ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9106050251 DOC.DATE: 90/12/31 NOTARIZED: NO DOCKET #
FACIL:50-397 WPPSS Nuclear Project, Unit 2, Washington Public Powe 05000397
AUTH.NAME AUTHOR AFFILIATION
BELL,J.C. Washington Public Power Supply System
RECIP.NAME RECIPIENT AFFILIATION
ZELLER,J.J. Washington, State of

see Rpt

SUBJECT: "Operational Ecological Monitoring Program for Nuclear Plant 2 - 1990 Annual Rept." W/910531 ltr.

DISTRIBUTION CODE: IE25D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 150
TITLE: Environmental Monitoring Rept (per Tech Specs)

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD5 LA	3	3	PD5 PD	1	1
	ENG,P.L.	1	1			
INTERNAL:	ACRS	1	1	AEOD/DSP/TPAB	1	1
	NRR/DREP/PRPB11	2	2	REG FILE 01	1	1
	RES RADDATZ,C.	1	1	RGN5 DRSS/RPB	1	1
	RGN5 FILE 02	1	1			
EXTERNAL:	EG&G SIMPSON,F	2	2	NRC PDR	1	1

R I D S / A D D S

R I D S / A D D S

NOTE TO ALL "RIDS" RECIPIENTS:

PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM P1-37 (EXT. 20079) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 16 ENCL 16

E/R

50-397 WPPSS WNP

Operational Ecological
Monitoring Program
1990 annual Rpt

w/ltr. dtd. 5/31/91 #9106050251

UNDERSIZED
DOCUMENTS

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352-0968 • (509) 372-5000

May 31, 1991

Mr. Jason J. Zeller
EFSEC Manager
Mail Stop FA-11
Olympia, WA 98504-1211

SUBJECT: TRANSMITTAL OF OPERATIONAL ECOLOGICAL MONITORING PROGRAM NUCLEAR PLANT 2 ANNUAL REPORT

Dear Mr. Zeller:

Enclosed are five (5) copies of the subject report.

Sincerely,

J.C. Bell
Manager
Plant Services

JCB:pg

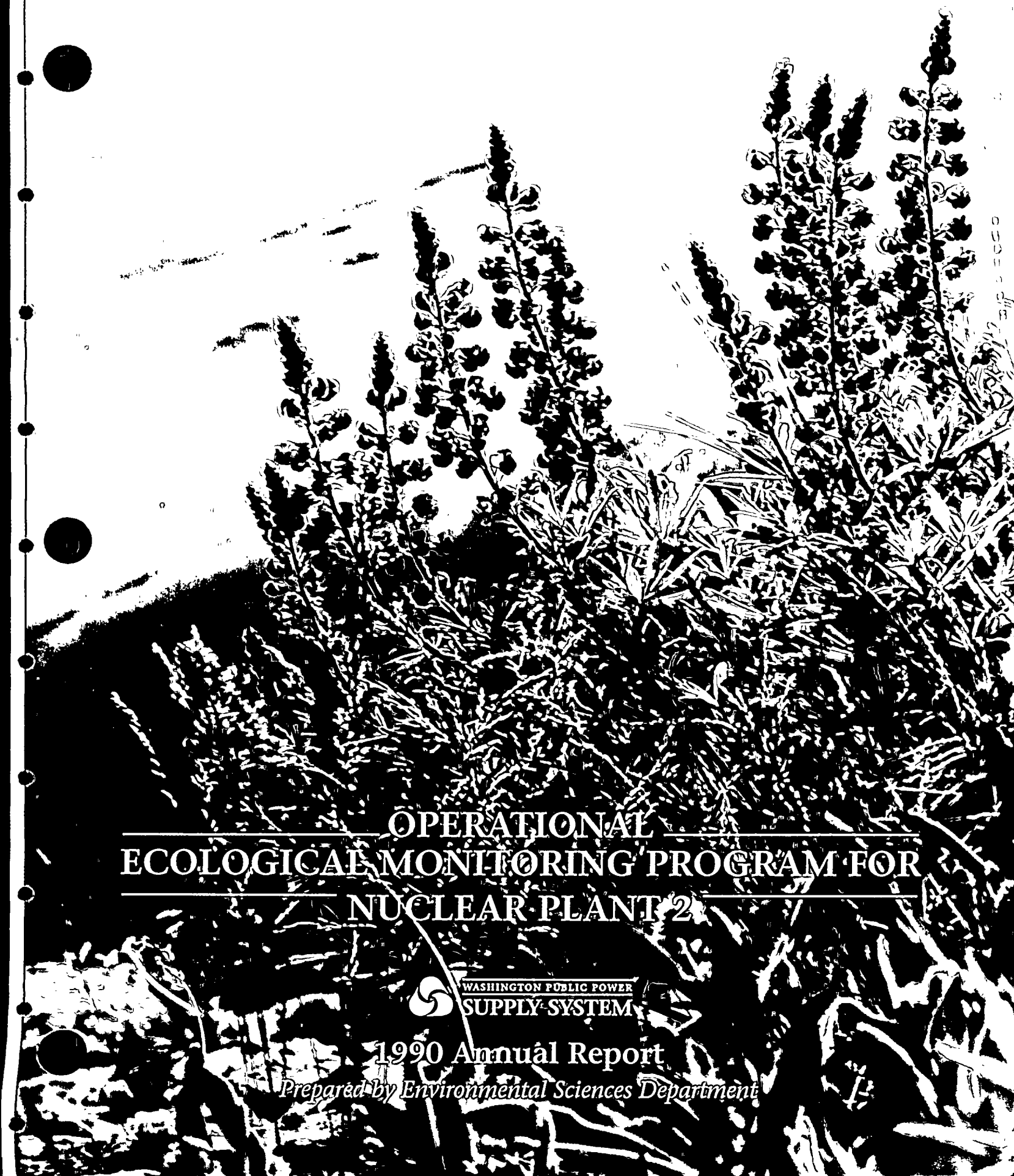
Enclosures

cc: Document Control Desk, NRC (w/enclosures)
R.B. Samworth, NRC (w/enclosures)
C.D. Becker, Battelle (w/enclosures)
D. Geist, Washington Department of Fisheries (w/enclosures)

9106050251 901231
PDR ADOCK 05000397
R PDR

JE25 1/1

#9106050251



OPERATIONAL ECOLOGICAL MONITORING PROGRAM FOR NUCLEAR PLANT 2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

1990 Annual Report

Prepared by Environmental Sciences Department

NO. 910406-23
DATE 5/22
OFFICIAL PHOTO.

WASHINGTON PUBLIC POWER
SUPPLY SYSTEM
P.O. BOX 968
RICHLAND, WA 99352
CREDIT UPON PUBLICATION

TABLE OF CONTENTS

Section	Page
EXECUTIVE SUMMARY	i
ACKNOWLEDGEMENTS	ii
TABLES	iii
FIGURES	v
1.0 INTRODUCTION	1-1
1.1 BACKGROUND	1-1
1.2 THE SITE	1-2
1.3 BIBLIOGRAPHY	1-4
2.0 NOTABLE ENVIRONMENTAL OBSERVATIONS	2-1
2.1 INTRODUCTION	2-1
2.2 METHODS	2-1
2.3 RESULTS	2-1
3.0 FISH BIOASSAYS	3-1
3.1 INTRODUCTION	3-1
3.2 METHODS AND MATERIALS	3-1
3.3 RESULTS AND DISCUSSION	3-4
3.4 REFERENCES	3-5
4.0 WATER QUALITY	4-1
4.1 INTRODUCTION	4-1
4.2 MATERIALS AND METHODS	4-1
4.2.1 SAMPLE COLLECTION	4-2
4.2.2 FIELD EQUIPMENT & MEASUREMENTS	4-3
4.2.3 LABORATORY MEASUREMENTS	4-3

TABLE OF CONTENTS
(Continued)

Section		Page
4.3	RESULTS	4-4
4.3.1	TEMPERATURE	4-4
4.3.2	DISSOLVED OXYGEN (DO)	4-4
4.3.3	pH AND ALKALINITY	4-4
4.3.4	CONDUCTIVITY	4-5
4.3.5	TOTAL RESIDUAL CHLORINE (TRC)	4-5
4.3.6	METALS	4-6
4.3.7	HARDNESS	4-8
4.3.8	OIL AND GREASE	4-8
4.3.9	AMMONIA-NITROGEN AND NITRATE-NITROGEN	4-9
4.3.10	TOTAL PHOSPHORUS AND ORTHOPHOSPHORUS	4-9
4.3.11	SULFATE	4-9
4.3.12	TOTAL DISSOLVED SOLIDS, TOTAL SUSPENDED SOLIDS AND TURBIDITY	4-10
4.4	DISCUSSION	4-11
4.5	BIBLIOGRAPHY	4-11
5.0	COOLING TOWER DRIFT STUDIES	5-1
5.1	INTRODUCTION	5-1
5.2	MATERIALS AND METHODS	5-1
5.2.1	HERBACEOUS CANOPY COVER	5-1
5.2.2	HERBACEOUS PHYTOMASS	5-2
5.2.3	SHRUB CANOPY COVER	5-2
5.2.4	SHRUB DENSITY	5-3
5.2.5	SOIL CHEMISTRY	5-3
5.2.6	VEGETATION CHEMISTRY	5-4

TABLE OF CONTENTS
(Continued)

Section		Page
5.3	RESULTS AND DISCUSSION	5-4
5.3.1	HERBACEOUS COVER	5-4
5.3.2	HERBACEOUS PHYTOMASS	5-5
5.3.3	SHRUB COVER AND DENSITY	5-6
5.3.4	SOIL CHEMISTRY	5-6
5.3.5	VEGETATION CHEMISTRY	5-7
5.4	SUMMARY AND CONCLUSIONS	5-7
5.5	COOLING TOWER DRIFT MODEL VALIDATION STUDY	5-8
5.5.1	INTRODUCTION	5-8
5.5.2	MATERIALS AND METHODS	5-9
5.5.2.1	SAMPLE PLAN	5-9
5.5.2.2	SAMPLE COLLECTION	5-10
5.5.2.3	ANALYTICAL METHODS	5-11
5.5.3	SAMPLE PREPARATION AND COLLECTION	5-11
5.5.4	SAMPLE MEASUREMENT AND ANALYSIS	5-12
5.5.5	DATA ANALYSIS	5-12
5.5.6	RESULTS	5-13
5.6	BIBLIOGRAPHY	5-15
6.0	INTAKE STRUCTURE FOULING SURVEYS	6-1
6.1	INTRODUCTION	6-1

TABLE OF CONTENTS

(Continued)

Section		Page
7.0	AERIAL PHOTOGRAPHY	7-1
7.1	INTRODUCTION	7-1
7.2	MATERIALS AND METHODS	7-1
7.3	RESULTS AND DISCUSSION	7-3
7.4	BIBLIOGRAPHY	7-5

APPENDIX A PLANT OPERATIONAL DATA

APPENDIX B METEOROLOGICAL CONDITIONS

APPENDIX C ANALYTICAL RESULTS FOR EACH SAMPLE STATION

EXECUTIVE SUMMARY

During 1990 there were no unusual events which resulted in significant environmental impacts from the operation of WNP-2.

There were no unanticipated or emergency discharges of water or wastewater during the reporting period.

The first fish bioassay required by the WNP-2 NPDES Permit was performed in October, 1990. A 100% survival rate was observed.

Significant interstation differences could not be detected among any of the water quality parameters measured for nearly all sampling periods. 1990 marks the first year in which results of metals analyses performed on plant discharge water are included in the report. It appears that during 1990, WNP-2 cooling water discharge had little effect upon Columbia River water quality.

The cooling tower drift model verification study concluded sample collection in March 1990. Results indicated and further investigations proved that the model's isopleths incorrectly predict areas of maximum and minimum cooling tower drift. The isopleths, as drawn, predict maximum deposition along transects running in a northeasterly and nearly south-southwesterly direction. This contradicts prevailing wind directions which are southerly (blowing north) and northeasterly (blowing southeast).

Total herbaceous cover decreased 38.01% in 1990. A corresponding decrease in herbaceous phytomass was also observed. Soil and vegetation analyte concentrations were generally within the ranges observed in previous years. Changes in vegetation cover and density recorded in 1990 appear to be climatically induced and no signs of adverse impacts from the operation of WNP-2 cooling towers are evident.

Color infrared aerial photographs along 5 flightlines were taken in June 1990. Because of the lateness in the season when the photographs were taken, most of the grasses were inactive and growth patterns could not be discerned. The general health of those plants and shrubs that were active was good. No adverse impact was evident from Plant 2 operation.

ACKNOWLEDGEMENTS

This annual report, prepared by Washington Public Power Supply System, describes the aquatic, terrestrial and water quality programs for Nuclear Project No. 2 (WNP-2).

Project Team

Joe Bell	Manager, Plant Services
Terry E. Northstrom	Supervisor, Environmental Sciences
Sara L. Lindberg	Environmental Scientist I
John E. McDonald	Environmental Scientist I
Deborah C. Singleton	Environmental Scientist I
Richard E. Welch	Environmental Scientist I
Todd A. Borak	Environmental Scientist II
Lana S. Schleder	Environmental Scientist II
Kathryn E. Humphreys	Administrative Specialist

List of Tables

Number	Title	Page
3-1	Size and Weight of Fish Used in Bioassay Test	3-7
3-2	Summary of Bioassay Parameters and Associated EPA Methods	3-8
3-3	Temperature and pH Measurements	3-9
3-4	Dissolved Oxygen and Conductivity Measurements	3-10
3-5	Total Alkalinity and Total Hardness Measurements	3-11
3-6	Magnesium and Calcium Measurements	3-12
3-7	Total Copper Concentrations	3-13
3-8	Total Zinc Concentrations	3-14
4-1	Summary of Water Quality Parameters, Stations, and Sampling Frequencies, 1990	4-13
4-2	Summary of Water Quality Parameters EPA and ASTM Method Numbers	4-14
4-3	Summary of Temperature Measurements for 1990	4-15
4-4	Summary of Dissolved Oxygen Measurements for 1990	4-16
4-5	Summary of pH Measurements for 1990	4-17
4-6	Summary of pH, Alkalinity and Hardness Measurements for 1990	4-18
4-7	Summary of Conductivity Measurements for 1990	4-19
4-8	Summary of Turbidity and Total Residual Chlorine Measurements for 1990	4-20
4-9	Summary of Copper Measurements for 1990	4-21
4-10	Summary of Nickel and Zinc Measurements for 1990	4-22
4-11	Summary of Iron and Lead Measurements for 1990	4-23
4-12	Summary of Cadmium and Chromium Measurements for 1990	4-24
4-13	Summary of Oil and Grease, and Ammonia Measurements for 1990	4-25
4-14	Summary of Nitrate and Total Phosphorus Measurements for 1990	4-26
4-15	Summary of Orthophosphate and Sulfate Measurements for 1990	4-27
4-16	Summary of Total Dissolved and Total Suspended Solids Measurements for 1990	4-28
5-1	Vascular Plants Observed During 1990 Field Work	5-16
5-2	Vascular Plants Observed During 1975-1990 Field Work	5-19

List of Tables
(Continued)

Number	Title	Page
5-3	Herbaceous Cover for Fifteen Sampling Stations-1990	5-23
5-4	Mean Herbaceous Cover for 1975 Through 1990	5-24
5-5	Mean Frequency Values (%) by Species for Each Sampling Station - 1990	5-26
5-6	Mean Terrestrial Phytomass for 1990	5-27
5-7	Comparison of Herbaceous Phytomass for 1975 Through 1990	5-28
5-8	Summary of Shrub Density for 1990	5-29
5-9	Summary of Shrub Cover (%) at Five Stations for 1990	5-30
5-10	Summary of Soil Chemistry for 1990	5-31
5-11	Summary of Vegetation Chemistry for 1990	5-32
5-12	Drift Sampler Locations in Reference to WNP-2 Cooling Towers	5-33
5-13	Drift Deposition Rates (Gross and Background Corrected)	5-34
A-1	Plant Operational Data for Collection Period 1	A-1
A-2	Plant Operational Data for Collection Period 2	A-2
A-3	Plant Operational Data for Collection Period 3	A-3
A-4	Plant Operational Data for Collection Period 4	A-4
A-5	Plant Operational Data for Collection Period 5	A-5
A-6	Plant Operational Data for Collection Period 6	A-6
A-7	Plant Operational Data for Collection Period 7	A-7
A-9	Plant Operational Data for Collection Period 8	A-8
A-10	Plant Operational Data for Collection Period 9	A-9
A-11	Plant Operational Data for Collection Period 10	A-10
A-12	Plant Operational Data for Collection Period 11	A-11
A-2	Plant Operational Data for Collection Period 12	A-12
B-1	Meteorological Conditions for March 1989	B-1
B-2	Meteorological Conditions for April 1989	B-2
B-3	Meteorological Conditions for May 1989	B-3
B-4	Meteorological Conditions for June 1989	B-4
B-5	Meteorological Conditions for July 1989	B-5

List of Tables
(Continued)

Number	Title	Page
B-6	Meteorological Conditions for August 1989	B-6
B-7	Meteorological Conditions for September 1989	B-7
B-8	Meteorological Conditions for October 1989	B-8
B-9	Meteorological Conditions for November 1989	B-9
B-10	Meteorological Conditions for December 1989	B-10
B-11	Meteorological Conditions for January 1990	B-11
B-12	Meteorological Conditions for February 1990	B-12
B-13	Meteorological Conditions for March 1990	B-13
C-1	Analytical Results for Each Sample Location - April 1989	C-1
C-2	Analytical Results for Each Sample Location - May 1989	C-2
C-3	Analytical Results for Each Sample Location - June 1989	C-3
C-4	Analytical Results for Each Sample Location - July 1989	C-4
C-5	Analytical Results for Each Sample Location - August 1989	C-5
C-6	Analytical Results for Each Sample Location - September 1989	C-6
C-7	Analytical Results for Each Sample Location - October 1989	C-7
C-8	Analytical Results for Each Sample Location - November 1989	C-8
C-9	Analytical Results for Each Sample Location - December 1989	C-9
C-10	Analytical Results for Each Sample Location - January 1990	C-10
C-11	Analytical Results for Each Sample Location - February 1990	C-11
C-12	Analytical Results for Each Sample Location - March 1990	C-12

List of Figures

Number	Title	Page
1-1	WNP-2 Gross Thermal Production for 1990	1-7
1-2	WNP-2 Days Per Month Discharging and Mean Monthly Discharge	1-8
1-3	WNP-2 Location Map	1-9
1-4	Columbia River Mean Monthly Flow for 1990	1-10
2-1	WNP-2 Property Boundary	2-3
3-1	Attachment 1.0, Test Plan 27 Secondary Chemistry Report	3-15
3-2	Attachment 2.0, Water Chemistry Report	3-16
4-1	Location of Sampling Stations in the Columbia River	4-29
4-2	Sampling Station Locations for Water Chemistry	4-30
4-3	Columbia River Temperature Measurements at Six Stations During 1990	4-31
4-4	Columbia River Dissolved Oxygen Measurements at Four Stations During 1990	4-32
4-5	Columbia River pH Measurements at Six Stations During 1990	4-33
4-6	Columbia River Total Alkalinity Measurements at Four Stations During 1990	4-34
4-7	Columbia River Conductivity Measurements at Six Stations During 1990	4-35
4-8	Columbia River Total Zinc Measurements at Four Stations During 1990	4-36
4-9	Columbia River Total Iron Measurements at Four Stations During 1990	4-37
4-10	Columbia River Total Hardness Measurements at Four Stations During 1990	4-38
4-11	Columbia River Nitrate - Nitrogen Measurements at Four Stations During 1990	4-39
4-12	Columbia River Total Sulfate Measurements at Four Stations During 1990	4-40
4-13	Columbia River Total Dissolved Solids Measurements at Four Stations During 1990	4-41

List of Figures
(Continued)

Number	Title	Page
4-14	Columbia River Total Suspended Solids Measurements at Four Stations During 1990	4-42
4-15	Columbia River Turbidity Measurements at Four Stations During 1990	4-43
5-1	Soil and Vegetation Sampling Location Map	5-35
5-2	Layout of Vegetation and Soil Sampling Plots	5-36
5-3	Mean Herbaceous Cover for 1975 Through 1990	5-37
5-4	Mean Herbaceous Cover, Mean Dry Weight (g/m^2), Total Precipitation, and Mean Temperature From 1982 Through 1990	5-38
5-5	Mean Herbaceous Phytomass at Grassland and Shrub Stations for 1975 Through 1990	5-39
5-6	Mean Herbaceous Cover and Phytomass for Stations G01 to G04 for 1980 Through 1990	5-40
5-7	Mean Herbaceous Cover and Phytomass for Stations G05 to G08 for 1980 Through 1990	5-41
5-8	Mean Herbaceous Cover and Phytomass for Stations S01 to S04 for 1980 Through 1990	5-42
5-9	Mean Herbaceous Cover and Phytomass for Stations S05 to S07 for 1980 Through 1990	5-43
5-10	Shrub Density at Five Stations for 1984 Through 1990	5-44
5-11	Mean Total Shrub Cover for 1975 Through 1990	5-45
5-12	Shrub Cover and Density for Five Stations for 1990	5-46
5-13	Soil pH and Conductivity for 1980 Through 1990	5-47
5-14	Soil Sulfate and Chloride for 1980 Through 1990	5-48
5-15	Soil Bicarbonate and Copper for 1980 Through 1990	5-49
5-16	Soil Lead and Nickel for 1980 Through 1990	5-50
5-17	Soil Cadmium and Zinc for 1980 Through 1990	5-51
5-18	Soil Chromium and Sodium for 1980 Through 1990	5-52
5-19	Soil Potassium and Calcium for 1980 Through 1990	5-53
5-20	Soil Magnesium for 1980 Through 1990	5-54
5-21	Copper Concentration (ug/g) in *Phlox longifolia* and *Bromus tectorum* by Station for 1984 Through 1990	5-55

List of Figures
(Continued)

Number	Title	Page
5-22	Copper Concentration (ug/g) in *Artemisia tridentata* and *Purshia tridentata* by Station for 1984 Through 1990	5-56
5-23	Copper Concentration (ug/g) in *Sisymbrium altissimum* and *Poa sandbergii* by Station for 1984 Through 1990	5-57
5-24	Chloride Concentration (%) in *Bromus tectorum* and *Phlox longifolia* by Station for 1984 Through 1990	5-58
5-25	Chloride Concentration (%) in *Artemisia tridentata* and *Purshia tridentata* by Station for 1984 Through 1990	5-59
5-26	Chloride Concentration (%) in *Poa sandbergii* and *Sisymbrium altissimum* by Station for 1984 Through 1990	5-60
5-27	Sulfate Concentration (%) in *Phlox longifolia* and *Sisymbrium altissimum* by Stationfor 1984 Through 1990	5-61
5-28	Sulfate Concentration (%) in *Artemisia tridentata* and *Purshia tridentata* by Station for 1984 Through 1990	5-62
5-29	Sulfate Concentration (%) in *Poa sandbergii* and *Bromus tectorum* by Station for 1984 Through 1990	5-63
5-30	Total Vegetation Copper, Chloride and Sulfate for 1990	5-64
5-31	Predicted Salt Deposition Patterns Out to 0.5 Mile (0.8 km) (lb/acre/yr)	5-65
5-32	Predicted Salt Deposition Patterns Out to 6.9 Miles (11.1 km) (lb/acre/yr)	5-66
5-33	Location Map of Cooling Tower Drift Monitoring Sites	5-67
5-34	Cooling Tower Drift Collection Vessel	5-68
5-35	Cumulative Wind Rose April 1989 Through March 1990 WNP-2 Meteorological Station 33 Foot Level	5-69
5-36	Cumulative Wind Rose 1984 Through 1989 WNP-2 Meterological Station 33 Foot Level	5-70
5-37	Deposition Rate as a Function of Distance	5-71
7-1	Aerial Photography Flightlines	7-6

1.0 INTRODUCTION

1.1 BACKGROUND

Washington Public Power Supply System (Supply System) began site preparation for Nuclear Plant Number 2 (WNP-2) near Richland, Washington in March 1973. WNP-2 loaded fuel in December 1983, reached approximately 75 percent thermal load in November 1984, and began commercial operation in December 1984.

The Site Certification Agreement (SCA) for WNP-2, executed on May 17, 1972, between the State of Washington and the Supply System requires that ecological monitoring be conducted during the preoperational and operational phases of site development and use. The Washington State Energy Facility Site Evaluation Council (EFSEC) approved a change in 1978 to the technical scope of environmental monitoring required by the SCA (EFSEC Resolution No. 132, January 23, 1978). In 1980, the aquatic and water quality portions of the preoperational monitoring program were terminated (EFSEC Resolution No. 166, March 24, 1980). The following year the preoperational and operational terrestrial monitoring program scope for WNP-2 was modified (EFSEC Resolution No. 193, May 26, 1981). Prior to operation, the council reviewed the preoperational aquatic monitoring data and approved the operational monitoring program (EFSEC Resolution No. 214, November 8, 1982).

The Supply System in 1974 retained Battelle Pacific Northwest Laboratories (BNW) to conduct the preoperational aquatic monitoring for WNP-2. The results of aquatic studies performed from September 1974 through August 1978 are presented in various reports (Battelle 1976, 1977, 1978, 1979a and 1979b). From August 1978 through March 1980 the aquatic studies were performed by Beak Consultants, Inc. (Beak 1980). In 1982 the Supply System analyzed the 1974-1980 aquatic data and presented the results and a recommended operational monitoring program to EFSEC (Mudge et. al., 1982). The operational program was accepted with minor modifications and initiated in March 1983. Due to

operational conditions, the plant did not consistently discharge liquid effluents until the fall of 1984. Figures 1-1 and 1-2 present summaries of electrical generation and monthly discharges for 1990.

Terrestrial monitoring was initiated in 1974 and was conducted by BNW until 1979 (Rickard and Gano, 1976, 1977, 1979a, 1979b). Beak Consultants, Inc. performed the vegetation monitoring program from 1980-1982 (Beak 1981, 1982a, 1982b). Since 1983, Supply System scientists have been responsible for the vegetation aspects of the program (Northstrom et. al. 1984; Supply System 1985, 1986, 1987, 1988, 1989). During 1981, the animal studies program was taken over by Supply System scientists and results were reported annually (Schleder 1982, 1983, 1984; Supply System 1985, 1986, 1987, 1988, 1989). The first comprehensive operational environmental report was prepared by Supply System scientists in 1984 (Supply System 1985).

During their regular meeting of September 14, 1987 the Energy Facility Site Evaluation Council approved Resolution No. 239 which adopted a long-term environmental monitoring program for WNP-2. This decision was based upon the council's examination of the document titled Review of the Environmental Monitoring Program for WNP-2 with Recommendations for Design of Continuing Studies (Davis and Northstrom, 1987).

This report presents the results of the Ecological Monitoring Program (EMP) for the period January 1990 through December 1990.

1.2 THE SITE

The WNP-2 plant site is located 19 km (12 miles) north of Richland, Washington in Benton County (Figure 1-3). The Supply System has leased 441 hectares (1089 acres) from the U.S. Department of Energy's Hanford Site for WNP-2.

WNP-2 lies within the boundaries of the Columbia Basin, an extensive area south of the Columbia River between the Cascade Range and Blue Mountains in Oregon and approximately two thirds of the area lying east of the Cascades in Washington. The plant communities within the region are described as shrub-steppe communities consisting of various layers of perennial grasses overlayed by a discontinuous layer of shrubs. In general, moisture relations do not support arborescent species except along streambanks. Approximately 5 km (3.25 miles) to the east, the site is bounded by the Columbia River. In August of 1984 a range fire destroyed much of the shrub cover which occupied the site and temporarily modified the shrub-steppe associations which were formerly present.

The aquatic and water quality sampling stations are located near the west bank of the Columbia River at mile 352. Sampling was limited to the main channel Benton County side which, near the site, averages 370 meters (1200 feet) wide at a river elevation of 105 meters (345 feet) above sea level and ranges to 7.3 meters (24 feet) deep. Sampling stations have been established in the river both upstream and downstream from the plant intake and discharge structures. The river-level in this area fluctuates considerably diurnally and from day-to-day in response to release patterns at the Priest Rapids Dam (River Mile 397). These fluctuations cause large areas of river bottom to be alternately exposed and covered. The river bottom within the study area varies from exposed Ringold conglomerate to boulders, cobble, gravel, and sand. River velocities at the surface average approximately 2 meters (5 to 6 feet) per second in this area of the river, and water temperature varies from approximately 0 to 22°C.

The flow of the Columbia River at WNP-2 is controlled by releases from Priest Rapids Dam. The minimum flow, measured at the USGS stream-quality station located at river mile 388.1 near the Vernita bridge, was 58,400 cfs (cubic feet per second), while average and maximum flows in 1989 were 134,022 cfs and 322,000 cfs, respectively (Figure 1-4).

The terrestrial sampling locations are all within an 8 km (5 mile) radius from WNP-2. The topography is flat to gently rolling, gradually increasing from an elevation of 114 meters (375 feet) at the riparian sampling locations to approximately 152 meters (500 feet) at more distant shrubgrass sample stations.

1.3 BIBLIOGRAPHY

Battelle Pacific Northwest Laboratories. 1976. Aquatic ecological studies conducted near WNP-1, 2, and 4, September 1974 through September 1975. Supply System Columbia River ecology studies Vol. 2. Richland, WA.

Battelle Pacific Northwest Laboratories. 1977. Aquatic ecological studies near WNP-1, 2, and 4, October 1975 through February 1976. Supply System Columbia River Ecology Studies Vol. 3. Richland, WA.

Battelle Pacific Northwest Laboratories. 1978. Aquatic ecological studies near WNP-1, 2, and 4, March through December 1976. Supply System Columbia River ecology studies Vol. 4. Richland, WA.

Battelle Pacific Northwest Laboratories. 1979a. Aquatic ecological studies near WNP-1, 2, and 4, March through December 1977. Supply System Columbia River ecology studies Vol. 5. Richland, WA.

Battelle Pacific Northwest Laboratories. 1979b. Aquatic ecological studies near WNP-1, 2, and 4, January through August 1978. Supply System Columbia River ecology studies Vol. 6. Richland, WA.

Beak Consultants, Inc. 1980. Aquatic ecological studies near WNP-1, 2, and 4, August 1978 through March 1980. Supply System Columbia River ecology studies Vol. 7. Portland, OR.

Beak Consultants, Inc. 1981. Terrestrial monitoring studies near WNP-1, 2, and 4, May through December 1980. Portland, OR.

Beak Consultants, Inc. 1982a. Terrestrial monitoring studies near WNP-1, 2, and 4, May through December 1981. Portland, OR.

Beak Consultants, Inc. 1982b. Preoperational terrestrial monitoring studies near WNP-1, 2, and 4, May through August 1982. Portland, OR.

Davis, W. III and T.E. Northstrom. 1987. Review of the environmental monitoring program for WNP-1 with recommendations for design of continuing studies. Washington Public Power Supply System, Richland, WA.

Mudge, J.E., T.B. Stables, W. Davis III. 1982. Technical review of the aquatic monitoring program of WNP-2. Washington Public Power Supply System, Richland WA.

Northstrom, T.E, J.L. Hickam and T.B. Stables. 1984. Terrestrial monitoring studies for 1983. Washington Public Power Supply System, Richland, WA.

Rickard, W.H. and K.A. Gano. 1976. Terrestial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for the period July 1974 to June 1975. Battelle Pacific Northwest Laboratories, Richland, WA.

Rickard, W.H. and K.A. Gano. 1977. Terrestial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1976. Battelle Pacific Northwest Laboratories, Richland, WA.

Rickard, W.H. and K.A. Gano. 1979a. Terrestial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1977. Battelle Pacific Northwest Laboratories, Richland, WA.

Rickard, W.H. and K.A. Gano. 1979b. Terrestial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1978. Battelle Pacific Northwest Laboratories, Richland, WA.

Schleder, L.S. 1982. Preoperational animal studies near WNP-1, 2 and 4. Annual report for 1981. Washington Public Power Supply System, Richland, WA.

Schleder, L.S. 1983. Preoperational animal studies near WNP-1, 2 and 4. Annual report for 1982. Washington Public Power Supply System, Richland, WA.

Schleder, L.S. 1984. Preoperational animal studies near WNP-1, 2 and 4. Annual report for 1983. Washington Public Power Supply System, Richland, WA.

Washington Public Power Supply System. 1985. Operational ecological monitoring program for Nuclear Plant 2. Annual report for 1984. Richland, WA.

Washington Public Power Supply System. 1986. Operational ecological monitoring program for Nuclear Plant 2. Annual report for 1985. Richland, WA.

Washington Public Power Supply System. 1987. Operational ecological monitoring program for Nuclear Plant 2. Annual report for 1986. Richland, WA.

Washington Public Power Supply System. 1988. Operational ecological monitoring program for Nuclear Plant 2. Annual Report for 1987. Richland, WA.

Washington Public Power Supply System. 1989. Operational ecological monitoring program for Nuclear Plant 2. Annual Report for 1988. Richland, WA.

Washington Public Power Supply System. 1990. Operational ecological monitoring program for Nuclear Plant 2. Annual Report for 1989. Richland, WA.

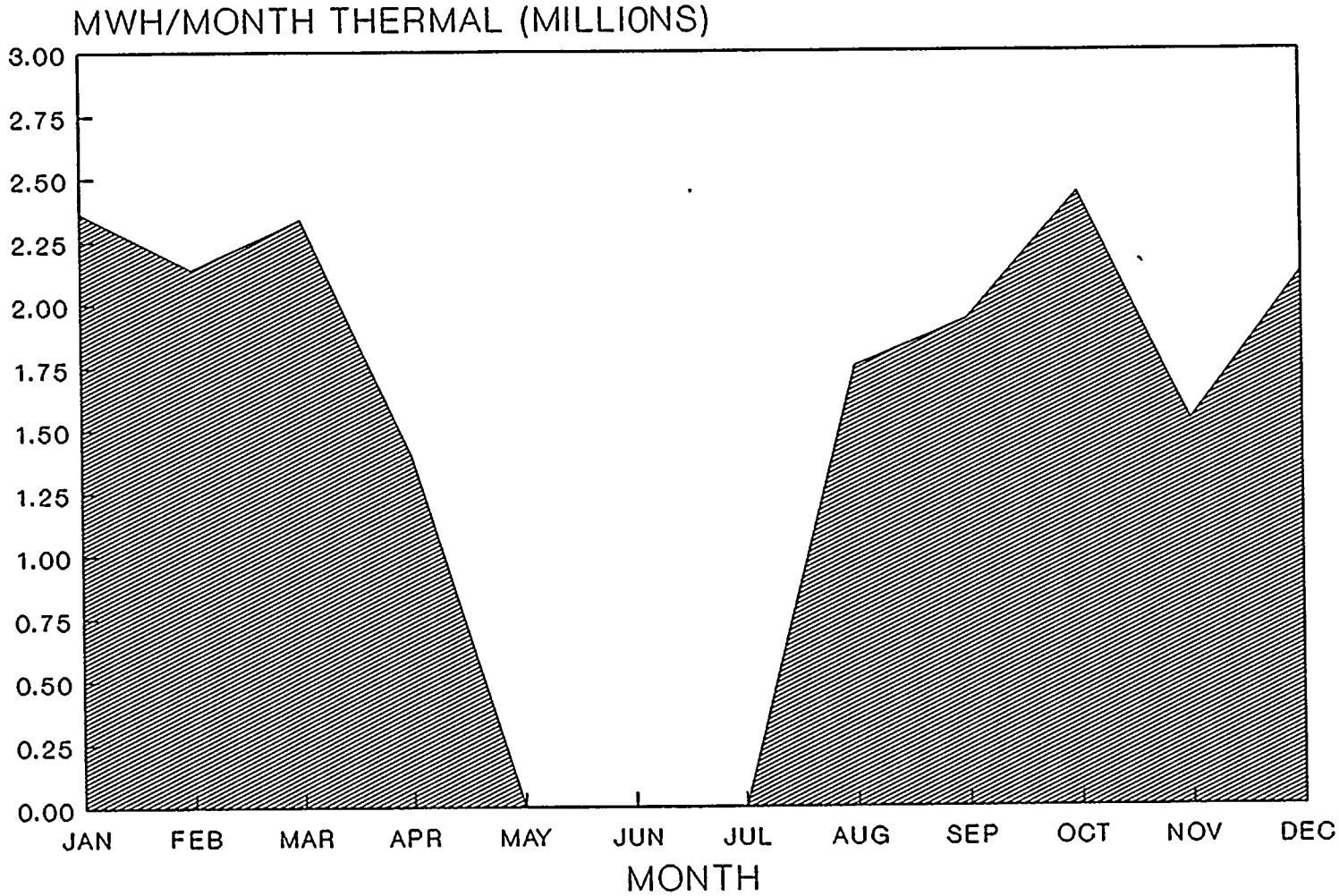


FIGURE 1-1
WNP-2 GROSS THERMAL PRODUCTION FOR 1990

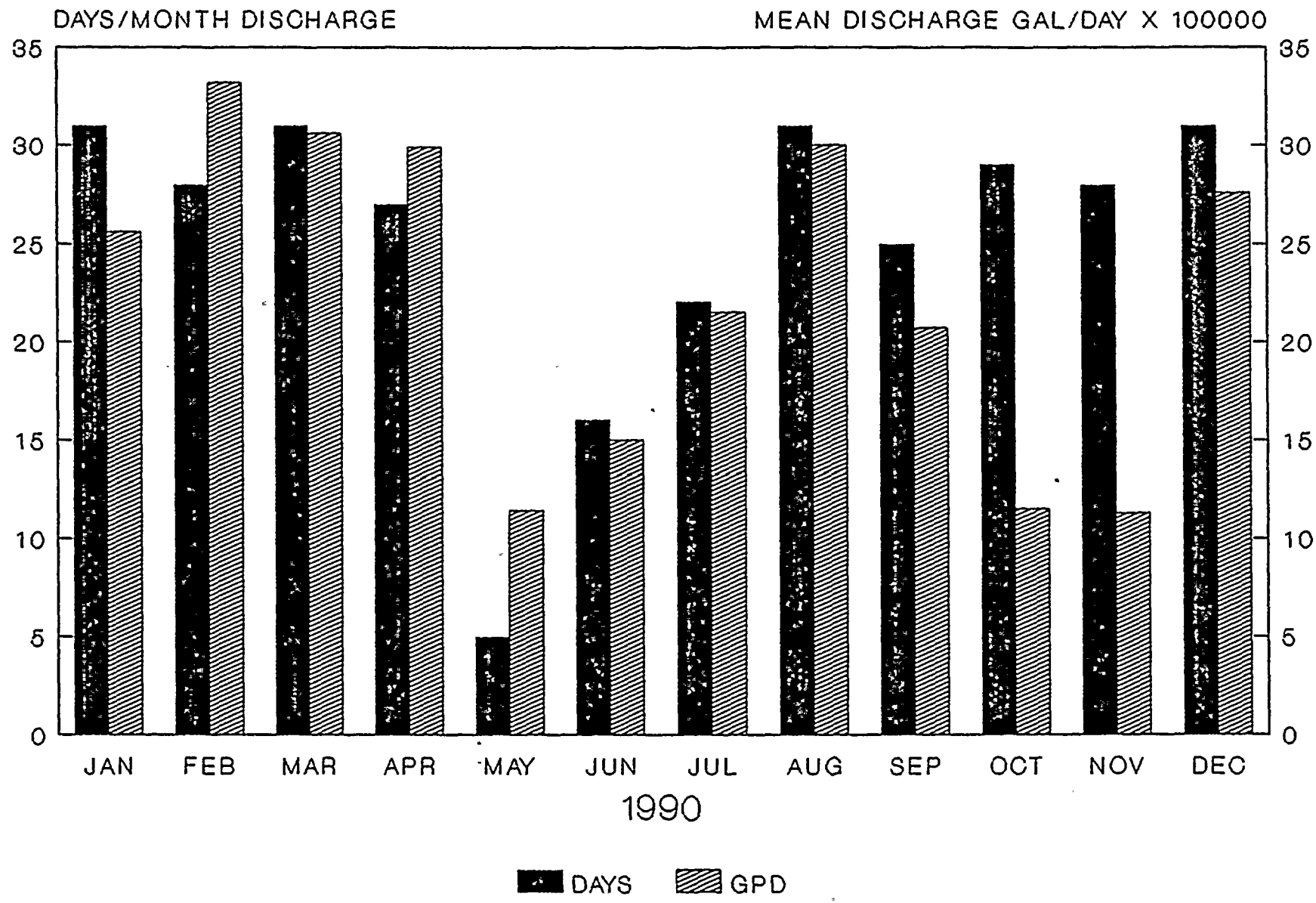


FIGURE 1-2
WNP-2 DAYS PER MONTH DISCHARGE AND MEAN MONTHLY DISCHARGE

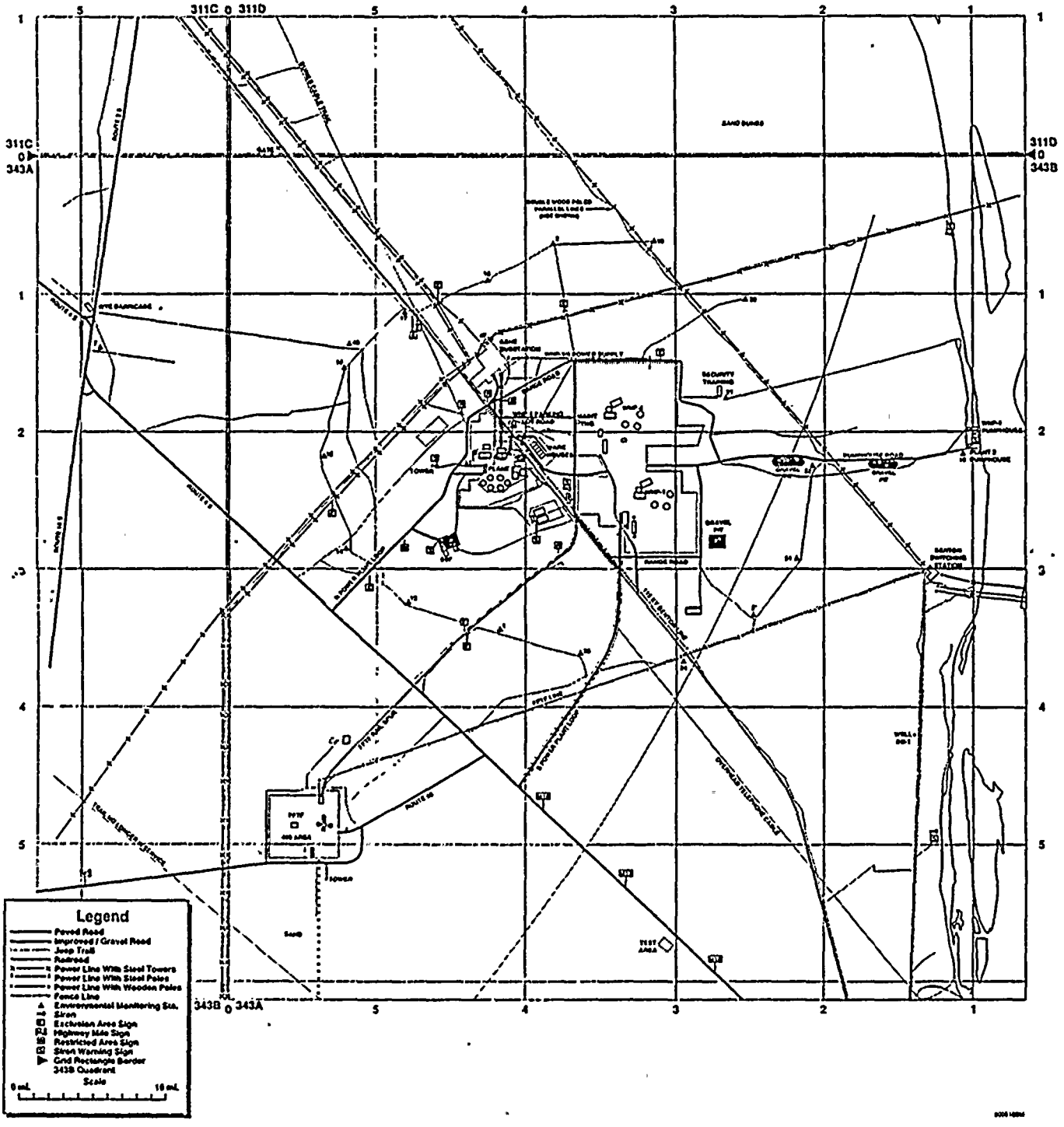


FIGURE 1-3
WNP-2 LOCATION MAP

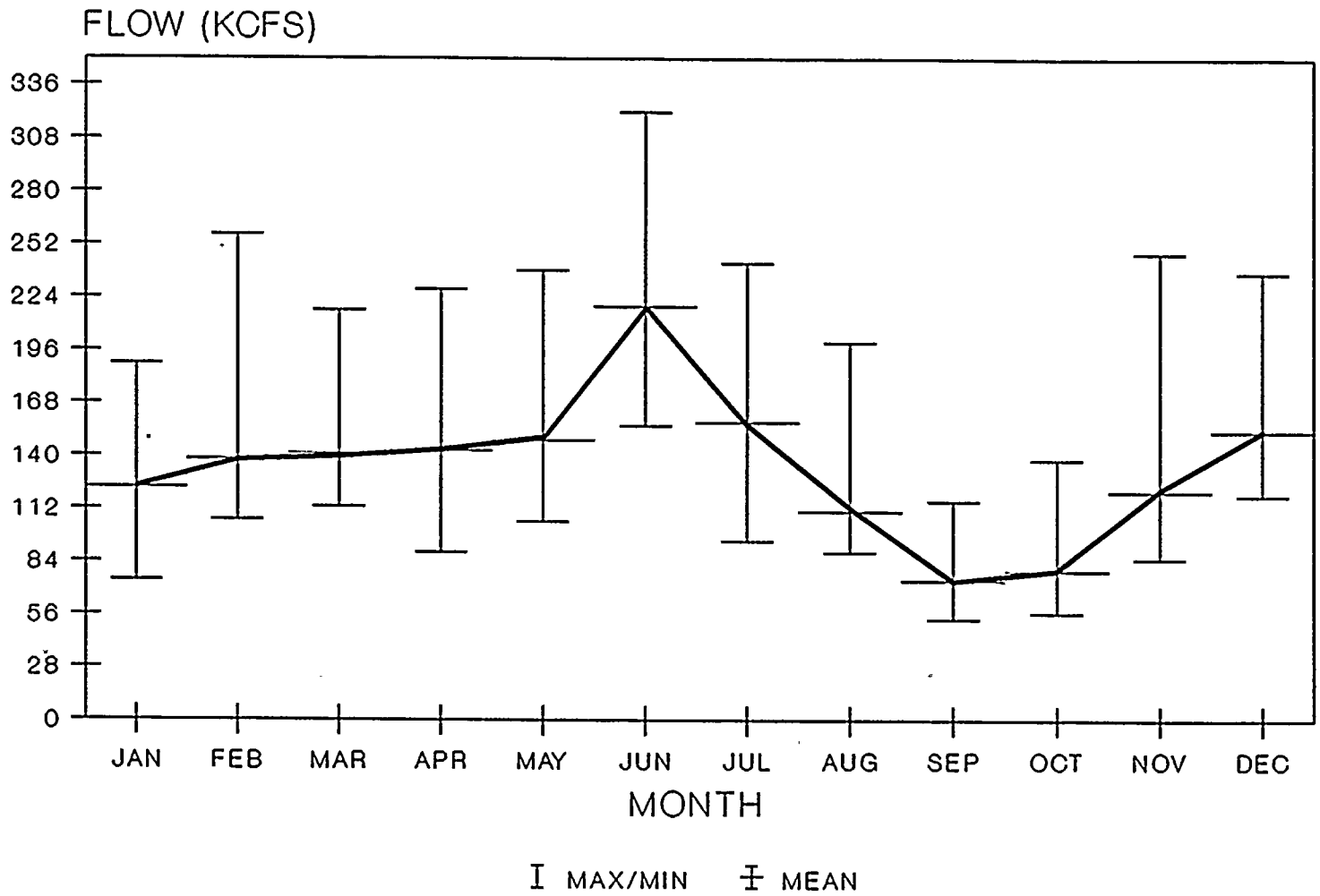


FIGURE 1-4
COLUMBIA RIVER MEAN MONTHLY FLOW FOR 1990

2.0 NOTABLE ENVIRONMENTAL OBSERVATIONS

2.1 INTRODUCTION

Any occurrence of an unusual or notable event that indicates or could result in a significant environmental impact causally related to plant operation shall be recorded and reported to the NRC within 24 hours followed by a written report. The following are examples: excessive bird impaction events, onsite plant or animal disease outbreaks, mortality or unusual occurrence of any species protected by the Endangered Species Act of 1973, fish kills, increase in nuisance organisms or conditions, and a significant, unanticipated or emergency discharge of waste water or chemical substances.

2.2 METHODS

Weekly ground surveys were conducted from January 1st through December 31st to document the occurrence of unusual species or events within the property boundary of WNP-2 (Figure 2.1). Additional information was supplied by security and environmental personnel.

2.3 RESULTS

There were no unusual or notable events which resulted in significant environmental impacts from the operation of WNP-2.

There were, however, some general observations worth noting.

The long-billed curlew (*Numenius*, *Americanus*) continues to be a common resident during spring periods, with several nesting pairs sighted in the shrub-steppe communities surrounding WNP-2.

The burrowing owl, Athene cunicularia, is also a springtime resident of the Hanford Reservation, with several sightings being reported from locations within WNP-2's site area boundary. Of particular note during 1990, was the establishment of a nesting pair at the edge of a gravel parking lot, immediately northeast of Plant 2. Although the pair was continuously subjected to disturbances from human activities (a major access road and railroad bordered the burrow on each side), their breeding attempt was successful. On May 25, a total of four young were observed at the burrow entrance. Several more observations of the owls were reported in early June.

Spring 1990 produced one of the largest grasshopper hatches in recent memory. Vegetation in some areas was severely impacted. In late May, a large population of gulls were using the grasshoppers as a major food source. Feeding groups numbering from a few individuals to several dozen birds were routinely sighted at several locations near WNP-2.

There were no unanticipated or emergency discharges of water or wastewater during the reporting period.

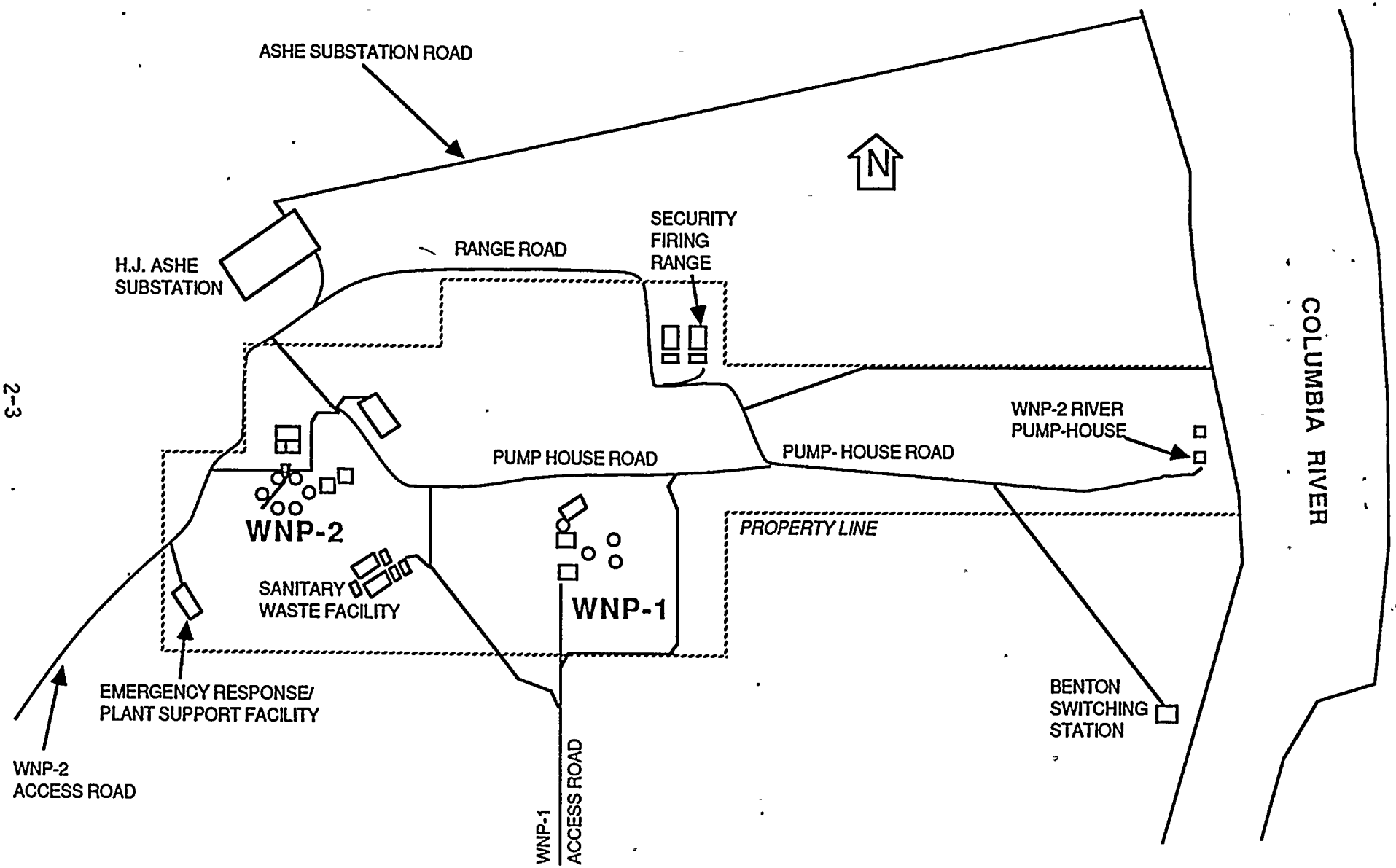


FIGURE 2-1
WNP-2 PROPERTY BOUNDARY

3.0 FISH BIOASSAYS

3.1 INTRODUCTION

A bioassay using chinook salmon (Oncorhynchus tshawytscha) was performed from October 20 through October 24, 1990, in compliance with Special Condition S4 of the WNP-2 National Pollutant Discharge Elimination System Waste Discharge Permit (NPDES No. WA-002515-1). Specifically, the permit requires 96-hour flow-through testing in 0% (control) and 100% effluent concentrations. An 80% or greater survival rate in 100% effluent is specified as the successful test criteria.

At the time of the test, normal operating conditions for WNP-2 were characterized by 100% power production and a recirculating cooling water system exhibiting 12 cycles of concentration. Calgon PCL 8125 is added to the recirculating water to inhibit corrosion of the admiralty brass condenser tubes. In addition, chlorine and sulfuric acid are introduced to the system on a routine basis for biofouling treatment and pH adjustment, respectively. Recirculating cooling water blowdown (effluent) is discharged on a continuous basis except during periods of biofouling treatment. Following a treatment, discharge is resumed when total residual halogen concentration meets permit requirements (less than or equal to 0.1 mg/l). The discharge rate during the bioassay averaged 1350 gpm, ranging from a low of 1200 gpm on October 20 to a high of 1500 gpm on October 24, 1990. Secondary Chemistry Program Data (Attachment 1) includes information on the chemical composition of the recirculating water system (CW) for a sample taken on October 23, 1990.

3.2 METHODS AND MATERIALS

The bioassay generally adhered to the requirements set forth in EPA Publications "Methods for Measuring the Acute Toxicity of Effluents to

Freshwater and Marine Organisms," 1985, and "Quality Assurance Guidelines for Biological Testing," 1978. Specific methodology is provided in Environmental Programs Instruction 13.2.11, "WNP-2 Aquatic Bioassays" and "Environmental Sciences and Plant Support Chemistry Quality Assurance Manual," (Washington Public Power Supply System, 1990).

The bioassay test facility is situated on the west bank of the Columbia River directly adjacent to the WNP-2 makeup water pumphouse. Effluent used for the test was diverted from the discharge pipe and pumped to the test facility. Control (dilution) water was untreated Columbia River water pumped from the makeup water pumphouse directly to the test facility. Water Quality Program data from a Columbia River monitoring station sample taken October 2, 1990 provides information as to the chemical makeup of the control (dilution) water (Attachment 2).

Temperature control for the holding tank water and the 0% (control) and 100% plant effluent solutions was provided by a 200,000 BTU capacity chiller and an in-house designed temperature conditioning unit. A system of heat exchangers, flow and temperature control valves, water heater, and controllers produced a test water temperature of 12°C, controllable to within +/-1°C.

The chinook salmon juveniles utilized for the bioassay were obtained from the Washington Department of Fisheries, Ringold Hatchery on October 4, 1990. The fish were acclimatized in a 2000-liter capacity holding tank for 14 days. The water temperature of the holding tank was gradually reduced from an initial temperature of 15.9°C (which approximated the temperature of the hatchery holding pond) to the desired test temperature at 12°C four days prior to the start of the 96-hour test. At no time did the change in temperature exceed 3°C in a 12-hour period. A commercial fish food (Bio-Dry by Bioproducts) was utilized, with food size and feeding rates as used at the hatchery. Fish were not fed for 48 hours prior to handling or during the 96-hour test.

The flow-through system consisted of six 132.5-liter capacity glass aquaria, each containing a volume of approximately 114 liters. The system included three control (100% Columbia River water) and three toxicant (100% plant effluent) aquaria selected on a random basis. Aquaria flow rates were approximately 1.43 liters/minute/aquaria.

Water temperature in both the control and toxicant head boxes was monitored continuously by use of an Astro-Med Dash 2 recorder.

Control water (Columbia River) flow to all six aquaria was initiated at 2400 hours on October 6, 1990. At 1400 hours on October 17, 1990, ten fish were distributed to each aquaria, two per tank, in a stratified random manner. The aquarium loading factor was approximately 180 grams or 1.58 g/liter.

Fish were acclimatized in the aquaria at 100% control water for 48 hours prior to toxicant (plant effluent) introduction. The 96-hour test was begun by siphoning down the aquaria (including controls) until there was approximately 23 liters of water remaining, and then toxicant flow was initiated to the test aquaria. Control aquaria were allowed to refill with river water. The aquaria were checked for mortalities twice per day.

Fork lengths and wet weights were determined by anesthetizing and measuring control fish at the end of the test (Table 3-1). All fish surviving the test were released to the Columbia River.

Temperature, dissolved oxygen, pH and conductivity were measured daily in the control and toxicant head boxes, and each aquaria. Grab water samples were collected daily from the control and toxicant head boxes and each aquaria, and analyzed for calcium, magnesium, alkalinity, total copper, and total zinc.

The pH and temperature measurements were made with an IBM Model EC105-2A portable pH meter. Prior to each use the instrument was

calibrated using pH standards of 4.0, 7.0, and 10.0. If necessary, the probes were adjusted to within 0.1 unit of the standards. The temperature probe was calibrated against an NBS-traceable thermometer.

Dissolved oxygen measurements were made using a Yellow Springs Instrument (YSI) Model 57 meter. The meter was air-calibrated prior to each use per manufacturer's instruction. In addition, Winkler D.O. measurements were made prior to the bioassay and results compared to the Model 57 meter.

Conductivity measurements were made with a YSI Model 33 meter. Daily measurements using conductivity standards were performed.

Sample holding times followed those recommended by the U.S. Environmental Protection Agency (USEPA 1983). Analyses were performed per USEPA (1983) approved methods (Table 3-2).

3.3 RESULTS AND DISCUSSION

No fish mortalities were observed in any of the control (0% effluent) or toxicant (100% effluent) aquaria. This result is in agreement with several static bioassays conducted at WNP-2 during 1984 and 1985 (Supply System, 1986) .

Temperature measurements remained fairly constant throughout the test period. Only slight variations occurred between control and toxicant solutions. All measurements were within the required range of 12°C +/-1°C (Table 3-3). The pH values are presented in Table 3-3. Discharge water (toxicant) exhibited a value about one unit higher than the control values.

Dissolved oxygen measurements were fairly constant. Discharge aquaria averaged approximately 2 mg/l less than control aquaria throughout the bioassay (Table 3-4). Conductivity measurements (Table 3-4) demonstrate the difference in concentration (cycles) between control (Columbia River) and toxicant (100% effluent) water sources.

Total alkalinity measurements for both the control and toxicant aquaria remained constant throughout the bioassay. Discharge values were approximately four times higher than control values (Table 3-5).

Total hardness values given in Table 3-5 are indicative of the cycles of concentration. Hardness was determined by calculation from magnesium and calcium measurements (Table 3-6). The number of cycles of concentration of discharge water ranged from approximately 11.6 at the start of the test to 10.1 at the end of the test period. This calculation is based on calcium levels recorded from control and toxicant head boxes.

Copper and zinc concentrations are presented in Tables 3-7 and 3-8, respectively. The elevated levels in the discharge water may be attributed to corrosion of the condenser tubes and system piping as well as concentration of metals in the makeup water. These values are considerably lower than the concentrations observed during the static bioassays of 1984/1985. A discussion of the chemical composition of Calgon PCL 8125 and its ability to chemically bind toxic metal forms is presented in the "Operational Ecological Monitoring Program for Nuclear Plant No. 2, 1985 Annual Report" (Supply System, 1986).

3.4 REFERENCES

Standard Methods for the Examination of Water and Wastewater, 16th Edition, APHA, AWWA, WPCF, Washington, D.C., 1985

Methods for Chemical Analysis of Water and Wastes, EPA-0600/4-79-/020, Environmental Monitoring and Support Laboratory, Environmental Protection Agency, Cincinnati, Ohio 1983

"Environmental and Plant Support Chemistry Laboratory Quality Assurance Manual," Washington Public Power Supply System, 1990

Methods of Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA/600/4-85/013, Environmental Protection Agency, March 1985

Quality Assurance Guidelines for Biological Testing, EPA/600/4-78/043, Environmental Protection Agency, 1978

Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA/600/4-85/014, December 1985

"Operational Ecological Monitoring Program for Nuclear Plant No. 2, 1985 Annual Report," Washington Public Power Supply System, 1986

"WNP-2 Aquatic Bioassays," Environmental Programs Instruction 13.2.11, Washington Public Power Supply System, 1990

Table 3-1. Size and Weight of Fish used in Bioassay Test.

		Fork Length (cm)		Weight (g)	
Species	Number	Average	Range	Average	Range
Chinook	30	11.0	8.9 - 16.2	15.6	8.5 - 50.8

Table 3-2. Summary of Bioassay Parameters and Associated EPA Methods.

Parameter	EPA Method Number
Water Temperature (°C)	170.1
Conductivity (us/cm) at 25°C	120.1
Dissolved Oxygen (mg/l)	360.1 360.2
pH (su)	150.1
Total Alkalinity (Mg/l as $CaCO_3$)	310.1
Total Hardness (mg/l as $CaCO_3$)	130.2
- Calcium	200.7
- Magnesium	200.7
Total Copper (ug/l as Cu)	220.2 200.7
Total Zinc(ug/l as Zn)	289.2 200.7

Table 3-3. Temperature and pH Measurements

Sample Date	Temperature (°C) Head Box % Discharge Conc. 0	Temperature (°C) Head Box % Discharge Conc. 100	Temperature (°C) Aquaria % Discharge Conc. 0	Temperature (°C) Aquaria % Discharge Conc. 100	pH Head Box % Discharge Conc. 0	pH Head Box % Discharge Conc. 100	pH Aquaria % Discharge Conc. 0	pH Aquaria % Discharge Conc. 100
10/20/90	11.4	11.6	11.7	11.9	7.91	8.63	7.71	8.57
			11.7	11.8			7.74	8.62
			11.7	11.9			7.81	8.62
10/21/90	11.7	12.1	11.9	12.4	7.87	8.67	7.82	8.61
			11.9	12.5			7.81	8.67
			12.0	12.5			7.84	8.66
10/22/90	12.3	12.1	12.7	13.0	7.88	8.69	7.87	8.64
			12.7	13.0			7.90	8.67
			12.7	13.0			7.89	8.66
10/23/90	12.0	12.5	11.9	12.3	7.95	8.65	7.95	8.63
			11.9	12.3			7.91	8.66
			11.9	12.3			7.92	8.65
10/24/90	11.8	12.1	12.0	12.5	7.95	8.60	7.93	8.55
			12.0	12.3			7.92	8.61
			11.9	12.2			7.93	8.57

Table 3-4. Dissolved Oxygen and Conductivity Measurements

Sample Date	Dissolved Oxygen (mg/l) Head Box % Discharge Conc. 0	100	Dissolved Oxygen (mg/l) Aquaria % Discharge Conc. 0	100	Conductivity (uS/cm) Head Box % Discharge Conc. 0	100	Conductivity (uS/cm) Aquaria % Discharge Conc. 0	100
10/20/90	10.2	8.5	10.5	8.9	98	1050	100	900
			10.2	9.9			99	900
			10.4	9.3			103	890
10/21/90	9.8	7.8	9.4	7.8	100	1050	99	1000
			9.5	7.8			99	1020
			9.6	7.9			100	1000
10/22/90	10.0	7.7	9.5	7.7	100	970	100	950
			9.5	7.8			100	970
			9.5	7.8			100	970
10/23/90	10.2	8.0	9.9	8.2	90	890	97	900
			9.9	8.2			97	900
			9.9	8.2			98	900
10/24/90	9.9	7.8	9.6	7.8	95	790	99	850
			9.5	7.9			98	860
			9.6	7.8			100	850

Table 3-5. Total Alkalinity and Total Hardness Measurements

Sample Date	Total Alkalinity (mg/l)				Total Hardness (mg/l)			
	Head Box		Aquaria		Head Box		Aquaria	
	% Discharge Conc.		% Discharge Conc.		% Discharge Conc.		% Discharge Conc.	
	0	100	0	100	0	100	0	100
10/20/90	54.0	197.0	53.0	177.0	65.2	768	64.7	689
			54.0	180.0			64.0	656
			55.0	176.0			64.2	666
10/21/90	54.0	194.0	55.0	196.0	63.7	735	64.1	595
			54.0	197.0			62.1	717
			54.0	197.0			62.9	740
10/22/90	54.0	190.0	54.0	191.0	64.0	678	62.3	683
			54.0	192.0			61.6	670
			54.0	188.0			63.3	665
10/23/9054.0	196.0	53.0	202.0	61.5	633	61.6	652	
			54.0	200.0			60.7	613
			54.0	202.0			62.9	655
10/24/90	55.0	179.0	55.0	180.0	61.4	615	63.0	610
			54.0	180.0			62.9	660
			54.0	179.0			61.6	595

Table 3-6. Magnesium and Calcium Measurements

Sample Date	Magnesium (mg/l) Head Box % Discharge Conc. 0	100	Magnesium (mg/l) Aquaria % Discharge Conc. 0	100	Calcium (mg/l) Head Box % Discharge Conc. 0	100	Calcium (mg/l) Aquaria % Discharge Conc. 0	100
10/20/90	4.2	52.0	4.2	46.0	19.2	222.0	19.0	200.0
			4.2	44.0			18.7	190.0
			4.2	44.0			18.8	194.0
10/21/90	4.3	50.0	4.3	42.0	18.4	212.0	18.6	169.0
			4.1	48.0			18.1	208.0
			4.1	50.0			18.4	214.0
10/22/90	4.2	46.0	4.2	46.0	18.7	196.0	18.0	198.0
			4.1	44.0			17.9	196.0
			4.2	44.0			18.4	194.0
10/23/90	4.0	42.0	4.1	42.0	18.0	184.0	17.9	192.0
			4.0	48.0			17.7	167.0
			4.1	44.0			18.4	190.0
10/24/90 4.1	40.0	4.2	40.0	17.8	180.0	18.3	178.0	
			4.1	44.0			18.4	192.0
			4.1	40.0			17.9	172.0

Table 3-7. Total Copper Concentrations (ppb)

Sample Location	Percent Discharge Concentration	October 20 (0 hrs)	October 21 (24 hrs)	October 22 (48 hrs)	October 23 (72 hrs)	October 24 (96 hrs)
		Sample Dates				
Head Box	0	0.3	0.8	1.6	1.3	1.2
	100	81.0	78.0	78.0	75.0	71.0
Aquaria (3)	0	0.4	0.5	1.0	1.1	1.2
	0	0.4	0.3	1.1	1.0	1.1
	0	0.3	0.3	1.1	0.9	0.4
	100	70.0	78.0	76.0	73.0	67.0
	100	72.0	76.0	77.0	75.0	68.0
	100	68.0	76.0	75.0	73.0	69.0

Table 3-8. Total Zinc Concentrations (ppb)

Sample Location	Percent Discharge Concentration	October 20 (0 hrs)	October 21 (24 hrs)	October 22 (48 hrs)	October 23 (72 hrs)	October 24 (96 hrs)
		Sample Dates				
Head Box	0	2.0	2.0	2.0	3.0	*
	100	87.0	64.0	59.0	64.0	60.0
Aquaria	0	4.0	4.0	2.0	4.0	*
	0	4.0	4.0	*	3.0	*
	0	4.0	2.0	1.0	1.0	*
	100	59.0	61.0	63.0	62.0	55.0
	100	62.0	63.0	61.0	62.0	57.0
	100	55.0	62.0	58.0	61.0	57.0

*Less than detection limit.

DATE: 10/25/90
DIC: 1444.27

ENVIRONMENTAL AND PLANT SUPPORT CHEMISTRY LABORATORY
TEST PLAN 27
SECONDARY CHEMISTRY REPORT

TERRY NORTHSTROM EXT. 8462 RICK WELCH EXT. 8324

SAMPLE #: 3197. DATE RECEIVED: 10/23/90
LOCATION: CW
CUSTOMER: R. E. WELCH DATE COMPLETED:
REVIEWED BY: T. NORTHSTROM T.N. ANALYST: SL LINDBERG

TOTAL - METALS (mg/l)

	A	B	C		A	B	C
CALCIUM	190			ALUMINUM	0.12	89	
MAGNESIUM	40.1			MANGANESE	0.018	88	
SODIUM	45			POTASSIUM	7.0		
COPPER	0.063	91		CHROMIUM	<0.006	89	
ZINC	0.052	91		PHOSPHORUS	4.2		
NICKEL	0.03	84		SULFUR	149		
IRON	0.13	83		SILICON	24.3		

DISSOLVED METALS (mg/l)

CALCIUM	175	ALUMINUM	<0.03
MAGNESIUM	38.6	MANGANESE	0.003
SODIUM	44	POTASSIUM	6.3
COPPER	0.058	CHROMIUM	<0.006
ZINC	0.049	PHOSPHORUS	3.9
NICKEL	0.02	SULFUR	140
IRON	0.043	SILICON	22.8

INORGANIC NON-METALS AND
PHYSICAL PROPERTIES

	A	B	C		A	B	C
SULFATE	410			PHOSPHATE	0.86		
CHLORIDE	22						
FLUORIDE	0.82			pH	8.58		
NITRATE	1.2			CONDUCTIVITY	1138	uS	

CALCULATED RESULTS

CYCLES (Ca) 10.6 CALGON PCL-8125
SIO2 48.79 mg/l (P BASIS) 85.92 mg/l

LEGEND

COLUMN:
A SAMPLE ANALYSIS RESULTS
B SPIKE SAMPLE RESULTS (% RECOVERY)
C QC SAMPLE RESULTS (% OF TRUE VALUE)

3-1 Attachment 1.0

REPORT DATE:02/12/91

ENVIRONMENTAL AND PLANT SUPPORT CHEMISTRY LABORATORY
WATER CHEMISTRY
REPORT

TERRY NORTHSTROM EXT. 8462 SARA LINDBERG EXT. 8035

SAMPLE # 3124.
DESCRIPTION:WATER QUALITY 91-1
CUSTOMER: RE WELCH
ANALYST: RW
DATE SAMPLE TAKEN:

DATE RECEIVED: 10/02/90
DATE COMPLETED 12/07/90
REVIEWED BY: TA

ANALYSIS

AMMONIA NITROGEN	0.016	(mg/l)	NITRATE NITROGEN	<dl	(mg/l)
SULFATE	8.97	(mg/l)	TEMPERATURE	17.8	(C)
DISSOLVED OXYGEN	10.0	(mg/l)	CONDUCTIVITY	134.1	(us/cm/25C)
TOTAL RESIDUAL CL	<0.05	(ug/l)	OIL & GREASE	<0.5	(mg/l)
TOTAL PHOSPHORUS	0.016	(mg/l)	ORTHOPHOSPHORUS	<dl	(mg/l)
TOT.DISSOLVED SLDS	79.0	(mg/l)	PH	7.87	
TOT SUSPENDED SLDS	2.5	(mg/l)			
TURBIDITY	0.85	(NTU)	HARDNESS	61.6	(mg/l)
ALKALINITY	58.0	((mg/l)			

COPPER	1.1	(ug/l)	ZINC	3.9	(ug/l)	NICKEL	0.3	(ug/l)
CHROMIUM	0.20	(ug/l)	IRON	58.0	(ug/l)	LEAD	0.41	(ug/l)
CADMIUM	<0.1	(ug/l)						

3-2 Attachment 2.0

4.0 WATER QUALITY

4.1 INTRODUCTION

The water quality monitoring program documents the chemical character of the Columbia River in the vicinity of the WNP-2 discharge. The monitoring data is used to assess if chemical changes in the Columbia River result from WNP-2 cooling tower blowdown. The program is performed to comply with EFSEC Resolution No. 239.

4.2 MATERIALS AND METHODS

Columbia River surface water was sampled monthly January 1990 through December 1990. Samples were collected near River Mile 352 from four stations numbered 1, 7, 11, and 8 (Figures 4-1, 4-2). Station 1 is upstream of the WNP-2 intake and discharge and represents a control. Station 7 is in the center of the mixing zone approximately 45 meters (150 feet) downstream of the discharge and provides a measure of near-field discharge effects. Station 11, at 91 meters (300 feet) downstream from the discharge, represents the extremity of the mixing zone allowed by WNP-2's National Pollutant Discharge Elimination System (NPDES) permit. Sub-stations 11M and 11B sample water from middle and bottom depths, respectively. Station 8 is approximately 568 meters (1870 feet) downstream from the discharge and represents a location where the discharge is well mixed in the Columbia River.

Plant discharge water (P.H.Dis.) was sampled monthly during 1990. Samples were collected from the discharge pipe, at a sample point located in the WNP-2 makeup water pumphouse, immediately prior to its entering the Columbia River.

The samples were analyzed for temperature, dissolved oxygen (DO), pH, conductivity, turbidity, total alkalinity, total hardness, filterable residue (total dissolved solids), nonfilterable residue (total suspended solids), ammonia-nitrogen, nitrate-nitrogen, total phosphorus,

orthophosphorus, sulfate, oil and grease, total residual chlorine, total copper, total iron, total zinc, total nickel, total lead, total cadmium and total chromium. A summary of water quality parameters, stations and sample frequencies is presented in Table 4-1.

Discharge samples were analyzed for total copper, total iron, total zinc, total nickel, total lead, total cadmium and total chromium.

4.2.1 Sample Collection

Columbia River samples were collected by boat approximately 300 feet from the Benton County shore. Temperature, conductivity, dissolved oxygen, and pH were determined in-situ with portable instruments. Water for total metal, conductivity, sulfate, orthophosphorus, ammonia-nitrogen, nitrate-nitrogen, turbidity, total alkalinity and total hardness analyses was collected in one-liter polypropylene cubitainers and kept on ice until delivered to the Supply System's Environmental Programs Laboratory (EPL). Water for total copper analysis from Stations 11M and 11B were collected in 125 ml nalgene bottles with an All-Teflon pump and Tygon tubing. In the laboratory the metals samples were acidified to 0.5% with concentrated nitric acid. Determinations for filterable residue, non-filterable residue, total phosphorus, and total residual chlorine were made on water samples collected in 3.8-liter polypropylene cubitainers and kept on ice until delivered to the Supply System's Radiological Services Laboratory (RSL). Water for oil and grease analysis was skimmed from the surface into solvent rinsed borosilicate glass bottles. After collection, samples were placed on ice and transported to the RSL for analysis.

Discharge samples were collected in one-liter polypropylene cubitainers and kept on ice until delivered to the EPL for analysis.

During the annual plant maintenance outage (May through July) only Station 1 (control) samples were collected.

4.2.2 Field Equipment and Measurements

Surface temperature and dissolved oxygen measurements were made using a Yellow Springs Instruments (YSI) Model 57 meter. Temperature was recorded to within 0.1°C after the probe had been allowed to equilibrate in the river for a minimum of one minute. The field probe was calibrated monthly, against an NBS-traceable thermometer in the laboratory.

The DO meter was air-calibrated prior to each field sample date per manufacturer's instruction. In addition, Winkler DO measurements were made every month and results were compared to the field probe.

Conductivity measurements were made with a YSI model 34 meter. Prior to each sample date, measurements of conductivity standards were performed.

pH measurements were made with an IBM Model EC105-2A portable pH meter. Prior to each use the instrument was calibrated using pH standards of 4.0, 7.0, and 10.0. If necessary, the probes were adjusted to within 0.1 unit of the standards.

4.2.3 Laboratory Measurements

Total metals, sulfate, conductivity, orthophosphorus, ammonia-nitrogen, nitrate-nitrogen, turbidity, total alkalinity and total hardness were determined by Supply System Environmental Programs personnel. The remaining analyses were performed by Supply System's Radiological Services personnel. Sample holding times followed those recommended by the U.S. Environmental Protection Agency (USEPA 1983). Analyses were performed per USEPA (1983) and ASTM approved methods (Table 4-2).

4.3 RESULTS

Data obtained during the annual maintenance period (May through July) is not included in table summaries.

4.3.1 Temperature

Columbia River temperatures varied seasonally with a minimum temperature of 3.3°C at Stations 1, 7, 11 and 8 on February 15th and a maximum of 19.6°C at Stations 11M and 11B on August 15 (Table 4-3). River temperatures measured in 1990 are presented graphically in Figure 4-3.

4.3.2 Dissolved Oxygen (DO)

The mean and range of DO measurements for each sample station are presented in Table 4-4. Columbia River DO concentrations ranged from 9.3 mg/l at Station 7 in September to 13.6 mg/l at Station 7 in April. The mean DO concentrations ranged from 11.1 mg/l at Stations 7 and 8 to 11.2 mg/l at Stations 1 and 11.

DO concentrations were inversely related to river temperature as would be expected from solubility laws. DO levels were never below the 8 mg/l water quality standard for Class A waters (WDOE 1988) indicating good water quality with respect to dissolved oxygen throughout the year. Dissolved oxygen measurements are presented graphically in Figure 4-4.

4.3.3 pH and Alkalinity

Columbia River pH values ranged from 7.43 at Station 7 in January to 8.27 at Station 7 in March (Table 4-5). The variation in pH between sample stations is small. The largest difference of 0.44 standard units occurred between Station 7 (pH 8.27) and Station 11B (pH 7.83) in March.

The pH water quality standard for Class A waters is from 6.5 to 8.5 (WDOE 1988). Measurements for all stations throughout 1990 were within this range. pH measurements, presented graphically in Figure 4-5, generally agree with historical data for the Columbia River (Silker 1964).

The alkalinity of a water is a measure of its capacity to neutralize acids and is generally due to the presence of carbonates, bicarbonates, phosphates, silicates, borates, and hydroxides. Columbia River alkalinities ranged from 49.0 to 63.0 mg/l as calcium carbonate (Table 4-6). The alkalinity measurements are presented graphically in Figure 4-6.

4.3.4 Conductivity

Conductivity is a measure of the ionic content of a solution. Columbia River conductivity measurements ranged from 118.5 uS/cm at 25°C at Station 11M in August to 162.0 uS/cm at 25°C at Station 7 in January (Table 4-7). Station mean conductivities ranged from 136.6 uS/cm at 25°C at Station 1 to 138.6 uS/cm at 25°C at Station 11. The conductivity results are very comparable to those reported in earlier studies of the Columbia River (Silker 1964). The measurements are presented graphically in Figure 4-7.

4.3.5 Total Residual Chlorine (TRC)

Total residual chlorine (TRC) measurements for 1990 were less than the measured detection limit of 50 ug/l (Table 4-8).

TRC measurements were made using the Amperometric Titration Method. This method has a detection limit of 50 ug/l.

4.3.6 Metals

Total Copper

Columbia River total copper values ranged from < 1.2 ug/l to 3.4 ug/l (Table 4-9). The largest interstation difference in copper occurred between Station 1 (3.4 ug/l) and all other stations in April. However, the value of 3.4 is uncharacteristic and is probably an indication of a contaminated sample rather than an actual copper measurement. Our copper results show good agreement with earlier studies. In 1962, Silker (1964) analyzed 27 Columbia River samples collected upstream of WNP-2 and reported a mean copper concentration of 4.3 ug/l. Neutron activation analysis of Columbia River water was done in 1968-1969 by Cushing and Rancitelli (1972). They reported a mean copper concentration of 1.4 ug/l. Florence and Batley (1977) state that total copper concentrations in the range of 0.3 - 3.0 ug/l are found in many unpolluted fresh-water rivers throughout the world. The Hanford reach of the Columbia River would generally be in that category.

Plant discharge total copper concentrations ranged from 24.0 ug/l in April to 209.0 ug/l in August.

Total Zinc

Mean total zinc measurements ranged from 6.6 ug/l at Station 11 to 7.0 ug/l at Station 7 (Table 4-10). Individual zinc measurements ranged from 2.8 ug/l at Station 1 to 12.4 ug/l at Station 7. The greatest interstation difference (3.8 ug/l) occurred between Station 7 (12.4 ug/l) and Station 8 (8.6 (ug/l) in April.

Discharge water total zinc measurements ranged from 26.0 ug/l in August to 79.0 ug/l in February.

Total Iron

Columbia River mean iron concentrations ranged from 136.1 ug/l at Station 8 to 154.9 ug/l at Station 1 (Table 4-11). The greatest interstation difference in concentration of 176 ug/l occurred between Station 8 (48.0 ug/l) and Station 7 (224.0 ug/l) in February. However, measurements for Stations 1 and 7 for February are uncharacteristic and may represent contaminated sample containers rather than actual iron concentrations.

Plant discharge total iron concentrations ranged from 180.0 ug/l in January to 1400.0 ug/l in November.

Total Nickel

Total nickel concentrations were below the detection limit (2.6 ug/l) for nearly all periods, except November. The 5.8 ug/l recorded for Station 7 in March is uncharacteristic and probably represents a contaminated sample rather than an actual Columbia River nickel measurement.

Plant discharge total nickel concentrations ranged from <2.6 ug/l in August to 14.2 ug/l in October.

Total Lead

Total lead concentrations were low with nearly all stations recording levels below detection limits for most periods (Table 4-11).

Discharge water total lead measurements ranged from <1.2 ug/l in September to 6.8 ug/l in August.

Total Cadmium

Cadmium concentrations were below detection limits for all stations during all periods.

Plant discharge total cadmium concentrations were below the detection limit (0.5 ug/l) for all periods except March, in which 1.1 ug/l was recorded.

Total Chromium

Chromium concentrations were below detection limits for all periods except November (Table 4-12).

Plant discharge total chromium concentrations ranged from <1.9 ug/l (January, March, August) to 32.0 ug/l in October.

Total zinc and total iron measurements are presented graphically in Figures 4-8 and 4-9, respectively.

4.3.7 Hardness

Hardness indicates the quantity of divalent metallic cations present in the system, principally calcium and magnesium ions. Hardness ranged from 58.0 to 71.3 mg/l as calcium carbonate (Table 4-6). Mean hardness values ranged from 64.8 mg/l at Station 7 to 65.2 mg/l at Station 11. The hardness measurements are presented graphically in Figure 4-10.

4.3.8 Oil and Grease

Oil and grease values were below the detection limit of 0.5 mg/l for all stations and periods except December 1990. Oil and grease measurements are summarized in Table 4-13.

4.3.9 Ammonia-Nitrogen and Nitrate-Nitrogen

Ammonia and nitrate are forms of nitrogen commonly found in water systems. Both nitrate and ammonia are assimilated by plants and converted to proteins. Common sources of nitrate and ammonia to the aquatic system are breakdown of organic matter in the soil, industrial discharges, fertilizers and septic tank leachate.

Ammonia concentrations ranged from <0.01 to 0.04 mg-N/l (Table 4-13). Nitrate concentrations ranged from <0.01 to 0.13 mg-N/l. The nitrate measurements are summarized in Table 4-14. The nitrate measurements are presented graphically in Figure 4-11.

4.3.10 Total Phosphorus and Orthophosphorus

Phosphorus is a required nutrient for plant growth and, while found in certain minerals, is commonly added to streams through fertilizers, treated sewage, and septic tank leachate.

Measured total phosphorus concentrations ranged from <0.1 to 0.19 mg-P/l. Orthophosphorus concentrations were below the detection limit of 0.01 mg/l for all stations and periods (Table 4-15).

4.3.11 Sulfate

Mean sulfate concentrations ranged from 9.16 mg/l at Station 8 to 9.27 mg/l at Station 11 (Table 4-15). Individual sulfate measurements ranged from 8.00 to 10.60 mg/l. Sulfuric acid is added at WNP-2 to control circulating water pH and a by-product is sulfate. Based on the river measurements, WNP-2 discharges are not appreciably altering river sulfate concentrations. Total sulfate measurements are presented graphically in Figure 4-12.

4.3.12 Total Dissolved Solids, Total Suspended Solids and Turbidity

Total dissolved solids or total filterable residue, TDS, is defined as that portion of the total residue that passes through a glass fiber filter and remains after ignition at 180°C for one hour. Total dissolved solids do not necessarily represent only the dissolved constituents but may also include colloidal materials and some small particulates. The mean TDS measured in the Columbia River varied from 77.7 mg/l at Station 1 to 80.2 mg/l at Station 7 (Table 4-16). There were no consistent differences in TDS concentrations between stations or through time.

Total suspended solids (TSS) or total nonfilterable residue is the material retained on a standard glass fiber filter after filtration of a well-mixed sample. TSS concentrations were generally low and varied from <1.2 to 23.1 mg/l (Table 4-16). Mean TSS concentrations ranged from 4.5 mg/l at Station 7 to 4.8 mg/l at Station 8.

Turbidity is a measure of the suspended matter that interferes with the passage of light through water. In the Columbia River, measured turbidities were low and ranged from 0.80 nephelometric turbidity units (NTU) to 17.0 NTU (Table 4-8). Total dissolved solids, total suspended solids and turbidity data are presented graphically in Figures 4-13, 4-14, and 4-15.

4.4 DISCUSSION

Unusually warm temperatures and heavy precipitation during November resulted in high flow rates for the Columbia River and a corresponding increase in the levels of several parameters. Turbidity values were the highest recorded since the water quality progam began in April, 1983. The figure of 17.0 NTUs for Stations 1, 11 and 8 was greater than three times the previous maximum of 5.4 NTUs reported for Stations 7 and 11 in June, 1983. Other parameters demonstrating seasonally uncharacteristic increases included copper, nickel, iron, lead, chromium and total suspended solids.

Plant discharge data basically demonstrates the increase in certain constituents of the blowdown due mainly to concentrating the circulating cooling water (Columbia River water). Preferred operating conditions at WNP-2 are in part characterized by a circulating water concentration of 12 cycles.

In comparing river and plant discharge data, it is evident that the impact on the Columbia River is minimal, with no significant inter-station differences being detected.

Overall, it appears that, with respect to all the measured parameters sampled under the operating conditions prevailing during 1990, WNP-2 cooling water discharge had little effect upon Columbia River water quality.

4.5 BIBLIOGRAPHY

Cushing, C.E., and L.A. Rancitelli. 1972. Trace element analyses of Columbia River water and phytoplankton. Northwest Science 46(2):115-121.

Florence, T.M. and G.E. Batley. 1977. Determination of the chemical forms of trace metals in natural waters with special reference to copper, lead, cadmium and zinc. Talanta 24:151-158.

Silker, W.B. 1964. Variations in elemental concentrations in the Columbia River. Limnol. Oceanogr. 9:540-545.

Environmental Protection Agency. 1983. Methods for chemical analysis of water and wastes. Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, OH.

Standard Methods for Examination of Water and Waste Water, 16th Edition, APHA, AWWA, WPCF, Washington, D.C., 1985.

Washington Department of Ecology. 1988. Water Quality Standards for Surface Waters of the State of Washington. Water Quality Planning Office of Water Programs. Olympia, WA.

Washington Public Power Supply System. 1987. Operational Ecological Monitoring Program for Nuclear Plant 2. Annual Report for 1986. Richland, WA.

Washington Public Power Supply System. 1988. Operational Ecological Monitoring Program for Nuclear Plant 2. Annual Report for 1987. Richland, WA.

Washington Public Power Supply System. 1989. Operational Ecological Monitoring Program for Nuclear Plant 2. Annual Report for 1988. Richland, WA.

Washington Public Power Supply System. 1990. Operational Ecological Monitoring Program for Nuclear Plant 2. Annual Report for 1989. Richland, WA.

Table 4-1. Summary of Water Quality Parameters, Stations, and Sampling Frequencies, 1990

Parameter	Stations 1	7++	11++	11M & 11B++	8++	Wells in Vicinity of Plant Site+
Quantity (flow)	-	-	-	-	-	-
Temperature	M	M	M	M	M	-
Dissolved Oxygen	M	M	M	-	M	-
pH	M	M	M	M	M	Q
Turbidity	M	M	M	-	M	-
Total Alkalinity	M	M	M	-	M	Q
Filterable Residue (Total Dissolved Solid)	M	M	M	-	M	-
Nonfilterable Residue (Suspended Solids)	M	M	M	-	M	-
Conductivity	M	M	M	M	M	-
Iron (Total)	M	M	M	-	M	-
Copper (Total)	M	M	M	M**	M	-
Nickel (Total)	M	M	M	-	M	-
Zinc (Total)	M	M	M	-	M	-
Lead (Total)	M	M	M	-	M	-
Cadmium (Total)	M	M	M	-	M	-
Chromium (Total)	M	M	M	-	M	-
Sulfate	M	M	M	-	M	-
Ammonia Nitrogen	M	M	M	-	M	-
Nitrate Nitrogen	M	M	M	-	M	Q
Ortho Phosphorus	M	M	M	-	M	Q
Total Phosphorus	M	M	M	-	M	Q
Oil and Grease	M	M	M	-	M	-
Chlorine, Total Residual	M	M	M	-	M	-
Hardness	M	M	M	-	M	-

Symbols Key

M = Monthly
Q = Quarterly
+ Samples will be collected if wells are being used for drinking water.
- Analysis not required
** Samples taken in triplicate
++ Samples collected only if the plant is operating.

Table 4-2. Summary of Water Quality Parameters, EPA and ASTM Method Number

Parameter	EPA Method Number	ASTM Method Number
Water Temperature (°C)	170.1	
Turbidity, (NTU)	180.1	
Conductivity (umhos/cm) at 25°C	120.1	
Dissolved Oxygen (mg/l) probe	360.1	
Dissolved Oxygen (mg/l) Modified Winkler*	360.2	
pH (Standard Unit)	150.1	
Total Alkalinity (mg/l as $CaCO_3$)	310.1	
Total Hardness (mg/l as $CaCO_3$)	130.2, 6010	
Oil and Grease (mg/l)	413.2	
Nitrogen, Ammonia, Total (mg/l as N)	350.3	
Nitrate Nitrogen, Total (mg/l as N)	352.1	D4327-88
Total Phosphorus (mg/l as P)	365.2	
Ortho Phosphorus (mg/l as P)	365.2	D4327-88
Sulfate (mg/l as SO_4)	375.4	D4327-88
Total Copper (ug/l as Cu)	220.1, 220.2, 200.7	
Total Iron (ug/l as Fe)	236.1, 236.2, 200.7	
Total Nickel (ug/l as Ni)	249.1, 249.2	
Total Zinc (ug/l as Zn)	289.1, 289.2, 200.7	
Total Lead (ug/l as P6)	239.1, 239.2	
Total Cadmium (ug/l as Cd)	213.1, 213.2	
Total Chromium (ug/l as Cr)	218.1, 218.2	
Total Residual Chlorine (ug/l)	330.1	
Filterable Residue: Total Dissolved Solids (mg/l)	160.1	
Non-Filterable Residue: Total Suspended Solids (mg/l)	160.2	

Table 4-3. Summary of Temperature Measurements for 1990.

Sample Date	Temperature (Degrees C) 1	7	11	11M	11B	8
01/18/90	4.7	5.0	4.9	4.8	4.8	4.8
02/15/90	3.3	3.3	3.3	3.6	3.5	3.3
03/14/90	4.7	4.3	4.3	4.9	4.5	4.6
04/11/90	7.3	7.3	7.3	7.5	8.0	7.4
05/16/90	11.3	--	--	--	--	--
06/13/90	13.6	--	--	--	--	--
07/18/90	18.2	--	--	--	--	--
08/15/90	19.3	19.4	19.3	19.6	19.6	19.3
09/13/90	19.0	19.2	19.0	18.9	18.6	19.3
10/02/90	17.8	17.6	17.8	18.0	17.8	17.9
11/28/90	9.5	9.4	9.4	9.5	9.5	9.4
12/12/90	8.3	8.3	8.3	8.7	8.2	8.3
Mean	10.4	10.4	10.4	10.6	10.5	10.5
SD	6.5	6.5	6.5	6.5	6.5	6.5
Maximum	19.3	19.4	19.3	19.6	19.6	19.3
Minimum	3.3	3.3	3.3	3.6	3.5	3.3

Table 4-4. Summary of Dissolved Oxygen Measurements for 1990.

Sample Date	Dissolved Oxygen (mg/l) 1	7	11	8
01/18/90	Meter Breakdown in Field			
02/15/90	12.8	12.7	12.7	12.8
03/14/90	12.1	12.0	12.0	12.0
04/11/90	13.4	13.6	13.5	13.5
05/16/90	12.7	--	--	--
06/13/90	12.3	--	--	--
07/18/90	10.8	--	--	--
08/15/90	9.5	9.6	9.5	9.7
09/13/90	9.4	9.3	9.4	9.4
10/02/90	10.0	9.5	9.8	9.4
11/28/90	11.2	11.2	11.2	11.1
12/12/90	11.2	11.2	11.2	11.2
Mean	11.2	11.1	11.2	11.1
SD	1.5	1.6	1.5	1.6
Maximum	13.4	13.6	13.5	13.5
Minimum	9.4	9.3	9.4	9.4

Table 4-5. Summary of pH Measurements for 1990.

Sample Date	pH 1	7	11	11M	11B	8
01/18/90	7.57	7.43	7.49	7.61	7.57	7.57
02/15/90	7.68	7.67	7.71	7.71	7.68	7.73
03/14/90	7.91	8.27	7.87	7.87	7.83	7.90
04/11/90	7.76	7.62	7.71	7.67	7.61	7.73
05/16/90	7.71	--	--	--	--	--
06/13/90	7.73	--	--	--	--	--
07/18/90	7.71	--	--	--	--	--
08/15/90	7.73	7.64	7.72	7.78	7.79	7.78
09/13/90	7.87	7.74	7.82	7.84	7.88	7.80
10/02/90	7.87	7.87	7.91	7.89	7.93	7.87
11/28/90	7.68	7.73	7.71	7.68	7.69	7.69
12/12/90	7.74	7.72	7.73	7.74	7.74	7.76
Mean						
SD						
Maximum	7.91	8.27	7.91	7.89	7.93	7.90
Minimum	7.57	7.43	7.49	7.61	7.57	7.57

Table 4-6. Summary of Alkalinity and Hardness Measurements for 1990.

Sample Date	Total Alkalinity (mg/l) (as $CaCO_3$) 1	7	11	8
01/18/90	63.0	63.0	62.5	61.0
02/15/90	59.0	59.0	58.0	60.0
03/14/90	59.5	59.5	59.0	60.0
04/11/90	57.5	58.0	60.0	59.0
05/16/90	65.0	--	--	--
06/13/90	54.0	--	--	--
07/18/90	51.0	--	--	--
08/15/90	54.0	55.0	54.0	54.0
09/13/90	54.0	55.0	55.0	54.0
10/02/90	58.0	58.0	59.0	57.0
11/28/90	49.0	50.0	51.0	50.0
12/12/90	58.5	60.0	60.0	59.0
Mean	56.9	57.5	57.6	57.1
SD	4.1	3.7	3.6	3.7
Maximum	63.0	63.0	62.5	61.0
Minimum	49.0	50.0	51.0	50.0

Sample Date	Total Hardness (mg/l) (as CaCO[illegible]) 1	7	11	8
01/18/90	71.0	70.0	71.2	71.3
02/15/90	68.5	65.6	69.9	69.4
03/14/90	68.1	68.4	67.6	67.7
04/11/90	64.9	66.2	65.1	64.9
05/16/90	58.6	--	--	--
06/13/90	60.4	--	--	--
07/18/90	54.7	--	--	--
08/15/90	58.5	58.0	58.7	58.3
09/13/90	63.3	63.9	62.9	61.6
10/02/90	61.6	61.8	61.6	62.0
11/28/90	58.9	60.1	59.9	60[illegible]
12/12/90	69.3	69.0	69.8	69.7
Mean	64.9	64.8	65.2	65.0
SD	4.6	4.2	4.7	4.7
Maximum	71.0	70.0	71.2	71.3
Minimum	58.5	58.0	58.7	58.3

Table 4-7. Summary of Conductivity Measurements for 1990.

Conductivity at 25°C (uS/cm)

Sample Date	1	7	11	11M	11B	8
01/18/90	155.1	162.0	161.8	153.8	154.6	154.1
02/15/90	151.7	152.1	151.9	151.8	152.3	151.9
03/14/90	153.6	153.7	156.5	156.1	157.8	154.6
04/11/90	136.4	137.0	137.7	136.2	136.3	136.4
05/16/90	121.0	--	--	--	--	--
06/13/90	123.9	--	--	--	--	--
07/18/90	119.3	--	--	--	--	--
08/15/90	119.8	127.6	126.9	118.5	118.8	126.9
09/13/90	127.1	126.3	128.0	127.5	129.4	127.3
10/02/90	134.1	131.3	132.0	133.1	133.7	133.7
11/28/90	126.9	126.3	126.7	127.3	127.9	126.7
12/12/90	125.3	125.4	125.5	126.2	126.5	125.4
Mean	136.6	138.0	138.6	136.7	137.5	137.4
SD	13.5	14.2	14.3	13.8	14.0	12.6
Maximum	155.1	162.0	161.8	156.1	157.8	154.6
Minimum	119.8	125.4	125.5	118.5	118.8	125.4

Table 4-8. Summary of Turbidity and Total Residual Chlorine Measurements for 1990.

Sample Date	Turbidity (NTU) 1	7	11	8	Sample Date	Total Residual Chlorine (mg/[illegible]) 1	7	11	8
01/18/90	1.0	1.1	1.1	1.1	01/18/90	<0.05	<0.05	<0.05	<0.05
02/15/90	1.2	1.3	1.2	1.2	02/15/90	<0.05	<0.05	<0.05	<0.05
03/14/90	1.1	1.2	1.2	1.2	03/14/90	<0.05	<0.05	<0.05	<0.05
04/11/90	1.1	1.1	1.1	1.5	04/11/90	<0.05	<0.05	<0.05	<0.05
05/16/90	2.2	--	--	--	05/16/90	<0.05	--	--	--
06/13/90	2.0	--	--	--	06/13/90	<0.05	--	--	--
07/18/90	1.2	--	--	--	07/18/90	<0.05	--	--	--
08/15/90	0.9	1.0	1.0	0.9	08/15/90	<0.05	<0.05	<0.05	<0.05
09/13/90	0.8	0.8	0.8	0.9	09/13/90	<0.05	<0.05	<0.05	<0.05
10/02/90	0.9	0.8	0.9	0.8	10/02/90	<0.05	<0.05	<0.05	<0.05
11/28/90	17.0	16.0	17.0	17.0	11/28/90	<0.05	<0.05	<0.05	<0.05
12/12/90	1.5	1.4	1.7	1.7	12/12/90	<0.05	<0.05	<0.05	<0.05
Mean	2.8	2.7	2.9	2.9	Mean	-	-	-	-
SD	5.3	5.0	5.3	5.3	SD	-	-	-	-
Maximum	17.0	16.0	17.0	17.0	Maximum	-	-	-	-
Minimum	0.8	0.8	0.8	0.8	Minimum	-	-	-	-

Table 4-9. Summary of Copper Measurements for 1990.

Copper (ug/l)

Sample Date	1	7	11	11M	11B	8	PH DIS
01/18/90	1.2	<1.0	<1.0	1.3	1.2	<1.0	30.0
02/15/90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	42.0
03/14/90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	48.0
04/11/90	3.4	<1.0	<1.0	<1.0	<1.0	<1.0	24.0
05/16/90	1.2	--	--	--	--	--	--
06/13/90	1.7	--	--	--	--	--	--
07/18/90	<1.0	--	--	--	--	--	--
08/15/90	<1.0	1.3	<1.0	<1.0	<1.0	<1.0	209.0
09/13/90	1.3	1.3	1.5	1.5	1.2	1.2	104.0
10/02/90	<1.0	1.3	1.2	1.2	1.2	1.2	64.0
11/28/90	2.6	2.6	--	3.3	2.7	2.6	82.0
12/12/90	1.5	2.8	<1.0	<1.0	<1.0	2.4	60.0
Mean	--	--	--	--	--	--	73.7
SD	--	--	--	--	--	--	53.4
Maximum	3.4	2.8	1.5	3.3	2.7	2.6	209.0
Minimum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	24.0

Table 4-10. Summary of Nickel and Zinc Measurements for 1990.

Nickel (ug/l)						Zinc (ug/l)					
Sample Date	1	7	11	8	PH Dis.	Sample Date	1	7	11	8	PH Dis.
01/18/90	<3.0	<3.0	<3.0	<3.0	4.7	01/18/90	3.4	3.8	4.1	5.1	33.0
02/15/90	<3.0	<3.0	<3.0	<3.0	5.8	02/15/90	8.1	7.3	9.5	7.4	79.0
03/14/90	<3.0	5.8	<3.0	<3.0	5.5	03/14/90	10.4	8.0	9.7	10.3	59.0
04/11/90	<3.0	<3.0	<3.0	<3.0	3.4	04/11/90	9.8	12.4	9.2	8.6	41.0
05/16/90	<3.0	—	—	—	—	05/16/90	10.7	—	—	—	—
06/13/90	<3.0	—	—	—	—	06/13/90	8.3	—	—	—	—
07/18/90	<3.0	—	—	—	—	07/18/90	5.6	—	—	—	—
08/15/90	<3.0	<3.0	<3.0	<3.0	<3.0	08/15/90	2.8	3.1	4.8	3.1	26.0
09/13/90	<3.0	<3.0	<3.0	<3.0	12.3	09/13/90	7.6	7.9	6.7	5.7	71.0
10/02/90	<3.0	<3.0	<3.0	<3.0	14.2	10/02/90	3.9	5.8	3.0	5.5	62.0
11/28/90	12.9	10.2	13.3	13.6	12.9	11/28/90	8.3	7.6	7.5	9.5	60.0
12/12/90	<3.0	<3.0	<3.0	<3.0	10.8	12/12/90	5.8	7.1	6.7	4.2	60.0
Mean	—	—	—	—	8.7*	Mean	6.7	7.0	6.8	6.6	54.6
SD	—	—	—	—	4.0*	SD	2.8	2.7	2.4	2.5	17.6
Maximum	12.9	10.2	13.3	13.6	14.2	Maximum	10.4	12.4	9.7	10.3	79.0
Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	Minimum	2.8	3.1	3.0	3.1	26.0

*Less-than values not included.

Table 4-11. Summary of Iron and Lead Measurements for 1990.

Sample Date	Iron(ug/l) 1	7	11	8	PH Dis.	Sample Date	Lead (ug/l) 1	7	11	8	PH Dis.
01/18/90	43.0	29.0	28.0	28.0	180.0	01/18/90	<1.0	<1.0	<1.0	<1.0	4.7
02/15/90	112.0	224.0	59.0	48.0	346.0	02/15/90	<1.0	<1.0	—	<1.0	4.1
03/14/90	56.0	43.0	49.0	43.0	380.0	03/14/90	<1.0	<1.0	<1.0	<1.0	3.5
04/11/90	46.0	53.0	39.0	40.0	205.0	04/11/90	1.8	<1.0	<1.0	<1.0	2.1
05/16/90	59.0	—	—	—	—	05/16/90	<1.0	—	—	—	—
06/13/90	116.0	—	—	—	—	06/13/90	1.9	—	—	—	—
07/18/90	30.0	—	—	—	—	07/18/90	<1.0	—	—	—	—
08/15/90	39.0	34.0	35.0	34.0	198.0	08/15/90	<1.0	<1.0	<1.0	<1.0	6.8
09/13/90	42.0	50.0	46.0	47.0	385.0	09/13/90	<1.0	<1.0	<1.0	<1.0	<1.2
10/02/90	58.0	57.0	59.0	65.0	785.0	10/02/90	<1.0	<1.0	<1.0	<1.0	1.4
11/28/90	905.0	745.0	845.0	820.0	1400.0	11/28/90	1.9	1.5	1.2	1.7	2.2
12/12/90	93.0	94.0	93.0	100.0	1040.0	12/12/90	<1.0	<1.0	<1.0	<1.0	2.5
Mean	154.9	147.7	139.2	136.1	546.6	Mean	—	—	—	—	3.4*
SD	282.4	231.9	265.3	257.3	432.3	SD	—	—	—	—	1.7*
Maximum	905.0	745.0	845.0	820.0	1400.0	Maximum	1.9	1.5	1.2	1.7	6.8
Minimum	39.0	29.0	28.0	28.0	180.0	Minimum	<1.0	<1.0	<1.0	<1.0	<1.0

*Less-than values not included.

Table 4-12. Summary of Cadmium and Chromium Measurements for 1990.

Cadmium (ug/l)						Chromium (ug/l)					
Sample Date	1	7	11	8	PH Dis.	Sample Date	1	7	11	8	PH Dis.
01/18/90	<0.5	<0.5	<0.5	<0.5	<0.5	01/18/90	<2.0	<2.0	<2.0	<2.0	<2.0
02/15/90	<0.5	<0.5	<0.5	<0.5	<0.5	02/15/90	<2.0	<2.0	<2.0	<2.0	5.0
03/14/90	<0.5	<0.5	<0.5	<0.5	1.1	03/14/90	<2.0	<2.0	<2.0	<2.0	
04/11/90	<0.5	<0.5	<0.5	<0.5	<0.5	04/11/90	<2.0	<2.0	<2.0	<2.0	25.0
05/16/90	<0.5	—	—	—	—	05/16/90	<2.0	—	—	—	—
06/13/90	<0.5	—	—	—	—	06/13/90	<2.0	—	—	—	—
07/18/90	<0.5	—	—	—	—	07/18/90	<2.0	—	—	—	—
08/15/90	<0.5	<0.5	<0.5	<0.5	<0.5	08/15/90	<2.0	<2.0	<2.0	<2.0	<2.0
09/13/90	<0.5	<0.5	<0.5	<0.5	<0.5	09/13/90	<2.0	<2.0	<2.0	<2.0	3.4
10/02/90	<0.5	<0.5	<0/5	<0/5	<0.5	10/02/90	<2.0	<2.0	<2.0	<2.0	32.0
11/28/90	<0.5	<0.5	<0.5	<0.5	<0.5	11/28/90	4.0	2.1	3.6	4.0	3.3
12/12/90	<0.5	<0.5	<0.5	<0.5	<0.5	12/12/90	<2.0	<2.0	<2.0	<2.0	2.0
Mean	—	—	—	—	—	Mean	—	—	—	—	11.8*
SD	—	—	—	—	—	SD	—	—	—	—	12.0*
Maximum	<0.5	<0.5	<0.5	<0.5	1.1	Maximum	4.0	2.1	3.6	4.0	32.0
Minimum	<0.5	<0.5	<0.5	<0.5	<0.5	Minimum	<2.0	<2.0	<2.0	<2.0	<2.0

*Less-than values not included.

Table 4-13. Summary of Oil and Grease, and Ammonia Measurements for 1990.

Sample Date	Oil & Grease (mg/l) 1	7	11	8	Sample Date	Ammonia (mg NH_3 - N/l) 1	7	11	8
01/18/90	<0.5	<0.5	<0.5	<0.5	01/18/90	<0.01	<0.01	<0.01	<0.01
02/15/90	<0.5	<0.5	<0.5	<0.5	02/15/90	<0.01	<0.01	<0.01	<0.01
03/14/90	<0.5	<0.5	<0.5	<0.5	03/14/90	<0.01	<0.01	<0.01	<0.01
04/11/90	<0.5	<0.5	<0.5	<0.5	04/11/90	0.02	<0.01	<0.01	<0.01
05/16/90	<0.5	<0.5	<0.5	<0.5	05/16/90	<0.01	--	--	--
06/13/90	<0.5	--	--	--	06/13/90	<0.01	--	--	--
07/18/90	<0.5	--	--	--	07/18/90	<0.01	--	--	--
08/15/90	<0.5	<0.5	<0.5	<0.5	08/15/90	0.03	0.02	0.02	0.04
09/13/90	<0.5	<0.5	<0.5	<0.5	09/13/90	0.02	0.02	0.02	0.01
10/02/90	<0.5	<0.5	<0.5	<0.5	10/02/90	0.02	0.01	0.01	0.02
11/28/90	<0.5	<0.5	<0.5	<0.5	11/28/90	<0.01	<0.01	<0.01	<0.01
12/12/90	0.6	0.8	0.8	0.8	12/12/90	<0.01	<0.01	<0.01	<0.01
Mean	-	-	-	-	Mean	--	--	--	--
SD	-	-	-	-	SD	--	--	--	--
Maximum	0.6	0.8	0.8	0.8	Maximum	0.03	0.02	0.02	0.04
Minimum	<0.5	<0.5	<0.5	<0.5	Minimum	<0.01	<0.01	<0.01	<0.01

Table 4-14. Summary of Nitrate and Total Phosphorus Measurements for 1990.

Sample Date	Nitrate (mg/l) 1	7	11	8	Sample Date	Total Phosphorus (mg/l) 1	7	11	8
01/18/90	0.12	0.12	0.12	0.12	01/18/90	<0.1	<0.12	<0.1	<0.10
02/15/90	0.10	0.10	0.10	0.10	02/15/90	0.15	0.15	0.16	0.19
03/14/90	0.10	0.10	0.10	0.10	03/14/90	<0.1	<0.1	<0.1	<0.1
04/11/90	0.12	0.13	0.12	0.12	04/11/90	<0.1	<0.1	<0.1	<0.1
05/16/90	0.03	--	--	--	05/16/90	<0.1	--	--	--
06/13/90	0.06	--	--	--	06/13/90	<0.1	--	--	--
07/18/90	<0.01	--	--	--	07/18/90	<0.1	--	--	--
08/15/90	<0.01	<0.01	<0.01	<0.01	08/15/90	<0.1	<0.1	<0.1	<0.1
09/13/90	--	--	--	-	09/13/90	<0.1	<0.1	<0.1	<0.1
10/02/90	<0.01	<0.01	<0.01	<0.01	10/02/90	<0.1	<0.1	<0.1	<0.1
11/28/90	0.11	0.11	0.12	0.11	11/28/90	<0.1	<0.1	<0.1	<0.1
12/12/90	0.13	0.13	0.13	0.13	12/12/90	<0.1	<0.1	<0.1	0.1
*Mean	0.11	0.12	0.12	0.11	Mean	--	--	--	--
* SD	0.01	0.01	0.01	0.01	SD	--	--	--	--
Maximum	0.13	0.13	0.13	0.13	Maximum	0.15	0.15	0.16	0.19
(-EAST-)	<0.01	<0.01	<0.01	<0.01	Minimum	<0.1	<0.1	<0.1	<0.1

*Less-than values not included.

Table 4-15. Summary for Orthophosphate and Sulfate Measurements for 1990.

Orthophosphate (mg/l)					Sulfate (mg/l)				
Sample Date	1	7	11	8	Sample Date	1	7	11	8
01/18/90	<0.01	<0.01	<0.01	<0.01	01/18/90	9.63	9.72	9.94	9.64
02/15/90	<0.01	<0.01	<0.01	<0.01	02/15/90	10.10	10.20	10.10	10.10
03/14/90	<0.01	<0.01	<0.01	<0.01	03/14/90	10.20	10.40	10.60	10.30
*04/11/90	<0.01	<0.01	<0.01	<0.01	04/11/90	9.60	9.50	9.20	9.40
05/16/90	<0.01	--	--	--	05/16/90	8.85	--	--	--
06/13/90	<0.01	--	--	--	06/13/90	8.60	--	--	--
07/18/90	<0.01	--	--	--	07/18/90	7.55	--	--	--
08/15/90	<0.01	<0.01	<0.01	<0.01	08/15/90	8.04	8.03	8.15	8.00
*09/13/90	<0.01	<0.01	<0.01	<0.01	09/13/90	--	--	--	--
10/02/90	<0.01	<0.01	<0.01	<0.01	10/02/90	8.97	9.02	9.09	8.97
11/28/90	<0.01	<0.01	<0.01	<0.01	11/28/90	7.66	7.76	7.81	7.66
12/12/90	<0.01	<0.01	<0.01	<0.01	12/12/90	9.16	9.20	9.29	9.20
Mean	--	--	--	--	Mean	9.17	9.23	9.27	9.16
SD	--	--	--	--	SD	0.92	0.95	0.95	0.93
Maximum	--	--	--	--	Maximum	10.20	10.40	10.60	10.30
Minimum	--	--	--	--	Minimum	8.04	8.03	8.15	8.00

Table 4-16. Summary of Total Dissolved and Total Suspended Solids Measurements for 1990.

Sample Date	Total Dissolved Solids (mg/l) 1	7	11	8	Sample Date	Total Suspended Solids (mg/l) 1	7	11	8
01/18/90	80.0	84.0	83.0	82.0	01/18/90	1.5	1.2	1.3	1.6
02/15/90	73.0	75.0	74.0	74.0	02/15/90	3.8	3.9	3.8	4.0
03/14/90	78.0	91.0	96.0	81.0	03/14/90	1.4	1.7	1.5	1.7
04/11/90	79.0	81.0	77.0	80.0	04/11/90	2.6	2.7	2.5	2.6
05/16/90	74.0	--	--	--	05/16/90	3.7	--	--	--
06/13/90	83.0	--	--	--	06/13/90	6.4	--	--	--
07/18/90	79.0	--	--	--	07/18/90	2.9	--	--	--
08/15/90	67.0	69.0	68.0	71.0	08/15/90	2.1	2.4	2.6	2.8
09/13/90	83.0	80.0	82.0	84.0	09/13/90	2.0	1.9	2.0	2.0
10/02/90	79.0	82.0	75.0	79.0	10/02/90	2.5	2.0	2.3	2.4
11/28/90	77.0	75.0	76.0	74.0	11/28/90	23.1	21.7	22.5	23.1
12/12/90	83.0	85.0	87.0	83.0	12/12/90	2.7	2.8	2.9	3.1
Mean	77.7	80.2	79.8	78.7	Mean	4.6	4.5	4.6	4.8
SD	5.0	6.5	8:3	4.6	SD	7.0	6.5	6.8	6.9
Maximum	83.0	91.0	96.0	84.0	Maximum	23.1	21.7	22.5	23.1
Minimum	67.0	69.0	68.0	71.0	Minimum	1.4	1.2	1.3	1.6

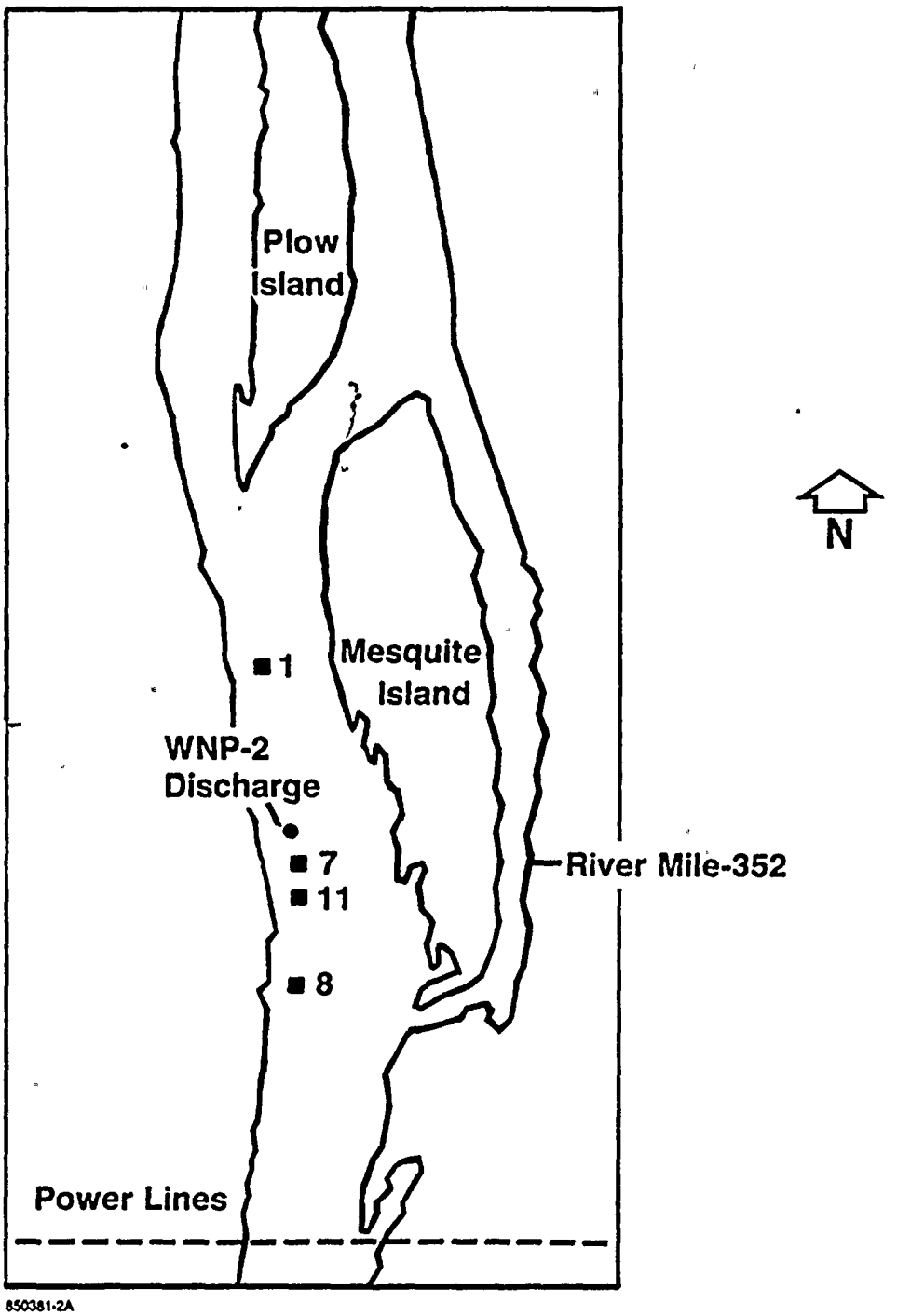


Figure 4-1 Location of Sampling Stations in the Columbia River

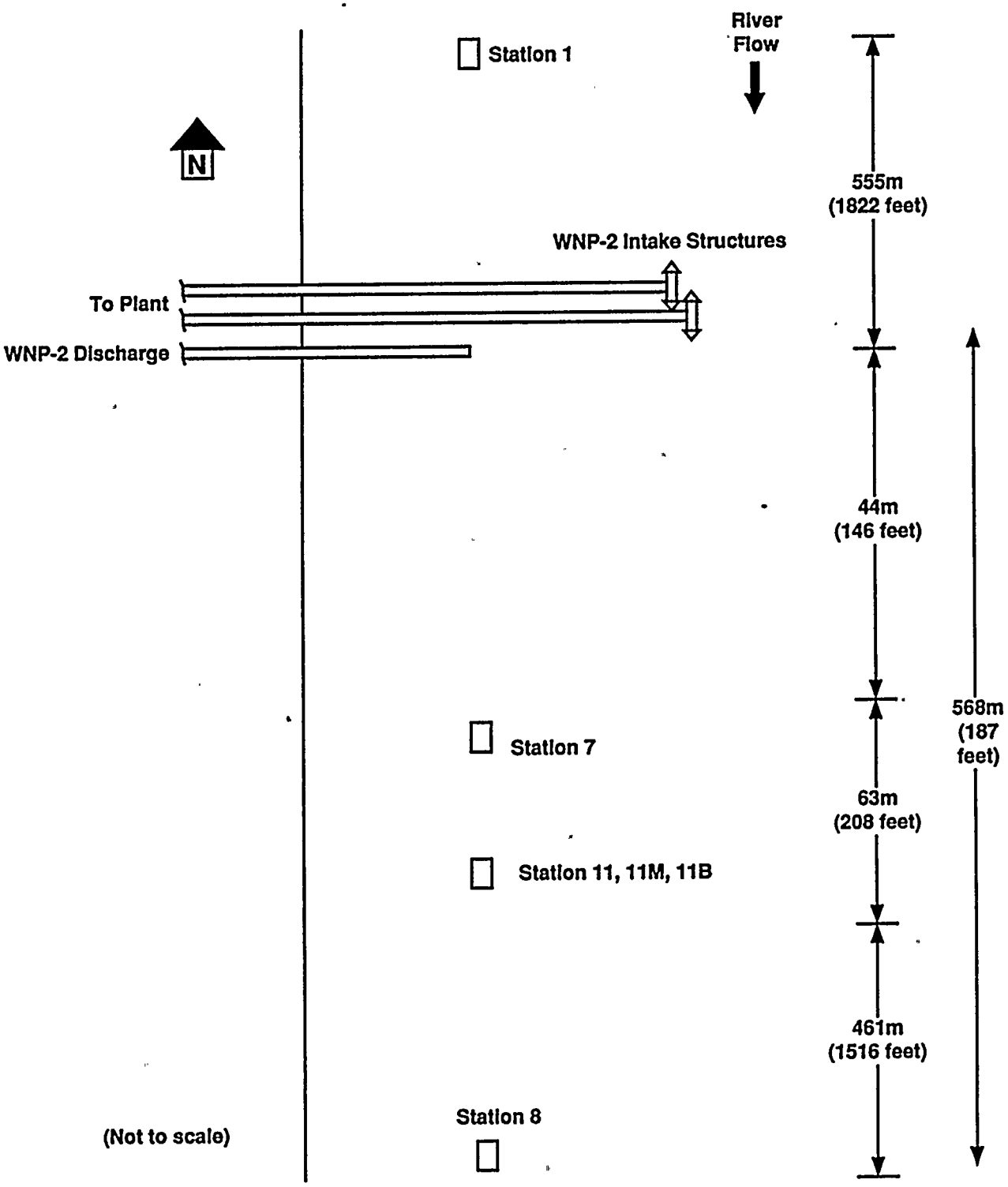


Figure 4-2 Sampling Station Locations for Water Chemistry

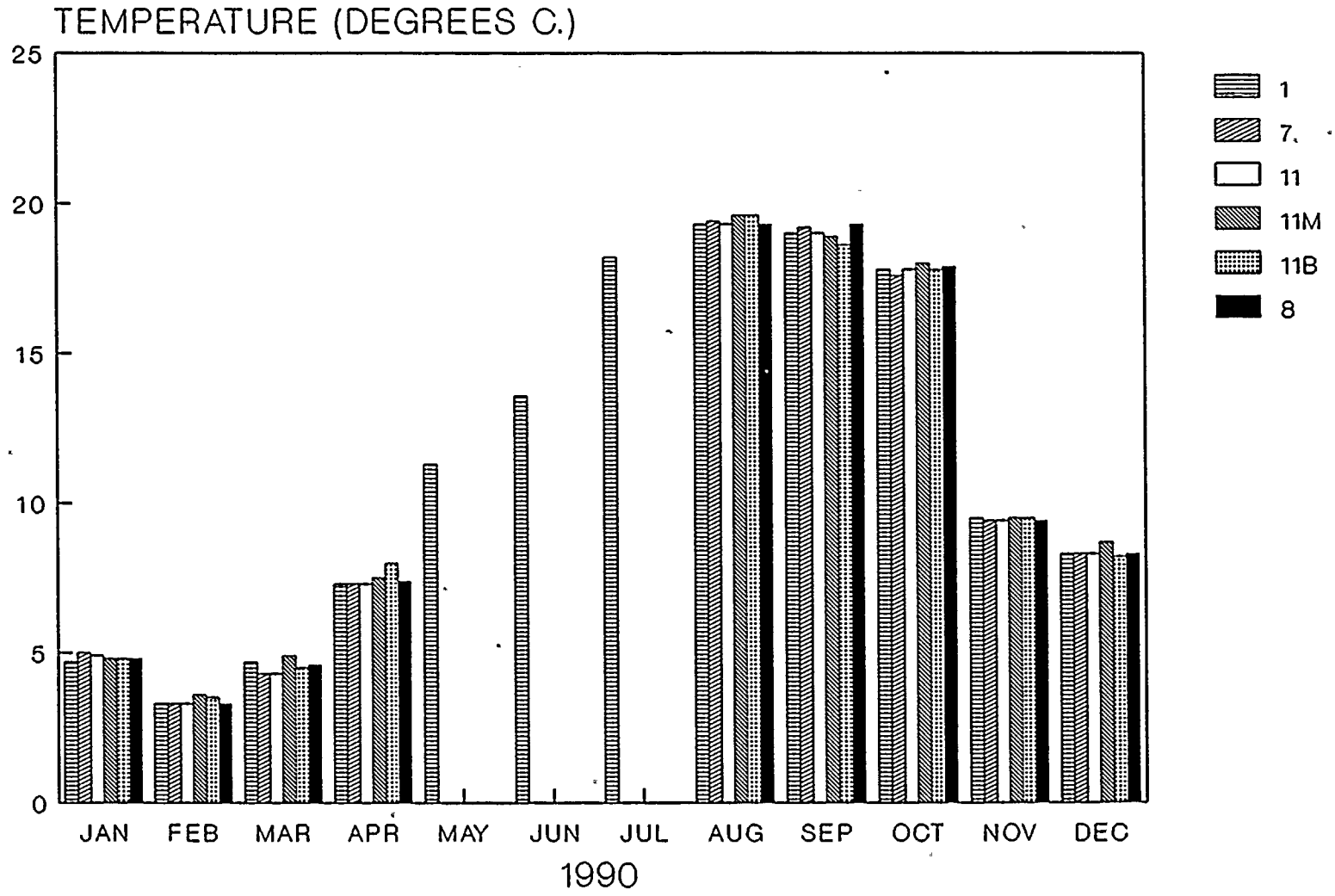


Figure 4-3 Columbia River Temperature Measurements at Six Stations During 1990

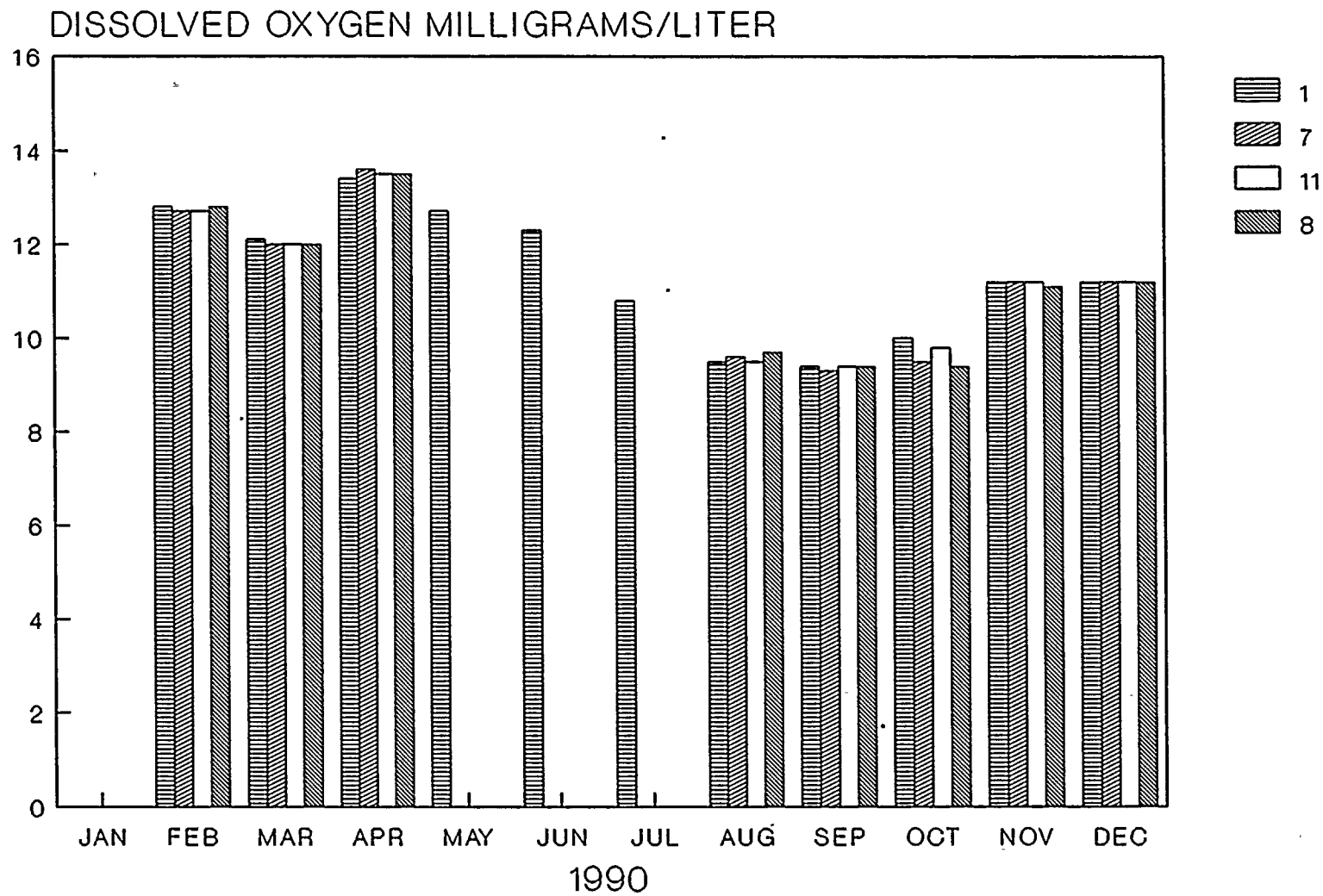


Figure 4-4 Columbia River Dissolved Oxygen. Measurements at Four Stations During 1990

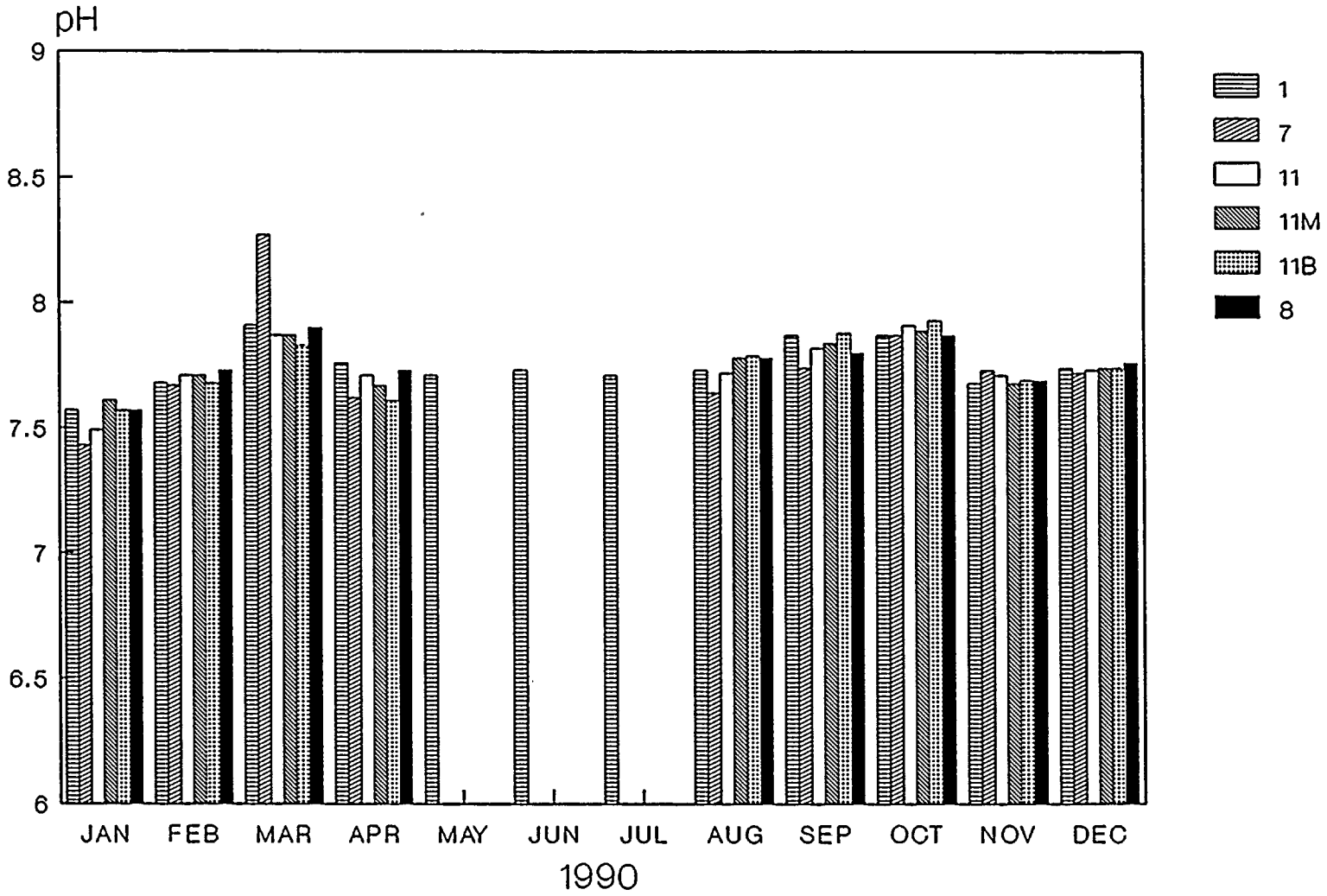


Figure 4-5 Columbia River pH Measurements at Six Stations During 1990

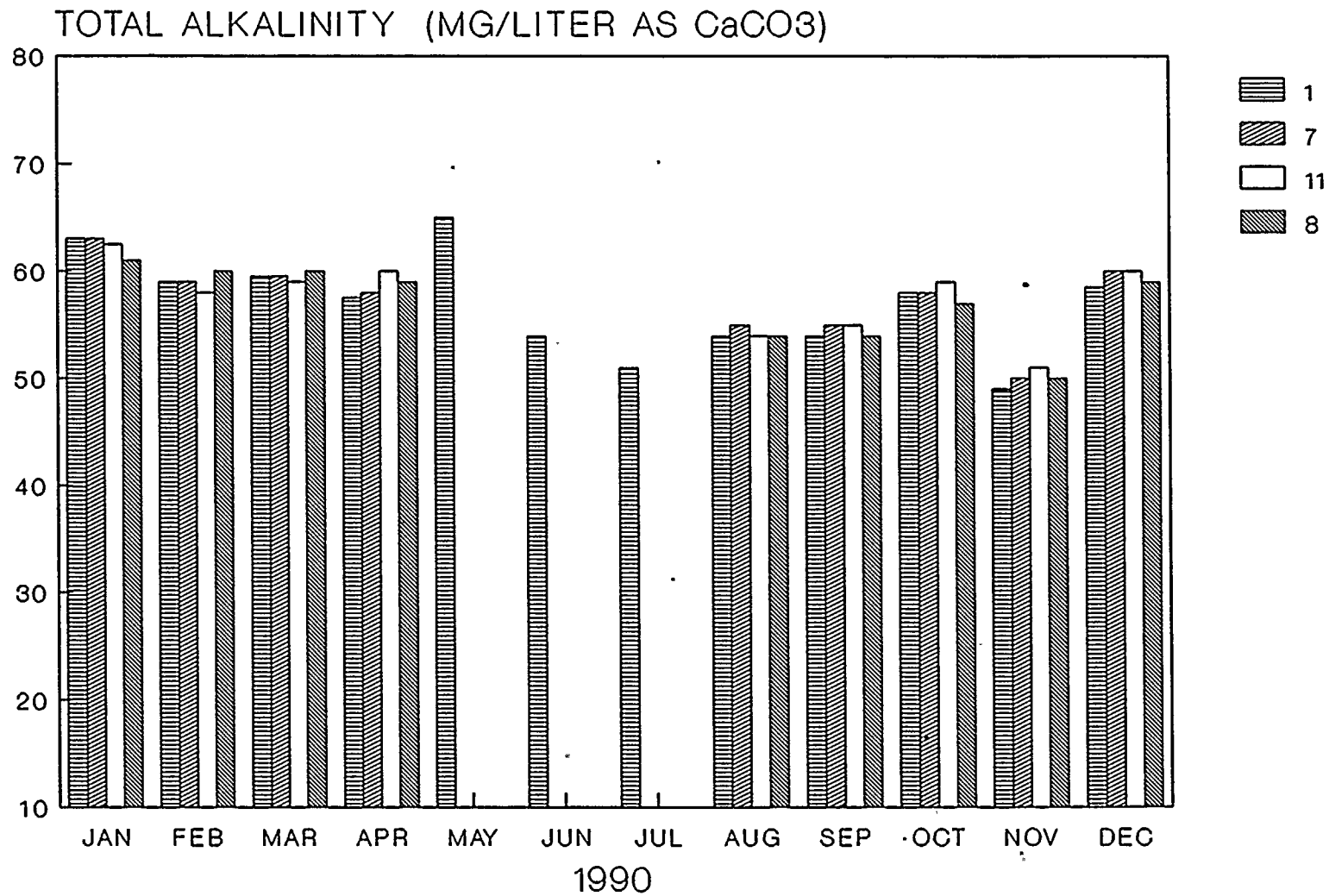


Figure 4-6 Columbia River Total Alkalinity Measurements at Four Stations During 1990

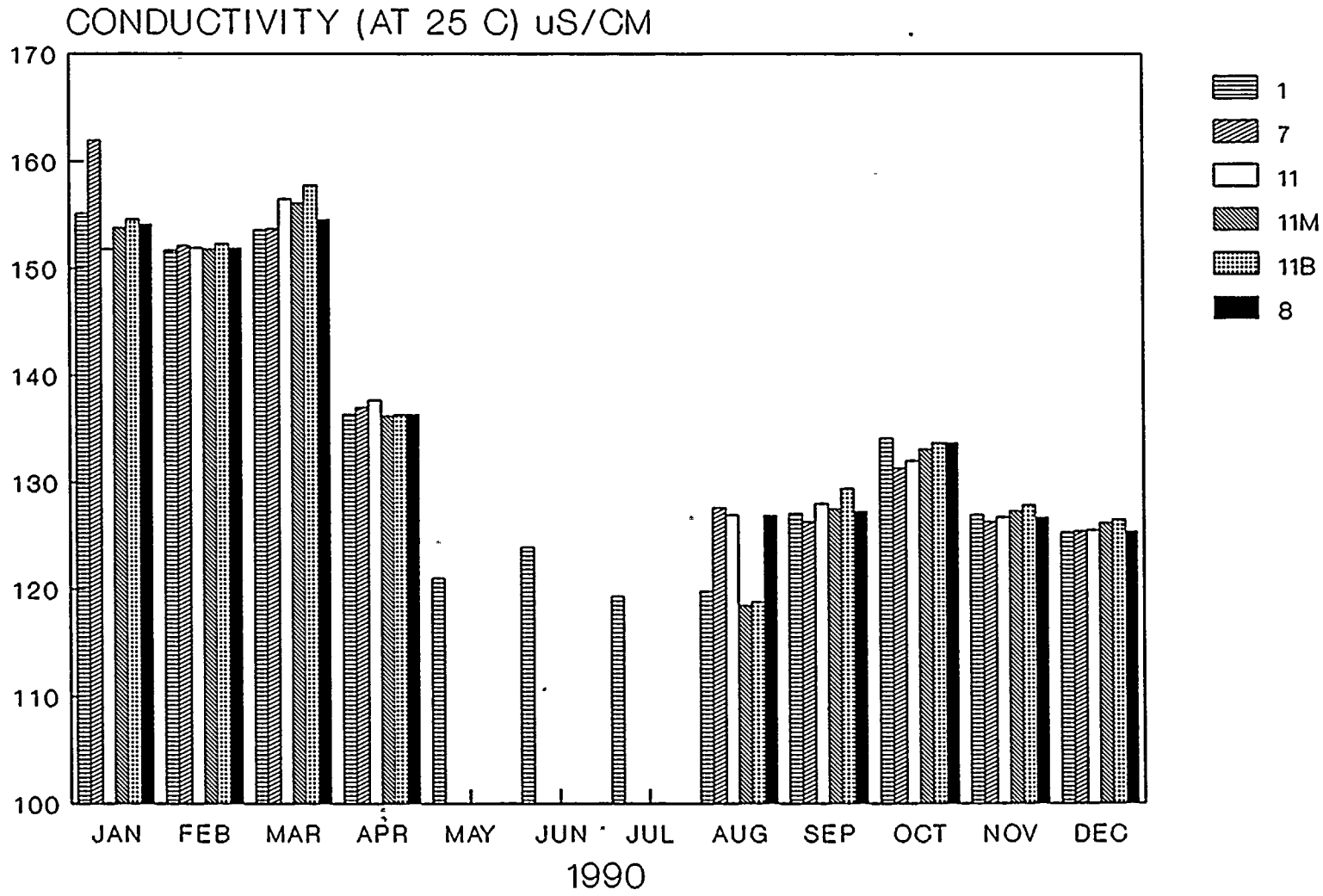


Figure 4-7 Columbia River Conductivity Measurements at Six Stations During 1990

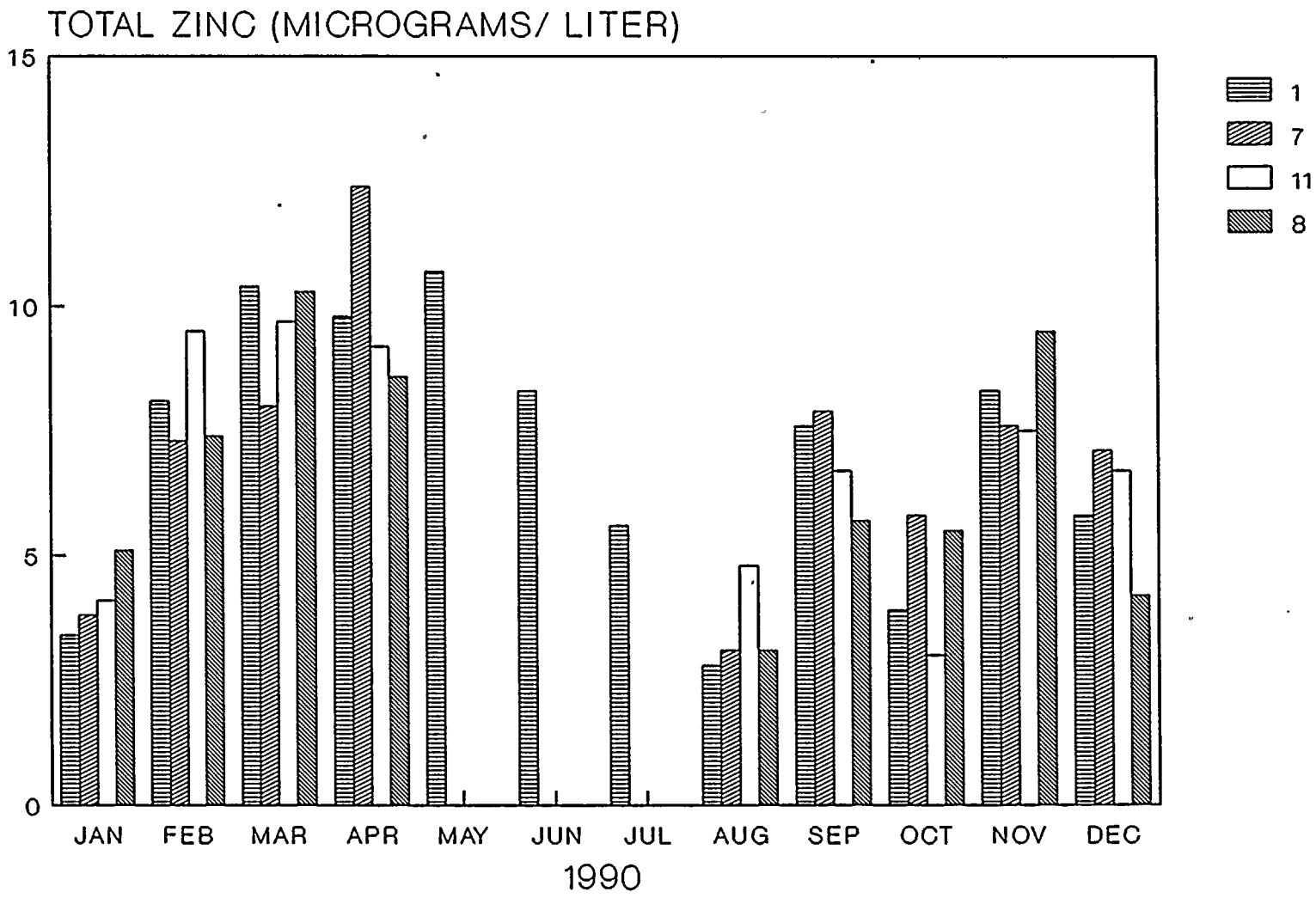


Figure 4-8 Columbia River Total Zinc Measurements at Four Stations During 1990

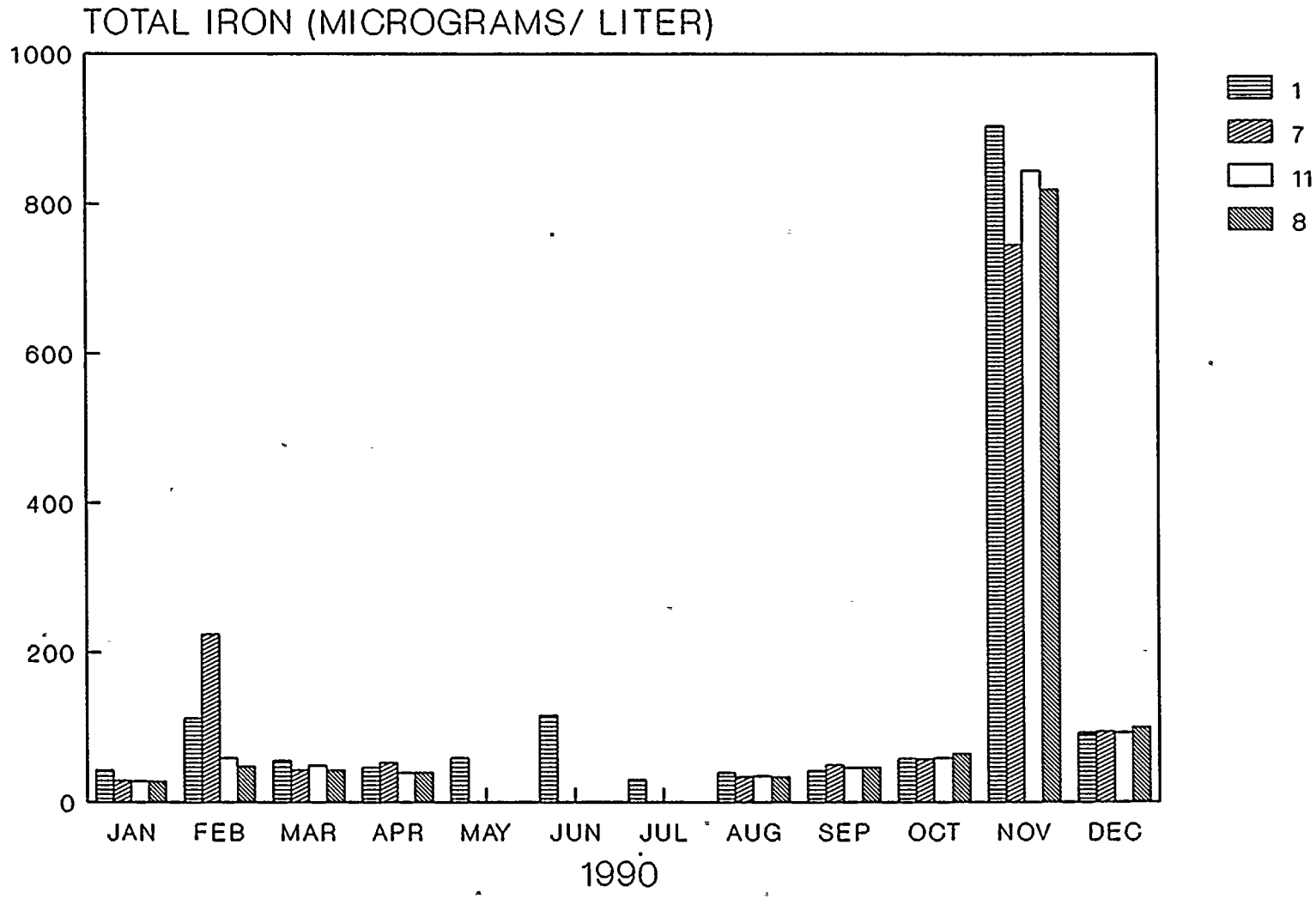


Figure 4-9 Columbia River Total Iron Measurements at Four Stations During 1990

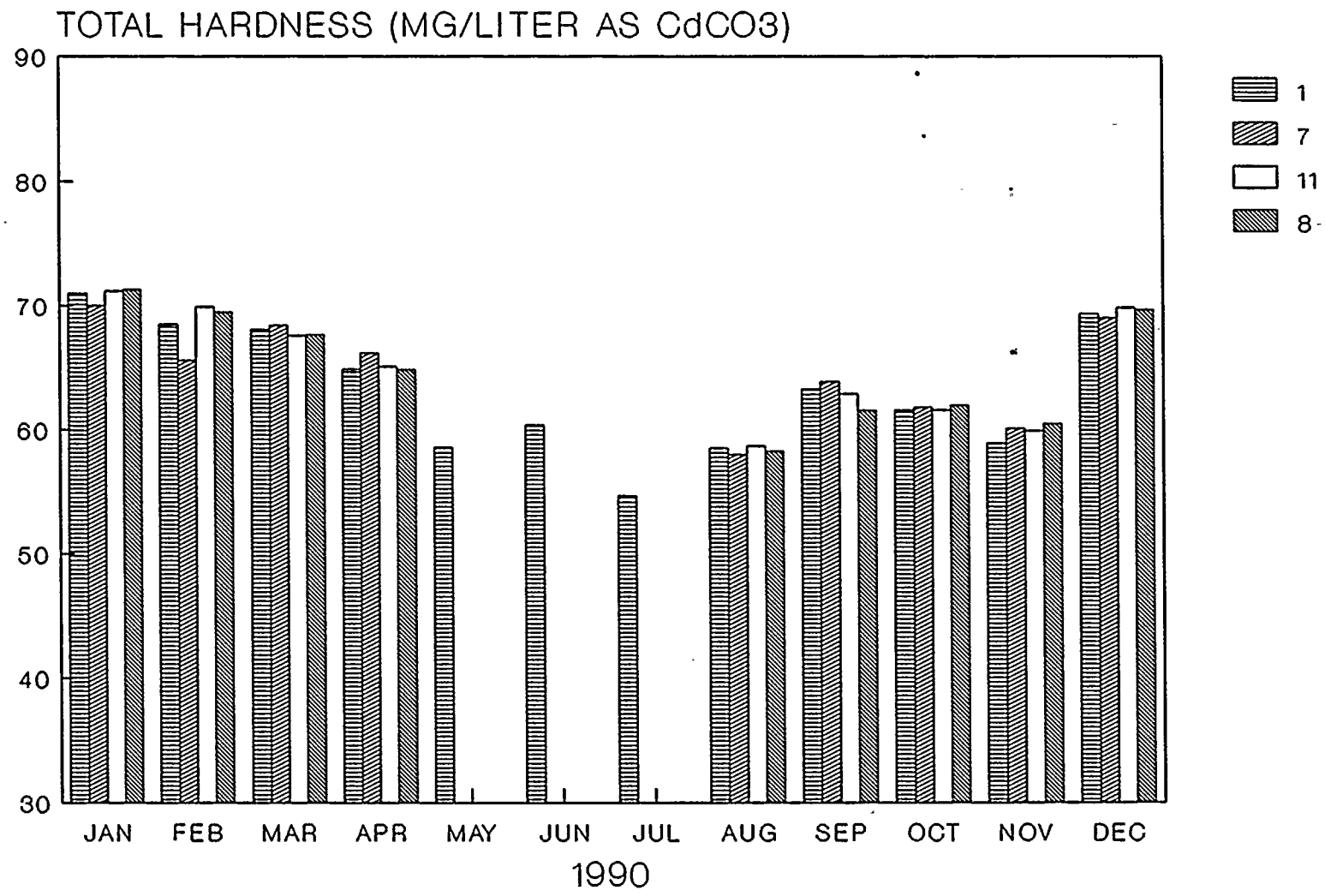


Figure 4-10 Columbia River Total Hardness Measurements at Four Stations During 1990

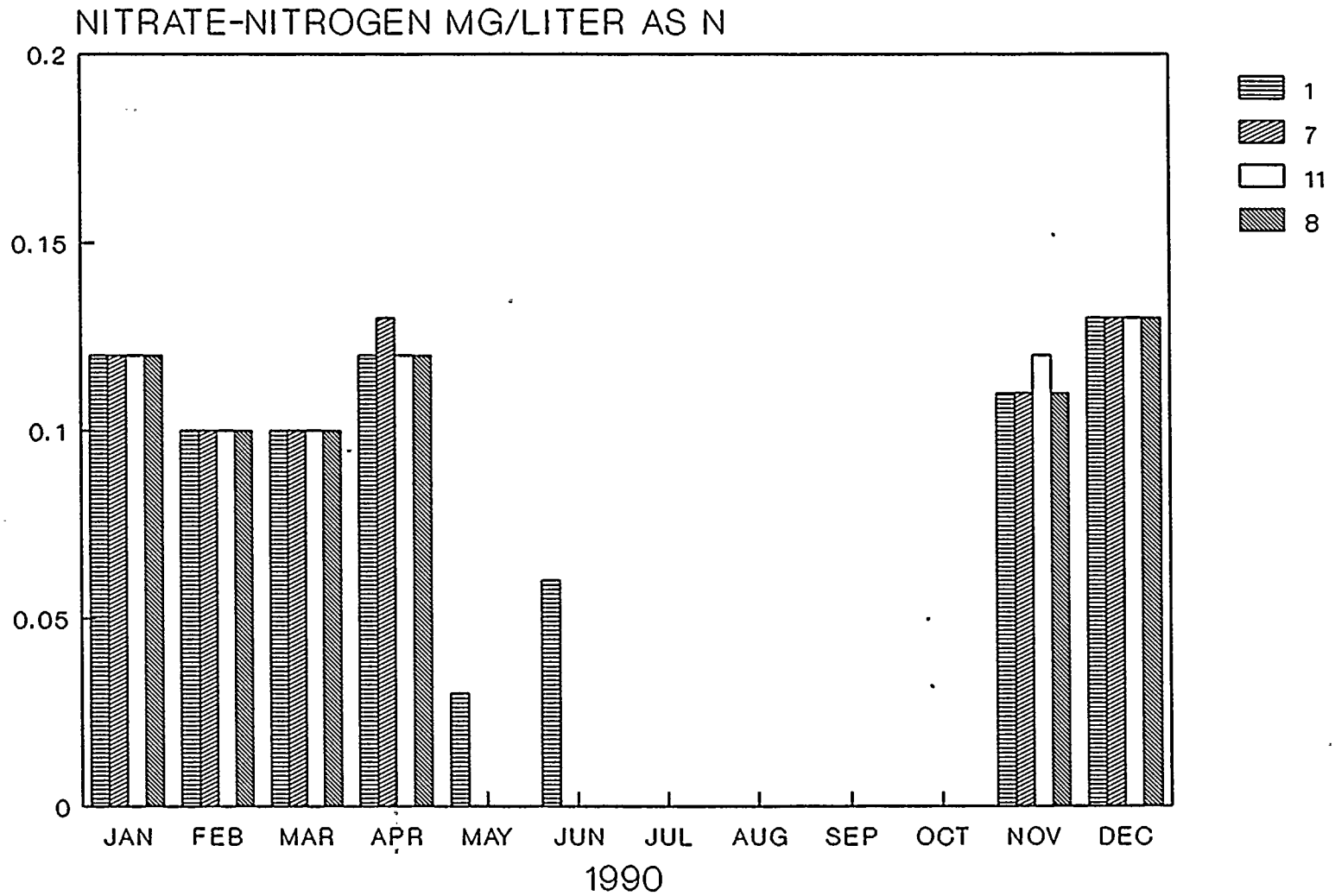


Figure 4-11 Columbia River Nitrate - Nitrogen Measurements at Four Stations During 1990

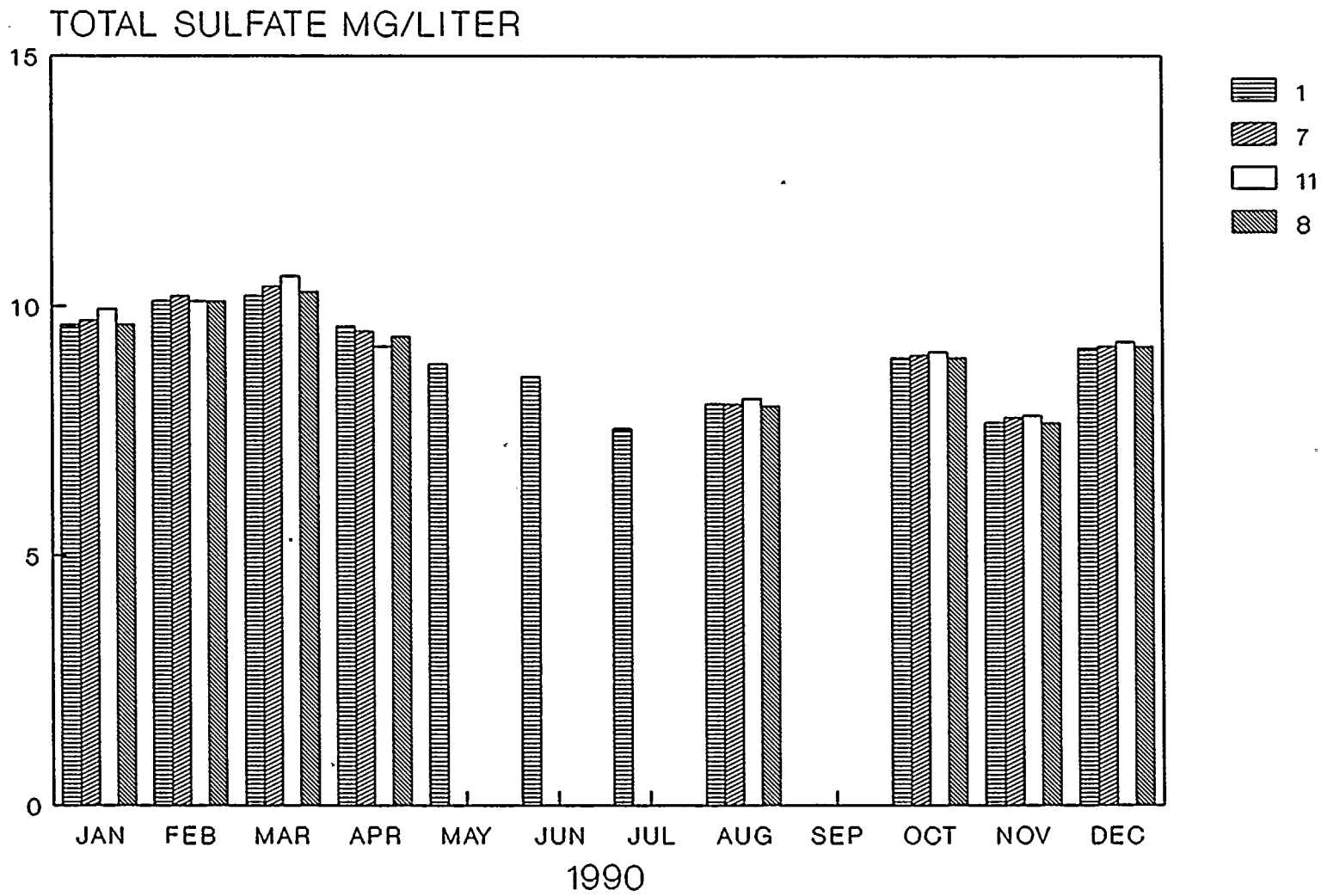


Figure 4-12 Columbia River Total Sulfate Measurements at Four Stations During 1990

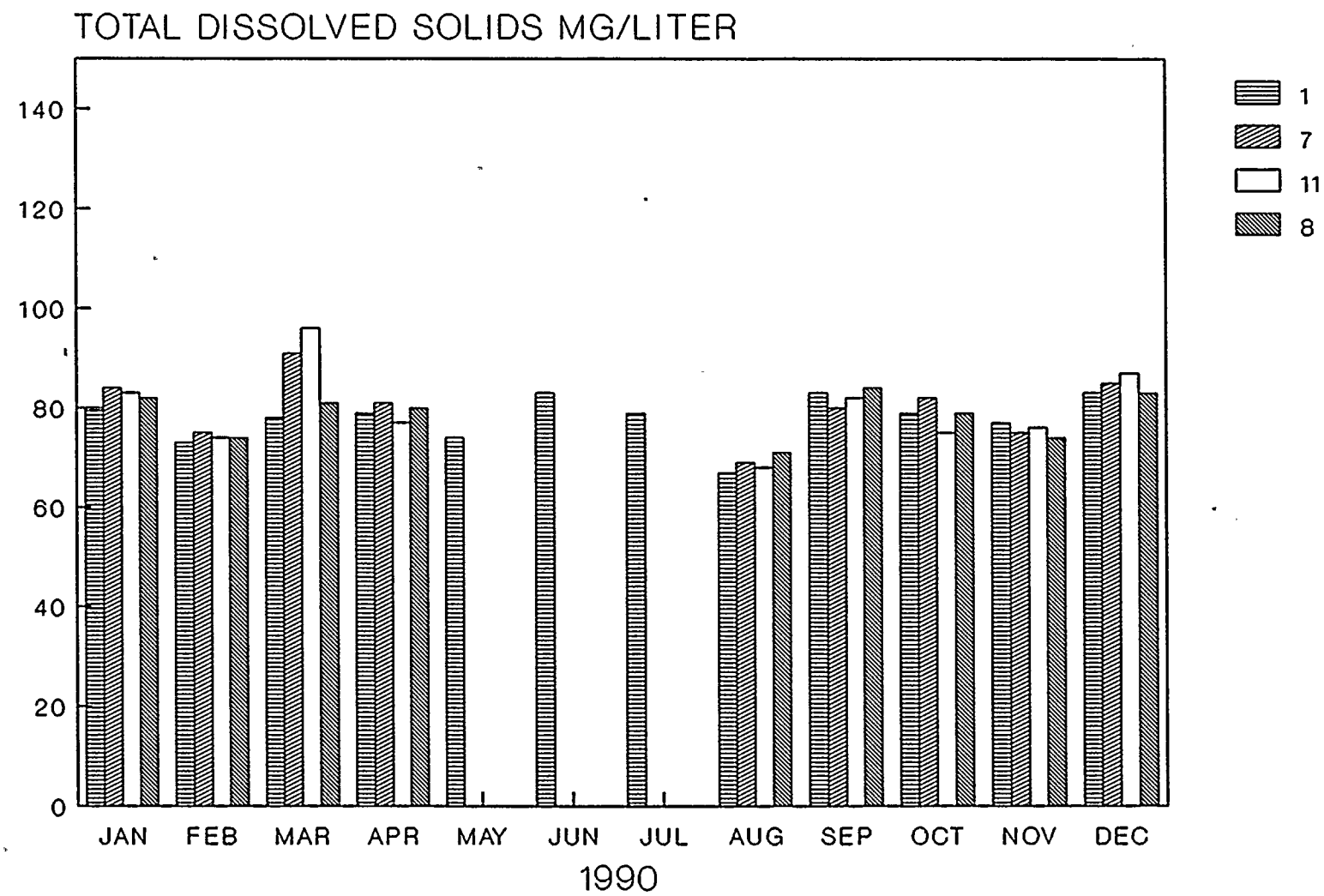


Figure 4-13 Columbia River Total Dissolved Solids Measurements at Four Stations During 1990

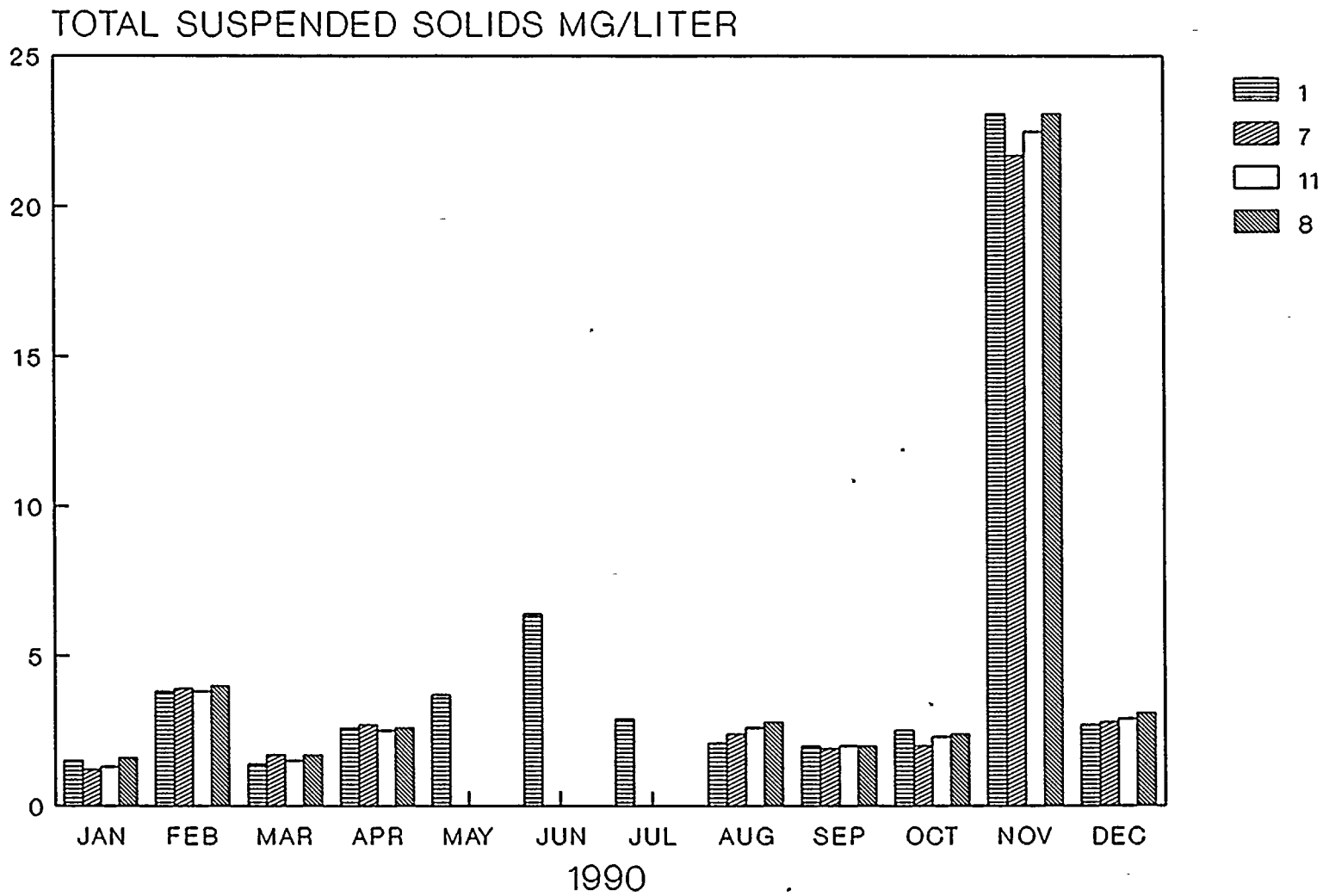


Figure 4-14 Columbia River Total Suspended Solids Measurements at Four Stations During 1990

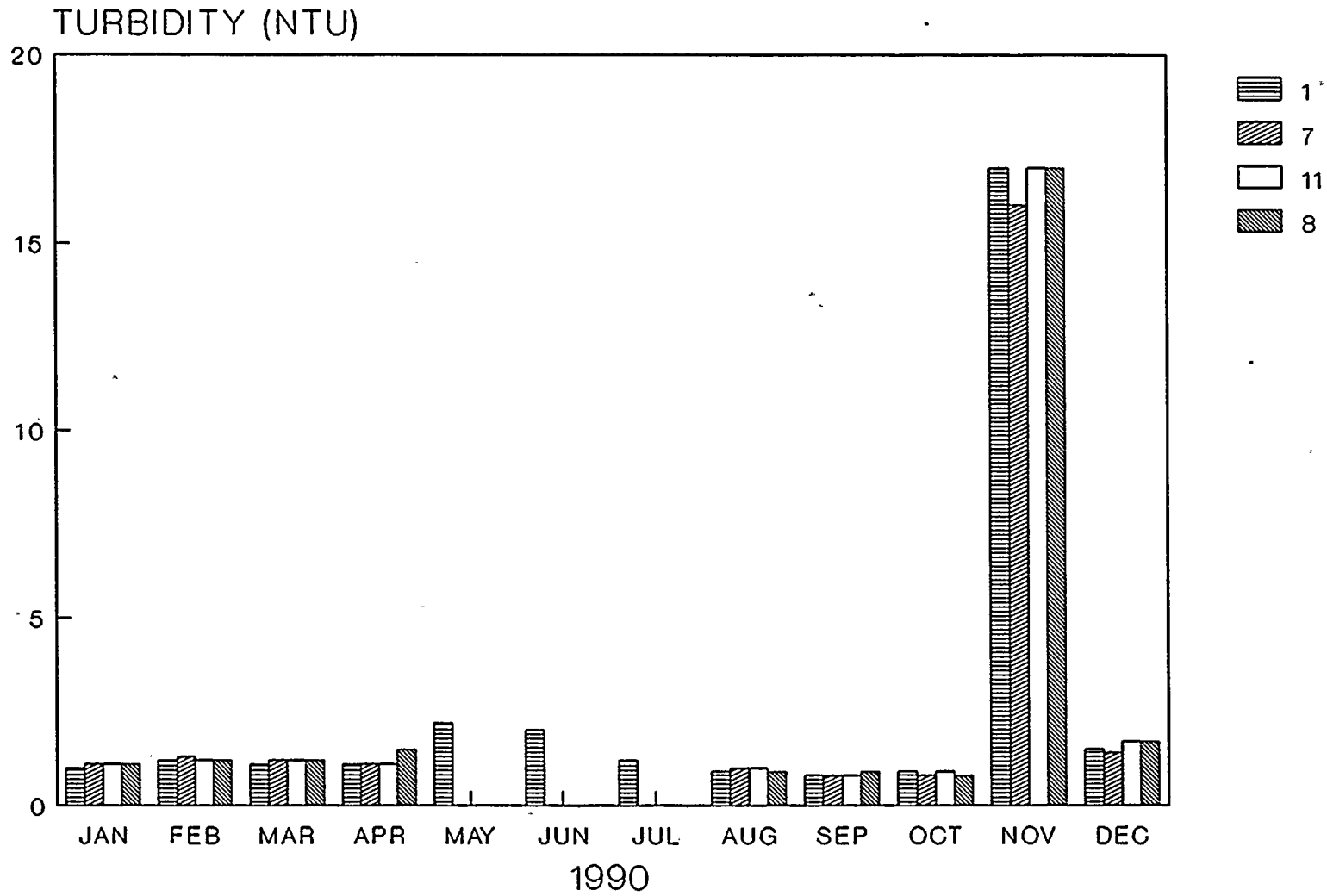


Figure 4-15 Columbia River Turbidity Measurements at Four Stations During 1990

5.0 COOLING TOWER DRIFT STUDIES

5.1 INTRODUCTION

The cooling tower drift studies were designed to identify any impact of cooling tower operation upon the surrounding plant communities, as well as any edaphic impacts. The program includes the measurement of herbaceous and shrub canopy cover, shrub density, herbaceous phytomass, vegetation chemistry and soil chemistry. Soil chemical parameters measured include pH, carbonate, bicarbonate, sulfate, chloride, sodium, potassium, calcium, magnesium, copper, zinc, lead, chromium, nickel, cadmium, and conductivity. Vegetation chemistry includes extractable sulfate, chloride and total copper. This study provides operational data for comparison with preoperational data and meets the requirements of Washington State Energy Facility Site Evaluation Council (EFSEC) Resolution 239 dated September 14, 1987.

In past years, sampling was conducted in May at each of nine permanent stations, four grassland Stations G01-G04, and five shrub Stations S01-S05. In 1988, preliminary data was obtained for six additional stations. In 1989, the additional six stations were added to the sampling program, four grassland sites G05, G06, G07 and G08 and 2 shrub Stations S06 and S07. Two of these Stations, S06 and S07 are on the east side of the Columbia River in Franklin County. Figure 5-1 shows the location of each station. The orientation of the various components including transects and productivity plots within each community are depicted in Figure 5-2.

5.2 MATERIALS AND METHODS

5.2.1 Herbaceous Canopy Cover

Fifty microplots (20 cm x 50 cm) were placed at 1-m intervals on alternate sides of the herbaceous transect (Figure 5-2). Canopy cover was estimated for each species occurring within a microplot using Daubenmire's (1968) cover classes. Data were recorded on a standard data sheet.

Quality assurance was accomplished by twice sampling three randomly selected microplots on each herbaceous transect. The entire transect was resampled if cover estimates for any major species (>50 percent frequency) differed by more than one cover class.

All vegetation studies including cover, density, productivity, and chemistry were sampled, as in previous years, at the peak of the cheatgrass growth cycle known as the purple stage (Klemmedson and Smith 1964).

5.2.2 Herbaceous Phytomass

Phytomass sampling was conducted concurrently with cover sampling. Phytomass sampling plots were randomly located within an area adjacent to the permanent transects or plots (Figure 5-2). At each station, all live herbaceous vegetation rooted in five randomly located microplots (20 x 50 cm) was clipped to ground level and placed in paper bags. Each bag was stapled shut and labeled with station code, plot number, date and personnel.

Sample bags were transported to the laboratory, opened, and placed in a drying oven until a consistent weight is obtained. Following drying, the bags were removed singly from the oven and their contents immediately weighed to the nearest 0.1 g. Laboratory quality assurance consisted of independently reworking 10 percent of the phytomass samples to assess data validity and reliability.

5.2.3 Shrub Canopy Cover

Five 50-m lines were used to measure shrub canopy cover in each of the seven shrub plots (Figure 5-2). Whenever a shrub was crossed by a tape stretched between the end posts, its species and the distance (cm) at which it intercepted the line were recorded. For each shrub plot, intercept distances of each species along all five lines were summed to give a total intercept distance. From this, a shrub canopy cover value (percent) was obtained by dividing total intercept distance by total line length.

Quality assurance procedures consisted of twice sampling one major species along a randomly selected shrub transect. Resampling was conducted if intercept lengths differed by more than 10 percent.

5.2.4 Shrub Density

Individual live shrubs were counted and recorded by species within each of the four strips delineated by shrub intercept transects (Figure 5-2). Number of shrubs per strip were summed to obtain shrub density by species for the entire 1000 m^2 plot. Sampling was concurrent with cover sampling.

Quality assurance consisted of resampling one randomly selected species within one strip. Resampling was conducted if the count difference exceeded one individual.

5.2.5 Soil Chemistry

At each of the fifteen grassland and shrub stations, five soil samples were collected from the top 15 cm of soil with a clean stainless steel trowel. The samples were placed in 250 ml sterile plastic cups with lids, labeled and refrigerated at 4°C. Sixteen parameters were analyzed in each sample including pH, bicarbonate, carbonate, conductivity, sulfate, chloride, copper, zinc, nickel, cadmium, lead, chromium, calcium, magnesium, sodium and potassium. Samples were analyzed for pH, bicarbonate, carbonate, sulfate, chloride and conductivity according to Methods of Soil Analysis (1965). Samples for chromium, cadmium and lead were analyzed by graphite furnace atomic absorption spectroscopy according to Methods for Chemical Analysis of Water and Wastes (USEPA 1983). The remaining elements were analyzed by inductively coupled plasma emission spectroscopy (ICPES) (USEPA 1983). Aliquots of soil for trace metal analyses were digested according to Gilman (1990). Preservation times and conditions, when utilized, were according to USEPA (1983).

Laboratory quality control comprised 10% - 20% of the sample analysis load. Routine quality control samples included internal laboratory standards, reagent blanks, and prepared EPA or NIST controls.

5.2.6 Vegetation Chemistry

Samples of *Bromus tectorum*, *Poa sandbergii*, *Artemisia tridentata* and *Purshia tridentata* were collected at each station. Two species were substituted at some of the stations due to absence of one or more of those listed above. Substitute species were *Phlox longifolia* and *Sisymbrium altissimum*. Samples were collected as close to the soil sampling station as possible. Sufficient quantities of leafy material of each species were collected to yield at least five grams of dry weight. The clipped material was sealed in a plastic bag, labeled and refrigerated at 4°C until sample preparation.

In the laboratory, the clipped plant tissue was oven dried to a constant weight, ground in a Wiley mill and digested according to Gilman (1990). Sulfate was analyzed by nephalometry and chloride by mercuric chloride titration according to USEPA (1983). Copper was analyzed by ICPES according to USEPA (1983).

5.3 RESULTS AND DISCUSSION

During the 1990 season, 58 plant taxa were observed in the study area. These are presented in Table 5-1. Table 5-2 lists by year the species of vascular plants observed during field activities from 1975-1990. Many of the graphs will depict a preoperational, operational and 1990 status. The preoperational data is that which was collected annually prior to WNP-2 becoming fully operational (1980-1984). Operational data is that which is collected after 1984 but not including the current year which is listed separately (1990).

5.3.1 Herbaceous Cover

Herbaceous cover data for 1990 are summarized in Tables 5-3 and 5-4. Figures 5-3 and 5-4 provide a comparison of shrub and grassland sites (annual grasses - AG, perennial grasses - PG, annual forbs - AF, and perennial forbs - PF) with the data of previous years. There is a noticable trend of the herbaceous cover reverting back to its original state prior to the fire of 1984.

Total herbaceous cover averaged 45.56% in 1990 which represents a 38.01% decrease from 1989 (73.5%). As in previous years, the dominant annual grass was Bromus tectorum with 25.80% followed by Festuca octoflora with 0.25%. Perennial grasses averaged 11.73% in comparison to 32.5% in 1989. Poa sandbergii (9.18%) was the dominant perennial grass at most stations followed by Stipa comata (1.94%).

Total annual forb cover averaged 5.8% down from the 11.3% measured in 1989. Holosteum umbellatum was the dominant component with 2.37% followed by Draba verna (1.55%) and Microsteris gracilis with .93%.

Perennial forb cover decreased 63.3% from 1989 (1.98% vs. 5.4%). The dominant species were Cymopterus terebinthinus (.84%) and Balsamorhiza careyana (.48%).

Species frequency values (%) for each station were similar to previous years and are summarized in Table 5-5. The greatest diversity of species was observed at Station S02 (17) while the smallest was observed at Station S07 (2). Due to misinterpretation of 1989 data, Station S02 was listed as having the greatest diversity of species, the text should have listed station G05(19) as having the greatest diversity.

Growing season precipitation decreased 51% from 1989 (6.83 cm vs 13.97 cm), with the total precipitation for the 1990 growing season being 6.83 cm. December 1989 and March 1990 precipitation, 0.74 cm and 0.25 cm, respectively, were lower than all previously recorded data for those months. Mean temperature during the growing season was 6.4°C in 1990 vs. 4.5°C in 1989.

5.3.2 Herbaceous Phytomass

Mean production of herbaceous phytomass in 1990 was 34.95 gm/m2. At grassland stations, phytomass production averaged 33.8 g/m2 while at shrub stations it was 36.2 g/m2. Production varied widely among stations from a low of 4.1 g/m2 at Station G02 to a high of 78.3 g/m2 at Station S02. Mean herbaceous phytomass production at grassland stations and at shrub stations for 1990 is shown graphically in Figure 5-5 (Stations G05, G06, G07, G08, S06 and S07 were

not added until 1989) and is summarized in Table 5-6. Table 5-7 presents mean phytomass values for each station in each year since 1975. Mean herbaceous phytomass and percent herbaceous cover for each station from 1980 through 1990 are presented graphically in Figures 5-6 through 5-9.

5.3.3 Shrub Cover and Density

There are four shrub species in the study area: Artemisia tridentata, Purshia tridentata, Chrysothamnus nauseosus and Chrysothamnus viscidiflorus. Eriogonum niveum (a subshrub) and Opuntia polyacantha (a cactus) are also present, however, they are not included in the cover data. During a 1984 August range fire, all viable shrubs were completely destroyed at Stations S02 and S04, while the only individuals surviving at Station S01 were isolated clumps of low growing Eriogonum niveum.

Shrub density and cover data continue to reflect recovery from the 1984 fire. Percent cover measurements taken in 1990 are very similar to those measured in 1989 with an overall slight decrease in average cover (1.56% versus 1.63%). Shrub density increased slightly at Stations S02 and S05, and decreased slightly at Stations S01, S03, and S04. Shrub density data for 1990 is summarized in Table 5-8, while shrub density data at each station from 1980 through 1990 is presented in Figure 5-10. Shrub cover data for 1990 is summarized in Table 5-9, while Figure 5-11 presents mean shrub cover values measured from 1975 through 1990. Shrub cover and density at each station for 1990 are presented graphically in Figure 5-12.

5.3.4 Soil Chemistry

The results of the 1990 soil chemical analyses are presented in Table 5-10 and are shown graphically in Figures 5-13 through 5-20.

Most metallic element concentrations were within the ranges observed in previous years. There is no concentration of carbonate, due to the pH level of the samples (< 8.3). The pH value has to be above 8.3 in order for carbonate to be present.

Bicarbonates was similar to that observed in past data. Conductivity was generally within range at all stations except G03 (96.8), where it increased markedly, as well as in 1985 and 1988 (98.0 and 125.6, respectively). The pH of station G03 increased slightly after a steady decrease for the past 5 years. Sulfate and chloride concentrations were generally higher than were observed in previous year's data.

5.3.5 Vegetation Chemistry

The results of the 1990 vegetation chemical analyses are presented in Table 5-11 and shown graphically in Figures 5-21 through 5-30.

Total vegetation copper concentrations were generally within the ranges previously observed in all of the species examined. Extractable chloride concentrations were generally within the ranges observed in previous years, while extractable sulfate concentrations were higher than in previous years except at Station G08 for *Poa sandbergii*.

5.4 SUMMARY AND CONCLUSIONS

A 51% decrease in precipitation during the 1989-90 growing season was associated with a 38.01% decrease in mean herbaceous cover for 1990 (Figure 5-4). A corresponding decrease in herbaceous phytomass was observed at all Stations, except S02 and G04. The remaining analytes were generally within the ranges previously observed. Changes in vegetation cover and density recorded in 1990 appear to be climatically induced and no signs of adverse impacts from the operation of WNP-2 cooling towers are evident.

Shrub cover and density data continue to reflect recovery from the 1984 range fire with slight changes in cover and density evident at most stations.

No adverse trends or impacts upon soil or vegetation chemistry are apparent from the six years of operational data.

5.5 COOLING TOWER DRIFT MODEL VALIDATION STUDY

5.5.1 Introduction

This study was implemented in January 1989 and its intent was to measure the levels of and determine the rate of airborne salt deposition originating from the WNP-2 cooling tower steam condensate plume. The WNP-2 heat rejection system consists of a steam condenser, six mechanical draft cooling towers and the interconnecting piping. Operation of the cooling towers results in the emission of droplets of the circulating cooling water. These droplets are referred to as drift.

The differentiation between drift and the visible steam plume condensate is important. The drift droplets are produced mechanically within the towers whereas the visible plume condensate droplets are created by the cooling of the saturated tower exhaust air. The drift droplets contain similar, if not identical, concentrations of chemicals as the circulating cooling tower water. Depending upon the chemicals present in the circulating water, the drift may have an effect on the environment. In order to assess environmental impact, it is important that the amount of drift and its resulting distributions be determined. (Laulainen, et al)

This section reports the results of a year-long study designed to verify the predicted areas of maximum and minimum deposition. This program was performed to comply with EFSEC Resolution No. 239, dated September 14, 1987.

5.5.2 Experimental Methods

5.5.2.1 Sample Plan

An isopleth graphically depicting the predicted cooling tower drift deposition patterns was devised by Battelle in 1976. This prediction was based upon preliminary estimates of operative data and site specific meteorological data regarding predominant wind directions. A cooling tower drift deposition model devised by C. L. Hosler was used for the calculations (Droppo, et al 1976).

The resulting prediction of deposition patterns, as published by Battelle, is presented in figures 5-31 and 5-32. As shown in these figures, the predicted maximums of drift deposition lie in a northwesterly direction and a nearly south-southwesterly direction. These areas of predicted maximums were later revised by the Supply System. The final orientation was chosen in a northwesterly and a nearly south-southeasterly direction. The sampling stations were chosen to lie along a northwest radial transect and an approximately south-southeast radial transect.

Sixteen sample locations were initially included in this study. A map of these locations is shown in Figure 5-33. Directions and approximate distances from the center of the cooling towers are listed in Table 5-12 for each sampling station. The sixteen locations included a pair of collectors located in the center of the six cooling towers and a control pair of collectors located approximately seven miles north-northwest of WNP-2 at the old Hanford townsite. The remaining fourteen pairs of collectors were placed at equidistant intervals out from the plant, seven pairs along each transect.

Preliminary sampling was initiated in January 1989 and actual data collection began in April 1989. A separate program involving the determination of drift deposition rates in the transformer yards surrounding WNP-2 began sample collection in July 1989. This involved the placement of an additional eight pairs of collectors, five pairs in a transformer yard 0.25 miles north, one pair in a transformer yard 0.5 miles north, one pair in a transformer yard 0.5 miles east-southeast of the WNP-2 cooling towers. While the information was intended for another purpose, the sampling was performed in the same manner as the original sixteen samplers and the results provide additional data for drift deposition characterization. It should be noted, however, that the transformer yard sampling coincided with only nine of the twelve months of sampling for the original sixteen sites.

5.5.2.2 Sample Collection

Data gathered for this study involved surface deposition measurements. These measurements were used to determine bulk mineral mass deposition rates.

Sample collection was based upon criteria set forth in the American Standard Test Method (ASTM) D1739-70 for the collection and analysis of dust fall.

The sample collection vessel consisted of an open topped linear polyethylene cylinder with vertical sides and a flat bottom. The cylinder was six inches in diameter and eighteen inches high. A support stand positioned the cylinder such that its bottom was eighteen inches above grade. The top of the container was three feet above grade which deviates from the ASTM recommended minimum and maximum heights of eight and fifty feet. This was to more closely monitor drift deposition at the typical height of local vegetation. A metal bird ring was positioned above the cylinder to help prevent interference from birds. The cylinder was also covered with a screen to prevent sample contamination from bird droppings and insects. Figure 5-34 illustrates a typical sample collector. A pair of collectors were placed at each sampling location.

Sample collection occurred monthly (every 30 ± 2 days when possible). In the laboratory, the cylinders were thoroughly washed and rinsed, filled with four liters of deionized water and covered. They were then transported to the field and placed in the support stands. During the summer months, the samplers were checked periodically and additional deionized water added when necessary to insure an adequate liquid level was maintained. An antifreeze, isopropyl alcohol, was initially used during the preliminary sampling months of February and March. This was discontinued, however, due to its general ineffectiveness and to eliminate a potential source of contamination. After approximately thirty days in the field, the cylinders were covered, exchanged with clean samplers, and transported back to the laboratory. Any evidence of contamination such as insects or bird droppings was noted and recorded. At the laboratory, the total volume of water was measured; a 500 milliliter aliquot was taken for sample analysis, and the remaining sample was discarded.

5.5.2.3 Analytical Methods

Sample analysis involved determination of five inorganic constituents normally found in high concentrations in the cooling tower circulating water. These analytes included calcium, magnesium, sodium, sulfate and chloride.

Analytical techniques utilized ion chromatography for sulfate and chloride. A Dionex Series 4000i ion chromatograph equipped with an AS4A anion separation column was used. Calcium, magnesium and sodium were analyzed using inductively-coupled plasma (ICP) atomic emission techniques. Analyses were performed on a Perkin-Elmer P40 Model ICP.

5.5.3 Plant Operation

During the sampling period from March 22, 1989 to March 20, 1990, WNP-2 operated for a total of 6826 hours or 284.4 days. Plant operational data for each sampling period is presented in Appendix A. Circulating water flow, estimated amount of drift release per day and concentrations of the tracer ions in the circulating water are listed.

The plant normally operated with circulating water at approximately twelve cycles. In January 1990, however, a tube leak in a condenser was identified. As a result, the circulating water was kept at a maximum of five to six cycles until the annual maintenance outage. This reduced the circulating water ion concentrations by more than half for the remainder of the sampling period.

Drift estimates were calculated using a drift rate of 0.05 percent of the circulating water flow. Amounts of each ionic species released per month were calculated using the average concentration for each ion during the sampling period. Until July 1989, the circulating water was analyzed daily for calcium while the remaining ion concentrations were calculated based on the calcium concentration and established ion ratios for sodium, magnesium, chloride and sulfate to calcium. Beginning in July, the circulating water was sampled weekly and each constituent was determined by direct analysis.

5.5.4 Meteorological Conditions

The detailed meteorological conditions concerning the sampling period are contained in Appendix B. These data were obtained at the Hanford Meteorological Station in the 200 Area of the Hanford Site, located approximately 25 miles northwest of Richland, Washington. Included in the

appendix are maximum, minimum and mean temperatures, prevailing wind directions, average wind speed and relative percent humidity for March 1989 through March 1990. A windrose generated from the onsite WNP-2 meteorological station at the 33 foot level is featured in Figure 5-35. This represents prevailing wind directions and percentages for the sampling period of April 1989 through March 1990. The predominant wind directions were from the south blowing north (13.4 percent) and from the northwest blowing southeast (11.2 percent). This correlates fairly well with a windrose generated from cumulative WNP-2 meteorological data gathered from 1984 through 1989, shown in Figure 5-36. For this six year period, the predominant wind directions were from the south (10.9 percent) and from the northwest (10.6 percent). Although the direction frequency percentages were somewhat higher for the sampling period, the prevailing directions were the same.

5.5.5 Data Analysis

The monthly raw analytical results for each sample location are located in Appendix C. Presented there is the average gross deposition mass in milligrams for each ion analyzed and the standard deviation between the duplicate collectors located at each site. The average ion masses for each of the analytes were summed to give a monthly bulk deposition for each of the sixteen sampling locations. The twelve monthly depositions for each station were then totaled to give a yearly bulk deposition in milligrams. Using the diameter of the collection vessel to determine the surface area of the sampler, this mass was converted to a value in units of pounds per acre year. The values for each station are tabulated in Table 5-13. Deposition rates were corrected for background deposition by subtracting the control site deposition rate from each drift sampler rate.

5.5.6 Results

On the basis of the predicted drift patterns, the greatest deposition is expected to occur adjacent to the cooling towers and to decrease as a function of distance from the towers. This is verified by the sampling program, showing a maximum deposition rate of 52 lbs/acre-year at 0.2 miles south from

the towers (Station 7), decreasing to a deposition rate not significantly higher than background deposition at a distance of 3 miles. This is graphically presented in Figure 5-37.

The model also predicts deposition rates will be much higher during the winter months due to high humidities and lower temperatures which permit the larger diameter drift droplets to intersect the ground surface. As a result, the drift falls as wet deposition in more highly concentrated areas as opposed to undergoing evaporation and subsequently a wider dispersion. This prediction is verified by the study. At Station 7, as an example, the drift accumulated during November, December and February accounted for almost 70 percent of the total drift mass deposited there during the twelve month sampling period. Significant increases of deposition rates were also noted during these three months for Station 8, located in the center of the towers. The drift deposited during the same three month period accounted for almost 60 percent of the total accumulated mass.

In predicting the areas of maximum deposition, the maximum salt deposition will be directly proportional to the wind direction frequency (Droppo). From this statement and the site-specific wind frequency percentages from the past six years, one would expect the maximum areas of deposition to be found to the north and southeast of the plant, correlating with the maximum wind direction frequencies of 10.9 percent from the south (drift to the north) and 10.6 percent from the northwest (drift to the southeast). This is in direct contradiction with the isopleths showing the predicted areas of deposition. The figures show areas of maximum deposition to lie in a northwesterly and nearly southwesterly direction. Referencing the text of the Battelle document in which the isopleths are presented shows further contradictions between the expected areas of maximum deposition and the isopleths. From the document, "the maximum wind direction frequency at WNP-2 was 9 percent from the south (drift to the north). The measurement elevation was seven meters (23 feet). At an elevation of 122 meters (400 feet) at the Hanford Meteorological Station, the maximum direction frequency was 20 percent from the northwest (drift to the southeast) (Droppo). Further investigation confirmed that the isopleths, as originally presented, had been rotated a full 180°, thus

incorrectly predicting the areas of maximum deposition. As a result, the monitoring stations, as placed for this study, are not in the expected areas of maximum deposition. This is substantiated by field data collected for the transformer yard sampling stations. At a transformer yard 0.25 miles north of the cooling towers, samplers experienced an average rate of 112 lbs/acre for a nine month period coinciding with the original sample collection. This rate is more than two times greater than the maximum twelve month rate determined by the samplers placed along the two radial transects. It is concluded that the isopleths, as presently drawn, do not accurately predict the areas of maximum and minimum deposition.

Since the samplers were not placed along transects in line with the directions of maximum deposition, it is difficult to verify the predicted extent of the drift plume, or the distance at which the cooling tower drift deposition is no longer distinguishable from background drift. The isopleths predict that at approximately 0.5 miles from the towers, drift deposition will diminish to a rate of 1 lb/acre-year. The sampling at distances of approximately 0.5 miles from the towers determined rates ranging from 8 to 22 lbs/acre year, significantly higher than that predicted by the model. This indicates that appreciable amounts of drift may be deposited beyond the 0.5 mile radius at higher rates than predicted.

The maximum rates predicted by the model were 400 lbs/acre-year and 300 lbs/acre-year, 0.25 miles from the towers. These estimates are high as compared to the highest rate of deposition determined by the field sampling which was 112 lbs/acre for a nine month period, in a transformer yard 0.25 miles north of the towers. The efficiency factor for the drift collectors used has not been determined, thus it is difficult to compare the predicted absolute rate with the experimentally determined relative rate of deposition. If an efficiency rate of 100 percent is assumed, however, the measured rates are still within the same order of magnitude as those which were predicted. Sources of error which may have biased the experimental results low include the fact that only five constituents were analyzed to

determine the amount of drift deposited. The plant also operated at reduced cycles from mid-January through the end of the sampling period which also decreased the amount of drift which was actually released to the atmosphere.

5.6 BIBLIOGRAPHY

ASTM D1739-70, Standard Method for Collection and Analysis of Dustfall.

Daubenmire, R. 1968. Plant communities. Harper and Row, New York, NY.

Droppo, J. G., C. E. Hane and R. K. Woodruff, Atmospheric Effects of Circular Mechanical Draft Cooling Towers at Washington Public Power Supply System Nuclear Power Plant Number Two, B2311200735, November 1976.

Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, OH.

Gilman, Lee B. 1989. Microwave Sample Preparation. CEM Corporation.

Klemmedson, J. O. and J. G. Smith, 1964. Cheat Grass (Bromus tectorum L.) Bot. Rev. 30; 226-262.

Laulainen, N. S., R. O. Webb, K. R. Wilber, and S. L. Ulanski, Comprehensive Study of Drift From Mechanical Draft Cooling Towers: Final Report, September, 1979, Battelle PNL-3083.

NUS Corporation, Annual Report for the PVNGS Salt Deposition Monitoring Program January-December 1986; April 1987.

Table 5-1. Vascular Plants Observed During 1990 Field Work

	Common Name
APIACEAE	Parsley Family
Cymopterus terebinthinus (Hook.) T.&G. var. terebinthinus	Turpentine cymopterus
Lomatium macrocarpum (Nutt.) Coult & Rose	Large-fruit lomatium
ASTERACEAE	Aster Family
Achillea millefolium L.	Yarrow
Antennaria dimorpha (Nutt.) T&G	Low pussy-toes
Artemisia tridentata Nutt.	Big sagebrush
Balsamorhiza careyana Gray	Carey's balsamroot
Chrysothamnus nauseosus (Pall.) Britt	Gray rabbitbrush
Chrysothamnus viscidiflorus (Hook.) Nutt	Green rabbitbrush
Crepis atrabarba Heller	Slender hawksbeard
Franseria acanthicarpa Hook.	Bur ragweed
Layia glandulosa (Hook.) H&A	White daisy tidytips
Tragopogon dubius Scop.	Yellow salsify
Aster canescens (Pursh)	Hoary Aster
BORAGINACEAE	Borage Family
Amsinckia lycopsoides Lehm.	Tarweed fiddleneck
Cryptantha circumscissa (H&A) Johnst.	Matted cryptantha
Cryptantha pterocarya (Torr.) Greene	Winged cryptantha
BRASSICACEAE	Mustard Family
Descurainia pinnata (Walt.) Britt.	Western tansymustard
Draba verna L.	Spring draba
Erysimum asperum (Nutt.) DC.	Prairie rocket
Sisymbrium altissimum L.	Tumblemustard
CACTACEAE	Cactus Family
Opuntia polyacantha Haw.	Starvation cactus
CARYOPHYLLACEAE	Pink Family
Arenaria franklinii Dougl. var. franklinii	Franklin's sandwort
Holosteum umbellatum L.	Jagged chickweed
CHENOPODIACEAE	Chenopod Family
Salsola kali L.	Russian thistle

Table 5-1. (Continued)

	Common Name
FABACEAE	Pea Family
Astragalus purshii Dougl.	Wooly-pod milk-vetch
Astragalus sclerocarpus Gray	Stalked-pod milk-vetch
Psoralea lanceolata Pursh	Lance-leaf scurf-pea
HYDROPHYLLACEAE	Waterleaf Family
Phacelia hastata Dougl.	Whiteleaf phacelia
Phacelia linearis (Pursh) Holz.	Threadleaf phacelia
LILIACEAE	Lily Family
Brodiaea douglasii Wats.	Douglas' brodiaea
Calochortus macrocarpus Dougl.	Sego lily
Fritillaria pudica (Pursh) Spreng.	Chocolate lily
LOASACEAE	Blazing-star Family
Mentzelia albicaulis Dougl.	White-stemmed mentzelia
MALVACEAE	Mallow Family
Sphaeralcea munroana (Dougl.) Spach	White-stemmed globe-mallow
ONAGRACEAE	Evening-primrose Family
Oenothera pallida Lindl. var. *pallida*	White-stemmed evening-primrose
PLANTAGINACEAE	Plantain Family
Plantago patagonica Jacq.	Indian-wheat
POACEAE	Grass Family
Agropyron cristatum (L.) Gaertn.	Crested wheatgrass
Agropyron dasystachyum (Hoak.) Scribn.	Thick-spiked wheatgrass
Agropyron spicatum (Pursh) Scribn. & Smith	Bluebunch wheatgrass
Bromus tectorum L.	Cheatgrass
Festuca octoflora Walt.	Six-weeks fescue
Koeleria cristata Pers.	Prairie Junegrass
Oryzopsis hymenoides (R&S) Ricker	Indian ricegrass

Table 5-1. (Continued)

	Common Name
Poa sandbergii Vasey	Sandberg's bluegrass
Sitanion hystrix (Nutt.) Smith	Bottlebrush squirreltail
Stipa comata Trin & Rupr.	Needle-and-thread
POLEMONIACEAE	Phlox Family
Gilia minutiflora Benth.	Gilia
Gilia sinuata Dougl.	Shy gilia
Microsteris gracilis (Hook.) Greene var. *humilior* (Hook.) Cronq.	Pink microsteris
Phlox longifolia	Long-leaf phlox
POLYGONACEAE	Buckwheat Family
Eriogonum niveum Dougl.	Snow buckwheat
Rumex venosus Pursh	Wild begonia
RANUNCULACEAE	Buttercup Family
Delphinium nuttallianum Pritz. ex Walpers	Larkspur
ROSACEAE	Rose Family
Purshia tridentata (Pursh) DC.	Antelope bitterbursh
SANTALACEAE	Sandalwood Family
Comandra umbellata (L.) Nutt.	Bastard toad-flax
SAXIFRAGACEAE	
Ribes aureum Pursh	Golden current
SCROPHULARIACEAE	Figwort Family
Penstemon acuminatus Dougl.	Sand-dune penstemon
VALERIANACEAE	Valerian Family
Plectritis macrocera T&G	Longhorn plectritis

Table 5-2. Vascular Plants Observed During 1975-1990 Field Work

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990
Annual Grasses															
Bromus tectorum	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Festuca octoflora	X					X	X	X	X	X	X	X	X	X	X
Festuca sp.		X		X											
Perennial Grasses															
Agropyron cristatum							X	X	X	X	X	X	X	X	X
Agropyron dasystachyum				X			X	X	X	X	X	X	X	X	X
Agropyron spicatum						X	X	X	X	X	X	X	X	X	X
Koeleria cristata				X		X	X	X	X	X	X	X	X	X	X
Oryzopsis hymenoides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Poa sandbergii							X	X	X	X	X	X	X	X	X
Poa scabrella							X	X	X	X		X	X		
Sitanion hystrix						X		X	X	X	X	X	X	X	X
Stipa comata		X		X	X	X	X	X	X	X	X	X	X	X	X
Stipa thurberiana					X										

Table 5-2. (Cont'd)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990
Annual Forbs															
Franseria acanthicarpa	X		X	X	X			X	X	X	X	X	X	X	X
Amsinckia lycopsoides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Amsinckia menziesii							X	X							
Chenopodium leptophyllum			X												
Cryptantha pterocarya		X		X		X	X	X	X	X	X	X	X	X	X
Cryptantha circumscissa	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Descurainia pinnata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Draba verna	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Epilobium paniculatum	X	X	X	X	X										
Erysimum asperum							X	X	X	X	X	X	X	X	X
Gilia minutiflora					X				X		X	X	X	X	X
Gilia sinuata						X		X	X	X	X	X	X	X	X
Holosteum umbellatum	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Lagophylla ramosissima						X									
Layia glandulosa			X		X			X	X	X	X	X	X	X	X
Mentzelia albicaulis			X		X			X	X	X	X	X	X	X	X
Microsteris gracilis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Orobanche californica													X	X	
Phacelia hastata							X	X	X	X	X	X	X	X	X
Phacelia linearis				X		X	X	X	X	X	X	X	X	X	X
Phacelia sp.		X													
Plantago patagonica	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Plectritis macrocera		X							X		X	X	X	X	X

Table 5-2. (Cont'd)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990
Polemonium micranthum	X			X											
Salsola kali	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sisymbrium altissimum	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tragopogon dubius				X			X	X	X	X	X	X	X	X	X
Perennial Forbs															
Achillea millefolium	X	X	X			X	X	X	X	X	X	X	X	X	X
Antennaria dimorpha						X	X	X	X	X	X	X	X	X	X
Arenaria franklinii var. *franklinii*						X	X	X	X	X	X	X	X	X	X
Aster canescens (*Machaeranthera canescens*)		X			X				X	X	X	X	X	X	X
Astragalus lyallii			X												
Astragalus purshii	X	X				X	X	X	X	X	X	X	X	X	X
Astragalus sclerocarpus						X	X	X	X	X	X	X	X	X	X
Astragalus sp.				X											
Balsamorhiza careyana	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Brodiaea douglasii	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Brodiaea howellii				X											
Calochortus macrocarpus	X				X										X
Comandra umbellata	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Crepis atrabarba		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cryptantha leucophaea						X	X	X	X		X	X			

Table 5-2. (Cont'd)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990
Cymopterus terebinthinus	X			X		X	X	X	X	X	X	X	X	X	X
Delphinium sp.				X					X	X	X	X	X	X	X
Erigeron divergens							X								
Fritillaria pudica									X	X	X	X	X	X	X
Lomatium macrocarpum	X		X		X	X	X	X	X	X	X	X	X	X	X
Lomatium sp.				X											
Oenothera pallida	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Penstemon acuminatus							X	X	X	X	X	X	X	X	X
Penstemon sp.						X									
Phlox longifolia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Psoralea lanceolata	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Rumex venosus				X		X	X	X	X	X	X	X	X	X	X
Sphaeralcea munroana								X	X		X	X	X	X	X
Shrubs, subshrubs, cacti															
Artemisia tridentata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrysothamnus nauseosus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrysothamnus viscidiflorus	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Eriogonum niveum	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Leptodactylon pungens									X	X					
Opuntia polyacantha	X			X		X	X	X	X	X	X	X	X	X	X
Purshia tridentata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ribes aureum											X	X	X	X	X

Table 5-3 Herbaceous Cover for Fifteen Sampling Stations - 1990

	G01	G02	G03	G04	G05	G06	G07	G08	S01	S02	S03	S04	S05	S06	S07	AVERAGE G01-S07	AVERAGE G01-G04	AVERAGE S01-S05	AVG. G01-G04 S01-S05
Annual Grasses																			
Bromus tectorum	18.60	7.75	61.55	13.65	22.15	35.30	35.55	19.75	36.80	16.80	17.05	30.40	53.35	12.90	5.45	25.80	25.39	30.88	28.44
Festuca octoflora	0.00	0.00	0.00	0.00	1.65	0.15	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.25	0.00	0.40	0.22
Total Annual Grass Cover	18.60	7.75	61.55	13.65	23.80	35.45	35.55	19.75	36.80	16.80	17.05	32.40	53.35	12.90	5.45	26.05	25.39	31.28	28.66
Perennial Grasses																			
Agropyron spicatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	0.00	0.05	2.65	0.00	0.37	0.00	0.59	0.33
Oryzopis hymenoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30	0.00	1.25	0.00	0.00	0.00	0.24	0.00	0.71	0.39
Poa sandbergii	18.70	0.00	0.00	13.15	11.85	1.50	9.30	11.65	3.30	5.15	18.35	11.45	0.00	15.75	17.55	9.18	7.96	7.65	7.79
Stipa comata	0.00	0.00	0.00	16.85	0.05	9.20	0.00	0.45	0.00	2.50	0.00	0.00	0.00	0.00	0.00	1.94	4.21	0.50	2.15
Total Perennial Grass Cover	18.70	0.00	0.00	30.00	11.90	10.70	9.30	12.10	3.30	12.85	18.35	12.70	0.05	18.40	17.55	11.73	12.18	9.45	10.66
Annual Forbs																			
Amsinckia lycopsoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.05	0.00	0.00	0.00	0.05	0.00	0.03	0.00	0.07	0.04
Chenopodium leptophyllum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cryptantha circumscissa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Crypthantha pterocarya	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Descurainia pinnata	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.02	0.04	0.01	0.02
Draba verna	3.20	1.25	1.75	1.70	1.20	1.70	1.70	2.15	3.00	0.15	2.60	1.10	1.75	0.00	0.00	1.55	1.98	1.72	1.83
Franseria acanthacarpa	0.00	0.00	1.15	0.00	0.00	0.30	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.11	0.29	0.05	0.16
Gilia sinuata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Holosteum umbellatum	2.95	0.40	9.35	0.30	1.15	3.65	4.90	2.15	1.25	0.95	2.05	0.45	6.05	0.00	0.00	2.37	3.25	2.15	2.64
Layia glandulosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mentzelia albicaulis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.07	0.04
Microsteris gracilis	0.35	0.60	2.65	0.00	0.30	1.05	0.60	1.75	3.10	0.10	1.00	1.80	0.65	0.00	0.00	0.93	0.90	1.33	1.14
Phacelia linearis	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.11	0.06
Plantago pategonica	1.15	0.10	0.00	1.20	0.00	0.00	0.00	0.40	0.00	0.00	2.45	0.00	0.45	0.00	0.00	0.38	0.61	0.58	0.59
Salsola kali	0.00	0.00	0.00	0.00	0.05	0.10	0.00	0.00	0.00	0.10	0.00	0.15	0.00	0.00	0.00	0.03	0.00	0.05	0.03
Sisymbrium altissimum	0.10	0.00	0.80	0.00	0.05	0.10	1.15	0.55	0.30	0.00	0.05	1.05	0.00	0.00	0.00	0.28	0.23	0.28	0.26
Tragopogon dubius	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Annual Forb Cover	7.75	2.35	15.70	3.35	2.75	6.90	8.95	7.00	7.95	2.60	8.15	4.55	8.90	0.10	0.00	5.80	7.29	6.43	6.81
Perennial Forbs																			
Achillea millefolium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.05	0.00	0.00	0.00	0.00	0.21	0.00	0.63	0.35
Astragulus purshii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aster canescens	0.00	0.00	0.00	0.00	0.45	0.05	0.00	0.10	0.10	0.10	0.00	0.05	0.05	0.00	0.00	0.06	0.00	0.06	0.03
Astragalus sclerocarpus	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balsamorhiza careyana	0.00	0.00	0.00	0.00	2.45	0.60	0.00	0.00	0.00	0.00	0.30	3.85	0.00	0.00	0.00	0.48	0.00	0.83	0.46
Brodiaea douglasii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Comandra umbellata	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Crepis atrabarba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.06	0.00	0.19	0.11
Cymopterus terebinthinus	0.00	0.00	0.00	0.00	0.00	6.25	0.00	0.00	0.00	6.35	0.00	0.00	0.00	0.00	0.00	0.84	0.00	1.27	0.71
Oenothera pallida	0.00	0.00	0.05	0.10	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.04	0.00	0.02
Phlox longifolia	0.00	0.05	0.00	1.10	0.75	0.30	0.05	0.10	0.30	0.00	0.45	0.00	0.00	0.00	0.00	0.21	0.29	0.15	0.21
Rumex venosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Perennial Forb Cover	0.00	0.05	0.05	1.20	3.95	8.55	0.05	0.20	0.40	9.55	1.75	3.90	0.05	0.00	0.00	1.98	0.33	3.13	1.88
Total Herbaceous Cover	45.05	10.15	77.30	48.20	42.40	61.60	53.85	39.05	48.45	41.80	45.30	53.55	62.35	31.40	23.00	45.56	45.18	50.29	48.02

Table 5-4 Mean Herbaceous Cover for 1975 through 1990

CLASS	YEAR	S01	S02	S03	S04	S05	S01-5	S06	S07	XS	G01	G02	G03	G04	X G01-4	G05	G06	G07	G08	XG	XSG	X G01-4, S01-5
AG	1975	49.90	35.30	43.80						43.00	43.90	43.00								43.45	43.18	43.18
PG	1975	0.60	2.00	4.50						2.37	3.70	5.50								4.60	3.26	3.26
AF	1975	14.60	11.70	11.70						12.67	29.50	13.00								21.25	16.10	16.10
PF	1975	4.30	0.90	1.80						2.33	1.50	2.10								1.80	2.12	2.12
ALL	1975	69.40	49.90	61.80						60.37	78.60	63.60								71.10	64.66	64.66
AG	1976	50.70	40.90	34.30						41.97	71.20	51.60								61.40	49.74	49.74
PG	1976	0.40	10.50	10.30						7.07	4.40	3.10								3.75	5.74	5.74
AF	1976	5.50	5.30	7.20						6.00	11.90	8.50								10.20	7.68	7.68
PF	1976	0.00	0.50	0.20						0.23	0.00	0.20								0.10	0.18	0.18
ALL	1976	56.60	57.20	52.00						55.27	87.50	63.40								75.45	63.34	63.34
AG	1977	1.35	0.65	1.90						1.30	5.20	1.45								3.33	2.11	2.11
PG	1977	0.35	11.30	8.28						6.64	3.25	2.90								3.08	5.22	5.22
AF	1977	0.25	0.05	0.90						0.40	2.40	9.35								5.88	2.59	2.59
PF	1977	0.55	0.60	1.42						0.86	0.05	6.30								3.18	1.78	1.78
ALL	1977	2.50	12.60	12.50						9.20	10.90	20.00								15.45	11.70	11.70
AG	1978	51.00	67.00	51.00						56.33	68.00	42.00								55.00	55.80	55.80
PG	1978	3.00	18.00	11.00						10.67	8.00	7.00								7.50	9.40	9.40
AF	1978	38.00	10.00	33.00						27.00	23.00	25.00								24.00	25.80	25.80
PF	1978	8.00	0.00	5.00						4.33	2.00	3.00								2.50	3.60	3.60
ALL	1978	100.00	95.00	100.00						98.33	101.00	77.00								89.00	94.60	94.60
AG	1979	25.00	29.00	9.00						21.00	31.00	10.00								20.50	20.80	20.80
PG	1979	1.00	18.00	11.00						10.00	7.00	5.00								6.00	8.40	8.40
AF	1979	2.00	4.00	10.00						5.33	43.00	33.00								38.00	18.40	18.40
PF	1979	11.00	0.00	3.00						4.67	0.00	7.00								3.50	4.20	4.20
ALL	1979	39.00	51.00	33.00						41.00	81.00	55.00								68.00	51.80	51.80
AG	1980	50.40	51.80	24.30	56.20	56.40	47.82			47.82	64.30	77.80	73.80	12.30	57.05					57.05	51.92	51.92
PG	1980	1.00	7.20	23.30	10.90	0.10	8.50			8.50	28.30	64.00	0.10	26.60	29.75					29.75	17.94	17.94
AF	1980	7.60	4.20	22.50	3.40	14.10	10.36			10.36	7.30	5.00	28.70	4.90	11.48					11.48	10.86	10.86
PF	1980	2.20	2.20	4.70	4.60	1.80	3.10			3.10	0.40	0.00	0.00	4.60	1.25					1.25	2.28	2.28
ALL	1980	61.20	65.40	74.80	75.10	72.40	69.78			69.78	100.30	146.80	102.60	48.40	99.53					99.53	83.00	83.00
AG	1981	74.80	54.60	66.50	49.80	76.20	64.38			64.38	77.40	84.00	88.40	48.90	74.68					74.68	68.96	68.96
PG	1981	0.10	4.70	14.30	5.80	0.00	4.98			4.98	19.60	25.90	0.00	36.70	20.55					20.55	11.90	11.90
AF	1981	5.30	3.50	18.20	1.20	12.50	8.14			8.14	15.90	11.90	17.50	5.90	12.80					12.80	10.21	10.21
PF	1981	0.00	3.20	0.70	4.90	0.50	1.86			1.86	0.20	0.00	0.00	1.90	0.53					0.53	1.27	1.27
ALL	1981	80.20	66.00	99.70	61.70	89.20	79.36			79.36	113.10	121.80	105.90	93.40	108.55					108.55	92.33	92.33
AG	1982	51.50	25.80	36.60	32.70	20.00	33.32			33.32	42.20	45.50	51.00	22.90	40.40					40.40	36.47	36.47
PG	1982	0.40	6.40	17.90	4.30	0.80	5.96			5.96	11.20	11.60	0.10	31.30	13.55					13.55	9.33	9.33
AF	1982	4.60	4.20	7.50	1.60	17.30	7.04			7.04	9.70	4.60	4.60	4.10	5.75					5.75	6.47	6.47
PF	1982	0.20	4.30	0.70	6.20	1.00	2.48			2.48	0.30	0.00	1.30	3.80	1.35					1.35	1.98	1.98
ALL	1982	56.70	40.70	62.70	44.80	39.10	48.80			48.80	63.40	61.70	57.00	62.10	61.05					61.05	54.24	54.24

Table 5-4 Mean Herbaceous Cover for 1975 through 1990 (continued)

CLASS	YEAR	S01	S02	S03	S04	S05	S01-5	S06	S07	XS	G01	G02	G03	G04	X G01-5	G05	G06	G07	G08	XG	XSG	G01-4, S01-5
AG	1983	53.80	37.60	33.65	36.75	31.85	38.73			38.73	49.50	39.55	62.75	17.55	42.34					42.34	40.33	40.33
PG	1983	2.15	7.70	14.45	6.40	1.29	6.40			6.40	2.10	15.75	0.00	25.50	10.84					10.84	8.37	8.37
AF	1983	8.20	7.85	12.55	3.45	22.35	10.88			10.88	18.70	8.85	8.65	6.65	10.71					10.71	10.81	10.81
PF	1983	0.70	3.10	1.05	4.40	1.95	2.24			2.24	0.65	0.05	2.10	4.00	1.70					1.70	2.00	2.00
ALL	1983	64.85	56.25	61.70	51.00	57.44	58.25			58.25	70.95	64.20	73.50	53.70	65.59					65.59	61.51	61.51
AG	1984	41.50	32.75	39.35	36.30	36.50	37.28			37.28	60.85	71.30	60.85	9.60	50.65					50.65	43.22	43.22
PG	1984	1.85	8.80	11.55	8.55	0.40	6.23			6.23	1.20	4.45		25.00	10.22					10.22	6.87	7.73
AF	1984	12.35	8.10	11.10	4.00	13.40	9.79			9.79	20.65	9.70	19.45	7.95	14.44					14.44	11.86	11.86
PF	1984	0.30	4.00	0.75	6.55	0.65	2.45			2.45	0.70	0.20	1.10	1.25	0.81					0.81	1.72	1.72
ALL	1984	56.00	53.65	62.75	55.40	50.95	55.75			55.75	83.40	85.65	81.40	43.80	73.56					73.56	63.67	63.67
AG	1985	2.10	2.15	14.60	4.95	27.05	10.17			10.17	8.00	8.10	18.30	7.25	10.41					10.41	10.28	10.28
PG	1985	1.05	4.70	17.85	2.40	1.85	5.57			5.57	9.20	17.95	0.00	13.90	10.26					10.26	7.66	7.66
AF	1985	0.70	1.35	9.40	2.30	4.75	3.70			3.70	18.20	8.15	7.55	3.05	9.24					9.24	6.16	6.16
PF	1985	0.00	1.35	1.15	3.00	0.25	1.15			1.15	0.80	0.10	2.35	0.90	1.04					1.04	1.10	1.10
ALL	1985	3.85	9.55	43.00	12.65	33.90	20.59			20.59	36.20	34.30	28.20	25.10	30.95					30.95	25.19	25.19
AG	1986	17.45	1.95	7.20	11.45	13.05	10.22			10.22	9.40	4.65	13.25	7.35	8.66					8.66	9.53	9.53
PG	1986	2.20	10.75	17.25	9.85	1.30	8.27			8.27	19.85	38.65	0.00	26.00	21.13					21.13	13.98	13.98
AF	1986	25.40	16.65	38.10	10.25	16.70	21.42			21.42	27.65	34.15	25.45	8.70	23.99					23.99	22.56	22.56
PF	1986	1.15	5.35	2.30	9.15	1.25	3.84			3.84	1.80	1.95	0.05	2.55	1.59					1.59	2.84	2.84
ALL	1986	46.20	34.70	64.85	40.70	32.30	43.75			43.75	58.70	79.40	38.75	44.60	55.36					55.36	48.91	48.91
AG	1987	28.90	9.95	7.80	19.05	33.40	19.82			19.82	23.85	9.45	51.65	4.65	22.40					22.40	20.97	20.97
PG	1987	3.60	21.90	42.65	19.55	2.30	18.00			18.00	32.45	58.79	0.05	45.95	34.31					34.31	25.25	25.25
AF	1987	12.56	8.50	10.80	6.55	11.40	9.96			9.96	10.30	11.32	14.00	3.25	9.72					9.72	9.85	9.85
PF	1987	5.00	6.00	2.00	10.40	1.75	5.03			5.03	0.90	1.90	0.15	1.55	1.13					1.13	3.29	3.29
ALL	1987	50.06	46.35	63.25	55.55	48.85	52.81			52.81	67.50	81.46	65.85	55.40	67.55					67.55	59.36	59.36
AG	1988	13.80	5.05	8.10	13.80	10.15	10.18	10.40	12.24	10.51	22.95	10.10	16.75	4.80	13.65	11.95	19.20	15.85	10.40	14.00	12.32	11.72
PG	1988	1.75	8.40	11.95	9.40	3.35	6.97	16.85	17.50	9.89	17.85	21.70	0.05	30.20	17.45	9.50	12.05	10.45	14.30	14.51	12.34	11.63
AF	1988	6.08	5.25	3.60	3.10	4.00	4.41	0.00	0.35	3.20	6.30	16.15	7.55	1.80	7.95	1.20	1.45	12.35	6.12	6.61	5.16	5.98
PF	1988	11.55	15.75	2.10	4.85	3.25	7.50	0.10	0.00	5.37	0.20	2.00	0.00	4.40	1.65	15.25	8.70	2.45	4.34	4.34	4.79	4.90
ALL	1988	33.18	34.45	25.75	31.15	20.75	29.06	27.35	30.09	28.96	47.30	49.95	24.35	41.20	40.70	37.90	41.40	41.10	32.52	39.47	34.60	34.23
AG	1989	21.85	12.50	12.45	10.25	32.90	17.99	15.00	47.65	21.80	22.50	13.20	65.85	3.05	26.15	22.35	35.10	38.05	12.05	26.52	24.05	21.62
PG	1989	8.30	29.55	64.00	13.00	1.25	23.22	30.35	37.50	26.28	60.40	59.60	0.05	49.55	42.40	36.75	16.20	32.05	48.95	37.94	32.54	31.74
AF	1989	12.50	6.95	13.05	6.45	11.10	10.01	0.85	5.15	8.01	12.85	5.90	42.20	2.85	15.95	8.85	13.55	13.05	13.95	14.15	11.48	12.65
PF	1989	4.45	14.50	4.40	8.20	0.55	6.42	0.10	0.00	4.60	3.85	1.10	0.05	3.00	2.00	6.45	10.40	12.90	10.60	6.04	5.23	4.46
ALL	1989	47.10	63.50	93.90	37.90	45.80	57.64	46.30	90.30	60.69	99.60	79.80	108.15	58.45	86.50	74.40	75.25	96.05	85.55	84.66	73.31	70.47
AG	1990	36.80	16.80	17.50	32.40	53.35	31.37	12.90	5.45	25.03	18.60	7.75	61.55	13.65	25.39	23.80	35.45	35.55	19.75	27.01	26.06	28.71
PG	1990	3.30	12.85	18.35	12.70	0.05	9.45	18.40	17.55	11.89	18.70	0.00	0.00	30.00	12.18	11.90	10.70	9.30	12.10	11.59	11.73	10.66
AF	1990	7.95	2.60	8.15	4.55	8.90	6.43	0.10	0.00	4.61	7.75	2.35	15.70	3.35	7.29	2.75	6.90	8.95	7.00	6.84	5.80	6.81
PF	1990	0.40	9.55	1.75	3.90	0.05	3.13	0.00	0.00	2.24	0.00	0.05	0.05	1.20	0.33	3.95	8.55	0.05	0.20	1.76	1.98	1.88
ALL	1990	48.45	41.80	45.30	53.55	62.35	50.29	31.40	23.00	43.69	45.05	10.15	77.30	48.20	45.18	42.40	61.60	53.85	39.05	47.20	45.56	48.02

Table 5-5 Mean Frequency Values (%) by Species of Each Sampling Station - 1990

	G01	G02	G03	G04	G05	G06	G07	G08	S01	S02	S03	S04	S05	S06	S07
Annual Grasses															
Bromus tectorum	100	100	98	96	94	100	98	96	98	76	94	98	100	72	98
Festuca octoflora					36	60						40			
Perennial Grasses															
Agropyron spicatum										20			2	10	
Oryzopis hymenoides										6		2			
Poa sandbergii	94	100		96	68	10	62	70	18	32	98	56		60	96
Stipa comata				72	2	24		8		12					
Annual Forbs															
Amsinckia lycopsoides									2	2				2	
Chenopodium Leptophyllum															
Cryptantha circumscissa										2					
Cryptantha pterocarya															
Descurainia pinnata				6						2				2	
Draba verna	78	50	60	48	48	68	58	86	90	6	84	44	60		
Franseria acanthacarpa			8			12				10					
Gilia sinuata															
Holosteum umbellatum	68	16	96	12	26	86	76	66	40	28	52	18	92		
Layia glandulosa															
Mentzelia albicaulis										4					
Microsteris gracilis	14	24	86		12	42	24	50	84	4	40	72	26		
Phacelia linearis							22			22					
Plantago patagonica	46	4		38				16			78		18		
Salsola kali					2	4				4		6			
Sisymbrium altissimum	4		22		2	4	46	22	12		2	42			
Tragopogon dubius							2								
Perennial Forbs															
Achillea millefolium										10	2				
Aster canescens					18	2		4	4	4		2	2		
Astragulus purshii															
Astragulus sclerocarpus						2									
Balsamorhiza careyana					4	4					2	12			
Brodiaea douglasii															
Comandra umbellata					2										
Crepis atrabarba											8				
Cynopterus terebinthinus						20									
Oenothera pallida			2	4		4									
Phlox longifolia		2		16	2	2	2	4	2		8				
Rumex venosus															
Total Species per Site	7	7	7	9	13	16	9	10	9	17	11	11	7	5	2

Table 5-6 Mean Terrestrial Phytomass for 1990

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/18	G01	4-8	0.3	2.5
05/18	G01	29-4	0.7	7.3
05/18	G01	12-3	0.5	5.4
05/18	G01	18-5	2.2	22.3
05/18	G01	41-6	3.0	30.4
		AVG	1.4	13.6
		STD	1.1	10.8

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/29	S01	41-6	4.3	42.8
05/29	S01	12-3	2.9	29.0
05/29	S01	4-8	2.4	23.6
05/29	S01	29-4	2.7	27.4
05/29	S01	18-5	4.1	41.2
		AVG	3.3	32.8
		STD	0.8	7.7

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/18	G02	12-3	0.2	2.1
05/18	G02	29-4	0.2	1.8
05/18	G02	18-5	0.5	5.3
05/18	G02	4-8	0.3	2.7
05/18	G02	41-6	0.9	8.5
		AVG	0.4	4.1
		STD	0.3	2.5

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/29	S02	41-6	0.5	5.3
05/29	S02	29-4	3.9	39.4
05/29	S02	4-8	3.6	35.8
05/29	S02	18-5	3.7	36.5
05/29	S02	12-3	27.4	274.3
		AVG	7.8	78.3
		STD	9.9	98.8

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/18	G03	18-5	7.7	77.2
05/18	G03	4-8	7.7	77.1
05/18	G03	12-3	5.2	51.8
05/18	G03	29-4	4.6	45.9
05/18	G03	41-6	6.8	68.1
		AVG	6.4	64.0
		STD	1.3	13.0

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/29	S03	18-5	2.8	28.1
05/30	S03	12-3	3.2	32.3
05/30	S03	4-8	2.5	24.7
05/30	S03	29-4	4.6	45.7
05/30	S03	41-6	1.0	10.4
		AVG	2.8	28.2
		STD	1.1	11.4

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/18	G04	12-3	7.5	75.1
05/18	G04	18-5	5.5	54.9
05/18	G04	41-6	2.4	23.6
05/18	G04	29-4	19.0	189.7
05/18	G04	4-8	2.3	22.5
		AVG	7.3	73.2
		STD	6.2	61.5

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/29	S04	4-8	5.4	53.8
05/29	S04	12-3	2.5	24.6
05/29	S04	41-6	2.0	19.6
05/29	S04	18-5	1.6	15.7
05/29	S04	29-4	4.1	40.7
		AVG	3.1	30.9
		STD	1.4	14.3

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/30	G05	12-3	1.1	10.8
05/30	G05	4-8	4.5	44.5
05/30	G05	18-5	1.4	13.9
05/30	G05	29-4	2.8	28.3
05/30	G05	41-6	8.6	86.4
		AVG	3.7	36.8
		STD	2.8	27.5

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/29	S05	12-3	3.5	34.5
05/29	S05	41-6	4.5	45.4
05/29	S05	4-8	4.3	43.0
05/29	S05	29-4	3.7	36.9
05/29	S05	18-5	5.7	57.3
		AVG	4.3	43.4
		STD	0.8	8.0

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/31	G06	12-3	5.2	51.9
05/31	G06	41-6	2.8	28.2
05/31	G06	18-5	4.6	45.6
05/31	G06	29-4	4.4	43.09
05/31	G06	4-8	2.9	29.3
		AVG	4.0	39.8
		STD	0.9	9.4

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/31	S06	18-5	4.4	44.3
05/31	S06	12-3	4.4	43.6
05/31	S06	4-8	3.8	37.5
05/31	S06	41-6	2.1	20.8
05/31	S06	29-4	2.4	23.7
		AVG	3.4	34.0
		STD	1.0	9.9

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/30	G07	18-5	3.6	36.1
05/30	G07	4-8	1.4	14.1
05/30	G07	41-6	2.5	25.1
05/30	G07	12-3	6.2	61.7
05/30	G07	29-4	0.9	8.7
		AVG	2.9	29.1
		STD	1.9	18.8

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/31	S07	4-8	0.2	2.4
05/31	S07	29-4	0.1	1.0
05/31	S07	12-3	0.7	6.9
05/31	S07	18-5	1.3	13.3
05/31	S07	41-6	0.7	6.9
		AVG	0.6	6.1
		STD	0.4	4.3

DATE	SITE	PLOT	WT.(g)	WT./ SQ.METER
05/30	G08	18-5	0.2	1.6
05/30	G08	41-6	0.8	7.8
05/30	G08	12-3	0.3	2.7
05/30	G08	29-4	1.5	15.2
05/30	G08	4-8	2.3	22.5
		AVG	1.0	10.0
		STD	0.8	7.9

Phytomass Summary

MEAN G01-G08	33.8	Grams/sq. meter
MEAN S01-S07	36.2	Grams/sq. meter
MEAN B01-B05	0.0	Grams/sq. meter

Table 5-7 Comparison of Herbaceous Phytomass for 1975 through 1990

SITE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
G01	359	108	21	166	64	160	200	90	77	94	70	50	83	34	174.3	13.6
G02	302	258	11	162	37	68	255	60	137	116	27	61	77	14	65.7	4.1
G03	-	-	-	-	-	53	261	62	64	133	12	32	134	16	105.1	64.0
G04	-	-	-	-	-	79	159	113	82	67	37	35	90	61	49.5	73.2
G05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.2	36.8
G06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61.0	39.8
G07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	113.1	29.1
G08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	112.3	10.0
S01	126	137	4	173	21	36	180	98	171	104	5	35	62	59	53.9	32.8
S02	144	98	7	128	28	63	115	24	232	57	1	112	144	73	72.8	78.3
S03	88	177	7	115	16	43	31	22	54	95	27	25	48	15	67.0	28.2
S04	-	-	-	-	-	78	52	39	68	93	11	176	108	24	39.8	30.9
S05	-	-	-	-	-	71	81	184	136	43	61	42	145	19	103.7	43.4
S06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72.7	34.0
S07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149.5	6.1

Table 5-8 Summary of Shrub Density for 1990

Station	Species	1	2	3	4	Total	S/Ha	S/a
S01	Artemisia tridentata	3	2	4	0	9	90	36
	Chrysothamnus nauseosus	0	0	0	0	0	0	0
	Chrysothamnus viscidiflorus	0	0	0	0	0	0	0
	Purshia tridentata	0	2	1	1	4	40	16
						13	130	52
						Total	S/Ha	S/a
S02	Artemisia tridentata	1	1	0	0	2	20	8
	Chrysothamnus nauseosus	0	0	0	0	0	0	0
	Chrysothamnus viscidiflorus	0	0	0	0	0	0	0
	Purshia tridentata	0	0	0	0	0	0	0
						2	20	8
						Total	S/Ha	S/a
S03	Artemisia tridentata	6	15	12	15	48	480	192
	Chrysothamnus nauseosus	4	2	2	1	9	90	36
	Chrysothamnus viscidiflorus	0	0	0	0	0	0	0
	Purshia tridentata	0	0	0	0	0	0	0
						57	570	228
						Total	S/Ha	S/a
S04	Artemisia tridentata	1	2	1	5	9	90	36
	Chrysothamnus nauseosus	0	0	0	0	0	0	0
	Chrysothamnus viscidiflorus	0	0	0	0	0	0	0
	Purshia tridentata	0	0	0	0	0	0	0
						9	90	36
						Total	S/Ha	S/a
S05	Artemisia tridentata	0	0	0	0	0	0	0
	Chrysothamnus nauseosus	0	1	4	2	7	70	28
	Chrysothamnus viscidiflorus	0	0	0	1	1	10	4
	Purshia tridentata	1	3	4	0	8	80	32
						16	160	64

Table 5-9 Summary of Shrub Cover (%) at Five Stations for 1990

Shrub Cover (%)

Shrubs	S01	S02	S03	S04	S05	X
Artemisia tridentata	0.00	0.13	5.65	0.00	0.00	1.16
Chrysothamnus nauseosus	0.00	0.00	0.89	0.00	0.23	0.22
Chrysothamnus viscidiflorus	0.00	0.00	0.00	0.00	0.13	0.03
Purshia tridentata	0.76	0.00	0.00	0.00	0.00	0.15
Total Shrub Cover	0.76	0.13	6.54	0.00	0.36	1.56

Table 5-10 Summary of Soil Chemistry for 1990

	G01	G02	G03	G04	G05	G06	G07	G08	S01	S02	S03	S04	S05	S06	S07
pH (1:2 soil-water)	6.86	6.92	6.95	6.94	6.77	7.02	7.12	7.07	7.19	7.65	6.78	6.93	7.00	7.13	7.20
Conductivity (1:2 soil-water) microsiemens/cm	46.3	54.6	96.8	28.8	14.4	19.0	53.2	38.0	27.8	32.2	39.4	29.9	21.9	55.2	65.8
Sulfate ug/gm	6.62	6.87	14.29	7.07	6.8	6.77	5.77	6.78	6.78	6.80	6.88	12.95	6.78	6.81	6.62
Chloride ug/gm	1.12	0.56	1.76	0.24	1.04	0.8	1.12	0.48	1.44	1.28	1.04	0.96	0.32	0.64	0.88
Copper ug/gm	11.10	9.18	9.61	6.92	7.42	8.2	8.54	8.14	7.64	6.84	8.82	7.94	7.20	9.48	13.14
Lead ug/gm	6.04	4.96	3.10	2.58	2.3	2.6	3.92	2.08	1.14	0.70	1.26	1.00	1.53	1.36	1.71
Cadmium ug/gm	0.014	0.062	0.072	0.100	0.120	0.139	0.062	0.064	0.118	0.070	0.058	0.060	0.080	0.020	0.030
Chromium ug/gm	8.2	6.4	5.1	3.5	5.6	4.7	4.8	6.0	6.8	5.6	5.0	5.7	3.9	9.4	12.5
Nickel ug/gm	11.93	9.94	8.94	8.54	9.54	8.90	7.28	9.90	9.78	9.16	9.72	9.18	8.36	10.08	15.42
Zinc ug/gm	40.59	37.89	37.32	29.27	26.51	29.97	38.38	31.58	33.51	21.61	37.93	31.87	30.42	38.55	47.31
Sodium %	0.037	0.038	0.033	0.029	0.026	0.031	0.035	0.027	0.028	0.021	0.033	0.031	0.033	0.032	0.042
Potassium %	0.191	0.164	0.124	0.079	0.087	0.093	0.137	0.119	0.125	0.066	0.132	0.128	0.085	0.167	0.216
Calcium %	0.273	0.292	0.351	0.298	0.261	0.289	0.319	0.245	0.282	0.356	0.309	0.274	0.306	0.377	0.434
Bicarbonates (meq/HCO3/gm)	0.0015	0.0020	0.0014	0.0009	0.0006	0.0008	0.0017	0.0015	0.0010	0.0013	0.0014	0.0009	0.0009	0.0023	0.0027
Magnesium %	0.374	0.391	0.376	0.321	0.302	0.339	0.374	0.365	0.376	0.302	0.366	0.355	0.333	0.420	0.632

Table 5-11 Summary of Vegetation Chemistry for 1990

	SITE	POSA	BRTE	SIAL	PHLO	PUTR	ARTR	CHVI	GRSP
Copper (ug/gm)	G01	2.80	4.80	6.60	4.20				
	G02	3.00	5.00	3.60	3.64				
	G03	4.20	6.60	3.60	4.40	4.60			
	G04	2.80	4.00	3.40	4.00	4.40			
	G05	2.20	4.83		2.60	3.60	7.20		
	G06	2.60	4.20				10.00	6.00	
	G07	4.40	5.20				8.20	10.20	
	G08	2.60	4.80	3.40	4.00		9.20		
	S01	2.60	4.00	3.20	3.40				
	S02	2.80	4.20		4.00	3.80	8.20		
	S03	3.20	5.00		4.20		10.20		
	S04	3.60	4.80	3.40	3.60		9.00		
	S05	3.60	4.60	3.20		5.00	9.20		
	S06	3.80	6.40				8.00	7.80	4.40
	S07	3.20	6.00				6.20		5.00
Extractable Sulfate (%)	G01	0.020	0.041	0.084	0.023				
	G02	0.019	0.029	0.073	0.018				
	G03	0.023	0.036	0.125		0.041			
	G04	0.020	0.021	0.055		0.015			
	G05	0.019	0.018			0.023	0.02		
	G06	0.018	0.018				0.018	0.022	
	G07	0.018	0.023				0.016	0.052	
	G08	0.000	0.022	0.097	0.025		0.02		
	S01	0.019	0.020	0.063	0.021				
	S02	0.019	0.019		0.018	0.019	0.024		
	S03	0.026	0.027		0.026		0.021		
	S04	0.019	0.017	0.049	0.018		0.02		
	S05	0.019	0.030	0.047		0.018	0.021		
	S06	0.024	0.025				0.037	0.032	0.097
	S07	0.018	0.029				0.018		0.041
Extractable Chloride (%)	G01	0.21	0.29	0.57	0.12				
	G02	0.21	0.24	0.78	0.07				
	G03	0.29	0.29	0.62	0.08	0.17			
	G04	0.32	0.14	0.43	0.06	0.11			
	G05	0.25	0.18		0.09	0.14	0.92		
	G06	0.22	0.26				0.90	0.23	
	G07	0.24	0.24		0.05		0.67	0.48	
	G08	0.28	0.12	0.04	0.08		0.63		
	S01	0.25	0.21	0.68	0.08				
	S02	0.25	0.19		0.09	0.10	0.95		
	S03	0.30	0.19		0.10		0.78		
	S04	0.32	0.18	0.38	0.07		0.91		
	S05	0.32	0.16	0.34		0.18	0.89		
	S06	0.16	0.10				0.73	0.49	2.11
	S07	0.17	0.20				0.59		1.85

Table 5-12 Drift Sampler Locations in Reference to WNP-2 Cooling Towers

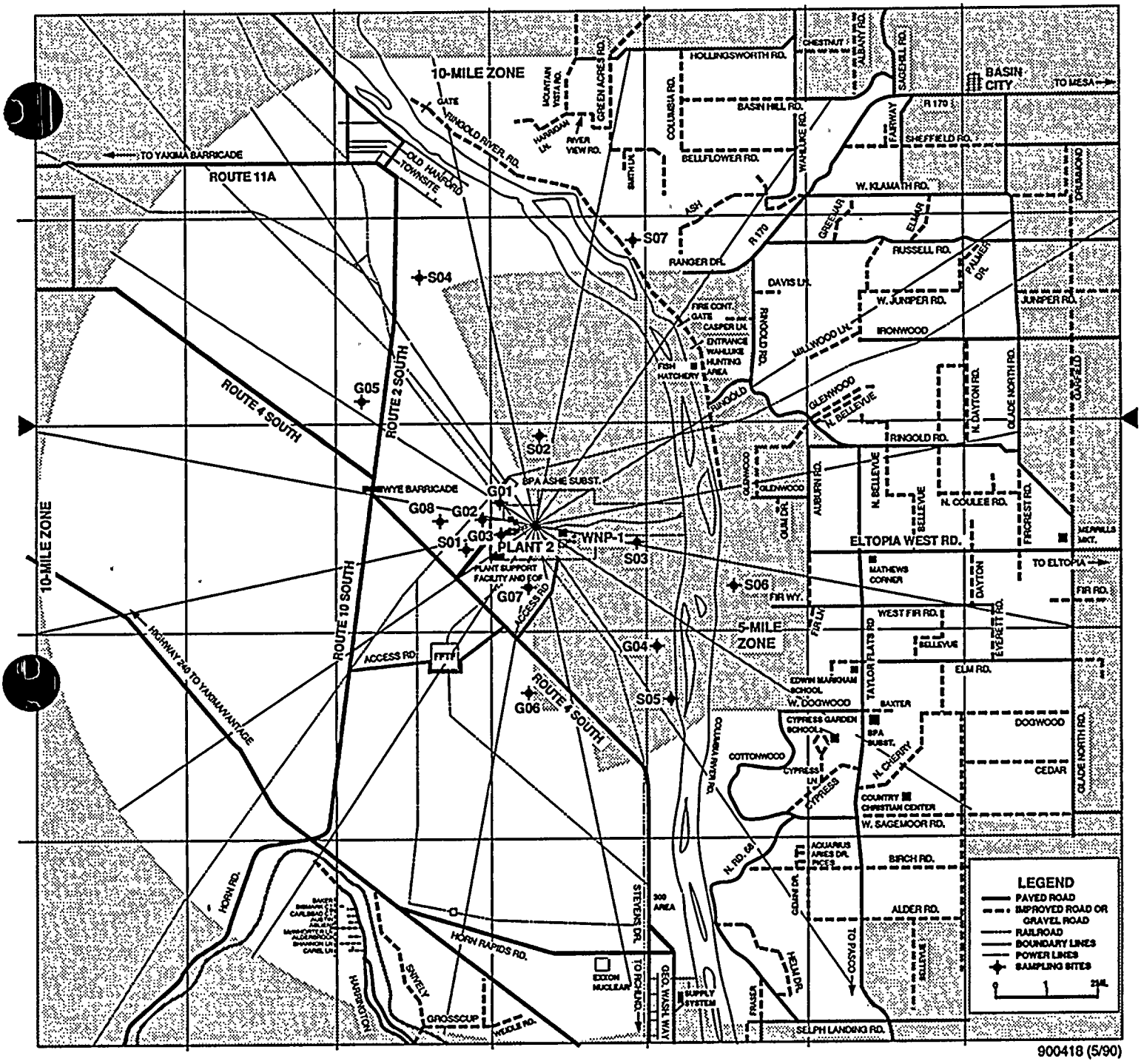
Station	Distance	Direction (0° North)
1	3.1 miles	165°
2	2.6 miles	167.5°
3	2.1 miles	170°
4	1.6 miles	172.5°
5	1.15 miles	175°
6	0.65 miles	180°
7	0.2 miles	205°
8	Center of Towers	-
9	0.4 miles	294°
10	0.9 miles	306°
11	1.33 miles	312°
12	1.83 miles	314°
13	2.35 miles	315°
14	2.83 miles	314°
15	3.36 miles	312°
*16	7 miles	287°

*Control Samplers

Table 5-13 Drift Deposition Rates (Gross and Background Corrected)

Station	LB/Acre-Year	Corrected for Background (lb/acre-year)
1	11	3
2	9	1
3	10	2
4	14	6
5	12	4
6	17	9
7	60	52
8	2998	2990
9	16	8
10	11	3
11	9	1
12	9	1
13	8	0
14	8	0
15	8	0
16	8	*

*Control Site

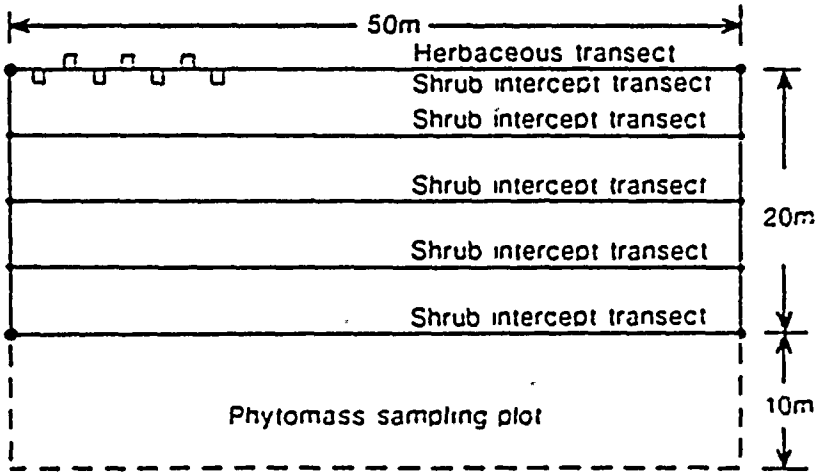


1 thru 8 G0 = Grassland Site

1 thru 7 S0 = Shrub Site

Figure 5-1 Soil and Vegetation Sampling Location Map

Shrub Community



Herbaceous Community

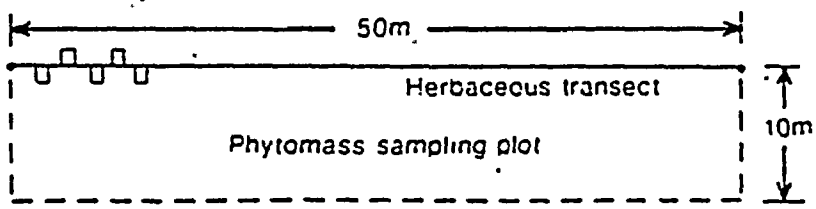
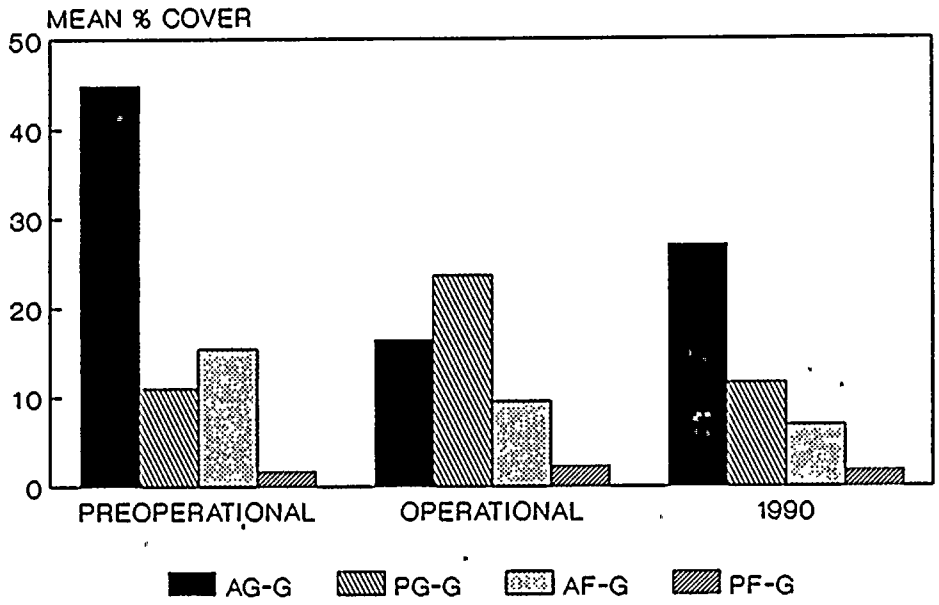


Figure 5-2 Layout of Vegetation and Soil Sampling Plots



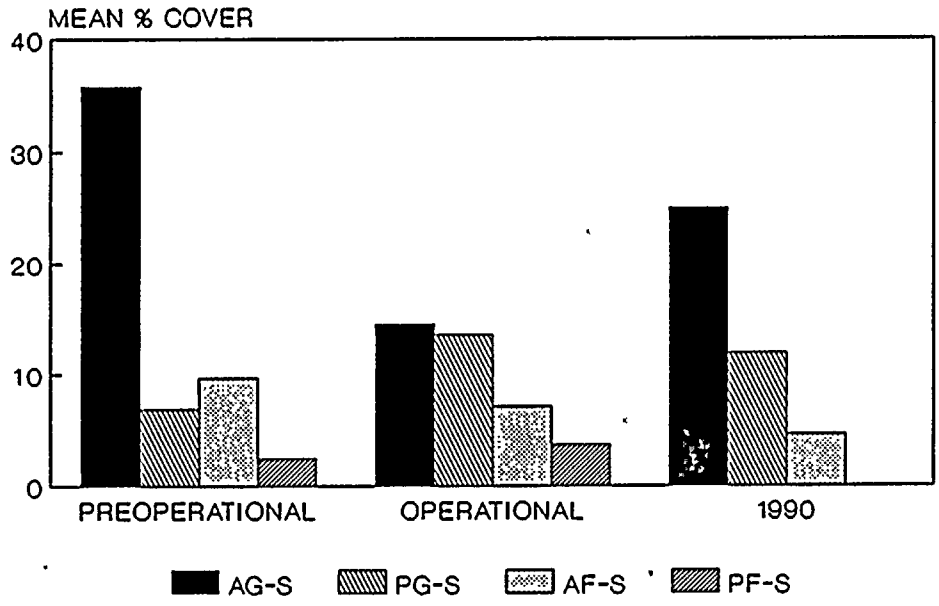


Figure 5-3 Mean Herbaceous Cover for 1975 Through 1990

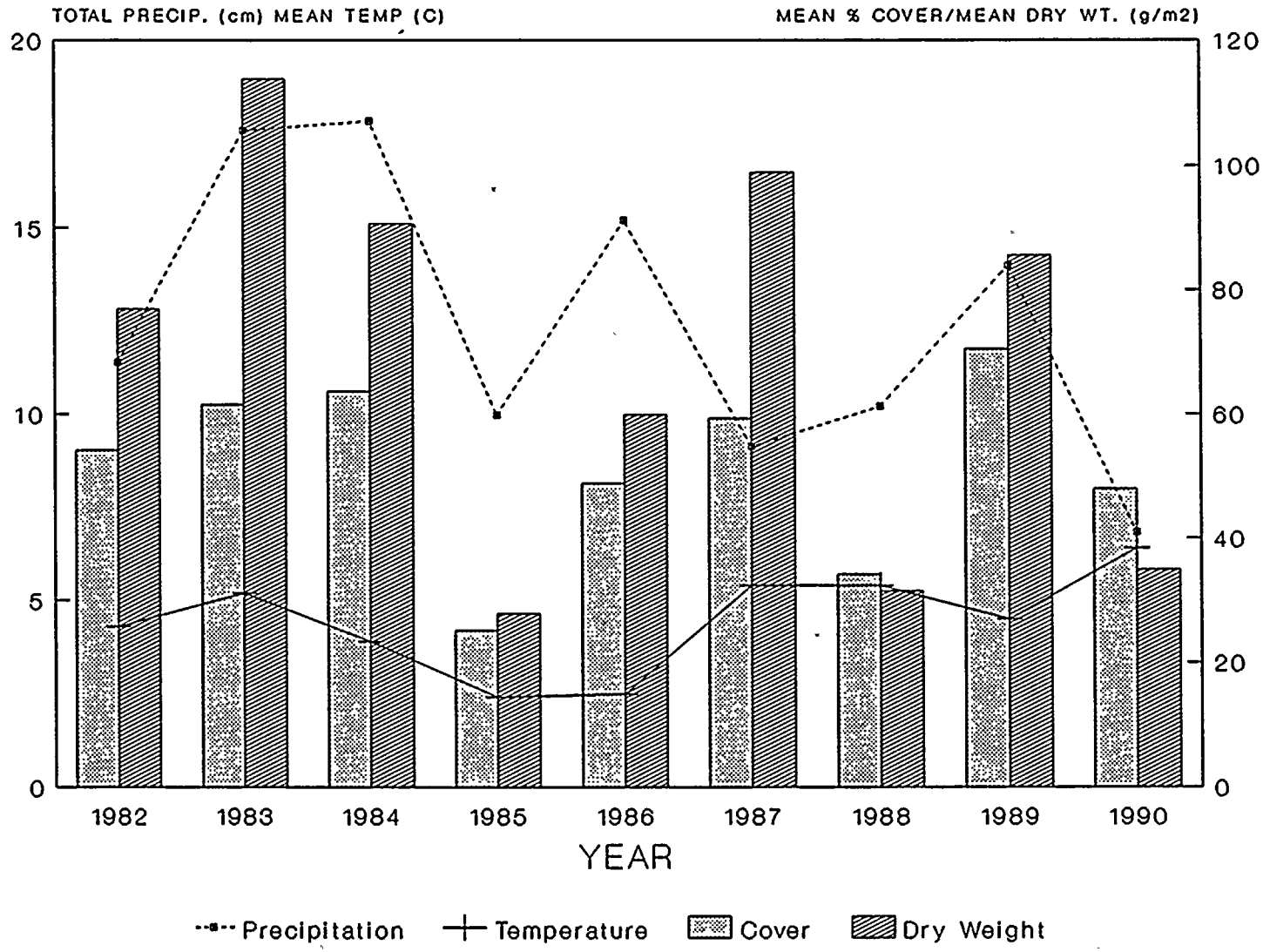
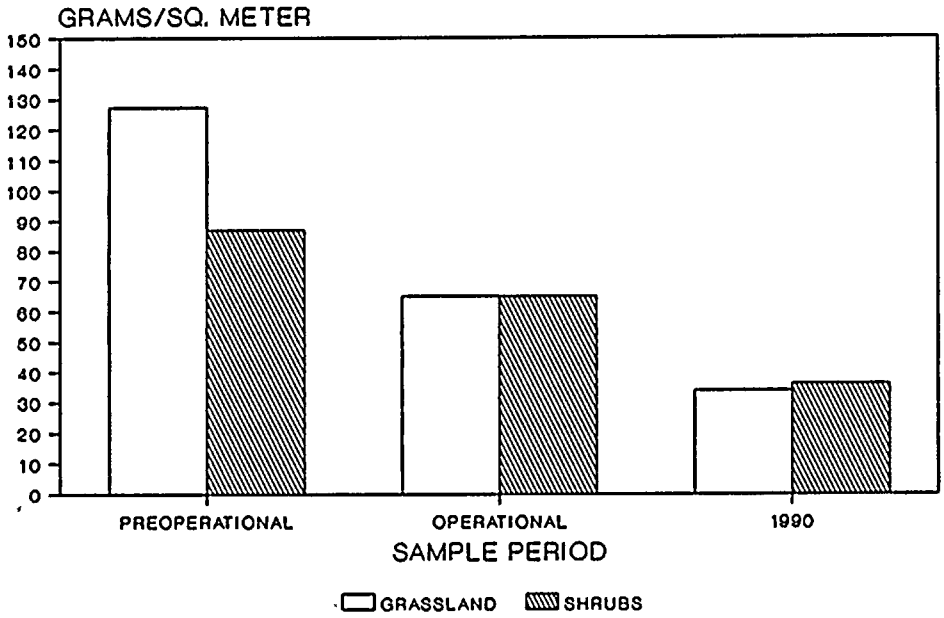


Figure 5-4 Mean Herbaceous Cover, Mean Dry Wgt. (g/m^2), Total Precipitation, and Mean Temperature From 1982 Through 1990



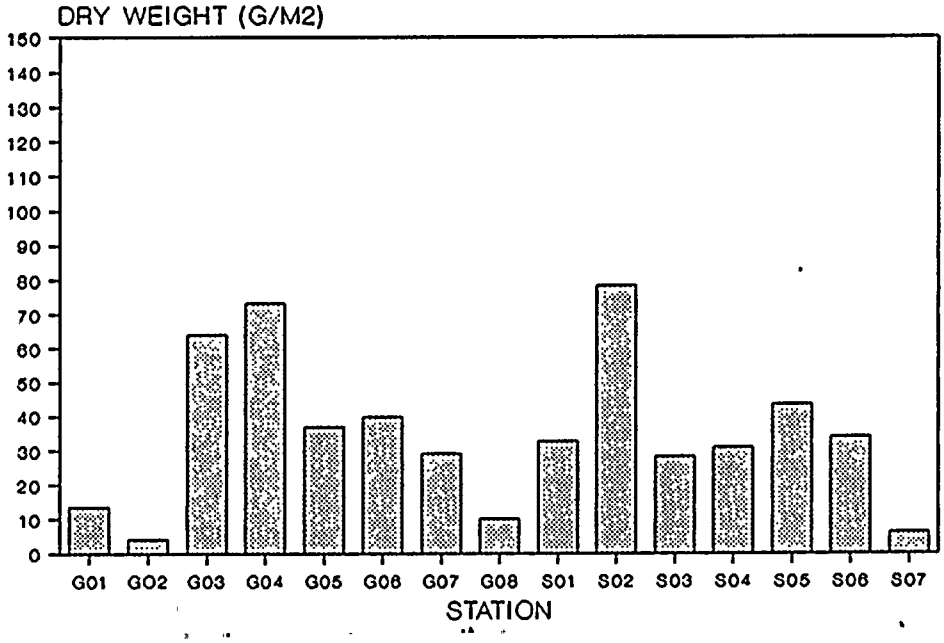


Figure 5-5 Mean Herbaceous Phytomass at Grassland and Shrub Stations for 1975 Through 1990

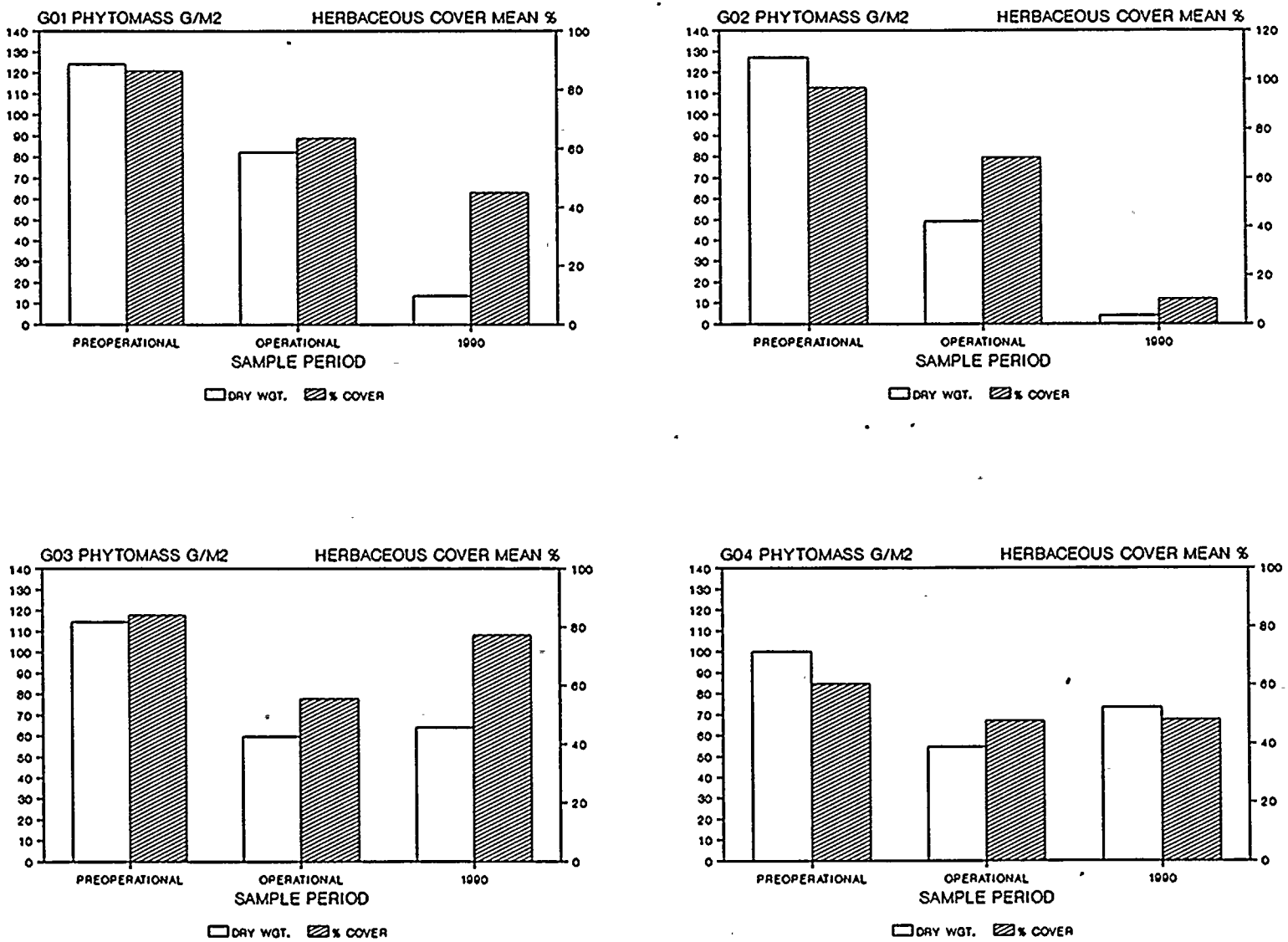


Figure 5-6 Mean Herbaceous Cover and Phytomass for Stations G01 to G04 for 1980 Through 1990

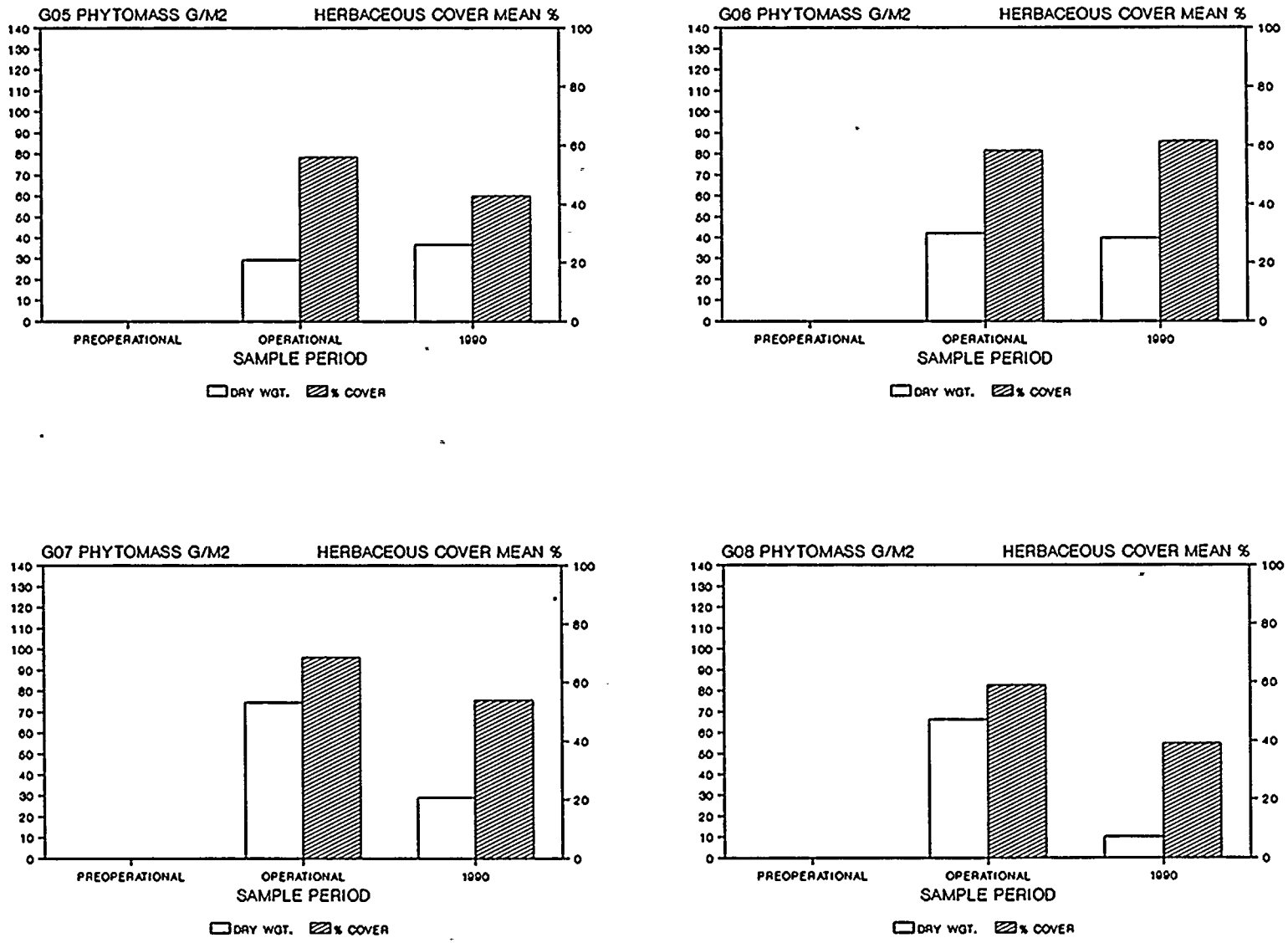


Figure 5-7 Mean Herbaceous Cover and Phytomass for Stations G05 to G08 for 1989 Through 1990

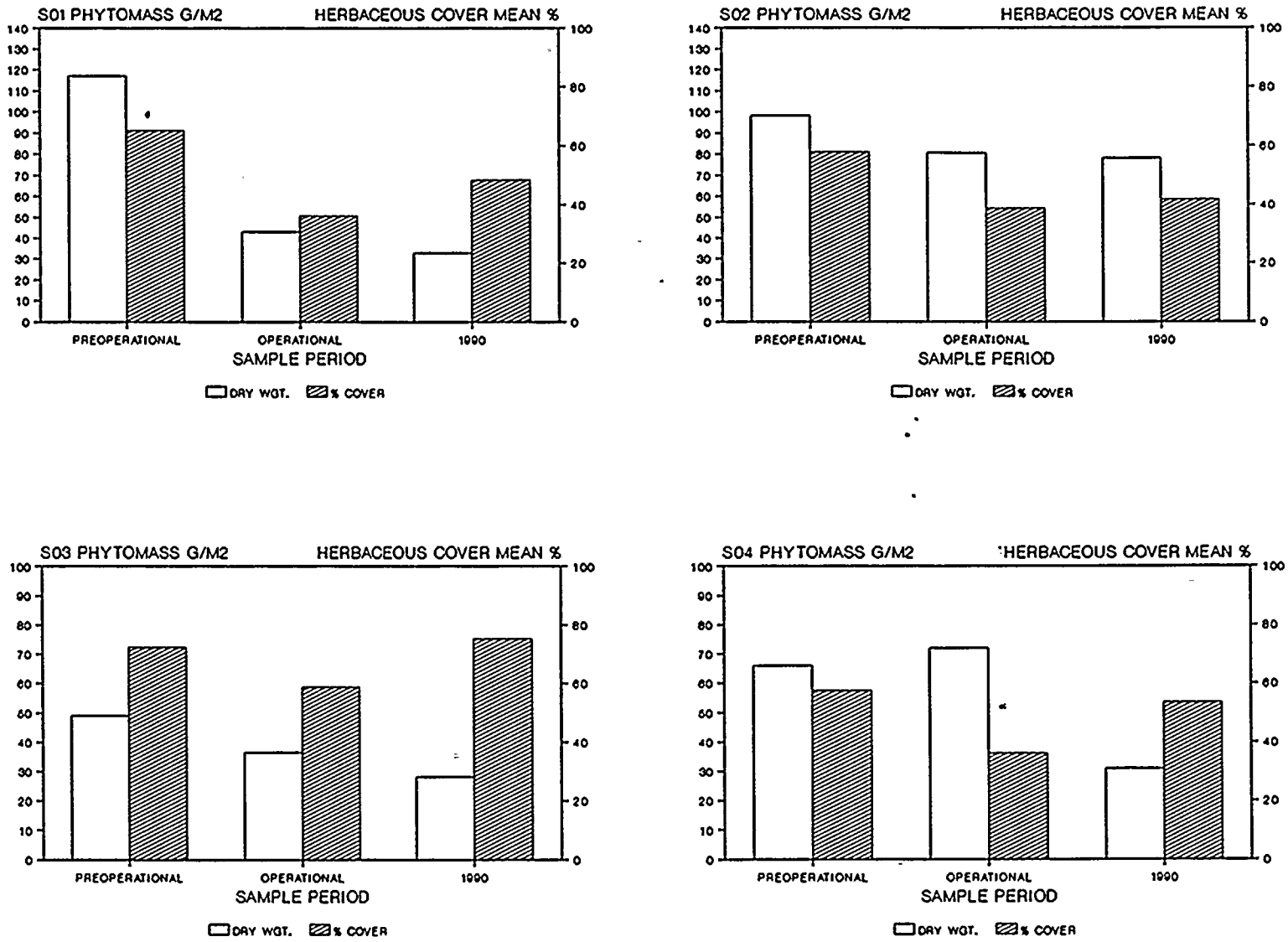


Figure 5-8 Mean Herbaceous Cover and Phytomass for Stations S01 to S04 for 1980 Through 1990

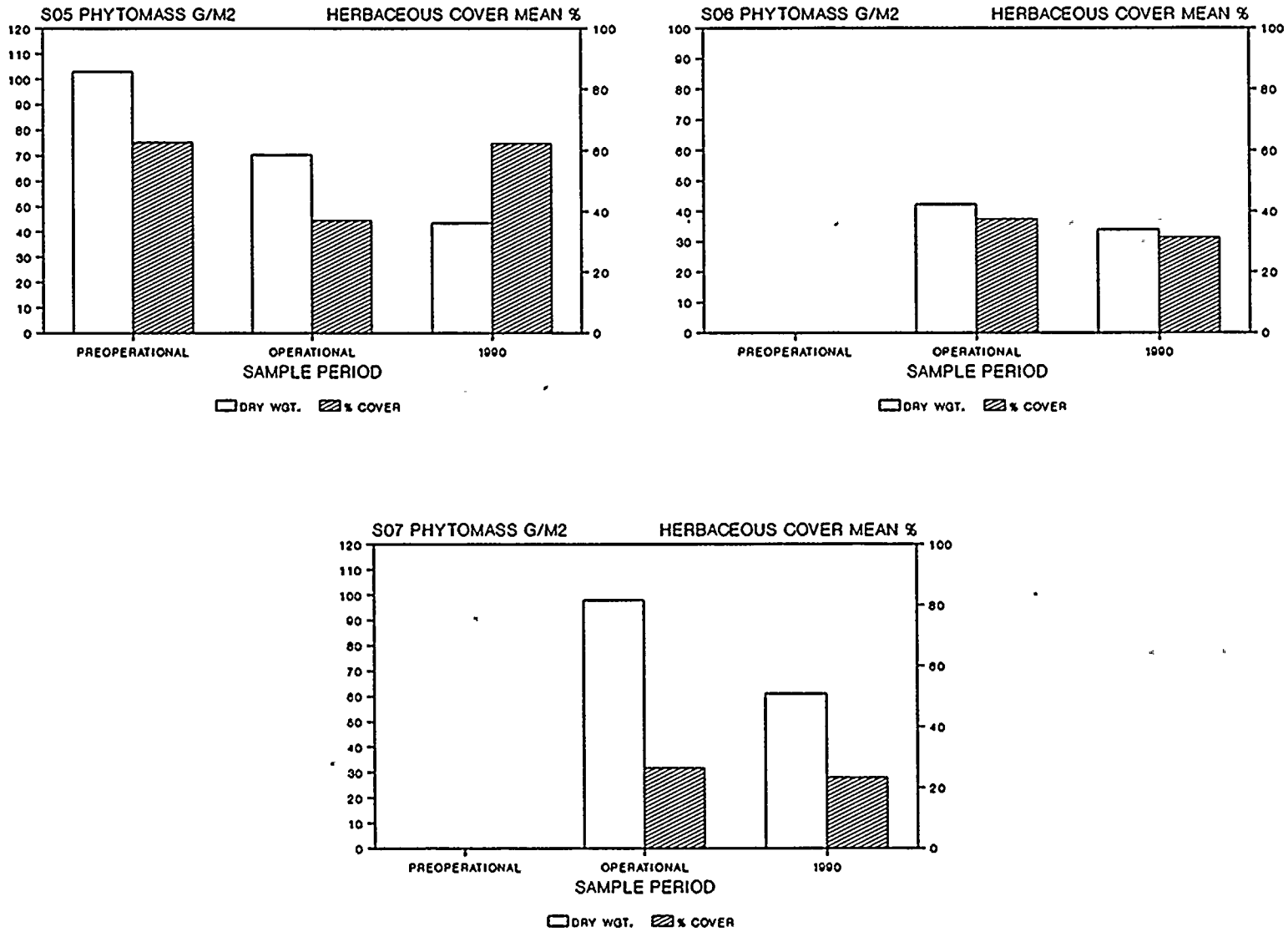


Figure 5-9 Mean Herbaceous Cover and Phytomass for Stations S05 for 1980 through 1990 and Stations S06 and S07 for 1989 Through 1990

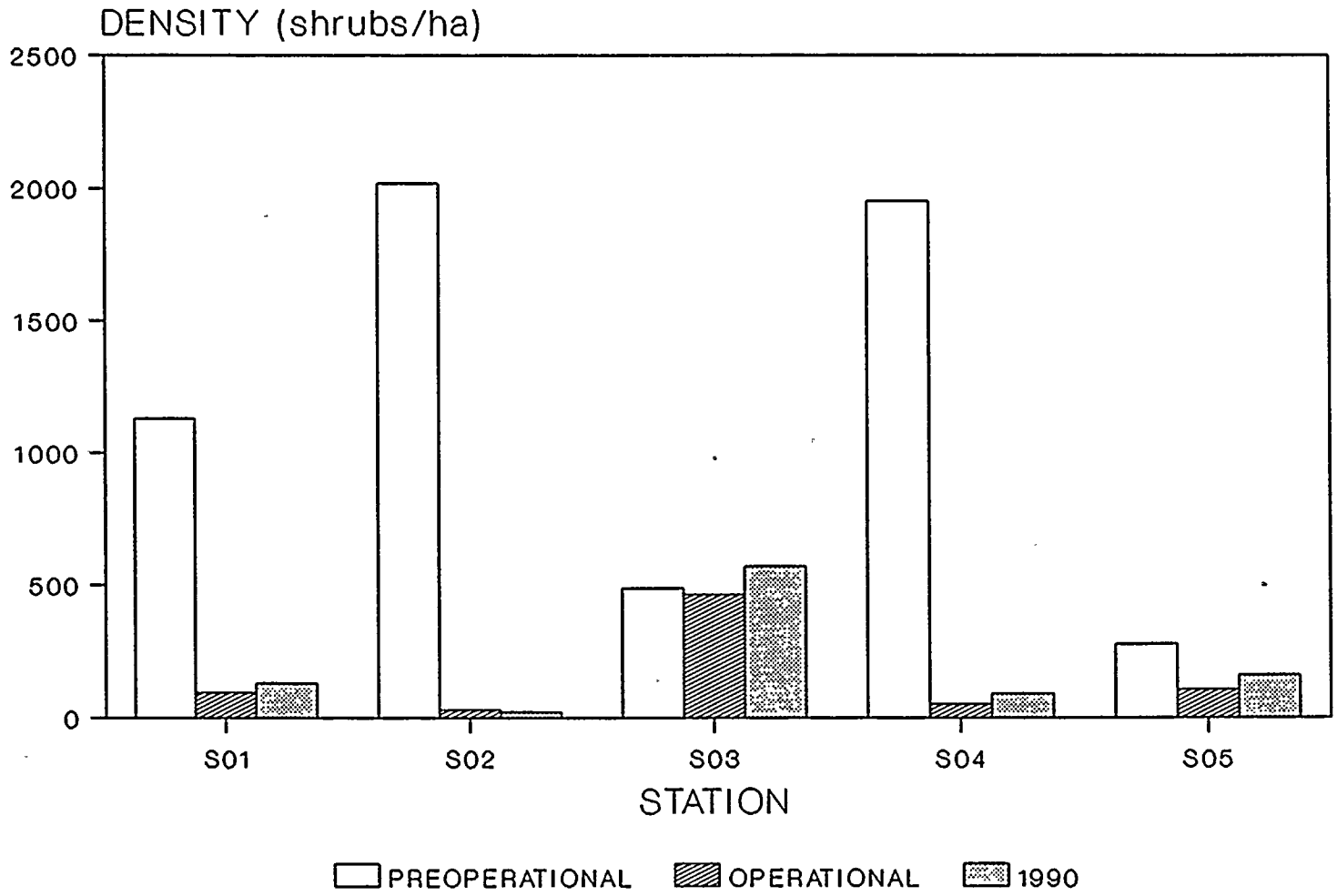


Figure 5-10 Shrub Density at Five Stations for 1975 Through 1990

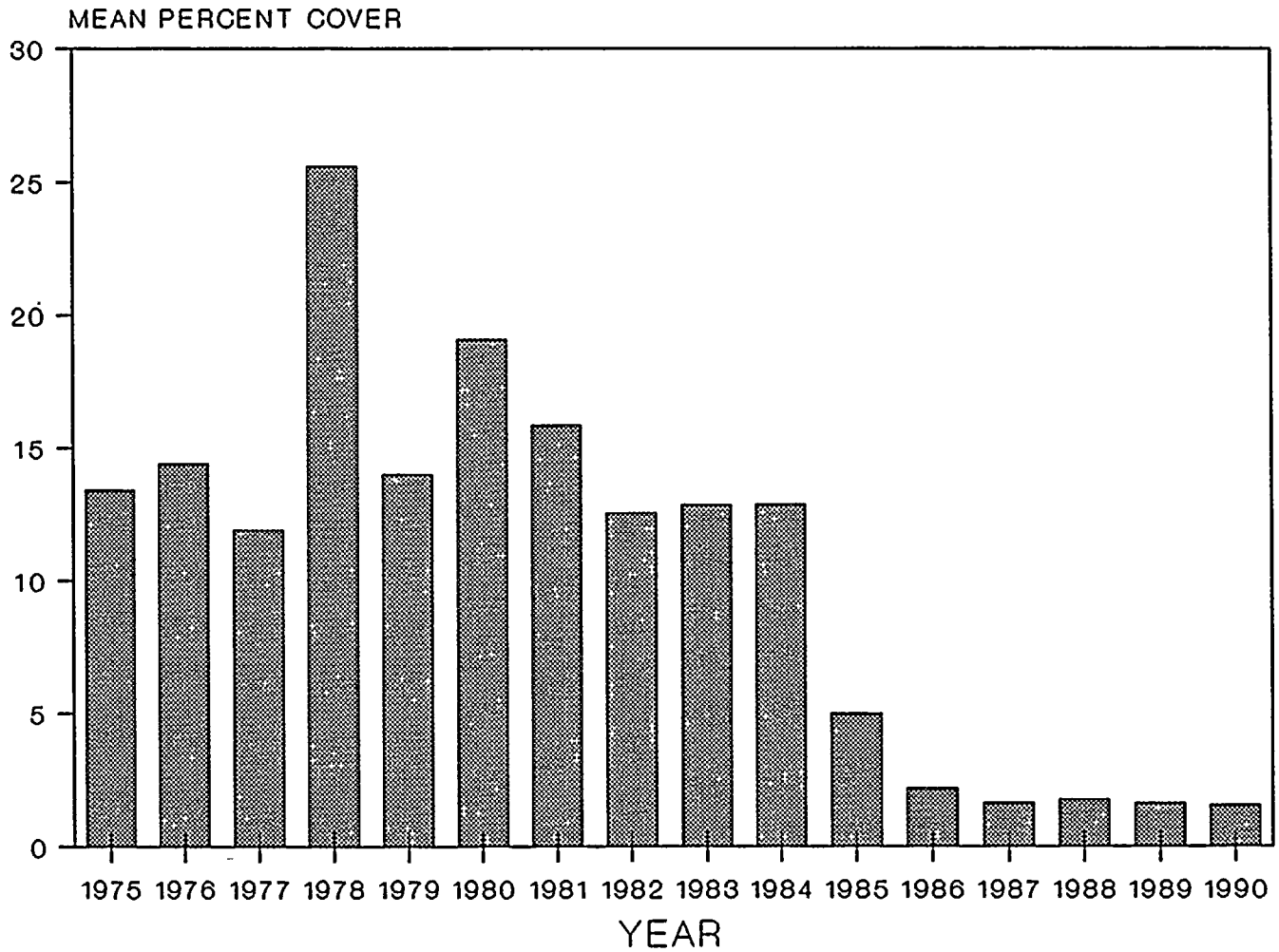


Figure 5-11 Mean Total Shrub Cover for 1975 Through 1990

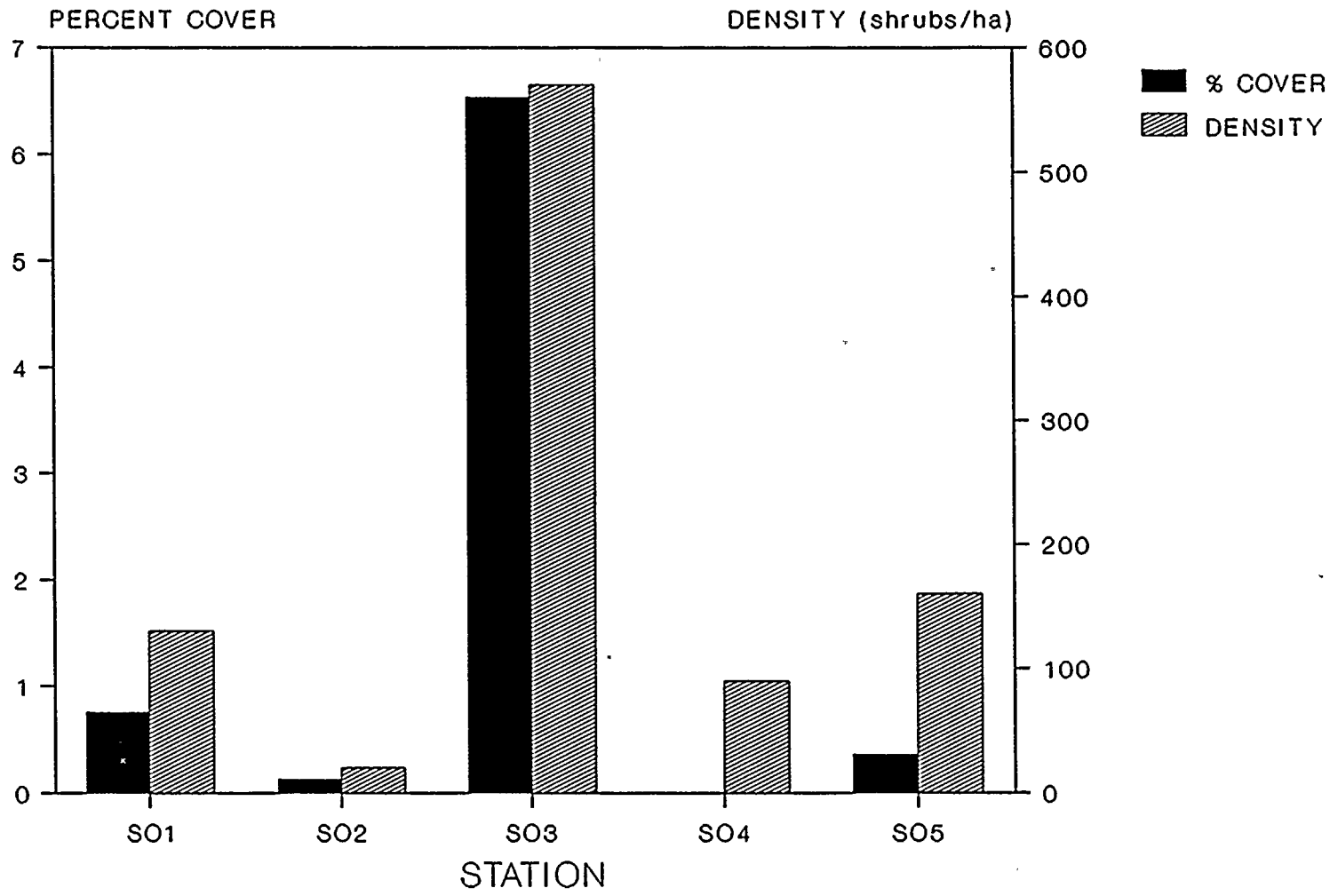
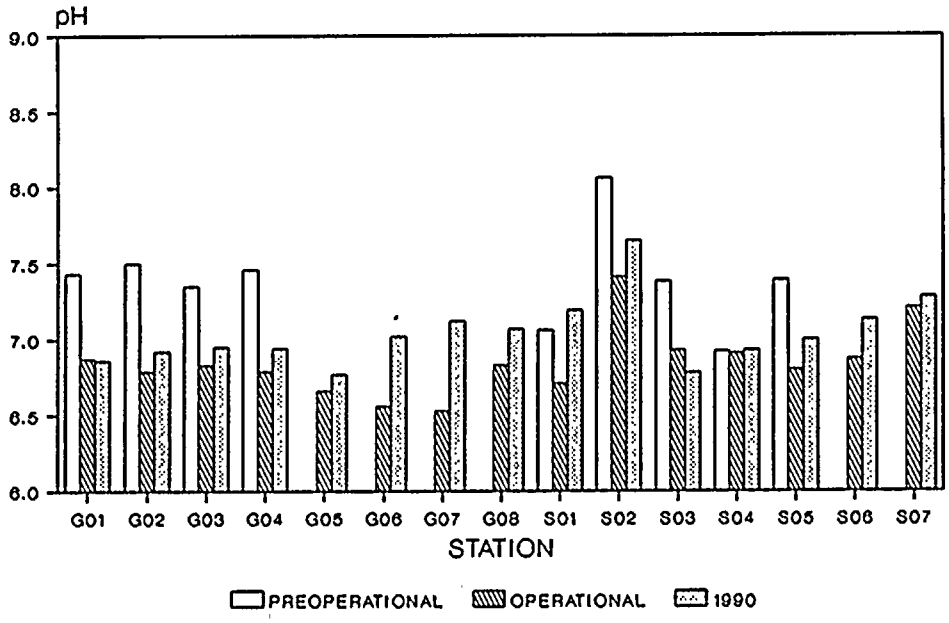


Figure 5-12 Shrub Cover and Density for Five Stations for 1990



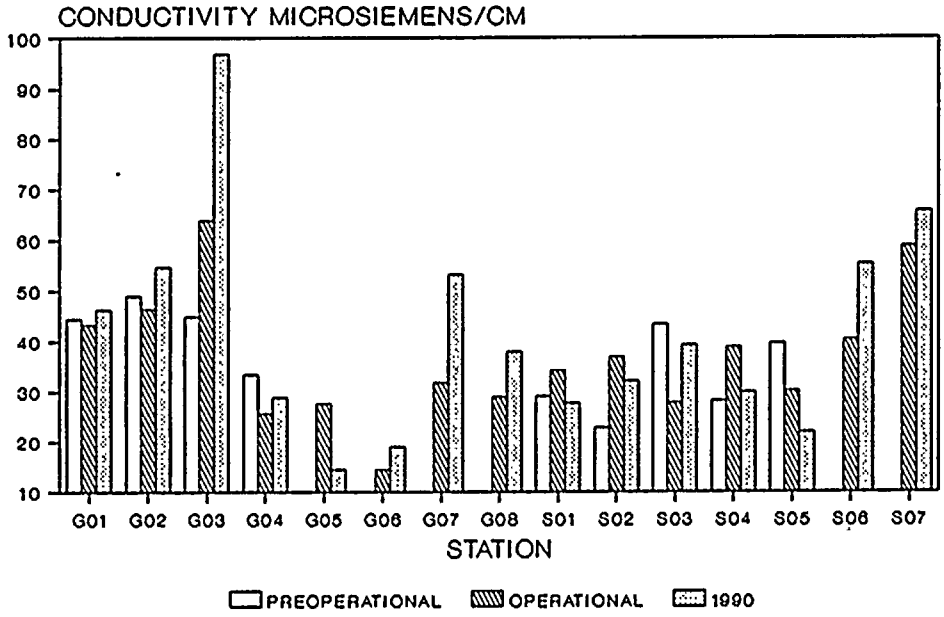
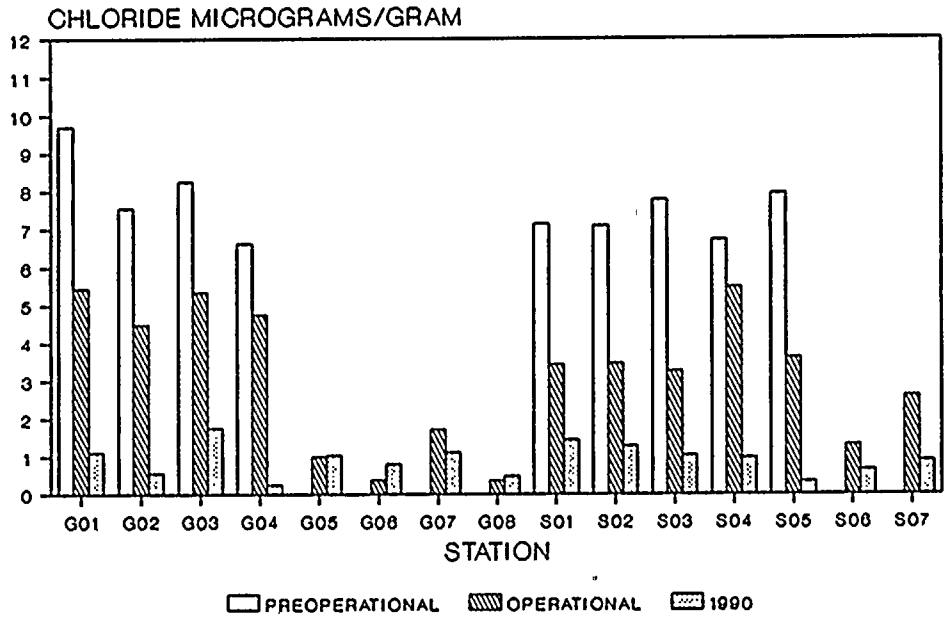


Figure 5-13 Soil pH and Conductivity for 1980 Through 1990



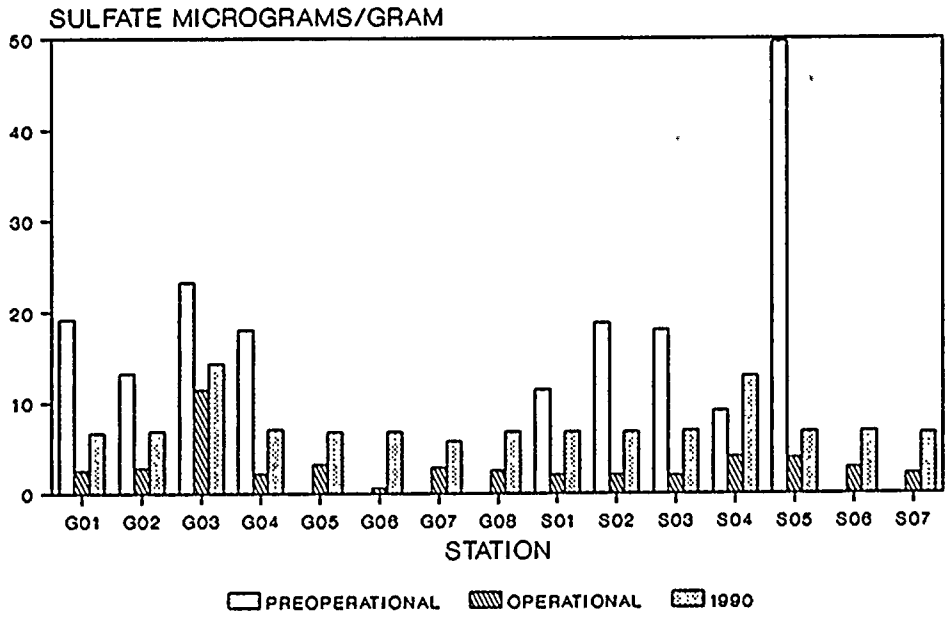
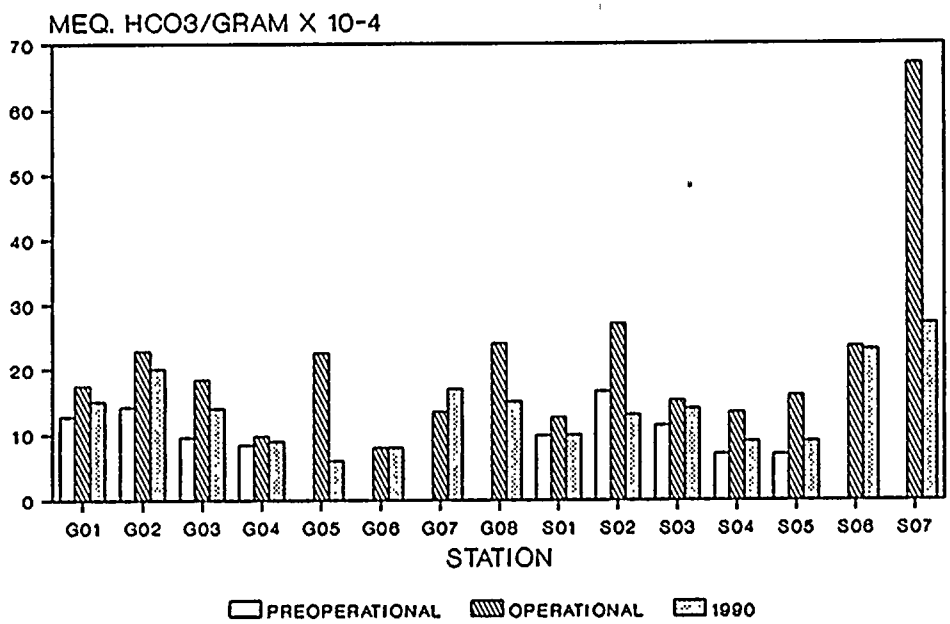


Figure 5-14 Soil Sulfate and Chloride for 1980 Through 1990



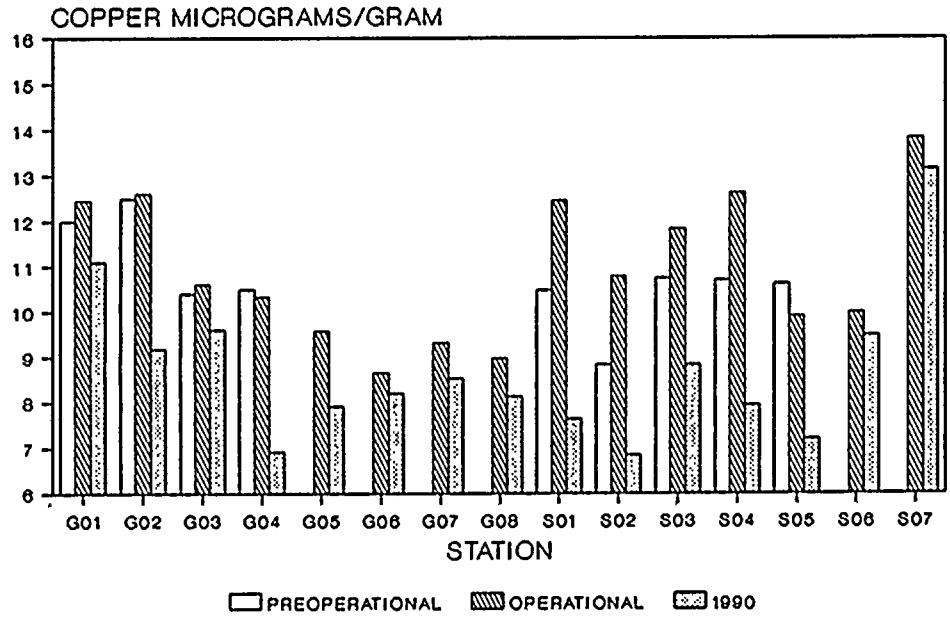
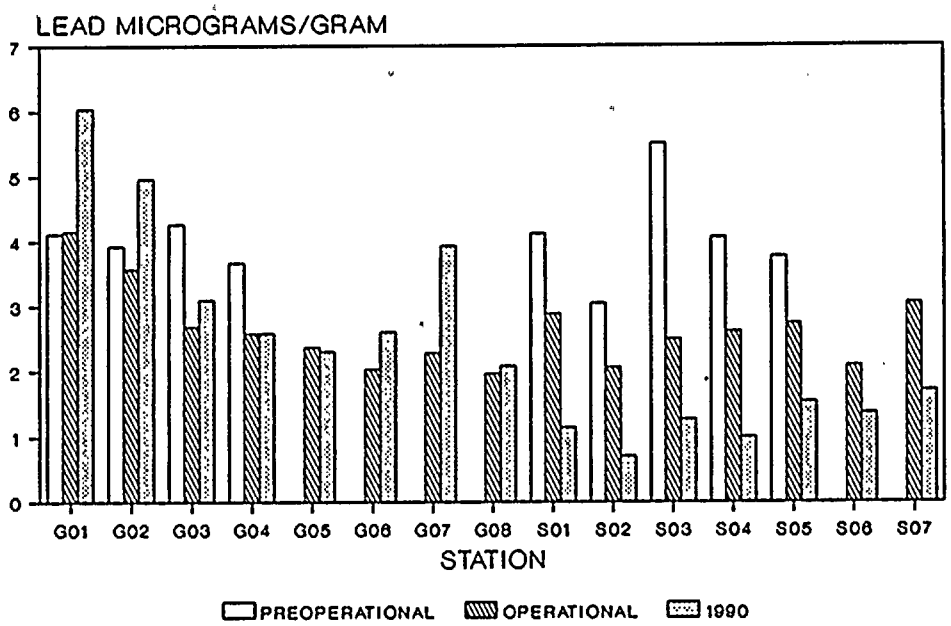


Figure 5-15 Soil Bicarbonate and Copper for 1980 Through 1990



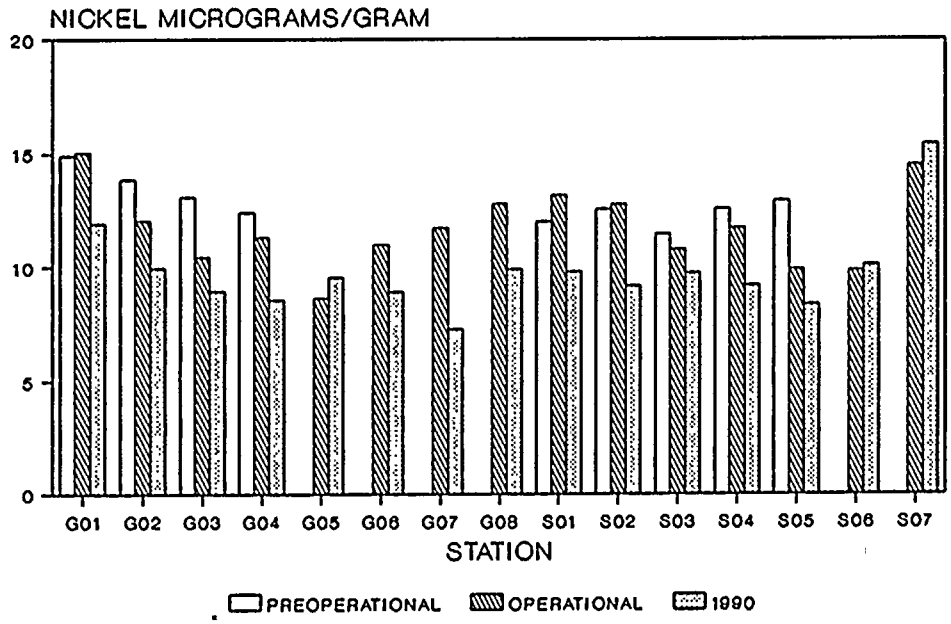
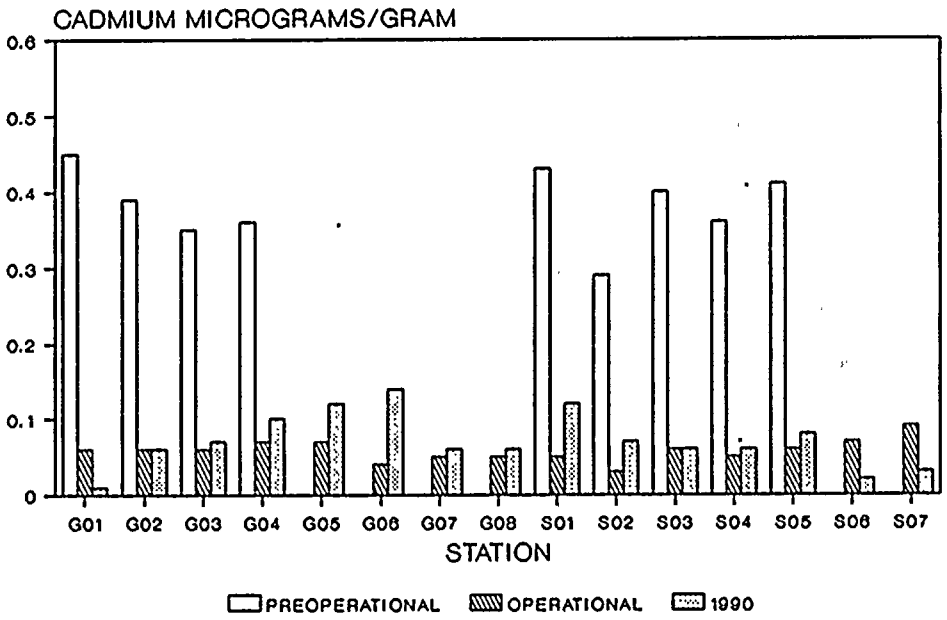


Figure 5-16 Soil Lead and Nickel for 1980 Through 1990



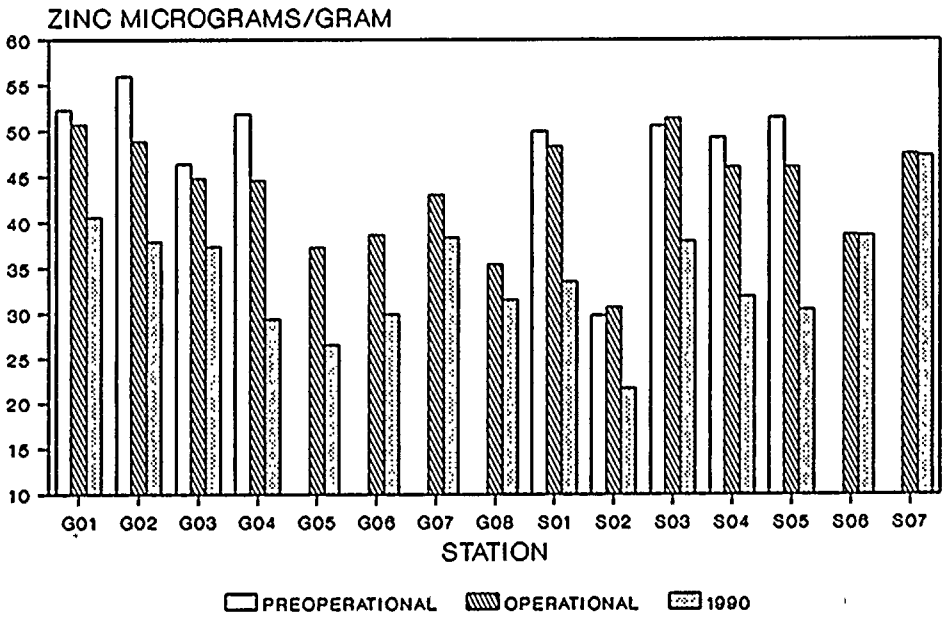
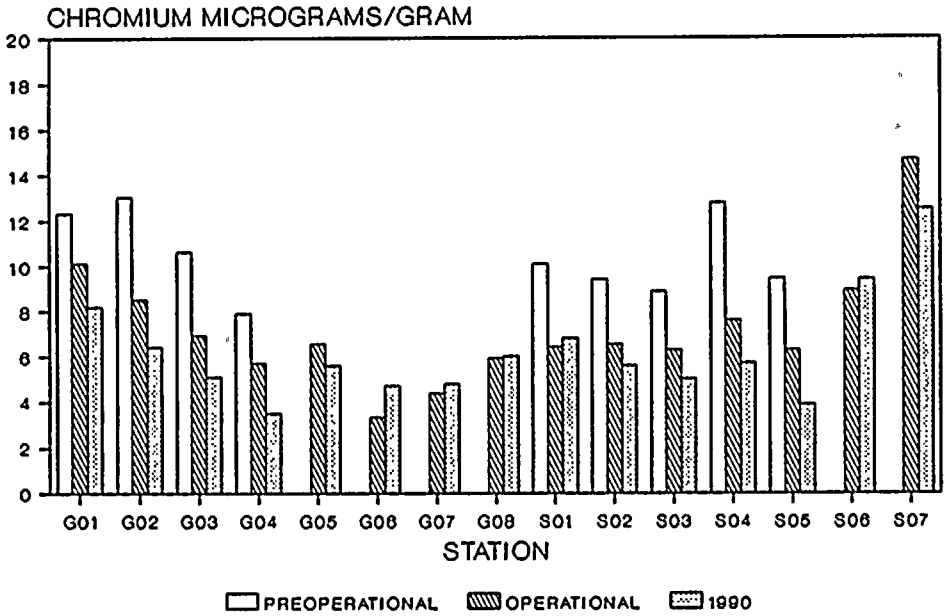


Figure 5-17 Soil Cadmium and Zinc for 1980 Through 1990



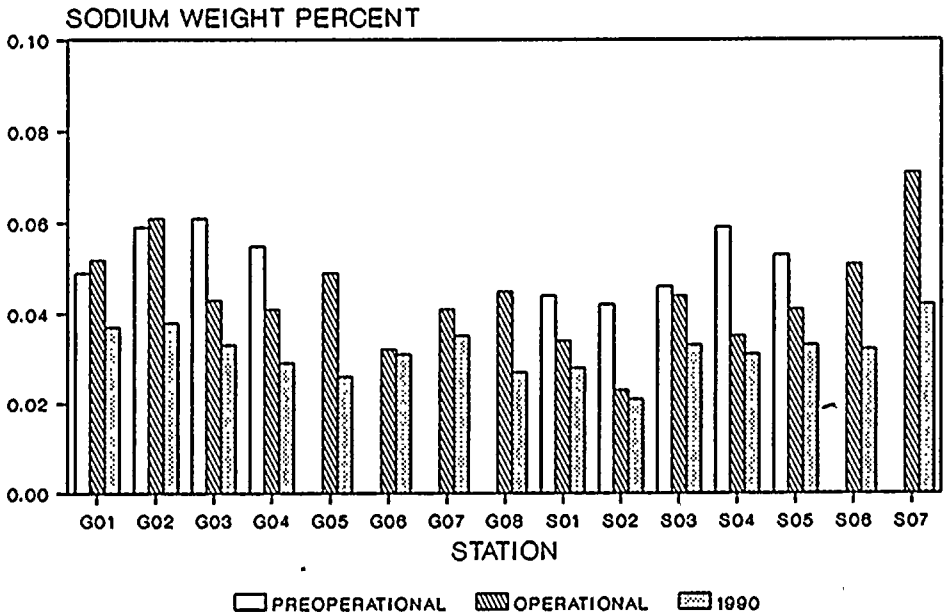
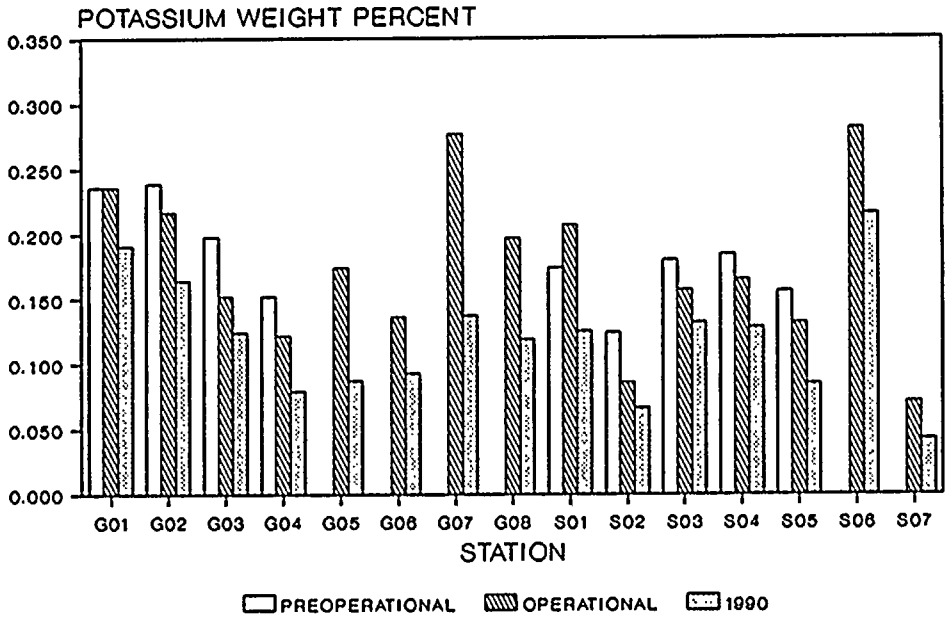


Figure 5-18 Soil Chromium and Sodium for 1980 Through 1990



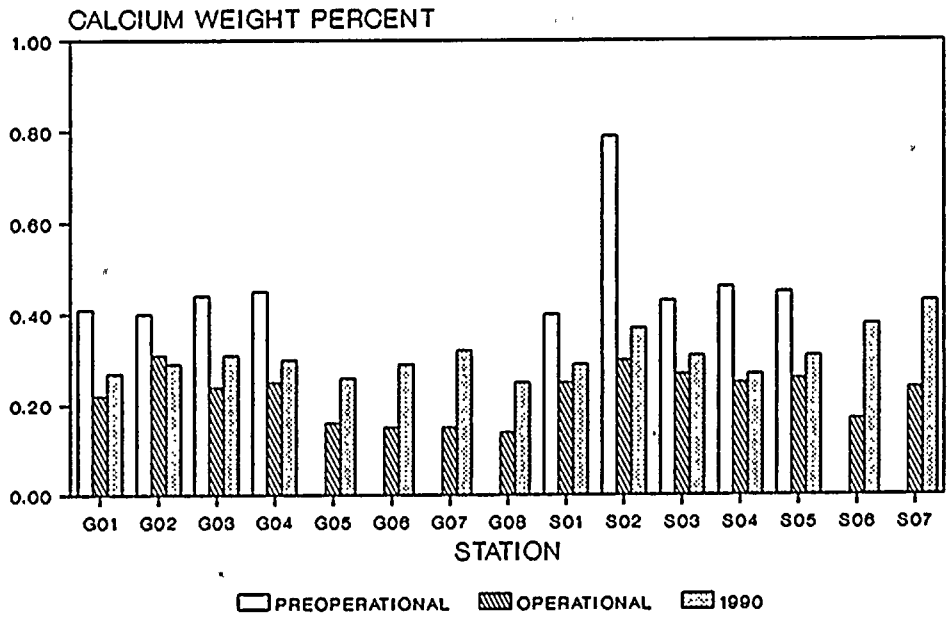


Figure 5-19 Soil Potassium and Calcium for 1980 Through 1990

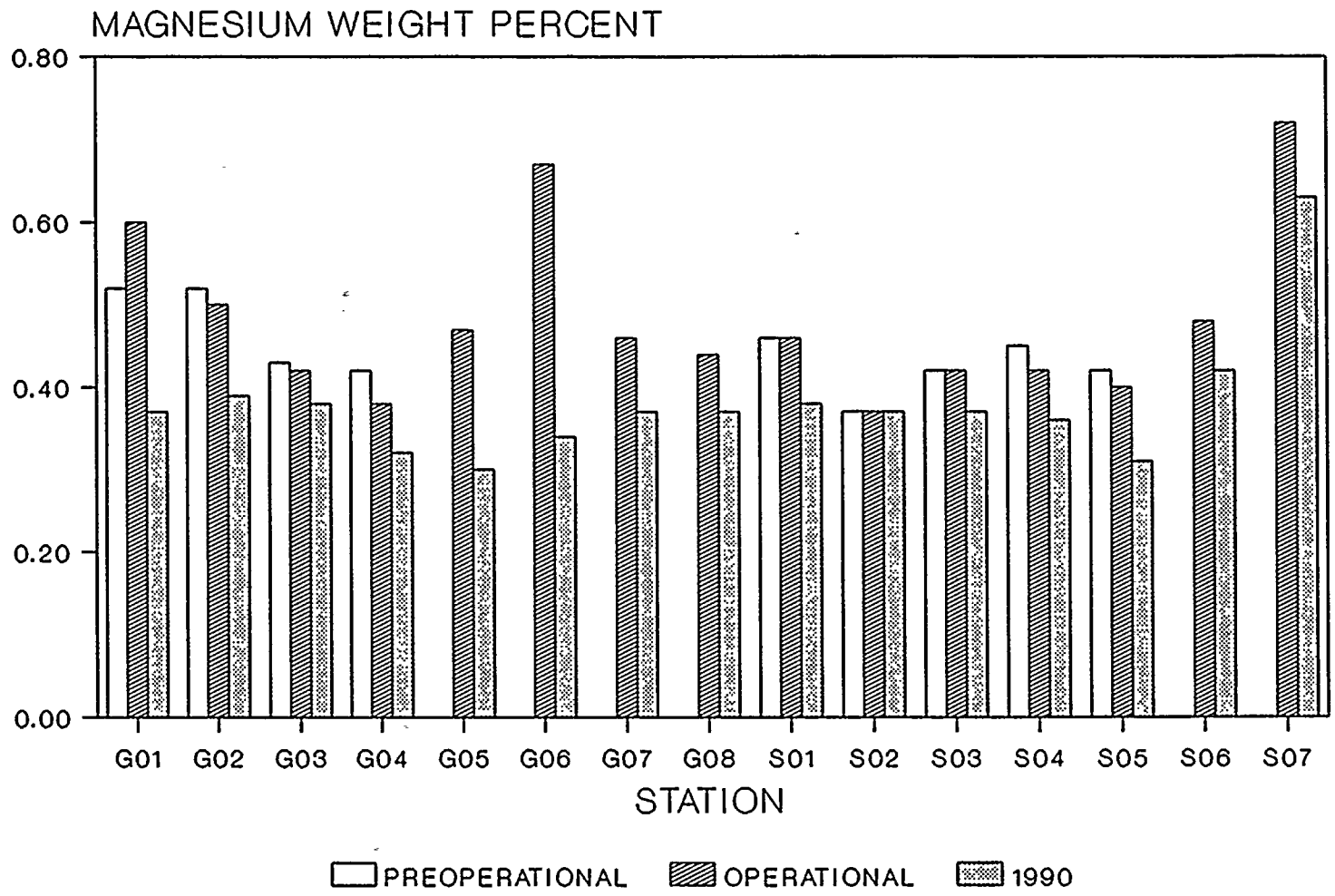


Figure 5-20 Soil Magnesium for 1980 Through 1990

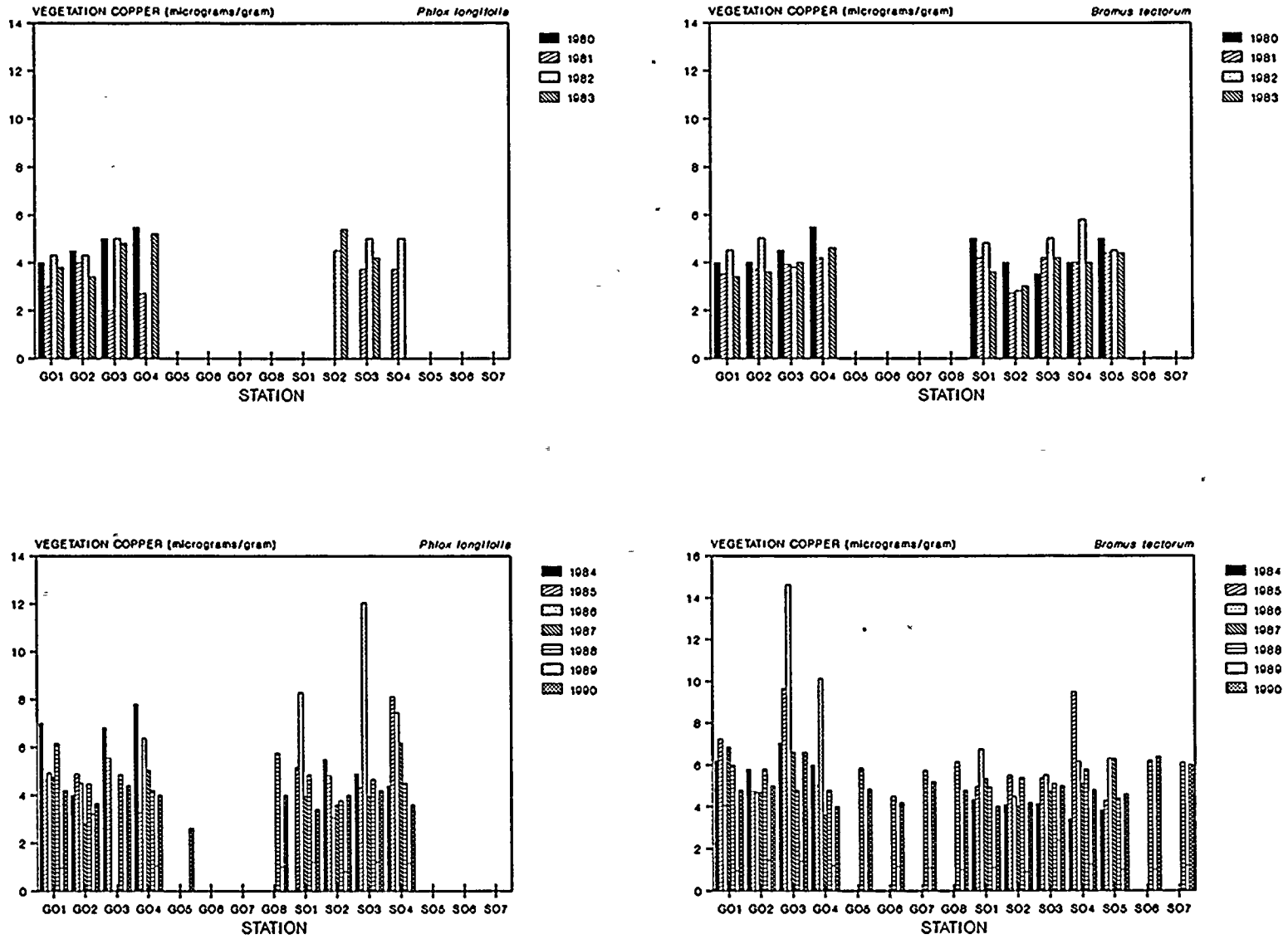


Figure 5-21 Copper Concentrations (ug/g) in Phlox longifolia and Bromus tectorum for 1980 Through 1990

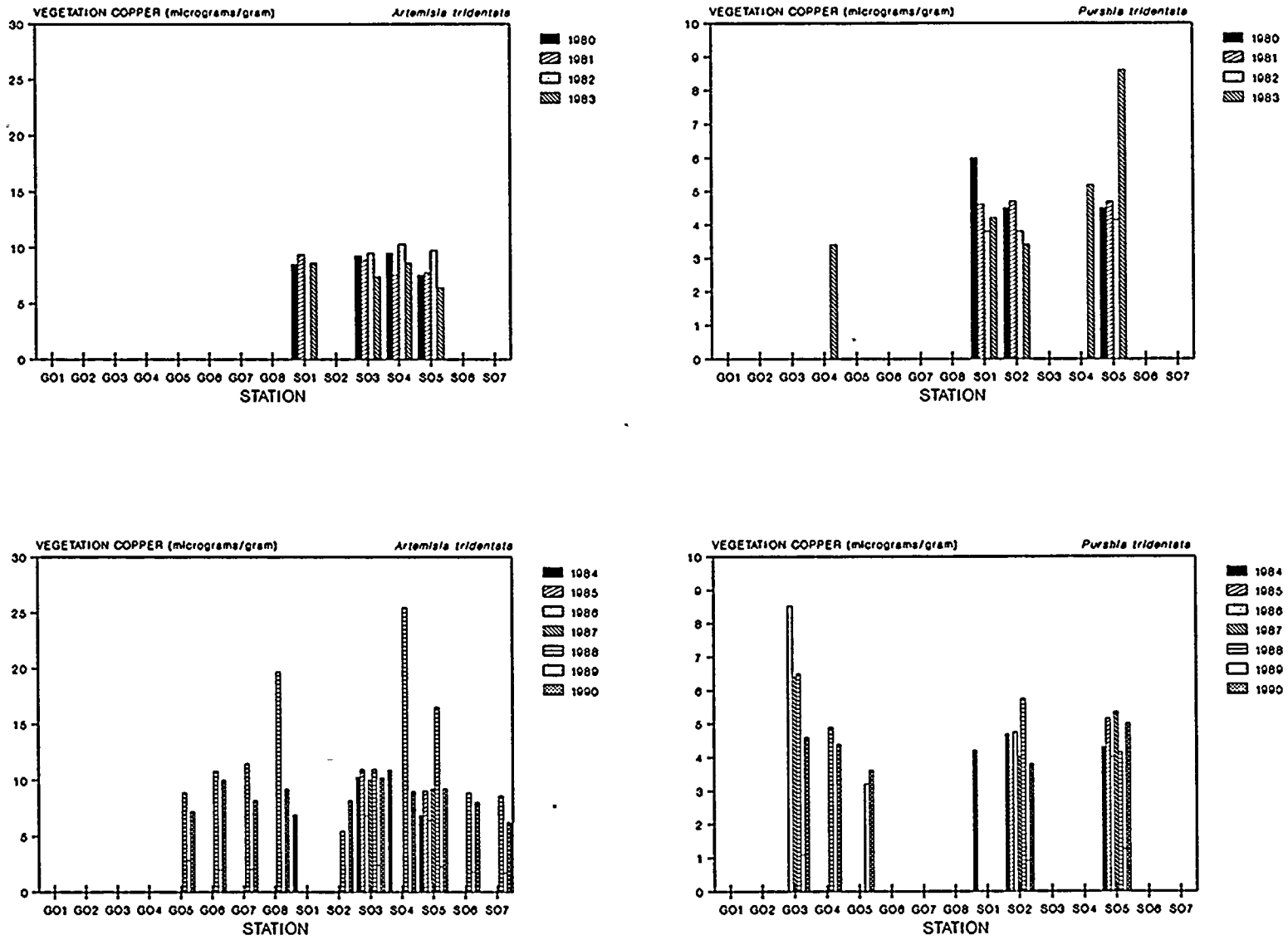


Figure 5-22 Copper Concentration (ug/g) in Artemisia tridentata and Purshia tridentata for 1980 Through 1990

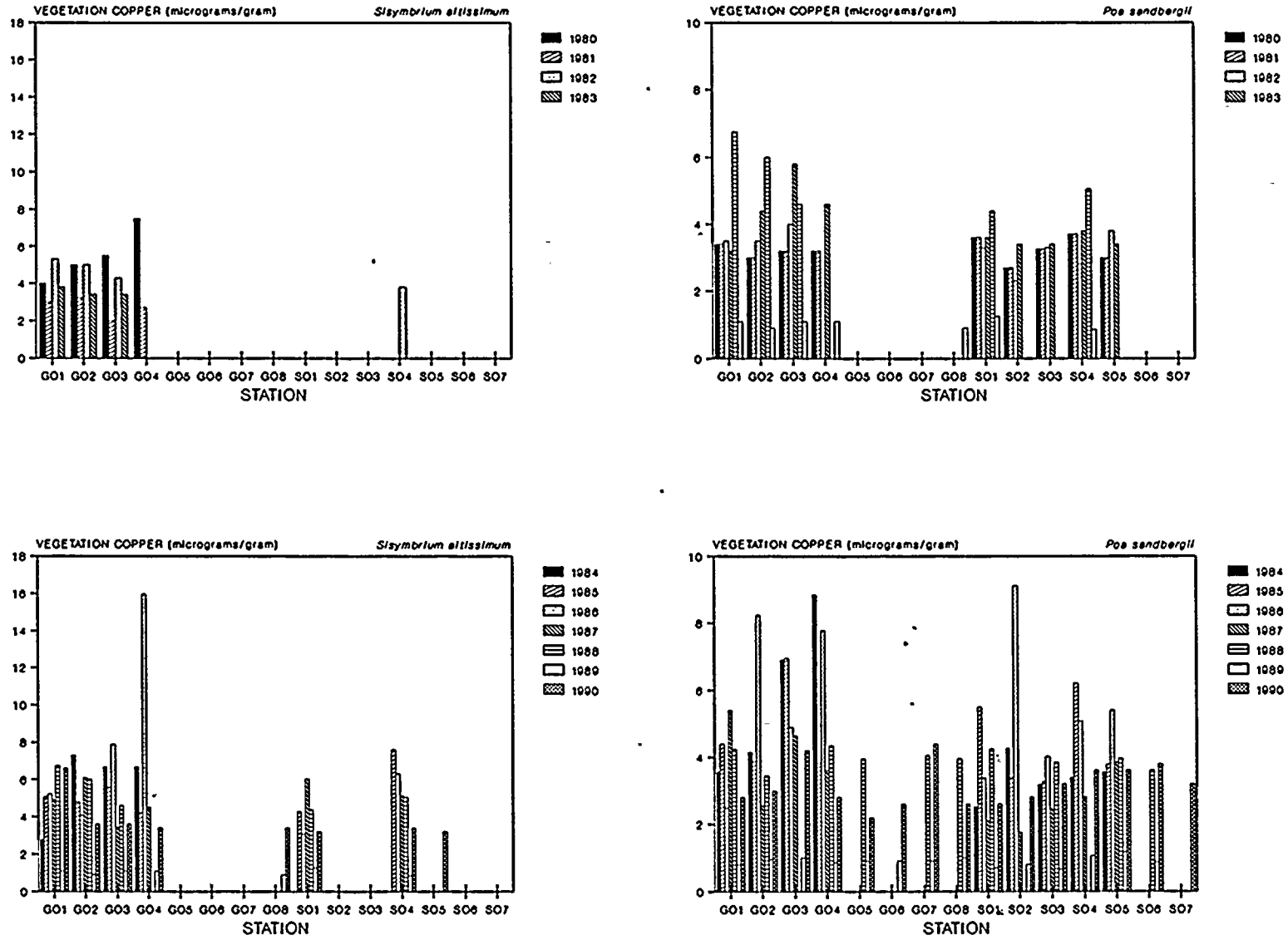


Figure 5-23 Copper Concentration (ug/g) in Sisymbrium altissimum and Poa sandbergii for 1980 Through 1990

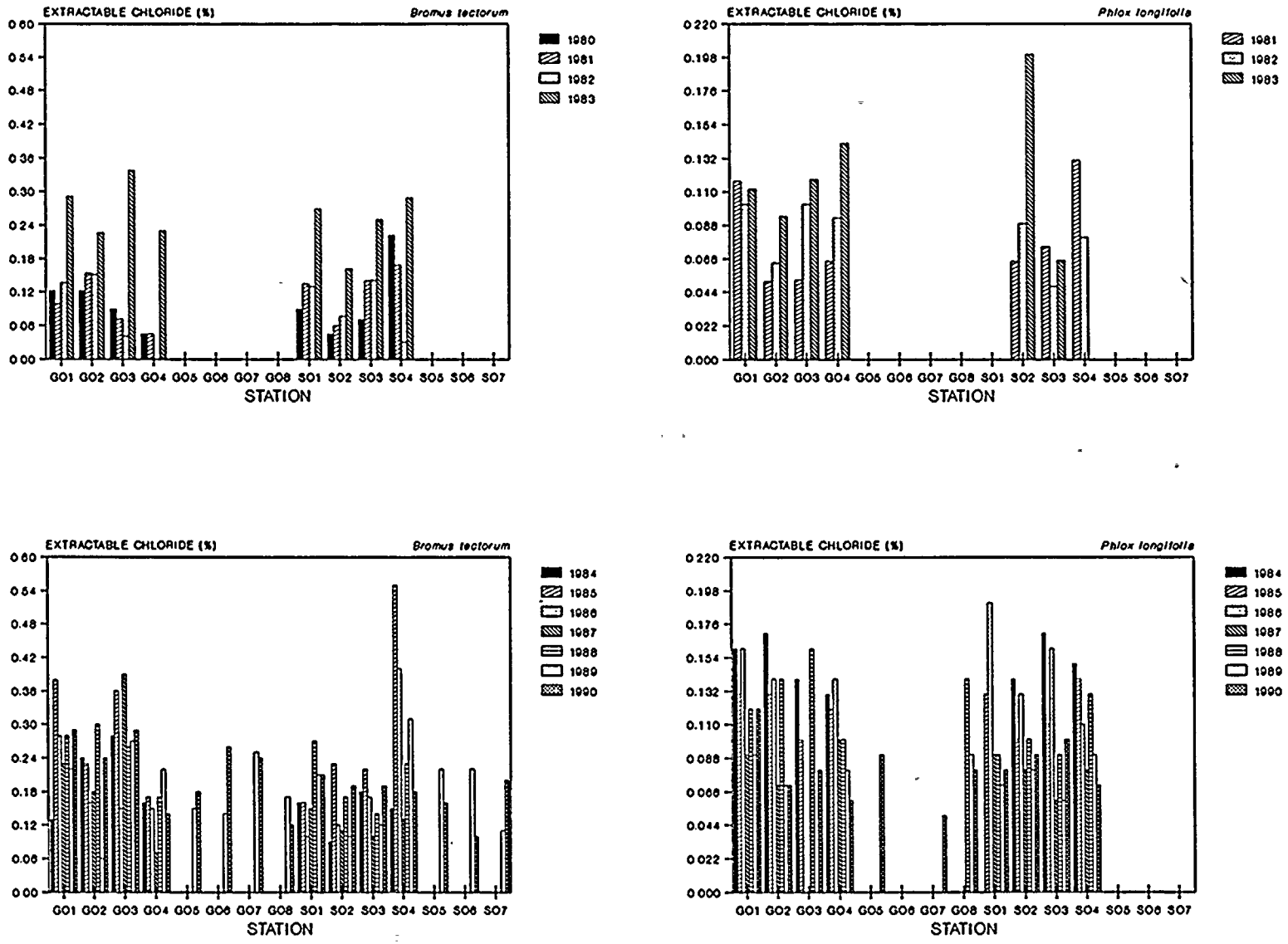


Figure 5-24 Chloride Concentration (%) in Bromus tectorum and Phlox longifolia for 1980 Through 1990

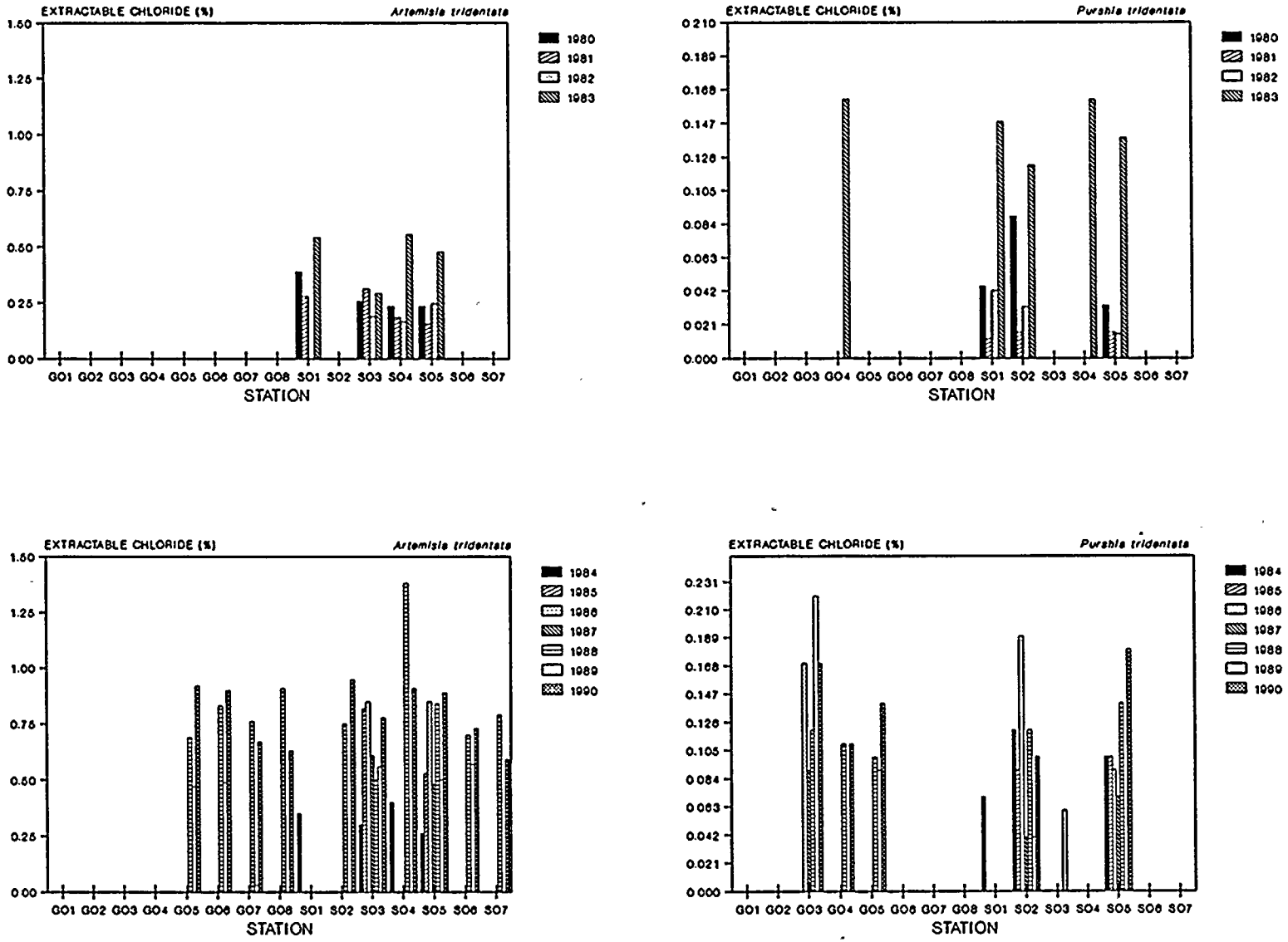


Figure 5-25 Chloride Concentration (%) in Artemisia tridentata and Purshia tridentata for 1980 Through 1990

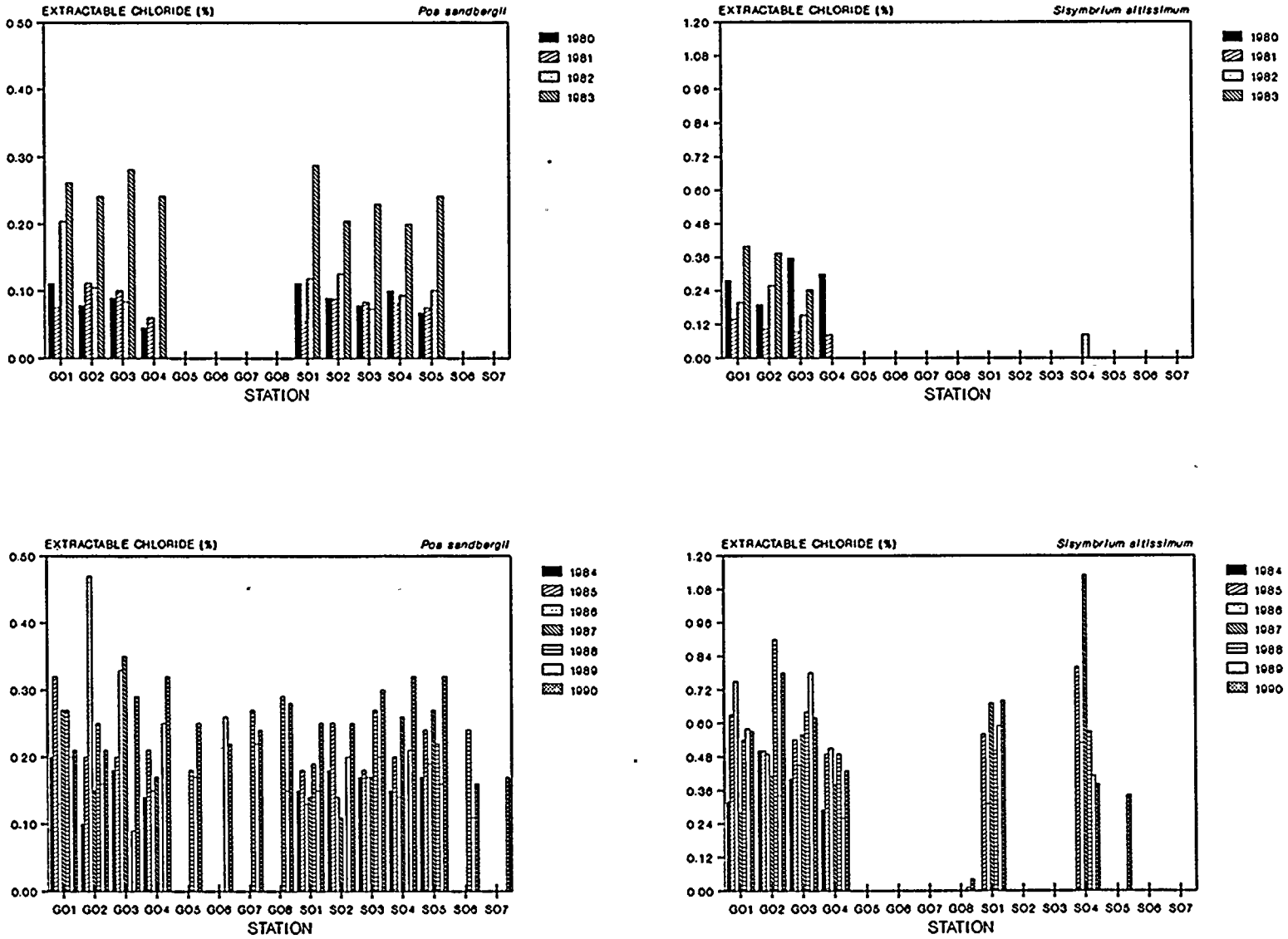


Figure 5-26 Chloride Concentration (%) in Poa sandbergii and Sisymbrium altissimum for 1980 Through 1990

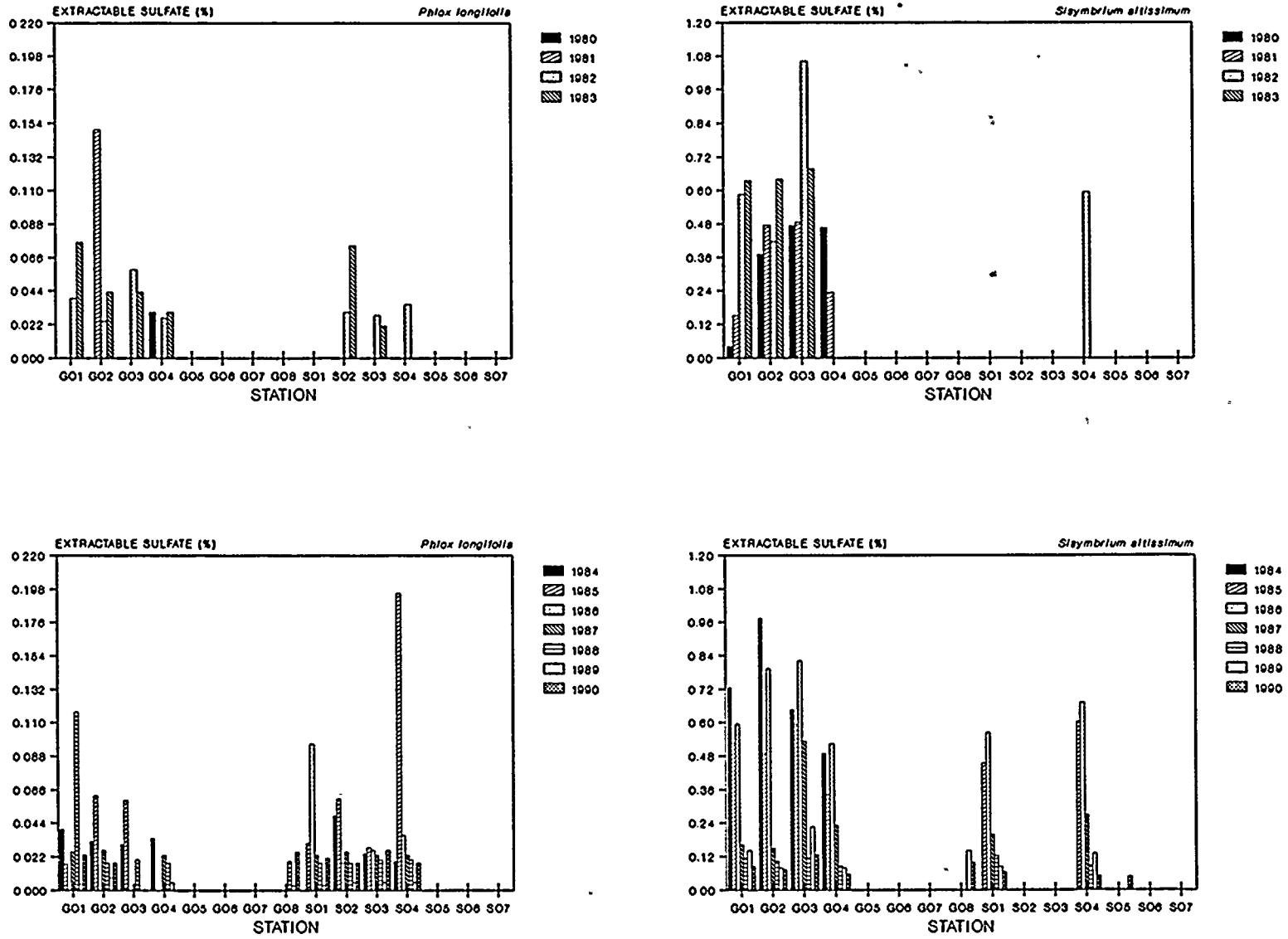


Figure 5-27 Sulfate Concentration (%) in Phlox longifolia and Sisymbrium altissimum for 1980 Through 1990

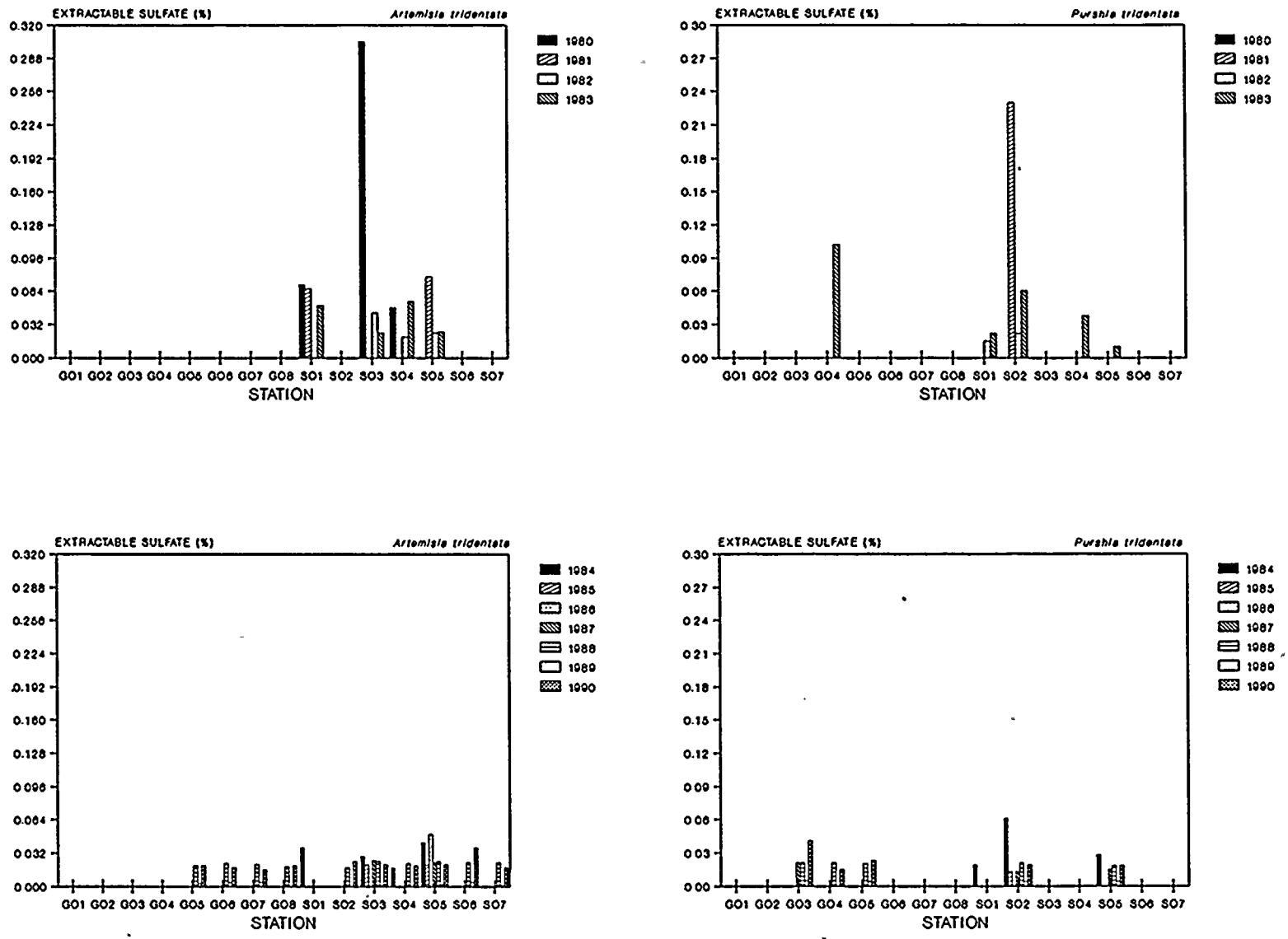


Figure 5-28 Sulfate Concentration (%) in Artemisia tridentata and Purshia tridentata for 1980 Through 1990

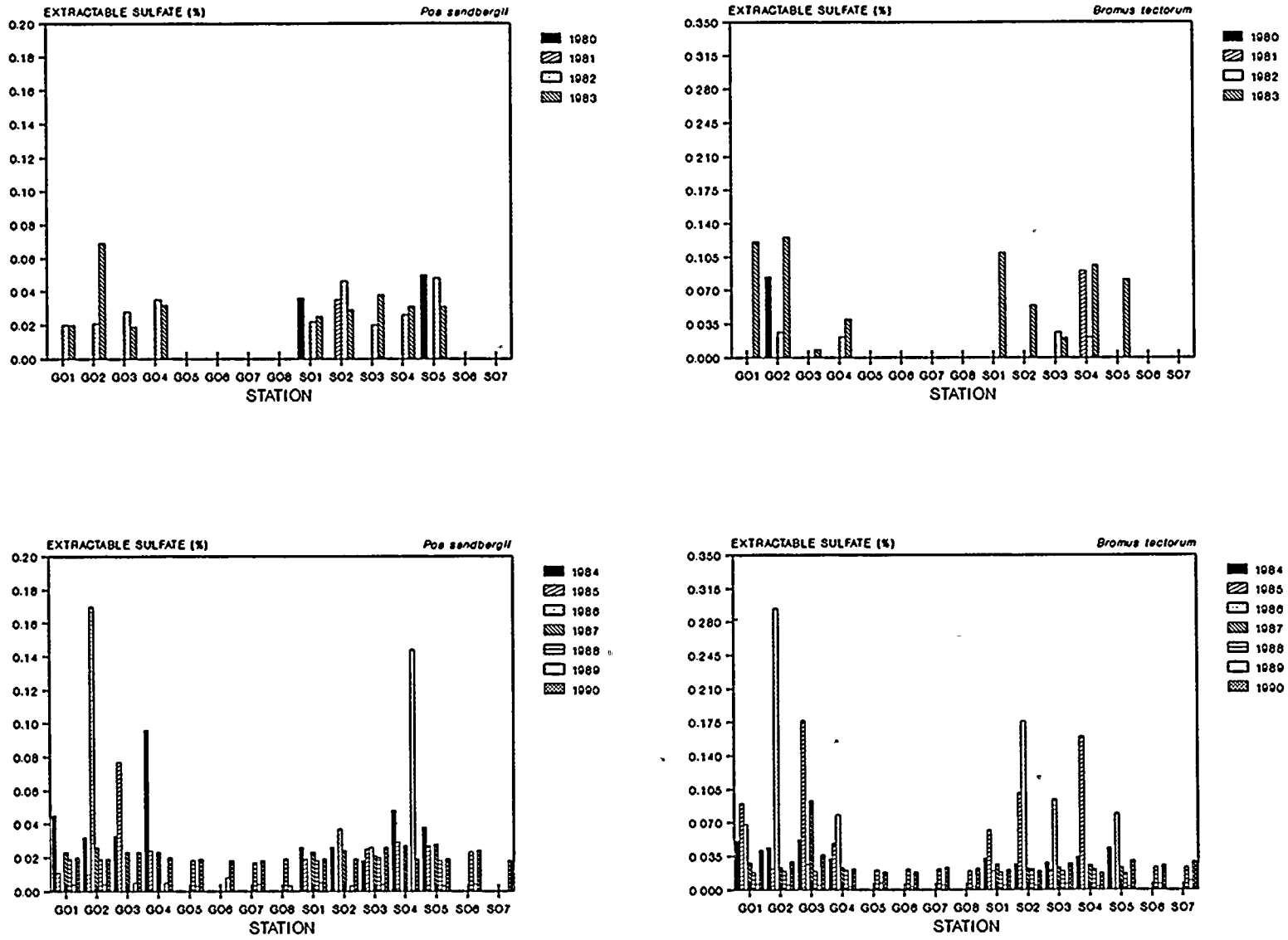


Figure 5-29 Sulfate Concentration (%) in Poa sandbergii and Bromus tectorum for 1980 Through 1990

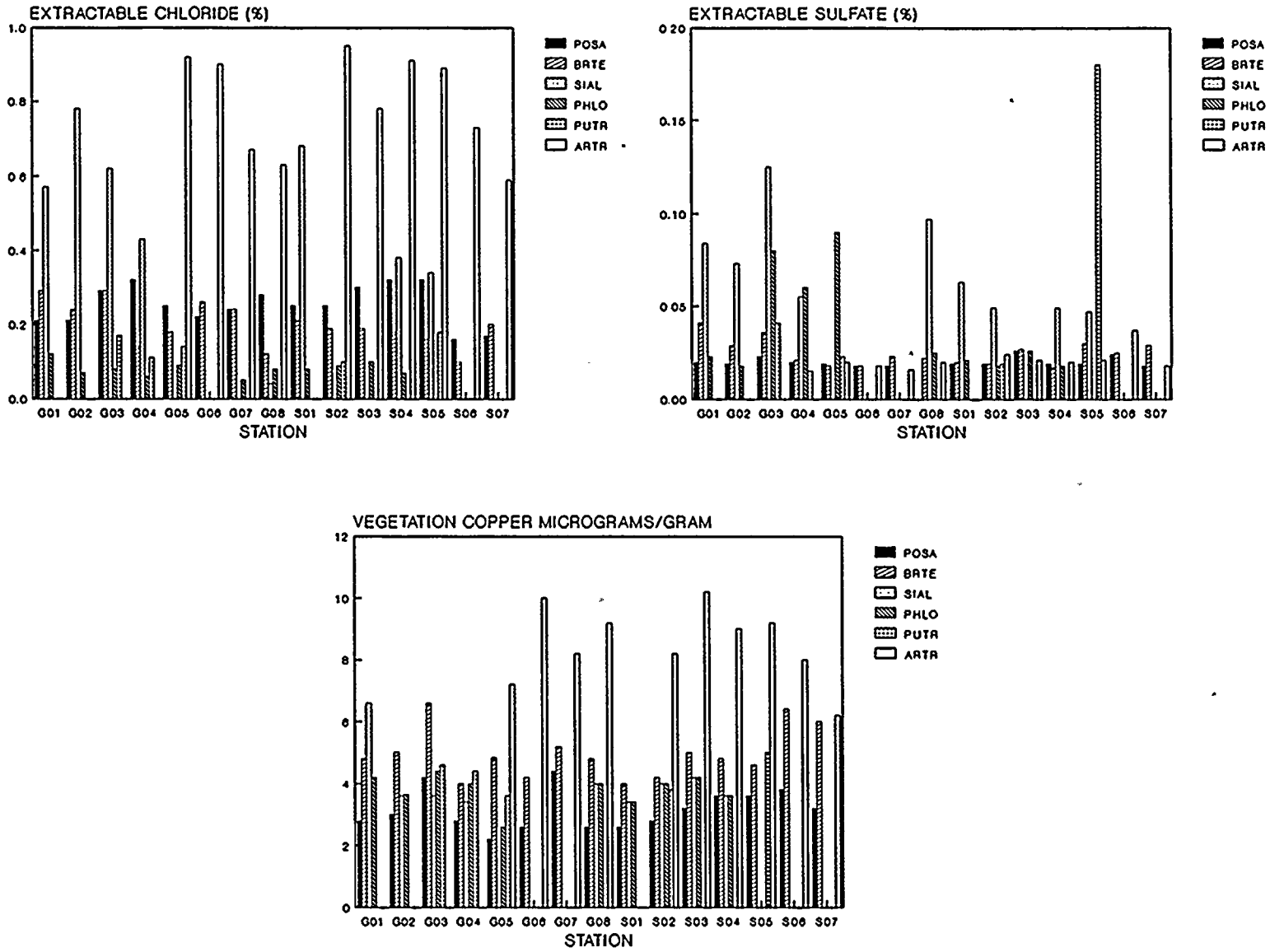


Figure 5-30 Total Vegetation Copper, Chloride and Sulfate for 1990

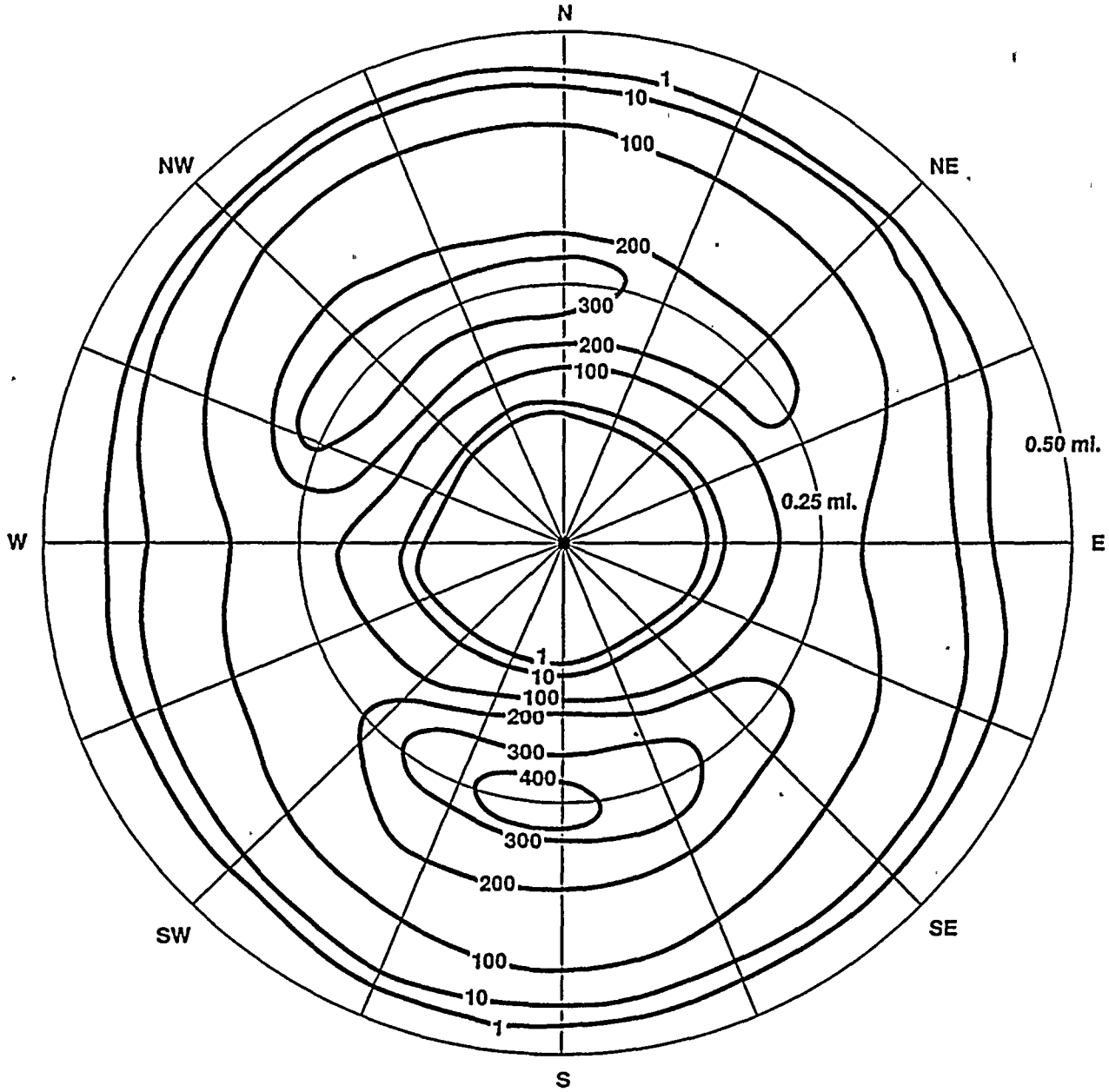
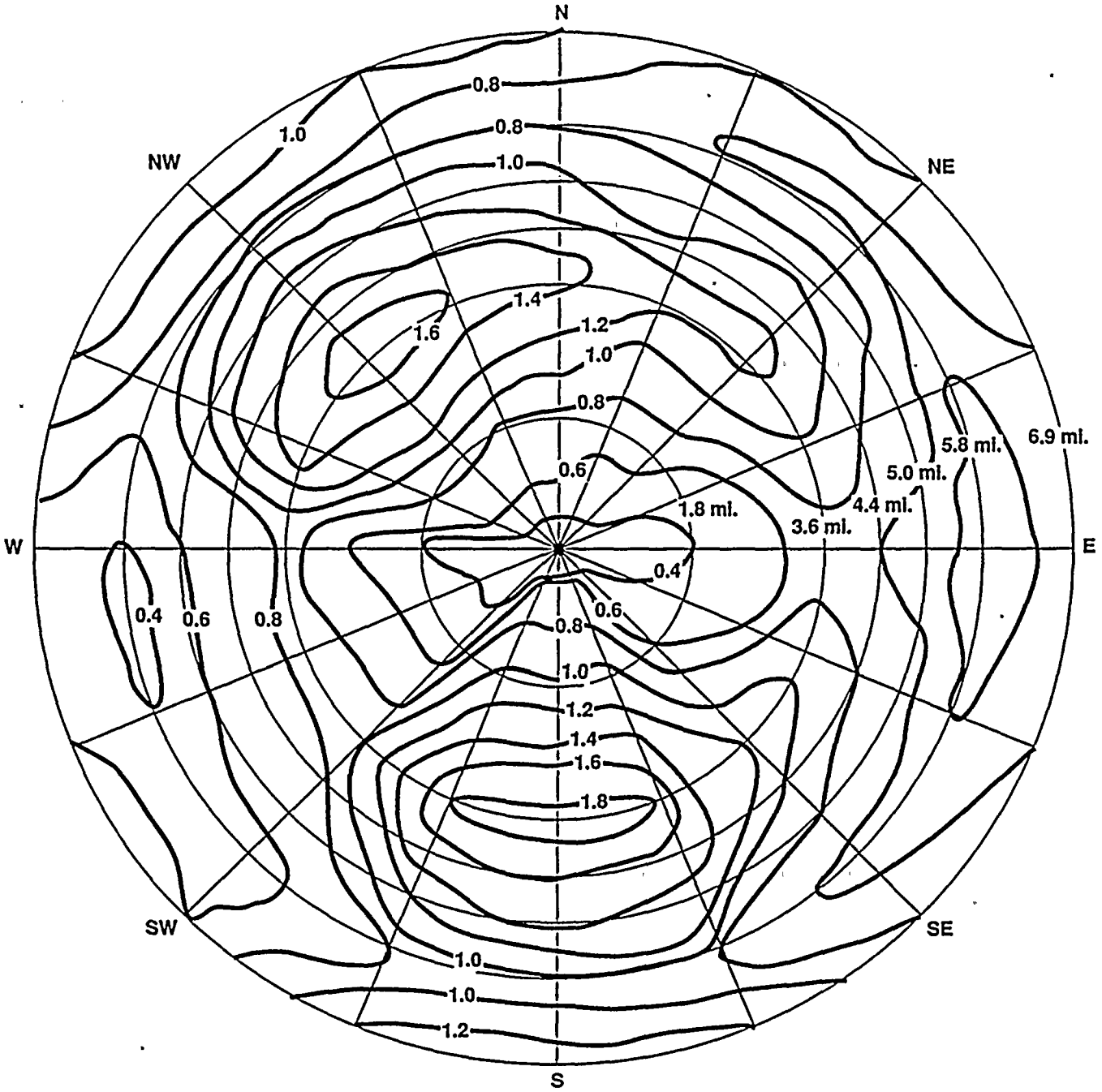
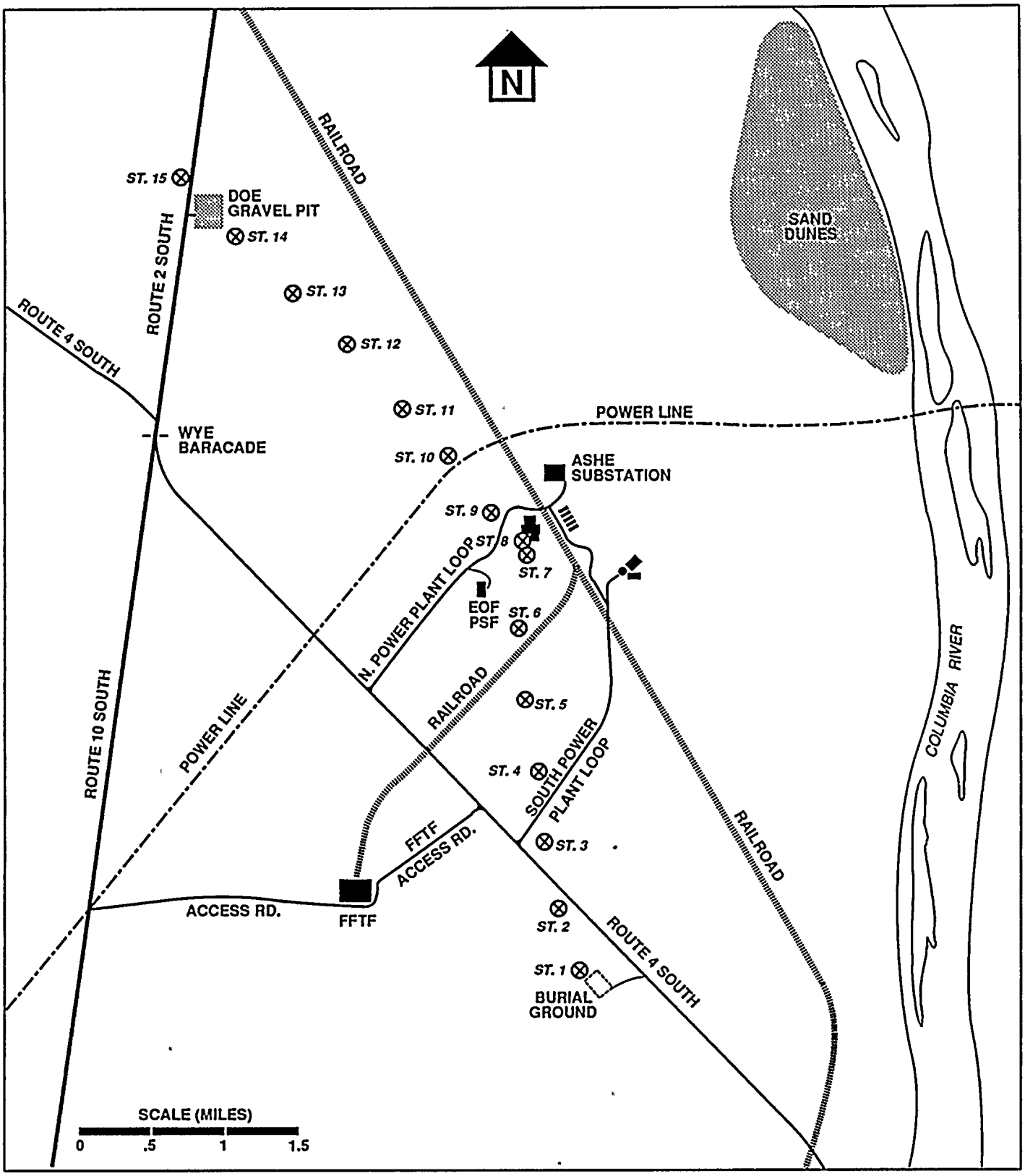


Figure 5-31 Predicted Salt Deposition Patterns Out to 0.5 Mile (0.8 km) (lb/acre/yr)



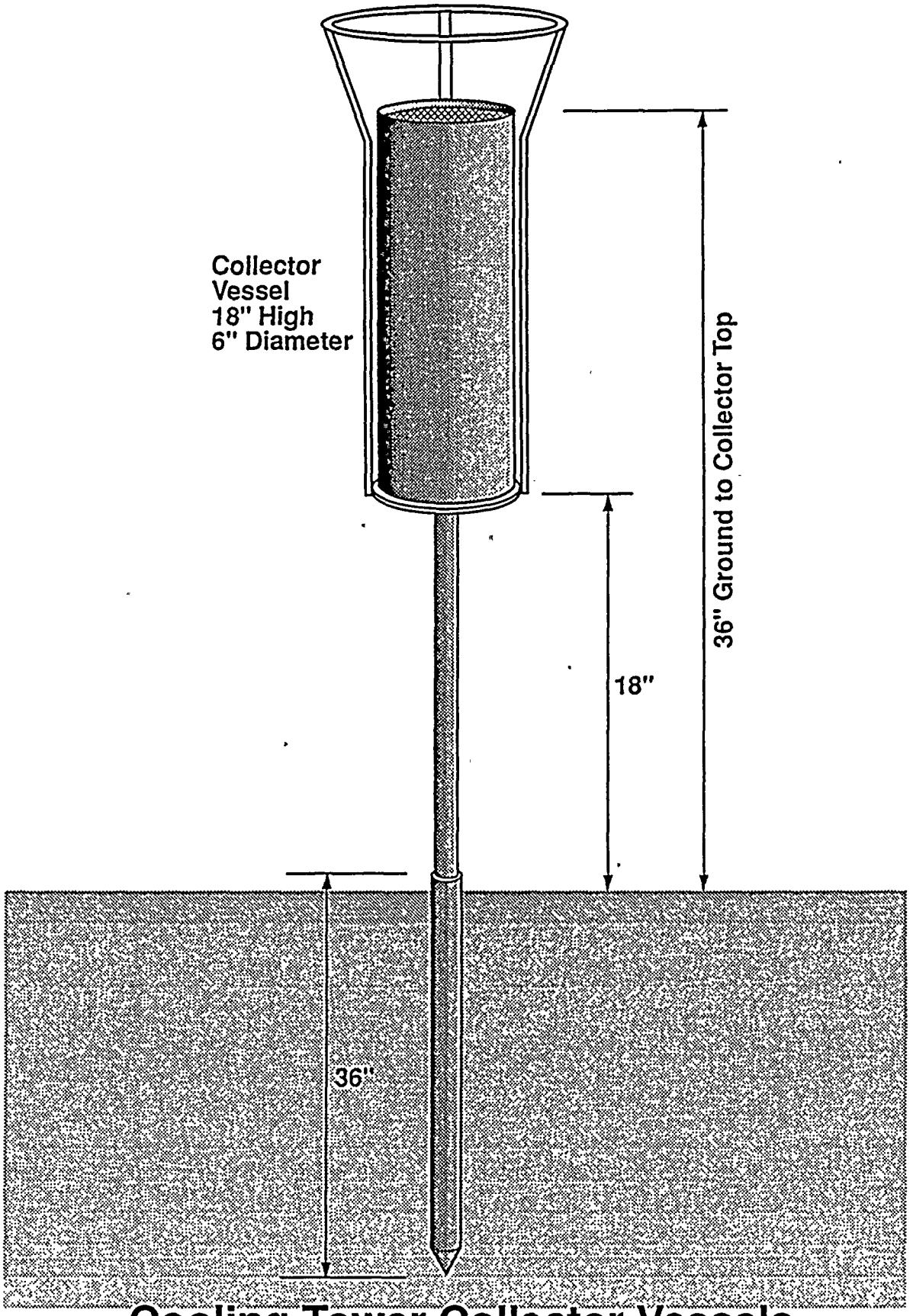
910370.2

Figure 5-32 Predicted Salt Deposition Patterns Out to 6.9 Mile (11.1 km) (lb/acre/yr)



880351
MARCH 1989

Figure 5-33 Location Map of Cooling Tower Drift Monitoring Sites



Cooling Tower Collector Vessels

890317

Figure 5-34 Cooling Tower Drift Collection Vessel

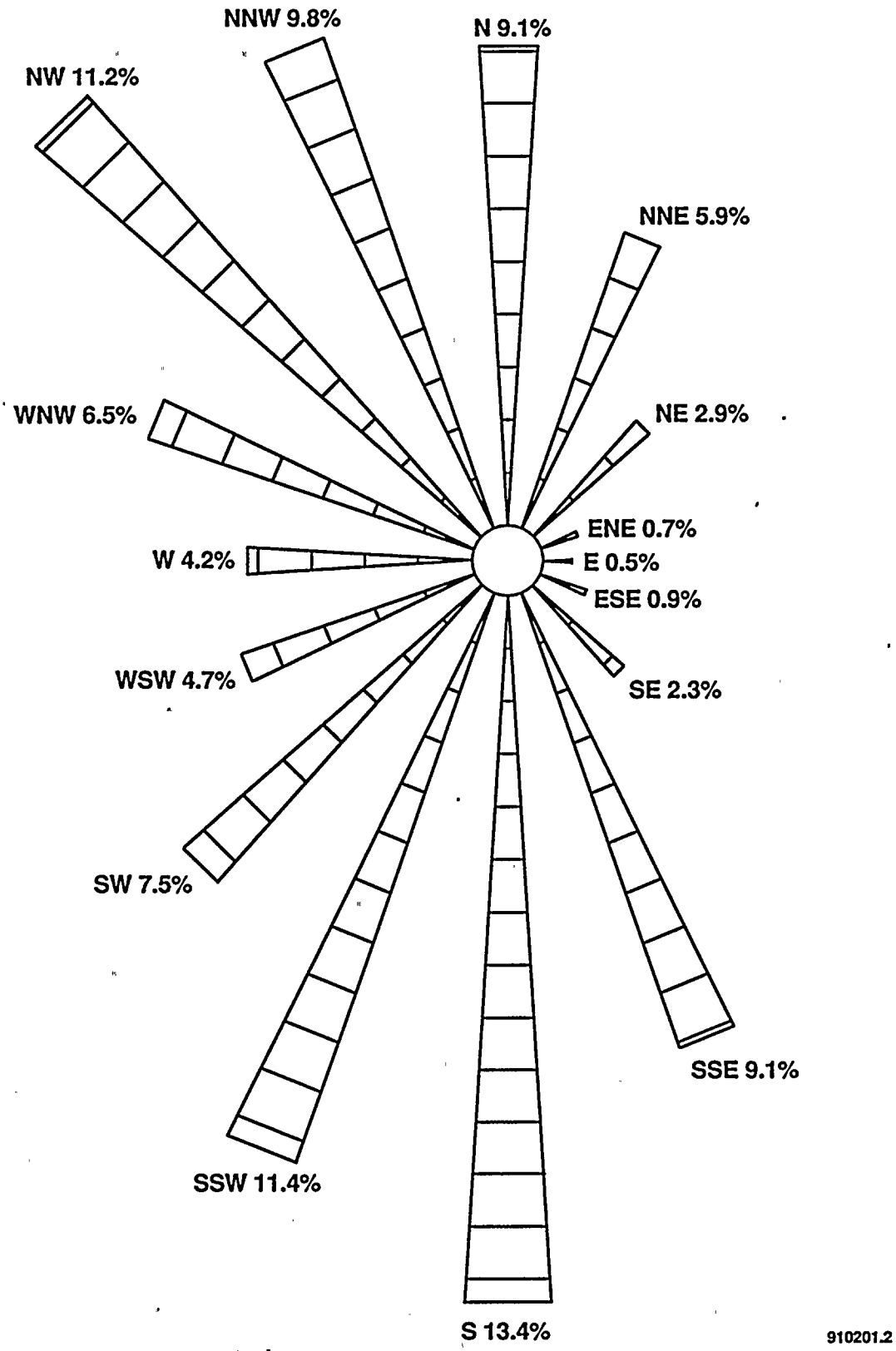


Figure 5-35 Cumulative Wind Rose
April 1989 through March 1990
WNP-2 Meterological Station 33 Foot Level

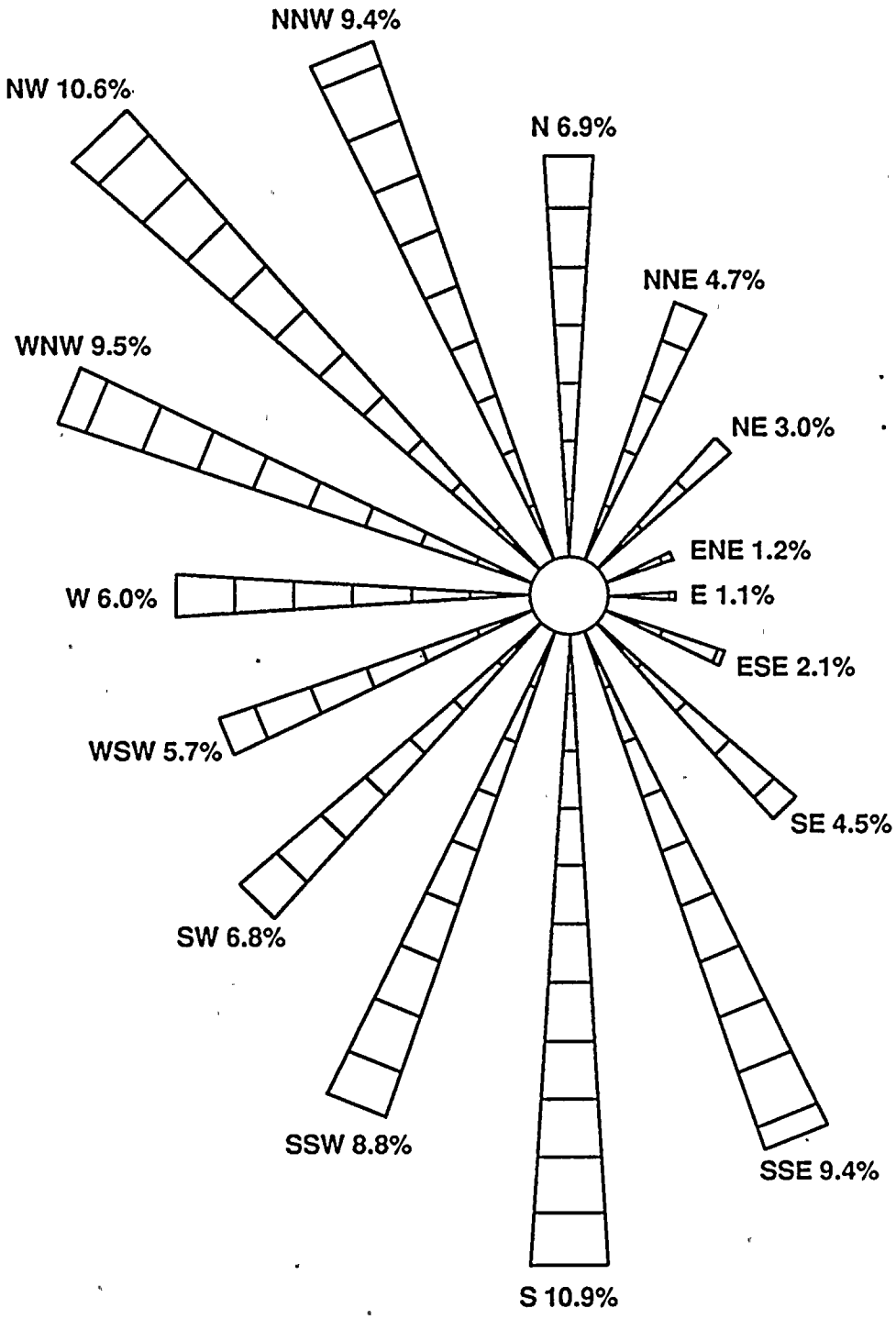


Figure 5-36 Cumulative Wind Rose 1984 through 1989
WNP-2 Meterological Station
33 Foot Level

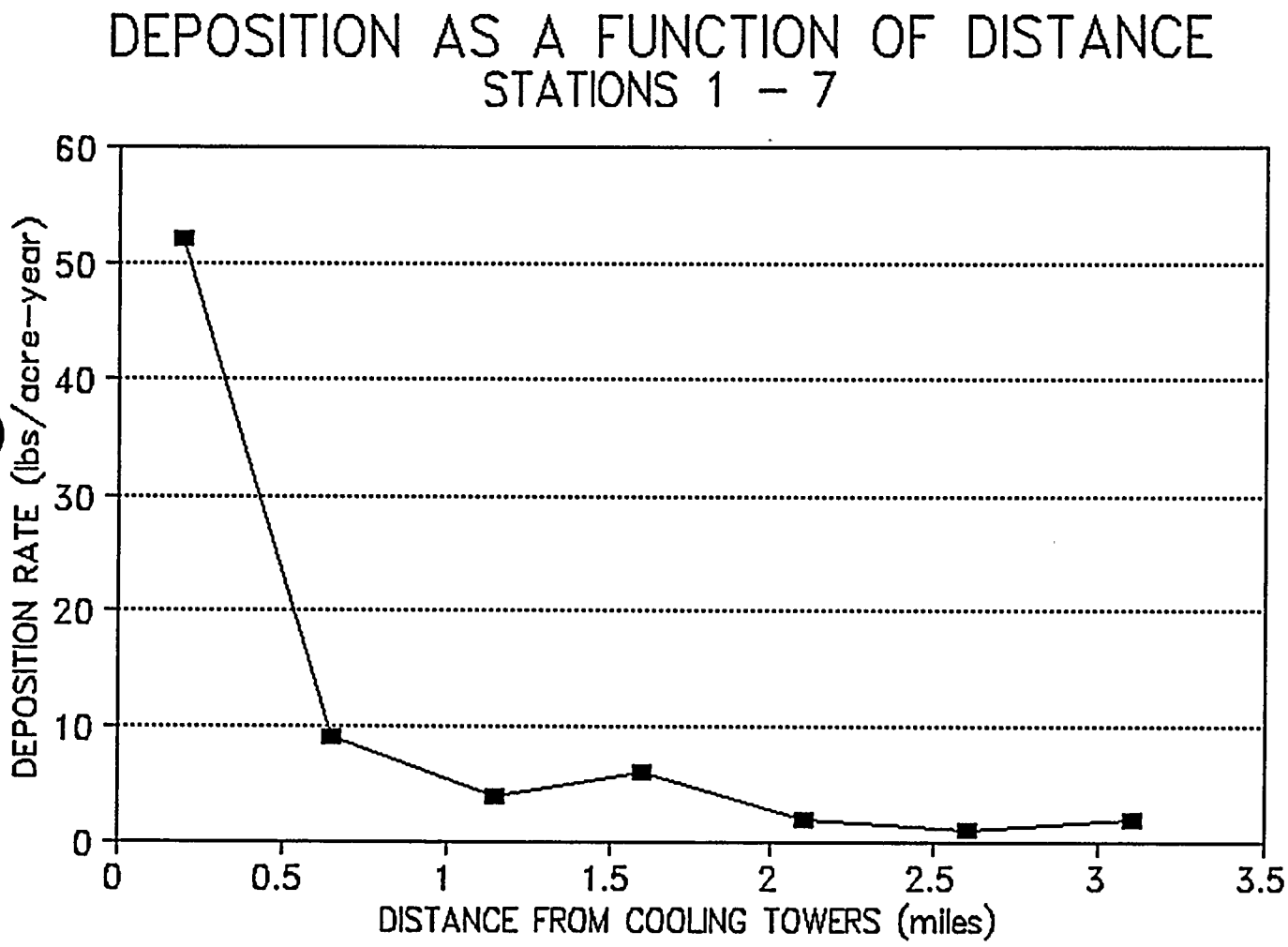


Figure 5-37 Deposition Rate as a Function of Distance

6.0 INTAKE STRUCTURE FOULING SURVEYS

6.1 INTRODUCTION

The regulatory commitment for this study has been satisfied and no further studies are planned. No fish were found impinged during any of the inspections and algal growth was moderate. Incidental observations will be made when maintenance inspections of the intakes are conducted.

7.0 AERIAL PHOTOGRAPHY PROGRAM

7.1 INTRODUCTION

The aerial photography program began in June of 1988 to monitor the vegetation surrounding WNP-2 for impact due to cooling tower operation. Aerial photographs taken with color infrared (CIR) film, allow large areas to be monitored and to detect signs of possible stress before it becomes visible to the human eye. In addition to examination for stress, the photographs will be compared with those taken in following years to look for changes in vegetation patterns and evidence of cumulative damage. This program is performed to comply with Washington State Energy Facility Site Evaluation Council (EFSEC) Resolution No. 239, dated September 14, 1987.

7.2 MATERIALS AND METHODS

This program was planned using guidelines published in NUREG/CR-1231 (NRC, 1980). This report outlined the basic requirements for an aerial monitoring program and suggested types of film, photograph scales, frequency of photograph acquisition and the size of prints.

Five flightlines (Figure 7.1) were planned to cover the areas of greatest deposition according to the drift model constructed by Battelle Pacific Northwest Laboratories (PNL, 1976). Two flightlines, approximately 7 miles (11.2 Km) in length, run in a general north-south direction. These flightlines run between the two areas of greatest deposition according to the model. The other three flightlines of approximately 5 miles (8.1 Km) in length, run in an east-west direction and were placed to cross gradients of deposition. The five flightlines were flown at an altitude of 1,550 feet (477m) above mean sea level. The flightline coordinates are stored in the long-range navigation (LORAN) system in the contractors airplane. This allows the same lines to be photographed in following years.

The photographs were taken with Kodak Aerochrome 2443 color infrared film in a Hasselblad ELM 70mm camera. A Planar lens with a 80mm focal length was used with a number 12 Wratten filter attached. The scale is 1:6,000 in a 70mm x 70mm format. The relatively large scale of 1:6,000 was chosen as being large enough to differentiate the types of shrubs in the areas surrounding WNP-2. The 70mm size was chosen over the larger nine inch by nine inch format for ease of handling and the storage of the nearly 300 photographs.

Color infrared (CIR) film was chosen over natural color or black and white film because the symptoms of stress on vegetation may show in the infrared wavelengths before it becomes apparent in the visible wavelengths. CIR film is easier to interpret than black and white infrared because the shades of color are easier to differentiate than the subtler shades of gray in the monochromatic infrared. Healthy vegetation will show as a dark red or magenta color. Stressed vegetation will show lighter shades of red to white. Interpretation of the photographs is done on a light table and viewed with magnifying glass or stereo microscope. A plastic sheet is put over the photographs to protect the film and to allow areas of interest to be marked with a grease pencil. Each photograph is examined and signs of stress are noted by flightline number and frame number. The photographs are taken with an overlap of 50% to make it possible to view them in stereo if desired. The 50% overlap was maintained during the acquisition by controlling the shutter with an intervelometer.

The photographs were used in the placing of the samplers for the cooling tower drift study. The samplers were placed on portions of the two north-south flightlines. In future overflights, the stations may be used to ground truth the photographs. Markers will be placed next to the samplers to make the stations easier to find on the photographs. The ground truthing will consist of a survey of an area or areas on a flightline and examination of the vegetation for other signs of stress.

7.3 RESULTS AND DISCUSSION

The overflight was performed by the contractor, Photography Plus of Umatilla, Oregon on June 18 and the photographs received on July 6, 1990. The initial examination of the flightlines was to determine the quality of the photographs, which was found to be generally good, except for a few frames that apparently had been exposed to light. These had a green tinge to them and made it impossible to determine the health of vegetation in the photographs. A second, more detailed examination followed for the purpose of interpretation.

The acquisition of the photographs was late in the spring season and missed the period of peak photosynthesis. Because of this, it was only possible to determine the health of the medium shrubs, such as Chrysothamnus nauseosus and Chrysothamnus visidiflorus, and the larger shrubs, Artemisia tridentata and Purshia tridentata. Most of the smaller forbs such as Phlox longifolia had become inactive as had the perennial and annual grasses. It is difficult to determine the activity of smaller plants because the dark red of a healthy, active plant and the dark green of a dead or inactive plant appear very close in the 1:6,000 scale of the photographs.

The medium sized shrubs were more numerous than the larger shrubs, and more evenly distributed through the flightlines. These shrubs may be specimens of C. nauseosus and C. visidiflorus or smaller specimens of A. tridentata and P. tridentata. Many of the smaller shrubs noted on the northern half of flightline 2 were determined in 1989 to be immature Artemisia. The large shrubs were mostly limited to isolated individuals or small clusters because the flightlines cover the area that had burned in the 1984 range fire.

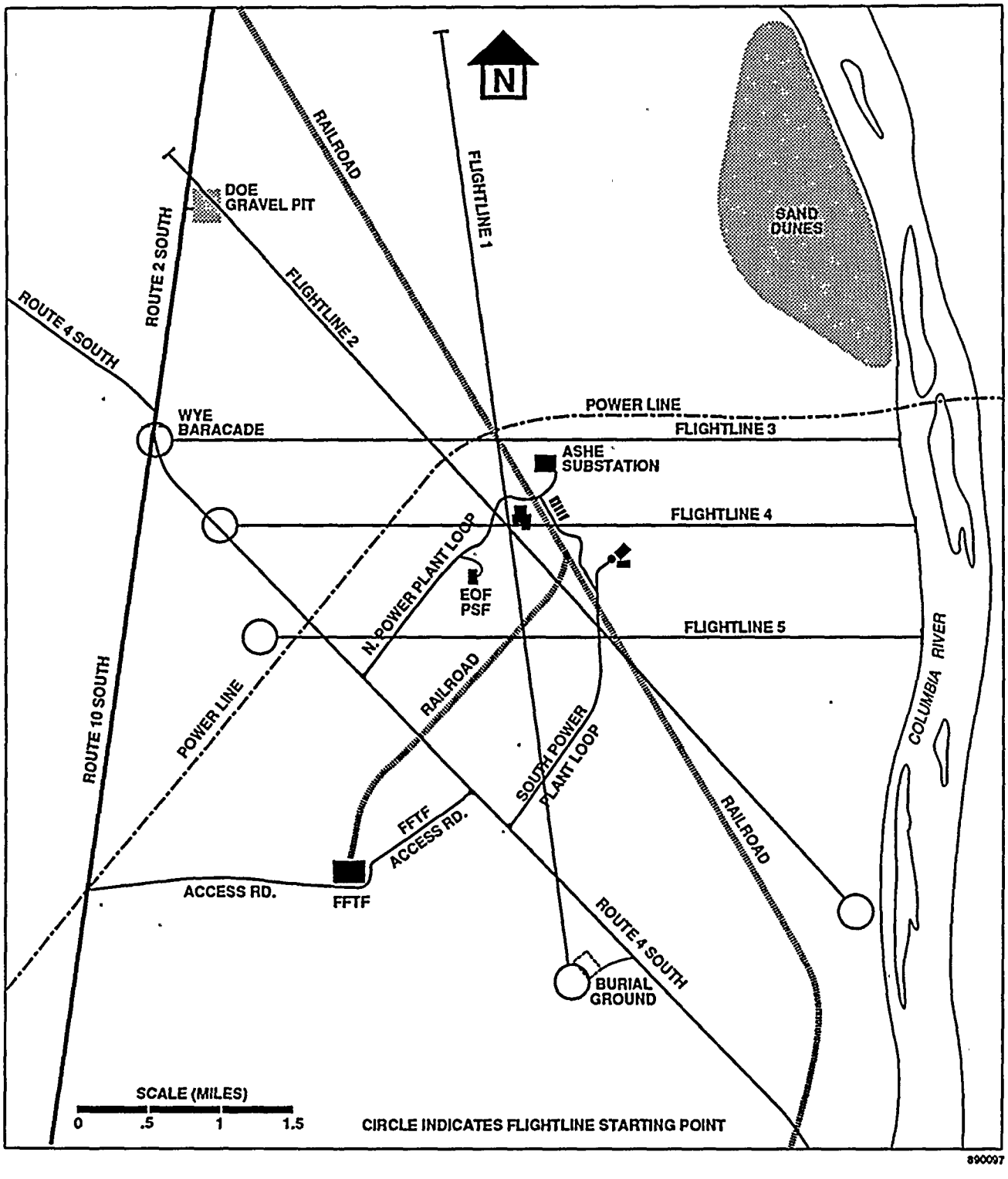
Many small plants were noted along the edges of active dunes in the northern half of flightlines 1 and 2. These are most likely clumps of Agropyron spicatum, Stipa comata, or Rumex venosus. A large, healthy group of Salsola kali was found along the eastern side of the Ashe Substation, north of Plant 2. Salsola is also seen along other disturbed area such as railroads, highways and gravel pits.

The general health of those plants and shrubs that were active was good. Some small, localized area of stress may be seen on several flightlines but, due to the mixture of healthy vegetation to those exhibiting stress, it would seem better explained by disease or infestation. No adverse impact was evident from the operation of Plant 2.

7.4 BIBLIOGRAPHY

Shipley, B.L., S.B. Pahwa, M.D. Thompson and R.B. Lantz. 1980. NUREG/CR-1231. Remote sensing for detection and monitoring of salt stress on vegetation: Evaluation and guidelines. Final report, September 1976-March 1979. Nuclear Regulatory Commission, Washington, D.C.

Droppo, J.G., C.E. Hane and R.K. Woodruff. 1976. Atmospheric effects of circular mechanical draft cooling towers at Washington Public Power Supply System Nuclear Power Plant Number Two. Battelle Pacific Northwest Laboratories, Richland, WA.



CIRCLE INDICATES FLIGHTLINES STARTING POINT

Figure 7-1. Aerial Photography Flightlines

COLLECTION PERIOD 1

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
22-Mar-89	24	456736		328850	508	41	204	49	20
23-Mar-89	24	456736		328850	506	41	203	49	20
24-Mar-89	24	456736		328850	555	45	223	53	22
25-Mar-89	24	456736		328850	532	43	214	51	21
26-Mar-89	24	456736		328850	538	43	216	52	22
27-Mar-89	24	456736		328850	516	41	207	50	21
28-Mar-89	24	456736		328850	590	47	237	57	24
29-Mar-89	24	456736		328850	354	19	177	42	18
30-Mar-89	24	456736		328850	344	19	172	41	17
31-Mar-89	24	456736		328850	333	18	166	40	17
01-Apr-89	24	456736		328850	278	15	139	33	14
02-Apr-89	23	456736		315148	250	14	125	30	12
03-Apr-89	24	456736		328850	217	12	109	26	11
04-Apr-89	24	456736		328850	280	15	140	34	14
05-Apr-89	24	456736		328850	245	13	122	29	12
06-Apr-89	24	456736		328850	198	11	99	24	10
07-Apr-89	24	456736		328850	250	14	125	30	12
08-Apr-89	24	456736		328850	237	13	119	28	12
09-Apr-89	24	456736		328850	225	12	112	27	11
10-Apr-89	24	456736		328850	208	11	104	25	10
11-Apr-89	24	456736		328850	245	13	122	29	12
12-Apr-89	24	456736		328850	230	13	115	28	11
13-Apr-89	24	456736		328850	242	13	121	29	12
14-Apr-89	24	456736		328850	269	15	134	32	13
15-Apr-89	24	456736		328850	264	15	132	32	13
16-Apr-89	24	456736		328850	251	14	126	30	13
17-Apr-89	24	456736		328850	214	12	107	26	11
18-Apr-89	24	456736		328850	216	12	108	26	11
TOTAL	671 HOURS			9194096 GALLONS					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					325	21	149	36	15
AVERAGE POUNDS PER COLLECTION PERIOD=					24893	1629	11438	2745	1144

Ca - Circ Water Analyses by Chem Lab

SO4 - Used SO4/Ca of 2.49 when Ca >200; 2.0 when Ca <200

Cl - Used Cl/Ca of 0.20 when Ca >200; 0.11 when Ca <200

Mg - Used Mg/Ca of 0.24

Na - Used Na/Ca of 0.10

Plant Operational Data for Collection Period 1

COLLECTION PERIOD 2

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
19-Apr-89	24	456736		328850	245	13	122	29	12
20-Apr-89	24	456736		328850	232	13	116	28	12
21-Apr-89	24	456736		328850	227	12	114	27	11
22-Apr-89	24	456736		328850	278	15	139	33	14
23-Apr-89	24	456736		328850	234	13	117	28	12
24-Apr-89	24	456736		328850	214	12	107	26	11
25-Apr-89	24	456736		328850	208	11	104	25	10
26-Apr-89	24	456736		328850	274	15	137	33	14
27-Apr-89	24	456736		328850	234	13	117	28	12
28-Apr-89	22.8	456736		312407	308	17	154	37	15
29-Apr-89	0	456736							
30-Apr-89	0	456736							
01-May-89	0	456736							
02-May-89	0	456736							
03-May-89	0	456736							
04-May-89	0	456736							
05-May-89	0	456736							
06-May-89	0	456736							
07-May-89	0	456736							
08-May-89	0	456736							
09-May-89	0	456736							
10-May-89	0	456736							
11-May-89	0	456736							
12-May-89	0	456736							
13-May-89	0	456736							
14-May-89	0	456736							
15-May-89	0	456736							
16-May-89	0	456736							
TOTAL	238.8 HOURS			3272057 GALLONS					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					245	14	123	29	12
AVERAGE POUNDS PER COLLECTION PERIOD=					6696	368	3348	804	335

Ca - Circ Water Analyses by Chem Lab

SO4 - Used SO4/Ca of 2.49 when Ca >200; 2.0 when Ca <200

Cl - Used Cl/Ca of 0.20 when Ca >200; 0.11 when Ca <200

Mg - Used Mg/Ca of 0.24

Na - Used Na/Ca of 0.10

Plant Operational Data for Collection Period 2

COLLECTION PERIOD 3

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
16-May-89	0	456736		0					
17-May-89	0	456736		0					
18-May-89	0	456736		0					
19-May-89	0	456736		0					
20-May-89	0	456736		0					
21-May-89	0	456736		0					
22-May-89	0	456736		0					
23-May-89	0	456736		0					
24-May-89	0	456736		0					
25-May-89	0	456736		0					
26-May-89	0	456736		0					
27-May-89	0	456736		0					
28-May-89	0	456736		0					
29-May-89	0	456736		0					
30-May-89	0	456736		0					
31-May-89	0	456736		0					
01-Jun-89	0	456736		0					
02-Jun-89	0	456736		0					
03-Jun-89	0	456736		0					
04-Jun-89	0	456736		0					
05-Jun-89	0	456736		0					
06-Jun-89	0	456736		0					
07-Jun-89	0	456736		0					
08-Jun-89	0	456736		0					
09-Jun-89	0	456736		0					
10-Jun-89	0	456736		0					
11-Jun-89	0	456736		0					
12-Jun-89	0	456736		0					
13-Jun-89	0	456736		0					
14-Jun-89	0	456736		0					
15-Jun-89	0	456736		0					
16-Jun-89	0	456736		0					
17-Jun-89	0	456736		0	60	3	30.1	7	3
18-Jun-89	0	456736		0	62	3	31.2	7	3
19-Jun-89	0	456736		0	50	3	25.2	6	3
20-Jun-89	0	456736		0	69	4	34.4	8	3
TOTAL	0 HOURS			0 GALLONS					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					60	3	30	7	3
AVERAGE POUNDS PER COLLECTION PERIOD=					0	0	0	0	0

Ca - Circ Water Analyses by Chem Lab

SO4 - Used SO4/Ca of 2.49 when Ca >200; 2.0 when Ca <200

Cl - Used Cl/Ca of 0.20 when Ca >200; 0.11 when Ca <200

Mg - Used Mg/Ca of 0.24

Na - Used Na/Ca of 0.10

Plant Operational Data for Collection Period 3

COLLECTION PERIOD 4

DATE	HOURS	2 PUMP SPM	3 PUMP SPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
21-Jun-89	0	456736		0					
22-Jun-89	0	456736		0					
23-Jun-89	0	456736		0					
24-Jun-89	0	456736		0					
25-Jun-89	0	456736		0					
26-Jun-89	0	456736		0					
27-Jun-89	0	456736		0					
28-Jun-89	8.43	456736		115509					
29-Jun-89	0.05	456736		685					
30-Jun-89	10.23	456736		140172					
01-Jul-89	0	456736		0					
02-Jul-89	20.53	456736		281304					
03-Jul-89	24	456736		328850					
04-Jul-89	24	456736		328850					
05-Jul-89	24	456736		328850					
06-Jul-89	24	456736		328850	247	35	118	26	18
07-Jul-89	24	456736		328850					
08-Jul-89	24	456736		328850					
09-Jul-89	24	456736		328850					
10-Jul-89	24	456736		328850					
11-Jul-89	24	456736		328850	490	42	189	44	24
12-Jul-89	24	456736		328850					
13-Jul-89	24	456736		328850					
14-Jul-89	24	456736		328850					
15-Jul-89	24	456736		328850					
16-Jul-89	24	456736		328850					
17-Jul-89	24	456736		328850					
18-Jul-89	24	456736		328850	606	37	216	51	24
TOTAL	423.24 HOURS			5799268 GALLONS					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					448	38	174	40	22
AVERAGE POUNDS PER COLLECTION PERIOD=					21644	1837	8429	1950	1064

Plant Operational Data for Collection Period 4

COLLECTION PERIOD 5

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
19-Jul-89	24	456736		328850					
20-Jul-89	24	456736		328850					
21-Jul-89	24	456736		328850					
22-Jul-89	24	456736		328850					
23-Jul-89	24	456736		328850					
24-Jul-89	24	456736		328850					
25-Jul-89	24	456736		328850					
26-Jul-89	24	456736		328850					
27-Jul-89	24	456736		328850					
28-Jul-89	24	456736		328850	594	41	217	52	20
29-Jul-89	24	456736		328850					
30-Jul-89	24	456736		328850					
31-Jul-89	24	456736		328850					
01-Aug-89	24	456736		328850	566	48	239	58	27
02-Aug-89	24	456736		328850					
03-Aug-89	24	456736		328850					
04-Aug-89	24	456736		328850					
05-Aug-89	24	456736		328850					
06-Aug-89	20.45	456736		280208					
07-Aug-89	0	456736		0					
08-Aug-89	0	456736		0					
09-Aug-89	15.95	456736		218548	515	25	213	54	19
10-Aug-89	24	456736		328850					
11-Aug-89	18.07	456736		247597					
12-Aug-89	0	456736		0					
13-Aug-89	0	456736		0					
14-Aug-89	0	456736		0					
15-Aug-89	0	456736		0					
TOTAL	510.47			6994501					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					558	38	223	55	22
AVERAGE POUNDS PER COLLECTION PERIOD=					32558	2216	13004	3188	1283

Plant Operational Data for Collection Period 5

COLLECTION PERIOD 6

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
16-Aug-89	10.9	456736		149353					
17-Aug-89	8.32	456736		114001					
18-Aug-89	22.37	456736		306516	490	39	196	51	28
19-Aug-89	24	456736		328850					
20-Aug-89	24	456736		328850					
21-Aug-89	24	456736		328850					
22-Aug-89	24	456736		328850	484	39	165	39	19
23-Aug-89	24	456736		328850					
24-Aug-89	24	456736		328850					
25-Aug-89	24	456736		328850					
26-Aug-89	24	456736		328850					
27-Aug-89	24	456736		328850					
28-Aug-89	24	456736		328850					
29-Aug-89	24	456736		328850					
30-Aug-89	24	456736		328850					
31-Aug-89	24	456736		328850	587	63	252	58.9	30
01-Sep-89	24	456736		328850					
02-Sep-89	24	456736		328850					
03-Sep-89	24	456736		328850					
04-Sep-89	24	456736		328850					
05-Sep-89	24	456736		328850					
06-Sep-89	24	456736		328850					
07-Sep-89	24	456736		328850					
08-Sep-89	24	456736		328850	507	40	168	40	18.4
09-Sep-89	24	456736		328850					
10-Sep-89	24	456736		328850					
11-Sep-89	24	456736		328850					
12-Sep-89	24	456736		328850					
13-Sep-89	24	456736		328850					
14-Sep-89	24	456736		328850	612	54	246	55.3	27.5
15-Sep-89	24	456736		328850					
16-Sep-89	24	456736		328850					
17-Sep-89	24	456736		328850					
18-Sep-89	24	456736		328850					
19-Sep-89	24	456736		328850					
TOTAL	809.59			11093067					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					536	47	205	49	25
AVERAGE POUNDS PER COLLECTION PERIOD=					49571	4347	18996	4517	2273

Plant Operational Data for Collection Period 6

COLLECTION PERIOD 7

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
20-Sep-89	24	456736		328850					
21-Sep-89	17.27	456736		236635					
22-Sep-89	0	456736		0					
23-Sep-89	0	456736		0					
24-Sep-89	0	456736		0					
25-Sep-89	0	456736		0					
26-Sep-89	0	456736		0					
27-Sep-89	0	456736		0					
28-Sep-89	0	456736		0					
29-Sep-89	2.57	456736		35214					
30-Sep-89	24	456736		328850					
01-Oct-89	24	456736		328850					
02-Oct-89	24	456736		328850					
03-Oct-89	24	456736		328850					
04-Oct-89	24	456736		328850					
05-Oct-89	24	456736		328850					
06-Oct-89	24	456736		328850					
07-Oct-89	24	456736		328850					
08-Oct-89	24	456736		328850					
09-Oct-89	24	456736		328850					
10-Oct-89	24	456736		328850					
11-Oct-89	24	456736		328850					
12-Oct-89	24	456736		328850	520	57.8	251	61.3	29.9
13-Oct-89	24	456736		328850					
14-Oct-89	24	456736		328850					
15-Oct-89	24	456736		328850					
16-Oct-89	24	456736		328850					
17-Oct-89	24	456736		328850	614	37.9	230	56	23.5
TOTAL	475.84			6519998					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					567	48	241	59	27
AVERAGE POUNDS PER COLLECTION PERIOD=					30821	2601	13073	3188	1451

Plant Operational Data for Collection Period 7

COLLECTION PERIOD 8

DATE	HOURS	2 PUMP SPM	3 PUMP SPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
18-Oct-89	24	456736		328850					
19-Oct-89	24	456736		328850					
20-Oct-89	24	456736		328850					
21-Oct-89	24	456736		328850					
22-Oct-89	24	456736		328850					
23-Oct-89	24	456736		328850					
24-Oct-89	24	456736		328850					
25-Oct-89	24	456736		328850					
26-Oct-89	24	456736		328850	473	41	209	48.2	23.1
27-Oct-89	24	456736		328850					
28-Oct-89	24	456736		328850					
29-Oct-89	25	456736		342552					
30-Oct-89	24	456736		328850					
31-Oct-89	24	456736		328850	562	39	227	53.2	23.5
01-Nov-89	24	456736		328850					
02-Nov-89	24	456736		328850					
03-Nov-89	24	456736		328850					
04-Nov-89	24	456736		328850					
05-Nov-89	24	456736		328850					
06-Nov-89	24	456736		328850					
07-Nov-89	24	456736		328850					
08-Nov-89	24	456736		328850					
09-Nov-89	24	456736		328850	671	38	250	60.6	23
10-Nov-89	24	456736		328850					
11-Nov-89	24	456736		328850					
12-Nov-89	24	456736		328850					
13-Nov-89	24	456736		328850					
14-Nov-89	24	456736		328850	658	42	244	59.4	26.4
15-Nov-89	24	456736		328850					
TOTAL	697			9550350					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					591	40	233	55	24
AVERAGE POUNDS PER COLLECTION PERIOD=					47056	3185	18512	4407	1911

Plant Operational Data for Collection Period 8

COLLECTION PERIOD 9

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
16-Nov-89	24	456736		328850					
17-Nov-89	24	456736		328850					
18-Nov-89	24	456736		328850					
19-Nov-89	24	456736		328850					
20-Nov-89	24	456736		328850					
21-Nov-89	24	456736		328850	723	40	266	65.2	25.5
22-Nov-89	24	456736		328850					
23-Nov-89	24	456736		328850					
24-Nov-89	24	456736		328850					
25-Nov-89	24	456736		328850					
26-Nov-89	24	456736		328850					
27-Nov-89	24	456736		328850					
28-Nov-89	24	456736		328850	555	26	232	55	17.9
29-Nov-89	24	456736		328850					
30-Nov-89	24	456736		328850					
01-Dec-89	24	456736		328850					
02-Dec-89	24	456736		328850					
03-Dec-89	24	456736		328850					
04-Dec-89	24	456736		328850					
05-Dec-89	24	456736		328850	321	18.5	178	41.5	14
06-Dec-89	24	456736		328850					
07-Dec-89	24	456736		328850					
08-Dec-89	24	456736		328850					
09-Dec-89	24	456736		328850					
10-Dec-89	24	456736		328850					
11-Dec-89	24	456736		328850					
12-Dec-89	24	456736		328850	516	14	178	39.1	12.7
TOTAL	648			8878948					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					529	25	214	50	18
AVERAGE POUNDS PER COLLECTION PERIOD=					39140	1823	15804	3716	1297

Plant Operational Data for Collection Period 9

COLLECTION PERIOD 10

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
13-Dec-89	24	456736		328850					
14-Dec-89	24	456736		328850					
15-Dec-89	24	456736		328850					
16-Dec-89	24	456736		328850					
17-Dec-89	24	456736		328850					
18-Dec-89	24	456736		328850					
19-Dec-89	24	456736		328850	644	16	195	46.1	14.2
20-Dec-89	24	456736		328850					
21-Dec-89	24	456736		328850					
22-Dec-89	24	456736		328850					
23-Dec-89	24	456736		328850					
24-Dec-89	24	456736		328850					
25-Dec-89	24	456736		328850					
26-Dec-89	24	456736		328850					
27-Dec-89	24	456736		328850					
28-Dec-89	24	456736		328850					
29-Dec-89	24	456736		328850					
30-Dec-89	24	456736		328850					
31-Dec-89	24	456736		328850					
01-Jan-90	24	456736		328850					
02-Jan-90	24	456736		328850	427	27	241	59	14
03-Jan-90	24	456736		328850					
04-Jan-90	24	456736		328850					
05-Jan-90	24	456736		328850					
06-Jan-90	24	456736		328850					
07-Jan-90	24	456736		328850					
08-Jan-90	24	456736		328850					
09-Jan-90	24	456736		328850	564	24	199	50	16.1
10-Jan-90	24	456736		328850					
11-Jan-90	24	456736		328850					
12-Jan-90	24	456736		328850					
13-Jan-90	24	456736		328850					
14-Jan-90	24	456736		328850					
15-Jan-90	24	456736		328850					
16-Jan-90	24	456736		328850	163	15.3	138	35	13.5
17-Jan-90	24	456736		328850					
18-Jan-90	24	456736		328850					
19-Jan-90	24	456736		328850					
20-Jan-90	24	456736		328850					
21-Jan-90	24	456736		328850					
22-Jan-90	24	456736		328850					
23-Jan-90	24	456736		328850	138	12	95	24	8.5
TOTAL	1008			13811697					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					387	19	174	43	13
AVERAGE POUNDS PER COLLECTION PERIOD=					44585	2172	19990	4931	1527

Plant Operational Data for Collection Period 10

COLLECTION PERIOD 11

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
24-Jan-90	24	456736		328850					
25-Jan-90	24	456736		328850					
26-Jan-90	24	456736		328850					
27-Jan-90	24	456736		328850					
28-Jan-90	24	456736		328850					
29-Jan-90	24	456736		328850					
30-Jan-90	24	456736		328850	170	8.7	122	30	10.1
31-Jan-90	24	456736		328850					
01-Feb-90	24	456736		328850					
02-Feb-90	24	456736		328850					
03-Feb-90	24	456736		328850					
04-Feb-90	24	456736		328850					
05-Feb-90	24	456736		328850					
06-Feb-90	24	456736		328850	204	10.1	96	24	10.9
07-Feb-90	24	456736		328850					
08-Feb-90	24	456736		328850					
09-Feb-90	24	456736		328850					
10-Feb-90	24	456736		328850					
11-Feb-90	24	456736		328850					
12-Feb-90	24	456736		328850					
13-Feb-90	24	456736		328850	330	15	135	33	11
14-Feb-90	24	456736		328850					
15-Feb-90	24	456736		328850					
16-Feb-90	24	456736		328850					
17-Feb-90	24	456736		328850					
18-Feb-90	24	456736		328850					
19-Feb-90	24	456736		328850					
20-Feb-90	24	456736		328850	126	9.2	97	22	8.8
21-Feb-90	24	456736		328850					
TOTAL	696			9536648					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					208	11	113	27	10
AVERAGE POUNDS PER COLLECTION PERIOD=					16498	855	8945	2167	811

Plant Operational Data for Collection Period 11

COLLECTION PERIOD 12

DATE	HOURS	2 PUMP GPM	3 PUMP GPM	DRIFT GALS/DAY	SO4 PPM	Cl PPM	Ca PPM	Mg PPM	Na PPM
22-Feb-90	24	456736		328850					
23-Feb-90	24	456736		328850					
24-Feb-90	24	456736		328850					
25-Feb-90	24	456736		328850					
26-Feb-90	24	456736		328850					
27-Feb-90	24	456736		328850	145	11	140	35	11
28-Feb-90	24	456736		328850					
01-Mar-90	24	456736		328850					
02-Mar-90	24	456736		328850					
03-Mar-90	24	456736		328850					
04-Mar-90	24	456736		328850					
05-Mar-90	24	456736		328850					
06-Mar-90	24	456736		328850	145	8.7	99	24	10.5
07-Mar-90	24	456736		328850					
08-Mar-90	24	456736		328850					
09-Mar-90	24	456736		328850					
10-Mar-90	24	456736		328850					
11-Mar-90	24	456736		328850					
12-Mar-90	24	456736		328850					
13-Mar-90	24	456736		328850	173	13.9	127	29	12.6
14-Mar-90	24	456736		328850					
15-Mar-90	24	456736		328850					
16-Mar-90	24	456736		328850					
17-Mar-90	24	456736		328850					
18-Mar-90	24	456736		328850					
19-Mar-90	24	456736		328850					
20-Mar-90	24	456736		328850	250	10.6	121	27	17.6
TOTAL	648			8878948					
AVERAGE CONC. PER COLLECTION PERIOD (PPM)=					178	11	122	29	13
AVERAGE POUNDS PER COLLECTION PERIOD=					13195	819	9012	2128	957

Plant Operational Data for Collection Period 12

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: March 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) OR ICE ON GROUND AT 0400 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT)	
1	35	23	29	-11	36	0	.08	.9	T	N	6.5	15	NW	85	61	10	F, GL	
2	30	18	24	-15	41	0	.07	0.8	2.1	NW	6.1	14	NNW	75	254	7	F	
3	35	14	24	-15	41	0			1.5	E	4.2	16	SE	56	379	0		
4	33	20	26	-14	39	0	T	T	T	NW	6.2	17	NW	65	172	10		
5	33	29	31	-9	34	0	.23	.4	T	NW	4.8	16	NW	91	83	10	F, GL	KFR 2115
6	60	27	44	+3	21	0			T	W	6.0	30	SSW	76	358	3	F	
7	54	32	43	+1	22	0				E	3.8	18	WSW	60	335	2		
8	56	38	47	+5	18	0				NW	5.5	17	NW	63	301	9		
9	50	40	45	+3	20	0	.31			NW	7.9	29	SSE	89	103	10	F	KFR 1900
10	64	38	51	+8	14	0				E	5.0	25	SE	77	296	6	F	
11	67	42	54	+11	11	0	.24			W	6.1	23	NW	70	370	4	DL	KFR 0310
12	65	44	54	+11	11	0	.08			SE	4.6	36	SW	74	310	7		
13	55	41	48	+4	17	0	T			W	10.5	27	WSW	60	237	9		KFR 0500
14	56	34	45	+1	20	0	.02			SW	6.9	24	WSW	57	308	6	A, AU	
15	50	29	40	-4	25	0	.02			N	2.4	10	N	77	199	10		
16	43	33	38	-7	27	0	.22			NW	6.6	20	NNW	91	52	10	F	
17	57	27	42	-3	23	0	T			S	3.8	21	SSW	69	355	8	F	
18	60	42	51	+5	14	0	.04			W	8.6	29	NW	63	380	8		KFR 0400
19	60	36	48	+2	17	0				W	5.4	17	NW	51	386	1		
20	60	28	44	-2	21	0	.05			E	2.7	14	SE	60	423	8		
21	64	39	52	+6	13	0	.01			W	9.5	42	WSW	63	416	5		KFR 1020
22	56	35	46	-1	19	0				NW	4.2	23	WNW	50	285	10		
23	56	34	45	-2	20	0				NW	5.6	18	NW	55	348	3		
24	56	37	46	-1	19	0	.05			NW	4.1	14	WNW	59	292	8		
25	62	38	50	+3	15	0	.14			W	5.1	23	WSW	77	310	8	F	KFR 0600
26	57	37	47	-1	18	0				S	7.5	32	SSW	58	350	7		
27	60	46	53	+5	12	0				SW	14.4	41	SW	52	245	10		
28	63	41	52	+4	13	0				W	7.0	26	NW	46	467	5		
29	57	36	46	-2	19	0	T			W	7.0	24	W	46	280	8		
30	57	28	42	-7	23	0	T			S	5.3	23	SSW	57	298	10		
31	60	40	50	+1	15	0				W	9.5	33	W	47	492	6	AU	KFR 0115
SUM					658	0	1.56	3.1										
AVG	53.9	33.7									6.2					7.0		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
*(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	1.56		
DEPARTURE FROM NORMAL	+1.16		
GREATEST IN 24 HRS.	0.31	ON	9
NUMBER OF DAYS WITH:			
TRACE OR MORE	19	0.25 OR MORE	1
0.01 OR MORE	14	0.50 OR MORE	0
0.10 OR MORE	5	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	3.1		
GREATEST IN 24 HOURS:	2.7	ON	1-2
GREATEST ON GND:	2.7	ON	2

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)	6.2		
DEPARTURE FROM NORMAL	-2.4		
PEAK GUST	42	FROM	WSW
ON	21		

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	43.7	WET BULB (°F)	39
REL. HUM. (%)	65.1	DEW PT (°F)	31.4

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL
AU = AURORA
D = DUST
F = FOG
GL = GLAZE
H = SMOKE
BD = BLOWING DUST
BS = BLOWING SNOW
DL = DISTANT LIGHTNING
DS = DRIFTING SNOW
IC = ICE CRYSTALS
T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH	43.8		
DEPARTURE FROM NORMAL	-0.6		
HIGHEST	67	ON	11
LOWEST	14	ON	3
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW	1		
MAX. 90 OR ABOVE	0		
MIN. 32 OR BELOW	11		
MIN. 0 OR BELOW	0		

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	658
DEPARTURE FROM NORMAL	+20
SEASONAL TOTAL (SINCE JULY 1)	4540
SEASONAL DEPARTURE FROM NORMAL	-152

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION	29.176		
HIGHEST SEA LEVEL	30.36	ON	20
LOWEST SEA LEVEL	29.58	ON	25

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL	295.0		
GREATEST DAILY	492	ON	31
LEAST DAILY	52	ON	16

MISCELLANEOUS NUMBER OF DAYS

CLEAR	5	FOG	9
PARTLY CLOUDY	9	THUNDER	0
CLOUDY	17	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	99	ON	17+
LOWEST	22	ON	31

BM-1800-023 (1-73), ASCO-OL AMBULANCE, WASH.

Meteorological Conditions for March 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: April 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT) (IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) (IN.) (GROUND) (FROM 6 AM)	WIND (30 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS)	SKY COVER (TENTHS) (FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	56	36	46	- 3	19	0	.01			S	7.7	35	SW	62	232	9	KFR 2210
2	58	37	48	- 2	17	0				SW	12.6	36	WSW	48	387	7	
3	59	35	47	- 3	18	0				W	9.3	26	WSW	47	476	3	
4	59	36	48	- 3	17	0	T			S	4.9	19	SSW	62	258	10	
5	73	52	62	+11	3	0				SW	16.6	44	SSW	54	365	8	
6	79	47	63	+12	2	0				SW	9.5	36	WSW	55	298	9	
7	75	51	63	+11	2	0				NW	13.3	39	NW	28	474	7	
8	68	44	56	+ 4	9	0				NW	6.0	17	WNW	28	533	5	
9	67	39	53	+ 2	12	0				NE	9.8	29	NE	29	527	8	
10	69	42	56	+ 4	9	0	T	T		NW	7.0	21	NW	35	397	5	
11	75	36	56	+ 4	9	0				N	3.4	16	WNW	42	552	0	
12	77	41	59	+ 7	6	0				S	3.1	15	SE	40	506	4	
13	80	44	62	+10	3	0				W	4.6	13	WNW	38	534	6	
14	80	48	64	+12	1	0				NW	6.0	30	NW	38	368	9	
15	71	50	60	+ 8	5	0				NW	13.4	35	NW	40	277	9	
16	68	37	52	0	13	0				E	4.2	19	NW	36	527	7	
17	73	46	60	+ 9	5	0				W	6.2	27	W	26	602	0	
18	79	41	60	+ 8	5	0				NW	5.8	16	WSW	31	514	4	DL
19	77	54	66	+14	0	1	.02			W	6.9	49	W	54	452	8	DL
20	75	50	62	+10	3	0	.07			NW	9.8	35	NW	55	365	9	KFR 1555
21	62	47	54	+ 1	11	0	.07			W	4.7	15	WSW	67	307	9	
22	65	40	52	- 1	13	0				S	6.4	22	SE	45	523	7	
23	67	38	52	- 2	13	0				N	4.9	18	ENE	56	547	3	
24	72	44	58	+ 4	7	0				N	11.6	35	NNE	45	476	10	
25	62	46	54	- 1	11	0	.35			NW	9.1	43	SE	74	219	9	A, T, DL
26	60	46	53	- 2	12	0	.04			NW	4.7	17	NNW	82	293	10	F
27	66	48	57	+ 2	8	0	.28			N	3.5	14	NW	74	391	9	
28	68	45	56	+ 1	9	0				NE	7.5	24	ENE	52	438	8	
29	72	41	56	0	9	0				N	5.4	18	N	45	645	0	
30	79	44	62	+ 6	3	0				W	4.6	16	NNE	40	646	0	
31																	
SUM					254	1	0.84	T									
AVG	69.7	43.5									7.4				6.4		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 8 DENOTES A TRACE.
(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	0.84		
DEPARTURE FROM NORMAL	+0.45		
GREATEST IN 24 HRS.	0.37	ON	25-26
NUMBER OF DAYS WITH:			
TRACE OR MORE	9	0.25 OR MORE	2
0.01 OR MORE	7	0.50 OR MORE	0
0.10 OR MORE	2	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	T		
GREATEST IN 24 HOURS:	T	ON	10
GREATEST ON GND:		ON	

WIND (30 FT. LEVEL)

AVERAGE SPEED (MPH)	7.4		
DEPARTURE FROM NORMAL	-1.8		
PEAK GUST	49	FROM	W	ON	19

AVERAGE PSYCHROMETRIC DATA

DAY BULB (°F)	56.8	WET BULB (°F)	46
REL. HUM. (%)	47.6	DEW PT (°F)	34.4

* DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL
AU = AURORA
D = DUST
F = FOG
GL = GLAZE
H = SMOKE
BD = BLOWING DUST
BS = BLOWING SNOW
DL = DISTANT LIGHTNING
DS = DRIFTING SNOW
IC = ICE CRYSTALS
T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			56.6
DEPARTURE FROM NORMAL			+4.3
HIGHEST	80	ON	14+
LOWEST	35	ON	3
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			0
MAX. 90 OR ABOVE			0
MIN. 32 OR BELOW			0
MIN. 0 OR BELOW			0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	254
DEPARTURE FROM NORMAL	-128
SEASONAL TOTAL (SINCE JULY 1)	4794
SEASONAL DEPARTURE FROM NORMAL	-280

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.224
HIGHEST SEA LEVEL	30.37	ON	9
LOWEST SEA LEVEL	29.64	ON	1

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			437.6
GREATEST DAILY	646	ON	30
LEAST DAILY	219	ON	25

MISCELLANEOUS NUMBER OF DAYS

CLEAR	6	FOG	1
PARTLY CLOUDY	9	THUNDER	1
CLOUDY	15	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	98	ON	26
LOWEST	11	ON	17

BM -1800-023 (1-73)

Meteorological Conditions for April 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: May 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW (ICE PELLETS SLEET) ON GROUND AT 0100 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	PEAK GUST DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "AFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	71	55	63	+ 7	2	0	0.12			W	8.1	28	WNW	57	274	9	
2	74	53	64	+ 1	1	0				W	6.9	30	WNW	47	473	7	
3	79	45	62	+ 5	3	0				W	5.9	28	NW	43	627	0	
4	81	51	66	+ 8	0	1				S	3.5	21	W	39	637	1	
5	84	52	68	+ 9	0	3				N	3.3	15	NE	45	543	8	DL
6	88	56	72	+13	0	7	T			NW	6.4	33	NW	50	523	9	DL
7	85	62	74	+15	0	9				NW	7.9	28	NW	36	581	4	
8	85	57	71	+11	0	6				W	4.3	17	WNW	37	630	3	
9	76	58	67	+ 7	0	2	T			NW	7.8	30	WNW	50	250	10	T
10	68	44	56	- 4	9	0				W	11.0	35	W	44	500	7	
11	69	42	56	- 4	9	0				W	9.4	28	NW	35	674	1	
12	71	45	58	- 2	7	0				W	4.2	20	WNW	34	661	2	
13	76	47	62	+ 1	3	0				N	5.1	20	ENE	33	585	2	
14	77	51	64	+ 3	1	0				N	6.5	35	ENE	35	602	3	
15	82	49	66	+ 5	0	1				NW	6.5	29	NW	31	655	1	
16	77	54	66	+ 4	0	1				NW	12.4	37	WNW	34	539	10	
17	73	47	60	- 2	5	0				SW	10.5	49	WSW	45	252	10	BD KFR 1700
18	63	39	51	-13	14	0	T	T		W	10.4	36	W	42	529	6	
19	70	44	57	- 6	8	0				NW	13.1	37	WSW	36	707	0	
20	74	40	57	- 6	8	0				NW	4.7	23	NW	36	602	6	
21	78	51	64	+ 1	1	0				NW	6.0	25	WNW	36	647	9	
22	70	49	60	- 3	5	0	0.06			SE	4.8	22	SSE	46	337	10	T, DL KFR 2240
23	66	46	56	- 7	9	0	0.31			SW	13.3	38	WSW	56	587	6	T, DL
24	68	41	54	- 9	11	0				W	10.1	29	WSW	46	463	8	
25	74	45	60	- 3	5	0				NW	7.0	36	NW	40	687	3	
26	72	48	60	- 3	5	0	T			SW	6.1	23	SW	46	499	10	
27	62	45	54	- 9	11	0	0.08			W	5.2	25	NW	71	353	9	T, DL
28	61	43	52	-12	13	0	0.01			N	7.0	21	NE	65	365	9	
29	68	49	58	- 6	7	0	0.01			NW	5.0	19	SE	64	390	7	
30	78	44	61	- 4	4	0				SE	3.9	19	SE	57	712	1	
31	88	50	69	+ 3	0	4				S	4.8	22	NW	43	699	4	
SUM					141	34	0.59	T									
AVG	74.5	48.5									7.1					5.6	

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL.15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			0.59
DEPARTURE FROM NORMAL			+0.06
GREATEST IN 24 HRS.	0.37	ON	22-23

NUMBER OF DAYS WITH:

TRACE OR MORE	10	0.25 OR MORE	1
0.01 OR MORE	6	0.50 OR MORE	0
0.10 OR MORE	2	1.00 OR MORE	0

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL; AU = AURORA; B = GUST; F = FOG; GL = GLAZE; S = SMOKE; BD = BLOWING DUST; BS = BLOWING SNOW; DL = DISTANT LIGHTNING; DS = DRIFTING SNOW; IC = ICE CRYSTALS; T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			61.5
DEPARTURE FROM NORMAL			+0.2
HIGHEST	88	ON	31+
LOWEST	39	ON	18

NUMBER OF DAYS WITH:

MAX. 32 OR BELOW	0
MAX. 90 OR ABOVE	0
MIN. 32 OR BELOW	0
MIN. 0 OR BELOW	0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	141
DEPARTURE FROM NORMAL	-20
SEASONAL TOTAL (SINCE JULY 1)	4935
SEASONAL DEPARTURE FROM NORMAL	-300

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			T
GREATEST IN 24 HOURS	T	ON	18
GREATEST ON GND.		ON	

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)			7.1
DEPARTURE FROM NORMAL			-1.8
PEAK GUST	49	FROM	WSW	ON	17

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	61.9	WET BULB (°F)	50
REL. HUM. (%)	44.5	DEW PT (°F)	37.8

* DENOTES LATEST OF SEVERAL DATES

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.189
HIGHEST SEA LEVEL	30.24	ON	19
LOWEST SEA LEVEL	29.62	ON	17

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			534.9
GREATEST DAILY	712	ON	30
LEAST DAILY	250	ON	9

MISCELLANEOUS NUMBER OF DAYS

CLEAR	11	FOG	0
PARTLY CLOUDY	8	THUNDER	4
CLOUDY	12	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	95	ON	30
LOWEST	14	ON	13

BM -1800-023 (1-73) BATTELLE, RICHLAND, WASH.

Meteorological Conditions for May 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: June 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) ON GROUND (INCHES)	WIND (33 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	PEAK GUST DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	94	57	76	+10	0	11				S	5.2	27	WNW	34	708	1	
2	90	69	80	+13	0	15				W	7.0	23	NNE	32	665	2	AU
3	86	62	74	+ 7	0	9	T			NE	13.9	43	NE	35	541	3	BD
4	90	59	74	+ 6	0	9				N	7.8	28	NE	27	734	1	
5	97	55	76	+ 8	0	11				W	6.4	33	NW	25	736	0	
6	95	66	80	+12	0	15				W	9.6	39	WNW	22	740	0	
7	90	51	70	+ 2	0	5				NE	3.5	20	WNW	34	737	0	
8	94	55	74	+ 6	0	9				NW	8.6	42	WNW	30	717	2	
9	85	58	72	+ 4	0	7				NW	10.6	39	NW	35	683	1	
10	87	56	72	+ 4	0	7				N	5.6	24	NW	34	704	1	AU
11	92	54	73	+ 5	0	8				N	3.4	26	NE	35	716	7	
12	96	61	78	+10	0	13				N	3.5	16	N	30	668	7	
13	90	67	78	+10	0	13				SW	7.5	32	WSW	37	294	10	
14	83	64	74	+ 5	0	9	0.01			W	6.6	29	SW	51	333	10	
15	78	56	67	+ 2	0	2				W	8.5	30	WNW	43	427	10	
16	78	52	65	- 5	0	0				W	8.5	31	WNW	32	707	4	
17	80	46	63	- 8	2	0				SW	7.8	27	SW	35	679	6	KFR 2245
18	84	53	68	- 3	0	3				W	7.7	25	W	38	631	4	
19	75	51	63	- 9	2	0	T			SW	13.2	34	SSW	39	698	6	
20	77	50	64	- 8	1	0				NW	14.4	40	NW	35	742	2	
21	80	47	64	- 8	1	0				SE	4.3	20	NW	33	688	6	
22	82	60	71	0	0	6	T			N	10.0	35	N	31	451	7	
23	90	59	74	+ 3	0	9				NE	9.0	27	ENE	32	733	0	
24	93	62	78	+ 7	0	13				N	5.0	21	NE	25	709	3	
25	94	67	80	+ 9	0	15				W	5.7	22	W	27	620	6	
26	86	58	72	+ 2	0	7				NW	13.2	37	NW	32	689	4	KFR 1700
27	75	55	66	- 4	0	1				E	7.0	27	WNW	32	512	9	
28	85	62	74	+ 4	0	9	T			NW	6.1	24	NW	32	539	10	
29	78	62	70	0	0	5	T			W	5.0	24	WNW	46	367	10	
30	80	58	69	- 1	0	4				SW	12.7	30	SW	37	575	6	
31																	
SUM					6	215	0.01	0									
AVG	86.2	57.7									7.9				4.6		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
*(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	0.01		
DEPARTURE FROM NORMAL	-0.44		
GREATEST IN 24 HRS.	0.01	ON	14
NUMBER OF DAYS WITH:			
TRACE OR MORE	6	0.25 OR MORE	0
0.01 OR MORE	1	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL	BD = BLOWING DUST
AU = AURORA	BS = BLOWING SNOW
G = GUST	DL = DISTANT LIGHTNING
F = FOG	DS = DRIFTING SNOW
GL = GLAZE	IC = ICE CRYSTALS
K = SMOKE	T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			72.0
DEPARTURE FROM NORMAL			+2.7
HIGHEST	97	ON	5
LOWEST	46	ON	17
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			0
MAX. 90 OR ABOVE			13
MIN. 32 OR BELOW			0
MIN. 0 OR BELOW			0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	6
DEPARTURE FROM NORMAL	-29
SEASONAL TOTAL (SINCE JULY 1)	4941
SEASONAL DEPARTURE FROM NORMAL	-329

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			0
GREATEST IN 24 HOURS:		ON	
GREATEST ON GND:		ON	

WIND (33 FT. LEVEL)

AVERAGE SPEED (MPH)			7.9
DEPARTURE FROM NORMAL			-1.4
PEAK GUST	43	FROM NE	ON 3

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	73.1	WET BULB (°F)	56
REL. HUM. (%)	33.7	DEW PT (°F)	40.8

+ DENOTES LATEST OF SEVERAL DATES

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.145
HIGHEST SEA LEVEL	30.30	ON	21
LOWEST SEA LEVEL	29.69	ON	5

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			624.9
GREATEST DAILY	742	ON	20
LEAST DAILY	294	ON	13

MISCELLANEOUS NUMBER OF DAYS

CLEAR	13	FOG	0
PARTLY CLOUDY	11	THUNDER	0
CLOUDY	6	DUST	1

REL. HUM. EXTREMES (%)

HIGHEST	81	ON	15
LOWEST	8	ON	6

BM -1800-023 (1-73) ASCO, RICHLAND, WASH.

Meteorological Conditions for June 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: July 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) DEPTH ON GROUND (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUSTS SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLAR (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: *TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	75	54	64	- 7	1	0				W	7.5	25	WSW	42	368	9	
2	84	50	67	- 5	0	2				W	3.5	17	SW	42	659	5	
3	86	61	74	+ 2	0	9				W	11.6	36	WNW	36	729	1	
4	83	49	66	- 7	0	1				NW	9.8	28	NW	34	744	1	
5	86	51	68	- 6	0	3				W	4.[illegible]	19	WNW	32	671	2	
6	94	56	75	0	0	10				NW	4.3	14	SE	29	736	0	
7	94	63	78	+ 3	0	13				NW	11.4	38	NW	26	722	1	
8	85	59	72	- 3	0	7				NW	7.8	27	W	30	735	0	
9	89	60	74	- 1	0	9				NW	8.1	31	NW	33	704	2	
10	86	58	72	- 4	0	7	T			NW	5.8	23	WNW	39	605	4	OL
11	92	58	75	- 1	0	10				NW	6.0	18	N	36	713	0	
12	96	70	83	+ 7	0	18				NW	6.8	23	NE	29	493	6	
13	96	66	81	+ 4	0	16				N	4.6	20	WNW	38	682	0	
14	101	73	87	+10	0	22				NW	8.1	37	NW	39	668	3	
15	93	64	78	+ 1	0	13				NW	10.5	35	WNW	33	705	2	
16	74	56	65	-12	0	0	0.01			SW	6.4	22	SW	56	283	9	
17	87	54	70	- 8	0	5				SW	6.5	22	WSW	44	716	3	
18	94	64	79	+ 1	0	14				W	3.5	16	SSE	36	543	7	
19	100	70	85	+ 7	0	20				NW	6.5	26	NW	34	706	2	OL
20	96	64	80	+ 2	0	15				NW	10.8	38	WNW	32	694	2	
21	86	58	72	- 6	0	7				NW	9.6	33	NW	33	708	0	
22	90	58	74	- 4	0	9				N	5.3	25	NNE	29	706	0	
23	98	60	79	+ 1	0	14				NW	7.5	31	NW	26	677	2	
24	94	66	80	+ 2	0	15				NW	6.9	31	NW	27	668	3	
25	96	60	78	- 1	0	13				NW	4.5	19	WNW	26	629	2	
26	99	71	85	+ 6	0	20				NW	7.9	28	NW	26	470	4	
27	93	56	74	- 5	0	9				NW	7.2	34	NW	40	682	0	
28	92	50	71	- 8	0	6				E	3.1	14	NE	31	695	0	
29	97	58	78	- 1	0	13				NW	4.6	23	WNW	30	672	0	
30	94	62	78	- 1	0	13				NW	7.8	32	NW	37	664	0	
31	91	59	75	- 4	0	10				W	10.2	43	WSW	37	655	0	
SUM					1	323	0.01	0									
AVG	91	059	0								7.0				2.3		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIC / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			0.01
DEPARTURE FROM NORMAL			-0.15
GREATEST IN 24 HRS.	0.01	ON	16
NUMBER OF DAYS WITH:			
TRACE OR MORE	2	0.25 OR MORE	0
0.01 OR MORE	1	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			0
GREATEST IN 24 HOURS:		ON	
GREATEST ON GND:		ON	

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)			7.0
DEPARTURE FROM NORMAL			-1.6
PEAK GUST	43	FROM	WSW	ON	31

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	76.2	WET BULB (°F)	58
REL. HUM. (%)	34.3	DEW PT (°F)	43.5

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL; AU = AURORA; B = DUST; F = FOG; GL = GLAZE; H = SMOKE; BD = BLOWING DUST; BS = BLOWING SNOW; DL = DISTANT LIGHTNING; DS = DRIFTING SNOW; IC = ICE CRYSTALS; T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			75.5
DEPARTURE FROM NORMAL			-1.1
HIGHEST	101	ON	14
LOWEST	49	ON	4
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			0
MAX. 90 OR ABOVE			20
MIN. 32 OR BELOW			0
MIN. 0 OR BELOW			0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	1
DEPARTURE FROM NORMAL	-3
SEASONAL TOTAL (SINCE JULY 1)	1
SEASONAL DEPARTURE FROM NORMAL	-3

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.172
HIGHEST SEA LEVEL	30.20	ON	5
LOWEST SEA LEVEL	29.69	ON	29

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			648.5
GREATEST DAILY	744	ON	4
LEAST DAILY	283	ON	16

MISCELLANEOUS NUMBER OF DAYS

CLEAR	24	FOG	0
PARTLY CLOUDY	5	THUNDER	0
CLOUDY	2	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	81	ON	17
LOWEST	9	ON	7

BM -1800-023 (1-73) [illegible]

Meteorological Conditions for July 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

23 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: August 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) ON GROUND AT 0600 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS SINCE FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "AFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	80	61	70	-8	0	5				SW	9.0	33	SW	37	515	8	
2	84	56	70	-8	0	5				W	8.6	27	SSW	38	634	4	
3	84	58	71	-7	0	6				NW	4.8	28	NW	40	554	6	
4	89	55	72	-5	0	7				NW	3.7	24	N	38	638	0	
5	95	60	78	+1	0	13				E	3.2	16	E	31	647	0	
6	102	67	84	+7	0	19				N	5.5	28	W	27	629	1	DL
7	103	70	86	+9	0	21				NW	4.9	16	NW	24	636	1	DL
8	95	77	86	+8	0	21	T			NW	7.4	25	NNW	33	259	10	T, DL
9	92	67	80	+2	0	15	0.07			SW	8.3	29	NW	41	512	4	T, DL, AU
10	91	57	74	-4	0	9				NW	5.2	23	NW	33	646	0	AU
11	90	54	72	-6	0	7				SE	3.8	15	ENE	33	642	0	
12	92	58	75	-2	0	10				NW	6.0	26	WNW	30	414	7	
13	89	57	73	-4	0	8				E	5.1	23	NW	36	617	0	
14	86	62	74	-2	0	9				NW	8.0	40	NW	40	380	7	
15	80	55	68	-7	0	3				NW	8.2	29	NW	38	505	5	
16	80	54	67	-8	0	2				W	3.7	16	NW	44	497	5	
17	86	57	72	-2	0	7				NE	4.3	15	NE	41	611	1	
18	91	62	76	+2	0	11				NW	4.0	19	WNW	37	582	2	
19	89	66	78	+4	0	13	T			NW	6.6	25	E	42	415	9	DL
20	88	63	76	+3	0	11	T			W	7.5	30	NW	42	585	3	
21	86	66	76	+3	0	11	T			W	10.0	30	SW	44	493	9	
22	80	57	68	-5	0	3	0.04			S	3.6	28	SSW	63	340	9	T, DL
23	79	58	68	-4	0	3				NW	11.0	35	NW	47	389	9	
24	82	58	70	-2	0	5	0.01			NW	8.6	35	E	52	359	8	
25	79	52	66	-5	0	1				SE	3.7	20	SE	62	506	4	DL
26	80	59	70	-1	0	5	T			N	5.8	18	E	60	416	6	DL
27	85	55	70	0	0	5	0.14			W	3.7	42	W	55	508	2	T, DL
28	84	56	70	0	0	5				NW	4.3	13	WNW	47	532	6	
29	86	56	71	+1	0	6				NW	5.8	18	NW	41	413	9	DL
30	88	64	76	+6	0	11				NW	9.4	38	WNW	37	458	4	T, DL
31	82	54	68	-2	0	3				W	5.0	22	W	42	548	2	
SUM					0	260	0.26	0									
AVG	87.0	59.7									6.1				4.6		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	0.26		
DEPARTURE FROM NORMAL	-0.03		
GREATEST IN 24 HRS.	0.14	ON	27
NUMBER OF DAYS WITH:			
TRACE OR MORE	9	0.25 OR MORE	0
0.01 OR MORE	4	0.50 OR MORE	0
0.10 OR MORE	1	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	0	
GREATEST IN 24 HOURS		ON
GREATEST ON GND		ON

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)	6.1		
DEPARTURE FROM NORMAL	-1.9		
PEAK GUST	42	FROM	W	ON	27

AVERAGE PSYCHROMETRIC DATA

DAY BULB (°F)	73.6	WET BULB (°F)	58
REL. HUM. (%)	41.1	DEW PT (°F)	46.3

*DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL	BD = BLOWING DUST
AU = AURORA	BS = BLOWING SNOW
D = DUST	DL = DISTANT LIGHTNING
F = FOG	DS = DRIFTING SNOW
GL = GLAZE	IC = ICE CRYSTALS
K = SMOKE	T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH	73.4		
DEPARTURE FROM NORMAL	-1.2		
HIGHEST	103	ON	7
LOWEST	52	ON	25
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW	0		
MAX. 90 OR ABOVE	9		
MIN. 32 OR BELOW	0		
MIN. 0 OR BELOW	0		

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	0
DEPARTURE FROM NORMAL	-7
SEASONAL TOTAL (SINCE JULY 1)	1
SEASONAL DEPARTURE FROM NORMAL	-10

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION	29.121		
HIGHEST SEA LEVEL	30.10	ON	13
LOWEST SEA LEVEL	29.66	ON	21

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL	512.3		
GREATEST DAILY	647	ON	5
LEAST DAILY	259	ON	8

MISCELLANEOUS NUMBER OF DAYS

CLEAR	12	FOG	0
PARTLY CLOUDY	11	THUNDER	5
CLOUDY	8	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	96	ON	25
LOWEST	12	ON	9+

BM -1800-023 (1-73) [illegible]

Meteorological Conditions for August 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: September 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL HUM %	SOLAR (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	79	51	65	- 5	0	0				W	6.5	27	WNW	44	388	8	DL
2	81	51	66	- 4	0	1				W	8.4	28	NW	42	407	3	
3	81	47	64	- 6	1	0				E	3.6	16	SE	42	536	1	AU
4	89	49	69	- 1	0	4				NW	5.8	32	NW	38	532	1	AU
5	81	60	70	0	0	5				NW	6.3	22	NNW	33	536	0	
6	82	54	68	- 1	0	3				N	9.0	28	N	33	515	0	
7	85	57	71	+ 2	0	6				N	5.8	18	N	35	500	1	
8	86	58	72	+ 3	0	7				N	10.2	37	NE	37	471	0	KFR 1850
9	79	51	65	- 4	0	0				N	7.5	22	NNE	31	503	0	
10	80	45	62	- 6	3	0				N	4.3	26	N	27	478	4	
11	81	50	66	- 2	0	1				NW	5.3	16	NNW	29	483	0	
12	85	47	66	- 1	0	1				E	3.0	12	WSW	27	468	0	
13	87	47	67	0	0	2				E	2.8	11	ESE	31	463	0	
14	91	47	69	+ 3	0	4				SE	4.3	24	NW	30	454	0	
15	94	56	75	+ 9	0	10				W	7.3	24	WSW	24	469	0	
16	86	52	69	+ 3	0	4				NW	8.4	27	NW	31	408	7	
17	69	58	64	- 1	1	0				NW	7.4	21	NW	43	188	10	
18	77	51	64	- 1	1	0				NW	6.0	19	NW	37	431	1	AU
19	78	44	61	- 4	4	0				W	3.8	13	S	36	437	0	AU
20	82	52	67	+ 3	0	2				N	6.5	17	NW	36	437	0	
21	83	46	64	0	1	0				N	4.1	13	E	36	430	1	
22	85	52	68	+ 4	0	3				NW	5.2	14	NW	39	410	0	
23	88	53	70	+ 6	0	5				S	3.5	10	ESE	39	398	2	
24	90	51	70	+ 6	0	5				NW	4.9	15	NW	40	388	0	
25	86	54	75	+12	0	10	0.02			NW	9.0	42	SSE	39	257	10	DL
26	79	52	66	+ 3	0	1				W	4.8	22	SW	57	221	10	
27	80	47	64	+ 1	1	0				W	4.2	10	N	57	389	1	
28	87	51	69	+ 7	0	4				NW	6.3	15	N	39	388	0	
29	88	61	74	+12	0	9				NW	8.6	18	WNW	32	344	6	
30	76	58	67	+ 6	0	2	T			W	10.0	32	WNW	46	140	9	
31																	
SUM					12	89	0.02	0									
AVG	83.2	52.1									6.1				12.5		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
*(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			0.02
DEPARTURE FROM NORMAL			-0.27
GREATEST IN 24 HRS.	0.02	ON	25

NUMBER OF DAYS WITH:

TRACE OR MORE	2	0.25 OR MORE	0
0.01 OR MORE	1	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL; BD = BLOWING DUST; AU = AURORA; BS = BLOWING SNOW; D = DUST; DL = DISTANT LIGHTNING; F = FOG; DS = DRIFTING SNOW; GL = GLAZE; IC = ICE CRYSTALS; K = SMOKE; T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			67.6
DEPARTURE FROM NORMAL			+1.4
HIGHEST	94	ON	15
LOWEST	44	ON	19

NUMBER OF DAYS WITH:

MAX. 32 OR BELOW	0
MAX. 90 OR ABOVE	3
MIN. 32 OR BELOW	0
MIN. 0 OR BELOW	0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	12
DEPARTURE FROM NORMAL	-55
SEASONAL TOTAL (SINCE JULY 1)	13
SEASONAL DEPARTURE FROM NORMAL	-65

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	0	
GREATEST IN 24 HOURS:		ON
GREATEST ON GND:		ON

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)			6.1	
DEPARTURE FROM NORMAL			-1.3	
PEAK GUST	42	FROM	SSE	ON 25

AVERAGE PSYCHROMETRIC DATA

DAY BULB (°F)	67.9	WET BULB (°F)	53
REL. HUM. (%)	37.0	DEW PT (°F)	38.4

+DENOTES LATEST OF SEVERAL DATES

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.185
HIGHEST SEA LEVEL	30.22	ON	21
LOWEST SEA LEVEL	29.60	ON	17

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			415.6
GREATEST DAILY	536	ON	5+
LEAST DAILY	140	ON	30

MISCELLANEOUS NUMBER OF DAYS

CLEAR	22	FOG	0
PARTLY CLOUDY	3	THUNDER	0
CLOUDY	5	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	91	ON	27
LOWEST	6	ON	15

BM -1800-023 (1-73) BATTELLE, RICHLAND, WASH.

Meteorological Conditions for September 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: October 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS OR ICE ON GROUND AT 0600 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	71	56	64	+4	1	0				N	9.5	26	N	39	295	8	
2	68	43	56	-4	9	0	0.04			N	8.8	27	N	41	387	0	
3	70	36	53	-6	12	0				N	3.2	13	SSE	38	380	0	
4	75	33	54	-4	11	0				E	2.9	16	E	41	337	7	
5	76	50	63	+5	2	0				NW	3.0	9	WNW	51	334	5	
6	76	51	64	+7	1	0				N	5.0	15	NW	46	343	1	
7	79	45	62	+5	3	0				E	3.4	12	NNW	47	296	6	
8	80	50	65	+8	0	0				NW	2.7	15	ESE	50	334	5	
9	80	45	62	+5	3	0				SE	3.1	11	WNW	53	332	0	
10	80	48	64	+8	1	0				W	10.0	37	WNW	52	284	6	KFR 1245
11	69	49	59	+3	6	0				SW	7.9	21	WSW	43	278	9	
12	68	54	61	+5	4	0	T			SW	3.0	16	W	54	77	10	
13	74	46	60	+5	5	0				W	6.6	28	SW	54	250	7	KFR 1550
14	65	43	54	-1	11	0				NW	8.4	30	NNW	41	318	3	
15	62	38	50	-4	15	0				NW	5.8	16	NW	42	311	7	
16	62	35	48	-6	17	0				NW	4.1	15	NW	43	301	3	
17	65	38	52	-1	13	0				W	3.8	14	NE	42	294	1	
18	62	38	50	-2	15	0				S	3.0	12	W	48	179	10	KFR 1840
19	68	44	56	+4	9	0	0.01			NW	6.0	20	NW	52	268	3	
20	67	47	57	+5	8	0	T			E	3.8	22	S	58	152	10	
21	60	48	54	+3	11	0	0.14			S	6.2	33	SSW	69	70	10	KFR 1534
22	59	44	52	+1	13	0	0.02			SE	3.3	20	SE	84	117	10	
23	62	49	56	+6	9	0	0.09			NW	8.2	46	WSW	81	70	10	DL KFR 1225, KFR 1702
24	60	35	48	-1	17	0				W	3.5	28	WSW	68	181	8	AU
25	62	40	51	+2	14	0				SW	3.7	16	S	70	238	3	AU
26	55	38	46	-2	19	0	0.12			SE	7.5	29	SSE	79	62	10	KFR 1710
27	59	36	48	+1	17	0				NW	8.9	29	NW	60	202	4	
28	56	34	45	-2	20	0				NW	6.3	21	NW	50	260	0	
29	53	27	40	-6	25	0				SE	2.5	11	SE	69	248	6	
30	48	28	38	-8	27	0				W	3.4	15	WNW	70	151	10	
31	54	35	44	-2	21	0				W	4.3	13	N	60	239	0	
SUM					339	0	0.42	0									
AVG	66.0	42.0									5.2					5.6	

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL.15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	0.42		
DEPARTURE FROM NORMAL	-0.04		
GREATEST IN 24 HRS.	0.15	ON	21-22
NUMBER OF DAYS WITH:			
TRACE OR MORE	7	0.25 OR MORE	0
0.01 OR MORE	6	0.50 OR MORE	0
0.10 OR MORE	2	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	0		
GREATEST IN 24 HOURS:		ON	
GREATEST ON GND:		ON	

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)	5.2		
DEPARTURE FROM NORMAL	-1.2		
PEAK GUST	46	FROM	WSW ON 23

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	53.7	WET BULB (°F)	45
REL. HUM. (%)	54.7	DEW PT (°F)	36.1

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL; AU = AURORA; D = DUST; F = FOG; GL = GLAZE; H = SMOKE; BD = BLOWING DUST; BS = BLOWING SNOW; DL = DISTANT LIGHTNING; DS = DRIFTING SNOW; IC = ICE CRYSTALS; T = THUNDERSTORM

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION	29.280		
HIGHEST SEA LEVEL	30.53	ON	29
LOWEST SEA LEVEL	29.61	ON	23

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL	244.7		
GREATEST DAILY	387	ON	2
LEAST DAILY	62	ON	26

MISCELLANEOUS NUMBER OF DAYS

CLEAR	11	FOG	0
PARTLY CLOUDY	9	THUNDER	0
CLOUDY	11	GUST	0

REL. HUM. EXTREMES (%)

HIGHEST	97	ON	23
LOWEST	14	ON	2

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH	54.0		
DEPARTURE FROM NORMAL	+0.9		
HIGHEST	80	ON	10+
LOWEST	27	ON	29
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW	0		
MAX. 90 OR ABOVE	0		
MIN. 32 OR BELOW	2		
MIN. 0 OR BELOW	0		

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	339
DEPARTURE FROM NORMAL	-31
SEASONAL TOTAL (SINCE JULY 1)	352
SEASONAL DEPARTURE FROM NORMAL	-96

SM-1800-023 (1-73) AIR-01 PNL/LAB. DIR.

Meteorological Conditions for October 1989

Battelle
Pacific Northwest Laboratories

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

23 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: November 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS OR ICE ACCRETIONS ON GROUND AT 0600 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLAR (LANGLEYS)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	53	28	40	-5	25	0				W	3.8	11	NW	68	236	2	
2	44	22	33	-12	32	0				N	2.1	9	NW	80	142	8	F
3	58	36	47	+3	18	0				NE	2.3	18	WSW	76	51	10	
4	62	46	54	+10	11	0				NW	9.3	31	W	54	142	6	KFR 0320
5	63	39	51	+8	14	0				SW	5.9	23	NW	56	133	7	
6	58	49	54	+11	11	0				SW	13.3	38	SSW	55	55	10	KFR 1545
7	60	40	50	+7	15	0				NW	6.3	25	W	49	184	2	
8	62	48	55	+12	10	0				SW	14.2	37	SW	53	77	10	
9	73	60	66	+24	0	1				SW	20.0	41	WSW	54	143	9	
10	73	56	64	+22	1	0				SW	12.2	32	SW	53	155	8	
11	66	48	57	+15	8	0				E	3.5	18	NNW	70	152	10	KFR 1800
12	53	42	48	+7	17	0	0.47			NW	5.5	16	NW	85	89	8	F
13	54	34	44	+4	21	0				W	8.1	37	W	60	190	4	KFR 1320
14	56	35	46	+6	19	0				W	8.0	22	WNW	55	202	1	
15	46	34	40	+1	25	0				NW	5.5	18	NW	65	107	10	
16	42	31	36	-3	29	0	0.19			NW	4.6	15	NW	86	82	10	F
17	47	32	40	+2	25	0	0.05			NW	4.1	18	NW	91	96	10	F
18	44	36	40	+2	25	0				NE	1.6	9	NW	94	40	10	F
19	48	38	43	+5	22	0	0.01			SE	2.4	14	NW	91	88	10	
20	52	38	45	+7	20	0				NW	3.0	16	NW	91	89	8	F
21	57	35	46	+9	19	0				NW	4.5	18	NE	80	176	0	F
22	50	28	39	+2	26	0				NW	6.3	16	NW	73	170	1	F
23	48	30	39	+2	26	0	0.14			N	3.6	24	S	91	83	8	F
24	52	32	42	+5	23	0				SW	5.3	24	SW	69	110	6	
25	51	36	44	+8	21	0	0.10			NW	5.5	25	SW	72	125	7	
26	50	34	42	+6	23	0	0.08			W	8.0	28	W	74	141	7	KFR 0100
27	47	30	38	+2	27	0				W	3.8	12	WSW	74	147	10	
28	39	27	33	-2	32	0				NW	4.5	12	NW	90	64	10	
29	30	21	26	-9	39	0				C	1.2	6	W	96	65	10	F
30	32	24	28	-7	37	0				C	0.3	6	SE	97	43	10	F
31																	
SUM					621	1	1.04	0									
AVG	52.3	36.3									6.0				7.4		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL.15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			1.04
DEPARTURE FROM NORMAL			+0.24
GREATEST IN 24 HRS.	0.47	ON	12

NUMBER OF DAYS WITH:

TRACE OR MORE	7	0.25 OR MORE	1
0.01 OR MORE	7	0.50 OR MORE	0
0.10 OR MORE	4	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH	0	
GREATEST IN 24 HOURS:		ON
GREATEST ON GND:		ON

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)	6.0		
DEPARTURE FROM NORMAL	±0		
PEAK GUST	41	FROM - WSW	ON 9

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	44.2	WET BULB (°F)	40
REL. HUM. (%)	73.4	DEW PT (°F)	35.3

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL
AU = AURORA
D = DUST
F = FOG
GL = GLAZE
H = SMOKE
BD = BLOWING DUST
BS = BLOWING SNOW
DL = DISTANT LIGHTNING
DS = DRIFTING SNOW
IC = ICE CRYSTALS
T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH		44.3
DEPARTURE FROM NORMAL		+4.8
HIGHEST	73	ON 9, 10
LOWEST	21	ON 29

NUMBER OF DAYS WITH:

MAX. 32 OR BELOW	2
MAX. 90 OR ABOVE	0
MIN. 32 OR BELOW	11
MIN. 0 OR BELOW	0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	621
DEPARTURE FROM NORMAL	-143
SEASONAL TOTAL (SINCE JULY 1)	973
SEASONAL DEPARTURE FROM NORMAL	-239

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.305
HIGHEST SEA LEVEL	30.60	ON	30
LOWEST SEA LEVEL	29.57	ON	25

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			119.2
GREATEST DAILY	236	ON	1
LEAST DAILY	40	ON	18

MISCELLANEOUS NUMBER OF DAYS

CLEAR	5	FOG	11
PARTLY CLOUDY	6	THUNDER	0
CLOUDY	19	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	100	ON	23+
LOWEST	32	ON	7

BH -1800-023 (1-73)

Meteorological Conditions for November 1989

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION
25 MILES N. W. OF RICHLAND, WASHINGTON
LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

December 1989

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) ON GROUND AT 0400 (IN.)	WIND (30 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLAR (LANGLEYS)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	35	31	33	- 3	32	0				SW	1.8	6	SW	91	28	10	
2	37	32	34	- 2	31	0	0.01			SE	4.0	11	SE	88	55	10	F
3	36	32	34	- 2	31	0	0.07			N	2.5	15	ESE	94	37	10	F
4	44	35	40	+ 4	25	0	0.09			N	4.5	18	NW	93	50	10	F KFR 1930
5	51	33	42	+ 7	23	0				NW	6.2	18	NW	87	109	9	F
6	39	35	37	+ 3	28	0				S	3.8	10	S	98	36	10	F
7	44	36	40	+ 7	25	0	0.01			NW	4.4	13	NNW	91	73	10	F
8	58	35	46	+13	19	0	0.01			SW	8.9	36	SW	76	154	0	F KFR 0230
9	50	35	42	+ 9	23	0				W	12.0	33	WNW	57	129	4	
10	48	27	38	+ 6	27	0				W	5.7	14	NNW	67	152	0	
11	39	23	31	- 2	34	0				W	6.4	14	SE	71	121	6	
12	38	20	29	- 4	36	0				W	3.4	11	SSW	84	126	6	
13	35	19	27	- 6	38	0				SW	2.9	10	S	91	140	6	F
14	31	26	28	- 5	37	0				S	3.2	12	S	96	37	10	F
15	40	28	34	+ 1	31	0				SE	3.2	13	SSE	92	121	4	F
16	33	30	32	- 1	33	0				SW	2.6	11	SW	89	35	10	F
17	32	25	28	- 5	37	0	T			S	2.8	9	S	88	29	10	F, GL
18	35	22	28	- 5	37	0				E	3.0	8	ESE	89	105	8	F
19	32	24	28	- 5	37	0				NW	2.3	8	NW	95	60	10	F
20	37	24	30	- 3	35	0				NW	3.2	14	NW	92	71	9	F
21	42	26	34	+ 1	31	0				NW	5.5	13	E	85	136	7	
22	39	24	32	- 1	33	0				NE	2.6	11	SSE	90	101	10	F
23	33	27	30	- 3	35	0				NW	3.2	12	NNE	95	26	10	F
24	37	32	34	+ 1	31	0	T			SW	4.0	11	WNW	94	34	10	F
25	36	32	34	+ 1	31	0	0.01	T		SE	3.2	10	SE	92	34	10	F
26	33	31	32	+ 0	33	0	0.02	0.3	T	E	2.2	8	SSE	92	16	10	F
27	33	30	32	+ 0	33	0	0.04	0.7	T	SE	3.0	11	SW	87	35	10	F
28	30	27	28	- 3	37	0	0.03	0.4	1.1	SW	2.3	9	WSW	98	27	10	F, GL
29	31	28	30	- 1	35	0	T		0.9	W	3.4	9	NW	95	41	10	F, GL
30	32	30	31	+ 1	34	0			0.6	SW	2.6	10	WNW	94	29	10	F
31	37	26	32	+ 3	33	0	T	T	0.1	S	3.0	12	SSW	93	46	8	F
SUM					985	0	0.29	1.4									
AVG	38.0	28.6									3.9				8.3		

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			0.29
DEPARTURE FROM NORMAL			- 0.66
GREATEST IN 24 HRS.	0.09	ON	4
NUMBER OF DAYS WITH:			
TRACE OR MORE	13	0.25 OR MORE	0
0.01 OR MORE	9	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			1.4
GREATEST IN 24 HOURS:	1.1	ON	27-28
GREATEST ON GND:	1.1	ON	28

WIND (30 FT. LEVEL)

AVERAGE SPEED (MPH)			3.9
DEPARTURE FROM NORMAL			-2.2
PEAK GUST	36	FROM SW	ON 8

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	32.9	WET BULB (°F)	32
REL. HUM. (%)	88.5	DEW PT (°F)	29.7

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL
AU = AURORA
G = GUST
F = FOG
GL = GLAZE
K = SMOKE
BB = BLOWING DUST
BS = BLOWING SNOW
BL = DISTANT LIGHTNING
DS = DRIFTING SNOW
IC = ICE CRYSTALS
T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			33.3
DEPARTURE FROM NORMAL			+0.2
HIGHEST	58	ON	8
LOWEST	19	ON	13
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			5
MAX. 90 OR ABOVE			0
MIN. 32 OR BELOW			25
MIN. 0 OR BELOW			0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	985
DEPARTURE FROM NORMAL	-5
SEASONAL TOTAL (SINCE JULY 1)	1958
SEASONAL DEPARTURE FROM NORMAL	-244

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.501
HIGHEST SEA LEVEL	30.69	ON	23
LOWEST SEA LEVEL	29.87	ON	8

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			70.8
GREATEST DAILY	154	ON	8
LEAST DAILY	16	ON	26

MISCELLANEOUS NUMBER OF DAYS

CLEAR	2	FOG	25
PARTLY CLOUDY	6	THUNDER	0
CLOUDY	23	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	100	ON	7+
LOWEST	39	ON	9

Meteorological Conditions for December 1989

Battelle
Pacific Northwest Laboratories

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

January 1990

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) DEPTH (GROUND) (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	47	32	40	+11	25	0				W	9.6	29	W	68	71	10	
2	46	31	38	+10	27	0				W	10.0	29	WNW	56	138	6	
3	50	29	40	+12	25	0				SW	7.0	31	SW	64	78	9	
4	60	38	49	+21	16	0				SW	11.9	37	SW	54	115	6	
5	59	30	44	+15	21	0				SW	10.4	49	SSW	68	61	9	
6	59	34	46	+17	19	0	T			S	9.3	44	S	65	61	10	
7	59	45	52	+23	13	0	0.31			SW	16.7	57	SSW	63	85	9	F
8	55	42	48	+19	17	0	0.21			W	16.5	61	W	69	85	7	F KFR 0130
9	60	41	50	+21	15	0	T			NW	7.4	50	WSW	79	41	10	F KFR 0230
10	50	37	44	+14	21	0				NW	7.7	26	WSW	56	109	10	KFR 1950
11	42	37	40	+10	25	0				NW	7.9	15	NW	58	48	10	
12	46	31	38	+ 7	27	0	0.01			NW	5.3	17	WNW	64	75	10	
13	40	28	34	+ 3	31	0	0.03			E	2.6	11	NW	93	58	10	F
14	44	30	37	+ 5	28	0				W	4.4	12	SE	86	83	10	
15	42	32	37	+ 5	28	0	T			NW	3.9	12	NW	91	54	10	F
16	48	34	41	+ 9	24	0	0.02			NW	8.0	16	NW	82	67	9	
17	47	25	36	+ 4	29	0				NW	5.8	18	N	61	169	0	
18	35	22	28	- 4	37	0				NW	7.5	15	NW	86	46	9	F
19	38	30	34	+ 2	31	0				NW	4.3	12	NW	74	86	10	
20	36	32	34	+ 3	31	0				SE	4.0	13	SSE	78	44	10	
21	36	30	33	+ 2	32	0				S	2.3	9	NW	83	48	10	F
22	56	28	42	+11	23	0				W	9.4	45	W	64	128	4	F KFR 0710
23	50	30	40	+10	25	0				W	13.8	41	WNW	49	191	0	KFR 0050
24	45	25	35	+ 5	30	0				W	3.1	18	WNW	67	97	10	
25	52	35	44	+14	21	0				SW	14.9	52	SW	57	60	10	KFR 2100
26	46	32	39	+ 9	26	0				W	14.2	32	WSW	47	121	8	
27	51	34	42	+12	23	0				SW	21.7	53	WSW	51	140	6	KFR 1400
28	56	39	48	+18	17	0	0.01			SW	18.1	73	SW	60	99	9	BD, WFR 1210, KFR 1730
29	50	35	42	+12	23	0	0.13			SW	12.6	55	W	57	134	8	KFR 2348
30	50	34	42	+12	23	0				W	7.9	34	SW	63	128	10	
31	42	28	35	+ 4	30	0	0.05	0.6		S	6.6	32	SSW	71	55	10	F
SUM					763	0	0.77	0.6									
AVG	48.3	32.6									9.2					8.4	

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL.15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH			0.77
DEPARTURE FROM NORMAL			-0.20
GREATEST IN 24 HRS.	0.39	ON	7-8
NUMBER OF DAYS WITH:			
TRACE OR MORE	11	0.25 OR MORE	1
0.01 OR MORE	8	0.50 OR MORE	0
0.10 OR MORE	3	1.00 OR MORE	0

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			0.6
GREATEST IN 24 HOURS:	0.6	ON	31
GREATEST ON GND:	0.6	ON	31

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)					9.2
DEPARTURE FROM NORMAL					+2.7
PEAK GUST	73	FROM	SW	ON	28

AVERAGE PSYCHROMETRIC DATA

DRY BULB (°F)	40.6	WET BULB (°F)	36
REL. HUM. (%)	67.2	DEW PT (°F)	29.7

+ DENOTES LATEST OF SEVERAL DATES

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL	BS = BLOWING SNOW
AU = AURORA	DS = BLOWING DUST
G = GUST	DL = DISTANT LIGHTNING
F = FOG	DS = DRIFTING SNOW
GL = GLAZE	IC = ICE CRYSTALS
K = SMOKE	T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			40.4
DEPARTURE FROM NORMAL			+10.3
HIGHEST	60	ON	9+
LOWEST	22	ON	18
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			0
MAX. 90 OR ABOVE			0
MIN. 32 OR BELOW			18
MIN. 0 OR BELOW			0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	763
DEPARTURE FROM NORMAL	-318
SEASONAL TOTAL (SINCE JULY 1)	2721
SEASONAL DEPARTURE FROM NORMAL	-562

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.200
HIGHEST SEA LEVEL	30.47	ON	11
LOWEST SEA LEVEL	29.28	ON	30+

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			89.6
GREATEST DAILY	191	ON	23
LEAST DAILY	41	ON	9

MISCELLANEOUS NUMBER OF DAYS

CLEAR	2	FOG	9
PARTLY CLOUDY	5	THUNDER	0
CLOUDY	24	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	99	ON	13+
LOWEST	25	ON	23

BM -1800-023 (1-73) ACCOL PORTLAND, OREG.

Meteorological Conditions for January 1990

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: February 1990

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) ON GROUND AT 0400 (IN.)	WIND (30 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA (NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT))
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	44	24	34	+ 2	31	0	T	T	.6	NW	6.5	24	W	77	161	8	F
2	55	38	46	+13	19	0				SW	16.8	40	SW	54	158	10	
3	53	39	46	+13	19	0	.06			S	9.2	31	NW	59	46	10	KFR 1940
4	50	34	42	+ 8	23	0				W	12.0	26	WSW	50	211	4	
5	52	38	45	+10	20	0				S	17.2	47	SW	46	183	7	
6	48	33	40	+ 5	25	0				SW	15.3	38	SW	49	199	4	
7	44	26	35	- 1	30	0				SW	15.3	55	SW	58	69	9	KFR 1915
8	48	27	38	+ 2	27	0				NW	3.9	13	S	70	140	9	
9	58	31	44	+ 8	21	0				SW	9.9	41	SW	64	118	10	
10	64	39	52	+15	13	0				SW	20.6	51	SW	58	206	9	
11	59	33	46	+ 9	19	0				SW	15.1	45	WSW	44	154	8	KFR 1300
12	41	29	35	- 3	30	0	T	.1		SW	11.7	32	SW	57	193	7	F
13	38	22	30	- 8	35	0	T	T		NW	11.1	30	NNW	42	184	6	
14	32	11	22	-17	43	0				SE	4.9	19	SE	58	227	5	
15	35	19	27	-12	38	0	.02	.4		NW	8.5	20	NW	81	109	10	F
16	35	22	28	-11	37	0	T		.3	NW	5.4	15	NW	79	116	10	
17	34	18	26	-13	39	0	.01	.2	T	NW	8.3	20	NW	68	241	6	F
18	34	9	22	-17	43	0				S	4.6	16	E	71	304	0	
19	36	14	25	-14	40	0				SE	4.5	17	SSE	74	257	9	
20	48	23	36	- 3	29	0	T			N	3.8	15	N	75	137	8	
21	64	30	47	+ 8	18	0				W	5.4	20	NW	64	241	8	
22	54	30	42	+ 2	23	0				NW	7.9	19	NNW	75	295	1	
23	55	30	42	+ 2	23	0	T			E	5.2	19	WNW	77	287	4	
24	48	36	42	+ 2	23	0	T			NW	3.5	18	NW	92	149	9	F
25	42	31	36	- 4	29	0				S	4.4	15	NW	95	71	10	F
26	55	26	40	0	25	0				W	5.9	19	E	60	332	0	
27	57	26	42	+ 2	23	0				NW	6.9	16	NW	53	333	0	
28	57	29	43	+ 3	22	0				W	6.0	16	NNW	53	337	0	
29																	
30																	
31																	
SUM					767	0	0.09	0.7									
AVG	47.9	27.4									8.9				6.5		

NOTES:

(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.

(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.

(3) THE LANGLEY (COL. 13) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)			
TOTAL FOR THE MONTH	0.09		
DEPARTURE FROM NORMAL	-0.47		
GREATEST IN 24 HRS.	0.06	ON	3
NUMBER OF DAYS WITH:			
TRACE OR MORE	10	0.25 OR MORE	0
0.01 OR MORE	3	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0
SNOW, ICE PELLETS (SLEET) (INCHES)			
TOTAL FOR THE MONTH	0.7		
GREATEST IN 24 HOURS	0.4	ON	15
GREATEST ON GND	0.6	ON	1
WIND (30 FT. LEVEL)			
AVERAGE SPEED (MPH)	8.9		
DEPARTURE FROM NORMAL	+1.8		
PEAK GUST 55 FROM SW ON 7			
AVERAGE PSYCHROMETRIC DATA			
DRY BULB (°F)	37.5	WET BULB (°F)	33
REL. HUM. (%)	64.4	DEW PT (°F)	25.5
+ DENOTES LATEST OF SEVERAL DATES			

MISC. PHENOMENA NOTATIONS USED IN COL. 17

A = HAIL
AU = AURORA
B = DUST
F = FOG
GL = GLAZE
K = SMOKE
BD = BLOWING DUST
BS = BLOWING SNOW
DL = DISTANT LIGHTNING
DS = DRIFTING SNOW
IC = ICE CRYSTALS
T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)			
AVERAGE FOR THE MONTH			37.6
DEPARTURE FROM NORMAL			- 0.2
HIGHEST	64	ON	21+
LOWEST	9	ON	18
NUMBER OF DAYS WITH:			
MAX. 32 OR BELOW			1
MAX. 90 OR ABOVE			0
MIN. 32 OR BELOW			20
MIN. 0 OR BELOW			0
HEATING DEGREE DAYS (BASE 65°F)			
TOTAL FOR THE MONTH			767
DEPARTURE FROM NORMAL			-4
SEASONAL TOTAL (SINCE JULY 1)			3488
SEASONAL DEPARTURE FROM NORMAL			-566

BAROMETRIC PRESSURE (IN.)			
AVERAGE STATION			29.292
HIGHEST SEA LEVEL	30.60	ON	27
LOWEST SEA LEVEL	29.54	ON	1
SOLAR RADIATION (LANGLEYS)			
AVERAGE DAILY TOTAL			194.9
GREATEST DAILY	337	ON	28
LEAST DAILY	46	ON	3
MISCELLANEOUS NUMBER OF DAYS			
CLEAR	5	FOG	6
PARTLY CLOUDY	8	THUNDER	0
CLOUDY	15	DUST	0
REL. HUM. EXTREMES (%)			
HIGHEST	100	ON	25+
LOWEST	26	ON	13

BN-1800-023 (1-73) ARC-26 RICHLAND, WASH.

Meteorological Conditions for February 1990

Battelle

CLIMATOLOGICAL DATA

HANFORD METEOROLOGY STATION

25 MILES N. W. OF RICHLAND, WASHINGTON

LATITUDE 46° 34' N., LONGITUDE 119° 36' W., ELEVATION (GROUND) 733 FEET

MONTH: March 1990

DATE	TEMPERATURE (°F-3 FT. LEVEL) MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	DEGREE DAYS BASE 65 HEATING	COOLING	PRECIP TOTAL (WTR. EQUIVALENT IN. IN.)	SNOW, ICE PELLETS (SLEET) (IN.)	SNOW, ICE PELLETS (SLEET) OR ICE ON GROUND AT 0600 (IN.)	WIND (50 FT. LEVEL) PREVAILING DIRECTION	AVERAGE SPEED (MPH)	PEAK GUST SPEED (MPH)	DIRECTION	AVERAGE REL. HUM. %	SOLRAD (LANGLEYS*)	SKY COVER (TENTHS FROM SUNRISE TO SUNSET)	FRONTS AND MISC. PHENOMENA NOTE: TIMES OF FRONTAL PASSAGES ARE GIVEN AFTER THE NOTATIONS "KFR" (COLD FRONT) AND "WFR" (WARM FRONT)
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17
1	57	24	40	0	25	0				W	4.1	12	WNW	61	340	0	
2	59	26	42	+3	23	0				NW	6.7	18	NW	55	347	0	
3	51	34	42	+3	23	0	T			W	4.9	16	NW	68	150	10	
4	54	35	44	+4	21	0	0.02			NW	8.3	19	WNW	78	193	10	
5	62	34	48	+8	17	0				W	5.6	20	WNW	63	308	4	
6	63	34	48	+7	17	0				S	3.2	12	S	62	290	10	
7	55	40	48	+6	17	0	0.01			S	6.3	30	S	69	124	10	KFR 2135
8	53	32	42	0	23	0				SW	17.8	51	SW	42	375	4	
9	56	37	46	+4	19	0	0.03			S	7.1	25	SSE	49	218	10	
10	52	38	45	+2	20	0	0.01			W	10.3	44	S	56	160	10	KFR 0415
11	54	31	42	-1	23	0	T			W	7.6	30	SW	42	356	4	
12	56	30	43	0	22	0				W	7.3	22	WNW	41	409	1	
13	58	29	44	0	21	0	T			W	6.1	28	SW	44	398	3	
14	61	36	48	+4	17	0				W	8.6	29	WNW	54	294	7	
15	62	29	46	+2	19	0				SE	4.4	14	SSE	54	405	3	
16	62	36	49	+4	16	0				NW	5.3	12	NW	52	301	10	
17	67	45	56	+11	9	0	T			W	4.8	11	ENE	52	306	9	
18	67	47	57	+11	8	0	0.02			NW	4.1	12	NNE	67	317	10	
19	72	44	58	+12	7	0				W	8.4	40	WSW	56	301	8	
20	68	39	54	+8	11	0				W	8.8	27	WSW	51	365	10	AU
21	65	40	52	+6	13	0				E	6.5	21	WNW	45	431	5	AU
22	61	36	48	+1	17	0	0.01			N	9.6	29	NNW	56	234	10	
23	46	33	40	-7	25	0	T	T	T	NW	4.3	20	NNE	66	230	10	
24	54	30	42	-5	23	0				NE	7.1	22	ENE	44	446	3	
25	60	24	42	-5	23	0				N	6.6	20	NNW	38	440	7	
26	64	32	48	0	17	0				W	5.2	13	WSW	32	478	0	
27	71	29	50	+2	15	0				W	5.2	22	NNE	32	489	0	
28	70	43	56	+8	9	0				NW	6.3	22	NNW	27	460	3	
29	71	34	52	+4	13	0				W	4.5	16	WNW	35	465	3	
30	74	36	55	+6	10	0				E	4.4	21	NW	40	458	6	AU
31	76	41	58	+9	7	0				E	4.3	21	WNW	46	458	6	AU
SUM					530	0	0.10	T									
AVG	61.3	34.8									6.6					6.0	

NOTES:
(1) UNLESS OTHERWISE SPECIFIED, THE DAILY SUMMARY PERIOD IS FROM MIDNIGHT TO MIDNIGHT, PACIFIC STANDARD TIME.
(2) "T" IN COLUMNS 7 - 9 DENOTES A TRACE.
(3) THE LANGLEY (COL. 15) IS THE UNIT USED TO DENOTE ONE GRAM CALORIE / CM 2

PRECIPITATION (IN)

TOTAL FOR THE MONTH	0.10		
DEPARTURE FROM NORMAL	-0.30		
GREATEST IN 24 HRS.	0.04	ON	9-10

NUMBER OF DAYS WITH:

TRACE OR MORE	11	0.25 OR MORE	0
0.01 OR MORE	6	0.50 OR MORE	0
0.10 OR MORE	0	1.00 OR MORE	0

MISC. PHENOMENA NOTATIONS USED IN COL. 17

- A = HAIL
- AU = AURORA
- G = GUST
- F = FOG
- GL = GLAZE
- K = SMOKE
- BD = BLOWING DUST
- BS = BLOWING SNOW
- DL = DISTANT LIGHTNING
- DS = DRIFTING SNOW
- IC = ICE CRYSTALS
- T = THUNDERSTORM

TEMPERATURE (°F; 3 FT. LEVEL)

AVERAGE FOR THE MONTH			48.0
DEPARTURE FROM NORMAL			+3.6
HIGHEST	76	ON	31
LOWEST	24	ON	25+

NUMBER OF DAYS WITH:

MAX. 32 OR BELOW	0
MAX. 90 OR ABOVE	0
MIN. 32 OR BELOW	11
MIN. 0 OR BELOW	0

HEATING DEGREE DAYS (BASE 65°F)

TOTAL FOR THE MONTH	530
DEPARTURE FROM NORMAL	-108
SEASONAL TOTAL (SINCE JULY 1)	4018
SEASONAL DEPARTURE FROM NORMAL	-674

SNOW, ICE PELLETS (SLEET) (INCHES)

TOTAL FOR THE MONTH			T
GREATEST IN 24 HOURS:	T	ON	23
GREATEST ON GND:	T	ON	23

WIND (50 FT. LEVEL)

AVERAGE SPEED (MPH)	6.6
DEPARTURE FROM NORMAL	-2.0

PEAK GUST: 51 FROM SW ON 8

AVERAGE PSYCHROMETRIC DATA

DAY BULB (°F)	48.4	WET BULB (°F)	40
REL. HUM. (%)	50.9	DEW PT (°F)	29.0

+ DENOTES LATEST OF SEVERAL DATES

BAROMETRIC PRESSURE (IN.)

AVERAGE STATION			29.286
HIGHEST SEA LEVEL	30.50	ON	23
LOWEST SEA LEVEL	29.52	ON	10

SOLAR RADIATION (LANGLEYS)

AVERAGE DAILY TOTAL			340.1
GREATEST DAILY	489	ON	27
LEAST DAILY	124	ON	7

MISCELLANEOUS NUMBER OF DAYS

CLEAR	10	FOG	0
PARTLY CLOUDY	8	THUNDER	0
CLOUDY	13	DUST	0

REL. HUM. EXTREMES (%)

HIGHEST	93	ON	21+
LOWEST	13	ON	27

R M -1800-023 (1-73) ALBUQUERQUE, WASH.

Meteorological Conditions for March 1990

STATION APRIL, 1989	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
1	0.3	0.022	0.1	0	0.27	0.057	0.05	0.022	0.04	0.014	0.76
2	0.42	0.078	0.12	0.036	0.32	0.071	0.06	0.014	0.07	0.028	0.99
3	0.31	0.01	0.09	0	0.26	0.064	0.06	0	0.05	0	0.77
4	0.26	0	0.11	0.028	0.21	0.057	0.03	0.01	0.3	0.29	0.91
5	0.32	0.028	0.12	0.022	0.24	0.064	0.04	0.014	0.05	0.01	0.77
6	0.29	0.014	0.1	0	0.28	0.036	0.05	0.01	0.11	0.036	0.83
7	1.25	0.036	0.12	0.014	0.86	0.12	0.17	0.01	0.15	0.028	2.55
8	168.07	30.893	9.48	2.574	59.55	10.508	19.41	2.991	8.42	1.421	264.93
9	0.39	0	0.07	0.028	0.33	0.01	0.09	0.014	0.09	0.022	0.97
10	0.55	0.276	0.22	0.149	0.28	0.085	0.11	0.078	0.06	0.014	1.22
11	0.11	0.149	0.03	0.036	0.21	0.042	0.05	0.022	0.09	0.022	0.49
12	0.31	0.05	0.12	0.036	0.21	0.042	0.08	0.042	0.14	0.036	0.86
13	0.1	0.141	0.05	0	0.32	0.085	0.06	0.022	0.1	0	0.63
14	0.26	0.01	0.1	0	0.2	0.014	0.06	0.01	0.09	0.014	0.71
15	0.23	0	0.07	0.014	0.41	0.085	0.07	0.022	0.06	0.01	0.84
16	0.19	0.014	0.08	0.022	0.23	0.028	0.04	0.014	0.07	0.028	0.61
BC	0	0	0	0	0	0	0	0	0.09	0	0.09

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - April 1989

STATION MAY, 1989	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
1	0.7	0.12	0.17	0.042	0.61	0.304	0.06	0.014	0.3	0.01	1.84
2	0.66	0.064	0.18	0.042	0.98	0.523	0.09	0.042	0.26	0.01	2.17
3	0.73	0.028	0.16	0.01	0.3	0.05	0.05	0.01	0.24	0.01	1.48
4	0.59	0.042	0.15	0.014	1.01	0.53	0.1	0.057	0.2	0.014	2.05
5	0.77	0.014	0.16	0.01	0.56	0.325	0.07	0.01	0.26	0.022	1.82
6	0.93	0.064	0.23	0	0.61	0.071	0.07	0	0.31	0.113	2.15
7	2.25	0.318	0.26	0	1.21	0.24	0.21	0.014	0.26	0	4.19
8	81.87	7.304	4.59	0.481	37.11	3.465	9.12	0.912	4.28	0.212	136.97
9	0.88	0.163	0.33	0.057	1.18	0.12	0.16	0.092	0.24	0.028	2.79
10	0.64	0.05	0.2	0.064	0.5	0.036	0.07	0.01	0.14	0.014	1.55
11	0.6	0.064	0.19	0.057	0.37	0.092	0.05	0.01	0.17	0.022	1.38
12	0.38	0.184	0.32	0.141	0.35	0.106	0.07	0.01	0.14	0.022	1.26
13	0.53	0.05	0.18	0.028	0.52	0.24	0.06	0.022	0.12	0.022	1.41
14	0.47	0.022	0.14	0	0.42	0.078	0.05	0	0.11	0.022	1.19
15	0.52	0.014	0.15	0	0.27	0.05	0.04	0.014	0.09	0.014	1.07
16	0.41	0.014	0.14	0.01	0.32	0.042	0.04	0	0.06	0.014	0.97
BC	0	0	0	0	0.08	0.071	0	0	0	0	0.08

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - May 1989

STATION JUNE, 1989	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
1	1.02	0.615	0.75	0.636	0.65	0.297	0.08	0.042	0.15	0.036	2.65
2	0.58	0.01	0.27	0.106	0.5	0.191	0.06	0.014	0.14	0	1.55
3	0.72	0.071	0.22	0.028	0.64	0.127	0.06	0.01	0.12	0.014	1.76
4	0.44	0.078	0.18	0.01	0.3	0.071	0.04	0.022	0.15	0.022	1.11
5	0.49	0.156	0.37	0.311	0.52	0.127	0.06	0.01	0.14	0.028	1.58
6	0.45	0.184	0.19	0.057	0.42	0.028	0.06	0.01	0.1	0.014	1.22
7	0.7	0.064	0.21	0.022	0.52	0.135	0.07	0.014	0.13	0.022	1.63
8	2.42	0.233	0.23	0.028	2.03	0.127	0.25	0.014	0.21	0.028	5.14
9	0.56	0.022	0.42	0.141	0.45	0.149	0.08	0.028	0.15	0.022	1.66
10	0.51	0.099	0.18	0.014	0.48	0.318	0.07	0.022	0.1	0.014	1.34
11	0.31	0.05	0.22	0.064	0.29	0.028	0.05	0.028	0.11	0.022	0.98
12	1.19	1.124	0.79	0.283	0.1	0.05	0.02	0	0.13	0.028	2.23
13	0.73	0.078	0.19	0.014	0.61	0.05	0.07	0.01	0.12	0.022	1.72
14	0.45	0.057	0.17	0.022	0.31	0.042	0.04	0.01	0.1	0.014	1.07
15	0.49	0.022	0.18	0.022	0.47	0.057	0.05	0.01	0.11	0	1.3
16	0.6	0.12	0.24	0.064	0.48	0.014	0.05	0.014	0.12	0.022	1.49
BC	0	0	0.18	0.141	0.12	0.17	0	0	0	0	0.3

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - June 1989

STATION JULY, 1989	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
1	2.32	1.124	1.21	0.127	0.08	0.014	0.08	0.01	0.44	0.022	4.13
2	0.26	0.028	0.17	0.022	0.35	0.141	0.12	0.085	0.13	0.064	1.03
3	0.38	0.283	0.11	0.01	0.35	0.085	0.05	0.028	0.08	0.01	0.97
4	0.3	0.042	0.13	0.01	0.21	0.014	0.05	0.01	0.06	0.022	0.75
5	0.29	0.036	0.11	0.01	0.28	0.099	0.05	0.01	0.05	0.014	0.78
6	0.25	0.022	0.06	0	0.26	0.071	0.04	0.01	0.07	0.022	0.68
7	0.43	0.057	0.11	0.014	0.29	0.022	0.07	0.01	0.08	0.01	0.98
8	45.14	2.291	6.52	0.17	14.64	1.131	5.05	0.233	4.46	0.057	75.81
9	0.25	0.036	0.11	0.05	0.53	0.014	0.1	0.036	0.05	0.01	1.04
10	0.26	0.01	0.1	0.042	0.65	0.325	0.06	0.028	0.06	0.014	1.13
11	0.31	0.156	0.13	0.014	0.29	0.05	0.04	0.014	0.04	0.014	0.81
12	0.27	0.036	0.13	0.028	0.24	0.022	0.03	0	0.05	0.01	0.72
13	0.22	0.022	0.11	0.022	0.4	0.248	0.04	0.014	0.04	0	0.81
14	0.24	0.071	0.08	0.01	0.51	0.163	0.04	0.01	0.03	0.014	0.9
15	0.22	0.022	0.19	0.022	0.3	0.156	0.03	0.01	0.07	0.01	0.81
16	0.18	0.01	0.14	0.042	0.31	0.085	0.03	0	0.05	0	0.71
BC	0	0	0	0	0.18	0.106	0.01	0.01	0.02	0.022	0.21

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - July 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP
AUGUST, 1989											
1	0.89	0.05	0.21	0.014	0.36	0.163	0.07	0.036	0.14	0	1.67
2	1.41	0.679	0.19	0.036	0.94	0.516	0.15	0.092	0.07	0.099	2.76
3	0.81	0.269	0.27	0.12	0.41	0.248	0.08	0.022	0.16	0.028	1.73
4	3.28	3.514	1.25	1.506	0.61	0.488	0.2	0.078	0.35	0.396	5.69
5	1.05	0.17	0.19	0.01	0.56	0.135	0.09	0	0.15	0.022	2.04
6	1.67	1.117	0.96	1.018	0.97	0.693	0.14	0.113	0.1	0.028	3.84
7	1.78	0.212	0.18	0.022	0.71	0.106	0.12	0.014	0.13	0.036	2.92
8	234.7	26.587	17.34	1.683	71.92	7.227	19.88	1.669	11.5	1.117	355.34
9	1.14	0.304	0.2	0.042	0.57	0.417	0.11	0.036	0.13	0.099	2.15
10	1.14	0.629	0.79	0.898	0.18	0.163	0.03	0.022	0.23	0.177	2.37
11	1.83	0.976	1.36	1.64	0.1	0.071	0.02	0.022	0.26	0.297	3.57
12	0.69	0.014	0.16	0.057	0.32	0	0.03	0.014	0.08	0.028	1.28
13	1.1	0.022	0.26	0.028	0.25	0.156	0.04	0.028	0.17	0.127	1.82
14	0.8	0.085	0.3	0.191	0.41	0.057	0.04	0.022	0.09	0.042	1.64
15	0.78	0.078	0.15	0.01	0.35	0.057	0.05	0.014	0.14	0.071	1.47
16	1.01	0.127	0.21	0.01	0.41	0.014	0.04	0	0.13	0.036	1.8
BC	0	0	0.12	0	0	0	0	0	0.24	0.085	0.36

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - August 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP
SEPTEMBER, 1989											
1	0.49	0.135	0.1	0.014	0.07	0.028	0.03	0.01	0.06	0.028	0.75
2	0.27	0.028	0.15	0.078	0.08	0.106	0.02	0.014	0.04	0.014	0.56
3	0.25	0.042	0.08	0.022	0.07	0.057	0.02	0	0.05	0.022	0.47
4	1.13	1.138	0.14	0.071	0.48	0.375	0.12	0.106	0.11	0.036	1.98
5	1.42	1.506	0.2	0.184	0.59	0.53	0.14	0.141	0.13	0.12	2.48
6	0.36	0.05	0.09	0.01	0.06	0	0.03	0	0.07	0.01	0.61
7	2.78	0.424	0.27	0.014	1.02	0.099	0.27	0.022	0.2	0.01	4.54
8	115.27	22.5	16.82	3.543	32.38	5.89	12.66	2.298	9.61	1.937	186.74
9	0.48	0.028	0.12	0.014	0.37	0.184	0.09	0.057	0.08	0.014	1.14
10	0.59	0.219	0.23	0.141	0.04	0.028	0.04	0	0.1	0.028	1
11	0.29	0.057	0.25	0.01	0.02	0.028	0.03	0.01	0.05	0.014	0.64
12	0.33	0.01	0.12	0.01	0.13	0.184	0.03	0.028	0.05	0.014	0.66
13	0.56	0.01	0.13	0.01	0.51	0.036	0.09	0.022	0.06	0.028	1.35
14	0.29	0.014	0.09	0	0.19	0.141	0.03	0.01	0.05	0.022	0.65
15	0.4	0.014	0.1	0.01	0.09	0.071	0.04	0.022	0.04	0.042	0.67
16	0.2	0.014	0.1	0	0.06	0.085	0.02	0.014	0.04	0.022	0.42
BC	0	0	0.08	0	0	0	0	0	0.02	0.028	0.1

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - September 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (ug)
OCTOBER, 1989											
1	0.36	0.057	0.12	0.01	0.26	0.028	0.03	0	0.04	0	0.81
2	0.39	0.014	0.11	0.036	0.51	0.01	0.04	0	0.09	0.036	1.14
3	0.33	0.064	0.14	0.078	0.56	0.233	0.05	0.022	0.04	0	1.12
4	0.29	0.01	0.09	0.01	0.4	0.127	0.04	0.01	0.04	0	0.86
5	0.35	0.028	0.08	0.01	0.49	0.141	0.05	0.014	0.04	0	1.01
6	0.45	0.12	0.08	0	0.24	0.184	0.03	0.028	0.02	0.028	0.82
7	2.76	0.198	0.31	0.01	1.23	0.205	0.28	0.022	0.15	0.014	4.73
8	92.33	3.21	14.23	1.351	27.46	0.509	12.47	0.474	8.55	0.354	155.04
9	0.39	0.014	0.09	0.01	0.71	0.036	0.15	0.057	0	0	1.34
10	0.38	0	0.11	0.014	0.5	0.135	0.05	0.01	0.01	0.014	1.05
11	0.36	0.071	0.11	0.022	0.55	0.163	0.06	0.01	0.09	0.01	1.17
12	0.62	0.509	0.19	0.141	0.51	0.106	0.08	0.01	0.07	0.01	1.47
13	0.51	0.163	0.26	0.078	0.51	0.014	0.08	0.01	0.1	0.01	1.46
14	0.34	0.036	0.19	0.014	0.5	0.262	0.06	0.014	0.08	0.022	1.17
15	0.7	0.573	0.24	0.141	0.6	0.163	0.09	0.042	0.1	0	1.73
16	0.2	0.014	0.09	0.01	0.44	0.042	0.05	0.014	0.09	0.036	0.87
BC	0	0	0.08	0	0.37	0.014	0.02	0	0.12	0	0.59

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - October 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
NOVEMBER, 1989											
1	1.06	0.085	0.38	0.099	0.51	0.347	0.06	0.028	0.15	0.014	2.16
2	1.07	0.078	0.3	0	0.27	0.099	0.06	0.036	0.15	0.028	1.85
3	1.15	0.219	0.32	0.01	0.47	0.106	0.08	0.022	0.14	0	2.16
4	1.18	0.488	0.31	0	0.68	0.354	0.08	0.057	0.17	0	2.42
5	0.75	0.099	0.33	0.212	0.31	0.028	0.03	0.01	0.17	0.042	1.59
6	1.33	0.071	0.48	0.01	0.51	0.156	0.1	0.022	0.15	0.028	2.57
7	12.22	1.817	0.93	0.191	4.64	0.792	1.09	0.191	0.67	0.135	19.55
8	499.39	59.128	36.17	3.917	173.74	13.782	53.59	6.35	27.01	2.772	789.9
9	2.36	0.955	0.32	0.127	2.98	2.312	0.52	0.467	0.21	0.01	6.39
10	0.72	0.028	0.23	0	0.87	0.141	0.1	0.028	0.13	0	2.05
11	0.73	0.184	0.25	0.092	0.26	0.17	0.05	0.042	0.13	0.022	1.42
12	0.54	0.042	0.48	0.01	0.34	0.022	0.04	0	0.1	0.042	1.5
13	1.18	0.962	0.29	0.17	0.41	0.233	0.06	0.028	0.12	0.028	2.06
14	0.76	0.17	0.39	0.12	0.51	0.057	0.05	0	0.1	0.042	1.81
15	0.62	0.022	0.5	0.01	0.53	0.071	0.06	0.01	0.13	0.022	1.84
16	0.78	0.085	0.49	0.01	0.47	0.036	0.09	0.014	0.09	0.028	1.92
BC	0	0	0.08	0	0.33	0.014	0.04	0.022	0.04	0.057	0.49

VALUES ARE IN MILLIGRAMS PER SAMPLER
BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - November 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
DECEMBER, 1989											
1	0.97	0.198	0.2	0	0.95	0.057	0.2	0.113	0.48	0.672	2.8
2	0.94	0.028	0.2	0	0.62	0.085	0.06	0.028	0.3	0.085	2.12
3	1.37	0.269	0.2	0	0.7	0.022	0.06	0.028	0.3	0.085	2.63
4	1.93	0.658	0.28	0	2.09	1.174	0.29	0.233	0.75	0.778	5.34
5	2.54	0.255	0.32	0.064	1.21	0.014	0.18	0.036	0.28	0.064	4.53
6	4.23	0.092	0.4	0.05	2.45	0.587	0.54	0.191	0.73	0.424	8.35
7	17.7	2.022	1.05	0.248	7.44	0.799	1.61	0.212	2.34	0.622	30.14
8	514	1.414	22.43	0.813	199.63	6.541	50.89	1.259	50.88	1.945	837.83
9	2.06	0.028	0.28	0	1.57	0.233	0.26	0.078	0.3	0.135	4.47
10	1.84	1.202	0.16	0.01	2.2	2.029	0.2	0.17	0.23	0.156	4.63
11	0.94	0.424	0.16	0	1.54	1.16	0.3	0.311	0.18	0.085	3.12
12	1.26	0.255	0.2	0	0.67	0.269	0.08	0.057	0.3	0.036	2.51
13	0.66	0.099	0.24	0.057	0.31	0.092	0.01	0.014	0.23	0.092	1.45
14	1.14	0.262	0.27	0	0.54	0.01	0.04	0	0.35	0.163	2.34
15	0.74	0.022	0.42	0.191	0.38	0.028	0.02	0.01	0.4	0	1.96
16	0.74	0.248	0.18	0.141	0.32	0.057	0.01	0.014	0.22	0.198	1.47
BC	0	0	0.1	0.141	0.14	0.036	0	0	0.16	0.05	0.4

VALUES ARE IN MILLIGRAMS

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - December 1989

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
JANUARY, 1990											
1	1.01	0.248	0.15	0	0.35	0.283	0.03	0.014	0.19	0.149	1.73
2	0.95	0	0.15	0	0.22	0	0.03	0	0.08	0.106	1.43
3	2.45	1.768	0.15	0	1.62	1.803	0.14	0.113	0.26	0	4.62
4	2.12	0.509	0.19	0	1.45	1.301	0.18	0.099	0.19	0.106	4.13
5	2.78	0.014	0.19	0	1.04	0.036	0.23	0.01	0.33	0.022	4.57
6	5.73	0.042	0.35	0.01	2.32	0.064	0.49	0.01	0.52	0.036	9.41
7	20.48	0.276	0.84	0	8.41	0.01	1.86	0.022	1.75	0.036	33.34
8	1127.5	0	44	0	511.5	0	121	0	107.25	0	1911.25
NO 8A SAMPLE AVAILABLE--DOES NOT REPRESENT AN AVERAGED VALUE											
9	3.3	0.113	0.21	0.028	1.26	0.135	0.29	0.022	0.3	0.057	5.36
10	1.27	0.022	0.37	0.318	0.47	0.028	0.07	0	0.23	0.022	2.41
11	0.86	0.014	0.15	0	0.23	0.05	0.04	0.01	0.23	0.05	1.51
12	1.26	0.82	0.16	0.028	0.72	0.608	0.06	0.064	0.31	0.022	2.51
13	0.56	0.01	0.13	0.028	0.23	0.05	0.01	0.01	0.22	0.057	1.15
14	1.34	1.054	0.17	0.022	0.42	0.495	0.07	0.099	0.33	0.099	2.33
15	0.86	0.382	0.15	0	0.81	0.46	0.06	0.057	0.26	0	2.14
16	0.61	0.106	0.13	0.028	0.3	0.212	0.02	0.022	0.27	0.05	1.33
BC	0	0	0	0	0.11	0.127	0	0	0.24	0.057	0.35

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - January 1990

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (mg)
FEBRUARY, 1990											
1	0.53	0.099	0.24	0.036	0.39	0.106	0.05	0.014	0.19	0.057	1.4
2	0.68	0.141	0.31	0.014	0.48	0.092	0.06	0.01	0.28	0.028	1.81
3	0.54	0.057	0.27	0.022	0.38	0.092	0.05	0.01	0.24	0.064	1.48
4	0.74	0.17	0.27	0.01	0.56	0.177	0.08	0.014	0.32	0.022	1.97
5	0.65	0.106	0.26	0.014	0.45	0.078	0.06	0.014	0.31	0.036	1.73
6	0.69	0.092	0.27	0.014	0.51	0.028	0.06	0.01	0.05	0.071	1.58
7	1.12	0.036	0.29	0.01	0.75	0.078	0.1	0.014	0.17	0.078	2.43
8	637.75	68.801	36.12	2.432	232.82	14.856	70.31	7.601	80.76	9.001	1057.76
9	0.9	0.092	0.24	0.028	1	0.092	0.15	0.042	0.13	0.042	2.42
10	0.7	0.226	0.22	0	0.61	0.042	0.06	0.01	0.08	0.028	1.67
11	0.44	0.099	0.2	0.078	0.38	0.01	0.05	0.01	0.23	0.036	1.3
12	0.47	0.022	0.22	0.036	0.44	0.022	0.05	0	0.22	0.01	1.4
13	0.56	0.078	0.17	0.057	0.93	0.028	0.09	0.01	0.15	0.085	1.9
14	0.54	0.042	0.22	0.036	0.54	0.042	0.06	0.022	0.17	0.057	1.53
15	0.41	0.042	0.15	0.022	1.2	0.036	0.07	0.01	0.22	0.042	2.05
16	0.66	0.502	0.15	0.022	0.61	0.297	0.06	0.042	0.19	0.022	1.67
BC	0	0	0	0	0.14	0.028	0.01	0	0.2	0	0.35

VALUES ARE IN MILLIGRAMS PER SAMPLER
BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - February 1990

STATION	AVE SO4	STD DEV	AVE Cl	STD DEV	AVE Ca	STD DEV	AVE Mg	STD DEV	AVE Na	STD DEV	BULK DEP (ug)
MARCH, 1990											
1	0.66	0.036	0.11	0.022	0.36	0.106	0.03	0	0.22	0.042	1.38
2	0.91	0.354	0.13	0	0.72	0.622	0.1	0.078	0.18	0.064	2.04
3	0.64	0.028	0.1	0.01	0.61	0.24	0.08	0.036	0.13	0	1.56
4	0.66	0.028	0.13	0	0.7	0.219	0.06	0.014	0.16	0.042	1.71
5	0.7	0.057	0.11	0.028	0.64	0.191	0.06	0.01	0.18	0.022	1.69
6	1.56	0.064	0.13	0	0.86	0.057	0.14	0.01	0.22	0	2.91
7	8.09	0.474	0.52	0	3.87	0.269	0.9	0.071	1.14	0.071	14.52
8	197.25	12.092	10.67	0.438	98.31	4.554	26.59	0.764	33.44	0.976	366.26
9	0.79	0.05	0.12	0.022	0.62	0.042	0.09	0.022	0.17	0.05	1.79
10	0.58	0.12	0.12	0.022	0.61	0.022	0.05	0.014	0.18	0.028	1.54
11	0.49	0.036	0.1	0	0.4	0.127	0.04	0.01	0.09	0.022	1.12
12	0.47	0.028	0.13	0	0.37	0.113	0.04	0.01	0.16	0	1.17
13	0.58	0.078	0.12	0.022	0.73	0.191	0.07	0.014	0.18	0.071	1.68
14	0.5	0.099	0.12	0.022	0.58	0.339	0.05	0	0.15	0.071	1.4
15	0.5	0.05	0.21	0.106	0.43	0.092	0.03	0.014	0.19	0.028	1.36
16	0.65	0.212	0.16	0.085	1.21	0.863	0.11	0.092	0.15	0.022	2.28
BC	0	0	0	0	0.18	0.198	0.01	0.01	0.22	0.028	0.41

VALUES ARE IN MILLIGRAMS PER SAMPLER

BC = BUILDING CONTROL SAMPLERS

Analytical Results for Each Sample Location - March 1990