Rio Blanco Oil Shale Project

PROGRESS REPORT 3 - SUMMARY

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United States Department of the Interior

GEOLOGICAL SURVEY

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July 29, 1975

The attached report is the third of a planned series of reports from the Federal Oil Shale Lessees to the Area Oil Shale Supervisor describing progress under approved exploration and baseline data plans.

The purpose of these reports is to provide interested parties with a review of ongoing operations and a summary of the data being collected. Because of the sheer volume of data being generated, these reports should be considered as the first (overview) phase of planned data distribution. Parties interested in reviewing more detailed data on specific portions of the program should contact the Area Oil Shale Office in Grand Junction where such data will be kept on file.

We would appreciate receiving any comments or suggestions you may have concerning these reports.

PROGRESS REPORT 3 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

July 31, 1975

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

The Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana) , hereafter referred to in this report as RBOSP, is presenting its third summary progress report for Tract C-a to the U.S.G.S Area Oil Shale Supervisor (AOSS). This report is a summary of the work accomplished from the period of March 1, 1975, through May 31, 1975. The data collected from the Geotechnical Data Gathering Project and the Environmental Baseline Data Gathering Project for this period are on file in the AOSS office in Grand Junction, Colorado. These data comprise Progress Report-3. This summary report presents an overview and highlights of these data and has been correlated to and organized consistent with Progress Report-3.

It should be noted that results of data taken but not available in time for this progress report will be included in the following progress report(s).

In Progress Report 2 - Summary, RBOSP stated that it was their desire to keep the AOSS informed of its plans and position during the course of developing information for the Detailed Development Plan (DDP). Although not required, that progress report summary included an appendix giving a complete overview of the project. In keeping with this policy, the appendix section of Progress Report 3 - Summary gives an update of the areas being studied for the DDP. This includes discussions of the major alternatives being considered in the areas of mining and processing.

Figure 1 is a location map of Tract C-a. The map includes major drainages, roads, towns and counties in the vicinity of the tract. Figure 2 shows Tract C-a in greater detail and generally locates the drill holes, stream gaging stations, air quality towers and roads.

United States Department of the Interior
OFFICE OF THE SECRETARY
MISSOURI BASIN REGION
DENVER, COLORADO 80225

Oil Shale
Environmental Advisory Panel
Room 690, Building 67
Denver Federal Center
August 8, 1975

Memorandum

To: Members of the Oil Shale Environmental Advisory Panel

From: Executive Director

Subject: Enclosed Quarterly Report and Additional Information on Rangely Meeting

Enclosed is Rio Blanco Oil Shale Project's Progress Report 3 for review in advance of the Rangely meeting.

With apologies to the Rio Blanco organization, we want to correct an error in the August 1 memorandum. At the top of page two the tract to be visited was erroneously identified as C-b rather than the C-a tract.

On Wednesday evening, August 27, a representative of the Rio Grande Railroad will make a presentation on rail transportation of oil. This is planned for the College cafeteria after dinner.

On the August 28 tour we will drive on to 84 Mesa on the way into the C-a tract in order to view that proposed off tract plant and disposal site.

It is essential that you advise Elanor as to arrival and accommodations needed as we have requests from a number of non-panel members for space at the dorm and it is limited to 40 beds.

Accommodations at the College dorm will be $4 per person this year and should be paid to the Executive Director before you depart on Thursday.

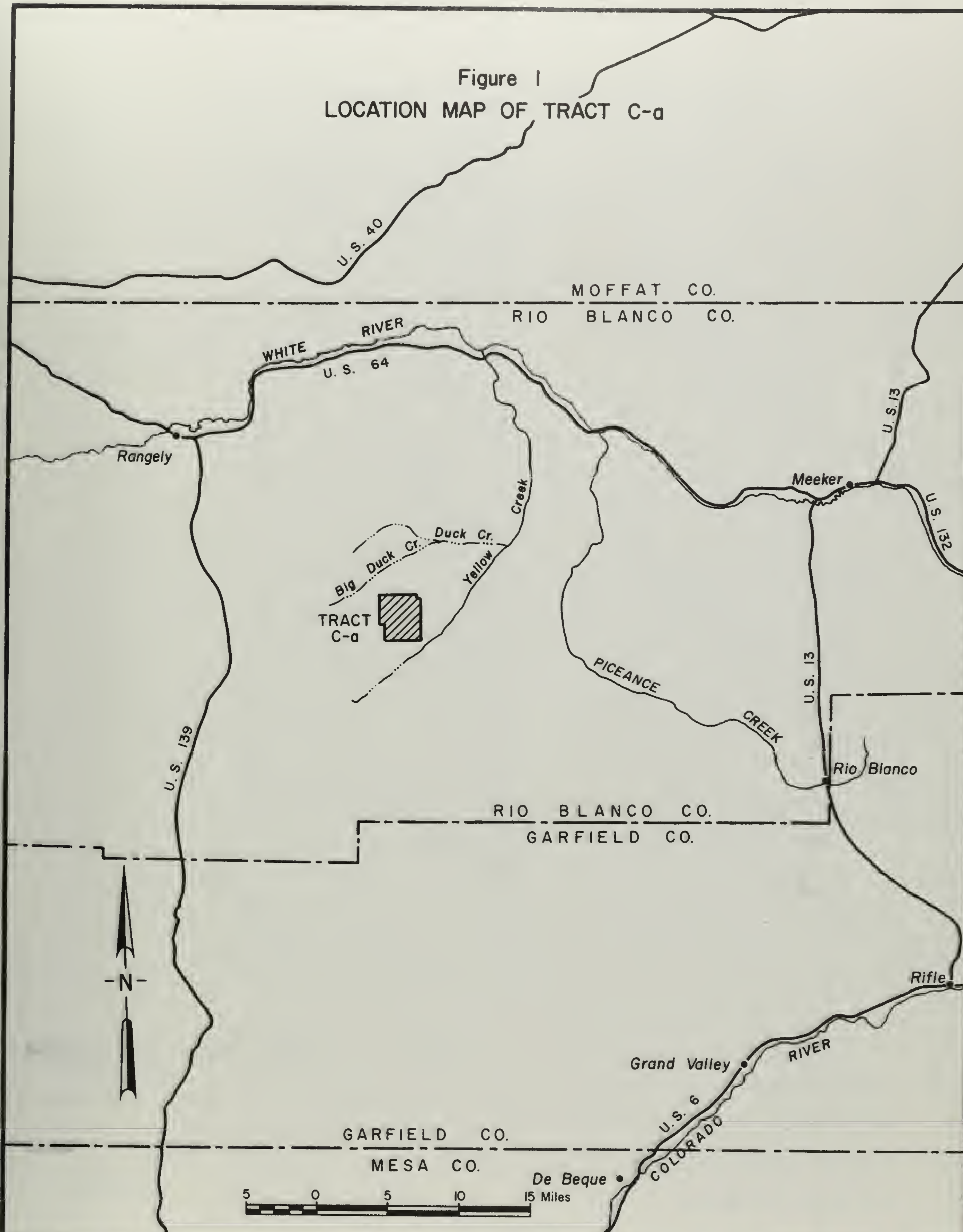
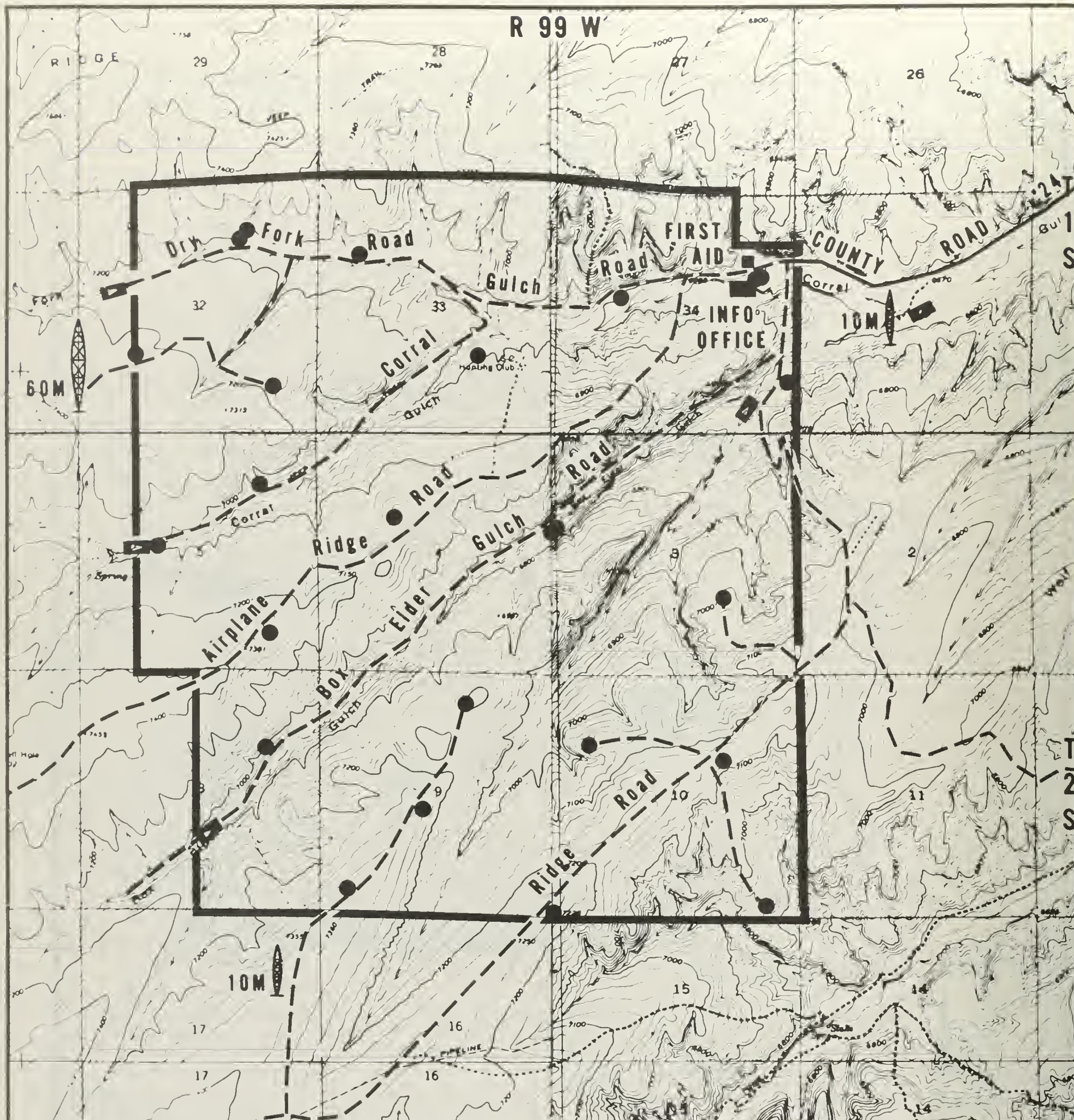


Figure 1
LOCATION MAP OF TRACT C-a
U.S. 40
MOFFAT CO.
RIO BLANCO CO.
WHITE RIVER
U.S. 64
Rangely
U.S. 13
Meeker
U.S. 132
Creek
Duck Cr.
Big Duck Cr.
Yellow
TRACT C-a
PICEANCE CREEK
U.S. 13
Rio Blanco
U.S. 139
RIO BLANCO CO.
GARFIELD CO.
N
Rifle
RIVER
Grand Valley
U.S. 6
COLORADO
GARFIELD CO.
MESA CO.
De Beque
5 0 5 10 15 Miles



LEGEND

TRACT OUTLINE

DRILL HOLES

STREAM GAGING STATIONS

AIR QUALITY TOWERS

ROADS

GULF - STANDARD (INDIANA)

RIO BLANCO OIL SHALE PROJECT

TRACT C-a

RIO BLANCO COUNTY, COLORADO

0 3000

Figure 2

Geotechnical Data Gathering Project

1.0 GEOTECHNICAL DATA GATHERING PROJECT

The geotechnical data required for the Detailed Development Plan are being acquired through the Geotechnical Data Gathering Project. RBOSP Progress Report 2 - Summary describes the project. Figure 1.0-1 from that summary is included here and illustrates the project breakdown of the Geologic and the Hydrologic Programs. Each of these programs was conducted by various contractors under the supervision of Rio Blanco.

1.1 Geologic Program

Data concerning resource parameters which will affect the design of an oil shale mine on Tract C-a are being compiled and correlated under the Geologic Program. Figure 1.1-1, a functional flow diagram, is presented as a review of the logic of the nine tasks which make up the program. These major tasks were essentially completed prior to the third quarterly reporting period. Status of much of the Geologic Program during the reporting period was that of correlating, interpreting, updating and revising data for input to the engineering studies. The status of each of the nine tasks and related sub-tasks are summarized in the following sections.

1.1.1 Corehole Program

The corehole program was described in section 1.1.1 of RBOSP Progress Report 2 - Summary. Figure 1.1-2 is a map of Tract C-a showing the pre-lease coreholes as well as the location of Gulf-Standard (Indiana) coreholes drilled during the summer and fall of 1974.

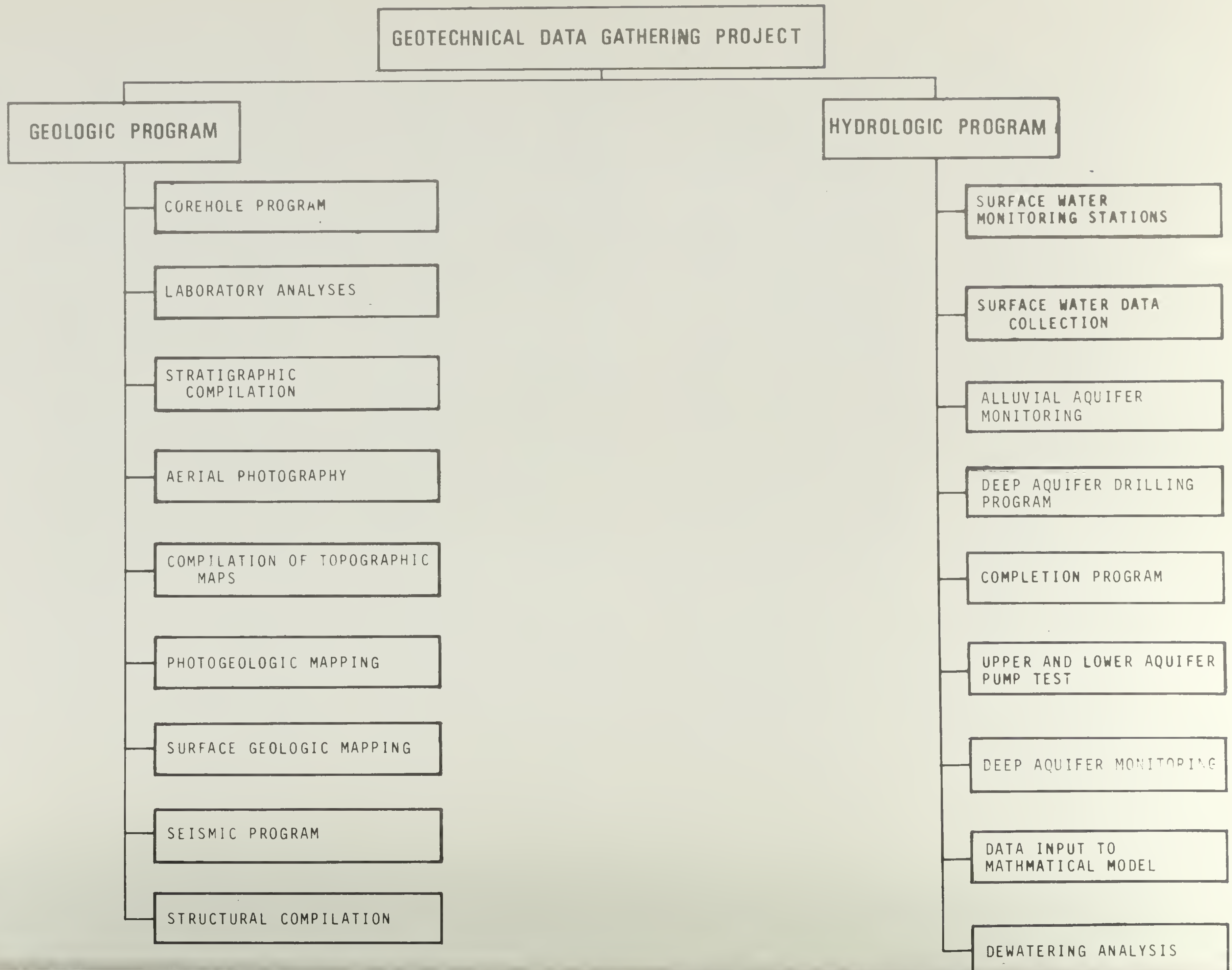
1.1.2 Laboratory Analyses

Oil shale samples from the core drilling program have been used for a variety of laboratory analyses. Most of the sample analysis programs have been completed, although in a few cases, review of data has indicated a need for confirmation testing.

1.1.2.1 Oil Shale Assays

Modified Fischer assays of the oil shale core have been completed and reported (in Section 1.1.2.1, RBOSP Progress Report 2) except for the entire core from GS-13, as well as short core intervals that have been withheld for rock mechanics tests as described in section 1.1.2.1 of RBOSP Progress Report 2 - Summary. The entire core from GS-13 is being withheld from assay in order to preserve samples which may, in the near future, be desired for additional rock mechanics or other lab testing. When rock mechanics tests have been completed on the short intervals,they will then be assayed and reported. When it has been determined that all lab tests have been satisfactorily completed, the oil shale core from GS-13 will be assayed by the modified Fischer method and the results reported to the Area Oil Shale Supervisor.

Figure 1.0 - 1


GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
STRUCTURAL COMPILATION
HYDROLOGIC PROGRAM
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DATA INPUT TO MATHMATICAL MODEL
DEWATERING ANALYSIS

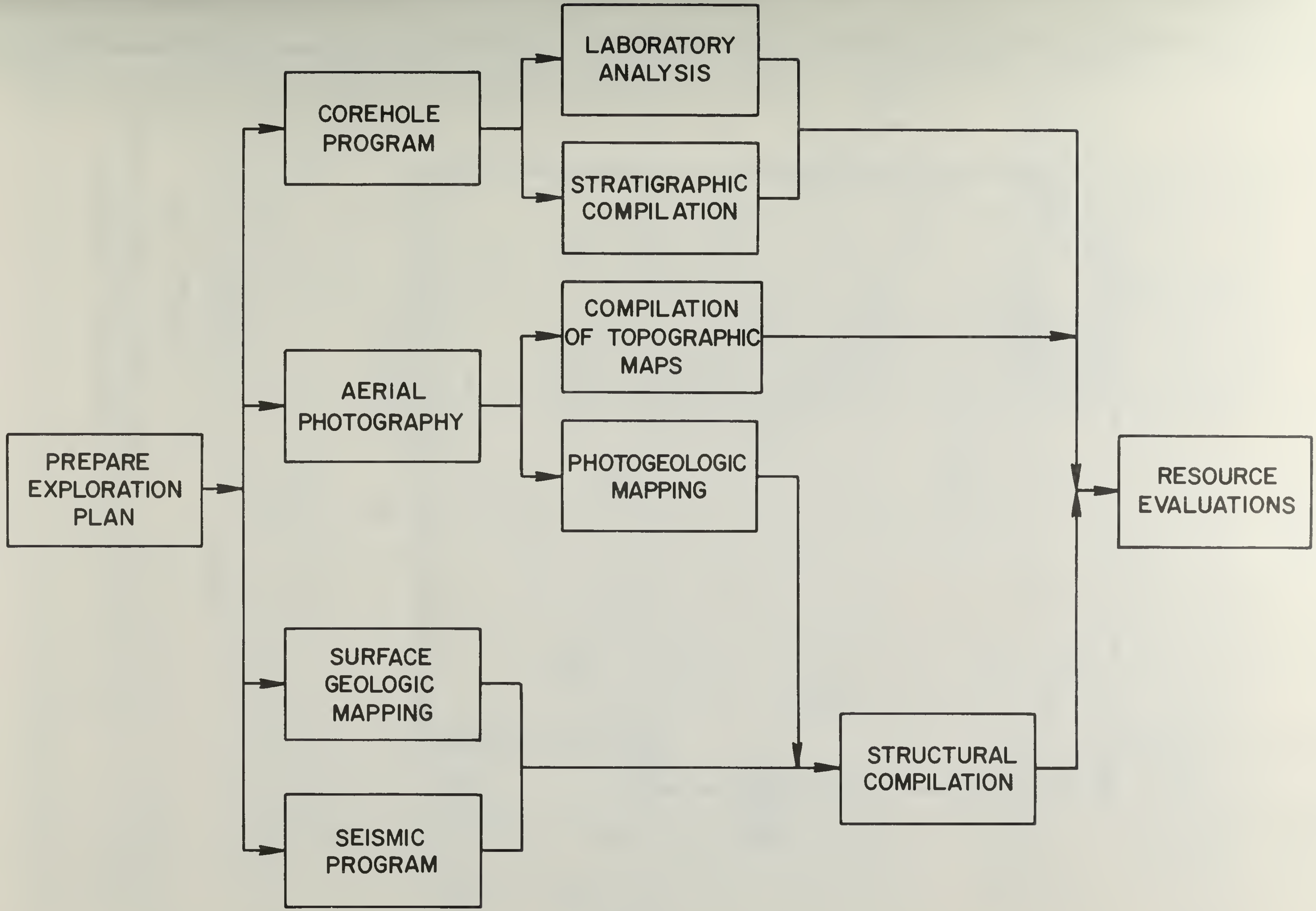
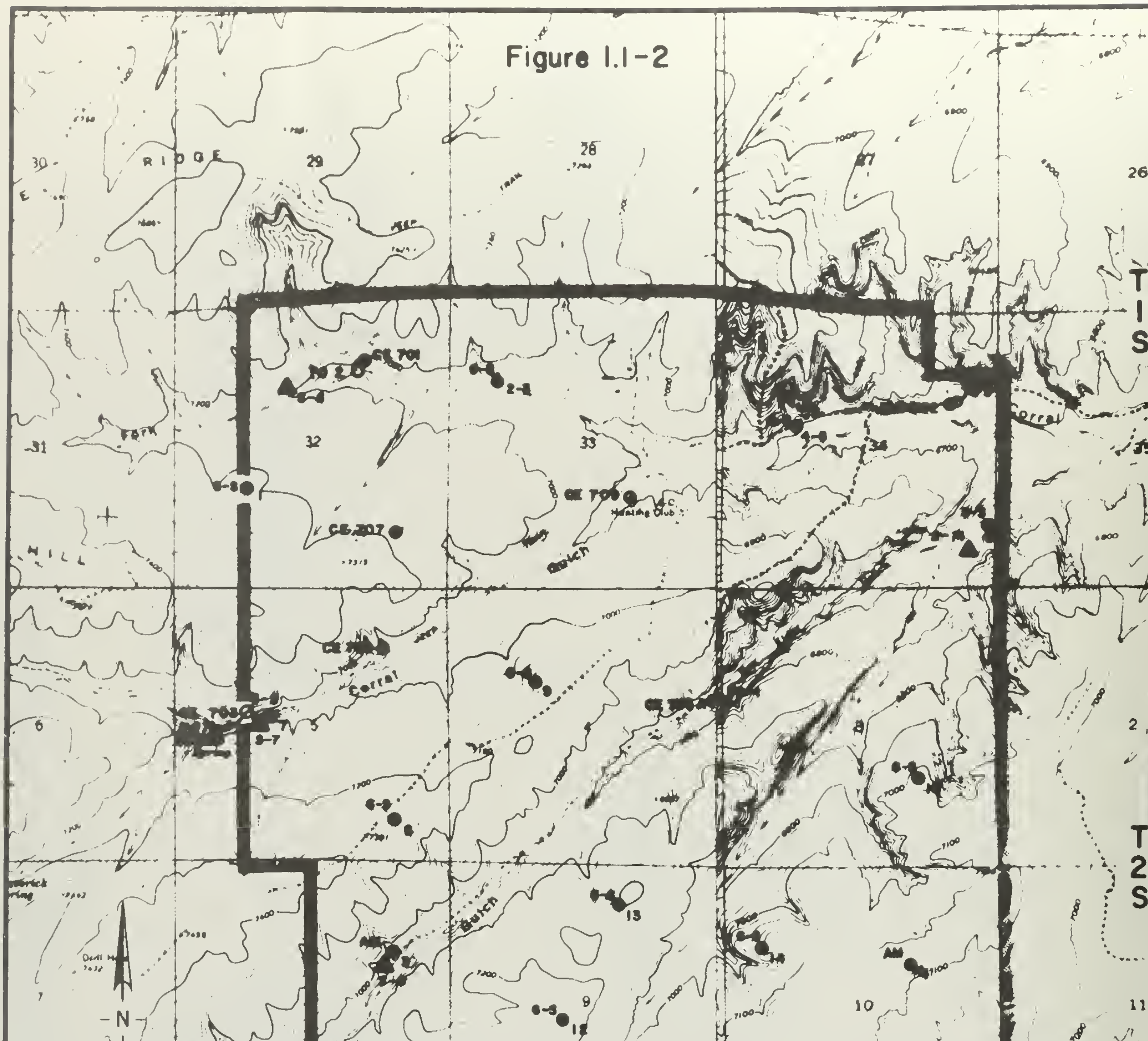


Figure 1.1-1

GEOLOGIC PROGRAM FUNCTIONAL FLOW DIAGRAM

Figure 1.1-2



GULF-STANDARD (INDIANA)

TRACT C-a

RIO BLANCO OIL SHALE PROJECT

COREHOLE PROGRAM

1.1.2.2 Nahcolite Analyses

Results of the nahcolite analyses were reported to the Area Oil Shale Supervisor as described in section 1.1.2 of RBOSP Progress Report 2 - Summary. The rare occurrence and low concentration of nahcolite under Tract C-a does not represent a potentially recoverable resource.

1.1.2.3 Extractable Alumina

Analyses for extractable alumina in spent shale from the oil shale assay have been completed and submitted to the Area Oil Shale Supervisor as reported in section 1.1.2.3 of RBOSP Progress Report 2 - Summary. Studies have been initiated to determine the commercial potential of alumina extraction from Tract C-a oil shale.

1.1.2.4 Trace Element Analyses

The analyses of seven trace elements in fresh and spent oil shale samples were reported in section 1.1.2.4 of RBOSP Progress Report 2 - Summary. The oil shale lease requires the identification of the mineral occurrences of the seven trace elements. The Colorado School of Mines, in conjunction with Core Laboratories, Inc. conducted the mineral identification and qualitative analyses for the occurrence of seven trace elements (cadmium, antimony, arsenic, mercury, selenium, fluide ion, and boron) by x-ray diffraction techniques. The qualitative analyses for each of the seven trace elements indicated that each of the elements occur in the eight common mineral constituents of oil shale (quartz, dolomite, calcite, analcime, andesine, illite, dawsonite, and pyrite). The results of the identification are submitted to the Area Oil Shale Supervisor as a part of the RBOSP Progress Report 3.

1.1.2.5 Gas Samples

Core Laboratories analyzed the gas samples obtained through the corehole program as explained in section 1.1.2.5 of RBOSP Progress Report 2 - Summary. The results of the analyses have been submitted to the Area Oil Shale Supervisor.

1.1.2.6 Rock Mechanics

Rock mechanics tests continued through the reporting period. A description of the rock mechancis testing program was presented in the RBOSP Progress Report 2 - Summary. It is anticipated that results from rock mechanics testing will be reported in Progress Report 4.

1.1.3 Stratigraphic Compilation

The stratigraphic characteristics of the oil shale formation as it is now interpreted by Rio Blanco was reported to the Area Oil Shale

Supervisor in RBOSP Progress Report 2, section 1.1.3. A report titled "Summary Report Post-Drilling Geologic Studies C-a Tract" by Amuedo and Ivey, Consulting Geologists, describing the basic criteria used in the construction of the correlation network was submitted to the Area Oil Shale Supervisor in section 1.1.3 of RBOSP Progress Report 3.

1.1.4 Aerial Photography

The aerial photography is completed as reported in RBOSP Progress Report 2 - Summary, section 1.1.4.

1.1.5 Compilation of Topographic Maps

Topographic maps of Tract C-a have been revised by adding new roads into corehole locations to the map. The revisions (both scales: 1"=500' and 1"=200') are submitted to the Area Oil Shale Supervisor (under separate cover) in section 1.1.5 of Progress Report 3.

1.1.6 Photogeologic Mapping

The photogeologic mapping was completed as reported to the Area Oil Shale Supervisor in section 1.1.6 of RBOSP Progress Report 2 - Summary.

1.1.7 Surface Geologic Mapping

Surface geologic mapping of about ten square miles has been completed as described and reported in section 1.1.7 of RBOSP Progress Report 2-Summary.

1.1.8 Seismic Program

The seismic program was discontinued because of its inability to detect a mappable reflection surface. A seismic report by Petroleum Geophysical, Inc., the contractor, has been submitted to the Area Oil Shale Supervisor in section 1.1.8 of Progress Report 2.

1.1.9 Structural Compilation

The structural compilation was reported in section 1.1.9 of RBOSP Progress Report 2. In the event that future studies modify the structure as it is presently accepted, then revisions will be made and reported. The middle A-groove structure map, submitted in section 1.1.9 of RBOSP Progress Report 2, is a compilation of photogeologic, surface geologic and subsurface corehole control.

1.2 Hydrologic Program

Rio Blanco Oil Shale Project is conducting a surface and sub-surface Hydrologic Program designed to establish baseline hydrologic data as well as to supply the data required to design mine dewatering. The Hydrologic Program is divided into nine tasks, the logic of which is shown in Figure 1.2-1. RBOSP Progress Report 2 presented the hydrologic data obtained during the corehole drilling program. This progress report will present data from the hydrologic monitoring as well as the pumping test programs. Interpretation of the pumping test data will be reported in RBOSP Progress Report 4.

RBOSP Progress Report 3 submits the data generated from the Hydrologic Program to the Area Oil Shale Supervisor in two parts. Those parts are: 1) Interpretive Text, and 2) Raw Data. The Interpretive Text contains interpretation and explanation of the hydrologic data while the Raw Data portion contains computer printouts of the raw field data. The raw field data was digitized for ease of storage and recall and to provide input to various computer programs. The computer printouts have been reduced in size to aid in handling.

The status of each of the nine tasks is summarized in the following sections.

1.2.1 Surface Water Monitoring Stations

RBOSP Progress Report 2 - Summary described the surface water monitoring program. Figure 1.2-2 is a map showing the location of the surface monitoring stations and alluvial aquifer monitoring test wells. Table 1.2-1 has been revised and lists the location of surface water monitoring stations and the U. S. Geological Survey identification number. The rain gaging stations are also listed in Table 1.2-1 and are shown on Figure 1.2-2.

1.2.2 Surface Water Data Collection

The surface water data collection was described in RBOSP Progress Report 2 - Summary. Table 1.2-2 has been revised and is a review of the data collected and the schedule of collection. The Water Resources Division of the U. S. Geological Survey processes the hydrological data from the stream gaging stations. This data is being submitted to the Area Oil Shale Supervisor in section 1.2.2 of RBOSP Progress Report 3 - Raw Data. Only three stream gaging stations recorded any discharge during the period beginning the first of March, 1975, and ending May 28, 1975, (the last date for data processed on July 2, 1975). The three gaging stations are: Corral Gulch near the west line of Tract C-a, Corral Gulch east of Tract C-a, and Yellow Creek near White River. Summaries of water quality analyses of samples from the three gaging stations recording surface flow are presented in Tables 1.2-3 through 1.2-5 for the period March 1, 1975, through May 28, 1975. The Water Resources Diviision of the U. S. Geological Survey has provided only preliminary data sheets from the continuous monitoring of surface flow, temperature

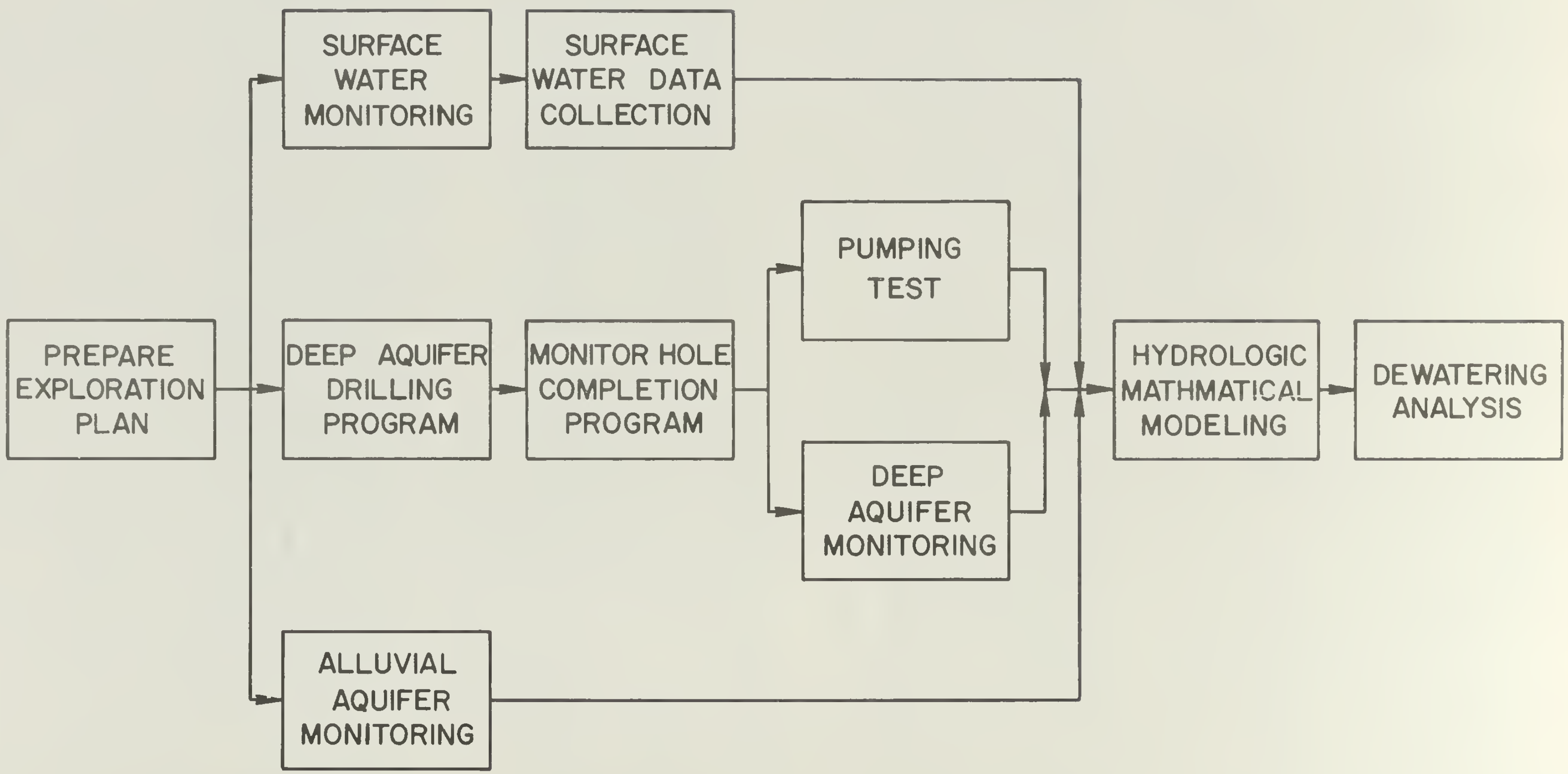


Figure 1.2-1
HYDROLOGIC PROGRAM FUNCTIONAL FLOW DIAGRAM
RBOSP

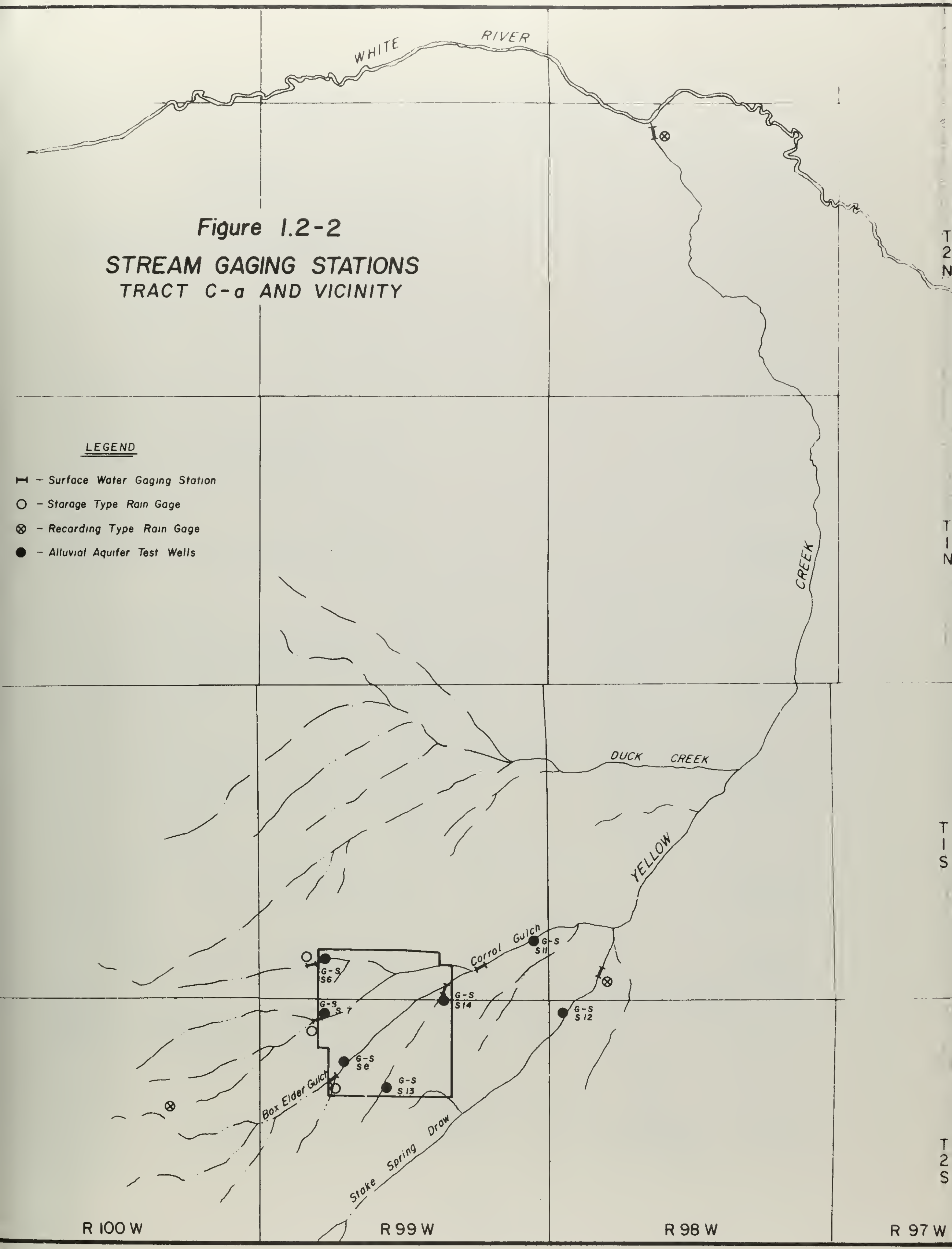


Figure 1.2-2
STREAM GAGING STATIONS
TRACT C-a AND VICINITY
LEGEND
– Surface Water Gaging Station
– Storage Type Rain Gage
– Recording Type Rain Gage
– Alluvial Aquifer Test Wells
WHITE RIVER
CREEK
DUCK CREEK
YELLOW
Corral Gulch
Box Elder Gulch
Stake Spring Draw
G-S S6
G-S S7
G-S S8
G-S S13
G-S S14
G-S S11
G-S S12
T2N
T1N
T1S
T2S
R 100 W
R 99 W
R 98 W
R 97 W

Table 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS
FOR SURFACE AND RAIN GAGING STATIONS
TRACT C-a AND VICINITY

USGS Identification number	Location
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306200	Stake Springs Draw near confluence with Corral Gulch
09306255*	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
	Rain Storage-Type Gages
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	Recording Rain Gage
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW-1/4, NW-1/4, Sec. 14, R100W T2S, R100W

* U.S.G.S. Identification No. 09306250 corrected to 09306255

Table 1.2-2

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

TRACT C-a AND VICINITY

<u>Continuously or Automatically</u>

Flow Rate
Sediment Discharge
Temperature
Specific Conductance

<u>Periodically</u>

Storage Rain Gages
Recording Rain Gages

<u>Semi-Monthly</u>

Water Samples Analyzed For

Barium	Sulfate	Turbidity
Boron	Zinc	Dissolved Oxygen
Calcium	Ammonia	pH
Chromium (Hexavalent)	Bicarbonate	Arsenic
Copper	Carbonate	Cadmium
Fluoride	Chloride	Lead
Iron	Color	Manganese
Lithium	Dissolved Solids	Mercury
Magnesium	Kjeldahl Nitrogen	Total Phosphate
Potassium	Nitrate	Ortho Phosphate
Selenium	Nitrite	Cyanide
Silica	Odor	Sulfide
Sodium	Oil and Grease	

<u>Quarterly</u>

Sample and Analyze

COD	Radioactivity	Spectrographic Scan
Fecal Coliform	Gross Alpha	67 Elements
Pesticides	4 Picocuries/l	TOC
Polycyclic Aromatics	Ra^{226}	10 mg/l
	Gross Beta	DOC
	100 Picocuries/l	SOC
	Th^{230}	Phenols
	Uranium	Sulfur
		Nitrogen

SUMMARY WATER ANALYSES

STREAM GAGING STATION, U.S.G.S. 09306235

CORRAL GULCH NEAR WEST LINE TRACT C-a

		3/12/75	3/16/75	4/9/75 1400	5/14/75 1045								
1	Alkalinity (mg/l)			324	291								
	Aluminum (ug/l)			---	---								
	Ammonia (mg/l)			.12	.04								
	Aromatics, Polycyclic			---	---								
	Arsenic (ug/l)			4	4								
	Barium (ug/l)			100	100								
	Beryllium (ug/l)			---	---								
	Bicarbonate (mg/l)			395	355								
	Bismuth (ug/l)			---	---								
	Boron (ug/l)			90	90								
	Cadmium (ug/l)			0	0								
	Carbonate (mg/l)			0	0								
	Carbon Dioxide (mg/l)			2.0	11								
	Chloride (mg/l)			7.8	8.9								
	Chromium (ug/l)			0	0								
	Cobalt (ug/l)												
	COD												
	Coliform, Total & Fecal												
	Color (PVC)			9	10								
	Conductivity, Specific			1080	1100								
	Copper (ug/l)			8	2								
	Cyanide (mg/l)			100	.01								
	Discharge (CFS)												
4	Discharge, Instantaneous			04	.02								
5	Dissolved Oxygen (mg/l)			--	8.7								
26.	Fluoride (mg/l)			.2	.2								
27.	Gallium (ug/l)												
	Germanium (ug/l)												
9.	Hardness (Ca, Mg) (mg/l)			460	420								
30.	Hardness, Non-Carbonate (mg/l)			140	130								
31.	Iron (ug/l)			50	20								
32	Kjeldahl Nitrogen (mg/l)			4.2	.30								
33.	Lead (ug/l)			0	1								
34.	Lithium (ug/l)			20	20								
35	Magnesium (mg/l)			60	56								
36.	Manganese (ug/l)			0	0								
	Mercury (ug/l)			1.0	.00								
	Molybdenum (ug/l)			---	---								
	Nickel (ug/l)			---	---								
40	Nitrate (mg/l)			4.3	2.2								
41.	Nitrite (mg/l)			.00	.00								
4.	Nitrite Plus Nitrate (mg/l)			.98	.50								
43	Nitrogen, Ammonia			.09	.03								
44	Odor (Severity)			1	0								
45.	Oil & Grease (mg/l)			3	0								
46	Ortho-Phosphate (mg/l)			.06	.06								
47	Ortho-Phosphorus (mg/l)			.02	.02								
48.	Pesticides												
	pH			8.5	7.7								
	Phosphorus, Total (mg/l)			1.3	.03								
	Potassium (mg/l)			1.6	1.5								
	Selenium (ug/l)			4	4								
	Silica (mg/l)			19	18								
54	Silver (ug/l)			---									
55.	Sodium (mg/l)			86	91								
56	Sodium Adsorption Ratio			1.7	1.9								
57	Sodium (%)			29	32								
58.	Solids, Dissolved (mg/l)			729	719								
59.	Solids, Dissolved T/D			.08	.04								
60.	Solids, Dissolved T/Ac-Ft			.99	.98								
61.	Solids, Suspended												
62.	Strontium (ug/l)			---	---								
63	Sulfate (mg/l)			2.70	290								
64.	Sulfide (mg/l)			.2	.0								
65.	Temperature (°C)			2.0	20.0								
66	Tin (ug/l)			---	---								
67	Titanium (ug/l)			---	---								
68	Turbidity (JTU)			450	18								
69	Vanadium (ug/l)			---	---								
70	Zinc (ug/l)			20	10								
71	Zirconium (ug/l)			---	---								
	Calcium (mg/l)			85	76								
	Complete Element Span												
74	Radioactivity												
	Gross Alpha (pci)												
	Radium 226*												
	Gross Beta												
	Thorium 230**												
	Uranium**												
	Total Organic Carbon (mg/l)			---	---								
	If TOC 10 mg/liter, then												
	Nitrogen (Base Extraction)												
	Organic Carbon, Dissolved												
	Organic Carbon, Suspended												
	Phenols												
	Sulfur (Acid Extraction)												
76	Ortho-Phosphorous			.45	.04								
	Phosphate			---	.09								

Table 1.2-4

SUMMARY WATER ANALYSES RBOSP
STREAM GAGING STATION U.S.G.S 09306255
YELLOW CREEK NEAR WHITE RIVER

	Date	3/12/75	3/26/75	4/9/75	4/9/75	4/[illegible]/75	5/15/75
	Time	1400	1030	[illegible]	1300	1000	1100
	Alkalinity (mg/l)	1330	1330	[illegible]	1580	[illegible]	1380
	Aluminum (ug/l)	150	--		---		--
	Ammonia (mg/l)	.00	.22	.24	.30	.0[illegible]	.08
	Aromatics, Polycyclic						
	Arsenic (ug/l)	5	3	1	5	6	[illegible]
	Barium (ug/l)	200	100	100	300	0	[illegible]
	Beryllium (ug/l)	< 4			---	--	
	Bicarbonate (mg/l)	1620	1210	1480	930	1490	1510
	Bismuth (ug/l)	<15	---	---	---	--	
	Boron (ug/l)	560	630	680	700	630	640
	Cadmium (ug/l)	<170	0	0	0	1	2
	Carbonate (mg/l)	0	203	97	0	1	87
13.	Carbon Dioxide (mg/l)	10	5.2	4.3	6.2	3.8	5.4
14	Chloride (mg/l)	130	110	130	130	120	120
15.	Chromium (ug/l)	<15	0	0	0	0	0
16.	Cobalt (ug/l)	<15	---	---	---	---	---
17.	COD	7	---	---	---	---	---
	Coliform, Total & Fecal						
	Color (PVC)	3	10	3	2	4	3
20.	Conductivity, Specific	3500	3600	3250	3400	3500	3000
21	Copper (ug/l)	5	0	3	1	7	3
22.	Cyanide (mg/l)	.00	.00	---	.00	.00	.00
23.	Discharge (CFS)	---	---	---	---	---	---
24.	Discharge, Instantaneous	2.9	2.2	1.2	3.3	1.9	1.7
25	Dissolved Oxygen (mg/l)	8.5	10.6	10.4	9.1	9.6	7.6
26.	Fluoride (mg/l)	2.0	1.9	1.2	1.6	2.1	2.1
27.	Gallium (ug/l)	<5	---	---	---	---	---
28.	Germanium (ug/l)	<20	---	---	---	---	---
29.	Hardness (Ca, Mg) (mg/l)	550	650	500	590	550	570
30.	Hardness, Non-Carbonate (mg/l)	0	0	0	0	0	0
31.	Iron (ug/l)	65	20	10	10	30	40
32.	Kjeldahl Nitrogen (mg/l)	.17	.71	---	2.6	.60	.30
33.	Lead (ug/l)	<16	0	0	0	9	4
34.	Lithium (ug/l)	160	120	120	140	130	170
35.	Magnesium (mg/l)	110	130	98	120	130	120
36.	Manganese (ug/l)	14	20	10	10	30	10
37.	Mercury (ug/l)	.0	.0	.3	.0	.0	.2
38.	Molybdenum (ug/l)	30	---	---	---	--	---
39.	Nickel (ug/l)	<10	---	---	---	--	---
40.	Nitrate (mg/l)	9.3	6.6	9.7	7.9	4.4	2.5
41.	Nitrite (mg/l)	.00	.03	.03	.03	.03	.03
42.	Nitrite Plus Nitrate (mg/l)	2.1	1.5	2.2	1.8	1.0	.58
43.	Nitrogen, Ammonia	.00	.17	.19	.23	.00	.06
44	Odor (Severity)	2	2	---	---	0	0
45.	Oil & Grease (mg/l)	3	3	---	2	2	1
46.	Ortho-Phosphate (mg/l)	.15	.37	.34	.15	.12	.06
47.	Ortho-Phosphorus (mg/l)	.05	.12	.11	.05	.04	.02
48.	Pesticides						
49.	pH	8.4	8.7	8.8	8.7	8.8	8.7
50.	Phosphorus, Total (mg/l)	.02	.13	---	.79	.09	.04
51.	Potassium (mg/l)	4.6	3.5	3.8	4.4	7.4	3.9
52.	Selenium (ug/l)	3	2	3	3	1	1
53.	Silica (mg/l)	20	14	14	14	11	7.1
54.	Silver (ug/l)	<2	---	---	---	---	---
55.	Sodium (mg/l)	710	700	680	840	710	740
56.	Sodium Adsorption Ratio	13	12	13	15	13	13
57.	Sodium (%)	74	70	75	75	73	74
58.	Solids, Dissolved (mg/l)	2320	2450	2270	2740	2330	2430
59.	Solids, Dissolved T/D	18.6	14.6	7.66	25.0	12.0	11.2
60.	Solids, Dissolved T/Ac-Ft	3.16	3.33	3.09	3.73	3.17	3.30
61.	Solids, Suspended						
62.	Strontium (ug/l)	3500	---	---	---		
63.	Sulfate (mg/l)	490	640	470	630	600	570
64.	Sulfide (mg/l)	.0	.1	.3	.2	.1	.1
65.	Temperature (°C)	9.0	3.5	6.0	9.0	9.0	17.0
66.	Tin (ug/l)	<15	---	---	---	---	---
67.	Titanium (ug/l)	<10	---	---	---	---	---
68.	Turbidity JTU)	3	85	3	400	56	18
69.	Vanadium (ug/l)	<8.0	---	---	---	---	---
70.	Zinc (ug/l)	6	0	6	20	0	6
71.	Zirconium (ug/l)	<25	---	---	---	---	
72.	Calcium (mg/l)	37	45	37	40	7.0	31
73.	Complete Element Span						
74.	Radioactivity						
	Gross Alpha (pci)	<36	---	---	---	---	
	Radium 226*						
	Gross Beta	8.8	--	---	---	--	
	Thorium 230**						
	Uranium**						
75.	Total Organic Carbon (mg/l)	4.7		---	---	---	
	If TOC 10 mg/liter, then						
	Nitrogen (Base Extraction)						
	Organic Carbon, Dissolved						
	Organic Carbon, Suspended						
	Phenols						
	Sulfur (Acid Extraction)						
	Total Ortho-Phosphorous (mg/l)	.06	12	.30	.42	01	[illegible]
77.	Phosphate	---	---	---	---	28	[illegible]
78.	Phosphorus, Dissolved	---	---	---	---	---	

Table 1.2-4

SUMMARY WATER ANALYSES
STREAM GAGING STATION U.S.G.S. 09306242
CORRAL GULCH EAST OF TRACT C-a

	Date	3/12/75	3/26/75	4/9/75	4/9/75	4/23/75	5/14/75	5/28/75					
	Time	1100	1415	1045	1100	1100	1245	1430					
	Alkalinity (mg/l)	417	---	---	739	603	421	668					
	Aluminum (ug/l)	20	---	---	---	---	---	---					
	Ammonia (mg/l)	.28	---	---	.35	.15	.03	.22					
4	Aromatics, Polycyclic												
	Arsenic (ug/l)	6	---	---	7	2	5	9					
	Barium (ug/l)	50	---	---	100	0	0	100					
	Beryllium (ug/l)	<2	---	---	---	---	---	---					
	Bicarbonate (mg/l)	508	---	---	901	735	513	815					
	Bismuth (ug/l)	<5	---	---	---	---	---	---					
10	Boron (ug/l)	100	---	---	320	550	160	670					
11	Cadmium (ug/l)	<60	---	---	0	1	1	0					
12	Carbonate (mg/l)	0	---	---	0	0	0	0					
13.	Carbon Dioxide (mg/l)	13	---	---	7.2	7.4	65	13					
14	Chloride (mg/l)	8.9	---	---	11	16	11	15					
	Chromium (ug/l)	<5	---	---	0	0	0	0					
16	Cobalt (ug/l)	<5	---	---	---	---	---	---					
	COD	94	-	---	---	---	---	---					
	Coliform, Total & Fecal												
	Color (PVC)	8	---	---	5	0	5	6					
	Conductivity, Specific	1200	---	---	1725	1550	1300	1550					
	Copper (ug/l)	2	---	---	3	6	1	1					
	Cyanide (mg/l)	.00	---	---	.00	.01	.01	.02					
	Discharge (CFS)												
24.	Discharge, Instantaneous	.34	---	---	1.1	1.3	.46	3.1					
25.	Dissolved Oxygen (mg/l)	9.0	---	5.4	5.4	7.3	8.0	8.1					
26.	Fluoride (mg/l)	.4	---	---	10	4.3	.4	2.8					
27	Gallium (ug/l)	<2	---	---	---	---	---	---					
28.	Germanium (ug/l)	<6	---	---	---	---	---	---					
	Hardness (Ca, Mg) (mg/l)	520	---	---	360	380	480	390					
30.	Hardness, Non-Carbonate (mg/l)	98	---	---	0	0	58	0					
31.	Iron (ug/l)	120	---	---	30	10	30	30					
	Kjeldahl Nitrogen (mg/l)	.67	---	---	2.4	1.1	.14	2.2					
	Lead (ug/l)	<6	---	---	2	8	1	1					
34	Lithium (ug/l)	14	---	---	30	20	10	20					
35	Magnesium (mg/l)	70	---	---	52	59	63	53					
36.	Manganese (ug/l)	43	---	---	0	70	20	6					
37.	Mercury (ug/l)	.0	---	---	.3	0	0	0					
	Molybdenum (ug/l)	30	---	---	---	---	---	---					
	Nickel (ug/l)	<4	---	---	---	---	---	---					
	Nitrate (mg/l)	1.2	---	---	1.2	1.5	1.4	3.0					
41	Nitrite (mg/l)	.07	---	---	.00	.10	.00	.03					
42	Nitrite Plus Nitrate (mg/l)	.28	---	---	.28	.36	.32	.68					
43.	Nitrogen, Ammonia	.22	---	---	.27	.12	.02	.17					
44.	Odor (Severity)	3	2	2	---	0	0	1					
45	Oil & Grease (mg/l)	4	---	---	2	3	0	2					
	Ortho-Phosphate (mg/l)	.28	---	---	.06	.12	.15	.12					
	Ortho-Phosphorus (mg/l)	.09	---	---	.02	.04	.05	.04					
	Pesticides												
	pH	7.8	---	---	8.3	8.2	7.1	8.0					
	Phosphorus, Total (mg/l)	.37	---	---	.60	.58	.05	.41					
	[illegible] (mg/l)	1.4	---	---	2.3	2.0	1.8	2.2					
	Selenium (ug/l)	2	---	---	2	1	2	2					
	Silica (mg/l)	13	---	---	19	19	21	20					
54	Silver (ug/l)	0	---	---	---	---	---	---					
55.	Sodium (mg/l)	110	---	---	300	240	120	250					
56	Sodium Adsorption Ratio	2.1	---	---	6.8	5.4	2.4	5.5					
	Sodium (%)	32	---	---	64	58	35	58					
	Solids, Dissolved (mg/l)	838	---	---	1140	1040	850	1020					
	Solids, Dissolved T/D	.77	---	---	3.57	3.73	1.06	3.54					
60.	Solids, Dissolved T/Ac-Ft	1.14	---	---	1.55	1.41	1.16	1.39					
61.	Solids, Suspended												
62.	Strontium (ug/l)	1600	---	---	---	---	---	---					
63.	Sulfate (mg/l)	290	---	---	240	280	290	200					
64.	Sulfide (mg/l)	.0	---	---	.3	.0	.2	.2					
65.	Temperature (°C)	8.0	---	---	7.0	13.0	14.0	11.0					
66.	Tin (ug/l)	<5	---	---	---	---	---	---					
67.	Titanium (ug/l)	<4	---	---	---	---	---	---					
68.	Turbidity (JTU)	1000	---	---	740	50	1	120					
69.	Vanadium (ug/l)	3.0	---	---	---	---	---	--					
70.	Zinc (ug/l)	0	---	---	40	10	6	10					
71.	Zirconium (ug/l)	<9	---	---	---	---	---	---					
	Calcium (mg/l)	90	---	---	60	55	88	68					
	Complete Element Span												
74	Radioactivity												
	Gross Alpha (pci)	<10	---	---	---	---	--	---					
	Radium 226*												
	Gross Beta	<2.4	---	---	---	---	---	---					
	Thorium 230**												
	Uranium**												
	Total Organic Carbon (mg/l)	9.8	---	---	---	---	---	---					
	If TOC >10 mg/liter, then												
	Nitrogen (Base Extraction)												
	Organic Carbon, Dissolved												
	Organic Carbon, Suspended												
	Phenols												
	Sulfur (Acid Extraction)												
	Total Ortho-Phosphorous	.11	---	-	58	.05	.06	.04					
	Phosphate	---	---			[illegible]	15	1.3					

and conductivity. When Rio Blanco Oil Shale Project receives the data in final form, then that data will be reported in the appropriate progress report.

Figure 1.2-3 is a plot of discharge and conductivity measurements at the gaging station on Corral Gulch east of Tract C-a. Plots of the discharge and conductivity for the other stations recording surface water flow are presented in section 1.2.2 of RBOSP Progress Report 3 - Interpretive Text. Figure 1.2-4 is a plot of precipitation versus time recorded at the rain gaging station on Stake Springs Draw. Plots from data on the other recording type rain gages are presented in section 1.2.2 of RBOSP Progress Report 3 - Interpretive Text. To date the Water Resources Division of the U. S. Geological Survey has not supplied Rio Blanco Oil Shale Project with precipitation records from the storage type rain gages, (see Figure 1.2-2 and Table 1.2-1). A review of the data from the Corral Gulch gaging station east of the tract shows a peak discharge of about 2 CFS (cubic feet per second) occurring in May, 1975. This appears to correlate with high precipitation records during that period. Conductivity for water flowing in Corral Gulch has generally been measured around 1100 umhos/cm. A high conductivity measurement of 1750 umhos/cm corresponds with the discharge of the lower aquifer water into Corral Gulch during the pumping test of GS-D19. Lower conductivity measurements correspond with periods of higher stream flows. Conductivity at the Yellow Creek gaging station fluctuated from 2100 umhos/cm to a high of 4500 umhos/cm recorded in April, 1975. The lower values again reflected periods of higher discharge due to higher runoff.

During periods when precipitation has been widespread, the rain gages show varying rates of precipitation from gage to gage. This variance is the result of the higher elevations generally receiving more precipitation than the lower elevations.

Peak amounts from the three rain gages from which records are available ranged up to a maximum of 0.84 inches recorded in any twenty-four hour period at the Cathedral Bluffs rain gage during May of 1975.

1.2.3 Alluvial Aquifers

RBOSP Progress Report 2 - Summary described the drilling and completion of seven alluvial aquifer test holes. Those holes which encountered water (G-S S7, G-S S8, G-S S11 and G-S S12) were fitted with continuous (Stevens, Type F) water level recorders. Table 1.2-6 is a summary of the water quality data from samples of the alluvial aquifer that has been processed and submitted to the Area Oil Shale Supervisor in section 1.2.3 of RBOSP Progress Report 3 - Raw Data.

Water quality data from the four "wet" holes (G-S S7, G-S S8, G-S S11 and G-S S12) cover March, April and May. Generally water temperatures have increased during this period due mainly to spring warming. Conductivity ranges from a stable value of 850 umhos/cm in G-S S8 to nearly 2000 umhos/cm in G-S S11. The pH has varied from about 6.0 to

Figure 1.2-3

DISCHARGE AND CONDUCTIVITY, CORRAL GULCH EAST OF TRACT C-a

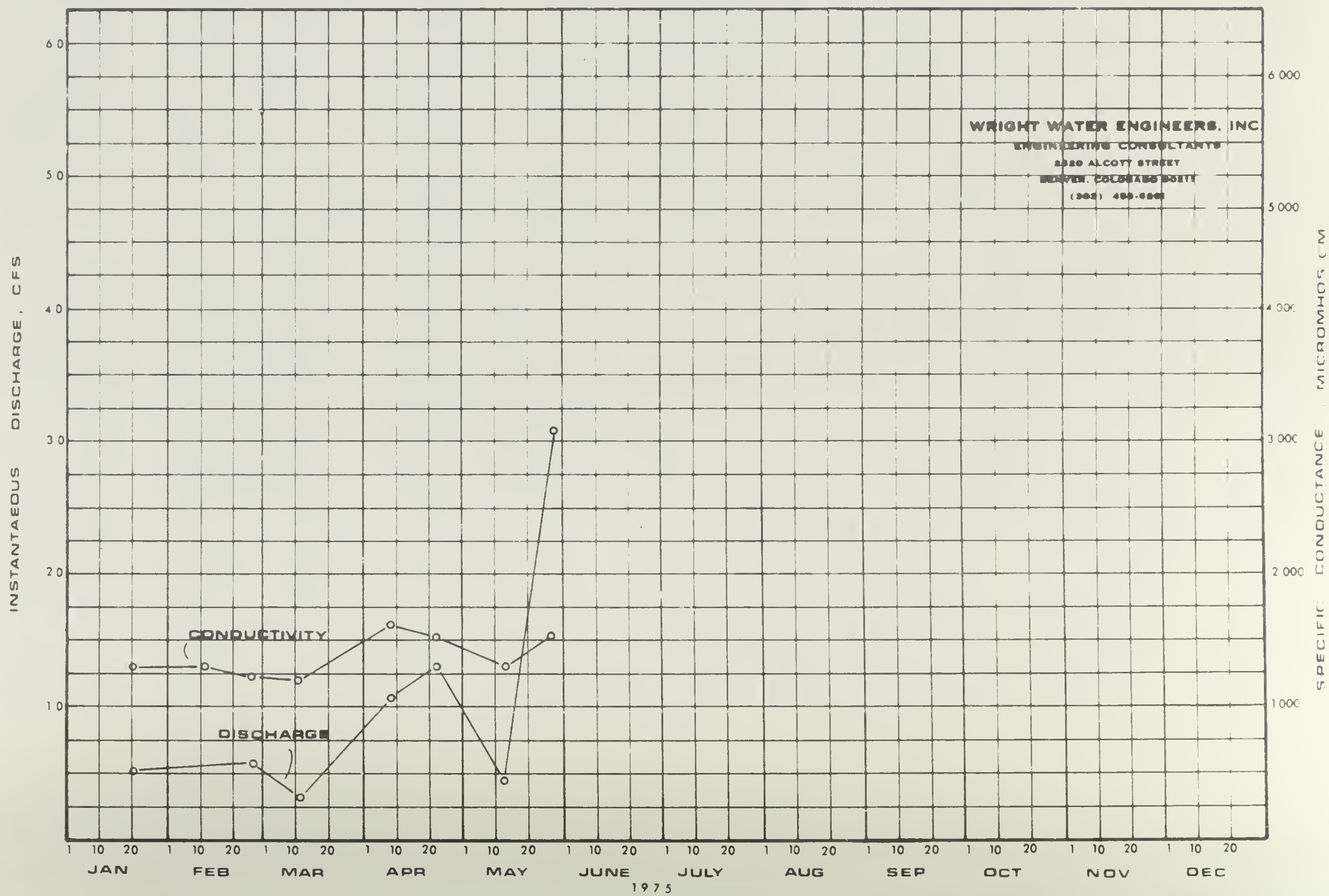


Figure 1.2-4

PRECIPITATION STAKE SPRINGS DRAW

RBOSP

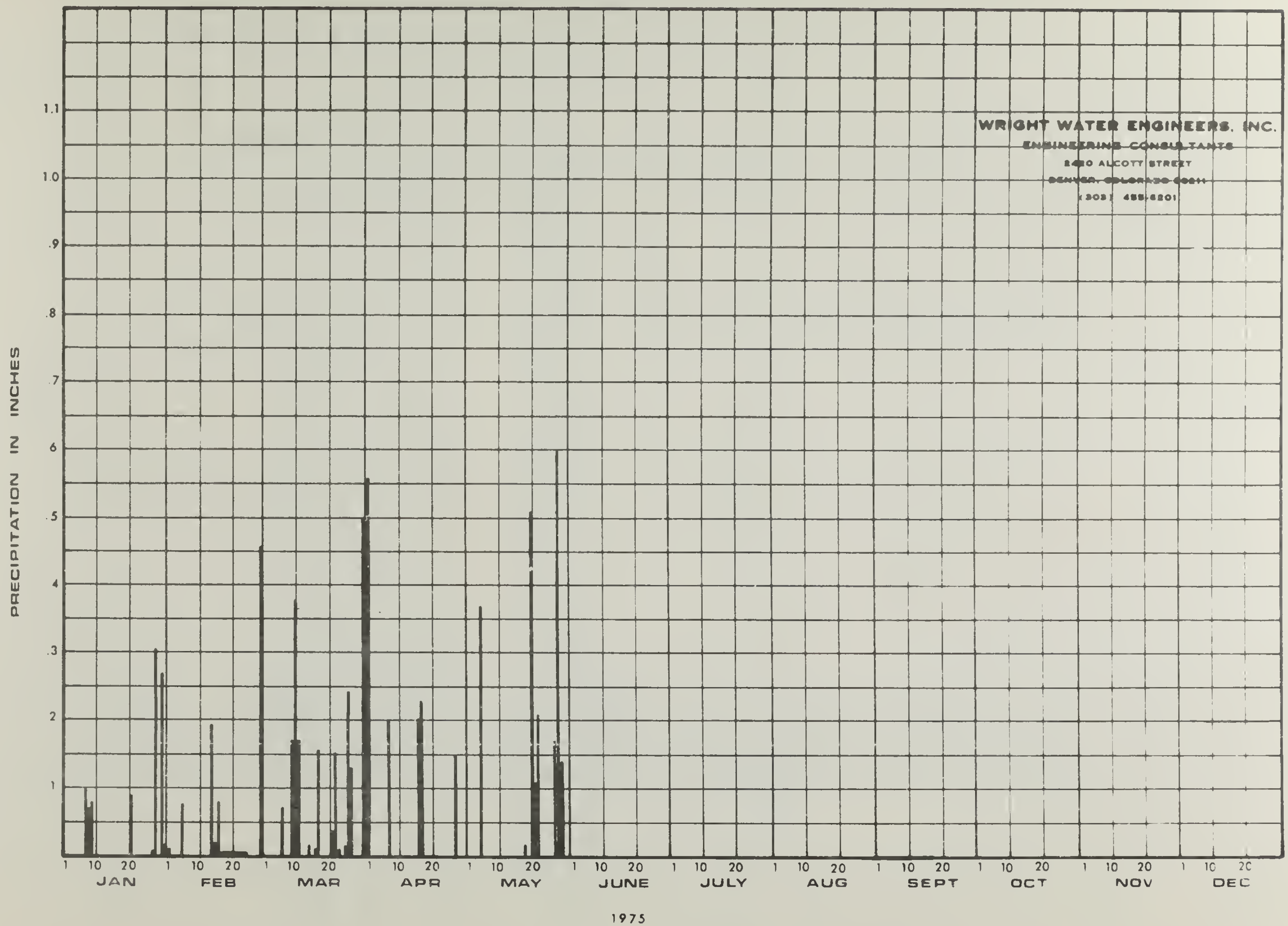


TABLE 1.2-6
SUMMARY OF WET CHEMICAL WATER ANALYSES
ALLUVIAL AQUIFER
TRACT C-a AND VICINITY
(mg/l)

Item	Alluvial Aquifer Low	High	Average	No. Items Avg.
Aluminum	< 0.100	< 0.100	0.0	4
Ammonia	< 0.100	1.000	0.342	19
Arsenic	< 0.010	< 0.010	0.0	20
Bicarbonate	370.000	710.000	555.750	20
Cadmium	< 0.010	0.030	0.006	20
Calcium	28.000	210.000	101.900	20
Carbonate	< 0.100	54.000	9.150	20
Chloride	7.000	71.000	19.045	20
Chromium	< 0.050	< 0.010	0.0	20
Copper	< 0.100	0.100	0.010	20
Fluoride	< 0.100	0.400	0.311	19
Hydroxide	-	-	0.0	0
Iron	< 0.050	28.000	6.910	20
Lead	0.020	0.700	0.211	20
Magnesium	3.700	874.000	96 600	20
Mercury	< 0.010	< 0.010	0.0	20
Nitrate	0.100	13.000	3.935	20
Phosphate	< 0.100	0.100	0.005	20
Potassium	-	-	0.0	0
Selenium	< 0.100	< 0.010	0.0	20
Silicon Dioxide	22.000	40.000	30.700	20
Sodium	75.000	300.000	199.500	20
Sulfate	145.000	580.000	365.000	20
Sulfide	-	-	0.0	0
Zinc	< 0.100	0.600	0.212	19
Gross Alpha	-	-	0.0	0
Gross Beta	-	-	0.0	0
Hardness	280.000	750.000	488.750	20
pH	6.000	6.800	6.450	20
Conductance	860.000	1940.000	1385.300	20
Dissolved Solids	640.000	1460.000	1058.000	20
Manganese	< 0.050	6.400	1.372	20
Alkalinity	329.000	580.000	464.255	20
Cyanide	< 0.010	0.010	0.000	20
Boron	< 0.010	27.000	3.248	20
Barium	< 1.000	< 1.000	0.0	20
Silver	< 0.010	< 0.010	0.0	20
Nickel	0.010	0.100	0.047	20
Lithium	-	-	0.0	0
Toc	7.000	100.000	35.500	16

6.8. Average temperature ranged from 7.9^{o} to 13.5^{o} C with the warming trend beginning in April. The variation in temperature was not as evident in G-S S7 as it was in G-S S8, G-S S11 and G-S S12. The temperature at G-S S7 ranged from 8.5^{o} C in late March to 9.8^{o} C through May. Figures 1.2-5 and 1.2-6 are example plots of temperature and pH versus time, and water level and conductivity versus time, respectively, for alluvial aquifer hole G-S S8. The plots for the other three "wet" holes are contained in section 1.2.3 of RBOSP Progress Report 3 - Interpretive Text. Water levels in alluvial aquifer holes G-S S7, G-S S8, G-S S11 and G-S S12 have been monitored since January 17, 1975. The water level in holes G-S S7 and G-S S12 have remained relatively stable with G-S S7 showing a slight fluctuation from April to mid June. The water level in holes G-S S8 and G-S S11 began to rise in mid April and continued rising into June. This rise is probably attributable to the percolation of snowmelt and runoff from spring showers where as the stable conditions indicated by G-S S12 and G-S S7 may indicate communication of the alluvial aquifer with the mild fluctuations of the piezometric surface of the upper aquifer.

1.2.4 Deep Aquifer Drilling Program

The data generated during the corehole drilling, deep aquifer monitor hole drilling and pump test hole drilling were reported in RBOSP Progress Report 2. This included subsections: 1.2.4.1, Water Production; 1.2.4.2, Water Quality; 1.2.4.3, Informal Pumping Tests; and 1.2.4.4, Geophysical Logs.

1.2.5 Deep Aquifer Completion Program

RBOSP Progress Report 2 described in detail the completion program. Thirty holes (including pre-lease holes) were completed for deep aquifer monitoring. Twenty-two of these were completed for upper and lower aquifer monitoring, three for upper aquifer only, and four for lower aquifer only.

Holes G-S 12 and G-S 4-5 were completed as dual monitor holes but were temporarily modified to serve as upper aquifer pumping holes. This modification (in order to effectively separate the two aquifers) entailed installing a temporary bridge-plug (packer) in the 5 1/2" liner (see construction Figure 1-17, page 1-47, RBOSP Progress Report 2 - Summary) so that strata producing water which was open to the hole above the packer could be pump tested. Following the pumping test the holes were returned to dual completion monitor holes. Table 1.2-7 is a revised completion summary.

1.2.6 Upper and Lower Aquifer Pumping Tests

The Area Oil Shale Supervisor approved a plan for the pumping tests of four holes completed in the upper aquifer and four holes completed in the lower aquifer. The pumping tests were conducted to determine such aquifer characteristics as transmissivity, coefficient of storage, upper and lower aquitard permeabilities and recharge and barrier boundaries. The pumping test began in late December, 1974, and was concluded in early June, 1975. The data collected during June have been

Figure 1.2-5

TEMPERATURE AND pH, ALLUVIAL WELL G-S S8
TRACT C-a

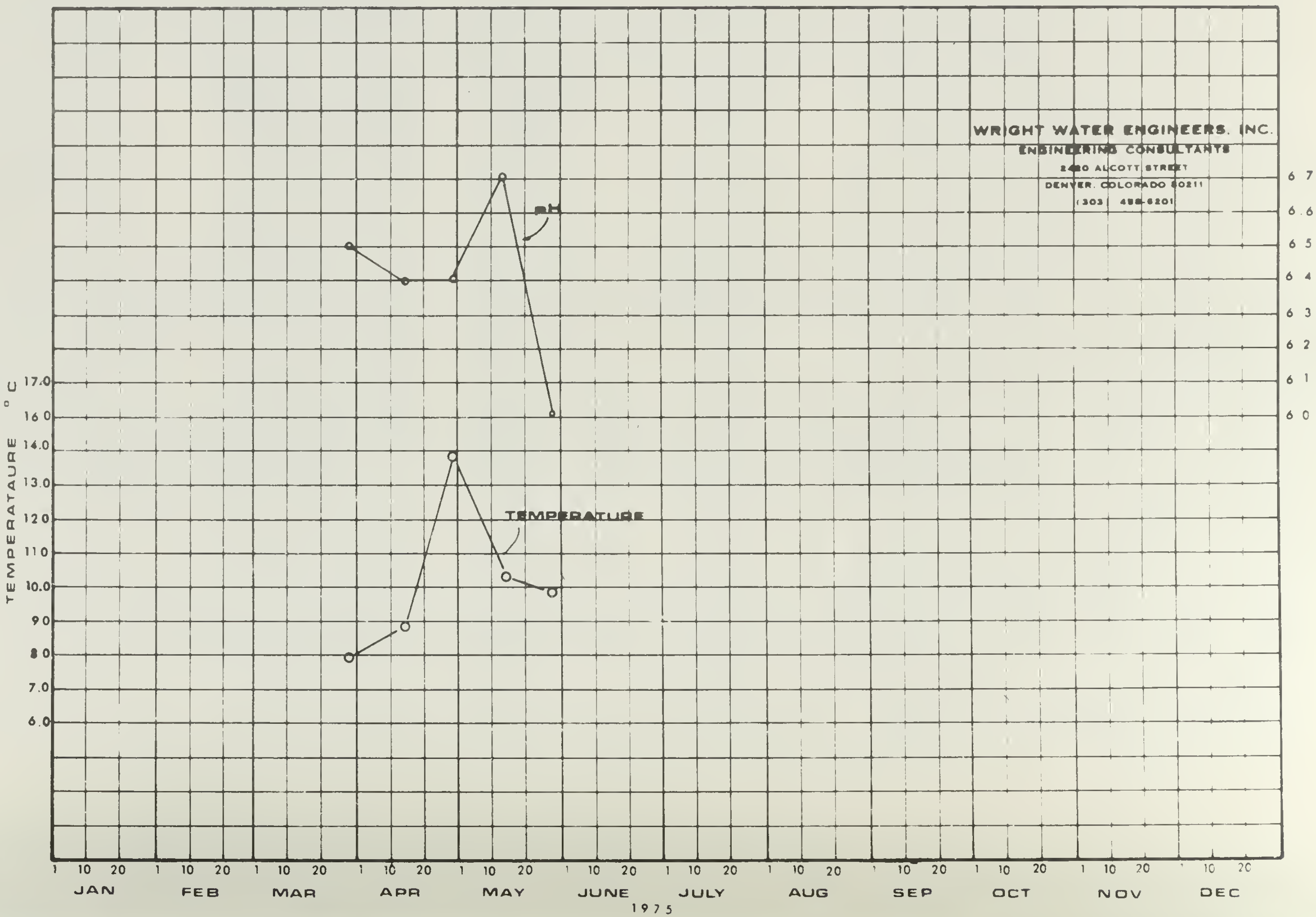


Figure 1.2-6

WATER LEVEL AND CONDUCTIVITY, ALLUVIAL WELL G-S S8

TRACT C-a

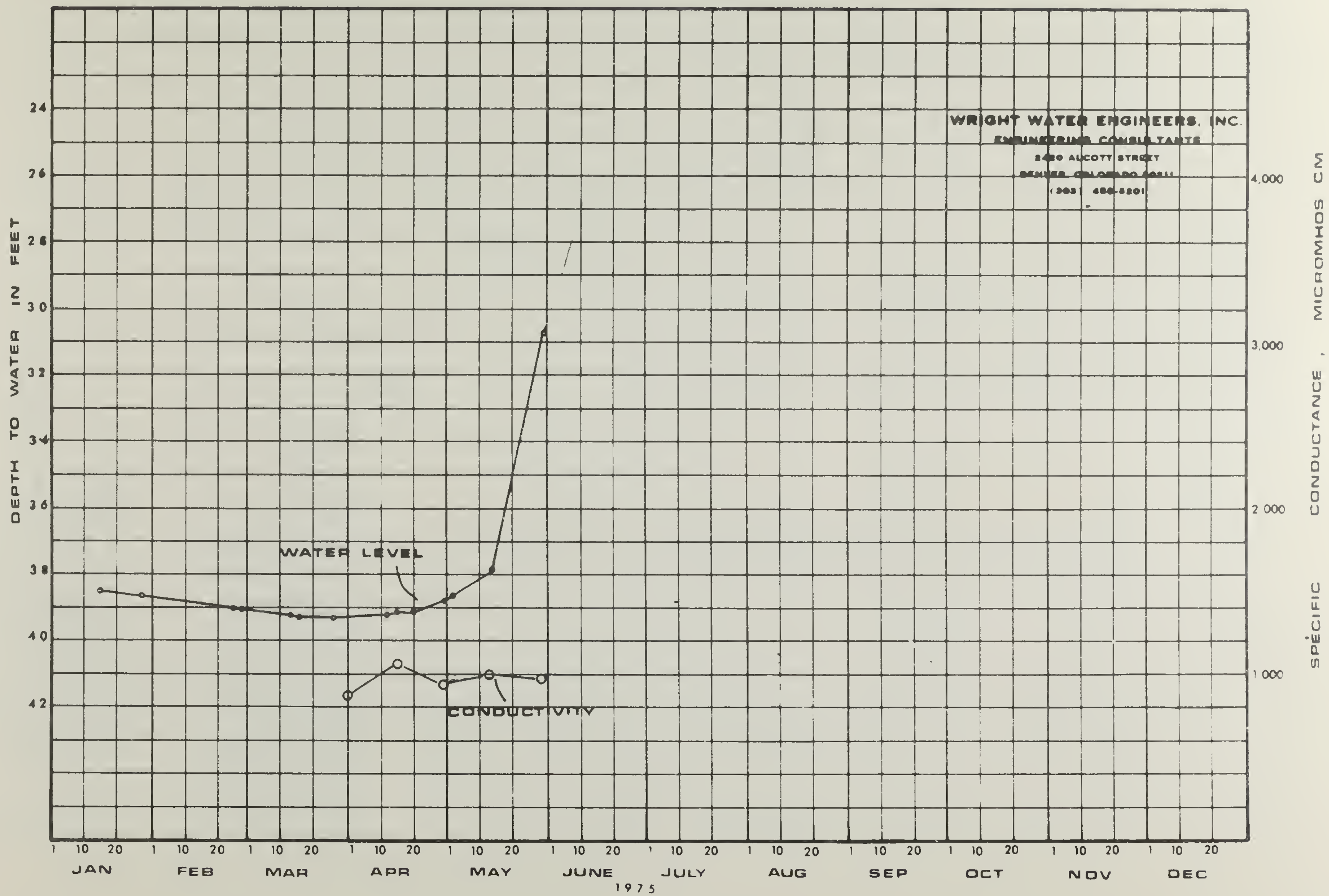


Table 1.2-7

DRILL HOLE COMPLETION SUMMARY
TRACT C-a AND VICINITY
Thirty On-Tract Holes

Drill Hole	Completion	Drill Hole	Completion
G-S 1	U&L	Am 4	P&A
G-S 2-3	U&L	CE - 701	Upper Aquifer Pumping Test
G-S 4-5*	U&L*	CE - 702	U&L
G-S 6	U&L	CE - 703	P&A
G-S 7	P&A	CE - 705-A	Upper Aquifer Pumping Test
G-S 8	Lower Aquifer Only	CE - 707	U&L
G-S 9	U&L	CE - 708	U&L
G-S 10	U&L	CE - 709	U&L
G-S 11	U&L	TO 1	U&L
G-S 12*	U&L*	TO 2	U&L
G-S 13	U&L	TO 3	Upper Aquifer Pumping Test
G-S 14	P&A	G-S D16	Lower Aquifer Pumping Test
G-S 15	U&L	G-S D17	Lower Aquifer Pumping Test
Am 2-A	U&L	G-S D18	Lower Aquifer Pumping Test
Am 3	U&L	G-S D19	Lower Aquifer Pumping Test

Four Off-Tract Holes

Drill Hole	Completion
G-S M 1	U&L
G-S M 2	U&L
G-S M 3	U&L
G-S M 4	U&L

Totals

Completions in Upper and Lower Aquifers	22
Completions in Upper Aquifer Only	3
Completions in Lower Aquifer Only	5
Holes Plugged and Abandoned	4
Total Number of Holes	34

Am = Amoco Production Company
CE = Cameron Engineers, Inc.
G-S = Gulf-Standard (Indiana)
TO = The Oil Shale Company
U&L = Upper and Lower Aquifer Completions
P&A = Plugged and Abandoned

*Holes Temporarily Modified for Upper Aquifer Pumping Test included in Progress Report 3 to facilitate the reporting of the pumping test data. Upper aquifer pump testing holes were TO 3, CE 701, CE 705A, TO 3 and G-S 4-5. Pumping test in hole CE 701 was not successful in that the hole was pumped dry minutes after the pumping started. Following the attempted pumping test, CE 701 was monitored regularly as an observation hole. The additional pumping test of G-S 4-5 was approved by the Area Oil Shale Supervisor. The lower aquifer pump tests were conducted in G-S D16, G-S D17, G-S D18 and G-S D19. Table 1.2-8 lists the pumping tests, locations, durations and production rates. Figure 1.2-7 is a map showing the location of the pump tested holes as well as the observation holes.

Production rates from the pumping hole were monitored in gallons per minute as shown on Table 1.2-8. Figure 1.2-8 and Figure 1.2-9 are examples of the pump placement in an upper and lower pumping test hole respectively. The diagrams of the placement of pumps in the other pumped holes are contained in RBOSP Progress Report 3 - Interpretive Text.

During the pumping test program water production was monitored for temperature, conductivity and pH. Samples were collected at regular intervals for water quality analyses. Tables 1.2-9 and 1.2-10 summarize the wet chemical and spectographic analyses, respectively, of water samples from the upper and lower aquifers. The individual sample analyses are contained in section 1.2.6 of RBOSP Progress Report 3 - Raw Data. The samples are identified as to the origin by the name of the hole from which they came and also the method number from each data sheet. The drilling program is designated method number one (1). The pumping test data is designated method number two (2). The monitoring program has been designated method number three (3). From time to time the fluid used during drilling was analyzed and has been designated method number zero (0). In future progress reports the water quality data will be presented under section 1.2.7, Deep Aquifer Monitoring. Water quality and levels have all been included in section 1.2.6 because of the close relationship this data has to the interpretation of the pump testing program.

Water produced from the upper aquifer varied in temperature from about 14^{o} C to about 23^{o} C. Conductivity varied from 1350 umhos/cm to 1705 umhos/cm with the exception of the TO 3 upper aquifer test which produced water averaging over 3500 umhos/cm. The reason for the high conductivity in TO 3 appears to be due to some type of communication with the lower aquifer. The pH of the upper aquifer water appeared stable and averaged between 6.8 and 7.5. Figure 1.2-10 is an example plot of temperature, pH and conductivity during an upper aquifer pumping test.

Water produced from the lower aquifer ranged in temperature from 17^{o} C to 30^{o} C. The conductivity ranged from 1700 umhos/cm to about 5000 umhos/cm. The water produced from the lower aquifer had an average pH of 7.5. Figure 1.2-11 is an example plot of temperature, pH and conductivity during a lower aquifer pumping test.

Table 1.2-8

PUMPING TEST SCHEDULE

TRACT C-a

Pumped Hole	Aquifer Location	Date Pump Turned On	Time Pump Turned On	Date Pump Turned Off	Time Pump Turned Off	Gallons Pumped per Minute	Total Time (in Minutes)
CE 701	Upper	2/05/75	1033	2/05/75	1036	± 60	3
CE 705-A	Upper	2/26/75	1230	3/08/75	0850	72	14180
CE 705-A	Upper	3/19/75	0950	3/22/75	1405	264	4220
CE 705-A	Upper	3/25/75	0825	4/01/75	1515	259	10490
GS-4-5	Upper	5/02/75	0945	5/19/75	0715	81.3	24330
GS-12	Upper	4/02/75	1045	4/13/75	0845	64.3	15720
TO-3	Upper	1/07/75	1000	1/28/75	1310	76.7	30430
GS-16	Lower	2/11/75 (Step Drawdown)	0945	2/11/75	1800	151 200 250	495
GS-16	Lower	2/15/75	1300	3/09/75	1230	123	31650
GS-17	Lower	1/06/75	1600	1/11/75	0928	275	6808
GS-17	Lower	1/18/75	1300	2/03/75	0830	275	22770
GS-18	Lower	5/21/75	1030	6/05/75	1100	174	21630
GS-19	Lower	4/08/75	1100	5/05/75	0030	667	38250
GS-19	Lower	5/20/75	1000	5/26/75	0655	667	8455

Figure 1.2-7

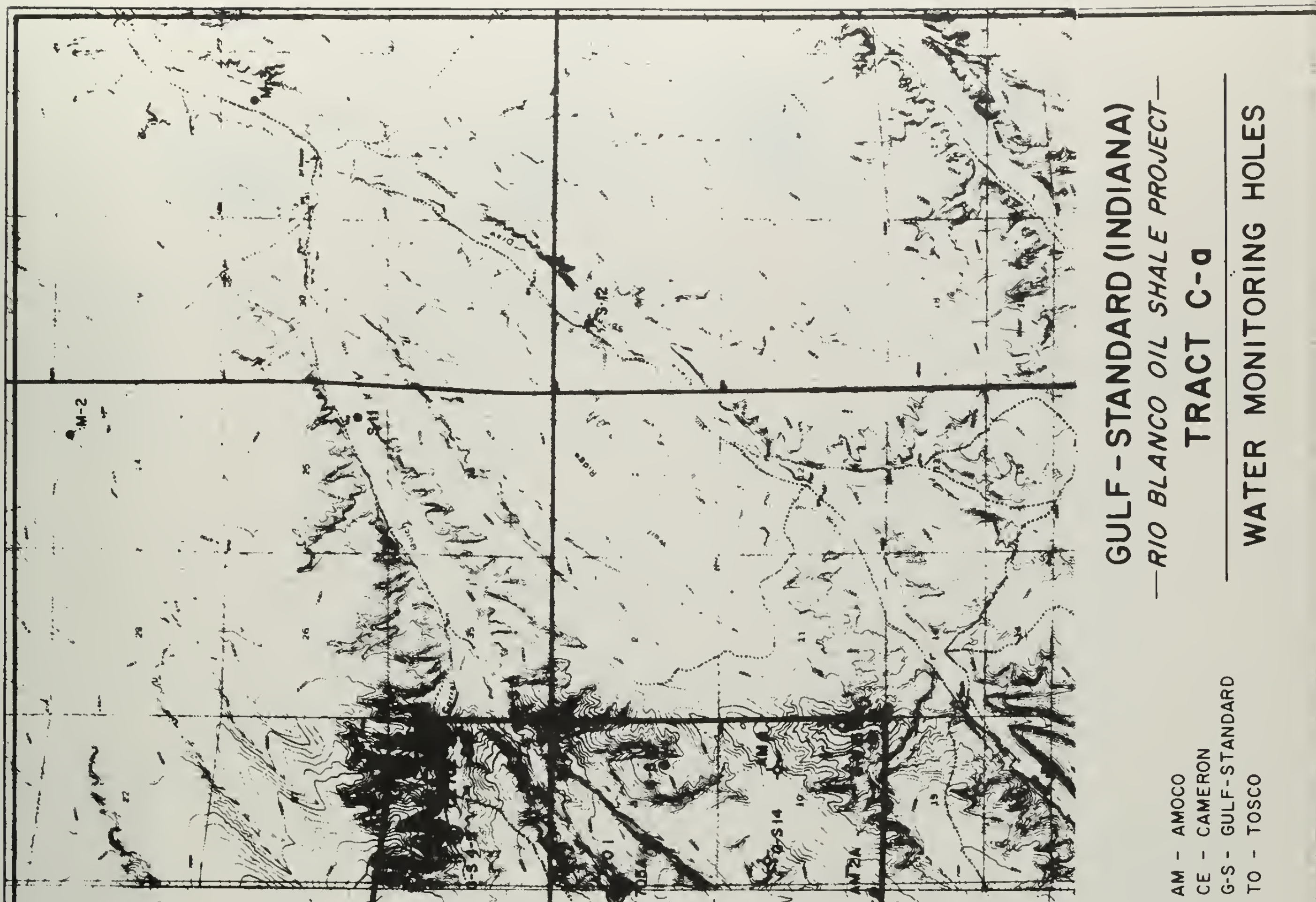

GULF-STANDARD (INDIANA)
—RIO BLANCO OIL SHALE PROJECT—
TRACT C-a
WATER MONITORING HOLES
LEGEND
WATER MONITORING HOLES
HOLE PLUGGED & ABANDONED
PUMP TEST HOLES
AM - AMOCO
CE - CAMERON
G-S - GULF-STANDARD
TO - TOSCO

Figure 1.2-8

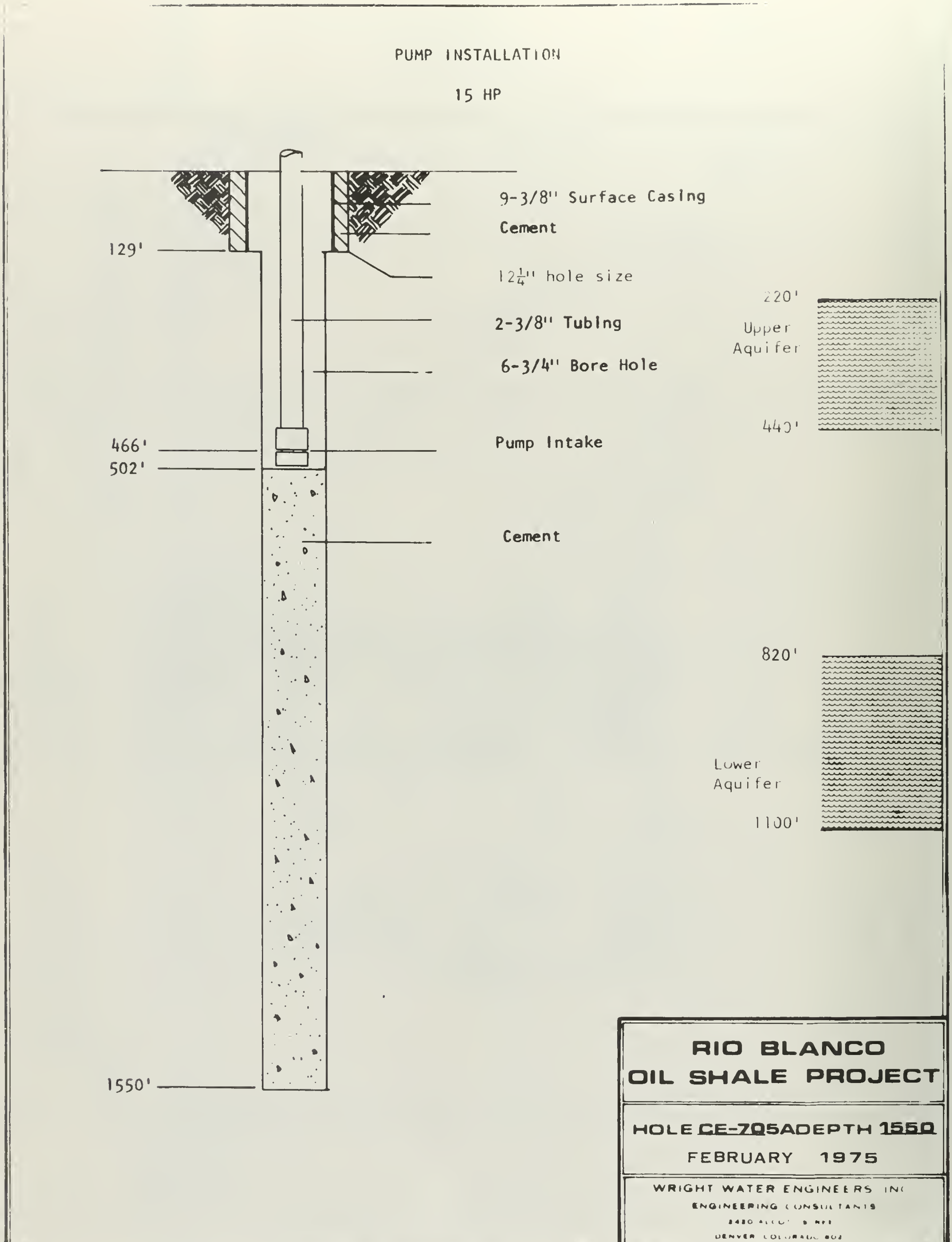

PUMP INSTALLATION
15 HP
9-3/8" Surface Casing
Cement
12¼" hole size
2-3/8" Tubing
6-3/4" Bore Hole
Pump Intake
Cement
129'
466'
502'
1550'
220'
Upper Aquifer
440'
820'
Lower Aquifer
1100'
RIO BLANCO
OIL SHALE PROJECT
HOLE CE-705A DEPTH 1550
FEBRUARY 1975
WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS

Figure 1.2-9

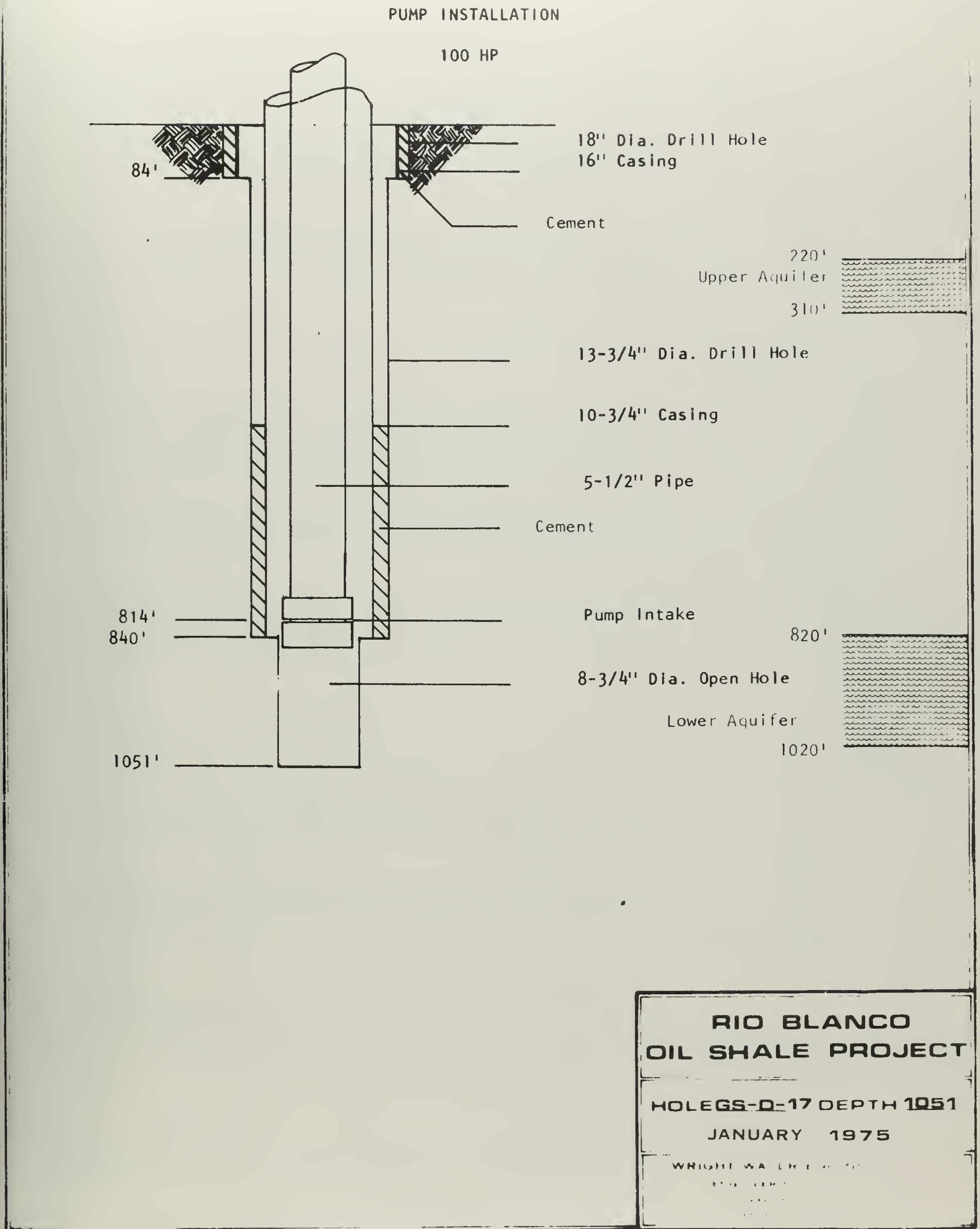

PUMP INSTALLATION
100 HP
18" Dia. Drill Hole
16" Casing
84'
Cement
220'
Upper Aquifer
310'
13-3/4" Dia. Drill Hole
10-3/4" Casing
5-1/2" Pipe
Cement
814'
840'
Pump Intake
820'
8-3/4" Dia. Open Hole
Lower Aquifer
1020'
1051'
RIO BLANCO
OIL SHALE PROJECT
HOLE GS-D-17 DEPTH 1051
JANUARY 1975

Table 1.2-9
SUMMARY OF WET CHEMICAL WATER ANALYSES
UPPER, LOWER, AND COMBINED AQUIFERS
TRACT C-a AND VICINITY
(mg/l)

Item	Lower Aquifer Low	Lower Aquifer High	Lower Aquifer Average	Lower Aquifer No. Items Avg.	Upper Aquifer Low	Upper Aquifer High	Upper Aquifer Average	Upper Aquifer No. Items Avg.	Combined Aquifer Low	Combined Aquifer High	Combined Aquifer Average	Combined Aquifer No. Items Avg.
Aluminum	-0.100	1.600	0.120	45	-0.100	2.200	0.176	46	-0.100	0.100	0.005	21
Ammonia	-0.100	5.600	0.601	79	-0.100	10.600	0.766	100	-0.100	3.000	0.974	28
Arsenic	-0.050	0.050	0.001	99	0.050	0.200	0.005	111	-0.100	0.500	0.038	30
Bicarbonate	-0.100	11800.000	1143.114	114	-0.100	2690.000	625.259	139	350.000	19600.000	2073.000	58
Cadmium	-0.010	0.030	0.002	100	-0.010	0.030	0.002	95	-0.010	0.070	0.009	24
Calcium	-1.000	515.000	48.877	114	3.100	780.000	72.984	139	0.100	88.000	26.290	58
Carbonate	-1.000	3160.000	97.721	114	-0.100	1190.000	34.368	138	-0.100	3000.000	163.982	57
Chloride	-1.000	205.000	37.952	114	-1.000	240.000	29.194	139	3.000	6600.000	238.352	58
Chromium	-0.050	0.010	0.000	95	-0.050	0.500	0.009	96	-0.050	0.570	0.057	24
Copper	-0.100	0.200	0.014	100	-0.100	0.780	0.024	95	-0.100	0.100	0.004	24
Fluoride	-0.050	120.000	13.347	115	0.060	80.000	4.993	139	0.200	60.000	12.869	58
Hydroxide	-0.100	890.000	221.250	8	-0.100	380.000	9.268	41	-0.100	-0.100	0.0	30
Iron	-0.050	33.000	2.343	114	-0.050	16.000	1.841	123	-0.050	16.000	0.685	51
Lead	-0.050	4.600	0.285	100	-0.050	3.400	0.287	95	-0.050	0.500	0.065	24
Magnesium	-1.000	140.000	39.154	114	-0.100	140.000	48.330	138	0.700	96.000	27.265	57
Mercury	-0.010	0.002	0.000	96	-0.010	0.045	0.001	98	-0.010	-0.010	0.0	16
Nitrate	-0.100	55.000	0.977	114	-0.100	5.000	0.456	139	-0.100	15.000	1.152	58
Phosphate	-0.100	2.400	0.060	101	-0.100	9.200	0.288	98	-0.100	8.200	2.425	24
Potassium	-1.000	84.000	26.800	5	-1.000	93.000	12.773	41	-1.000	76.000	15.167	30
Selenium	-0.010	-0.001	0.0	100	-0.100	0.010	0.000	112	-0.100	0.010	0.000	30
Silicon Dioxide	-0.100	50.000	12.675	114	-0.100	58.000	25.737	139	6.400	41.000	17.790	58
Sodium	86.000	5290.000	552.026	114	40.000	1170.000	274.381	139	165.000	12000.000	1007.276	58
Sulfate	-5.000	740.000	244.522	114	-4.000	800.000	324.547	139	-4.000	535.000	180.534	58
Sulfide	-0.010	2.400	1.467	3	-1.000	4.100	1.556	18	-1.000	12.000	2.753	19
Zinc	-0.500	10.000	0.537	100	-0.500	4.400	0.409	86	-0.500	1.000	0.286	14
Gross Alpha	0.300	23.000	7.486	22	0.900	10.000	4.500	21	0.500	12.000	6.675	8
Gross Beta	4.000	260.000	40.545	11	13.000	38.000	22.333	3	1.000	57.000	26.229	7
Hardness	20.000	1260.000	281.131	114	32.000	1870.000	379.503	139	30.000	520.000	175.000	57
Ph	6.000	12.200	7.328	114	6.000	10.200	7.142	139	6.800	8.800	7.904	57
Conductance	760.000	15800.000	2469.750	112	675.000	6200.000	1518.623	138	880.000	28000.000	3426.754	57
Diss. Solids	430.000	12200.000	1682.257	113	425.000	3140.000	1165.762	139	650.000	30700.000	2869.509	57
Manganese	-0.050	0.400	0.058	108	-0.100	0.780	0.099	111	-0.200	0.320	0.018	40
Alkalinity	-0.100	10480.000	965.895	109	-0.100	2360.000	530.599	97	31.000	9310.000	1069.629	27
Cyanide	-0.100	-0.010	0.0	94	-0.010	-0.010	0.0	70	--	--	0.0	0
Boron	-0.100	25.000	2.130	97	-0.100	4.400	0.760	82	-0.100	1.500	0.620	10
Barium	-1.000	-0.100	0.0	95	-1.000	-1.000	0.0	71	--	--	0.0	0
Silver	-0.010	0.110	0.006	95	-0.010	0.100	0.012	71	--	--	0.0	0
Nickel	-0.100	0.100	0.020	93	-0.010	0.200	0.024	71	--	--	0.0	0
Lithium	--	--	0.0	0	-0.500	-0.500	0.0	2	--	--	0.0	0
TOC	2.000	37.000	9.227	44	-1.000	27.000	7.477	44	--	--	0.0	0

TABLE 1.2-10
SUMMARY OF SPECTOGRAPHIC ANALYSES, UPPER, LOWER, AND COMBINED AQUIFERS
TRACT C-a (mg/l)

	Lower Aquifer				Upper Aquifer				Combined Aquifer			
Item	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.
Aluminum	0.010	1.000	0.199	45	0.010	1.000	0.172	74	0.010	1.000	0.182	50
Antimony	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Arsenic	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Barium	0.001	0.100	0.042	9	0.001	0.050	0.015	6	0.100	0.100	0.100	1
Beryllium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Bismuth	--	--	0.0	0	--	--	0.0	0	0.100	0.100	0.100	1
Boron	0.050	99999.000	0.608	45	-0.020	5.000	0.350	74	0.050	5.000	0.456	53
Cadmium	99999.000	99999.000	0.0	0	99999.000	99999.000	0.0	0	--	--	0.0	0
Calcium	5.000	99999.000	8.000	5	1.000	99999.000	5.500	2	2.000	99999.000	5.500	4
Cerium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Cesium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Chromium	0.010	0.010	0.010	1	0.000	0.050	0.010	13	0.001	0.050	0.012	13
Cobolt	--	--	0.0	0	0.001	0.001	0.001	1	--	--	0.0	0
Columbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Copper	0.001	0.100	0.012	37	0.000	0.050	0.014	45	0.000	0.050	0.006	30
Dysprosium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Erbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Europium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gadolinium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gallium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Germanium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gold	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Hafnium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Holmium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Indium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Iridium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Iron	0.005	5.000	0.341	47	0.010	1.000	0.130	72	0.010	10.000	0.518	50
Lanthanum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Lead	0.050	0.050	0.050	3	0.001	0.500	0.094	8	0.005	0.500	0.129	9
Lithium	0.001	5.000	0.179	32	-0.500	0.200	0.056	43	-0.500	1.000	0.153	36
Lutetium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Magnesium	5.000	99999.000	5.714	7	5.000	99999.000	8.000	5	1.000	99999.000	6.750	12
Manganese	0.001	0.100	0.017	32	0.001	1.000	0.057	41	0.010	10.000	0.520	22
Mercury	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Molybdenum	0.001	0.010	0.003	18	0.001	0.050	0.007	32	0.001	0.061	0.012	28
Neodymium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Nickel	--	--	0.0	0	0.001	0.010	0.005	2	--	--	0.0	0
Osmium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Palladium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Platinum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Potassium	0.010	99999.000	2.214	40	0.050	99999.000	1.409	59	0.100	99999.000	1.538	42
Praseodymium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Radium	0.400	0.400	0.400	1	0.100	0.300	0.175	4	0.300	0.500	0.400	3
Rhenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Rhodium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Rubidium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Ruthenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Samarium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Scandium	--	--	0.0	0	-	--	0.0	0	--	--	0.0	0
Selenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Silicon	-0.500	99999.000	8.023	44	2.000	50.000	16.932	74	5.000	99999.000	16.245	53
Silver	0.000	0.001	0.001	10	-0.001	0.001	0.000	11	0.000	0.000	0.000	3
Sodium	0.100	99999.000	5.025	4	2.000	99999.000	5.667	3	99999.000	99999.000	0.0	0
Strontium	0.010	1.000	0.197	40	0.100	1.000	0.215	53	0.100	0.500	0.185	34
Tantalum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Terbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thallium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thorium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thulium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Tin	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Titanium	0.001	0.050	0.008	27	0.00[illegible]	0.150	0.02[illegible]	45	0.00[illegible]	0.200	0.020	38
Tungsten	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Uranium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Vanadium	--	--	0.0	0	0.001	0.100	0.0[illegible]	[illegible]6	0.00[illegible]	0.050	0.019	[illegible]9
Ytterbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Yttrium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Zinc	0.001	0.500	0.[illegible]	9	0.010	0.500	0.[illegible]44	5	0.005	0.[illegible]00	0.04[illegible]	4
Zirconium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0

Figure 1.2-10

WATER QUALITY UPPER AQUIFER PUMP TEST G-S 4-5
TRACT C-a

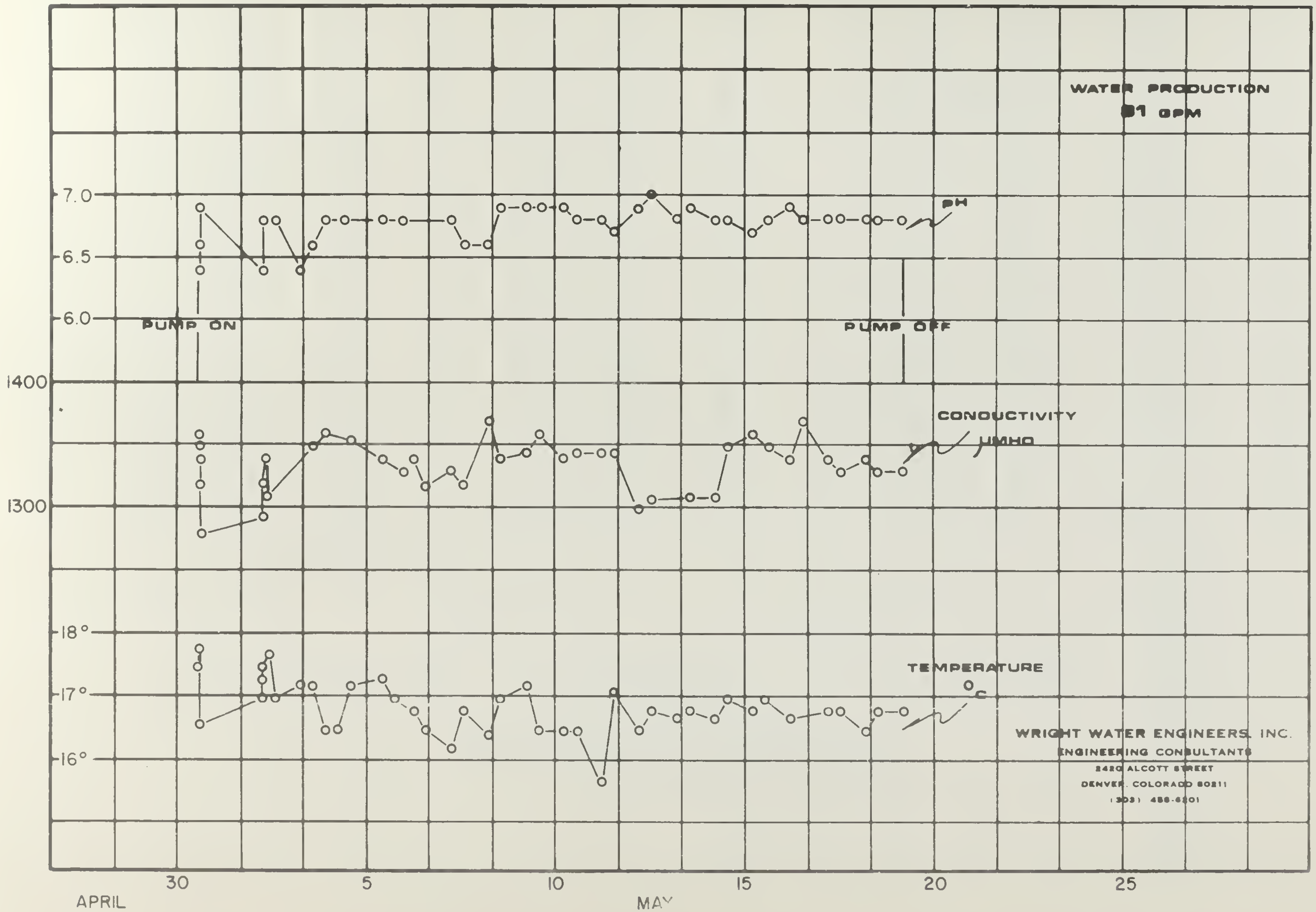
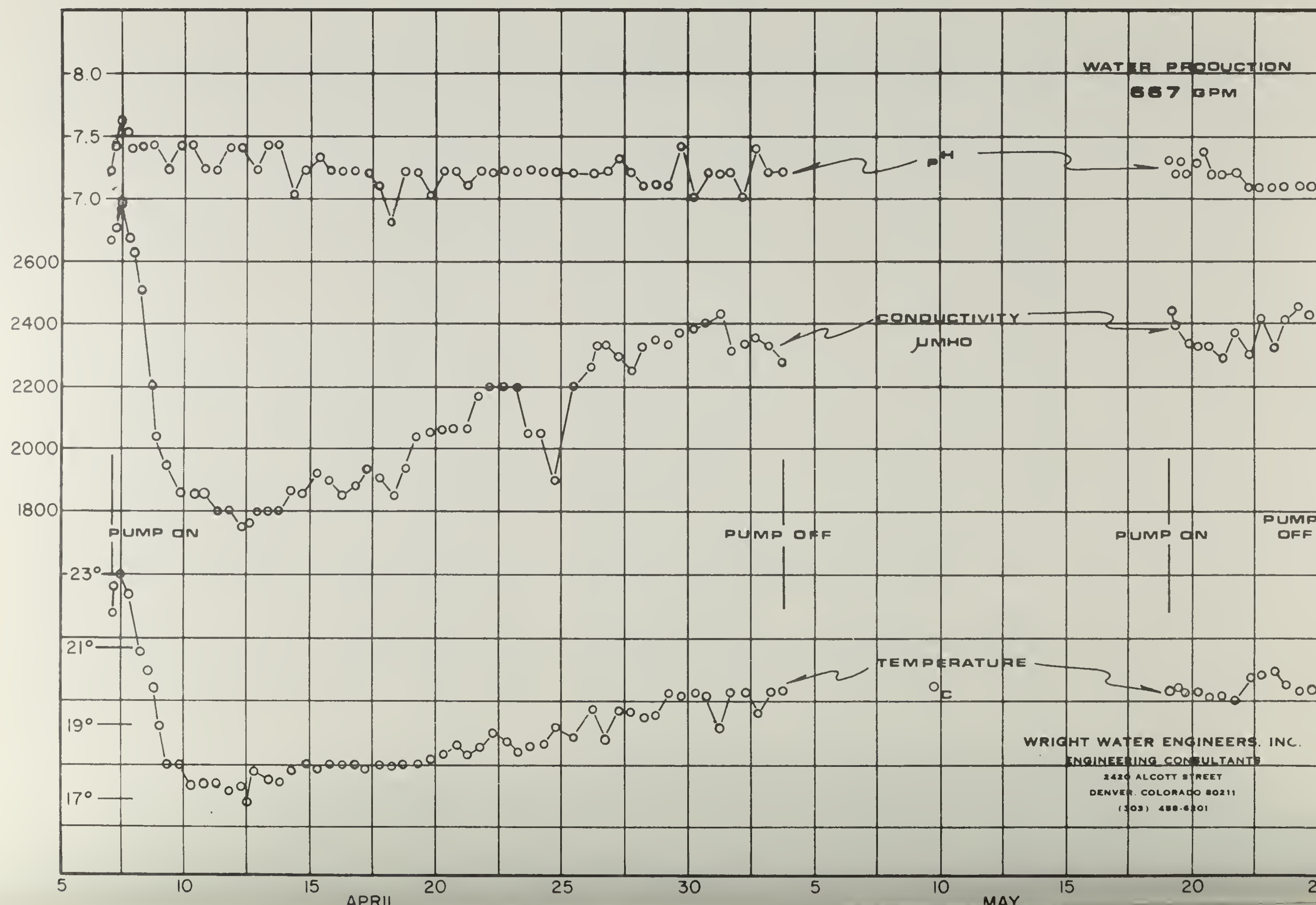


Figure 1.2-11

WATER QUALITY LOWER AQUIFER PUMP TEST G-S D19
TRACT C-a



The water quality data for individual samples are contained in section 1.2.6 of RBOSP Progress Report 3 - Raw Data.

Water levels were measured at regular intervals in each of the observation (or monitor) holes shown on Table 1.2-7 of section 1.2.5 of this progress Report. Computer plotted hydrographs of each of the monitor holes (all 30 open holes, both upper and lower aquifers) are contained in section 1.2.6, RBOSP Progress Report 3 - Interpretive Text Appendix. Figure 1.2-12 is an example of the hydrographs.

Values for transmissivity and coefficients of storage were calculated using the simplified Jacobs' method on data from the pumping hole and all effected observation holes. Semi-log plots of drawdown versus time were generated by computer from the raw field data. The transmissivity and coefficients of storage were then computed by linear regression from selected segments of the semi-log plots. Table 1.2-11 is a summary of the transmissivity and coefficients of storage values calculated from the data obtained during the Upper and Lower Aquifer Pump Testing Program. The semi-log plots are contained in section 1.2.6 of TBOSP Progress Report 3 - Interpretive Text Appendix.

1.2.7 Deep Aquifer Monitoring

Monitoring of the deep aquifers as stipulated in the Oil Shale Lease was initiated in December of 1974. The present monitoring system consists of collecting monthly samples from all deep monitor holes. Completion information for the monitor holes is provided in Table 1.2-7. The location of each of the monitoring holes is shown on Figure 1.2-7. The samples are analyzed by wet chemical and spectographic methods. Static water levels are measured while the monitoring holes are being sampled. The fresh samples are measured immediately for temperature, conductivity and pH.

Water quality data have been included in section 1.2.6 of RBOSP Progress Report 3 because of the close relationship of the water quality data to the interpretation of the pumping test program and because the majority of the samples analyzed to date have originated from the drilling or pumping test programs. Computer tabulation of the results from all of the water analyses is contained in section 1.2.6 of RBOSP Progress Report 3 - Raw Data. The sample origin is identified by hole number, aquifer designation, and method number. Method number three (3) designates all samples collected during the Deep Aquifer Monitoring program. Section 1.2.6 of RBOSP Progress Report 3 - Raw ta has an explanation of the identification and coding system for the water quality data contained in that section. Tables 1.2-10 and 1.2-11 of section 1.2.6 are summaries of the wet chemical and spectrographic analyses of all the water quality samples collected to date. The tables show the range and average of the chemical constituents tested and the aquifer from which they were collected. Where concentrations are less than the lowest detectable limit the lowest detectable limit is listed and preceded by a minus (-) sign. The chemical constituents shown as being less than the detectable limit are considered to have a zero value and are averaged with the rest as such.

Figure 1.2-12

HYDROGRAPH OF LOWER AQUIFER Am 2-A
January 1, 1975 - May 30, 1975
TRACT C-a

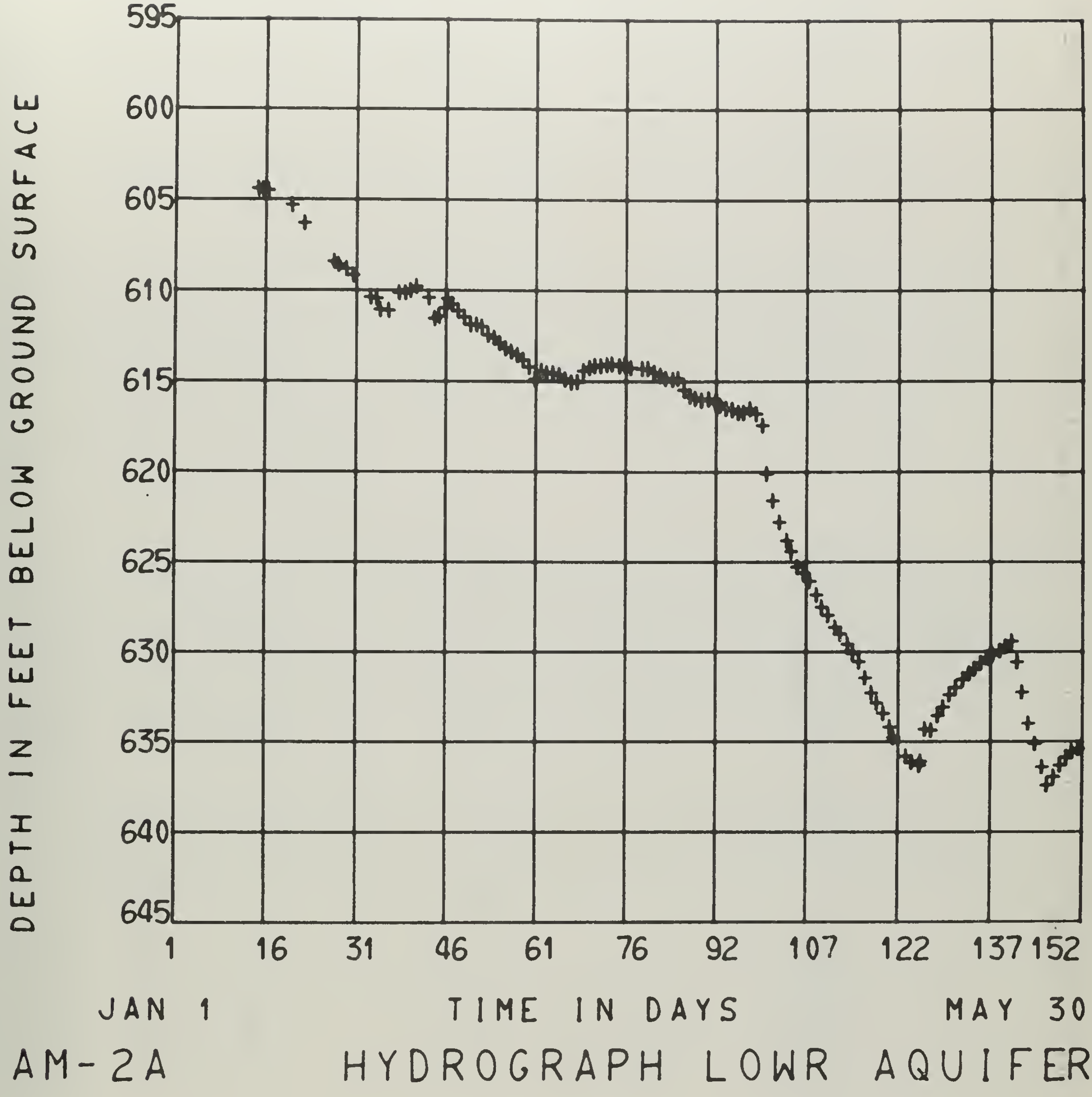


Table 1.2-11

PUMPING TEST
SUMMARY
TRACT C-a

Pumping Hole	Average Transmissivity[1] Drawdown	Average Coefficient of Storage Drawdown	Average Transmissivity[1] Recovery	Average Coefficient of Storage Recovery
Upper Aquifer				
CE 705 A	--	--	25925 (2)	1.86×10^{-5} (1)
CE 705 A	17767 (3)	2.26×10^{-5} (2)	16990 (3)	3.31×10^{-5} (2)
CE 705 A	29348 (4)	4.51×10^{-5} (3)	24891 (4)	4.22×10^{-5} (2)
GS 4-5			5176 (1)	--
GS - 12	2381 (4)	1.06×10^{-4} (3)	7569 (2)	2.72×10^{-6} (1)
TO - 3	11769 (3)	9.9×10^{-5} (3)	20905 (2)	2.02×10^{-4} (2)
Lower Aquifer				
GS - 16	--	--	--	--
GS - 16	6458 (22)	1.19×10^{-6} (22)	58109 (11)	1.91×10^{-5} (11)
GS - 17	12218 (7)	1.09×10^{-4} (7)	19025 (10)	1.41×10^{-4} (8)
GS - 17	7547 (21)	6.21×10^{-5} (20)	24602 (18)	6.76×10^{-5} (18)
GS - 18	--	--	22843 (21)	5.38×10^{-5} (20)
GS - 19	7041 (22)	1.78×10^{-4} (21)	22890 (22)	1.25×10^{-4} (22)
GS - 19	14598 (19)	8.04×10^{-5} (18)	43461 (21)	1.65×10^{-4} (20)

( ) Number of observation holes

[1] Transmissivity in gallons per day per foot

Hydrographs, (plots of water level with respect to time), during the period of pumping tests are contained in section 1.2.6 of RBOSP Progress Report 3 - Interpretive Text Appendix. The value of the hydrographs to the interpretation of the pumping test program warranted placing the water level data in section 1.2.6, Upper and Lower Aquifer Pumping Tests, RBOSP Progress Report 3.

In future progress reports all data pertianing to the Deep Aquifer Monitoring will be separated from the drilling and pumping test and presented to the Area Oil Shale Supervisor in section 1.2.7, Deep Aquifer Monitoring.

From that data generated to date water quality has not shown any significant variations. Generally speaking, the water quality is poorer in the northeastern portion of Tract C-a than in other areas. Seasonal spring recharge from the percolation of snowmelt and rain water appears to affect the water quality as bicarbonates, alkalinity and magnesium have shown a decrease in concentration in both the upper and lower aquifer. The concentration of zinc and iron have increased since sampling was initiated.

1.2.8 Data Input to Mathematical Model

A mathematical model for the hydrologic modelling and dewatering analysis have been selected. This model will forecast the dewatering and production rates for various pumping and mining configurations. Data for input have come from RBOSP drilling and pumping tests, as well as from publications of the U. S. Geological Survey, Water Resources Division. At the present, the mathematical model is being calibrated and tested prior to developing the dewatering analysis.

1.2.9 The Dewatering Analyses

The dewatering analyses resulting from the hydrologic mathematical model should determine potential pumping rates for various mining configurations with time. It is anticipated that preliminary information will be contained in RBOSP Progress Report 4.

Environmental Baseline Data Gathering Project

2.0 ENVIRONMENTAL BASLINE DATA GATHERING PROJECT

The environmental baseline programs satisfy lease requirements and provide information in addition to these requirements. The individual components of this project appear in Figure 2-1. Programs not previously described in Progress Report 2 are enclosed by thick black lines in Figure 2-1.

During the quarter, the steadily expanding data base indicated the need for the partial revision of certain environmental studies. Therefore, the scopes of work of several major contractors were revised during this quarter. The proposed changes were presented to the Area Oil Shale Supervisor (AOSS) for review and comment. They were later reviewed by the Oil Shale Environmental Advisory Panel (OSEAP) and were accepted. The revised scopes of work were then approved by the AOSS.

Some of these changes are represented in this report. Other changes have not yet been implemented and will not appear until the fourth quarterly progress report is released. Descriptions of those objectives and methods for programs not undergoing change during the reporting quarter are not repeated here. Please refer to Progress Report 2 for this information.

A description of Tract C-a, the basic objectives of the environmental programs and the contractors involved in these studies appear in Progress Report 2, section 2.0.

Section 2 of this progress report discusses the data gathered from March through May, 1975. Interpretations are minimal to avoid premature conclusions from limited data.

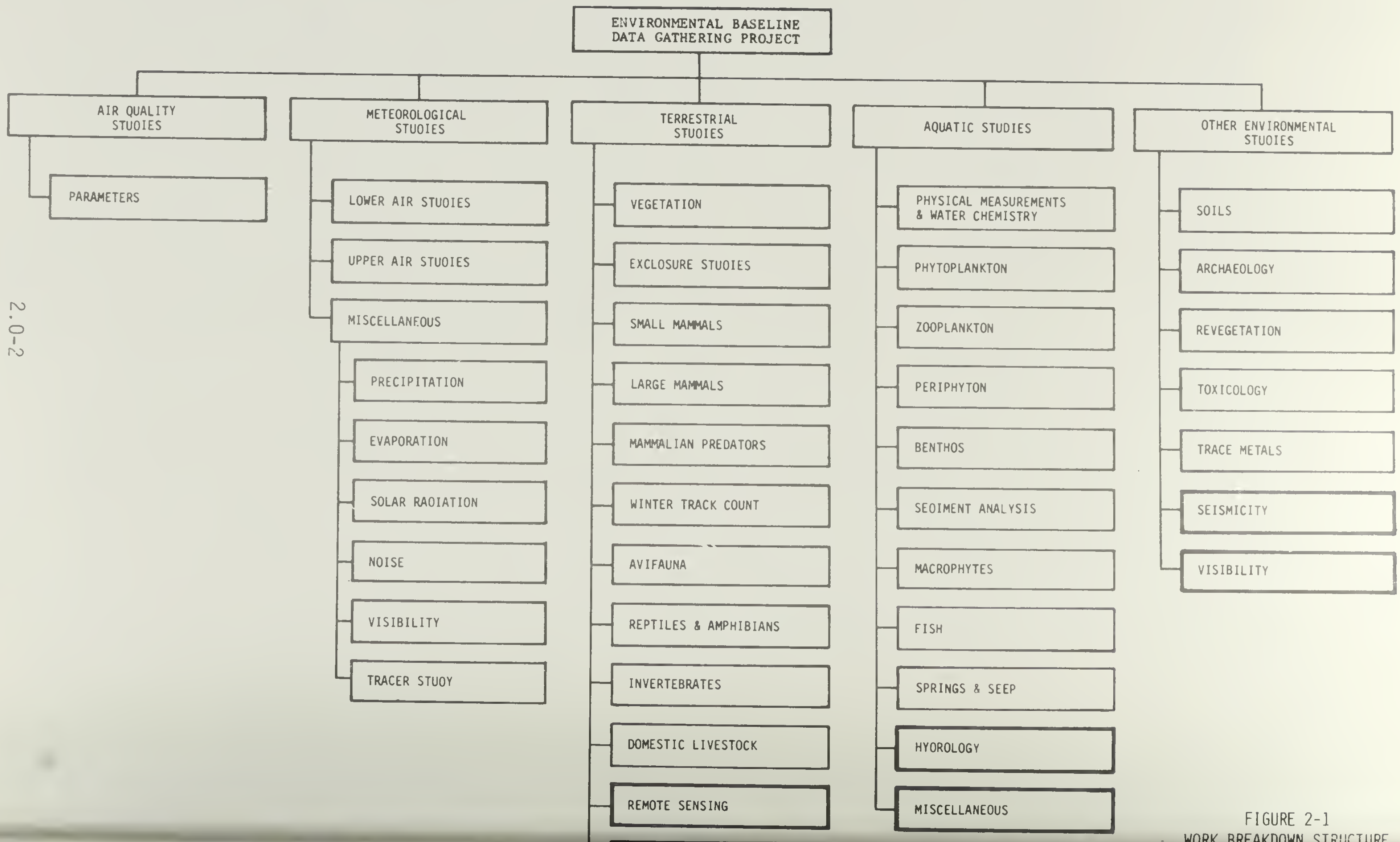


FIGURE 2-1
WORK BREAKDOWN STRUCTURE

2.1 AIR QUALITY

The air quality studies are designed to at least meet and, in some cases, exceed the environmental lease stipulations. The Air Quality and Meteorological Data Acquistion System for the RBOSP consists of: four monitoring sites, each with tower-mounted meteorological instruments and trailer-contained air quality instrumentation; interface electronics; RF data telemetry links; and a central minicomputer for data storage and processing. Figure 2.1-1 is an artist's representation of the system indicating parameters measured at each site. The air quality parameters measured at each site are:

Site No.	THC	CH_4	SO_2	H_2S	NO_x	NO	CO	O_3	Particulates
1	X	X	X	X	X	X	X	X	X
2	X	X	X	X					X
3	X	X	X	X	X	X	X	X	X
4	X	X	X	X					X

Data from all stations are sent to the minicomputer at the central station. The minicomputer stores the data on magnetic tape, the primary recording medium. A high speed printer provides a hard copy printout. Backup analog recorders are located in the air quality trailers.

2.1.1 Parameters

2.1.1.1 Objectives

Air quality parameters are measured to determine background concentrations prior to any major development on Tract C-a, to compare the observed levels with prevailing and proposed Federal and State Air Quality standards, and to meet, or in some cases exceed, the environmental lease stipulation requirements for the tract.

2.1.1.2 Methods

The ambient air at each of the four sites is continuously sampled at an air sampler intake located 10 feet above ground level. This intake is connected to a manifold which supplies air samples to air quality parameter gas-monitoring instruments. Data from each instrument are then fed into the Site 1 processor (minicomputer), which performs the necessary analyses and converts the information into engineering units, i.e., parts per million values, and subsequently displays these

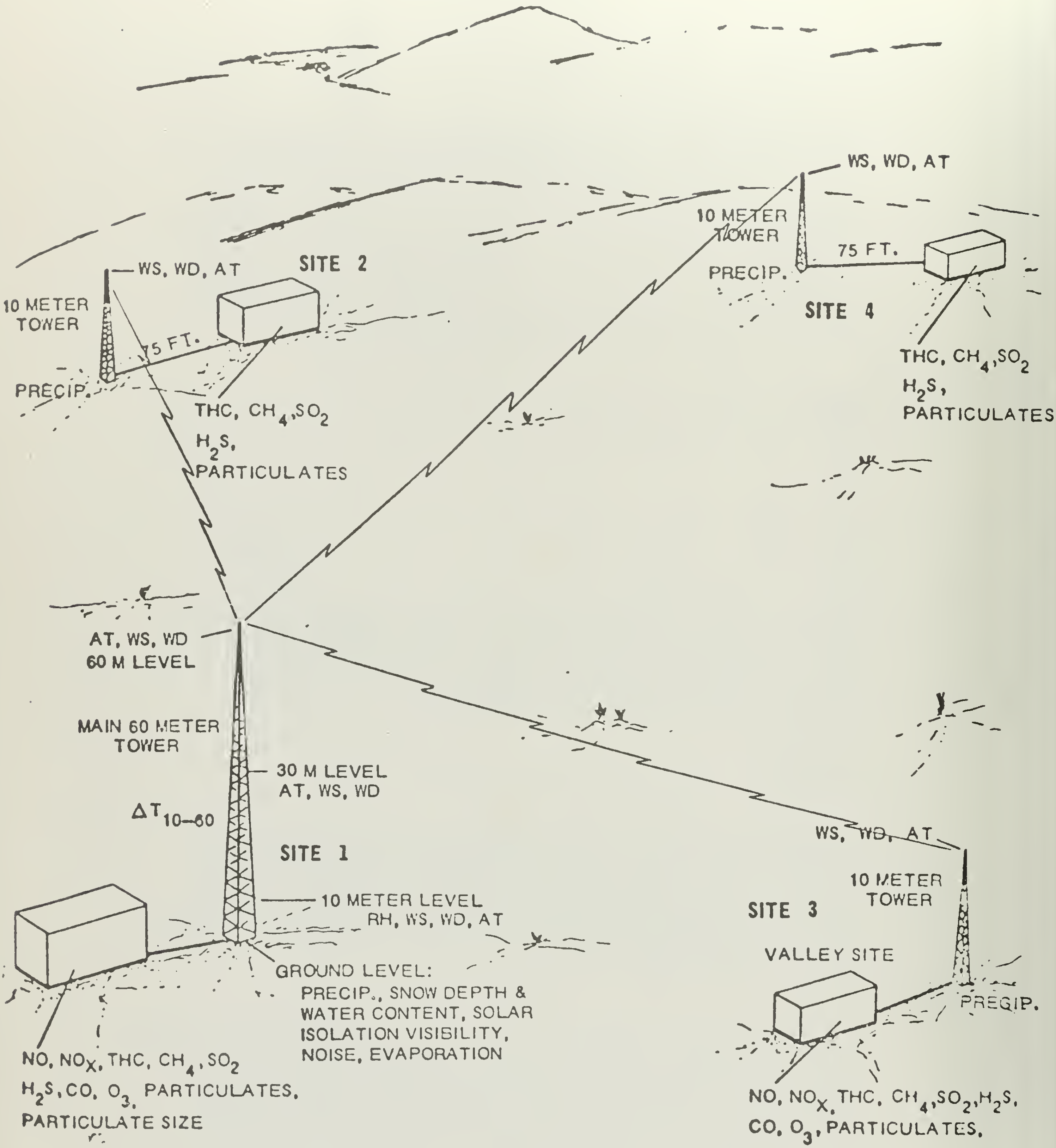


Figure 2.1-1 - RBOSP Meteorological and Air Quality Data Acquisition System for Tract C-a

values. Continuous strip chart analog records are also recorded for each parameter. Particulates are not sampled continuously but by batch sample measurements which are performed every 3rd day for a 24-hour period. Size distribution of particulates is measured each 21st day and a trace element analysis made once per quarter.

Table 2.1-1 lists the instruments and air quality measurement techniques used for monitoring gases.

2.1.1.3 Results

Analysis of the air quality parameters measured on Tract C-a indicates that with the exception of particulates, ozone and hydrocarbons, the mean values are small. The results of the analysis are discussed and tabulated in this section.

The Federal Secondary 24-hour maximum particulate concentration standard (150 $\mu g/m^3$) was exceeded once at Site 3. The Federal primary 24-hour maximum particulate standard (260 $\mu g/m^3$) was not exceeded. The Colorado Ambient Air Standard is the same as the Federal Secondary standard, and was also exceeded once during the quarter.

The seasonal minimum, maximum and mean values of all measured air quality parameters for Spring 1975 are presented in Table 2.1-2. Table 2.1-2 indicates that the mean values for CO, NO, NO_x, H_2S and SO_2 are small compared to the standards associated with man's activity. The high hydrocarbon (both methane and nonmethane) concentrations remain relatively constant throughout the day, while the ozone exhibits definite diurnal variations with a maximum at about noon (40 ppb) and a minimum at about midnight (20 ppb). Inter-site comparisons between identical parameters show good agreement, both in absolute values and variations.

Table 2.1-3 gives the particulate concentration data for the quarter for each site. The large variation between samples and sites was possibly due to fugitive dust resulting from work activities on site and road dust. For example, Site 3, where measured particulate values were high, is not far from a well-traveled road. The high values at Site 1 probably result from work activity in the immediate area and dust from the nearby 200-foot knoll, southwest of the Site.

The 163.09 ug/m^3, measured on 25 April at Site 3, is in excess of the Federal Secondary Standard. However, the geometric means for all sites during the spring quarter are considerably below the Federal and State Annual Standards. Occasionally, on windy days, such as 25 April, it can be anticipated that the Federal Secondary and State of Colorado Air Quality Standard of 150 ug/m^3 will be exceeded.

Table 2.1-1 Gas instrumentation and measurement technique

Parameter	Manufacturer	Model	Technique	Lower Detectable Limit (ppm)
SO_2/H_2S	Bendix	8700X	Flame photometric with separation column for SO_2 and H_2S	0.005
NO_2/NO	Bendix	8101-B	Chemiluminescence	0.005
THC/CH_4	Bendix	8201	Flame ionization detector with separation column for CH_4	0.005
Photochemical Oxidant (O_3)*	Bendix	8002	Chemiluminescence	0.001
CO	Bendix	8501-5B	Nondispersive infrared detector	0.5

*Photochemical oxidant corrected for interference due to nitrogen oxide and nitrogen dioxide as measured by the Federal Reference as ozone (O_3) with the chemiluminescence method.

Table 2.1-2 Air quality parameters seasonal summary for Spring 1975, RBOSP Tract C-a

Parameter	Units	Minimum	Maximum	Arithmetic Mean
		SITE 1		
O_3	ppm	0.021	0.054	0.037
CO	ppm	0.000	1.291	0.332
NO	ppm	0.000	0.014	0.003
NO_x	ppm	0.000	0.038	0.005
CH_4	ppm	0.864	1.526	1.184
THC	ppm	0.907	1.745	1.272
H_2S	ppm	0.000	0.005	0.001
SO_2	ppm	0.000	0.009	0.003
Particulates	$\mu g/m^3$	7.67	95.28	29.31*
		SITE 2		
CH_4	ppm	0.875	1.567	1.239
THC	ppm	1.012	1.627	1.389
H_2S	ppm	0.000	0.012	0.002
SO_2	ppm	0.000	0.009	0.002
Particulates	$\mu g/m^3$	0.61	84.18	11.40*
		SITE 3		
O_3	ppm	0.002	0.069	0.033
CO	ppm	0.000	1.844	0.303
NO	ppm	0.000	0.159	0.005
NO_x	ppm	0.000	0.154	0.008
CH_4	ppm	0.883	1.860	1.291
THC	ppm	0.975	2.678	1.396
H_2S	ppm	0.000	0.008	0.003
SO_2	ppm	0.000	0.012	0.001
Particulates	$\mu g/m^3$	3.49	163.09	23.09*
		SITE 4		
CH_4	ppm	0.979	1.545	1.213
THC	ppm	1.134	1.678	1.301
H_2S	ppm	0.001	0.008	0.003
SO_2	ppm	0.001	0.022	0.005
Particulates	$\mu g/m^3$	2.70	111.16	19.46*

*Geometric Mean

Table 2.1-3 Particulate concentration data for Spring 1975, RBOSP with values presented in micrograms per cubic meter ($\mu g/m^3$)

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
March	4	1975	NA	4.11	NA	8.58
	8			8.71	11.47	32.68
	12			1.84	5.82	2.88
	16			4.90	31.73	19.50
	20			13.37	23.97	39.73
	24			0.61	6.81	6.07
	28			6.68	8.40	5.40
April	1	1975	NA	8.22	21.15	7.85
	4			15.33	22.26	11.59
	7			20.54	30.53	28.69
	10			5.40	8.71	7.79
	13			17.66	42.18	22.07
	16			37.16	77.80	110.67
	19			25.20	26.24	21.70
	22			19.44	33.48	35.56
	25		81.91	53.65	163.09	111.16
	28		7.67	12.20	20.23	14.10
May	1	1975	11.83	14.16	23.36	19.37
	4		95.28	84.18	NA	83.38
	7		38.26	5.33	19.44	18.52
	10		10.85	20.29	54.63	24.40
	13		46.60	12.02	55.30	NA
	16		60.58	38.93	78.30	103.25
	19		36.85	24.34	47.15	33.97
	22		9.01	6.87	17.47	14.71
	25		36.05	19.37	31.70	31.45
	28		28.88	3.31	3.49	2.70
	31		41.04	1.71	18.52	16.31
GEOMETRIC MEAN			29.31	11.40	23.09	19.46

NA = Data Not Available due to compounded instrument problems.

Particle size data by concentration and particle size range are given in Table 2.1-4. These data show that a large portion of the particulate weight is made up of particles of 0 to 1 micron. The zeros in the data taken on 28 April 1975 and 10 May 1975 represent particles, collected in the first four stages of the impactor, which did not weigh enough to be measured.

The results of particle trace element analysis on a particulate sample taken on 1 May 1975 are given in Table 2.1-5.

Table 2.1-4 Particulate concentration by equivalent aerodynamic* diameter (micrograms per cubic meter) RBOSP Tract C-a April through May 1975

Size Range (microns)	28 April 1975	10 May 1975	22 May 1975
7.2 - ∞	0	0	0.31
3.0 - 7.2	0	0	1.04
1.5 - 3.0	0	0	0.06
0.95 - 1.5	0	0	1.04
0 - 0.95	7.67	10.85	6.56

*"Equivalent Aerodynamic Diameter" is defined as the size of a spherical particle of density 1 gm/cm^3 which has the same terminal settling velocity as the sampled particle.

Table 2.1-5 High volume filter trace element analysis results for Spring 1975, RBOSP

Parameter	Concentration (ng/cm^3)	Parameter	Concentration (ng/cm^3)	Parameter	Concentration (ng/cm^3)	Parameter	Concentration (ng/cm^3)
Uranium	<0.01 ng/cm^3	Terbium	<0.01 ng/cm^3	Ruthenium	<0.01 ng/cm^3	Vanadium	5.3
Thorium	<0.01 ng/cm^3	Gadolinium	<0.01 ng/cm^3	Molybdenum	19	Titanium	380
Bismuth	<0.01 ng/cm^3	Europium	<0.01 ng/cm^3	Niobium	0.50	Scandium	<0.01 ng/cm^3
Lead	45	Samarium	<0.01 ng/cm^3	Zirconium	2.2	Calcium	≈1700
Thallium	<0.01 ng/cm^3	Neodymium	<0.01 ng/cm^3	Yttrium	0.91	Potassium	≈2200
Mercury	NR*	Praseodymium	<0.01 ng/cm^3	Strontium	12	Chlorine	43
Gold	<0.01 ng/cm^3	Cerium	3.5	Rubidium	4.2	Sulfur	530
Platinum	<0.01 ng/cm^3	Lanthanum	1.6	Bromine	1.8	Phosphorus	82
Iridium	<0.01 ng/cm^3	Barium	21	Selenium	<0.01 ng/cm^3	Silicon	4800
Osmium	<0.01 ng/cm^3	Cesium	<0.01 ng/cm^3	Arsenic	1.9	Aluminum	670
Rhenium	Internal Standard	Iodine	<0.01 ng/cm^3	Germanium	<0.01 ng/cm^3	Magnesium	960
Tungsten	<0.01 ng/cm^3	Tellurium	<0.01 ng/cm^3	Gallium	<0.01 ng/cm^3	Sodium	High Blank
Tantalum	<0.01 ng/cm^3	Antimony	<0.01 ng/cm^3	Zinc	<0.01 ng/cm^3	Fluorine	420
Hafnium	<0.01 ng/cm^3	Tin	0.96	Copper	76	Oxygen	NR*
Lutecium	<0.01 ng/cm^3	Indium	Internal Standard	Nickel	<0.01 ng/cm^3	Nitrogen	NR*
Ytterbium	<0.01 ng/cm^3	Cadmium	<0.01 ng/cm^3	Cobalt	<0.01 ng/cm^3	Carbon	NR*
Thullium	<0.01 ng/cm^3	Silver	<0.01 ng/cm^3	Iron	950	Boron	NR*
Erbium	<0.01 ng/cm^3	Palladium	<0.01 ng/cm^3	Manganese	29	Beryllium	<0.01 ng/cm^3
Holmium	<0.01 ng/cm^3	Rhodium	<0.01 ng/cm^3	Chromium	<0.01 ng/cm^3	Lithium	5.0
Dysprosium	<0.01 ng/cm^3						

*NR - Not Reported

2.2 METEOROLOGY

The meteorological studies are designed to at least meet and, in some cases, exceed environmental lease stipulations.

The RBOSP meteorological data acquisition system is integrated into the network described in Section 2.1. It includes the instrument towers at Sites 1, 2, 3, and 4. Data Transmission from the remote sites and recording methods are similar to those utilized in the air quality studies, i.e., hardcopy reports are provided hourly, and continuous analog records are made for each parameter.

The Central Station is located at Site 1 which has a 60-meter meteorological tower. Wind speed, wind direction, air temperature and relative humidity are measured at the 10-meter level. Ambient temperature, wind speed, and wind direction are measured at the 30-and 60-meter levels, and the temperature differences between the 10-and 60-meter levels are recorded. Additionally, precipitation and solar insolation are monitored at ground level at Site 1.

The following parameters are not part of the automatic data acquisition system, but are monitored routinely or seasonally:

- Evaporation Rate
- Snow Depth and Water Content
- Particulates
- Visibility

At each of the remote sites (2, 3, and 4) there is a 10-meter meteorological tower. Wind speed, wind direction, and ambient air temperature are measured at the 10-meter level.

A seasonal upper-air study to measure winds and temperatures to an elevation of 13,000 feet above Mean Sea Level (MSL) is scheduled over Tract C-a for the first five quarters of the program. These studies, performed with pilot ballons in conjunction with theodolite tracking and aircraft-mounted temperature sensors, provide basic information on the mean mixing layer height above Tract C-a.

Tracer diffusion studies designed to tract dispersion of the tracer material in the lower atmosphere to evaluate modeling predictions and lead to a better understanding of terrain effects will be conducted. Ambient noise level measurements will also be made.

All of the data obtained are used to define the baseline atmospheric conditions and for application in the appropriate diffusion models used to predict the effects of shale oil operations on ambient air quality.

The baseline meteorological program is established at two lower atmospheric levels, referred to in this report as lower air studies and upper air studies. The lower air studies include data obtained at the four station networks; the upper air studies involve obtaining data on the winds aloft and vertical temperature profiles. Upper air studies are performed on a seasonal basis. Tracer studies are performed twice during the baseline study period concurrently with upper air wind and temperature samplings. Studies which provide useful information but do not fall into these categories are: precipitation, evaporation, solar radiation, noise, and visibility (discussed under Miscellaneous, Section 2.2.3).

2.2.1 <u>Lower Air Studies</u>

The lower air studies refer to the meteorological data acquired from the four station ground networks and include wind speed, direction, and temperature at 10 meters above the surface at all four monitoring sites. Relative humidity at 10 meters, wind speed wind direction, air temperature at 30 and 60 meters above the surface and snow course measurements at the main monitoring site are also included.

2.2.1.1 Objectives

The objectives in measuring meteorological parameters in the lower atmosphere are: a) supply site and area specific baseline data which may also be used for necessary ecological modeling, and b) supply data necessary for mathematical diffusion modeling to predict air quality impact. These data and knowledge of key shale oil operations emission factors allow the calculation of expected pollutant concentrations. The measurements made will be used as input data in the model applied to the complex terrain of Tract C-a.

2.2.1.2 Methods

No change has occured since Progress Report 2. See section 2.2.1.2 in Progress Report 2 for specific methods used in the meteorological lower air studies.

2.2.1.3 Results

The seasonal summaries for Spring 1975, of the minimum, maximum, and mean values of the meteorological parameters measured at each site are presented in Table 2.2-1. The composite hour is the mean of the data taken during a particular hour of the day for all days of the month. A composite day defines the maximum, minimum, and mean values for 24 composite hours of a month. The maximum and minimum listed are the individual hourly averages which are greater than or less than all other hourly averages.

Winds at Sites 1 and 2 (10-meter level) were predominantly from the southwest during Spring 1975. The mean wind speeds were 8.72 and 10.43 mph respectively. Although Sites 1 and 2 are at about the same elevation (7400 feet above MSL) the local terrain at Site 2 is relatively flatter than at Site 1. The Site 2 monitoring location is the highest point within a radius of approximately 1 km. The 10-meter level of the main meteorological tower at Site 1 is approximately 50 meters lower than the elevation of several nearby knolls. The terrain influence at Site 1 is probably responsible for the lower mean wind speed.

The mean wind speeds at Sites 3 and 4 during the Spring 1975 period were 6.98 and 6.95 mph, respectively. Sites 3 and 4, below the plateau levels, are situated in the approximate centers of Corral Gulch and Yellow Creek Gulch at elevations of 6570 and 6280 feet above MSL. Corral Gulch runs in a west to east direction.

Wind rose data for Spring 1975 are presented for all four monitoring stations in Figures 2.2-1 through 2.2-4.

Wind rose data (10-meter level) from Sites 1 and 2 are comparable. The reduced frequency of occurrence of southwest winds relative to south-southwest and west-southwest winds is probably caused by the influence from a small knoll about 200 meters to the southwest of Site 1. Terrain induced wind channeling effects exist at Sites 3 and 4. Winds at Site 3 are predominantly from the west, which is in agreement with the westerly course of Corral Gulch. The predominate winds at Site 4 are from the south-southwest, corresponding to the orientation of Stake Springs Draw and Yellow Creek. In addition to the terrain-induced channeling of the gradient winds at Sites 3 and 4, there probably exist significant contributions to the frequency of occurrence of the wind directions from valley drainage flows.

A least squares fit to the mean seasonal wind speed as a function of height at the 60-meter tower (Site 1) was done to investigate the applicability of the logarithmic wind profile:

$$u = \frac{u_*}{K} \ln \left(\frac{Z}{Z_o}\right)$$

Table 2.2-1 Meteorological parameters monthly summary for April 1975, RBOSP

Parameter	Minimum	Maximum	Mean	Units
		SITE 1		
Wind Speed (10 meters)	0.84	26.80	8.82	mph
Wind Speed (30 meters)	0.60	34.20	10.76	mph
Wind Speed (60 meters)	0.99	38.43	12.64	mph
Air Temperature (10 meters)	-12.10	14.84	1.11	C
Air Temperature (30 meters)	-11.60	14.09	0.64	C
Temperature Difference (60 to 10 meters)	-2.57	1.44	0.23	C
Relative Humidity (10 meters)	19.66	91.58	45.81	%
		SITE 2		
Wind Speed (10 meters)	0.70	33.84	10.71	mph
Air Temperature (10 meters)	-13.60	14.64	0.71	C
		SITE 3		
Wind Speed (10 meters)	0.80	21.80	7.15	mph
Air Temperature (10 meters)	-21.60	17.05	0.61	C
		SITE 4		
Wind Speed (10 meters)	0.67	28.63	7.08	mph
Air Temperature (10 meters)	-27.00	18.34	0.90	C

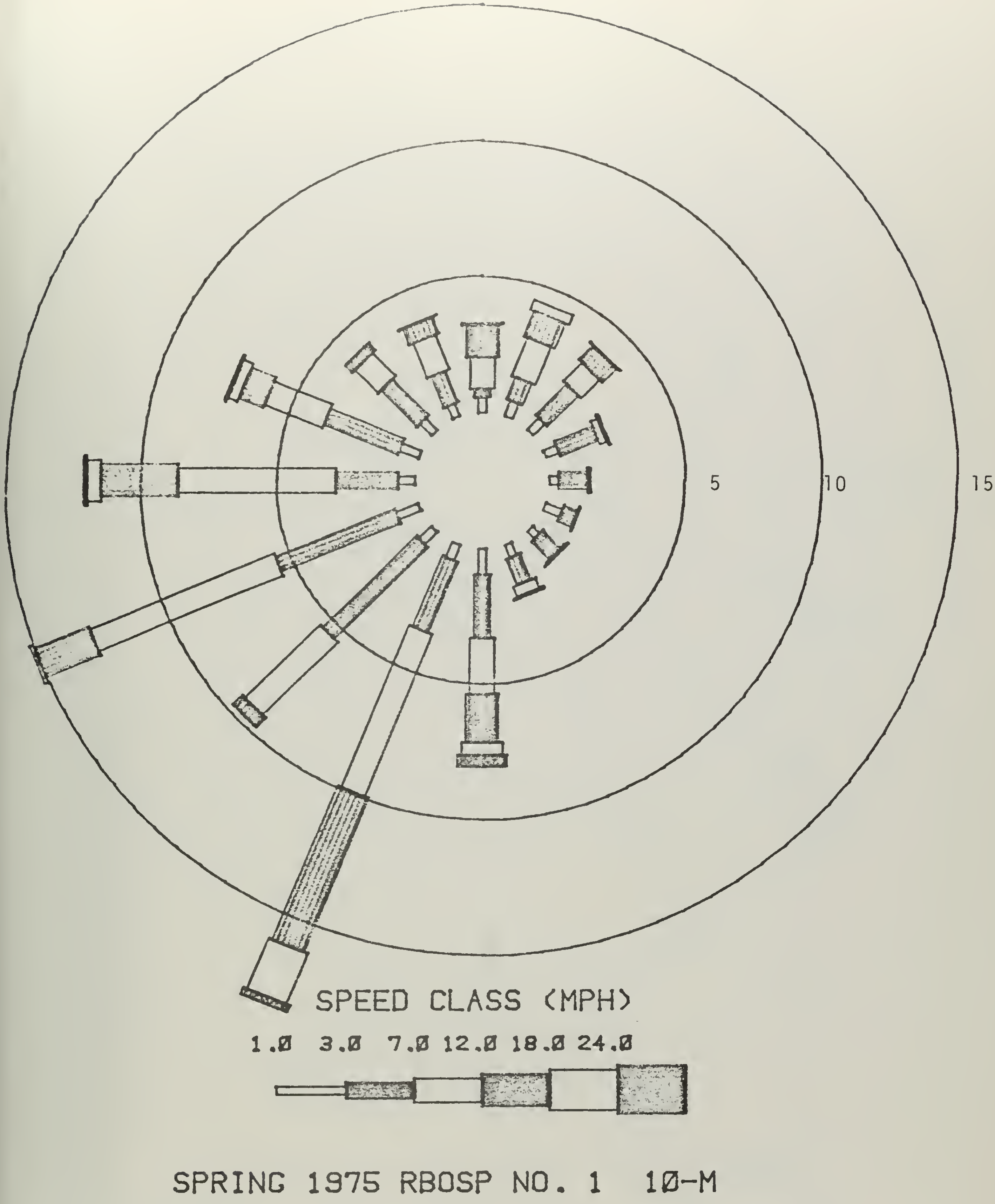


Figure 2.2-1 - Spring 1975 Wind Rose from the 10-Meter Level at Site 1 of the RBOSP.

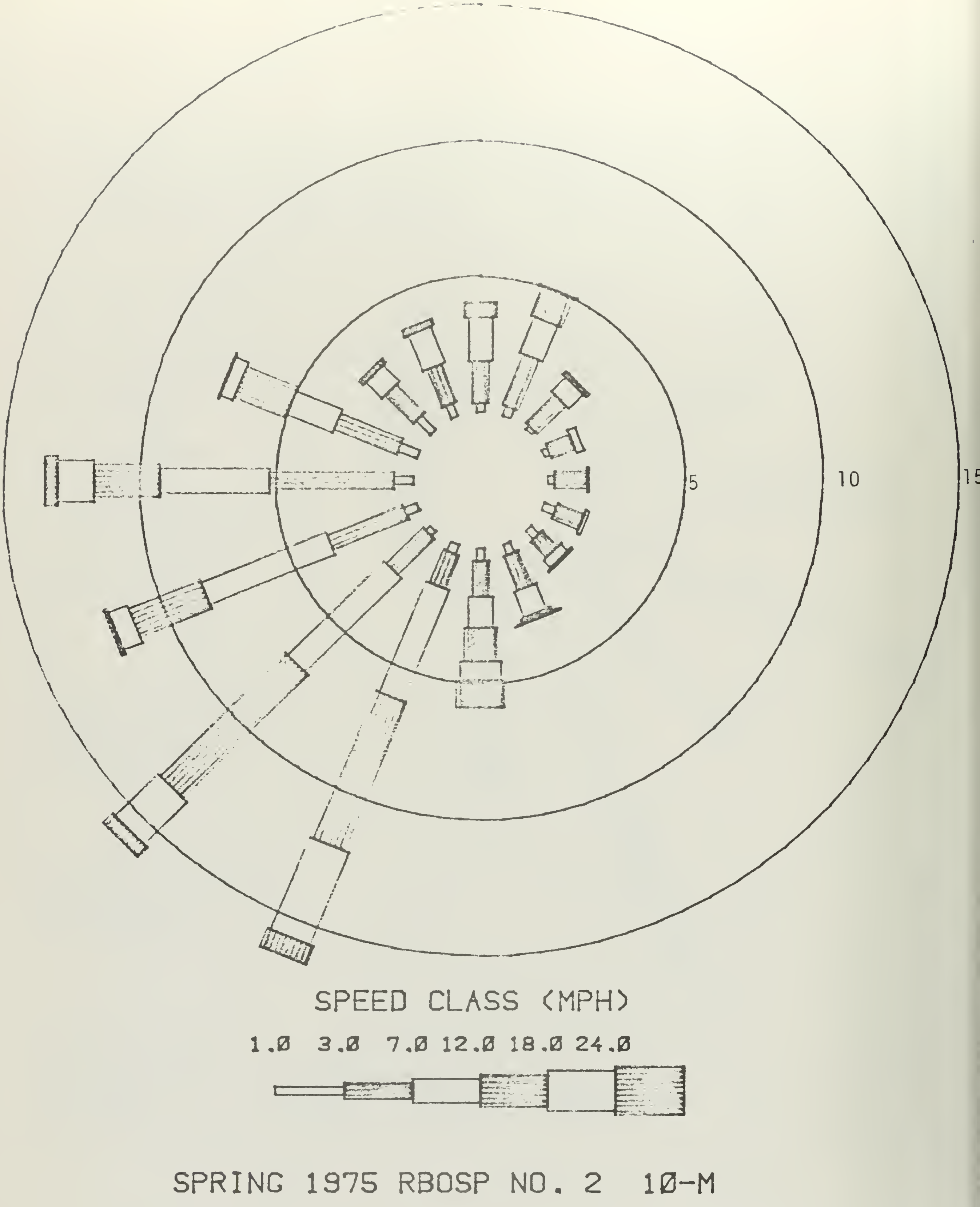


Figure 2.2-2 - Spring 1975 Wind Rose from the 10-Meter Level at Site 2 of the RBOSP.

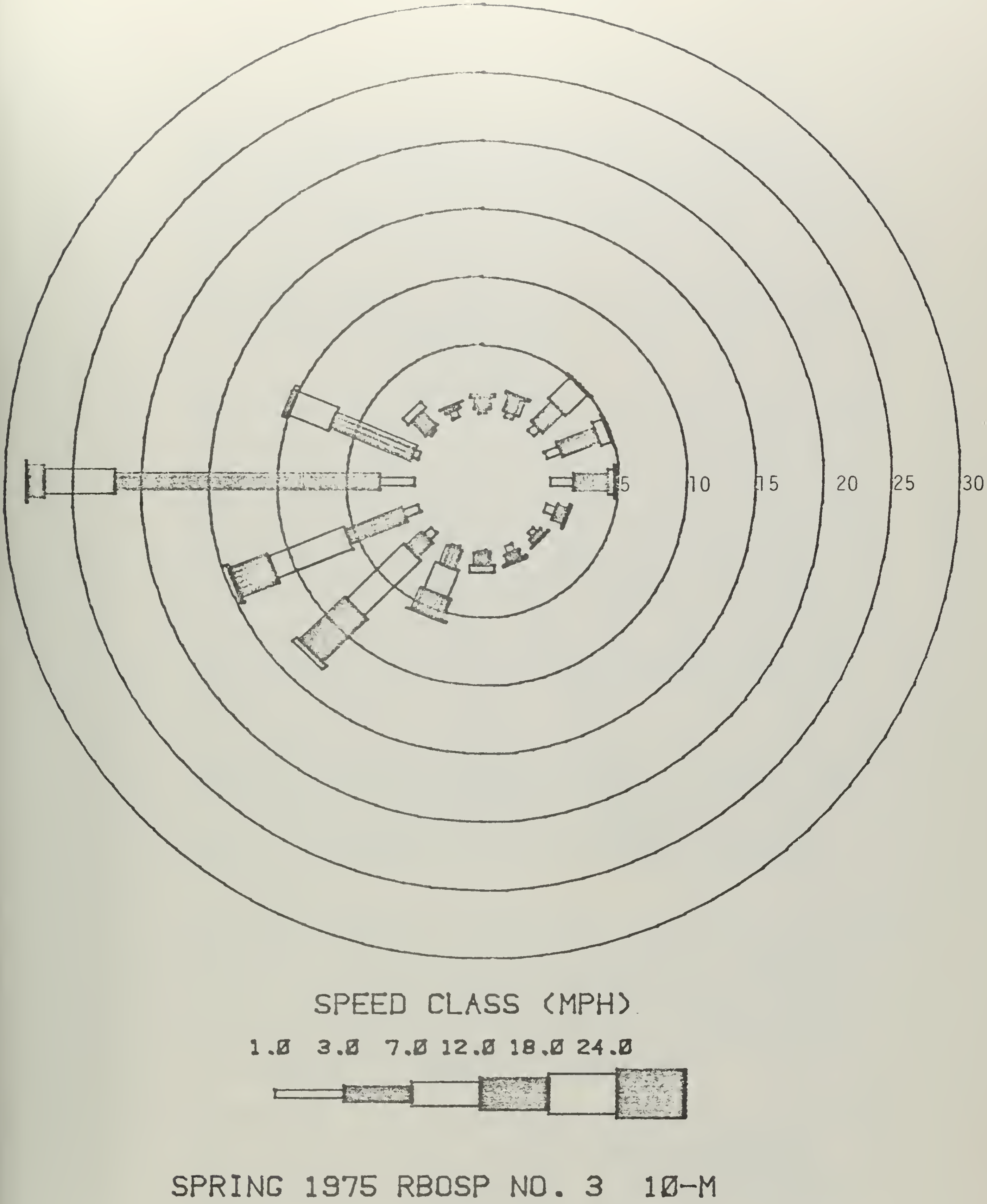
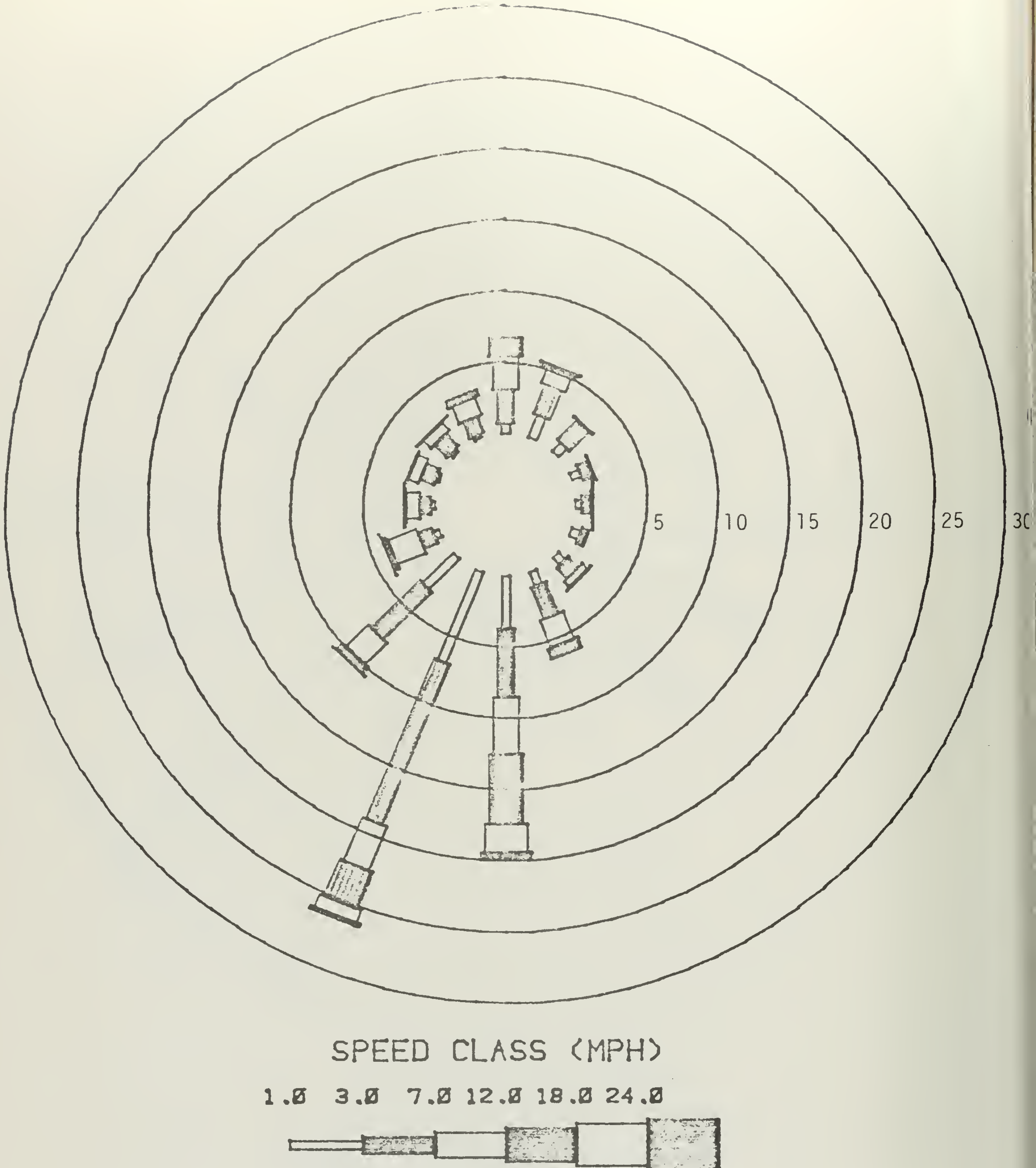


Figure 2.2-3 - Spring 1975 Wind Rose from the 10-Meter Level at Site 3 of the RBOSP.



SPRING 1975 RBOSP NO 4 10-M

Figure 2.2-4 - Spring 1975 Wind Rose from the 10-Meter Level at Site 4 of the RBOSP.

where Z_0 is the roughness parameter, K is the von Karman constant, u_* is the friction velocity and Z is the height above ground (m). The seasonal data fit the logarithmic wind profit to a high degree of confidence (coefficient of determination = r^2 - 0.99) with u_*/K = 0.85 m/sec and Z_0 = 0.11 meter.

The minimum, maximum, and mean values of air temperature at the 10-meter level as a function of the hour of the day for each of the four sites and for each month of the Spring study are plotted in Figures 2.2-5 through 2.2-16.

The valley sites (3 and 4) have a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Sites 1 and 2, is much greater. This is probably because of cold air valley drainage flows. The composite day air temperature data for Sites 3 and 4 indicate that more cold air accumulates at Site 4 than at Site 3. The 200-foot elevation difference and the Stake Spring Draw air flow, as well as the Corral Gulch air flow draining into the Yellow Creek Gulch, contribute to this intensity difference.

Although there is substantial difference in the diurnal variation between all sites, the average temperatures over each month and the season agree well (to within 1 Celsius) among sites.

Atmospheric stability was determined from temperature difference measurements made between the 10-meter and the 60-meter level on the main meteorological tower at Site 1. Figures 2.2-17, 2.2-18, and 2.2-19 present the minimum, maximum, and mean composite day temperature differences as a function of the time of day for March, April, and May 1975, respectively.

These data indicate that the mean-surface inversion is relatively weak (about a -0.2 Celsius difference in temperature) during the interval from 1900 hours MST in the evening until 0600 hours MST the following morning. The break-up of the mean surface inversion occurs rapidly about an hour after sunrise when the lapse rate becomes significantly unstable. The intensities of the most stable inversions are much larger than those of the most unstable conditions.

The percentage of occurrence of the modified Pasquill stability categories for Spring 1975 and their associated mean wind speeds are presented in Table 2.2-2. The wind speeds, as a function of stability category, show a definite relationship. Categories A through D are associated with a significantly higher wind speed than Categories E through G.

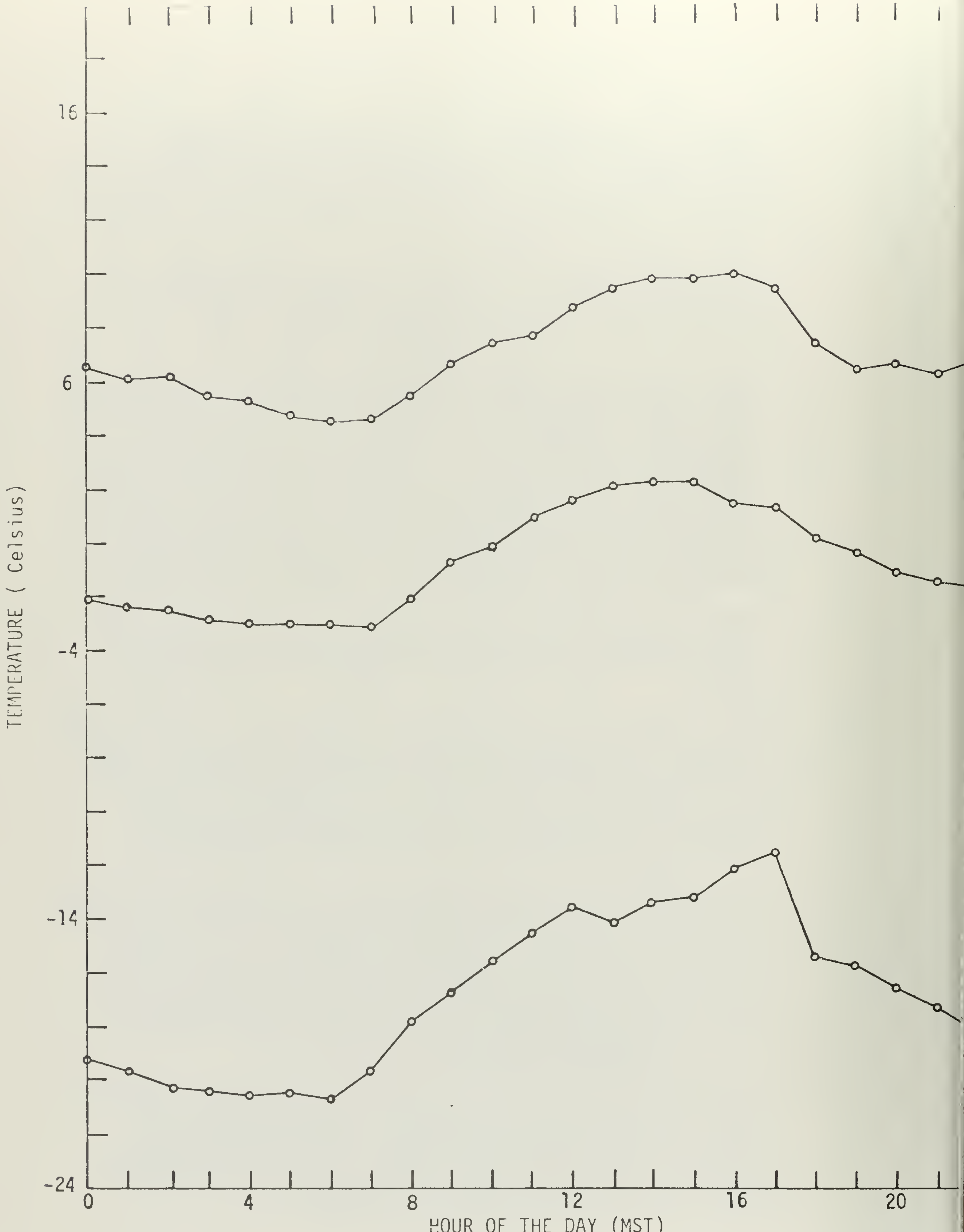


Figure 2.2-5 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from March 1975 at Site 1 of the RBOSP.

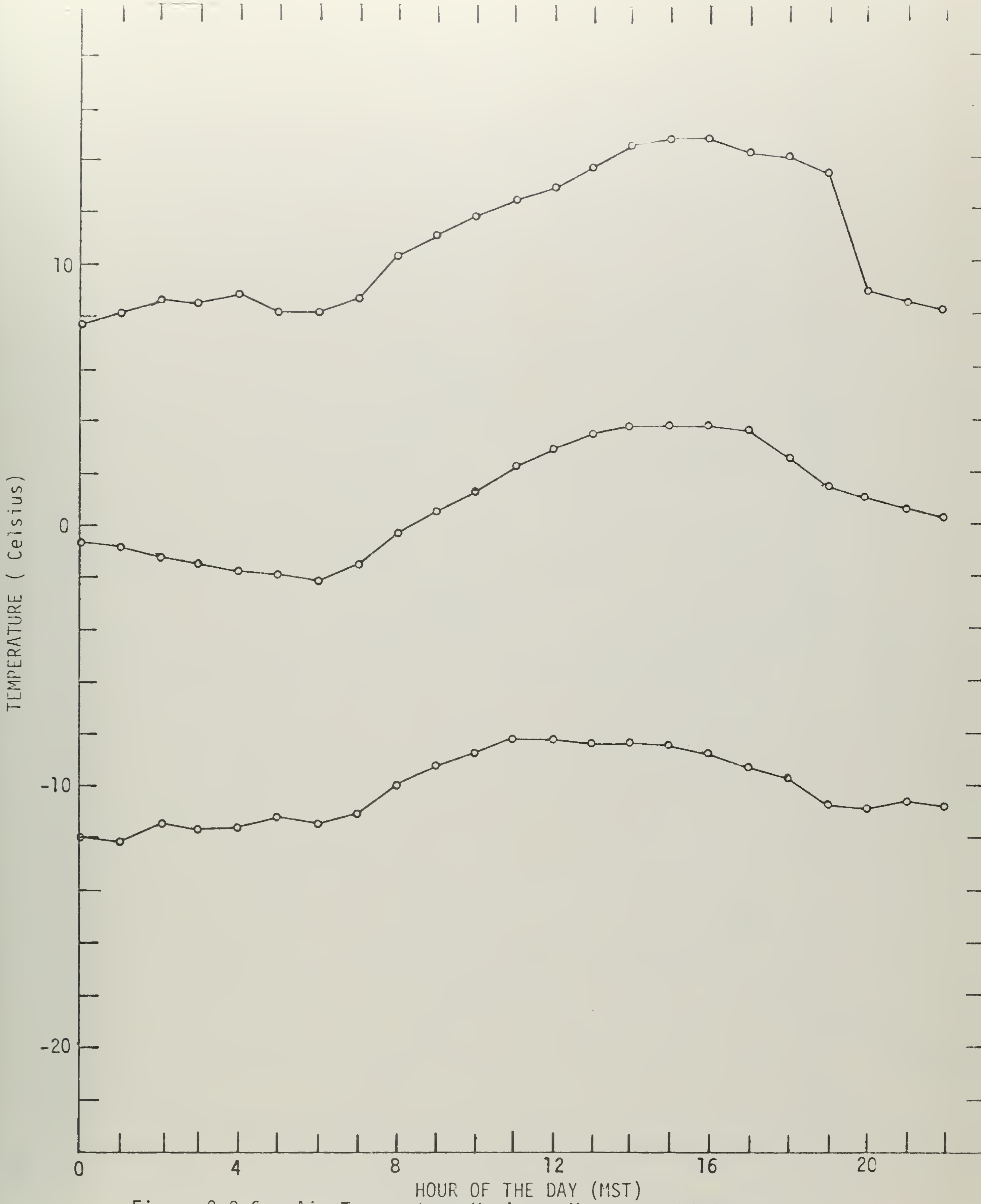


Figure 2.2-6 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from April 1975 at Site 1 of the RBOSP.

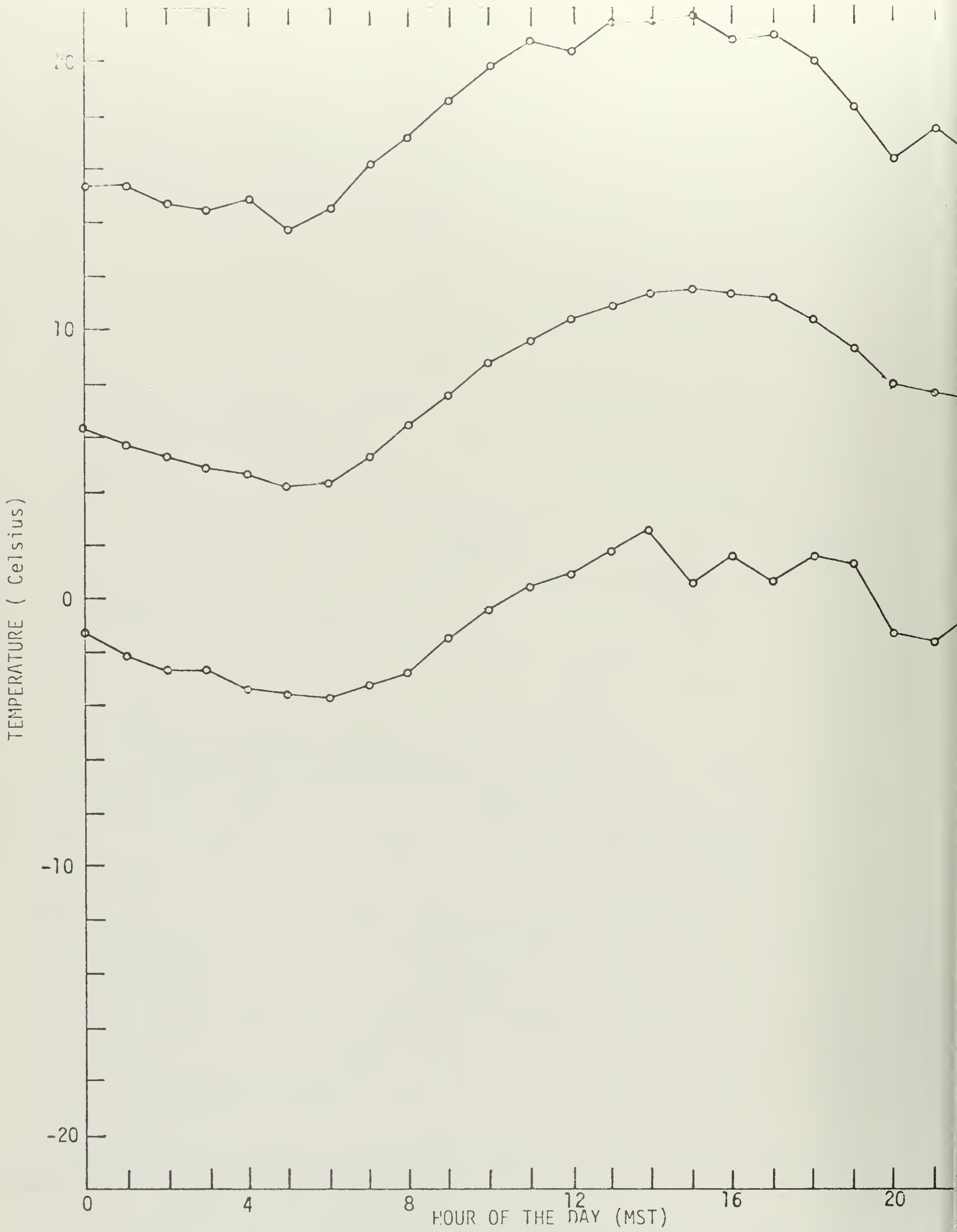


Figure 2.2-7 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from May 1975 at Site 1 of the RBOSP.

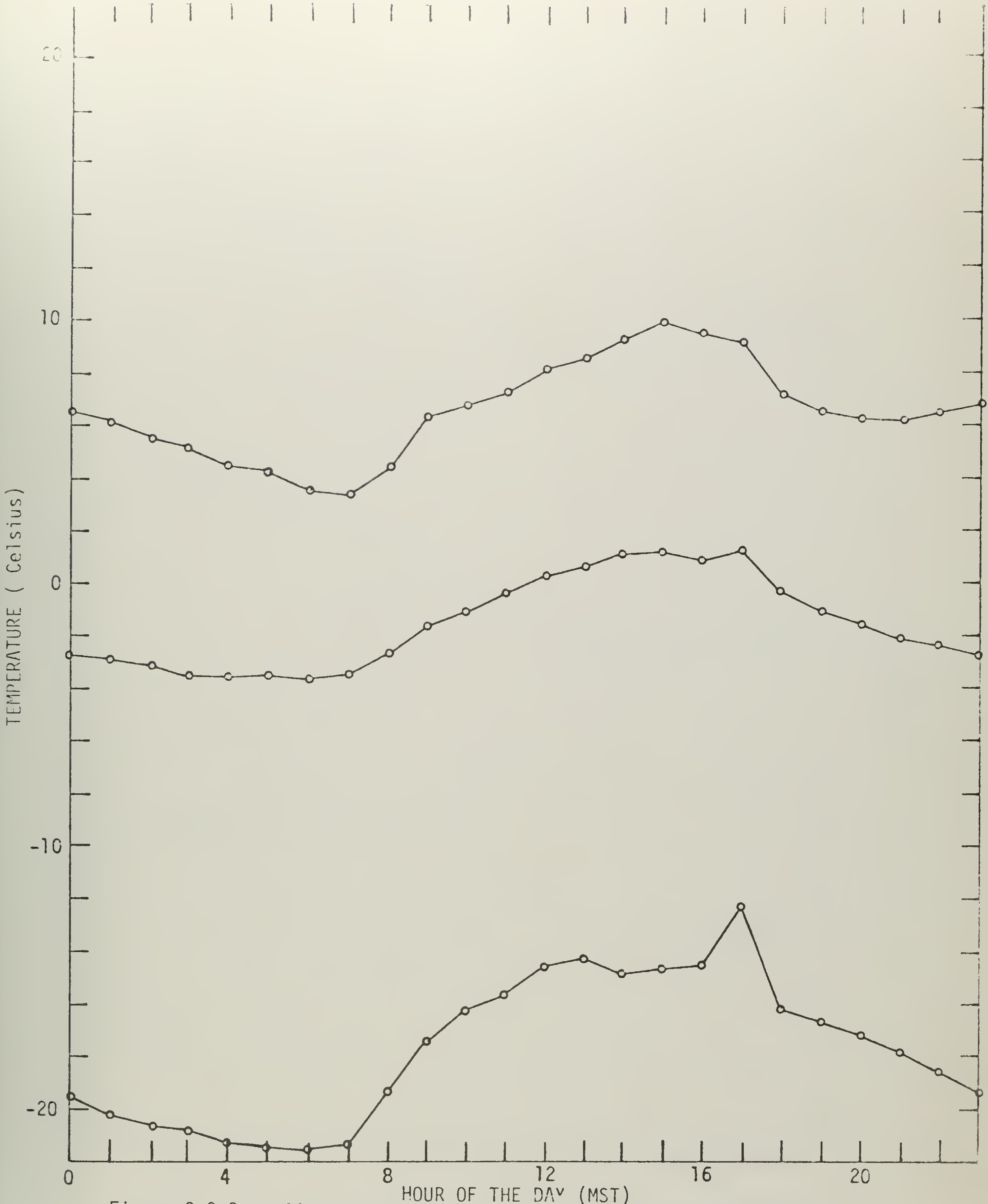


Figure 2.2-8 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from March 1975 at Site 2 of the RBOSP.

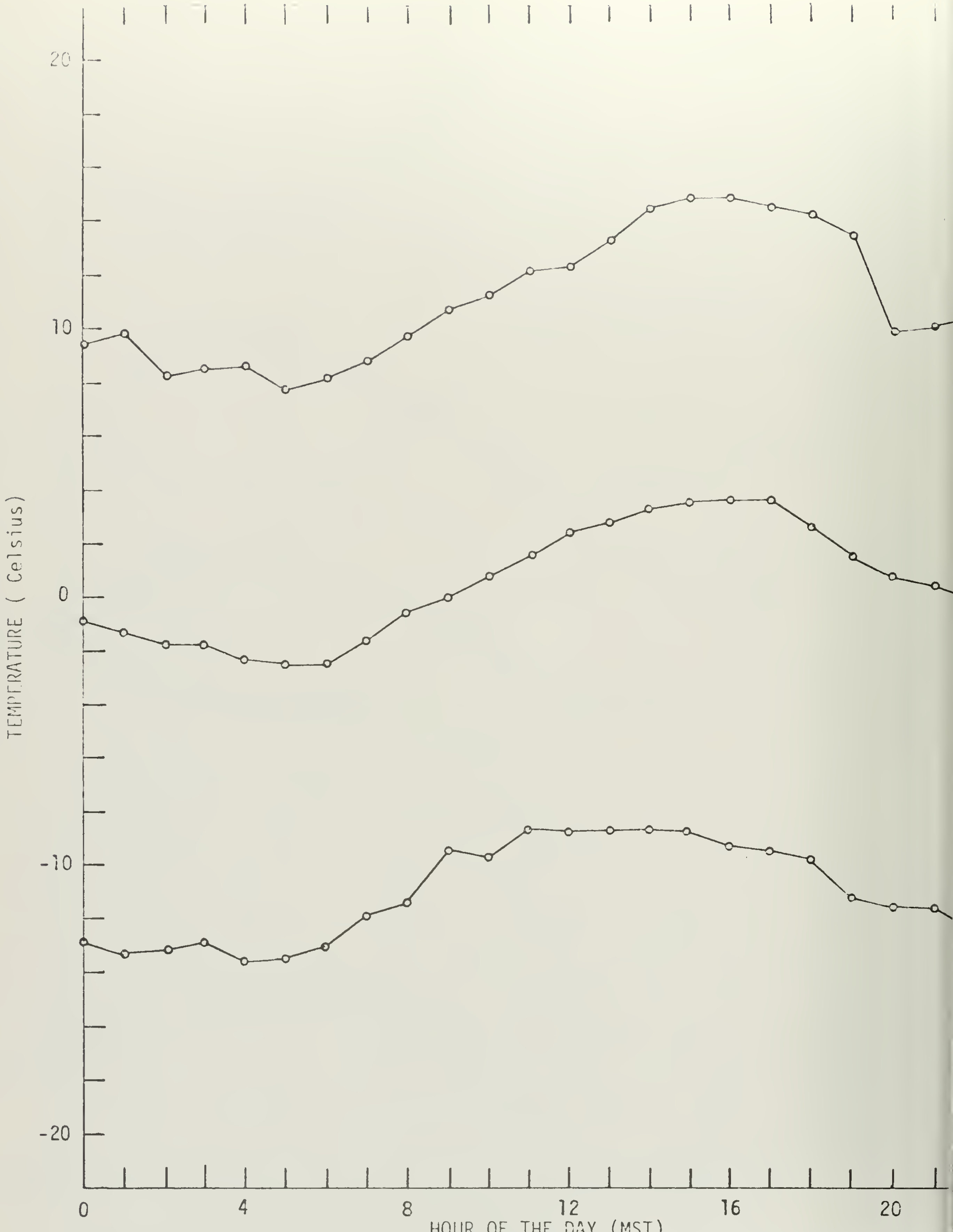


Figure 2.2-9 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from April 1975 at Site 2 of the RBOSP.

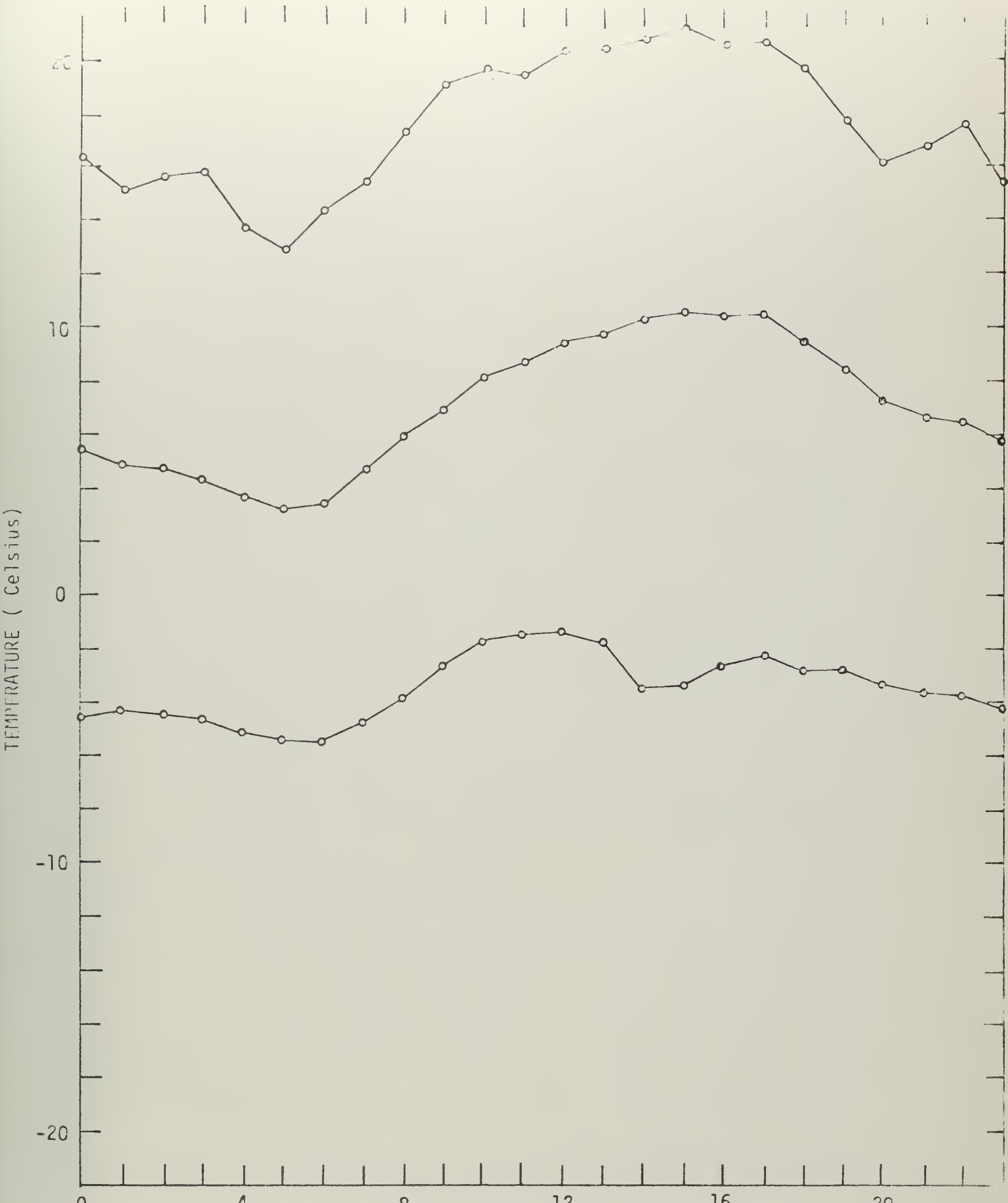


Figure 2.2-10 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from May 1975 at Site 2 of the RBOSP.

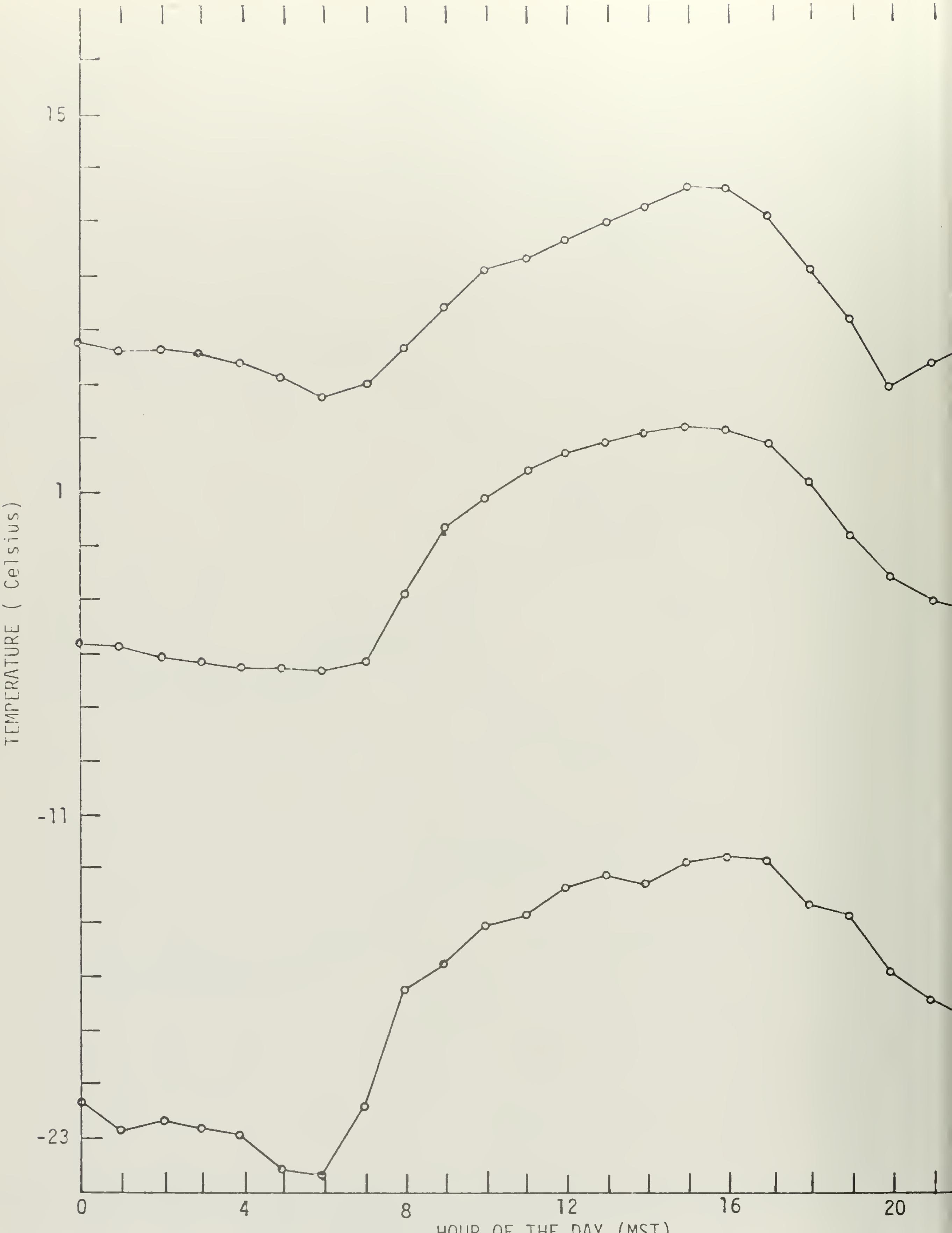


Figure 2.2-11 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from March 1975 at Site 3 of the RBOSP.

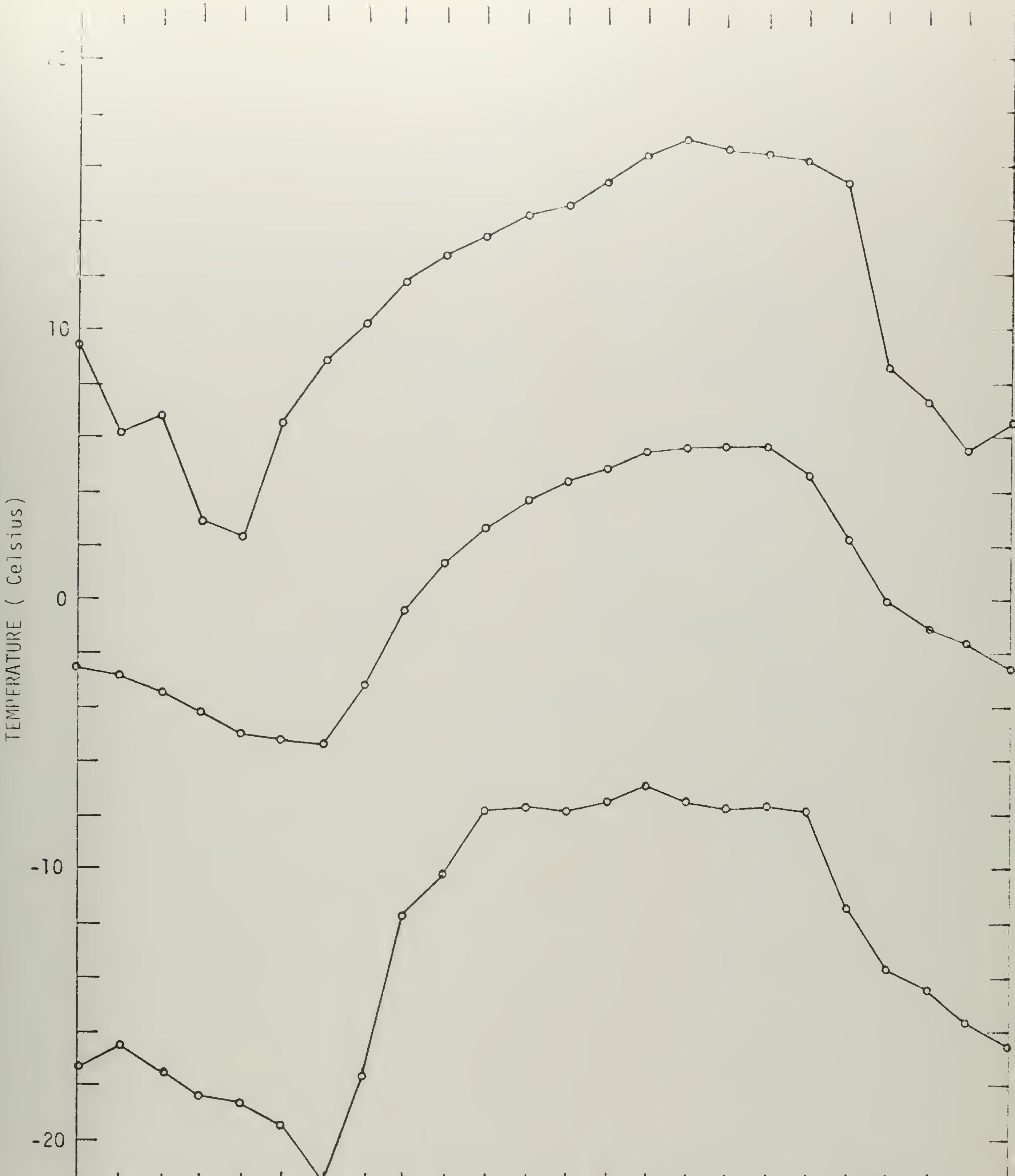


Figure 2.2-12 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from April 1975 at Site 3 of the RBOSP.

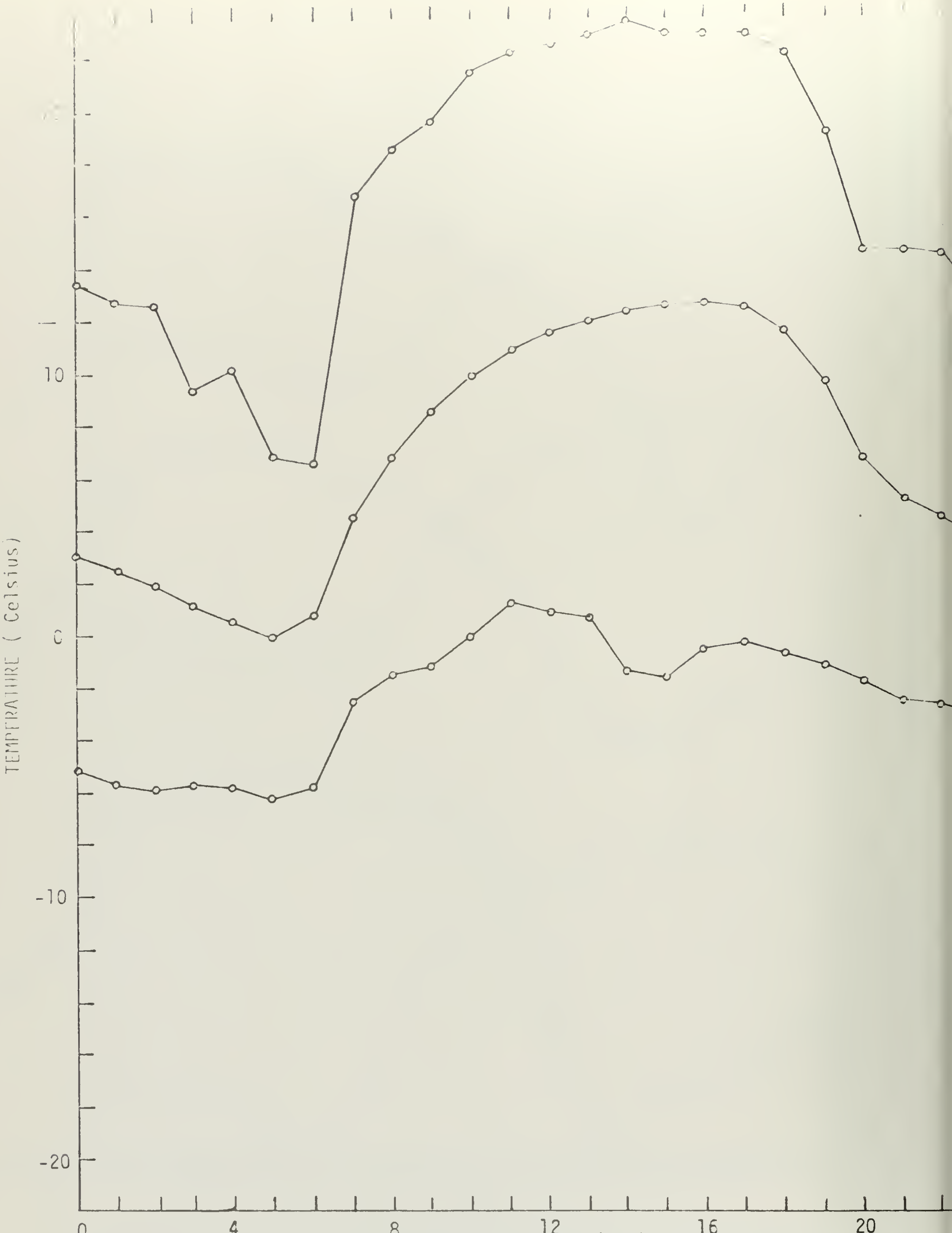


Figure 2.2-13 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from May 1975 at Site 3 of the RBOSP.

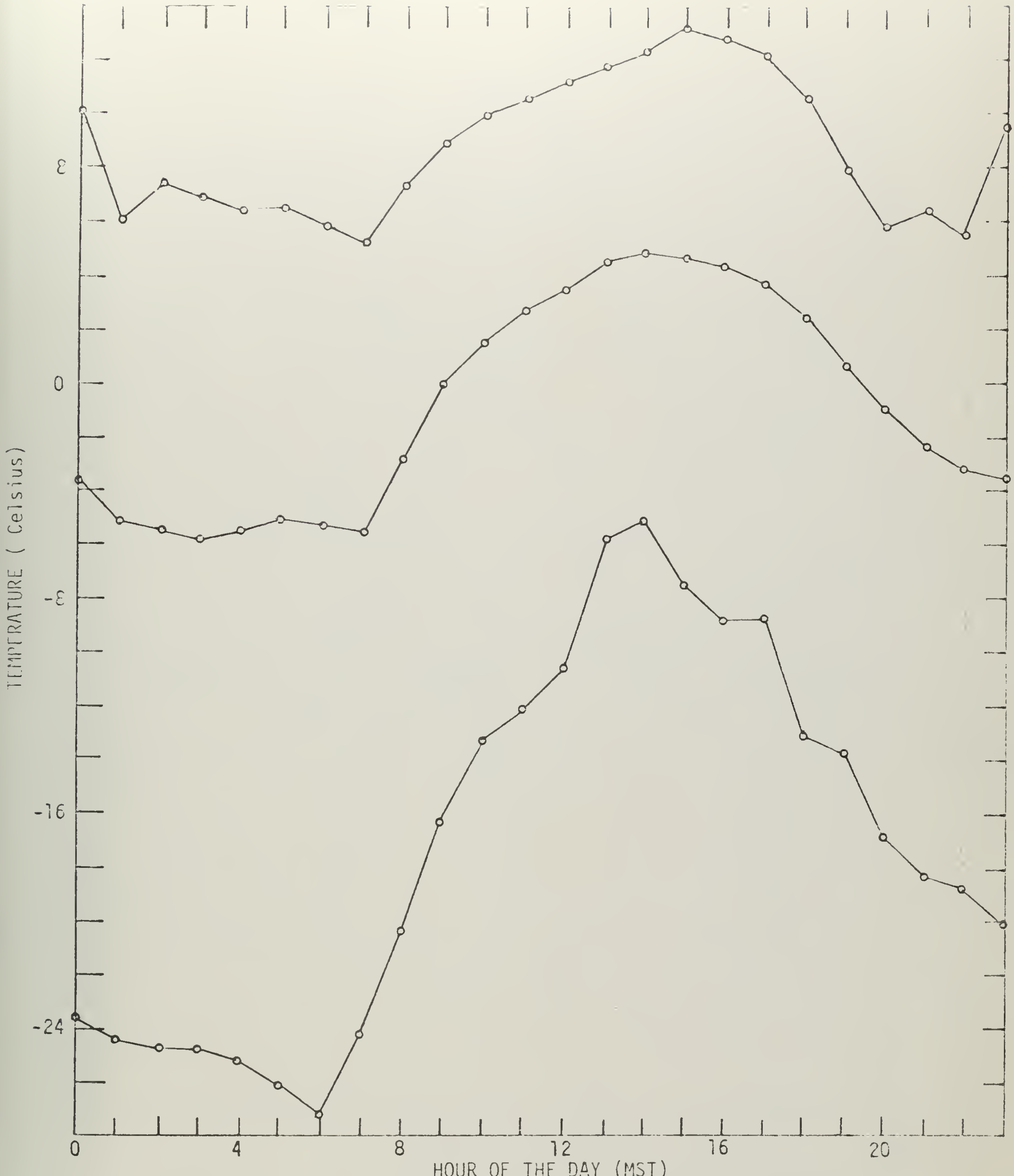


Figure 2.2-14 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from March 1975 at Site 4 of the RBOSP.

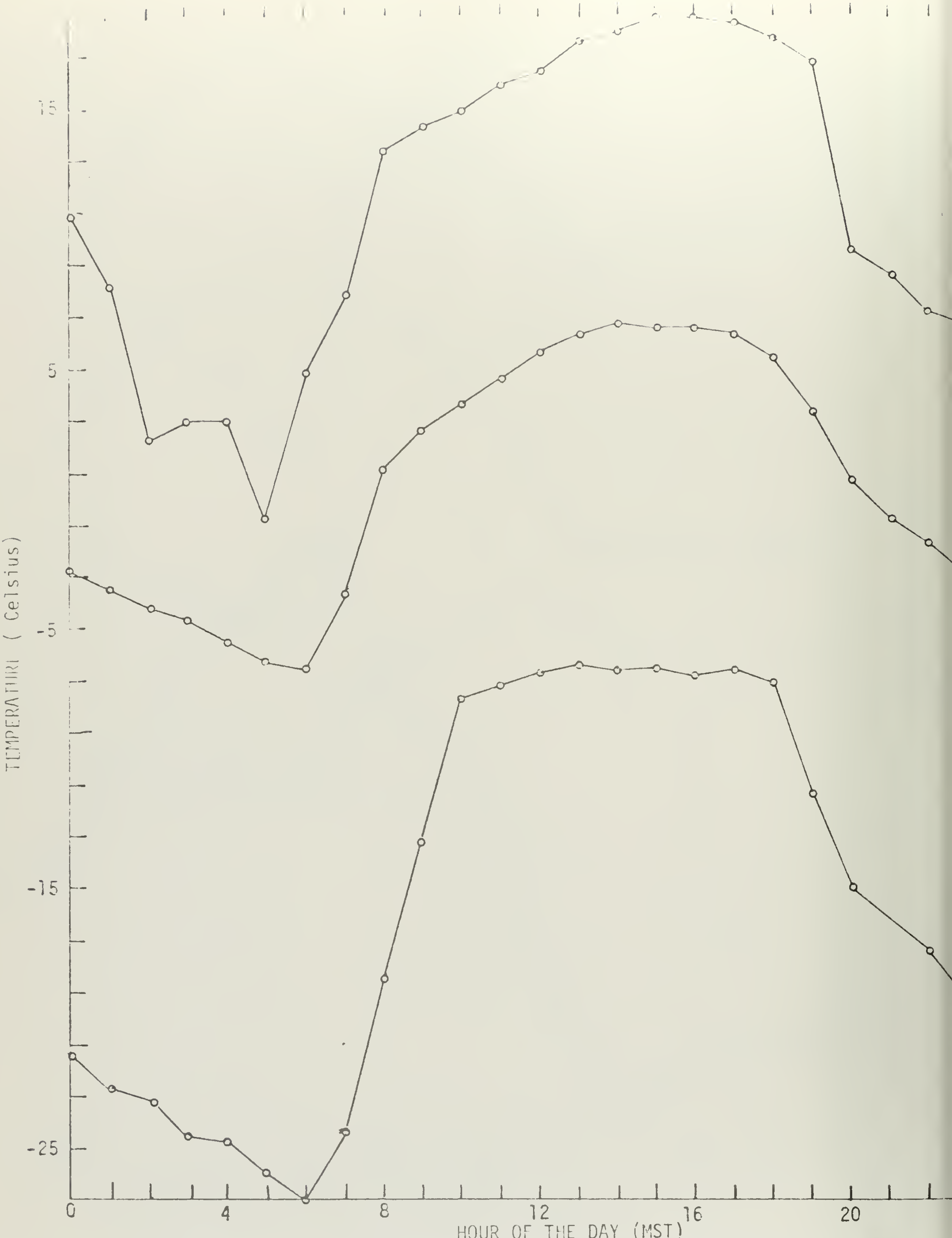


Figure 2.2-15 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from April 1975 at Site 4 of the RBOSP.

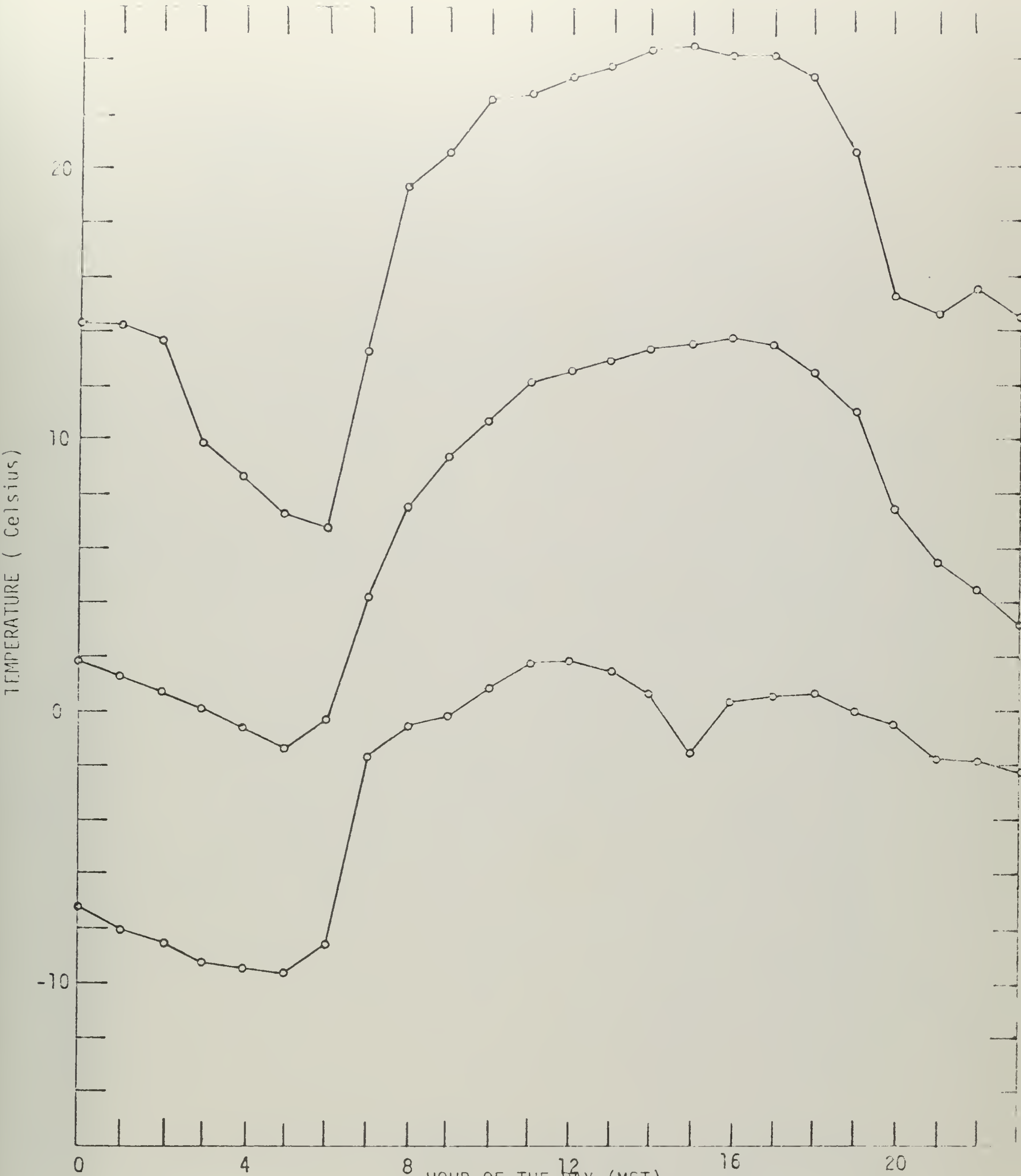


Figure 2.2-16 - Air Temperature Maximum, Mean, and Minimum by Hour of the Day from May 1975 at Site 4 of the RBOSP.

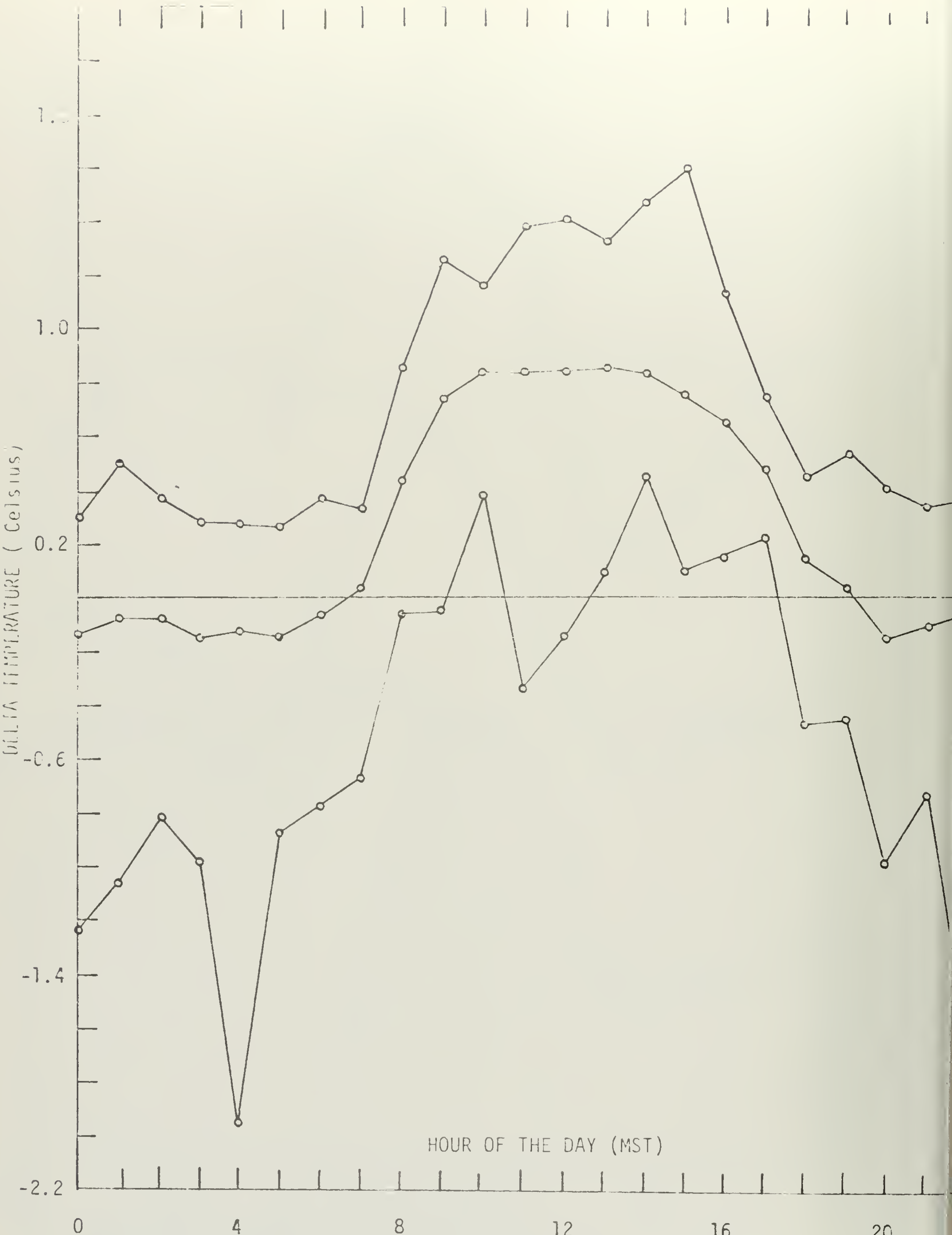


Figure 2.2-17 - Temperature Difference between the 10-Meter and 60-Meter Levels (Maximum, Mean, and Minimum by Hour of the Day) for March 1975 at Site 1 of the RBOSP.

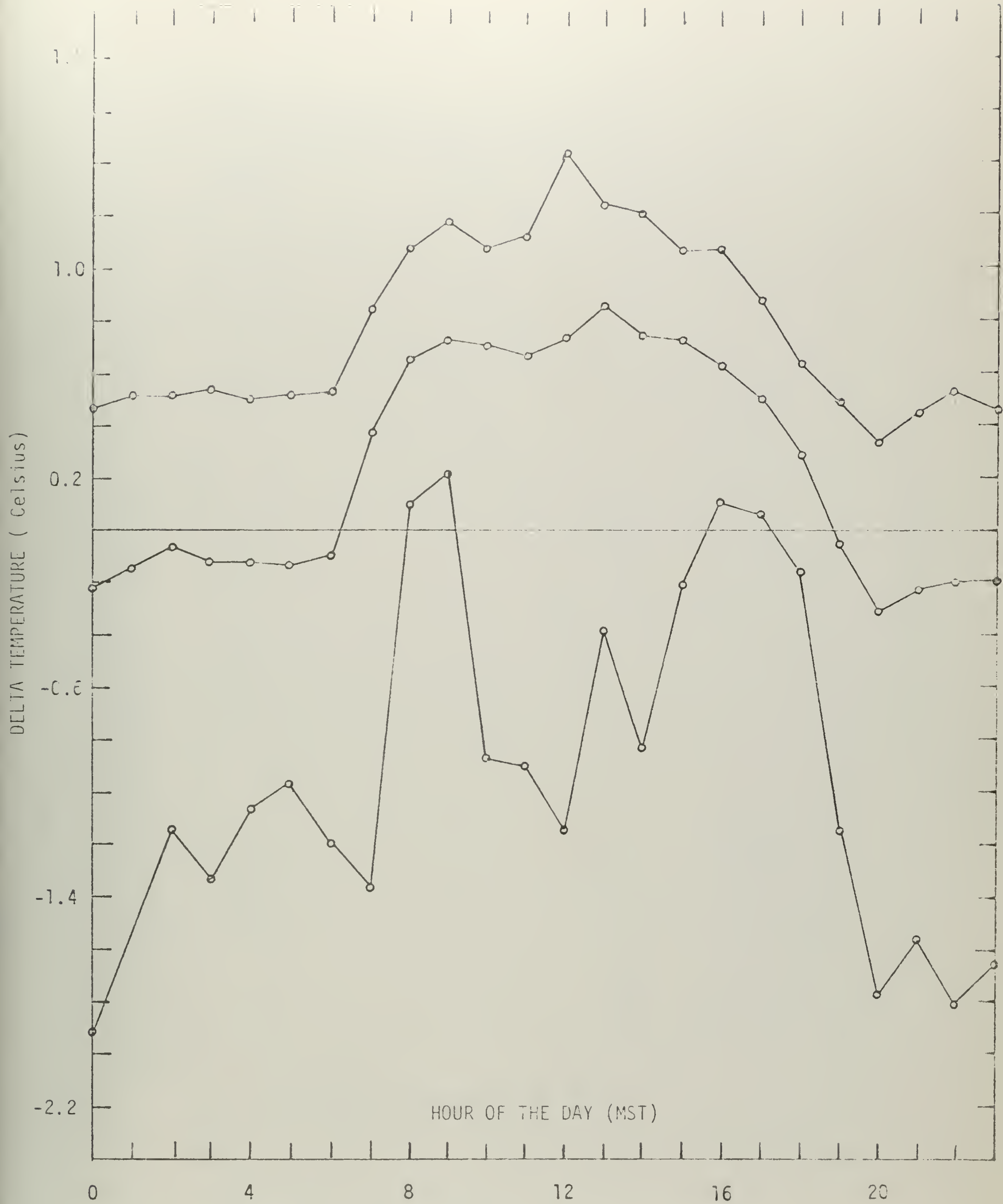


Figure 2.2-18 - Temperature Difference between the 10-Meter and 60-Meter Levels (Maximum, Mean, and Minimum by Hour of the Day) for April 1975 at Site 1 of the RBOSP.

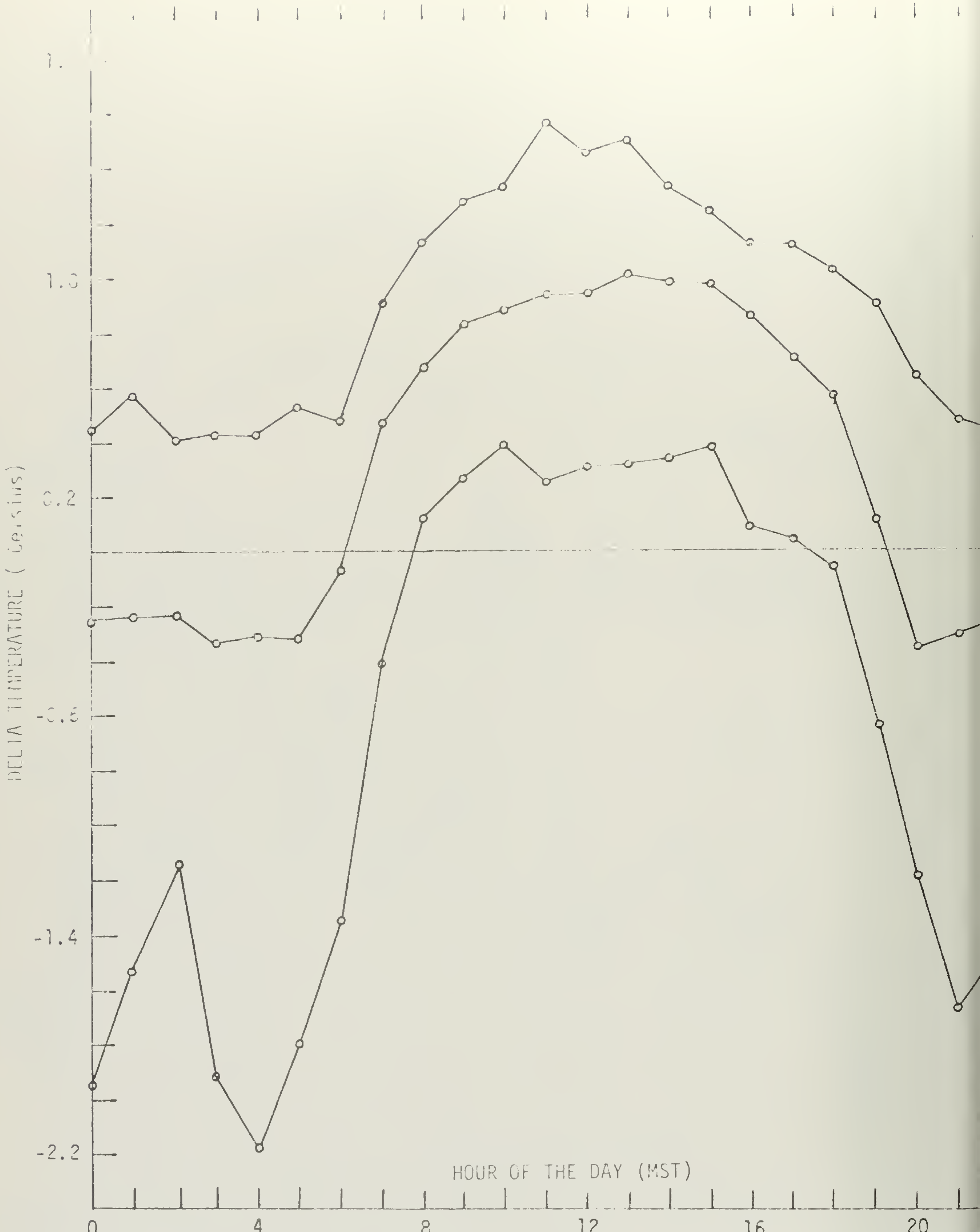


Figure 2.2-19 - Temperature Difference between the 10-Meter and 60-Meter Levels (Maximum, Mean, and Minimum by Hour of the Day) for May 1975 at Site 1 of the RBOSP.

Table 2.2-2 Percent of occurrence of the Pasquill stability classes at Site 1. Stability category determined from the temperature difference between the 10- and 60-meter levels for Spring 1975, RBOSP

Stability Classification	Pasquill Categories	Temperature Change with Height (C/100m)	Percent of Occurrence	Mean Wind Speed (mph)
Extremely Unstable	A	Less than -1.9	11.54	9.87
Moderately Unstable	B	-1.9 to -1.7	6.19	9.28
Slight Unstable	C	-1.7 to -1.5	6.05	9.61
Neutral	D	-1.5 to -0.5	30.27	9.55
Slightly Stable	E	-0.5 to 1.5	40.26	7.39
Moderately Stable	F	1.5 to 4.0	5.58	7.58
Extremely Stable	G	Greater than 4.0	0.09	5.08

Figures 2.2-20 through 2.2-22 graphically present the maximum, minimum and mean composite day relative humidities as a function of hour of the day for March, April, and May, 1975. The relative humidity data were taken at the 10-meter level at Site 1. There was a significant decrease (65% to 35%) in the average relative humidity at sunrise. The effect is probably due to the rapid surface heating of the air, although the transition period takes over two hours. The decrease probably arises from the increased thermally generated turbulent mixing caused by the reversal of the average lapse rate from slightly stable to slightly unstable and increased surface temperature. The diurnal variation of the maximum hourly humidity is greater than that of the minimum hourly humidity. Although there is no ready explanation, it is apparent that this effect is real and is probably not a statistical variation.

Snow course measurements were made at Site 1 on the days shown in Table 2.2-3. Because of the time of year, little data were available. Traces of snow fell on several days, but no measureable amount was produced on the actual snow course because of drifting. Maximum snow depth of 7.4 inches was recorded on 1 April, water content was 0.20 inch.

2.2.2 Upper Air Studies

2.2.2.1 Objectives

The objective of these studies is to investigate the temperature and wind structure of the atmosphere over Tract C-a as a function of season. These data will be included in modeling studies to predict the environmental impact of future oil shale developments.

The studies required 15 days of soundings, 4 each day. Since inclement weather could force cancellation of aircraft flights and limit tracking, a successful data day is defined as one having a minimum of two temperature profiles, one of which is flown into the valley below Tract C-a.

The period of performance of the field work was from 14 April through 1 May 1975.

2.2.2.2 Methods

The vertical temperature structure from the surface to 13,000 feet Mean Sea Level (MSL) was determined four times each day

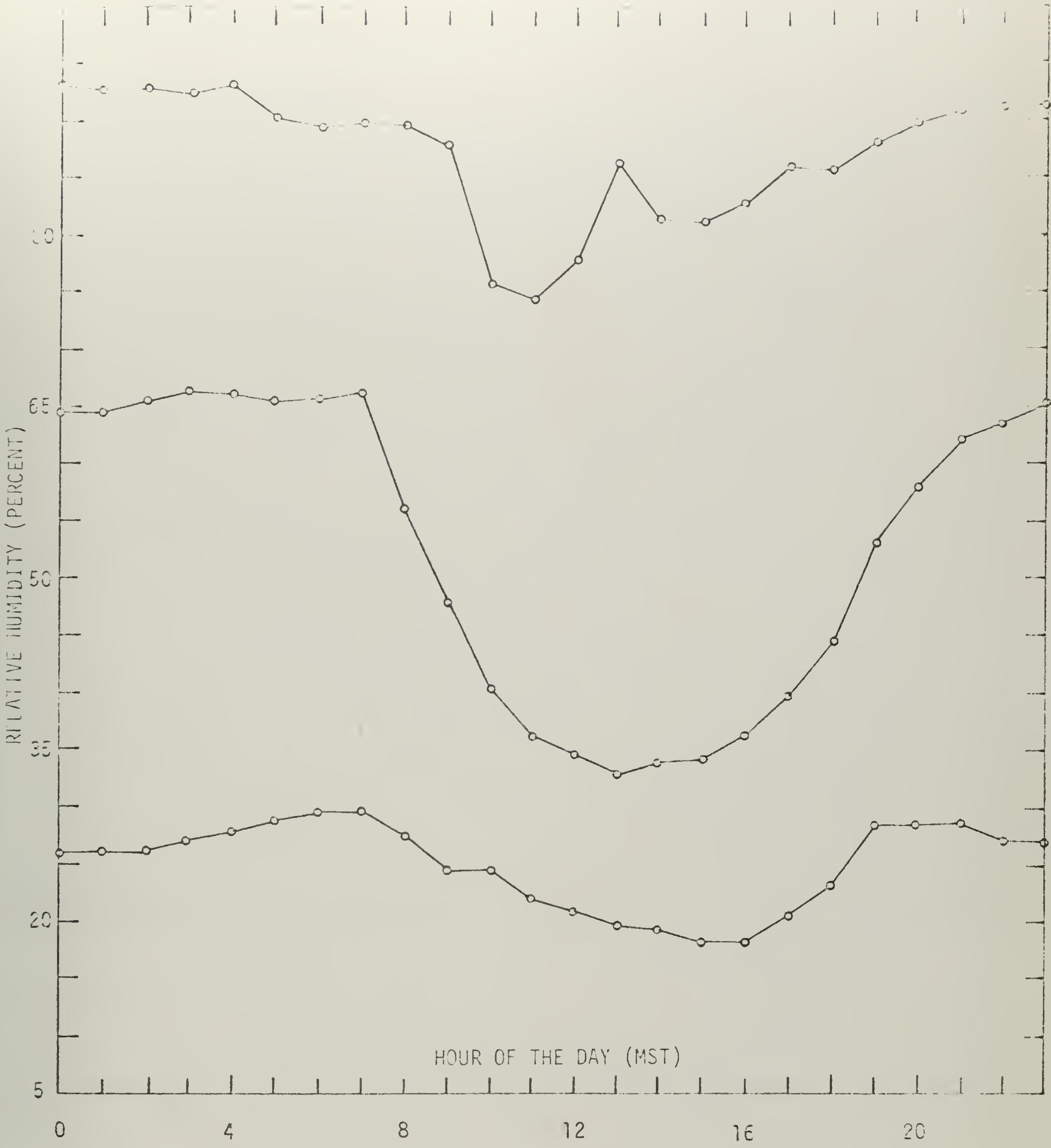


Figure 2.2-20 - Relative Humidity (percent), Maximum, Mean, and Minimum by Hour of the Day for March 1975 at Site 1 of the RBOSP.

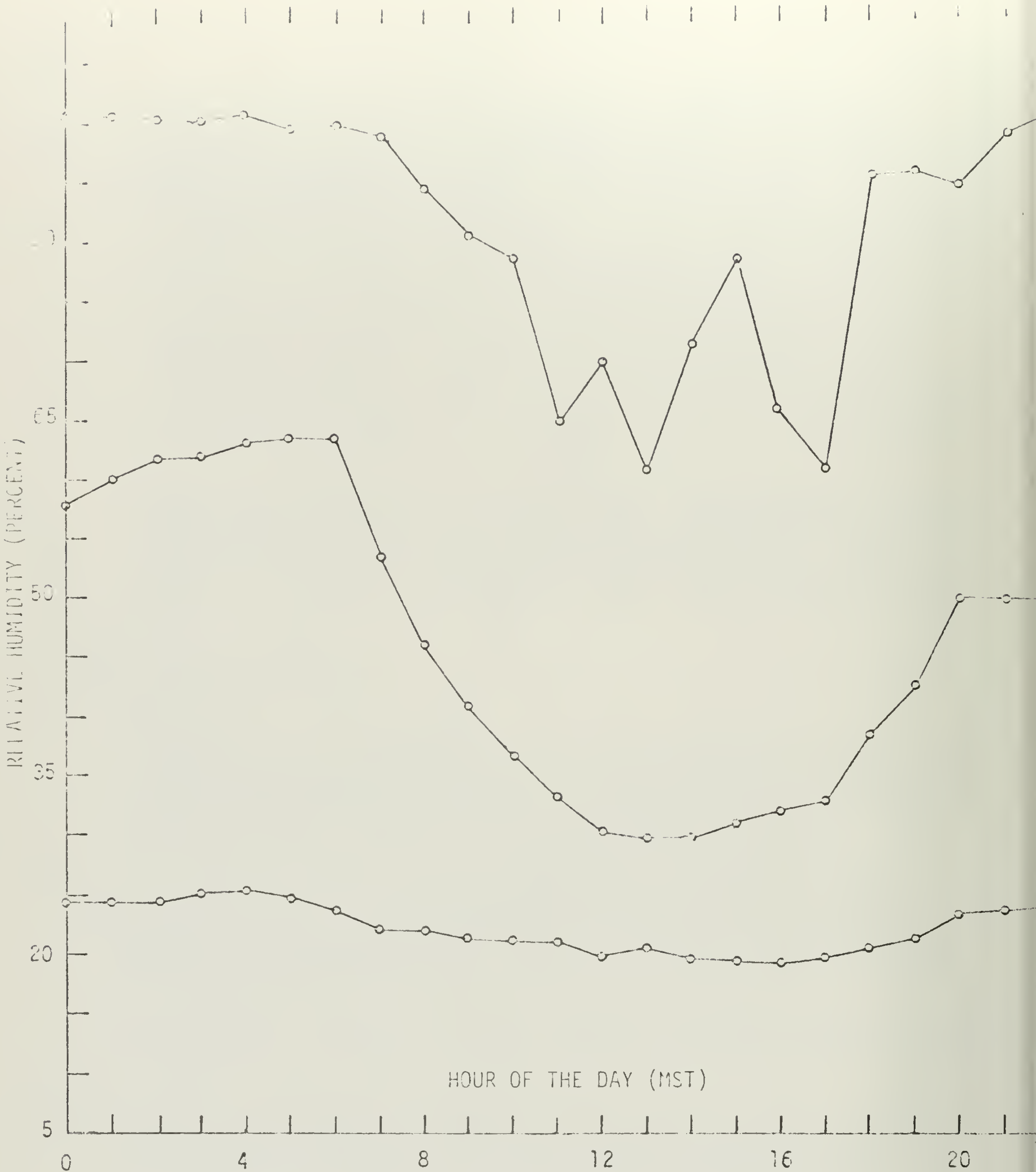


Figure 2.2-21 - Relative Humidity (percent), Maximum, Mean, and Minimum by Hour of the Day for April 1975 at Site 1 of the RBOSP.

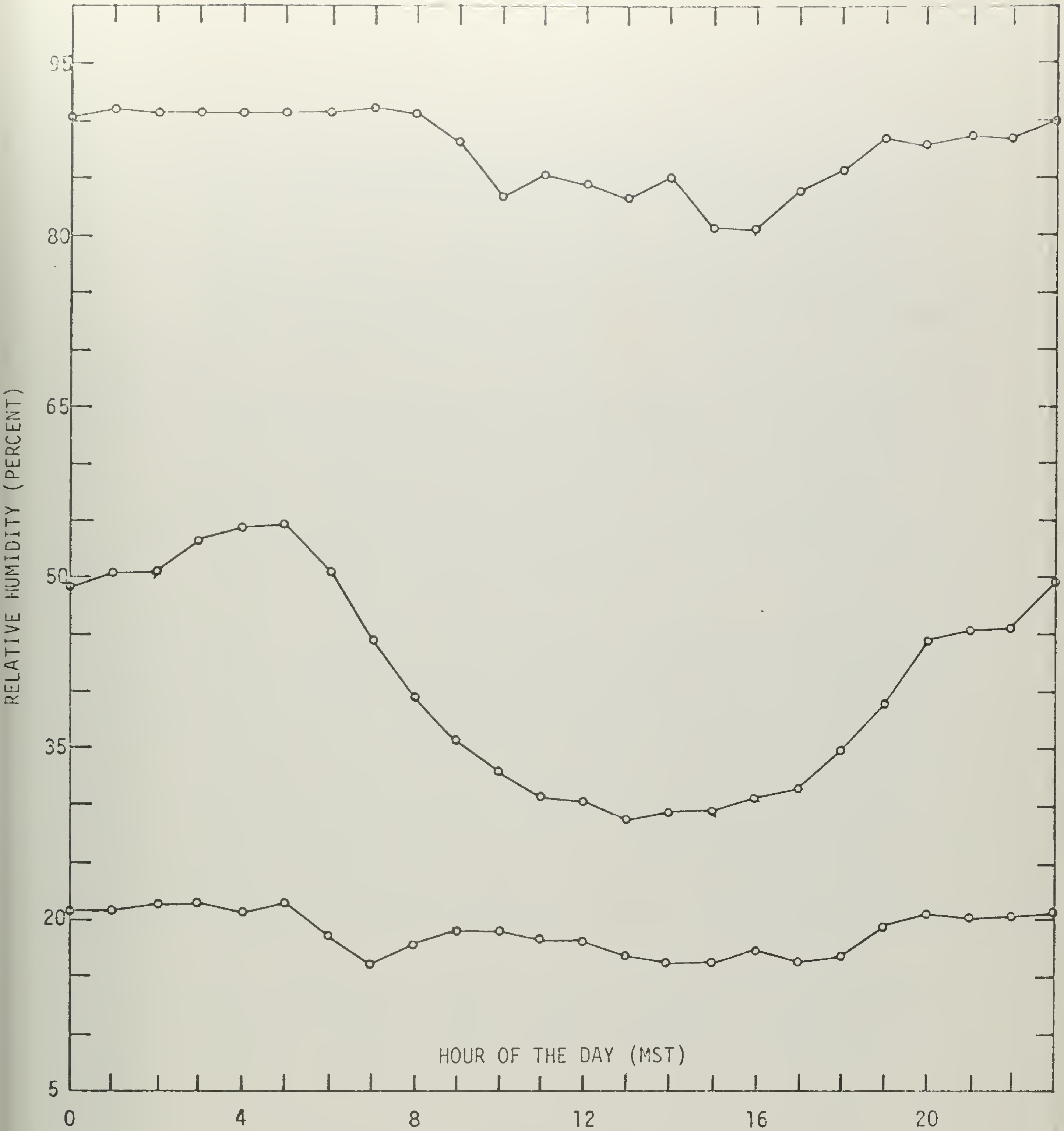


Figure 2.2-22 - Relative Humidity (percent), Maximum, Mean, and Minimum by Hour of the Day for May 1975 at Site 1 of the RBOSP.

Table 2.2-3 Snow course measurements for Spring 1975, RBOSP

Date of Sample	Total Snow Depth (inches)	Sample (inches of H_2O)
3/11/75	3.5	0.15
3/12/75	2	0.10
3/17/75	1.5	0.05
3/28/75	-- (Several inches but drifted)	—
4/1/75	7.4	0.20
4/9/75	— (Several inches but drifted)	—

with a sensitive shielded thermistor mounted on the wing strut of a light aircraft. The four flights were made at approximately 0500, 0800, 1100, and 1700 hours MST. Soundings were made to within 100 feet of the surface during the day; during night flights, 500-foot safety margins were observed. Flights were also made in valleys at 0500, 0800, and 1100 hours MST to determine the temperature structure of the air at lower elevations than the proposed plant site.

To investigate the existence of measurable horizontal temperature gradients under the presence of an inversion, seven flights were made at constant altitudes through the Piceance Creek valley. These flights (only undertaken when inversions were present) started at the confluence of Ryan Gulch and the Piceance Creek valley and terminated just over Redd Ranch. They were flown at constant altitudes of 6400 or 6500 feet above MSL, depending upon safety considerations (100 or 200 feet above the surface, respectively).

The vertical wind structure from the surface to 13,000 feet MSL, or cloud base, was determined 4 times each day with 30-gram pilot balloons in conjunction with a theodolite. The theodolite was aligned to magnetic north and then corrected to true north by rotating it 15 degrees counterclockwise. The balloons were carefully "weighed off" by using a standard National Weather Service inflation kit for 30-gram balloons inside an enclosed area to negate the influence of wind and released approximately 100 meters east-northeast of the main meteorological tower on Tract C-a. These balloons rise at an approximately constant rate of 600 feet per minute. During night operations, small water-activated batteries connected to a tungsten filament bulb were attached to the balloon, before it was "weighed off," to allow optical tracking.

The balloons were released at 0500, 0800, 1100, and 1700 hours MST in conjunction with temperature soundings. At 30-second intervals, azimuth and elevation were vocally recorded to within 0.1 degree, although interpolations were attempted to within 0.02 degree.

The balloons were kept in the field of view at all times. After the sounding was completed, the voice records were transcribed to data sheets.

2.2.2.3 Results*

The wind structure above Tract C-a depends heavily upon the upper (500-millibar) level flows as well as the detailed surface topography, which is complex. In general, the upper level winds are from the southwest, although variable winds from all directions were represented during the study period. In addition, wind speeds during early morning hours were smaller and winds less gusty than later in the day. The topography of Federal Oil Shale Tract C-a consists of several finger-like plateaus sloping generally to the northeast. Between the plateau-like regions are broad steep-sided valleys.

The temperature structure over Tract C-a followed the dry adiabatic lapse rate well above 1,000 feet on clear days without surface inversions and a wet adiabatic behavior on moist days with very few surface-based stable layers. The air from the surface to the 1000-foot level exhibited a complex profile with inversions in the morning hours, which broke up by late morning on each measurement day. Temperature inversions were quite pronounced in the valleys below Tract C-a, but none were greater than 3.3 C per 100 meters (Pasquill, Category F). The average mixing layer depth in the presence of a surface inversion at the early morning sounding (0500 MST) was 200 feet above the base of the main meteorological tower at Tract C-a. These values indicate that there are significant differences in the mixing layer heights and intensities when an inversion is present as compared with the Fall 1974 Upper Air Data (AL-ECP-74-108) and Winter 1975 Upper Air Data (AL-EC-118).

Several flights to determine the horizontal temperature structure at constant altitude, but at varying heights (dependent upon terrain), showed little horizontal dependence even when these were performed in the presence of a surface inversion. However, surface-based measurements of the actual temperature indicate that large horizontal temperature gradients probably exist when a surface-based vertical temperature inversion is present.

During the 18-day study period, soundings over Tract C-a were aborted on 3 days because of inclement weather and dangerous flying conditions.

In general, there is good agreement between pibal soundings made at different times of the day. The general clockwise turning of direction with height (Ekman effect) is apparent. Most soundings show this expected behavior; however, exhibit complex structures. Another

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*For a more complete description of the processes involved and a more extensive summary, the reader is referred to EG&G Report No. ECR-75-003, 27 June 1975, "Upper Air Comparison Studies for Spring 1975 Between Federal Oil Shale Tracts C-a and C-b and Grand Junction, Colorado.

outstanding feature of the wind sounding plots is the consistency of the directionality - all upper level winds (above 2,000 feet from the surface) are entirely from the west hemi-circle, with the majority from southwest through northwest.

Soundings were made in valleys during the day to investigate the temperature structure of air at lower elevations than the proposed plant site. These soundings indicate that in most cases, when an inversion was present, the inversion intensity at the lower levels was more severe than at the proposed plant altitude. Examples of this behavior are shown in the temperature profiles taken at 0456 on April, 1975 and 0510 on 1 May 1975, Figures 2.2-23 and 2.2-24. Of the 15 days of data collection, 7 show evidence of thermal or inversion conditions. The fall and winter studies showed a higher percentage of surface inversion based days (91% and 60% respectively). During the winter, 4 of the 15 days of data collection were without snowfall in the area, indicating an extended period of generally unstable conditions. Conversely, this study (Spring 1975) had only 5 of the 15 days of data collection associated with precipitation, indicating a definite trend toward more unstable conditions during the spring than the fall or winter.

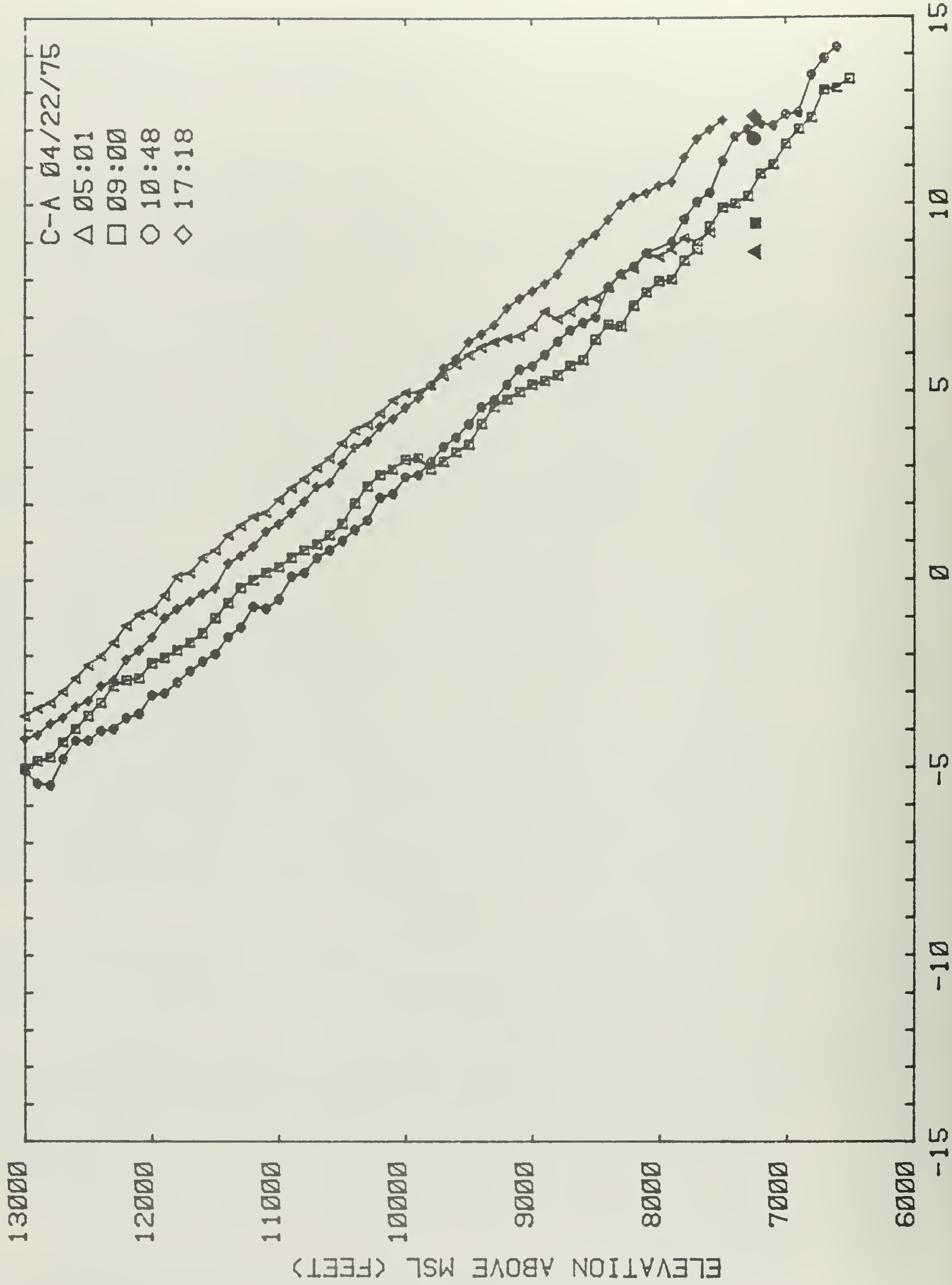
The unconnected solid symbols plotted at the elevation of the base of the tower (7,400 feet) represent the results of temperature measurements made at the 10-meter level of the meteorological tower on Tract C-a in conjunction with the respective aircraft temperature soundings. In many cases, these measurements show large differences, which follow a simple pattern. In the early morning, the surface temperature was colder than the sounding temperature value at the absolute elevation of the surface-based measurement. During the mid- and late-morning soundings, the surface measurements were in agreement with the sounding measurements at the same elevation. During the afternoon, the surface temperature was usually higher than the sounding temperature at the same elevation. The pattern is probably caused by strong surface heating and cooling. This pattern is not reflected in the fall or winter upper air data.

As a continuing effort in the investigation of the depth and extent of horizontal temperature gradients, several special flights were made throughout the Piceance Creek basin during the April, 1975 study.

Comparisons of the vertical temperature structure over Tract C-a with the results of the horizontal sounding indicate (even with moderate to strong inversions present) that the horizontal temperature variation is less than 2 C. Horizontal gradients of the magnitude postulated (but not measured by the aircraft) in the Winter 1975 upper air study were not found in any of the horizontal flights during Spring 1975.

2.2.3 Miscellaneous

The meteorological paramenters grouped into this category are precipitation, evaporation, solar insolation (or radiation), noise, visibility,


C-A Ø4/22/75
Δ Ø5:Ø1
□ Ø9:ØØ
○ 1Ø:48
◇ 17:18
TEMPERATURE (CENTIGRADE)
ELEVATION ABOVE MSL (FEET)
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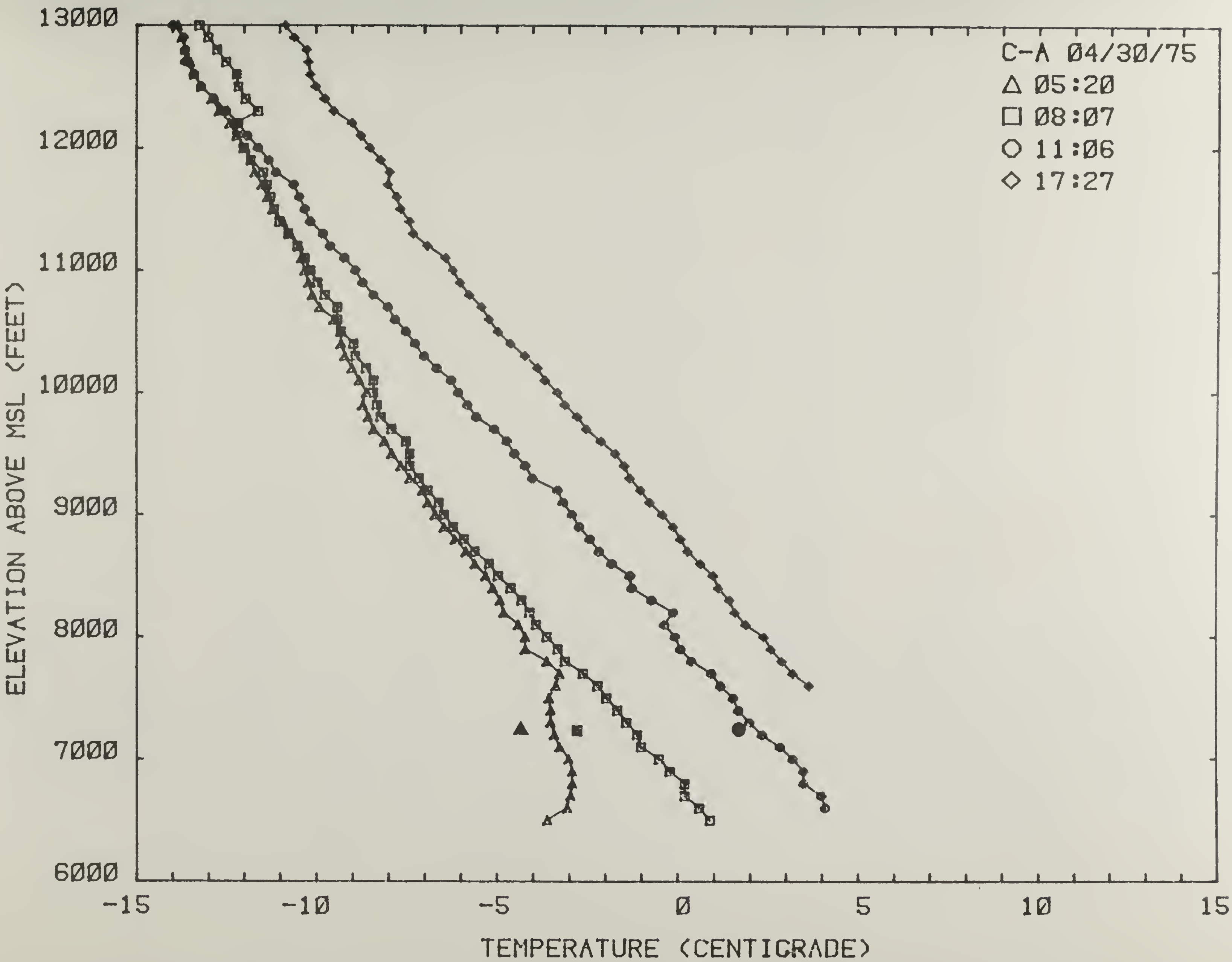


Figure 2.2-24 - Temperature Profiles over Tract C-a, RBOSP 30 April 1975

and tracer studies. All of these parameters, except precipitation and evaporation, are measured only at Site 1. The evaporation measurement is made at Site 3 because of water availability. The evaporation rate and visibility are not continuously monitored but are recorded on a routine basis. Noise measurements are scheduled for summer and winter only.

2.2.3.1 Precipitation Measurements

2.2.3.1.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.1.1 in Progress Report 2 for specific objectives of the precipitation measurements.

2.2.3.1.2 Methods

No change has occurred since Progress Report 2. See section 2.2.3.1.2 in Progress Report 2 for specific methods used in the precipitation measurements.

2.2.3.1.3 Results

The precipitation data summary for Spring 1975 is presented in Table 2.2-4. The total and daily amount of precipitation are shown for each site. Maximum total precipitation for 1 hour was 0.17 inch at Site 4 at 0200 hours MST on 29 May 1975. A maximum daily accumulation of precipitation of 0.38 inch H_2O also occurred at Site 4 on 29 May 1975.

2.2.3.2 Evaporation Measurements

2.2.3.2.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.2.1 in Progress Report 2 for specific objectives of the evaporation measurements.

2.2.3.2.2 Methods

No change has occurred since Progress Report 2. See section 2.2.2.3.2 in Progress Report 2 for specific methods used in the evaporation measurements.

2.2.3.2.3 Results

The evaporation measurements started 24 May 1975 at 1700 hours MST. The first reading was taken on 31 May 1975 at 1220 hours MST with 0.15 inch of water required to correct for evaporation and 0.44 inch of precipitation, which fell during the interval between measurements. This is equivalent to 1.52 grams/cm^2 over 163.3 hours or an evaporation rate of 0.00931 grams/cm^2/hour. The relative humidity was significantly above average throughout the same interval.

Table 2.2-4 Precipitation data for Spring 1975, RBOSP presented in inches of water

Date	Site 1 Total	Site 2 Total	Site 3 Total	Site 4 Total
3/6/75	0.01	—	0.01	--
3/9/75	0.01	--	0.01	0.10
3/10/75	0.04	--	0.06	0.28
3/11/75	0.01	0.01	0.04	0.12
3/14/75	--	--	—	0.01
3/17/75	0.02	--	—	0.03
3/22/75	—	--	0.01	0.09
3/25/75	—	--	0.01	--
3/26/75	0.01	—	--	0.02
3/31/75	0.02	—	0.01	0.27
March Total	0.12	0.01	0.15	0.92
4/1/75	0.02	0.04	0.16	0.25
4/7/75	—	—	0.02	0.05
4/16/75	0.01	—	—	—
4/17/75	0.10	0.01	0.02	0.08
4/18/75	0.01	0.01	0.07	0.17
4/27/75	—	0.01	0.01	0.01
4/30/75	—	—	—	0.01
April Total	0.14	0.07	0.28	0.57
5/5/75	—	0.02	0.03	0.25
5/12/75	—	-	0.01	--
5/17/75	—	—	--	0.02
5/20/75	0.01	—	0.07	0.13
5/21/75	0.02	0.02	0.10	0.38
5/22/75	--	--	0.03	0.11
5/27/75	0.03	0.02	0.07	0.13
5/28/75	0.04	0.04	0.27	0.26
5/29/75	0.03	0.02	0.10	0.06
May Total	0.13	0.12	0.68	1.09
SPRING TOTAL	0.39	0.20	1.11	2.58

2.2.3.3 Solar Radiation Measurement

2.2.3.3.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.3.1 in Progress Report 2 for specific objectives of the solar radiation measurements.

2.2.3.3.2 Methods

No change has occurred since Progress Report 2. See section 2.2.3.3.2 in Progress Report 2 for specific methods used in the solar radiation measurements.

2.2.3.3.3 Results

The maximum, minimum, and mean composite day solar radiation measurements (solar insolation), as a function of hour of the day for March, April, and May, 1975, are graphically presented in Figures 2.2-25 through 2.2-27. The solar insolation data were taken at ground level at Site 1. The hourly means follow a close approximation to a sine curve. The maximum, minimum, and mean hourly solar insolation measurements are presented in Table 2.2-5.

Table 2.2-5 Solar insolation summary Site 1, monthly and seasonal maximum, minimum, and mean for Spring 1975, RBOSP. Units are in langleys, cal/cm^2/min

	March	April	May	Spring 1975
Minimum	0.098	0.070	0.215	0.070
Average	0.398	0.510	0.612	0.504
Maximum	1.471	1.600	1.730	1.730

2.2.3.4 Noise Measurements

2.2.3.4.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.4.1 in Progress Report 2 for specific objectives of the noise measurements.

2.2.3.4.2 Methods

No change has occurred since Progress Report 2. See section 2.2.3.4.2 in Progress Report 2 for specific methods used in the noise measurements.

2.2.3.4.3 Results

Noise level measurements are scheduled for mid-summer 1975.

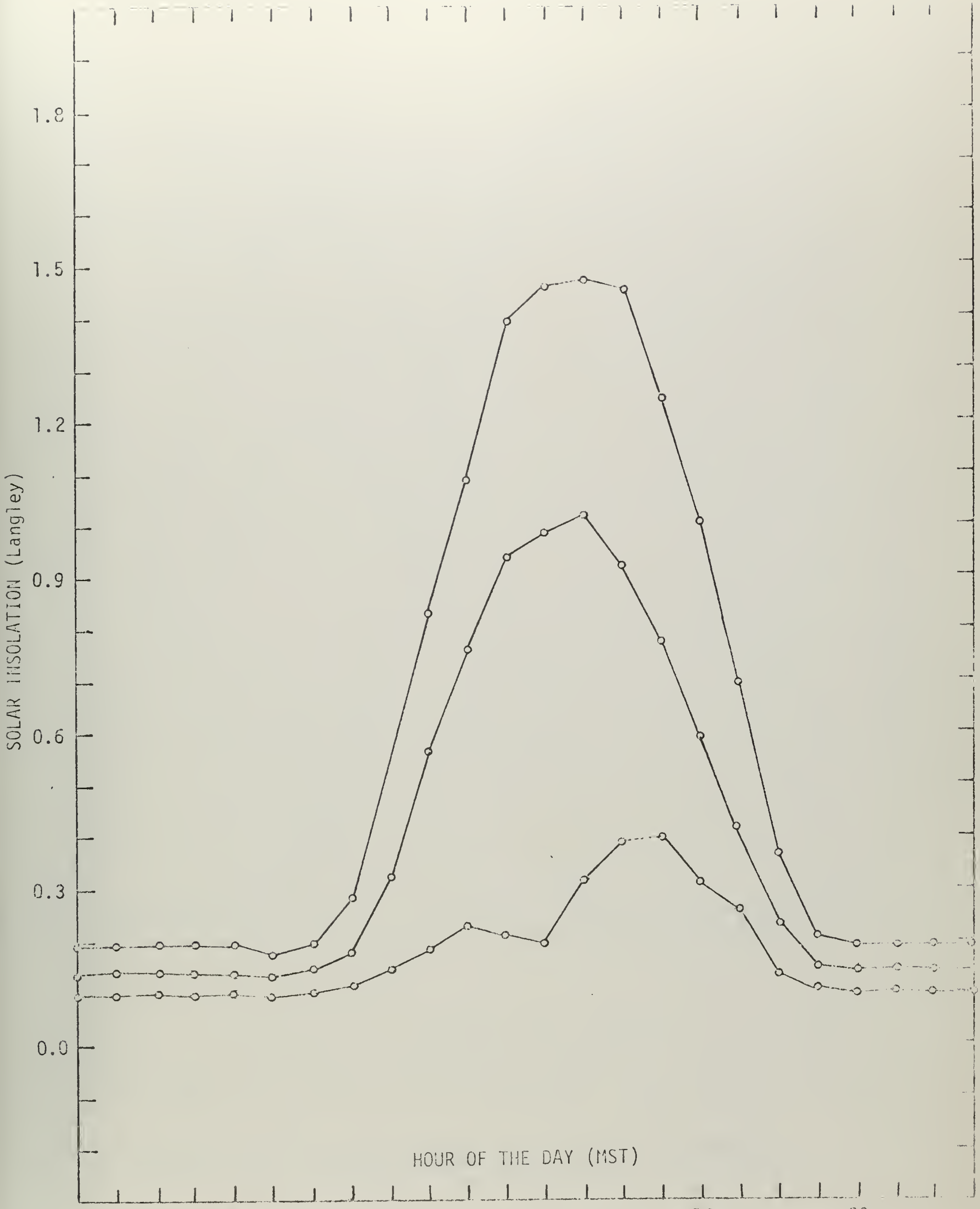


Figure 2.2-25 - Solar Insolation Maximum, Mean, and Minimum by Hour of the Day for March 1975 at Site 1 of the RBOSP.

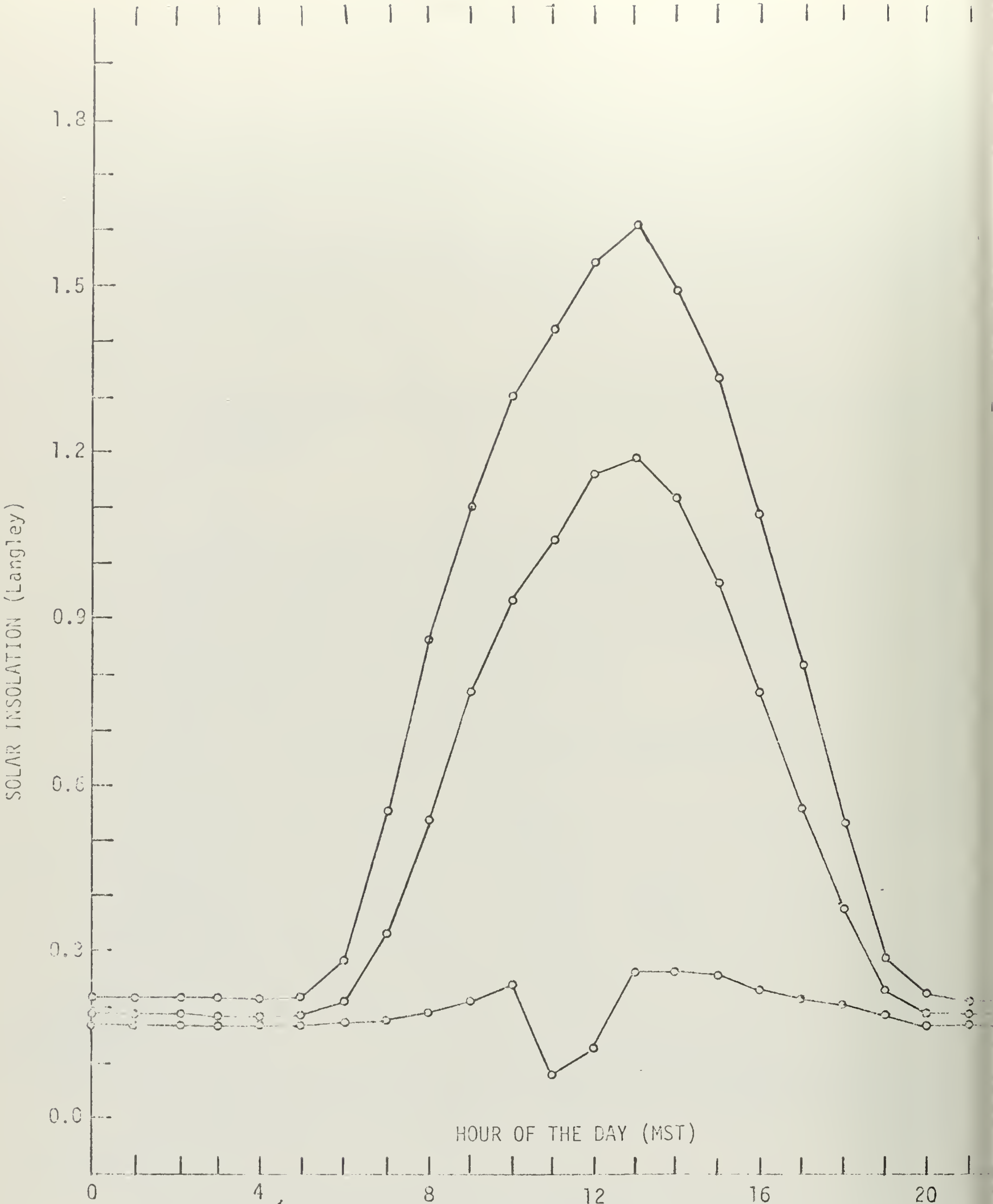


Figure 2.2-26 - Solar Insolation Maximum, Mean, and Minimum by Hour of the Day for April 1975 at Site 1 of the RBOSP.

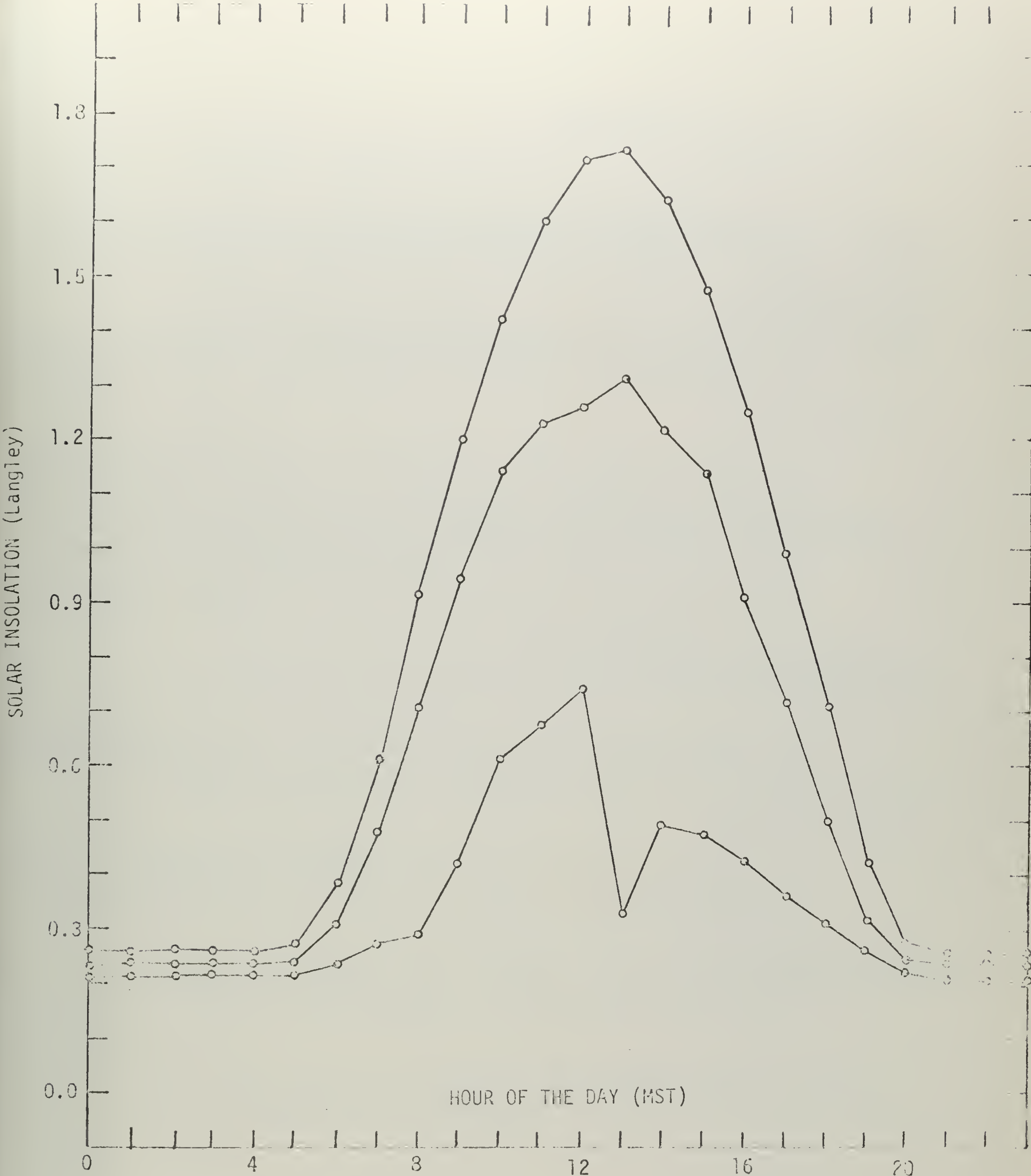


Figure 2.2-27 - Solar Insolation Maximum, Mean, and Minimum by Hour of the Day for May 1975 at Site 1 of the RBOSP.

2.2.3.5 Visibility Mesurements

2.2.3.5.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.5.1 in Progress Report 2 for specific objectives of the visibility measurements.

2.2.3.5.2 Methods

No change has occurred since Progress Report 2. See section 2.2.3.5.2 in Progress Report 2 for specific methods used in the noise measurements.

2.2.3.5.3 Results

During March and May, 1975, the ground was wet or snow-covered most of the time. Consequently, these periods were virtually free of fugitive dust and particulates, and visibility was essentially unlimited at the times of measurements. The major obstacle to good visibility during April, and to a lesser extent, May, was precipitation or convective storms in the vicinity. Visibility data are presented in the interpretative text on file at the Area Oil Shale Supervisor's office.

2.2.3.6 Tracer Study Measurements

2.2.3.6.1 Objectives

No change has occurred since Progress Report 2. See section 2.2.3.6.1 in Progress Report 2 for specific objectives of the Tracer Study measurements.

2.2.3.6.2 Methods

No change has occurred since Progress Report 2. See section 2.2.3.6.2 in Progress Report 2 for specific methods used in the Tracer Study measurements.

2.2.3.6.3 Results

Tracer study measurements are scheduled for Fall 1975.

2.3 TERRESTRIAL STUDIES

The terrestrial program is designed to gather two years of baseline data on vegetation, small mammals, large mammals, mammalian predators, avifauna, herpetofauna, invertebrates, domestic livestock and threatened and endangered species. A variety of standardized methodologies is employed to gather these data in the field. All studies are designed to gather the definitive data necessary to describe existing ecosystems as required by the environmental stipulations in the oil shale lease.

2.3.1 Vegetation

2.3.1.1. Objectives

No changes have been implemented since Progress Report 2-Summary. See section 2.3.1.1 in Progress Report 2-Summary for the objectives of the vegetation studies.

2.3.1.2 Methods

No changes have been implemented since Progress Report 2-Summary. See section 2.3.1.2 in Progress Report 2-Summary for specific methods used in previous vegetation studies.

2.3.1.3 Results

Vegetation data were not gathered during the reporting quarter March through May, 1975.

2.3.2 Grazing Exclosures

2.3.2.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.2.1 in Progress Report 2-Summary for the objectives of the grazing exclosure studies.

2.3.2.2 Methods

No changes have been implemented since Progress Report 2-Summary. See section 2.3.2.2 in Progress Report 2-Summary for specific methods used in grazing exclosure studies.

2.3.2.3 Results

Grazing exclosure data were not gathered during the reporting quarter March through May, 1975.

2.3.3 Small Mammals

2.3.3.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.2.1 in Progress Report 2-Summary for the objectives of the small mammal studies.

2.3.3.2 Methods

Methods employed include: live trapping and marking, limited snap trapping to gather animals for laboratory analysis of reproductive effort and stomach contents, mist-netting (for bats), pitfall trapping (for species not readily captured by Sherman live traps), spotlight censusing (for nocturnal species) and field observations. Figure 2.3-1 shows the locations of all small mammal sampling sites.

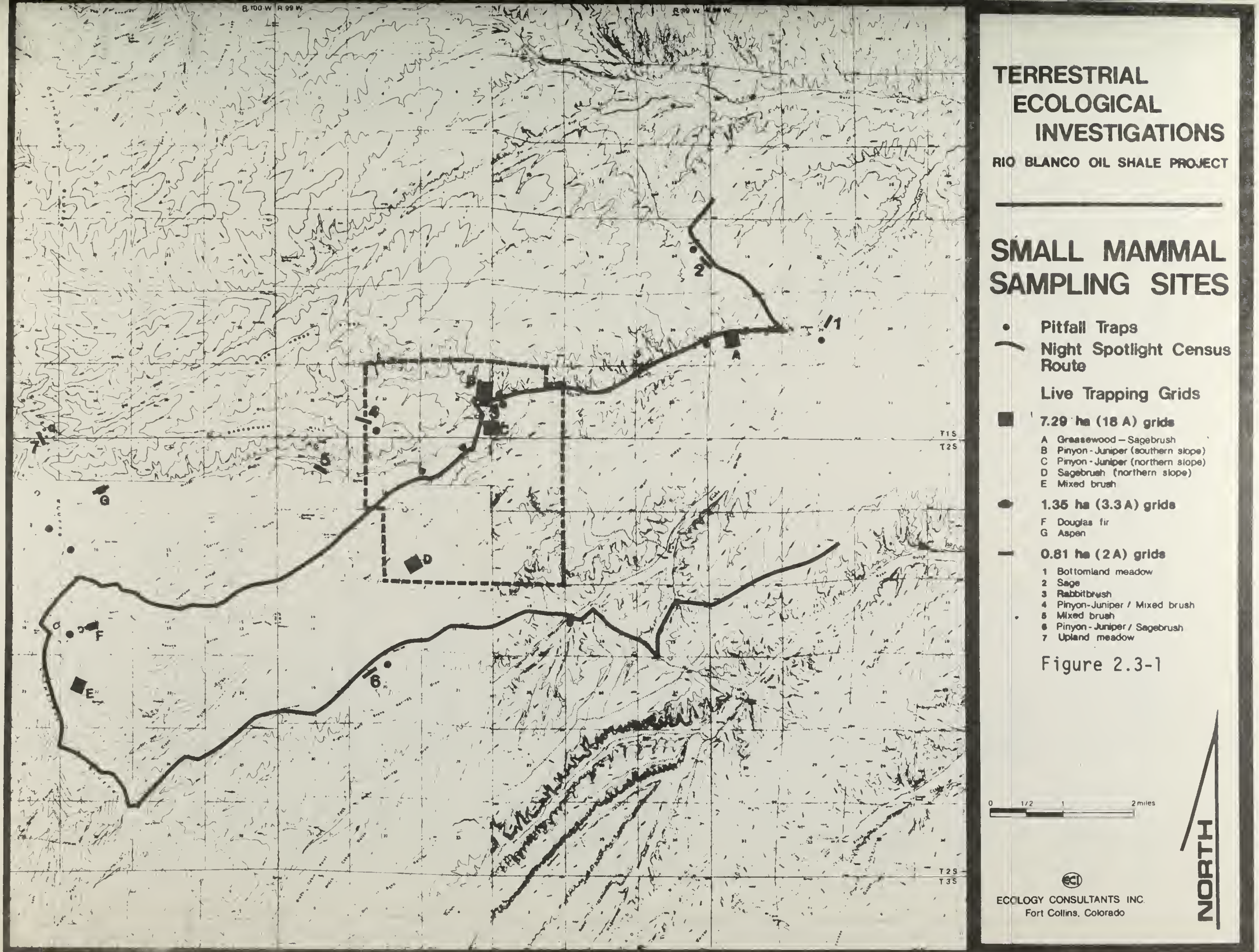
2.3.3.3 Results

Small mammals were sampled from eight different vegetation types and variants of these types in fourteen separate locations during May, 1975. Ecological distribution, abundance, average weight and reproductive data for each species and vegetation type have been summarized and tentatively interpreted.

Thirteen different small mammal species were recorded during May, 1975 at fourteen live-trap grids on and near Tract C-a. See Table 2.3-1 for a list of all mammalian species recorded for RBOSP to date. The deer mouse (Peromyscus maniculatus) and the least chipmunk (Eutamias minimus) exhibited the widest ecological range and the greatest relative abundance of any of the small mammals captured. The red-backed vole (Clethrionomys gapperi), piñon mouse (Peromyscus truei) and Colorado chipmunk (Eutamias quadrivittatus) seemed to show definite habitat preferences. The red-backed vole appeared only in Douglas fir and aspen while the piñon mouse and Colorado chipmunk were taken only in pinyon-juniper vegetation types.

The greatest number of different small mammal species was recorded for the south slope mixed brush vegetation type (8300 ft elevation) and three pinyon-juniper sample sites; pinyon-juniper north and south slopes (6900 ft and 7000 ft elevation, respectively) and north slope pinyon-juniper/mixed brush at an elevation of 7400 ft. Five different small mammal species were captured in each of these vegetation types except pinyon-juniper south slope were six different species were recorded (Table 2.3-2).

The greatest number of individual small mammals was recorded for the rabbitbrush vegetation type. Small mammal ecological distribution and abundance data gathered during May, 1975 are presented in Table 2.3-2.



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TERRESTRIAL ECOLOGICAL INVESTIGATIONS
RIO BLANCO OIL SHALE PROJECT
SMALL MAMMAL SAMPLING SITES
Pitfall Traps
Night Spotlight Census Route
Live Trapping Grids
7.29 ha (18 A) grids
A Greasewood – Sagebrush
B Pinyon - Juniper (southern slope)
C Pinyon - Juniper (northern slope)
D Sagebrush (northern slope)
E Mixed brush
1.35 ha (3.3 A) grids
F Douglas fir
G Aspen
0.81 ha (2 A) grids
1 Bottomland meadow
2 Sage
3 Rabbitbrush
4 Pinyon-Juniper / Mixed brush
5 Mixed brush
6 Pinyon - Juniper / Sagebrush
7 Upland meadow
0 1/2 1 2 miles
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Figure 2.3-1

Table 2.3-1. Species of mammals encountered from October, 1974 through May, 1975 for RBOSP [1/]

FAMILY Species	Common Name
SORICIDAE (Shrews)	
Sorex cinereus	Masked shrew
Sorex merriami (not previously recorded in the area)	Merriam's shrew
Sorex vagrans [2/] [3/]	Vagrant shrew
LEPORIDAE (Hares and rabbits)	
Lepus californicus [2/] [3/]	Black-tailed jackrabbit
Lepus townsendii	White-tailed jackrabbit
Sylvilagus sp. [3/]	Cottontail
SCIURIDAE (Squirrels, ground squirrels, chipmunks)	
Spermophilus lateralis [3/]	Golden-mantled ground squirrel
Spermophilus tridecemlineatus [3/]	Thirteen-lined ground squirrel
Eutamias minimus [3/]	Least chipmunk
Eutamias quadrivittatus [3/]	Colorado chipmunk
Tamiasciurus hudsonicus	Red squirrel
GEOMYIDAE (Pocket gophers)	
Thomomys talpoides [2/] [3/]	Northern pocket gopher
CRICETIDAE (New World mice and rats)	
Peromyscus maniculatus [3/]	Deer mouse
Peromyscus truei [3/]	Pinon mouse
Neotoma cinerea [3/]	Bushy-tailed woodrat
Clethrionomys gapperi [3/]	Gapper's red-backed vole
Microtus montanus [3/]	Montane vole
Microtus longicaudus [3/]	Long-tailed vole
Lagurus curtatus [3/]	Sagebrush vole
HETEROMYIDAE (Pocket mice, kangaroo rats and mice)	
Perognathus apache [2/] [3/]	Apache pocket mouse
CANIDAE (Coyote, wolves and foxes)	
Canis latrans	Coyote

Table 2.3-1. (Continued)

FAMILY Species	Common Name
MUSTELIDAE (Mustelids, weasels, skunks)	
Mustela frenata	Long-tailed weasel
Mustela erminea 2/ 3/	Ermine
FELIDAE (Cats)	
Lynx rufus	Bobcat
CERVIDAE (Deer and elk)	
Cervus canadensis 3/	Elk
Odocoileus hemionus 3/	Mule deer
EQUIDAE (Horses)	
Equus coballus 3/	Feral horse

1/ The following authority is used for small mammal nomenclature:

Hall, E.R. and K.R. Kelson. 1959. The mammals of North America. Ronald Press Company, New York, New York. 1162 pages.

The following authority is used for large mammal (except horses) nomenclature:

Lechleitner, R.R. 1969. Wild mammals of Colorado. Pruett Publishing Company, Boulder. 254 pages.

2/ New species recorded during the quarter March through May, 1975.

3/ Small mammals captured or observed during May, 1975 sampling period.

Table 2.3-2. Ecological distribution and abundance (animals/100 trap nights) of trappable small mammals captured on live trapping grids during May, 1975 for RBOSP

Vegetation Type (Grid #) (Slope Aspect/Elevation)	Trap Nights	*Peromyscus maniculatus*	*Microtus montanus*	*Clethrionomys gapperi*	*Lagurus curtatus*	*Microtus longicaudus*	*Peromyscus truei*	*Eutamias quadrivittatus*
Greasewood/Sagebrush (A) (Flat/6400')	665	5.1	0	0	0	0	0	0
Sagebrush (D) (North Slope/7100')	665	3.6	0	0	0.3	0	0	0
Mixed Brush (E) (South Slope/8300')	665	3.5	0	0	0.8	0.3	0	0
Mixed Brush (5) (North Slope/7200')	165	7.9	0	0	0	0	0	0
Bottomland Meadow (1) (Flat/6300')	165	4.2	1.2	0	0	0	0	0
Upland Meadow (7) (Flat/8500')	165	7.9	0	0	0	0	0	0
Douglas Fir (F) (North Slope/8200')	305		0	6.2	0	0	0	0
Aspen (G) (North Slope/8100')	305	0.3	0	5.2	0	0	0	0
Pinyon-Juniper (B) (South Slope/7000')	665	5.1	0	0	0	0	0.9	2.3
Pinyon-Juniper (C) (North Slope/6900')	665	4.0	0	0	0	0	0.3	1.2
Pinyon-Juniper/Mixed Brush(4) (North Slope/7400')	165	7.9	0	0	0	0	0	1.8
Pinyon-Juniper/Sagebrush(6) (Flat/7400')	165	13.3	0	0	0	0	0	0
Rabbitbrush (3) (Flat/6800')	165	16.4	0	0	0	0	0	0
Sagebrush (2) (Flat/6500')	165	3.0	0	0	0	0	0	0

Table 2.3-2. (Continued)

Vegetation Type (Grid #) (Slope Aspect/Elevation)	Trap Nights	Eutamias minimus	Neotoma cinerea	Mustela erminea	Spermophilus lateralis	Spermophilus tridecemlineatus	Perognathus apache	Total
Greasewood/Sagebrush (A) (Flat/6400')	665	6.6	0	0	0.8	0	0	12.5
Sagebrush (D) (North Slope/7100')	665	5.9	0	0	0.8	0	0	10.6
Mixed Brush (E) (South Slope/8300')	665	7.7	0	0	0.6	0	0	12.6
Mixed Brush (5) (North Slope/7200')	165	14.5	0	0	0	0	0	22.4
Bottomland Meadow (1) (Flat/6300')	165	1.2	0	0	0	0	0	6.6
Upland Meadow (7) (Flat/8500')	165	1.8	0	0	0	0	0	9.7
Douglas Fir (F) (North Slope/8200')	305	3.0	0	0	0	0	0	9.2
Aspen (G) (North Slope/8100')	305	4.9	0	0	0	0	0	10.4
Pinyon-Juniper (B) (South Slope/7000')	665	5.1	0.5	0	0.8	0	0	14.7
Pinyon-Juniper (C) (North Slope/6900')	665	2.7	0	0	1.2	0	0	9.5
Pinyon-Juniper/Mixed Brush(4) (North Slope/7400')	165	13.3	0	0.6	0.6	0	0	24.2
Pinyon-Juniper/Sagebrush(6) (Flat/7400')	165	7.3	0	0	0.6	0	1.2	22.4
Rabbitbrush (3) (Flat/6800')	165	18.2	0	0	2.4	0	0	37.0
Sagebrush (2) (Flat/6500')	165	7.3	0	0	0	1.8	0	12.1

Reproductive information gathered in the field during May, 1975 sampling is not conclusive. Nearly 30 percent of all adult small mammals of both sexes examined during the May, 1975 sampling period were reproductively active.

Unfavorable weather conditions resulting in reduced small mammal activity precluded collection of the desired number of specimens for stomach analyses. The nineteen deer mice (Peromyscus maniculatus) examined from five different vegetation types fed primarily on seeds, however, they did show a tendency to make greater use of invertebrate and succulent plant material during May, 1975 sampling. The four long tailed voles examined from the high elevation aspen sampling site fed primarily on seeds (96 percent of the stomach contents). Four least chipmunks (Eutamias minimus) examined from a north slope sagebrush (elevation 7100 ft) vegetation type fed mainly on succulent plant material (58.0 percent of the stomach contents). Five other least chipmunks examined from a flat greasewood/sagebrush (elevation 6400 ft) vegetation type fed primarily on seeds.

Thirty-one females of the three predominant small mammal species in the vicinity of Tract C-a (deer mouse, least chipmunk, and long-tailed vole) were examined in the laboratory during May, 1975 for reproductive effort. Fourteen (45 percent) of the 31 adult females examined contained either embryos or placental scars and were classified as reproductively active. Ten of the eleven pregnant females examined, 91 percent, were from sampling stations below 7100 ft elevation.

Pitfall traps were established in 13 locations, each in a different vegetation type or a variant of a vegetation type. Eight individual small mammals representing three different species were captured in four separate locations. The species captured were the mountain pocket gopher (Thomomys talpoides), the Apache pocket mouse (Perognathus apache) and the montane vole (Microtus montanus).

Voucher specimens of five different small mammal species were collected during the May, 1975 sampling period. These specimens are now being prepared in the laboratory and will be entered into the RBOSP voucher specimen collection.

2.3.4 Large Mammals

2.3.4.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See section 2.3.4.1 in Progress Report 2-Summary for objectives of the large mammal studies.

2.3.4.2 Methods

Large mammals (mule deer, elk, feral horses, large predators, and domestic livestock) are censused along established transects with a fixed-wing aircraft to determine distribution, abundance, and migration routes. Track counts are also employed along an established road transect to determine spring migratory routes of mule deer. Mule deer pellet-group transects are utilized to help determine areas of concentrated mule deer use. Locations of mule deer migration study aerial transects, the mule deer track count transect and pellet plot transects are shown in Figure 2.3-2. Large mammal aerial transects are the same as shown in Figure 2-14 of Progress Report 2-Summary.

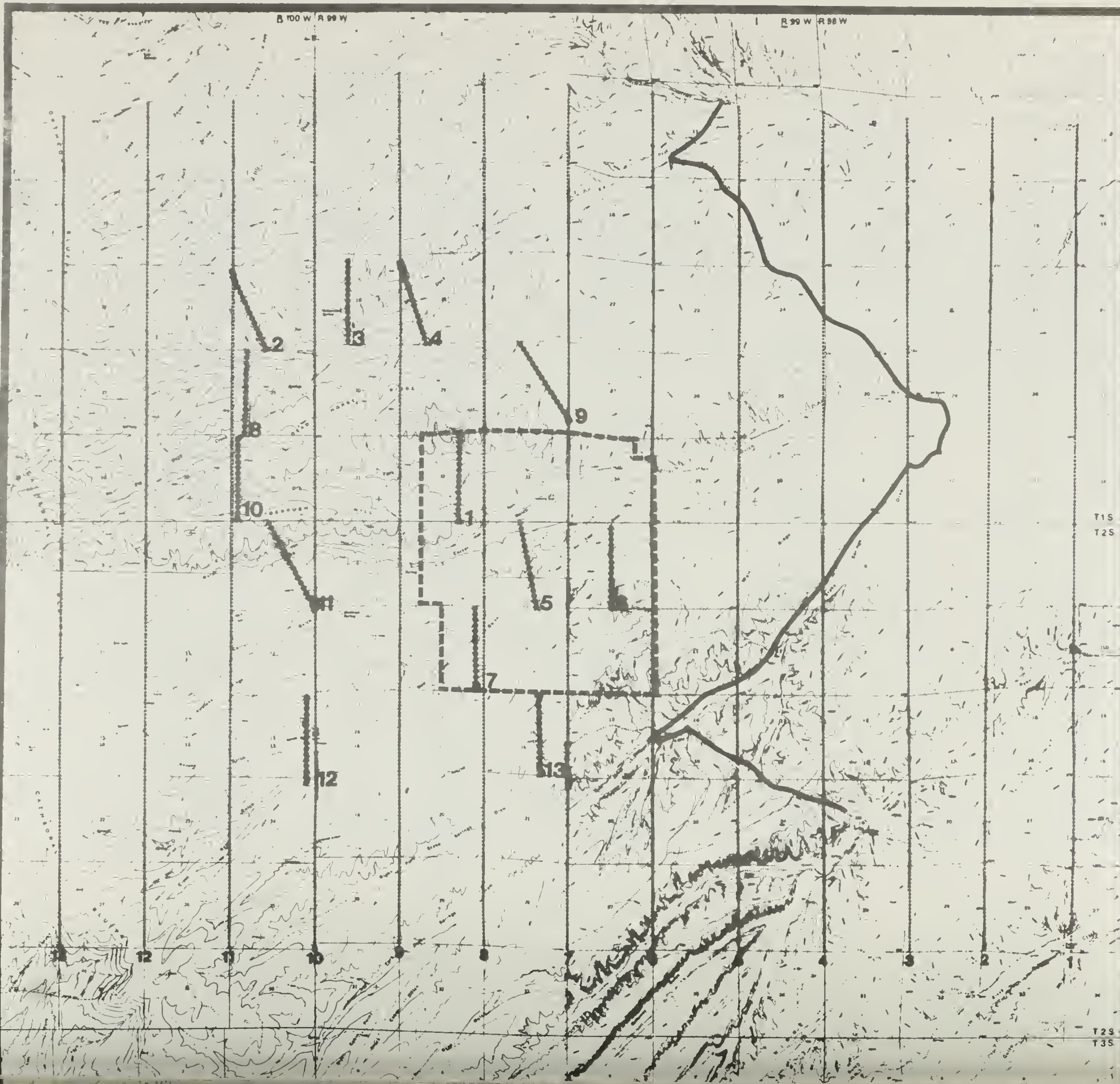
2.3.4.3 Results

Mule deer winter counts were conducted on March 4 and 13 and on April 3 and 14, 1975. A mule deer migration study including both aerial surveys and track counts was conducted during the period April 13 through April 26, 1975. Elk and feral horse aerial surveys were conducted on March 4 and April 14, 1975. Nine new mule deer pellet-group plots were established in areas off of Tract C-a during mid-May and the four pellet plots on Tract C-a were inspected during the same time period.

The majority of the mule deer observed during this period were located in the eastern census area (Table 2.3-3). Small herds were observed on Tract C-a while only 4 animals were observed on the west census area. The mule deer were concentrated in the meadows within the eastern census area during the April, 1975 survey. See Figure 2.3-3 for the numbers and approximate locations of mule deer observed during the March-April 1975 census.

Minor movements of mule deer were recorded during the census period. Deer appeared to concentrate in the meadows along Yellow Creek, Ryan Gulch and Black Sulfur Gulch. However, track count data indicate that animals were moving across all sections of the road used for the track count survey, except for the portion south of Stake Springs Draw almost to the crest of the ridge. Deer appeared to be moving generally westward across the road although there were many trails which appeared to cross and recross the road. Intermittent snow showers and green forage in the meadows may have extended a portion of the migration past the date of the final flight.

Pellet-group count transects were established on areas off Tract C-a during May 16-19 and the transects on Tract C-a were examined for groups deposited during the winter of 1975. Very limited data suggest that the eastern portion of the tract received heavier deer use in the winter than the western portion.



TERRESTRIAL ECOLOGICAL INVESTIGATIONS

RIO BLANCO OIL SHALE PROJECT

LARGE MAMMALS

mule deer migration count aerial transects

mule deer track count transect

location of pellet plot transects

Figure 2.3-2

0 1/2 1 2 miles

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Table 2.3-3. Mule deer observed on four census areas during four census periods (March-April, 1975) for RBOSP[1/]

Date of Census	Census Area				
	Total Observed	Tract C-a	East	West	North of Tract
March 4	244	7	229	0	8
March 13	324	14	296	0	14
April 3	258	24	220	4	10
April 14	500	12	469	0	19
Totals	1,326	57	1,214	4	51

[1/]The figures represent only those animals observed within the census area boundaries.

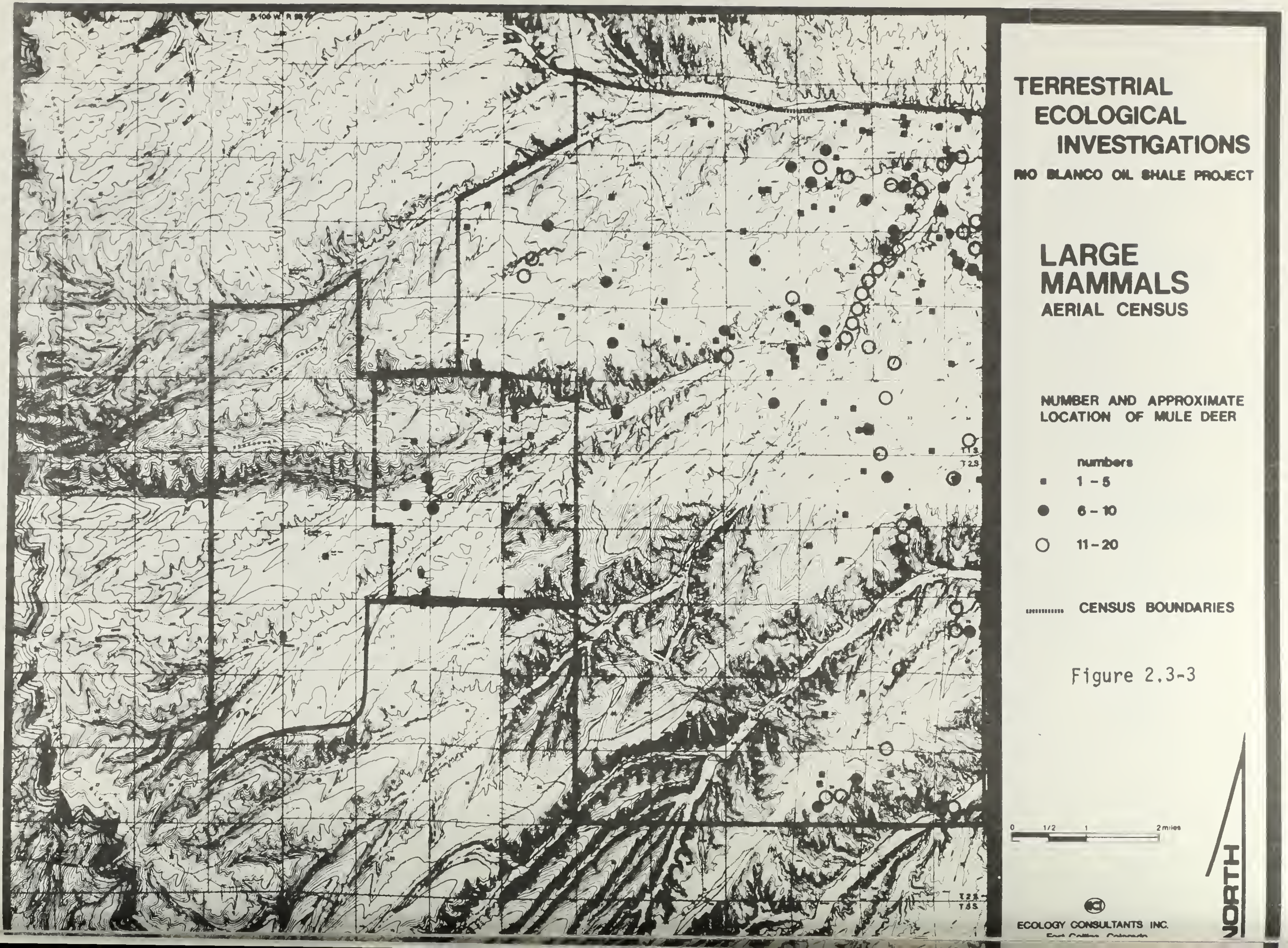
TERRESTRIAL
ECOLOGICAL
INVESTIGATIONS
RIO BLANCO OIL SHALE PROJECT
LARGE
MAMMALS
AERIAL CENSUS
NUMBER AND APPROXIMATE
LOCATION OF MULE DEER
numbers
1 - 5
6 - 10
11 - 20
CENSUS BOUNDARIES
0
1/2
1
2 miles
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Figure 2.3-3

Elk and feral horse investigations revealed that a small herd of elk occupied an area west of Tract C-a while another small herd occurred south of the tract during the census period. Horses seemed to occupy areas west and south of Tract C-a as well as 84 Mesa and portions of the tract during the survey period.

2.3.5 Mammalian Predators

2.3.5.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.5.1 in Progress Report 2-Summary for the objectives of the mammalian predator studies.

2.3.5.2 Methods

No change has occurred since Progress Report 2-Summary. See section 2.3.5.2 in Progress Report 2-Summary for specific methods used in mammalian predator studies.

2.3.5.3 Results

Mammalian predator data were not gathered during the reporting quarter March through May, 1975.

2.3.6 Winter Track Counts

2.3.6.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.6 in Progress Report 2-Summary for the objectives of the winter track count studies.

2.3.6.2 Methods

No change has occurred since Progress Report 2-Summary. See section 2.3.6 in Progress Report 2-Summary for specific methods used in winter track count studies.

2.3.6.3 Results

Winter track count data were not gathered during the reporting quarter March through May, 1975.

2.3.7 Avifauna

2.3.7.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.7.1 in Progress Report Summary for objectives of the avifauna studies.

2.3.7.2 Methods

No change has been implemented since Progress Report 2-Summary. See section 2.3.7.2 in Progress Report 2-Summary for specific methods used in avifauna studies.

2.3.7.3 Results

Thirteen different vegetation associations in 20 separate locations were sampled in April, 1975 by Emlen strip census. Emlen strip transect locations, representing a variety of different slope aspects and elevations were selected in each vegetation type; these generally correspond to the small mammal live-trap grids. A total of 27 different avian species was recorded along Emlen strip transects during the sampling period.

The largest number of individual birds and the greatest number of different avian species were encountered in aspen, Douglas fir, south slope pinyon-juniper, greasewood/sagebrush, riparian and bottomland meadow vegetation types during April with the bottomland types exhibiting by far the greatest diversity. All other habitat types exhibited low avian species diversity and low numbers of birds during this sampling period.

The mountain chickadee, mountain bluebird, red-winged blackbird, dark-eyed junco and gray-headed junco were observed in greater numbers than any other bird species during the early spring survey. Of these, the mountain bluebird and gray-headed junco appeared in a wider variety of vegetation types than did other bird species.

Qualitative "walk through" surveys to record avian species not encountered along Emlen transects were conducted during the same periods as were Emlen strip censuses. These surveys documented the presence of an additional 34 avian species during the early spring sampling period. Table 2.3-4 lists these species in addition to all other avian species observed to date for RBOSP.

Waterfowl surveys at the Stake Springs impoundment were conducted twice during April, 1975. Two waterfowl species, the mallard and green-winged teal, were observed.

Night owl transects were conducted April 26-27 and April 28-29, 1975. Only one great horned owl was heard.

Aerial sage grouse strutting ground (lek) surveys were conducted on April 25 and 26, 1975. Two leks were discovered east of the Cathedral Bluffs. Greater sandhill cranes, classified as an endangered species in Colorado when nesting in the state, were observed in

Table 2.3-4. Species of birds observed during field investigations from October 1974 through May 1975 in the vicinity of Tract C-a for RBOSP [1]

ORDER FAMILY Species	Common Name	Field Code [3]
CICONIIFORMES		
ARDEIDAE		
Ardea herodia [2]	Great blue heron	ARHE
CICONIIDAE		
Plegadis chihi [2]	White-faced ibis	PLCH
ANSERIFORMES		
ANATIDAE		
Anas platyrhynchos [2]	Mallard	ANPL
Anas crecca [2]	Green-winged teal	ANCR
Anas discors [2]	Blue-winged teal	ANDI
FALCONIFORMES		
ACCIPITRIDAE		
Accipiter cooperii [2]	Cooper's hawk	ACCO
Buteo jamaicensis [2]	Red-tailed hawk	BUJA
Buteo lagopus	Rough-legged hawk	BULA
Aquila chrysaetos [2]	Golden eagle	AQCH
Haliaeetus leucocephalus	Bald eagle	HALE
Circus cyaneus [2]	Marsh hawk	CICY
FALCONIDAE		
Falco mexicanus	Prairie falcon	FAME
Falco peregrinus [2]	Peregrine falcon	FAPE
Falco sparverius [2]	American kestrel	FASP
GALLIFORMES		
TETRAONIDAE		
Dendragapus obscurus	Blue grouse	DEOB
Centrocercus urophasianus [2]	Sage grouse	CEUR
GRUIFORMES		
GRUIDAE		
Grus canadensis tabida [2]	Greater sandhill crane	GRCA

Table 2.3-4. (Continued)

ORDER FAMILY Species	Common Name	Field Code 3/
CHARADRIIFORMES		
CHARADRIIDAE		
Charadrius vociferus 2/	Killdeer	CHVO
SCOLOPACIDAE		
Capella gallinago 2/	Common snipe	CAGA
Actitis macularia 2/	Spotted sandpiper	ACMA
Tringa flavipes 2/	Lesser yellowlegs	TRFL
PHALAROPODIDAE		
Steganopus tricolor 2/	Wilson's phalarope	STTR
COLUMBIFORMES		
COLUMBIDAE		
Zenaida macroura 2/	Mourning dove	ZEMA
STRIGIFORMES		
STRIGIDAE		
Otus asio	Screech owl	OTAS
Bubo virginianus 2/	Great horned owl	BUVI
Glaucidium gnoma	Pygmy owl	GLGN
Asio flammeus	Short-eared owl	ASFL
PICIFORMES		
PICIDAE		
Colaptes auratus cafer 2/	Common (red-shafted) flicker	COAC
Dendrocopos pubescens 2/	Downy woodpecker	DEPU
PASSERIFORMES		
TYRANNIDAE		
Sayornis saya 2/	Say's phoebe	SASA
Contopus sordidulus 2/	Western wood pewee	COSO
ALAUDIDAE		
Eremophila alpestris 2/	Horned lark	ERAL

Table 2.3-4. (Continued)

ORDER FAMILY Species	Common Name	Field Code 3/
PASSERIFORMES (Continued)		
HIRUNDINIDAE		
Iridoprocne bicolor 2/	Tree swallow	IRBI
Stelgidopteryx ruficollis 2/	Rough-winged swallow	STRU
Hirundo rustica 2/	Barn swallow	HIRU
CORVIDAE		
Cyanocitta stelleri 2/	Steller's jay	CYST
Aphelocoma coerulescens 2/	Scrub jay	APCO
Pica pica 2/	Black-billed magpie	PIPI
Corvus corax 2/	Common raven	COCO
Gymnorhinus cyanocephalus 2/	Pinyon jay	GYCY
Nucifraga columbiana 2/	Clark's nutcracker	NUCO
PARIDAE		
Parus atricapillus 2/	Black-capped chickadee	PAAT
Parus gambeli 2/	Mountain chickadee	PAGA
Parus inornatus	Plain titmouse	PAIN
Psaltriparus minimus	Common bushtit	PSMI
SITTIDAE		
Sitta carolinensis 2/	White-breasted nuthatch	SICA
Sitta canadensis 2/	Red-breasted nuthatch	SICN
Sitta pygmaea	Pygmy nuthatch	SIPY
CERTHIIDAE		
Certhia familiaris	Brown creeper	CEFA
MIMIDAE		
Oreoscoptes montanus 2/	Sage thrasher	ORMO
TURDIDAE		
Turdus migratorius 2/	American robin	TUMI
Sialia currucoides 2/	Mountain bluebird	SICU
Myadestes townsendi	Townsend's solitaire	MYTO

Table 2.3-4, (Continued)

ORDER FAMILY Species	Common Name	Field Code 3/
PASSERIFORMES (Continued)		
SYLVIIDAE		
Polioptila caerulea 2/	Blue-gray gnatcatcher	POCA
Regulus calendula	Ruby-crowned kinglet	RECA
MOTACILLIDAE		
Anthus spinoletta 2/	Water pipit	ANSP
BOMBYCILLIDAE		
Bombycilla cedrorum	Cedar waxwing	BOCE
LANIIDAE		
Lanius excubitor	Northern shrike	LAEX
Lanius ludovicianus 2/	Loggerhead shrike	LALU
STURNIDAE		
Sturnus vulgaris 2/	Starling	STVU
PARULIDAE		
Vermivora celata 2/	Orange crowned warbler	VECE
Vermivora virginiae 2/	Virginia's warbler	VEVI
Dendroica coronata 2/	Yellow-rumped warbler	DECO
PLOCEIDAE		
Passer domesticus	House sparrow	PADO
ICTERIDAE		
Sturnella neglecta 2/	Western meadowlark	STNE
Agelaius phoeniceus 2/	Red-winged blackbird	AGPH
Euphagus cyanocephalus	Brewer's blackbird	EUCY
FRINGILLIDAE		
Carpodacus mexicanus	House finch	CAME
Leucosticte atrata	Black rosy finch	LEAT
Leucosticte australis	Brown-capped rosy finch	LEAU
Spinus pinus 2/	Pine siskin	SPPI
Chlorura chlorura 2/	Green-tailed towhee	CHCH

Table 2.3-4. (Continued)

ORDER FAMILY Species	Common Name	Field Code [3/]
PASSERIFORMES (Continued)		
FRINGILLIDAE		
Pipilo erythrophthalmus [2/]	Rufous-sided towhee	PIER
Pooecetes gramineus [2/]	Vesper sparrow	POGR
Amphispiza belli	Sage sparrow	AMBE
Melospiza melodia [2/]	Song sparrow	MEME
Junco hyemalis [2/]	Dark-eyed junco	JUHY
Junco caniceps [2/]	Gray-headed junco	JUCA
Spizella arborea [2/]	Tree sparrow	SPAR
Spizella passerina [2/]	Chipping sparrow	SPPA
Spizella breweri [2/]	Brewer's sparrow	SPBR
Zonotrichia leucophrys [2/]	White-crowned sparrow	ZOLE
Passerella iliaca	Fox sparrow	PAIL
Rhynchophanes mccownii	McCown's longspur	RHMC
Calcarius ornatus	Chestnut-collared longspur	CAOR
Plectrophenax nivalis	Snow bunting	PLNI

[1/] The following authorities are used for bird nomenclature:
American Ornithologists' Union. 1957. Checklist of North American birds, fifth edition. Port City Press, Baltimore, Maryland. 691 pages.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union checklist of North American birds (fifth edition, 1957). Auk 90: 411-419.

[2/] Species encountered during the April field period.

[3/] Four letter code, designates the scientific name and is used to simplify the recording of field data.

sagebrush areas on 84 Mesa and near Little Duck Creek. An estimated 30-35 birds were first observed on April 17, 1975 and later repeatedly, from April 25 through April 30, 1975. The cranes fed and displayed (dancing) on 84 Mesa in areas of sparse sagebrush. Only about half of the birds were observed displaying at any given time.

Ground surveys to locate raptor nests were conducted between April 26 and April 30, 1975. Forty-three nest sites were located. Of these, 20 nests were active, either containing eggs or chicks, or both.

Six raptor species were observed during raptor survey flights conducted over the area of Tract C-a in early spring, 1975. One Cooper's hawk, one red-tailed hawk, one marsh hawk, 10 golden eagles, one peregrine falcon and 48 common ravens were observed. Of all birds recorded during these surveys, the common raven was observed most frequently. Table 2.3-5 lists all raptors encountered during aerial surveys, night transects and opportunistic sightings during early spring, 1975.

2.3.8 Reptiles and Amphibians

2.3.8.1 Objectives

No change has been implemented since Progress Report 2-Summary. See section 2.3.8 in Progress Report 2-Summary for the objectives of the reptile and amphibian section.

2.3.8.2 Methods

Two lizard sampling grids established on rocky south-facing slopes are surveyed four times per year to determine lizard abundance. All captured lizards are identified, sexed, weighed, toe clipped and released. Line transect techniques are employed to sample reptile and amphibian species in all major vegetation types on and near Tract C-a. Two nights during May and June of each year are devoted to sampling potential amphibian breeding sites on and near Tract C-a.

2.3.8.3 Results

Lizard grid and line transect census data for reptiles and amphibians were not gathered during the reporting quarter March through May, 1975.

Potential amphibian breeding sites in four different locations were visited on two different nights in mid-May. One individual of each of the three different species encountered was collected and prepared as a voucher specimen. The three species collected were the tiger salamander (*Ambystoma tigrinum*), both adult and larva, the chorus frog (*Pseudacris triseriata*), and the spadefoot toad (*Scaphiopus* sp.).

Table 2.3-5. Raptor species encountered during aerial surveys, night transects and opportunistic sightings during early spring 1975 for RBOSP

Species	Total Number Observed		
	Aerial Surveys	Ground Investigations	Total
Cooper's hawk	1	5	6
Red-tailed hawk	1	19	20
Marsh hawk	1	6	7
Golden eagle	10	5	15
Peregrine falcon	1	0	1
American kestrel	0	17	17
Great horned owl	0	13	13
Common raven	48	39	87
TOTAL			166

2.3.9 <u>Invertebrates</u>

2.3.9.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.9 in Progress Report 2-Summary for the objectives of the invertebrate studies.

.3.9.2 Methods

Field sampling is conducted at five sites situated in the major vegetation types found in the study area. Field sampling involves five basic operations: pitfall trapping, malaise trapping, D-Vac suction sampling, sweep netting and opportunistic sampling. Each sampling technique is designed to capture a particular group of invertebrates.

2.3.9.3 Results

Invertebrate data were not gathered during the reporting quarter March through May, 1975.

2.3.10 <u>Domestic Livestock</u>

2.3.10.1 Objectives

No change has occurred since Progress Report 2-Summary. See section 2.3.10 in Progress Report 2-Summary for the objectives of the domestic livestock section.

2.3.10.2 Methods

No change has occurred since Progress Report 2-Summary. See section 2.3.10 in Progress Report 2-Summary for methods used in domestic livestock studies.

2.3.10.3 Results

Aerial surveys of domestic livestock were conducted in conjunction with the elk and feral horse counts on March 4 and April 14, 1975. Totals of 56 and 63 cattle were observed on the aerial surveys conducted on March 4 and April 14, respectively. During both surveys, the cattle were concentrated in feeding and calving areas in Ryan Gulch, Black Sulfur Creek and Duck Creek.

2.3.11 Remote Sensing

2.3.11.1 Objectives

Several ongoing investigations are designed to determine the applicability of remote sensing data analysis techniques in the terrestrial baseline data accumulation program. These include: determining the distribution, areal extent, density and successional status of the vegetation community types encompassing Tract C-a and the adjacent zones; determining the erosion condition of Tract C-a; determining the distribution of wildlife habitat for large and small mammals; determining the distribution of western harvester ant colonies; determining the location of suspected and known habitats of major avifauna, including raptor species; and determining the location of possible archaeological sites.

2.3.11.2 Methods

Several flights are planned to obtain color infrared (CIR) imagery for subsequent interpretation. Low level flights to obtain CIR imagery at a scale of 1:2000 are planned for the spring of 1975 and 1976. Flights during the fall of 1975 and 1976 are planned to obtain CIR imagery at a scale of 1:6000.

2.3.11.3 Results

Remote sensing data were not gathered during the reporting quarter March through May, 1975.

2.3.12 Threatened and Endangered Species

2.3.12.1 Objectives

Efforts are directed toward determining whether threatened or endangered wildlife species inhabit Tract C-a and its environs. If discovered, particular efforts will be given to determining the distribution and habitat utilization of threatened and endangered species on the study area.

2.3.12.2 Methods

Specific, quantitative sampling techniques have been described which are performed within all major vegetative associations of the tract to inventory and enumerate the species of plants and animals present. Cumulatively, these techniques should ascertain the presence of "threatened" or "endangered" species.

2.3.12.3 Results

Three threatened or endangered avian species were observed in the study area of Tract C-a during the quarter March through May, 1975. The three species are the prairie falcon ("Threatened" - U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife. 1973. Threatened Wildlife of the United States. Res. Publ. 114 Gov. Print. Off., Washington, D.C. 289 pages); the peregrine falcon ("Endangered" - U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Endangered Species Act of 1973 - Public Law 93-205; 87 Stat. 884, December 28, 1973; United States List of Endangered Fauna, May, 1975); and the greater sandhill crane ("Undetermined" - Position Statement Concerning Endangered Species Unanimously Adopted by the Colorado Wildlife Commission on March 22, 1973). The greater sandhill crane is considered endangered in Colorado only as a summer nesting resident. Birds migrating through Colorado are not considered endangered in the state. Therefore, status of this species in the vicinity of Tract C-a is, at present, undetermined.

On April 17, 1975, 30-35 greater sandhill cranes were observed overhead in the vicinity of Little and Big Duck Creeks. During an aerial sage grouse lek survey over 84 Mesa on April 25, 1975, cranes were observed in a sagebrush community. From April 25 through April 30, 1975, between 17 and 29 cranes were observed foraging and displaying in an area of sparse sagebrush on 84 Mesa. One flock of 13 birds was observed near Little Duck Creek on April 26. The cranes were foraging above the dry creek in dense sagebrush. These observations indicate that the Tract C-a vicinity was being utilized routinely by this crane during mid-to-late April, 1975. At this time, the intensity of use and the degree of crane attachment to the area are not known. During this same period, greater sandhill cranes were also congregated near Hayden, Colorado close to the Yampa River. Cranes staging near Hayden are known to nest in northwestern Colorado. Cranes congregated on and near 84 Mesa might nest in the area or may continue north on a migration to Idaho, Wyoming or Montana. Additional studies to resolve this question are currently underway.

Two sightings of prairie falcons were recorded during mid-May, 1975 near the southeast corner of Tract C-a. One peregrine falcon was sighted during an aerial raptor survey on April 3, 1975 in section 1, T2S, R99W.

2.4 Aquatic Studies

The Aquatic Baseline Data Accumulation Program is intended to perform those environmental studies described in the Federal Register, Volume 39, Number 230, Part 3, Oil Shale Lease Environmental Stipulations and in the Tract C-a Exploratory plan of May, 1974. Specific lease requirements addressed were "The Lessee shall make studies of the flora and fauna...and also of the aquatic habitat as far downstream as the Mining Supervisor shall require." "The Lessee shall compile an inventory of natural surface features, such as springs and seeps."

No detailed studies of the aquatic ecosystems of Tract C-a have been made prior to the present baseline study. However, studies of similar habitats indicate that the composition and abundance of the aquatic flora and fauna are primarily determined by the permanency of flow.

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development. The ongoing programs are summarized in Table 2.4-1.

In order to fulfill these objectives, 35 sampling stations have been selected to represent the general aquatic habitats present. Emphasis has been placed on Yellow Creek and the White River which are permanently flowing streams. The locations of aquatic sampling stations are depicted in Figure 2.4-1. Sampling periods discussed herein are December, 1974 - January, 1975 and April, 1975. The condition (dry or flowing) of each station during this period and dates on which aquatic samples were taken are shown in Table 2.4-2. Physical, chemical, and biological measurements are taken concurrently at each sampling site.

2.4.1 Physical and Chemical Characteristics

2.4.1.1 Objectives

The objectives of this segment of the aquatic studies include the determination of certain physical characteristics of the streams at each sampling station and the correlation of these characteristics with the chemical and biological data collected. In addition, certain chemical parameters which may be of particular biological significance are determined and correlated with the physical and biological data collected at the same time.

2.4.1.2 Methods

The method of preserving magnesium, potassium, silica, sodium, dissolved organic carbon, and total organic carbon has changed from the addition of HNO_3 to the addition of HCl. No other change in methods has occurred since Progress Report 2. See Table 2.4-3 for specific analytical methods.

Table 2.4-1. Summary of RBOSP Aquatic Sampling Programs December 1974 - January 1975, April 1975.

Group Sampled	Objective	Methodology	No. of Sample Sites Dec.'74-Jan.'75,	Apr.'75
Physical measurements	To measure existing physical parameters	Flow, O_2, pH, cond., and temp. meters	24	27
Water chemistry	Analysis of certain chemical characteristics of particular biological significance	Pump-type or bottle-type	24	27
Phytoplankton	Population studies and species inventory	Pump-type or bottle-type	24	27
Zooplankton	Population studies and species inventory	Wisconsin nets w/flow meter or pump	24	27
Periphyton	To estimate abundance, determine biomass and productivity	Scraped off rock	24	27
Benthos	Population studies and species inventory	Ekman, modified Surber, D-frame	24	27
Macrophytes	Species inventory	Random transect	24	27
Fish	Population studies, species inventory, condition, food habits	Electrofishing/ seining	15	15
Sediment chemistry	To measure existing chemical characteristics		24	27
Rare and endangered species			Opportunistic	
Springs & seeps			Opportunistic	
Water quality	To measure existing quality in the White River near Yellow Creek			2

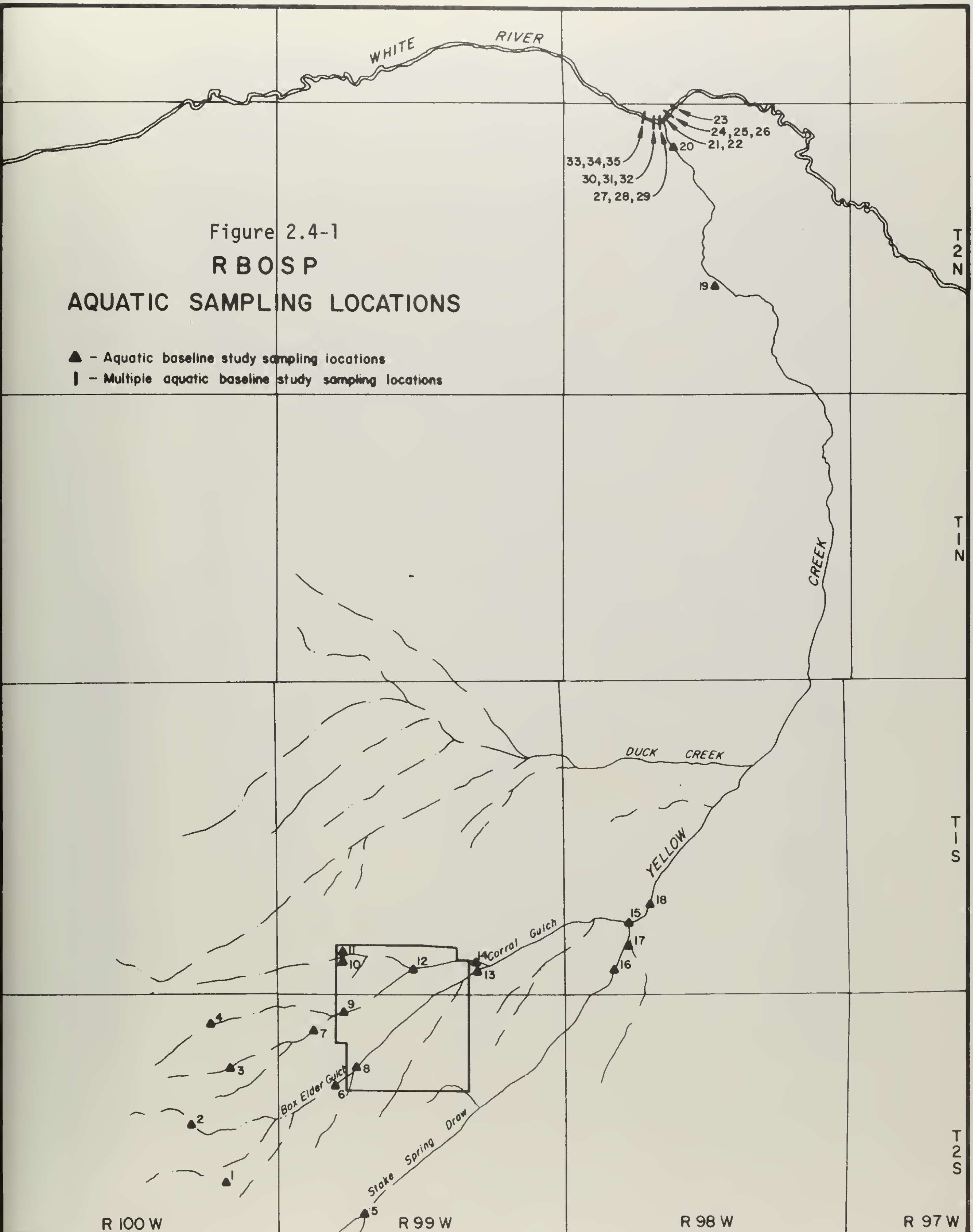


Figure 2.4-1
RBOSP
AQUATIC SAMPLING LOCATIONS
▲ - Aquatic baseline study sampling locations
| - Multiple aquatic baseline study sampling locations
WHITE RIVER
YELLOW CREEK
DUCK CREEK
Corral Gulch
Box Elder Gulch
Stake Spring Draw
23
24,25,26
21,22
20
33,34,35
30,31,32
27,28,29
19
18
15
17
16
14
13
12
10
9
7
8
6
5
4
3
2
1
T 2 N
T 1 N
T 1 S
T 2 S
R 100 W
R 99 W
R 98 W
R 97 W

Table 2.4-2. Dates of Sampling for RBOSP Aquatic Baseline Studies. December 1974 - January 1975, and April 1975

Station	Date Sampled	Flow Condition
1	1-10-75	Inaccessible
2	1-10-75	Inaccessible
3	1-15-75	Flowing
4	1-14-75	Flowing
5	1-16-75	Flowing
6	1-10-75	Dry
7	1-10-75	Frozen
8	1-10-75	Flowing
9	1-10-75	Flowing
10	12- 9-74	Dry
11	12- 9-74	Dry
12	12- 9-74	Dry
13	12- 9-74	Flowing
14	1- 6-75	Flowing
15	12- 9-74	Frozen
16	12- 9-74	Dry
17	12- 9-74	Dry
18	12- 9-74	Frozen
19	1- 6-75	Flowing
20	12- 4-74	Flowing (Ice covered)
21	12- 4-74	Flowing (Ice covered)
22	12- 4-74	Flowing (Ice covered)
23	12-10-74	Flowing (Ice covered)
24	12- 5-74	Flowing (Ice covered)
25	12- 5-74	Flowing (Ice covered)
26	12- 5-74	Flowing (Ice covered)
27	12- 2-74	Flowing (Ice covered)
28	12- 2-74	Flowing (Ice covered)
29	12- 2-74	Flowing (Ice covered)
30	12- 3-74	Flowing (Ice covered)
31	12- 3-74	Flowing (Ice covered)
32	12- 3-74	Flowing (Ice covered)
33	12-10-74	Ice covered
34	12-10-74	Flowing (Ice covered)
35	12-10-74	Flowing (Ice covered)

Table 2.4-2. Continued

Station	Date Sampled	Flow Condition
1	4-17-75	Flowing
2	4-10-75	Flowing
3	4-15-75	Flowing
4	4-15-75	Flowing
5	4- 9-75	Flowing
6	4- 9-75	Dry
7	4-15-75	Flowing
8	4-10-75	Flowing
9	4- 8-75	Flowing
10	4- 8-75	Dry
11	4- 8-75	Dry
12	4- 8-75	Dry
13	4- 9-75	Flowing
14	4- 9-75	Flowing
15	4- 9-75	Dry
16	4- 9-75	Dry
17	4- 9-75	Dry
18	4- 9-75	Dry
19	4-11-75	Flowing
20	4-30-75	Flowing
21	4-30-75	Flowing
22	4-30-75	Flowing
23	4-26-75	Flowing
24	4-24-75	Flowing
25	4-24-75	Flowing
26	4-24-75	Flowing
27	4-22-75	Flowing
28	4-22-75	Flowing
29	4-21-75	Flowing
30	4-23-75	Flowing
31	4-23-75	Flowing
32	4-23-75	Flowing
33	4-25-75	Flowing
34	4-25-75	Flowing
35	4-25-75	Flowing

Table 2.4-3. Water chemistry, Analytical Laboratory Methodology. RBOSP Aquatic Baseline Studies.

Parameter	Measurement Methodology[1]	Detection Limit (ppm)[2]	Sample Preservation
Alkalinity, total	Colorimetric	2	None required
Ammonia nitrogen	Electrode	0.10	$HgCl_2$
Calcium, dissolved	Atomic absorption	0.02	None required
Chloride, dissolved	Potentiometric	0.4	None required
Hardness, total	EDTA Titration	2	None required
Magnesium, dissolved	Atomic absorption	0.005	HCl
Kjeldahl nitrogen	Kjeldahl digestion	0.10	$HgCl_2$
Nitrate, dissolved	Brucine	0.02	$HgCl_2$
Nitrite, dissolved	Diazotization	0.01	$HgCl_2$
Phosphate, ortho (dissolved)	Ammonium molybdate - potassium antimonyl tartrate	0.005	$HgCl_2$
Phosphate, total	Same as orthophosphate	0.01	$HgCl_2$
Potassium, dissolved	Atomic absorption	0.01	HCl
Silica, dissolved	Molybdosilicate	0.005	HCl
Sodium, dissolved	Atomic absorption	0.005	HCl
Sulfate, dissolved	Gravimetric	0.30	Refrigeration
Carbon, dissolved organic	Beckman TOC Analyzer	2	HCl
Carbon, total organic	Beckman TOC Analyzer	2	HCl
Solids, suspended	Filtration	1	None required
Solids, total dissolved	Filtration and evaporation	1	None required
	SEDIMENT CHEMISTRY[3]		
Arsenic	Extraction and Atomic absorption	1.	Refrigeration
Aluminum	Extraction and Atomic absorption	10	Refrigeration
Herbicide	Gas Chromatography	100ppb	Refrigeration
Lead	Extraction and Atomic absorption	0.5	Refrigeration
Mercury	Extraction and Atomic absorption	0.02	Refrigeration
Nitrogen, total Kjeldahl	Kjeldahl digestion - Electrode	10	Refrigeration
Phosphate, total	Persulfate digestion	0.25	Refrigeration
Solids, total volatile	Filtration, evaporation volatilization	10	Refrigeration
Zinc	Extraction and Atomic absorption	0.5	Refrigeration

[1]Methods are those specified in the Federal Register, Vol. 38, No. 199, Oct. 16, 1973 except for use of specific ion electrode.

[2]For water samples, this detection limit is the minimum concentration which will be reported on natural and treated water samples (99.99% H_2O) with the indicated method and using a sample of defined size.

[3]Detection limits vary with sample size

2.4.1.3 Results

A total of eight sampling sites was dry during the April, 1975, sampling period; the dry sites included Station 6, 10 - 12, and 15 - 18.

The ranges of selected physical and chemical parameters observed in the White River and Yellow Creek during April are presented below. As a result of the beginning of spring run-off, turbidities in the streams remained high during the sampling period. Dissolved oxygen concentrations also remained high during this period of relatively cold temperatures and increasing flow.

	White River	Yellow Creek
Specific conductance (µmhos/cm)	630 - 850	2500 - 3700
pH	8.2 - 8.5	8.5 - 8.6
Alkalinity, total ($CaCO_3$)mg/l	169 - 211	707 - 1306
Chloride (mg/l)	24 - 39	26 - 110
Sulfate (mg/l)	48 - 71	194 - 291
Dissolved solids (mg/l)	453 - 644	2000 - 2500
Turbidity (JTU)	42 - 110	65 - 86
Dissolved oxygen (mg/l)	8.3 - 10.1	7.9 - 11.4
Temperature (^oC)	10 - 15	10 - 14

2.4.2 Phytoplankton

2.4.2.1 Objectives

No change in objectives has occurred since Progress Report 2. See section 2.4.2.1 of Progress Report 2 for specific objectives.

2.4.2.2 Methods

No change in methods has occurred since Progress Report 2. See section 2.4.2.2 of Progress Report 2 for specific methods used in phytoplankton studies.

2.4.2.3 Results

Ninety-nine algal taxa were observed in the December, 1974 - January, 1975 collections (both replicates). As a result of additional taxonomic study of the October - November, 1974 and December, 1974 - January, 1975 phytoplankton, the following revisions in nomenclature have been made: organisms reported previously as *Chrysidiastrum catenatum* will be reported as *Chrysidiastrum ocellatum*, organisms reported previously as *Rivularia* sp. will be reported as *Calothrix* sp., and organisms reported previously as *Stephanodiscus tenuis* will be reported as *Thalassiosira fluviatilis*.

During the December - January period, diatoms were generally the most abundant algal group at all locations sampled. Analyses of all

December - January samples indicate that at the headwater stations phytoplankton abundance was generally low and the most abundant organisms were diatoms. The most abundant species at these stations included Achnanthes minutissima, Navicula salinarum, and Nitzschia linearis. At tract Stations 5 and 14, phytoplankton abundance was quite low. At tract Stations 8 and 9, the most abundant species was Chrysidiastrum ocellatum (a species belonging to the Chrysophyceae), while diatoms were the most abundant organisms at other tract stations. The most abundant species at these stations included Chrysidiastrum ocellatum, Achnanthes minutissima and Navicula salinarum. Diatoms were the most abundant organisms at the Yellow Creek stations. The most abundant species in Yellow Creek included Cymbella affinis, Cyclotella meneghiniana, and Navicula salinarum. Phytoplankton abundance was much lower at Station 19 than at any of the other Yellow Creek sites, most likely due to the fact that samples were obtained at the outflow of a spring where low densities would be expected. In the White River, diatoms were the most abundant phytoplankton group and the most abundant species was Diatoma vulgare. Other abundant species included Cymbella affinis, Synedra ulna, Nitzschia frustulum, and Gomphonema ventricosa.

To date, a total of 123 algal taxa has been observed in the April collection. At most headwater stations, the diatom Achnanthes minutissima and an unidentified flagellate were abundant. At the tract stations, Achnanthes minutissima and an unidentified chlorophyte were moderately abundant. Based on the data analyzed to date, the phytoplankton density at Station 14 (a small pond area) was much greater than at the other tract stations during April. In the Yellow Creek, the phytoplankton species composition and abundance at Station 19 was somewhat different from that found at Stations 20 and 22, and the phytoplankton density at Station 21 was quite low. The most abundant taxa in Yellow Creek included Surirella ovata, Cyclotella meneghiniana, Navicula pelliculosa, Rhodomonas minuta, and an unidentified chlorophyte. In the White River, the diatoms Navicula viridula and Thalassiosira fluviatilis were generally abundant at all stations. At Station 33, more Cyanophyta (blue-green algae) were observed than at other stations and at Station 31, the diatom Gomphonema ventricosum was very abundant.

2.4.3 Zooplankton

2.4.3.1 Objectives

No change in objectives has occurred since Progress Report 2. See section 2.4.3.1 of Progress Report 2 for specific objectives.

2.4.3.2 Methods

No change in methods has occurred since Progress Report 2. See section 2.4.3.2 of Progress Report 2 for specific methods used in zooplankton studies.

2.4.3.3 Results

A total of 50 zooplankton taxa was observed in the December, 1974 - January, 1975 collections. As a result of further taxonomic study, organisms which were previously reported as Alona rectangula will now be reported as Alona sp. At the headwater stations, the most abundant taxa in December - January included the protozoans Centropyxis aculeata and C. constricta, and bdelloid rotifers. At the tract stations, the most abundant taxa included the protozoans Centropyxis aculeata and Vorticella sp.; the rotifers Colurella spp., Notholca acuminata, N. Squamula, Monostyla sp., and M. closterocerca; and crustacean nauplii and Bryocamptus hiemalis. At the Yellow Creek stations, the most abundant taxa included the protozoans Centropyxis aculeata, and C. constricta; the rotifers Monostyla sp., M. closterocerca, and Notholca acuminata; and ostracods. Zooplankton abundance was much lower at Station 19 than at any of the other Yellow Creek stations; these low densities can probably be attributed to the fact that the samples from Station 19 were collected at the outflow of a spring. Zooplankton densities at the White River stations were generally greater than those found in other study areas. The most abundant taxa in the White River included the protozoans Centropyxis aculeata and Vorticella sp. and the rotifer Proales sp.

In the analysis of one replicate from the zooplankton collections of April, 1975, a total of 39 species has been observed. Laboratory analyses to date indicate that at the headwater stations above Tract C-a the most abundant taxa were Centropyxis aculeata, Epistylis sp., bdelloid rotifers, unidentified rotifer species (contracted), and crustacean nauplii. At the tract stations, the most abundant taxa included Centropyxis aculeata, Vorticella sp., bdelloid rotifers, and Notholca squamula. At the Yellow Creek stations, the most abundant taxa were Centropyxis aculeata, Difflugia accuminata, Notholca accuminata, and bdelloid rotifers. At the White River stations, Centropyxis aculeata, Chilodonella spp., Epistylis sp., Vorticella sp., bdelloid rotifers, Notholca squamula, Proales sp., and unidentified rotifer species (contracted) were the most abundant taxa.

2.4.4 Periphyton

2.4.4.1 Objectives

No change in objectives has occurred since Progress Report 2. See section 2.4.4.1 of Progress Report 2 for specific objectives.

2.4.4.2 Methods

No change in methods has occurred since Progress Report 2. See section 2.4.4.2 of Progress Report 2 for specific methods used in periphyton studies.

2.4.4.3 Results

A total of 79 algal taxa was observed in the December, 1974 - January, 1975 periphyton collections. As a result of additional taxonomic study, taxa previously reported as Rivularia sp. and Stephanodiscus tenuis will now be reported as Calothrix sp. and Thalassiosira fluviatilis, respectively. Based upon the results from the three replicate samples taken at each station, the most abundant algae in the periphyton of the headwater stations during December - January were the diatoms Achnanthes lanceolata, A. minutissima, Gomphonema intricatum, Nitzschia frustulum, and N. linearis (Achnanthes minutissima was particularly abundant at Station 4). At the tract stations, the most abundant species were the diatoms Achnanthes minutissima, Cymbella affinis, Navicula cryptocephala, Nitzschia denticula, and Synedra amphicephala. Periphyton densities were quite low at Stations 8 and 9, whereas densities of Achnanthes minutissima were very high at Station 14. In Yellow Creek, the most abundant species at Station 19 were the diatoms Navicula cryptocephala, N. viridula, Nitzschia frustulum, N. palea, Surirella ovata, and Synedra amphicephala. In the White River, densities were generally high and the diatoms Diatoma vulgare, Epithemia sorex, and Navicula cryptocephala were particularly abundant. Several species of Cyanophyta (blue-greens), including Calothrix sp. and Lyngbya sp., were also quite abundant.

During the analysis of one replicate from the periphyton collections made during 1975, a total of 64 taxan was encountered. The following results are based upon partial analysis of the April periphyton collections. At the headwater stations, the most abundant species include the diatoms Achnanthes minutissima, Gomphonema intricatum, Meridion circulare, Surirella ovata, and Synedra amphiciphala. At the tract stations, the blue-green alga Plectonema sp. and diatoms Achnanthes minutissima, Gomophonema intricatum, Nitzschia denticula, and N. frustulum were the most abundant periphyton taxa. In Yellow Creek, the most abundant species were the diatoms Achnanthes minutissima, Fragilaria vaucheriae, Navicula pelliculosa, and Surirella ovata. In the White River, the blue-green Calothrix sp. and the diatoms Epithemia sorex, Navicula cryptocephala, N. tripunctata, N. viridula, Nitzschia dissipata, and Gomphonema olivaceum were the most abundant species.

2.4.5 Benthos

2.4.5.1 Objectives

No change in objectives has occurred since Progress Report 2. See section 2.4.5.1 of Progress Report 2 for specific objectives.

2.4.5.2 Methods

The methods reported in section 2.4.5.2 of Progress Report 2 remain unchanged, with the exception that the D-frame net was not utilized during the April sampling. Instead, a modified Surber sampler which is 63 cm high was utilized in deeper areas of the White River. In addition, in several of the very narrow streams on or near Tract C-a, an elliptical modified Surber sampler was used to collect the benthos samples in April.

2.4.5.3 Results

A total of 10 taxa of Oligochaeta and 35 taxa of Chironomidae was observed in the December, 1974 - January, 1975 benthos collections. The total number of taxa (including all taxonomic groups) identified in benthos samples taken during December - January is 108. Further taxonomic study of both the October - November and December - January benthos has resulted in the following revisions in classification of organisms: taxa previously reported as Neotrichia (Trichoptera: Hydroptilidae) will now be reported as Glossosomatidae (Trichoptera); the following revisions have been made to Chironomidae reported for the October - November period: Chaetocladius sp., Parakiefferiella sp. 2, Orthocladiinae sp. 2, and Orthocladiinae sp. 3 and 4, will now be reported as Parametriocnemus-Paracladius, Paracladius sp., Cardiocladius sp., and Orthocladiinae sp. 1, respectively. In addition, the following have been added to the list of taxa observed during October - November: Cricotopus (Cricotopus) festivellus group, Cricotopus (Cricotopus) trifascia, Cricotopus (Isocladius) c. f. tricinctus, Parametriocnemus sp., and Paraphaenocladius sp. (all of these taxa belong to the family Chironomidae).

During the analysis of one replicate of the benthos samples collected during April, 1975, a total of 45 taxa has been observed. Table 2.4-4 lists the taxa observed in April samples. The following results are based upon partial analysis of the April benthos collections: at the headwater stations the most abundant taxa included Chironomidae, Nematoda, Oligochaeta, Baetidae, Ceratopogonidae, and Simuliidae; at the tract stations, taxa belonging to the Chironomidae, Baetidae, and Oligochaeta were most abundant; and in Yellow Creek the most abundant taxa belonged to the Chironomidae, Ephemerellidae, Tricorythidae, and Oligochaeta.

2.4.6 Sediment Chemistry

2.4.6.1 Objectives

The objectives of sediment chemistry studies remain the same as those stated in section 2.4.6.1 of Progress Report 2.

2.4.6.2 Methods

As indicated in Table 2.4-3, refrigeration is used to preserve sediment samples. Since Progress Report 2, the analytical methods utilized for total Kjeldahl nitrogen and total phosphate have been changed to Kjeldahl digestion and electrode and per-sulfate digestion, respectively; and sediment detection limits have been updated.

Table 2.4-4. List of Macroinvertebrate Species Observed During RBOSP Aquatic Baseline Studies, April 1975.

Nematoda

Mollusca
  Gastropoda
    Basommatophora
      Physidae
        Physa Draparnaud
      Lymnaeidae
        Lymnaea Lamarck

Annelida
  Hirudinea
    Rhynchobdellida
      Glossiphoniidae
        Helobdella stagnalis (Linnaeus)

  Oligochaeta

Arthropoda
  Arachnoidea
    Acari
  Crustacea
    Amphipoda
      Talitridae
        Hyallela azteca (Saussure)

Insecta
  Ephemeroptera
    Heptageniidae
      Epeorus Eaton
      Rhithrogena Eaton
    Baetidae
      Baetis Leach
      Callibaetis Eaton
    Ephemerellidae
      Ephemerella Walsh
    Tricorythidae
      Tricorythodes Ulmer

  Odonata
    Zygoptera
      Coenagrionidae
        Enallagma Charpentier

Table 2.4-4. Continued

Anisoptera
  Gomphidae

Plecoptera
  Euholognatha
    Capniidae
  Systellognatha
    Perlodidae
      Isoperla Banks

Coleoptera
    Dytiscidae
      Deronectes Sharp
      Oreodytes Seidlitz
    Elmidae
      Dubiraphia Sanderson
      Microcylloepus Hinton
      Zaitzevia Champion
    Dryopidae
      Helichus Erichson

Trichoptera
    Glossosomatidae
    Hydropsychidae
      Hydropsyche Pictet
    Hydroptilidae
      Hydroptila Dalman
    Limnephilidae
      Hesperophylax Banks
    Leptoceridae
      Oecetis McLachlan
    Brachycentridae
      Brachycentrus Curtis

Lepidoptera
    Pyralidae

Diptera
    Tipulidae
      Dicranota Zetterstedt
      Holorusia Loew
      Limnophila Macquart
    Psychodidae
      Pericoma Walker
    Ceratopogonidae
    Chironomidae
    Culicidae

Table 2.4-4. Continued

Simuliidae
- *Simulium argus* Wiilston
- *S. piperi* Dyar & Shannon
- *S. vittatum* Zetterstedt

Stratiomyiidae
- *Euparyphus* Gerstaecker
- *Stratiomyia* Geoffroy

Tabanidae
- *Chrysops* Meigen

Rhagionidae
- *Atherix variegata* Walker

Empididae
- *Clinocera* Meigen
- *Hemerodromia* Meigen

Anthomyiidae
- *Limnophora aequifrons* Stein
- *L. Discreta* Stein

2.4.6.3 Results

Table 2.4-5 includes the results of chemical analysis of sediment samples taken during the April, 1975 sampling period.

2.4.7 Macrophytes

2.4.7.1 Objectives

The objectives of this aspect of the aquatic studies are to identify and enumerate the aquatic macrophyte species at each sampling station, to determine their relative abundance, and to estimate the percentage of substrate area covered by major beds of macrophytes.

2.4.7.2 Methods

No change in methods has occurred since Progress Report 2. See section 2.4.7.2 of Progress Report 2 for specific methods used.

2.4.7.3 Results

Aquatic macrophytes were observed at a single sampling location during the April, 1975 sampling period. At Station 2, water cress (Rorippa nasturtium aquaticum) was found in scattered abundance. At the macrophyte sampling transect at Station 2, water cress covered an area of 162.6 cm^2. Within 15.2 m (50 ft.) of the sampling transect, water cress was found to cover areas of 284 cm^2 and 853 cm^2.

2.4.8 Fish

2.4.8.1 Objectives

The objectives of fish studies remain the same as those stated in section 2.4.8.1 of Progress Report 2.

2.4.8.2 Methods

No change in methods has occurred since Progress Report 2. See section 2.4.8.2 of Progress Report 2 for specific methods employed in fish studies.

2.4.8.3 Results

During April, approximately 148 fish representing 11 species were captured in the White River and lower Yellow Creek. The major portion of the catch during April was composed of flannelmouth and bluehead sucker, mottled sculpin, longnose dace, and fathead minnow. The catch was dominated by rough and forage fishes with few game fish observed (a small number of rainbow trout, brown trout, and mountain whitefish were found in the White River). High turbidity generally interfered with fishing efforts during April, as suggested by the relatively few specimens of mottled sculpin captured. Table 2.4-6 presents fish data from April, 1975 sampling.

Table 2.4-5. Results of Sediment Herbicide Analysis, RBOSP Aquatic Baseline Studies. April 1975

Station	Parameter	
	Tordon 22K	Silvex
1-A[1]		
1-B	<0.05	<0.05
2-A	<0.05	<0.05
2-B	<0.05	<0.05
3-A	<0.05	<0.05
3-B	<0.05	<0.05
4-A	<0.05	<0.05
4-B	<0.05	<0.05
5-A	<0.05	<0.05
5-B	2.0	<0.05
7-A	2.0	<0.05
7-B	1.3	<0.05
8-A	<0.05	<0.05
8-B	<0.05	<0.5
9-A	0.40	<0.05
9-B	0.10	<0.05
13-A	<0.05	<0.05
13-B	0.70	<0.05
14-A	0.10	<0.05
14-B	0.20	<0.05
19-A	<0.05	<0.05
19-B	<0.05	<0.05
20-A	<0.05	<0.05
20-B	0.10	<0.05
21-A	<0.05	<0.05
21-B	<0.05	<0.05
22-A	<0.05	<0.05
22-B	<0.05	<0.05
23-A	<0.05	<0.05
23-B	<0.05	<0.05
24-A	<0.05	<0.05
24-B	<0.05	<0.05
25-B	<0.05	<0.05
26-B	<0.05	<0.05
27-A	<0.05	<0.05
27-B	<0.05	<0.05
28-A	<0.05	<0.05
28-B	<0.05	<0.05
29-A	<0.05	<0.05
29-B	<0.05	<0.05
30-B	<0.05	<0.05
32-A	<0.05	<0.05
33-A	3.30	<0.05
33-B	2.70	<0.05
34-A	1.50	<0.05
34-B	1.70	<0.05

Table 2.4-6. List of Fish Species and Numbers Captured in the White River and Lower Yellow Creek, RBOSP Aquatic Baseline Studies. April 1975

Common Name	Scientific Name	Number Captured
Rainbow trout	*Salmo gairdneri*	4
Brown trout	*Salmo trutta*	1
Mountain whitefish	*Prosopium williamsoni*	2
Fathead minnow	*Pimephales promelas*	10
Longnose dace	*Rhinichthys cataractae*	12
Speckled dace	*Rhinichthys osculus*	9
Bluehead sucker	*Catostomus discobolus*	14
Flannelmouth sucker	*Catostomus latipinnis*	66
Mottled sculpin	*Cottus bairdi*	28
Roundtail chub	*Gila robusta*	1
Bluehead sucker-Flannelmouth sucker hybrid	*Catostomus discobolus* X *Catostomus latipinnis*	1

2.4.9 Springs and Seepages

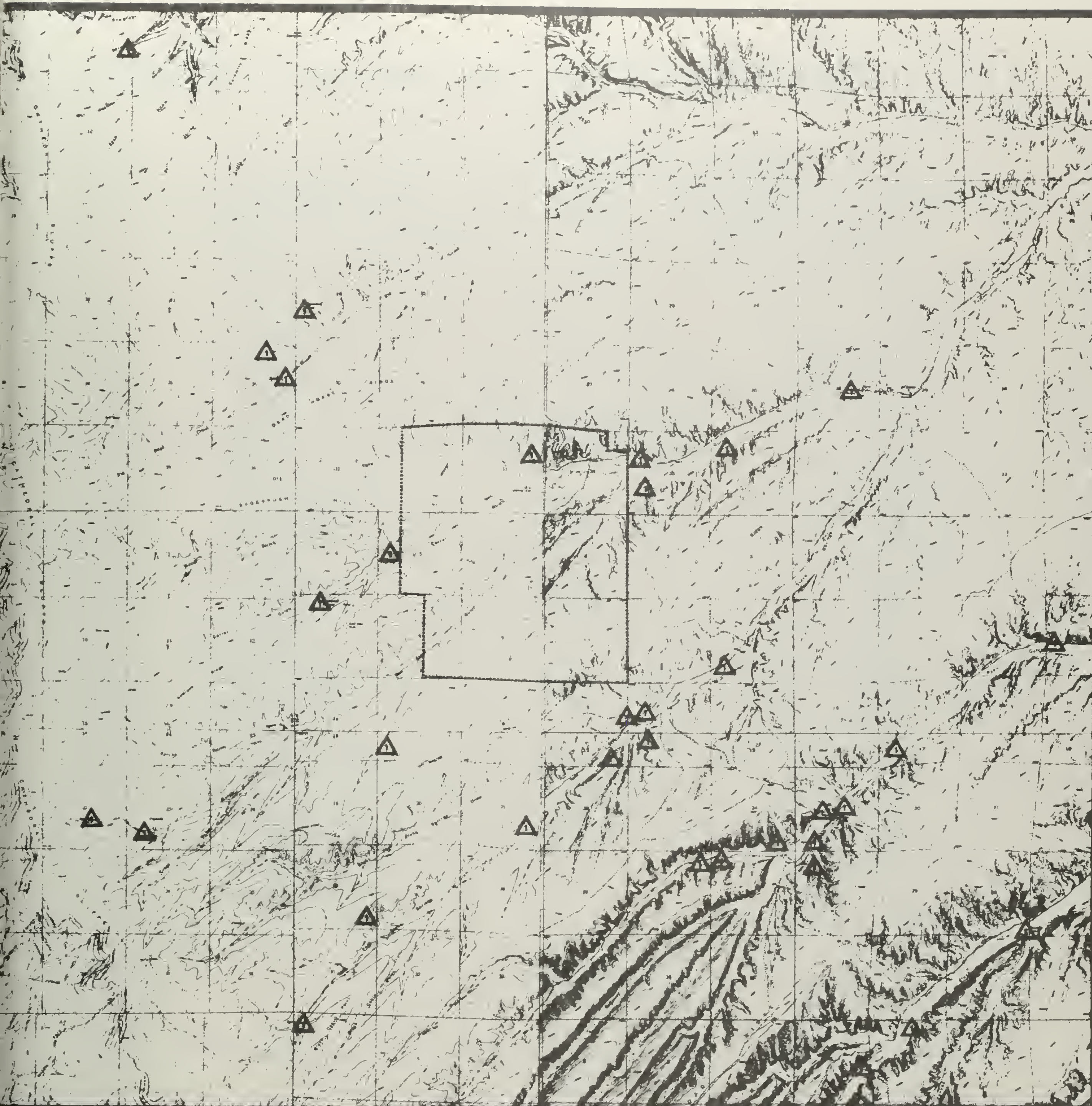
The objective of this aspect of the aquatic program is to identify and record the location of springs and seepages as they are encountered during routine aquatic sampling. The methods used include analysis of color infrared photography as well as field investigations. Locations of springs and seepages on or near Tract C-a are shown on Figure 2.4-2.

2.4.10 Hydrology

Eight sampling sites were dry during the April, 1975 sampling period. The approximate stream velocities at the other sampling locations are given in Table 2.4-7.

2.4.11 Miscellaneous Studies

The objective of this aspect of the aquatic program is to perform comprehensive water quality analyses in the White River. Duplicate samples are obtained at Stations 24 and 35. The frequency of collection of the various parameters included in these investigations and the list of parameters are presented in Table 2.4-8. Data from a portion of the April, 1975 water quality studies are presented in Tables 2.4-9 and 2.4-10.



ENVIRONMENTAL
STUDIES FOR THE
RIO BLANCO OIL SHALE PROJECT

TRACT C-a

LIMNETICS, INC.
Denver, Colorado

5/75

SPRING & SEEPAGE LOCATIONS

△ springs and seepages as of 5/75

Figure 2.4-2

N

MILES
0 1/2 1 2

Table 2.4-7. Stream Flows Observed During RBOSP Aquatic Baseline Studies. April 1975.

Station	Flow Rate
1	0.1(1/sec)
2	0.8
3	0.4
4	0.5
5	0.9;0.3
7	0.5
8	1.0
9	1.7
13	1.0
14	0.5
19	2.4
20	1.6;1.0
21	1.3;1.7
22	1.3;0.4
23	1.2;3.5
24	1.7;2.0;3.8
25	3.8;3.6;3.0
26	3.0;2.8;2.5
27	0.4;1.2
28	1.9;1.9
29	1.9;3.6
30	1.3;2.2;2.2
31	2.3;2.5;2.4
32	2.4;2.0;1.0
33	1.4;2.5
34	3.5;2.5
35	4.6;2.7

[1]Stations 6, 10 - 12, and 15 - 18 were dry at the time of sampling

Table 2.4-8. List of Parameters and Sampling Frequency for Water Quality Investigations.

Semi-Monthly	Semi-Monthly[1]
Element or Compound	Element or Compound
Barium	Arsenic
Boron	Cadmium
Calcium	Lead
Chromium	Manganese
Copper	Mercury
Fluoride	Phosphorus
Iron	Cyanide
Lithium	Sulfide
Magnesium	
Potassium	
Selenium	
Silicon	
Sodium	
Sulfate	
Zinc	
Ammonia	
Bicarbonate	
Carbonate	
Chloride	
Color	
Dissolved solids	
Kjeldahl nitrogen	
Nitrate	
Nitrite	
Odor	
Oil and Grease	
Turbidity	

[1]Subject to review

Table 2.4-8. (Continued)

Quarterly		
Organics	Radioactivity	Element or Compound
Total organic C	Gross Alpha	Complete Element Scan
· if $<$ 10mg/l no additional analysis	$>$ 4 picocuries/l analyze for RA 226	
· if $>$ 10mg/l then, Dissolved organic C, Suspended organic C, Phenols, Sulfate, Nitrogen	Gross Beta · if $>$ 100 picocuries/l analyze for Th 230 and Natural Uranium	
Chemical oxygen demand		
Fecal coliform		
Pesticides		

Table 2.4-9. Water Quality Data, RBOSP Aquatic Baseline Studies. April 1975. (Data are expressed in mg/l unless otherwise noted.)

PARAMETER	STATION REPLICATE			
	25		34	
	A	B	A	B
Arsenic (As), Diss	<0.01	<0.01	<0.01	<0.01
Barium (Ba), Diss	<0.1	<0.1	<0.1	<0.1
Boron (Bo), Diss	<0.5	<0.5	<0.5	<0.5
Cadmium (Cd), Diss	<0.01	<0.01	<0.01	<0.01
Carbon (C) Organic	14	14	14	9
Carbon (C) Organic Diss	12	11	12	10
Carbon (C) Organic Suspended	2	3	2	1
Chemical Oxygen Demand (O_2)	23	22	17	17
Chromium (Cr) Total Diss	<0.03	<0.03	<0.03	<0.03
Copper (Cu), Diss	0.03	<0.02	<0.02	<0.02
Cyanide (Cn), Total	<0.001	<0.001	<0.001	0.001
Fluoride (F), Diss	0.48	0.72	0.72	0.68
Iron (Fe), Total Diss	0.02	0.02	0.02	0.02
Lead (Pb) Diss	<0.05	<0.05	<0.05	<0.05
Lithium (Li) Diss	0.02	0.02	0.02	0.02
Manganese (Mn), Diss	<0.02	<0.02	<0.02	<0.02
Mercury (Hg), Diss (μg/l)	0.3	6.6	0.3	<0.3
Nitrogen (N), Organic	0.87	1.0	0.62	0.68
Phosphorus (P), Total Diss	0.03	0.04	0.02	0.03
Phenolic compounds (Phenol)	0.011	0.012	0.009	0.011
Selenium (Se), Diss	<0.01	<0.01	<0.01	<0.01
Solvent extract (Oil)	0.17	0.09	0.13	0.16
Sulfate (S), Diss	53	56	51	51
Sulfide (S), Diss	<0.02	<0.02	<0.02	<0.02
Sulfur (S), Organic	1	<1	2	<1
Zinc (Zn), Diss	<0.02	0.02	<0.02	<0.02
Gross Alpha (α) pCi/l	1.2±0.8	1.2±0.8	1.3±0.8	0.83±0.65
Gross Beta (β) pCi/l	10.1±1.6	9.4±1.5	9.4±1.5	8.0 ± 1.4

Diss = Dissolved

Table 2.4-10. Fecal Coliform Bacterial Analyses. RBOSP Aquatic Baseline Studies, April 1975.

Station-Replicate	Colonies/100 ml
25-A	80
25-B	50
34-A	50
34-B	50

2.5 Other Environmental Programs

2.5.1 Soils Survey and Productivity Assessment Studies

2.5.1.1 Objectives

Objectives of the soils program remain unchanged. Consult Progress Report 2, section 2.5.1.1 for specifics.

2.5.1.2 Methods

Methods employed in the soil studies are described in section 2.5.1.2 of Progress Report 2.

2.5.1.3 Results

Soil surveying and mapping is being carried out by the Soil Conservation Service (SCS) according to standard techniques. The SCS has completed trace element and soil horizon analyses of two pits in the area. A soil map has been prepared and will be finalized and become available in June.

A soils contractor will be selected in a few weeks and this phase of the program will be initiated in July. The program will include the collection and analyses of soils samples associated with major vegetation types. Trace metal concentrations will be determined and soil-plant relationships will be interpreted.

2.5.2 Archaeological Survey

2.5.2.1 Objectives

The archaeological program is designed to prevent the inadvertent loss of valuable historical or archaeological data as development of the area progresses.

2.5.2.2 Methods

Methods by which archaeological surveys are performed are described in Progress Report 2, section 2.5.2.2.

2.5.2.3 Results

Several potential development areas were examined for the presence of archaeological or historical artifacts during the study period. They included proposed plant sites 2 and 3, shallow alluvial water monitoring test holes S-5, S-16, S-17, S-18, S-19, S-22 and S-23, an unnumbered location immediately south of 84 Ranch and monitoring hole M-5. Clearances were granted for each.

2.5.3 Revegetation

2.5.3.1 Objectives

Program objectives are discussed in section 2.5.3.1 of Progress Report 2. The revegetation program will be developed in accordance with the most recent information from the literature and the success of revegetation study plots in the vicinity of Tract C-a.

2.5.3.2 Methods

Composite mixtures of native and introduced species will be planted in proportions designed to produce desired density ratios. Extremely palatable species will be avoided to decrease stress by overgrazing on study areas. Seeds will be planted by drilling and broadcasting.

Plots will be 90 x 40 m, with 1 m buffer zones surrounding the plot. Mulches of hay, wood fiber and crushed rock will be applied. Balanced fertilizers will be applied on seeded plots in the fall after the first growing season at 80 pounds per acre.

Number of emerged seedlings for each species for each plot will be determined after the first growing season. Number of surviving seedlings will be determined after the second growing season and production of total above-ground biomass will be determined after the third growing season. Communities will be ranked from 1 to 10 according to soil cover. Controls will be established in which no seeding, mulching or fertilizing is done.

Nine individual treatments will be used, with four replicates of each treatment. Species within each treatment will be harvested independently. Treatments will be deterministic rather than random, necessitating Model I factorial analysis.

Soil moisture determinations will be made. In addition, soils will be analyzed at each site for texture, pH, exchangeable sodium percentage, electrical conductivity and organic matter.

2.5.3.3 Results

The study was designed and a Request for Proposal was prepared during the quarter. Contracts will be signed and work will be initiated during the next quarter of study.

2.5.4 Toxicology

2.5.4.1 Objectives

No changes have occurred since the last progress report. See section 2.5.4.1 of Progress Report 2 for more details.

2.5.4.2 Methods

No change has occurred since the last report. See Progress Report 2 for specific methodology.

2.5.4.3 Results

No toxicology data were collected during the quarter.

2.5.5 Trace Metals

Trace metal analyses were performed on soils from two SCS pits during the quarter. Results of these analyses will be available within a few weeks. Analyses of plant and animal tissues will be performed if interpretations of the soils data indicate that trace metal concentrations in the soils are sufficiently high enough to warrant further investigation.

2.5.6 Visibility Studies

A cooperative basin-wide visibility program is in the planning stages. This study will be designed to determine visibility from several selected spots in the basin around both oil shale tracts C-a and C-b. This study will be finalized and conducted during the fourth quarter of study.

2.5.7 Seismicity

2.5.7.1 Objectives

The purpose for performing a seismicity investigation of the Piceance Creek Basin in which Tract C-a lies was to determine the extent of seismic activity near the site due to earthquakes.

2.5.7.2 Methods

To develop the information necessary for this study, a literature search was performed by Dr. E. D. Alcock, consultant to RBOSP in the area of seismicity, to establish both recorded and reported events in the area. Contact was made with various governmental and private organizations to gather the relevant data.

2.5.7.3 Results

The Piceance Creek Basin in which oil shale Tract C-a lies appears to be an area of very low seismicity.

a. Earthquake Distribution - The seismic risk map (Figure 2.5.7-1) shows that all of the Piceance Creek Basin is a quiet seismic area and is classified as zone 1. Structures in this zone with fundamental periods greater than 1.0 sec. can be expected to suffer no more than minor damage from large distant earthquakes. Examination of the Seismic Activity of Colorado maps issued annually between 1966 and 1971 shows that the only earthquakes in Colorado within 40 miles of the Tract C-a (magnitude 2 or greater) were at the Harvey Gap Reservoir and at Rangely. The last available map, Seismicity of Colorado, 1972, shows the same seismicity for the basin. Those events at the Harvey Gap Reservoir are believed to have been due to the effect of the loading by the stored water on the underlying geologic structure. Those events at Rangely have been postulated to result from the water flooding of the Rangely oil field.

A search was made of the National Oceanic and Atmospheric Administration (NOAA) historical seismic data in an area within 50 miles and 100 miles of the C-a tract. This search covered the period from 1941 to 1975 for earthquakes greater than magnitude 3. The results of this search are shown in Figure 2.5.7-2

CER Geonuclear Corp. operated a seismic station in connection with Project Rio Blanco from November 20, 1971, to December 17, 1973. This station was located in Sec. 28, T2S, R98W, only about 10 km from Tract C-a. In this time interval, aside from the earthquake and aftershocks resulting from the detonation of Project Rio Blanco, only 2 microearthquakes (local magnitude less than 1) were recorded within 40 km of the station.

In preparation for the seismic investigation of the Rangely oil field the U. S. Geological Survey made a search of the seismic data recorded for a seven year period at the Uinta Basin Observatory for earthquakes originating near the oil field, 65 km ESE of the observatory. This search covers the area in which Tract C-a lies and shows no more than one earthquake of local magnitude greater than 1 in the seven year period. This seems to be in close agreement with the results from the CER seismic station.

b. Crustal Stress - The strain release map of the area (Figure 2.5.7-3) indicates very little probability of any strain stored in the subsurface to cause earthquakes. In preparation for the Project Rio Blanco several calculations of subsurface stress existing at various points in the Rio Blanco unit area were made using Kehle's method of determining the stress from hydraulic fracturing data. In all cases the principal stress was compressive and vertical and within the limits of the method equal to the lithostatic pressure. There was no evidence of any significant horizontal stress.

In view of the available data reviewed, it is felt that the seismicity of the oil shale Tract C-a is very low and is amply documented. A.R. Sanford & S. Singh ("Minimum Recording Times for Determining Short-Term Seismicity from Microearthquake Activity," Bull. of Seismological Society of America, Vol. 58, No. 2, pp. 639-644, April 1968) have shown that in general about six months of recording will give a reliable estimate of the earthquake-frequency relation from which short term (10 yrs.) seismicity is calculated.

It is felt that additional seismic monitoring at the present time is redundant and could be postponed until six or eight months in advance of actual mine operations. At that time a review of the situation could change the seismic program due to the mining techniques to be used and the specific objectives of the seismic program, i.e., environmental safety, mine safety, and so forth.

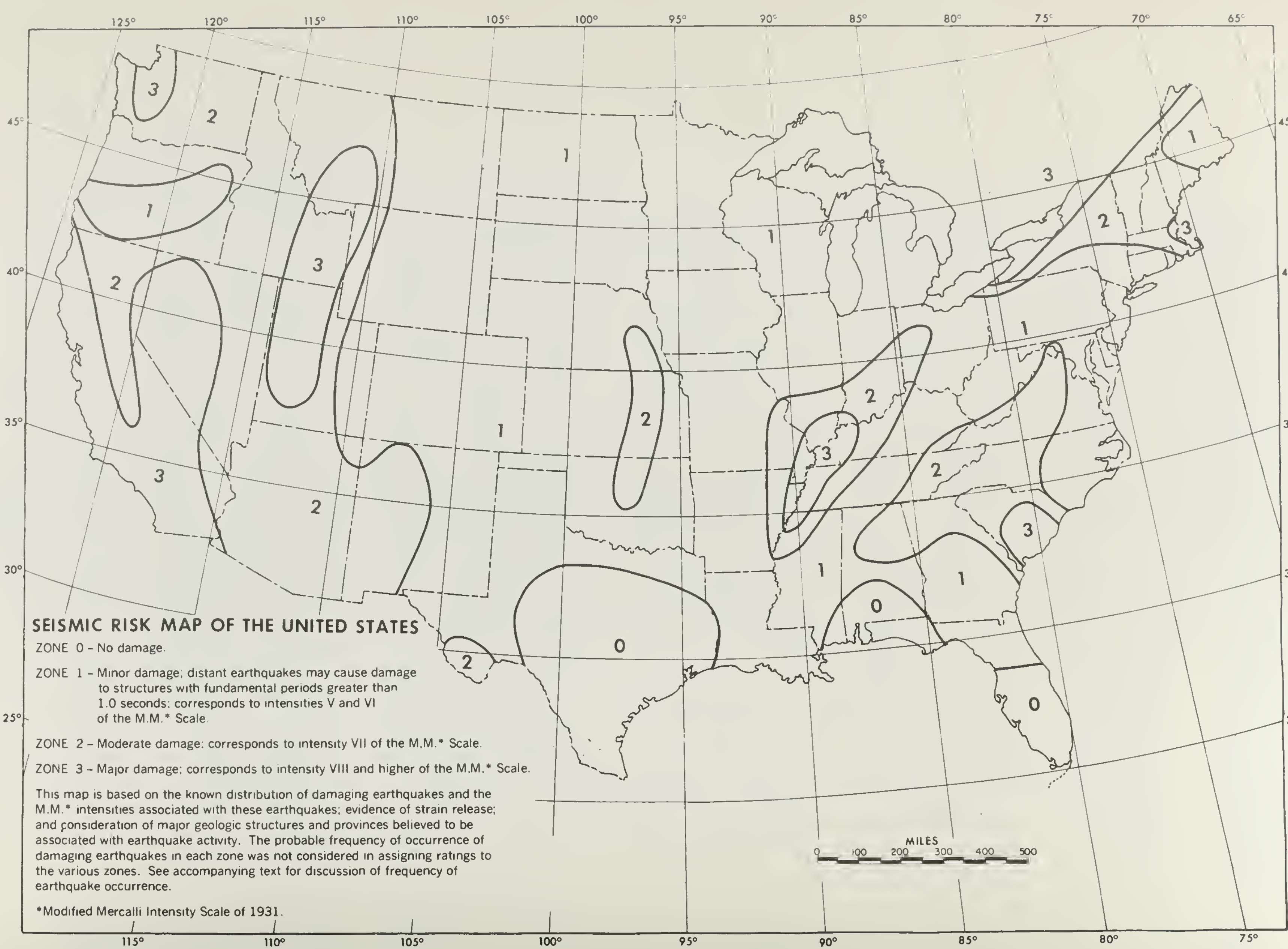


Figure 2.5.7-1 Seismic Risk Map of the United States

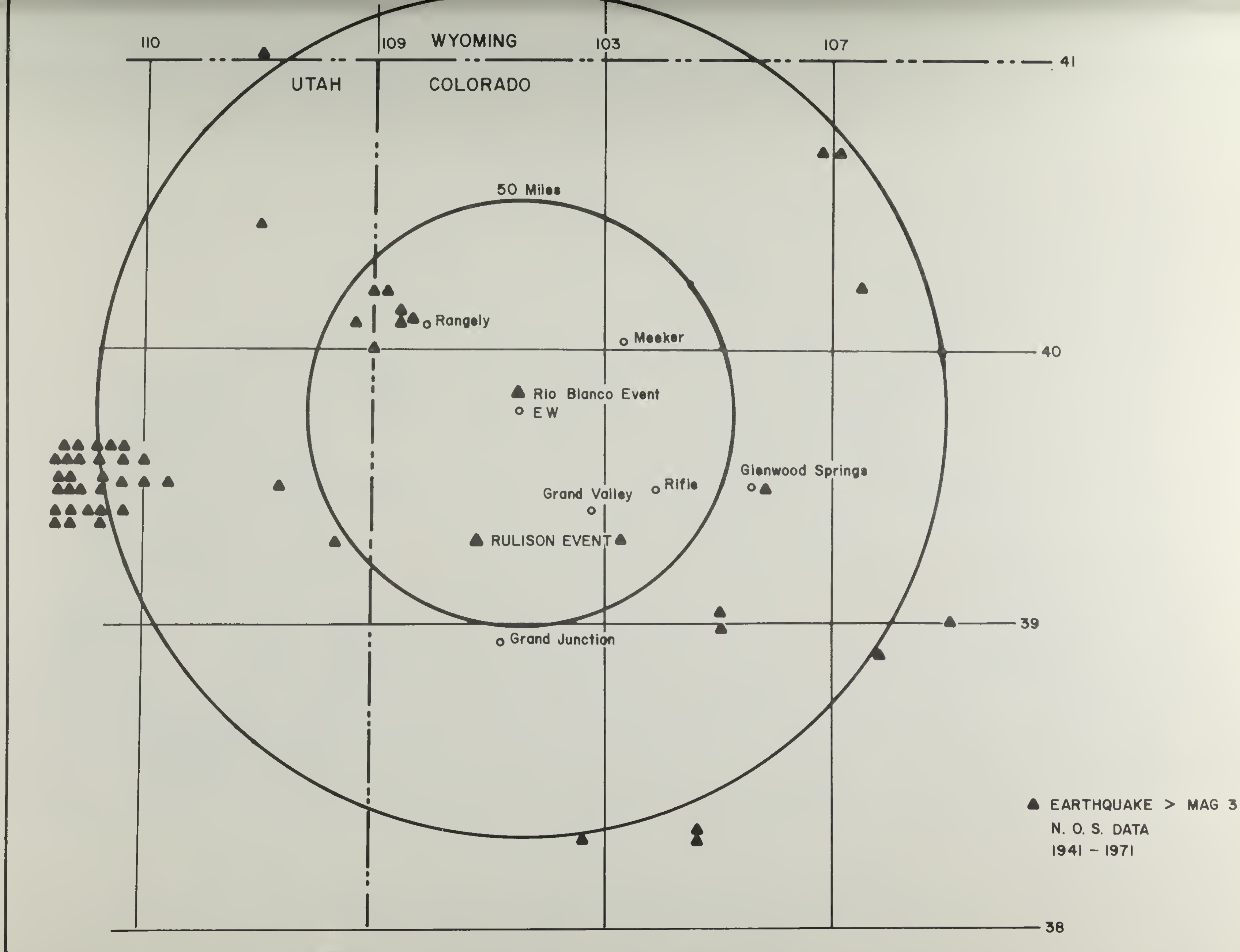


Figure 2.5.7-2 Seismic activity of general area

Figure 2.5.7-3 Strain release in the United States, 1900 to 1965, expressed as the equivalent number of magnitude four earthquakes

Appendix A

INTRODUCTION TO APPENDIX A

In the appendix section of Progress Report 2 - Summary, a complete overview of the Rio Blanco Oil Shale Project was presented. It was intended to show the relationship between the geotechnical and environmental studies and the other major engineering tasks being studied. In this appendix, progress concerning engineering, mining, processing and offsites studies will be discussed and the various alternatives being considered will be outlined.

The roughly 5 million dollar engineering study contract was awarded to Morrison-Knudsen in December, 1974, for mining, processing and offsite work. Foster Wheeler Energy Corporation is doing the processing studies as a subcontractor to Morrison-Knudsen. The studies are scheduled for completion by the end of 1975 and their purpose is twofold: first, to provide the engineering information needed for the Detailed Development Plan, and second, to provide data for calculating the economic viability of the project.

A 1.0 ENGINEERING STUDIES - ALTERNATIVE CASES STUDIED

During the first half of 1975, RBOSP looked at a number of alternatives for developing the tract and these will be briefly reviewed. As mentioned in the appendix of Progress Report 2 - Summary, the base cases (designated Plan "A") have been sized to produce roughly 50,000 barrels per stream day (B/SD) of upgraded shale oil or syncrude suitable for processing in a normal refinery. RBOSP has studied both open pit and underground room and pillar mines for supplying the required raw shale. To permit full development of the tract the open pit mine requires locating the processing facilities off tract and requires off tract disposal for overburden and spent shale. The underground room and pillar mine does not require off tract land but recovers only a little more than 1/5 as much oil as an open pit mine. This will be further detailed in the mining section.

Two types of retorts have been studied - the TOSCO II and the gas combustion. The raw shale throughput of the TOSCO II retort is 11,000 tons per day (T/D). For the gas combustion retort, RBOSP studied two sizes, 3,000 T/D and 6,000 T/D of raw shale. After full evaluation, retorts were selected as follows. For the open pit mine a combination consisting of one 11,000 T/D TOSCO II retort for each 6,000 T/D gas combustion retort was selected. For the underground mine, the TOSCO II retort alone was picked. The upgrading for both the open pit and underground mine cases is the same, consisting of hydrotreating plus coking, visbreaking or deasphalting to produce the synthetic crude oil. Sulfur and ammonia are recovered as by-products.

Although 50,000 B/D was the base case studied, RBOSP also looked at maximum development of the C-a tract--both for open pit and underground room and pillar mines. With an open pit mine, capacity can reasonably grow to about 300,000 B/D output and this is the best overall development of the tract based on present available technology. As was mentioned earlier, the underground room and pillar mine can recover only about 1/5 as much of the resource as the open pit and thus can only grow to a maximum of about 100,000 B/D output. RBOSP looked at these big cases to get an idea of the best ultimate development and to make sure its initial efforts would be compatible with the best long range plan.

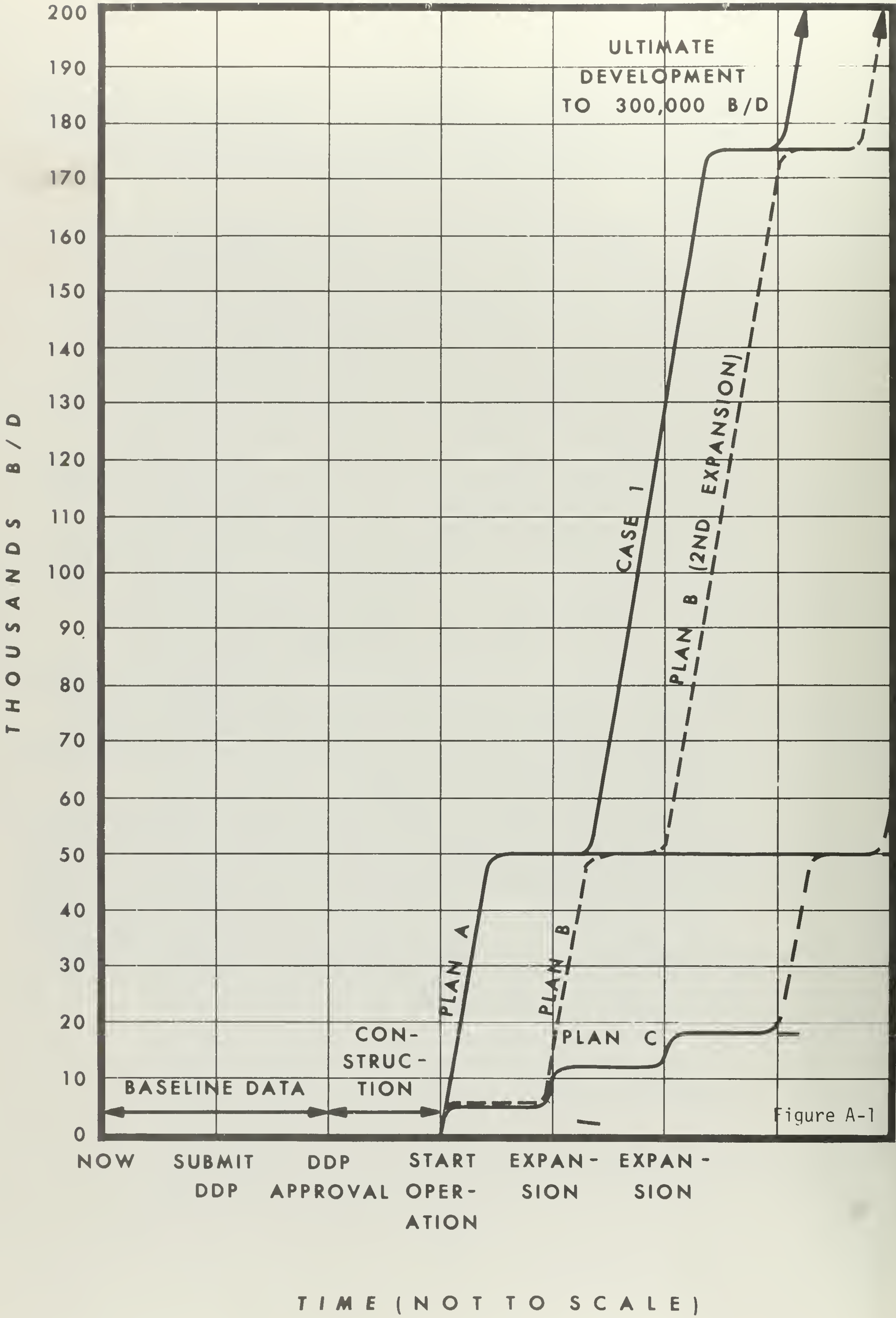
In addition to looking at these cases - much bigger than the base Plan "A" 50,000 B/D size - RBOSP also looked at smaller ones. The Plan "B" concept starts small and after one year of operation, work to expand to 50,000 B/SD is planned. Again, both room and pillar and open pit mines were considered. In the underground mine case, a single TOSCO II 11,000 T/D retort is planned, and with an open pit mine one 11,000 T/D TOSCO II and one 6,000 T/D gas combustion type is used. Upgrading before expansion consists of coking or visbreaking to produce a pipelineable material.

A third case - Plan "C" envisions a modular approach starting with a single TOSCO II retort in both underground and open pit cases and expanding more slowly - a second retort is added three years after the first and a third in another three years. This schedule approximates the tons of rock specified in the minimum royalty clauses in the lease. Upgrading in Plan "C" is the same as Plan "B" prior to expansion.

Figure A-1 shows these Plan "A," "B" and "C" concepts graphically. The vertical axis shows B/D of production, and the horizontal axis shows time (not to scale). Presently RBOSP is collecting environmental baseline data and doing the engineering work for the DDP. Following submittal, the next step is DDP approval by the Area Oil Shale Supervisor, which allows construction to start on the case selected. The fastest path to ultimate tract development would be Plan "A" with two expansions to an ultimate production level of approximately 300,000 B/D (Case 1 on Figure A-1). The Plan "B" case with three expansions (represented by the dotted line) would be a slightly slower development case in that it starts out smaller. Plan "C" as represented on the graph would track the minimum royalty requirements during the early years of the lease and could be expanded at any time conditions warranted. It should be made clear that the small cases are merely stepping stones. They present a modular approach to achieving full development, but they are not a desirable or profitable end point. The level of production in Plan "C" after the third module is only good if further developoment occurs. Production would either stop or be expanded as conditions warrant.

Based on preliminary estimations, the number of people, both construction and permanent miners and operators required for these cases are as follows. For Plan "A" about 1,100 permanent people will be needed. The construction peak will be about 2,300 which occurs before the full permanent staff is on hand. For the first modules for Plans "B" and "C" about 300 permanent people are required and the construction force peaks at about 700.

The present engineering work by Morrison-Knudsen and Foster Wheeler Energy Corporation consists of finishing up the work done on Plan "A" cases so it will be in suitable form for possible use in the Detailed Development Plan and also fully developing the Plan "C" modular cases. In this further development of the modular concept RBOSP is continuing to study both the open pit and underground mine cases. More accurate cost estimates will be prepared. When this work is completed by the end of the year, RBOSP will have the engineering information needed for fully evaluating the project and can select the basis for submitting the Detailed Development Plan.



THOUSANDS B/D
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ULTIMATE DEVELOPMENT TO 300,000 B/D
CASE 1
PLAN B (2ND EXPANSION)
PLAN A
PLAN B
PLAN C
CON-STRUC-TION
BASELINE DATA
Figure A-1
NOW
SUBMIT DDP
DDP APPROVAL
START OPER-ATION
EXPAN-SION
EXPAN-SION
TIME (NOT TO SCALE)

A 2.0 MINING CONSIDERATIONS

As mentioned in section A 1.0, mine engineering studies begun late in 1974 are progressing on schedule; thus far results have been about as expected. RBOSP will continue engineering studies of both open pit and room and pillar mining during the second half of 1975 because the work to date continues to indicate that developments for extracting shale oil incorporating either of these two methods are about a stand-off, economically.

For Tract C-a, there are several development alternatives available. Open pit is high on the list and RBOSP feels certain that it was also a primary objective in the government's prototype leasing of Tract C-a that it be developed, at least in part, by open pit methods to test both the economic and environmental feasibility of this method of oil shale mining. Open pit mining provides, of course, the highest percentage of resource recovery and also has a very high probability of being technically feasible.

Studies have been made to determine the suitability of Tract C-a for open pit mining. One of the parameters used to measure this suitability is stripping ratio, or the measure of the amount of waste that must be removed for each ton of ore. This is a common parameter for determining the open-pit mineability of various materials. In the case of oil shale a more diagnostic figure, which takes into account not only thickness of overburden and oil shale but also the grade of the oil shale, is tons of waste per recoverable barrel of oil.

Information on the geology of the Piceance Creek Basin published by the U.S.G.S. indicates overburden depths ranging from zero at the outcrop to 1600 feet in the interior of the basin. There are substantial areas of the basin in which oil shale is covered by more than 1000 feet of overburden. Another generally prevalent factor throughout the basin is that both the thickness and the grade, or oil content, of the oil shale also increases as the center of the basin is approached. Thus a higher stripping ratio in terms of tons of waste per recoverable barrel of oil may be found near the outcrop at the edge of the basin than is found in the center of the basin where there is considerable depth of overburden. Eventually, overburden depth as well as the tremendous amount of material involved in the side slopes of a deep pit become overriding factors in forcing the stripping ratio in tons per recoverable barrel up rather rapidly as the center of the basin is approached. It can be generally shown that there is a belt containing the optimum open pit areas somewhere intermediate in the basin between the deeper and shallower overburden in which the stripping ratio per recoverable barrel is at its lowest values.

RBOSP's studies indicate that Tract C-a lies in this general belt and is well-located for open pit mining. Further, RBOSP thinks the most logical directions for open pit expansion are either generally to the north or to the south, and, that although expansion may take place in an easterly or westerly direction, the spot where open pit mining is not economically attractive would be reached much sooner. These cutoffs, of course, will remain rather general. In addition, they are not fixed but are moving lines, being dependnet on a host of variable economic and technical factors.

By comparison, room and pillar mining, which is still being studied extensively because it appears to be in the same "economic ball park" as open pit, has a much higher degree of uncertainty with regard to its technical feasibility. Further, if no means is found of economically extracting ore after a room and pillar operation is completed (from pillars or between mined intervals), this would result in very low resource recovery compared to open pit for Tract C-a, somewhere on the order of one-fifth the resource recovery expected for open pit. This potentially low resource recovery is indirectly a very real cost, both environmentally and in terms of resource recovery, because it means that to produce equivalent amounts of shale oil it would require many more mining projects, and their environmental impact would be spread out over a much larger area. In the example cited it would take five room and pillar tracts like C-a to produce as much shale oil as one tract could by open pit methods.

RBOSP is also investigating other mining methods which might some day be used on Tract C-a, and which have potential for being superior to either open pit or room and pillar mining environmentally, technically, and economically. Methods such as in situ extraction or "bulk" underground mining methods capable of mining a several-hundred foot interval are, to the best of Rio Blanco's knowledge, presently relatively unproven. Both Gulf and Standard have recently joined WESTCO which is a joint venture aimed at developing methods of in situ mining and extraction. The primary objective of the experiment will be to determine the recovery efficiency of in situ retorting of oil shale rubblized by utilizing conventional underground mining and blasting techniques. It is anticipated that, either individually as Gulf or Standard or jointly through Rio Blanco, engineering work involved with some of these other bulk methods of mining will be pursued.

Nevertheless, open pit mining remains a primary concern. Along with this, it becomes increasingly clear that, for an extended period of time, RBOSP would have to put a lot of waste somewhere on the surface while an open pit is being dug deep enough and large enough so that backfilling of waste can begin. The EIS prepared for the prototype oil shale leasing program contends that backfilling could not begin for perhaps 10 to 20 years based on a 100,000 b/d operation. Based on studies to date, RBOSP now thinks it will be at least 30 years for its operation. Once backfilling does begin, it will be of substantial economic benefit to adjacent operations.

If an open pit operation on Tract C-a is started, there are only three basic approaches to the handling of waste. The first of these would be to place all the waste that we possibly can on tract, all over probable open pit reserves. The next approach would be utilization of an area like 84 Mesa wherein RBOSP would be putting waste over possible but very unlikely open pitable reserves because of the great depth of overburden. This would be one of the most unlikely spots in the Piceance Creek Basin for open pit mining. The third would be placing waste completely off the oil shale area, probably to the west in some of the areas that have been studied.

One RBOSP investigation for open pit mining on Tract C-a considered keeping all the waste on tract. This study showed that this allowed open pit mining for only about 30 years producing about 50,000 b/d. The waste from the pit would be stacked at every available place on the tract for depths upwards of 700 feet in places. At this point, a limit had been reached and plans would dictate going to underground room and pillar mining. The net effects of doing that would mean that the amount of oil recovered from Tract C-a would be somewhere around 25% of what it would be if the entire tract were mined by open pit methods.

Another case considered was mining the entire tract by moving the waste piles several times. RBOSP's work to date shows that this alternative of mining the entire tract and limiting waste disposal to Tract C-a is not a viable alternative because of the high economic and environmental costs and low resource recovery resulting from such a scheme.

The placement of waste off tract and to the west of the oil shale outcrop has been looked at from a number of different viewpoints, with much the same conclusion. The economic and environmental costs of placing waste to the west do not appear justified at this time, and this would be a poor second choice compared to 84 Mesa.

Attention has been directed continually toward 84 Mesa for the reasons that have been discussed: environmental, economic, and resource conservation, i.e., the fact that spent shale would cover oil shale that is unlikely to ever lend itself to open pit mining. RBOSP has made initial economic evaluations of waste disposal as well as environmental evaluations. Detailed evaluations of alternate disposal sites will continue. More detailed information containing the rationale for evaluating different offsite disposal areas has been sent to the Bureau of Land Management and is included as "Enclosure 1." Figure A-2 shows the disposal areas.

Another significant result of RBOSP's work to date has been that it indicates that the location of a first open-pit operation on Tract C-a should be in the northeast quadrant of the tract rather than the northwest quadrant as originally shown in the preliminary development plan. Having made these major decisions, then, with regard to mining on Tract C-a RBOSP will continue engineering studies of mining methods, equipment, and costs in the second half of 1975.

Gulf Mineral Resources Co.
A Division of Gulf Oil Corporation

Standard Oil Company (Indiana)

Dayton Commons
9725 East Hampden Avenue
Denver, Colorado 80231
303-751-2030

Rio Blanco Oil Shale Project

ENCLOSURE 1

April 30, 1975

Mr. Dale R. Andrus
State Director, Bureau of Land Management
Colorado State Office
Room 700
Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202

Dear Mr. Andrus:

Thank you for your letter of April 10, 1975, requesting backup materials in support of the information conveyed to you by our letter of February 13, 1975. We will try to be as responsive as possible to your request. As you are probably aware, in-depth environmental evaluations of the sites have not been made. The supporting information for each of the disposal sites will be listed in the same order in which they appeared in our February 13 letter. Several references will be made to characteristics of the various sites which can be readily confirmed by inspection of the appropriate USGS quadrangle maps. These characteristics include relationship to drainage patterns, general topography, relative elevations and proximity to Tract C-a. Examination of other published maps will support the comments made with respect to those sites, the use of which would cover mineable reserves. We have made several references to the effect of waste haulage distance on economics in comparing one site to another. These distances are listed for each area, and are summarized in the enclosed table; preliminary estimates indicate that the present value of increased waste haulage distance, for the 50,000 barrel per day project we presently envisage, would be on the order of five million dollars per mile, as shown in the enclosed preliminary estimate summary.

Stake Springs Draw

The principal advantages of Stake Springs Draw are related to its proximity to Tract C-a and include restricting the area subject to environmental impact and relatively low cost of moving spent shale from the tract to the disposal area. With respect to capacity for holding waste, the Stake Springs area covers roughly 9,500 acres; at an approximate average thickness of 160 feet, the area would accommodate approximately 2.4 billion cubic yards. Another advantage of the site would be the impact on only one drainage. And, as for other valley fill sites, visual impact would be minimized. We also expect reclamation would be less difficult and less costly than for several other potential waste disposal sites.

ENCLOSURE 1

A major disadvantage of the Stake Springs Draw site is that, although it is roughly equivalent to 84 Mesa in both distance and vertical lift considerations, waste placement in Stake Springs Draw would cover substantial oil shale resources under relatively shallow overburden, and thereby probably mineable by open-pit methods. Further, the area would be subjected to runoff from a large water shed; flooding and water pollution would be potentially significant problems. Stake Springs, a major source of water for livestock and deer would also be covered, as would a substantial area of relatively good valley bottom grazing.

West Spring Creek

The following statements amplify the advantages of this disposal area. No mineable reserves would be covered by waste disposal in this area, and water pollution and drainage problems should be minimized since it is located near the headwaters of a single drainage system. The waste capacity of the West Spring Creek site (which would be a canyon fill) is relatively good. On approximately 5,600 acres, at an average depth of about 360 feet, the area could contain almost 3.3 billion cubic yards. The surface area to be reclaimed would be relatively less than for other areas because of the much deeper fill; reclamation should be less difficult than the other potential waste areas, because of greater precipitation at this elevation.

Available information does not indicate any significant usage by feral horses. Although a subjective observation, it is thought that use of this area would have little visual impact, since it is remote and not readily visible. The site is relatively well protected from the effects of the wind so that fugitive dust problems should be minimal.

There are several disadvantages to the use of the West Spring Creek site. Currently the area provides good to excellent livestock grazing and wildlife summer range, and contains potential raptor nesting areas. It is a scenic area including heavy evergreen stands; we believe it has a comparatively good potential for archeological values. Use of this disposal site would significantly extend the environmental impact of the project, since an extensive conveyor belt system to carry spent shale and waste would be required. The conveyor belt system would average about eight miles in length and would impact more than one ecosystem. Additionally, it would be quite costly to move the spent shale and waste for a total distance of some eight miles (about four miles further than 84 Mesa, requiring 1200 feet of additional lift). Use of this site would also require acquisition of approximately 600 acres now privately owned, adding to the cost. These extra costs, although initially paid by the company, would ultimately be borne by the public.

ENCLOSURE 1

West and Northwest of Tract

The advantages of these four areas, shown on the map attached to this letter, are the proximity to the tract, resulting in minimal major environmental impact, with that impact being limited to the same basic ecosystem. They also have, in our opinion, relatively limited scenic value, and relatively low grazing value for either livestock or wildlife. As valley fill sites, their use would cause relatively little negative visual impact. The four areas taken together cover approximately 7600 acres. The fill would be about 190 feet in average thickness and would accommodate approximately 2.3 billion cubic yards.

Disadvantages of these four disposal areas are several. They overlie mineable oil shale reserves with relatively shallow overburden. There are title questions with respect to the ownership of this land, and it is not certain that it would even be available for waste disposal. These four areas, although located near the headwaters of the various drainages, are each in a separate drainage course, and use for waste disposal would cover several seepage springs. The area is a summer range for feral horses, although other wildlife use is not thought to be extensive. This disposal site would require approximately 600 feet more vertical lift than would 84 Mesa, although the distance to move waste is comparable to 84 Mesa.

Douglas Creek

The principal advantages of the Douglas Creek disposal site are: no mineable reserves of oil shale would be covered by use of this area, the area is poor grazing for both domestic livestock and wildlife, and, although revegetation would be difficult, successful efforts would probably improve the present carrying capacity. The scenic values of the area, although not significant, could be enhanced by a successful revegetation program.

There are several disadvantages to the Douglas Creek disposal site. It is limited in capacity. It would be necessary to fill five separate canyons, East Fourmile Draw, State Bridge Draw, Vandemore Draw, Philadelphia Draw and Cow Canyon, the total area of which would be about 6,500 acres. With an average depth approximating 170 feet, the total capacity of these five canyons would be approximately 1.8 billion cubic yards. The areas are also at excessive distances from the tract, requiring waste haulage distances averaging around eleven miles (seven miles further than 84 Mesa). These additional distances would significantly expand the environmental impact and would involve several ecosystems, including the unique area of Cathedral Bluffs. Because the disposal sites are next to the Douglas Pass Highway, there would be a high visual impact in areas that had not been reclaimed. Use of this disposal area would affect several drainage systems which would not otherwise be impacted, and would affect potential raptor nesting areas. This area would be significantly more costly because of the distance and disposal complications on the steep face of the bluffs. This expense would be ultimately passed on to the consumer.

ENCLOSURE 1

84 Mesa

The advantages of 84 Mesa include its immediate proximity to Tract C-a, which results in reducing the total area impacted, and in limiting the impact to one ecosystem. The disposal site covers oil shale reserves, but at overburden depths similar to Tract C-b, where open-pit mining is not believed economically feasible. This area is of marginal value for wildlife habitat and does not possess unusual or outstanding scenic values. Also, it is not believed to contain any valuable or unique floral species. Because 84 Mesa does not contain any major established drainages, water pollution and runoff problems could result only from the precipitation on the area itself or from the waste disposal operations. The waste haulage distance to the area would average about four miles. Waste would cover about 3,700 acres. With an average thickness of 260 feet, the capacity would be about 1.6 billion cubic yards. Of the areas considered, 84 Mesa appears least costly, both economically and environmentally. A successful reclamation effort should measurably improve the habitat characteristics of this waste disposal area.

The disadvantages of the use of 84 Mesa disposal site include its wide visual impact, since it will be visible from virtually every direction. We believe appropriate contouring and reclamation can effectively minimize this impact, however. This site would have relatively greater vulnerability to wind and runoff erosion as compared to valley filling, but the use of overburden to finally cover spent shale and sufficiently stabilized final slopes should provide adequate retention of both rain and snow precipitation without significant surface erosion. The area is sometimes used by feral horses.

I believe that the information provided herein is responsive to your request.

Very truly yours,

W. T. Herget

WTH/dh

Enclosures

cc: P. A. Rutledge

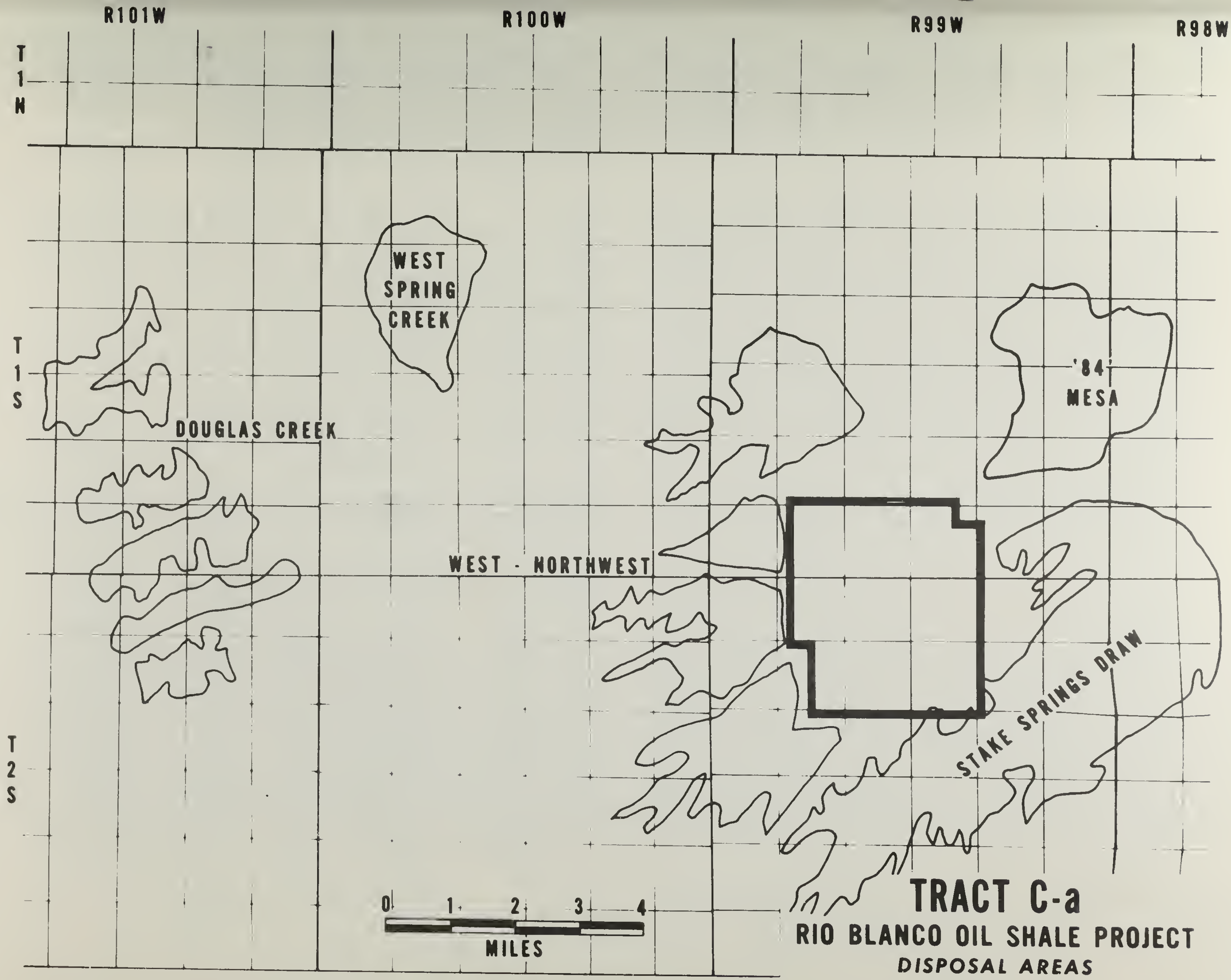
bxc: C. O. Spielman - without map
W. E. Moffett " "
Harris Sherman, Colorado Dept. of Natural Resources

ENCLOSURE 1

SUMMARY TABLE
WASTE DISPOSAL SITE
GEOMETRY

Area	Waste Haulage Distance*	Approximate Waste Pile Dimensions		
		Area	Height	Volume
Stake Springs Draw	4 Miles	9,500 Acres	160 Ft.	2.4 billion c.y.
West Spring Creek	8	5,600	360	3.3
West & Northwest of Tract C-a	3	7,600	190	2.3
Douglas Creek	11	6,500	170	1.8
84 Mesa	4	3,700	260	1.6

*Straight-line distance from center of Section 33 on Tract C-a to approximate center of waste area.



TRACT C-a
RIO BLANCO OIL SHALE PROJECT
DISPOSAL AREAS
FIGURE A-2

A 3.0 PROCESSING METHODS

During the first half of this year, RBOSP's processing contractor, Foster Wheeler Energy Company of Livingston, New Jersey, was engaged in scoping studies of various concepts for processing oil shale from Tract C-a. The processing of oil shale includes preparing the mined oil shale for feed to the retorts, retorting the oil shale, and upgrading the resultant raw shale oil into a pipeline-quality product. As in all of the contractor's work, the studies were limited to using known technology to carry out these conceptual engineering plans.

The retort feed preparation facilities begin with the method of reclaiming the material from the primary crushed oil shale stockpile and end with the delivery of retort feed from the feed storage stockpile to the retort feed equipment. Retort feed preparation equipment is basic material handling equipment such as secondary and tertiary crushers to reduce the particle size as required by the retorts, together with conveyors and screens which scalp out fine material ahead of each crusher so that the desired size consist is prepared for each retort with minimum dust loss and power consumption. In cases where gas combustion retorts were combined with TOSCO II retorts, it was necessary to provide separate feed preparation trains with separate storage and delivery facilities. Even though the average particle size was larger in such cases, the actual cost of the feed preparation equipment increased due to the paralling of equipment for preparing the two different particle sizes. However, advantages from increased retort efficiency outweighed this cost increase.

RBOSP requested the contractor to evaluate two oil shale retorting processes in this project - the TOSCO II retorting process, and the gas combustion retorting process. The TOSCO II retorting process has already been demonstrated in a 1,000 ton per day semi-works plant, and it is more suitable for handling finely crushed rich oil shale. The gas combustion process, on the other hand, is more suitable for leaner lump size particles. Some of the evaluation work done by the contractor was for plants with all TOSCO II retorts, and some of the evaluation studies included a combination of TOSCO II retorts with gas combustion retorts. The combination of retorts was indicated to be the most attractive for the development of Tract C-a. Besides separating the retort feed into those particle sizes which are optimum to feed each retort, other advantages include a better fuel balance because the excess low-BTU gas from the gas combustion retort can be used to fuel the TOSCO II retort, thus increasing the yield of high-quality products for sale. Additional savings occur because the hot shale oil vapors from the TOSCO II retort can be quenched with cool gas combustion retort oil, thereby avoiding a pump-around cooler on the quench tower. Gas combustion oil is fractionated in the same operation, thus saving energy for distillation.

The contractor studies indicated that a logical case for modular development of the tract would be to install a TOSCO II retort as the first unit of a planned 50,000 barrel per day plant. This unit, processing about 11,000 tons of oil shale in a day, would produce about

6,000 barrels of raw shale oil, which would be moved to market by pipeline. Thermal processing of the oil to make it suitable for pipelining would be carried out at the site. About three years after installation of the TOSCO retort, either a second, improved TOSCO retort would be installed, or the second retort would be a gas combustion retort, depending on successful operation of the first unit. The thermally processed shale oil from both the first and second retort module will be sent via pipeline to the mid-continent region. After operation of these retort modules has proved out the commercial-size retort design, the plant might then be expanded to the 50,000 barrel per day size foreseen for the initial commercial facility.

At the same time that replicate retort units are added to bring the plant up to its 50,000 barrel per day capacity, the upgrading equipment would be installed to convert the raw shale oil into synthetic crude oil. The upgrading process is required because the retort oil is not a very desirable refinery feed stock. It contains substantial amounts of nitrogen, sulfur, and oxygen. It is chemically unsaturated, which means that it is unstable and tends to produce unstable refinery products. The upgrading process uses high-pressure hydrogenation, wherein the hydrogen reacts with the impurities and saturates the hydrocarbons, resulting in a high-quality, synthetic crude oil which probably would be considered a premium-quality refinery feed stock at any refinery in the country.

Foster Wheeler evaluated the following basic upgrading method for production of the low-nitrogen syncrude:

a. Delayed coking of a portion of the raw shale oil residue left from distillation of the retort shale oil. Foster Wheeler's own delayed coking process was used for this study.

b. Production of carbon monoxide and hydrogen (synthesis gas) from the remaining portion of the raw oil shale residue by Texaco's synthesis gas process. In this process synthesis gas is converted to hydrogen by water gas shift.

c. Hydrotreating of the raw shale naptha and gas oil and the coker distillate by Atlantic Richfield's shale oil hydrotreating process.

While it is believed the above base case upgrading scheme is very practicable and feasible, RBOSP's goals are to optimize the upgrading scheme to maximize the production of synthetic crude oil from the project. For this reason, studies of alternates to the delayed coking process, which is in the base case, are continuing. Foster Wheeler has already made scoping studies of solvent deasphalting and flexicoking process as alternates to the delayed coking scheme. Additional work will be planned for further evaluation of these schemes, since both are indicated to be promising with regard to increased production of syncrude. In any of the upgrading schemes, ammonia and elemental sulfur will be recovered as valuable by-products.

A 4.0 OFFSITE DEVELOPMENT

A 4.1 Surface Water Acquisition

The water supply program is geared to the acquisition of 58,000 acre feet (AF) of surface water and 7,000 AF of groundwater annually. The program is designed to ensure the net water requirement of 60,000 AF per year needed for the ultimate potential development. It is possible that the groundwater pumping may supply more than 7,000 AF annually, but these studies are still incomplete. Meanwhile, plans are proceeding to retain flexibility to develop both surface water and groundwater to optimum capacity.

An option agreement was signed with the Rocky Mountain Power Company (ROMPOCO) to acquire their rights to White River water if RBOSP's studies indicate that they can supply at least 45,000 AF per year from their conditional water decrees. An application to change the point of diversion of the ROMPOCO water rights to a point on the White River about 25 miles below Meeker was submitted April 30, 1975, to the District Court in Glenwood Springs, Colorado. Several Statements of Opposition have been received by the Water Court, and it is expected that pre-trial conferences and trial dates will be scheduled in the near future.

Arrangements were made with the U. S. Geological Survey to install gaging stations at the original decreed points of diversion. Three gaging stations were installed on June 24 and 25, 1975, using a helicopter for access. Correlation of these new records with the past 30 years of downstream gaging can then be accomplished through statistical analysis to refine the calculations of ROMPOCO's yield as foreseen in the option agreement.

Related activities concerning acquisition of surface water include studies to expand the right-of-way acquisition for the water supply system and the integration of surface runoff and groundwater system right-of-way needs. The right-of-way studies will recognize that the Yellow Creek Dam will not likely be required before the mid to late 1980's at the earliest. However, RBOSP's planning must consider that this system will be required eventually, not only because of Tract C-a needs, but it may be needed for a co-operative White River Development project wherein RBOSP would share White River water with other industrial users.

A 4.2 Groundwater System

An amendment of the groundwater application was submitted to the Water Court on May 12, 1975. This was formulated for separate legal acquisition on a Phase I system which was designed solely for mine-dewatering and quantified at some 27,000 AF/year. Also applied for was a Phase II system to be implemented for additional on-tract groundwater development of some 14,800 AF/year if subsequently proved desirable. The quantities of water claimed were deliberately set at about twice the amount previously anticipated by RBOSP's consultants as the upper limit of inflow. As stated previously, RBOSP believes that groundwater yield may be as low as 7,000 AF/year, but by claiming higher amounts, it is hoped to obviate any chance of arousing later opposition in case actual pumping produces more water than had been anticipated. A pre-trial hearing on groundwater has been set for September 22, 1975, and the trial time has been set for December, 1975.

Well permit applications were submitted to the State Engineer on May 12, 1975, for 62 Phase I wells and 34 Phase II wells. Morrison-Knudsen is currently developing a computer model of the effect of these wells on surrounding areas using the latest hydrology from Tract C-a plus all other available water data. A regional map showing all existing water-rights, springs and wells in Piceance Basin has been prepared for use in illustrating regional affects at various time increments- for example, 30 years development and 100 years of recovery time. All information is to be derived from computer analysis.

A 4.3 Power

On September 27, 1974, a Letter of Agreement was executed with Moon Lake Electric Association to cover Moon Lake's cost of engineering, right-of-way work, and environmental studies for a 230 KV transmission line to serve Tract C-a. This line will extend from an existing 138 KV line east of Rangely to the northwest corner of Tract C-a. To date, Moon Lake has completed the engineering design and the route selection for the line. An exact centerline of the proposed route along with location of each transmission line structure soon will be sent to the Bureau of Land Management for their approval. The Bureau had previously given tentative approval of the general routing for the line.

Moon Lake will develop an environmental analysis for the approved route, and this assessment will be ready in August, 1975. All work for the line is on schedule and long delivery items have been ordered so that construction may start in mid-1976. Completion of this line and related facilities is scheduled by Moon Lake for January 1, 1977, by which date it is anticipated that construction power will be needed at the tract.

A formal power contract must be executed with Moon Lake by August 1, 1975. This is the latest date Moon Lake can tolerate before they will enter penalty situations on the materials that have been ordered. At the present time, a contract for short-term power for construction and initial development of Tract C-a is being negotiated with Moon Lake.

Basically, this contract will incorporate the present Letter of Agreement and in addition, will provide payments to Moon Lake for their costs of construction and material for the 230 KV transmission line, substation, and tap into their 138 KV Rangely line. The line will be operated initially at 138 KV, but will be designed for eventual operations at 230 KV. Delay or cancellation of the transmission line facilities is provided for. In case of cancellation, in addition to the transmission line facilities underway or completed, RBOSP is also committed for payment of any penalties associated with the purchase of outside power for our account.

A 4.4 Communications

There have been several meetings with Mountain Bell in regard to their supplying RBOSP's construction and production communications needs for Tract C-a. Based on information received on the number of trunk lines and telephones in use at a number of refineries and other industrial plants, RBOSP arrived at a common denominator of its needs as one (1) trunk line for every ten (10) telephones per every forty (40) employees. With an estimate of about 1,000 employees for a 50,000 B/D plant, requirements were determined to be about 25 trunk lines and 250 telephones.

Mountain Bell has investigated the feasibility of both microwave and cable service. At this time, they feel that cable will be more reliable, less costly, and present fewer problems. There are two routes being analyzed. One route is from Rangely to Tract C-a following alongside RBOSP's proposed access road route. A second route which appears more feasible would be from Meeker to Tract C-a. This route is longer, but can be installed in existing corridors with minimum difficulty. This route has the advantage of being able to handle additional business such as from Superior, Tract C-b, and other industries in the area.

A 4.5 Roads

Arrangements have been made with Rio Blanco County to improve County Road No. 24 from the Ryan Gulch Schoolhouse to Tract C-a, using funds supplied by RBOSP. This money is intended to be seed money for the County to use in procuring oil shale bonus monies for offset of oil shale impacts. The improvement consists of widening and straightening, for safety reasons, portions of the road between the Ryan Gulch Schoolhouse and the "84" Ranch. In addition, all the road will be covered with six inches of crushed sandstone rock obtained from pits in the area. Joslin Construction Company has been awarded the contract for this work from Rio Blanco County, and construction started on July 8, 1975. Joslin has nearly completed a separate contract to widen and gravel the roads on Tract C-a itself. Completion of these two contracts should greatly alleviate the dust control problems experienced on the tract in the past.

The main thrust of RBOSP's activities towards the future road requirements for Tract C-a is the designation of a corridor towards Rangely to be used for an access road to that community, as well as the actual survey of the road layout itself. RBOSP regards this road to be an essential committment on the part of County and State Highway people in order to provide its employees with the most convenient community.

Studies conducted by Morrison-Knudsen have indicated that the most promising route is from Highway 64, just east of Rangely, up Gillam Draw to east Spring Creek Fork, then to Tract C-a. This route is about 25 miles long, and RBOSP believes it offers the best possibility for a permanent access route to Rangely from Tract C-a. Once this road is installed, the convenience of traveling only 25 miles to Rangely, compared to over 50 miles to Meeker, and 60 miles to Rifle, should result in most of RBOSP's employees choosing to live in Rangely.