmosphere, and is usually expressed in terms of how much sunlight is lost on its way through the atmosphere when no clouds are present.) This finding was entirely unexpected and puzzling. Subsequent investigations from 1973-1977 confirmed that the haze was strongest in late winter/early spring (Fig. 1).

Investigations were made with a research aircraft at Barrow to try to learn more about the haze. These showed that the haze concentration usually increased from the surface and reached maximum concentrations at several thousand meters altitude (Fig. 2). From this, we deduced that the haze is not produced from nearby surface sources. The altitude of the haze, its horizontal extent covering hundreds of kilometers, and its association with air masses coming from the north have made it difficult to understand exactly where the haze originates. All that could be said at the time of the early studies was that the particles had been carried in from very distant sources. The source of the haze itself remained a puzzle.

In 1976 studies of arctic haze were intensified. A series of chemical sampling experiments, carried out by Kenneth Rahn

and Randolph Borys at the University of Rhode Island, were aimed at determining the composition of arctic haze. The results were quite surprising. They told us that arctic haze is rich in elements associated with industrial pollution, such as vanadium (V) and manganese (Mn). This was the first of several indications we now have that arctic haze is not natural in origin but is associated with industrial air pollution.

### THE SUMMER-WINTER CONTRAST

The presence of haze in the arctic atmosphere during winter is as surprising as its absence in the summer. Why is the seasonal variation opposite from that found at the midlatitudes?

At most places the strongest pollution concentrations occur during summer. Near arctic coastal regions in summer, one can

imagine a suite of local particle sources: organic vapors, combustion products from wildfires, windblown material from loess deposits, and salty particles blown from the arctic seas, among others. These sources disappear in the winter and, in addition, air convection currents also disappear or are much weaker in winter. That is why it is so surprising to find a decrease, rather than an increase, in haziness as winter changes to summer in the Arctic.

The winter-summer contrast is apparently Arctic-wide; we've found that sampled particles from the air at Thule, Greenland, at Spitsbergen, and near Fairbanks (representative of interior Alaska), all show pronounced winter maxima. In general, one can say that arctic air is clean in summer, but dirty in winter.

Generally the haziness is small in the autumn months but starts building in late

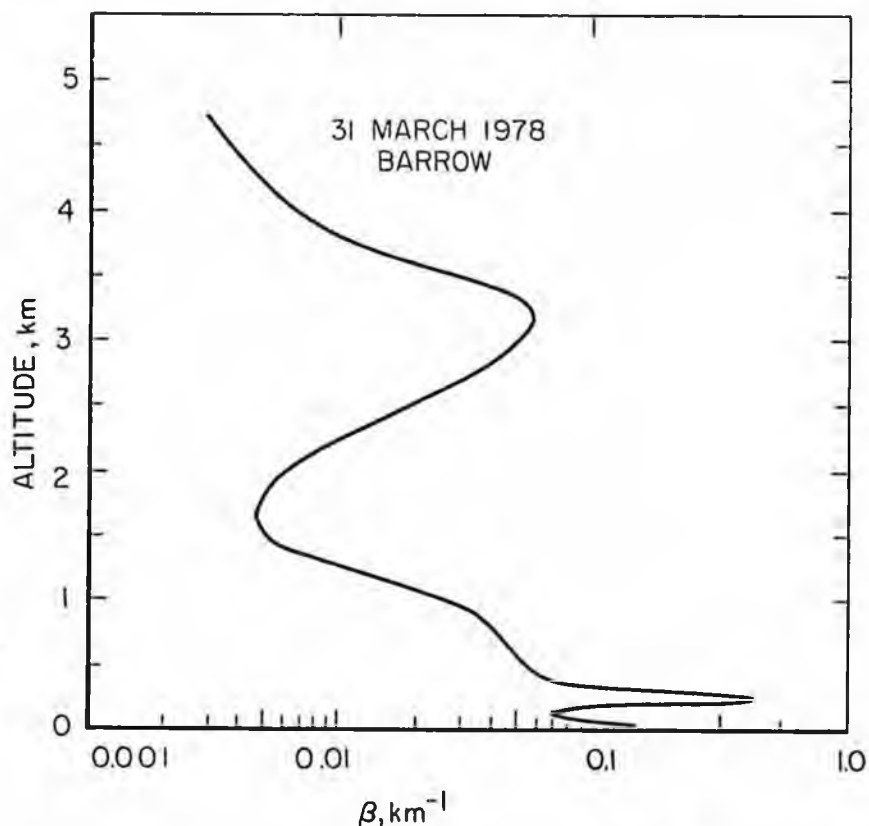


Figure 2. Vertical profile of arctic haze over northern Alaska, representing the profile of optical extinction; it is more or less proportional to the particle mass concentration.

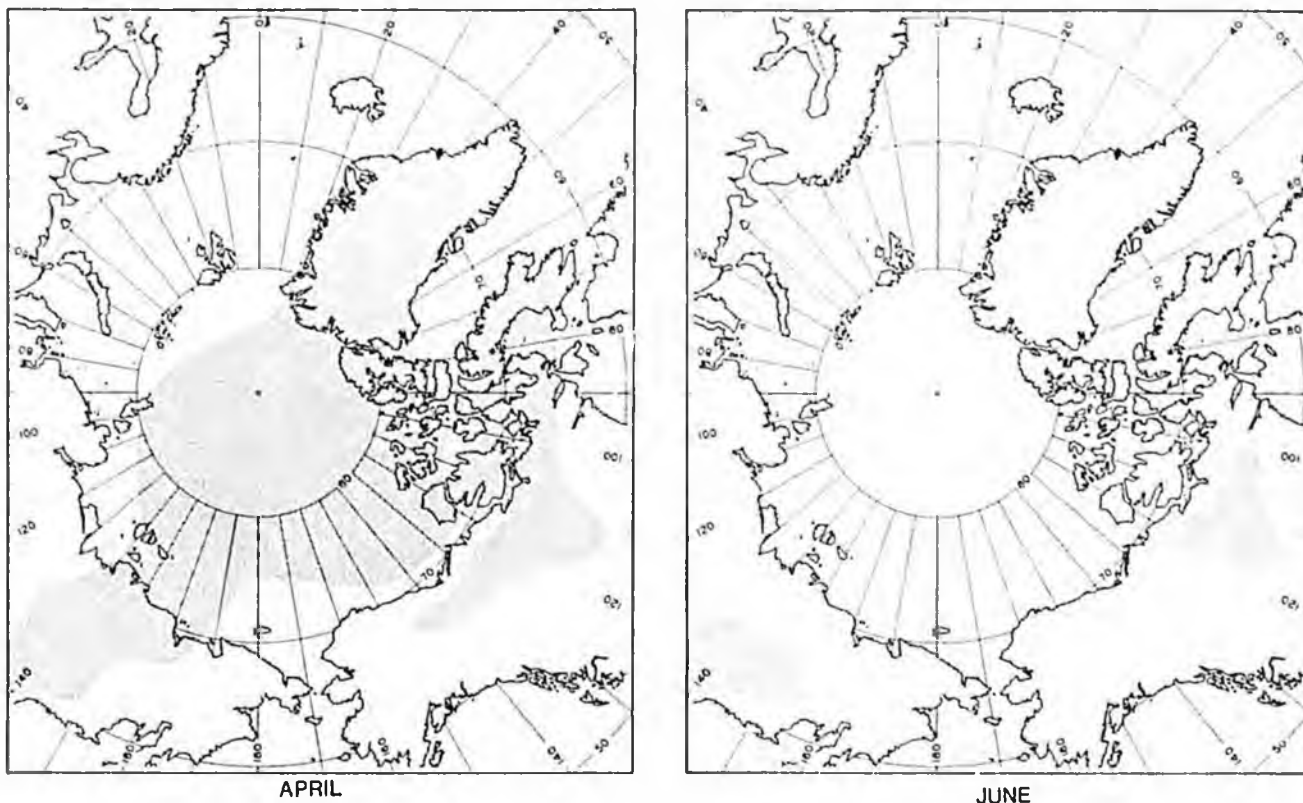


Figure 3. The arctic haze disappears in the late spring, with the onset of extensive cloudiness. Shaded areas are cloud-free.

November and December, reaching a maximum in March-April; after that, the haze virtually disappears. The disappearance of the haze in late spring is associated with the onset of extensive cloudiness in the Arctic (Fig. 3). Apparently the water droplets in the stratus clouds filter out the haze and clear the air.

The arctic air remains very clear all summer, except for occasional inflows of smoke from wild fires burning in the tundra or in the high-latitude forests. In any case, the chemical pollution indication disappears in summer; all we find are occasional bursts of naturally occurring substances, such as wind-blown dust, sea salt particles, or forest fire smoke particles.

In late winter the situation is very different: the entire arctic basin is then filled with pollution-derived substances.

#### POLLUTION COMPONENT OF THE ARCTIC WINTER AEROSOL

The conclusion that arctic haze is mainly pollution-derived can be supported by studies of individual strong haze episodes that occur during winter in relation to the meteorological situation that preceded the haze buildup. In this way, Wolfgang Raatz identified the major pollution trans-

port pathways to the Alaskan Arctic. Raatz, working on his Ph.D. dissertation, found that the most important source region for arctic haze in Alaska is the general geographic area of Eurasia (Fig. 4).<sup>4</sup> North American sources contribute only in minor ways to the Alaskan-sector air pollution problem. Some of the major transport pathways of pollution by-products to the Alaskan Arctic are illustrated schematically in Figure 5.

The strongest indication that arctic haze is pollution-derived comes from the high concentrations of pollution-associated elements, such as vanadium. A useful way of expressing the relative increase in concentration enrichment (or for that matter depletion) of an element is to compare its concentration with that nor-

mally found in the earth's crust. The strong enhancements seen in vanadium and manganese in the winter months imply that arctic haze consists of particles from industrial pollution.

Another indicator of pollution is the gray coloration of winter filter samples. The color comes from the presence of

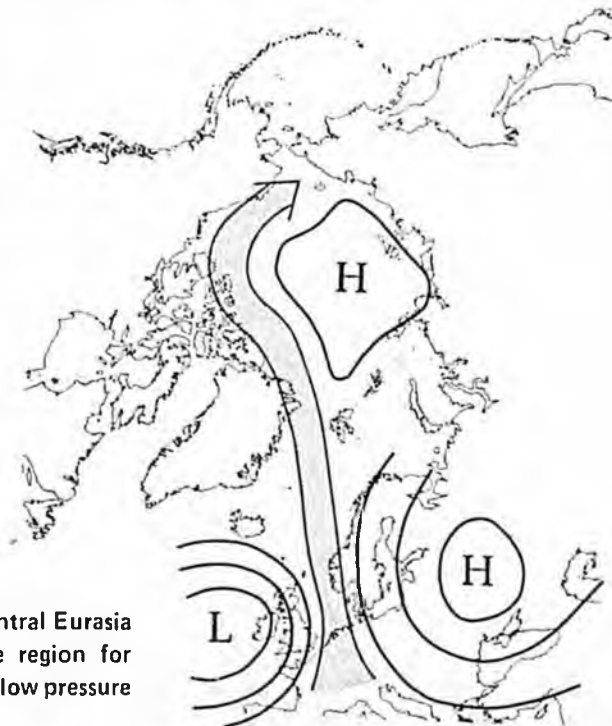


Figure 4. Map showing that central Eurasia is the most important source region for Alaska's arctic haze.<sup>4</sup> High and low pressure areas are indicated.

sooty, unburned carbon, an element likely to have originated from man-made combustion processes. Perhaps the most convincing evidence for a man-made source of the haze is the high concentrations of sulfate in the haze that always occur simultaneously with the pollution tracers. Sulfate accounts for more than one-half of the mass of atmospheric particles over Barrow (Fig. 6). By considering the transport and evolution of sulfate aerosol, Rahn and McCaffrey have found that the majority of it is likely to come from conversion of gaseous sulfur dioxide to particles.<sup>5</sup> The major source of this is SO<sub>2</sub> is from midlatitude pollution!

### WHY IS THE ARCTIC POLLUTED?

The concentration of haze and gases such as sulfur dioxide in the Antarctic is about a tenth of that found in the Arctic. This is not surprising if the hypothesis is true that arctic haze comes from industrial activity, for 90 percent of the world's industrialization is concentrated in the northern hemisphere. Strong convective storms in the Intertropical Convergence Zone near the equator prevent most northern pollutants from passing into the southern hemisphere.

The arctic regions in general, and especially the Alaskan Arctic regions, are distant from air pollution sources. Within the northern hemisphere the atmospheric circulation patterns that transport pollutants north-south are less efficient in summer than in winter. In summer the east-west airflow effectively cuts off the arctic regions from the lower latitudes; this is a major reason for the low summer pollution at places such as Barrow. In summer the arctic air is almost as clean as the antarctic air. In winter, as we have mentioned, the arctic atmosphere becomes dirty.

There are three reasons why arctic haze is most pronounced in winter: (1) increased winter emissions of pollutants, (2) more rapid and efficient poleward transport by meteorological systems in winter, and (3) longer residence times of the haze particles in the atmosphere. The third reason is based on the fact that clouds and precipitation are quite efficient at removing ("scavenging") pollution particles from the atmosphere, and both clouds and precipitation are less prevalent in the Arctic during winter than they are in summer (Fig. 3).

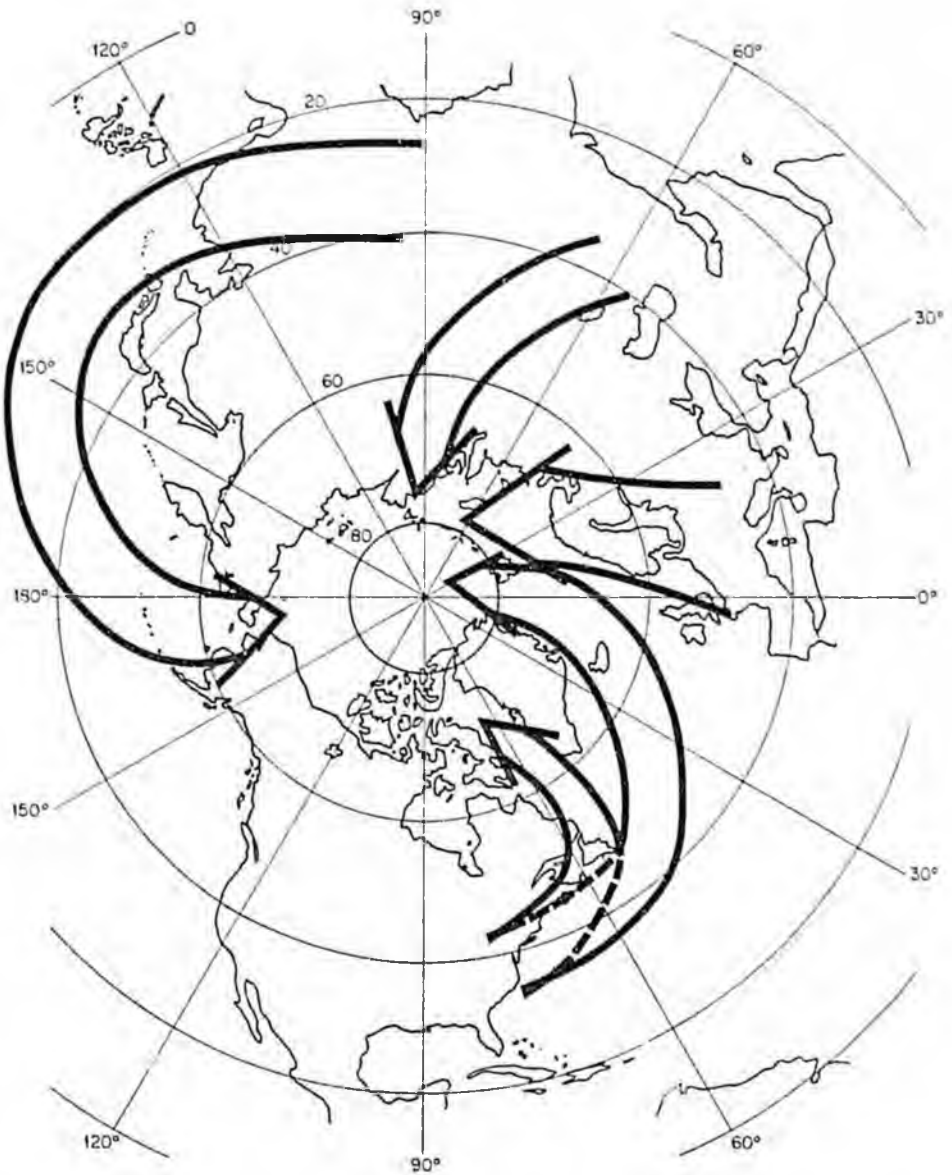


Figure 5. A schematic presentation of the major pathways of industrial pollution into the Arctic.

It also probably is true that particle removal rates decline substantially in winter due to the high convective stability of arctic air. Arctic air is analogous to the stable cold air which sinks down to the bottom of a deep-freeze chest. Because stability limits the strength and number of turbulent eddies, it takes longer for particles to be removed by being carried close to and catching on or diffusing onto the surface.

### RESEARCH ON THE SOURCES OF ARCTIC HAZE

Efforts are being made to trace the origins and pathways of arctic haze and to pin down the source regions in more detail. By observation alone, it is easy to

eliminate eastern Asia as a major source of Arctic aerosol: the air from the Pacific pathway is the cleanest observed, because of the extensive storminess along the route. Likely source regions were early on suspected to be eastern North America and Europe, including the western USSR.

Ratz<sup>4</sup> analyzed synoptic weather patterns occurring during and before episodes of arctic haze at Barrow. By using an iterative "closure" approach, he was able to demonstrate that most strong episodes of haze in the Alaskan Arctic are preceded by surges of northward-flowing air over polluted areas in eastern North America, Europe and the Soviet Union. The pollution-laden air travels in characteristic large-scale anticyclonic air circulation patterns.

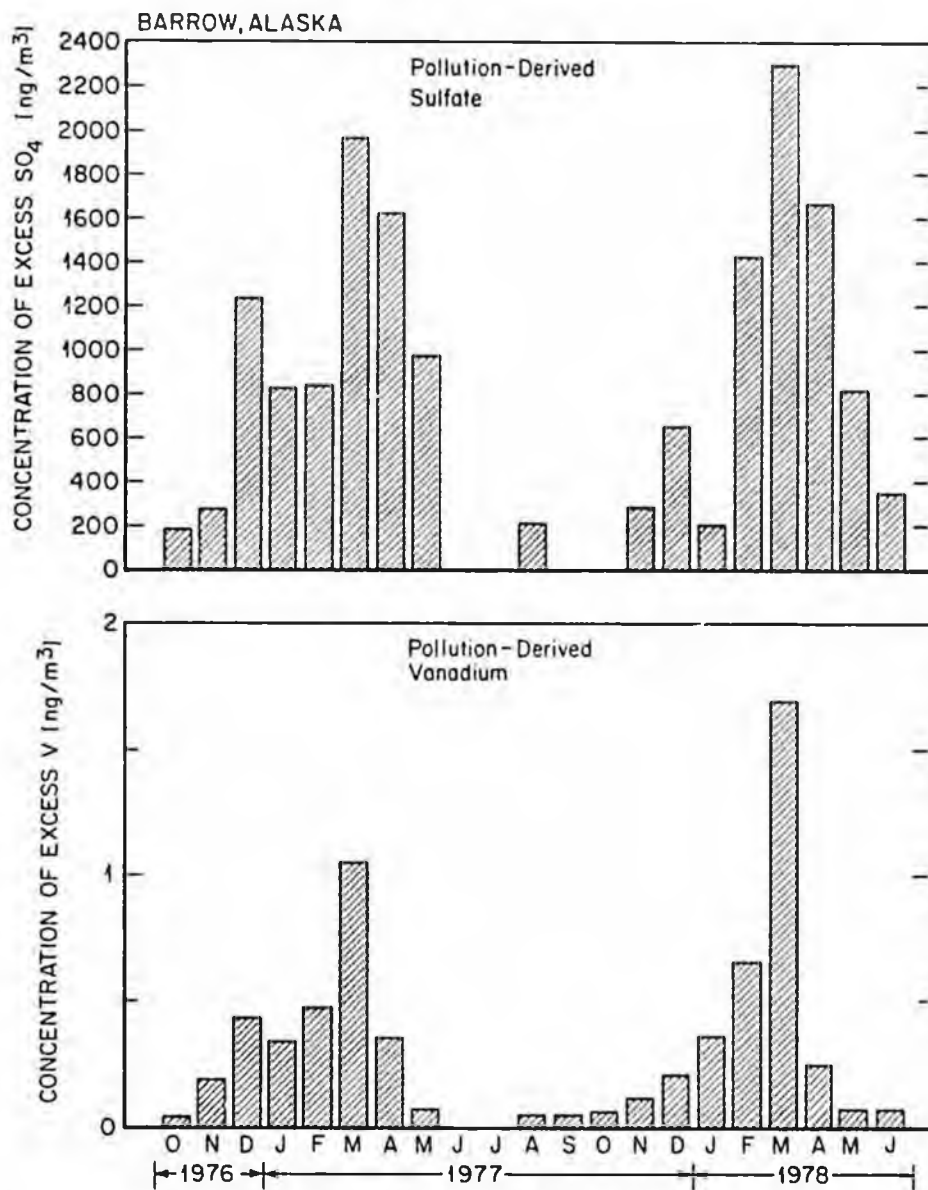


Figure 6. Seasonal variation of pollution-derived sulfate and vanadium, Barrow, Alaska.

having been formed from the conversion of trace gases, especially by the oxidation of sulfur gases.<sup>5</sup> The models indicate that the transit time to the Arctic is about 10 days. Thus it appears that arctic haze is caused by particles and gases injected from the lower latitudes. Both Rahn and Raatz deduced that central Eurasia is the primary source region for arctic haze in Alaska during midwinter, whereas European sources become more predominant in spring. North American sources are fairly minor, contributing perhaps one-fifth of the arctic haze in Alaska.<sup>7</sup>

#### SIGNIFICANCE OF AIR POLLUTION AEROSOL IN THE ARCTIC

The average size of particles making up arctic haze is around half a micrometer, a size comparable to the wavelength of visible light (Fig. 7). Particles such as these interact strongly with sunlight and redistribute the radiation fluxes in the atmosphere and at the surface. In addition, radiative interactions occur between the particles and the infrared terrestrial (heat) radiative fluxes in winter, when the sun is down. What, if any, effect does the redistribution of radiant energy have on climate? Unfortunately a complete answer is not yet available.

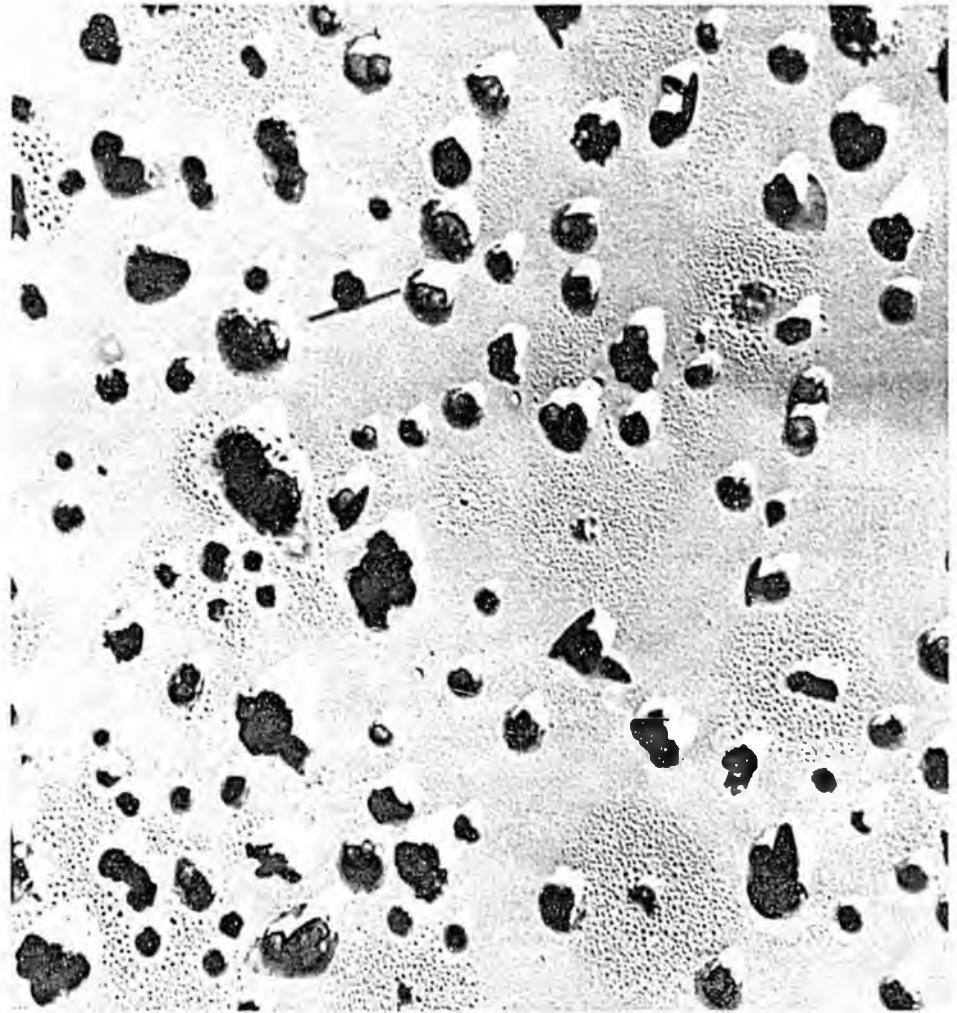
Preliminary calculations indicate that in springtime the haze introduces slight cooling at the surface and a relatively strong heating within the haze layer itself. In winter, the haze would warm the lower layers of the atmosphere and the surface.<sup>9</sup> The response of weather, and ultimately climate, to such forced cooling and heating is difficult to predict because of complicating positive and negative feedback mechanisms. For example, the cooling near the surface and the heating aloft alters the dynamic stability of the atmosphere and introduces air subsidence which could affect cloudiness. The haze may also affect the nucleation properties of the arctic atmosphere and through this mechanism change cloudiness and precipitation. Very little is known about the extent of these effects.

Rahn,<sup>6,7</sup> on the other hand, investigated the use of chemical signatures in air samples collected in the Arctic. Characteristic signatures of certain trace elements present in the aerosol component of arctic haze seem to relate to specific, albeit large, geographical regions in which the pollution aerosol was injected initially into the atmosphere. An example is the ratio of "non-crustal" manganese to vanadium which varies for source regions in the eastern U.S., in Europe, Eastern Europe and the Soviet Union. Part of the reason for the variation pertains to the abundances of elements present in fuels. Another factor may be sociological in nature, reflecting the variations in the air pollution controls in the different countries, the relative ratio of coal to oil burned, the number of automobiles, etc. The central region of the

Soviet Union, for instance, is a coal-based society with a heavy steel-processing industry and, apparently, considerable air pollution.<sup>8</sup> The region is a heavy producer, relatively speaking, of submicron particles containing Mn, whereas V is a common submicron aerosol found in effluents from industrial sources burning fuel oils. Since the United States is an oil-based society, the Mn/V ratio is larger in pollution by-products from the Soviet Union than it is from the United States. The example shows the principle on which characteristic chemical patterns can be used to deduce relative strengths and source regions of pollution flowing to the Arctic.

From analytical models of the transport of material from midlatitudes to the Arctic, it has been learned that arctic haze particles are mainly secondary products,

Figure 7. Electron microscope photograph of arctic haze particles collected at Barrow, Alaska. Most of the particles contain sulfur. They have been overcoated with a thin layer of barium monoxide so they can be photographed more clearly; the electron beam illuminating the sample casts slant shadows. (Photograph courtesy of Dr. E.K. Bigg.)



Arctic haze particles will deposit on the surface, though in relatively low concentrations, and the environmental consequences of deposited acidity, sulfate, nitrate, heavy metals and organic substances on the pack ice and tundra are not yet known.

The most significant result of studies of arctic haze is the recognition that huge areas of the world are being affected by pollution aerosols and gases. On a monthly basis, the Arctic and Euro-Asian subarctic are all nearly equally polluted by sulfate aerosol, at least in winter. Clearly arctic haze is a multinational, even a multinational phenomenon. Future research should clarify many questions about arctic haze that are presently unanswered.

#### ACKNOWLEDGMENTS

The research on arctic haze has been supported by the Office of Naval Research under contract N-00014-C-0435 and the National Science Foundation under grant DPP77-27242. Facilities of the Naval Arctic Research Laboratory, Barrow, were used in the studies (Fig.8).

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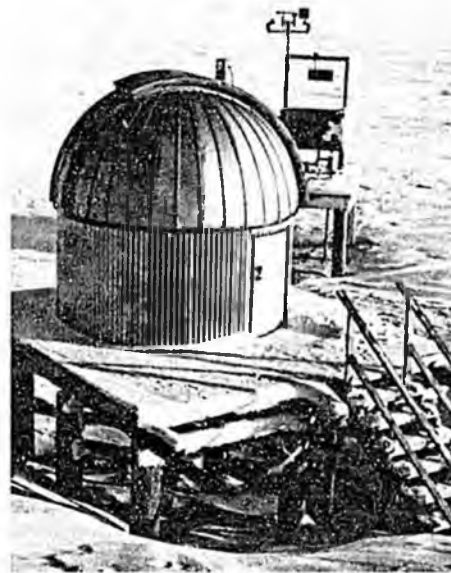


Figure 8. Typical observation station at Barrow (operated by U.S. Dept. of Commerce).

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Air

November 1983

*F's  
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# Carbon Monoxide Study Anchorage, Alaska

November 22, 1982  
to  
February 11, 1983



ANCHORAGE  
CARBON MONOXIDE STUDY

November 22, 1982 - February 11, 1983

Prepared by  
Jon W. Schweiss  
U.S. Environmental Protection Agency, Region 10

With The Cooperation and Concurrence  
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DISCLAIMER

This report has undergone the U. S. Environmental Protection Agency's (EPA) peer review process and has been reviewed by both the Anchorage Air Pollution Control Authority/Municipality of Anchorage (AAPCA/MOA) and the Alaska Department of Environmental Conservation (ADEC) and is approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the EPA, AAPCA/MOA, or ADEC, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

## PREFACE

As prescribed in the Clean Air Act (CAA) of 1970, the U.S. EPA established National Ambient Air Quality Standards (NAAQS) for protection of the public's health from carbon monoxide in air external to buildings to which the public has access. In a number of cities nationwide, including Anchorage, these standards have not yet been attained. Plans to achieve the standards are required under the CAA Amendments of 1977. It is hoped that the material presented herein will assist in achieving progress towards the protection of the public's health through the attainment of these standards.

## ACKNOWLEDGEMENTS

I gratefully acknowledge the invaluable assistance of members of the Anchorage Air Pollution Control Authority/Municipality of Anchorage (AAPCA/MOA), Alaska Department of Environmental Conservation (ADEC) and Alaska Department of Transportation (ADOT). Without their continuing cooperation and unfailing efforts the successful completion of this study would not have been realized.

The study was accomplished with the following division of labor. The EPA was primarily responsible for study design and funding, quality assurance development, some field training, data processing and analyses, and report preparation. The AAPCA was primarily responsible for budget and contractor management, sampling initiation and maintenance, data collection and reduction, and quality assurance functions. These efforts were coordinated by George LaMore, Director of AAPCA/MOA and supported by a staff of Stephen Morris, Wes Tindall, Brenda Horn, and Ron King of MOA's Planning Department. Tom Chapple and Leonard Verrelli of ADEC were primarily responsible for providing State input to most study functions and coordinating the implementation of the traffic count program with ADOT and the MOA's Traffic Engineering Department.

The contributions of the National Weather Service/Anchorage International Airport, the control tower crew at the Merrill Field airport, and the meteorological staff at Elmendorf Air Force Base were also greatly appreciated.

Finally, a great debt is owed to the many members of the EPA Regional staff who provided guidance, encouragement, and assistance to the task at hand. Special gratitude is due to both Kenneth Carson and Laurie Fiske for their endeavors at the computer keyboard and Cathy Chavez for her enduring patience in many hours with the word processor.

## ABSTRACT

Typically, levels of ambient carbon monoxide (CO) vary widely among the four existing permanent monitoring sites distributed throughout the city of Anchorage. An ambient air sampling program was designed and implemented to clarify and define, if possible, the relationship of carbon monoxide (CO) levels reported from these permanent sites and levels occurring elsewhere in the city. Integrated bag sampling was conducted on weekdays at approximately 50 sites during the interval spanning November 22, 1982 and February 11, 1983. Samples collected from each site were analyzed by the non-dispersive infrared (NDIR) method. Comparisons were then made between data arising from the study sites and the four permanent monitoring sites. A comprehensive quality assurance program was developed and ordered to the study to ensure the collection of data that were of known and appropriate accuracy, precision, representativeness, comparability and completeness.

In largely fulfilling the purpose of the study, the primary conclusions arising from analysis of the study data were twofold: 1) The permanent monitoring network does not adequately characterize either the absolute magnitude of CO levels or the frequency of standards exceedances encountered at an array of locations elsewhere in the study area, and 2) The basic or immediate representativeness of each permanent monitoring site has largely been established.

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## INTRODUCTION

Since the onset of ambient air monitoring in 1974, a carbon monoxide (CO) problem has been identified with the city of Anchorage, Alaska. Violations of the standard\* established by EPA for the protection of the public's health from ambient CO levels have been routinely recorded at each of the four permanent monitoring sites currently operated in Anchorage. It is estimated that some 90 percent of all the emissions of this colorless, odorless, and tasteless pollutant in Anchorage are directly attributable to motor vehicle exhaust. The persistence and severity of this problem have aroused and garnered the active concern of the general public, automobile industry and virtually all levels of government, local to federal.

Additional information relative to the magnitude and spatial distribution of this problem was sought to define the relationships between CO levels measured at the permanent sites and concentrations elsewhere throughout Anchorage. Accurate knowledge of this kind is critical in preparing an effective and comprehensive abatement strategy insofar as the interpretation of the ambient record bears heavily on the nature, scope and degree of control required.

The three entities with jurisdictional interest in the issue, the Municipality of Anchorage(MOA), the Alaska Department of Environmental Conservation (ADEC) and the U. S. Environmental Protection Agency (EPA) conceived and conducted a sampling study towards resolving the representativeness of the permanent monitoring network. This report presents the major results and conclusions from that study.

## STUDY PURPOSE AND OBJECTIVES

The express purpose of the study was to examine and establish, if possible, the representativeness of each site in Anchorage's permanent CO monitoring network in characterizing the magnitude, spatial, and temporal aspects of the city's CO problem. The immediate utility of the information arising from the study would be twofold. It would assist in establishing a credible technical basis for the derivation of a design value for the city. This is the value to which the ultimate control strategy would be targeted for reduction of ambient CO to levels in compliance with EPA's standard. And it would serve in the selection of the permanent monitoring site(s) against which the effectiveness of the ultimate control strategy would be subsequently indexed.

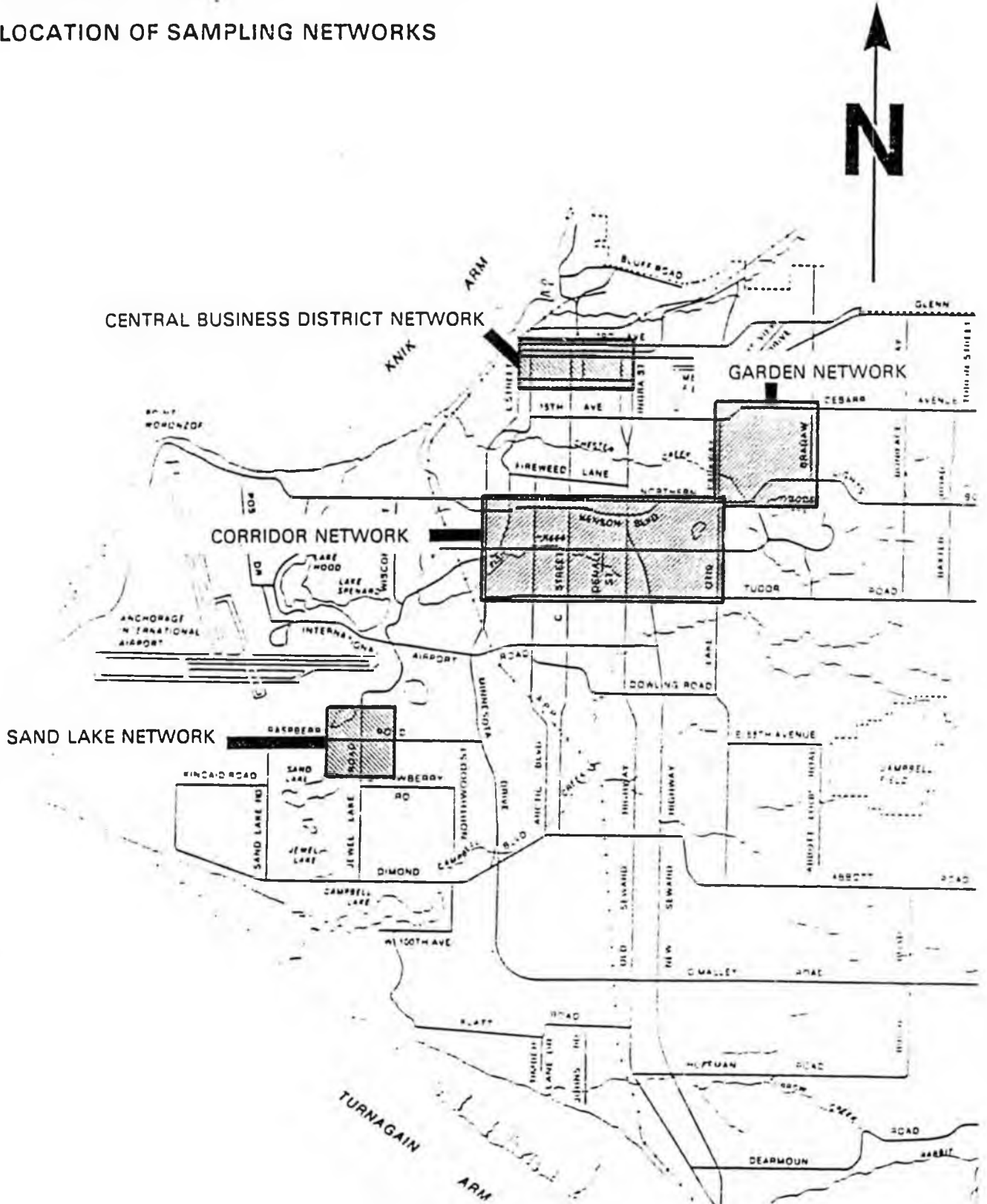
Explicit objectives were developed to ensure that this purpose was fulfilled within the context of intervening time and resource constraints. Particular emphasis was given to the representativeness of the "7th and C", "Spenard", and "Garden" permanent CO sites in recognition of their relative importance in completing study aims. Another primary study objective was to provide for the retrieval of data possessing both high and demonstrable quality and statistically adequate quantity through application of a comprehensive and rigorous quality assurance program.

\* The National Ambient Air Quality Standard (NAAQS) for CO is "...10 milligrams per cubic meter (9 p.p.m.) - maximum 8-hour concentration not to be exceeded more than once per year." (40 CFR Part 50)

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

FIGURE 1

LOCATION OF SAMPLING NETWORKS



## STUDY DESIGN

Prior to the onset of actual sampling, a monitoring plan was developed to integrate and implement the various study objectives. The plan was designed to encompass three largely distinct functional components: siting, sampling and data analyses. These respective functions represented the three basic phases through which the study progressed. What follows is a brief description of each of these phases characterizing the study. It should be noted that a more exhaustive treatment of the siting and sampling functions may be found in two support documents: "Anchorage Carbon Monoxide Monitoring Plan 1982-1983" and the "Quality Assurance Plan for 1982-1983 Anchorage CO Study".

### SITING METHODOLOGY

This particular study was unique in that it incorporated intensive and simultaneous sampling from the three spatial scales of representativeness most often emphasized in comprehensive CO monitoring programs: micro- (up to 100 meters), middle- (100 to 500 meters) and neighborhood- (.5 to 4 kilometers) spatial scales. Concurrent monitoring in each of these spatial scales provided a profile of CO impacts experienced in the urban core, along major traffic facilities, and residential neighborhoods.

Two terms are used here to discuss the concept of representativeness:

- 1) "Homogenous representativeness" is used in reference to the air mass over which the concentration of a pollutant is considered uniform.
- 2) "Analogous representativeness" is used in reference to two or more non-adjointing areas of homogenous representativeness sharing essentially identical pollutant concentration characteristics

There were two principal methods employed in designing the bulk of the study network located in Figure 1. The hot-spot approach, applied primarily to the design of the central business district (CBD) portion of the network and depicted in Figure 2 and Table 1, focused on the issue of analogous representativeness, while the grid technique used to configure the "Garden" (Figure 4 and Table 3) and "Sand Lake" (Figure 5 and Table 4) portions of the network emphasized homogenous representativeness. The "Corridor" network portrayed in Figure 3 and Table 2 was designed using both techniques.

Corollary, but largely subordinate study interests also intervened in the design exercise, and will be identified and discussed throughout the narrative that follows.

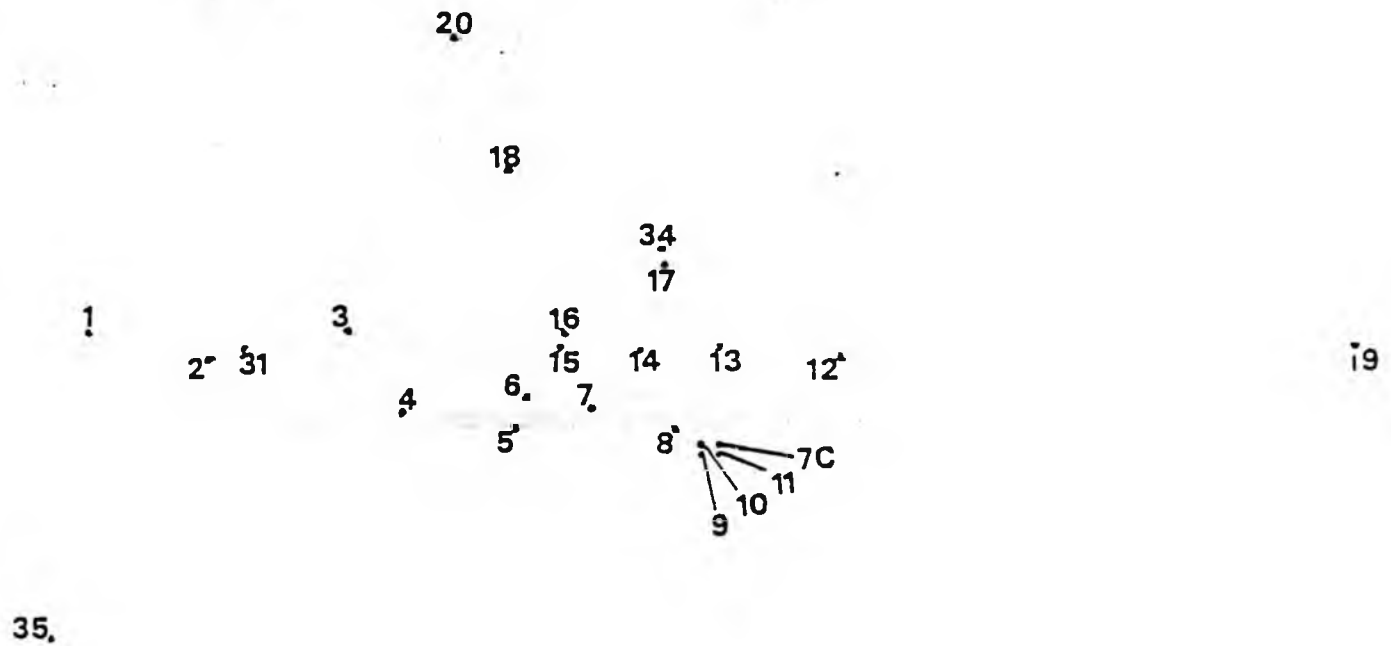
### Hot-Spot Screening Technique

Generally, attempts to model absolute concentrations of CO over areas of small dimensions (up to 100 meters) and high emission density have met with little consistent success. Therefore, as in previous Region 10 CO studies, the screening model found in EPA's Carbon Monoxide Hot-Spot Guidelines (EPA 450/3-78-035) was used to identify sites of potentially high, NAAQS threatening CO concentrations and to subsequently configure an effective microscale sampling network for measuring maximum CO concentrations.

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

LOCATION OF SAMPLING SITES  
CENTRAL BUSINESS DISTRICT NETWORK

FIGURE 1



PERMANENT SITE  
7TH & C-7C

Table 1

Anchorage CO Study  
November 22, 1982 - February 11, 1983

Site Identification  
Central Business District Network

Site	Group*	Adjacent Street	Cross Street	Side of St	Type of Sampler	Spatial Scale
1	1	5th Ave	E/O L	N	Integrated	Micro
2	2	I St	S/O 5th Ave	W	"	"
3	2	5th Ave	W/O G St	S	"	"
4	2	6th Ave	E/O G St	N	"	"
5	1	6th Ave	W/O E St	S	"	"
6	1	E St	N/O 5th Ave	W	"	"
7	1	6th Ave	W/O D St	N	"	"
8	1	6th Ave	W/O C St	S	"	"
9**	1	C St	S/O 6th Ave	E	"	"
10**	N/A	C St	S/O 6th Ave	E	"	"
11***	1	C St	S/O 6th Ave	E	"	Middle
12	1	A St	S/O 5th Ave	W	"	Micro
13	1	5th Ave	E/O C St	S	"	"
14	2	5th Ave	E/O D St	S	"	"
15	1	5th Ave	E/O E St	S	"	"
16	2	5th Ave	E/O E St	N	"	"
17	2	4th Ave	W/O C St	S	"	"
18	1	3rd Ave	W/O E St	S	"	"
19	1	5th Ave	E/O Gambell St	S	"	"
20	1	F St	N/O 2nd Ave	E	"	Neighborhood
31	2	5th Ave	E/O I St	S	"	Micro
34	2	4th Ave	W/O C St	N	"	"
35	2	L St	N/O 9th St	W	"	"

## Permanent Site

7th & C	N/A	C St	S/O 6th Ave	E	Continuous	Middle
---------	-----	------	-------------	---	------------	--------

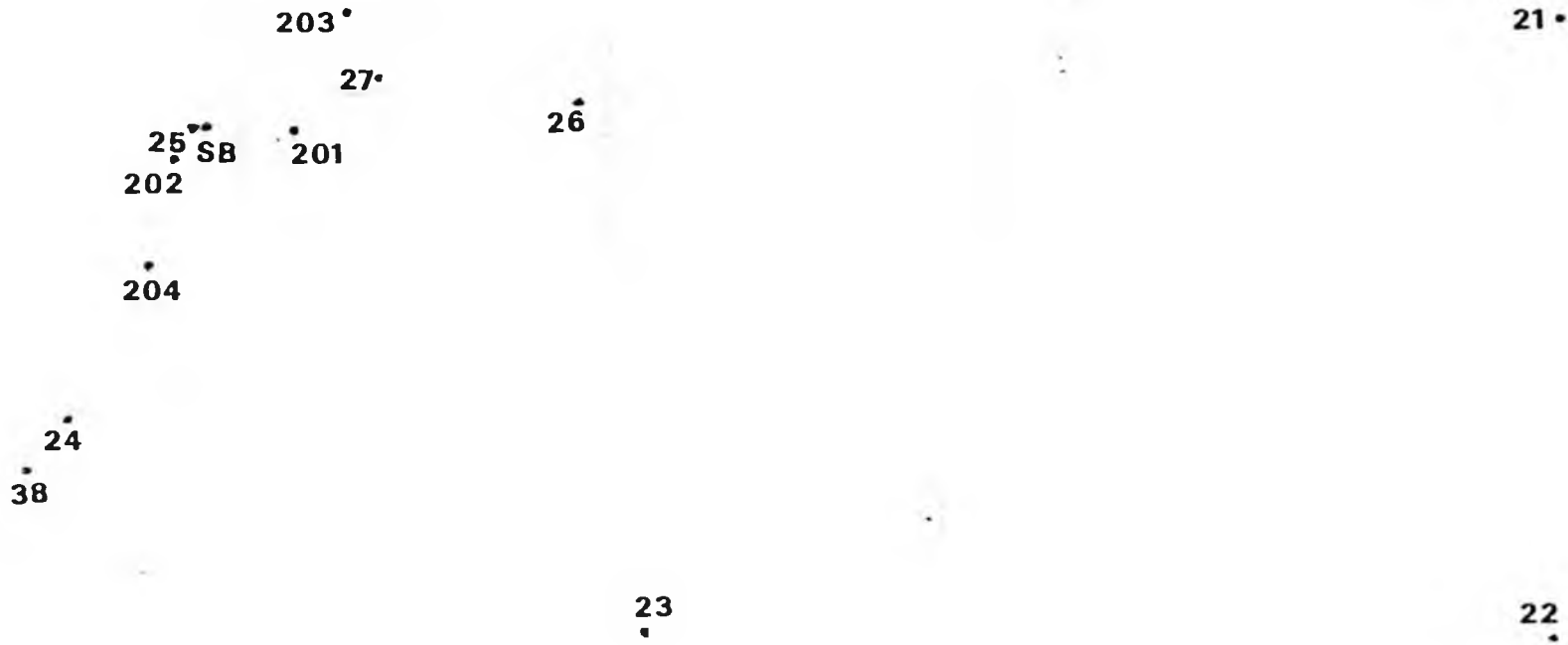
\* - Group 1 sites were sampled a nominal 54 days.  
Group 2 sites were sampled a nominal 30 days.

\*\* - Collocated

\*\*\* - Collocated with permanent site

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

LOCATION OF SAMPLING SITES  
CORRIDOR NETWORK



PERMANENT SITE  
SPENARD & BENSON SB

- 5 -

10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20

Table 2

Anchorage CO Study  
 November 22, 1982 - February 11, 1983

Site Identification  
 Corridor Network

Site	Group*	Adjacent Street	Cross Street	Side of Street	Type of Sampler	Spatial Scale
21	1	Seward	N/O Northern Lights	W	Integrated	Micro
22	2	Tudor	W/O Lake Otis	N	"	"
23	2	Tudor	E/O C St	N	"	"
24	1	Spenard	W/O Minnesota	S	"	"
25**	1	Benson	W/O Spenard	S	"	"
26	1	Benson	W/O C St	S	"	"
27	1	Arctic	S/O Northern Lights	W	"	"
201	N/A	Address:	1101 30th Ave	N/A	Sequential	Mid/Neigh
202	N/A	Address:	3002 Spenard Road	N/A	"	"
203	N/A	Address:	900 W 25th	N/A	"	"
204	N/A	Address:	1411 W 33rd	N/A	"	"
38	N/A	Address:	1807 McKinley	N/A	"	"

Permanent Site

Spenard/Benson Benson W/O Spenard S Continuous Micro

\* - Group 1 sites were sampled a nominal 54 days.  
 Group 2 sites were sampled a nominal 30 days.

\*\* - Collocated with permanent site

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

FIGURE 4

LOCATION OF SAMPLING SITES  
GARDEN NETWORK



101

103

105 G

102

104

PERMANENT SITE

GARDEN - G

Table 3

Anchorage CO Study  
 November 22, 1982 - February 11, 1983

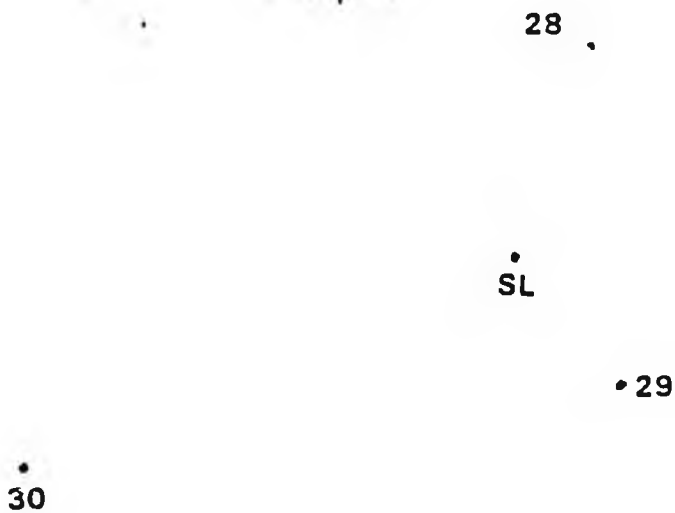
Site Identification  
 Garden Network

Site	Adjacent Street	Cross Street	Side of Street	Type of Sampler	Spatial Scale
101	E 15th St	W/O Alder	N/A	Sequential	Neighborhood
102	Alder	S/O E 20th St	W	"	"
103	Rosemary	S/O E 15th St	W	"	"
104	E 20th St	W/O Nichols	S	"	"
105*	E 16th	E/O Garden	S	"	"
Permanent Site					
Garden.	16th St	E/O Garden	S	Continuous	"

\* - Collocated with permanent site

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

LOCATION OF SAMPLING SITES  
SAND LAKE NETWORK



PERMANENT SITE  
SAND LAKE-SL

Table 4.

Anchorage CO Study  
November 22, 1982 - February 11, 1983

Site Identification  
Sand Lake Network

Site	Adjacent Street	Cross Street	Side of Street	Type of Sampler	Spatial Scale
28	W. 64th St	W/O Cranberry St	N	Integrated	Neighborhood
29	Cranberry St	N/O W. 71st St	E	"	"
30	Caravelle Dr	W/O Crawford St	S	"	"

Permanent Site

SL*	Raspberry Rd	W/O Cranberry St	S	Continuous	Neighborhood
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\* - Sand Lake

This screening model is predicated on an extensive array of relatively severe underlying assumptions (low ambient temperature and wind speed, "ideal" receptor location, vehicle composition, etc.). When considered collectively, these assumptions compose a conservative or worst-case scenario for the inducement of CO exceedance potential at subject intersections. Model output is simply in terms of whether an intersection exhibits hot-spot potential. The model does not characterize the nature of this potential with respect to either absolute magnitude or projected frequency of standard exceedance.

The number of intersections identified by the model as potential CO hot-spots far exceeded the number of samplers available to the study. Therefore, each intersection identified to possess potential subsequently underwent a second-tier evaluation towards ranking the entire candidate pool with respect to the adjusted strength of potential. Heavily reliant on previous sampling experience, several factors were subjectively weighted relative to their aggregate contribution to CO concentrations at each intersection. Finally, intersections from this ranked listing were considered against the logistical limitations posed by both the sampling methodology and the spatial distribution of candidate sites.

Each of these samplers was sited in conformance with EPA's siting criteria for monitoring maximum concentrations of CO in a micro spatial scale (40 CFR Part 58, Appendix E).

#### Grid Design Technique

The grid design technique is a relatively straightforward method of establishing both the homogenous and analogous aspects of pollutant concentrations throughout an airmass. This technique is particularly applicable to the design of a sampling network emphasizing the middle- and neighborhood- spatial scales of representativeness of existing permanent monitoring sites.

The technique used here involved designing a grid of samplers at sites both equidistant from the permanent monitor and each other and in basically comparable physical environments. The dimension of the circumscribing radius was arbitrary. The dimension(s) selected for this study coincided as nearly as possible with the increments EPA uses in defining middle- and neighborhood- scales of representativeness: 100 meters to .5 kilometers and .5 kilometers to 4 kilometers respectively (40 CFR 58, Appendix D). Once the general sampling location had been determined, other pertinent factors were considered in the selection of individual prospective sites towards enhancing inter-site comparability.

Each of these samplers was sited to conform to EPA's siting criteria for sampling in a neighborhood spatial scale (40 CFR Part 58, Appendix E). Due to design peculiarities, probe inlet height for the sequential samplers was approximately two (2) meters lower than the lower limit prescribed by the siting criteria. However, since these sites were sufficiently removed from roadways, this slight probe inconsistency is not thought to have affected the data to any discernible extent.

## SAMPLING METHODOLOGY

This function was itself composed of several individual elements including: selection of study and sampling intervals, selection of sampling methods, and quality assurance.

### Selection of Study and Sampling Intervals

Ambient CO levels are typically cyclic in nature, revolving through several temporal scales simultaneously, from diurnal to seasonal in duration. In order to optimize the probability of sampling the phenomenon of interest, i.e. high CO concentrations and thereby realize the most effective utilization of resources, a pre-study analysis was performed to determine the seasonal and daily intervals most frequently characterized by maximum CO potential. This was accomplished through a historical review of the data reported from each of the four permanent CO sites in Anchorage during the four previous winter seasons. The results of the review are summarized in Table 5.

TABLE 5 Results of Pre-Study Data Analyses

<u>Permanent CO Site</u>	<u>Months of Greatest Exceedance Frequency (Decreasing Order)</u>	<u>5 Consecutive Days of Greatest Exceedance Frequency</u>	<u>Daily 8-hour or 16-Hour Interval* of Greatest Exceedance Frequency</u>
7th and C	Dec, Jan, Nov, Feb	Monday-Friday	11:00 a.m. - 7:00 p.m.
Spenard and Benson	Dec, Jan, Nov, Feb	Monday-Friday	11:00 a.m. - 7:00 p.m.
Garden	Dec, Jan, Nov, Feb	Monday-Friday	9:00 a.m. - 1:00 a.m.
Sand Lake	Dec, Jan, Nov, Feb	Monday-Friday	N/A

\* - Duration of subject interval corresponds to type of sampler used in conjunction with permanent site.

In retrospect, all sampling intervals selected for these sub-networks were largely validated by subsequent sampling data.

### Selection of Sampling Methods

Sampling methods were selected which retrieved the types of information that most effectively responded to the study objectives. This, while satisfying a mix of other selection criteria including: direct and indirect resource consumption per data unit, physical and performance specifications, etc.

Two basic types of samplers were employed to collect ambient CO samples: single bag samplers and multiple, consecutive sequencing bag samplers, hereinafter referred to as integrated and sequential samplers respectively. Both samplers operate on the integrated principle where an ambient sample is pumped at a constant rate over the time interval of interest. All bag samples were analyzed via the NDIR (non-dispersive infra-red) method\* to yield the "average" ambient CO concentration over the subject interval.

\* - EPA-designated reference method: Beckman Model 866 CO Analyzer

The integrated samplers, deployed extensively in the CBD and Corridor portions of the study network, were used to collect two consecutive four-hour "average" samples each study day. The resultant concentrations were then averaged to construct an eight-hour average concentration of CO for comparison against the eight-hour NAAQS. Three of these samplers were modified to collect a single eight-hour bag sample and deployed in the grid about the Sand Lake permanent monitor.

The sequential samplers were located throughout the study network, but primarily in the Spenard and Garden grid networks where a discrete hourly profile was desired for comparison with the focal permanent site and other sites in the grid. These samplers collected 16 consecutive samples allowing for the construction of up to as many as eight overlapping 8-hour intervals each study day for comparison against each other and the standard.

Traffic and meteorological data were also collected over the term of the study. While these data are of particularly critical significance to future analyses of the data, they will not be included in this report.

#### Quality Assurance

A comprehensive and rigorous quality assurance (QA) program was developed, documented, and implemented to ensure that study data were of known and appropriate quality, completeness, comparability, and representativeness. This program provided for routine measures of accuracy and precision for sampling, analytical, and data reduction functions.

The quality of all meteorological and traffic count data are largely unknown due to the lack of direct control of the data generation operation. The quality is believed to be sufficient for the ultimate intended purpose of the data.

#### DATA ANALYSES

Several methods exist by which to analyze and compare data from the study sites and the permanent monitors. Two basic approaches are presented in this report to examine the representativeness of the permanent sites. The first approach compares data on a day-to-day basis. Because the study sites were sampled for a single eight- or sixteen-hour period each day, data from the permanent monitors for the identical interval were chosen for purposes of temporal congruity.

The second approach compares data from the entire study interval, regardless of whether the compared data occurred on the same day. This method of analysis lends itself to examining larger patterns and frequencies of CO levels throughout the term of the study while smoothing the daily inter-site variability which can occur especially as a result of meteorological impacts.

The results of the analyses presented here reflect the most significant results and conclusions stemming from a more extensive treatment. Because of time constraints, this expanded treatment of study data will not be compiled into a single report document until some later date.

## LIMITATIONS

Even well-designed studies of this nature are subject to uncertainties of which both researcher and reader alike should be cognizant. These qualifications do not necessarily impair the validity of the study results, but rather frames their present and future application and interpretation within the context of appropriate caution. The following uncertainties have been identified with this study:

1) The study spanned only a single CO "season". There is a possibility, albeit remote, that the variety of conditions influencing CO levels (traffic, economic, construction, meteorological, etc.) combined to create a situation grossly anomalous with respect to both previous and succeeding seasons.

Comment: In a general sense, this situation is not thought to have occurred here. cursory inspection of the two factors to which CO levels are particularly sensitive, traffic volumes and certain meteorological parameters, indicate basic conformity to conditions characterizing previous seasons. However, future construction activities and traffic revisions may impair the long-term utility of site-specific study data by the degree of their cumulative effect on CO levels.

2) Study sampling data was collected daily for discrete eight- or sixteen-hour periods. Just as inter-site relationships may exhibit some degree of daily variability when data are compared for concurrent periods, these relationships may also vary during periods within a day for which comparable study data are largely lacking.

Comment: The pre-study analyses conducted to determine optimum sampling intervals were validated by data actually collected during the study. While these intervals, particularly the eight-hour, may not have wholly accounted for any or all of this potential temporal variability, the study data strongly reflect the intervals most frequently exhibiting the daily maximum concentrations as measured by the focal permanent sites. The glaring exception to this is found at the Sand Lake network which enjoyed a more limited study treatment and where the pre-study analysis was largely ignored for logistical reasons.

3) As referenced previously, the number of intersections identified as possessing CO potential in the pre-study siting exercise far outstripped the number of available samplers. Because of resource and logistical considerations, many of the intersections rated at higher potential were passed over for lower rated ones.

Comment: When reviewing the study results, the reader should note that data for that portion of the network sited to retrieve maximum concentrations in no way reflects all areas in Anchorage thought to possess CO potential. Additionally, the reader should be cautioned not to interpret the proportion of relatively higher impact sites to lower impact sites in the data displays as necessarily characteristic of the severity of CO levels occurring throughout the study area.

4) There were some uncertainties associated with the siting of individual microscale samplers for measuring maximum concentrations. Because CO can be a highly localized phenomenon, especially when considered over micro spatial scales, there is a relatively low theoretical probability of selecting the particular leg and then the particular side of the leg of an intersection at which the maximum concentration most frequently occurs.

Comment: It is possible there are other locations at or near subject intersections that experience consistently higher CO levels than those measured at the study site. Previous experience in evaluating site specific features enhances the probability of proper selection. However, this too is often counterbalanced by difficulties in siting opportunity and/or logistics. On balance then, the data presented herein should not be interpreted to necessarily represent the maximum CO concentrations occurring at any particular intersection. Therefore, caution should be exercised when drawing inter-site and NAAQS comparisons.

5) The study data were generated by ambient air quality sampling methods which are not approved by EPA for use as the primary basis for either NAAQS attainment/nonattainment determinations or the definitive demonstration of control strategy effectiveness.

Comment: There are uncertainties associated with virtually all methods employed to monitor ambient pollutants, EPA-approved or not. While the methods chosen for this study are subject to relatively greater variability in precision and accuracy than the EPA-approved methods located at the permanent sites in Anchorage, special measures were taken towards defining and minimizing it. As discussed later, these measures were really quite successful in yielding a data base of roughly comparable quality to that generated by the permanent network.

6) Gaps in the data record for each study site can impair inter-site comparisons in that data from certain sites may not reflect phenomena of interest which were measured successfully at other sites.

Comment: This is a real problem which we hoped to minimize by sampling over a long interval. What is particularly troublesome in relatively short-term studies of this kind is that the inter-site relationships that are generally well-described by regression analysis for instance may not be so well defined for some relatively isolated but nevertheless important features of interest, such as maximum concentrations. Because of this, gaps in the data record can be critical. Unfortunately, the occurrence of at least some gaps are unavoidable (refer to Table 13 for data capture rates for each site). Every effort was made to minimize the number of these gaps while preserving the fundamental integrity of the data base. Additionally, analysis involving direct comparisons between sites were performed, where possible, using data bases reflecting only concurrently sampled data.

## CONCLUSIONS

The major conclusions relative to the primary study purpose are as follows:

- 1) Carbon monoxide levels at a number of sites throughout the study area exceeded the standard with greater frequency and were of consistently higher magnitude than the sites in the permanent monitoring network for the period of study. The general consensus among the study principals (MOA, ADEC, and EPA) is that this situation is duplicated within a range at an array of other locations throughout the Municipality.
- 2) When considered in aggregate, the permanent monitoring network frequently exhibited sub-exceedance values when one or more study sites elsewhere in the study area reported standards exceedances.
- 3) The most severe CO impacts in terms of both magnitude and frequency, were exhibited by microscale sites on larger traffic facilities or corridors.
- 4) There was typically wide variability in the CO levels between some locations throughout the study area for corresponding intervals. On a number of occasions when one or more microscale study sites measured concentrations exceeding the standard, sub-exceedance values were being measured at other microscale and neighborhood sites.
- 5) While only certain combinations of study sites from the microscale network were well-correlated when considered on a date-paired (simultaneous) basis, all of these sites, including those collocated with the permanent sites were extremely well-correlated with each other on a rank-paired (season-long) basis.
- 6) The 7th & C permanent site was relatively representative of the lower level microscale sites and may be at or below levels measured at the neighborhood sites.
- 7) While the Spenard & Benson permanent site was often representative of study sites reporting CO levels in the mid to upper range (but not the highest range) on a study-long basis, it was not very successful in characterizing levels at other individual study sites on a daily basis. This site is also properly designated as a microscale site, although it may have definite utility in characterizing levels in adjoining (homogenous representativeness) and nearby but non-adjointing (analogous representativeness) neighborhoods with an appropriate correction factor.
- 8) The Garden permanent site was not unduly influenced by a single and/or immediate CO source, and generally characterized CO levels throughout the adjoining Garden neighborhood grid (homogenous representativeness). It may experience CO levels somewhat elevated over other areas in the Garden grid by virtue of its central location in the emission grid.
- 9) The Sand Lake permanent site generally characterized CO levels in both the adjoining (homogenous representativeness) and nearby but non-adjointing (analogous representativeness) neighborhoods.

## RESULTS AND DISCUSSION

Samples collected during virtually identical periods over a large array of sites affords a characterization of CO distribution over a relatively wide area. Data were analyzed for (1) the relative magnitude of CO concentrations reported at various sites throughout Anchorage and (2) any suggested patterns of ambient levels. Direct comparisons were made with data arising from the permanent monitors. Comparisons were also made in the form of ratios and regression/correlation analyses. Since at most study sites either two 4-hour or 16 hourly samples were collected daily, some measure of temporal variability was also subject to comparative evaluation.

Summary statistics are primarily depicted in the form of tables and box-plots or box-plot/base map combinations which enable a visualization of the spatial and temporal distribution of values for the statistics of interest. The box-plots portray the distribution of subject data as follows: maximum value, 9th decile, 3rd quartile, mean, median (2nd quartile), 1st quartile, 1st decile, minimum value. The treatment of eight-hour average data also includes the number of instances when the standard was exceeded and, when individual sites are considered, the second highest value to which the standard is indexed.

The tables and box-plots do not depict data from all sites at which sampling was conducted. Sites which were sampled either over a very short term or to fulfill relatively minor study objectives were not included.

Finally, the various major analysis sections may not contain identical slates of parameters that underwent analytical consideration. Parameters were chosen that best reflected the critical emphasis of the study.

### MICROSCALE STUDY NETWORK: CBD AND CORRIDOR SITES

This first section discusses the results from that portion of the study network sited primarily to retrieve maximum CO concentrations in a micro spatial scale. The microscale network was composed of two rather distinct sub-networks, one located within the general boundaries of the Anchorage's CBD and the other adjacent to outlying (the CBD) traffic corridors. While virtually all of these microscale sites were identical with respect to physical probe siting characteristics (i.e. distance to: nearest traffic lane, nearest intersection, obstructions, ground, etc.), there are several basic features that distinguish the CBD network from the Corridor network: 1) The CBD generally has a higher density of streets with 'significant' traffic volumes, 2) Several CBD sites were located on streets bordered on one or both sides by one-story or higher buildings whereas all of the Corridor sites were located in relatively open, well-ventilated areas, and 3) Streets adjacent to and nearby the Corridor sites typically carried higher traffic volumes than those in the CBD.

As a quality assurance measure of inter-method comparability, study sites 24 and 25 were collocated with the 7th & C and Spenard permanent sites respectively. In an effort to bolster the comparability of data actually undergoing analyses (with respect to variability, completeness, etc.), comparisons of data from study sites to the 7th & C and Spenard & Benson

permanent sites were actually referenced to the data record for these integrated sites, hereinafter referred to as site 11/7th&C and site 25/Spenard respectively.

It was recognized from the study's outset that in order to ensure that sampling objectives were effectively and efficiently realized, the study network as originally configured would be subject to periodic revision as a function of ongoing data analysis and resource considerations. Study design prescribed the magnitude and schedule of these network revisions by striking a balance between the statistical integrity (number of cases) and ultimate utility of the study data.

As a result, of the 29 individual study sites evaluated in this exercise, 18 (hereinafter referred to as Group 1 sites) were sampled a nominal 50 days. Group 1 consists of sites 1, 5, 6, 7, 8, 9, 11, 12, 13, 15, 18, 19, 20, 21, 24, 25, 26, and 27. Site 10 was collocated with site 9 and was therefore excused from the exercise. Site 20 was the "background" CBD site and is included here for purposes of contrast and comparison.

The remaining 10 sites (hereinafter referred to as Group 2 sites) were sampled a nominal 30 days. Group 2 consists of sites 2, 3, 4, 14, 16, 17, 22, 23, 34, 31, and 35. Eight sites, 2, 3, 4, 14, 16, 17, 22, and 23 were sampled during roughly the first half of the study. With the exception of site 17, these sites were discontinued because they were redundant with other sites in the study network and were re-sited one or more times in order to fulfill other short-term study objectives. Site 17 was the target of chronic vandalism and was subsequently moved directly across the street at mid-study and re-numbered to 34. Sites 31 and 35 were the only other sites sampled during the second half of the study for which data are considered in this exercise.

Because of the disparate size and contribution of these two groups, Group 2 data receives minimal treatment in this narrative.

#### Study-Long Network Statistics

The statistics that follow primarily reflect the characteristics of CO measured at each study site.

##### Maximum Eight-Hour Averages -

Elevated concentrations of CO were measured not only in the immediate vicinity of the 7th & C and Spenard permanent monitors, but at other sites throughout Anchorage (see Limitations 3 and 4). Figures 6, 7, and 8 and Tables 6 and 7 exhibit the maximum eight-hour averages reported from each site during the study.

#### Group 1 Sites

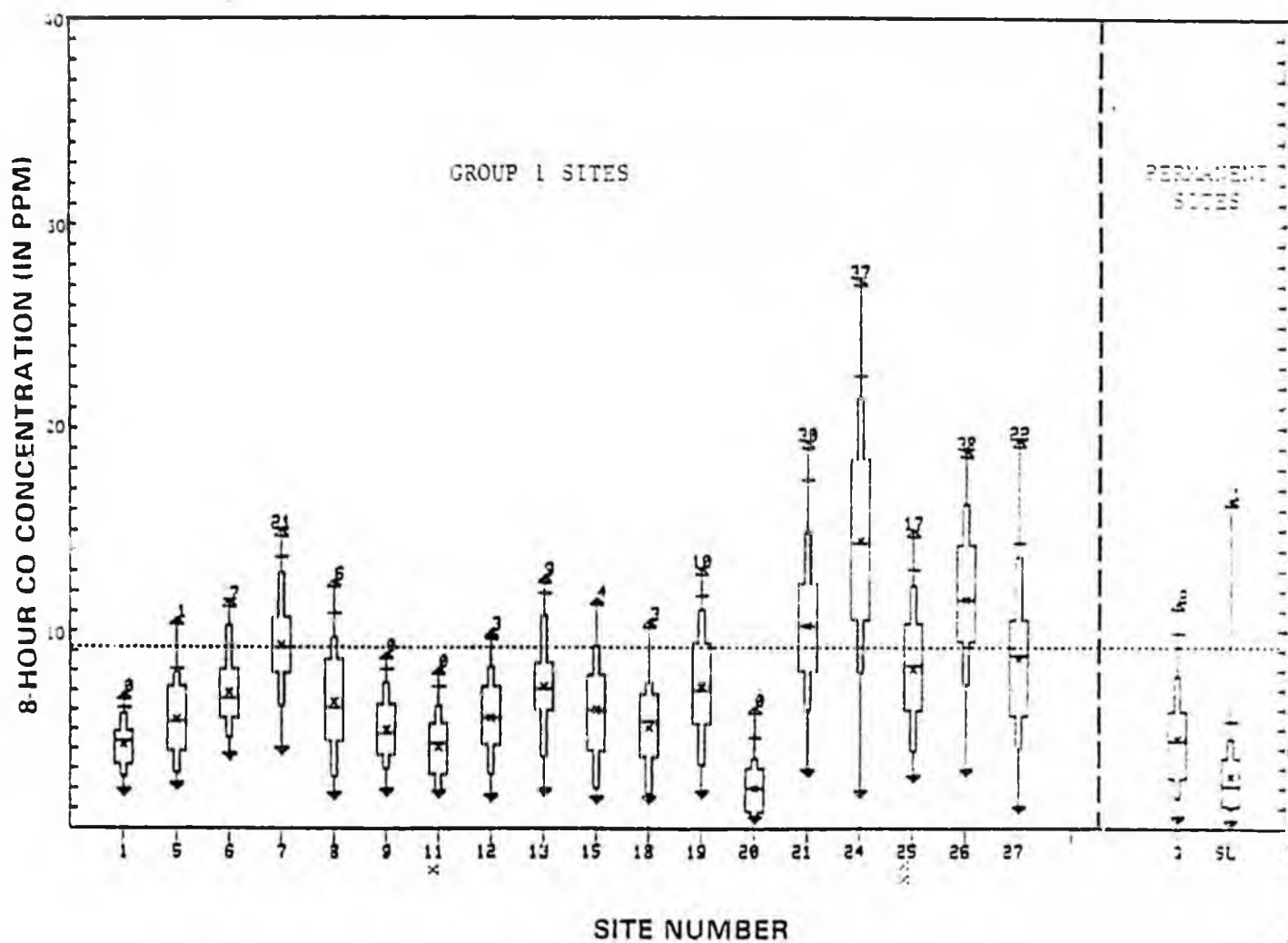
##### (General Discussion)

- A. Eight-hour maximums for Group 1 sites ranged from 5.2 ppm (site 20) to 27.4 ppm (site 24).
- B. Eight-hour maximums for site 11/7th&C and site 25/Spenard were 8.1 ppm and 15.1 ppm respectively.

FIGURE 4

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
AVERAGE CONCENTRATIONS FOR AN 8-HOUR  
PERIOD  
(11:00 A.M. to 7:00 P.M.) AT EACH SITE

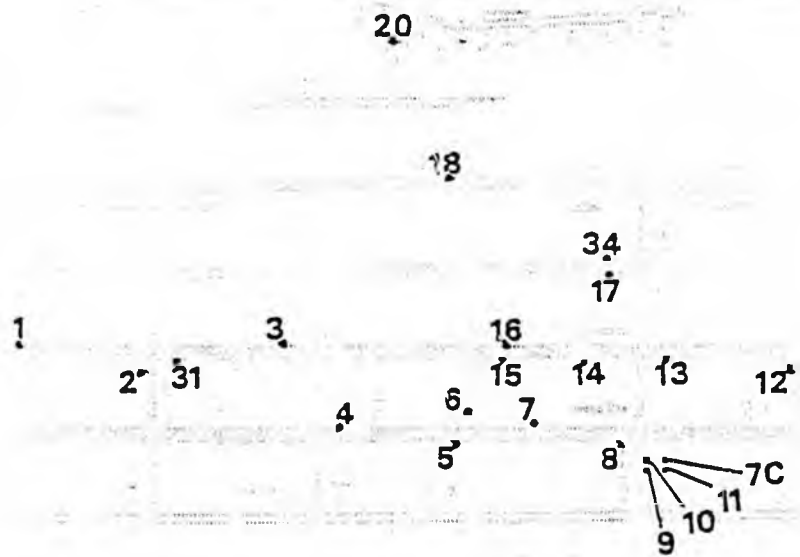
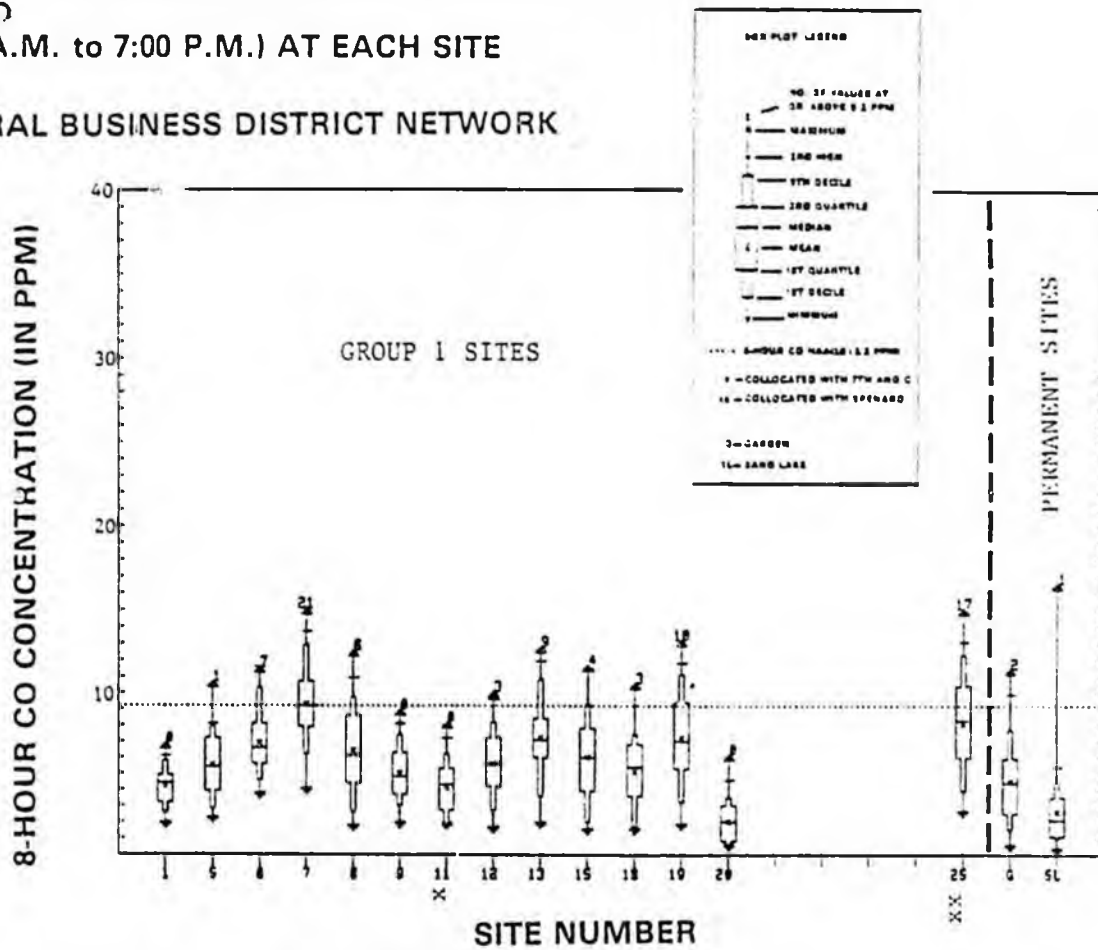


ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

FIGURE 7

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
AVERAGE CONCENTRATIONS FOR AN 8-HOUR  
PERIOD  
(11:00 A.M. to 7:00 P.M.) AT EACH SITE

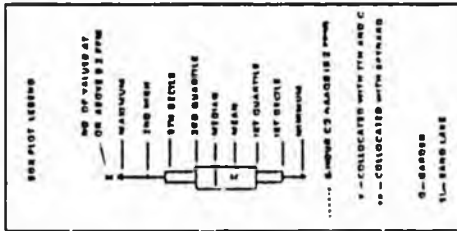
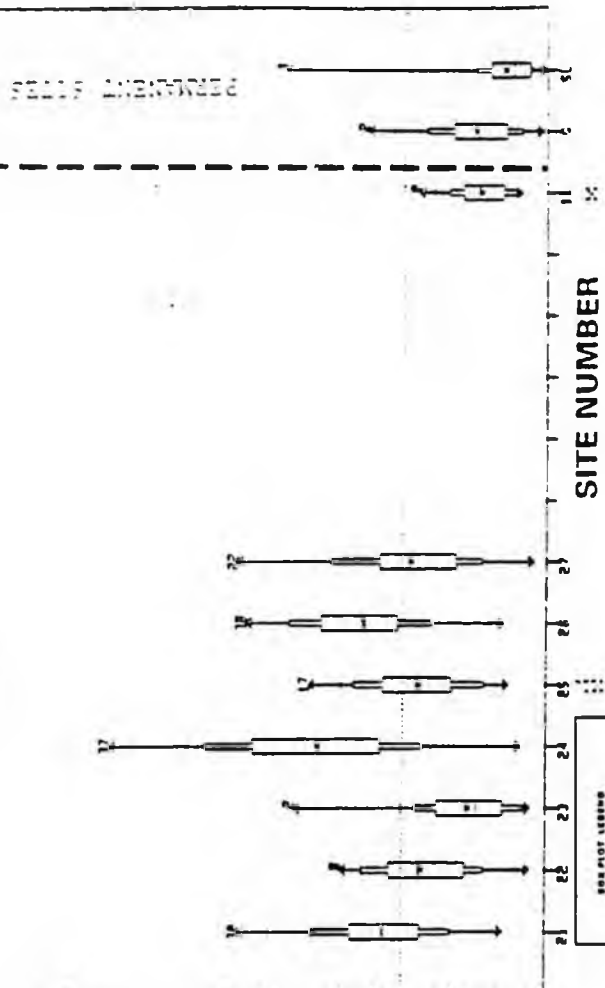
CENTRAL BUSINESS DISTRICT NETWORK



ANCHORAGE CARBON MONOXIDE STUDY  
 11/22/82 TO 2/11/83  
 CHARACTERISTICS OF WEEKDAY CARBON  
 MONOXIDE  
 AVERAGE CONCENTRATIONS FOR AN 8-HOUR  
 PERIOD  
 (11:00 A.M. to 7:00 P.M.) AT EACH SITE  
 CORRIDOR NETWORK

8-HOUR CO CONCENTRATION  
 (IN PPM)

GROUP 1 SITES



21

27

26

25 SB

24

23

22

(Study/Permanent Site Comparisons)

- C. Eight-hour maximums at 15 of the 17 Group 1 sites were 10% to 238% higher than that for site 11/7th&C (9 of which were over 50% higher).
- D. Eight-hour maximums at five Group 1 sites were greater than or equal to that for site 25/Spenard (four of which were between 26% and 81% higher).
- E. Eight-hour maximums at 11 Group 1 sites were within  $\pm 30\%$  of that at site 25/Spenard.

Table 5 Distribution of Maximum 8-Hour CO Concentration From the Study Sites

<u>Range of Maximum 8-HR CO (In ppm)</u>	<u>Percentage of Group 1 Within Range</u>	<u>Percentage of Group 2 Within Range</u>	<u>Percentage of Group 1 and Group 2 Within Range</u>
0 - 2.9	0%	0%	0%
3.0 - 5.9	0%	0%	0%
6.0 - 8.9	16.7%	45.5%	27.6%
9.0 - 11.9	33.3%	27.3%	31.0%
12.0 - 14.9	16.7%	18.2%	17.2%
15.0 - 17.9	11.1%	9.1%	10.3%
18.0 - 20.9	16.7%	0%	10.3%
20.9 -	5.6%	0%	3.4%

Table 7 Comparison of Maximum 8-Hour CO Concentrations\*  
From Study Sites and Permanent Sites

Site No. Group	Date of Max 8-HR CO Conc.	Maximum 8-HR CO Conc. (ppm)	Ratio of Study Site to Site 11** (8.1 ppm)	Ratio of Study Site to Site 25*** (15.1 ppm)
<b>1 Sites</b>				
1	01/05/82	6.9	0.9	0.5
5	01/05/83	10.7	1.3	0.7
6	02/09/83	11.6	1.4	0.8
7	12/20/82	15.1	1.9	1.0
8	01/05/83	12.6	1.6	0.8
9	01/05/83	9.0	1.1	0.6
11**	12/3/82	8.1	1.0	0.5
12	01/05/83	10.1	1.3	0.7
13	12/20/82	12.8	1.6	0.9
15	12/03/82	11.7	1.4	0.8
18	12/03/82	10.5	1.3	0.7
19	12/20/82	13.2	1.6	0.9
20	01/05/83	6.2	0.8	0.4
21	12/03/82	19.4	2.4	1.3
24	12/03/82	27.4	3.3	1.8
25***	12/20/82	15.1	1.9	1.0
26	12/03/82	19.0	2.4	1.3
27	12/03/82	19.5	2.4	1.3
<b>Group 2 Sites</b>				
2	01/04/83	6.0	0.7	0.4
3	01/05/83	3.4	0.8	0.4
4	12/03/82	7.3	0.9	0.5
14	01/05/83	11.5	1.4	0.8
16	12/03/82	10.1	1.3	0.7
17	12/03/82	12.5	1.5	0.8
22	12/30/82	13.1	1.6	0.9
23	12/03/82	16.0	2.0	1.1
31	01/21/83	7.5	0.9	0.5
34	02/03/83	10.5	1.3	0.7
35	01/14/83	8.2	1.0	0.5

\* - Measured during the period 11:00 a.m. to 7:00 p.m. on study sampling days only.

\*\* - Collocated with the 7th & C permanent site

\*\*\* - Collocated with the Spenard & Benson permanent site.

## Second Highest Eight-Hour Averages -

The eight-hour NAAQS for CO is indexed to the second highest eight-hour average concentration of CO measured at a given site in a calendar year. Similar to maximum averages, the levels of second high CO averages were also elevated throughout the study network. Figures 6, 7, and 8 exhibit the second highest eight-hour average measured at each site during the study.

### Group 1 Sites

#### (General Discussion)

- A. Eight-hour second highs for Group 1 sites range from 4.6 ppm (site 20) to 22.5 ppm (site 24).
- B. Eight-hour second highs for site 11/7th&C and site 25/Spenard were 7.2 ppm and 14.6 ppm respectively.

#### (Study/Permanent Site Comparison)

- C. Eight-hour second highs for 15 of 17 Group 1 sites were between 13% and 213% higher than that for site 11/7th&C (11 of which were over 50% higher).
- D. Eight-hour second highs at 5 Group 1 sites equaled or exceeded that for site 25/Spenard (3 of which were 34% to 70% higher).
- E. Eight-hour second highs at 3 Group 1 sites were within  $\pm 30\%$  of that for site 25/Spenard.

Table 8 - Comparison of 2nd Highest 8-Hour CO Concentrations\*  
From Study Sites and Permanent Sites

Site No. Group 1 Sites	Date of 2nd Hi 8-HR CO Conc.	2nd Hi 8-HR CO Conc. (ppm)	Ratio of Study Site to Site 11** (7.2 ppm)	Ratio of Study Site to Site 25*** (13.1 ppm)
1	12/22/82	6.1	0.85	0.47
5	02/09/83	8.1	1.13	0.62
6	01/18/83	11.6	1.61	0.89
7	12/03/82	13.7	1.90	1.05
8	01/18/83	10.9	1.51	0.83
9	11/29/82	9.1	1.13	0.62
11**	02/01/83	7.2	1.00	0.49
12	12/03/82	9.6	1.33	0.73
13	12/21/82	11.9	1.65	0.91
15	12/13/82	11.4	1.58	0.87
18	01/05/83	10.2	1.42	0.73
19	01/05/83	11.8	1.64	0.90
20	12/03/82	4.6	0.64	0.35
21	12/20/82	17.5	2.43	1.34
24	12/17/82	22.5	3.13	1.72
25***	02/01/83	13.1	1.82	1.00
26	02/01/83	18.6	2.58	1.27
27	12/23/82	14.4	2.00	1.10
<u>Group 2</u>				
2	12/13/82	5.9	0.82	0.45
3	01/04/83	6.0	0.83	0.46
4	12/16/82	6.4	0.89	0.49
14	12/03/82	11.1	1.54	0.85
16	01/04/83	9.7	1.35	0.74
17	12/13/82	9.3	1.29	0.71
22	12/09/82	11.7	1.63	0.89
23	01/05/83	9.3	1.29	0.71
31	01/31/83	5.8	0.94	0.52
34	02/01/83	10.4	1.44	0.77
35	01/18/83	5.7	0.79	0.44

\* - Measured during the period 11:00 a.m. to 7:00 p.m. on study sampling days only.

\*\* - Collocated with the 7th & C permanent site

\*\*\* - Collocated with the Spenard & Benson permanent site.

## Eight-Hour Means and Medians -

Measures of central tendency such as means (arithmetic averages) and medians (the mid-point value of data ranked by magnitude) were examined to evaluate aspects of the chronic nature of concentrations reported at each site. As there is little significant difference between the mean and median for each site, only the mean will be referenced here. For each site, all eight-hour averages reported during the study were averaged to produce the mean eight-hour concentration. Figures 6, 7, and 8 exhibit eight-hour means and medians for each sampling site.

### Group 1 Sites

#### (General Discussion)

- A. Means for the Group 1 sites ranged from 2.0 ppm (site 20) to 14.5 ppm (site 24).
- B. Means for sites 11/7th&C and 25/Spenard were 4.1 and 8.1 respectively.

#### (Study/Permanent Site Comparison)

- C. Means for 16 Group 1 sites were 2% to 254% greater than that for site 11/7th&C (10 of which were more than 50% higher).
- D. Means for 5 Group 1 sites were 6% to 79% greater than that for site 25/Spenard (3 of which were 27% to 79% higher).
- E. Means for 4 Group 1 sites were greater than the standard while none of the permanent sites exhibited one.
- F. Means for 8 Group 1 sites were within + 30% of that for site 25/Spenard.

## Frequency of Eight-Hour NAAQS Exceedances -

There was wide variability in the number of eight-hour NAAQS exceedances reported from sites in the study network. The statistic chosen for evaluation here is the simple frequency of exceedance values to all values for each site. Figures 6, 7, and 8 exhibit exceedance characteristics.

### Group 1 Sites

#### (General Discussion)

- A. The frequency of exceedances for the 14 Group 1 sites exhibiting exceedances ranged from 2% (site 5) to 84% (site 24).
- B. The frequency of exceedances for site 11/7th&C and site 25/Spenard were 0% and 37% respectively.

(Study/Permanent Site Comparison)

- C. The frequency of exceedances for 5 Group 1 sites were 30% to 111% higher than that for site 25/Spenard (3 of which were 30% to 228% higher).
- D. The frequency of exceedances at 12 Group 1 sites were 70% or lower than that for site 25/Spenard (5 of which measured one or no exceedances).

Minimum Eight-Hour Averages -

Minimum values are of interest insofar as they assist in characterizing "background" types of concentrations. Figures 6, 7, and 8 exhibit the minimum eight-hour averages for each site.

Group 1 Sites

(General Discussion)

- A. Minimum eight-hour averages for Group 1 sites ranged from 0.2 ppm (site 20) to 3.7 ppm (site 7).
- B. Minimum eight-hour averages for site 11/7th&C and site 25/Spenard were 1.5 ppm and 2.3 ppm respectively.
- C. Minimum eight-hour averages for 2 Group 1 sites in the CBD (sites 6 & 7) were at least 1.0 to 2.0 ppm higher than any other Group 1 sites.

Ratios of Study to Permanent Sites

An intuitively appealing way of expressing the relationship between a pair of sites is computing a simple ratio of the sites' values for the same day. The relationship between each of the microscale sites and site 11/7th&C and site 25/Spenard are exhibited in Figures 9 and 10 respectively.

Group 1 Sites

- A. All but one Group 1 sites (site 20, the CBD "background" site) had a mean ratio with site 11/7th&C greater than 1.0.
- B. Seven of the 18 Group 1 sites had mean ratios with site 25/Spenard greater than or equal to 1.0.

FIGURE 9

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
COMPOSITE OF DAILY 8-HOUR (11:00 A.M. TO  
7:00 P.M.) RATIOS OF EACH STUDY  
SITE TO THE 7TH & C STUDY SITE

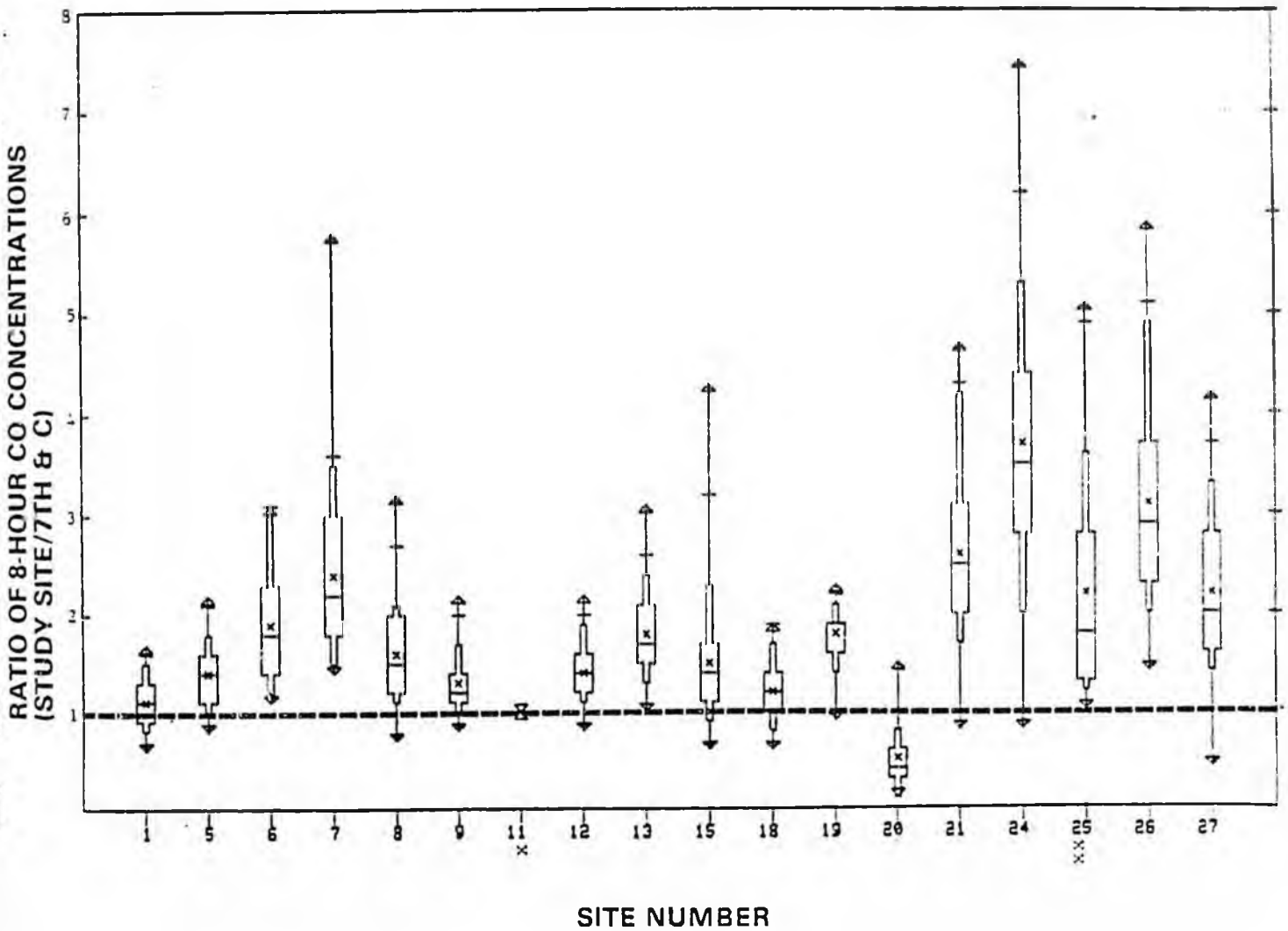
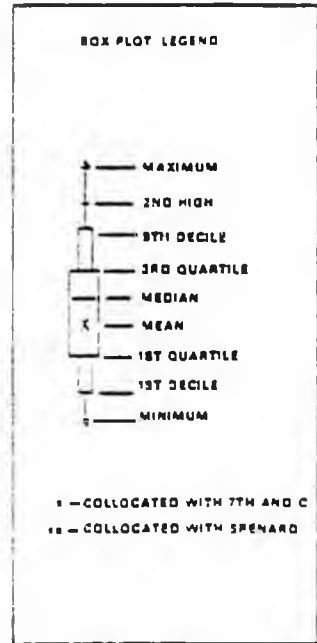
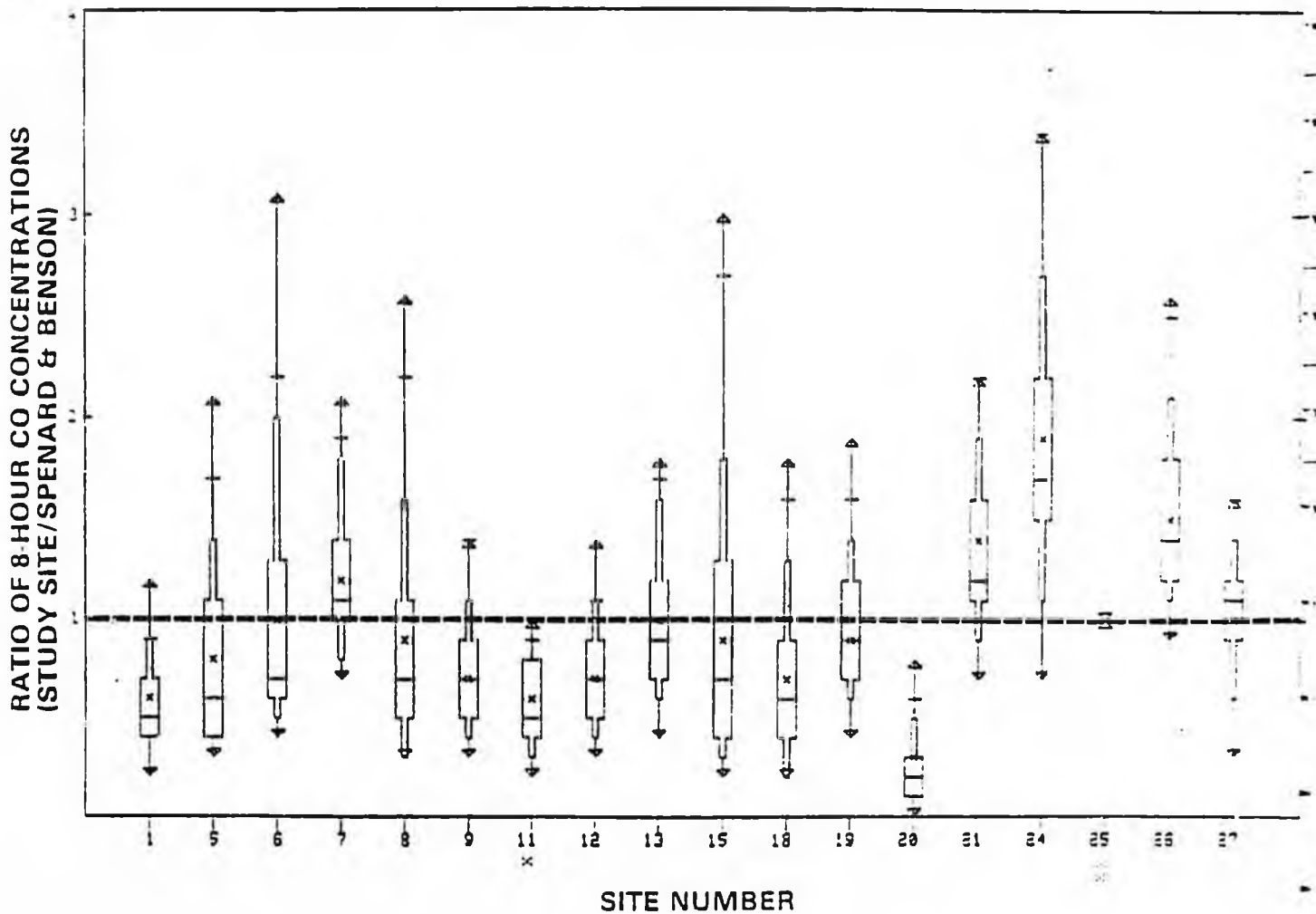
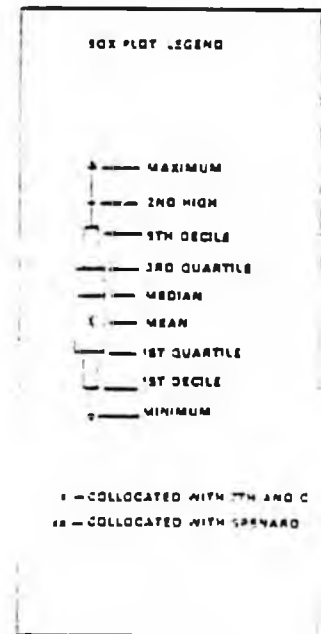


FIGURE 10

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
MONOXIDE  
COMPOSITE OF DAILY 8-HOUR (11:00 A.M. TO  
7:00 P.M.) RATIOS OF EACH STUDY  
SITE TO THE SPENARD & BENSON STUDY SITE



### Daily Network Characteristics

Another facet of the data analysis examined the day-to-day characteristics of the study data. This kind of analysis not only provides a profile of "simultaneous" impacts throughout the study area, but facilitates examining patterns of CO concentrations measured at the permanent sites and elsewhere in the study area. Figures 11 and 12 exhibit the daily composite of 8-hour concentrations reported from Group 1 study sites.

#### Daily Maximum Eight-Hour Averages -

The daily maximum value reported from among all sites in the study network illustrate the variable and chronic aspects of inter-site relationships on a day-specific basis. Table 9 exhibits the relationship of the daily study network maximum to corresponding site 11/7th&C and site 25/Spenard daily values.

#### Group 1 Sites

##### (General Discussion)

- A. Daily maximum eight-hour averages for Group 1 sites ranged from 6.1 ppm (12/27) to 27.4 ppm (12/3), both measured at site 24.
- B. The daily maximum eight-hour average was most frequently recorded at sites 24 and 26. Site 24 was the site of the daily maximum on 69% of the sample days (with 5 "ties"\*), while site 26 recorded the daily maximum on 24% of the sample days (with 9 "ties").
- C. The daily maximum eight-hour average was recorded at only four other Group 1 sites at an individual frequency of less than 7% of all sample days.
- D. Site 11/7th&C and site 25/Spenard reported the daily maximum on 0% and 2% ("tied" with 3 other sites) respectively over all sample days.

\* - Tied values are those within approximately  $\pm 0.5$  ppm of each other.

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
COMPOSITE RANGE OF CO CONCENTRATIONS  
FOR ALL SITES DURING THE 8-HOUR PERIOD  
(11:00 A.M. TO 7:00 P.M.)

NOVEMBER & DECEMBER 1982

(GROUP 1 SITES ONLY)

FIGURE III

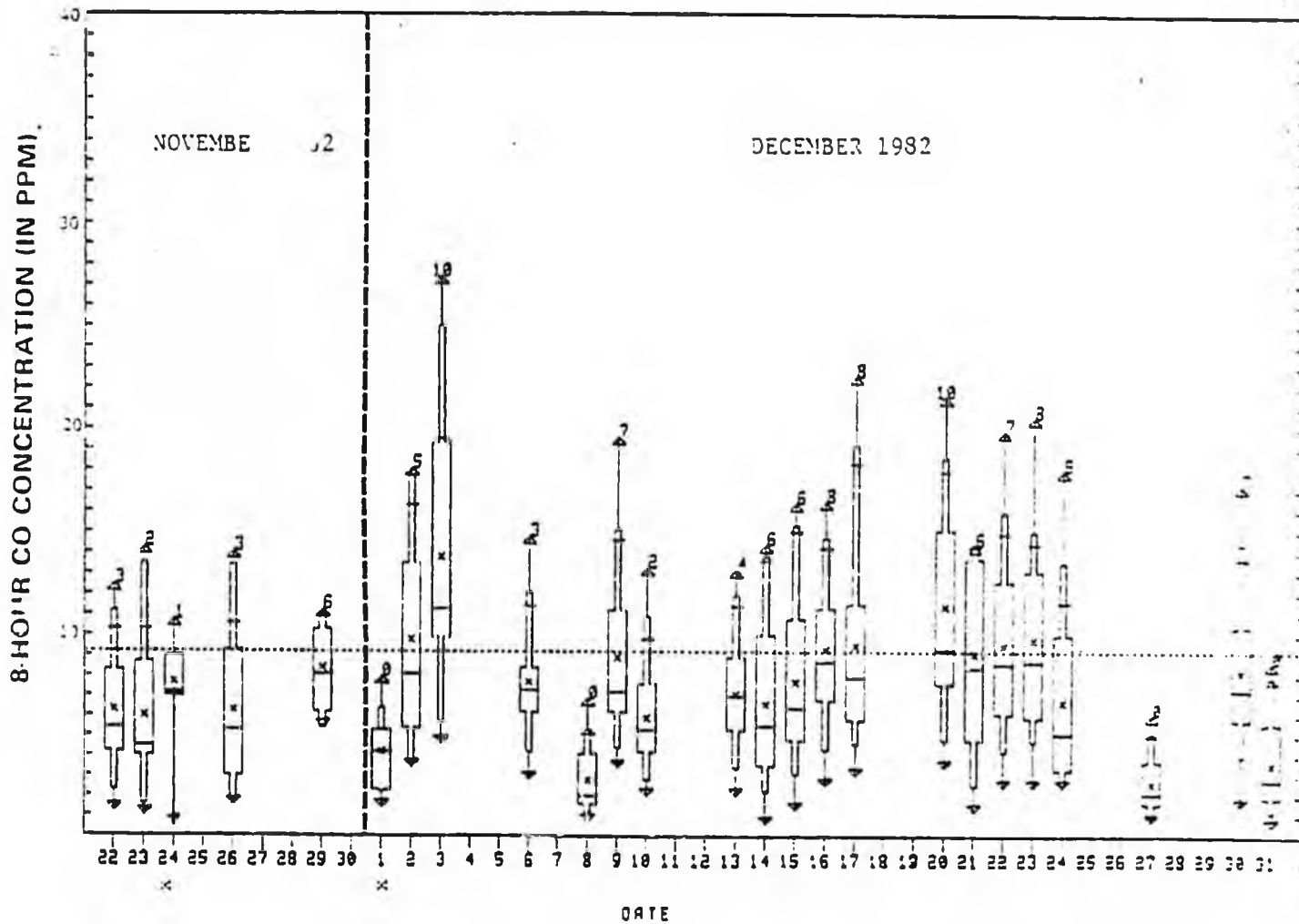
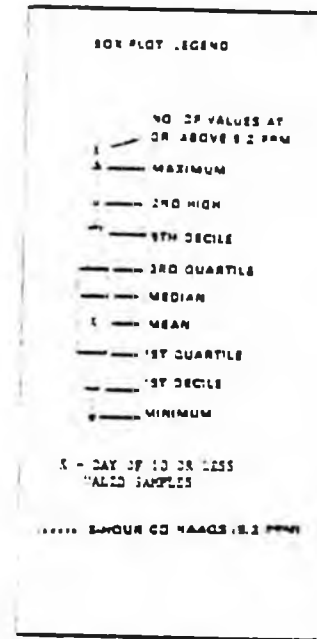


FIGURE 12

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
COMPOSITE RANGE OF CO CONCENTRATIONS  
FOR ALL SITES DURING THE 8-HOUR PERIOD  
(11:00 A.M. TO 7:00 P.M.)

JANUARY & FEBRUARY 1983

(GROUP 1 SITES ONLY)

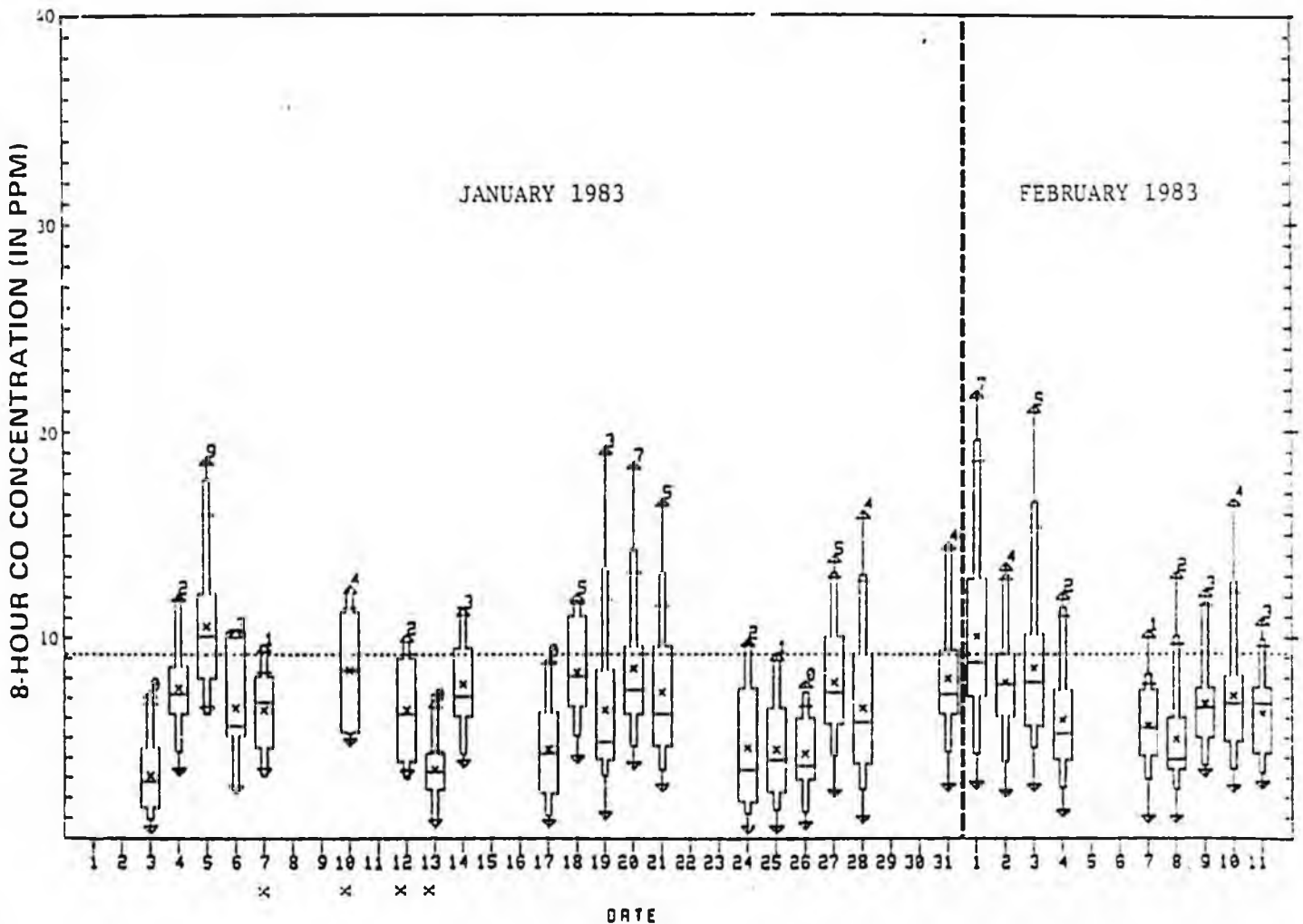
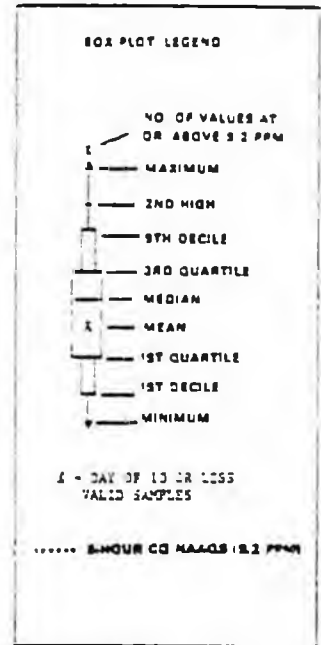


Table 7  
 Daily Comparison of Sulfur Hexafluoride Maximum 8-hour SO<sub>2</sub> Concentration to Permanent Site Values

Site No. Date	Daily Maximum 8-HR SO <sub>2</sub> Conc. (PPM)	Site 11/77830 Corresponding 8-HR SO <sub>2</sub> Conc. (PPM)	Ratio of Daily Maximum Site To Site 11/77830	Site 20 scenario Corresponding 8-HR SO <sub>2</sub> Conc. (PPM)	Ratio of Daily Max. Site To Site 20 scenario
24	11/22/82	12.0	3.1	4.0	1.9
24	11/23/82	14.0	-	7.0	1.0
7	11/24/82	10.0	-	-	-
24	11/25/82	14.1	2.7	7.5	1.9
24(20)	11/29/82	11.3	5.4	6.0	1.9
24	12/01/82	8.0	2.3	3.3	2.4
24	12/02/82	15.1	5.1	10.5	1.7
24	12/03/82	27.4	5.1	14.5	1.9
24	12/06/82	14.0	5.3	6.0	2.3
15	12/08/82	8.0	1.5	2.3	3.0
24	12/09/82	19.5	5.9	10.7	1.8
24	12/10/82	13.5	3.2	5.3	1.6
24	12/13/82	15.2	4.7	6.0	2.5
24	12/14/82	14.4	-	9.7	1.5
24	12/15/82	16.4	5.5	10.4	1.6
24	12/18/82	19.5	5.2	6.2	3.1
24	12/17/82	22.0	5.0	9.9	2.2
24	12/20/82	21.0	5.2	15.1	1.4
20(21)	12/21/82	14.4	3.9	12.4	1.2
24	12/22/82	19.9	4.0	11.8	1.7
24	12/23/82	20.5	5.0	12.3	1.7
24	12/24/82	18.0	2.4	10.4	1.7
15	12/27/82	5.1	1.9	2.3	2.2
24	12/30/82	17.5	5.1	7.3	2.4
7	12/31/82	8.7	1.5	7.7	1.1
20	1/03/83	7.4	1.7	4.9	1.5
20(21)	1/04/83	12.2	5.1	6.2	2.0
24	1/05/83	18.0	5.2	3.0	-
20(21)	1/06/83	10.4	-	2.0	5.2
24	1/07/83	9.7	3.5	5.7	1.7
24	1/10/83	12.0	-	11.3	1.1
20	1/12/83	10.2	-	5.4	1.9
20(24)	1/13/83	5.9	2.3	5.9	1.0
21(20)	1/14/83	11.5	-	5.3	2.2
21(24)	1/17/83	9.1	2.1	5.0	1.8
20(21)	1/18/83	12.2	5.4	6.6	1.8
24	1/19/83	15.3	3.7	9.9	1.5
24	1/20/83	15.0	5.8	9.5	1.6
24	1/21/83	10.0	3.9	10.9	0.9
24(20)	1/24/83	10.0	1.7	5.9	1.7
20(20)	1/25/83	9.5	1.9	5.4	1.7
20	1/26/83	9.5	-	3.0	3.2
20	1/27/83	14.1	4.6	13.0	1.1
24	1/28/83	15.2	2.5	9.0	1.7
24(20,29)	1/31/83	14.7	5.5	2.7	5.4
24	2/01/83	22.0	7.2	3.1	7.1
24	2/02/83	13.7	5.2	5.0	2.7
20	2/03/83	15.4	5.0	3.9	3.9
20	2/04/83	12.5	4.5	2.0	6.3
30	2/07/83	14.0	5.0	2.9	4.8
24	2/08/83	15.0	3.1	4.3	3.5
24	2/09/83	12.4	5.7	5.0	2.5
24	2/10/83	10.0	5.5	4.0	2.5
20(29)	2/11/83	11.0	3.4	4.3	2.5

\* Tied = 0.5 ppm

(Study/Permanent Site Comparison)

- E. The daily maximum from one (or more) of the Group 1 sites exceeded the corresponding value from site 11/7th&C and site 25/Spenard on all but one sample day (1/13 when site 25/Spenard "tied" three other study sites at a value of 6.9 ppm).
- F. The daily maximums, from one (or more) of the study sites was on average, 285% higher than the corresponding values at site 11/7th&C, ranging from 110% to 650% higher.
- G. The daily maximum from one (or more) of the study sites was on average 195% higher than corresponding values at site 25/Spenard, ranging from 0% to 240% higher.

Frequency of Daily Eight-Hour Exceedances From the Network -

The number of eight-hour exceedances reported by the study network on a daily basis provides a measure of the spatial severity of the CO situation during identical periods.

Group 1 Sites

(General Discussion)

- A. An exceedance of the standard was recorded at one or more Group 1 sites on 85% of all sample days.
- B. An exceedance of the standard was reported at four or more Group 1 sites on 57% of all days sampled.

(Study/Permanent Site Comparison)

- C. Site 11/7th&C did not report an exceedance on any day when one or more Group 1 sites did.
- D. Site 25/Spenard did not report an exceedance on 56% of the days when one or more Group 1 sites did and on 36% of the days when four or more Group 1 sites did.

Distribution of Daily Eight-Hour Averages

Quartiles and deciles were derived to describe the distribution of values reported from the study network during a sample day.

Group 1 Sites

(Study/Permanent Site Comparison)

- A. On a daily basis, site 25/Spenard was at or below the median (2nd quartile) of Group 1 sites on 23% of the days and at or below the 3rd quartile on 74% of the days for which corresponding data are available.

- B. On a daily basis, site 11/7th&C was at or below the 1st quartile of all Group 1 sites on 87% of the days for which corresponding data are available.

#### Range of Daily Eight-Hour Averages

The range of values reported from the study network during a particular day can provide a valuable index of intra-network variability. In addition, it can grossly imply that portion of the daily maximum which may be attributable to "background" levels of CO. This information can be important insofar as the calculation of the design value incorporates a "background" component. For instance, a high "background" level might establish that less site-specific control is required to bring levels at an 'offending' site into compliance. The reverse is also the case for low "background" levels.

#### Group 1 Sites

- A. The daily range of eight-hour averages ranged from 4.0 ppm(11/24) to 22.8 ppm (12/3).
- B. The daily range of eight-hour averages, averaged 11.9 ppm.
- C. The daily range of eight-hour averages exceeded 18.0 ppm on seven or 13% of the sample days, and 20.0 ppm on one day.
- D. On the 22 days when the daily range of eight-hour averages was less than 10.0 ppm, the daily maximum did not exceed 12.6 ppm.

#### Correlation and Regression Analysis

One way of mathematically expressing the relationship between data from two sites is by fitting a line that best minimizes the distance of all data points to that line. One such line is the linear regression line. Straight by definition, a simple equation describes the origin and rate of change or slope of this line. So, by knowing the value of what is called the "independent" variable, one can predict what could be described as the "average" value of the "dependant" variable.

This "average" value is typically subject to some error due to the fact that not all actual data points are situated precisely on the regression line. Therefore, statistics are needed to describe the variability associated with this prediction. One such statistic is the coefficient of correlation. When squared, it becomes the coefficient of determination which is the proportion of variation in the dependant variable explained by variation in the independent variable. The higher the value of this coefficient, the more variation is explained and the stronger the relationship is between two data sets.

A particularly nettlesome problem with the traditional regression line is that it assigns all the variability due to sampling error to the dependant variable ignoring similar errors introduced by the independent variable. Since this

would not accurately reflect the realities of errors in study sampling, a variation of this approach called two-way regression has been devised by statisticians to distribute this error term symmetrically to both variables. The regression parameters for Group 1 sites, including both one-way and two-way regression lines are presented in Table 10 (it should be noted that one cannot actually "solve" for 'x' in the one-way line). It should be noted that all references to regression parameters such as slope and intercept reflect the two-way line.

Typically, the greater the number of cases one can inspect relative to a particular phenomenon, the greater the confidence one has in 'understanding' it. This is exhibited in regression/correlation statistics where the confidence interval about some statistic (correlation coefficient for instance) shrinks, or confidence increases as more cases are considered. For reference in conjunction with the regression/coefficient tables, Table 11 has been prepared to illustrate the effect the number of cases has on confidence limits about various 'r' values.

Two basic kinds of correlation/regression analyses were performed on the data. The first type of analysis compared data for a particular interval that were paired by date to examine relative levels of CO experienced concurrently at a pair of sites. The second analytical approach used data sets ranked by magnitude and paired by rank. This second approach recognizes the effects of especially meteorology on the temporal variability of CO levels between sites, in particular microscale sites, by not 'requiring' any pair of sites to 'perform' in some characteristic fashion simultaneously (as the first approach does). This typically lends itself to examining larger (seasonal) patterns and frequencies of CO levels throughout some study area.

#### Date-Paired Correlation/Regression

##### Group 1 Sites

- A. All eighteen sites had coefficients of correlation greater than or equal to 0.80 with at least one other site, ranging from one site (site 25) to twelve sites (site 12).
- B. Sixteen sites had coefficients of correlation greater than or equal to 0.85 with at least one other site, ranging from one site (sites 15 and 25) to six sites (sites 12 and 27).
- C. Nine sites had coefficients of correlation greater than or equal to 0.90 with at least one other site, ranging from one site (sites 1,8,9, and 18) to three sites (sites 12 and 19).

#### Rank-Paired Correlation/Regression

Each Group 1 site correlated with all other Group 1 sites at 0.93 or better.

TABLE 10 CORRELATION/REGRESSION RESULTS FOR GROUP 1 SITES

LONGITUDE (W), SITE CORRELATION COEFFICIENT, NO. OF PAIRS 2-WAY REGRESSION (R), 2-WAY REGRESSION (R)

1	6	0.859	0.739	34.0	Y	1.4151	-0.227	Y	1.3941	-0.251
1	7	0.877	0.759	38.0	Y	2.7091	-0.259	Y	1.3091	-0.251
1	8	0.795	0.579	33.0	Y	2.6691	-0.224	Y	1.5991	-0.271
1	9	0.799	0.520	38.0	Y	2.6071	-0.559	Y	1.7191	-0.291
1	10	0.815	0.564	40.0	Y	1.5491	-0.367	Y	1.6691	-0.271
1	11	0.792	0.612	40.0	Y	1.2911	-0.164	Y	0.8971	-0.271
1	12	0.849	0.609	40.0	Y	1.7751	-0.201	Y	1.5191	-0.218
1	13	0.824	0.643	42.0	Y	2.2661	-0.225	Y	1.4591	-0.190
1	14	0.805	0.58	34.0	Y	3.4101	-0.111	Y	1.4091	-0.176
1	15	0.803	0.574	41.0	Y	2.6111	-0.270	Y	1.4791	-0.199
1	16	0.835	0.647	35.0	Y	2.4961	-0.217	Y	1.4321	-0.251
1	17	0.843	0.629	43.0	Y	1.0191	-0.225	Y	3.4191	-0.150
1	18	0.817	0.607	41.0	Y	3.1031	-0.202	Y	2.1691	-0.212
1	19	0.795	0.632	35.0	Y	3.3191	-0.277	Y	1.4291	-0.029
1	20	0.810	0.572	41.0	Y	3.3191	-0.291	Y	1.5101	-0.191
1	21	0.750	0.562	40.0	Y	3.8371	-0.336	Y	2.2591	-0.217
1	22	0.817	0.668	39.0	Y	3.4601	-0.309	Y	2.3991	-0.253
5	3	0.794	0.630	39.0	Y	0.9311	1.451	Y	0.7501	2.411
5	4	0.846	0.471	36.0	Y	1.4211	1.414	Y	0.4751	4.367
5	5	0.832	0.684	39.0	Y	1.3611	-0.257	Y	1.2421	-0.491
5	6	0.802	0.641	39.0	Y	0.8191	0.582	Y	1.4471	1.374
5	7	0.792	0.628	38.0	Y	0.6671	0.300	Y	0.5671	0.491
5	8	0.818	0.702	40.0	Y	0.4721	0.148	Y	0.2191	3.441
5	9	0.783	0.613	43.0	Y	1.1651	0.551	Y	0.8911	2.131
5	10	0.802	0.644	34.0	Y	1.3741	-0.222	Y	1.0191	0.012
5	11	0.835	0.675	42.0	Y	1.1111	-0.090	Y	1.0151	-0.227
5	12	0.765	0.586	34.0	Y	1.4951	-0.281	Y	1.2491	1.295
5	13	0.832	0.641	42.0	Y	0.5711	-0.134	Y	0.5191	-0.150
5	14	0.725	0.525	41.0	Y	1.7201	0.376	Y	1.2911	3.464
5	15	0.814	0.574	37.0	Y	3.7691	-0.162	Y	1.5491	5.449
5	16	0.840	0.615	34.0	Y	3.0441	-0.404	Y	0.5101	4.492
5	17	0.876	0.632	41.0	Y	2.4631	-0.176	Y	1.0121	5.470
5	18	0.880	0.463	34.0	Y	2.1111	-0.074	Y	1.1591	1.491
6	1	0.818	0.643	36.0	Y	1.4351	-0.441	Y	0.4911	5.214
6	2	0.814	0.792	37.0	Y	1.3671	-0.103	Y	1.0911	-0.111
6	3	0.799	0.636	39.0	Y	0.8171	-0.097	Y	0.6141	3.279
6	4	0.794	0.554	40.0	Y	0.7191	-0.291	Y	0.5901	3.012
6	5	0.831	0.401	41.0	Y	1.1481	-0.281	Y	0.4911	3.285
6	6	0.839	0.651	41.0	Y	1.5621	-0.258	Y	0.7591	1.424
6	7	0.782	0.611	35.0	Y	1.3431	-0.228	Y	0.4961	-0.110
6	8	0.777	0.604	40.0	Y	1.2531	-0.220	Y	0.4761	-0.122
6	9	0.804	0.441	34.0	Y	1.4111	-0.264	Y	0.4921	1.316
6	10	0.815	0.401	43.0	Y	0.5151	-0.258	Y	0.4941	-0.290
6	11	0.809	0.754	41.0	Y	2.7011	-0.010	Y	0.4911	1.276
6	12	0.885	0.611	36.0	Y	7.0771	-0.467	Y	1.3191	2.231
6	13	0.802	0.604	41.0	Y	174.7301	0.0000000	Y	0.4911	3.276
6	14	0.804	0.624	42.0	Y	3.5941	-0.136	Y	0.6271	1.271
6	15	0.800	0.619	39.0	Y	3.4001	-0.349	Y	0.7111	1.745
6	16	0.817	0.447	35.0	Y	0.8241	-0.211	Y	0.4511	2.147
6	17	0.813	0.624	34.0	Y	0.4811	0.517	Y	0.3471	1.743
6	18	0.853	0.433	36.0	Y	0.5271	-0.482	Y	0.1241	3.261
6	19	0.879	0.756	35.0	Y	0.7631	-0.180	Y	0.6471	-0.076
6	20	0.834	0.715	34.0	Y	1.0161	-0.207	Y	0.4511	-0.115
6	21	0.839	0.652	34.0	Y	1.0751	-0.219	Y	0.4011	2.257
6	22	0.859	0.473	37.0	Y	0.9191	-0.164	Y	0.5241	4.444
6	23	0.797	0.615	29.0	Y	1.2251	-0.267	Y	0.4171	-0.112
6	24	0.809	0.649	34.0	Y	0.2531	-0.167	Y	0.2191	-0.117
6	25	0.814	0.694	34.0	Y	1.4641	-0.145	Y	1.1771	-0.224
6	26	0.847	0.662	35.0	Y	2.5791	-0.191	Y	1.3191	-0.111
6	27	0.759	0.567	34.0	Y	1.1221	-0.263	Y	1.2921	-0.261
6	28	0.849	0.574	34.0	Y	1.0891	-0.171	Y	1.1291	1.051
6	29	0.874	0.774	37.0	Y	1.5591	-0.215	Y	1.3011	-0.279
6	30	0.715	0.554	38.0	Y	0.5801	1.176	Y	1.1271	1.210
6	31	0.765	0.624	36.0	Y	0.5061	1.434	Y	0.4191	1.024
6	32	0.707	0.600	40.0	Y	0.5971	1.219	Y	0.5491	0.124
6	33	0.801	0.463	41.0	Y	0.9171	1.417	Y	0.6111	1.131
6	34	0.874	0.774	36.0	Y	1.7201	-0.403	Y	0.4941	1.091
6	35	0.885	0.749	40.0	Y	0.7991	0.123	Y	0.7111	2.299
6	36	0.852	0.626	34.0	Y	1.1111	0.283	Y	0.7091	3.724
6	37	0.829	0.645	42.0	Y	0.6211	-0.285	Y	0.7991	-0.117
6	38	0.820	0.695	40.0	Y	1.4111	1.192	Y	1.1771	4.292
6	39	0.851	0.605	34.0	Y	4.0511	-0.134	Y	0.3441	4.435
6	40	0.854	0.665	36.0	Y	2.1961	-0.246	Y	0.3991	4.447
6	41	0.829	0.684	34.0	Y	2.2161	-0.186	Y	0.4111	4.216
6	42	0.871	0.623	34.0	Y	1.4401	-0.011	Y	0.5191	4.442
6	43	0.817	0.641	40.0	Y	0.6671	-0.230	Y	1.4011	-0.116
6	44	0.847	0.641	41.0	Y	1.2761	-0.249	Y	1.3111	2.167
6	45	0.816	0.511	42.0	Y	1.6841	-0.161	Y	1.1911	1.664
6	46	0.833	0.633	35.0	Y	1.9241	-0.212	Y	0.4771	1.453
6	47	0.841	0.608	42.0	Y	1.3851	-0.179	Y	1.1091	-0.249
6	48	0.871	0.759	35.0	Y	1.7501	-0.292	Y	0.4771	-0.299
6	49	0.880	0.662	43.0	Y	0.6411	-0.274	Y	1.5001	-0.270
6	50	0.800	0.690	40.0	Y	2.3741	-0.279	Y	1.1271	3.123
6	51	0.854	0.647	37.0	Y	4.8701	-0.176	Y	0.4111	4.276
6	52	0.804	0.667	42.0	Y	1.5171	-0.191	Y	0.7491	1.744
6	53	0.861	0.437	42.0	Y	3.0511	-0.411	Y	0.3441	1.434
6	54	0.848	0.603	40.0	Y	3.1671	-0.102	Y	0.1701	2.141

(TABLE 10 CONT.)

1962 SITE	1961 SITE	CORRELATION	CONFIDENCE	NO. OF PAIRS	2000 PERCENTAGE	1000 PERCENTAGE	500 PERCENTAGE	200 PERCENTAGE		
11	12	0.743	0.743	40.0	Y	1.4223	-0.141	1	1.2111	0.2111
11	14	0.404	0.404	40.0	Y	1.7708	0.014	1	1.2541	2.107
11	15	0.604	0.416	37.0	Y	1.4531	-2.111	1	1.0041	1.611
11	14	0.444	0.714	42.0	Y	1.5571	-1.272	1	1.2171	0.155
11	14	0.420	0.447	35.0	Y	1.4401	-0.744	Y	1.7111	0.144
11	20	0.302	0.401	33.0	Y	0.7051	-0.411	Y	1.5411	-0.251
11	21	0.545	0.545	30.0	Y	2.0601	-0.471	1	1.5411	1.611
11	21	0.701	0.192	30.0	Y	4.5671	-0.441	1	2.1511	4.401
11	25	0.457	0.201	41.0	Y	1.5451	-0.441	Y	1.8411	4.441
11	26	0.744	0.541	42.0	Y	2.7611	-0.271	Y	1.7511	4.445
11	27	0.721	0.523	42.0	Y	2.4101	-1.401	Y	1.6511	1.451
12	11	0.911	0.420	44.0	Y	1.2771	0.201	Y	1.0971	0.911
12	15	0.547	0.556	37.0	Y	1.6541	-1.207	Y	0.4171	1.412
12	14	0.435	0.547	43.0	Y	1.2281	-1.623	Y	0.4911	-0.122
12	19	0.935	0.575	35.0	Y	1.3241	-0.131	Y	1.2101	0.444
12	20	0.704	0.501	44.0	Y	0.5271	-0.450	Y	1.4411	-0.436
12	21	0.600	0.740	42.0	Y	1.7611	0.233	Y	1.4111	2.224
12	21	0.402	0.444	37.0	Y	1.1011	-2.915	Y	2.0511	2.704
12	25	0.627	0.193	41.0	Y	1.9401	-2.590	Y	0.7011	2.673
12	26	0.423	0.477	42.0	Y	1.9611	0.624	Y	1.4411	3.475
12	27	0.435	0.647	40.0	Y	2.0491	-2.816	Y	1.5411	-0.024
13	15	0.630	0.396	30.0	Y	1.1421	-2.431	Y	0.6441	1.064
13	14	0.777	0.604	47.0	Y	1.0401	-2.103	Y	0.4251	-0.544
13	19	0.400	0.424	36.0	Y	1.1651	-1.103	Y	1.0411	-0.237
13	20	0.615	0.374	45.0	Y	0.3711	-0.747	Y	0.3201	-0.335
13	21	0.407	0.452	45.0	Y	1.5341	-0.911	Y	1.1141	1.041
13	21	0.411	0.605	41.0	Y	2.0551	-1.114	Y	1.3021	0.474
13	24	0.444	0.120	47.0	Y	1.4341	-2.354	Y	0.4271	2.383
13	26	0.403	0.645	46.0	Y	1.6661	-0.431	Y	1.2311	2.424
13	27	0.450	0.723	44.0	Y	1.6041	-2.041	Y	1.2411	-0.037
14	14	0.365	0.585	34.0	Y	0.4461	0.400	Y	0.6731	1.211
14	14	0.511	0.241	30.0	Y	1.3071	-0.651	Y	0.5471	1.454
14	20	0.743	0.552	38.0	Y	0.3461	-0.141	Y	0.3201	3.011
14	21	0.551	0.304	34.0	Y	1.5651	0.411	Y	0.7101	5.444
14	25	0.340	0.145	32.0	Y	4.8041	-14.074	Y	0.4441	0.627
14	25	0.040	0.040	36.0	Y	4.1811	-14.704	Y	1.1041	7.447
14	26	0.401	0.101	37.0	Y	2.2701	-1.574	Y	0.5741	4.444
14	27	0.491	0.443	36.0	Y	1.9401	-2.492	Y	0.7031	4.474
14	14	0.777	0.603	36.0	Y	1.2711	0.004	Y	0.4341	2.141
14	20	0.425	0.441	45.0	Y	0.5041	-0.549	Y	0.4671	-0.336
14	21	0.471	0.454	43.0	Y	1.6121	1.640	Y	0.3141	5.735
14	24	0.401	0.401	41.0	Y	2.2621	-1.304	Y	1.3511	7.204
14	25	0.462	0.304	42.0	Y	2.6071	-5.104	Y	0.3401	0.040
14	26	0.412	0.174	35.0	Y	2.1521	1.236	Y	1.3721	4.611
14	27	0.637	0.414	43.0	Y	2.0231	-1.441	Y	1.0421	1.272
15	20	0.650	0.416	34.0	Y	0.3301	-0.344	Y	0.3021	-0.133
15	21	0.427	0.607	37.0	Y	1.7321	1.304	Y	0.4441	3.093
15	21	0.421	0.674	30.0	Y	2.0471	-0.292	Y	1.5261	1.424
15	25	0.471	0.451	37.0	Y	1.2241	-0.647	Y	0.7641	7.530
15	26	0.447	0.700	36.0	Y	1.3071	1.463	Y	1.1141	1.464
15	27	0.409	0.655	35.0	Y	1.3031	-1.038	Y	1.0031	1.105
20	21	0.676	0.454	44.0	Y	1.6671	2.444	Y	1.4071	4.644
20	21	0.600	0.360	40.0	Y	4.8141	1.044	Y	2.5141	4.757
20	26	0.361	0.112	44.0	Y	4.8411	-4.557	Y	1.0911	4.157
20	26	0.524	0.274	45.0	Y	5.5441	0.464	Y	1.6511	4.424
20	27	0.606	0.367	43.0	Y	5.0031	-1.066	Y	1.0421	4.664
21	21	0.422	0.675	34.0	Y	1.6441	-1.941	Y	1.2341	2.142
21	25	0.706	0.547	42.0	Y	0.4741	-1.440	Y	0.7511	1.424
21	26	0.405	0.744	43.0	Y	1.1601	0.541	Y	1.1141	7.231
21	27	0.441	0.776	41.0	Y	1.1041	-2.643	Y	0.9611	-1.177
21	26	0.371	0.547	37.0	Y	0.5131	0.674	Y	0.4541	1.411
21	26	0.401	0.745	41.0	Y	0.6741	1.422	Y	0.6241	4.520
21	27	0.440	0.743	30.0	Y	0.5441	-0.400	Y	0.6041	-0.144
24	26	0.705	0.614	43.0	Y	1.1771	2.404	Y	1.4931	4.521
24	27	0.451	0.724	42.0	Y	1.1041	-0.602	Y	0.3221	1.064
24	27	0.354	0.724	44.0	Y	0.9711	-2.761	Y	0.4111	-0.127

Table 11 95% Confidence Limits About 'n' as a Function of 'n'

	10	20	30	40	50	60	70	80	90	100
C.10	0.10 .69/-0.57	0.10 .52/-0.36	0.10 .44/-0.27	0.10 .40/-0.22	0.10 .37/-0.18	0.10 .35/-0.16	0.10 .33/-0.14	0.10 .31/-0.12	0.10 .30/-0.11	0.10 .29/-0.10
C.20	0.20 .74/-0.49	0.20 .59/-0.27	0.20 .52/-0.17	0.20 .48/-0.12	0.20 .45/-0.08	0.20 .43/-0.06	0.20 .42/-0.04	0.20 .40/-0.02	0.20 .39/-0.01	0.20 .38/-0.00
C.30	0.30 .75/-0.41	0.30 .66/-0.16	0.30 .60/-0.07	0.30 .56/-0.01	0.30 .53/0.02	0.30 .51/0.03	0.30 .50/0.07	0.30 .49/0.09	0.30 .48/0.10	0.30 .47/0.11
C.40	0.40 .72/-0.31	0.40 .72/-0.09	0.40 .66/0.05	0.40 .63/0.10	0.40 .61/0.14	0.40 .59/0.16	0.40 .59/0.15	0.40 .57/0.20	0.40 .56/0.21	0.40 .55/0.22
C.50	0.50 .68/-0.19	0.50 .77/0.07	0.50 .73/0.17	0.50 .70/0.22	0.50 .68/0.26	0.50 .67/0.23	0.50 .66/0.20	0.50 .65/0.11	0.50 .64/0.11	0.50 .63/0.10
C.60	0.60 .59/-0.09	0.60 .82/0.21	0.60 .79/0.31	0.60 .77/0.15	0.60 .75/0.19	0.60 .74/0.14	0.60 .73/0.12	0.60 .72/0.14	0.60 .72/0.15	0.60 .71/0.16
C.70	0.70 .52/0.13	0.70 .87/0.37	0.70 .85/0.49	0.70 .83/0.30	0.70 .82/0.32	0.70 .81/0.34	0.70 .80/0.36	0.70 .80/0.37	0.70 .79/0.39	0.70 .79/0.39
C.80	0.80 .45/0.24	0.80 .92/0.59	0.80 .90/0.62	0.80 .89/0.65	0.80 .88/0.67	0.80 .88/0.69	0.80 .87/0.70	0.80 .87/0.70	0.80 .86/0.71	0.80 .86/0.72
C.90	0.90 .38/0.62	0.90 .96/0.76	0.90 .95/0.80	0.90 .95/0.82	0.90 .94/0.83	0.90 .94/0.84	0.90 .94/0.84	0.90 .93/0.84	0.90 .93/0.85	0.90 .93/0.85

### Comparison of CBD and Corridor Sites

Both the magnitude of CO levels and the frequency of NAAQS exceedances recorded at most Corridor sites were consistently and markedly higher than those recorded at most of the CBD sites.

#### Group 1 Sites

- A. Maximum eight-hour averages for CBD sites ranged from 6.2 ppm (sites 1 and 20) to 15.1 ppm (site 7), while those for the Corridor sites ranged from 15.1 ppm (site 25/Spenard) to 27.4 (site 24).
- B. The second highest eight-hour averages for CBD sites ranged from 4.6 ppm (site 20) to 13.7 ppm (site 7), while those for the Corridor sites ranged from 13.1 ppm (site 25/Spenard) to 22.6 ppm (site 24).
- C. The frequency of NAAQS exceedances for CBD sites ranged from 0% (sites 1, 9, 11, and 20) to 51% (site 7), while those for Corridor sites ranged from 37% (site 25) to 84% (site 24).
- D. The means and ranges (minimum to maximum) of values at all Corridor sites were markedly greater than those for all CBD sites, except that CBD site 7's mean was greater than two of the five Corridor sites (sites 25 and 27).
- E. Site 1 had a coefficient of correlation greater than or equal to 0.75 with fourteen of the seventeen other Group 1 sites (and 0.80 for nine) in both CBD and Corridor locations.
- F. While ten sites in the CBD (sites 1,5,6,8,9,11,12,13,18, and 19) had coefficients of correlation greater than approximately 0.75 with between five (site 6) to eleven (site 5) other CBD sites, they did not correlate with any Corridor sites at 0.75 or better.
- G. Three CBD sites (sites 7,15, and 20) had coefficients of correlation greater than approximately 0.75 with between four (site 7) and ten (site 1) other CBD sites and with between two (site 11) and four (sites 1,7,12,13, and 19) of the five Corridor sites.
- H. All five corridor sites had coefficients of correlation greater than 0.77 with each other.
- I. Site 25/Spenard did not correlate with any CBD sites at 0.80 or better. However, when the continuous record is used in lieu of the integrated data, the Spenard & Benson permanent site correlated at 0.74, 0.77, and 0.81 with sites 7,12, and 13 respectively.

### Relationship of "AM" to "PM" Four-Hour Averages

The analysis of both intra-site and inter-site relationships of "AM" (11:00 A.M. to 3:00 P.M.) and "PM" (3:00 P.M. to 7:00 P.M.) four-hour values can provide a characterization of the temporal variability of CO levels at individual sites and over the entire study area. Figures 13 and 14 present the composite statistics from each site for the "AM" and "PM" periods, respectively. Due to time constraints, this analysis received a relatively limited treatment in this report.

#### Group 1 Sites Only

- A. For parameters such as range, maximums, 2nd highs, minimums, means, and medians, each site's "PM" values were consistently greater than or equal to the "AM" values when all sample days are considered. The notable exceptions to this were sites 13 and 20 where the maximum and 2nd highest "AM" values exceeded those "PM" measures, with site 13's "AM" mean also exceeding its "PM" mean.
- B. The maximum "AM" averages ranged from 6.4 ppm (site 1) to 25.1 (site 24). The maximum "PM" averages ranged from 5.8 ppm (site 20) to 30.7 ppm (site 24).
- C. The minimum values for both "AM" and "PM" periods were essentially equal (within  $\pm 1.0$  ppm) at 15 of the 18 Group 1 sites.
- D. The median of each site's daily "AM"/"PM" ratio ranged from 2.2 (sites 1, 5, 7, 9, 11, 18, and 20) to 1.2 (site 13).
- E. Some 16 of the Group 1 sites exhibited median "AM"/"PM" ratios less than or equal to 1.0, demonstrating general dominance of "PM" over "AM" values when considered on a daily basis.
- F. The minimum "AM"/"PM" ratios ranged from 0.0\* (sites 20) to 0.5 (sites 13, 15, and 24), with an average minimum ratio over all sites of 0.3.
- G. The maximum "AM"/"PM" ratios ranged from 1.5 (sites 1 and 18) to 17.8 (site 26) with an average maximum ratio over all Group 1 sites of 3.0.

#### Groups 1 and 2 Combined

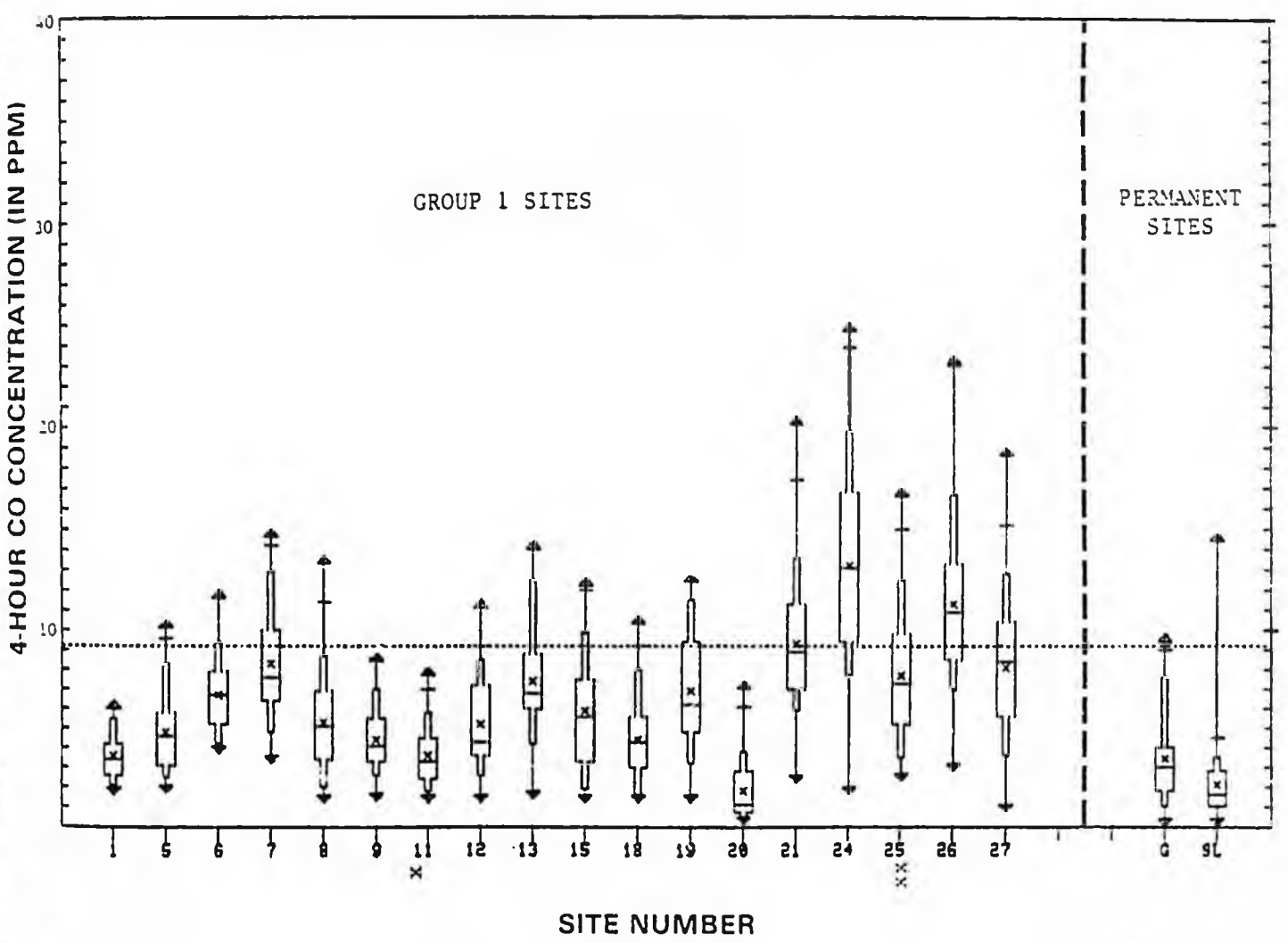
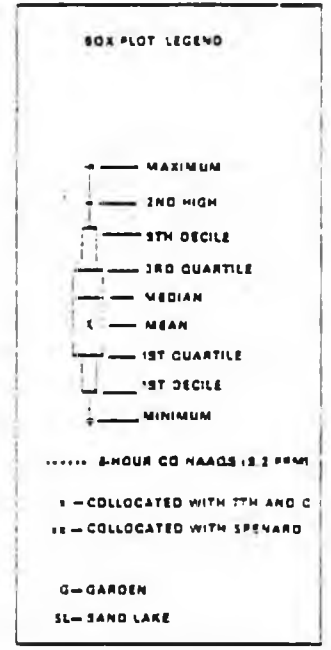
- H. Considering all sites (Groups 1 and 2), the daily "PM" maximum was greater than the "AM" maximum on 59% of all sample days (not including 10 days that were within  $\pm 0.5$  ppm) by an average of 4.6 ppm, and ranging from 0.6 ppm (T2/1) to 16.3 ppm (2/1) greater. Conversely, the daily "AM" maximum was greater than the "PM" maximum on 22% of all sample days, not including those days within 0.5 ppm, by an average of 3.2 ppm, and ranging from 0.7 ppm (1/3) to 10.7 ppm (12/10) greater.

\* - Reflects rounding of a ratio value less than 0.05.

FIGURE 13

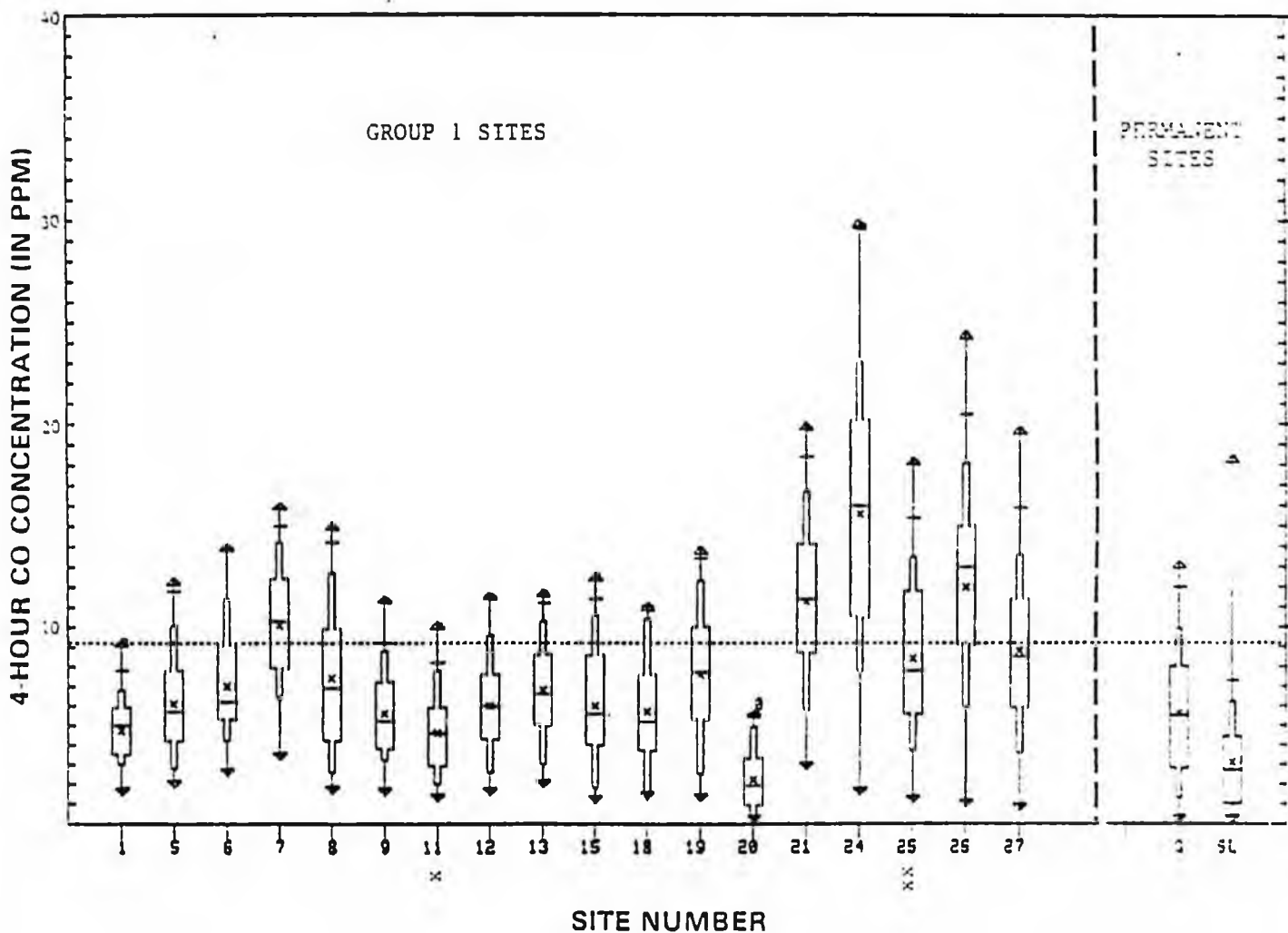
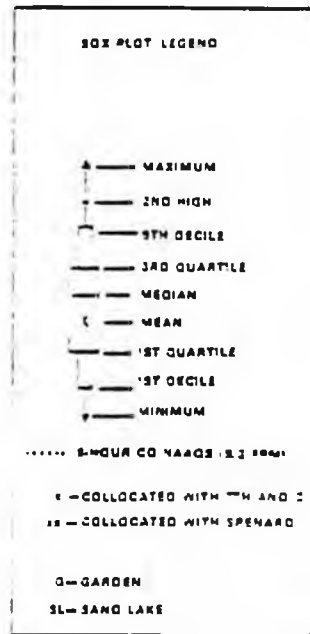
ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
AVERAGE CONCENTRATIONS FOR THE "AM"  
4-HOUR PERIOD  
(11:00 A.M. TO 3:00 P.M.) AT EACH SITE



ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
AVERAGE CONCENTRATIONS FOR THE "PM"  
4-HOUR PERIOD  
(3:00 A.M. TO 7:00 P.M.) AT EACH SITE



- I. On 67% of all sample days, the daily composite median of all sites' (again Groups 1 and 2) "AM"/"PM" ratios was less than 1.0.
- J. The average number of daily exceedances reported from the study network (Groups 1 and 2) was essentially identical regardless of whether the "AM"/"PM" ratio was greater or less than 1.0. However, on the day when the highest proportion of sites exceeded the standard (78% on 12/3), "AM" averages were clearly greater than "PM" at over 55% of the study sites. Conversely, on the day when the second highest proportion of exceedances were recorded (68% on 1/5), "PM" averages were clearly greater than "AM" averages at about 63% of the study sites.

### GRID NETWORKS

The primary emphasis of the grid monitoring networks was to establish the representativeness of the Spenard & Benson, Garden, and Sand Lake permanent sites over middle and neighborhood spatial scales. The results and discussion that follow are given on a network-specific basis.

#### Garden Network

The objective for the Garden study network was to examine and establish, if possible, the homogenous representativeness of the permanent Garden site. A total of five sequential samplers were dedicated to this study network. The locations of these samplers are plotted in Figure 4. Note that site 105 was collocated with the permanent probe for purposes of method comparison and quality assurance. Inspection of the data reveals that a systematic difference between the sequential and continuous sampling methods may be indicated (refer to Quality Assurance section). Therefore, site 105 was considered the surrogate of the permanent site for the purpose of maintaining congruity among the data bases considered during the regression portion of the analysis.

Even though the samplers employed in this network collected hourly data, four-hour block data were used in these inter-site comparisons to overcome potential biases due to autocorrelation and to dampen potential temporal shifts or offsets associated with impacts at one sampler (or samplers) not simultaneously, but eventually experienced at the other grid sites. If these temporal variations were profound (on the order of two or more hours) and/or intermittent, then the determination of homogeneity would be made immensely more difficult. This is not thought to have occurred here to any appreciable extent.

Data arising from the Garden network are displayed in Table 12 and Figure 15.

- A. The Garden permanent site had a coefficient of correlation between 0.94 (site 101) and 0.96 (sites 102 and 103) with each of the five sites in the Garden study network (0.95 with collocated site 105).
- B. The regression lines for each of the Garden site/study site pairings had slopes of between 0.33 and 0.37 with intercepts at or below 0.5 ppm.

Table 11 Correlation/Regression Results\* for Permanent and Study Sites

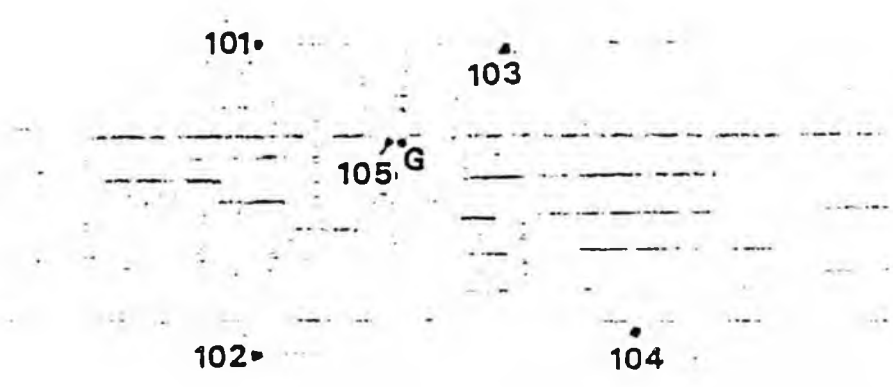
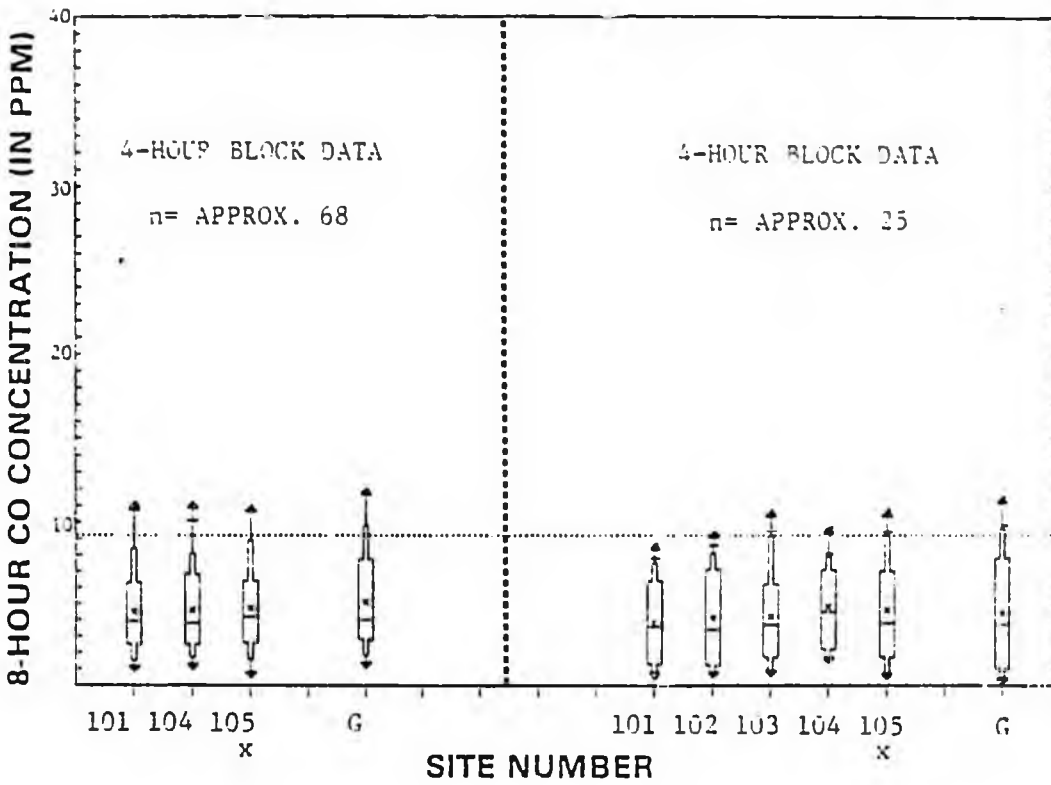
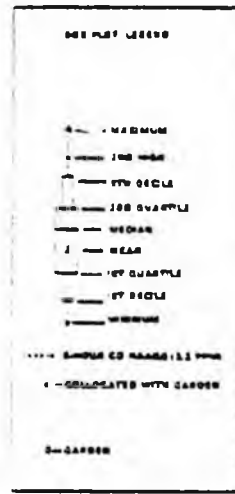
IND.	SITE	DEP.	SITE CORRELATION COEF.	DATE	NO. OF PAINS	1-DAY REGRESSION EQ.	1-WEEK REGRESSION EQ.	
7AC	SPBE	3.702	0.492	211.0	Y =	2.118X + -0.971	Y =	1.215X + 2.150
7AC	GARD	0.734	-0.518	218.0	Y =	1.752X + -1.244	Y =	1.114X + 1.605
7AC	SDLA	0.654	0.425	207.0	Y =	1.224X + -1.748	Y =	0.744X + -0.291
7AC	1019	0.640	0.410	107.0	Y =	1.585X + -1.583	Y =	0.458X + 0.947
7AC	1029	0.589	0.347	51.0	Y =	1.872X + -2.552	Y =	0.868X + 1.317
7AC	1039	0.563	0.317	44.0	Y =	1.584X + -1.559	Y =	0.730X + 1.550
7AC	1049	0.546	0.355	48.0	Y =	1.602X + -1.539	Y =	0.794X + 1.414
7AC	1059	0.527	0.393	48.0	Y =	1.509X + -1.464	Y =	0.415X + 1.243
7AC	2019	0.785	0.616	97.0	Y =	0.956X + 0.292	Y =	0.758X + 0.978
7AC	2029	0.751	0.584	90.0	Y =	1.334X + -0.197	Y =	0.770X + 0.746
7AC	4019	0.784	0.621	58.0	Y =	1.101X + -0.901	Y =	0.450X + 0.358
7AC	1019	0.690	0.477	75.0	Y =	2.058X + 0.417	Y =	1.160X + 1.523
SPBE	GARD	0.694	0.482	213.0	Y =	0.831X + -0.761	Y =	0.510X + 0.542
SPBE	SDLA	0.783	0.613	202.0	Y =	0.595X + -1.294	Y =	0.518X + -0.760
SPBE	1019	0.586	0.344	107.0	Y =	0.802X + 0.346	Y =	0.449X + 1.101
SPBE	1029	0.632	0.400	54.0	Y =	0.880X + -0.635	Y =	0.494X + 0.674
SPBE	1039	0.647	0.419	46.0	Y =	0.575X + 0.199	Y =	0.448X + 1.127
SPBE	1049	0.546	0.298	39.0	Y =	1.031X + 0.246	Y =	0.424X + 1.608
SPBE	1059	0.590	0.348	48.0	Y =	0.588X + 0.500	Y =	0.428X + 1.584
SPBE	2019	0.687	0.471	48.0	Y =	0.498X + 0.746	Y =	0.417X + 1.215
SPBE	2029	0.460	0.260	91.0	Y =	0.592X + 0.075	Y =	0.546X + 0.154
SPBE	2039	0.604	0.444	57.0	Y =	0.716X + -0.766	Y =	0.113X + -0.145
SPBE	1019	0.749	0.561	76.0	Y =	0.797X + 1.184	Y =	0.611X + 1.467
GARD	SDLA	0.665	0.469	209.0	Y =	0.865X + -0.540	Y =	0.527X + 0.180
GARD	1019	0.943	0.490	106.0	Y =	0.811X + 0.234	Y =	0.792X + 0.416
GARD	1029	0.958	0.318	54.0	Y =	0.875X + 0.133	Y =	0.443X + 0.279
GARD	1039	0.958	0.317	47.0	Y =	0.835X + 0.540	Y =	0.405X + 0.712
GARD	1049	0.945	0.493	100.0	Y =	0.844X + 0.317	Y =	0.405X + 0.501
GARD	1059	0.953	0.409	48.0	Y =	0.847X + 0.336	Y =	0.414X + 0.516
GARD	2019	0.723	0.523	100.0	Y =	0.544X + 1.108	Y =	0.400X + 1.669
GARD	2029	0.754	0.569	93.0	Y =	0.591X + 0.415	Y =	0.503X + 1.225
GARD	2039	0.806	0.467	56.0	Y =	0.853X + 0.174	Y =	0.466X + 1.071
GARD	1019	0.470	0.221	76.0	Y =	1.078X + 1.084	Y =	0.447X + 0.548
SDLA	1019	0.586	0.343	103.0	Y =	1.514X + 0.418	Y =	0.751X + 2.254
SDLA	1029	0.725	0.526	48.0	Y =	1.621X + -0.135	Y =	1.017X + 1.316
SDLA	1039	0.670	0.449	47.0	Y =	1.544X + 0.171	Y =	0.944X + 1.463
SDLA	1049	0.565	0.320	44.0	Y =	2.194X + -0.581	Y =	0.907X + 2.250
SDLA	1059	0.557	0.310	44.0	Y =	1.465X + 0.536	Y =	0.891X + 2.604
SDLA	2019	0.588	0.345	46.0	Y =	1.618X + 1.178	Y =	0.594X + 2.308
SDLA	2029	0.701	0.492	43.0	Y =	1.035X + 1.192	Y =	0.719X + 1.421
SDLA	2039	0.667	0.445	58.0	Y =	1.308X + 0.791	Y =	0.706X + 1.657
SDLA	1019	0.569	0.324	71.0	Y =	2.526X + 1.027	Y =	1.011X + 0.318
1019	1029	0.475	0.266	44.0	Y =	1.179X + -0.456	Y =	1.012X + 1.271
1019	1039	0.418	0.243	37.0	Y =	1.081X + 0.263	Y =	0.386X + 0.419
1019	1049	0.920	0.446	40.0	Y =	1.623X + 0.449	Y =	1.940X + 0.452
1019	1059	0.907	0.423	46.0	Y =	1.036X + 0.058	Y =	0.337X + 0.447
1019	2019	0.712	0.507	94.0	Y =	0.617X + 1.198	Y =	0.501X + 1.662
1019	2029	0.710	0.505	49.0	Y =	0.670X + 0.744	Y =	0.533X + 1.291
1019	2039	0.630	0.396	58.0	Y =	0.419X + -0.195	Y =	0.555X + 0.194
1019	1019	0.659	0.210	63.0	Y =	1.432X + 0.647	Y =	0.611X + 0.103
1029	1039	0.695	0.401	45.0	Y =	1.028X + 0.163	Y =	0.917X + 0.522
1029	1049	0.724	0.453	46.0	Y =	0.927X + 0.437	Y =	0.870X + 0.726
1029	1059	0.940	0.483	28.0	Y =	1.086X + -0.174	Y =	1.010X + 0.184
1029	2019	0.650	0.423	40.0	Y =	0.433X + 1.791	Y =	0.365X + 2.551
1029	2029	0.749	0.561	15.0	Y =	0.577X + 0.569	Y =	0.559X + 1.224
1029	1019	0.410	0.168	52.0	Y =	1.254X + 2.864	Y =	0.450X + 0.257
1039	1049	0.640	0.392	37.0	Y =	0.955X + 0.268	Y =	0.454X + 1.514
1039	1059	0.963	0.927	27.0	Y =	1.240X + -0.105	Y =	0.300X + 1.263
1039	2019	0.779	0.607	10.0	Y =	0.744X + 0.600	Y =	0.644X + 1.131
1039	2029	0.636	0.302	34.0	Y =	0.767X + 0.154	Y =	0.678X + 0.192
1039	1019	0.503	0.253	43.0	Y =	1.629X + 1.873	Y =	1.648X + 0.344
1049	1059	0.887	0.787	51.0	Y =	1.047X + -0.276	Y =	0.324X + 0.440
1049	2019	0.712	0.507	33.0	Y =	0.648X + 1.264	Y =	0.521X + 1.535
1049	2029	0.729	0.531	71.0	Y =	0.735X + 0.376	Y =	0.581X + 1.263
1049	2039	0.604	0.360	52.0	Y =	0.601X + -0.169	Y =	0.525X + 0.291
1049	1019	0.419	0.176	58.0	Y =	1.669X + 0.987	Y =	0.534X + 0.790
1059	2019	0.686	0.471	75.0	Y =	0.661X + 0.931	Y =	0.515X + 1.559
1059	2029	0.704	0.496	77.0	Y =	0.651X + 0.688	Y =	0.514X + 1.371
1059	2039	0.619	0.383	52.0	Y =	0.787X + 0.022	Y =	0.533X + 1.142
1059	1019	0.459	0.211	44.0	Y =	1.585X + 0.726	Y =	0.571X + 0.141
2019	2029	0.691	0.793	33.0	Y =	1.401X + -0.245	Y =	0.391X + 0.157
2019	2039	0.632	0.692	33.0	Y =	1.191X + -0.907	Y =	0.701X + -0.124
2019	1019	0.602	0.362	57.0	Y =	2.192X + -1.577	Y =	1.158X + 1.159
2029	2039	0.664	0.743	51.0	Y =	1.123X + -0.698	Y =	0.353X + -0.442
2029	1019	0.651	0.424	47.0	Y =	2.031X + 0.564	Y =	1.254X + 0.216
2039	1019	0.326	0.265	13.0	Y =	1.968X + -1.036	Y =	1.466X + 0.712

\* - Reflects Data for Three 4-Hour Blocks per Day: 11:00 a.m. - 3:00 p.m.  
3:00 p.m. - 7:00 p.m.  
7:00 p.m. - 11:00 p.m.

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE

GARDEN NETWORK



- C. While the correlation coefficients for the pairings of site 105 and the other Garden network study sites were somewhat lower than those for the Garden permanent site pairings, ranging from 0.89 (site 104) to .96 (site 103), the slopes were closer to unity (1.0) ranging from 0.93 (site 102) to 0.97 (site 101), with intercepts less than 0.6ppm.

#### Sand Lake Network

The objective for the Sand Lake study network was to examine and establish, if possible, the homogenous and analogous representativeness of the Sand Lake permanent site. Three study sites were deployed about the permanent site. Their locations are plotted on Figure 5. Study site 29 was sited to examine the homogenous representativeness of the Sand Lake site. Because sites 28 and 30 were located across one or more well-traveled arterials from the Sand Lake site, they yielded data relative to analogous representativeness.

As a result of the use of 8-hour integrated samplers in this network, daily eight-hour block data were used in these inter-site comparisons. In addition, sampling was not conducted during the period of most frequent maximum daily concentrations for logistical reasons. Therefore, the relationships described by Figure 16 and the correlation/regression results appearing in Table 12 may not adequately characterize the circumstances of other periods within a day.

- A. The Sand Lake permanent site had a coefficient of correlation of 0.88 with site 28, 0.97 with site 29, and 0.92 with site 30, with slopes indicating that study sites 29 and 30 were 2% and 19% higher on average than the Sand Lake site, while site 28 was 6% lower on average.
- B. Site 30, across Jewell Lake Road from the other sites, correlated at 0.79 and 0.73 with sites 28 and 29 respectively, with slopes indicating that it is 26% lower than site 28 and 4% higher than site 29 on average.

#### Spenard & Benson Network

The objective for the Spenard & Benson network was to examine and establish the homogenous and analogous representativeness of the Spenard permanent site. A total of four sites were eventually deployed in the Spenard network, consisting of three sequential and one integrated samplers. The location of these sites are plotted on Figure 3. Sites 201 and 203 were located across one or more major traffic facilities and therefore retrieved data relative to analogous representativeness. Sites 202 and 204 were located in the neighborhood contiguous with the Spenard permanent site and examined homogenous representativeness.

Again, though hourly data were available from three of these study sites, four-hour block data were utilized in the correlation/regression analysis. As site 204 retrieved 8-hour block data, comparisons with that site were made on that basis.

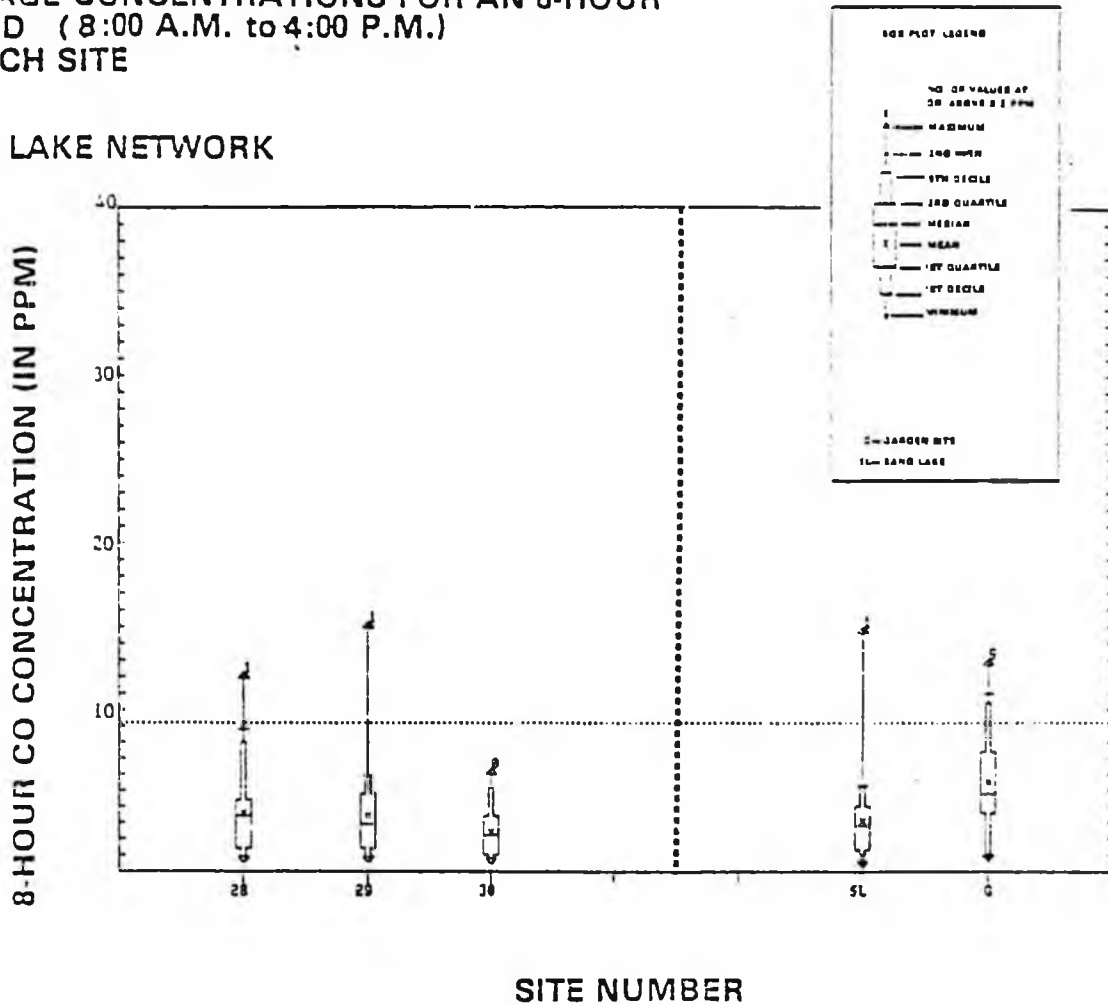
In addition to the Spenard grid sites, site 38, located in the neighborhood of the intersection of Spenard and Minnesota was included for comparison with the Spenard grid network.

ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83

FIGURE 16

CHARACTERISTICS OF WEEKDAY CARBON MONOXIDE  
AVERAGE CONCENTRATIONS FOR AN 8-HOUR  
PERIOD (8:00 A.M. to 4:00 P.M.)  
AT EACH SITE

SAND LAKE NETWORK



28

SL

29

30

Data arising from this network are displayed in Figure 17 and Table 12.

- A. The Spenard permanent site had coefficients of correlation of 0.69, 0.86, and 0.80 with sites 201, 202, and 203 respectively, at slopes of 0.50, 0.59, and 0.72.
- B. On an 8-hour block basis, the Spenard permanent site correlated at 0.72 with study site 204.
- C. Site 202 correlated at 0.89 and 0.96 with sites 201 and 203 respectively, and with slopes of 1.00 and 1.12.
- D. Site 201 correlated with site 203 at 0.83 with a slope of 1.10.
- E. On an 8-hour block basis, site 204 correlated with sites 201, 202, and 203 at 0.80 or better with slopes indicating that it is on average between 15% to 28% higher.
- F. On an 8-hour block basis, site 204 correlated at 0.35 with site 38, running 4% higher on average.

#### INTER-NETWORK COMPARISONS

Relationships of CO levels measured in areas spatially removed from each other were examined in order to characterize their distribution throughout the city. This kind of analysis can be difficult in that impacts may not be simultaneous over the entire breadth of the study area (city). A more exhaustive analysis towards accounting for any of these potential temporal shifts will be attempted when time allows.

Four-hour block data was used throughout the bulk of this analysis. Correlation/regression results are displayed in Table 12. Instances where it was necessary to use 8-hour block data (as with the Sand Lake samplers) are identified.

Because there was no integrated sampler collocated with the Garden permanent site, Garden data were used for comparisons with the integrated sites. However, it should be noted when reviewing these comparisons that there may be a small systematic difference in the sampling methodologies between the integrated and continuous sites with the latter perhaps 3% to 5% higher than the former on average (refer to Quality Assurance section).

Finally, all available data (including weekends) from the permanent sites were used in comparisons with each other.

#### Inter-Permanent Site Comparisons

- A. Between the permanent sites, correlations ranged from 0.69 to 0.80.
- B. As indicated by the slope of the regression line, Spenard & Benson was 98% and 31% higher on average than the Garden & Sand Lake sites respectively, with intercepts of -0.61 and 1.10.
- C. Spenard & Benson was 11% higher on average than the Garden site.

**ANCHORAGE CARBON MONOXIDE STUDY  
11/22/82 TO 2/11/83**

**CHARACTERISTICS OF WEEKDAY CARBON  
MONOXIDE**

**SPENARD & BENSON NETWORK**

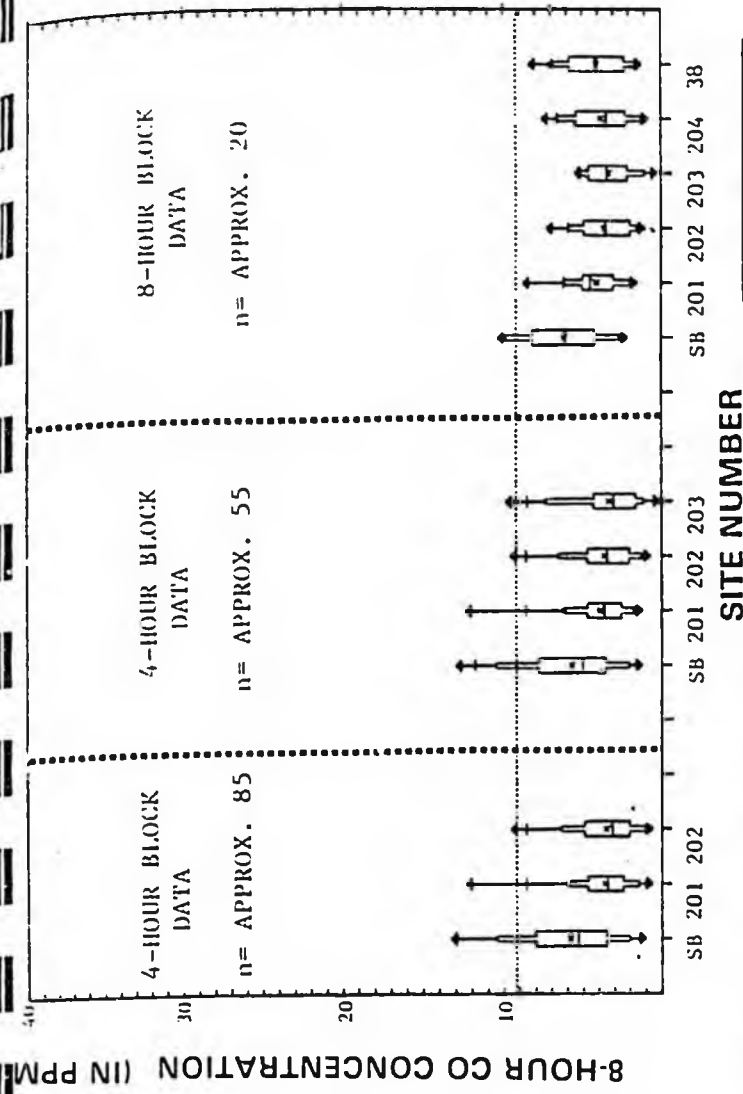


FIGURE 17



- D. Garden was 87% and 73% higher on average than the 7th & C and Sand Lake sites respectively, with intercepts of -1.15 and 0.11.
- E. Sand Lake was 9% higher on average than the 7th & C site, with an intercept of -1.00.

Permanent/Group 1 Site Comparisons (8-Hour Block Data)

- F. The 7th & C and Spenard & Benson sites have been compared to Group 1 sites in a previous section.
- G. The Garden site correlated at 0.80 or better with four other Group 1 sites (sites 19, 21, 24, and 26).
- H. The Sand Lake site did not correlate at 0.80 or better with any Group 1 sites.

Permanent/Garden Network Comparison

- I. The 7th & C, Spenard & Benson and Sand Lake permanent sites did not correlate at 0.75 or better with any Garden study site

Permanent/Sand Lake Network Comparison (8-Hour Block Data)

- J. The 7th & C, Spenard & Benson, and Garden sites correlated at 0.74 to 0.80 with site 29 in the Sand Lake network. In addition, Spenard & Benson correlated at 0.87 with site 28 in the Sand Lake Network.

Permanent/Spenard & Benson Network Comparison

- K. The 7th & C and Garden permanent sites correlated at 0.75 or better with five (sites 201, 202, and 203 on a 4-hour block basis, and sites 204 and 38 on an 8-hour block basis), and one (site 202) sites respectively in the Spenard & Benson network. The Sand Lake site did not correlate with any Spenard network site at 0.75 or better.

Other Network to Network Comparisons

- L. Sites 201 and 202 of the Spenard grid network correlated at 0.75 or better with one (site 103) and two (sites 102 and 103) sites respectively in the Garden network.
- M. Twelve of eighteen Group 1 sites and no Group 2 sites correlated at 0.75 or better with site 38 (in the neighborhood adjoining Spenard and Minnesota).

Table 13 Correlation/Regression Results\* for Permanent Sites

IND. SITE	DEP. SITE	CORRELATION	COEF. OF DET.	NO. OF PAIRS	2-WAY REGRESSION EQ.	1-WAY REGRESSION EQ.
7&C	SPBL	0.780	0.609	417.0	$Y = 1.9832 + -0.310$	$Y = 1.1511 + 1.1207$
7&C	GARD	0.151	0.165	436.0	$Y = 1.2662 + -1.449$	$Y = 1.2191 + 1.424$
7&C	SULA	0.492	0.479	410.0	$Y = 1.3991 + -1.102$	$Y = 1.1373 + 1.113$
SPBL	GARD	1.717	0.543	422.0	$Y = 3.9048 + -0.377$	$Y = 3.9444 + 1.491$
SPBL	SULA	0.196	0.211	199.0	$Y = 0.5511 + -0.204$	$Y = 3.4911 + -0.142$
GARD	SULA	0.703	0.694	416.0	$Y = 3.5787 + -0.201$	$Y = 1.4742 + 1.149$

\* - Reflects Data for Six 4-Hour Blocks per Day

## QUALITY ASSURANCE

The number and diversity of study sampling regimes necessitated a comprehensive and highly coordinated approach to yield data of appropriate precision, accuracy, and completeness. As referenced previously, a rigorous quality assurance (QA) program was developed and applied to the study. An enormous body of quality assurance documentation was amassed during the study in support of data quality. This QA program was composed of three basic elements: sampling QA, analytical QA, and data handling QA to preserve both the integrity and completeness of the data.

### Sampling QA

Explicit and routine field QA protocols were designed and implemented to ensure that samples being collected were both representative of ambient CO concentrations at the individual sampling sites and comparable in terms of quality to samples collected elsewhere in the study network. Measures of sampling performance are described below.

#### Sampling Precision

A pair of integrated samplers was collocated (within 2 meters) to quantify the extent of variability associated with the sampling method. The results in terms of 8-hour averages are described below:

- A. Collocated samplers 9 and 10 correlated at 0.97 with a slope of nearly 1.0.
- B. The mean difference between sites 9 and 10 was 0.0, with individual differences ranging from -0.9 to 1.6 ppm.
- C. Eighty percent of the differences between sites 9 and 10 were within  $\pm 0.6$  ppm (leaving only two differences greater than  $\pm 0.6$  ppm: -0.9 ppm and 1.6 ppm).

#### Sampling Accuracy

Pairs of integrated samplers/permanent monitors and sequential sampler/permanent monitor were deployed in the study network. While in the traditional sense this was not a true audit of sampler accuracy since an absolute standard was not directly employed, it was assumed that data retrieved from the permanent monitors were of sufficiently higher or at least less variable quality that they were considered a "quasi" audit source. This also provided a measure of method comparability. The results are described below:

- A. Collocated sites 11 and 7th & C correlated at 0.95 with the permanent site running about 3% higher on average than site 11.
- B. Absolute differences between site 11 and 7th & C ranged from -1.1 ppm to 1.1 ppm.
- C. Collocated sites 25 and Spenard correlated at 0.90 with the Spenard & Benson permanent site running about 5% higher on average (at an intercept of -1.52) than site 25.

- D. Of the 43 total pairs of data resulting from the comparison of site 25 and the Spenard & Benson permanent site, differences ranged from -1.8 ppm to 4.8 ppm. Of these, 22 were within  $\pm 1.3$  ppm and 38 were within  $\pm 2.6$  ppm. Seventeen of the 21 differences greater than  $\pm 1.3$  ppm occurred when one or both members of the pair were less than 9.0 ppm.

(Because the variability exhibited by this particular pair of sites was greater than that of other collocated pairs, it became the object of further investigation towards accounting for the source of the variability. It is now thought that both sampling devices were operating within their normal respective limits and that the source of most of the few but large differences is attributable to site-specific peculiarities.)

- E. Using 4-hour block data, collocated sites 105 and Garden correlated at 0.95 with the permanent site running 18% higher on average than 105 (a systematic dilution problem associated with the sequential method is suspected as the source of this offset).

#### Study Sampling Method Comparison

An integrated sampler and a sequential sampler were collocated to provide an index of the comparability of these two methods. Collocated sites 7 and 301 correlated at 0.90 with the integrated sampler (site 7) running about 12% higher on average than the sequential sampler (the same sequential dilution problem referenced in "C" above is suspected as the source of this difference).

#### Analytical QA

Analytical performance was continually monitored to ensure the integrity of the study data. Two measures of this analytical performance are described below.

#### Analytical Precision

The Beckman Model 366 CO analyzer used for analysis of bag samples was challenged 5 to 10 times daily with a precision atmosphere traceable to the National Bureau of Standards (NBS). Due to the limited availability of precision materials, the level of these precision checks varied from 10% to 36% of analyzer range. It should be noted that the precision confidence limits were computed using the percent difference of analyzer response to the known concentration of the precision atmosphere. As the proportional difference of a fixed absolute difference is greater for lower than higher concentrations, results from each precision level were considered individually. The results of these checks are described below.

- A. For the 24 precision checks performed at the nominal 6 ppm level, the absolute differences ranged from -0.7 ppm to 0.3 ppm, with percent differences yielding an upper 95% confidence limit (CI) of 5.62 and a lower 95% CI of -5.18.

- B. For the 84 precision checks performed at the nominal 9 ppm level, the absolute differences ranged from -0.7 ppm to 0.3 ppm, with percent differences yielding an upper 95% CI of 6.42 and a lower 95% CI of -2.20.
- C. For the 102 precision checks performed at the 17 ppm level, the absolute differences ranged from -0.7 ppm to 0.3 ppm, with percent differences yielding an upper 95% CI of 2.31 and a lower 95% CI of -2.01.

Another routine measure of analytical precision was the re-analysis of a number of samples to ascertain the cumulative variability associated with the analytical protocol. The results of these checks are not presented here.

#### Analytical Accuracy

The CO analyzer was audited two times with test atmospheres traceable to NBS to evaluate its response to known and absolute concentrations of CO. The number of audits do not merit a statistical treatment of the resulting data. The results of these audits are summarized below:

- A. The first audit (performed on January 5, 1983) indicated that the analyzer was reading between 2.0% and 4.4% high.
- B. The second audit (performed on February 18, 1983) indicated that the analyzer was reading between 0.4% and 2.5% high.

#### Data Handling QA

The abundant amount of data arising from the study and the numerous manipulations it underwent created the potential for errors in transcription, processing, and computation. A rigorous program of routine checks was instituted towards identifying and correcting these errors. The results of this program will not be presented here. However, this program was extremely effective in minimizing and eliminating these errors.

#### Data Completeness

Data completeness is a function of two somewhat competing objectives: 1) maximizing the proportion of successfully collected samples relative to all sampling attempts while 2) preserving the fundamental and desired integrity of the data base. The stated objective of this study was to successfully capture valid data for 85% of the total attempts (validity criteria was defined in the study QA plan). Data recovery rates for each of the subject study sites are shown in Table 13.

Table 14 Valid Data Recovery Rates By Site

<u>Group 1 Sites</u>	<u>"AM"* Data Recovery Rate (in percent)</u>	<u>"PM"** Data Recovery Rate (in percent)</u>	<u>8-Hour Data Recovery Rate (in percent)</u>
1	85.2	96.3	81.5
5	95.3	85.2	83.3
6	92.6	88.9	83.3
7	81.5	94.4	75.9
8	90.7	79.6	77.8
9	98.1	87.0	85.2
11	92.6	92.6	85.2
12	95.3	88.9	85.2
13	96.3	94.4	92.6
15	81.5	88.9	74.1
18	90.7	96.3	90.7
19	92.6	75.9	70.4
20	96.3	90.7	90.7
21	94.4	88.9	85.2
24	90.7	90.7	81.5
25	95.3	87.0	85.2
26	95.3	92.6	90.7
27	90.7	94.4	85.2
<u>Sand Lake Sites***</u>			
28			85.7
29			85.7
30			82.1

\* - 11:00 a.m. to 3:00 p.m.

\*\* - 3:00 p.m. to 7:00 p.m.

\*\*\* - Reflects eight-hour interval of 8:00 a.m. to 4:00 p.m.

STATE  
of ALASKA

# MEMORANDUM

TO:  Stanley W. Hungerford  
Environmental Engineer IV

DATE: April 2, 1980

FILE NO:

TELEPHONE NO:

FROM: T.C. Tribble *T.C.T.*  
Chief, EQM&LO

SUBJECT: Tesoro-Alaska  
Kenai Refinery;  
Suggestions for  
Monitoring

I have reviewed Mr. Frates' letter regarding the Tesoro-Alaska Kenai refinery. The following are my suggestions and comments.

Generally speaking, the many concerns expressed by Mr. Frates represent hypothetical situations rather than actual or anticipated conditions. There is no point in my trying to address Mr. Frates' concerns individually since I presume that you will be doing that in your letter.

However, there are some actions that we can take in order to provide you with factual information regarding environmental conditions.

We can develop an ambient air monitoring strategy for the area of concern considering siting requirements, instrument selection and performance testing, calibration, maintenance and data reduction. District office personnel must operate the equipment, however. We might want to establish SO<sub>2</sub>, O<sub>3</sub>, Oxides of Nitrogen and TSP sites at one or two locations.

We can develop a program for monitoring water quality of nearby lakes and streams evaluating parameters such as TKN, NO<sub>3</sub>-NO<sub>2</sub>, sulfate, pH, carbonate alkalinity and perhaps even hydrocarbons. Again district office support would be required to collect samples and measure pH as well as carbonate alkalinity. EQM&LO can provide the required laboratory support.

In order for you to decide how far you wish to go with this problem, I have included in the following an estimate of new equipment costs.

I AMBIENT AIR MONITORING

A Sulfur Dioxide

1. TECO Model 43 SO <sub>2</sub> analyzer	8,500
2. METRONICS Dynacalibrator	5,350
3. SUPERSCRIBE strip chart recorder	1,600
4. MONITOR LABS signal averager	1,100
5. Miscellaneous commodities	250
	<hr/> 16,800 per site

B Ozone

1. DUCIBI Model 1003-RS Ozone analyzer	5,750
2. SUPERSCRIBE strip chart recorder	1,600
3. MONITOR LABS signal averager	1,100
4. Miscellaneous commodities	250
	<hr/> 8,700 per site

C Oxides of Nitrogen

1. MONITOR LABS Model 844-E NO(X) analyzer	10,000
2. CSI Gas phase titration calibrator	9,000
3. SUPERSCRIBE strip chart recorder	1,600
4. MONITOR LABS signal averager	1,100
5. Miscellaneous commodities	<u>250</u>
	21,950 per site

Total equipment costs per site for ambient air monitoring are \$47,450. I recommend a back-up strip chart recorder and signal averager for an additional \$2,700 and a total of \$50,150.

II WATER QUALITY MONITORINGA Non-conservative Parameters

1. ORION pH meter, probe and buffer solutions, alkalinity gear 950

B Conservative Parameters

1. All required water chemistry can be incorporated into the existing program.

I have included one of these sites in our request for additional ambient air monitoring equipment. Please advise me how you want to go with this problem.

II A 50

Tom Tribble  
Chief, EQM & LO

April 9, 1980

Stanley W. Hingerford  
Environmental Engineer IV

*Stan*

Kenai Air/Water  
Monitoring Program

Tom, your suggestions for a multi-parameter monitoring program for obtaining "background" air and water quality data in the Kenai area looks good to me. Please obtain the equipment (via Tom Hanna's grant funds) and arrange to set up a monitoring station somewhere in the vicinity of the Collier-Phillips-Tesoro industrial complex about 10 miles north of Kenai. Enclosed is a map from Tesoro's PSD application which indicates calculated pollutant concentrations in the area, and another map showing locations of major facilities.

I hope you can get the program started while I am on leave, but if not, we should get together as soon as I return. Here are the names of company officials who might be able to help you site the instruments and obtain power:

Union Chemicals --

Mr. George Ford, Plant Manager (776-8121)  
Mr. Bill Witzer, Environment Engineer

Phillips Petroleum --

Mr. J. F. Settle (776-8166)

Tesoro Alaska Refining --

Mr. Mark Necessary (776-8191)  
Mr. Ray Measles, Laboratory Supervisor

Chevron USA (refinery) --

Mr. George E. Day, Manager (776-8161)

Chugach Electric Ass'n --

Mr. L. J. Schultz, General Manager (276-3500)  
Mr. Larry Marley, Manager, Environmental

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
CREATED FROM NATIONAL AEROMETRIC DATA BANK

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SUSPENDED PARTICULATE UG/M<sup>3</sup> - ALASKA 1983

METHOD: GRAVIMETRIC, 24-HOUR HI-VOLUME FILTER SAMPLE-91

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER 24-HR OBS.	ANNUAL GEOMETRIC MEAN	24-HR VALUES		24-HR VALUES		
					> 260	> 150	1ST MAX DATE	2ND MAX DATE	
ANCHORAGE BOROUGH									
020043003101 STATE M.I.N. PROGRAM BLDG 527 E. 4TH AVE. ANCHORAGE	91	020	59	55	5		223 05/12	195 06/20	
020043005101 CITY FIRE STATION 7TH & C STREET ANCHORAGE	91	020	58	64	10		224 04/06	223 06/23	
020043009101 TUDOR #1 - 3500 EAST TUDOR ROAD ANCHORAGE	91	020	59	65	10		215 09/27	188 05/12	
020040119101 1/4 MILE S OILWELL RD & 3/4 MILE MULDOON ANCHORAGE	91	020	57	21			100 01/30	100 02/11	
020043020101 1045 WEST 8TH STREET ANCHORAGE	91	020	59	49	3		170 06/23	160 05/12	
020040121101 SAND LAKE DISTRICT 3426 RASPBERRY ROAD ANCHORAGE	91	020	19	44	2		208 03/25	156 03/07	
020043029101 TUDOR #2 - 3500 EAST TUDOR ROAD ANCHORAGE	91	020	59	63	8		232 09/27	181 06/23	
FAIRBANKS NORTH STAR BOROUGH									
020160110F01 675 7TH AVE, FAIRBANKS FAIRBANKS	91		38	105	1	11	265 12/08	245 04/06	
020160115G01 NEW BOROUGH BLDG SITE #1 - 4TH & LACEY FAIRBANKS	91	020	30	93	3		238 06/11	157 04/18	

*State Standard*

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
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SUSPENDED PARTICULATE UG/M3 ALASKA 1983

METHOD: GRAVIMETRIC, 24-HOUR HI-VOLUME FILTER SAMPLE-91

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER 24-HR OBS.	ANNUAL GEOMETRIC MEAN	24-HR VALUES > 260 > 150	24-HR VALUES	
						1ST MAX DATE	2ND MAX DATE
FAIRBANKS NORTH STAR BOROUGH							
020160016G01 NEW BOROUGH BLDG SITE #2 4TH & LACEY FAIRBANKS	91	020	59	76	4	233 06/11	174 12/08
020160017G01 NORDALE ELEMENTARY SCHOOL HAMILTON-EUREKA FAIRBANKS	91	020	54	66	2	175 10/15	152 09/27
020160019G01 NOEL WIEN LIBRARY - COWLES & AIRPORT RDS FAIRBANKS	91	020	59	67	2	201 10/15	159 11/08
020160022G01 NOEL WIEN LIBRARY #2, COWLES & AIRPORT RDS FAIRBANKS	91		11	76?	2	207 10/15	158 11/08
JUNEAU BOROUGH							
02020002F01 JUNEAU FIRE DEPARTMENT JUNEAU	91	020	57	35	1	162 05/06	120 10/15

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
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SUSPENDED PARTICULATE UG/M3 ALASKA 1983

METHOD: GRAVIMETRIC, 24-HOUR HI-VOLUME FILTER SAMPLE-91

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER OF 24-HOUR CONCENTRATIONS IN RANGES:							OVER 455 *
			** * 0 * TO 65	66 TO 130	131 TO 195	196 TO 260	261 TO 325	326 TO 390	391 TO 455	
ANCHORAGE BOROUGH										
020040003101 STATE W.I.M. PROGRAM BLDG 527 E. 4TH AVE. ANCHORAGE	91	020	35	16	7	1				
020040005101 CITY FIRE STATION 7TH & C STREET ANCHORAGE	91	020	28	18	8	4				
020040009101 TUDOR #1 - 3500 EAST TUDOR ROAD ANCHORAGE	91	020	31	17	10	1				
020040019101 1/4 MILE S OILWELL RD & 3/4 MILE MULDCOM ANCHORAGE	91	020	53	4						
020040020101 1645 WEST 8TH STREET ANCHORAGE	91	020	40	14	5					
020040021101 SAND LAKE DISTRICT 3426 KASPERBY ROAD ANCHORAGE	91	020	11	6	1	1				
020040029101 TUDOR #2 - 3500 EAST TUDOR ROAD ANCHORAGE	91	020	31	18	9	1				
FAIRBANKS NORTH STAR BOROUGH										
020160010F01 675 7TH AVE, FAIRBANKS FAIRBANKS	91		9	15	8	5	1			
020160015G01 NEW BOROUGH BLDG SITE #1 - 4TH & LACEY FAIRBANKS	91	020	6	18	5	1				

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
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PAGE 2

SUSPENDED PARTICULATE UG/P3 ALASKA 1983

METHOD: GRAVIMETRIC, 24-HOUR HI-VOLUME FILTER SAMPLE-91

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER OF 24-HOUR CONCENTRATIONS IN RANGES:						OVER
			0 TO 65	66 TO 130	131 TO 195	196 TO 260	261 TO 325	326 TO 390	
FAIRBANKS NORTH STAR BOROUGH									
020160016G01 NEW BOROUGH BLDG SITE #2 4TH & LACEY FAIRBANKS	91	020	21	30	7	1			
020160017G01 NORDALE ELEMENTARY SCHOOL HAMILTON-EUREKA FAIRBANKS	91	020	22	29	3				
020160019G01 NOEL WIEN LIBRARY - COMLES & AIRPORT RDS FAIRBANKS	91	020	26	30	2	1			
020160022G01 NOEL WIEN LIBRARY #2, COMLES & AIRPORT RDS FAIRBANKS	91		4	5	1	1			
JUNEAU BOROUGH									
020200002F01 JUNEAU FIRE DEPARTMENT JUNEAU	91	020	39	17	1				

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
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LEAD

UG/P3

ALASKA

1983

METHODS: JARRELL-ASH EMISSION SPECTRA ICAP-90, EMISSION SPECT MUFFLE FURNACE-91, ATOMIC ABSORPTION-92, DITHIOZONE METHOD-93  
EMISSION SPECT (LOW TEMP ASH)-95, X-RAY FLUORESCENCE-96

SITE CODE AND ADDRESS	METH	REP ORG	QUARTER	NUMBER OF 24-HOUR SAMPLES	QUARTERLY ARITHMETIC AVERAGE
ANCHORAGE BOROUGH					
02J040J05101	92	020	JANUARY-MARCH	15	0.51
CITY FIRE STATION 7TH & C STREET			APRIL-JUNE	15	0.36
ANCHORAGE			JULY-SEPTEMBER	10	0.29
			OCTOBER-DECEMBER		
FAIRBANKS NORTH STAR BOROUGH					
020160J16G01	92	020	JANUARY-MARCH	13	0.64
NEW BOROUGH BLDG SITE #2 4TH & LACEY			APRIL-JUNE	15	0.19
FAIRBANKS			JULY-SEPTEMBER	14	0.19
			OCTOBER-DECEMBER	14	0.74

Lead Standard is 1.5 micrograms per  
cubic meter of air averaged over  
a calendar quarter

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
CREATED FROM NATIONAL AEROMETRIC DATA BANK

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CARBON MONOXIDE          PPM          ALASKA          1983

METHOD: NONDISPERSIVE INFRARED (NDIR) CONTINUOUS, HOURLY VALUES-11, FLAME IONIZATION-21

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER HOURLY OBS.	1-HOUR OBSERVATIONS			8-HOUR OBSERVATIONS		
				1ST MAX DATE-TIME	2ND MAX DATE-TIME	TIMES > 35	1ST MAX DATE TIME END HR	2ND MAX DATE TIME END HR	TIMES > 9
ANCHORAGE BOROUGH									
020040013101 625 C STREET ANCHORAGE	11		5122	15.0 02/24 1800	14.0 02/02 1600		8.5 01/05 1900	8.5 01/23 2200	
020040017101 2902 SPENARD ROAD ANCHORAGE ANCHORAGE	11	020	8595	34.0 12/02 1700	26.0 11/04 0800		20.2 12/02 2100	16.0 12/26 1900	72
020040018101 TRINITY CHRISTIAN CHURCH 3000 E. 16TH AVE ANCHORAGE	11	020	8401	23.0 01/28 0800	23.0 12/02 1700		19.6 12/27 1500	18.0 12/26 1900	43
020040021101 SAND LAKE DISTRICT 3426 RASPBERRY ROAD ANCHORAGE	11	020	8621	19.0 12/27 0800	18.0 12/02 1800		11.4 12/02 2100	11.3 12/26 2300	9
FAIRBANKS NORTH STAR BOROUGH									
020160013F01 675 7TH AVE, FAIRBANKS FAIRBANKS	11	020	5277	36.0 02/22 1800	33.0 02/22 1700	1	19.0 02/22 1900	15.9 02/23 2200	34
020160014G01 4TH AVE. AND LACEY ST., FAIRBANKS FAIRBANKS	11		6315	32.0 02/23 1700	31.5 02/23 1600		18.3 02/23 2100	17.6 02/04 1700	40
020160020G01 HUNTER ELEMENTARY SCHOOL 17TH & GILLIAM FAIRBANKS	11	020	5763	26.0 01/25 1800	22.0 02/22 1900		15.1 01/21 2300	14.0 01/25 1900	26

72 - Max level of  
standard  
violations

State standards 9 parts per million  
averaged over a 8 hour period

DATE: AUG. 02, 1984

STATE AND LOCAL AIR MONITORING REPORT  
CREATED FROM NATIONAL AEROMETRIC DATA BANK

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CARBON DIOXIDE PPM ALASKA 1983

METHOD: NONDISPERSIVE INFRARED (NDIR) CONTINUOUS, HOURLY VALUES-11, FLAME IONIZATION-21

SITE CODE AND ADDRESS	METH	REP ORG	NUMBER OF 8-HOUR AVERAGE CONCENTRATIONS IN RANGES:							OVER 28
			0 TO 4	5 TO 8	9 TO 12	13 TO 16	17 TO 20	21 TO 24	25 TO 28	
ANCHORAGE BOROUGH										
020040013101 625 C STREET ANCHORAGE	11		4755	315	5					
020040017101 2902 SPENARD ROAD ANCHORAGE ANCHORAGE	11	020 99503	6421	1636	440	67	8			
020040018101 TRINITY CHRISTIAN CHURCH 3000 E. 16TH AVE ANCHORAGE	11	020	7148	944	216	55	16			
020040021101 SAND LAKE DISTRICT 3426 RASPBERRY ROAD ANCHORAGE	11	020	8177	362	51					
FAIRBANKS NORTH STAR BOROUGH										
020160013F01 675 7TH AVE, FAIRBANKS FAIRBANKS	11	020	4150	864	171	33	4			
020160014G01 4TH AVE. AND LACEY ST., FAIRBANKS FAIRBANKS	11		5101	931	211	38	6			
020160020G01 HUNTER ELEMENTARY SCHOOL 17TH & GILLIAM FAIRBANKS	11	020	4819	732	169	15				

ALASKA  
DEPT. OF ENVIRONMENTAL CONSERVATION  
AUTOMATED ANALYZERS

NATIONAL AEROMETRIC DATA BANK  
ENVIRONMENTAL PROTECTION AGENCY  
SAROAD/PRECISION-ACCURACY REPORT

PAGE 1  
AUG 2, 1984  
NA283/NAP000

PRECISION-ACCURACY DATA KEY

\*\*\*\*\*  
RG ST RD TYP POLL YR-Q

10 02 020 C 42101 83-5  
\*\* CARBON MONOXIDE \*\*

P R E C I S I O N   D A T A

\*\*\*\*\*  
# OF    PRECIS    PROB LIM  
ANLYZRS CHECKS    LO    UP

005    0106    -03 +04

A C C U R A C Y   D A T A

\*\*\*\*\*  
SOURCE    TRACE    # AUDITS    PROB LIM    PROB LIM    PROB LIM    PROB LIM  
AUD GAS    ABLTY    L1-3 L4    LO-L1-UP    LO-L2-UP    LO-L3-UP    LO-L4-UP

0013 0000    -10 +06    -02 +04    -04 +03

**CHARACTERIZATION OF AIR QUALITY IMPACTS  
FROM RESIDENTIAL WOOD COMBUSTION IN  
JUNEAU AND FAIRBANKS, ALASKA**

**FINAL REPORT**

**VOLUME II  
FAIRBANKS**

**Prepared For:  
State of Alaska  
Dept. of Environmental Conservation  
Pouch O  
Juneau, Alaska 99811**

**By:  
NEA, INC.  
10950 S.W. 5th Street, Suite 380  
Beaverton, Oregon 97005**

**June 20, 1984**

CHARACTERIZATION OF AIR QUALITY IMPACTS  
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June 20, 1984

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## EXECUTIVE SUMMARY

The impact of wood smoke on ambient particulate levels in Fairbanks, Alaska, was studied during January and February of 1984. Aerosol samples were collected at the Nordale and Wood River schools using Sierra virtual impactor dichotomous samplers which sorted aerosol particles into a fine particles fraction ( $< 2.5 \mu\text{m}$ ) and a coarse particle fraction ( $> 2.5 \mu\text{m}$  but less than  $10 \mu\text{m}$  diameter). Twenty-four hour samples were collected on an every third day frequency. Samples were selected for analysis on the basis of high TSP loadings and fine particle loadings greater than  $20 \mu\text{g}/\text{m}^3$ .

Fine and coarse teflon filters were analyzed for their elemental content by X-ray fluorescence. Selected glass fiber TSP filters were analyzed for their organic and elemental carbon content by a pyrolysis-flame ionization procedure. Source contributions were quantified using a chemical mass balance receptor modeling procedure.

Eighty-five percent of the particulate mass collected by the dichotomous sampler was fine particles, most of which was carbon. Sulfur was the most abundant inorganic fine particle species accounting for 3.9% of the fine particle mass, almost twice the next most abundant species, which was Pb. Silicon was the most abundant coarse particle species (14.2%) followed by Ca (7.8%). The fine particle S concentration of  $1.03 \mu\text{g}/\text{m}^3$  was substantially greater than the  $0.68 \mu\text{g}/\text{m}^3$  concentration of coarse particle Si. Calcium and Si were more abundant in the coarse particle fraction while S, K, Br, and Pb were enriched in the fine particle fraction.

Sulfur and K are highly correlated with fine particle mass but not with each other. Lead is correlated with fine particle mass but less than S and K. Lead is also highly correlated with fine particle Br but was not correlated with S.

The average source contributions are summarized in Table I and illustrated with the pie charts shown in Figures I-IV.

There are three primary sources of fine particles: transportation, wood smoke, and distillate oil. This is consistent with the above noted correlations. Wood smoke was responsible for 47% ( $20 \text{ ug/m}^3$ ) of the fine particle mass sampled at Nordale school, while distillate oil contributed 18% ( $7.7 \text{ ug/m}^3$ ) and transportation contributed 16% ( $6.8 \text{ ug/m}^3$ ).

Soil and road dust accounted for 41% ( $1.7 \text{ ug/m}^3$ ) of the coarse particle mass at the Nordale school; coal fly ash accounted for 38% ( $1.6 \text{ ug/m}^3$ ) and transportation was responsible for 20% ( $0.84 \text{ ug/m}^3$ ).

A large portion of the TSP was not sampled by the dichotomous sampler and as a result was not apportioned to specific sources. This unapportioned TSP mass, however, more than likely originates from the same sources responsible for the dichotomous coarse particle mass. Since almost all of the wood smoke particles are less than  $2.5 \text{ }\mu\text{m}$ , the fine particle mass impacts for this source are an accurate representation of this source's contribution to TSP within its listed uncertainty.

Table I

## SUMMARY OF AVERAGE JANUARY AND FEBRUARY SOURCE CONTRIBUTIONS\*

City	Site No.	Site Name	Part. Size	SOURCE CONTRIBUTION*							RESIDU.	COAL.
				TRANSP	WBURN	DUST	SULFATE	MARINE	DSTOIL	RESIDU.		
Juneau	1	F.D. School	F	2.1	30	0.13	1.7	0.17	1.3	-	-	
			C	5.8	82	0.36	4.7	0.47	3.6	-	-	
	2	S. Bear	F	0.13	-	1.8	0.11	0.20	-	-	-	
			C	5.7	-	80	4.8	8.7	-	-	-	
			F	3.9	27	0.29	2.1	0.19	0.41	-	-	
Fairbanks	3	L. Creek	F	11.1	77	0.83	6.0	0.54	1.17	-	-	
			C	0.59	-	4.2	0.04	0.056	-	-	-	
	4	N. School	F	13.1	-	93	0.89	1.2	-	-	-	
			C	0.66	9.1	0.26	0.26	-	2.2	-	-	
			F	3.1	43	1.2	1.2	-	10.4	-	-	
Fairbanks	5	W.R. School	F	0.15	-	1.9	0.08	0.03	0.66	-	-	
			C	6.0	-	76	3.3	1.2	26	-	-	
	5	W.R. School	F	7.4	22	0.05	1.6	-	7.5	-	-	
			C	17	49	0.1	3.6	-	17	-	-	
			F	0.84	-	1.7	-	-	-	0.002	1.6	
5	W.R. School	C	20	-	41	-	-	-	0.05	38		
		F	3.0	12.3	1.2	1.1	-	1.1	-	-		
		C	14	57	5.6	5.1	-	5.1	-	-		
5	W.R. School	F	0.20	-	1.26	-	-	-	0.004	0.57		
		C	10.5	-	66	-	-	-	0.19	30		

\* The top number listed is the source contribution in  $\mu\text{g}/\text{m}^3$ , while the bottom number listed in the source contribution is percent of measured mass. TRANSP: Transportation, WBURN: Wood Smoke, DUST: Road and soil dust, SULFATE:  $\text{SO}_4$ , DSTOIL: Distillate oil smoke, RESIDU: Residual Oil smoke, COAL: Coal Fly Ash

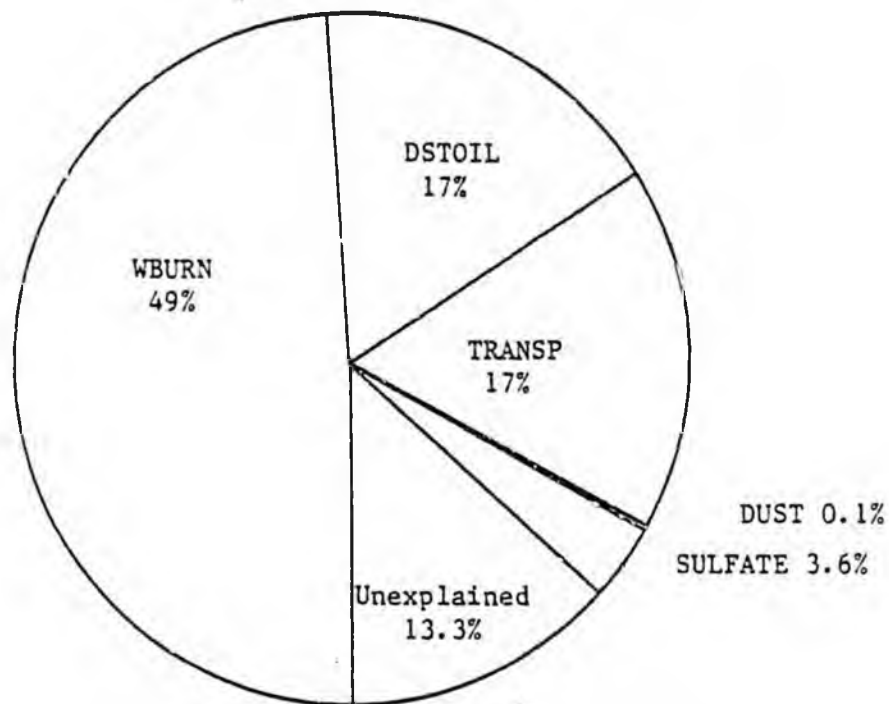


Figure I. Pie chart of percent source contributions to fine particle mass measured at the Nordale School monitoring site.

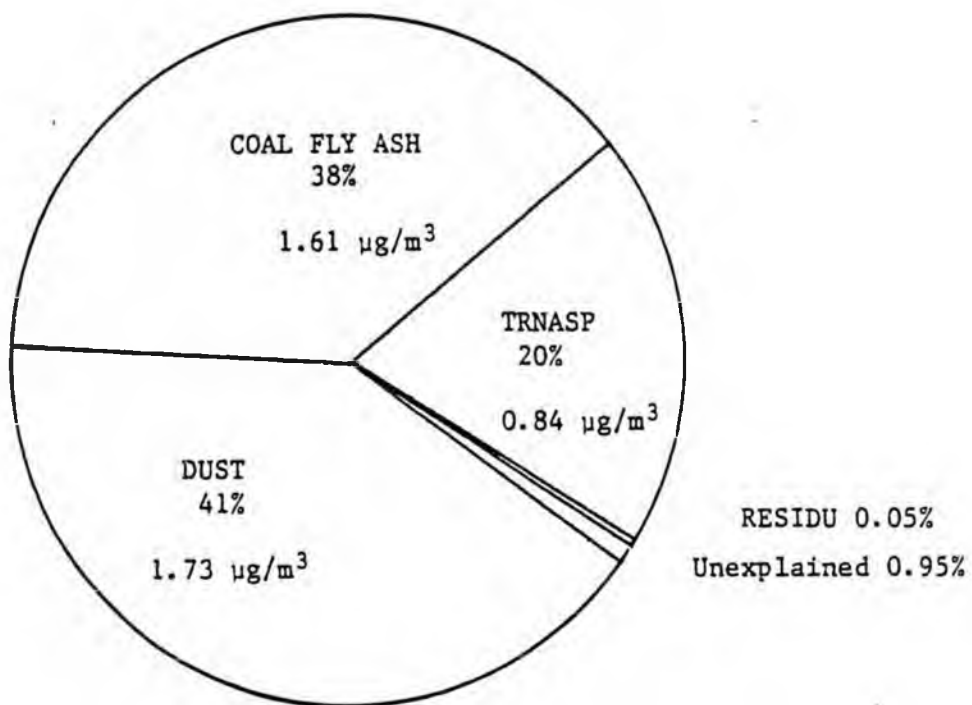


Figure II. Pie chart of percent source contributions to coarse particle mass measured at the Nordale School monitoring site.

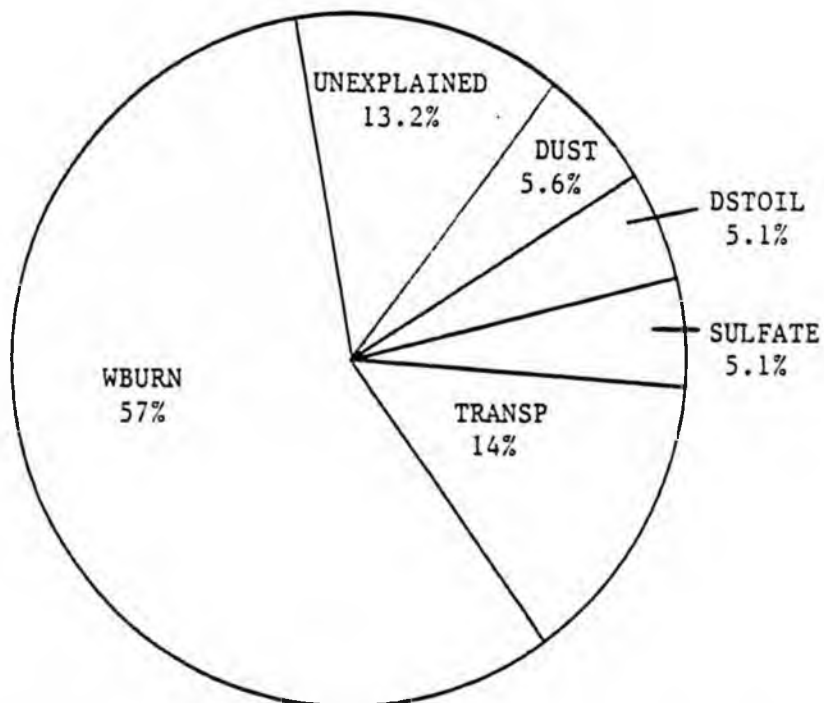


Figure III. Pie chart of percent source contributions to fine particle mass measured at the Wood River School monitoring site.

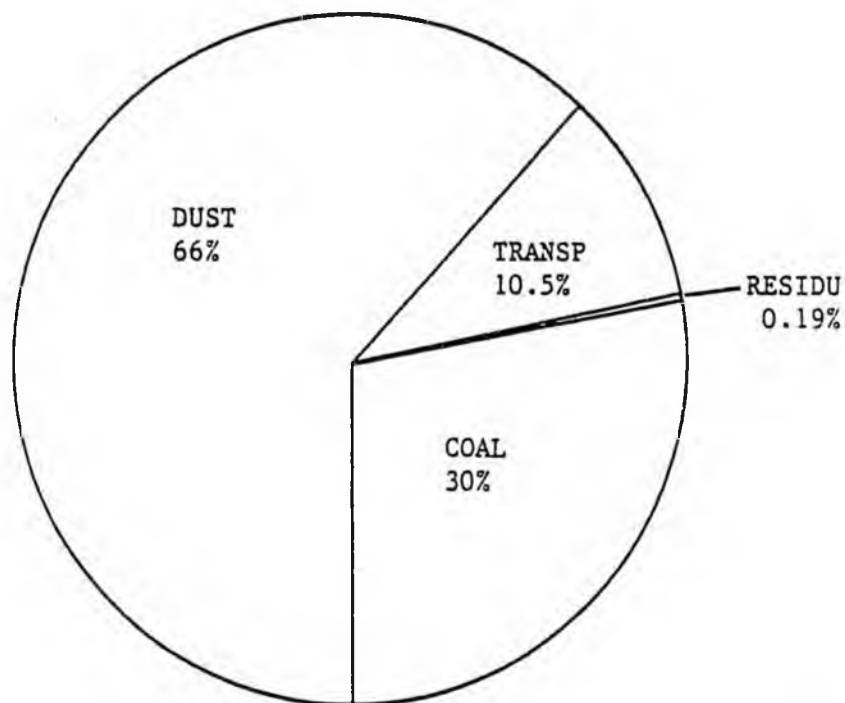


Figure IV. Pie chart of percent source contributions to coarse particle mass measured at the Wood River School monitoring site.

**CHARACTERIZATION OF AIR QUALITY IMPACTS  
FROM RESIDENTIAL WOOD COMBUSTION IN  
JUNEAU AND FAIRBANKS, ALASKA**

**FINAL REPORT**

**VOLUME I  
JUNEAU**

**Prepared For:  
State of Alaska  
Dept. of Environmental Conservation  
Pouch O  
Juneau, Alaska 99811**

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## EXECUTIVE SUMMARY

The impact of wood smoke on ambient particulate levels in Juneau, Alaska, was studied during January and February of 1984. Aerosol samples were collected at Floyd Dryden school, Super Bear shopping center, and at a Lemon Creek residential site using Sierra virtual impactor dichotomous samplers which sort aerosol particles into a fine particle fraction ( $< 2.5 \mu\text{m}$ ) and a coarse particle fraction ( $> 2.5 \mu\text{m}$  but less than  $10 \mu\text{m}$ ). Twenty-four hour samples were collected on an every third day frequency. Samples were selected for analysis on the basis of high TSP loadings and fine particle mass loadings greater than  $20 \mu\text{g}/\text{m}^3$ .

Fine and coarse teflon filters were analyzed for their elemental content by X-ray fluorescence. Selected glass fiber TSP filters were analyzed for their organic and elemental carbon content by a pyrolysis-flame ionization procedure. Source contributions were quantified using chemical mass balance receptor modeling procedures.

Eighty-one percent of the particulate mass collected by the dichotomous sampler was fine particles, most of which was carbon. Sulfur was the most abundant inorganic fine particle species accounting for 2.6% of the fine particle mass. Chlorine, Si, and Pb were also relatively abundant fine particle species. Silicon was the most abundant coarse particle species (12.5%) followed by Cl which accounted for 8.5% and Fe (3.2%). Silicon, Cl, Ca, and Fe were more abundant in the coarse fraction, while S, K, Zn, Br, and Pb were enriched in the fine particle fraction.

Sulfur and K are highly correlated with the fine particle mass and with each other. Lead is correlated with the fine particle mass but less than S and K. Lead is also highly correlated with Br.

The average source contributions are summarized in Table I and illustrated with pie charts shown in Figures I-VI.

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L. CMB Source Apportionment Results for TSP Samples Collected at the Super Bear Shopping Center	III
M. Field Data Sheets for Dichotomous Filters Collected in Juneau	III

Wood smoke was responsible for about 80% ( $30 \mu\text{g}/\text{m}^3$ ) of the fine particle mass. Transportation, secondary sulfate, and distillate oil are the only other fine particle sources.

Soil and road dust accounts for 80% of the coarse particle fraction.

High TSP episodes are usually the result of either high wood smoke, high soil and road dust, or combinations of these two sources.

Table I

## SUMMARY OF AVERAGE JANUARY AND FEBRUARY SOURCE CONTRIBUTIONS\*

City	Site No.	Site Name	Part. Size	SOURCE CONTRIBUTION*							RESIDU.	COAL
				TRANSP	WBURN	DUST	SULFATE	MARINE	DSTOIL	RESIDU.		
Juneau	1	F.D. School	F	2.1	30	0.13	1.7	0.17	1.3	-	-	
				5.8	82	0.36	4.7	0.47	3.6	-	-	
	2	S. Bear	F	0.13	-	1.8	0.11	0.20	-	-	-	
				5.7	-	80	4.8	8.7	-	-	-	
				3.9	27	0.29	2.1	0.19	0.41	-	-	
Fairbanks	3	L. Creek	C	11.1	77	0.83	6.0	0.54	1.17	-	-	
				0.59	-	4.2	0.04	0.056	-	-	-	
				13.1	-	93	0.89	1.2	-	-	-	-
				0.66	9.1	0.26	0.26	-	2.2	-	-	
Fairbanks	4	N. School	F	3.1	43	1.2	1.2	-	10.4	-	-	
				0.15	-	1.9	0.08	0.03	0.66	-	-	
	5	W.R. School	C	6.0	-	76	3.3	1.2	26	-	-	
				7.4	22	0.05	1.6	-	7.5	-	-	
				17	49	0.1	3.6	-	17	-	-	
Fairbanks	4	N. School	F	0.84	-	1.7	-	-	-	0.002	1.6	
				20	-	41	-	-	-	0.05	38	
	5	W.R. School	C	3.0	12.3	1.2	1.1	-	1.1	-	-	
				14	57	5.6	5.1	-	5.1	-	-	
				0.20	-	1.26	-	-	-	0.004	0.57	
5	W.R. School	C	10.5	-	66	-	-	-	-	0.19	30	

\* The top number listed is the source contribution in  $\mu\text{g}/\text{m}^3$ , while the bottom number listed in the source contribution is percent of measured mass. TRANSP: Transportation, WBURN: Wood Smoke, DUST: Road and soil dust, SULFATE:  $\text{SO}_4$ , DSTOIL: Distillate oil smoke, RESIDU: Residual Oil smoke, COAL: Coal Fly Ash

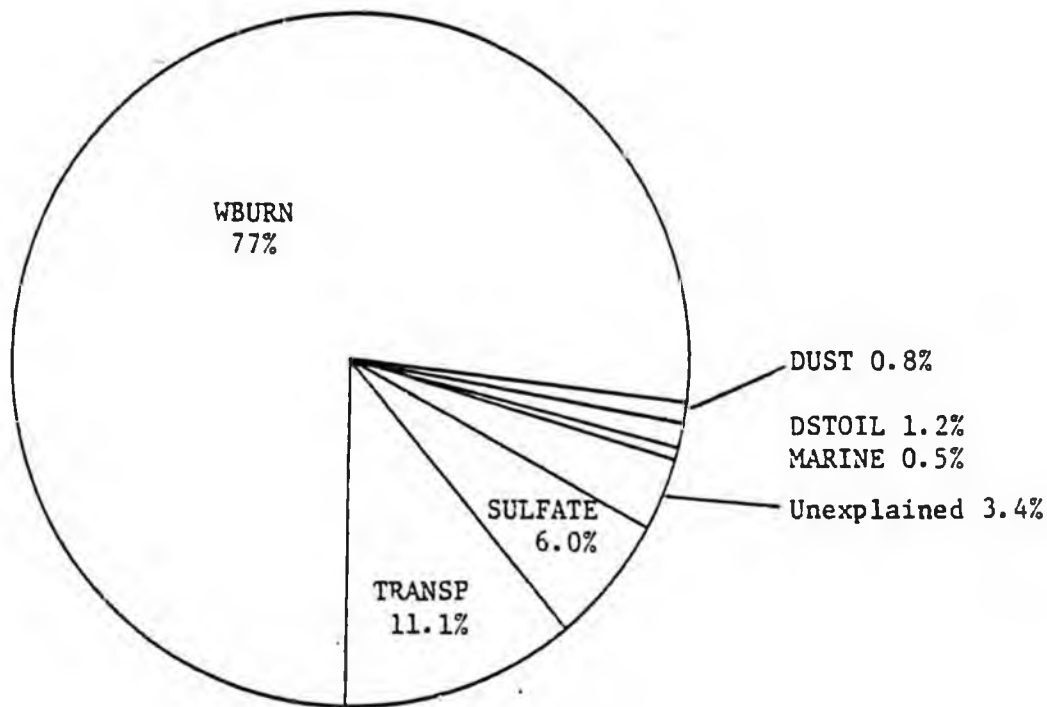


Figure III. Pie chart of percent source contributions to fine particle mass measured at the Super Bear monitoring site.

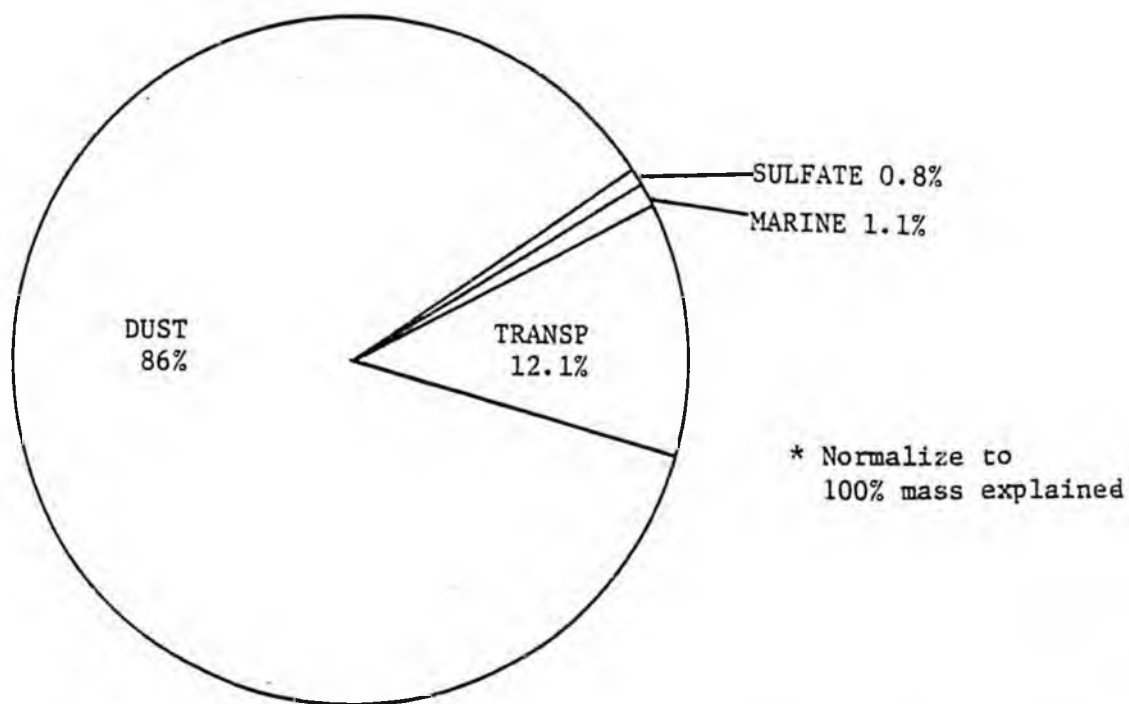


Figure IV. Pie chart of percent source contributions to coarse particle mass measured at the Super Bear monitoring site.

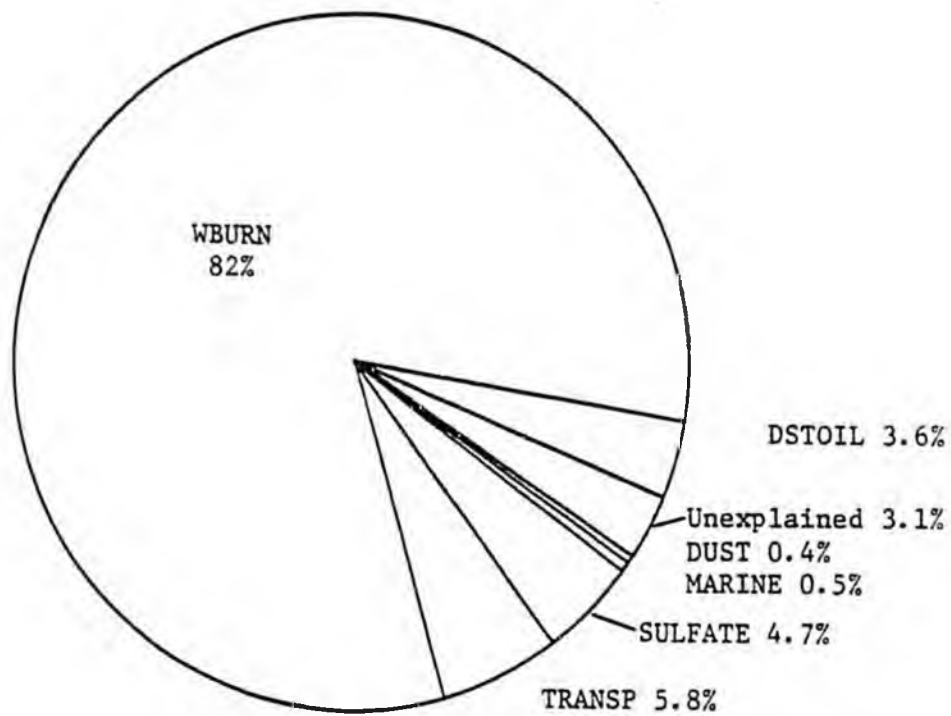


Figure I. Pie chart of percent source contributions to fine particle mass measured at the Floyd Dryden school monitoring site.

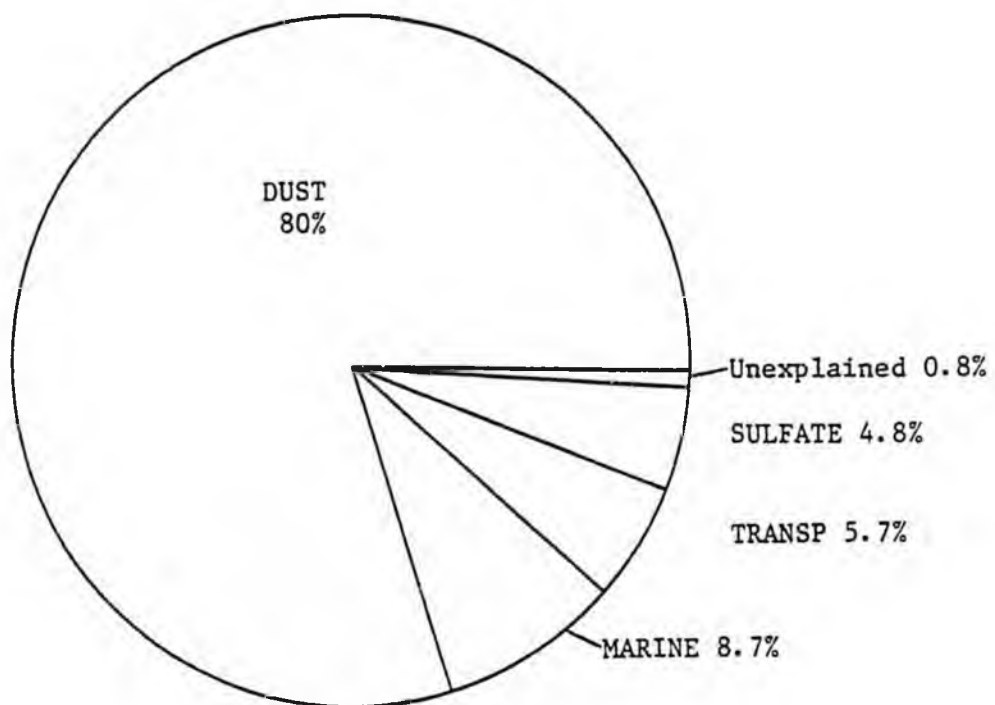


Figure II. Pie chart of percent source contributions to coarse particle mass measured at the Floyd Dryden school monitoring site.

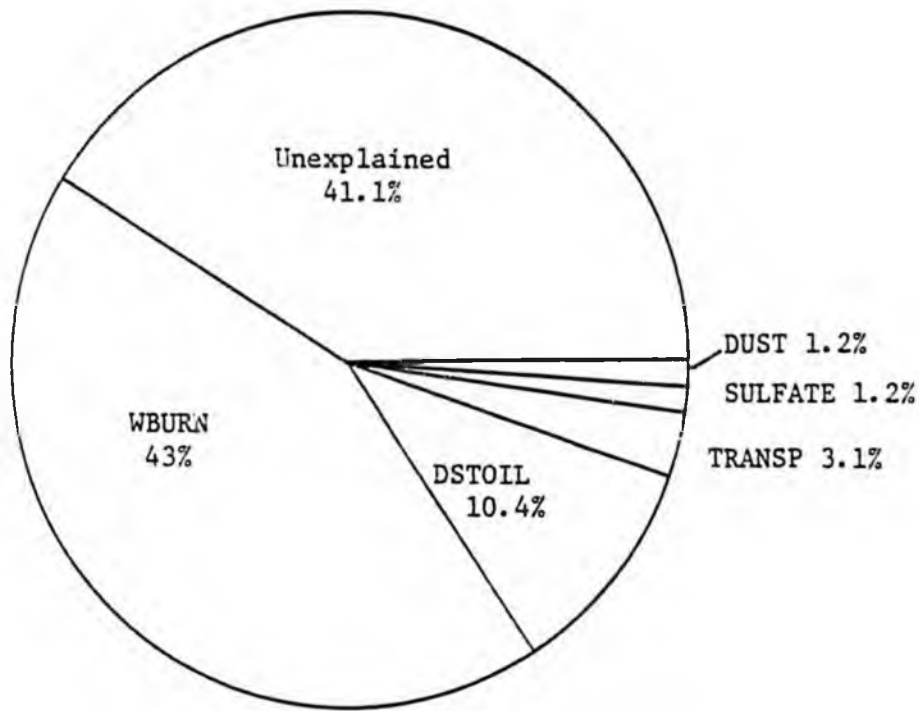


Figure V. Pie chart of percent source contributions to fine particle mass measured at the Lemon Creek monitoring site.

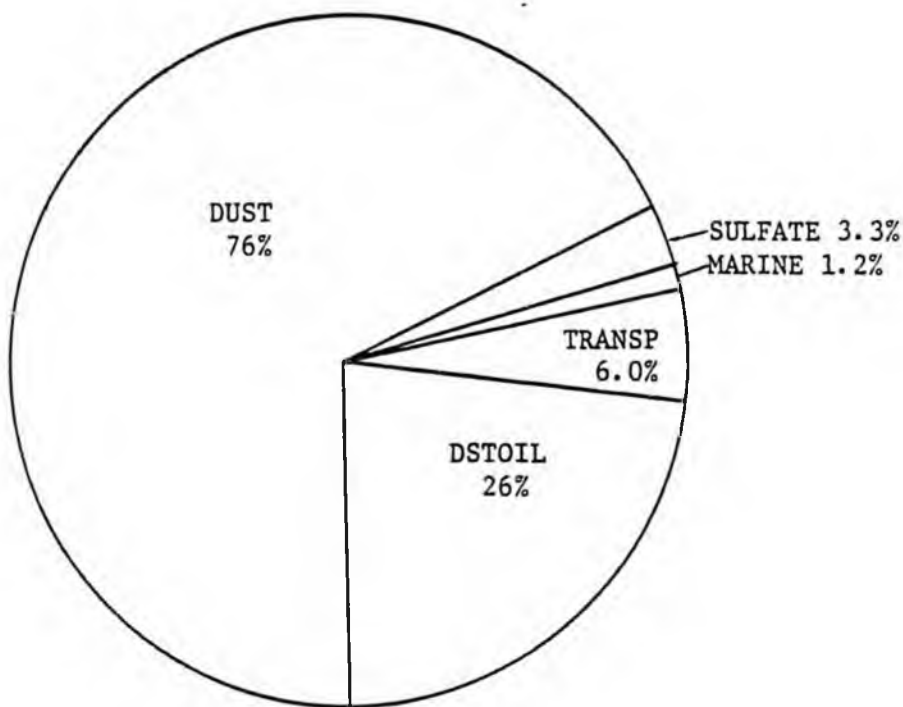


Figure VI. Pie chart of percent source contributions to coarse particle mass measured at the Lemon Creek monitoring site.

F10E2A  
KENAI

A PRELIMINARY STUDY OF THE WATER QUALITY OF SELECTED KENAI LAKES  
WITH CONSIDERATIONS OF ACID RAINFALL

KENAI, ALASKA

SEPTEMBER 1980

A WORKING PAPER

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION  
DIVISION OF ENVIRONMENTAL QUALITY OPERATIONS  
ENVIRONMENTAL QUALITY MONITORING AND LABORATORY OPERATIONS

A working paper presents results of investigations which may be limited or incomplete. Therefore, conclusions expressed or implied are tentative. Mention of trade names or commercial products does not constitute endorsement or recommendation by the State of Alaska.

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## PURPOSE

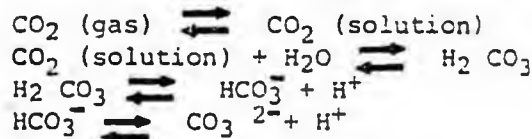
This investigation was conducted in order to evaluate the water quality of selected lakes located within the boundaries of the Kenai Peninsula. Of particular interest was the collection of parametric data that would determine the presence or absence of acid rainfall. The area under study was the Kenai industrial complex and surrounding public lands.

The planned expansion of the Kenai Tesoro refinery, together with the existing industrial complex, have raised questions regarding potential impacts upon the Kenai National Moose Range. Of concern are the levels of sulfur dioxide and oxides of nitrogen in ambient air and impacts, if any, caused by those pollutants on nearby aquatic and terrestrial environments.

## INTRODUCTION

Through the combustion of fossil fuels, sulfur dioxide and oxides of nitrogen are emitted into the atmosphere. As these gases react with water vapor and rain, sulfuric and nitric acids are formed. Power plants, home oil furnaces, automobiles and refineries - in fact any process that oxidizes fossil fuels - can contribute to ambient levels of sulfur dioxide and nitrogen oxides.

Acid precipitation in the form of rain, snow, hail, sleet, fog or dew is considered to have a pH of less than 5.6(1). A pH of 7.0 is considered to be neutral. The international pH scale is logarithmic; each whole number is a factor of ten larger than its preceding value. Precipitation in relatively clean air will have an approximate pH of 5.6. Rain is slightly acidic normally because atmospheric carbon dioxide is soluble in water and forms a dilute solution of carbonic acid. This in turn dissociates to form bicarbonate and carbonate ions via the following equilibrium:



Acid deposition onto the earth's surface has a net cumulative effect. It results from a complex mixture of dissociated acidic and basic substances. The deposition of these substances may result from dissolution in the precipitation itself, and is referred to as "wet deposition". Or it may result from the "dry deposition" of particulate matter - smoke - through gravitational settling, impaction of particulate aerosols and/or absorption or adsorption of gases. In nature, both deposition processes are usually at work, to varying degrees.

The effects of atmospheric deposition upon freshwater aquatic ecosystems have been well documented in the Scandanavian countries and Canada (5). Although not as comprehensive, data is available that shows increasing acidity in lakes and streams predominately in the Northeast United States (6,8). This situation places stress upon the biota of an aquatic ecosystem, especially fish. Acid rainfall can mobilize heavy metal ions, decrease carbonate alkalinity and hence buffering capacity, and increase nitrate and sulfate concentrations (1,6).

Wind is the mechanism by which the source of acid rainfall is transported. Atmospheric deposition can occur a considerable distance from the emission

source. It has been suggested that at least a portion of the acid rain found in Europe may originate from the large Northeast cities in the United States.

During the winter acid precipitation may accumulate in the form of snow. During spring thaw, acid melt water can surge into the aquatic ecosystem in a short time. Unless the natural buffering capacity of a lake or stream can neutralize the hydrogen ion activity of the melted snow, a significant decrease in pH can occur. This acidic condition stresses the aquatic biota. A substantial change in pH may prove toxic to emerging biota.

#### DESCRIPTION

The Kenai industrial complex is located on the west side of the Kenai Peninsula along Cook Inlet (See Figs. 1,2). It is approximately 8.5 miles north of Kenai, Alaska and situated along North Kenai Road. The complex includes the following industries:

1. Collier Ammonia and Urea Plant.
2. Phillips Marathon Liquification Facility.
3. Tesoro Refinery.
4. Standard Refinery.
5. Chugach Power Plant.

The Kenai National Moose Range lies east of the Tesoro Refinery with its closest boundary approximately 6.5 miles due east. Between the industrial complex and the Moose Range lies a strip of land utilized for residential, commercial and undeveloped state/municipal public lands.

Figure 3 shows the approximate wind directions during 1977 in per cent of month units for the Kenai area (10). Prevailing wind directions for Kenai based on a nineteen year record (pre-1970 data) depict a northerly direction during the fall, winter and spring months and a southerly direction in the summer. Apparently, this is related to a wind channeling effect of the inlet (7).

The maximum precipitation period in the Kenai area usually occurs between June through October with a maximum of 3.6 inches in September (7).

The surrounding terrestrial environment is typically flat and forested predominately with spruce, birch, and aspen. Forest and wetlands are the dominant ecotypes of the study environs. A network of glacially formed pothole lakes, bogs, interconnecting streams and the Kenai River provide aquatic diversity to the area.

#### METHODS

In order to determine the effects of industry upon lakes surrounding Kenai and within the Kenai National Moose Range, water samples were taken from several lakes and one stream drainage in the study area. Sampling locations were selected on the basis of accessibility, prevailing wind direction, distance both from the industrial complex and from Tesoro Alaska's model of ambient NO<sub>2</sub> concentrations (9).

For this study, Scout Lake was designated as an experimental control. This lake was selected in the same manner as the study lakes except that Scout was expected to be least impacted by the industrial development. Scout Lake is approximately 20 miles south - southwest from the Tesoro refinery and about one quarter mile south of the Sterling Highway. The lake is reasonably isolated from the highway by vegetation. There is no observable inlet or outlet stream and the western half of the lake is predominately muskeg. There are two residential sites at the southwestern tip of the lake and a public campground along the northwestern shore. Float plane facilities were also visible at the western tip of the lake.

Five lakes and one creek were selected as the study lakes:

1. Bernice Lake - located 0.5 miles north of the Tesoro refinery. Bernice has muskeg bog drainage into an outlet stream.
2. Island Lake - located 2 to 3 miles northeast of the Tesoro refinery. No apparent stream drainage.
3. Daniels Lake - located about 6 to 8 miles northeast of the refinery. This lake has both an inlet and an outlet stream.
4. Lower Salamantof Lake - This lake is located 4 miles south by southeast of the Tesoro refinery. Inlet and outlet drainages are visible.
5. Rainbow Lake - located about 20 miles <sup>EAST</sup>~~WEST~~ of the refinery. This lake is situated within the Kenai National Moose Range along the Swanson River Road approximately 13 miles north. This lake has an outlet stream but no apparent inlet stream.
6. Bishop Creek - located 10 miles east by northeast of the Tesoro refinery. This stream was sampled where it intersects the North Kenai Road. A gauging station was in place about 150 yards downstream from the sampling site.

For additional information related to these sampling locations refer to the Appendix.

Transportation to and from the sampling locations was arranged through cooperation with the Alaska Department of Fish and Game, Sport Fish Division in Soldotna. Field assistance involving manpower and some equipment was arranged through cooperation with both the US Fish and Wildlife Service - Fishery Resource Center in Kenai and the Alaska Department of Environmental Conservation Field Office in Soldotna.

Water samples were acquired with the use of an 8 foot Zodiac inflatable boat and a 16 foot skiff and outboard motor, depending upon circumstances. However, the skiff had distinct advantages. Good access was available at all sampling locations.

The following parameters, sampling methods and analysis were employed:

PARAMETER	SAMPLING METHOD	ANALYTICAL METHOD
Water temperature	In Situ	YSI Model 57 D.O. Meter
Dissolved Oxygen	In Situ	YSI Model 57 D.O. Meter
pH	On Site	Orion Model 407 A Ionalyzer
Carbonate Alkalinity	On Site	EPA Method 310.0 titration to pH 4.5 end point
Color	Grab @ surface Van Dorn Bottle @ Depth	Laboratory - Standard Methods
Turbidity	Grab @ surface Van Dorn Bottle @ Depth	Laboratory - Standard Methods
Total Non Filterable	Grab @ surface Van Dorn Bottle @ Depth	Laboratory - Standard Methods
Residue dried @ 103-105C	Grab @ surface Van Dorn Bottle @ Depth Refridgerated	Laboratory - Standard Methods
Nitrate	Grab @ surface Van Dorn Bottle @ Depth Refridgerated Frozen at laboratory	Manual Cadmium Reduction; EPA Method
Sulfate	Grab @ surface Van Dorn Bottle Sample @ Depth Refridgerated	Barium sulfate turbidity method
Heavy Metals	Grab @ surface Van Dorn Bottle @ Depth Refridgerated	Graphite furnace AA. See See Table 3 which includes lower limits of detection and method for each parameter.

Sampling depths varied with the maximum depth of each lake. Sample stations were usually located at two sites for each lake, roughly in the center of each lake half. However, knowledge of bathymetry helped determine at least one sample site for each lake. Due to the extreme shallowness of lower Salamantof Lake, four stations were sampled at depths of zero and one meter with the lake quartered and each sampling station located roughly at the center

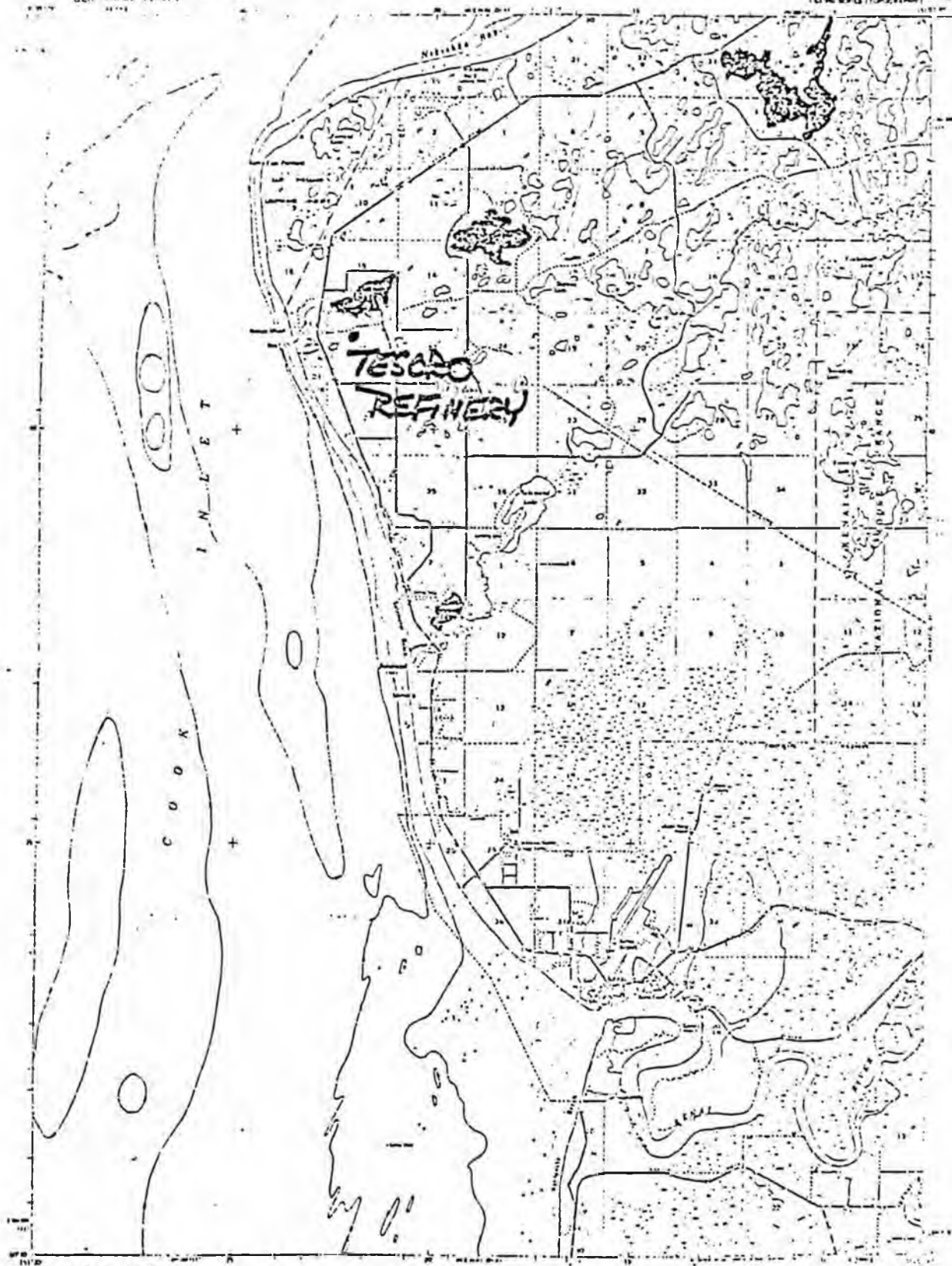
of each quarter.

Bishop Creek was sampled at a cross section located approximately 150 yards above the gauging station. This station is located on the southern side of the North Kenai Road where it intersects Bishop Creek. Flow was estimated using the "floating object method". It is believed that the creek is representative of its drainage basin with respect to water quality.

All sampling was performed between September 4, 1980 through September 8, 1980.

#### RESULTS

The results of this study are tabulated on Tables 4 through 10. Analysis for antimony and berrilyium are pending receipt of necessary standard materials. All other determinations are complete.

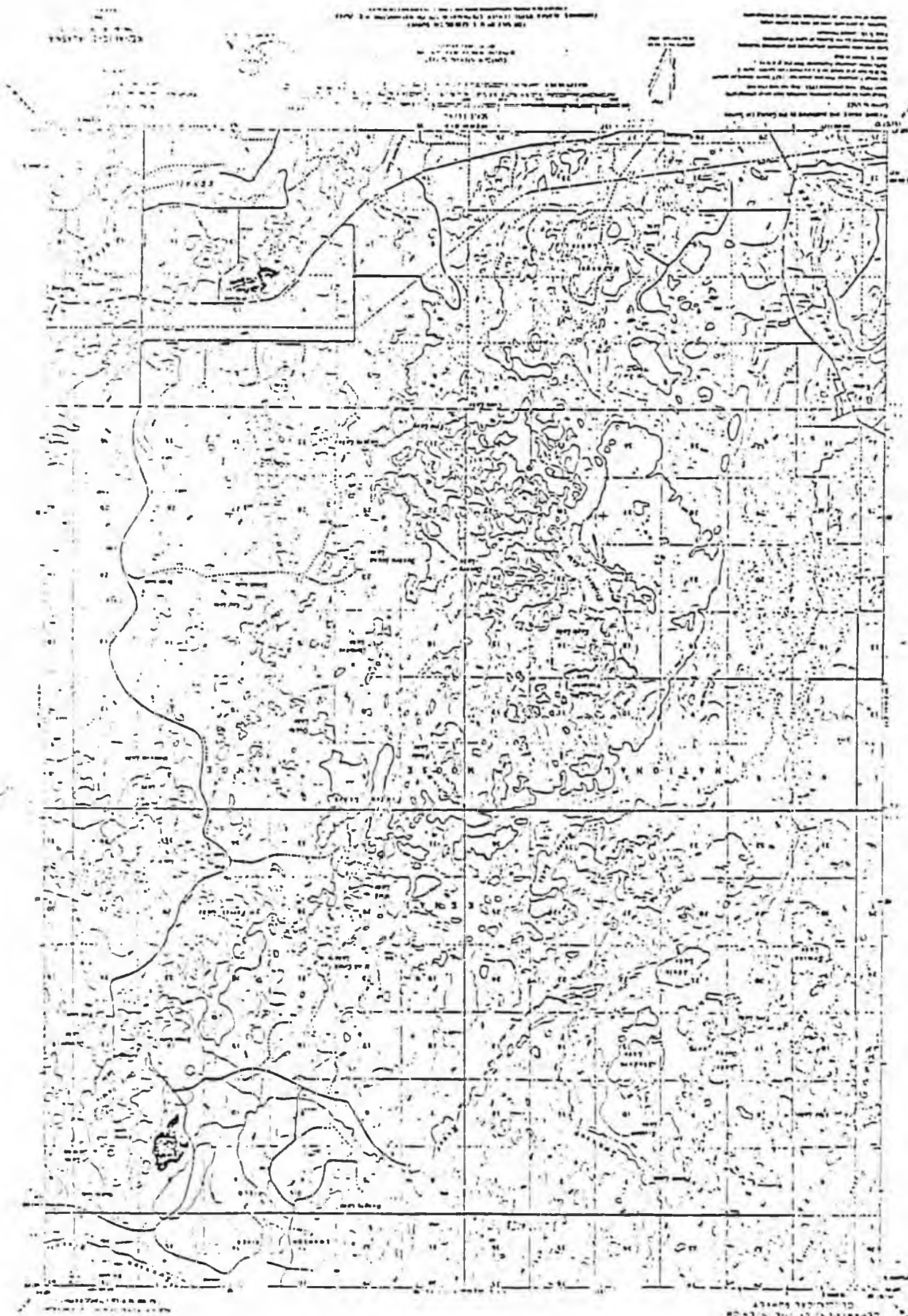


This map is based on the original map of the Kenai (C-4) Quadrangle, Alaska, published by the Geological Survey in 1950. It is a reproduction of the original map and is not to be used for any other purpose. The map is a technical drawing and is not to be used for any other purpose. The map is a technical drawing and is not to be used for any other purpose. The map is a technical drawing and is not to be used for any other purpose.

UNITED STATES GEOLOGICAL SURVEY  
WASHINGTON, D. C. 20540  
GEOLOGICAL SURVEY  
1950  
1:50,000 (1:62,500)

FIGURE 1/6

FIGURE 2/7



REVISIONS

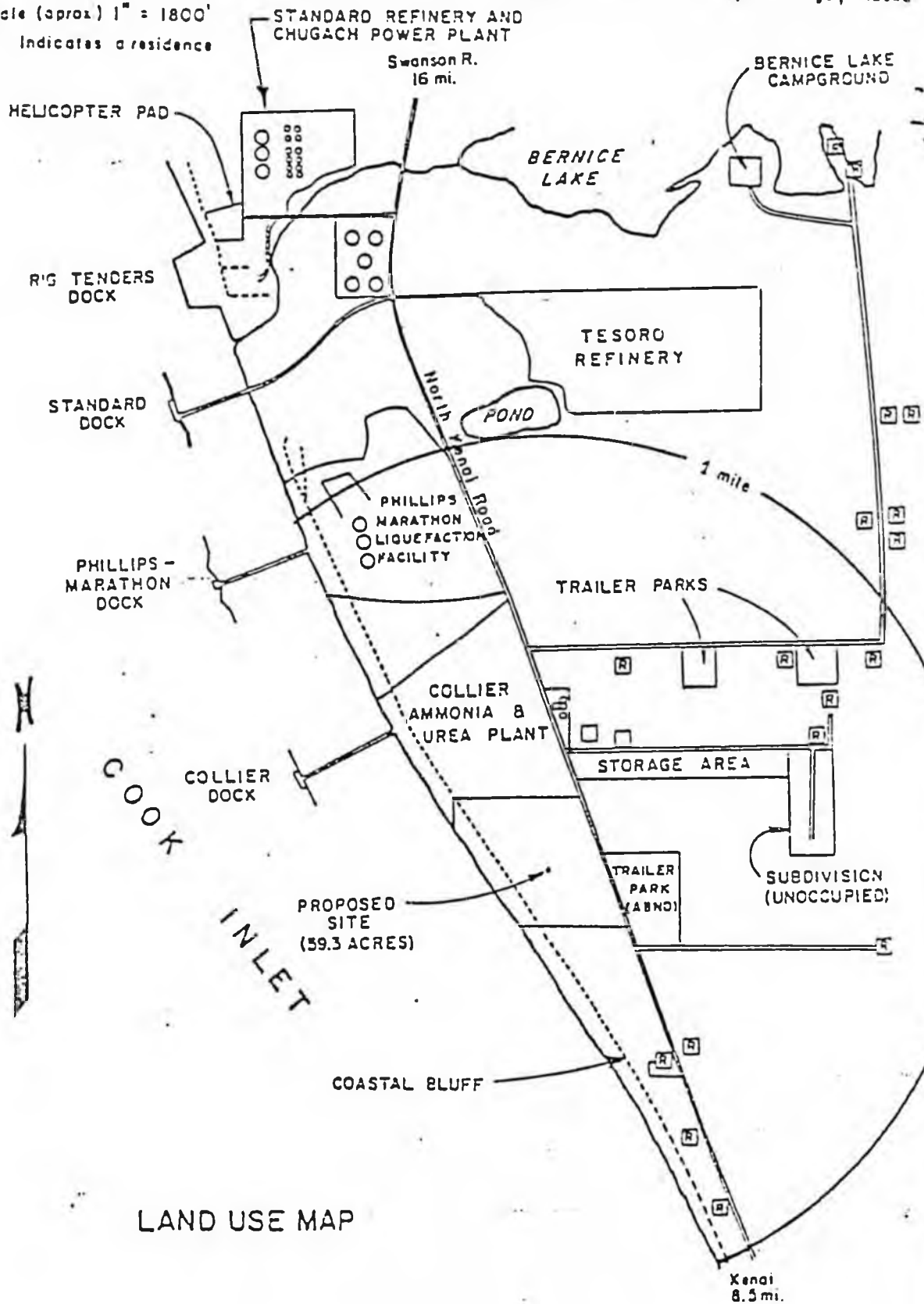
GENERAL NOTES

1. This drawing is a reproduction of the original drawing.

PROPERTY OF THE SCHOOL

Prepared from aerial photograph XMA3-14, 10-17-68, by Air-Photo Tech, Anchorage, Alaska  
 Scale (approx) 1" = 1800'

☐ Indicates a residence



LAND USE MAP

FIGURE 3/8

BARND & BARND

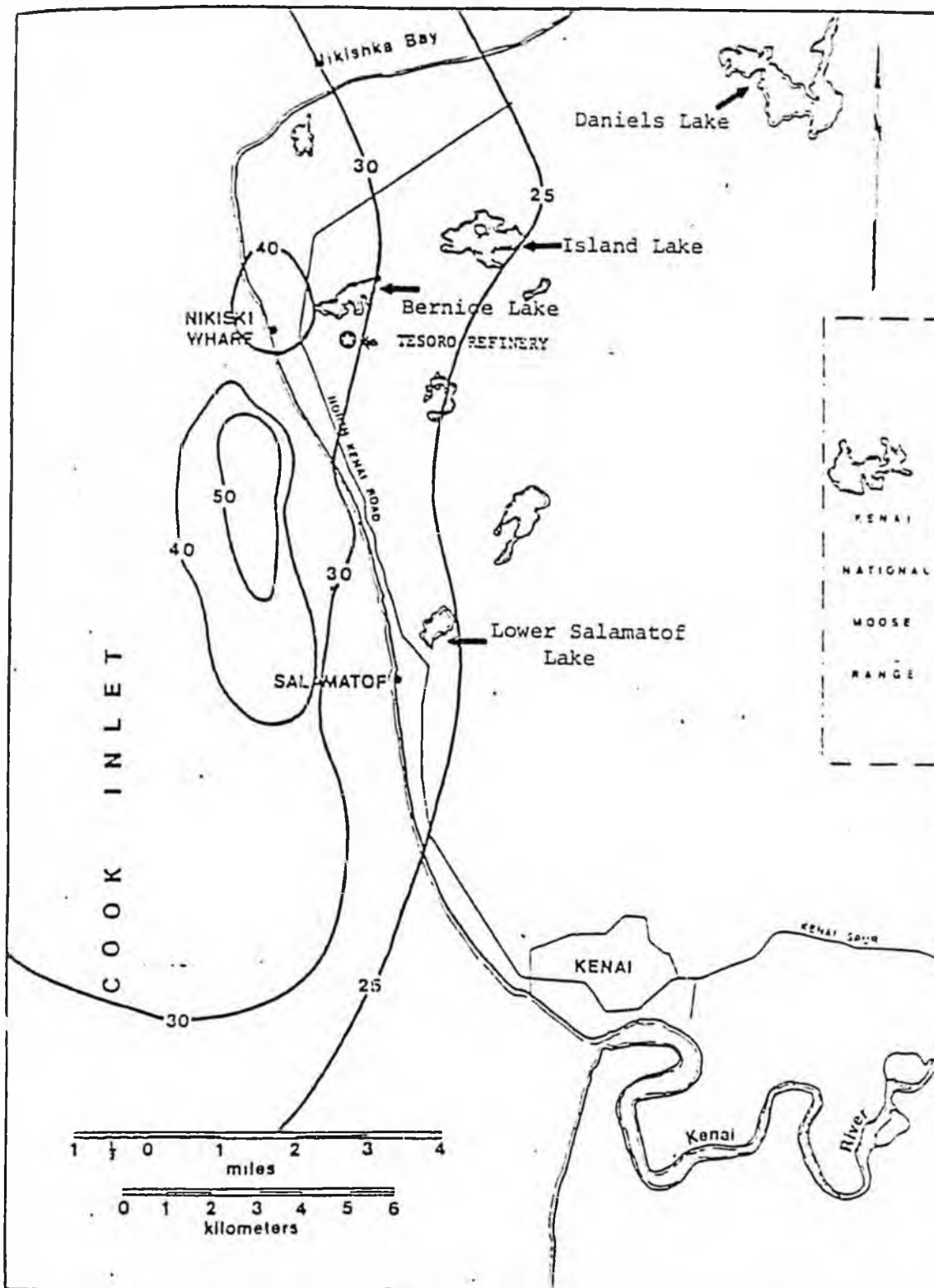


Figure 4. Existing NO<sub>2</sub> Concentrations in the Immediate Area of the Tesoro Refinery as Predicted by CDM (Background level included)

TABLE 1

Prevailing Wind Direction for Kenai by month, based on 19 year length of record (pre-1970 data). From: CLIMATOLOGICAL DATA SUMMARY; Dept. of Commerce, ESSA-Environmental Data Service.

Jan.	NNE	July	SSW
Feb.	N	August	S
March	N	Sept.	N
April	N	Oct.	N
May	N	Nov.	NNE
June	SSW	Dec.	NNE

June - October - Maximum precipitation period.

September mean for 19 year length of record = 3.6 inches.

Annual mean hourly wind speed based on 19 year length of record = 6.6 M.P.H.

TABLE 2

APPROXIMATE WIND DIRECTIONS

FOR KENAI - YEAR 1977

CLIMATIC ATLAS, VOLUME 1

GULF OF ALASKA - 1977

APPROXIMATE WIND DIRECTIONS - % OF MONTH

	N	NE	E	SE	S	SW	W	NW	CALM
Jan.	22	36	6	*	*	4	*	*	18
Feb.	37	30	*	*	5	*	*	*	14
March	38	22	*	*	6	*	*	7	11
April	29	17	6	5	9	9	*	8	13
May	17	13	7	7	15	18	5	6	10
June	9	8	*	7	24	29	5	*	9
July	8	5	*	8	28	29	5	*	11
August	13	11	5	8	22	18	*	*	15
Sept.	23	19	7	8	9	8	*	5	16
Oct.	30	25	8	8	6	*	*	*	15
Nov.	29	25	8	5	*	*	*	*	14
D. c.	30	33	7	*	*	*	*	*	19

\*Denotes <5% of winds from specified direction.

TABLE 2

Parameter of Interest	Lower Limit of detection (mg/l)	Low Limit of quantification (mg/l)	mg/l Reporting Interval	mg/l MCL	Method
Ag	<0.0003	0.003	ND<Trace<0.003	0.05	AA/HGA
As	<0.001	0.005	ND<Trace<0.005	0.05	AA/HGA
Ba	<0.002	0.05	ND<Trace<0.05	1.0	AA/HGA
Cd	<0.0002	0.001	ND<Trace<0.001	0.01	AA/HGA
Cr	<0.0007	0.005	ND<Trace<0.005	0.05	AA/HGA
F	<0.02	0.2	ND<Trace<0.2	2.4	Electrochem.
Fe	<0.01	0.1	ND<Trace<0.1	0.3	AA/HGA
Hg	<0.0002	0.001	ND<Trace<0.001	0.002	Flameless AA
Mn	<0.0004	0.005	ND<Trace<0.005	0.05	AA/HGA
Na	<0.1	0.03	ND<Trace<5.0	250	Flame AA
NO <sub>3</sub>	<0.05	1.0	ND<Trace<1.0	10	Cd reduction
Pb	<0.003	0.005	ND<Trace<0.005	0.05	AA/HGA
Se	<0.001	0.003	ND<Trace<0.003	0.01	AA/HGA
Cu	<0.001	0.005	ND<Trace<0.005		AA/HGA
Ni	<0.003	0.010	ND<Trace<0.010		AA/HGA
Zn	<0.0005	0.010	ND<Trace<0.010		AA/HGA
Mo	<0.010	0.050	ND<Trace<0.050		AA/HGA
PO <sub>4</sub>	<0.05	0.5	ND<Trace<0.5		Colorimetry
C.O.D.	<6.1	25	ND<Trace<25		Digestion
SO <sub>4</sub>	<1	10	ND<Trace<10		Turbidity
NH <sub>3</sub>	0.03	0.1	0.03<Tr.<0.1		Electrochem.
Cl	1	10	1<Tr.<10		Flame AA
K	0.05	1.0	0.05<1.0<1		Flame AA
CA	0.1	5.0	ND<Tr.<5		Flame AA
Mg	0.1	5.0	ND<Tr.<5		Flame AA

## DISCUSSION OF RESULTS

### SCOUT LAKE

Scout Lake was chosen as the control lake. Since it is located far from the industrial complex, it was expected to be less subjected to ambient levels of sulfur dioxide and oxides of nitrogen generated from the refineries.

Scout has no apparent inlet or outlet. It has a maximum depth of 7.3 meters and surface area of about 9.5 acres. Scout Lake was found to be well oxygenated having DO concentrations ranging from 9 to 10 mg/l. It was also well thermally mixed at the time of sampling. The pH of this lake was relatively low compared to others in this study, ranging from 5.9 to 6.6. Similarly carbonate alkalinity was found to be low - only 5 to 8 mg/l expressed as CaCO<sub>3</sub>.

Unexpectedly, levels of 'color' in Scout Lake were low ranging from 5 to 10 Platinum Cobalt Units (PCU). If this lake was receiving significant quantities of humic or fulvic acids from decaying vegetation as was assumed, it would be expected to have the color of weak tea - from 50 to 100 PCU.

Turbidity and total-non filterable residue (TNFR) were all quite low. Nitrate and sulfate were present in trace quantities or less.

Manganese found at 0.026-0.027 mg/l was the only measurable metal parameter. Trace quantities of arsenic, barium, cadmium, magnesium, sodium, calcium, nickel, zinc, and iron were also present.

### BISHOP CREEK

At the point of sample collection, Bishop Creek was approximately 6 meters wide and about 1.3 meters deep. Flow was estimated to be 4 to 10 CFS. The drainage area for this creek is not known.

The sampling site for Bishop Creek lies close to the terminus of the drainage basin, just south of the North Kenai Road. This creek provides drainage for a number of lakes and streamlets, interspersed throughout the public and private lands west of the Kenai National Moose Range. Due to the large number of lakes and streams which ultimately discharge into Bishop Creek, one might assume that the creek would be representative of the overall drainage water quality. Naturally, the water quality of Bishop Creek should provide a generalized indicator of water quality within its drainage.

Dissolved oxygen was found to be 10.8 mg/l. pH at the Bishop Creek sampling station was 7.1 and carbonate alkalinity 25.6 mg/l. Color was quite high - 45 PCU - as compared to Scout Lake. Turbidity was 1.6 NTU and TNFR was found to be 10 mg/l. Nitrate was below detectable limits and sulfate levels existed in trace quantities.

### DANIELS LAKE

This lake has both an observable inlet and outlet. It has an area of about 600 acres and a maximum depth of 24.5 meters.

Found to be well oxygenated in the upper levels, dissolved oxygen decreases with depth and ranges from 9.4 to 7.9 mg/l. A slight 1 C decrease in temperature was measured from the surface to a 10 meter depth. It is suspected

that a depth of greater than 5 meters undergoes thermal stratification during the summer with associated low dissolved oxygen levels in the hypolimnion. Fall turnover was not complete at the time of sampling.

The pH of Daniels Lake was somewhat higher than the other lakes ranging from 7.7 to 8.1, with a correspondingly high carbonate alkalinity ranging from 19 to 22 mg/l. Color varied from 10 to 15 PCU. Turbidity was low - 0.7 to 1.1 NTU. Values for TNFR were found to be not detectable to 10 mg/l at station 1-10 meter depth. This may have resulted from bottom sediments being introduced during sampling. Nitrate was 0.05 mg/l and sulfate was not detectable, except in two instances where it was found in trace quantities.

Trace quantities of arsenic, barium, magnesium, sodium, nickel and zinc were detectable in Daniels Lake. Measurable quantities of manganese and calcium were found. One instance of zinc exceeding trace quantities was also determined.

#### RAINBOW LAKE

Rainbow Lake occupies 170 surface acres with a maximum depth of 7.6 meters. It is thermally homogenous with temperatures varying only from 12.0 to 12.5 C. Dissolved oxygen was found at levels of 10.4 to 10.6 mg/l. pH ranged from 6.6 to 6.9; carbonate alkalinity 7.4 to 8.0 mg/l.

The water of Rainbow Lake was moderately colored - 15 to 20 PCU; turbidity was 0.8 to 1.7 NTU and TNFR found from not detectable to 10 mg/l.

Nitrates were below detectable limits 0.05 mg/l. Trace quantities to less than 10 mg/l of sulfate was measured at both the 2 meter depth sampling stations.

Trace quantities of magnesium, sodium, calcium and nickel were detected. Trace quantities of barium and iron were present at the 4 meter depth of station number one. Measurable quantities of manganese and zinc were intermittently detected.

#### ISLAND LAKE

Island Lake covers 268 surface acres and has a maximum depth of 9.5 meters. Lake temperatures found inferred that it is weakly thermally stratified during the summer months, at least at station 9-2. Temperatures were 14.0 C at the surface to 13.8 C at depth. Dissolved oxygen declined below 5 meters, ranging from 9.7 to 9.0 mg/l.

pH ranged from 6.6 to 7.8 and generally decreased with depth. Carbonate alkalinity declined similarly, ranging from 8 to 11 mg/l. Color was moderately low, ranging from 10 to 20 PCU. Turbidity ranged from 1.2 to 2.3 NTU and TNFR were either non-detectable or found at trace levels 10 mg/l. Nitrate was below detectable limits. Sulfate likewise was, for the most part, below detectable limits.

Measurable quantities of manganese were present with occasional measurable quantities of barium, cadmium, nickel and zinc present. Trace quantities of barium, magnesium, sodium, calcium, zinc and iron were also identified.

### BERNICE LAKE

Bernice Lake has a surface area of 134 acres and a maximum depth of 3 meters. It is located approximately by occasional residential lots, a public campground and a highway at the southern end.

Results for the September sampling period indicate temperature homogeneity, with temperatures ranging from 11.5 to 12.0 C. Dissolved oxygen ranged from 7.6 to 8.7 mg/l. pH was somewhat low ranging from 6.1 to 6.8, carbonate alkalinity was likewise low ranging from 8-9 mg/l.

Color was high - 30-45 PCU - indicating the possible presence of humic and fulvic acids. Bernice Lake exemplified shallow, boggy like conditions with much littoral vegetation present. Somewhat more turbid than the other lakes studied, turbidity varied from 1.7 to 2.5 NTU. TNFR results were found from non-detectable to 10 mg/l. Windy conditions may have caused disturbance and mixing of bottom sediments from increased circulation, as well as wave action present along the shoreline areas, resulting in generally higher residue levels.

Nitrate was found in trace quantities ( 1 mg/l) and sulfate was either non-detectable or trace quantities.

Manganese, calcium and iron were present in measurable quantities. Other metals present in trace amounts were arsenic, barium, magnesium, sodium, copper zinc.

### LOWER SALAMANTOF LAKE

Lower Salamantof Lake is an extremely shallow lake, with a maximum depth of 1.2 meters and a surface coverage of 100 acres. It has both an observable inlet and an outlet. Much of the lake is surrounded by boggy areas of littoral vegetation. Approximately one quarter of the lake was densely populated with aquatic vegetation. There are a few residential sites along its shoreline, and several floatplanes were moored along its banks.

Water temperature ranged from 10.0 to 10.5 C, no thermal stratification being evident. Quite well oxygenated due to its shallow depth, levels of DO ranged from 11.2 to 11.5 mg/l. pH ranged from 7.3 to 8.2 with carbonate alkalinity ranging from 12.0 to 15.6 mg/l.

Color varied widely from 5 to 120 PCU. The high color determination was only present at station 2-1 meter depth. This was probably a result of introducing bottom sediments into the sampler. Aquatic vegetation made sampling difficult. The arithmetic mean for color was approximately equal to 40 PCU, excluding the suspected sample. Again this tends to indicate the presence of organic acids.

Turbidity values ranged from 0.6 to 2.1 NTU. Again poor sampling techniques were responsible at station 2-1 meter depth yielding a result of 21 NTU, due to bottom sediment disturbance. Station 4-1 meter depth had a turbidity of 7.1 NTU which probably resulted from similar disturbance. TNFR data ranged from non-detectable to 30 mg/l. Excluding the station 2-1 datum, all TNFR levels were less than 10 mg/l.

Nitrate was found to be below detectable levels. Sulfate analysis yielded trace quantities. However, station 2-1 meter yielded levels of 11 mg/l, probably due to bottom sediment disturbance.

Trace quantities of arsenic, barium, cadmium, magnesium, sodium, nickel and zinc were found. Measurable quantities of manganese, calcium and iron were also present.

ANALYSIS OF pH AND CARBONATE ALKALINITY DATA

The following table lists the average pH and carbonate of each lake investigated. Approximate distances and directions from the Kenai Tesoro Refinery are specified in the right hand column:

WATER BODY	pH	mg/l CARBONATE ALKALINITY $\frac{A}{P}$	APPROXIMATE DISTANCE AND DIRECTION
Bishop Creek	7.1	25.6 34	11 mile N.E.
Daniels Lake	7.9	20.8 25	7 mile N.E.
Lower Salamantof Lake	7.7	14.1 15	4.5 mile S.
Island Lake	7.0	4.4 0.3	1.5 mile N.E.
Bernice Lake	6.3	8.4 13	0.5 mile N.
Rainbow Lake	6.7	7.6 11	19.5 mile W.E
Scout Lake	6.2	6.5 10	21 mile S.



1.05

## CONCLUSIONS

1. With the exception of Scout and Bernice Lakes, none of the lakes or streams exceeded AWQS for pH. In the case of Scout and Bernice, no hypothesis is proposed to explain why either lake is slightly low in pH and carbonate alkalinity. There is no evidence to determine that it is either a natural occurrence or a result of man's activity. The pH of these two lakes is not particularly low nor was any evidence found to indicate environmental degradation. Bernice Lake is high in color indicating the presence of humic or fulvic acids. Scout Lake was the farthest lake from the Kenai industrial complex. It gave the lowest pH of any lake measured and yet was low in color.
2. No general pattern was established that relates lake pH to distance from the industrial complex. We did not accumulate sufficient data to establish this relationship, if indeed, one exists.
3. If acid rainfall is occurring as a result of industrial activities on the Kenai Peninsula, it was not found with this study. It is possible that we may have selected lakes too close to the potential source. That is, plumes of  $\text{NO}_x$  and  $\text{SO}_2$  - if they exist in concentrations to be of concern - may be windblown at high altitudes well outside the study area. Perhaps acid rainfall is occurring, but the natural buffering capacity of the ecosystem under examination is ameliorating its effects. Levels of nitrate and sulfate found in the water column were not unusual; however, this is hardly conclusive. These parameters are either part of the nutrient cycle or incorporated into lake sediments. Therefore, an excess source of either nitrate or sulfate from ambient air may not be measurable until the pathways incorporating them become upset or overloaded.
4. At the time of this study, the lakes were found to be well oxygenated and low in carbonate alkalinity. They were low in nitrate, sulfate, turbidity, and TNFR. Color was found to be moderate suggesting the presence of organic acids. Trace quantities of arsenic, barium, magnesium, sodium and zinc were encountered.
5. Scout Lake proved not to be an adequate control. The lake that is used for a basis of comparison with the study lakes must be located away from human activity, preferably in a remote location, with similar lithology or in the same watershed.

## RECOMMENDATIONS FOR FUTURE WORK

1. Future studies will be made on rainfall and snowfall to determine levels of pH, nitrate and sulfate. More direct conclusions can then be reached concerning the input from ambient levels of  $\text{NO}_x$  and  $\text{SO}_2$ . Some of these sites will be selected for long term studies.
2. Long term seasonal studies should be undertaken including additional lakes, both in the immediate vicinity of refineries, as well as lakes at greater distances from them than this study.
3. The quantities and effects of organic acids should be investigated to determine their role in controlling lake pH in the Kenai Peninsula.

4. A fixed ambient air monitoring site will be established on the Kenai Peninsula to determine levels of  $\text{NO}_x$  and  $\text{SO}_2$ . This site will assist in determining the magnitude of acid rainfall.

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