GW - 32

GW Monitor Plan

2/82

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Application

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Submitted February 3, 1982

ATTACHMENT B-2

GROUND-WATER MONITORING PLAN
CINIZA REFINERY
NEAR GALLUP, NEW MEXICO
FOR SHELL OIL COMPANY

Dames & Moore

Job. No. 00216-244
November 24, 1981

Dames & Moore

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Shell Oil Company
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Attention: Mr. Rich Higgins

Gentlemen:

This letter transmits five copies of our final report, "Ground-Water Monitoring Plan, Ciniza Refinery, Near Gallup, New Mexico, For Shell Oil Company." This work was performed under Shell Purchase Order No. CR 0889.

We have structured this report so that the sections entitled "Ground-Water Monitoring Program" and "Ground-Water Quality Assessment Program" can be separated from the preceding sections, since the latter comprises background information which is not strictly required to be provided in the "Plan".

A few modifications have been made in the preliminary draft of the report and are incorporated in this final version. These changes mostly consist of additional detail and do not fundamentally alter the procedures described in the preliminary draft.

It has been a pleasure performing this service for Shell Oil Company. If you should have further questions, please call us.

Yours very truly,

DAMES & MOORE

William E. Mead

William E. Mead
Partner

WEM:lj

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Part 265 - Subpart F
Ground-Water Monitoring

Appendix B - Sampling, Chain of Custody and Analysis Record

* * *

Excerpt From "Procedures Manual For Ground Water Monitoring at Solid Waste Disposal Facilities" EPA-530/SW-611, August 1977: Chapter 6, Paragraph 6.2.3, "Chain of Custody".

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GROUND-WATER MONITORING PLAN
CINIZA REFINERY
NEAR GALLUP, NEW MEXICO
FOR SHELL OIL COMPANY

INTRODUCTION

Shell Oil Company operates a crude oil refinery near U.S. Interstate Highway I-40 about 17 miles east of Gallup, New Mexico. Certain waste products generated by the refinery contain contaminants at levels of concentration which are considered hazardous to health under criteria established by the U.S. Environmental Protection Agency through the Resource Conservation and Recovery Act of 1976 (RCRA). Shell deposits these contaminated materials in a hazardous waste management facility.

Under the RCRA regulations, all hazardous waste facilities must be monitored for possible effects upon the ground-water system. A minimum ground-water monitoring well network must be in place and a program of monitoring procedures initiated by November 19, 1981. The purpose of the program undertaken by Dames & Moore on behalf of Shell Oil Company was to install the monitoring wells and to formulate a ground-water monitoring plan in compliance with RCRA requirements.

FACILITY DESCRIPTION

The Ciniza Refinery produces leaded and unleaded gasoline and diesel fuel. Refinery capacity is 18,000 barrels per day.

Waste products discharged at the facility include sewage effluent, water softener brines, API sludge, cooling tower blowdown, leaded tank bottoms and ASO process wastes. The brines are discharged to evaporation ponds. Sewage is discharged to an unlined lagoon. The API sludge and other process wastes contain concentrations of barium, chromium, cyanide, fluoride, lead, mercury and selenium. Lead is present in sufficient amounts to classify the waste as hazardous according to the RCRA diagnostic criteria. This waste is deposited in a land treatment area which therefore constitutes a hazardous waste facility. The refinery facilities and waste disposal areas are shown on Plate 1, Site Map.

SITE CONDITIONS

GEOHYDROLOGIC CHARACTERISTICS OF THE REFINERY AREA

Earlier investigations conducted by Dames & Moore and others served to generally characterize the geohydrologic regime in the refinery area.

The plant facilities are directly underlain by the Chinle Formation of Triassic age. The Chinle strata consist primarily of reddish-brown clays and sandy clays grading with depth into green and purple variegated silty shale. The clays forming the uppermost beds are believed to be the weathered equivalent of the deeper shale. These strata dip northwest at about 1.5 to 2.5 degrees (135 to 231 feet per mile). A few thin, discontinuous lenses of fine- to medium-grained sand or sandstone are present within the Chinle sequence.

Earlier investigations identified a fine- to medium-grained sandstone layer, in part silty to clayey, which is approximately 12 to 15 feet thick and which appears to be continuous beneath the site. The sandstone ranges in depth from about 30 feet in the south (updip) portion of the refinery property to about 145 feet near the north (downdip) limit of the property. Beneath the hazardous waste facility the depth of this sandstone bed is about 100 to 112 feet as shown on Plate 2, Cross Section A-A'. The sandstone yields a small amount of water and has been designated the uppermost aquifer for purposes of RCRA compliance.

Water supply wells at the Shell property pump from the San Andres limestone-Glorieta sandstone aquifer of Permian age occurring at a depth of about 800 feet. Geologic logs for these wells indicate that beneath the uppermost aquifer lie more than 500 feet of Chinle Formation composed principally of siltstone and mudstone. Within this interval, one or two other 20-foot sandstone beds have been identified.

The sandstone aquifer herein defined as "uppermost" is under artesian confinement. In the vicinity of the hazardous waste facility, the potentiometric surface of the ground water in the uppermost aquifer lies 70 to 100 feet above the aquifer, or at a depth of approximately 10 to 30 feet below the land surface.

GROUND-WATER QUALITY

Earlier investigations have provided some data relative to the quality of ground water in the uppermost aquifer. Observation wells installed as part of these investigations have been sampled chemically

three separate times at three- to five-month intervals as of the date of this report. The locations of these observation wells (OW-series) are shown on Plate 1.

Well OW-11 is upgradient from the plant facilities and is considered representative of background water quality conditions. Chemical analyses of ground water from OW-11 and other selected wells are shown on Table 1.

A few observation wells near the refinery and downgradient from it have shown concentration levels for lead, total chromium, mercury, and barium which have exceeded the National Interim Primary Drinking Water Standards one or more times in the three sampling periods mentioned above. Values for certain constituents listed under the Proposed Secondary Drinking Water Standards also have been exceeded in a number of cases. While these high constituent levels under both sets of standards suggest that the refinery and disposal facilities are the source of contamination, they do not relate to the hazardous waste facility for the following reasons:

1. Several of the observation wells showing contamination are hydraulically upgradient from the hazardous waste facility and, in fact, upgradient from all of the waste disposal facilities.

2. The hazardous waste facility went into operation in October, 1980. Considering the amount of confining head in the uppermost aquifer and the thickness of the relatively impermeable beds above the aquifer, it is highly unlikely that any contaminants from the

TABLE 1

GROUND-WATER QUALITY IN SELECTED OBSERVATION WELLS[1]

	OW-11	OW-20	Shallow OW-17	OW-12	OW-4	OW-2
Arsenic	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Barium	0.3(9/81)	1.0(9/81)	--	1.0(9/81)	0.3(9/81)	3.0(9/81)
Cadmium	<0.001(9/81)	<0.001(9/81)	--	<0.001(9/81)	<0.001(9/81)	<0.001(9/81)
Chromium	0.003(9/81)	0.038(9/81)	--	0.15(9/81)	0.002(9/81)	0.005(9/81)
Cyanide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	0.021(9/81	0.015(9/81)	--	0.08(9/81)	0.028(9/81)	0.025(9/81)
Mercury	<0.0004(9/81)	<0.0004(9/81)	--	<0.0004(9/81)	0.0042(9/81)	0.0077(9/81)
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver	<0.01(9/81)	<0.01(9/81)	--	<0.01(9/81)	<0.01(9/81)	<0.01(9/81)
Fluoride	0.09(9/81)	0.34(9/81)	--	--	0.55(9/81)	0.55(9/81)
Nitrate	1.8	1.3	0.8	0.1	0.2	0.1
Calcium	11	6.6	400	11	14	20
Chloride	88	100	86	120	57	39
Iron	0.3	0.3	0.5	0.7	0.1	1.1
Manganese	0.03	0.02	4.2	0.08	0.07	0.2
Phenols	<0.001(9/81)	<0.001(9/81)	--	<0.001(9/81)	<0.001(9/81)	<0.001(9/81)
Sodium	380	320	250	310	230	390
Sulfate	196	214	319	100	188	16
pH	7.8	11.6	7.4	7.5	8.1	7.6
Sp.Cond.[2]	1500	1950	1400	--	--	1180
TDS	935	841	818	746	741	856
Total Organic Carbon	20(6/81)	--	43(6/81)	26(6/81)	--	--
Total Organic Halogens	<0.4(9/81)	<0.4(9/81)	--	<0.4(9/81)	<0.4(9/81)	<0.4(9/81)
Oil & Grease	--	5.5	25.0	7.1	--	--

[1] Latest determination at time of this report.
All samples collected Dec., 1980 unless otherwise indicated.
All values in mg/l unless otherwise indicated.

[2] micromhos

hazardous waste facility could have reached the aquifer in this twelve-month period.

The presence of contamination in the uppermost aquifer, however sporadic and ill-defined to date, nevertheless indicates the possibility that such contamination can reach the aquifer from the refinery, at least in upgradient portions of the site where the aquifer is shallower and under less confining head.

RCRA GROUND-WATER MONITORING REQUIREMENTS

Part 265, Subpart F of the RCRA regulations addresses the manner in which hazardous waste facilities will be monitored to detect their possible effects upon ground water. Basically, the operator of a hazardous waste facility must accomplish the following by November 19, 1981 (one year after the effective date of the regulations), unless a waiver from these requirements has been granted:

1. Have in operation a monitoring well system consisting of at least one well hydraulically upgradient and at least three wells hydraulically downgradient from the waste management area, completed in the uppermost aquifer. The downgradient wells must immediately detect any statistically significant amounts of hazardous waste constituents that migrate from the waste management area into the uppermost aquifer. Basic requirements for monitoring well construction are defined in the regulations.

2. Have on file at the facility a ground-water monitoring plan which is followed diligently during the operating life of the facility and which outlines procedures and techniques to be used for:

    a. sample collection

    b. sample preservation

    c. laboratory analysis

    d. chain of custody control

3. Collect and analyze samples from these wells according to a specific schedule and list of parameters, and collect water level data with each sampling operation.

4. Have on file an outline of a more comprehensive ground-water monitoring program capable of determining:

    a. if hazardous waste constituents have entered the ground water

    b. rate and extent of migration of these constituents

    c. concentration of the hazardous waste constituents

    In the event that sampling in accordance with the prescribed schedule discloses that the aquifer is being contaminated, the operator must prepare a specific plan to replace the original more generic outline for providing information on the rate of migration, affected area and concentration of the contaminants.

5. Initiate and maintain the record-keeping and reporting procedures as outlined under Part 265.94 of the regulations.

GROUND-WATER MONITORING PROGRAM

GENERAL

The purpose of this section of the report is to insure that Shell Oil Company's ground-water monitoring program complies with all of the RCRA guidelines for the first year of implementation (November 19, 1981 through November 18, 1982) and for subsequent years of operation. We will carefully follow the RCRA specifications in formulating this program, but will not re-state in full the lengthy pertinent sections in the Federal Register. Rather, we have provided a copy of Part 265 in its entirety as an appendix (Appendix A) so that a cross-check on the adequacy of the program will be possible.

INSTALLED MONITORING WELL SYSTEM

Based on our understanding that the land treatment facility is the sole hazardous waste management area at the Ciniza Refinery, we have installed one upgradient monitoring well (MW-4) and three downgradient monitoring wells (MW-1 through MW-3) as shown on Plates 1 and 2. All four wells have been constructed through the uppermost aquifer and have been cased, screened, sand-packed, sealed with bentonite, cemented and protected with a capped surface casing to insure their proper functioning. Boring logs for these wells and the well construction details are presented on Plates 4-A through 4-D and on Plate 5. (Note: The four

above-referenced wells each have a welded number on the well cover which does not correspond to the numbers given herein. The correlation of the two sets of numbers is as follows:)

Number on Well Cover	Should Be
~~SW-1~~	MW-1
~~NE-2~~	MW-2
~~E-3~~	MW-3
~~SE-4~~	MW-4

GROUND-WATER MONITORING PLAN

Sampling Frequency and Analytical Parameters

Part 265.92 states the sampling frequency and list of parameters to be measured in both the upgradient and downgradient monitoring wells. These requirements are more extensive for the first year of sampling (November 19, 1981 through November 18, 1982) than for subsequent years, so that background concentrations can be defined as a reference base for comparison with levels measured in the second year of monitoring and beyond. Significant changes in the concentrations of certain designated indicator parameters which are detected after the first year of monitoring and which can be attributed to the effects of the hazardous waste facility will result in the need for more monitoring wells and more frequent sampling than the minimum plan outlined in Part 265.92. Standard statistical procedures will be used to determine whether such changes are "significant" according to the RCRA criteria.

Three general groups of parameters are to be analyzed in the sampling program. These are as follows:

Group 1	Interim primary drinking water standards
Group 2	Ground-water quality parameters
Group 3	Indicator parameters of ground-water contamination

These parameters are listed in Table 2, along with the EPA maximum permissible limits for the Group 1 parameters.

Shell Oil Company will collect samples from the four monitoring wells at the following frequencies and obtain analyses of the required parameters in compliance with Part 265.92 of the RCRA regulations:

First Year (November 19, 1981 through November 18, 1982):

Upgradient Well (MW-4)

One sample taken quarterly and analyzed for the Group 1 and Group 2 parameters.

Four replicate samples taken quarterly and analyzed for the Group 3 parameters.

At the end of the first year, the 16 values for each indicator parameter will be pooled to determine the initial background arithmetic mean and variance.

TABLE 2

ANALYTICAL PARAMETERS

Group 1 - Interim Primary Drinking Water Standards

Parameter	Maximum Permissible Level	
Arsenic	0.05	mg/l
Barium	1.0	"
Cadmium	0.01	"
Chromium	0.05	"
Fluoride	1.4-2.4	"
Lead	0.05	"
Mercury	0.002	"
Nitrate (as N)	10	"
Selenium	0.01	"
Silver	0.05	"
Endrin	0.0002	"
Lindane	0.004	"
Methoxychlor	0.1	"
Toxaphene	0.005	"
2,4-D	0.1	"
2,4,5-TP (Silvex)	0.01	"
Radium	5	pCi/l
Gross Alpha	15	pCi/l
Gross Beta	4	millirems/yr
Coliform Bacteria	1/100 ml	By MEMBRANE FILTER TECH. 2/100 ml BY MPN TUBE FERMENTATION

Group 2 - Ground-Water Quality Parameters

Chloride
Iron
Manganese
Phenols
Sodium
Sulfate

Group 3 - Indicator Parameters of Ground-Water Contamination

pH
Specific Conductance
Total Organic Carbon
Total Organic Halogen

Water level elevations measured quarterly (at time of sampling).

Downgradient Wells (MW-1, 2 and 3)

One sample taken quarterly and analyzed for the Group 1, 2 and 3 parameters.

Water level elevations measured quarterly.

After the First Year

All four wells (MW-1 through MW-4)

One sample taken annually and analyzed for the Group 2 parameters.

Four replicate samples taken semi-annually and analyzed for the Group 3 parameters.

After each semi-annual sampling, the replicate measurements will be pooled for each parameter in each well to determine arithmetic mean and variance for comparison with the initial background mean, using the Student's t-test.

Water level elevations measured semi-annually (at time of sampling).

A flow sheet for the required sampling and analysis is provided on Table 3 to facilitate Shell's adherence to this plan.

Sample Collection

The method of sample collection from the monitoring wells is of major importance in assuring the validity of the samples. Extraction methods typically employed involve the use of pumps, compressed air, bailers or special samples. Shell will utilize a submersible pump for this purpose.

Means will also be provided to determine water level elevations at the time of sample collection to within an accuracy of 0.05 feet. Prior to initial pumping, any presence of oil in the well and its thickness will be noted.

Use of a thermometer, pH meter and conductivity meter to obtain on-site measurements of these unstable ground-water parameters is recommended but not mandatory.

A minimum of one volume of water in the well casing will be removed before sampling, and three to five volumes will be withdrawn, if possible, to avoid collecting stagnant water that may be chemically stratified. In low yield wells such as the four monitoring wells to be sampled in this program, it may be practical to remove only one volume of water before allowing the water level to recover and collecting a sample. This sample may be extracted with a simple, clean bailer if desired, after removing the pump.

It is possible that the ground water pumped from one or more of the wells will be turbid, although we have endeavored to design each well so as to prevent this occurrence. Allowing water level recovery after

TABLE 3

GROUND-WATER SAMPLING FREQUENCY AND REPORTING FLOW SHEET [1]

Before:	FIRST YEAR [2]					EACH SUCCESSIVE YEAR				
	2-19-82[3]	5-19-82[3]	8-19-82[3]	11-19-82[3]	3-1-83	2-19	5-19	8-19	11-19	3-1
UPGRADIENT WELL (MW-4)										
Group 1 - IPDWS	1*	1*	1*	1*	A	-	-	-	-	-
Group 2 - Quality	1	1	1	1	A	-	-	-	1	A
Group 3 - Indicator	4	4	4	4[4]	A	-	4[5]	-	4[5]	A
Water elevations	1	1	1	1	A	-	1	-	1	A
DOWNGRADIENT WELLS(MW-1,2,3)										
Group 1 - IPDWS	1*	1*	1*	1*	A	-	-	-	-	-
Group 2 - Quality	1	1	1	1	A	-	-	-	1	A
Group 3 - Indicator	1	1	1	1	A	-	4[5]	-	4[5]	A
Water elevations	1	1	1	1	A	-	1	-	1	A

1] Minimum program
2] Initial background determination
3] Number of complete sets of analyses
4] Compute arithmetic mean and variance for all 16 samples
5] Statistical comparison with initial background mean
* Results reported to Regional Administrator each quarter
A Annual report to Regional Administrator on results and elevations for previous calendar year.(Paragraph 265.75)

flushing and before sampling will minimize the amount of turbidity and sediment in the samples. The sample should not be filtered to remove this particulate matter.

The recovered sample will be conveyed as rapidly as possible from the lifting device to a clean sample container of appropriate volume and conposition to which the necessary preservatives have been previously added. Recommended volumes of sample for the required suites of analyses are given in Table 4.

Sample Preservation and Shipment

The addition of chemical preservatives to the water samples at the time of collection is required to maintain the stability of certain constituents until laboratory analysis is undertaken. These preservatives will usually have been added to the sample bottles before delivery to the field. Table 4 lists the specific preservation methods which will be utilized. Because many of these samples will be acidic in composition, they cannot be shipped by air.

Maintenance of sample temperatures at about four degrees Centigrade will be achieved by packing in ice at the time of collection and retaining this ice pack until delivery at the laboratory. Shell will notify the laboratory when each shipment is made. In all cases, the time interval between collection and analysis will be as short as possible. Holding time for many of the parameters in all three groups of constituents is recommended not to exceed 24 hours.

TABLE 4

SAMPLE COLLECTION

Group 1	Group 2	Group 3	Quantity (each sample)	Container	Preservative
As Ba Cd Cr Pb Hg Se Ag	Fe Mn Na		1 Liter	Plastic	HNO_3 to pH less than 2
Radium-226, 228 Gross Alpha Gross Beta			1 Liter	Glass	HNO_3 to pH less than 2
Endrin Lindane Methoxychlor Toxaphene 2,4-D 2,4,5-TP			1 Liter	Glass Only	None Cool to 4° C
		Total Organic Halogen	250 ml	Plastic	6.25 mg $NaSO_3$
	Phenols		1 Liter	Glass Only	1 gram $CuSO_4$ Acidify to pH less than 4 with H_3PO_4.
F	Cl SO_4	pH Sp. Cond.	1 Liter	Plastic	None Cool to 4° C
Nitrate (as N)		Total Organic Carbon	250 ml	Plastic	H_2SO_4 to pH less than 2
Coliform Bacteria			250 ml	Sterile Glass	None Sodium thiosulfate

FORD CHEMICAL LABS
40 WEST LOUISE AVE.
SALT LAKE CITY, UTAH
84115
801-466-8761

64 PLASTIC LITER BOTTLES
40 GLASS LITER BOTTLES
12 PLASTIC 250 ml BOTTLES
4 GLASS 250 ml BOTTLES

44 LITERS MUST BE SHIPPED IN ICE

Analytical Procedures

Shell Oil Company will specify that the laboratory designated to perform these required analyses do so in accordance with the following references:

A. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, 1980, or,

B. Manual of Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, EPA-600/4-79-020, March, 1979.

C. "The Analysis of Organohalides (OX) in Water as a Group Parameter," R.C. Dressman, B.A. Najar, and R. Redzikowski, USEPA, Drinking Water Research Division, Cincinnati, OH, 1979.

Table 5 indicates the laboratory detection limits for each parameter and the method of laboratory analysis.

Record-Keeping and Reporting

Shell Oil Company will maintain in its files for the active life of the hazardous waste facility as well as during its post-closure care period, the records of all analyses performed in accordance with the schedule previously described and all statistical evaluations performed on these results. In addition, Shell will report the following groundwater information to the Regional Administrator:

EPA IN DALLAS

REGIONAL ADMINISTRATOR, REGION VI
U.S. ENVIRONMENTAL PROTECTION AGENCY
1201 ELM STREET, FIRST INTERNATIONAL BLDG.

TABLE 5

ANALYTICAL PROCEDURES

Group 1 - Drinking Water Standards Parameters

Parameter	Detection Limit	Method	EPA (1979) Method Number
Arsenic[x]	0.001 mg/l	Digestion followed by atomic absorption, furnace	206.2
Barium[x]	0.1 mg/l	Digestion followed by atomic absorption	208.1
Cadmium[x]	0.0001 mg/l	Digestion followed by atomic absorption, furnace	213.2
Chromium	0.001 mg/l	Digestion followed by atomic absorption, furnace	218.2
Fluoride	0.1 mg/l	Distillation followed by ion electrode: SPADNS	340.1
Lead[x]	0.001 mg/l	Digestion followed by atomic absorption, furnace	239.2
Mercury[x]	0.0002 mg/l	Flameless atomic absorption	245.1
Nitrate (as NO_3-N)	0.01 mg/l	Cadmium reduction	353.3
Selenium[x]	0.002 mg/l	Digestion followed by atomic absorption, furnace	270.2
Silver[x]	0.0002 mg/l	Digestion followed by atomic absorption, furnace	272.2
Endrin	0.0001 mg/l	Extraction, gas chromatography	509*
Lindane	0.001 mg/l	Extraction, gas chromatography	509*
Methoxychlor	0.001 mg/l	Extraction, gas chromatography	509*
Toxaphene	0.001 mg/l	Extraction, gas chromatography	
2,4-D	0.001 mg/l	Extraction, gas chromatography	504*
2,4,5-TP Silvex	0.001 mg/l	Extraction, gas chromatography	504*
Gross Alpha	3.0 pCi/l	Scintillation count	703*
Gross Beta	0.1 pCi/l	Scintillation count	703*
Radium 226	0.05 pCi/l	Scintillation count	706*
Radium 228	0.05 pCi/l	Scintillation count	707*
Coliform Bacteria	2.2 MPN/100 ml	Multiple tube fermentation	908*

Group 2 - Ground-Water Quality Parameters

Chloride	1.0 mg/l	Automated colorimetric	325.1
Iron[x]	0.03 mg/l	Digestion followed by atomic absorption	236.1
Manganese[x]	0.01 mg/l	Digestion followed by atomic absorption	243.1
Phenols	0.002 mg/l	Colorimetric, (4-AAP)	420.2
Sodium[x]	0.002 mg/l	Digestion followed by atomic absorption	273.1
Sulfate	3.0 mg/l	Colorimetric	375.2

Group 3 - Ground-Water Contamination Indicators

pH	±0.1 units	Electrometric measurement	150.1
Specific Conductance	±6 umhos/cm	Wheatstone bridge	120.1
Total Organic Carbon	1 mg/l	Combustion - with flame ionization	415.1
Total Organic Halogen	1 mg/l	Dohrmann micro-coulometric detector, carbon absorption	**

* Number is reference from Standard Methods for Examination of Waters and Wastewater, 15th Edition (1980)

** "The Analysis of Organohalides (OX) in Water as a Group Parameter" (EPA, 1979).

x Sampled, preserved and extracted in accordance with Section 4.1.4 of EPA 600/4-79-020 for total recoverable metals.

A. During the first year, and within 15 days after completing each quarterly analysis, the value of all Group 1 parameters in each of the monitoring wells. Shell will also identify in this reporting, any parameters in the four monitoring wells whose value exceeds the limits given for Group 1 parameters in Table 2.

B. By March 1, 1983, an annual report for calendar year 1982 will be submitted to the Regional Administrator which includes:

1. Values of all Group 3 parameters measured during the year in each monitoring well along with the required statistical evaluations.

2. Evaluation of water table elevations in the four monitoring wells to ascertain that the wells still satisfy the minimum monitoring criteria of one upgradient well and three downgradient wells peripheral to the hazardous waste management area.

C. During any subsequent year after the first year:

1. Notification of significant degradation of any Group 3 parameter in a downgradient well, based on a statistical comparison with initial background using the Student's t-test, and providing that the significant degradation is confirmed by immediate re-sampling and analyses in accordance with Paragraph 265.93 (c)(2) of Subpart F. This

confirmation will be reported within seven days.

2. Within 15 days of notification in accordance with Item 1 above, a specific plan for ground-water quality assessment which is capable of determining the rate and extent of hazardous waste migration and its concentrations.

3. Within 15 days of making the technical determinations described in Item 2 above, the results of these determinations.

D. At the end of the second and subsequent years, an annual report to the Regional Administrator which includes either:

1. Items B(1) and B(2) above, along with the identification for each upgradient well of any significant differences from initial background, or;

2. If the ground water is being monitored in accordance with a specific plan for ground-water quality assessment, the results of this assessment.

Chain of Custody Control

The chain of custody in handling ground-water samples between the time of collection at the monitoring wells and receipt by the designated laboratory can have legal ramifications in enforcement cases. Protection of the sample against accidental or willful mishandling is the aim of

tight custody control. This procedure is more important for some hazardous waste facilities than for others. We do not feel in the present instance that the most rigid possible control is necessary. Protection of samples collected at the Ciniza Refinery will entail the following procedures:

1. Limiting the number of persons handling the samples to as few as possible. The person collecting the samples will be responsible for their care and custody until shipment.

2. Sealing of each cooler or other multiple-sample container in such a manner that neither the identification tag nor the sample contents can be removed without breaking the seal. This will be done by the individual collecting the sample.

3. Chain of custody records will accompany the samples which identify the source of each sample, the individual collecting the sample, the preservatives used and the required analyses, along with other relevant data. A suggested format for the record card is given in Appendix B. Copies of these records will be placed in plastic envelopes and taped under the seal of the container. In addition, the sender will sign his name on the tape at the seam.

4. The sampler will maintain a notebook in which is recorded all essential details pertaining to the sample. This record will contain the names of any transferees handling the samples prior to acceptance by a public carrier, as well as the date and mode

of shipment. The sampler will sign each relevant page of the notebook.

Shell Oil Company will endeavor to insure that the person receiving the samples from the shipping agent on behalf of the laboratory signs for these samples and that such acknowledgement of receipt becomes a part of the laboratory's permanent records. The EPA "Procedures Manual for Ground-Water Monitoring at Solid Waste Disposal Facilities", EPA-530/SW-611, August, 1977, presents a more detailed discussion on the subject of chain of custody control. This section of the manual is provided in Appendix B.

Summary

Shell Oil Company will strive to follow the preceding schedules and procedures for the ground-water monitoring program to the fullest extent possible in order that compliance with the RCRA guidelines is achieved.

GROUND-WATER QUALITY ASSESSMENT PROGRAM

In accordance with Paragraph 265.93 of Subpart F, when comparison of down-gradient well contamination indicators with background contamination indicators exceeds the 99 percent confidence limits for any parameter based on the Students' t-test, and providing that such contamination is confirmed by immediate re-sampling, development of a more comprehensive ground-water quality assessment program is required.

The ground-water monitoring plan described in the previous section of this report is designed primarily to detect contamination in the uppermost aquifer if it occurs, and to accomplish such detection as early as possible before the contaminant plume lengthens signigicantly. Hence, three of the monitoring wells for the minimum plan have been located as close as practicable to the downgradient perimeter of the hazardous waste management area. These wells have been installed transversely to the direction of ground-water flow and to the pathway of any migrating contaminants. They are therefore not ideally situated to monitor the rate of migration in the expected direction of movement. It is for this reason that a plan must be conceptualized at this time which will provide a framework for a more specific plan to determine the rate of migration and other characteristics of the contaminant plume in the event that such contamination is detected in the perimeter wells.

The conceptual plan must anticipate the need for one or more additional monitoring wells downgradient from the existing well system. Based on present knowledge as to the rate of ground-water movement and the permeabilities of the uppermost aquifer and its overlying strata, one or more of the future monitoring wells may be placed less than 50 feet downgradient from the contaminated wells.

If deemed advisable after contamination is detected, sampling may be undertaken more frequently than prescribed in the ground-water monitoring plan described earlier, in both the original wells and the supplementary system. The parameters analyzed may also be changed, in recognition of the fact that different contaminants may exhibit variations in migration behavior. It is possible that certain of the indicator parameters

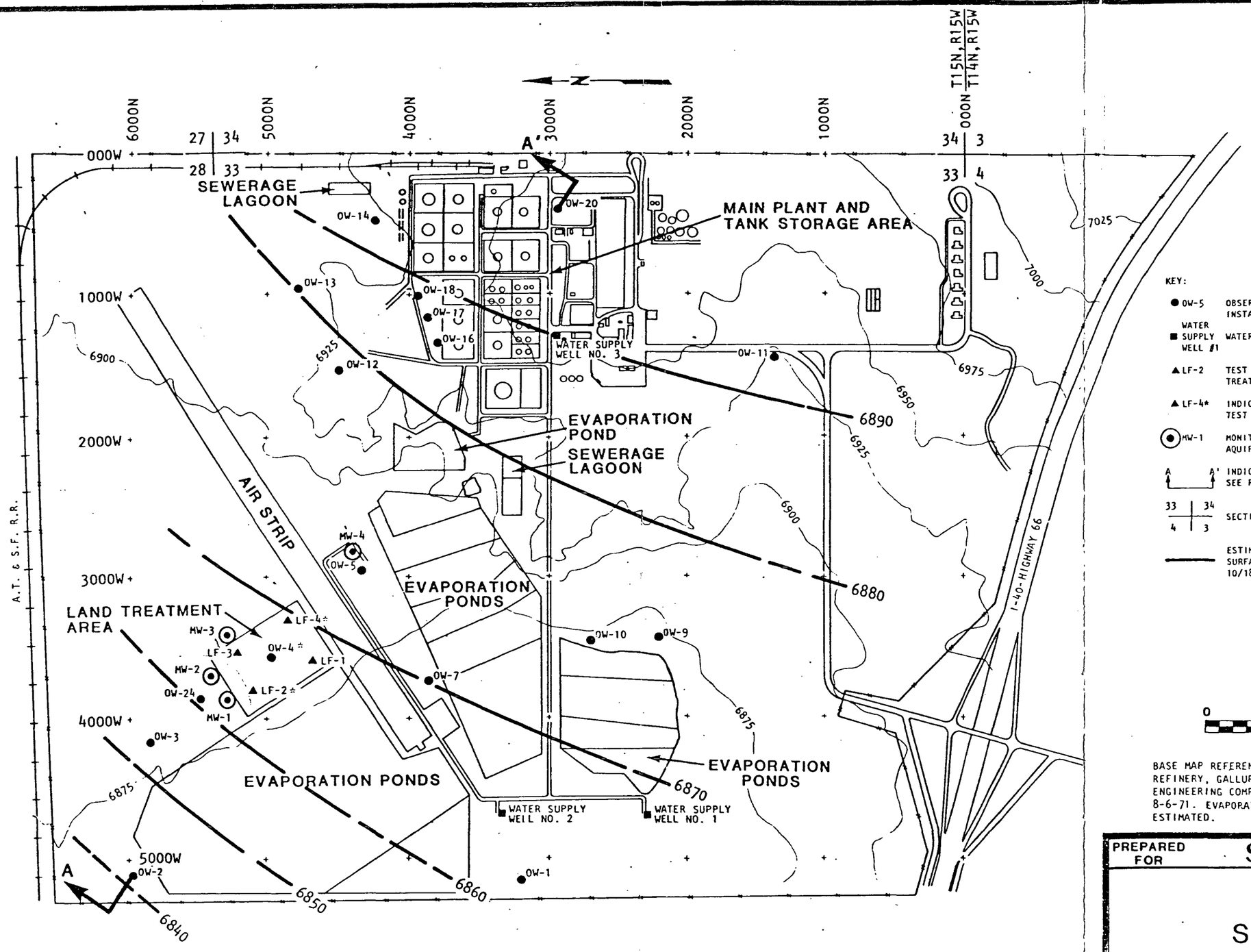
will travel at faster rates along the contaminant pathway than the more toxic constituents, thus allowing a greater margin in lead time for predicting the arrival of hazardous contaminants.

In addition to new monitoring wells installed downgradient along the presumed axis of the contaminant plume, other wells may be required to define the lateral extent of the plume. Experience has shown in numerous other cases that plume configurations may not possess simple geometric forms. Effective interception and capture of migrating contaminants depends upon developing to the fullest extent possible an understanding as to their distribution, both laterally and vertically. To serve that objective, either multiple sampling depths in single wells or well groupings with different screen settings may be required.

Specific plans for a ground-water quality assessment program which will lead to the implementation of abatement measures cannot be developed until statistically significant contamination is detected. If contamination does occur, the earliest it will be identified is in conjunction with the first semi-annual sampling of the original wells during the second year of monitoring. At such time, a specific plan will be developed which replaces the conceptual plan discussed herein and which is designed to determine, as a minimum, the following:

A. The rate and extent of migration of hazardous waste constituents in the ground water.

B. The concentrations of the hazardous waste constituents in the ground water.



KEY:

- ● OW-5 — OBSERVATION WELL INSTALLED BY DAMES & MOORE
- ■ WATER SUPPLY WELL #1 — WATER SUPPLY WELL
- ▲ LF-2 — TEST PIT IN LAND TREATMENT AREA
- ▲ LF-4± — INDICATES INFILTROMETER TEST SITE
- ⊙ MW-1 — MONITORING WELL IN UPPERMOST AQUIFER
- A — A' — INDICATES CROSS SECTION LINE SEE PLATE 2
- 33 | 34 / 4 | 3 — SECTION CORNER
- ESTIMATED POTENTIOMETRIC SURFACE IN FEET A.S.L. 10/18/81

SCALE

0 500 1000

FEET

BASE MAP REFERENCE: MASTER PLAN, CINIZA REFINERY, GALLUP, NEW MEXICO, SOUTHWESTERN ENGINEERING COMPANY, ZZ-02-122-EP, REVISION 8-6-71. EVAPORATION POND BOUNDARIES ARE ESTIMATED.

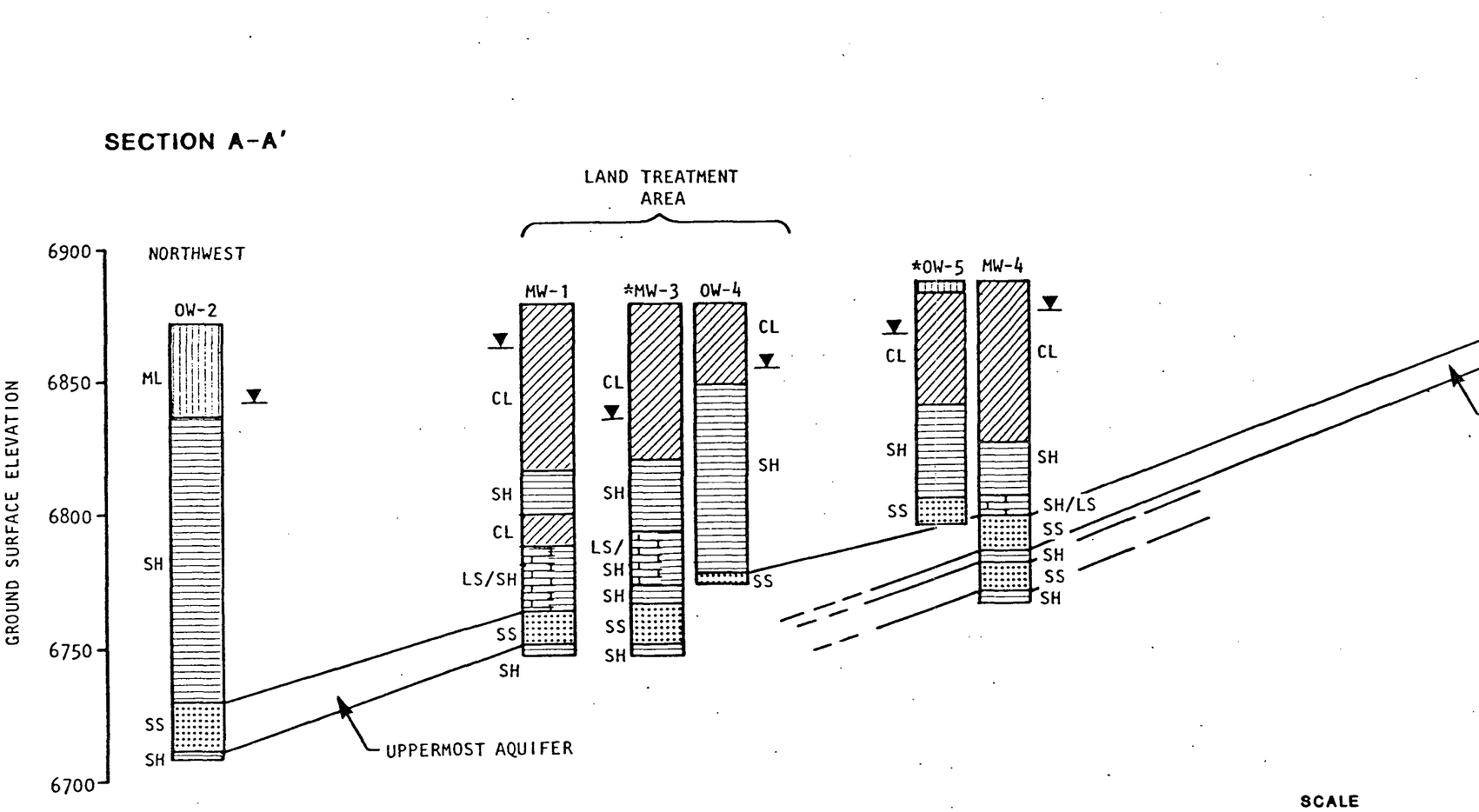
PREPARED FOR Shell Oil Co.

SITE MAP

BY Dames & Moore

Plate 1

SECTION A-A'



SCALE
0 250 500
FEET
VERTICAL EXAGGERATION: 10X

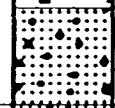
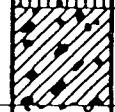
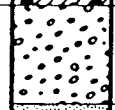
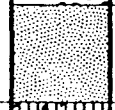
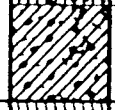
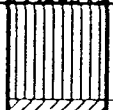
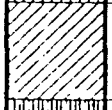
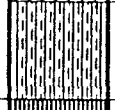
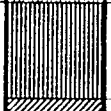
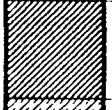
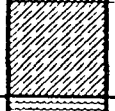
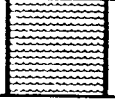
NOTES:

1. SEE PLATE 1 FOR CROSS SECTION LOCATION.
2. SOIL AND ROCK CONDITIONS SHOWN EXIST ONLY AT BORING LOCATIONS. CONTACTS ARE INTERPOLATED, AND CONDITIONS BETWEEN BORINGS MAY BE DIFFERENT THAN SHOWN.
3. GROUND WATER LEVELS INDICATED BY ▼. MEASURED OCTOBER 18, 1981 EXCEPT FOR MW-3 WHICH WAS MEASURED NOVEMBER 10, 1981.
4. * PROJECTED

PREPARED FOR **Shell Oil Co.**

CROSS SECTION A - A'

BY **Dames & Moore** Plate 2

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS — MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS — MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS — MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS — MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

DAMES & MOORE

PLATE 2

MONITORING WELL MW-1

SURFACE ELEVATION: 6876 FEET
(Unsurveyed)

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	BLOWS/FT. SAMPLES	SYMBOLS	DESCRIPTION
0											CL	REDDISH-BROWN SILTY CLAY, TRACE OF MEDIUM TO COARSE SAND AS BLEBS AND THIN INTERBEDS
10												WATER LEVEL 14.1 FEET B.G. 10/18/81
20												
30												
40												
50												
60											SC	PINKISH-PURPLE, SLIGHTLY SANDY (FINE) CLAY
											SH	VARIEGATED SILTY SHALE, REDDISH BROWN GRADING TO GREEN AND LIGHT PURPLE
70												
80											CL	REDDISH-BROWN SILTY CLAY, FIRM
90											LS/ SH	VARIEGATED LIGHT GREEN AND DARK RED LIMESTONE INTERBEDDED WITH SHALE
100												
110											SH	REDDISH-ORANGE SHALE
											LS	LIGHT-GREEN LIMESTONE DENSE, HARD
											SS	LIGHT GREENISH-GRAY, MEDIUM TO FINE, LOOSELY CEMENTED SANDSTONE INTERBEDDED WITH LIGHT GRAY, LOOSE CLAY
120												
130											SH	REDDISH-PURPLE SHALE
140												
150												
160												

BORING COMPLETED AT 130.4 FEET ON 10/14/81.

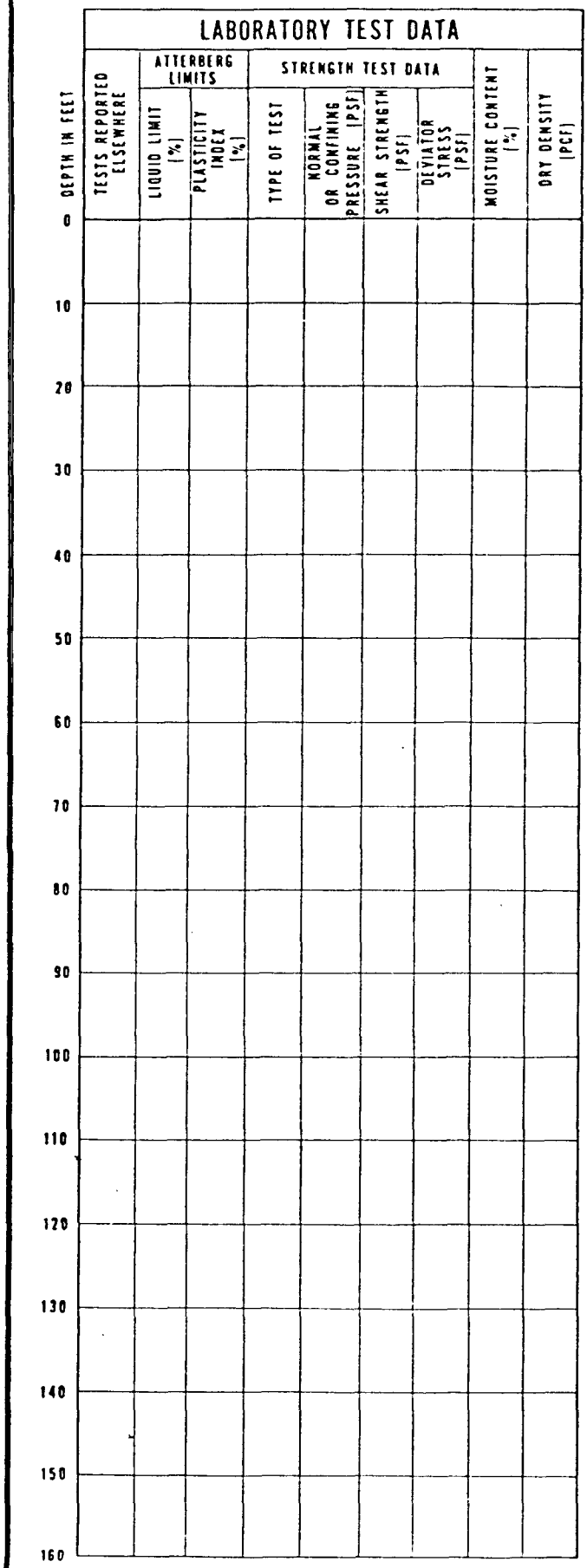
SCREENED INTERVAL

MW-1
P0
MW-4
1982

PLATE 4A

MONITORING WELL MW-2

SURFACE ELEVATION: 6877 FEET
(Unsurveyed)



SYMBOLS	DESCRIPTION
CL	REDDISH-BROWN SILTY CLAY, TRACE MEDIUM TO COARSE SAND AS LOOSE TO FIRM BLEBS
	WATER LEVEL 9.1 FEET B.G. 10/18/81
SC	PINKISH-PURPLE, SLIGHTLY SANDY (FINE) CLAY
SH	VARIEGATED REDDISH-BROWN, GREEN AND LIGHT PURPLE, SANDY TO SILTY SHALE
CL	REDDISH-BROWN SILTY CLAY, FIRM
LS/ SH	LIGHT GREEN TO DARK RED LIMESTONE INTERBEDDED WITH SHALE
LS	LIGHT GREEN LIMESTONE, HARD
SS	WHITE TO LIGHT-GRAY, FINE TO MEDIUM SAND; SOME CLAY; GRADES GREENISH GRAY TO PINK, COARSE TO MEDIUM SAND
SH	DEEP PURPLE SHALE, FIRM

BORING COMPLETED AT 138.0 FEET ON 10/15/81.

SCREENED INTERVAL

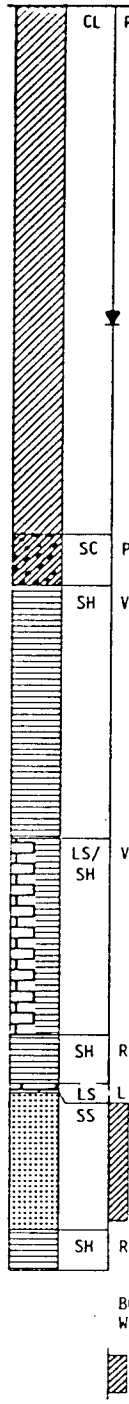
DAMES & MOORE

PLATE 4B

MONITORING WELL MW-3

SURFACE ELEVATION: 6880 FEET
(Unsurveyed)

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	BLOWS/FT. SAMPLES
0										
10										
20										
30										
40										
50										
60										
70										
80										
90										
100										
110										
120										
130										
140										
150										
160										



SYMBOLS	DESCRIPTION
CL	REDDISH-BROWN SILTY CLAY LOOSE GRADING TO FIRM
	GRADES SLIGHTLY SANDY 23-30 FEET AND AT 40 FEET
	WATER LEVEL 32 FEET B.G. 11/10/81
SC	PINKISH-PURPLE, SLIGHTLY SANDY CLAY
SH	VARIEGATED REDDISH-BROWN AND RED SILTY SHALE, LOOSE
	GRADES GREEN TO LIGHT PURPLE AND SANDY, 65-75 FEET
	GRADES FIRM REDDISH-BROWN SILTY SHALE, 75-85 FEET
LS/ SH	VARIEGATED LIGHT GREEN AND DARK RED LIMESTONE WITH INTERBEDDED REDDISH-BROWN SHALE
SH	REDDSIH-ORANGE SHALE, MODERATELY FIRM
LS	LIGHT BROWN LIMESTONE, BLOCKY, DENSE
SS	LIGHT GREENISH-GRAY, MEDIUM TO FINE SANDSTONE, LOOSE, SOME CLAY
	GRADES PINK AND COARSE TO MEDIUM
SH	REDDISH-PURPLE SHALE, MODERATELY FIRM

BORING COMPLETED AT 129.0 FEET ON 10/16/81.
WATER TABLE NOT MEASURED.

SCREENED INTERVAL

DAMES & MOORE

PLATE 4C

MONITORING WELL MW-4

SURFACE ELEVATION: 6883 FEET
(Unsurveyed)

LABORATORY TEST DATA

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	BLOWS/FT. SAMPLES
0										
10										
20										
30										
40										
50										
60										
70										
80										
90										
100										
110										
120										
130										
140										
150										
160										

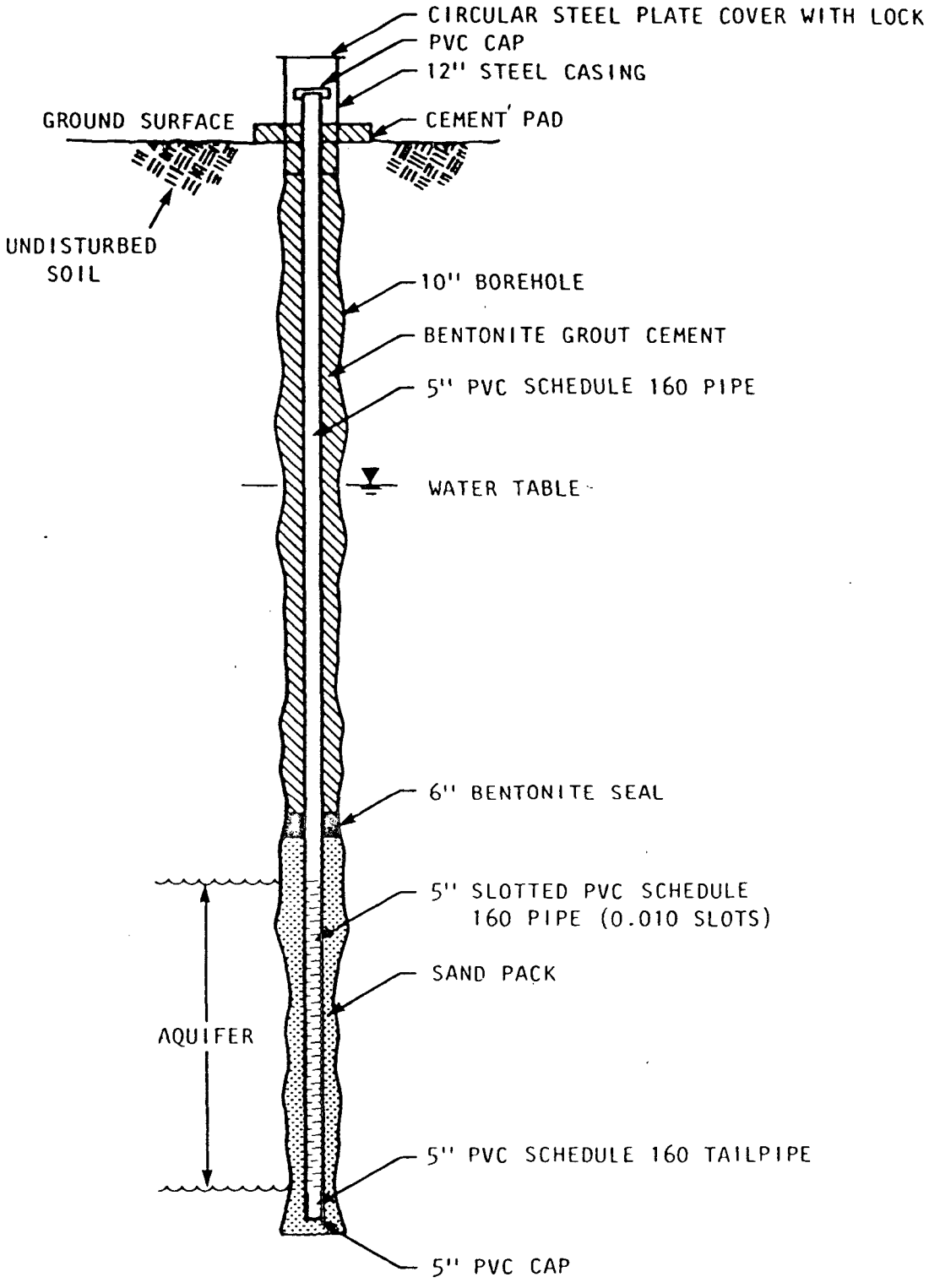
SYMBOLS	DESCRIPTION
CL	REDDISH-BROWN SILTY CLAY, LOOSE
CL	REDDISH-BROWN CLAY, FIRM WATER LEVEL 8.7 FEET B.G. 10/18/81 GRADES SILTY AND SANDY (COARSE) 20-25 FEET
SH	VARIEGATED REDDISH-BROWN, GREEN AND LIGHT PURPLE SILTY SHALE GRADES REDDISH-BROWN TO RED-ORANGE, 65-70 FEET
SH/LS	VARIEGATED LIGHT GREEN TO DARK RED SHALE AND THIN LIMESTONE BED
SH	REDDISH-ORANGE, SLIGHTLY SANDY SHALE
SS	WHITE TO LIGHT GRAY, CLAYEY SANDSTONE
SH	PURPLE SANDY SHALE
SS	WHITE TO LIGHT GRAY SANDSTONE, HARD
SH	PURPLE SHALE WITH THIN LENSES OF CLAYEY SAND

BORING COMPLETED AT 120.0 FEET ON 10/16/81.

SCREENED INTERVAL

DAMES & MOORE

PLATE 4D



PREPARED FOR **Shell Oil Co.**

MONITORING WELL CONSTRUCTION DETAILS

BY **Dames & Moore** Plate 5

APPENDIX A

RCRA HAZARDOUS WASTE REGULATIONS

PART 265 - SUBPART F

GROUND-WATER MONITORING

percent in weight and (2) for batch waste, any variation in piece count, such as a discrepancy of one drum in a truckload. Significant discrepancies in type are obvious differences which can be discovered by inspection or waste analysis, such as waste solvent substituted for waste acid, or toxic constituents not reported on the manifest or shipping paper.

(b) Upon discovering a significant discrepancy, the owner or operator must attempt to reconcile the discrepancy with the waste generator or transporter (e.g., with telephone conversations). If the discrepancy is not resolved within 15 days after receiving the waste, the owner or operator must immediately submit to the Regional Administrator a letter describing the discrepancy and attempts to reconcile it, and a copy of the manifest or shipping paper at issue.

§ 265.73 Operating record.

(a) The owner or operator must keep a written operating record at his facility.

(b) The following information must be recorded, as it becomes available, and maintained in the operating record until closure of the facility:

(1) A description and the quantity of each hazardous waste received, and the method(s) and date(s) of its treatment, storage, or disposal at the facility as required by Appendix I;

(2) The location of each hazardous waste within the facility and the quantity at each location. For disposal facilities, the location and quantity of each hazardous waste must be recorded on a map or diagram of each cell or disposal area. For all facilities, this information must include cross-references to specific manifest document numbers, if the waste was accompanied by a manifest;

[*Comment:* See §§ 265.119, 265.279, and 265.309 for related requirements.]

(3) Records and results of waste analyses and trial tests performed as specified in §§ 265.13, 265.193, 265.225, 265.252, 265.273, 265.345, 265.375, and 265.402;

(4) Summary reports and details of all incidents that require implementing the contingency plan as specified in § 265.56(j);

(5) Records and results of inspections as required by § 265.15(d) (except these data need be kept only three years);

(6) Monitoring, testing, or analytical data where required by §§ 265.90, 265.94, 265.276, 265.278, 265.280(d)(1), 265.347, and 265.377; and,

[*Comment:* As required by § 265.94, monitoring data at disposal facilities must be kept throughout the post-closure period.]

(7) All closure cost estimates under § 265.142 and, for disposal facilities, all post-closure cost estimates under § 265.144.

§ 265.74 Availability, retention, and disposition of records.

(a) All records, including plans, required under this Part must be furnished upon request and made available at all reasonable times for inspection by any officer, employee, or representative of EPA who is duly designated by the Administrator.

(b) The retention period for all records required under this Part is extended automatically during the course of any unresolved enforcement action regarding the facility or as requested by the Administrator.

(c) A copy of records of waste disposal locations and quantities under § 265.73(b)(2) must be submitted to the Regional Administrator and local land authority upon closure of the facility (see § 265.119).

§ 265.75 Annual report.

The owner or operator must prepare and submit a single copy of an annual report to the Regional Administrator by March 1 of each year. The report form and instructions in Appendix II must be used for this report. The annual report must cover facility activities during the previous calendar year and must include the following information:

(a) The EPA identification number, name, and address of the facility;

(b) The calendar year covered by the report;

(c) For off-site facilities, the EPA identification number of each hazardous waste generator from which the facility received a hazardous waste during the year; for imported shipments, the report must give the name and address of the foreign generator;

(d) A description and the quantity of each hazardous waste the facility received during the year. For off-site facilities, this information must be listed by EPA identification number of each generator;

(e) The method of treatment, storage, or disposal for each hazardous waste;

(f) Monitoring data under § 265.94(a)(2)(ii) and (iii), and (b)(2), where required;

(g) The most recent closure cost estimate under § 265.142, and, for disposal facilities, the most recent post-closure cost estimate under § 265.144; and

(h) The certification signed by the owner or operator of the facility or his authorized representative.

§ 265.76 Unmanifested waste report.

If a facility accepts for treatment, storage, or disposal any hazardous waste from an off-site source without an accompanying manifest, or without an accompanying shipping paper as described in § 263.20(e)(2) of this Chapter, and if the waste is not excluded from the manifest requirement by § 261.5 of this Chapter, then the owner or operator must prepare and submit a single copy of a report to the Regional Administrator within 15 days after receiving the waste. The report form and instructions in Appendix II must be used for this report. The report must include the following information:

(a) The EPA identification number, name, and address of the facility;

(b) The date the facility received the waste;

(c) The EPA identification number, name, and address of the generator and the transporter, if available;

(d) A description and the quantity of each unmanifested hazardous waste the facility received;

(e) The method of treatment, storage, or disposal for each hazardous waste;

(f) The certification signed by the owner or operator of the facility or his authorized representative; and

(g) A brief explanation of why the waste was unmanifested, if known.

[*Comment:* Small quantities of hazardous waste are excluded from regulation under this Part and do not require a manifest. Where a facility receives unmanifested hazardous wastes, the Agency suggests that the owner or operator obtain from each generator a certification that the waste qualifies for exclusion. Otherwise, the Agency suggests that the owner or operator file an unmanifested waste report for the hazardous waste movement.]

§ 265.77 Additional reports.

In addition to submitting the annual report and unmanifested waste reports described in §§ 265.75 and 265.76, the owner or operator must also report to the Regional Administrator:

(a) Releases, fires, and explosions as specified in § 265.56(j);

(b) Ground-water contamination and monitoring data as specified in §§ 265.93 and 265.94; and

(c) Facility closure as specified in § 265.115.

§§ 265.78–265.89 [Reserved]

Subpart F—Ground-Water Monitoring

§ 265.90 Applicability.

(a) Within one year after the effective date of these regulations, the owner or

operator of a surface impoundment, landfill or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as § 265.1 and paragraph (c) of this Section provide otherwise.

(b) Except as paragraphs (c) and (d) of this Section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of § 265.91, and must comply with §§ 265.92–265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.

(c) All or part of the ground-water monitoring requirements of this Subpart may be waived if the owner or operator can demonstrate that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells (domestic, industrial, or agricultural) or to surface water. This demonstration must be in writing, and must be kept at the facility. This demonstration must be certified by a qualified geologist or geotechnical engineer and must establish the following:

(1) The potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifer, by an evaluation of:

(i) A water balance of precipitation, evapotranspiration, runoff, and infiltration; and

(ii) Unsaturated zone characteristics (i.e., geologic materials, physical properties, and depth to ground water); and

(2) The potential for hazardous waste or hazardous waste constituents which enter the uppermost aquifer to migrate to a water supply well or surface water, by an evaluation of:

(i) Saturated zone characteristics (i.e., geologic materials, physical properties, and rate of ground-water flow); and

(ii) The proximity of the facility to water supply wells or surface water.

(d) If an owner or operator assumes (or knows) that ground-water monitoring of indicator parameters in accordance with §§265.91 and 265.92 would show statistically significant increases (or decreases in the case of pH) when evaluated under § 265.93(b), he may install, operate, and maintain an alternate ground-water monitoring system (other than the one described in §§ 265.91 and 265.92). If the owner or operator decides to use an alternate ground-water monitoring system he must:

(1) Within one year after the effective date of these regulations, submit to the Regional Administrator a specific plan, certified by a qualified geologist or geotechnical engineer, which satisfies the requirements of § 265.93(d)(3), for an alternate ground-water monitoring system;

(2) Not later than one year after the effective date of these regulations, initiate the determinations specified in § 265.93(d)(4);

(3) Prepare and submit a written report in accordance with § 265.93(d)(5);

(4) Continue to make the determinations specified in § 265.93(d)(4) on a quarterly basis until final closure of the facility; and

(5) Comply with the recordkeeping and reporting requirements in § 265.94(b).

§ 265.91 Ground-water monitoring system.

(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:

(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:

(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and

(ii) Not affected by the facility; and

(2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.

(b) Separate monitoring systems for each waste management component of a facility are not required provided that provisions for sampling upgradient and downgradient water quality will detect any discharge from the waste management area.

(1) In the case of a facility consisting of only one surface impoundment, landfill, or land treatment area, the waste management area is described by the waste boundary (perimeter).

(2) In the case of a facility consisting of more than one surface impoundment, landfill, or land treatment area, the waste management area is described by an imaginary boundary line which circumscribes the several waste management components.

(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water.

§ 265.92 Sampling and analysis.

(a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for:

(1) Sample collection;

(2) Sample preservation and shipment;

(3) Analytical procedures; and

(4) Chain of custody control.

[*Comment:* See "Procedures Manual For Ground-water Monitoring At Solid Waste Disposal Facilities," EPA–530/SW–611, August 1977 and "Methods for Chemical Analysis of Water and Wastes," EPA–600/4–79–020, March 1979 for discussions of sampling and analysis procedures.]

(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:

(1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III.

(2) Parameters establishing ground-water quality:

(i) Chloride,

(ii) Iron,

(iii) Manganese,

(iv) Phenols,

(v) Sodium,

(vi) Sulfate.

[*Comment:* These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under § 265.93(d).]

(3) Parameters used as indicators of ground-water contamination:

(i) pH,

(ii) Specific Conductance,

(iii) Total Organic Carbon,

(iv) Total Organic Halogen.

(c)(1) For all monitoring wells, the owner or operator must establish initial

background concentrations or values of all parameters specified in paragraph (b) of this Section. He must do this quarterly for one year.

(2) For each of the indicator parameters specified in paragraph (b)(3) of this Section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.

(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:

(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this Section at least annually.

(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this Section at least semi-annually.

(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.

§ 265.93 Preparation, evaluation, and response.

(a) Within one year after the effective date of these regulations, the owner or operator must prepare an *outline* of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§ 265.91 and 265.92) capable of determining:

(1) Whether hazardous waste or hazardous waste constituents have entered the ground water;

(2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and

(3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.

(b) For each indicator parameter specified in § 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with § 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.

(c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this Section show a significant increase (or pH decrease), the owner or operator must submit this information in accordance with § 265.94(a)(2)(ii).

(2) If the comparisons for *downgradient* wells made under paragraph (b) of this Section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.

(d)(1) If the analyses performed under paragraph (c)(2) of this Section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the Regional Administrator—within seven days of the date of such confirmation—that the facility may be affecting ground-water quality.

(2) Within 15 days after the notification under paragraph (d)(1) of this Section, the owner or operator must develop and submit to the Regional Administrator a specific plan, based on the outline required under paragraph (a) of this Section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment program at the facility.

(3) The plan to be submitted under § 265.90(d)(1) or paragraph (d)(2) of this Section must specify:

(i) The number, location, and depth of wells;

(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;

(iii) Evaluation procedures, including any use of previously-gathered ground-water quality information; and

(iv) A schedule of implementation.

(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this Section, and, at a minimum, determine:

(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground water; and

(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground water.

(5) The owner or operator must make his first determination under paragraph (d)(4) of this Section as soon as technically feasible, and, within 15 days after that determination, submit to the Regional Administrator a written report containing an assessment of the ground-water quality.

(6) If the owners or operator determines, based on the results of the first determination under paragraph (d)(4) of this Section, that no hazardous waste or hazardous waste constituents from the facility have entered the ground water, then he may reinstate the indicator evaluation program described in § 265.92 and paragraph (b) of this Section. If the owner or operator reinstates the indicator evaluation program, he must so notify the Regional Administrator in the report submitted under paragraph (d)(5) of this Section.

(7) If the owner or operator determines, based on the first determination under paragraph (d)(4) of this Section, that hazardous waste or hazardous waste constituents from the facility have entered the ground water, then he:

(i) Must continue to make the determinations required under paragraph (d)(4) of this Section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or

(ii) May cease to make the determinations required under paragraph (d)(4) of this Section, if the ground-water quality assessment plan was implemented during the post-closure care period.

(e) Notwithstanding any other provision of this Subpart, any ground-water quality assessment to satisfy the requirements of § 265.93(d)(4) which is initiated prior to final closure of the facility must be completed and reported in accordance with § 265.93(d)(5).

(f) Unless the ground water is monitored to satisfy the requirements of § 265.93(d)(4), at least annually the owner or operator must evaluate the data on ground-water surface elevations obtained under § 265.92(e) to determine whether the requirements under § 265.91(a) for locating the monitoring wells continues to be satisfied. If the evaluation shows that § 265.91(a) is no longer satisfied, the owner or operator must immediately modify the number, location, or depth of the monitoring wells to bring the ground-water monitoring system into compliance with this requirement.

§ 265.94 Recordkeeping and reporting.

(a) Unless the ground water is monitored to satisfy the requirements of § 265.93(d)(4), the owner or operator must:

(1) Keep records of the analyses required in § 265.92(c) and (d), the associated ground-water surface elevations required in § 265.92(e), and

the evaluations required in § 265.93(b) throughout the active life of the facility, and, for disposal facilities, throughout the post-closure care period as well; and

(2) Report the following ground-water monitoring information to the Regional Administrator:

(i) During the first year when initial background concentrations are being established for the facility: concentrations or values of the parameters listed in § 265.92(b)(1) for each ground-water monitoring well within 15 days after completing each quarterly analysis. The owner or operator must separately identify for each monitoring well any parameters whose concentration or value has been found to exceed the maximum contaminant levels listed in Appendix III.

(ii) Annually: concentrations or values of the parameters listed in § 265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under § 265.93(b). The owner or operator must separately identify any significant differences from initial background found in the upgradient wells, in accordance with § 265.93(c)(1). During the active life of the facility, this information must be submitted as part of the annual report required under § 265.75.

(iii) As a part of the annual report required under § 265.75: results of the evaluation of ground-water surface elevations under § 265.93(f), and a description of the response to that evaluation, where applicable.

(b) If the ground water is monitored to satisfy the requirements of § 265.93(d)(4), the owner or operator must:

(1) Keep records of the analyses and evaluations specified in the plan which satisfies the requirements of § 265.93(d)(3), throughout the active life of the facility, and, for disposal facilities, throughout the post-closure care period as well; and

(2) Annually, until final closure of the facility, submit to the Regional Administrator a report containing the results of his ground-water quality assessment program which includes, but is not limited to, the calculated (or measured) rate of migration of hazardous waste or hazardous waste constituents in the ground water during the reporting period. This report must be submitted as part of the annual report required under § 265.75.

§§ 265.95–265.109 [Reserved]

Subpart G—Closure and Post-Closure

§ 265.110 Applicability.

Except as § 265.1 provides otherwise:

(a) Sections 265.111–265.115 (which concern closure) apply to the owners and operators of all hazardous waste facilities; and

(b) Sections 265.117–265.120 (which concern post-closure care) apply to the owners and operators of all disposal facilities.

§ 265.111 Closure performance standard.

The owner or operator must close his facility in a manner that: (a) minimizes the need for further maintenance, and (b) controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground water, or surface waters, or to the atmosphere.

§ 265.112 Closure plan; amendment of plan.

(a) On the effective date of these regulations, the owner or operator must have a written closure plan. He must keep this plan at the facility. This plan must identify the steps necessary to completely close the facility at any point during its intended life and at the end of its intended life. The closure plan must include, at least:

(1) A description of how and when the facility will be partially closed, if applicable, and ultimately closed. The description must identify the maximum extent of the operation which will be be unclosed during the life of the facility, and how the requirements of § 265.111 and the applicable closure requirements of §§ 265.197, 265.228, 265.280, 265.310, 265.351, 265.381, and 265.404 will be met;

(2) An estimate of the maximum inventory of wastes in storage or in treatment at any given time during the life of the facility;

(3) A description of the steps needed to decontaminate facility equipment during closure; and

(4) A schedule for final closure which must include, as a minimum, the anticipated date when wastes will no longer be received, the date when completion of final closure is anticipated, and intervening milestone dates which will allow tracking of the progress of closure. (For example, the expected date for completing treatment or disposal of waste inventory must be included, as must the planned date for removing any residual wastes from storage facilities and treatment processes.)

(b) The owner or operator may amend his closure plan at any time during the active life of the facility. (The active life of the facility is that period during which wastes are periodically received.) The owner or operator must amend his plan any time changes in operating plans or facility design affect the closure plan.

(c) The owner or operator must submit his closure plan to the Regional Administrator at least 180 days before the date he expects to begin closure. The Regional Administrator will modify, approve, or disapprove the plan within 90 days of receipt and after providing the owner or operator and the affected public (through a newspaper notice) the opportunity to submit written comments. If an owner or operator plans to begin closure within 180 days after the effective date of these regulations, he must submit the necessary plans on the effective date of these regulations.

§ 265.113 Time allowed for closure.

(a) Within 90 days after receiving the final volume of hazardous wastes, the owner or operator must treat all hazardous wastes in storage or in treatment, or remove them from the site, or dispose of them on-site, in accordance with the approved closure plan.

(b) The owner or operator must complete closure activities in accordance with the approved closure plan and within six months after receiving the final volume of wastes. The Regional Administrator may approve a longer closure period under § 265.112(c) if the owner or operator can demonstrate that: (1) the required or planned closure activities will, of necessity, take him longer than six months to complete, and (2) that he has taken all steps to eliminate any significant threat to human health and the environment from the unclosed but inactive facility.

§ 265.114 Disposal or decontamination of equipment.

When closure is completed, all facility equipment and structures must have been properly disposed of, or decontaminated by removing all hazardous waste and residues.

§ 265.115 Certification of closure.

When closure is completed, the owner or operator must submit to the Regional Administrator certification both by the owner or operator and by an independent registered professional engineer that the facility has been closed in accordance with the

APPENDIX B

SAMPLING, CHAIN OF CUSTODY AND ANALYSIS RECORD

* * *

EXCERPT FROM "PROCEDURES MANUAL FOR GROUND-WATER MONITORING AT SOLID WASTE DISPOSAL FACILITIES"
EPA-530/SW-611, AUGUST 1977:
CHAPTER 6, PARAGRAPH 6.2.3, "CHAIN OF CUSTODY".

SAMPLING, CHAIN OF CUSTODY AND ANALYSIS RECORD
FOR RCRA GROUND WATER MONITORING PROGRAMS

Owner _____ Firm Responsible for Sampling _____

Address _____ Address _____

_____ _____

Attn: _____ Attn: _____

Job No. _____

Field Measurements

Well Identification _____ Temperature _____ Sampling Equipment _____

Casing Volumes Removed _____

Date of Sampling _____

ph _____

Time _____

Depth to Water _____ Conductance _____

Datum and Elevation _____ Comments _____

Ground Water Elevation _____ _____

Weather Conditions _____

Sample Preservation and Analyses

Check Samples Shipped	Ref. No.	Container	Preservative	Parameters for Analysis
_____	1	500 ml plastic	2.5 ml HNO_3 (Total Recoverable)	As, Ba, Cd, Cr, Pb, Hg, Ag, Se, Fe, Mn, Na
_____	2	1 liter plastic	Cool 4° C	F, Cl, SO_4, pH, SC
_____	3	250 ml plastic	0.25 ml H_2SO_4	NO_3, TOC
_____	4	1 liter glass	1 ml H_3PO_4, 1 g $CuSO_4$	Phenols
_____	5	1 liter glass	Cool, 4° C	Pesticides*, Herbicides**
_____	6	250 ml glass	Cool, 4° C, Sodium Thiosulfate	Coliform
_____	7	1 liter glass	1 ml HNO_3	Gross alpha, gross beta, radium-226, 228
_____	8	250 ml plastic	6.25 mg $NaSO_3$	TOX

(Circle parameters for analysis)

Shipping Information

Shipped or delivered to lab by _____

Date _____ Time _____

I hereby certify that to the best of my knowledge ground water samples listed above were obtained in accordance with _____'s (OWNER) filed sampling and analysis plan and are safely containerized and labeled for delivery to the laboratory.

Signature _____

RECEIVING LABORATORY _____

Address _____

Attn. _____

QUADRUPLICATE TESTS REQUIRED FOR:

[ ] TOC, TOX, pH, SC

_____ All samples received intact.

_____ List samples missing or damaged.

Date Received _____ Time _____

Accepted by _____

Distribution:

White - w/shipment to laboratory
Canary - to Dames & Moore P.M.
Pink - to Owner
Goldenrod - *retained by field engineer*

* Pesticides = Endrin, Lindane, Methoxychlor, Toxaphene

** Herbicides = 2,4-D and 2,4,5-TP Silvex
Bottle to be capped with aluminum foil or teflon

- sample temperature upon sampling;

- thermal preservation--(e.g., transportation in ice chest);

- analytical determinations (if any) performed in the field at the time of sampling and results obtained--(e.g., pH, temperature, dissolved oxygen, and specific conductance, etc.);

- analyst's identity and affiliation.

6.2.3 Chain of Custody

Proper chain of custody procedures play a crucial role in enforcement cases. The following are some basic guidelines which have legal significance:

- As few people as possible should handle the sample.

- Stream and ground-water samples should be obtained by using standard field sampling techniques as discussed in this manual.

- The chain of custody records should be attached to the sample container at the time the sample is collected, and should contain the following information: sample number, date and time taken, source of the sample (include type of sample and name of firm), the preservative and analysis required, name of person taking sample, and the name of witness. The prefilled side of the card should be signed, timed, and dated by the person sampling. The sample container should then be sealed, containing the regulatory agency's designation, date, and sampler's signature. The seal should cover the string or wire tie of the chain of custody record, so that the record or tag cannot be removed and the container cannot be opened without breaking the seal. The tags and seals should be filled out in legible handwriting. When transferring the possession of samples, the transferee should sign and record the date and time on the chain of custody record. Custody transfers, if made to a sample custodian in the field, should be recorded for each individual sample. To prevent undue proliferation of custody records, the number of custodians in the chain of possession should be as few as possible.

If samples are delivered to the laboratory when appropriate personnel are not there to receive them, the samples should be locked in a designated area within the laboratory so that no one can tamper with them.

- Blank samples should be collected in containers, with and without preservatives, so that the laboratory analysis can be performed to show that there was no container contamination.

- A field book or log should be used to record field measurements and other pertinent information necessary to refresh the sampler's memory in the event he later becomes a witness in an enforcement proceeding. A separate set of field notebooks should be maintained for each survey and stored in a safe place where they can be protected and accounted for at all times. A standard format should be established to minimize field entries and should include the types of information listed in Section 6.2.2. The entries should then be signed by the field sampler. The responsibility for preparing and retaining field notebooks during and after the survey should be assigned to a survey coordinator or his designated representative.

- The field sampler is responsible for the care and custody of the samples collected until properly dispatched to the receiving laboratory or turned over to an assigned custodian. He must assure that each container is in his physical possession or in his view at all times or stored in a locked place where no one can tamper with it.

- Photographs can be taken to set forth exactly where the particular samples were obtained. Written documentation on the back of the photograph should include the signature of the photographer, the time, date, and site location. Photographs of this nature, which may be used as evidence, should be handled according to the established chain of custody procedures.

- Each laboratory should have a sample custodian to maintain a permanent log book in which he records for each sample the person delivering the sample, the person receiving the sample, date and time received, source of sample, sample number, how transmitted to the lab, and a number assigned to each sample by the laboratory. A standardized

format should be established for log-book entries. The custodian should insure that heat-sensitive or light-sensitive samples or other sample materials having unusual physical characteristics or requiring special handling are properly stored and maintained. Distribution of samples to laboratory personnel who are to perform analyses should be made only by the custodian. The custodian should enter into the log the laboratory sample number, time, date, and the signature of the person to whom the samples were given. Laboratory personnel should examine the seal on the container prior to opening and should be prepared to testify that their examination of the container indicated that it had not been tampered with or opened.

6.3 SAMPLE CONTAINERS

For most samples and analytical parameters, either glass or plastic containers are satisfactory. Some exceptions are encountered such as the use of plastic for silica determinations and glass for phenols or oil and grease determination. Containers should be kept full until samples are analyzed to maintain anaerobic conditions.

As a general guide in choosing a sample container, the ideal material of construction should be non-reactive with the sample and especially the particular analytical parameter to be tested. Table 14 lists the recommended containers for various analyses.

Cleanliness of containers is of utmost importance. An effective procedure for cleaning containers is to wash with detergent, sequentially followed by: tap water rinse, nitric acid rinse, tap water rinse, hydrochloric acid rinse, tap water rinse, and finally a rinse with deionized or distilled water. In addition, the containers should be rinsed at least once with the sample at the time of sampling.

6.4 PRESERVATION OF SAMPLES AND SAMPLE VOLUME REQUIREMENTS

The following excerpt, including the tables, is a useful guide for sample preservation, sample volume requirements, and sample containers:[5]

> Complete and unequivocal preservation of samples, either domestic sewage, industrial wastes, or natural waters, is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent can never be achieved. At best, preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample