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START

Closure/Post-Closure Plan
300 Area Process Trenches

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FOREWORD

The U.S. Department of Energy, Richland Operations Office (DOE-RL) Part B Permit Application for the Hanford Site consists of separate permit applications for the following hazardous waste treatment, storage, and disposal units:

1. The Nonradioactive Dangerous Waste Landfill and Storage Facilities
2. Alkali Metal Treatment and Storage Facilities
3. Low-Level Burial Grounds and Retrievable Storage

In addition, the following hazardous waste units will be closed under interim status and have been described in a closure and/or post-closure plan:

1. The 300 Area Process Trenches (Closure/Post-Closure Plan)
2. Solar Evaporation Basins (Closure/Post-Closure Plan)
3. Solvent Evaporator (Closure Plan only)

Each separate permit application provides a complete description of hazardous waste management activities as is required in the Washington Administrative Code (WAC) 173-303-806 and Title 40 Code of Federal Regulations (CFR) Part 270 Subpart B. It is anticipated that each separate Part B will be reviewed individually and will undergo subsequent revisions prior to acceptance by the State of Washington Department of Ecology (WDOE) and the United States Environmental Protection Agency, Region X (EPA).

The following submittal contains the DOE-RL Closure/Post-Closure Plan for the 300 Area Process Trenches.

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1.0 PART A APPLICATION

1.1 INTRODUCTION

This Closure/Post-Closure Plan for the Hanford Site was prepared for the U.S. Department of Energy, Richland Operations Office (DOE-RL) for submittal to the State of Washington Department of Ecology (WDOE) and the U.S. Environmental Protection Agency, Region X (EPA) on November 8, 1985. It contains the proposed Closure Plan for the DOE-RL 300 Area Process Trenches.

1.2 PART A APPLICATION

The completed Part A application for the 300 Area Process Trenches is included in the following pages.

PART A

DANGEROUS WASTE PERMIT FORMS

(FORMS 1 and 3)

FORM 1

State of Washington Department of Ecology

WASHINGTON STATE

DANGEROUS WASTE PERMIT GENERAL INFORMATION

(Read "Form 1 Instructions" before starting)

I. EPA/STATE I.D. NUMBER: WA 7 8 9 0 0 0 8 9 6 7

II. NAME OF FACILITY

US DEPT OF ENERGY RICHLAND OPERATIONS OFFICE

III. FACILITY CONTACT

A. NAME & TITLE (last, first, & title): FITZSIMMONS, T. R. ASSISTANT MGR SAFETY*

B. PHONE (area code & no.): 509 376 7387

IV. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX: P.O. BOX 550

B. CITY OR TOWN: RICHLAND

C. STATE: WA

D. ZIP CODE: 99352

V. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER: HANFORD SITE

B. COUNTY NAME: BENTON

C. CITY OR TOWN: RICHLAND

D. STATE: WA

E. ZIP CODE: 99352

F. COUNTY CODE (if known): 005

VI. SIC CODES *(4-digit, in order of priority)*

A. FIRST: 9711 (specify) NATIONAL SECURITY

B. SECOND: 8922 (specify) NUCLEAR NONCOMMERCIAL RESEARCH DEVELOPMENT AND EDUCATION

C. THIRD: 9611 (specify) ADMINISTRATION AND GENERAL ECONOMICS PROGRAM

D. FOURTH: 4911 (specify) STEAM - ELECTRIC GENERATOR

VII. OPERATOR INFORMATION

A. NAME: US DEPT OF ENERGY RICHLAND OPERATIONS

B. Is the name listed in Item VII-A also the owner? [X] YES [ ] NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)
F = FEDERAL, S = STATE, P = PRIVATE, M = PUBLIC (other than federal or state), O = OTHER (specify)

F (specify)

D. PHONE (area code & no.): 509 376 7387

E. STREET OR P.O. BOX: PO BOX 550

F. CITY OR TOWN: RICHLAND

G. STATE: WA

H. ZIP CODE: 99352

VIII. INDIAN LAND

Is the facility located on Indian lands? [ ] YES [X] NO

COMPLETE BACK PAGE

*Office of Assistant Manager for Safety, Safeguards and Quality Assurance

ECY 030-31

SCL4 -979

IX. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids undergound. Include all springs, rivers and other surface water bodies in the map ares. See instructions for precise requirements.

X. NATURE OF BUSINESS *(provide a brief description)*

O NATIONAL DEFENSE NUCLEAR MATERIAL PRODUCTION

O ENERGY RESEARCH AND TECHNOLOGY DEVELOPMENT

O DEFENSE NUCLEAR WASTE MANAGEMENT

O BYPRODUCT STEAM, SOLD FOR ELECTRIC POWER GENERATION

O AND SIC 15: BUILDING CONSTRUCTION - GENERAL CONTRACTORS AND OPERATIVE BUILDERS

XI. CERTIFICATION *(see instructions)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
T.R. FITZSIMMONS, ASST. MANAGER		

FORM 3—INSTRUCTIONS

Completing This Form

Please type or print. If you print place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Section I

Existing dangerous waste management facilities should enter their EPA/STATE Identification Number *(if known)*. New facilities should leave this item blank.

Section II

A. FIRST APPLICATION. If this is the first application that is being filed for the facility place an "X" in either the Existing Facility box or the New Facility box.

1. EXISTING FACILITY. Existing facilities are:

a. Those facilities which received hazardous waste for treatment, storage, and/or disposal on or before November 19, 1980; or

b. Those facilities for which construction had commenced on or before November 15, 1980. Construction had "commenced" only if:

(1) The owner or operator had obtained all necessary Federal, State, and local preconstruction approvals or permits; **and**

(2-a) A continuous physical, on—site construction program had begun *(facility design or other preliminary non—physical and non—site specific preparatory activities do not constitute an on—site construction program)*, or

(2-b) The owner or operator had entered into contractual obligations *(options to purchase or contracts for feasibility, engineering, and design studies do not constitute contractual obligations)* which could not be cancelled or modified without substantial loss. Generally, a loss is deemed substantial if the amount an owner or operator must pay to cancel construction agreements or stop construction exceeds 10% of the total project cost.

EXISTING FACILITY DATE. If the Existing Facility box is marked, enter the date dangerous waste operations began *(i.e., the date the facility began treating, storing, or disposing of hazardous waste)* or the date construction commenced.

2. NEW FACILITY. New facilities are all facilities for which construction commenced, or will commence, after November 19, 1980.

NEW FACILITY DATE. If the New Facility box is marked, enter the date that operation began or is expected to begin.

B. REVISED APPLICATION. If this is a subsequent application that is being filed to amend data filed in a previous application, place an "X" in the appropriate box to indicate whether the facility has interim status or a permit.

1. FACILITY HAS AN INTERIM STATUS PERMIT. Place an "X" in this box if this is a revised application to make changes at a facility during the interim status period.

2. FACILITY HAS A FINAL PERMIT. Place an "X" in this box if this is a revised application to make changes at a facility for which a permit has been issued.

(NOTE: When submitting a revised application, applicants must resubmit in their entirety each item on the application for which changes are requested. In addition, Items I and IX [and Item X if applicable] must be completed. It is not necessary to resubmit information for other items that will not change).

Section III

The information in Section III describes all the processes that will be used to treat, store, or dispose of dangerous waste at the facility. The design capacity of each process must be provided as part of the description. The design capacity of injection wells and landfills at existing facilities should be measured as the remaining, unused capacity. See the form for the detailed instructions to Section III.

Section IV

The information in Section IV describes all the dangerous wastes that will be treated, stored, or disposed at the facility. In addition, the processes that will be used to treat, store, or dispose of each waste and the estimated annual quantity of each waste must be provided. See the form for the detailed instructions to Section IV.

Section V

All existing facilities must include a drawing showing the general layout of the facility. This drawing should be approximately to scale and fit in the space provided on the form. This drawing should show the following:

The property boundaries of the facility;

The areas occupied by all storage, treatment, or disposal operations that will be used during interim status;

The name of each operation. *(Example—multiple hearth incinerator, drum storage area, etc.);*

Areas of past storage, treatment, or disposal operations;

Areas of future storage, treatment, or disposal operations; and

The approximate dimensions of the property boundaries and all storage, treatment, and disposal areas.

Section VI

All existing facilities must include photographs that clearly delineate **all** existing structures; **all** existing areas for storing, treating, or disposing of hazardous waste; and **all** known sites of future storage, treatment, or disposal operations. Photographs may be color or black and white, ground-level or aerial. Indicate the date the photograph was taken on the back of each photograph.

Section VII

Enter the latitude and longitude of the facility in degrees, minutes, and seconds. For larger facilities, enter the latitude and longitude at the approximate mid-point of the facility. You may use the map you provided for Section IX of Form 1 to determine latitude and longitude. Latitude and longitude information is also available from Regional Offices of the U.S. Department of Interior, Geological Survey and from State agencies such as the Department of Natural Resources.

Section VIII

See the form for the instructions to Section VIII.

Section IX and Section X

All facility owners must sign Section IX. If the facility will be operated by someone other than the owner, then the operator must sign Section X. Federal regulations require the certification to be signed as follows:

A. For a corporation, by a principal executive officer at least the level of vice president;

B. For a partnership or sole proprietorship, by a general partner or the proprietor, respectively; or

C. For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.

Please print or type in the unshaded areas only
(fill—in areas are spaced for elite type, i.e., 12 characters/inch).

FORM **3**

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/STATE I.D. NUMBER

W	A	7	8	9	0	0	0	8	9	6	7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR
		7 5

FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

[ ] 2. NEW FACILITY *(Complete item below.)*

MO.	DAY	YR

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

[ ] 1. FACILITY HAS AN INTERIM STATUS PERMIT

[ ] 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES — CODES AND DESIGN CAPACITIES

A. PROCESS CODE — Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY — For each code entered in column A enter the capacity of the process.
1. AMOUNT — Enter the amount.
2. UNIT OF MEASURE — For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc.)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400* gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	D 8 4	3,000,000	G		7				
2					8				
3					9				
4					10				

CONTINUE ON REVERSE

Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

IV. DESCRIPTION OF DANGEROUS WASTES

A. **DANGEROUS WASTE NUMBER** — Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. **ESTIMATED ANNUAL QUANTITY** — For each **listed waste** entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste(s) that will be handled which possess that characteristic or contaminant.

C. **UNIT OF MEASURE** — For each quantity entered in column B enter the unit of meaaure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. **PROCESSES**

1. PROCESS CODES:

For listed dangerous waste: For each **listed** dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non—listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate **all** the processes that will be used to store, treat, and/or dispose of **all** the non—listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER — Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non—listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	included with above

Continued from page 2.
NOTE Photocopy this page before completing if you have more than 26 wastes to list

ID NUMBER (enter from page 1)
WA7890008967

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1		This unit does not			
2		currently and will			
3		not in the future			
4		accept discharges of			
5		regulated dangerous			
6		wastes. In the past,			
7		small quantities of			
8		laboratory, main-			
9		tenance and process			
10		waste were discharged			
11		into the 300 Area			
12		Process Trenches.			
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES *(continued)*

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

V. FACILITY DRAWING See Section V in the following pages

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS See Section VI in the following pages

All existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*
46 22 030	119 16 027

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
T.R. FITZSIMMONS, ASST. MANAGER		

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
T.R. FITZSIMMONS, ASST. MANAGER		

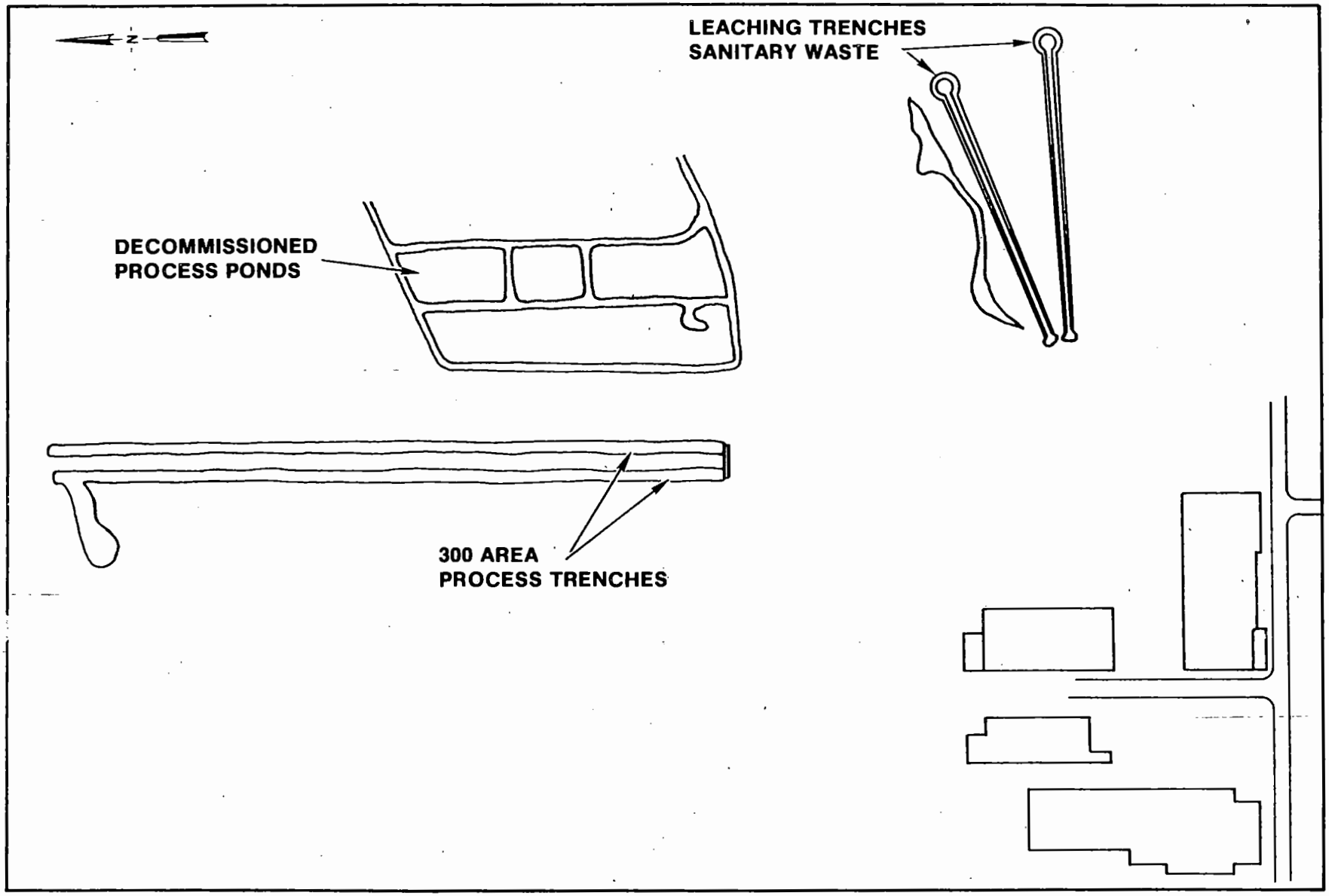
 CONTINUE ON PAGE 5

0 0 2 0 4 0 0 7 8 1 1 0 6

SECTION V - FACILITY DRAWINGS

90 1 7 8 4 0 0 2 1

300 AREA PROCESS TRENCHES



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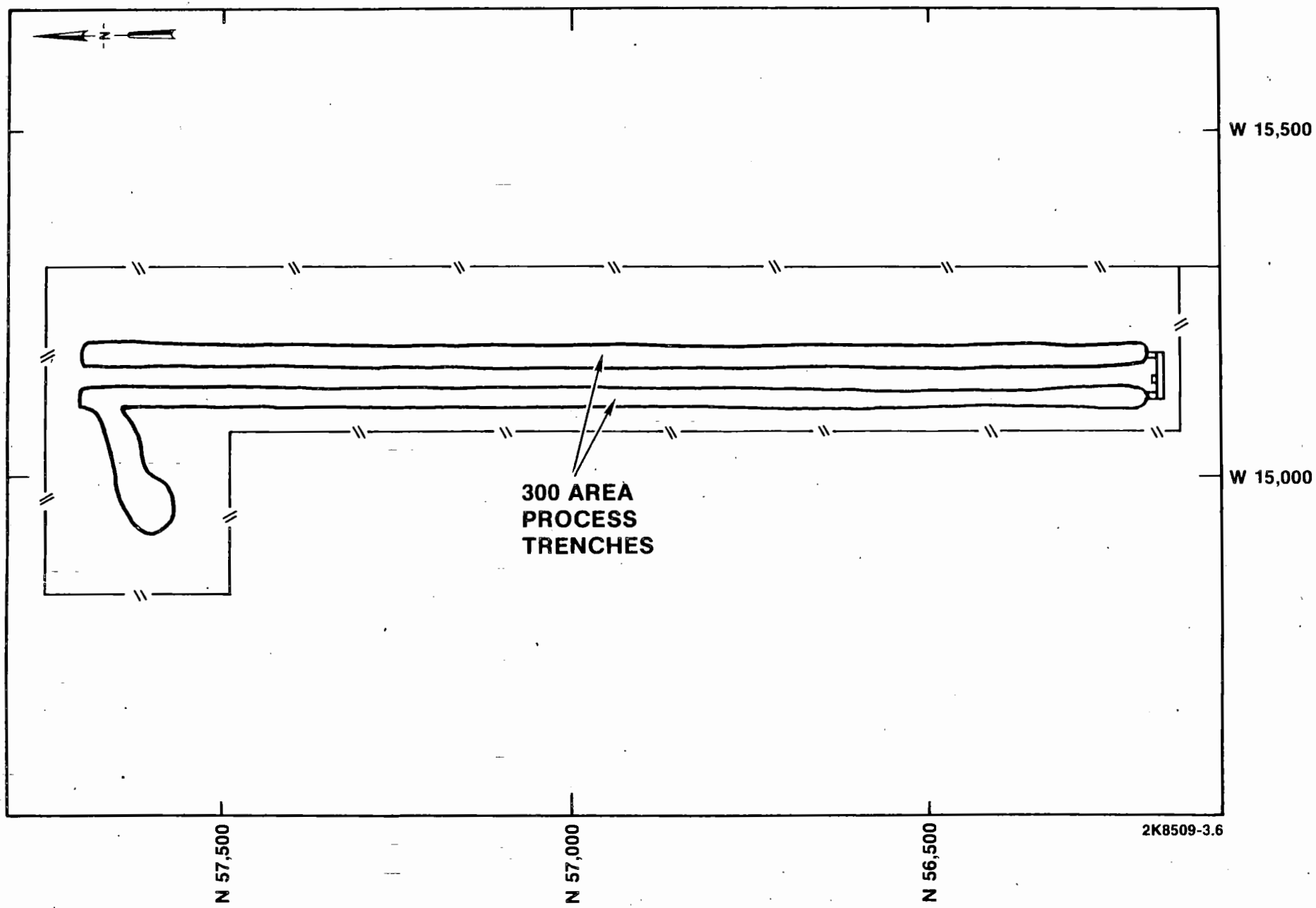
300 AREA PROCESS TRENCHES



WASHINGTON STATE
DANGEROUS WASTE PERMIT
GENERAL INFORMATION

Permit Application Process

There are two parts to a Dangerous Waste Permit Application—Part A and Part B. Part A consists of Form 1 and Form 3. Part B requires detailed site—specific information such as geologic, hydrologic, and engineering data. WAC 173-303-800 specifies the information that will be required from dangerous waste management facilities in Part B.

Operation During Interim Status

Part A of the permit application defines the processes to be used for treatment, storage, and disposal of dangerous wastes; the design capacity of such processes; and the specific dangerous wastes to be handled at a facility during the interim status period. Once Part A is submitted to the Department of Ecology, changes in the dangerous wastes handled, changes in design capacities, changes in processes, and changes in ownership or operational control at a facility during the interim status period may only be made in accordance with the procedures in WAC 173-303-820. Changes in quantity of waste handled at a facility during interim status can be made without submitting a revised Part A provided the quantity does not exceed the design capacities of the processes specified in Part A of the permit application. Failure to furnish all information required to process a permit application is grounds for termination of an interim status permit.

Confidential Information

All information submitted in this form will be subject to public disclosure, to the extent provided by RCRA and the Freedom of Information Act, 5 U.S.C. Section 552, and EPA's Business Confidentiality Regulations, 40 CFR Part 2 *(see especially 40 CFR 2.305)*, and will be subject to the State of Washington Public Records Act chapter 42.17 RCW and chapter 43.21A-160 RCW. Persons filing this form may make claims of confidentiality. Such claims must be clearly indicated by marking "confidential" on the specific information on the form for which confidential treatment is requested or on any attachments, and must be accompanied, at the time of filing, by a written substantiation of the claim, by answering the following questions:

Confidential Information (continued)

A. Which portions of the information do you claim are entitled to confidential treatment?

B. For how long is confidential treatment desired for this information?

C. What measures have you taken to guard against undesired disclosure of the information to others?

D. To what extent has the information been disclosed to others, and what precautions have been taken in connection with that disclosure?

E. Has the Department of Ecology, EPA or any other Federal or State agency made a pertinent confidentiality determination? If so, what would those harmful effects be and why should they be viewed as substantial? Explain the causal relationship between disclosure and the harmful effects.

If no claim of confidentiality or no substantiation accompanies the information when it is submitted, EPA or the department may make the information available to the public without further notice to the submitter.

Definitions

Terms used in these instructions and in this form are defined in the Definitions section of the Dangerous Waste Regulation, chapter 173-303 WAC.

ECY 030-31 INSTR.

FORM 1—INSTRUCTIONS

This form must be completed by all applicants.

Completing This Form

Please type or print. If you print, place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Section I

Space is provided at the upper right hand corner of Form 1 for insertion of your EPA/State identification number. If you have an existing facility, enter your identification number. If you don't have an EPA/State identification number, please contact the Department of Ecology (206) 459-6303 and one will be provided for you. If your facility is new (not yet constructed), leave this item blank.

Section II

Enter the facility's official or legal name. Do not use a colloquial name.

Section III

Give the name, title, and work telephone number of a person who is thoroughly familiar with the operation of the facility and with the facts reported in this application and who can be contacted if necessary.

Section IV

Give the complete mailing address of the office where correspondence should be sent. This often is not the address used to designate the location of the facility or activity.

Section V

Give the address or location of the facility identified in Section III of this form. If the facility lacks a street name or route number, give the most accurate alternative geographic information (e.g., section number or quarter section number from county records or at intersection of Rts. 425 and 22).

Section VI

List, in descending order of significance, the four 4-digit standard industrial classification (SIC) codes which best describe your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words. These classifications may differ from the SIC codes describing the operation generating the dangerous wastes.

SIC code numbers are descriptions which may be found in the "Standard Industrial Classification Manual" prepared by the Executive Office of the President, Office of Management and Budget, which is available from the Government Printing Office, Washington, D.C. Use the current edition of the manual. If you have any questions concerning the appropriate SIC code for your facility, contact your Department of Ecology Regional office (see Table 1).

Table 1. Department of Ecology Regional Offices

Northwest Regional Office 4350 - 150th NE Redmond, Washington 98052 Tel: 206-885-1900	Southwest Regional Office 7272 Cleanwater Lane Olympia, Washington 98504 Tel: 206-753-2353
Eastern Regional Office East 103 Indiana Spokane, Washington 99207 Tel: 509-456-2926	Central Regional Office 3601 West Washington Yakima, Washington 98903 Tel: 509-575-2490

Section VII-A

Give the name, as it is legally referred to, of the person, firm, public organization, or any other entity which operates the facility described in this application. This may or may not be the same name as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. Do not use a colloquial name.

Section VII-B

Indicate whether the entity which operates the facility also owns it by marking the appropriate box.

Section VII-C

Enter the appropriate letter to indicate the legal status of the operator of the facility. Indicate "public" for a facility solely owned by local government(s) such as a city, town, county, parish, etc.

Sections VII-D—H

Enter the telephone number and address of the operator identified in Item VII-A.

Section VIII

Indicate whether the facility is located on Indian lands.

Section IX

Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the facility which clearly show the following:

The legal boundaries of the facility;

The location and serial number of each of your existing and proposed intake and discharge structures;

All hazardous waste management facilities;

Each well where you inject fluids underground; and

All springs and surface water bodies in the area, plus all drinking water wells within ¼ mile of the facility which are identified in the public record or otherwise known to you.

If an intake or discharge structure, hazardous waste disposal site, or injection well associated with the facility is located more than one mile from the plant, include it on the map, if possible. If not, attach additional sheets describing the location of the structure, disposal site, or well, and identify the U.S. Geological Survey (or other) map corresponding to the location.

On each map, include the map scale, a meridian arrow showing north, and latitude and longitude at the nearest whole second. On all maps of rivers, show the direction of the current, and in tidal waters, show the directions of the ebb and flow tides. Use a 7-½ minute series map published by the U.S. Geological Survey, which may be obtained through the U.S. Geological Survey Offices listed below. If a 7-½ minute series map has not been published for your facility site, then you may use a 15 minute series map from the U.S. Geological Survey. If neither a 7-½ nor 15 minute series map has been published for your facility site, use a plat map or other appropriate map, including all the requested information; in this case, briefly describe land uses in the map area (e.g., residential, commercial).

You may trace your map from a geological survey chart, or other map meeting the above specifications. If you do, your map should bear a note showing the number or title of the map or chart it was traced from. Include the names of nearby towns, water bodies, and prominent points.

U.S.G.S. OFFICES	AREA SERVED
Western Mapping Center National Cartographic Information Center U.S.G.S. 345 Middlefield Road Menlo Park, Ca. 94025 Phone No. (415) 323-8111	Ariz., Calif., Hawaii, Idaho, Nev., Oreg., Wash., American Samoa, Guam, and trust Territories

Section X

Briefly describe the nature of your business (e.g., products produced or services provided).

Section XI

For a corporation, by a principal executive officer of at least the level of vice president.

For partnership or sole proprietorship, by a general partner or the proprietor, respectively; or

For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.

SECTION VI - PHOTOGRAPHS

90117840023

300 AREA PROCESS TRENCHES

46° 22' 30.195"
119° 16' 26.658"

PHOTO TAKEN 1985

9011784027

9 0 1 1 7 8 4 0 0 2 8

300 AREA PROCESS TRENCHES

46° 22′ 30.195″ N 119° 16′ 26.658″ W

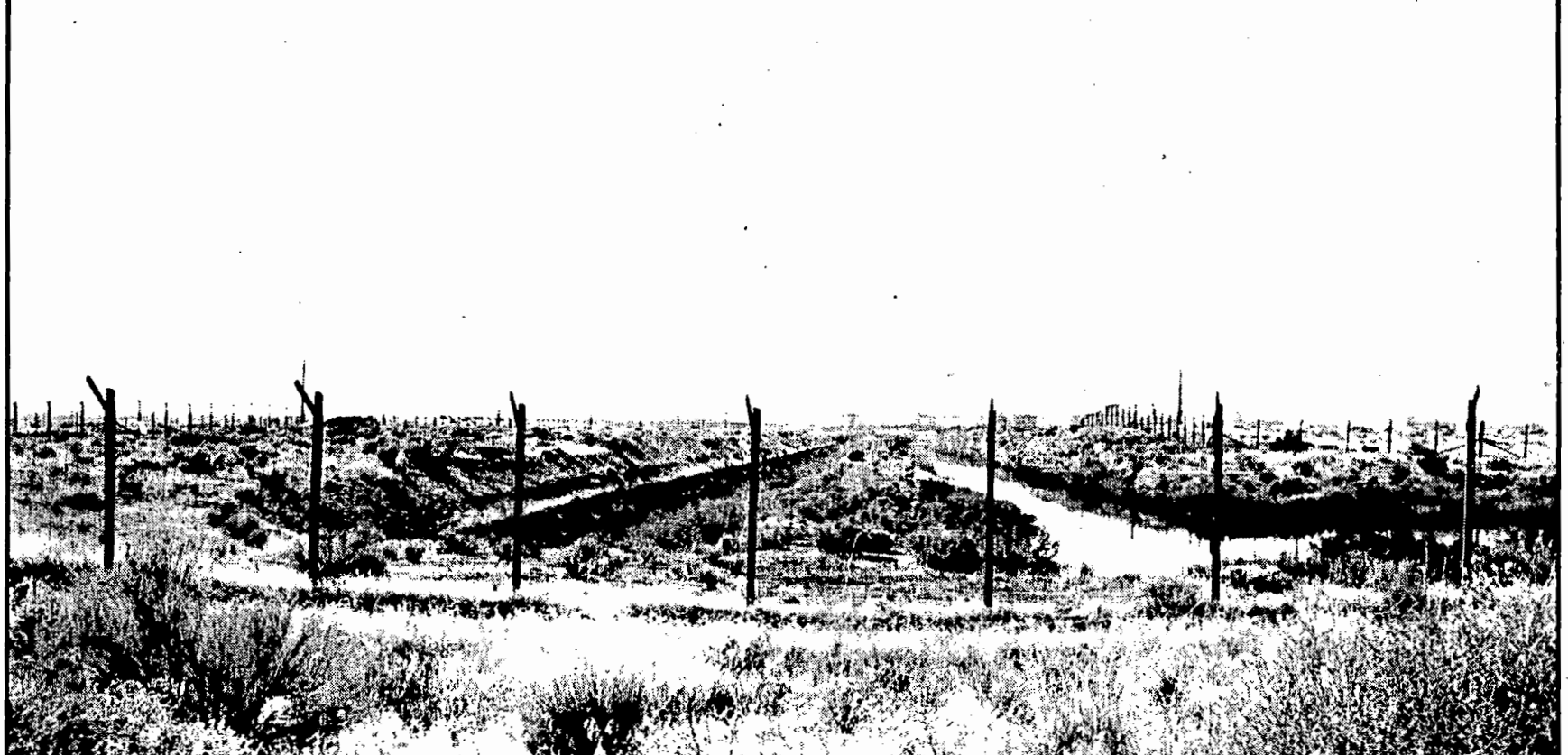


PHOTO TAKEN 1984

WA7890008967

2.0 FACILITY DESCRIPTION

This section provides a general description of the hazardous waste management facility as required by 40 CFR 270.14(b) and WAC 173-303-806(4)(a)i. This description is intended to acquaint the permit application reviewer/permit writer with an overview of the facility. More complete details can be found in other parts of this permit application and in the other permit application volumes.

The Hanford site is a 570 square mile tract of semiarid land which is owned and operated by the U.S. Department of Energy. The site is located primarily west and south of the section of the Columbia River immediately north of the city of Richland, Washington (Figure 2-1). In early 1943, the United States Army Corps of Engineers selected the Hanford Site as the location for reactor and chemical separation facilities for the production and purification of plutonium for possible use in nuclear weapons (Manhattan Project). A total of eight graphite-moderated reactors using Columbia River water for once-through cooling, and a new type of dual purpose reactor (N Reactor) using a recirculating water coolant and producing both plutonium and steam for electricity, were eventually built along the Columbia River. Today, only the N Reactor remains in operation.

Activities are centralized in numerically designated areas on the Hanford Site. The reactor facilities (active and decommissioned) are located along the Columbia River in what are known as the 100 Areas. The reactor fuel processing and waste management facilities are in the 200 Areas which are on a plateau about seven miles from the river. The 300 Area, just north of Richland, contains the reactor fuel manufacturing facilities and the research and development laboratories. The 400 Area, five miles northwest of the 300 Area, contains the Fast Flux Test Facility. The 1100 Area, north of Richland, contains facilities associated with maintenance and transportation functions for the Hanford Site. Administrative buildings and other research and development laboratories are found in the 3000 Area, north of Richland. The 600 Area, two miles southeast of the 200 East Area, contains the Nonradioactive Dangerous Waste Landfills.

This Part B volume consists of a Closure Plan for the 300 Area Process Trenches located north of the 300 Area outside the 300 Area perimeter fence. The 300 Area trenches include two 1500-foot-long leaching trenches used to dispose of cooling water and nonregulated aqueous wastes generated in the 300 Area.

The drawing in Appendix A is a general overview map of the entire Hanford site property and the surrounding countryside. This figure is intended as a location map and illustrates the following:

- The facility boundary which for purposes of the permit application is defined as those portions of the Hanford Site located within the perimeter security fences shown on the map.
- Surrounding land use including the Saddle Mountain National Wildlife Refuge and the State Game Reserve to the north and the Rattlesnake Mountain Ecological Reserve located to the west. Land east of the Site across the Columbia River is primarily farmland or a part of the Game Reserve. The surrounding land area is also shown on Figure 2-1.
- Contours sufficient to show surface water flow. Because of the large facility size, contours are 20 foot spacing.
- Locations of the various areas described in Section 2 of this document.
- Fire control facilities located on the Hanford Site.
- Locations of access roads, internal roads, railroads, and perimeter gates and barricades.
- Longitudes and Latitudes.

The 300 Area process trenches are located to the north of the 300 Area perimeter fence. A general layout of the 300 Area is shown on drawing No. H-3-53734 located in Appendix B. The location of the 300 Area trenches in relation to the 300 Area is shown in Figure 2-2, and the layout of the trenches and the enclosure fence is shown in Figure 2-3.

SURROUNDING LAND USE

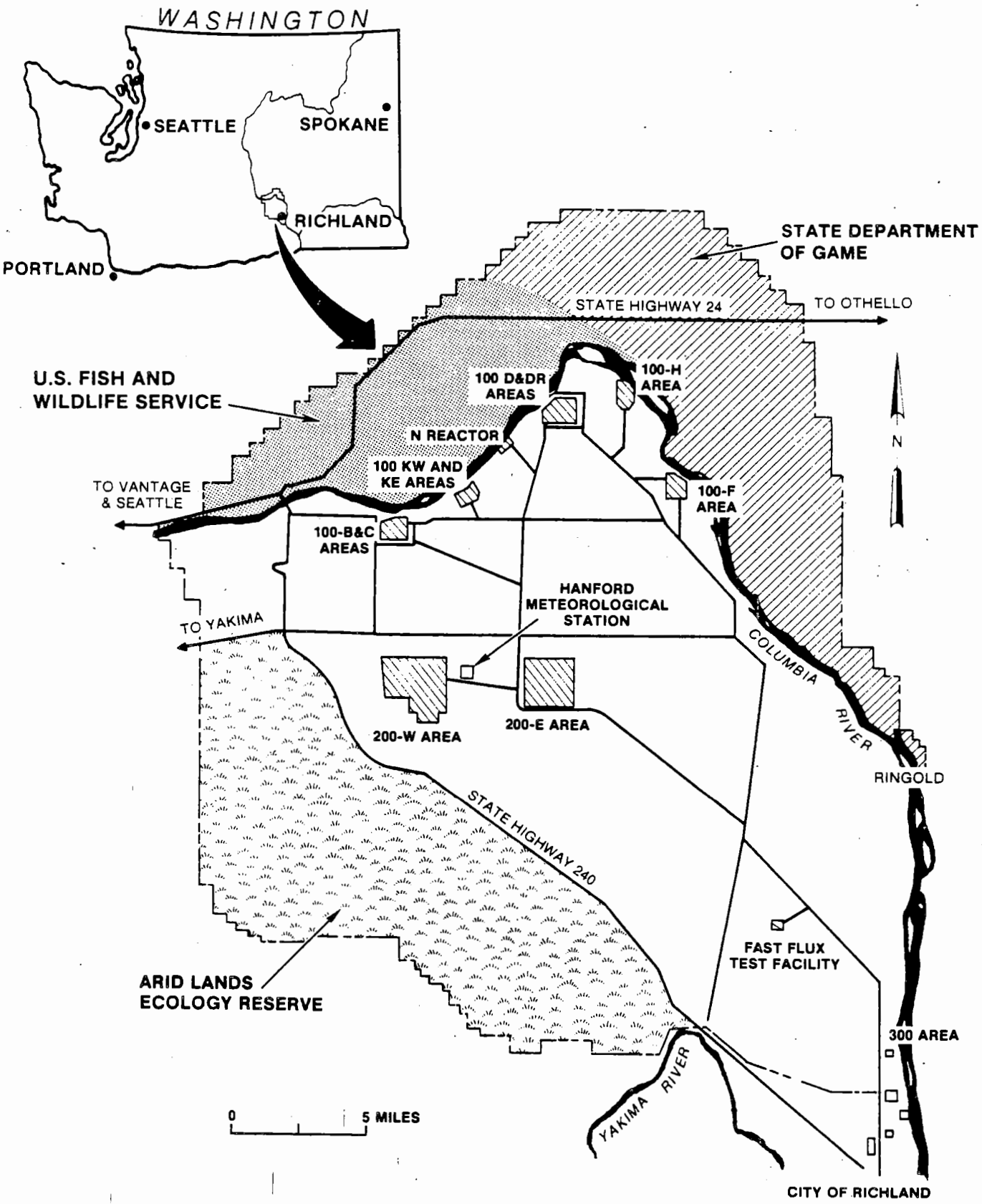


FIGURE 2-1. SURROUNDING LAND USE

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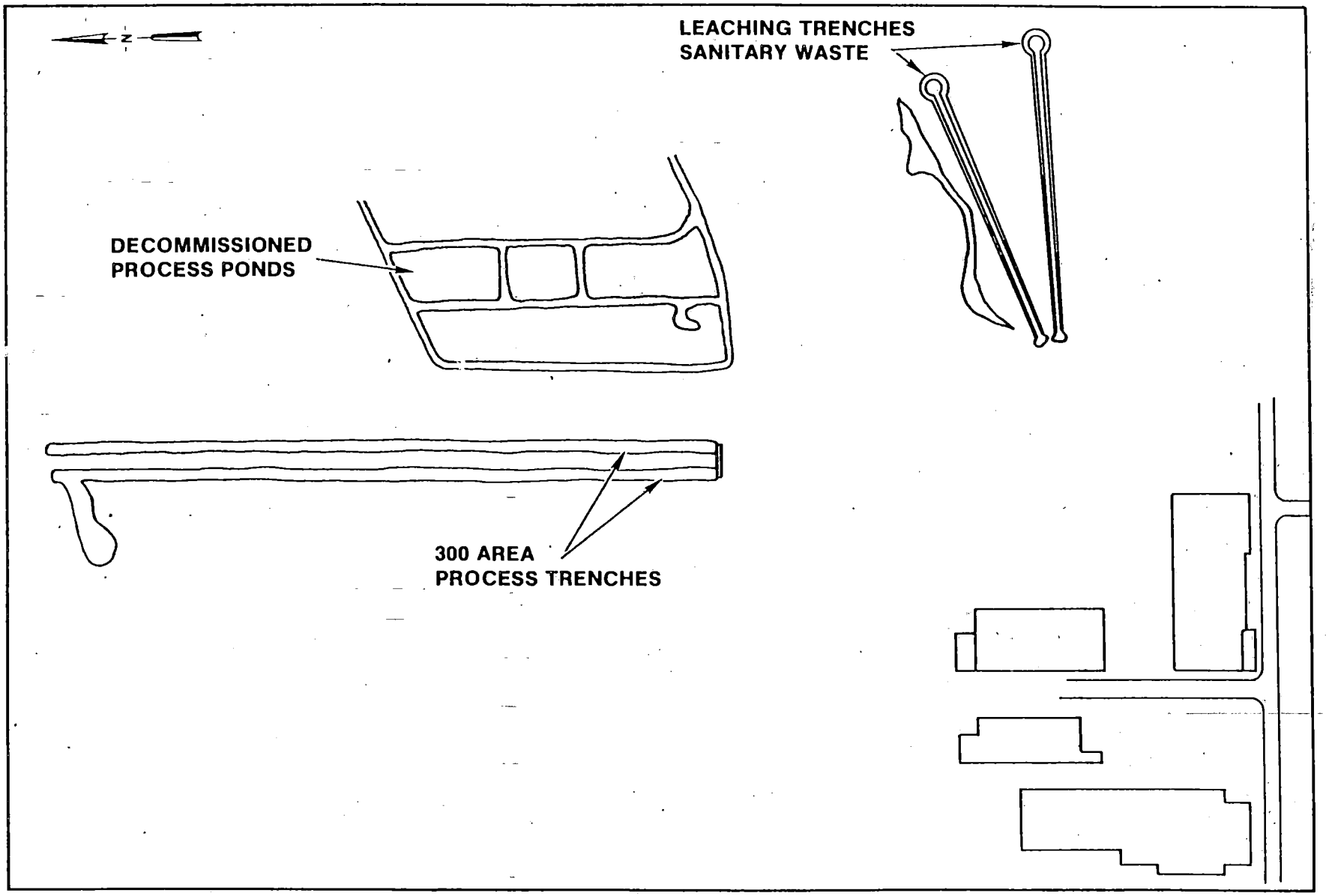
300 AREA PROCESS TRENCHES



2K8509-3.11

FIGURE 2-2. 300 AREA PROCESS TRENCHES

300 AREA PROCESS TRENCHES

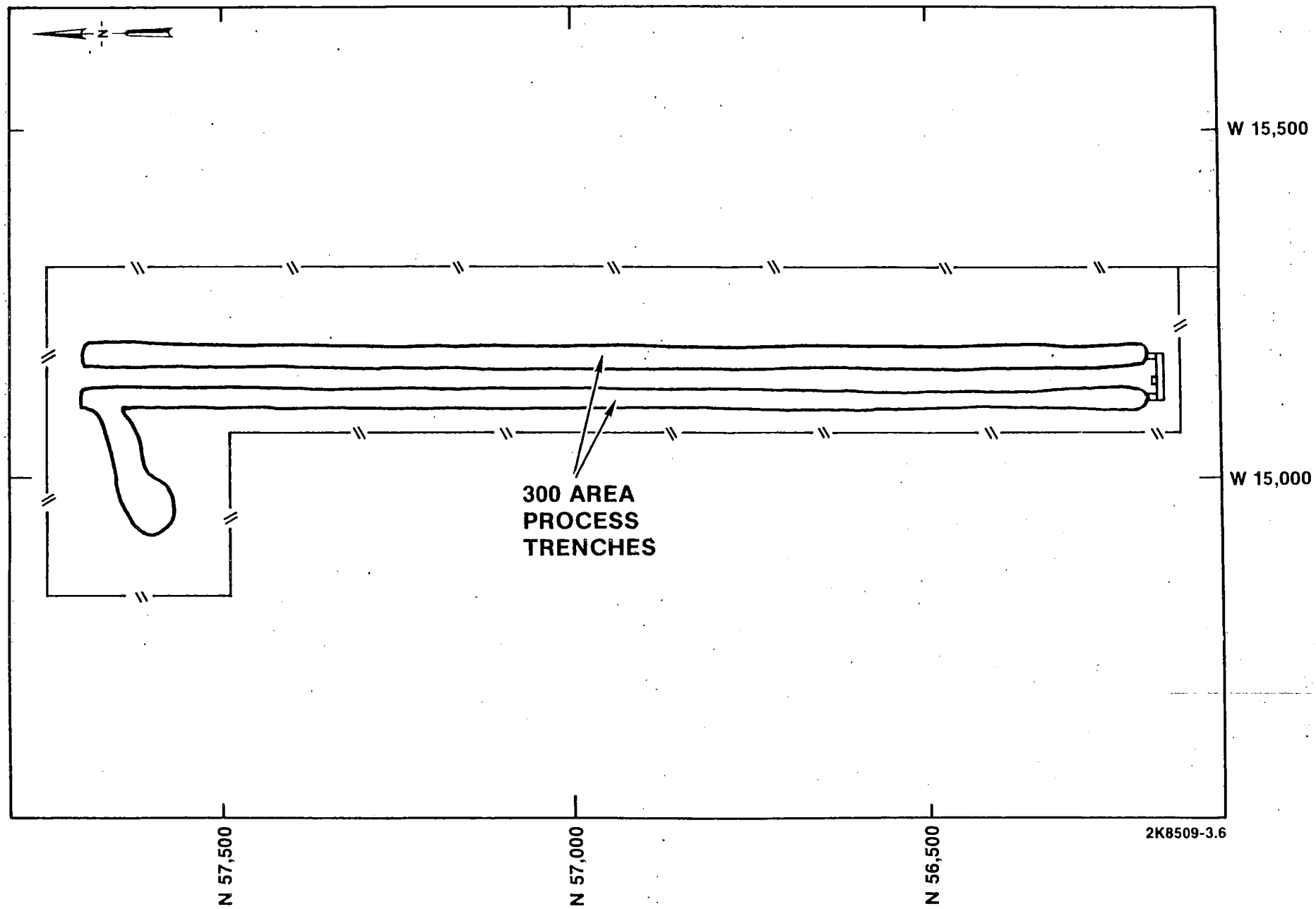


FIGURE 2-3. 300 AREA PROCESS TRENCHES WITH SECURITY FENCE

3.0 WASTE CHARACTERISTICS - 300 AREA PROCESS TRENCHES

This section describes the chemical and physical characteristics of the liquid wastes disposed of in the 300 Area Process Sewer system and the Retention Process system which discharge into one of two 1,500 foot long process trenches in the 300 Area. The process trenches receive liquid waste from all buildings of the Hanford 300 Area. Effluent process sewer flows are sampled by a composite sampler and measured by a weir and integrating flow recorder. Flow to the trenches averages approximately 2.5 million gallons per day.

Administrative steps were taken on February 1, 1985 to eliminate the disposal of any dangerous or hazardous wastes (as defined by Washington State and Federal regulations) to the Process Trenches. Prior to this, relatively small quantities of such wastes were disposed to the system. These are described below. Certain simple neutralization operations are permitted in order to discharge waste between the pH limits of 2 and 12.

The waste stream has always consisted primarily of water with small quantities of maintenance and process wastes. The primary sources of process and cooling water include nuclear fuel fabrication, operation of the 300 Area coal fired power plant, and various building maintenance and operation systems. Small quantities of cleaning agents and solvents entered the waste stream from these processes. Miscellaneous wastes from biological and chemical laboratories were also discharged to the process sewer. Since February 1, 1985, process trench influent consists only of cooling water, process water, and other non-sanitary waste which are not materials designated dangerous by RCRA State Regulations or the WHC Environmental Protection Manual, MG-99 (see Appendix C).

Administrative controls of the Process and Retention sewer systems prohibit direct disposal of oil or other immiscible organic liquids, (see Waste Management Manual, MG-75, Appendix D). Other administrative controls further direct that any hazardous organics, EPA classified Dangerous Wastes "DW" or extremely Hazardous Wastes "EHW", be disposed of only in an individual manner under the direction and supervision of HEDL's Waste Management Group, (see Manual MG-99,

Appendix C). Disposal of either DW or EHW liquid in either the retention or process sewer systems is forbidden. In addition to water, wastes are limited to a few potentially corrosive acids and bases which have been neutralized prior to discharge and some metallic elements and trace quantities of solvents. In the present operational and administrative mode, the influent to the 300 Area Process Trenches is not a hazardous or dangerous waste.

An analyses of the process trench liquid is made on a monthly basis. The sample analyzed is a composite of four to five weekly samples. These samples are taken for operational reasons but not specifically for regulatory compliance. The composite sample sent to the analytical laboratories from the trenches during July 1985, and analyzed the first part of August, is shown below:

TABLE 3-1

CHEMICAL ANALYSIS OF THE 300 AREA PROCESS TRENCH LIQUIDS

Liquid Waste Volume:	approx. 2.5 million gal. per day
pH	(7 to 9)
Total Organic Carbon (TOC):	0.005%
Uranium	0.051 ppm
Copper	0.082 ppm
Chromium	0.003 ppm
Fluoride	0.53 ppm
Chloride	10 ppm
Phosphate	0.8 ppm
Nitrate	18 ppm
Sulfate	15 ppm

The largest stream with potential contamination from Dangerous Wastes is N-Reactor fuel fabrication. The volume is about 4.1 million gallons per week compared to total of about 2.5 million gallons of liquid discharged to the trench per day. This stream meets the following discharge limits.

WEEKLY SAMPLING

Parameter	168-Hour Flow Weighted Average
Copper	2.0 ppm
Fluoride	4.0 ppm
Nitrate	200 ppm
Uranium	1.8 ppm
333 Building pH	3.0-9.0
313 Building pH	5.0-11.0

9 0 1 1 7 8 4 0 0 3 5

QUARTERLY SAMPLING

Parameter	168-Hour Flow Weighted Average
Silver	0.05 ppm
Cadmium	0.01 ppm
Chromium	0.5 ppm
Mercury	0.02 ppm
Manganese	0.05 ppm
Lead	0.05 ppm
Sulfate	250.0 ppm
Zinc	5.0 ppm
Nitrite	30.0 ppm

Parameter	Maximum Concentration
Oil and Grease	15.0 ppm
Perchloroethylene	0.20 ppm
1,1,1-Trichloroethane	0.20 ppm

The above analyses and limits indicate that the process trench influents are not a dangerous waste. Those materials which might in themselves be dangerous wastes are in concentrations below limits specified in state and federal regulations. The TOC is expected to be primarily from materials such as coal fines and other unregulated organic materials. Analyses are presently under way to determine the constituents making up the TOC.

4.0 PROCESS INFORMATION

The 300 Area Process Trenches are used to dispose of the cooling water and nonhazardous aqueous wastes generated in the 300 Area of the Hanford Site. The waste material is transported to the process trenches by the 300 Area process sewer system. Radioactive materials are not disposed of through the process trenches. The following is a general description of the process trenches and their operation.

The trenches are leaching trenches and dispose of the water by letting it drain away through the soil. There are two trenches, each of which is approximately 1500 feet long. The trenches vary between 10 and 12 feet from the bottom of the trench to grade. The trenches are located between the fenced area north of the 300 Area and are outside of the 300 Area perimeter fence. The layout and cross sections of the process trenches are shown in Figure 4-1. The Pond and Burial Grounds shown on this figure are retired.

The wastes collected by the process sewer system are transported to the process trenches by a 24-inch pipe which empties into the process sewer outlet structure at the south end of the process trenches. The outlet structure is concrete and is approximately 70 feet long by 10 feet wide by 9 feet high. The inlet from the 24-inch process sewer line is located in the middle of the structure and is three and one-half feet above the floor of the structure. Water from the process sewer flows toward both ends of the structure. At each end of the structure is an oil baffle and a sluice gate. The sluice gates allow selection of which trench the water will enter. The water flows through the sluice gate and down a concrete apron into the trench.

Estimates of past discharges are presented in Table 4-1. Since the process sewer serves many research and development laboratories in addition to building and process operations, practically any chemical may have been discharged to the trenches in laboratory quantities. The information in Table 4-1 was originally developed for the groundwater monitoring programs from 300 Area personnel experience and memory. The quantities are either based on known processes or are estimated reasonable maximums for the chemicals potentially discharged to the sewer. More information is available in Section 5.0 and in the Exposure Information Report.

TABLE 4-1

AN ESTIMATE OF CHEMICALS POTENTIALLY DISCHARGED TO THE 300 AREA PROCESS TRENCHES PRIOR TO FEBRUARY 1, 1985

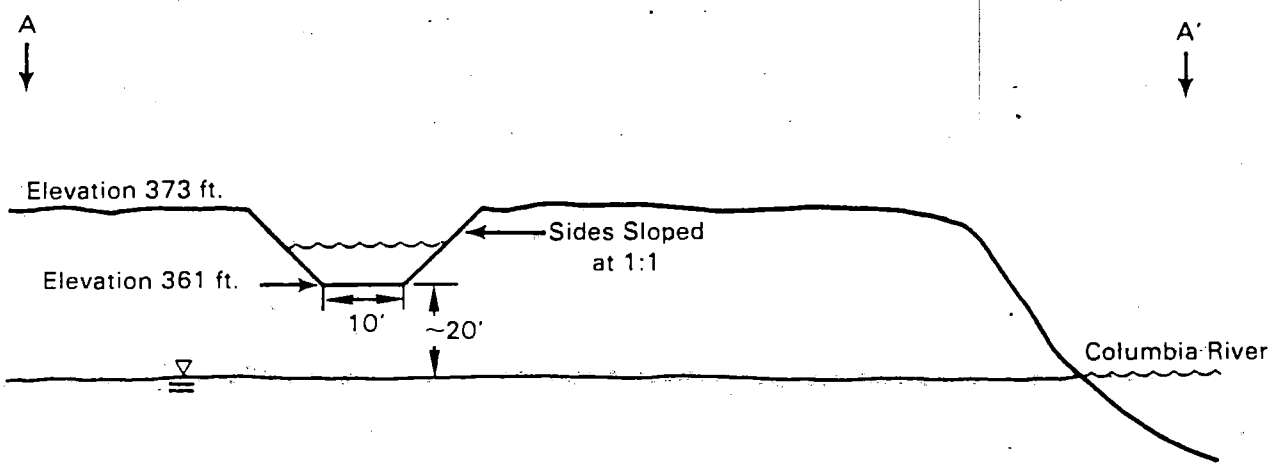
Intermittent Discharges		Later Discharges*	
<Grams	<kgs		
Ammonium Bifluoride	Benzene	Copper	~30 kg/mo**
Antimony	Carbon Tetrachloride	Detergents	≤30 kg/mo**
Arsenic	Chromium	Ethylene Glycol	≤200 l/mo
Barium	Chlorinated Benzenes	Hydrofluoric Acid	~100 kg/mo
Cadmium	Degreasing Solvents	Nitrates	≤2000 kg/mo**
Dioxane	Formaldehyde	Nitric Acid	≤300 l/mo
Dioxin†	Formic Ccid	Sodium Hydroxide	≤300 l/mo
Hydrocyanic Acid	Hexachlorophene	Paint Solvents	≤100 l/mo
Pyridine	Kerosene	Photo Chemicals	≤700 l/mo
Selenium & Compounds	Lead	Sodium Chloride	~75 ton/yr**
Thiourea	Methyl Ethyl Ketone	Uranium	~20 kg/mo**
Misc. Laboratory Chemicals	Mercury	Perchloroethylene	~450 l***
	Napthalene	Heating Oil	~300 l***
	Nickel	2-Butoxy Ethanol	1200 l/yr
	Phenol		
	Silver		
	Sulfuric Acid		
	Tetrachloroethylene (Perchloroethylene)		
	Toluene		
	Tributylphosphate (Paraffin Hydrocarbon Solvents)		
	1,1,1-Trichloroethane (Methyl Chloroform)		
	Trichloroethylene		
	Xylene		

†Included only because of the potential for Dioxin to exist as a trace impurity in Chlorinated Benzenes.

*These discharges were relatively continuous.

**These materials are still discharged.

***Known spills.



Water Table

Elevations are in feet
above mean sea level

Not to Scale

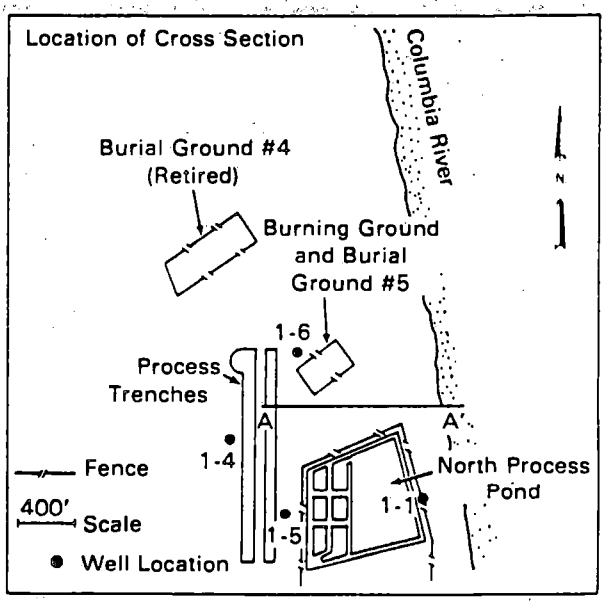


FIGURE 4-1. 300 AREA TRENCHES LAYOUT AND CROSS-SECTION

5.0 GROUNDWATER MONITORING

5.1 EXEMPTION FROM GROUNDWATER PROTECTION REQUIREMENTS

An exemption from the groundwater protection requirements is not being requested for this facility.

5.2 INTERIM STATUS MONITORING DATA

The interim status groundwater monitoring program for this facility was implemented in June of 1985. Because of previous groundwater monitoring data (see Section 5.4) which showed that dangerous waste constituents from the facility had entered the groundwater, an assessment program was developed instead of a detection program. A brief description of the interim status program is provided below; the complete, detailed plan for the program is contained in the Hazardous Waste Ground-Water Monitoring Plan (July 1985) presented as Appendix E.

The interim status monitoring network consists of 16 monitoring wells located in or near the 300 Area. Figure 5-1 shows the locations of the wells in the sampling network and also the general direction of groundwater flow. Two of the wells (399-8-2 and 699-S19-E13) are considered to be upgradient of the facility, although they may be within a zone affected by gradient reversals that occur when the river stage is high. (See Section 5.3 for a discussion of this phenomenon.) Analytical data being obtained under the interim status program will be used (along with water-table mapping) to determine if these wells are in an area affected by the facility. All of the other wells in the network (except 399-T-2) are open at the top of the aquifer. Well 399-T-2 is a deeper well which was recently installed to check a lower zone of the aquifer for the possible presence of solvents or other dense materials. Geologic logs and structural diagrams for all of the wells in the network are contained in Section 5.5a.

Sampling of the wells in the interim status network is being conducted on a monthly basis because they are close to the river. Previous studies conducted at the Hanford Site have shown that bank storage of river water causes seasonal fluctuations in concentrations of chemical constituents in wells near the river (Prater et al., 1984). Therefore, monthly sampling is considered

necessary for at least the first year of interim status monitoring. The sampling frequency will be reduced after sufficient information has been collected to define the seasonal variability.

The list of analyses for these samples was compiled on the basis of: (1) U.S. Environmental Protection Agency (EPA) guidance, and (2) information supplied by the facility manager. According to an EPA guidance document regarding assessment-level programs (EPA, undated draft), analyses must be conducted for constituents in Table 1 of Section 261.24 (Drinking Water parameters) and also for specific dangerous waste constituents known to have been discharged to the facility. Additional parameters, such as the contamination indicators, that are required for a detection-level program (but not for an assessment-level program) have recently been added for consistency with other interim status programs. Also, to provide information for this permit application and to check for other potential dangerous waste constituents, two wells at the facility (one upgradient well, 699-S19-E13, and one downgradient well, 399-1-5) are being analyzed for the dangerous waste constituents in WAC 173-303-9905, hereafter referred to as 9905. Table 5-1 contains the basic "assessment" list being performed on samples from all of the wells in the sampling network. The table also shows the minimum detectable concentrations and sizes of the sample containers. The list of additional 9905 parameters (being conducted on samples from wells 399-1-5 and 699-S19-E13) is contained in Table 5-2, along with the minimum detectable concentrations and sizes of the sample containers.

During the first three months of sampling, replicate samples were collected from five of the wells in the network, (except in June, when only four were replicated). The purpose of the replication was to provide information on sampling and analytical variability. Each of the replicates for a given well has received the same analyses. Future replication will be decided on the basis of information provided by the replicates that have been collected to date.

At this time, three sample sets have been collected (for June, July, and August), but the laboratory has only completed the analyses for the first set. Results for the chemical analyses conducted on the June sample set are shown in Tables 5-3 (metals), 5-4 (ions and contamination indicators), and 5-5

(volatile organics). Results of the radiological analyses for June are shown in Table 5-6. Because of the large number of analyses conducted (and the large number of parameters that were found to be less than the minimum detectable concentration in all samples), only the parameters that showed up as being present in one or more samples are listed on the tables. All other parameters were less than the minimum detectable concentrations and are listed in Tables 5-1 and 5-2. The results of Tables 5-3 through 5-6 have not yet been fully verified, because final quality control reports have not yet been submitted by the laboratory. These reports are expected to be delivered in late October or early November 1985, and, if necessary, Tables 5-3 through 5-6 will be revised and resubmitted at that time.

Tables 5-3 through 5-6 show data from only 14 of the 16 wells currently in the network, because 399-T-1 and 399-T-2 were not included in the network during the June sampling. Well 399-T-1 was added to the network in July. Pumps are currently being installed in well 399-T-2, so it should be ready for sampling by October.

Results for three specific volatile organics that were found to be present in some of the samples are not included in Table 5-5. The reason for omitting these three chemicals (1,1,1-trichloroethane, tetrachloroethene, and methylene chloride) is that the pump manufacturer has indicated that the pumps may be contaminating the samples with these chemicals. A letter explaining the problem is contained in Appendix F. To remedy the situation, the affected pumps will be removed and replaced with ones that are certified by the manufacturer to be clean.

Blank samples (containing deionized water) were taken into the field during sampling and were then delivered to the laboratory to be analyzed for volatile organics. One blank was taken into the field for each well to be sampled, and it was placed near the well during sample collection. All of the results for these blanks were less than detectable, except for 35 micrograms of trichloromethane found in the blank sample for well 399-1-6. Trichloromethane was not detected in the groundwater sample collected from well 399-1-6, but it was detected in groundwater samples from 399-2-1, 399-1-1, 399-1-2, 399-1-3, and 399-1-4. The source of the trichloromethane found in this blank sample has not yet been determined.

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Statistical evaluations, as described in 5.7h(7), have not yet been done on the interim status data because of the limited number of results presently available. Accordingly, very little can be said at this time about the analytical data in Tables 5-3 through 5-6, because they represent samples from only one month (taken in an area where seasonal variability in contaminant concentrations is known to exist). However, asterisks have been placed on Tables 5-3 through 5-6 to indicate results that are above the Primary Drinking Water Standards.

Additional interim status data will be made available as soon they are received from the laboratory. Current Plans call for making the first statistical evaluations in December 1985, after a computer tape containing analytical data for the first five months of the sampling is received from the laboratory. (Programming complications have delayed the laboratory's submittal of the computerized data, which, in the future, will be provided on a monthly basis.) The results of these first statistical evaluations will be available by April 1986. Further evaluations will be made as the interim status program continues, and a report containing the results for the first full year of sampling will be available by September 1986.

5.3 HYDROGEOLOGIC SETTING

As a preface to the discussion of the hydrogeologic properties of the formations underlying the facility, the total regional and local meteorologic, geologic, and hydrologic pictures are presented below. The description is provided so that the reader may understand the complex environmental framework and the physical factors that control migration of dangerous waste constituents from the solar evaporation basins.

5.3a Meteorological Conditions

Meteorological data are collected at a number of locations at the Hanford Site. Complete climatological data are available since 1945 for the Hanford Meteorological Station (HMS), located approximately five miles (eight kilometers) west of the 200 East Area. Temperature and precipitation data from a

nearby location are available for the period 1912 through 1943. A summary of these data, for the period through 1980, has been published by Stone et al. (1983).

Average monthly temperatures range from a low of 29.3 degrees F in January to a high of 76.4 degrees F in July. The maximum monthly average temperature at the HMS during the winter is 44.5 degrees F, and the minimum is 21.4 degrees F, both occurring during February. The maximum monthly average temperature during the summer is 81.8 degrees F in July, and the minimum is 63.0 degrees F in June. The annual average relative humidity at the HMS is 54 percent, with a maximum of about 75 percent during the winter months and a minimum of about 35 percent during the summer months.

Average annual precipitation at the Hanford Meteorological Station is 6.3 inches (16 centimeters). The months of November through February account for nearly one-half of the annual precipitation. Fewer than one percent of the days have rainfall greater than 0.5 inches (1.3 centimeters). Based on Hanford data, Stone et al. (1983) predicted that the maximum 24-hour rainfall event in a 100-year period would be 2.0 inches (5.0 centimeters). Total precipitation over the entire Pasco Basin is estimated at less than 8.0 inches (20 centimeters) annually. Mean annual runoff is generally less than 0.5 inches (1.3 centimeters) for most of the basin and the basin-wide runoff coefficient, for all practical purposes, is zero (Leonhart, 1979).

Average annual evaporation can exceed 60 inches (152 centimeters). Average annual lake evaporation ranges from approximately 39 to over 42 inches (99 to over 107 centimeters). Actual evapotranspiration for a 6-inch (15-centimeter) water-holding-capacity soil (uncultivated) is approximately 7.5 to 8.5 inches (19 to 22 centimeter) (Leonhart, 1979; Wallace, 1978). Studies by Last et al. (1976), Brown and Isaacson (1977), and Jones (1978) suggest nearly all percolated water was subsequently dispersed by evapotranspiration.

In summary, the Hanford climate is mild and dry with occasional periods of high winds. Summers are hot and dry; winters are less dry, but are relatively mild for this latitute. Average maximum temperatures occur in July, and average minimum temperatures occur in February. Average relative humidity is

lowest in the summer and highest in the winter. Average annual precipitation is about 6.3 inches (16 centimeters). The 100-year maximum predicted rainfall event in a 24-hour period is two inches (five centimeters). Potential evapotranspiration rates greatly exceed annual precipitation rates, but much of this precipitation is received between November and February when evapotranspiration rates are least. The highest monthly average winds occur during the hot summer, creating very high evaporative potentials.

5.3b Regional Geologic Setting

5.3b(1) Introduction

The Hanford Site in south-central Washington State is located in the Columbia Plateau Physiographic Province, which is generally defined by a thick accumulation of basaltic lava flows. These flows extend laterally from central Washington eastward into Idaho and southward into Oregon (Figure 5-2). Deformation of these lava flows has formed a series of broad structural and topographic basins. The Hanford Site is located in one of these basins, the Pasco Basin, at the confluence of the Yakima and Columbia Rivers.

The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills; on the south by a series of doubly plunging anticlines which merge with the Horse Heaven Hills; and on the east by a broad monocline, locally known as the Jackass Mountain Monocline (Figure 5-3). Very little topographic relief exists within the Pasco Basin.

The stratigraphy underlying the Pasco Basin is divided into six major units. They are, in general ascending order: (1) the basement rocks, (2) the Columbia River Basalt Group, (3) the Ellensburg Formation, (4) the Ringold Formation, (5) the early "Palouse" soil, and (6) the Hanford Formation. Alluvium, colluvium and eolian sediments locally veneer the surface of the Pasco Basin. These six units are described below.

5.3b(2) Basement Rocks

The basement rocks underlying the basaltic lava flows in the Pasco Basin are of uncertain composition. Pre-basalt rock types can be projected from the margins of the Columbia Plateau, 100 to 150 miles (160 to 240 kilometers) away, and are inferred to exist locally in the central plateau area, perhaps

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beneath the Pasco Basin. For example, data from the Basalt Explorer Well northeast of the Pasco Basin indicate that sandstones and shales comparable to the sedimentary rocks of the Cascade Range may lie beneath the Pasco Basin. Recent magnetotelluric surveys (BWIP, 1978) indicate a very deep conductive section, possibly representing these sediments. Beneath these sediments are probably granitic rocks comparable to those in the Okanogan Highlands; the Snoqualmie Pass area of the Cascade Range; the Moscow Basin, Idaho; the base of the Basalt Explorer Well; and parts of the core of the Blue Mountains, Oregon. There, granitic rocks were intruded into largely Paleozoic and early Mesozoic metavolcanic and metasedimentary rocks whose equivalents might also occur beneath the Pasco Basin.

5.3b(3) Columbia River Basalt Group

The regional geology surrounding the Pasco Basin is dominated by a tholeiitic flood basalt province in the Columbia Plateau and adjacent Blue Mountains of Washington, northern Oregon, and adjacent Idaho (Figure 5-2). The flood basalt province is a layered mass of more than 50,000 cubic miles (208,420 cubic kilometers) of basalt covering an area of more than 60,000 square miles (155,400 square kilometers). The flood basalts and associated rocks form a plano-convex lens. The upper surface of the lens slopes gently inward except where locally modified by fold systems (Figure 5-4). Basin deformation and the development of fold systems in the Columbia Plateau started between 16 and 13 million years before present and continued through Columbia River Basalt time (Bentley, 1977).

The basalts emanated from linear fissure systems in the eastern and southern portions of the Plateau (Swanson et al, 1975; Waters, 1961). Most of the basalt was emplaced during a three-million-year volcanic pulse between 16 and 13 million years before present during the Miocene Epoch (Baski and Watkins, 1973). However, sporadic fissure eruptions continued until about six million years before present (McKee et al., 1977).

The flood basalts are collectively designated the Columbia River Basalt Group, which has been subdivided into five formations (Figure 5-4) (Ledgerwood et al., 1978; Swanson et al., 1978). The lower two formations are the Imnaha Basalt (Hooper, 1974) and the Picture Gorge Basalt (Swanson et al., 1975).

The upper three formations, the Grande Ronde Basalt, the Wanapum Basalt, and the Saddle Mountains Basalt collectively constitute the Yakima Basalt Subgroup (Swanson et al., 1978).

In the Pasco Basin near the center of the area covered by the Columbia Plateau, the basalt sequence is more than 10,000 feet (3,048 meters) thick (Raymond and Tillson, 1968) and perhaps as much as 19,000 feet (5,791 meters) thick (BWIP, 1978). In the Basin, a 5,000 feet (1,524 meters) thick sequence of Columbia River Basalt apparently overlies a series of older basalt of Oligocene to Eocene age (Swanson et al., 1978). Approximately 100 basalt flows, including both Columbia River Basalt Group and older lavas have been identified from geophysical logs obtained from a 10,655 feet (3,248 meters) deep borehole located along the western margin of the Pasco Basin (Swanson et al., 1978).

5.3b(4) Ellensburg Formation

Within the upper part of the Columbia River Basalt sequence, sediments were transported into the central portion of the Columbia Plateau between basalt eruptions. These sediments, which include tuffs and tuffaceous sediments of many kinds in part now altered to clay, form the Ellensburg Formation (Swanson et al., 1978). Many basalt flows above the Vantage sandstone interbed are capped locally by stream-deposited sediments. The extent and thickness of the sediments generally increase upward in the section.

About 15 million years ago, ancestral river systems were crossing central Washington, laying down trains of gravel, sand, silt, and clay comparable to today's Columbia River and Snake River sediments. As the plateau subsided, the ancestral course of the Columbia River returned by gravity to the center of the Columbia Plateau, leaving sediment trains as a mark of its earlier courses. East of the present course of the Columbia River, sediments are virtually nonexistent between basalt flows. This attests to the fact that the ancestral Columbia River course being limited to the western half of the Columbia Plateau.

5.3b(5) Ringold Formation

Deformation during the later stages of Columbia River Basalt volcanism resulted in the emergence of the Yakima fold system in the western Plateau. Growth of these folds created a system of structural ridges and basins, which include: the Ellensburg Basin, Quincy Basin, Yakima Basin, Pasco Basin and Umatilla Basin (Figure 5-2). Thick sequences of sediments transported from the surrounding highlands accumulated in these basins.

In the Pasco Basin, the Pliocene (Gustafson, 1978) Ringold Formation was deposited in response to a flattening of the gradient of the Columbia and Snake River systems, perhaps related to the uplift of the Horse Heaven Hills (Newcomb, 1958; Newcomb et al., 1972). The Ringold Formation in the Pasco Basin accumulated to a thickness of up to 1,200 feet (365 meters).

The Ringold Formation can generally be divided into four units on the basis of texture: sand and gravel of the basal Ringold unit; clay, silt and fine sand with lenses of gravel of the lower Ringold unit; occasionally cemented sand and gravel of the middle Ringold unit; and silt and fine sand of the upper Ringold unit (Figures 5-4 and 5-5) (Brown, 1959).

The basal portion of the Ringold Formation is, in general, conformable with the surface of the underlying basalt bedrock. The lower Ringold unit is thickest in the central portion of the Pasco Basin and thins to the basin's margins. The matrix supported conglomerate of the middle Ringold unit overlies the lower unit. The upper Ringold unit is generally confined to the margins of the basin; elsewhere, it either was not deposited, or has been eroded by ancestral river systems and by Pleistocene catastrophic flooding of the basin.

5.3b(6) Early "Palouse" Soil

An eolian silt and fine sand (loess) overlie part of the eroded surface of the Ringold Formation in the western part of the Hanford Site (Figures 5-4 and 5-5) (Brown, 1970). Elsewhere, the silt was not deposited or was eroded during Pleistocene catastrophic flooding. The silt is considered to be the equivalent to early loesses of the Palouse Hills in eastern Washington and western Idaho. It indicates a climate comparable to that of today, with effective wind transport and deposition of sediment.

5.3b(7) Hanford Formation

The Ringold Formation and the basalts and sedimentary interbeds were locally eroded and truncated by multiple floods that occurred as ice-dammed lakes released catastrophic torrents of water and ice when the ice dams were breached during Pleistocene glaciation (Bretz, 1959; Baker, 1973; Fecht and Tallman, 1978). The floods scoured the land surface, leaving a network of buried channels crossing the Pasco Basin.

The glaciofluvial sediments in the Pasco Basin, informally named the Hanford Formation, were deposited on the Columbia River Basalt Group and Ringold Formation (Figures 5-4 and 5-5). These sediments can be divided into the coarser sand and gravel which are referred to as the Pasco Gravels (Brown, 1975), and the finer sand and silt units called the Touchet Beds (Flint, 1938).

The Touchet Beds represent low-energy (slackwater) sediments deposited in Glacial Lake Lewis, which formed when flood waters were backed up behind the Wallula Gap constriction (Flint, 1938). The Pasco Gravels represent high energy deposition in areas of more rapid water flow. In general, the Touchet Beds are found on the margins of the basin and the Pasco Gravels in and near the center of the basin. The characteristic variability of sediment size and degree of sorting within the "gravel" unit can be attributed to changes in water velocity and water level which occurred during the flooding process. The thickness of the Hanford Formation varies significantly within the basin, with the thickest occurrence in the region of buried channels.

5.3b(8) Eolian Deposits

Loess and sand dunes mantle the surface of the Pasco Basin (Lillie et al., 1978). These deposits are primarily reworked sediments of the Hanford Formation from surrounding areas. The thickness of the wind-blown sediments varies considerably, ranging from zero to more than 30 feet (9 meters) in some dunes.

The land surface has been only slightly modified since the deposition of the Hanford Formation. Eolian erosion and deposition have resulted in minor deflation and deposition of sand and silt veneers up to 25 feet (8 meters) thick.

5.3c REGIONAL HYDROLOGIC SETTING

5.3c(1) Surface Hydrology of the Hanford Site and Surrounding Pasco Basin

In the Pasco Basin, the Columbia River receives surface drainage from several adjacent basins (DOE, 1984). These major tributaries include the Yakima, Snake, and Walla Walla Rivers. No perennial streams are supported by hydrologic systems operating solely within the Pasco Basin. Streamflow within the Pasco Basin is recorded as inflow at the U.S. Geological Survey gage below Priest Rapids Dam and outflow at the gage below McNary Dam. Average annual flow at these stations is 87×10^6 and 140×10^6 acre-feet per year, (10×10^{12} and 17×10^{12} cubic meters per year) respectively. A total gaged flow of approximately 45×10^6 acre-feet per year (5.5×10^{10} cubic meters per year) enters from tributaries, and an additional 2.3×10^5 acre-feet per year (2.8×10^8 cubic meters per year) enter as irrigation returns.

The Hanford Site occupies approximately one-third of the land area within the Pasco Basin. Primary surface-water features associated with the Hanford Site include the Columbia and Yakima Rivers. Several artificial surface ponds and ditches are present, and are generally associated with fuel and waste processing activities (Figure 5-6).

Flow from approximately two-thirds of the Hanford Site is considered to drain directly into the Columbia River, although runoff is extremely low, if not zero. The section of the Columbia River along the Hanford Site reach has been inventoried and is described in detail in the U.S. Army Corps of Engineers (COE, 1977). Flow along this reach is controlled by the Priest Rapids Dam. Several drains and intakes are also present along this reach. Most notably, these include irrigation outfalls from the Columbia Basin Irrigation Project and Hanford Site intakes for the on-site water export system. Intake and outfall structures for the Hanford Generating Project and the "N" Reactor also occur in the Hanford Reactor.

West Lake, a shallow pond [three feet (one meter) deep], is the only natural pond on the Hanford Site. The pond generally averages 10 acres (30 square kilometers) in size. A number of man-made ditches and ponds are used for the routine disposal of chemical processing cooling waters, plant cooling water and several laboratory waste water streams (ERDA, 1975).

The Cold Creek watershed (area draining into Cold Creek) is located along the western boundary of the Pasco Basin. The 200 East Area lies outside the Cold Creek watershed. Cold Creek, trending northwest-southeast within the wash, is the only defined channel within the southeastern portion of the Hanford Site watershed (see Figure 5-6). The drainage system within the Cold Creek watershed may be described as ephemeral and discontinuous.

5.3c(2) Aquifer Identification

The regulations require identification and description of the uppermost aquifer and any hydraulically interconnected underlying aquifers.

5.3c(2)(a) Uppermost Aquifer

The uppermost aquifer in the 300 Area occurs in the Ringold Formation and the glaciofluvial sediments of the Hanford Formation. The water table is 30 to 40 feet (9 to 12 meters) below the land surface, and the saturated aquifer thickness is about 90 feet (27 meters) (Lindberg and Bond, 1979).

5.3a(2)(b) Underlying Aquifer

Underlying the uppermost aquifer is a series of generally confined aquifers within the Columbia River Basalt Group. The boundary between the underlying and uppermost aquifers is the silt and clay basal unit of the Ringold Formation. The low permeability of this silt and clay unit permits little if any communication between the aquifers. A semiconfined zone in the lower Ringold Formation is also known to exist beneath at least part of the 300 Area (Lindberg and Bond, 1979). This semiconfined zone has a higher head than the uppermost aquifer; therefore, the semiconfined zone is not expected to contain any dangerous waste constituents from the process trenches.

5.3c(3) Groundwater Hydrology of the Uppermost Aquifer

In this section the general characteristics of the regional hydrology are described (Gephart et al., 1979; Graham, 1981). The uppermost aquifer is unconfined, and within the boundaries of the Pasco Basin, lies in the Hanford Formation glaciofluvial sands and gravels and the Ringold Formation silts and gravels (Figures 5-4 and 5-5). The aquifer is dominated by the middle member of the Ringold formation, consisting of sorted sands and gravels of varying induration. The bottom of the aquifer is the basalt surface or, in some areas, the clay zones of the lower member of the Ringold Formation. The aquifer is over 230 feet (70 meters) thick in some areas, and thins to zero thickness along the flanks of the bordering structures.

5.3c(3)(a) Recharge

Major sources of natural recharge to the uppermost and unconfined aquifer are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephermeral streams, and river water along influent reaches of the Yakima and Columbia Rivers. The principal source of recharge occurs along the periphery of the basin where precipitation and runoff infiltrate to the water table. Small ephemeral streams draining the western slopes, such as Cold Creek and Dry Creek (Figure 5-6), lose water to the ground as they spread out on the valley plain. Within the basin, upward leakage from the lower basalt aquifers may enter the unconfined aquifer. Little, if any, recharge to the groundwater occurs from percolating rainfall on the broad areas of the desert terrain due to a high rate of evapotranspiration.

Artificial recharge to the groundwater occurs in the basin from two sources, agricultural irrigation and waste water disposal operations at Hanford. Agricultural irrigation on the eastern and northern sides of the Columbia River and in Cold Creek Valley to the west of the Hanford Site causes an undetermined amount of recharge to the system. Possibly as much as 40 percent of this irrigation water reaches the water table (U.S. Bureau of Reclamation, 1971). Artificial recharge from Hanford waste water disposal practices occurs principally from 200 East and 200 West Areas (the Separations Area). Although these discharges have been concentrated in U Pond, B Pond, and Gable Mountain Pond, the historical effects on the flow system have been widespread. Figure 5-7 shows the change in water table between January 1944 and January 1975.

Beneath the Separations Area, the two groundwater mounds have developed in response to large volumes of discharge to U Pond and B Pond (Figure 5-7). Under U Pond the water table has risen in excess of 85 feet (26 meters) since the start of disposal operations. The mound under B Pond has risen more than 30 feet (9 meters).

5.3c(3)(b) Movement

From the recharge areas, the groundwater flows downgradient to the discharge areas, primarily the Columbia River. This general flow pattern is interrupted locally by the two groundwater mounds in the Separations Area. These mounds alter the flow around them as evidenced by the groundwater mound beneath 200 West Area (Figure 5-8).

5.3c(3)(c) Discharge

Groundwater discharge from the underlying aquifer is principally to the Columbia River. There are lesser amounts of discharge to the Snake and Yakima River. Discharge of the unconfined aquifer flowing under Hanford is almost exclusively to the Columbia River north of Richland, Washington. Downward leakage to the underlying aquifer has occurred under the eastern groundwater mound. The rise in the water table above the potentiometric surface of the underlying aquifer provides the potential for this leakage (Graham et al., 1984).

5.3c(3)(d) Hydraulic Properties

The geologic and hydraulic properties of the Pasco Basin sediments are highly variable. The range of hydraulic conductivities can be several orders of magnitude. Figure 5-9 shows the areal distribution and range of hydraulic conductivities at the site. There have been numerous aquifer tests performed in the Pasco Basin, the majority of which were done on the Hanford Site. Gephart et al. (1979) presents results from more than 100 tests on the Pasco Basin. These results are summarized in Table 5-7.

5.3c(3)(e) Water Quality

Table 5-8 presents the mean of major chemical constituent concentrations in the groundwater in the basal Ringold unit and the Hanford Formation

glaciofluvial sediments. Figure 5-10 provides an Equivalent Parts Per Million (EPM) comparison for selected ions of the unconfined aquifer from the Hanford Site and the Pasco Basin.

5.3c(4) Groundwater Hydrology of the Underlying Aquifer

The underlying aquifer is generally confined and consists of sedimentary interbeds and/or interflow zones which occur between dense basalt flows in the Columbia River Basalt Group (Figures 5-4 and 5-5) (Graham et al., 1981). In some areas of the Hanford Site, post-glacial flood waters and the ancestral Columbia River eroded portions of the basaltic rock that separate the upper unconfined aquifer from the underlying confined aquifer (Graham, et al., 1984). The main water-bearing portion of the interflow zone occurs within a network of interconnecting vesicles and fractures of the flow tops or flow bottoms. The confining layers are dense basalt flows. Vertical cooling joints and fractures within the confining layers can permit localized leakage. This appears to be more prevalent in near-surface basalt flows.

Confined aquifers are known to underlie the Separations Area to a depth of 5,660 feet (1,725 meters) as evidenced from borehole ARH-DC-1 (Figure 5-11). Additional aquifers may exist at greater depths. The confined aquifers are continuous throughout most of the Pasco Basin, except where the aquifers have been eroded or stratigraphically pinched out. The thicknesses of the aquifers vary from over 170 feet (52 meters) with the Mabton interbed, to a few inches in some basalt flow contacts.

5.3c(4)(a) Recharge

Recharge to the Saddle Mountains Basalt occurs primarily at outcrops and near-surface subcrops as water infiltrates from precipitation and stream run-off. These recharge areas are the Rattlesnake Hills, Yakima Ridge, Umtanum Ridge, and the Saddle Mountains (Figures 5-3 and 5-6). Artificial recharge occurs from irrigation and irrigation runoff along the eastern and northeastern sections of the Pasco Basin.

5.3c(4)(b) Movement

The potentiometric surface for the underlying aquifer is influenced by the areas of recharge and discharge. The potentiometric surface gradient indicates the groundwater flow direction. In the Pasco Basin, this movement is

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assumed to conform closely with the regional dip of the basalts. However, in the Separations Area, flow is toward the Gable Mountain-Gable Butte area. Present day water levels show that the water table lies above the potentiometric surface of the underlying aquifer under major disposal ponds, creating the potential for aquifer leakage from the uppermost to the underlying aquifers in these areas.

5.3c(4)(c) Discharge

The major discharge area for the Saddle Mountains Basalt aquifers is presently assumed to be the Columbia River near Richland, Washington (Gephart, et al., 1979). In this area, the potentiometric surface lies above the mean stage of the river. Minor discharge also occurs to the Yakima River west of Richland and the Columbia River north of Umtanum Ridge.

5.3c(4)(d) Hydraulic Properties

Hydraulic conductivity values for the Saddle Mountains Basalt aquifers were obtained primarily by pump tests conducted at wells within the Hanford Site (Figure 5-11). The ranges of hydraulic properties for the underlying aquifers in these wells are presented in Table 5-9 (Gephart, et al., 1979).

5.3c(4)(e) Water Quality

Table 5-10 lists the mean and range of major chemical constituent concentrations for the groundwater in the Mabton interbed. The Mabton interbed is used to represent the confined aquifer system of the Saddle Mountains Basalt since it is extensive throughout the Pasco Basin and contains the most reported chemical analyses (Gephart, et al., 1979). On the average, the confined system contains much lower total dissolved solids than the uppermost aquifer and is of a sodium bicarbonate chemical type. The confined aquifer is also characteristically low in nitrate because of its isolation from surface disposal of chemical wastes. However, in the B Pond/Gable Mountain Pond area, intermixing of groundwater from the uppermost aquifer has occurred, as indicated from elevated nitrate and tritium concentrations in the underlying aquifer.

A small, depleted, low-pressure natural gas field (in production from 1929 to 1941) is present at the southern edge of the Hanford Site, 7 miles (11 kilometers) south of the Separations Area. Interpretation of carbon and hydrogen

isotopic data for methane gas from the underlying aquifers of the Wanapum and Saddle Mountains Basalts in the vicinity of the Hanford Site suggest the gas probably originated at shallow depths, from terrestrial carbonaceous matter in the interbeds of the Ellensburg Formation rather than from marine sediments at depth (DOE, 1984). The impact of these naturally-occurring hydrocarbons on groundwater geochemistry has not been assessed for either the uppermost aquifer or the underlying aquifer.

5.3c(4) Geology of the 300 Area

A number of wells have been installed in and around the 300 Area since the 1940's (Figure 5-12). Drilling logs exist for most of the wells, and these logs have been used to describe the local geology. The drilling logs for all of the wells in the interim status network are presented in Figures contained in 5.5a.

On-site excavations for various construction projects have also contributed to knowledge of subsurface formations. Further information was provided by an extensive study of the 300 Area hydrogeology that was conducted in 1977 to 1978 (Lindberg and Bond, 1979).

Geologic cross section locations of the 300 Area are shown in Figure 5-13. As shown in the cross sections (Figure 5-14), there are four geologic formations underlying this area. They are, in ascending order, the Columbia River Basalt Group, the Ringold Formation, the Hanford Formation, and the eolian sediments.

5.3c(4)(a) Columbia River Basalt Group

The Columbia River Basalt Group is present beneath the entire Hanford Site. In the 300 Area, the contact between the Ringold Formation and the basalts is at about 200 feet (61 meters) below the land surface (Lindberg and Bond, 1979).

5.3c(4)(b) Ringold Formation

The Ringold Formation lies above the Columbia River Basalts and is delineated by an increase in fine-grained materials. In the 300 Area, the contact between the two formations is indicated by increasing amounts of silt and some clay. The thickness of the Ringold Formation beneath the 300 Area is approximately 150 feet (46 meters) (Lindberg and Bond, 1979).

5.3c(4)(c) Hanford Formation

Overlying the Ringold Formation are glaciofluvial deposits (informally known as the Hanford Formation). The Hanford Formation is distinguished from the eolian sediments by less sand and silt and more gravel. Excavations and drilling logs indicate the presence of an old Columbia River channel cut into the Ringold Formation underlying the 300 Area. This channel is filled with glaciofluvial sediments of the Hanford Formation and is separated from the river by a natural levee of Ringold Formation sediments. The Hanford Formation ranges from about 50 to 90 feet (15 to 27 meters) thick in the 300 Area (Lindberg and Bond, 1979).

5.3c(4)(d) Eolian Sediments

The surface sediments in the 300 Area consist mainly of wind-transported sands and silts, deposited in dunes up to ten feet (three meters) in depth. These sands and silts increase in depth to the southwest and immediately north of the 300 Area (Lindberg and Bond, 1979).

5.3c(5) Hydrology of the 300 Area

On most of the Hanford Site, natural recharge of the uppermost aquifer occurs at the northwest margin of the Pasco Basin and artificial recharge occurs at the 200 Areas, near the center of the site. Groundwater flows from these recharge areas toward the Columbia River in a general southeasterly direction. However, in the southeast corner of the Hanford Site, groundwater recharge is mainly from the Yakima River. The 300 Area is located approximately at the point where these two groundwater sources meet. Figure 5-15 contains a schematic cross section showing the process trenches and their relationship to the water table. As a result, groundwater enters the 300 Area from the northwest, west, and southwest (Lindberg and Bond, 1979).

Near the process trenches, groundwater flows toward the river to the southeast and the east, as shown on a water-table map for December, 1984 (Figure 5-16). Exact direction of groundwater flow at any given time is influenced by both natural and man-made influences. One of these influences is the level of water in the Columbia River. It is documented in Lindberg and Bond (1979) that when the river stage rises during spring runoff, bank storage occurs and

causes a reversed water-table gradient in the 300 Area. During these times, groundwater tends to flow to the southeast in a direction roughly subparallel to the river. When the river level drops, the natural gradient is restored and groundwater flows more directly to the east, in a direction almost perpendicular to the river.

As mentioned earlier, an ancestral Columbia River channel underlies the 300 Area. This buried channel joins the present channel of the river about 2.0 miles (3.2 kilometers) north and about 1.0 mile (1.6 kilometer) south of the 300 Area. Changes in the hydraulic gradient in this area generally result in rapid changes in groundwater elevations, probably due to the high permeability of the sediments filling the old river channel (Lindberg and Bond, 1979).

Another influence on groundwater levels and flow direction is the process trenches, into which approximately 2.5×10^6 gallons (9.5×10^3 cubic meters) waste water per day are disposed. This large volume of waste water percolates quickly to the groundwater and creates a low mound in the water-table surface under the process trenches (Figure 5-16). This mound increases the water-table gradient, creating a greater head for the waste water as it flows toward the river.

Some aquifer tests have been done in wells in the 300 Area, although none of the wells tested were pumped for more than eight hours. Calculated transmissivities based on recovery data from these tests range from 40,000 square feet per day (3716 square meters per day) at well 399-8-2 to 102,000 square feet per day (9476 square meters per day) at well 399-8-1. At well 399-1-4, transmissivity was calculated to be 65,400 square feet per day (6076 square meters per day).

5.4 PLUME DESCRIPTION

As mentioned previously, the interim status monitoring program was implemented in June of 1985. Although the program was designed to provide the information needed for defining the extent of the plume of dangerous waste constituents, the data available at this time are not sufficient to allow plume description. However, past groundwater monitoring efforts in the 300 Areas have provided some useful information concerning the extent of the plume, and the results of

these efforts are summarized below. A more complete plume description will be provided when data for the first full year of interim status monitoring become available in June of 1986.

In the late 1940's, concern over the possible movement of uranium in the groundwater (resulting from discharges to the old process ponds) led to a groundwater study. Monitoring of water levels, groundwater temperatures, and uranium concentrations revealed that the groundwater system was being influenced by Columbia River fluctuations. Periods of high river stage were found to be causing a reversed gradient, resulting in the westward (or inland) movement of uranium-contaminated groundwater. The maximum detected westward penetration of the plume was to wells 399-8-1 and 399-8-3. Locations of these wells are shown on the map in Figure 5-12. It should be noted that dangerous waste constituents released in the more recent past may not have penetrated as far; construction of dams on the Columbia River has restricted the river's fluctuations and its resulting influence on the groundwater system (Lindberg and Bond, 1979).

Additional knowledge concerning the possible extent of dangerous waste constituents in the groundwater at the 300 Area has been provided by special groundwater monitoring that has been conducted in the recent past, following two unplanned releases of perchloroethylene (a solvent used onsite) to the process trenches. Both of these releases resulted from accidental discharge of this solvent during equipment cleaning operations. Following each discharge incident, samples were collected from nearby monitoring wells to track the movement of the perchloroethylene in the groundwater.

The first release occurred on November 4, 1982, when approximately 120 gallons of perchloroethylene were accidentally released to the process trenches. Sampling of the groundwater began five days after the release occurred. At first, samples were collected from wells closest to the trench. Later, as the perchloroethylene was transported away from the trenches, the sampling network was changed in order to track the plume's leading edge. Concentrations of the solvent in the groundwater were monitored for four months following the spill.

Results from sampling of the wells closest to the trench (399-1-5 and -1-2) are shown in Figure 5-17. The highest concentration of perchloroethylene (1,840 micrograms per liter) was found in well 399-1-5, which is the closest downgradient well. Well 399-1-2 showed a lower peak concentration of 1,050 micrograms per liter about five days later. Results from well 399-1-3 (not shown) indicated a higher peak concentration than in well 399-1-2, but at five to ten days later. This may be due to well 399-1-3 being located further from the trench but more in line with the downgradient direction than well 399-1-2. Moving the sampling points to follow the movement of the solvent led to sampling of wells 399-2-1, -2-2, -3-1, -4-7, and -4-10 at various times during the four months after the spill. Results of this sampling indicated lower peak concentrations of perchloroethylene with increasing distance from the trenches in the downgradient direction. A few samples collected from wells 399-8-3 and 699-S27-E14 showed less than detectable concentrations of perchloroethylene.

The second incident occurred on July 6, 1984, when approximately 20 gallons of perchloroethylene were released to the process trenches. Sampling of the groundwater was initiated four days later. The results showed the same general trends as described above. Results from sampling of wells 399-1-5 and -1-3 are shown in Figure 5-18. Again, the highest peak concentration (690 micrograms per liter) was found in well 399-1-5 five days after the spill, with the peak concentration in well 399-1-3 (240 micrograms per liter) following 16 days later. Sampling of wells 399-1-2, -2-1, and -2-2 indicated the same general pattern as with the first spill, of diminishing concentrations with distance from the source. Movement of the peak concentration was estimated at 35 feet per day (11 meters per day) (Raymond, 1984).

During the two perchloroethylene spill incidents described above, samples were collected from a 300 Area spring and from the river. During the first incident, river samples were collected in the mainstream of river flow and at the 300 Area water intake. Spring samples were also collected. The maximum concentration of perchloroethylene found in the spring samples was 270 micrograms per liter; all of the river samples showed less than detectable concentrations. During the second incident, river samples were collected approximately 100 yards (91 meters) downstream from spring #1 (shown on the map in Figure 5-12)

and about 10 yards (9 meters) offshore. These samples showed a maximum concentration of perchloroethylene of 18 micrograms per liter. Most of the samples were below two micrograms per liter. Samples from spring #1 showed a maximum of 80 micrograms per liter, with most below five micrograms per liter. Because of the difficulty in determining what effect diurnal changes in river level might have on spring and river samples, the results of sampling can be hard to interpret. However, this sampling did indicate that low levels of perchloroethylene had reached the spring and river sampling sites approximately 35 days after the spill occurred (Raymond, 1984).

Results of the spill monitoring described above indicate that the groundwater beneath the 300 Area has been affected by wastes discharged to the 300 Area Process Trenches. Because of these past monitoring efforts, the areal extent of the plume of dangerous waste constituents is approximately defined. Samples collected during the first perchloroethylene spill from some wells (such as 399-8-3 and 699-S27-E14) showed less than detectable concentrations, so it is expected that these wells lie outside the plume. A similar plume boundary was indicated by the earlier uranium study. As indicated previously, a more complete description of the plume will be available by September 1986, after an evaluation of the first full year of monitoring data has been completed. Full description of the plume cannot be accomplished until a full year of sampling has been conducted, because of the seasonal variations known to exist in this area. Prior to September, preliminary results can be provided on a periodic basis.

5.5 GROUNDWATER MONITORING PROCEDURES

The groundwater monitoring procedures that are being used for the interim status program (and that will ultimately be used for the final groundwater monitoring program, with a few possible modifications) are described in the following sections.

5.5a Description of Wells

Over 700 groundwater monitoring wells have been drilled at the Hanford Site since the 1940's. Most of the older wells are constructed of carbon steel and have perforations rather than screens. However, the newer wells constructed at the site generally have stainless steel screens, and some of them also have

stainless steel casings. Almost all of the wells (both old and new) were constructed using a cable-tool rig, and most of them are either six or eight inches in diameter. Through the years, care has been taken to regularly repair and maintain the monitoring wells so that they will continue to be useful sampling structures. The wells are swabbed or cleaned out periodically by a driller and are also checked for problems with a downhole television camera.

Some of the existing monitoring wells near the 300 Area Process Trenches are considered to be good sampling structures and are in the proper locations for monitoring the facility. Therefore, these wells have been used for the interim status program, rather than installing a completely new network of wells specifically designed for this effort. In cases where existing wells are not properly completed or in the right locations, new wells have been installed (and will continue to be, if it is determined that more are required). Applicability of the older wells for this type of monitoring effort is currently being studied by the Pacific Northwest Laboratory. Final results of this well comparison study should be available by November 1985, but initial indications are that the materials used in well construction may not (under Hanford Site conditions) have a large effect on sample results.

Locations of the 16 wells currently in the network are shown in Figure 5-1. Monitoring well installation details and geologic logs for these wells are contained in Figures 5-19 through 5-34. As indicated, six of the wells have stainless steel screens, and the other ten have perforated casings. Most of the wells in the network are open at the top of the aquifer; therefore, well 399-T-2 (Figure 5-23) was installed specifically to check for the possible presence of solvents or other dense materials in a deeper zone. This well was drilled to the top of the first continuous clay layer within the aquifer.

Figures 5-19 through 5-34 also show the water table and the position of the pumps. For the interim status program, each well has two pumps: (1) a submersible pump used for purging the well and for collection of samples to be analyzed for constituents that are not affected by air stripping, and (2) a Teflon bladder pump used for collection of samples that will be analyzed for volatile organics. As shown, both of these pumps are hung near the top of the water column (except in the deep well, 399-T-2).

5.5b Representative Samples

As mentioned in Section 5.2, the interim status network currently consists of 16 wells. The program being conducted is an assessment-level program and is intended to determine the extent of the plume of dangerous waste constituents from the facility. Data now being obtained under the program will be used to determine if more wells (either existing or new) are needed in the network. Refinement of the network is to be accomplished in a step-wise fashion, with analytical results being used to determine, at each step, if more wells are needed. The initial determination will be made by March 1986, and the additional wells will be added. The resulting interim status network should be sufficient to provide representative samples of the groundwater, both upgradient from the facility and at the point of compliance. In addition, the network will provide samples of the groundwater between the point of compliance and the facility boundary.

5.5c Sampling and Analysis Procedures

The procedures to be used for sampling and analysis are described in the following sections. These procedures were developed for the interim status monitoring program but will continue to be used for the final status monitoring program.

In developing these procedures, care has been taken to ensure that the samples collected are representative of the groundwater. The wells are purged prior to sampling, and the samples are collected using devices that should not induce sample alteration. Information on the pump types, materials, and position in the wells is given in Section 5.5a. Well purging is conducted according to the borehole volume removal procedure, but a check is done on the adequacy of the calculated purging time via measurements of pH, specific conductivity, and temperature. These measurements are taken periodically during the calculated purging time, and (with very few exceptions) show stabilization within that time period. This extra check gives some additional assurance that the stagnant water has been removed from the well and that the samples collected subsequently will be representative of the groundwater.

5.5c(1) Sample Collection Procedures

The field procedures to be used during sample collection are contained in the following sections. All aspects of sampling, including pump operation, borehole purging, and field measurements (pH, specific conductivity, and temperature) have been described.

These field procedures were written under the assumptions noted below. If the actual conditions differ from those assumed, then corresponding changes will be made in the procedures.

- These procedures are not meant to be all-inclusive and are not intended to replace proper field training for the equipment to be used.
- Each well to be sampled will have two dedicated pumps installed in it, one being a one-half or three-quarter horsepower submersible pump for purging and some sample collection, and one being a bladder or similar type pump suitable for collection of samples to be analyzed for volatile organics.
- The manufacturers' operating guidelines and maintenance instructions for the pumps and other sampling equipment will be used to supplement these procedures.
- The samples will be collected by trained Radiation Protection Technologists, under the supervision and direction of scientists and other technical personnel.

5.5c(1)(a) Sampling Precautions

The sample collection personnel will be instructed to heed the following precautions:

- Do not smoke, eat, or handle any objects not necessary for sampling while performing sampling procedures.
- Do not sample downwind of any potential volatile organics sources such as car exhausts, open fuel tanks, etc. These could result in contamination of the sample. If any such sources are unavoidable, make a note of them in the field logbook.
- Leave caps on the sample containers until just before filling.
- Avoid handling the teflon bottle cap liners. Do not use any liner which falls out of the cap and onto the ground.

- o Gloves should be worn when taking samples and when handling bottles, especially those with added preservative.

5.5c(1)(b) Sampling Procedures

1. Take water-level measurements according to the procedure described in Section 5.5d.

2. Check to see that the hose bibb for the submersible pump is open.

3. Plug the power cord into one of the 230-volt outlets on the generator and into the outlet at the well head. CAUTION: Be sure the power switch to the 230-volt outlets is turned off!

4. Start the electric generator.

5. Turn the power switch on to begin pumping process. Be sure not to handle energized power cords. If the pump does not work properly, indicated by lack of air flow out the discharge hose or by failure of the generator to "lug" down, immediately turn the switch off. After waiting a few seconds turn the switch on and off several times rapidly, finally pausing in the ON position to determine if the pump has started to function properly.

6. After the water begins to flow from the outlet, pump the well for the length of time indicated in Table 5-11 (or for an adjusted pumping time as explained in Table 5-11), and until pH, temperature, and conductivity stabilize. Measure the pH, temperature, and conductivity of the discharged water at least three times during purging, according to the procedures in sections 5.5c(1)(c), 5.5c(1)(d), and 5.5c(1)(e). The pH will be considered stable when two consecutive measurements agree within 0.2 pH units. Temperature will be considered stable when two consecutive measurements agree within 0.2 degrees C. Conductivity will be considered stable when two consecutive measurements agree within ten micromhos. If pH, temperature, and conductivity do not stabilize within the calculated purging time, contact the technical supervisor before collecting samples.

7. Enter time, date, and initials on all sample labels. Record information in field logbook as it becomes available. The information items that must be recorded in the field logbook are described in Section 5.5c(4)(c).

8. Check the labels on the sample bottles to determine which ones can be filled using the submersible pump. (A blue line on the right side of the sample label indicates that the submersible pump should not be used to fill that particular bottle.) Fill the appropriate sample containers. Attach a sample seal to each container and place in a cool, dark container (i.e., a cooler or ice chest).

9. Turn on the air compressor.

10. Attach the compressed gas source to the bladder pump pressure inlet on the face of the controller panel, using female portion of coupling supplied.

11. Connect either end of the red controller air hose to the pump supply on the right side of the control panel. Connect the other end of the controller air hose to the quick-connect nipple located in the well cap assembly.

12. Attach the appropriately-labeled extension line to the bladder pump discharge line.

13. Five to fifteen pumping cycles are required to purge the air from the bladder pump and tubing. Full water flow from the sample supply tube should then begin. After water flows from the outlet tube, run the bladder pump for at least five minutes.

14. To reduce the water flow rate during sample collection, turn the throttle control on the left side of the control panel in the counter-clockwise direction. For increased flow rate, turn the throttle control clockwise.

15. To optimize pumping efficiency for a specific well depth, refer to the manufacturer's operating instructions.

16. Unscrew the cap from the sample bottle, being careful not to touch the lip of the bottle or inside of the Teflon liner. Also avoid touching the mouth of the discharge line, and avoid splashing or agitating the water while the bottle is being filled.

17. Fill the sample bottle slowly by placing the outlet tube against the inner side of the sample bottle to prevent entrapment of any air bubbles.

    NOTE: For those bottles requiring no headspace, the bottle should be filled completely such that a meniscus forms. Place the cap on immediately, turn the bottle upside down, tap it a few times and check for air bubbles in the sample. If a bubble exists, discard the sample and repeat the sampling procedures until an air-free sample is obtained (unless the bottle to be filled contains a preservative, in which case only one attempt will be made to obtain an air-free sample).

18. As each container is filled, attach a sample seal to the container and place in a cool, dark container (i.e., a cooler or ice chest).

19. Turn off the air compressor.

20. Turn the power switch off and then turn the generator off. Unplug the power cord.

21. Complete the Chain-of-Custody and Sample Analysis Request forms.

22. Survey the sample bottle with a Geiger-Muller instrument. If the count is greater than 200 counts per minute, record in the logbook and use Radiation Work Procedures. Notify the supervisor for instructions concerning sample disposition.

23. Deliver the sample to the appropriate laboratory for analysis as soon as possible, following chain-of-custody procedures. If it can not be delivered to the lab the same day, store the sample in a sealed refrigerator

located inside a locked building within a secured area. The refrigerator must be capable of maintaining a constant temperature of four degrees C.

NOTE: If the well pumps dry while purging, it does not generally mean that a sample cannot be collected. Some wells pump down after a period of time. However, a sample can still be obtained by following these steps:

1. Turn off the submersible pump when the well pumps dry.

2. Wait for the well to recharge. This should be about 15 minutes, but may take as long as 30 minutes.

3. Using the electrical tape, check to ensure that water is covering the pumps.

4. Turn the submersible pump back on. Collect the samples that are designated for collection with the submersible pump.

5. Turn the bladder pump on. Pump for five minutes and then collect the samples that are designated for collection with the bladder pump.

5.5c(1)(c) Conductivity Measurement Procedure

The conductivity meter should be calibrated once a day, before leaving for the field to begin sampling. Field procedures for using the meter are described below.

1. Remove the cap on top of the sample cup.

2. Rinse the cup with the sample to be tested and dump it several times. Then fill the cup with the sample.

3. Turn the conductivity range switch to the correct range.

Range in micromhos:	
X1.	0 - 10
X10.	0 - 100
X100.	0 - 1,000
X1,000.	0 - 10,000

4. Turn the MODE switch to CONDUCTIVITY.

5. Press the OPERATE button on the side of the case.

6. Read the conductivity on the meter on the digital display to the nearest micromho and record in field logbook. Multiply the meter reading times the scale factor to obtain the correct placement of the decimal point.

7. After reading, dump the sample and refill the cup with distilled water.

8. Replace the cap.

5.5c(1)(d) pH Measurement Procedure

The pH meter should be calibrated once a day, before leaving for the field to begin sampling. Field procedures for using the meter are described below.

1. Remove the cap on the top of the sample cup.
2. Rinse the cup with the sample to be tested several times. Then fill the cup with the sample.
3. Turn the MODE selector switch to pH.
4. Press the OPERATE pushbutton on the side of the case.
5. Read the pH on the upper meter scale or on the digital display to the nearest tenth of a unit and record in field logbook.
6. Dump the sample and refill the cup with distilled water.
7. Replace the cap.

5.5c(1)(e) Temperature Measurement Procedure

1. Turn on the digital thermometer. Make sure that the switch is positioned so that the measurements will be in degrees C.
2. Place the probe into the stream of water being discharged from the pump.
3. The temperature is indicated by a flashing display, which will normally fluctuate for a few seconds. Wait until fluctuation ceases (i.e., until the same temperature is indicated on three consecutive flashes), and then record the temperature in the field logbook.

5.5c(2) Sample Analysis

A contract is in place with United States Testing Company (UST) for the analysis of environmental samples collected on the Hanford Site, including those to be collected under the groundwater monitoring program discussed in this chapter. This contractual agreement will last at least until September 1988.

UST operates analytical laboratories in Richland, Washington, and in Hoboken, New Jersey. The facility in New Jersey is involved in the Contract Lab Program administered by the Environmental Protection Agency and is capable of handling all state-of-the-art methodologies currently available for hazardous waste analysis. To support the interim status groundwater monitoring programs

currently being conducted at the Hanford Site, these analytical capabilities are being established at the Richland laboratory (which has until recently conducted primarily radiological analyses). All of the necessary capabilities, equipment and methodologies used at the Hoboken facility are now being transferred to the Richland facility, allowing local analysis of the samples. The Richland facility is using the same protocols and procedures as the New Jersey facility.

5.5c(2)(a) Analytical Methods

Information concerning the analyses being conducted under interim status is given below. The analyses to be conducted during final status will depend on what is found in the groundwater during interim status. Presumably, the list of analyses to be conducted during final status will contain the hazardous waste constituents that are found (during interim status monitoring) to be present in the groundwater. The final list of analyses may therefore contain some of the interim status "assessment" parameters (listed in Table 5-1) and possibly some parameters from the 9905 list (Table 5-2). Methods to be used during interim status for the two lists of parameters are discussed below and in Section 5.5c(2)(b).

Table 5-12 references the analytical methods to be used for each of the constituents that will be analyzed. When available, methods described in SW-846 (EPA, 1982) will be used. In instances where a method is not available in SW-846, an appropriate method from one of the standard references will be used. In some cases, a standard method is not available for a constituent. Where possible, methods for these constituents will be developed by the laboratory. In such cases, the method will be approved by the Pacific Northwest Laboratory (administrator of the contract with UST) and documented.

Table 5-12 also lists the preservation methods that will be used; shipment considerations are not included, because samples will be delivered by the sample collector directly to the analytical lab and no shipment will be involved.

5.5c(2)(b) Analytical Procedures for Constituents in WAC 173-303-9905

This section identifies the approach to be taken to analyze for the list of dangerous waste constituents contained in WAC 173-303-9905. UST will conduct analyses for those constituents on the list for which a method is currently available.

Table 5-13 contains a numbered list of all of the WAC 173-303-9905 constituents. This table also indicates the specific method to be used for analysis of each constituent. Where available, methods contained in SW-846 will be used (EPA, 1982). Where SW-846 does not provide sufficient information to analyze for a particular constituent, another standard method is listed. Two categories of compounds will not be analyzed directly: (1) constituents that are unstable in water, and (2) constituents for which no analytical method is available (labeled "exotic" in Table 5-13).

The following approach will be taken when analyzing for volatile and semivolatile constituents. A quantitative analysis will be performed by Gas Chromatography/Mass Spectrometry (GC/MS) on those compounds which are also in the priority pollutant list contained in 40 CFR Part 122 (EPA, 1984). All other volatile and semivolatile compounds on the 9905 list will be covered by performing a National Bureau of Standards Library computer search. This search will be conducted for all peaks in the chromatogram of the sample which are greater than 20 percent of the nearest internal standard. Quantification of the tentatively identified peak will be against the nearest internal standard, and the response factor will be assumed to be one (1). Rigorous quantification of the tentatively identified compounds will be performed upon request, and the analyses are subject to the availability of standards.

Chain-of-custody and general quality control procedures will be those detailed in the following sections. For additional quality control procedures specific to individual methods, see the methods referenced in Tables 5-12 and 5-13.

5.5c(3) Quality Control

The quality control effort will include checks performed on the laboratory through submission of blanks, spikes and replicate samples as well as the analytical laboratory's routine quality control procedures. A field blank and

transfer blank will be submitted with each sample that is to be analyzed for volatile organic analysis. In addition, during the first few months of sampling under the interim status program, blanks and replicates were used to test for various types of possible variation in the data. Details and results of this testing will be available soon; any routine replication or blank submission determined necessary as a result of this testing will be documented and conducted.

Inorganic analyses will be performed primarily using Inductively Coupled Plasma Emission Spectrometry (ICAP), Ion Chromatography and Graphite Furnace Atomic Absorption (GFAA). The following general quality-control procedures will be standard for all inorganic analyses:

- Standard curve - daily
- Verification of standard (to + or - 30 percent) - every 20 samples
- Blank - each extraction batch
- Random matrix spike for 10 percent of samples

Organic analyses will be performed primarily using Gas Chromatography (GC) and Gas Chromatography/Mass Spectrometry (GC/MS). The following general quality-control procedures will be standard for all organic analyses:

- 5-point curve - verify every 12 hours
- Random matrix spike for ten percent of samples
- Blank - every extraction batch
- Internal standards and surrogates

For additional quality control procedures specific to individual methods, see the methods referenced in Tables 5-12 and 5-13.

5.5c(4) Chain-of-Custody Procedures

To ensure the integrity of the samples from time of collection through data reporting, the history of the custody of each sample will be documented. A sample is considered to be under a person's custody if it is in any one of the following states: (1) in his physical possession, (2) in his view after he has taken possession, (3) secured by him so that no one can tamper with the

sample, or (4) secured by him in an area which is restricted to authorized personnel. Anyone having custody of samples must comply with the procedures described below.

5.5c(4)(a) Sample Labels

Gummed paper labels will be filled out and affixed to the sample container at the time of sample collection. The label to be used is shown in Figure 5-35. The well number noted on the label identifies the well location.

5.5c(4)(b) Sample Seals

Gummed paper seals will be attached to the samples immediately upon sample collection, before the samples leave the custody of the sampling personnel. The seal will be attached in such a way that it is necessary to break it in order to open the sample container.

5.5c(4)(c) Field Logbook

A field logbook will be utilized to record (in black ink) all pertinent information about each sample collected. It will be a bound book, with consecutively numbered pages. A sample page from the logbook is shown in Figure 5-36. The logbook will be kept in a locked cabinet when not in field use.

5.5c(4)(d) Chain-of-Custody Form

A Chain-of-Custody Form will accompany all samples from the time they are collected until they are disposed of after analysis and reporting. One form will be used for as many samples as possible. The form to be used is shown in Figure 5-37. Each sample handler who signs the form will return a copy of the form to the sample collection organization.

5.5c(4)(e) Sample Analysis Request Form

A Sample Analysis Request Form will accompany all samples delivered to the lab. The form to be used is shown in Figure 5-38. The field portion of the form will be completed by the sample collector; the laboratory portion will be completed by laboratory personnel.

5.5c(4)(f) Sample Delivery to the Laboratory

Samples will normally be delivered directly to the laboratory on the day of collection. If they cannot be delivered on the day of collection, they must be stored in a sealed refrigerator in a locked building. (No shipping of the samples will be necessary, due to the lab's proximity to the facility.) All samples will be accompanied by a Chain-of-Custody Form (Figure 5-37) and a Sample Analysis Request Form (Figure 5-38). The samples will be delivered only to authorized laboratory personnel.

5.5c(4)(g) Receipt and Logging of Samples

The chain-of-custody does not end at the laboratory door, and therefore the laboratory is being required to ensure its continuity by following the procedures described below and in Section 5.5c(4)(h).

All samples delivered to the laboratory are to be accepted by the Receiving Department in the following manner:

1. The sample cooler shall be removed from the delivery vehicle and brought into the receiving area.

2. The sample cooler shall be checked for any obvious damage.

3. The Chain-of-Custody and Sample Analysis Request forms shall be signed by receiving personnel.

4. If custody of the cooler is transferred from the person receiving shipment to one or more intermediates prior to delivery to the Sample Custodian, a Chain-of-Custody Form must be completed, and must reflect every change of custody.

5. The sample cooler shall be delivered to the Sample Custodian or designated alternate who will sign the Chain-of-Custody Form. He will then return one copy to the sender and will retain the remaining copies. The sample cooler is now the responsibility of the Sample Custodian or designated alternate. This individual must log the samples in and open the case file.

Upon notification of sample receipt, the Sample Custodian or designated alternate will proceed with sample inspection and log-in as follows:

1. Examine the sample coolers and record in the Sample Log-In Form:

    - o Presence/absence of custody seal(s) on the sample coolers
    - o Condition of custody seal(s)

2. Open sample coolers, remove the enclosed sample documents and record in the Sample Log-In Form:

   - Presence/absence of Chain-of-Custody Form(s)

3. Remove sample containers and record in Sample Log-In Form:

   - Condition of samples (intact, broken, leaking, etc.)
   - Presence/absence of sample labels
   - Any disagreement with Chain-of-Custody Form(s)

4. If discrepancies are found, contact the sender for clarification and notify the appropriate lab personnel.

5. Once all samples have been properly logged in, a copy of the Sample Log-In Form will be sent to the sender. Figure 5-39 presents an example of a Sample Log-In Form.

5.5c(4)(h) Assignment of Sample for Analysis

The following requirements for assignment of the samples will be followed:

1. An internal numbering system shall be used for identification of all samples.

2. Internal sample numbers shall be assigned by the Sample Custodian and shall be recorded in the Sample Log-In Form alongside the corresponding collector's sample number.

3. Properly labeled sample containers shall be placed in the secure storage area.

5.5d Groundwater Elevation

The elevation of the groundwater surface will be determined using the depth-to-water measurements taken at each well prior to sampling. The depth to water is measured from the top of the well casing, so these measurements must be subtracted from the surveyed elevation of the casing to obtain the elevation of the groundwater surface at each well. The groundwater elevations obtained for all wells in the sampling network during a particular sampling episode will be used to produce a contour map showing the groundwater surface at the point in time that the measurements were made. These maps will be used to define any changes in the groundwater flow direction with time. Using this information, the sampling network will be checked periodically to ensure that it is still adequate, given any such changes that might have occurred.

5.5d(1) Procedures for Depth-to-water Measurements

Depth-to-water measurements will be taken to the nearest 0.01 feet using a graduated steel tape. Prior to taking these official measurements, an electrical tape will be used to approximate the depth to water. Procedures for using both of these measuring devices are contained in this section. These types will either be dedicated to specific wells or decontaminated after each use.

5.5d(1)(a) Graduated Steel Tape Method

1. Chalk the one-foot section of steel tape below the zero reading point.

2. Lower the steel tape from the measuring point (marked with paint on the top of the casing) to the estimated water level. Take note of the amount of tape that is in the well by reading the tape at the measuring point. This value is referred to as the "hold point." Note: Values for the elevation of the measuring point and for the estimated depth to water can be found in Hanford Wells (McGhan, Mitchell, and Argo, 1985). An electric tape may also be used to find the approximate depth to water.

3. Remove the steel tape and check the wetted portion below the zero reading point. Note: If the chalked portion is not wet, repeat the procedure but allow more of the tape to go down the well (i.e., use a greater hold point).

4. Add the unwetted length (of the chalked portion of tape) to the hold point to obtain the depth-to-water measurement.

5. Repeat the entire procedure until two steel tape measurements agree within 0.05 feet.

6. Record the depth-to-water measurements, time of measurements, measuring device, and the name of the person taking the measurements in the field logbook.

7. Subtract the depth-to-water measurement from the surveyed elevation of the casing to obtain the elevation of the groundwater surface.

5.5d(1)(b) Electric Tape Method

As indicated previously, an electrical tape may be used to approximate the depth to water and thereby facilitate the steel tape measurement. Because of the steel tape's greater accuracy, it is the only one to be used for the official depth-to-water measurements.

1. Lower the electric tape from the measuring point into the well until contact with the water is indicated by the buzzer and the light.

2. Mark the electric tape at the measuring point and identify the nearest graduation on the electric tape.

3. If the water level is deeper than the nearest graduation marked on the tape, add the difference to the depth identified to obtain the true depth to water.

4. If the water level is shallower than the nearest graduation marked on the tape, subtract the difference from the depth identified to obtain the true depth to water.

5. Record the depth-to-water measurements, time of measurements, measuring device, and the name of the person taking the measurements in the field logbook.

6. Subtract the depth-to-water measurement from the surveyed elevation of the casing to obtain the elevation of the groundwater surface.

5.6 DETECTION MONITORING PROGRAM

According to the regulations, a detection monitoring program should be conducted if dangerous waste constituents have not been detected in the groundwater at the point of compliance when the permit application is submitted. Interim status monitoring data for this facility (summarized in Section 5.2)0 have shown that hazardous constituents are present in the groundwater; therefore, a compliance monitoring program is being proposed instead of a detection monitoring program. A description of the proposed program is contained in Section 5.7.

5.7 COMPLIANCE MONITORING PROGRAM

As indicated in Section 5.2, which contains a summary of the interim status data that are presently available, dangerous waste constituents have been detected in the groundwater at the point of compliance. Therefore, in accordance with the regulations, a compliance monitoring program is being proposed. The program description which follows is necessarily brief because of the present lack of monitoring data. A complete description will be provided by September 1986, along with a report containing an evaluation of the first full year of interim status monitoring data.

5.7a Waste Description

Starting in 1975, the process trenches were the main facility for disposal of most liquid wastes generated in the 300 Area. Administrative controls to prevent disposal of dangerous wastes to the trenches were initituted February 1,

1985. A variety of chemical wastes was included in these process wastes, although no large quantities of any one of these chemicals were disposed. A listing and estimated quantities of the chemicals potentially discharged to the facility are found in Table 5-14. However, the trenches are still receiving approximately 2.5 x 10^6 gallons (9.5 x 10^3 cubic meters) of waste water per day. This waste water contains mainly cooling water and some small quantities of nonhazardous maintenance and process wastes.

5.7b Characterization of the Plume of Dangerous Waste Constituents

As indicated in previous sections, the plume that has resulted from this facility cannot be fully described yet because of the limited amount of data concerning the dangerous waste constituents found in the groundwater. Present knowledge of the situation is described in Sections 5.2 and 5.4. A more complete description (including plume maps) will be provided by September 1986, after an evaluation of the first full year of interim status data has been completed. Preliminary results can be provided on a periodic basis prior to September.

5.7c Dangerous Constituents to be Monitored

The analyses that will be conducted under the final status program will depend on what is found in the groundwater during interim status. The final list of analyses may therefore contain some of the interim status "assessment" parameters (listed in Table 5-1) and possibly some parameters from the 9905 list (Table 5-2).

At the present time, the available interim status data are not sufficient to allow determination of the constituents that should be on the final status list. This determination will be made following collection and evaluation of additional interim status data and the resulting list of constituents will be contained in the program description to be provided by September 1986.

5.7d Concentration Limits

The concentration limits for the dangerous waste constituents cannot be specified yet because of the lack of interim status data. However, it is anticipated that alternate concentration limits will be proposed for at least some of the constituents. These limits and the necessary justification will be provided along with the list of constituents to be monitored.

5.7e Alternate Concentration Limits

As indicated in the previous section, these limits cannot be specified yet due to insufficient data. The proposed limits and necessary justification will be provided along with the list of constituents to be monitored.

5.7f Groundwater Monitoring System

The groundwater monitoring system to be used for the final status program will be based upon the system being used for the interim status program. For this facility, the interim status program is an assessment-level program rather than a detection-level program. Accordingly, the well network is designed to allow determination of the full extent of the plume, and this same network should be sufficient for the final status program.

As mentioned in previous sections, the interim status network being used now is not necessarily complete. When additional interim status monitoring data become available, they will be evaluated to determine if the network contains enough wells to define the extent of the plume and if the wells being used as background wells are suitable for that purpose. The initial determination will be made by March 1986. Wells that are determined to be needed will be added to the network during interim status and will be available for use by the time the interim status program is implemented.

5.7f(1) Description of Wells

The wells that are currently in the interim status network are fully described in Section 5.5a. Descriptions of any other wells that are deemed to be necessary additions to the network will be provided after they have been added.

5.7f(2) Representative Samples

The ability of the interim status network (which will, with some modifications, be the final status network) to provide representative samples is described in Section 5.5b.

5.7f(3) Non-Upgradient Background Monitoring Wells

It is anticipated that upgradient wells will be used for determining background water quality. At this time, insufficient data are available for determining if the wells currently being used as background wells are suitable

for that purpose, since the reverse gradient that may occur in this area during high river stage could have caused contamination of wells that are considered to be (at least most of the time) upgradient of the facility. If (after additional interim status data are received and evaluated) the wells currently being used are determined to be unsuitable for use as background wells, then existing or new upgradient wells will be added to the network as needed to meet this requirement.

5.7g Background Values

The interim status data presently available are not sufficient to establish background values, especially considering the large potential for seasonal variability at this site. Therefore, a plan for establishing background values is presented.

5.7g(1) Data Currently Available

The data presently available are insufficient for establishing background values, so a plan for establishing these values is presented in Section 5.7g(2).

5.7g(2) Plan for Establishing Groundwater Quality Data

Background water-quality values will be established during interim status monitoring, as described in the following sections.

5.7g(2)(a) Background Data

Background values will be established by sampling upgradient wells under the interim status monitoring program. As mentioned previously, attempts are currently being made to determine if the background wells currently being used are suitable for that purpose. If they are not, and if suitable existing wells cannot be found, then one or more new wells (as required to define the variability in background concentrations) will be installed during interim status.

Replicate measurements will be made in order to get information on sampling and analytical variability. Information on seasonal variability will be obtained by sampling on a monthly basis, at least during the first year of the interim status program.

5.7g(2)(b) Well Location

The well (or wells) to be used for establishing background values have not yet been determined, as discussed previously. Two upgradient wells are currently being sampled under the interim status program and are thereby being checked for suitability as background wells. If they are not suitable, and if no other existing wells are found to be suitable, then one or more new wells will be installed.

5.7g(2)(c) Sampling Frequency

Samples from all wells in the network will be taken on a monthly basis, at least during the first year of interim status monitoring. When sufficient data have been collected to define the seasonal variability, then it is anticipated that sampling frequency will be reduced to quarterly.

5.7g(2)(d) Sampling Quantity

As required by the regulations, a minimum of one sample set per well and four sample sets from the entire system will be collected each time the system is sampled. Current plans specify collection of at least one sample set from every well in the network each time the system is sampled.

5.7g(2)(e) Background Values

The background values will be expressed in the form necessary to conduct statistical evaluations. In particular, for any samples that are found to be less than the detection limit was (rather than just reporting that the result was "nondetectable"). Other appropriate data reporting conventions will be followed, with the exact formatting details to be determined when the statistical tests to be used have been determined.

5.7h Sampling, Analysis, and Statistical Procedures

The procedures to be used for sampling, analysis, and statistical data evaluation are described in the following sections (or in a previous section, in which case a reference to that section is given here). These procedures were developed for the interim status monitoring program but (with possible modifications) will continue to be used for the final status monitoring programs.

5.7h(1) Sample Collection Procedures

The field procedures to be used during sample collection are described in Section 5.5c(1).

5.7h(2) Sample Preservation and Shipment

The methods to be used for sample preservation are discussed in Section 5.5c(2)(a). Shipping procedures are not included, because the samples will be delivered directly to the laboratory by the sample collector and no shipment will be necessary.

5.7h(3) Analytical Procedures

The procedures to be used for sample analysis are described in Section 5.5c(2).

5.7h(4) Chain-of-Custody Procedures

The chain-of-custody procedures are described in Section 5.5c(4).

5.7h(5) Additional Requirements for Compliance Point Monitoring

Additional requirements for monitoring wells located at the compliance point are discussed below.

5.7h(5)(a) Sampling Frequency

As required by the regulations, the concentrations of dangerous waste constituents in the groundwater at each well at the compliance point will be determined at least quarterly during the compliance period. The concentrations will be expressed in the proper form for conducting statistical evaluations.

More frequent sampling is often necessary at sites (such as this one) where seasonal variations can be large. The concentrations of constituents in the groundwater at this facility may be influenced by changes in the groundwater flow system that are caused by the seasonal fluctuations of the Columbia River. However, samples are being collected on a monthly basis during interim status so that these variations can be defined. The intensive data collection effort being conducted now should provide sufficient information on these variations to allow quarterly sampling under the final status program.

5.7h(5)(b) Testing for Constituents in WAC 173-303-9905

As required in the regulations, samples from all wells at the compliance point will be analyzed at least annually for the dangerous waste constituents listed in WAC 173-303-9905. The approach to be taken for this analysis is discussed in Section 5.5c(2)(b).

5.7h(5)(c) Compliance Point Groundwater Quality Values

The analytical results for samples collected from all wells in the sampling network, including those at the compliance point, will be expressed in the proper form for conducting statistical evaluations. In particular, for any samples that are found to be less than the detection limit for a certain constituent, the laboratory will be required to report what the actual detection limit was (rather than just reporting that the result was "nondetectable"). Other appropriate data reporting conventions will be followed, with the exact formatting details to be determined when the statistical tests to be used have been selected.

5.7h(6) Annual Determination of Flow Rate and Direction

The depth-to-water measurements taken before sampling (as described in Section 5.5d) will be used in determining the flow rate and direction in the uppermost aquifer. These measurements will be used to produce water-table maps and thereby determine the hydraulic gradient and the flow direction. This information, together with Darcy's Law, will be used to determine the flow rate. The regulations require that this determination be made at least annually. Because of this facility's proximity to the river (and the resulting seasonal changes in the groundwater flow system), it may be appropriate to make this determination on a more frequent basis. Data to be collected under the interim status program will help to establish the seasonal variability in the flow patterns and should be of use in deciding whether an annual determination is sufficient.

5.7h(7) Statistical Determination

Appropriate statistical techniques will be used to determine if there has been a significant increase over background values or concentration limits for each

constituent measured at the compliance point. The statistical techniques proposed for use in evaluating the interim status data (and, ultimately, the data collected under final status) are outlined in the following section.

5.7h(7)(a) Data Handling and Statistical Evaluation Procedures

The analytical data provided by the laboratory will be entered into the Hanford Groundwater Data Base maintained by PNL. This computerized data base is used to store water-quality data, hydrographs, well-structure descriptions, and drilling logs for the monitoring wells at the Hanford Site. Once entered into the data base, the analytical data can be accessed for manipulation and evaluation using various programs, or they can be printed out in a number of different formats.

Evaluation of the data will be conducted using appropriate statistical and graphical techniques. The regulations do not specify the techniques to be used for data evaluation under compliance monitoring programs, although they do stipulate use of a particular version of the Student's t-test for detection monitoring programs. According to the regulations, the t-test (or some alternate method, if approved) is to be used for comparing results from downgradient wells with a specific concentration limit or with results from upgradient wells. The purpose of this comparison is to determine if dangerous waste constituents from the facility have entered the groundwater. However, this particular version of the t-test has certain flaws which make it less than optimum for this application. Specific problems associated with use of the t-test are discussed below.

First, the regulations require that replicate measurements be made. Experience has shown that the replicate measurements frequently provide redundant information, i.e., the replicates are not statistically independent. The effect of this is to overspecify the degrees of freedom, a parameter needed when judging the statistical significance of the calculated t statistic. The end result is that the test tends to indicate a significant difference between upgradient and downgradient wells when that is really not the case.

Second, the t-test does not take into account spatial variation in upgradient well concentrations if only one upgradient well is sampled (the minimum requirement). The end result will be the same as in the previous paragraph,

i.e., a tendency to falsely conclude from the test that the facility is leaking. This results because the variance of the estimated upgradient mean will be underestimated.

This problem with false positive results may be accentuated when the t-test is used for evaluating data from a compliance monitoring program, because of the high number of statistical comparisons that will be made under this type of monitoring program. Therefore, if the t-test is to be used for data evaluations under a compliance program, it may be necessary to use a higher level of significance than the 0.05 level that is normally required (Geotrans, 1983).

In addition to the problem of false positive test results, the test may not detect contamination because temporal (e.g., seasonal) variation in upgradient concentrations is not effectively taken into account. The pooling of quarterly data as specified in the regulations averages over the seasons, which has the effect of reducing the sensitivity (power) of the t-test to detect leakage of dangerous waste constituents from the facility. This problem can be avoided if point-in-time comparisons are made, using data collected from upgradient and downgradient wells simultaneously. This type of approach is, however, more costly, so the potential benefits must be weighed carefully before taking this tack.

Finally, the t-test requires the measurements to be at least approximately normally distributed. When this is not the case the performance of the t-test can be adversely affected, particularly if the number of measurements taken at upgradient and downgradient wells are far from being equal. This problem can be overcome by using a suitable nonparametric test or by an appropriate transformation of the data before computing the t-test. Other problems with the t-test are discussed in JRB Associates (1983).

Because of these problems with the t-test, other data evaluation techniques may be more appropriate for use in this effort. The applicability of these other techniques cannot be determined with certainty until the data are available for examination. The first statistical evaluations of the interim status data area planned for December 1985, and the appropriate statistical techniques will be determined and applied at that time. A description of the chosen

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techniques will be contained in the report of results to be prepared by April 1986. However, some of the techniques that may be appropriate are discussed below.

Methods involving graphical depiction of the data may be useful. One such method involves plotting the concentration data for each well over time. Another graphical method involves producing quality-control charts with upper and lower warning/action limits.

Other data evaluation techniques that may be used involve tests for long-term trends. Two of these tests are the Mann-Kendall test and the seasonal Kendall test (Van Belle and Hughes, 1984).

Tests for outliers can also be conducted. This type of test is routinely conducted on data entered into the Hanford Groundwater Data Base. Each new analytical data point for a given well is checked for conformance with the trend set by that well's recent history, using a program called ANATREND. Based on the established trend for the well, the program computes the predicted value for the next sampling date and sets an upper and lower limit of 2.09 standard deviations. Exactly 95 percent of the values are expected to fall within these limits and a new data point is consideed an outlier if it falls outside these limits. The date when the concentration in a given well is expected to exceed a critical safety limit or fall below a sensor detection limit can also be predicted by ANATREND.

The techniques mentioned above (as well as others that may be useful) will be checked for applicability when more data from the interim status monitoring program become available. At this point in time, when so few data are available from the interim status program, it is difficult to make decisions concerning the approach to be taken at some time in the future when a permit is granted. However, it is anticipated that some decisions concerning the evaluation techniques to be used in final status can be made after some initial assessments of the interim status data are completed.

5.7h(7)(b) Reporting of Results

Results of the statistical evaluation will be available (barring unforeseen problems) within about three months of sampling. As explained below, a three-month period is needed to accomplish all of the steps involved, including sample analysis, data entry, and statistical data evaluation.

Normally, the analytical laboratory is allowed one month to conduct the analyses and report the results, but delays are sometimes incurred, causing the results to be late. Once the analytical data are received from the laboratory, it can take as long as two or three weeks to enter the data into the database and complete preliminary checks. Finally, four to six weeks are required to perform the statistical evaluation and prepare a report containing the results. Therefore, a total of about 11 to 13 weeks (about three months) is considered to be necessary and reasonable for completion of this task.

5.8 CORRECTIVE ACTION PROGRAM

Appropriate corrective actions cannot be determined until the plume has been described. The interim status program is designed to provide this description, but (as mentioned previously) the presently available monitoring data are not sufficient. Therefore, plans for a corrective action program will be determined after enough data are collected (probably at the end of the first year of interim status monitoring). It is anticipated that alternate concentration limits will be proposed and the justification for these will be provided.

TABLE 5-1
300 AREA ASSESSMENT PARAMETERS

CONSTITUENT	MINIMUM DETECTABLE CONCENTRATION (MDC), μg/l*	SAMPLE SIZE**
Barium	6	200 ml
Cadmium	2	
Chromium	10	
Lead	30	
Silver	10	
Sodium	100	
Nickel	10	
Copper	10	
Vanadium	5	
Antimony	100	
Aluminum	150	
Manganese	5	
Potassium	100	
Iron	50	
Arsenic	5	100 ml
Mercury	0.1	200 ml
Selenium	5	100 ml
Cyanide	10	1 liter
Nitrate	500	50 ml
Sulfate	500	
Fluoride	500	
Chloride	500	
Phosphate	1 mg/l	
Perchlorate	1 mg/l	50 ml
Radium	1 pCi/l	1 liter
Gross alpha	4 pCi/l	1 liter
Gross beta	8 pCi/l	1 liter
TOC	1 mg/l	250 ml
Ammonium ion	50	100 ml
TOX	0.1 mg/l	250 ml

*MDC units except where indicated.

**Constituents grouped together within brackets are analyzed by the same method, using one sample of the size indicated.

(a) Most probable number.

(b) Field measurement.

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TABLE 5-1
(Continued)

CONSTITUENT	MINIMUM DETECTABLE CONCENTRATION (MDC), µg/l*	SAMPLE SIZE**
Endrin	1	1 liter
Methoxychlor	1	
Toxaphene	1	
Alpha-BHC	1	
Beta-BHC	1	
Gamma-BHC	1	
Delta-BHC	1	
2,4-D	1	1 liter
2,4,5-TP silvex	1	
Hydrazine	3 mg/l	5 ml
Hexachlorophene	10	1 liter
Naphthalene	10	
Chlorinated benzenes	10	
Phenol	10	
Coliform bacteria	3 mpn[a]	100 ml
Temperature	0.1°C	(b)
Specific conductance	1 µmho	(b)
pH	0.01 pH unit	(b)

*MDC units except where indicated.

**Constituents grouped together within brackets are analyzed by the same method, using one sample of the size indicated.

(a) Most probable number.

(b) Field measurement.

TABLE 5-2
(Continued)

CONSTITUENT	MINIMUM DETECTABLE CONCENTRATION (MDC), µg/l*	SAMPLE SIZE**
Paraldehyde	3 mg/l	5 ml
Cyanogen bromide	3 mg/l	
Cyanogen chloride	3 mg/l	
Acrylamide	3 mg/l	
Allyl alcohol	3 mg/l	
Chloral	3 mg/l	
Chloroacetaldehyde	3 mg/l	
3-chloropropionitrile	3 mg/l	
Cyanogen	3 mg/l	
Dichloropropanol	3 mg/l	
1,4-dioxane	3 mg/l	
Ethyl carbamate	3 mg/l	
Ethyl cyanide	3 mg/l	
Ethylene oxide	3 mg/l	
Ethyl methacrylate	3 mg/l	
Fluoroacetic acid	3 mg/l	
Glycidylaldehyde	3 mg/l	
Isobutyl alcohol	3 mg/l	
Methyl hydrazine	3 mg/l	
n-propylamine	3 mg/l	
2-propyn-1-ol	3 mg/l	
Carbophenothion	2	1 liter
Tetraethylpyrophosphate	100	1 liter
Disulfoton	2	
Dimethoate	5	
Methyl parathion	2	
Parathion	2	
Formalin	500	40 ml
Strychnine	50	1 liter
Maleic hydrazide	500	
Nicotinic acid	100	
Citrus red #2	1	1 liter
Additional 9905 volatiles(b)	10	40 ml
Additional 9905 semi-volatiles(b)	10	40 ml

*MDC units except where indicated

**Constituents grouped together within brackets are analyzed by the same method, using one sample of the size indicated.

(a)Minimum Detectable Concentration has not yet been determined.

(b)Listed in Appendix E.

TABLE 5-2
ADDITIONAL PARAMETERS FROM THE 9905 LIST

CONSTITUENT	MINIMUM DETECTABLE CONCENTRATION (MDC), µg/l*	SAMPLE SIZE**
Beryllium	5	200 ml
Osmium	300	
Strontium	300	
Zinc	5	
Calcium	50	
Thallium	10	200 ml
Thiourea	200	1 liter
1-acetyl-2-thiourea	200	
1-(o-chlorophenyl)thiourea	200	
diethylstilbesterol	200	
ethylenethiourea	200	
1-naphthyl-2-thiourea	200	
N-nitroso-N-ethylurea	(a)	
N-nitroso-N-methylurea	(a)	
N-phenylthiourea	200	
DDD	1	1 liter
DDE	1	
DDT	1	
Heptachlor	1	
Heptachlor epoxide	1	
Kepone	1	
Dieldrin	1	
Aldrin	1	
Chlordane	1	
Endosulfan	1	
Chlorobenzilate	100	
2,4,5-T	1	1 liter

*MDC units except where indicated.

**Constituents grouped together within brackets are analyzed by the same method, using one sample of the size indicated.

(a)Minimum Detectable Concentration has not yet been determined.

(b)Listed in Appendix E.

TABLE 5-3

RESULTS OF CHEMICALS ANALYSES FOR JUNE, 1985 (METALS)[a]

CONCENTRATION (μg/l)

	399-2-1	399-1-1					399-1-2					399-1-3	399-1-4
		REP-1	REP-2	REP-3	REP-4	MEAN[b]	REP-1	REP-2	REP-3	REP-4	MEAN[b]		
Aluminum	159	246	179	219	317	240	326	292	<150	214	<245	<150	<150
Arsenic	5	8	17	7	<5	<9	<5	<5	<5	<5	<5	<5	5
Barium	68	42	32	34	44	38	30	719	46	15	202	<6	20
Cadmium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Copper	16	20	21	21	21	21	13	10	17	<10	<12	28	23
Iron	4,930	353	161	97	275	221	126	166	173	306	193	91	403
Lead	55*	106*	109*	133*	162*	127*	118*	141*	173*	<30	115*	<30	38
Manganese	39	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Potassium	3,670	2,910	2,760	2,840	3,340	2,962	3,780	3,790	3,770	3,510	3,712	3,280	2,230
Sodium	15,000	13,400	13,400	13,000	13,600	13,350	13,300	13,200	15,500	14,300	14,075	21,500	7,870
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	10	19	17	21	26	21	29	30	14	14	22	<5	9
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--

* Result is above the Primary Drinking Water Standard. These lead results were obtained using the Inductively Coupled Plasma Method Subsequent analyses by graphite furnace yielded results below the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than"values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-3
(Continued)

CONCENTRATION (μg/l)

	399-8-2 (upgradient)	399-4-1	399-4-7 REP-1	399-4-7 REP-2	399-4-7 REP-3	399-4-7 REP-4	399-4-7 MEAN(b)	399-3-10 REP-1	399-3-10 REP-2	399-3-10 REP-3	399-3-10 REP-4	399-3-10 MEAN(b)	699-S19-E13 (upgradient)
Aluminum	154	270	296	347	337	188	292	495	344	168	206	303	482
Arsenic	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6
Barium	42	<6	<6	<6	<6	212	<60	<6	<6	<6	<6	<6	50
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	45,600
Chromium	<10	<10	<10	<10	28	<10	<20	<10	<10	10	<10	<10	<10
Copper	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	18
Iron	557	641	<50	<50	154	66	80	321	308	513	250	348	640
Lead	45	99*	96*	103*	60*	70*	82*	77*	89*	72*	72*	77.5*	126*
Manganese	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Potassium	5,240	5,600	5,730	6,310	5,880	5,120	5,760	4,530	4,400	4,370	4,340	4,410	7,390
Sodium	17,300	19,400	21,300	22,900	21,500	18,400	21,000	13,700	13,100	14,500	13,300	13,650	22,800
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	10
Vanadium	23	<5	<5	<5	<5	18	<8	<5	<5	<5	<5	<5	36
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	23

* Result is above the Primary Drinking Water Standard. These lead results were obtained using the Inductively Coupled Plasma Method. Subsequent analyses by graphite furnace yielded results below the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than"values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-3
(Continued)

CONCENTRATION (μg/l)

	699-S30-E15A	399-1-5	399-1-6	399-3-7
Aluminum	395	<150	<150	564
Arsenic	<5	<5	9	23
Barium	<6	7	35	50
Calcium	--	21,400	--	--
Chromium	<10	<10	<10	<10
Copper	<10	43	35	11
Iron	218	431	758	290
Lead	81*	<30	44	140*
Manganese	<5	<5	<5	<5
Potassium	8,210	3,210	2,610	6,820
Sodium	18,700	14,400	8,260	24,000
Thallium	--	<10	--	--
Vanadium	<5	<5	14	34
Zinc	--	8	--	--

* Result is above the Primary Drinking Water Standard. These lead results were obtained using the Inductively Coupled Plasma Method. Subsequent analyses by graphite furnace yielded results below the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent

NA Result is not available yet

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than"values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-4

RESULTS OF CHEMICAL ANALYSES FOR JUNE, 1985[a]

CONCENTRATION (μg/l)

	399-2-1	399-1-1					399-1-2					399-1-3	399-1-4
		REP-1	REP-2	REP-3	REP-4	MEAN[b]	REP-1	REP-2	REP-3	REP-4	MEAN[b]		
Ions													
Fluoride	360	380	380	440	380	395	360	400	360	400	380	500	460
Chloride	26,000	8000	8100	8500	8500	8275	8500	9000	8500	860	6715	14,900	8000
Nitrate	23,000	22,000	22,500	22,500	23,000	22,500	22,000	38,000	20,000	21,000	25,250	20,400	18,000
Phosphate	<1000	<1000[c]	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Ammonium	20	9	12	18	23	16	16	11	26	25	20	18	20
Sulfate	17,000	17,000	18,000	18,000	18,500	17,875	24,000	23,500	23,500	23,000	23,500	18,400	17,000
Sulfide	200	<200	200	200	1,000	<400	3,000	<200	<200	200	<900	600	400
Contamination Indicators													
TOX	--	--	--	--	--	--	--	--	--	--	--	--	--
TOC	--	--	--	--	--	--	--	--	--	--	--	--	--

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

1. All other parameters listed in Table 5-1 were analyzed for but were below detection limits in all monitoring wells.

2. Remaining parameters listed in Table 5-2 were not detected in wells 699-519-E13 and 399-1-5.

[a] Only the constituents with detectable concentrations in one or more samples are listed on the table.

[b] In calculating the mean, "less than"values were used as actual values, and the "<" symbol was carried through to the mean.

[c] The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

[d] These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-4

(Continued)

CONCENTRATION (μg/l)

	399-8-2 (upgradient)	399-4-1	399-4-7					399-3-10					699-S19-E13 (upgradient)
			REP-1	REP-2	REP-3	REP-4	MEAN	REP-1	REP-2	REP-3	REP-4	MEAN	
Ions													
Fluoride	300	310	400	350	320	410	370	350	350	420	420	385	260
Chloride	8,000	11,900	13,800	14,000	13,700	13,600	13,800	12,800	11,900	14,400	14,200	13,300	12,600
Nitrate	16,000	12,500	20,200	20,000	18,800	20,700	19,900	22,500	21,000	22,800	23,100	22,400	16,500
Phosphate	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Ammonium	11	16	15	14	16	16	15.3	19	29	20	19	22	14
Sulfate	25,000	32,300	27,100	28,100	27,800	34,500	29,400	18,200	18,300	19,500	19,400	18,900	44,000
Sulfide	600	1,000	600	600	400	300	500	600	400	600	<200	<500	200
Contamination Indicators													
TOX	--	--	--	--	--	--	--	--	--	--	--	--	<20
TOC	--	--	--	--	--	--	--	--	--	--	--	--	600

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

1. All other parameters listed in Table 5-1 were analyzed for but were below detection limits in all monitoring wells.

2. Remaining parameters listed in Table 5-2 were not detected in wells 699-519-E13 and 399-1-5.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than"values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-4
(Continued)

	CONCENTRATION (μg/l)			
	699-S30-E15A	399-1-5	399-1-6	399-3-7
Ions				
Fluoride	170	520	500	340
Chloride	4,700	8,000	7,000	12,000
Nitrate	15,200	17,500	18,000	13,000
Phosphate	<1000	<1000	<1000	<1000
Ammonium	15	23	20	11
Sulfate	18,000	19,500	17,000	36,000
Sulfide	400	400	200	600
Contamination Indicators				
TOX	--	72	--	--
TOC	--	1,400	--	--

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

1. All other parameters listed in Table 5-1 were analyzed for but were below detection limits in all monitoring wells.

2. Remaining parameters listed in Table 5-2 were not detected in wells 699-519-E13 and 399-1-5.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than" values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-5

RESULTS OF CHEMICAL ANALYSES FOR JUNE, 1985 (VOLATILE ORGANICS)[a]

CONCENTRATION (μg/l)

	399-T-1[a]	399-2-1	399-1-1					399-1-2					399-1-3	399-1-4
			REP-1	REP-2	REP-3	REP-4	MEAN[b]	REP-1	REP-2	REP-3	REP-4	MEAN[b]		
Volatile Organics														
Chloroform	--	13	30	30	28	26	28	15	15	15	17	15	42	30
Trichloroethene	--	<10[c]	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than" values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-5
(Continued)

CONCENTRATION (μg/l)

	399-8-2 (UPGRADIENT)	399-4-1	399-4-7					399-3-10					699-S19-E13 (UPGRADIENT)
			REP-1	REP-2	REP-3	REP-4	MEAN	REP-1	REP-2	REP-3	REP-4	MEAN	
Volatile Organics													
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	NA	NA	<10
Trichloroethene	<10	12	<10	<10	<10	<10	<10	<10	<10	<10	NA	NA	<10

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than" values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-5
(Continued)

CONCENTRATION (μg/l)

	699-S30-E15A	399-1-5	399-1-6	399-3-7
Volatile Organics				
Trichloroethene	NA	<10	<10	30
Chloroform	NA	25	38	<10

* Result is above the Primary Drinking Water Standard.

-- No analysis was conducted for this constituent.

NA Result is not available yet.

(a) Only the constituents with detectable concentrations in one or more samples are listed on the table.

(b) In calculating the mean, "less than" values were used as actual values, and the "<" symbol was carried through to the mean.

(c) The "<" symbol indicates that the constituent was below the minimum detectable concentration (MDC), with the MDC being the number following the "<" symbol.

(d) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-6

RESULTS OF RADIOLOGICAL ANALYSES FOR JUNE, 1985

ACTIVITY (pCi/l)[a]

		399-2-1	399-1-1	399-1-2	399-1-3	399-1-4	399-8-2	399-4-1 (UPGRADIENT)	399-4-7
Radium	REP-1	0.124±.276[b]	0.0925±.207[b]	0.875±.473	0.0176±.169[b]	0.718±.416	0.0585±.203[b]	0.138±.183[b]	0.150±.273[b]
	REP-2	--	0.275±.298[b]	-0.0237±.206[b,c]	--	--	--	--	0.0422±.169
	REP-3	--	0.240±.333[b]	-0.108±.0962[b,c]	--	--	--	--	0.0124±.115
	REP-4	--	0.484±.374	0.0437±.205[b]	--	--	--	--	0.0525±.105
	MEAN[d]	--	0.273±.174[b]	0.197±.268[b]	--	--	--	--	0.0643±.094
Gross Alpha	REP-1	17.4±2.24*	22.6±2.66*	17.1±2.26*	34.3±3.16*	11.2±1.71	2.88±1.05	1.31±.238	18.1±2.35*
	REP-2	--	18.0±2.26*	16.7±2.27*	--	--	--	--	19.9±2.29*
	REP-3	--	22.2±2.39*	13.7±2.04	--	--	--	--	23.6±2.71*
	REP-4	--	15.1±2.40*	14.9±2.13	--	--	--	--	10.7±1.50
	MEAN[d]	--	19.5±2.17*	15.6±1.35*	--	--	--	--	18.1±2.94*
Gross Beta	REP-1	9.75±1.02	6.11±.828	5.09±1.81	18.5±1.35	4.99±.864	5.19±.851	8.18±1.00	16.6±1.33
	REP-2	--	5.99±.873	6.16±1.92	--	--	--	--	16.1±1.33
	REP-3	--	5.64±.820	6.42±2.19	--	--	--	--	15.0±1.35
	REP-4	--	6.07±.931	7.10±.951	--	--	--	--	16.5±1.32
	MEAN[d]	--	5.95±.445	6.19±.983	--	--	--	--	16.1±.760

TABLE 5-6
(Continued)

		ACTIVITY (pCi/l)[a]					
		399-3-10	699-S19-E13 (UPGRADIENT)	699-S30-E15A	399-1-5	399-1-6	399-3-7
Radium	REP-1	0.0316±.100[b]	0.160±.271[b]	-0.0188±.135[b]	0.151±.261[b]	0.0213±.205[b]	0.0210±.173[b]
	REP-2	0.0221±.0915[b]	--	--	--	--	--
	REP-3	0.0653±.109[b]	--	--	--	--	--
	REP-4	0.155±.161[b]	--	--	--	-	--
	MEAN[d]	0.0685±.0665	--	--	--	-	--
Gross Alpha	REP-1	16.1±2.18*	1.21±.327	NA	7.73±1.46	14.0±1.92	8.17±1.61
	REP-2	6.74±1.29	--	--	--	--	--
	REP-3	19.1±2.40*	--	--	--	--	--
	REP-4	8.37±1.48	--	--	--	--	--
	MEAN[d]	12.6±3.13	--	--	--	--	--
Gross Beta	REP-1	11.7±1.14	5.00±.844	39.9±2.06	8.52±1.13	4.26±.774	5.88±.937
	REP-2	10.6±1.09	--	--	--	--	--
	REP-3	13.1±1.19	--	--	--	--	--
	REP-4	11.4±1.08	--	--	--	--	--
	MEAN[d]	11.7±.767	--	--	--	--	--

FOOTNOTES FOR TABLE 5-6

- No Sample

* Result is above the Primary Drinking Water Standard.

NA Result not available.

(a) Result includes two standard deviations above and below the mean.

(b) Result is less than the overall error.

(c) A negative number indicates that the activity in the sample was lower than the background activity.

(d) The mean was calculated as the average of the measurements ± the standard propagated error (SE) of the mean. The SE was calculated as follows:

$$SE = \frac{\sqrt{\frac{E_1^2 + E_2^2 + \ldots E_n^2}{n} + S^2}}{\sqrt{n}}$$

(e) These data are subject to revision upon receipt of final quality control reports from the laboratory.

TABLE 5-7

REPRESENTATIVE HYDRAULIC PROPERTIES IN THE UPPERMOST AQUIFER*

STRATIGRAPHIC INTERVAL	HYDRAULIC CONDUCTIVITY (ft/day)	(m/day)
Hanford Formation (informal name)	500-20,300	150-6,100
Undifferentiated Hanford and Middle Ringold Unit	100-7,000	30-2,100
Middle Ringold Unit	20-600	6-180
Lower Ringold Unit	0.1-10.0	0.03-3.0

*Modified after Gephart, et al., 1979

TABLE 5-8

WATER QUALITY OF SAMPLES COLLECTED FROM THE BASAL RINGOLD UNIT AND THE HANFORD FORMATION IN WELL 699-10E-12*

	HANFORD FORMATION		BASAL RINGOLD UNIT	
pH	7.5		7.9	
Specific conductance (μmhos/cm)	223		285	
CONSTITUENTS	mg/l	EPM**	mg/l	EPM
HCO_3^-	120.0	1.967	188.0	3.081
Cl^-	5.7	0.161	14.2	0.400
$SO_4^=$	24.0	0.500	3.0	0.062
NO_3	16.8	0.271	0.22	0.004
Total Anions		2.898		3.548
Na^+	20.5	0.892	55.0	2.392
K^+	7.1	0.182	8.6	0.220
Ca^{++}	22.0	1.098	12.0	0.599
Mg^{++}	6.8	0.559	3.7	0.304
Total Cations		2.73		3.516

*After Graham, et al., 1981

**EPM = Equivalent parts per million

TABLE 5-9

RANGES OF HYDRAULIC PROPERTIES IN THE UNDERLYING AQUIFER FROM WELLS DB-13, DB-14, DB-15, AND ARH-DC-1*

AQUIFER	TRANSMISSIVITY		THICKNESS		HYDRAULIC CONDUCTIVITY	
	(m^2/day)	(ft^2/day)	(m)	(ft)	(m/day)	(ft/day)
Elephant Mtn. Interflow [a]	569	6120	0.9	3	622	2040
Rattlesnake Ridge Interbed	0.8-28.5	8-307	15-25	50-82	0.03-1.8	0.10-6
Selah Interbed	0.8-43	9-462	6-11	20-36	0.1-7	0.4-23
Cold Creek Interbed	13-774	141-8326	14-29	46-94	0.5-55	1.50-181
Umatilla Interflow[b]	116	1253	1.8	6	55	179
Matton Interbed	13-177	136-1900	26-34	86-111	0.5-6	1.6-20

*After Graham, et al., 1981

[a] From Well DB-13

[b] From Well DB-15

TABLE 5-10

MEAN AND RANGE OF MAJOR CHEMICAL CONSTITUENT CONCENTRATIONS WITHIN GROUNDWATER IN THE UNDERLYING AQUIFER (MABTON INTERBED)*

CONSTITUENT	CONCENTRATION RANGE (mg/l)	CONCENTRATION MEAN (mg/l)
Anions		
HCO_3^-	169-267	217
Cl^-	4.3-63	20
$SO_4^=$	0.3-18	4.0
NO_3^-	<0.5	<0.5
F^-	0.1-8	2.2
Cations		
Na^+	36-122	83
K^+	7.7-14	11
Ca^{++}	0.5-22	4.7
Mg^{++}	0.1-12	1.8

*Modified after Gephart, et al., 1979

TABLE 5-11

CALCULATED PUMPING TIMES

WELL NUMBER	CALCULATED TIME (min.)
(399) 1-1	30
1-2	42
1-3	25
1-4	34
1-5	4*
1-6	6*
2-1	32
3-7	60
3-10	18
4-1	35
4-7	35
8-2	33
(699) S30-E15A	9*
S19-E13	12*

*All wells will be pumped a minimum of 15 minutes, even if the calculated time is less.

NOTE: These pumping times are based on voiding three bore-volumes of water from the well at a pumping rate of 10 gpm. To calculate an adjusted pumping time based on a field measurement of flow rate:

1. [size of container (gal) ÷ number of seconds to fill] x 60 = new pumping rate

2. [calculated time (Table 5-11) x 10] ÷ new pumping rate = new pumping time

TABLE 5-12

LIST OF PARAMETERS AND ANALYTICAL METHODS FOR THE GROUNDWATER MONITORING PROGRAM FOR THE 300 AREA PROCESS TRENCHES

CONSTITUENT	COLLECTION[a]/ PRESERVATION[b]	METHOD	DETECTION LIMIT ug/l**
Chromium	P[b], HNO_3 to pH <2	SW-846 #6010	10
Lead			30
Nickel			10
Vanadium			5
Copper			10
Manganese			5
Cadmium			2
Barium			6
Antimony			100
Silver			10
Sodium			100
Aluminum			150
Iron			50
Potassium			100
Mercury	P, HNO_3 to pH <2	SW-846 #7470	.1
Arsenic	P, HNO_3 to pH <2	SW-846 #7060	5
Selenium	P, HNO_3 to pH <2	SW-846 #7740	5
Tetrachloromethane	G, silicon/teflon septa, no headspace	SW-846 #8240	10
Benzene			
Dioxane			
Methylethyl Ketone			
Pyridine			
Toluene			
1,1,1-trichloroethane	G, silicon/teflon septa, no headspace	SW-846 #8240	10
1,1,2-trichloroethane			
1,1,2-trichloroethylene			
Perchloroethylene			
Hydrazine	P, None	DAI[c,d]	3 mg/ℓ
Xylene	G, teflon cap	SW-846 #8270	10
Hexachlorophene			
Napthalene			
Phenol			
Chlorinated benzenes			

TABLE 5-12
(Continued)

CONSTITUENT	COLLECTION[a]/ PRESERVATION[b]	METHOD	DETECTION LIMIT µg/l**
		#9010	
Sulfide	P, 2 ml zinc acetate + NaOH to pH >9	SW-846 #9030	1 mg/ℓ
Thiourea	G, None	SW-846 #8330	200
Formadelhyde	P, None	DAI[c,d]	500
Radium	P, HNO_3 to pH <2	EPA Method #903.0	1 pCi/l
Gross alpha	P, HNO_3 to pH <2	EPA Method 680/4-75-001	4 pCi/l
Gross beta			8 pCi/l
Coliform bacteria	P, None	Std. Methods #908C	3 mpn* (most probable number)
Total organic halogen	G, silicon/teflon septa, no headspace	SW-846 #9020	0.1 mg/ℓ
Total organic carbon	G, H_2SO_4 to pH 2	Std. Methods #505	1 mg/ℓ
Specific conductance	Field measurement	See Sec. 5-5c(1)(c)	1 µmho
pH	Field measurement	See Sec. 5-5c(1)(d)	0.01 pH unit
Temperature	Field measurement	See Sec. 5-5c(1)(e)	0.1°C
Chloride	P, None	IC[e,c]	500
Fluoride			500
Sulfate			500
Phosphate			1 mg/ℓ
Nitrate			500
Kerosene	G, None	GC/FID[f,c]	10 mg/ℓ
Ammonium	G, H_2SO_4 to pH <2	Std. Methods #417-A-E	50
Ethylene glycol	G, None	GC/FID[f,c]	10 mg/ℓ

TABLE 5-12
(Continued)

CONSTITUENT	COLLECTION[a]/ PRESERVATION[b]	METHOD	DETECTION LIMIT µg/l**
Endrin Lindane Methoxychlor Toxaphene	G, None	SW-846 #8080	1
2,4-D 2,4,5-TP Silvex	G, None	SW-846 #8150	1
Dioxin	G, None		0.1 mg/ℓ

[a]P = plastic, G = glass.

[b]All samples will be cooled to 4°C upon collection.

[c]In-house analytical method.

[d]DAI = Direct Aqueous Injection.

[e]IC = Ion Chromatography.

[f]GC/FID = Gas Chromatography/Flame Ionization Detection.

*Most probable number.

**Detection Limit units except where indicated.

0110487109

TABLE 5-13
DANGEROUS WASTE CONSTITUENTS LIST

	CONSTITUENT	METHOD[a]
1	Acetonitrile	SW-846, 8270
2	Acetophenone	SW-846, 8270
3	Warfarin	SW-846, 8270
4	2-Acetylaminofluorene	SW-846, 8270
5	Acetyl chloride	Unstable[b]
6	1-Acetyl-2-thiourea	SW-846, 8330
7	Acrolein	SW-846, 8240
8	Acrylamide	GC/MS, Dir. Inj.
9	Acrylonitrile	SW-846, 8240
10	Aflatoxins	Exotic[b]
11	Aldrin	SW-846, 8080
12	Allyl alcohol	GC/MS, Dir. Inj.
13	Aluminum phosphide	Unstable[b]
14	4-Aminobiphenyl	SW-846, 8270
15	Mitomycin C	Exotic[b]
16	5-(Aminomethyl)-3-isoxazolol	SW-846, 8270
17	Amitrole	SW-846, 8270
18	Aniline	SW-846, 8270
19	Antimony and compounds	SW-846, 6010
20	Aramite	SW-846, 8270
21	Arsenic and compounds	SW-846, 7060
22	Arsenic acid	SW-846, 7060
23	Arsenic pentoxide	SW-846, 7060
24	Arsenic trioxide	SW-846, 7060
25	Auramine	SW-846, 8270
26	Azaserine	Exotic[b]
27	Barium and compounds	SW-846, 6010
28	Barium cyanide	SW-846, 6010
29	Benz(c)acridine	SW-846, 8270
30	Benz(a)anthracene	SW-846, 8270
31	Benzene	SW-846, 8240
32	Benzenearsonic acid	SW-846, 7060
33	Benzene, dichloromethyl	SW-846, 8270
34	Benzenethoil	SW-846, 8270
35	Benzidine	SW-846, 8270
36	Benzo(b)fluoranthene	SW-846, 8270
37	Benzo(j)fluoranthene	SW-846, 8270
38	Benzo(a)pyrene	SW-846, 8270
39	p Benzoquinone	SW-846, 8270
40	Benzotrichloride	Unstable[b]
41	Benzyl chloride	SW-846, 8270
42	Beryllium and compounds	SW-846, 6010
43	Bis(2-chloroethoxy)methane	SW-846, 8270
44	Bis(2-chloroethyl) ether	SW-846, 8270
45	Chlornaphazine	SW-846, 8270
46	Bis(2-chloroisopropyl) ether	SW-846, 8270
47	Bis(chloromethyl) ether	SW-846, 8240

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
48	Bis(2-ethylhexyl) phthalate	SW-846, 8270
49	Bromoacetone	SW-846, 8240
50	Methyl bromide	SW-846, 8240
51	4-Bromophenyl phenyl ether	SW-846, 8270
52	Brucine	Exotic[b]
53	2-Butanone peroxide	Unstable[b]
54	Butyl benzyl phthalate	SW-846, 8270
55	2-sec-Butyl-4,6-dinitrophenol	SW-846, 8270
56	Cadmium and compounds	SW-846, 6010
57	Calcium chromate	SW-846, 6010
58	Calcium cyanide	SW-846, 9010
59	Carbon disulfide	SW-846, 8240
60	Carbon oxyfluoride	Unstable[b]
61	Chloral	GC/MS, Dir. Inj.
62	Chlorambucil	Exotic[b]
63	Chlordane	SW-846, 8080
64	Chlorinated benzenes	SW-846, 8270
65	Chlorinated ethane	SW-846, 9020
66	Chlorinated fluorocarbons	SW-846, 9020
67	Chlorinated naphthalene	SW-846, 9020
68	Chlorinated phenol	SW-846, 9020
69	Chloroacetaldehyde	GC/MS, Dir. Inj.
70	Chloroalkyl ethers	SW-846, 8270
71	P-Chloroaniline	SW-846, 8270
72	Chlorobenzene	SW-846, 8240
73	Chlorobenzilate	AOAC - 6.431
74	p-Chloro-m-cresol	SW-846, 8270
75	1-Chloro-2,3-epoxypropane	SW-846, 8270
76	2-Chloroethyl vinyl ether	SW-846, 8240
77	Chloroform	SW-846, 8240
78	Methyl chloride	SW-846, 8240
79	Chloromethyl methyl ether	SW-846, 8240
80	2-Chloronaphthalene	SW-846, 8270
81	2-Chlorophenol	SW-846, 8270
82	1-(o-Chlorophenyl)thiourea	SW-846, 8330
83	3-Chloropropionitrile	GC/MS, Dir. Inj.
84	Chromium and compounds	SW-846, 6010
85	Chrysene	SW-846, 8270
86	Citrus red No. 2	AOAC - 34.015 B
87	Coal tars	SM-505
88	Copper cyanide	SW-846, 6010
89	Creosote	SM-505
90	Cresols	SW-846, 8270
91	Crotonaldehyde	SW-846, 8240
92	Cyanides	SW-846, 9010
93	Cyanogen	GC/MS, Dir. Inj.
94	Cyanogen bromide	AOAC - 34.015 B

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
95	Cyanogen chloride	AOAC - 34.015 B
96	Cycasin	Exotic[b]
97	2-Cyclohexyl-4,6-dinitrophenol	SW-846, 8270
98	Cyclophosphamide	Exotic[b]
99	Daunomycin	Exotic[b]
100	DDD	SW-846, 8080
101	DDE	SW-846, 8080
102	DDT	SW-846, 8080
103	Diallate	Exotic[b]
104	Dibenz(a,h)acridine	SW-846, 8270
105	Dibenz(a,j)acridine	SW-846, 8270
106	Dibenz(a,h)anthracene	Sw-846, 8270
107	7H-Dibenzo(c,g)carbazole	SW-846, 8270
108	Dibenzo(a,e)pyrene	SW-846, 8270
109	Dibenzo(a,h)pyrene	SW-846, 8270
110	Dibenzo(a,i)pyrene	SW-846, 8270
111	1,2-Dibromo-3-chloropropane	SW-846, 8240
112	1-2-Dibromoethane	SW-846, 8240
113	Dibromomethane	SW-846, 8240
114	Di-n-butyl phthalate	SW-846, 8270
115	Benzene, 1,2-dichloro	SW-846, 8270
116	Benzene, 1,3-dichloro	SW-846, 8270
117	Benzene, 1,4-dichloro	SW-846, 8270
118	Dichlorobenzene	SW-846, 9020
119	3,3'-Dichlorobenzidine	SW-846, 8270
120	1,4-Dichloro-2-butene	SW-846, 8240
121	Dichlorodifluoromethane	SW-846, 8240
122	1,1-Dichloroethane	SW-846, 8240
123	1,2-Dichloroethane	SW-846, 8240
124	trans-1,2-Dichloroethene	SW-846, 8240
125	Dichloroethylene	SW-846, 9020
126	1,1-Dichloroethylene	SW-846, 8240
127	Methylene chloride	SW-846, 8240
128	2,4-Dichlorophenol	SW-846, 8270
129	2,6-Dichlorophenol	SW-846, 8270
130	2,4-D	SW-846, 8150
131	Dichlorophenylarsine	SW-846, 7060
132	Dichloropropane	SW-846, 9020
133	1,2-Dichloropropane	SW-846, 8240
134	Dichloropropanol	GC/MS, Dir. Inj.
135	Dichloropropene	SW-846, 9020
136	1,3-Dichloropropene	SW-846, 8240
137	Dieldrin	SW-846, 8080
138	1,2:3,4-Diepoxybutane	Unstable[b]
139	Diethylarsine	SW-846, 7060
140	N,N-Diethylhydrazine	SW-846, 8240
141	Carbophenothion	AOAC -29.039

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
142	0,0-Diethylphosphoric acid, 0-p-nitrophenyl ester	Exotic[b]
143	Diethyl phthalate	SW-846, 8270
144	Thionazin	Exotic[b]
145	Diethylstilbesterol	SW-846, 8330
146	Dihydrosafrole	SW-846, 8270
147	3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alcohol	Exotic[b]
148	Diisopropylfluorophosphate	Unstable[b]
149	Dimethoate	SW-846, 8140
150	3,3'-Dimethoxybenzidine	SW-846, 8270
151	p-Dimethylaminoazobenzene	SW-846, 8270
152	7,12-Dimethylbenz(a)anthracene	SW-846, 8270
153	3,3'Dimethylbenzidine	SW-846, 8270
154	Dimethylcarbamoyl chloride	Unstable[b]
155	1,1-Dimethylhydrazine	SW-846, 8240
156	1,2-Dimethylhydrazine	SW-846, 8240
157	Thiofanox	SW-846, 8270
158	alpha,alpha-Dimethylphenethylamine	SW-846, 8270
159	2,4-Dimethylphenol	SW-846, 8270
160	Dimethyl phthalate	SW-846, 8270
161	Dimethyl sulfate	Unstable[b]
162	Dinitrobenzene	SW-846, 8270
163	4,6-Dinitro-o-cresol and salts	SW-846, 8270
164	2,4-Dinitrophenol	SW-846, 8270
165	2,4-Dinitrotoluene	SW-846, 8270
166	2,6-Dinitrotoluene	SW-846, 8270
167	Di-n-octyl phthalate	SW-846, 8270
168	1,4-Dioxane	SW-846, 8240
169	Diphenylamine	SW-846, 8270
170	1,2-Diphenylhydrazine	SW-846, 8270
171	Di-n-propylnitrosamine	SW-846, 8270
172	Disulfoton	SW-846, 8140
173	2,4-Dithiobiuret	Exotic[b]
174	Endosulfan	SW-846, 8080
175	Endrin	SW-846, 8080
176	Ethyl carbamate	GC/MS, Dir. Inj.
177	Ethyl cyanide	GC/MS, Dir. Inj.
178	Ethylenebisdithiocarbamic acid	Exotic[b]
179	Ethyleneimine	SW-846, 8270
180	Ethylene oxide	GC/MS, Dir. Inj.
181	Ethylenethiourea	SW-846, 8330
182	Ethylmethacrylate	GC/MS, Dir. Inj.
183	Ethyl methanesulfonate	SW-846, 8270
184	Fluoranthene	SW-846, 8270
185	Fluorine	Unstable[b]
186	2-Fluoracetamide	Exotic[b]

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
187	Fluoroacetic acid	GC/MS, Dir. Inj.
188	Formaldehyde	Ion Chrom. (In-house)
189	Formic acid	Ion Chrom. (In-house)
190	Glycidylaldehyde	GC/MS, Dir. Inj.
191	Halomethane	SW-846, 9020
192	Heptachlor	SW-846, 8080
193	Heptachlor epoxide	SW-846, 8080
194	Hexachlorobenzene	SW-846, 8270
195	Hexachlorobutadiene	SW-846, 8270
196	Lindane and isomers	SW-846, 8080
197	Hexachlorocylopentadiene	SW-846, 8270
198	Hexachloroethane	SW-846, 8270
199	Hexachlorohexahydro-endo,endo-dimethanonaphthalene	Exotic[b]
200	Hexachlorophene	SW-846, 8270
201	Hexachloropropene	SW-846, 8270
202	Hexaethyl tetraphosphate	Exotic[b]
203	Hydrazine	SW-846, 8270
204	Hydrocyanic acid	SW-846, 9010
205	Hydrofluoric acid	Unstable[b]
206	Hydrogen sulfide	SW-846, 8240
207	Hydroxydimethylarsine oxide	SW-846, 7060
208	Indeno(1,2,3-cd)pyrene	SW-846, 8270
209	Iodomethane	SW-846, 8240
210	Iron Dextran	Exotic[b]
211	Methyl isocyanate	Unstable[b]
212	Isobutyl alcohol	GC/MS, Dir. Inj.
213	Isosafrole	SW-846, 8270
214	Kepone	SW-846, 8080
215	Lasiocarpine	Exotic[b]
216	Lead and compounds	SW-846, 6010
217	Lead acetate	SW-846, 6010
218	Lead phosphate	Sw-846, 6010
219	Lead subacetate	SW-846, 6010
220	Maleic anhydride	Unstable[b]
221	Maleic hydrazide	AOAC - 29.129
222	Malononitrile	SW-846, 8270
223	Melphalan	SW-846, 8270
224	Mercury Fulminate	SW-846, 7470
225	Mercury and compounds	SW-846, 7470
226	Methacrylonitrile	SW-846, 8240
227	Methanethiol	SW-846, 8240
228	Methapyrilene	SW-846, 8270
229	Metholonyl	SW-846, 8270
230	Methoxychlor	SW-846, 8080
231	2-Methylaziridine	SW-846, 8270
232	3-Methylcholanthrene	SW-846, 8270

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
233	Methyl chlorocarbonate	Unstable[b]
234	4,4'-Methylenebis	SW-846, 8270
235	Methyl ethyl ketone	SW-846, 8240
236	Methyl hydrazine	GC/MS, Dir. Inj.
237	2-Methyllactonitrile	SW-846, 8270
238	Methyl methacrylate	SW-846, 8270
239	Methyl methanesulfonate	Sw-846, 8270
240	2-Methyl-2-(methylthio)propionaldehyde -o-(methylcarbonyl) oxime	SW-846, 8270
241	N-Methyl-N'-nitro-N-nitrosoguanidine	Exotic[b]
242	Methyl parathion	SW-846, 8140
243	Methylthiouracil	SW-846, 8270
244	Mustard gas	Exotic[b]
245	Naphthalene	SW-846, 8270
246	1,4-Naphthoquinone	SW-846, 8270
247	1-Naphthylamine	SW-846, 8270
248	2-Naphthylamine	SW-846, 8270
249	1-Naphthyl-2-thiourea	SW-846, 8330
250	Nickel and compounds	SW-846, 6010
251	Nickel carbonyl	SW-846, 6010
252	Nickel cyanide	SW-846, 6010
253	Nicotine and salts	AOAC - 43.444
254	Nitric oxide	Exotic[b]
255	p-Nitroaniline	SW-846, 8270
256	Nitrobenzine	SW-846, 8270
257	Nitrogen dioxide	Unstable[b]
258	Nitrogen mustard and hydrochloride salt	Exotic[b]
259	Nitrogen mustard N-Oxide and hydrochloride salt	Exotic[b]
260	Nitroglycerine	Exotic[b]
261	4-Nitrophenol	SW-846, 8270
262	4-Nitroquinoline-1-oxide	Exotic[b]
263	Nitrosamine	SM-417
264	N-Nitrosodi-n-butylamine	SW-846, 8270
265	N-Nitrosodiethanolamine	SW-846, 8270
266	N-Nitrosodiethylamine	SW-846, 8270
267	N-Nitrosodimethylamine	SW-846, 8270
268	N-Nitroso-N-ethylurea	SW-846, 8330
269	N-Nitrosomethylethylamine	SW-846, 8270
270	N-Nitroso-N-methylurea	SW-846, 8330
271	N-Nitroso-N-methylurethane	SW-846, 8270
272	N-Nitrosomethylvinylamine	SW-846, 8270
273	N-Nitrosomorpholine	SW-846, 8270
274	N-Nitrosonornicotine	SW-846, 8270
275	N-Nitrosopiperidine	SW-846, 8270
276	Nitrosopyrrolidine	SW-846, 8270
277	N-Nitrososacrosine	Exotic[b]

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
278	5-Nitro-o-toluidine	SW-846, 8270
279	Octamethylpyprophosphoramide	Exotic[b]
280	Osmium tetroxide	SW-846, 6010
281	Endothol	Exotic[b]
282	Paraldehyde	Exotic[b]
283	Parathion	SW-846, 8140
284	Pentachlorobenzene	SW-846, 8270
285	Pentachloroethane	SW-846, 8240
286	Pentachloronitrobenzene	SW-846, 8270
287	Pentachlorophenol	SW-846, 8270
288	Phenacetin	SW-846, 8270
289	Phenol	SW-846, 8270
290	Phenylenediamine	SW-846, 8270
291	Phenylmercury acetate	SW-846, 7470
292	N-Phenylthiourea	SW-846, 8330
293	Phosgene	Unstable[b]
294	Phosphine	Exotic[b]
295	Phorate	Unstable[b]
296	Famphur	Unstable[b]
297	Phthalic acid esters	SW-846, 8270
298	Phthalic anhydride	Unstable[b]
299	2-Picoline	SW-846, 8270
300	Polychlorinated biphenyl	SW-846, 8080
301	Potassium cyanide	SW-846, 9010
302	Potassium silver cyanide	SW-846, 6010
303	Pronamide	SW-846, 8270
304	1,3-Propanesultone	Exotic[b]
305	n-Propylamine	GC/MS, Dir. Inj.
306	Propylthiouracil	Exotic[b]
307	2-Propyn-1-ol	GC/MS, Dir. Inj.
308	Pyridine	SW-846, 8240
309	Reserpine	SW-846, 8270
310	Resorcinol	SW-846, 8270
311	Saccharin and salts	Exotic[b]
312	Safrol	SW-846, 8270
313	Selenious acid	SW-846, 7740
314	Selenium and compounds	SW-846, 7740
315	Selenium sulfide	SW-846, 7740
316	Selenourea	SW-846, 7740
317	Silver and compounds	SW-846, 6010
318	Silver cyanide	SW-846, 6010
319	Sodium cyanide	SW-846, 9010
320	Streptozotocin	Exotic[b]
321	Strontium sulfide	SW-846, 6010
322	Strychnine and salts	AOAC - 38.068
323	1,2,4,5-Tetrachlorobenzene	SW-846, 8270
324	TCDD	SW-846, 8270

TABLE 5-13
(Continued)

	CONSTITUENT	METHOD[a]
325	Tetrachloroethane	SW-846, 8240
326	1,1,1,2-Tetrachlorethane	SW-846, 8240
327	1,1,2,2-Tetrachlorethane	SW-846, 8240
328	Tetrachlorethylene	SW-846, 8240
329	Tetrachloromethane	SW-846, 8240
330	2,3,4,6-Tetrachlorophenol	SW-846, 8270
331	Tetraethyldithiopyrophosphate	Unstable[b]
332	Tetraethyl lead	SW-846, 6010
333	Tetraethylpyrophosphate	Exotic[b]
334	Tetranitromethane	Exotic[b]
335	Thallium and compounds	SW-846, 7840
336	Thallic oxide	SW-846, 7840
337	Thallium (1) acetate	SW-846, 7840
338	Thallium (1) carbonate	SW-846, 7840
339	Thallium (1) chloride	SW-846, 7840
340	Thallium (1) nitrate	SW-846, 7840
341	Thallium selenite	SW-846, 7840
342	Thallium (1) sulfate	SW-846, 7840
343	Thioacetamide	Exotic[b]
344	Thiosemicarbazide	Exotic[b]
345	Thiourea	SW-846, 8330
346	Thiuram	SW-846, 8270
347	Toluene	SW-846, 8240
348	Toluenediamine	SW-846, 8270
349	o-Toluidine hydrochloride	SW-846, 8270
350	Tolulene diisocyanate	Unstable[b]
351	Toxaphene	SW-846, 8080
352	Bromoform	SW-846, 8240
353	1,2,4-Trichlorobenzene	SW-846, 8270
354	1,1,1-Trichloroethane	SW-846, 8240
355	1,1,2-Trichloroethane	SW-846, 8240
356	Trichloroethene	SW-846, 8240
357	Trichloromethanethiol	SW-846, 8240
358	Trichloromonofluoromethane	SW-846, 8240
359	2,4,5-Trichlorophenol	SW-846, 8270
360	2,4,6-Trichlorophenol	SW-846, 8270
361	2,4,5-T	SW-846, 8150
362	2,4,5-TP (Silvex)	SW-846, 8150
363	Trichloropropane	SW-846, 8240
364	1,2,3-Trichloropropane	SW-846, 8240
365	0,0,0-Triethyl phosphorothioate	SW-846, 8270
366	sym-Trinitrobenzene	SW-846, 8270
367	Tris(1-aziridinyl) phosphine sulfide	Unstable[b]
368	Tris(2,3-dibromopropyl) phosphate	SW-846, 8270
369	Trypan blue	Exotic[b]
370	Uracil mustard	Exotic[b]
371	Vanadic acid, ammonium salt	SW-846, 6010

TABLE 5-13
(Continued)

CONSTITUENT	METHOD[a]
372 Vanadium pentoxide	SW-846, 6010
373 Vinyl chloride	SW-846, 8240
374 Zinc cyanide	SW-846, 6010
375 Zinc phosphide	Unstable[b]

(a) SW-846: Environmental Protection Agency, 1982, Test Methods for Evaluating Solid Waste - Chemical/Physical Methods, SW-846, EPA, Washington, D.C.

SM: American Public Health Association, 1985, Standard Methods for the Examination of Water and Wastewater, APHA, Washington, D.C.

AOAC: Journal of the Association of Official Analytical Chemists.

(b) Analyses are not being conducted for: 1) constituents that are unstable in water, and 2) exotic constituents for which no analytical method is available.

TABLE 5-14

WASTES POTENTIALLY DISCHARGED TO THE 300 AREA PROCESS TRENCHES

Intermittent Discharges		Larger Discharges*	
<Grams	<kgs		
Ammonium Bifluoride	Benzene	Copper	~30 kg/mo**
Antimony	Carbon Tetrachloride	Detergents	≤30 kg/mo**
Arsenic	Chromium	Ethylene Glycol	≤200 l/mo
Barium	Chlorinated Benzenes	Hydrofluoric Acid	~100 kg/mo
Cadmium	Degreasing Solvents	Nitrates	≤2000 kg/mo**
Dioxane	Formaldehyde	Nitric Acid	≤300 l/mo
Dioxin†	Formic Acid	Sodium Hydroxide	≤300 l/mo
Hydrocyanic Acid	Hexachlorophene	Paint Solvents	≤100 l/mo
Pyridine	Kerosene	Photo Chemicals	≤700 l/mo
Selenium & Compounds	Lead	Sodium Chloride	~75 ton/yr**
Thiourea	Methyl Ethyl Ketone	Uranium	~20 kg/mo**
Misc. Laboratory Chemicals	Mercury	Perchloroethylene	~450 l***
	Napthalene	Heating Oil	~300 l***
	Nickel		
	Phenol		
	Silver		
	Sulfuric Acid		
	Tetrachloroethylene (Perchloroethylene)		
	Toluene		
	Tributylphosphate (Paraffin Hydrocarbon Solvents)		
	1,1,1-Trichloroethane (Methyl Chloroform)		
	Trichloroethylene		
	Xylene		

†Included only because of the potential for Dioxin to exist as a trace impurity in Chlorinated Benzenes.

*These discharges were relatively continuous

**These materials are still discharged

***Known spills

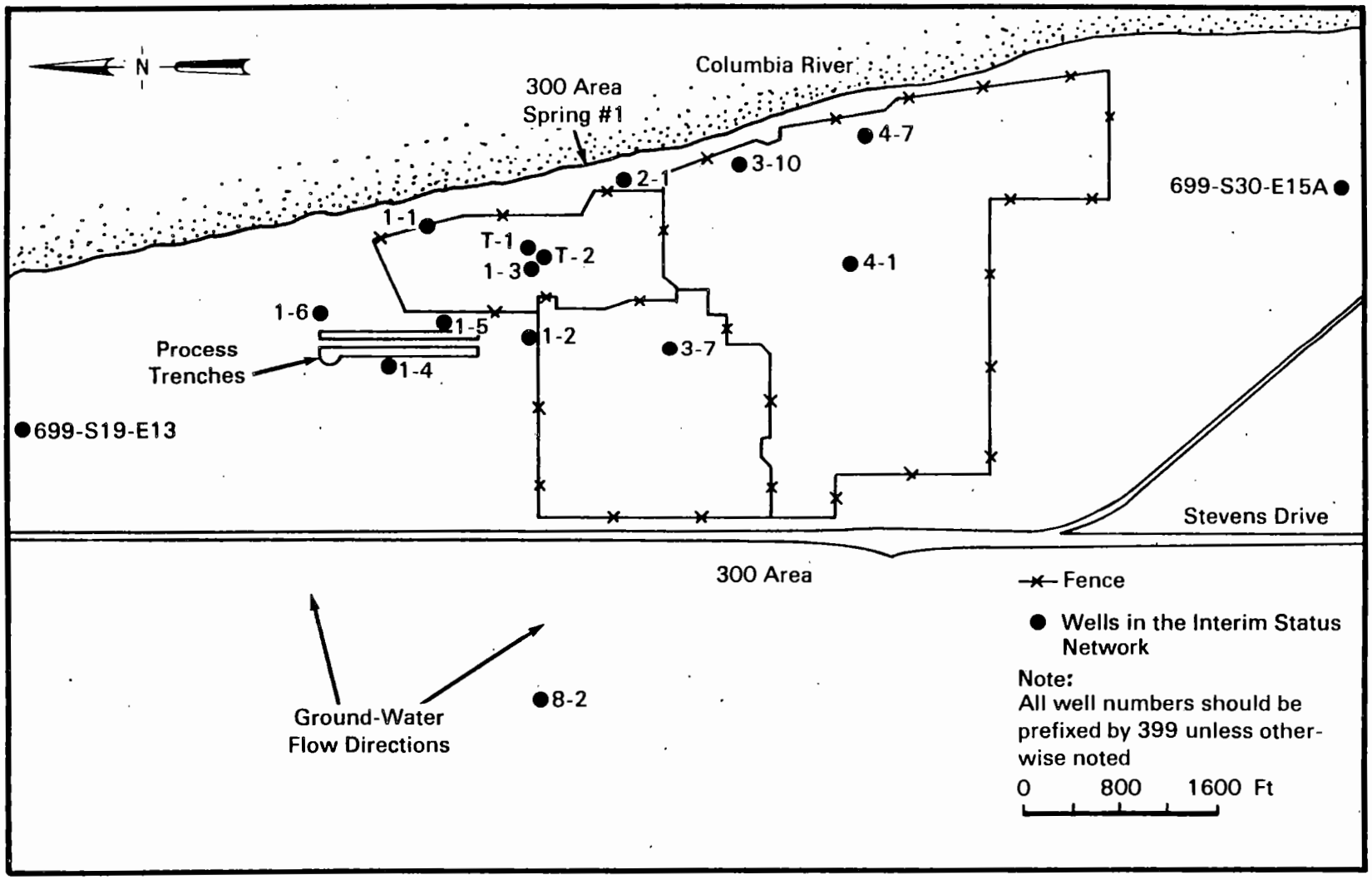


FIGURE 5-1. LOCATION OF WELLS IN THE INTERIM STATUS NETWORK

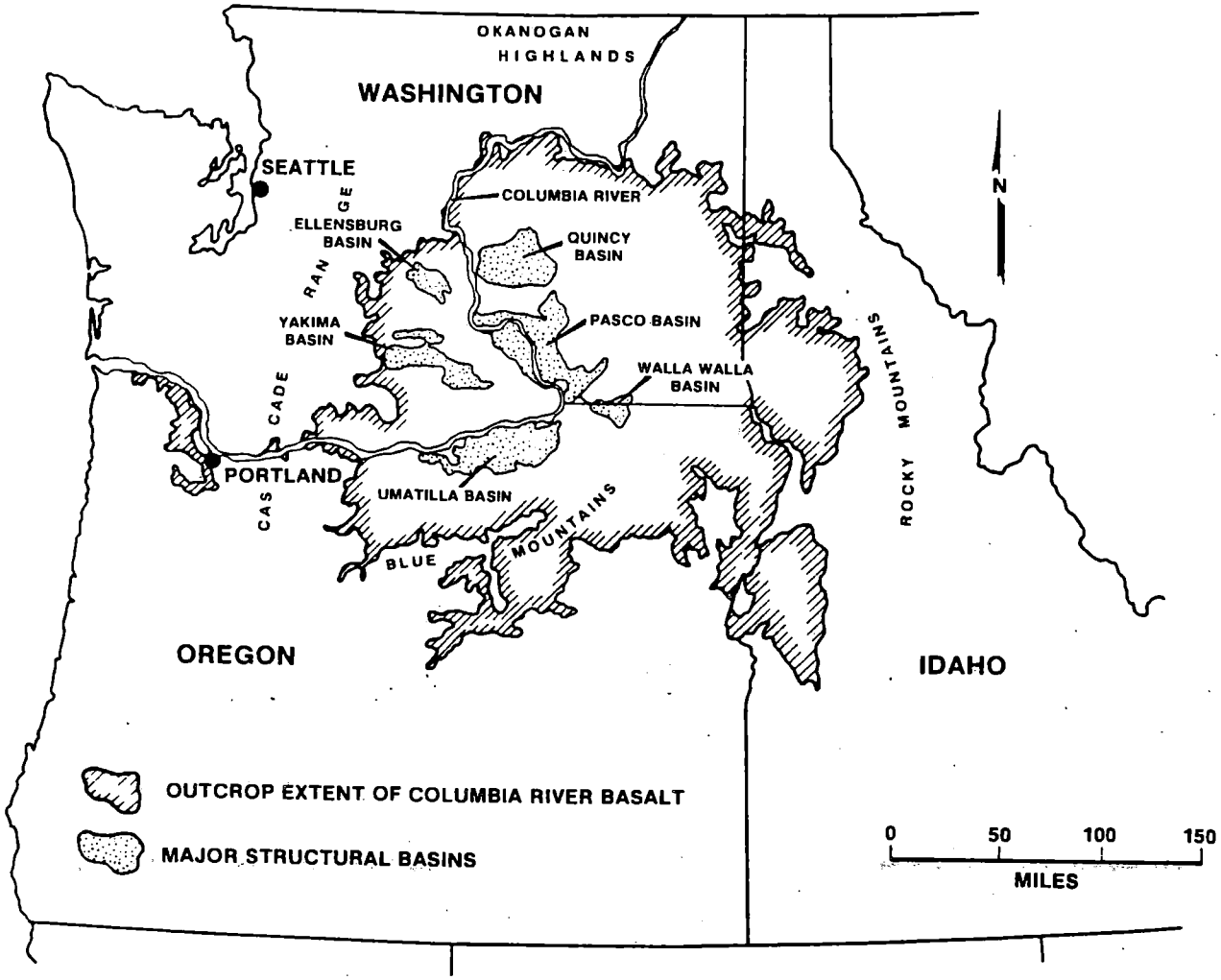


FIGURE 5-2. GEOGRAPHIC EXTENT OF THE COLUMBIA RIVER BASALT GROUP (AFTER TALLMAN ET AL., 1979)

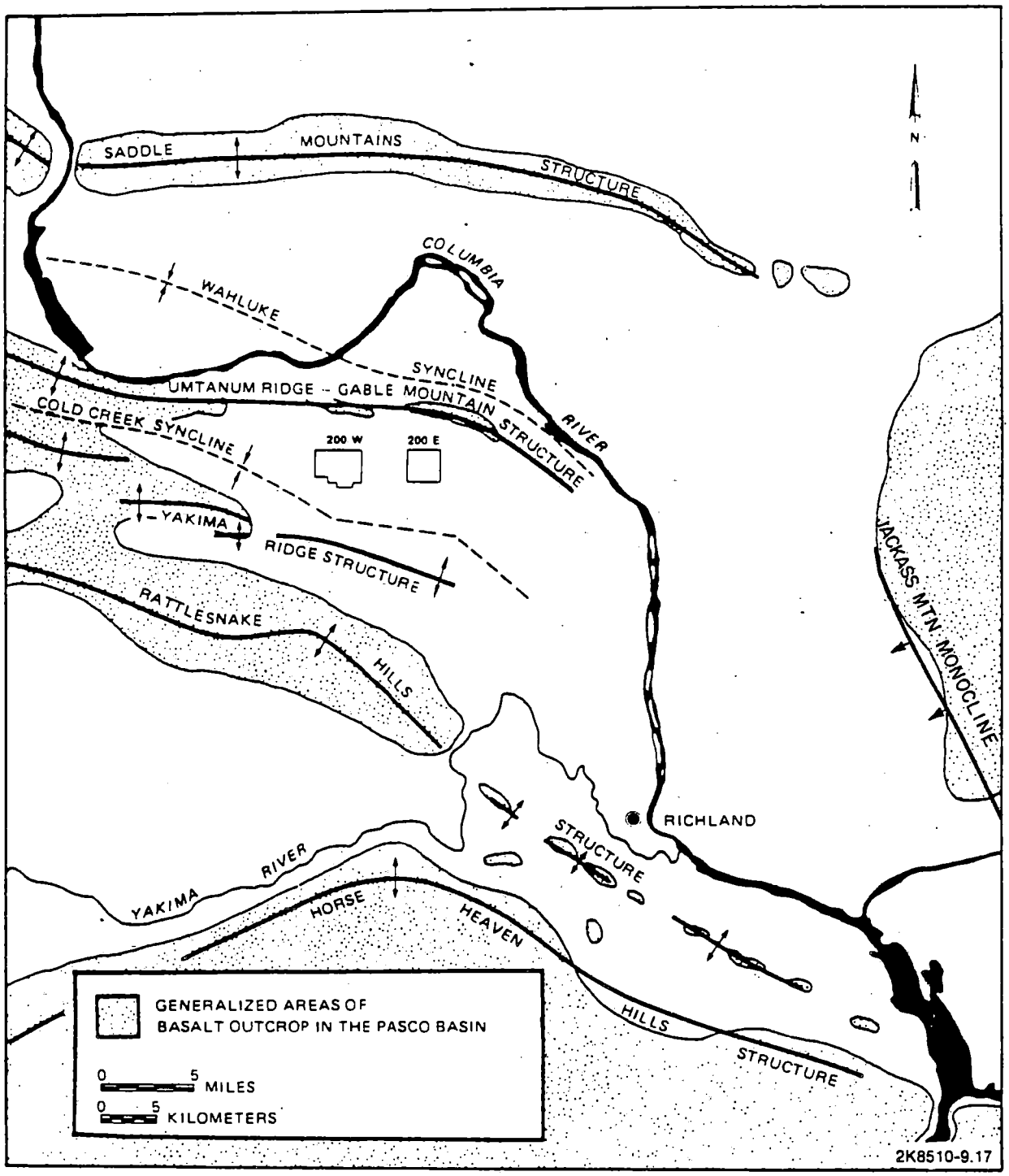


FIGURE 5-3. STRUCTURAL GEOLOGY OF THE PASCO BASIN (MODIFIED AFTER DOE, 1984)

Period	Epoch	Group	Subgroup	Formation	K-Ar Age Years x 10^6	Member or Sequence	Sediment Stratigraphy or Basalt Flows	
QUATERNARY	Pleistocene/ Holocene					Surficial Units	Loess	
							Sand Dunes	
							Alluvium and Alluvial Fans	
							Landslides	
							Talus	
							Colluvium	
	Pleisto-cene			Hanford		Touchet Beds/ Pasco Gravels		
TERTIARY	Pliocene						Plio-Pleistocene Unit ("Palouse" soil)	
				Ringold			Upper Ringold	Fanglomerate
							Middle Ringold	
							Lower Ringold	
							Basal Ringold	
	Miocene	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	8.5	Ice Harbor Member	Goose Island Flow	Ellensburg Formation
							Martindale Flow	
							Basin City Flow	
							Levey Interbed *	
					10.5	Elephant Mountain Member	Upper Elephant Mountain Flow	
							Lower Elephant Mountain Flow	
							Rattlesnake Ridge Interbed*	
					12.0	Pomona Member	Upper Pomona Flow	
							Lower Pomona Flow	
							Selah Interbed*	
						Esquatzel Member	Upper Gable Mountain Flow	
							Gable Mountain Interbed *	
							Lower Gable Mountain Flow	
							Cold Creek Interbed *	
						Asotin Member	Huntzinger Flow	
						Wilbur Creek Member	Wahluke Flow	
						Umatilla Member	Sillusi Flow	
							Umatilla Flow	
				Wanapum Basalt	13.6		Mabton Interbed*	
						Priest Rapids Member	Lolo Flow	
							Rosalia Flows	
							Quincy Interbed*	
						Roza Member	Upper Roza Flow	
							Lower Roza Flow	
							Squaw Creek Interbed*	
						Frenchman Springs Member	Aphyric Flows	
							Phyric Flows	
					15.6		Vantage Interbed*	
				Grande Ronde Basalt		Sentinel Bluffs Sequence	Undifferentiated Flows	
							Rocky Coulee Flow	
							Unamed Flow	
							Cahassett Flow	
							Undifferentiated Flows	
							McCoy Canyon Flow	
							Intermediated-Mg Flow	
						Schwana Sequence	Low-Mg Flow Above Umtanum	
							Umtanum Flow	
							High-Mg Flows Below Umtanum	
							Very High-Mg Flow	
					16.1		At Least 30 Low-Mg Flows	

* The interbeds are stratigraphically contained in the Ellensburg Formation

FIGURE 5-4. STRATIGRAPHIC NOMENCLATURE OF THE PASCO BASIN (AFTER DOE, 1984)

9011794012 4

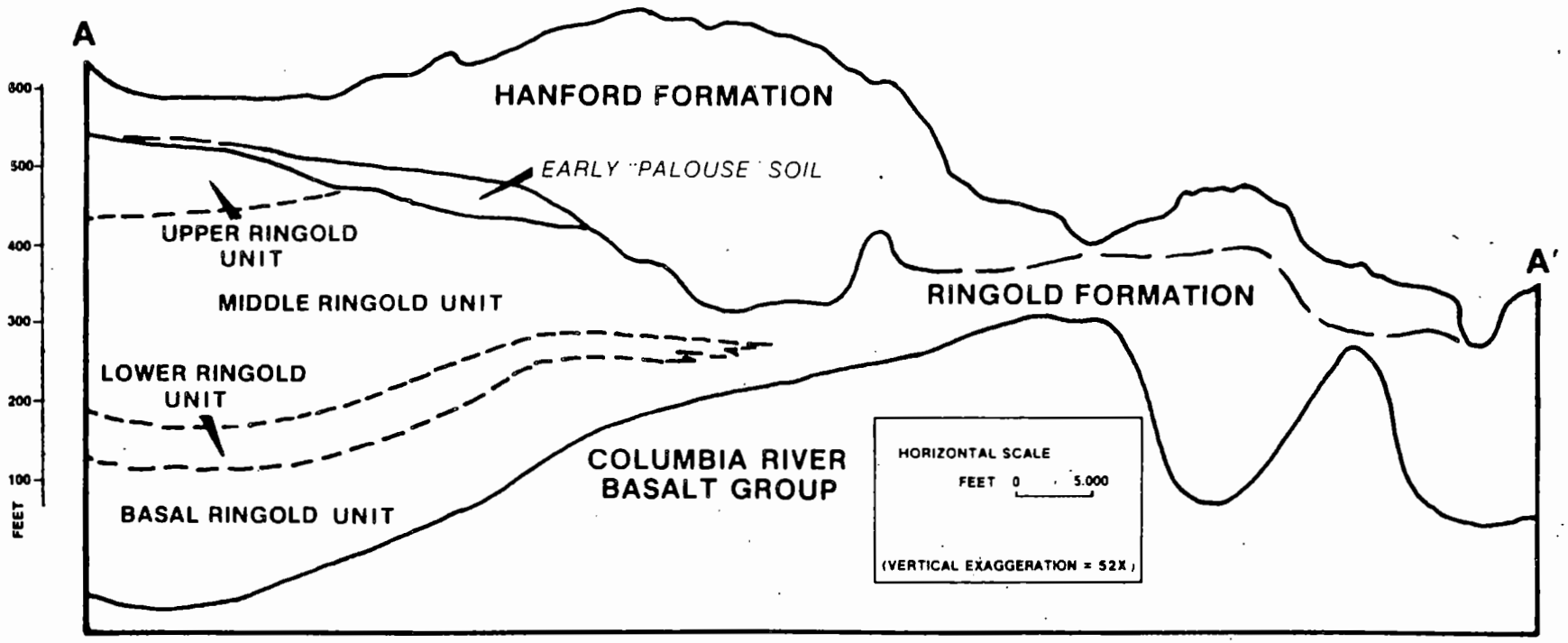


FIGURE 5-5. GENERALIZED GEOLOGIC CROSS SECTION THROUGH THE HANFORD SITE (AFTER TALLMAN ET AL., 1979)

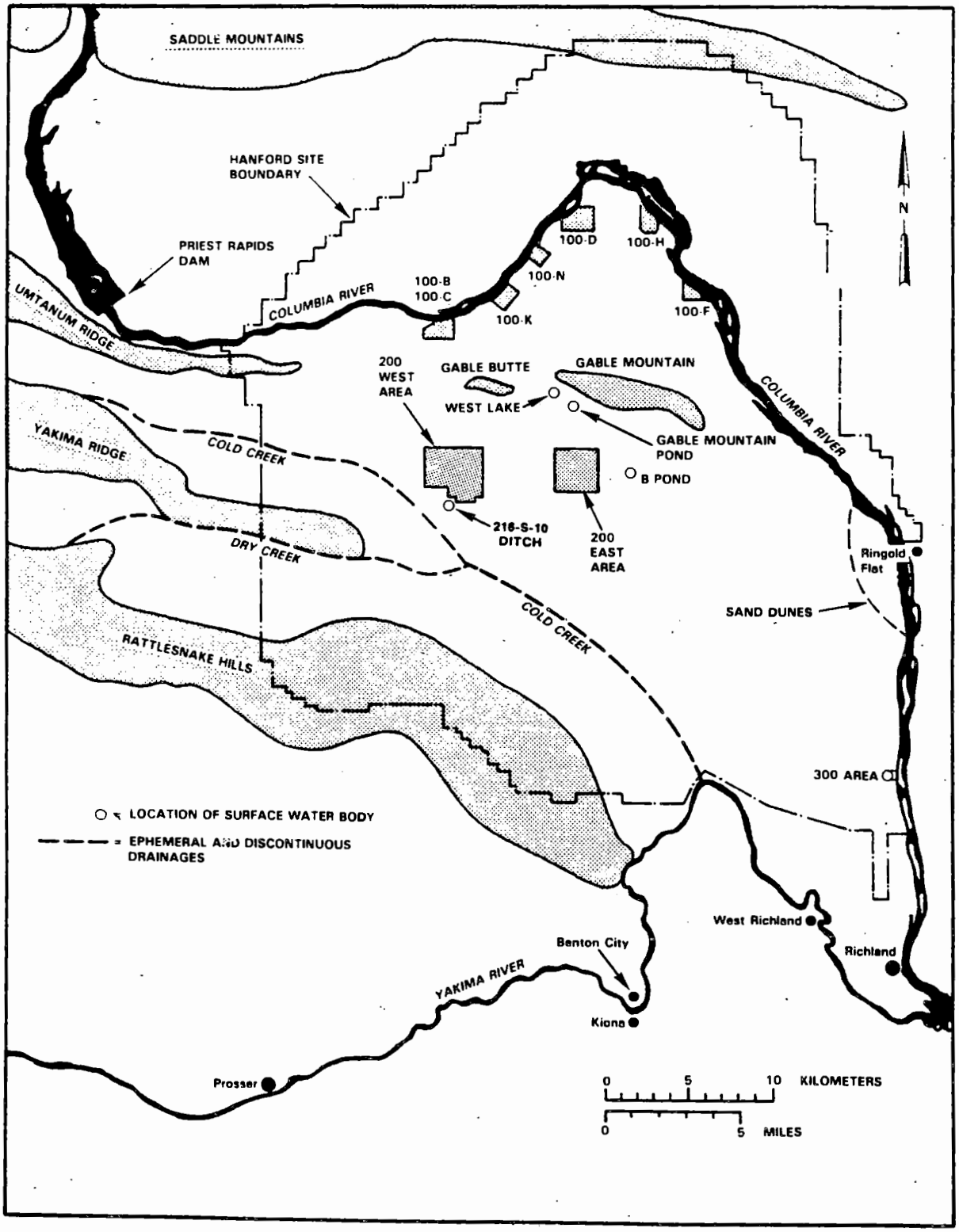


FIGURE 5-6. SURFACE WATER BODIES INCLUDING EPHEMERAL STREAMS ON THE HANFORD SITE (AFTER DOE, 1984)

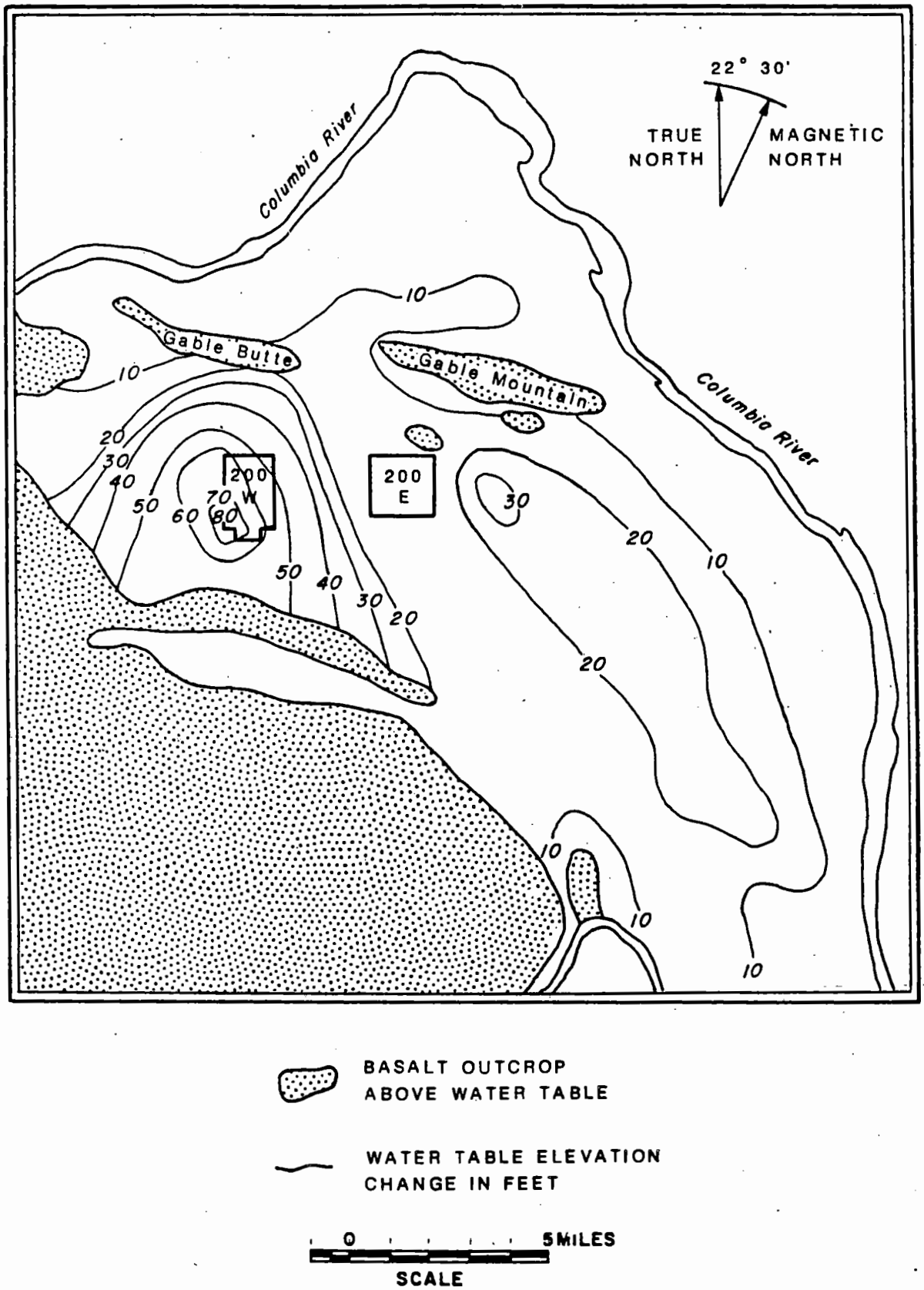
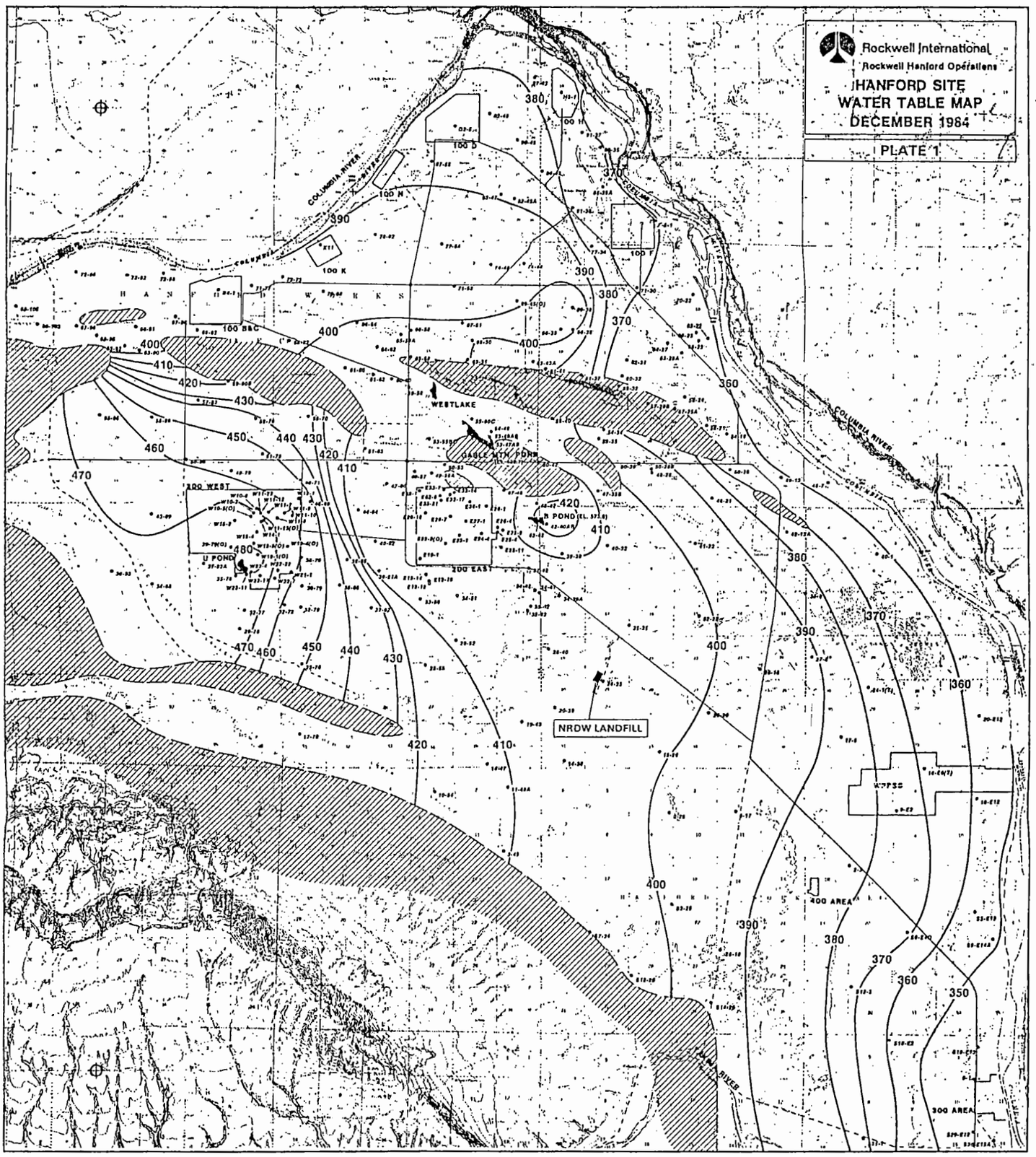


FIGURE 5-7. DIFFERENTIAL CHANGE IN THE HANFORD SITE WATER TABLE BETWEEN JANUARY 1944 AND JANUARY 1975 (AFTER ARCO, 1975)



SCALE

0 1 2 3 MILES

0 1 2 3 KILOMETERS

GRID MIN 1°43' 31 MILS — MIN 21° 373 MILS

UTM GRID AND 1951 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

• WELLS USED IN PREPARATION OF MAP

PONDS, WATER SURFACE ELEVATION (ft-MSL)

BASALT OUTCROPS ABOVE WATER TABLE, AS INFERRED

WATER TABLE CONTOURS IN FEET ABOVE MEAN SEA LEVEL (ft-MSL)

10 FOOT CONTOUR

BASE MAPS ARE PORTIONS OF HANFORD, COYOTE RAPIDS, RICHLAND AND CORRAL 15' QUADRANGLES PUBLISHED BY U.S. DEPT. OF INTERIOR, GEOLOGICAL SURVEY

The aquifer system underlying the Hanford site is composed of an upper unconfined aquifer and multiple confined aquifers. The Rattlesnake Ridge interbed is confined by the Elephant Mountain basalt and contains the uppermost confined aquifer. The purpose of water-level measurements and water-table mapping is to assess the impacts of liquid waste discharged to the ground on the unconfined and uppermost confined aquifers.

The water-table on the Hanford site is monitored on a semiannual basis. Unconfined ground-water elevation maps are prepared from water-level measurements made in June and December. Approximately 220 wells and piezometers are used in contouring the water table. The December water-level measurements are also used to produce a separations area water-table map and a separations area depth-to-water map. This enlarged map details ground-water elevation measurements and contours in and around the 200 areas.

The water table mound surrounding B Pond has expanded due to increased volume of water discharged to the B Pond system. Aside from this region, the water table has not significantly changed since the last measurements taken in June, 1984. Seasonal fluctuations along the Columbia River reflect surface water/ground water interaction.

The Rattlesnake Ridge confined aquifer is monitored monthly in the eastern portion of the separations area. The December, 1984 water-level measurements in 13 wells completed in the Rattlesnake Ridge interbed were used to contour the potentiometric surface of the Rattlesnake Ridge. Areal extent of downward gradient from the unconfined aquifer to this confined aquifer is inferred from the water-table map and the contours of the potentiometric surface of the Rattlesnake Ridge.

The Hanford site water-table map, separations area water-table map, and potentiometric surface of the Rattlesnake Ridge confined aquifer map are prepared by the Hydrogeology unit of the Research and Engineering function of Rockwell Hanford Operations. Water level measurements are made by the Environmental Evaluations section of Pacific Northwest Laboratory. The Hanford site water-table map is the 18th revision of Sheet H-2-38396 and depicts the water-table configuration in December, 1984.

DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE

ROCKWELL INTERNATIONAL
ROCKWELL HANFORD OPERATIONS

HANFORD SITE WATER TABLE MAP
DECEMBER 1984
H-2-38396 REV. 18

APPROVED	A.G. Law	
DATA COMPILED	A.L. Schatz	
DATA DRAFTED	A.L. Schatz	
MEASUREMENTS	C.S. Cline	
	E.J. Jensen	
	M.R. Quarders	

FIGURE 5-8. HANFORD SITE WATER-TABLE MAP (AFTER SCHATZ, 1985)

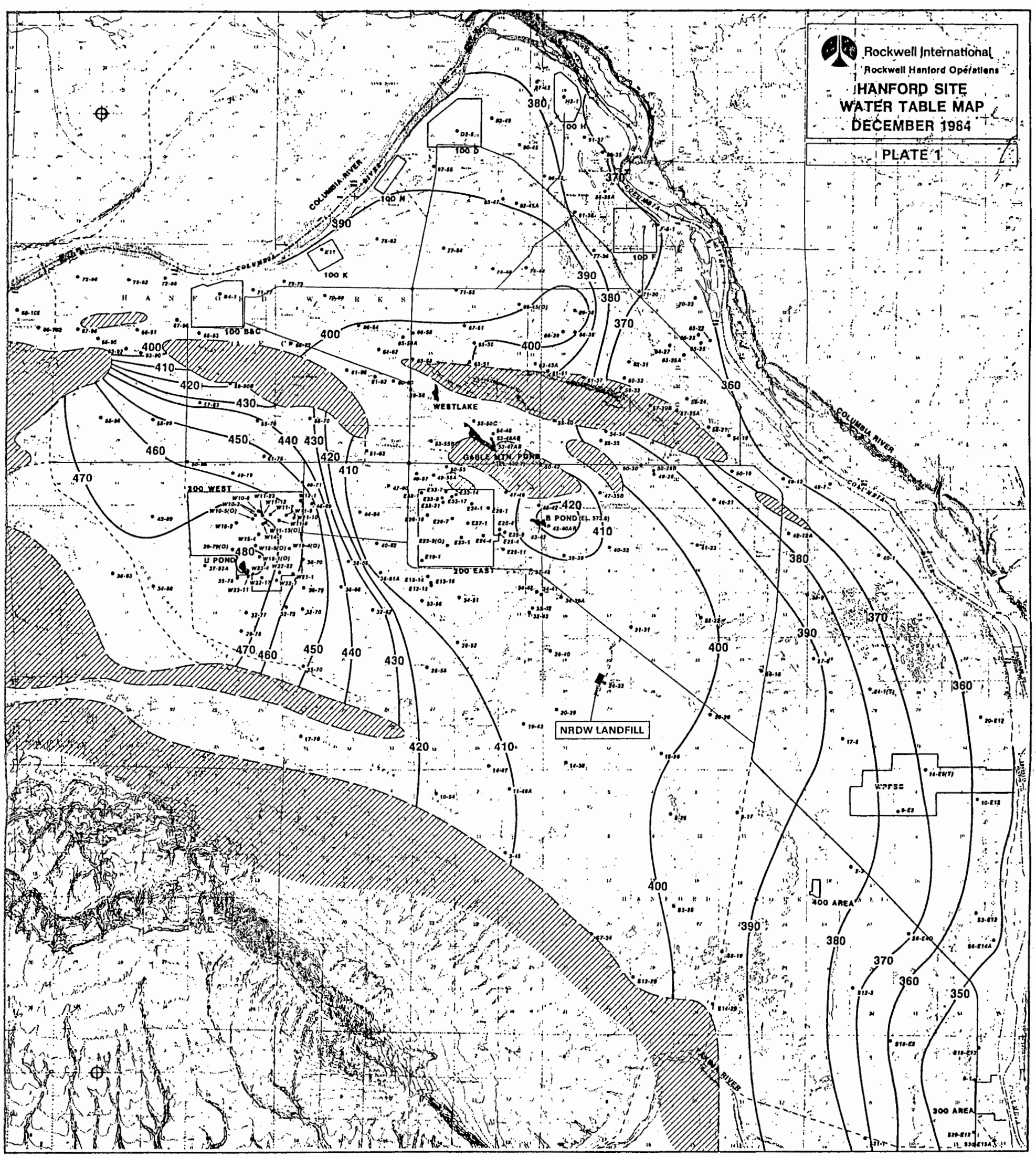


FIGURE 5-8. HANFORD SITE WATER-TABLE MAP (AFTER SCHATZ, 1985)

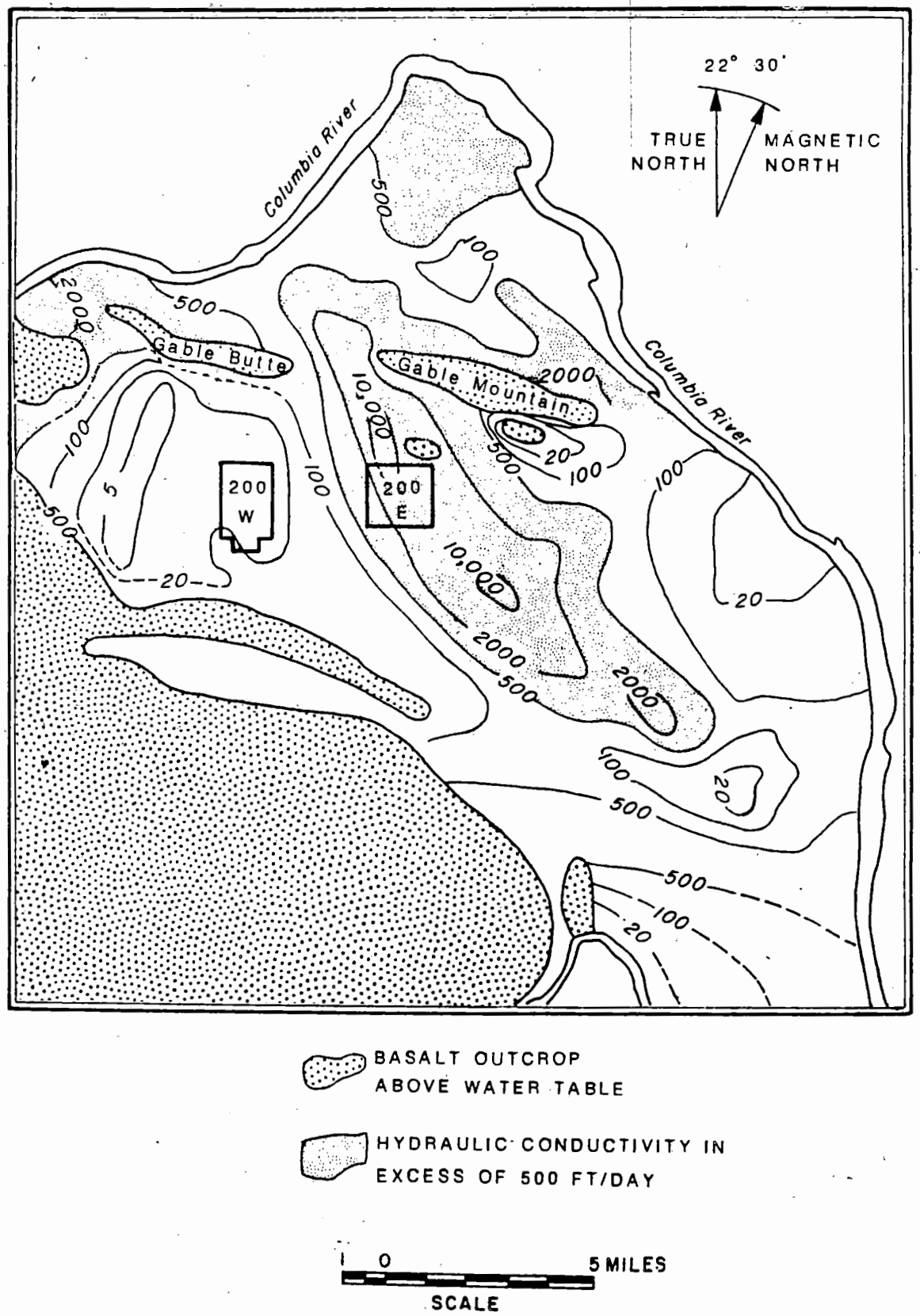


FIGURE 5-9. AREAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY FROM THE UPPERMOST AQUIFER AT THE HANFORD SITE (AFTER ARCO, 1975)

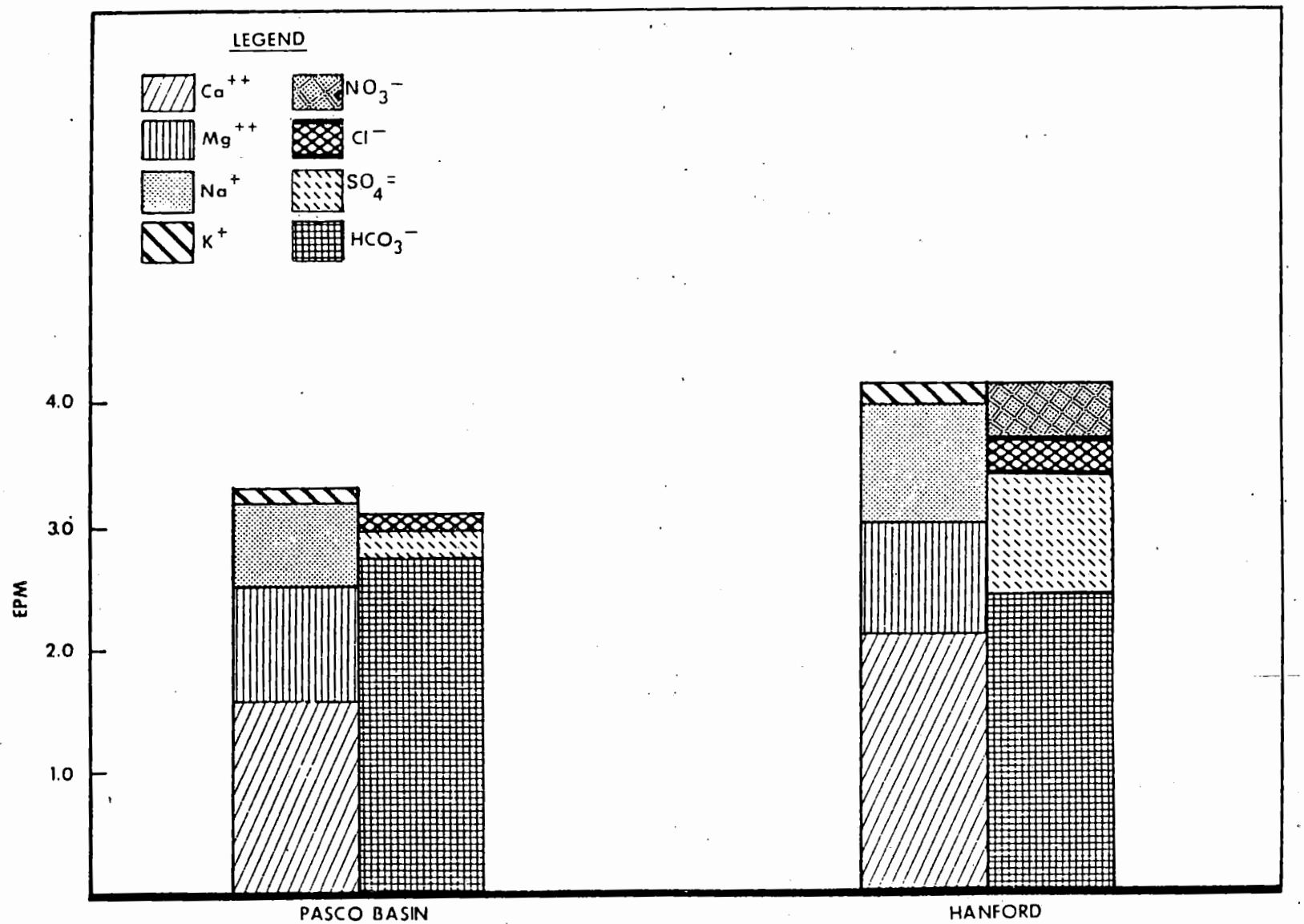


FIGURE 5-10. EQUIVALENT PARTS PER MILLION (EPM) COMPARISON OF UPPERMOST AQUIFER WATERS FROM THE HANFORD SITE AND SURROUNDING PASCO BASIN (AFTER GRAHAM ET AL., 1981)

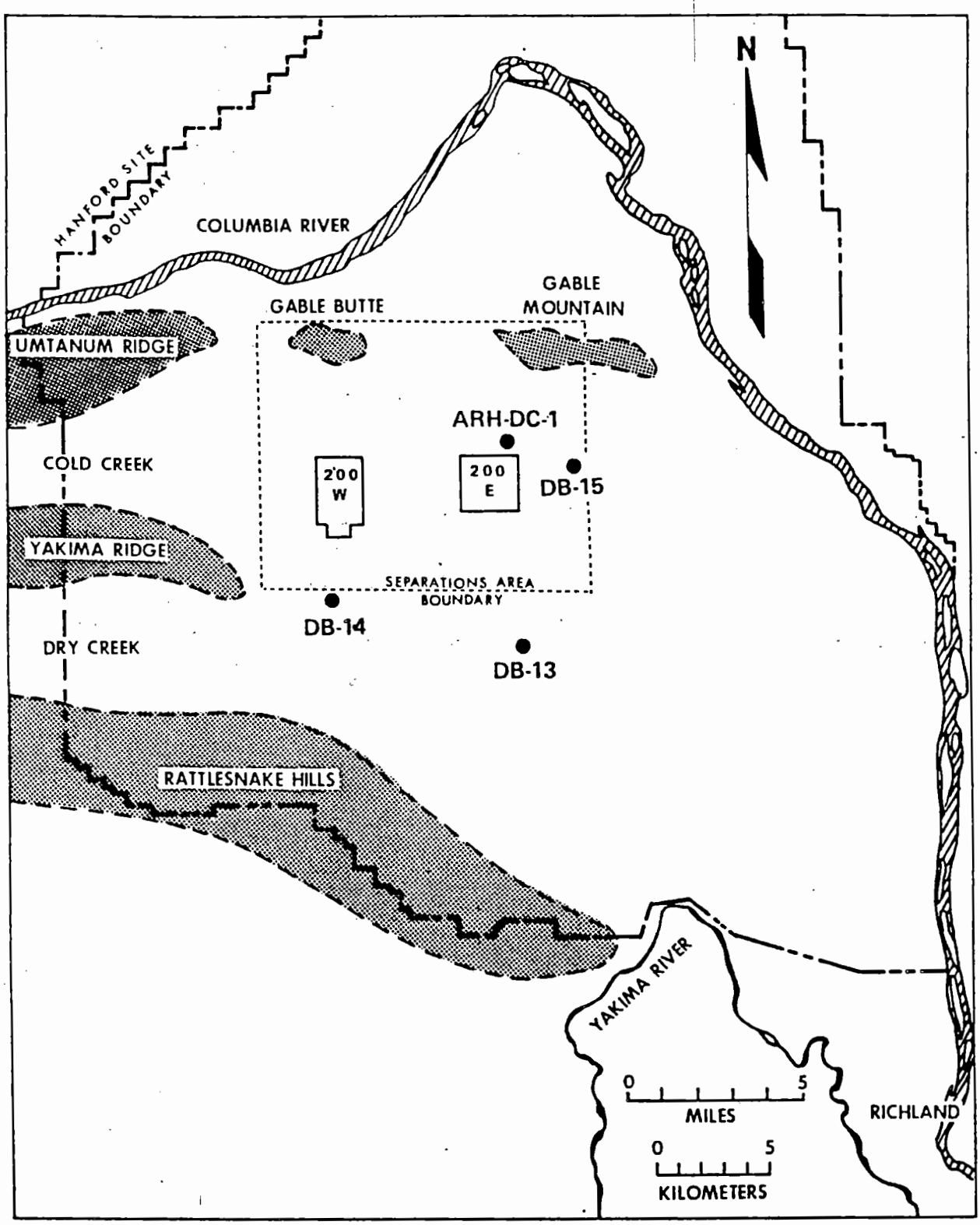


FIGURE 5-11. LOCATION OF WELLS DB-13, DB-14, DB-15, AND ARH-DC-1 (AFTER GRAHAM ET AL., 1981)

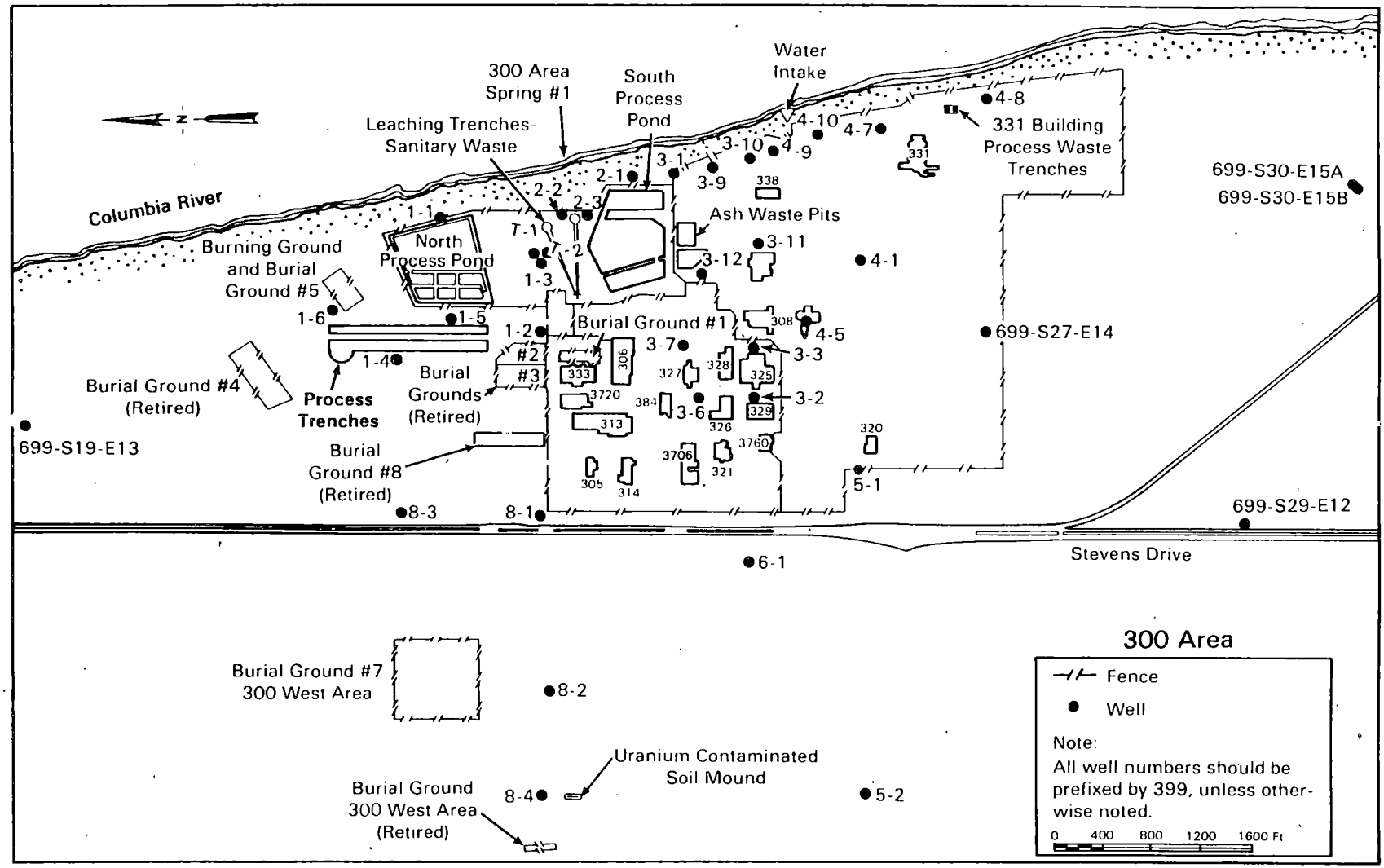


FIGURE 5-12. 300 AREA WELL LOCATION MAP

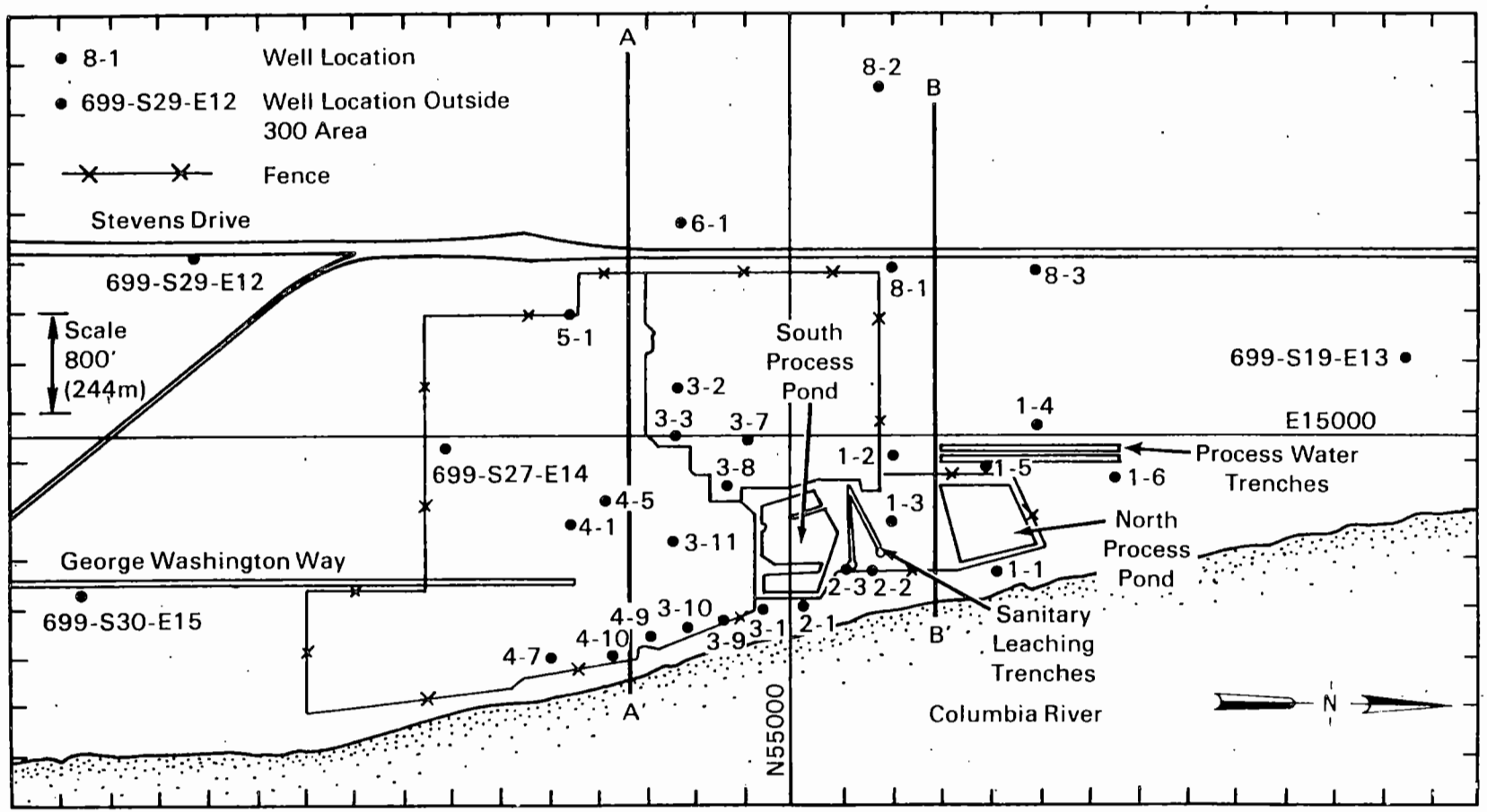


FIGURE 5-13. LOCATIONS OF GEOLOGIC CROSS SECTIONS

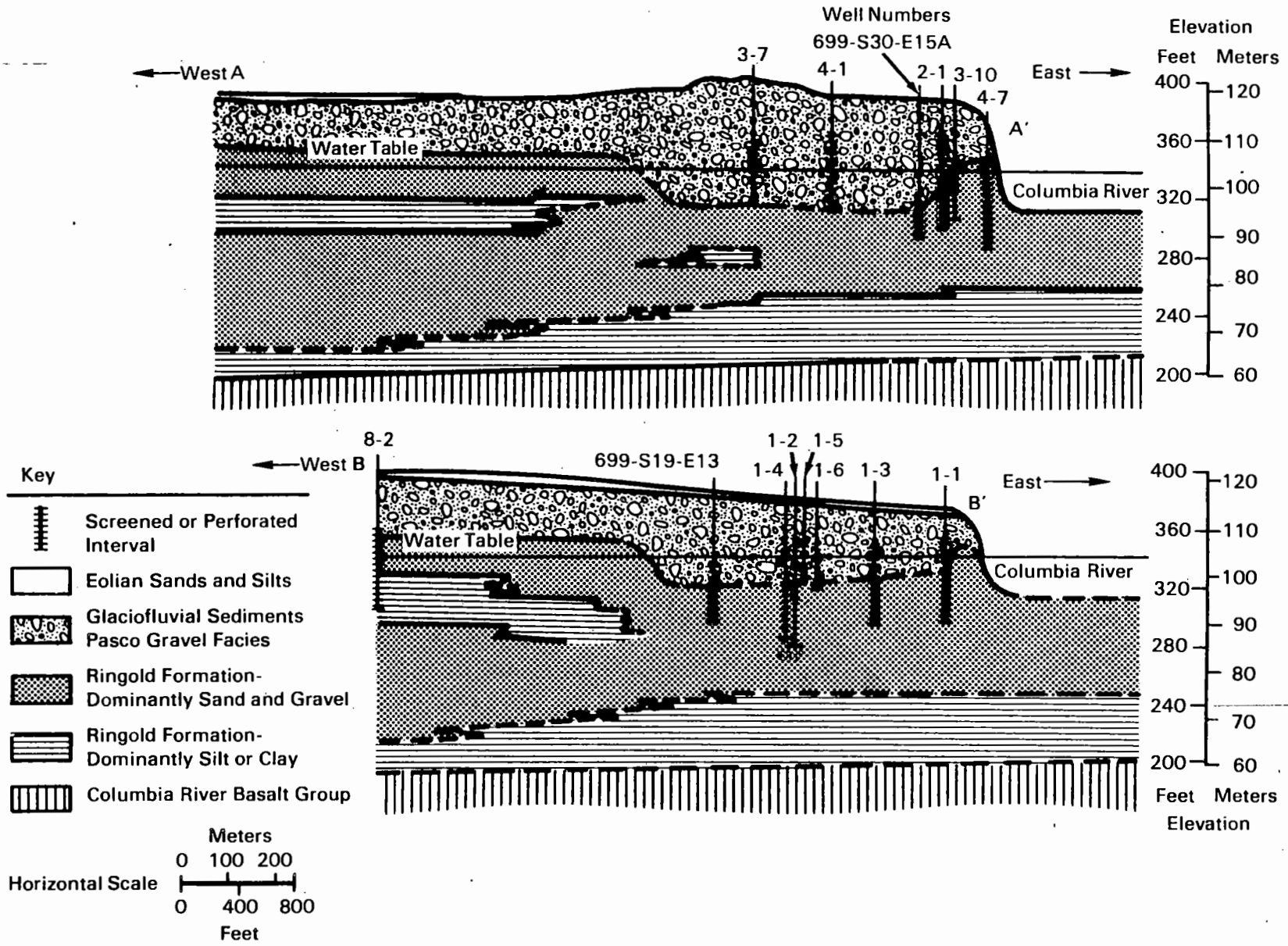
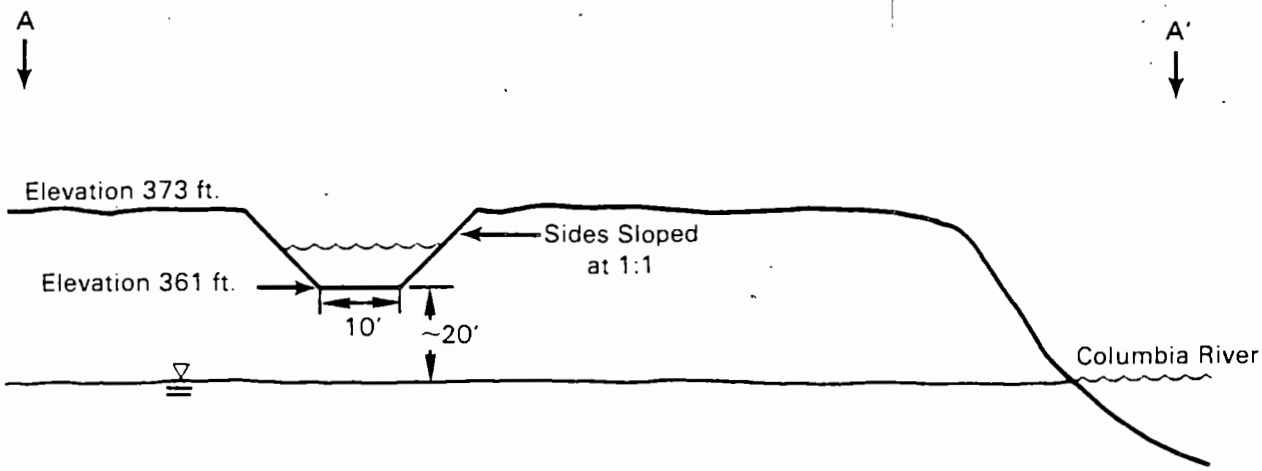


FIGURE 5-14. GEOLOGIC CROSS SECTIONS OF THE 300 AREA



Water Table

Elevations are in feet
above mean sea level

Not to Scale

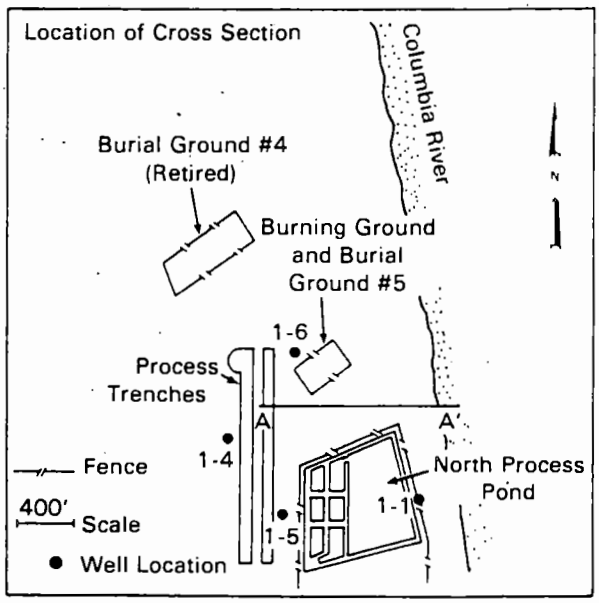


FIGURE 5-15. SCHEMATIC CROSS SECTION OF THE 300 AREA PROCESS TRENCHES

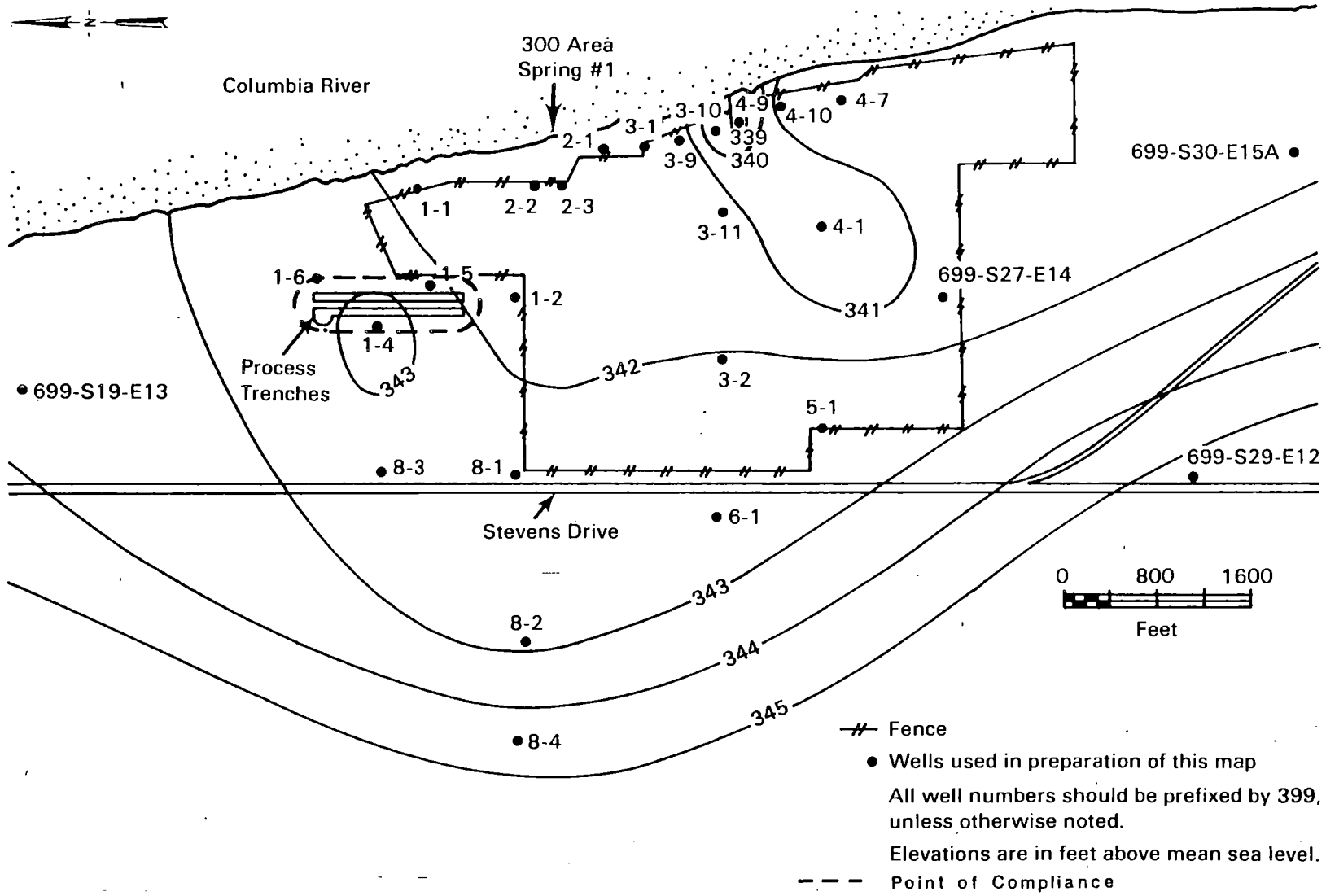


FIGURE 5-16. 300 AREA WATER-TABLE MAP (DECEMBER 17-18, 1984)

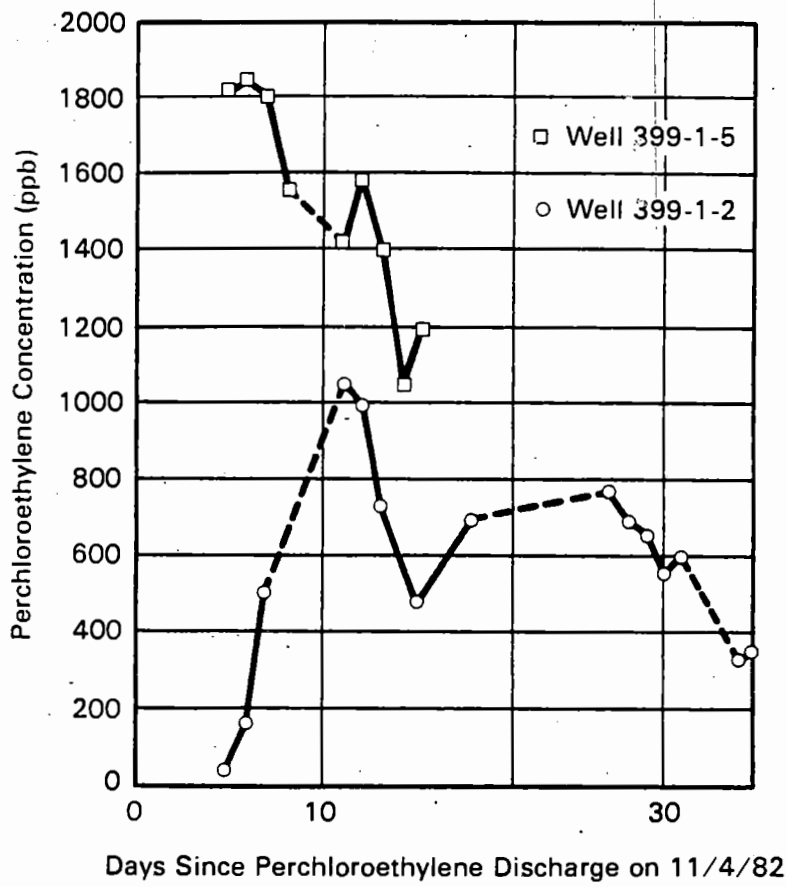


FIGURE 5-17. PERCHLOROETHYLENE CONCENTRATIONS IN THE SELECTED 300 AREA WELLS (NOVEMBER 4, 1982)

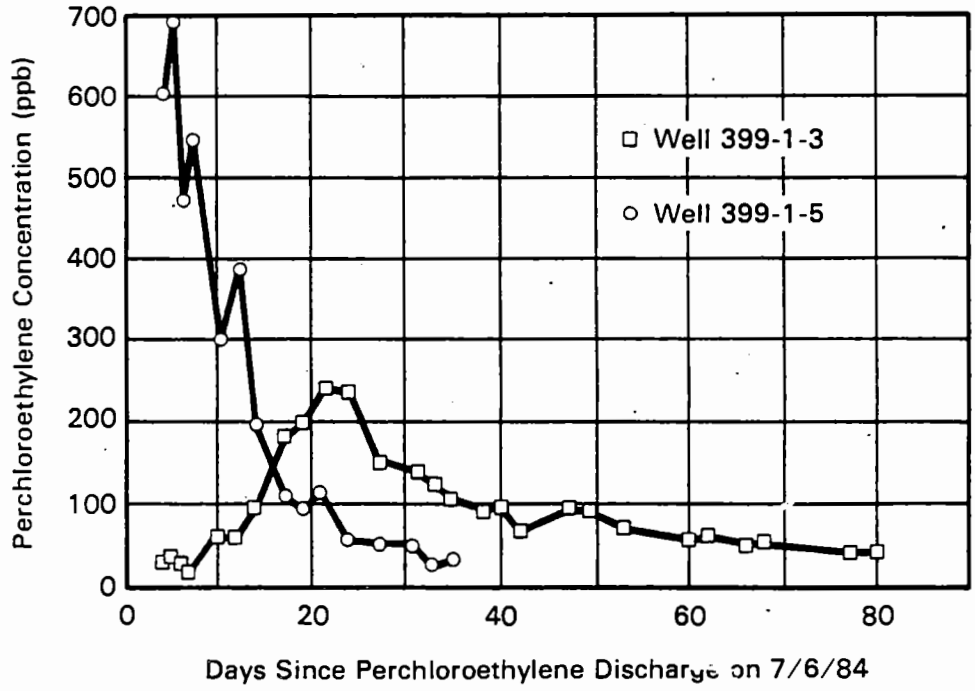


FIGURE 5-18. PERCHLOROETHYLENE CONCENTRATIONS IN THE SELECTED 300 AREA WELLS (JULY 6, 1984)

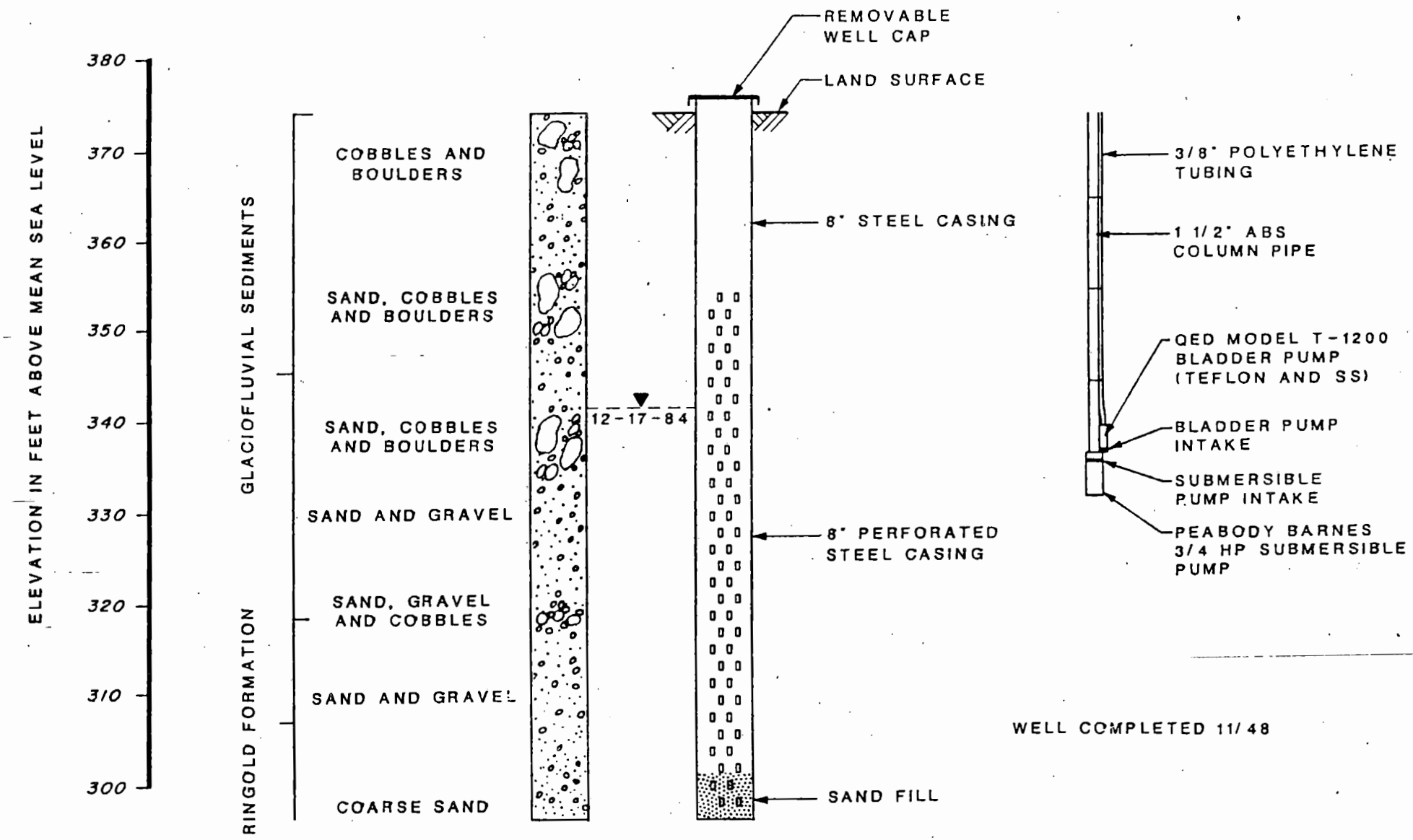


FIGURE 5-19. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR 399-1-1.

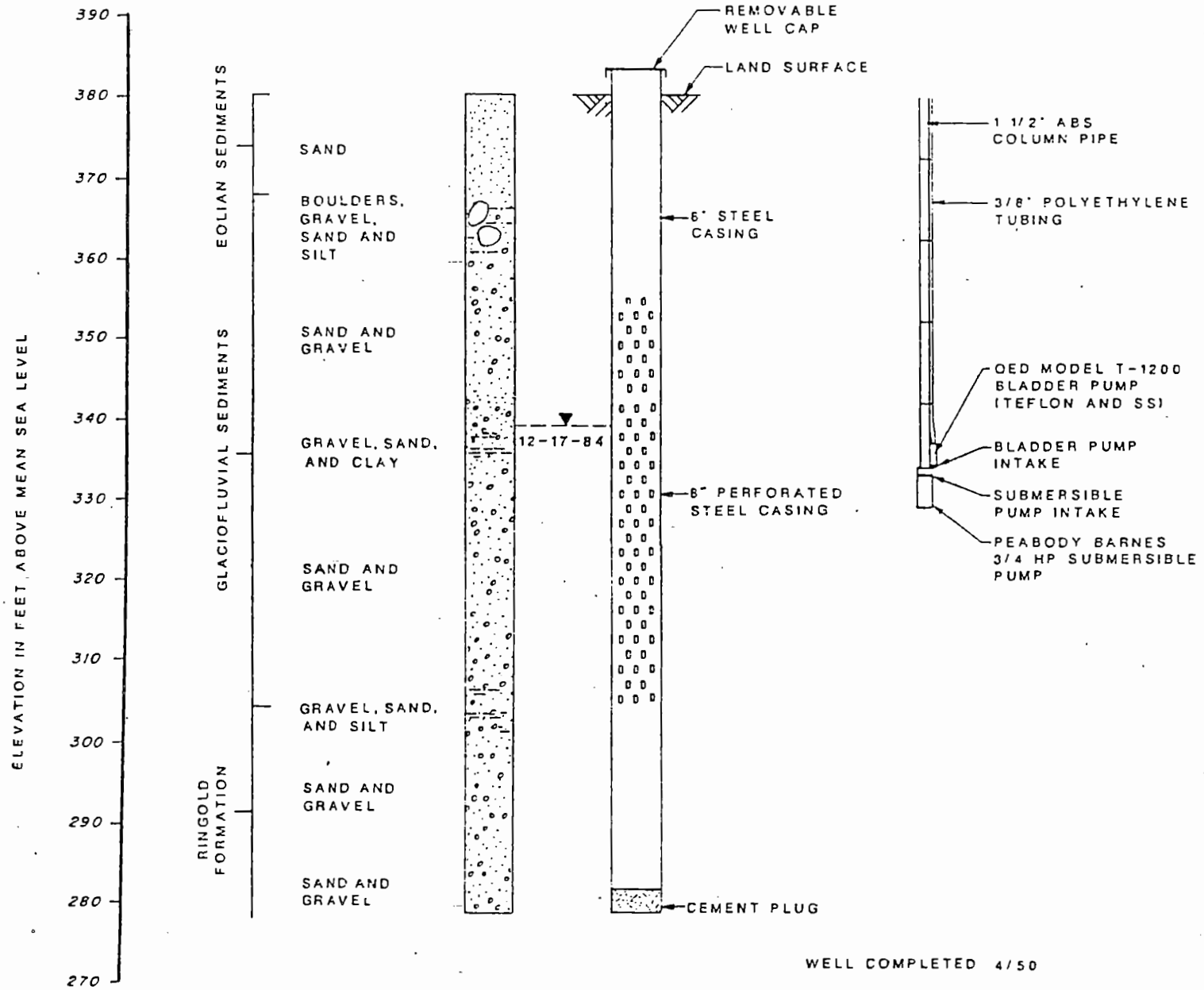


FIGURE 5-20. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-1-2

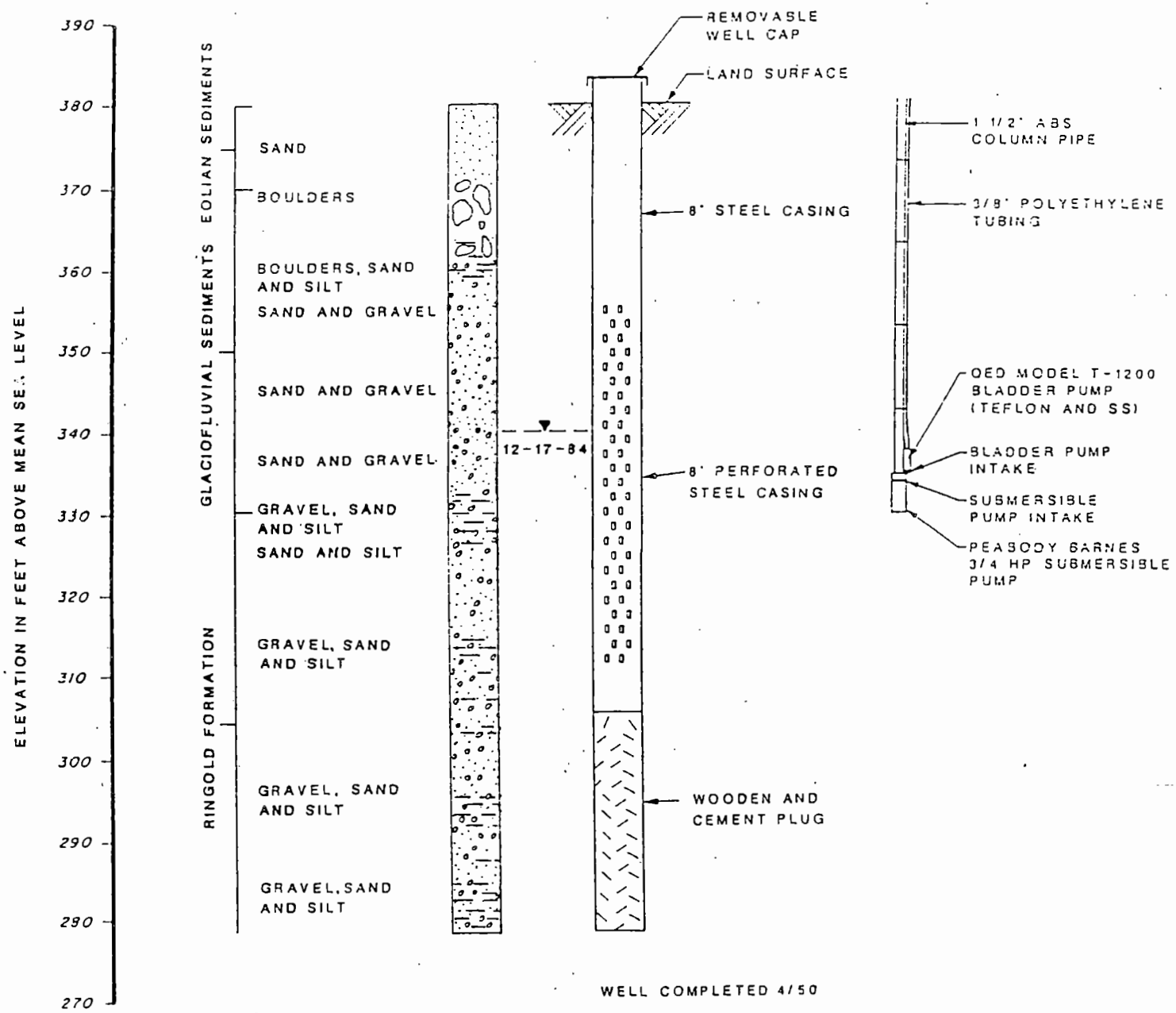


FIGURE 5-21. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-1-3

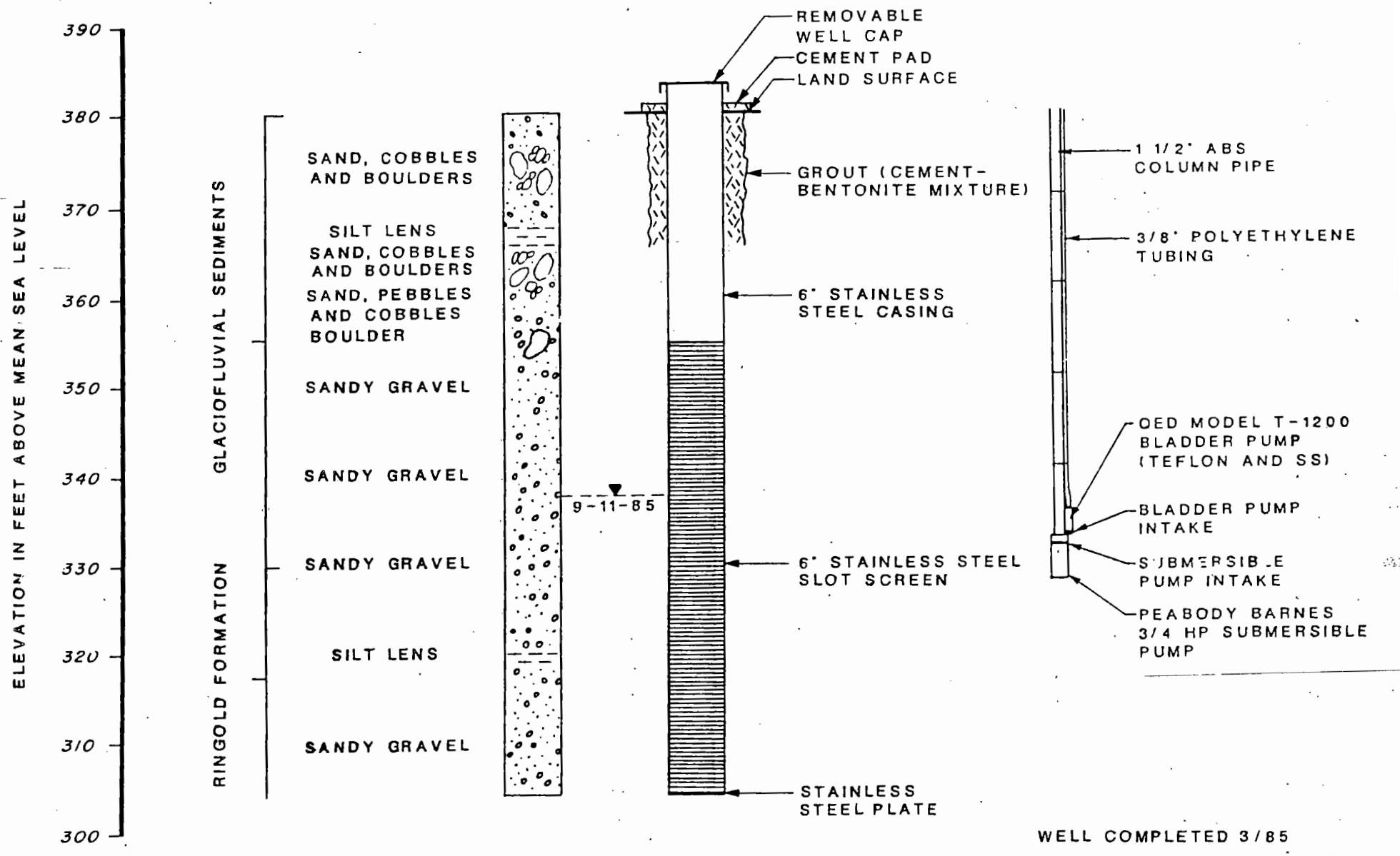


FIGURE 5-22. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-T-1.

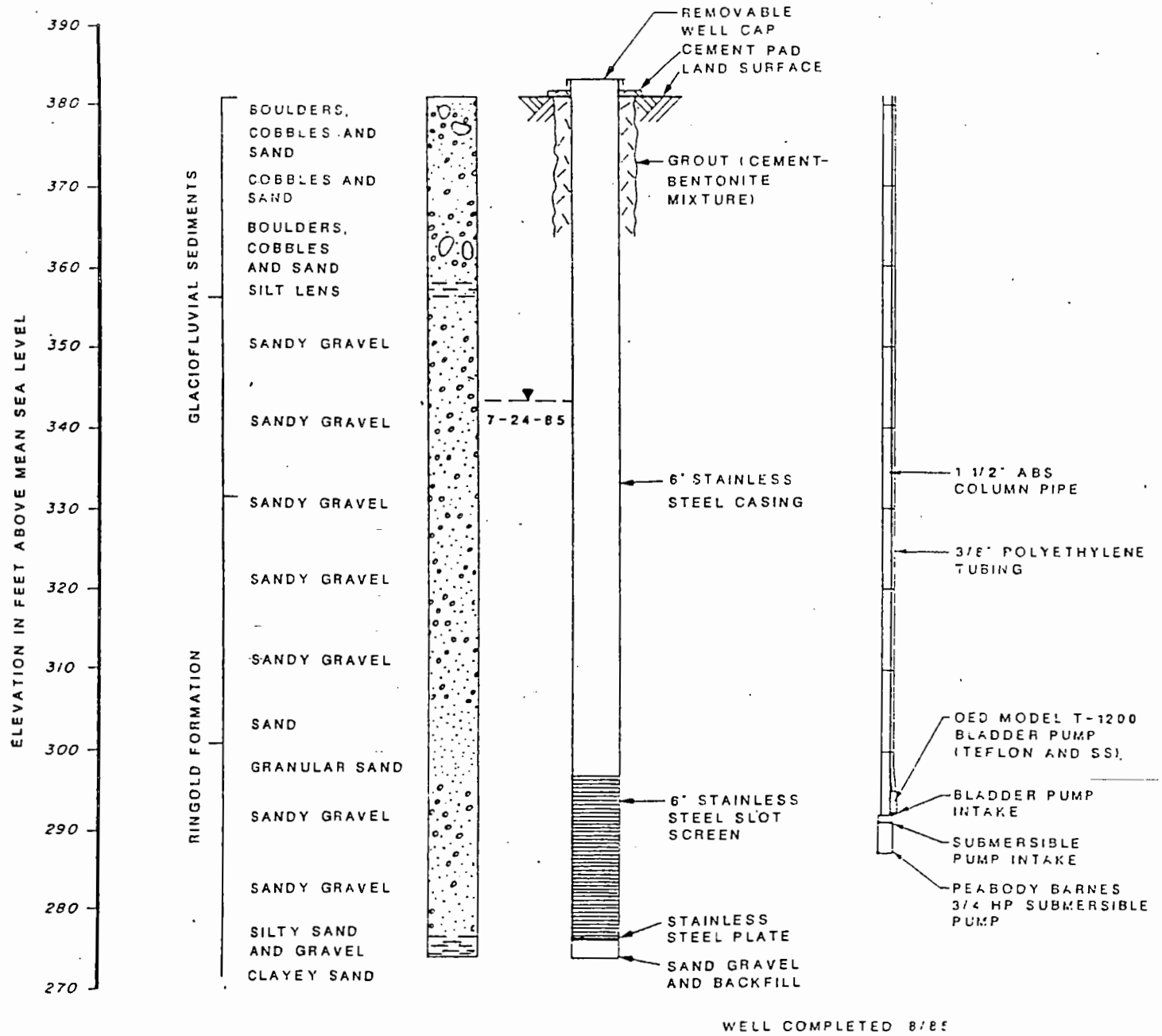


FIGURE 5-23. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-T-2

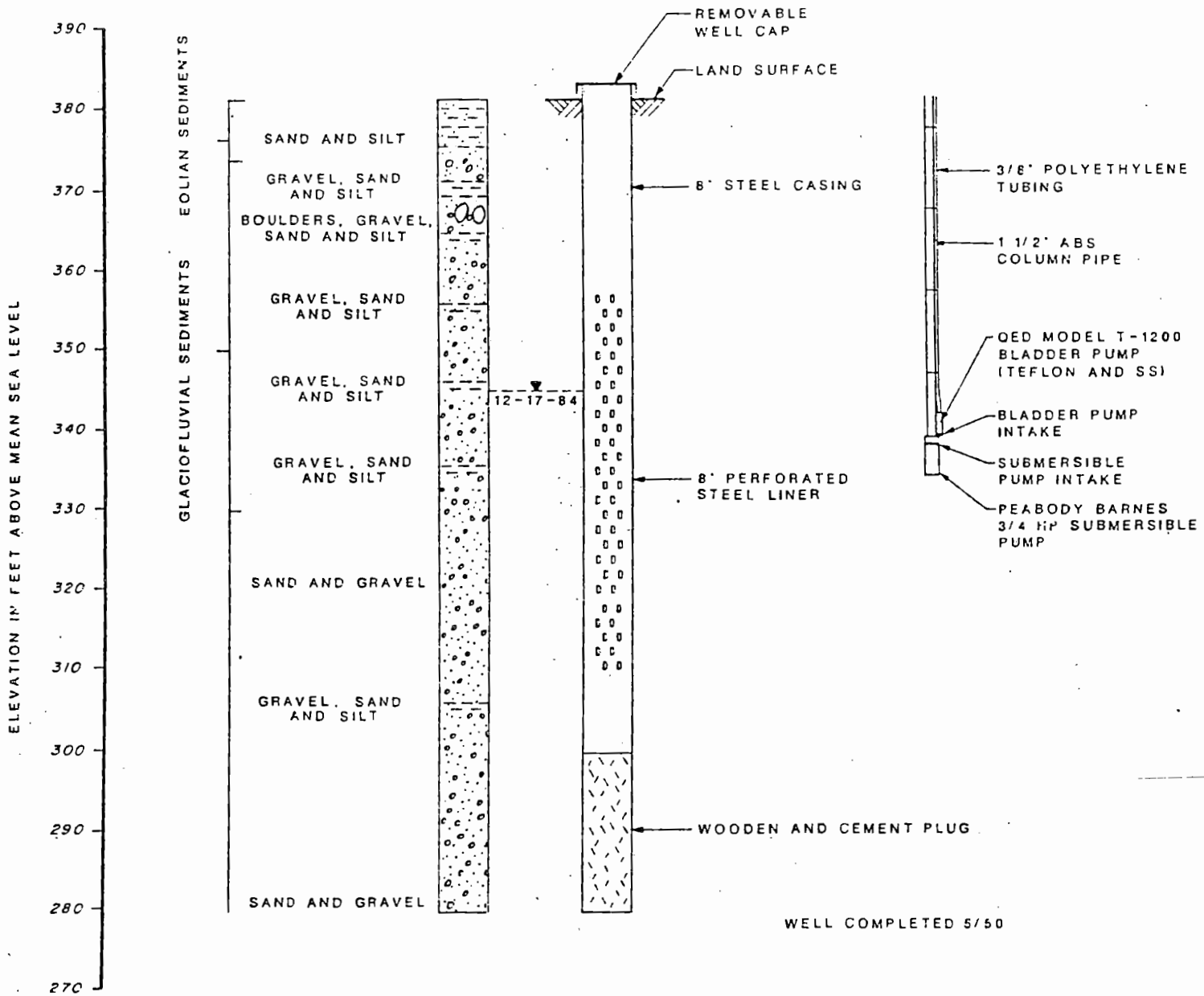


FIGURE 5-24. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-1-4.

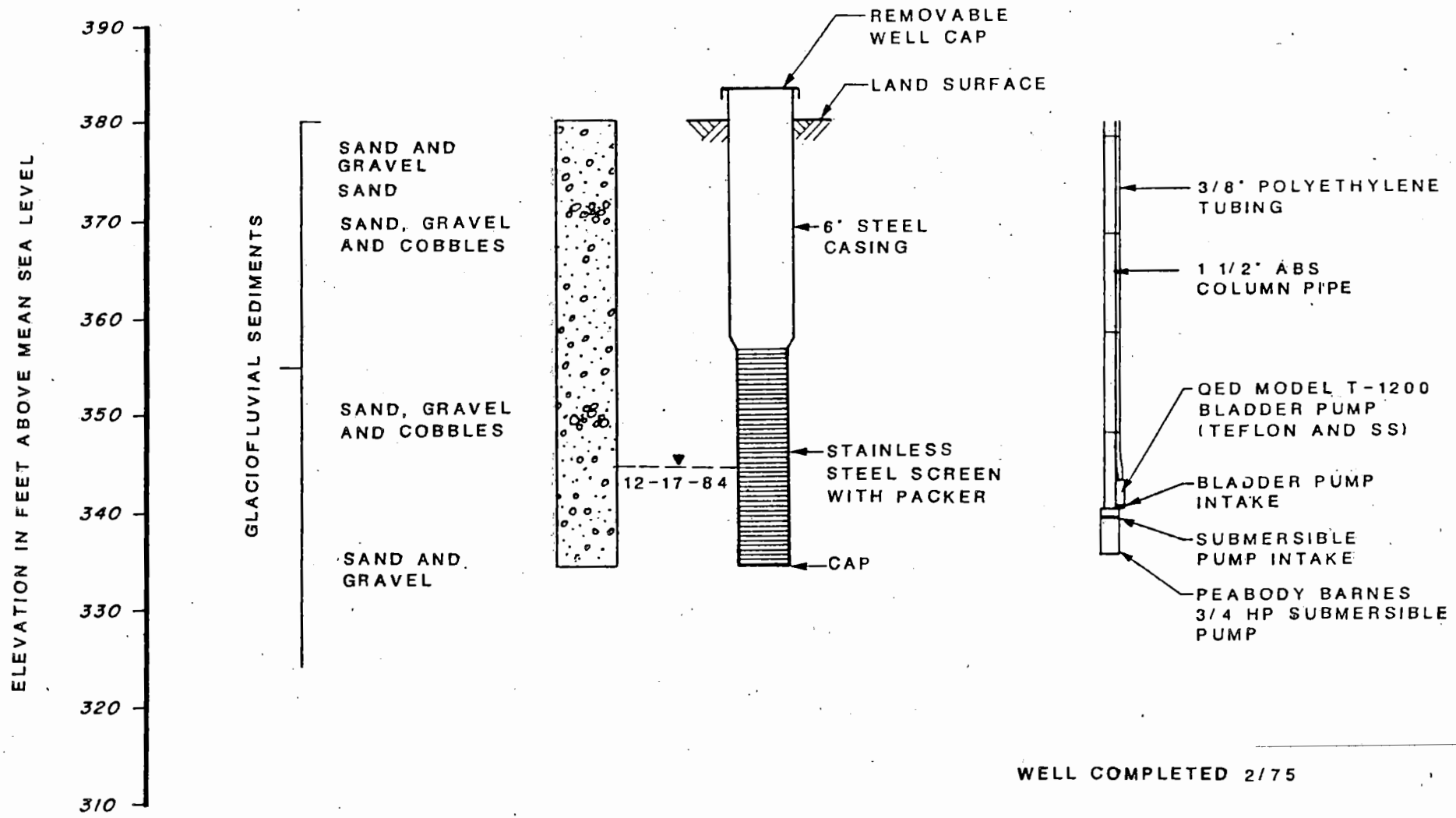


FIGURE 5-25. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-1-5.

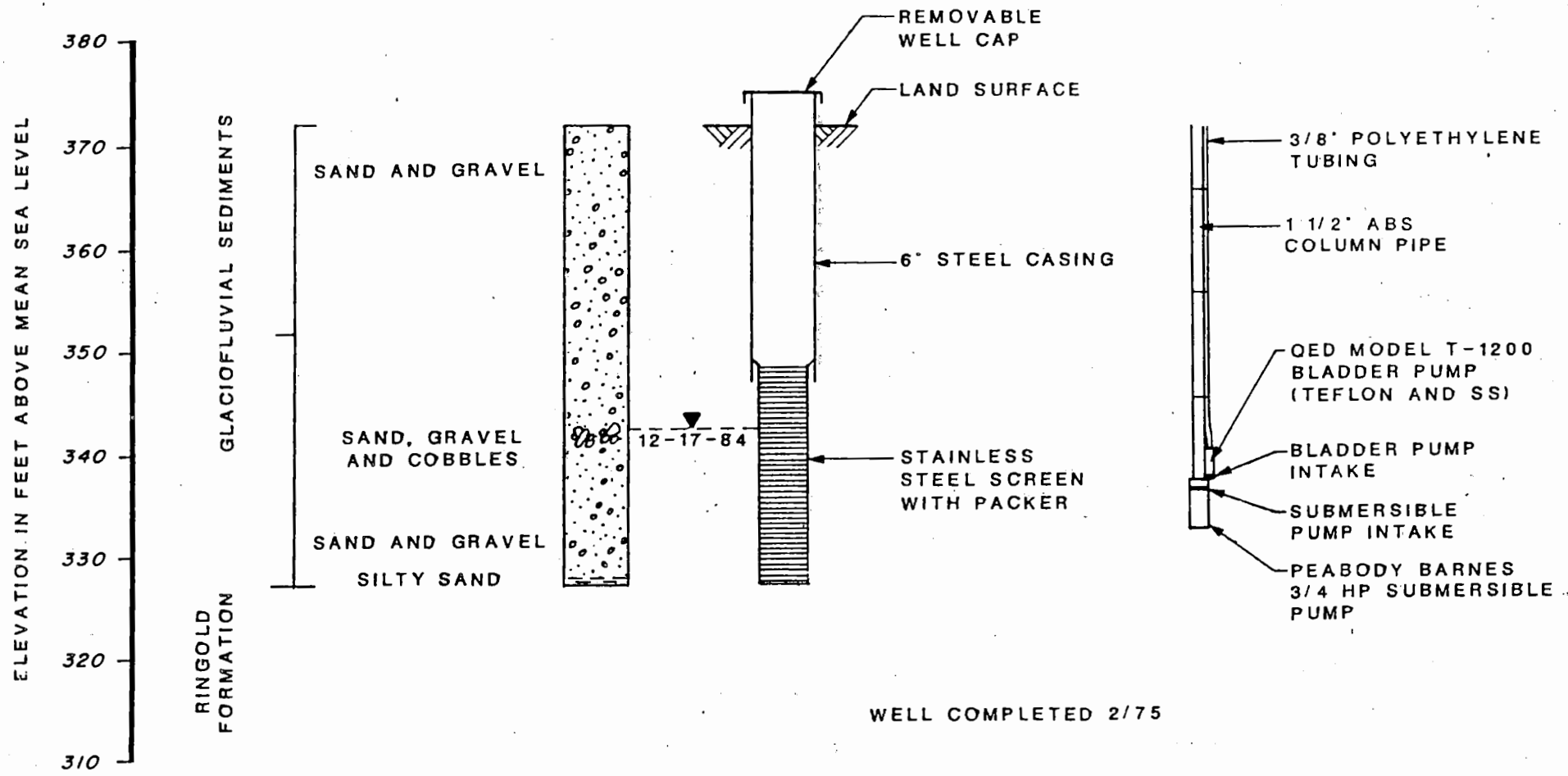


FIGURE 5-26. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-1-6.

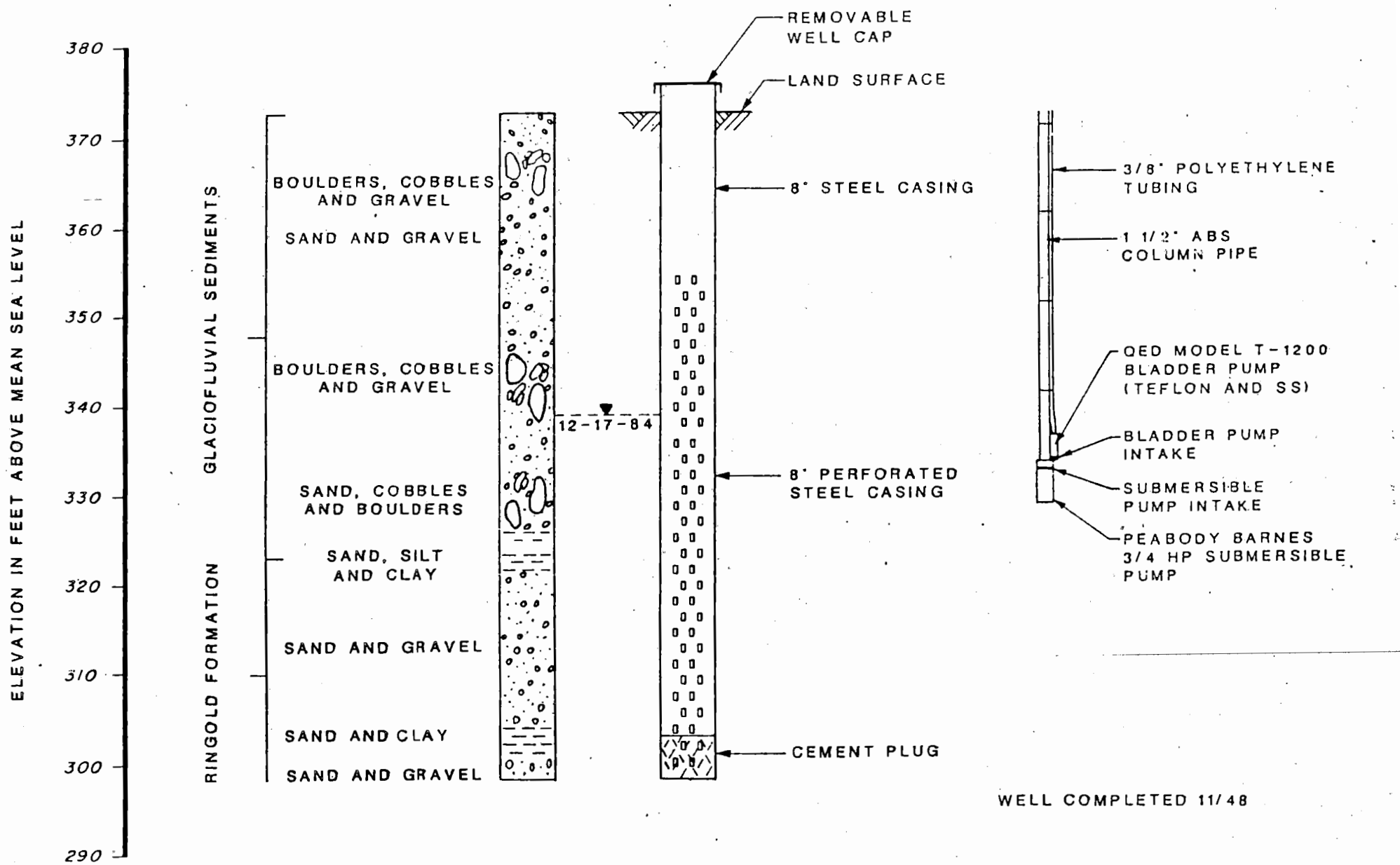


FIGURE 5-27. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-2-1.

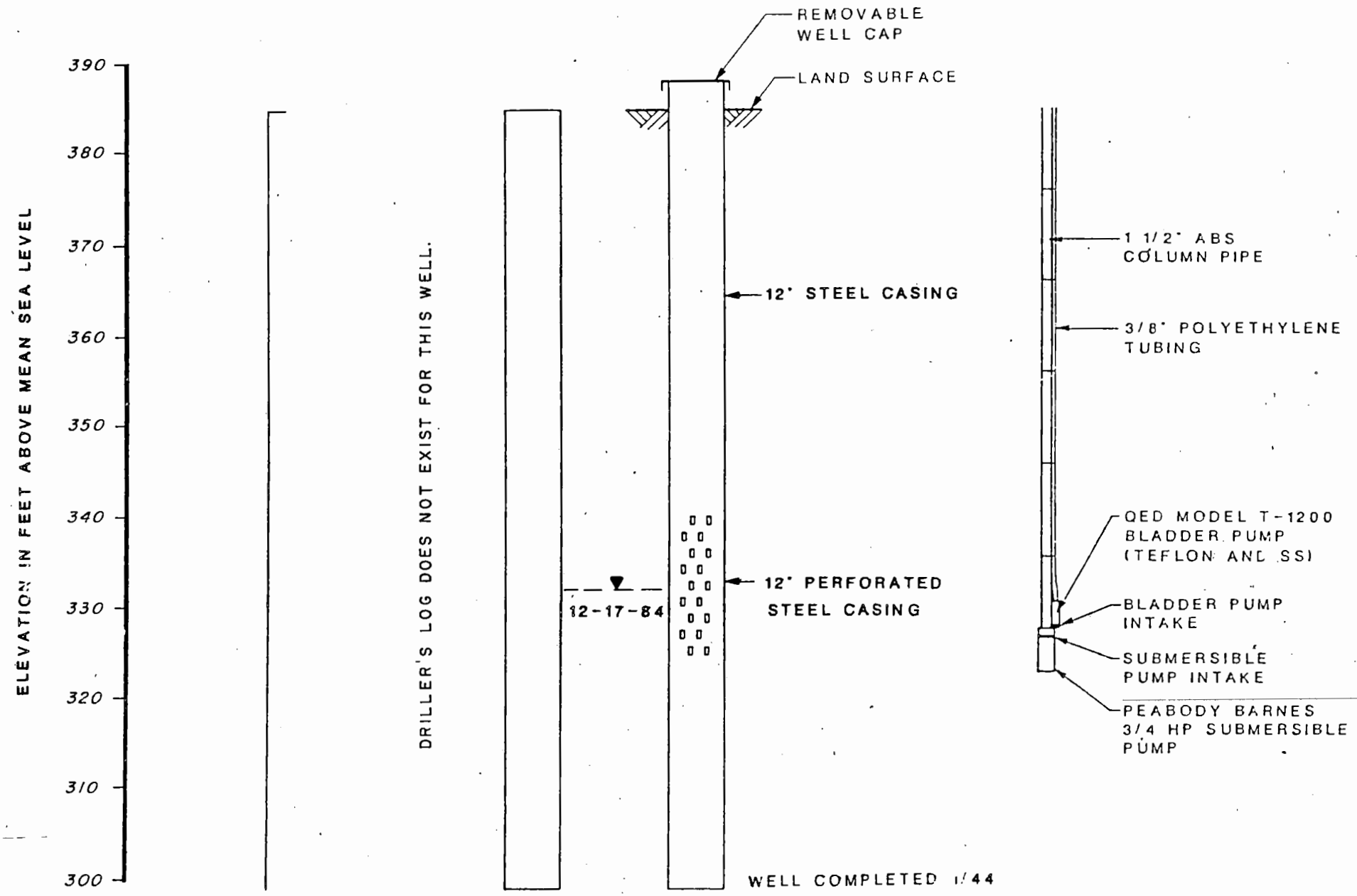


FIGURE 5-28 STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-3-7.

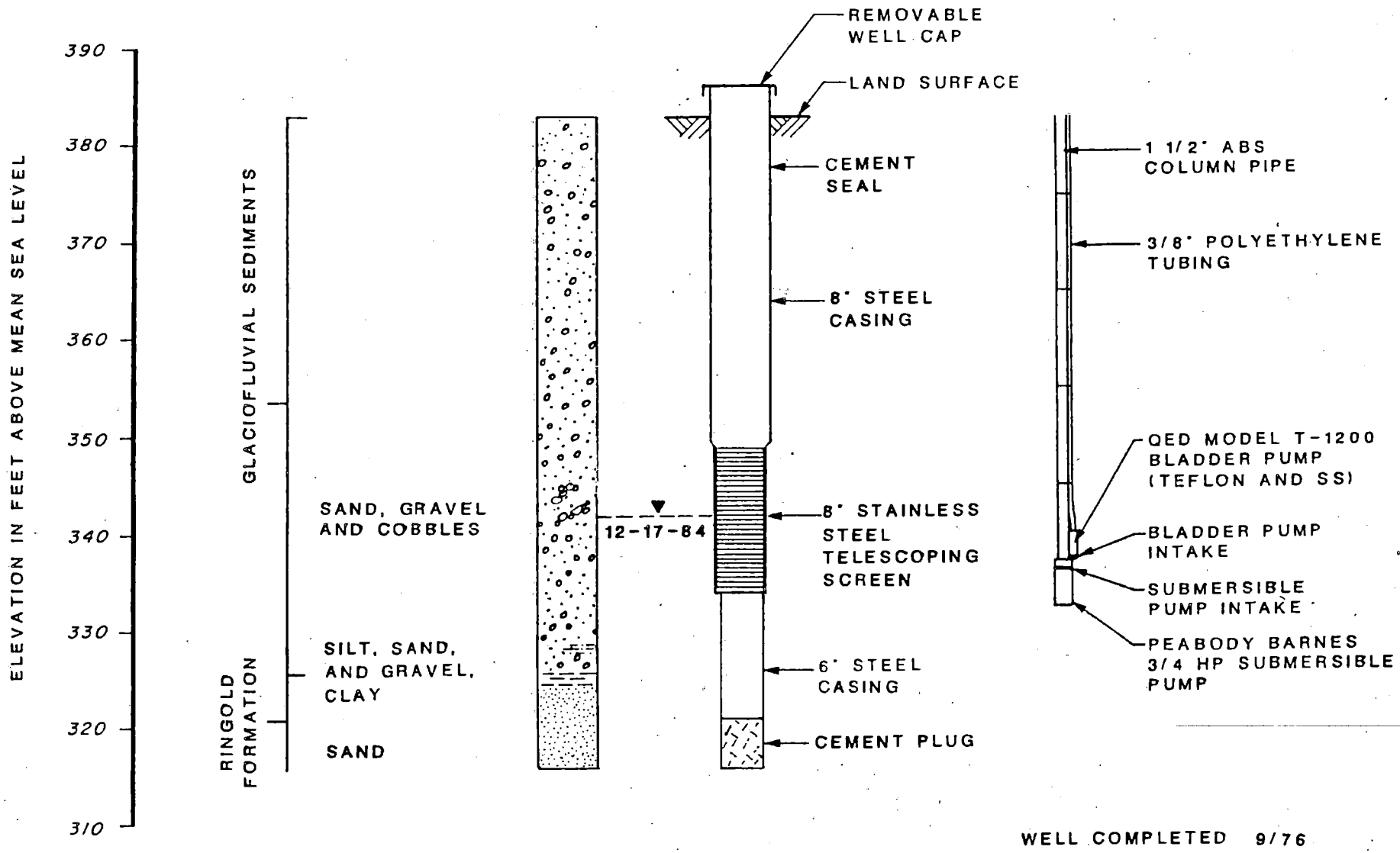


FIGURE 5-29 STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-3-10

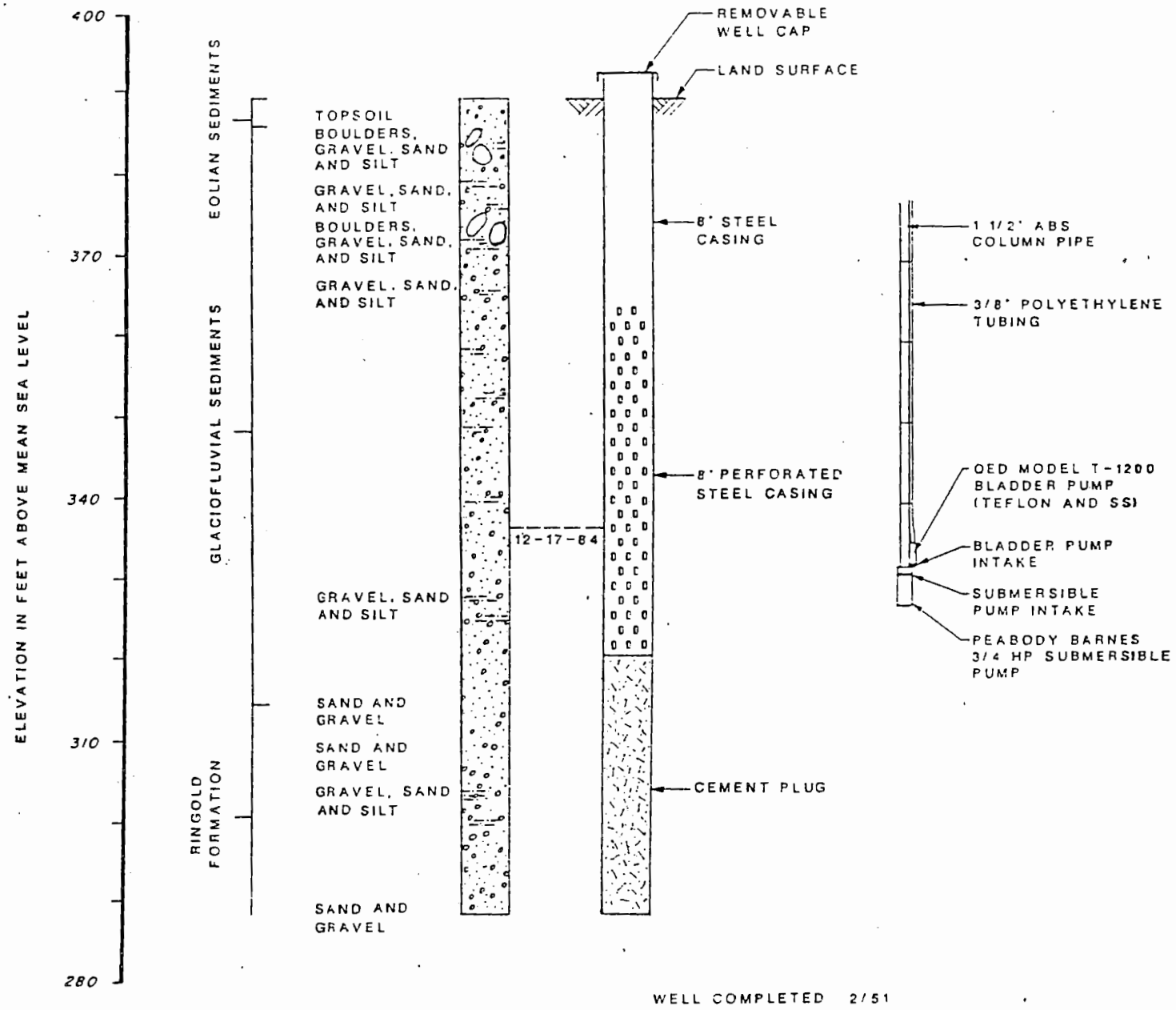


FIGURE 5-30. STRUCURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-4-1.

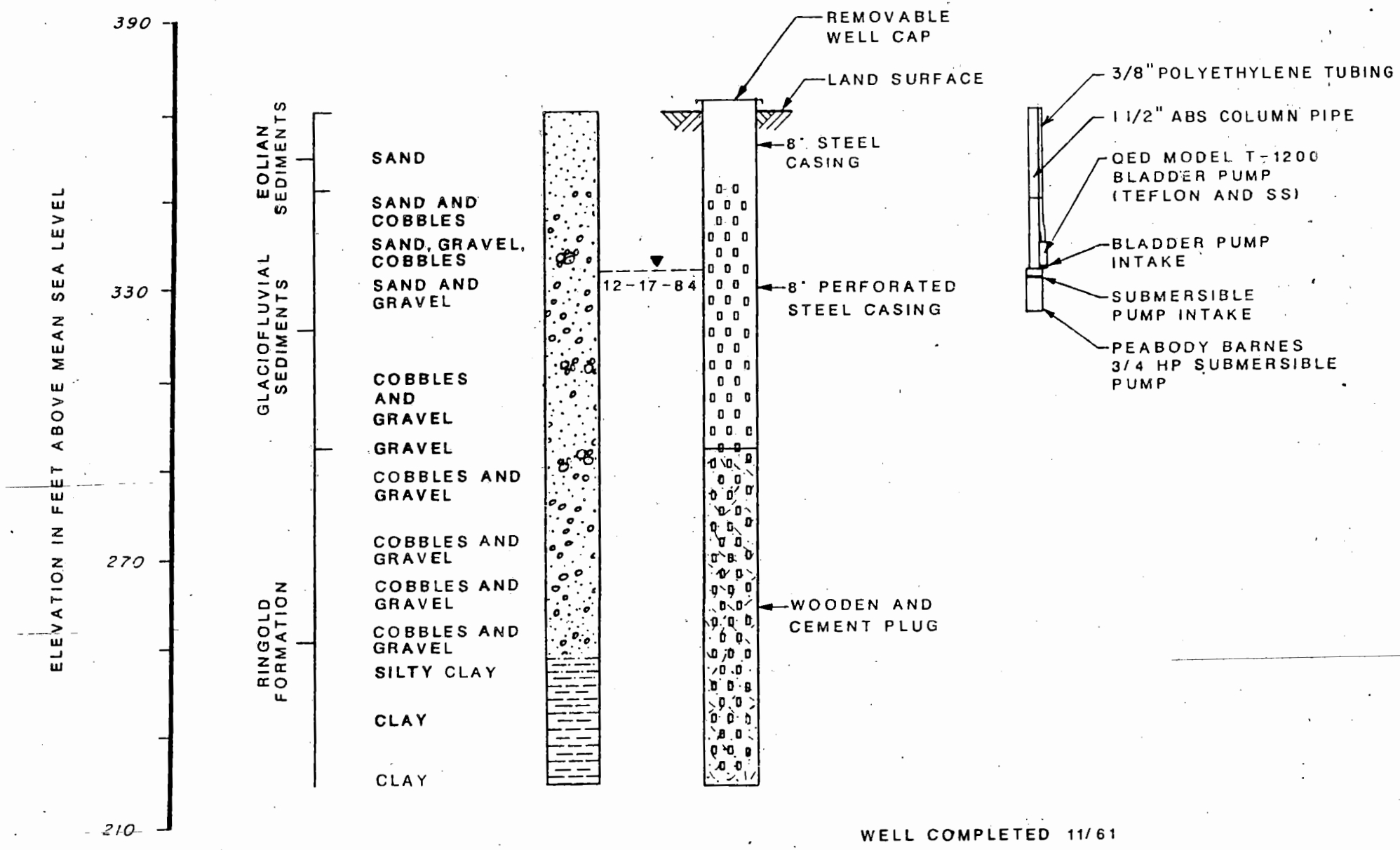


FIGURE 5-31 STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-4-7

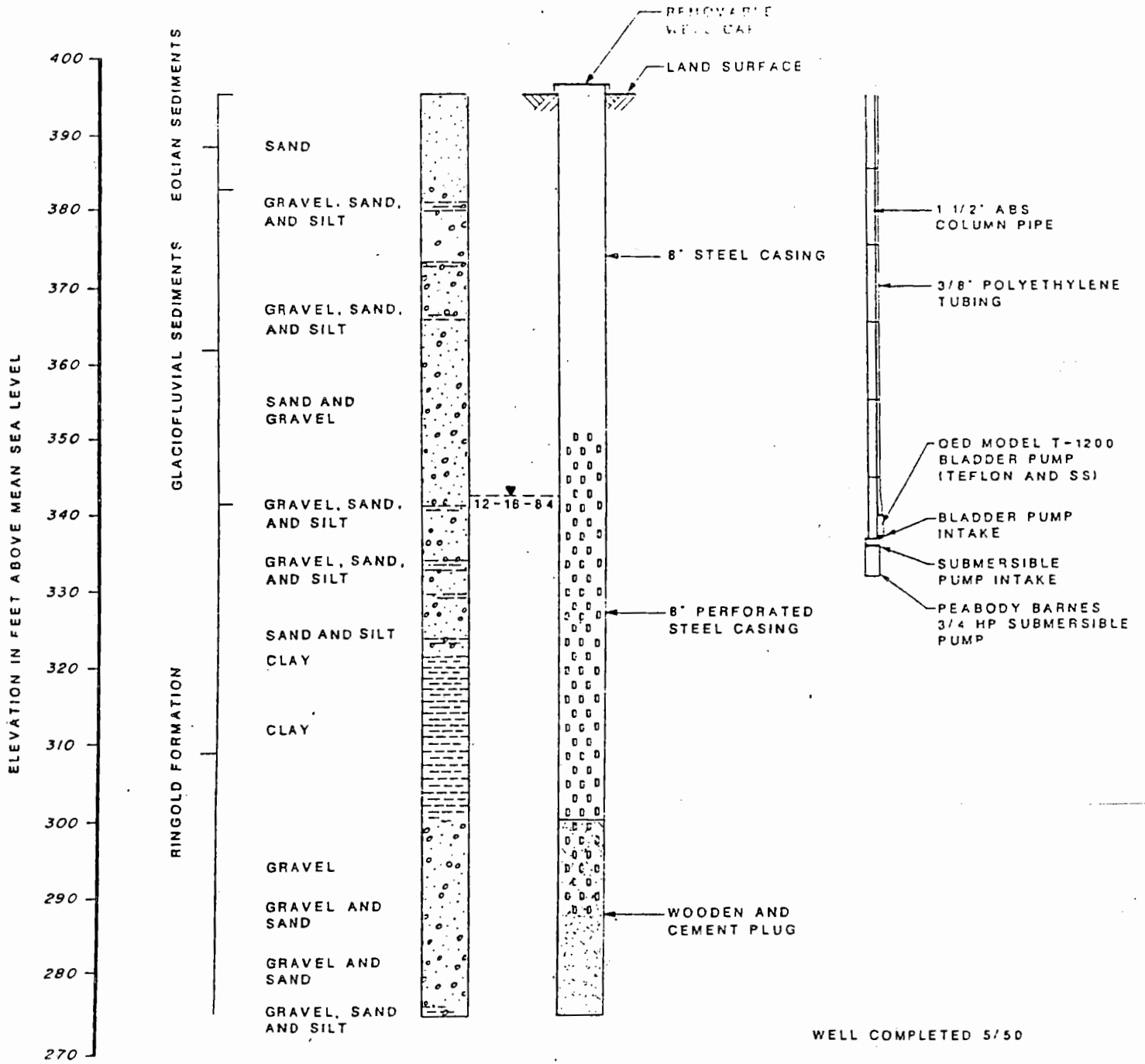


FIGURE 5-32. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 399-8-2.

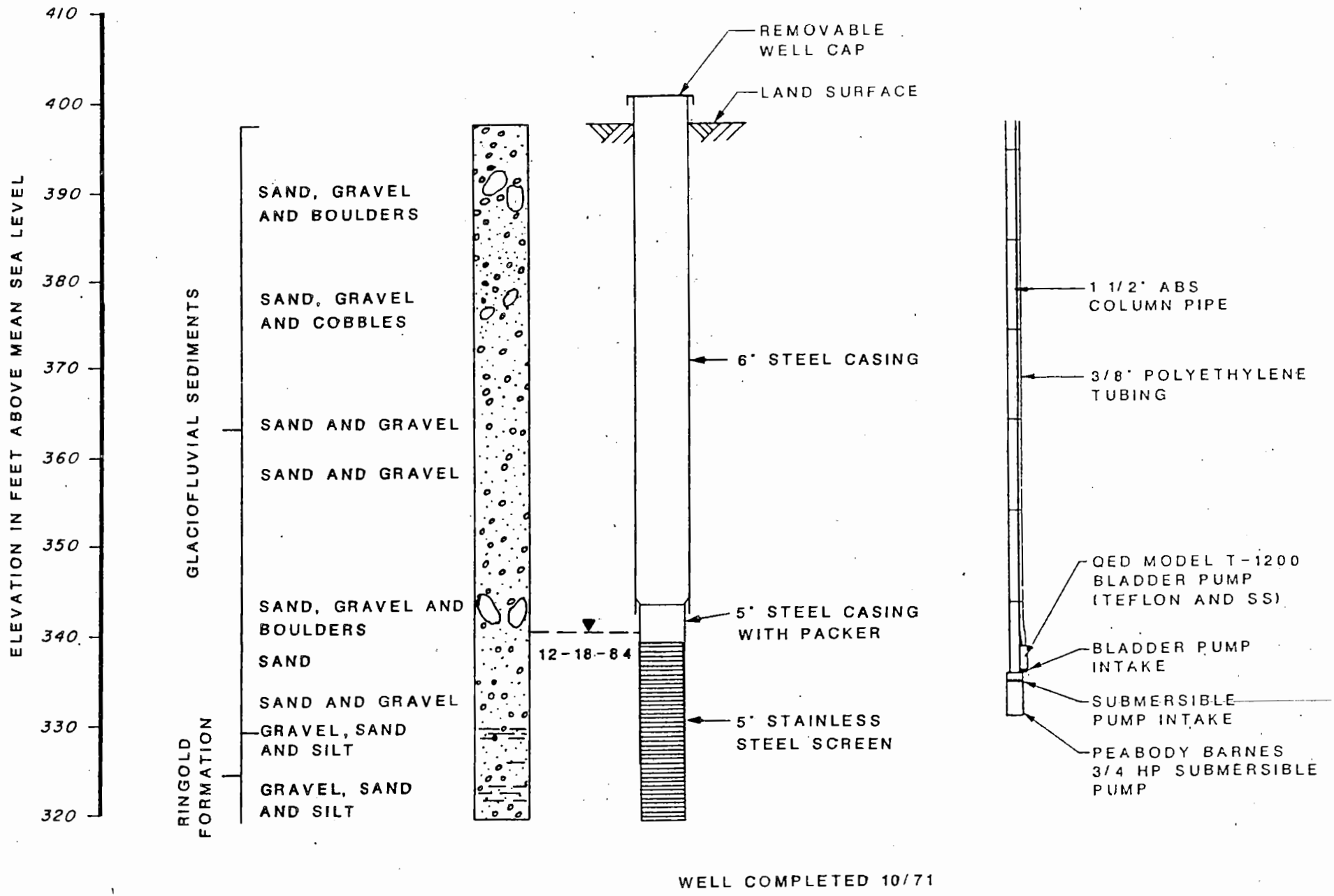


FIGURE 5-33 STRUCURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 699-S30-E15A.

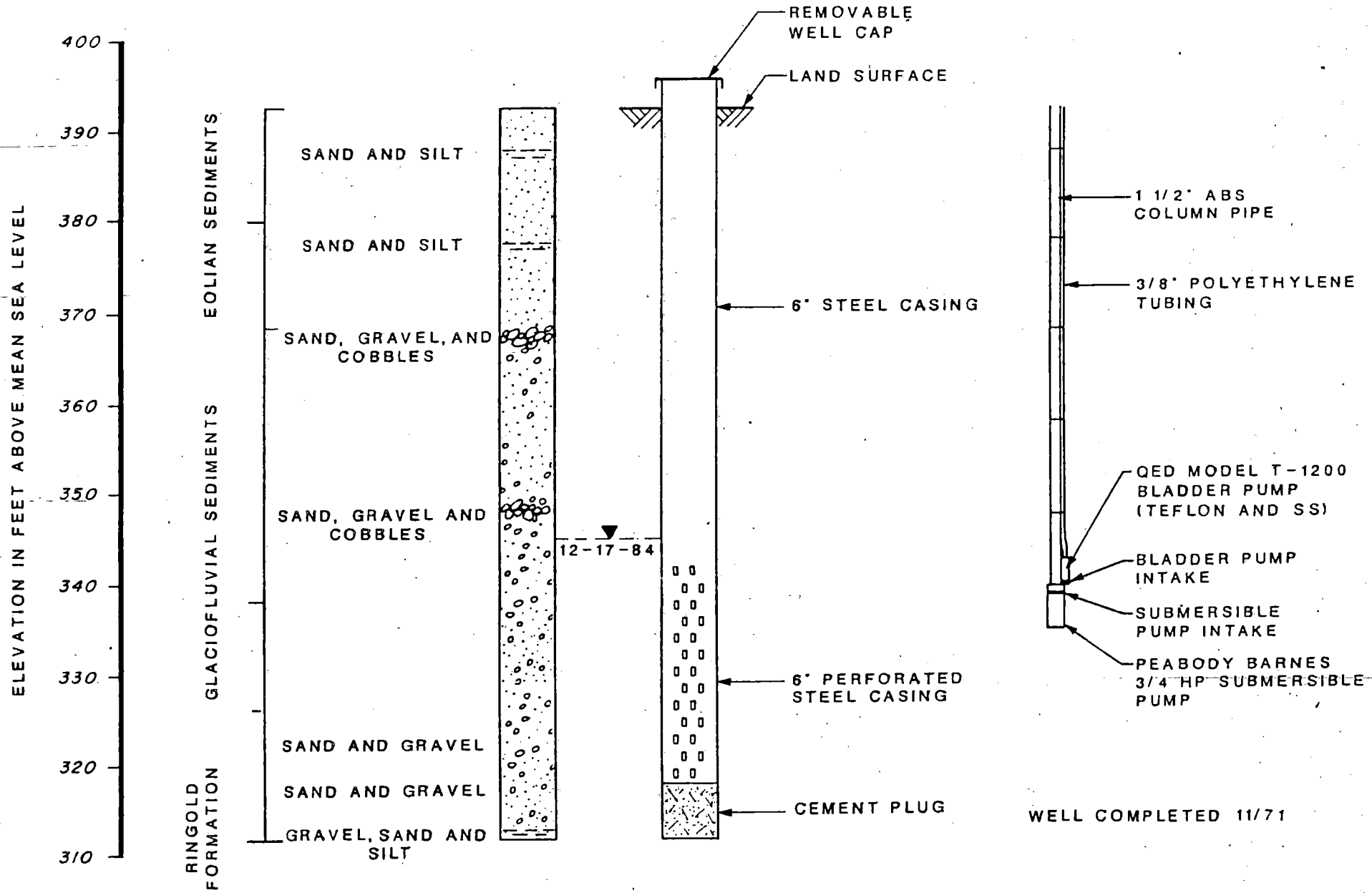


FIGURE 5-34. STRUCTURAL DIAGRAM AND GEOLOGIC LOG FOR WELL 699-S19-E13.

(sample number) - company code (list of analyses)

(well number)

(bottle preparation)

SAMPLE SIZE: _____ LAB: _____

DATE/TIME: _____

COLLECTOR: _____

FIGURE E-35. SAMPLE LABEL

Well Number Date

Pumping Time for Submersible

Precalculated at 10 gpm -

Calculated in field -

Bladder pump rate

Time Submersible On - Time Bladder On -

Samples Collected:

Sample No.	Volume	Pump Type	Collector

Field Measurements:

Water Level

E-tape -

Steel tape -

Held

Wet

Level

Time

pH

Cond.

Temp.

Field Observations

Data Recorder

FIGURE 5-36. SAMPLE FIELD LOGBOOK PAGE

CHAIN-OF-CUSTODY

Project Number:

Company Contact's Name: _____ Telephone: _____

Samples Collected by: _____

Date Sampled: _____ Time Sampled _____

Sample Location: _____

Remarks: _____

_____

_____

Method of Shipment: _____

Sample Identification	Type and Size Container

Chain of Possession

Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:

FIGURE 5-37. SAMPLE CHAIN-OF-CUSTODY FORM

S A M P L E A N A L Y S I S R E Q U E S T

Pacific Northwest Laboratory
P O Box 999
Richland WA 99352

United States Testing Company, Inc.
2800 George Washington Way
Richland WA 99352

Collector _____
Date /Time Sampled _____
Company Contact _____

Received by _____
Title _____
Date _____ Time _____

CHAIN OF CUSTODY NO. _____

SAMPLE ID _____

UST SAMPLE ID _____

COMMENTS

	CODE	CONSTITUENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	725	ICP METALS 6010														
2	726	ICP METALS 6010 ENHANCED														
3	A20	ARSENIC														
4	A21	MERCURY														
5	A22	SELENIUM														
6	A23	THALLIUM														
7	A24	THIOUREA 8330														
8	727	METHOD 8330 ENHANCED														
9	728	PESTICIDES 8080														
10	729	PESTICIDES 8080 ENHANCED														
11	730	VOA METHOD 8240														
12	731	VOA METHOD 8240 ENHANCED														
13	732	A/B/N 8270														
14	733	A/B/N 8270 ENHANCED														
15	C61	TETRETHLYPYROPHOSPHATE														
16	C62	CHLOROBENZILATE														
17	C63	CARBOPHENOTHION														
18	734	PESTICIDES METHOD 8140														
19	C68	TOX														
20	C69	TOC														
21	C70	CYANIDE														
22	C71	FORMALIN														
23	735	NITRATE, SULPHATE,.... (IC)														
24	C77	PERCHLORATE														
25	C78	SULFIDE														
26	C79	KEROSENE														
27	C80	AMONIUM ION														
28	C81	ETHYLENE GLYCOL														
29	109	COLIFORM BACTERIA														
30	181	RADIUM														
31	112	ALPHA														
32	111	BETA														
33	C86	DIOXIN														
34	C87	CITRUS RED #2														
35	C88	CYANOGEN BROMIDE														
36	C89	CYANOGEN CHLORIDE														
37	C90	PARALDEHYDE														
38	C91	STRYCHNINE														
39	C92	MALEIC HYDRAZIDE														
40	C93	NICOTINIC ACID														
41	736	DIRECT ACQUEOUS INJECTION														
42	738	HERBICIDE 2,4-D, 2,4,5-TP SILVEX														
43	737	HERBICIDE 8150 ENHANCED														

DR2:[7,1]196

FIGURE 5-38. SAMPLE ANALYSIS REQUEST FORM

UST-RD SAMPLE LOG-IN FORM

DATE:

TIME:

COOLER ID :
CLIENT SAMPLE ID:
UST-RD ID :
NUMBER OF BOTTLES IN COOLER :
IS CHAIN OF CUSTODY FORM PRESENT? :
CHAIN OF CUSTODY NUMBER :
IS SAMPLE ANALYSIS REQUEST FORM PRESENT? :

* IS THE CUSTODY SEAL ON THE COOLER INTACT? :

* ARE THE CUSTODY SEALS ON THE BOTTLES INTACT? :

* DO THE SAMPLE LABELS AGREE WITH THE CHAIN OF CUSTODY SHEET? :

* DO THE SAMPLE LABELS AGREE WITH THE SAMPLE ANALYSIS REQUEST SHEET? :

---

* IF ANSWER IS 'NO', PLEASE EXPLAIN BELOW IN DETAIL.

SAMPLES LOGGED IN BY: _____

REVIEWED BY SAMPLE CUSTODIAN: _____
Govind Rao

FIGURE 5-39. SAMPLE LOG-IN FORM

6.0 CLOSURE AND POST-CLOSURE REQUIREMENTS

The 300 Area Process Trenches comprise a facility that received regulated waste in the past. However, effective February 1, 1985 new administrative controls were instituted which prevent discharge of hazardous materials into the trenches. The trenches currently receive non-hazardous, non-regulated aqueous solutions (for composition of discharge, see Section 3.0). All future discharges into the trenches will be non-hazardous. The purpose of this section is to demonstrate that the U.S. Department of Energy - Richland Operations Office (DOE-RL) is cognizant of the current and past practices relative to the 300 Area Process Trenches and that DOE-RL has a plan to administer the unit so that any future releases are within acceptable limits and will not harm the environment. The general closure plan involves several steps, some of which have already been initiated as a demonstration of DOE-RL's intent. The general steps are:

(1) Discontinue Discharges of Regulated Materials to Trenches (implemented 2/1/85)

(2) Sample Trench Area Soils
- Shallow Sampling (initiated 6/25/85)
- Deep Sampling (planned 2/28/86)

(3) Analyze Samples for Hazardous Components (initiated 7/26/85)

(4) Close Facility Under RCRA
- Decontaminate
- Alternate Closure Option

DOE-RL wishes to make clear that a commitment to close the facility under RCRA does not necessarily preclude the use of the facility in its current capacity (i.e., as a receiver of non-regulated solutions). The intent of DOE-RL is to operate the trenches while establishing that the trenches are not an environmental hazard. Should investigations reveal that significant and non-localized contamination is present at depth, then DOE-RL will begin immediately to initiate physical closure of the facilities or to take other appropriate actions that are consistent with RCRA. Should they become necessary, those activities will be conducted in accordance with common best engineering practices, under the direction of a registered engineer and with the approval of the cognizant regulatory authority; i.e., either:

Regional Administrator
Region X
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

or

Director
Washington Department of Ecology
Mail Stop PV-aa
Olympia, Washington 98504

Details of the 300 Area Process Trenches Closure/Post-Closure Plan are presented below. The locations of official copies of the Closure/Post-Closure Plan are given in Appendix H. The person responsible for storage and updating these copies is given in Appendix I. The certification of closure is found in Appendix J.

6.1 CLOSURE PLANS

6.1a Closure Performance Standard

The 300 Area Process Trenches will be closed in a manner that minimizes further maintenance and that minimizes post-closure escape of regulated waste to the extent necessary to protect human health or the environment. If necessary, a cover system will be designed for the trenches [see Section 6.1e(2)] which will prevent contaminant migration to groundwater. The vegetative cover will consist of two perennial wheatgrasses which are drought-tolerant and well suited to the local soils, thus minimizing maintenance at the site [Section 6.1e(4)].

6.1b Partial and Final Closure Activities

The DOE-RL does not anticipate any partial closure activities. Instead, DOE-RL will proceed to final closure of both trenches upon approval of this plan (expected in 1986). However, since two trenches are involved, it is possible that different closure alternatives may be indicated for each. It is therefore possible that one trench may be closed while detailed characterization of the other trench is proceeding. Thus, while all activities relate to final closure, final closure of the facility may occur in stages.

Characterization activities leading to final closure follow a logical progression of increasing detail. In the initial phase, shallow samples will be taken of the soil in the trench. The maximum depth of the samples will be two feet. Samples will be taken by soil augers or other suitable method and will be split so that representative samples of sediment, sediment/gravel interface, and rock/gravel interface are obtained from each hole. The regular sampling grid will consist of a single line down the axis of each trench with a sample spacing of 100 feet. These samples will be supplemented by samples taken at significant depressions and areas where field analytical instruments (e.g., field gas chromatograph or organic vapor analyzer) detect local "hot spots." In addition, paired samples will be taken at each end and at the middle of the trench to test for lateral heterogeneity. If significant levels of contamination are discovered by the initial sample grid, a more close-packed sampling array will be constructed to define its nature and extent.

To permit sampling, the trenches will continue their parallel operation. That is, sampling in one trench will be conducted while the other trench is receiving water. Once the sampling program in the first trench is finished, holes will be backfilled with native materials and that trench will receive process water so the other trench can be sampled.

Because of past practices, the remote possibility exists that regulated waste materials may have seeped into the ground in the past and may currently reside at some depth below the bottom of the trench and above groundwater. A deep sampling program will be conducted to establish the condition of the soil at depth. The DOE-RL will drill vertical holes between the two trenches. The distance between the two trenches is such that sediments in the zone of influence of the trenches will be sampled via these vertical holes. Samples will be taken at five-foot intervals and auger tailings will be monitored continuously with an organic vapor analyzer. These deep holes will be drilled at a spacing of 300 feet along a line that parallels the axis of the trench.

In addition to sampling soils, samples of the sludges at the inlet weir box will be taken. Those and all other samples will be collected according to procedures in SW-846 (Second Edition, Revised 1984). All sampling tools will be steam cleaned or washed with detergent and rinsed between samples. All

samples will be labelled to indicate the trench, location, and depth from which they were taken. Samples will be logged in and preserved as they are taken and will be shipped for analysis at the end of each day.

Analyses will be performed in a manner that will ensure all analytical procedures and controls comply with EPA specifications. For quality assurance, unidentified blanks and five percent duplicate samples will accompany regular samples. In addition, five percent of all analyses will be confirmed by an independent laboratory. Proposed analytical parameters for the 300 Area Process Trenches are shown in Table 6-1. It is proposed that 20 percent of the samples be analyzed for the parameters in Table 6-1. The rest of the samples will be analyzed for metals and TOC. Any TOC results significantly above the average will require analysis for all parameters in Table 6-1.

All data generated by the sampling and analysis program will be evaluated to identify the most effective closure alternative. For example, if significant contamination is found and it is shallow or localized, then the contaminated sediments will be excavated, segregated into compatible groups as necessary, drummed, labeled, manifested, and transported for disposal at an authorized facility. If contaminated liquids are encountered in the trenches, the liquids will be removed using a vacuum truck. They will then be transferred to an authorized disposal site for solidification and disposal. If significant contamination is found at depth and is non-localized, then DOE-RL will take steps immediately to initiate closure of the trench (e.g., discontinue aqueous discharge into the trench, design and construct a cap containment structure).

6.1c Maximum Waste Inventory

The maximum waste inventory is currently unknown. It will be provided once the characterization activity for the trenches is complete.

6.1d Inventory Removal, Disposal or Decontamination of Equipment

If contamination is found, a variety of equipment will be used in the final closure of the 300 Area Process Trenches. These include:

- Tracked bulldozer
- Roadgrader
- Dump trucks
- Shovels, augers and rigs
- Water trucks (if needed).

All tools used in the sampling and final closure program will be assumed to be contaminated with regulated waste. They will be steam-cleaned prior to removal from the area. Cleaning will take place in a plastic-lined area where cleaning residues may be collected and analyzed for TOC and TOX. If cleaning residues contain hazardous constituents, the materials will be disposed of in a RCRA-regulated disposal facility at the Hanford Site.

6.1d(1) Closure of Containers

This section is not applicable to the 300 Area Process Trenches.

6.1d(2) Closure of Tanks

This section is not applicable to the 300 Area Process Trenches.

6.1d(3) Closure of Waste Piles

This section is not applicable to the 300 Area Process Trenches.

6.1d(4) Closure of Surface Impoundments

This section is not applicable to the 300 Area Process Trenches.

6.1d(5) Closure of Incinerators

This section is not applicable to the 300 Area Process Trenches.

6.1d(6) Closure of Land Treatment Facilities

This section is not applicable to the 300 Area Process Trenches.

6.1e Closure of Disposal Units

If contamination is extensive, the 300 Area Process Trenches will be closed as disposal units (i.e., contaminated materials will remain in place). The final cover and its expected performance is described in Section 6.1e(2).

6.1e(1) Disposal Impoundments

No preparation of wastes for final cover is expected to be required if the 300 Area Process Trenches are to be closed as disposal units.

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6.1e(2) Cover Design

It is believed that any contamination found in the 300 Area Process Trenches, will be removable by excavation. As a result, no cover will be required. However, if deep, significant, and/or extensive contamination renders total excavation impractical, then a cover for the facility will be constructed as described below.

Final Cover General Design Description

A multilayer cover will be used for closure of the trenches. The cover will consist of 4 foot (1.2 meter) deep revegetated soil underlain by a woven synthetic geotextile fabric and 6 inches (15 centimeters) of gravel. The 4 foot (1.2 meter) depth of soil will provide storage for annual precipitation and support the establishment and growth of a perennial grass cover that will stabilize the surface and enhance soil-water removal. The geotextile will minimize the sifting of fines into the gravel interstices. The gravel layer will serve as a capillary barrier between the cover soil and waste zone, increasing the amount of water storage potential in the upper soil layer and maintaining greater levels of plant available moisture.

Concept and Function of the Multilayer Cover

Soil water moves in response to pressure-head differences. The pressure heads are positive in saturated soils because of hydrostatic forces and negative in unsaturated soils because of capillary forces. In unsaturated soil, water movement is influenced both by capillary forces and by gravity. For relatively salt-free soils, the combination of capillary and gravitational heads determines the total hydraulic head, usually expressed in terms of length (centimeters or meters) of an equivalent water column. Infiltration into either uniform or layered soils can be predicted by properly characterizing the gradient of hydraulic head and hydraulic conductivity. Another simple, yet basic, soil water concept is the soil water outflow law [Richards, L. A., 1950, "Law of Soil Moisture", Trans. Amer. Geophys. Union, 31 (5)]. This law states that water will not move from soil into an open cavity until the water pressure is atmospheric or greater. For layered soils, this means that water will not move from fine soil into very coarse soils until the soil at the boundary between the soil layers is virtually saturated [i.e., until the water pressure (capillary pressure) in the fine soil at the boundary is near or

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equal to zero]. This basic law is fundamental to understanding the concept of a multilayer cover.

The final cover intended for use at the trenches is based on the concept just described. The gravel layer underlying the cover soil serves as a capillary barrier. As moisture infiltrates the cover soil, a wetting front moves downward through the soil of relatively fine porosity to the point of contact with the large-pored (gravel) layer. The volume of pores capable of holding water at the tensions which exist at the wetting front and water-filled cross section is reduced. Before the wetting front can advance, the soil-water pressure at that point must increase until it is large enough to allow the pores to fill with water. The overlying soil will retain considerably more water at this point than would the same soil depth had a coarse (gravel) layer not been present.

Fine Soil for Final Cover

In order for a multilayer cover to be effective in eliminating drainage, it must be capable of storing at least the anticipated annual precipitation and, preferably, the maximum expected amount. The greatest annual amount of precipitation recorded at Hanford to date is approximately 11 inches (28 centimeters). There is a greater than 95 percent probability that the 11 inch total will not be exceeded (see Figure 6-1). This amount of precipitation has been established as a design criterion.

To meet the criteria of higher water-holding capacity and less permeability, the final cover soil will have to be obtained from selected sites outside of the immediate areas surrounding the trenches. The most promising soil identified thus far belongs to the Esquatzel series. Esquatzel series soils are typically deep and medium-textured, and exhibit moderate permeability and high water-holding capacity. Relatively uniform deposits of this soil type have been indicated approximately 10 miles (16 kilometers) northwest of the nonradioactive dangerous waste landfill; however, further investigations and soil analyses are planned to locate a source of suitable materials nearer the trenches.

In lieu of detailed soil data, the Benton County Soil Survey was used to obtain estimated properties of the Esquatzel series soils. These estimated properties are as follows:

- Textural class: fine sandy loam
- Unified class: ML
- Permeability: 2.0 - 6.0 centimeters per hour
- Water-holding capacity 0.16 - 0.20 centimeters per centimeter soil

Based on the estimated minimum water-holding capacity of 0.16 inches water per inch soil, a non-layered 4 feet (1.2 meters) deep soil profile will retain 7.8 inches (20 centimeters) of water.

Gravel for Final Cover

Materials ranging in size from coarse, washed sand to cobble-sized rock could be used to achieve the textural change necessary for the capillary barrier; however, 1/4 to 1/2 inch (6 to 12 millimeters) gravel is easily handled and provides a stable base over which the remainder of the barrier can be constructed. The gravel is also available on site at the excess concrete batch plant. The thickness of the gravel or capillary barrier will be at least 6 inches (15 centimeters). Barrier experience gained thus far has shown that this is the minimum thickness obtainable by use of heavy equipment during construction.

Geotextile for Final Cover

The distinctness of the textural change between the soil and the gravel layer will be maintained by use of a woven synthetic geotextile fabric. The geotextile is commonly used for load distribution and subgrade stabilization during roadway construction and offers excellent resistance to installation abuse. The product chosen is manufactured by Mirafi Construction Fabrics (Product No. 600X) which offers the tested properties shown in Table 6-2.

This product has been used in barrier construction at Hanford to prevent soil fines from sifting into the underlying gravel layer. This experience should prove useful during construction of the final cover at the trenches.

Vegetative Cover

Having established the ability of the final cover to safely store maximum annual precipitation, a mechanism for removal of the stored soil water must be provided. While estimates of annual evaporation closely approximate the annual precipitation, these estimates relate more accurately to total potential evaporation. Evaporation does account for the majority of the soil water removed; however, its effectiveness diminishes with soil depth.

To prevent the eventual accumulation of moisture and the possibility of drainage through the capillary barrier, a vegetative cover will be established to enhance soil water removal.

The two perennial wheatgrasses selected for revegetation of the final cover are Siberian wheatgrass (Agropyron sibericum) and thickspike wheatgrass (Agropyron dasytachyum), both of which have been used routinely with good success at Hanford. These species are drought tolerant and well suited to the medium- to coarse-textured local soils.

Once established, the vegetative cover will assure effective removal of available moisture (i.e., water held at less than -15 bars) throughout the 4 foot (1.2 meter) deep soil layer. The soil layer depth is sufficient to support and contain the rooting depth of the intended plant cover, and similar plant covers are known to be effective in exploiting soil-water to depths of at least four feet. Plant root penetration into the gravel layer is not expected to occur because of the gravel pore size and resultant lack of available moisture.

6.1e(3) Minimization of Liquid Migration

The primary objective of a cover system design is prevention of water infiltration into underlying waste zones where contact may leach contaminants into the groundwater. Most cover designs typically rely on impermeable barriers. An impermeable barrier as envisioned by the EPA at the present time would consist of clay and/or a synthetic liner. However, the use of clays in an arid environment is unacceptable because an optimum moisture content necessary to maintain the integrity and intended purpose of the clay liner cannot be

assured. Eventual dessication will result in clay shrinkage and cracking with a subsequent loss of integrity. Synthetic liners would not be affected by the arid environment. However, their effectiveness depends heavily on the methods and care with which they are installed. Synthetic liners would be a barrier to both downward and upward moisture movement; but, over time, condensate would collect on the bottom side of the liner, which would act as a diverting mechanism for moisture to reenter the waste confinement zone. Therefore, neither clay nor synthetic material will fulfill the intent of the regulations, which are to prevent the entry of liquids into the closed waste containment area.

Recent research related to the long-term disposal of radioactive waste has shown that multilayer cover systems are effective in minimizing and preventing liquid migration into a buried waste zone in arid environments. Multilayer systems can use the natural material of rock and soil to provide a durable and long lasting cover system.

The basis for the multilayer approach is the soil water outflow law which states that water will not move from a fine-pore soil into much larger pores until the water is atmospheric or greater. For layered soils, this means that water will not move from fine soil into very coarse soils until the soil at the boundary between the soil layers approaches saturation. Field observations of layered soils indicate that significant increases in soil water storage can be attained when soils are underlain by coarse-textured materials. This is particularly true when the soil is moderately fine-textured. Table 6.3, (Miller, D. E., 1973, "Water Retention and Flow in Layered Soil Profiles", Field Soil Water Regime, R. R. Bruce, pp. 107-177, Soil Science Am. Special #5, Madison, Wisconsin) shows the effect of layering on water storage in an overlying soil.

The greater water retention is attributed to the textural differences between the upper soil and the capillary barrier. The coarser the underlying material, the less flow is expected until nearly saturated conditions prevail. The effectiveness of the multilayer cover to prevent or minimize liquid migration will thus be assured by:

- Highly nonlinear nature of unsaturated hydraulic conductivity across the fine soil/coarse gravel interface
- Water-holding capacity of the final cover soil
- Evapotranspiration of accumulated soil water

The soil of the multilayer cover system is a fine sandy loam. As a textural class, sandy loam is intermediate between loam and loamy sand. From Table 6-3, it can be inferred that moisture retention in a sandy loam soil underlain by coarse material (i.e., a capillary barrier) can be increased by a factor of at least 1.5. As stated previously in section 6.1e(2), a nonlayered 4 foot (1.2 meter) deep sandy loam soil profile will hold 7.8 inches (20 centimeters) of water, which is 2 inches (5 centimeters) more than the average annual precipitation and 3 inches (8 centimeters) less than the maximum recorded precipitation. Utilizing the above inferred increase in moisture retention capacity attributable to the presence of a capillary barrier, the estimated 7.8 inch total water retention capacity is increased to 11.7 inches (30 centimeters). Referring to Figure 6-1, the probability that annual precipitation will exceed this amount is estimated to be less than one percent. Further, assuming that evapotranspiration equals precipitation, the probability that precipitation will be great enough to penetrate the multilayer barrier can be estimated to be less than one percent.

6.1e(4) Maintenance Needs

Experience gained with Hanford Site surface stabilization (800 acres) since 1978 has shown that very little maintenance is required following the successful establishment of the vegetative cover. Successful establishment generally requires from two to three years. During this period, the straw mulch applied for initial stabilization and the natural emergence of cheatgrass (*Bromus tectorum*) which is ubiquitous in southeastern Washington, combine to protect the soil cover from erosion by wind. Also, trained personnel periodically evaluate seedling progress and recommend any necessary corrective actions. Herbicides are often used in the spring to selectively control annual broadleaf species which compete for available moisture and nutrients. Herbicide applications are discontinued following successful perennial grass establishment.

Fertilizer applications are sometimes needed after closure to stimulate plant vigor during the second or third year. Some instances of apparently increased small rodent activity have been discovered, primarily in the form of burrows in the trench cover side slopes. This potential problem has been practically eliminated by decreasing the side slope angles to three-to-one. The only other maintenance instituted as a result of periodic surveillance has been the manual removal of deep-rooted shrubs which might penetrate the soil cover. No additional backfilling has been required as a result of wind or water erosion to date. Maintenance of the final cover is not expected to be dissimilar from that experienced to date on other Hanford stabilization projects.

6.1e(5) Drainage and Erosion

No artificial drainage will be incorporated into the final cover system. Soil permeability and typical rainfall intensities are such that water erosion has not been a problem at Hanford. The greatest potential for erosion arises in the late winter when rapid snow melts may occur over frozen ground. No significant erosion has been recorded during routine surveillance of areas stabilized to date.

Initial erosion/abrasion protection will be provided by the application of a straw mulch. The entire cover and surrounding area disturbed during construction will be mulched at a rate of one ton of straw per acre. Mulching is an integral part of the revegetation process at Hanford and it has proven very successful in minimizing seedling damage and soil loss by winds. Once established, the perennial grasses will provide the protection necessary to minimize erosion over the long term. Little erosion has been recorded on other areas (800 acres) stabilized to date.

6.1e(6) Settlement and Subsidence

Localized settlement should not prove detrimental to the integrity of the multilayer cover. Significant subsidence events could disrupt the integrity of the final cover and reduce its effectiveness in preventing liquid migration. The geotextile will lend some support to the soil cover by providing load distribution should subsidence occur. Subsidence will be monitored through periodic surface measurements taken from permanent benchmarks

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and concrete perimeter posts. Possible maintenance actions are contained in the post-closure plan (6.2).

6.1e(7) Cover Permeability

Since no bottom liners (clay or synthetic) have been used at the trenches, the final cover system permeability need only be less than that of the underlying native soil. In lieu of detailed soils data, the Benton County Soil Survey was used to obtain estimated properties for Quincy series soils which correlate very closely to the Rupert series encountered at the trenches. These estimated properties are as follows:

- Textural class: loamy sand
- Unified class: SM
- Permeability: 25 centimeters per hour
- Water-holding capacity: 0.10 centimeters per centimeter soil

Referring to the estimated properties presented earlier for the Esquatzel series soils, the final cover soil has an estimated permeability of 0.8 to 2.5 inches per hour (6.0 centimeters per hour) compared to greater than 9.8 inches per hour (25.0 centimeters per hour) for the underlying native soil. Therefore, the permeability of the final cover soil (excluding the retarding effect of the cover system) is much less than that of the native soils at the trenches.

6.1f Continuance of Operations

During closure one trench will be in operation (i.e., receiving non-regulated aqueous solutions) while the other trench is characterized and remediated. Groundwater monitoring will continue as described in Section E.

6.1g Schedule for Closure

Closure will be initiated and all samples taken within 30 days of approval of the closure plan. All on-site waste will be removed by 90 days with final closure complete in 180 days. If a cover system is necessary, a detailed schedule for installation will be submitted to the regulating authority.

6.1h Extensions for Closure Time

If before or during the start of closure operations for the trenches it appears that closure may take more than 180 days, a demonstration will be made to the appropriate regulatory authority to explain the need to extend the 180 day closure time.

If the soil surrounding the trenches is contaminated and if extensive sampling and analysis are required, the removal of all the soil may take longer than 180 days. If this situation occurs, a demonstration will be made to the appropriate regulatory authority to explain the need to extend the 180-day closure time to protect human health and the environment.

6.2 POST-CLOSURE PLAN

If the contamination is extensive and the trenches are closed in place, the following post-closure plan will be implemented.

6.2a Inspection Plan

An engineer or scientist with experience in the construction and function of a multilayered cover system will perform the following monitoring activities semiannually for the first five years and annually for the remainder of the post-closure period:

a. Evaluation of settling/subsidence
b. Evaluation of vegetative cover
c. Evaluation of bench marks
d. Evaluation of security
e. Evaluation of rodent intrusion
f. Evaluation of erosion

The frequency of inspection is expected to be adequate to detect any serious problems with the cover system.

Maintenance action will be initiated within 90 days if the inspection reveals that the integrity of the final containment structure can potentially be breached.

A potential breach is defined below along with the possible maintenance action:

a. Settling/subsidence greater than three feet will initiate maintenance action. Maintenance action may include injecting a grout into identified void spaces and reestablishing the integrity of the multilayer cover system; or stabilizing the settling/subsidence area and relaying the multilayer system over the affected area. If, at the time of maintenance action, new products and/or information is available to perform the needed repair in a comparable manner to the actions listed above, those maintenance actions may be considered in lieu of the above proposed actions.

b. Vegetative cover less than ten percent after two years of closure (seeding) will initiate maintenance action. Maintenance action will include reseeding and possible fertilizer application.

c. Bench marks observed to be damaged or out of alignment will result in maintenance action. Maintenance action will include replacement of damaged bench marks and resurveying of bench marks found to be out of alignment.

d. Damage to the enclosing fences which allow access to the trenches will result in maintenance action. Maintenance action will include repair of the fence.

e. Rodent intrusion in densities that are judged to threaten the integrity of the multiliner system will result in maintenance action. Maintenance action might include the use of chemical deterrent and/or trapping.

f. Erosion damage that results in the loss of 0.5 meters of the fine soil top layer will result in maintenance action. Maintenance action will include replacement of the fine soil top layer at the affected area, reseeding, and performing other selected tasks that were performed during closure to insure a vigorous vegetative growth.

6.2b Monitoring Plan

During the post-closure care period, groundwater monitoring will be conducted as described in Section 5.7. There are no liners or leachate collection and removal systems at the 300 Area Process Trenches. All groundwater monitoring wells for the 300 Area Process Trenches are within a secured area of the Hanford Site. All wells will be routinely inspected to ensure proper operation.

6.2c Maintenance Plan

During the post-closure care period, the maintenance organizations are directed at maintaining the integrity of the waste containment system. Experience gained since 1978 with containment systems has shown that the waste

containment system will remain intact if the vegetative cover is successfully established. Invading plants, primarily Russian thistle (Salsola Kali), with root systems that can extend into the waste zones, are the greatest potential problem. The active elimination of these invading species for two years after seeding will give the vegetative cover enough time to become firmly established.

Each Spring (generally between March 15, and April 15) for two to three years following closure, selective herbicides 2,4-D amine and dicamba (or their equivalent) will be applied to the closure area to minimize the establishment of deep rooting broadleaf annual plants that compete with the grasses for moisture and nutrients. Field application rates of 0.57 to 1.32 pounds per acre with 2,4-D amine and 0.19 to 0.44 pounds per acre with dicamba have proven effective in controlling undesirable broadleaf species. Selective herbicide applications will be discontinued following successful establishment of the perennial grass cover. Following establishment of the perennial grass cover, manual removal of deep rooting shrubs may be required periodically.

Soil permeabilities and rainfall intensities at Hanford are such that water erosion has proven to be practically nonexistent. However, the potential for wind erosion is possible, particularly during the period of vegetative establishment. Current mulching practices, which will be implemented during closure, have been quite effective at minimizing wind erosion. To date, there has been no need to import or provide additional backfill as a result of erosion.

Maintenance of bench marks has not been a problem to date. Vegetative growth is limited in the arid environment and bench marks are easily observable. Enough ground cover exists so that drifting sand does not overrun the bench marks. If a bench mark needs to be replaced, that action will be completed within 90 days of the original observation.

6.2d Land Treatment

This section is not applicable to the 300 Area Process Trenches.

6.3 NOTICE IN DEED

Notice to Local Land Authority

The DOE-RL will file, within 90 days after the start of post-closure care period, the following documents or similar documents to the local land use authority and the regulating authority. The land use authority is the Benton County Planning Department located at Courthouse Building, Prosser, Washington, 99350.

a. A survey plat indicating the location and dimensions of trenches to the extent the information exists and with respect to permanently surveyed bench marks will be submitted. This plat will be prepared by a certified professional land surveyor.

b. The following note is to accompany the survey plat: This plat describes real property in which hazardous wastes have been disposed and buried in accordance with requirements of 40 CFR Part 264 and/or WAC 173-303. Although this hazardous waste disposal facility is now closed, public health, environmental safety, and regulations issued by the EPA in 40 CFR 264.119 and/or the WDOE in WAC 173-303-610(9) require that post-closure use of the property never be allowed to disturb the integrity of the final cover unless it can be demonstrated that any proposed disturbance will not increase any risk to the human health or the environment.

c. A record of the type, location, and quantity of hazardous wastes disposed of within each trench to the extent that the information exists will be submitted. During the post-closure care period, any changes to this record will be submitted to the regulating authority.

Notice in Deed to Property

The DOE-RL will, in accordance with state law, sign, notarize, and attach the following notation to the deed of the 300 Area Process Trenches within 180 days of the start of the post-closure care period:

TO WHOM IT MAY CONCERN:

The U.S. Department of Energy-Richland Operations Office, an operations office of the U.S. Department of Energy, which is a Department of the United States Government, the undersigned, whose local address is the Federal Building, 825 Jadwin Avenue, City of Richland, County of Benton, State of Washington, hereby gives the following notice as required by 40 CFR 270.14(b)(14) and/or WAC 173-303-806(4)(a)(xiv).

a. The U.S. Department of Energy is, and since April 1943, has been in possession in fee simple of the following described lands (legal description).

b. Since November 19, 1980, the U.S. Department of Energy-Richland Operations Office has disposed of hazardous and/or dangerous waste under the terms of regulations promulgated by the United States Environmental Protection Agency and/or Washington Department of Ecology to the above-described land.

c. The future use of the above-described land is restricted under the terms of 40 CFR 264.117(c) and/or WAC 173-303-610(7).

d. Any and all future purchasers of this land should inform themselves of the requirements of the regulations and ascertain the amount and nature of wastes disposed on the above-described property.

e. U.S. Department of Energy-Richland Operation Office have filed a survey plat with the Benton County Planning Department and with the United States Environmental Protection Agency Region 10 and/or Washington Department of Ecology showing the location and dimensions of trenches and a record of the type, location and quantity of waste disposed within each area of the facility.

6.4 CLOSURE COST ESTIMATE

This section is not applicable because federal facilities are exempt from this section per 40 CFR 264.140(c) and WAC 173-303-620-(1)(c).

6.5 FINANCIAL ASSURANCE MECHANISM FOR CLOSURE

This section is not applicable because federal facilities are exempt from this section per 40 CFR 264.140(c) and WAC 173-303-620-(1)(c).

6.6 POST-CLOSURE COST ESTIMATE

This section is not applicable because federal facilities are exempt from this section per 40 CFR 264.140(c) and WAC 173-303-620-(1)(c).

6.7 FINANCIAL ASSURANCE MECHANISM FOR POST-CLOSURE CARE

This section is not applicable because federal facilities are exempt from this section per 40 CFR 264.140(c) and WAC 173-303-620-(1)(c).

6.8 LIABILITY REQUIREMENTS

This section is not applicable because federal facilities are exempt from this section per 40 CFR 264.140(c) and WAC 173-303-620-(1)(c).

TABLE 6-1

PROPOSED ANALYTICAL PARAMETERS FOR THE 300 AREA PROCESS TRENCHES SAMPLES

Required Constituents (Drinking Water Parameters)

Arsenic	Nitrate (as N)	2,4-D
Barium	Selenium	2,4,5-TP Silvex
Cadmium	Silver	Radium
Chromium	Endrin	Gross alpha
Fluoride	Lindane	Gross beta
Lead	Methoxychlor	Coliform bacteria
Mercury	Toxaphene	

Site Specific Constituents

Hydrofluoric Acid	Listed
Hydrogen	Listed
Tetrachloromethane (Carbon tetrachloride)	Listed
Antimony	Listed
Benzene	Listed
Chlorinated Benzenes	Listed
Dioxane	Listed
Dioxin	Listed
Formaldehyde	Listed
Formic Adid	Listed
Hexachlorophene	Listed
Hydrazine	Listed
Hydrocyanic Acid	Listed[a]
Methyl Ethyl Ketone	Listed
Naphthalene	Listed
Nickel	Listed
Phenol	Listed
Pyridine	Listed
Selenium compound - Selenium Sulfide	Listed[a]

See footnotes at end of table.

TABLE 6-1

(Continued)

Site Specific Constituents (Continued)

Thiourea	Listed
Toluene	Listed
1,1,1-Trichloroethane (Methyl Chloroform)	Listed
Trichloroethane (Ethane 1,1,2-trichloro-)	Listed
Trichloroethene (Trichloroethylene)	Listed
Copper	Unlisted
Perchloroethylene	Listed
Nitric Acid	Unlisted[a]
Sulfuric Acid	Unlisted[a]
Sodium Hydroxide	Unlisted[a]
Ammonium Bifluoride	Unlisted[a]
Aluminum Nitrate	Unlisted[a]
Sodium Chloride	Unlisted[a]
Ethylene Glycol	Unlisted
Sodium Nitrate	Unlisted[a]
Xylene	Listed
Kerosene	Unlisted[a]
Tributylphosphate - Paraffin Hydrocarbon Solvents	Unlisted[b]
Degreasing Solvents	(b)
Detergents	(b)
Photochemicals	(b)

Additional constituents specifically required by EPA and State Regulations.

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[a] No approved analytical method is currently available for this compound; components will be analyzed separately where possible.

[b] When listing the chemicals discharged at the facility, the facility operators indicated these general categories of chemicals as well as some specific chemicals. No analysis is currently planned, pending further guidance.

TABLE 6-2
PROPERTIES OF MIRAFI GEOTEXTILE

600X FABRIC	UNIT	TEST METHOD	TYPICAL VALUES
Grab Tensile Strength	lb	ASTM D-1682-64	300
Grab Tensile Elongation	%	ASTM D-1682-64	35 (Max)
Burst Strength	psi	ASTM D-3786-80	600
Trapezoid Test Strength	lb	ASTM D-1117-80	120
Puncture Resistance	lb	ASTM D-3787-80	130

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TABLE 6-3

WATER RETENTION IN LAYERED SOIL PROFILES

SOIL MATERIAL	STORED WATER (cm Water/60 cm Soil) TEXTURE		
	LOAMY SAND	LOAM	SILT LOAM
Soil underlain by sand layer (at 60 cm depth)	16.4	17.4	20.0
Uniformly deep soil with no layer	6.7	11.4	16.7
Ratio layered/uniform	2.5	1.5	1.2

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6.1 DEFINITIONS

Process Waste

Cooling water, process water, and other nonsanitary waste water which contains no radioactive materials other than trace amounts of uranium or materials designated dangerous by MG-99.

Diversion Process Waste or Retention Process Waste

Laboratory waste that contains no materials designated dangerous by MG-99 and is normally uncontaminated by radionuclides but that has a potential for such contamination. If radioactivity in this waste exceeds 5×10^{-5} µCi/ml, the waste is automatically routed to the Radioactive Liquid Waste System.

Radioactive Liquid Waste

Liquid waste containing radioactivity in excess of 5×10^{-5} µCi/ml.

2 EQUIPMENT AND FACILITIES

2.1 Non-Radioactive Systems

Most facilities in the 300 Area are served by sanitary and process sewers. Since these systems are not radioactive liquid waste systems, it is important that they be given consideration in planning experimental work and processes to ensure that no radioactive materials are discharged to them, either intentionally or unintentionally. Care must be taken to avoid any possibility of contaminated or potentially contaminated waste entering these systems. Additionally, care must be taken to ensure materials designated dangerous by MG-99 do not enter these systems.

6.2 EQUIPMENT AND FACILITIES (continued)

Sanitary sewage is collected in a separate sewer system which is connected to all 300 Area buildings with restrooms, change rooms, and toilet facilities. The sewer pipes form a network which delivers sewage to septic tanks with a total volume of 95,000 gallons. The septic tank effluent is sampled by a composite sampler, chlorinated, and discharged to one of two 600-foot-long by 10-foot-wide leaching trenches. Liquid percolates into the ground from the trenches which are within approximately 500 feet from the Columbia River.

Flow through the sanitary sewer system varies from less than 300,000 gpd in the winter to over 600,000 gpd in the summer. Sewage flow is measured by a weir and recorder located just downstream of the septic tanks.

The trunk lines of the sanitary sewer system are shown in Figure 6-1.

Process sewage is cooling water, process water, and other nonsanitary waste which does not contain significant quantities of radioactive materials or materials designated dangerous by MG-99. Most facilities in the 300 Area with significant quantities of process and cooling water are connected to a process sewer system which discharges into one of two 1,500-foot-long disposal trenches. Process flows are sampled by a composite sampler and measured by a weir and integrating flow recorder. Flow to the trenches averages approximately 2.5 million gpd. Water enters the ground through percolation. Oil baffles in the influent flume permit recovery of spilled oil.

The east bay of the south process pond is now used for disposal of filter backwash water from the 300 Area water treatment plant. Flows average about 30,000 gpd, flowing by gravity through an 18-in. line from the 315 Building to the south pond. Water enters the ground through percolation.

The 300 Area Process Sewer lines are shown in Figure 6-2.

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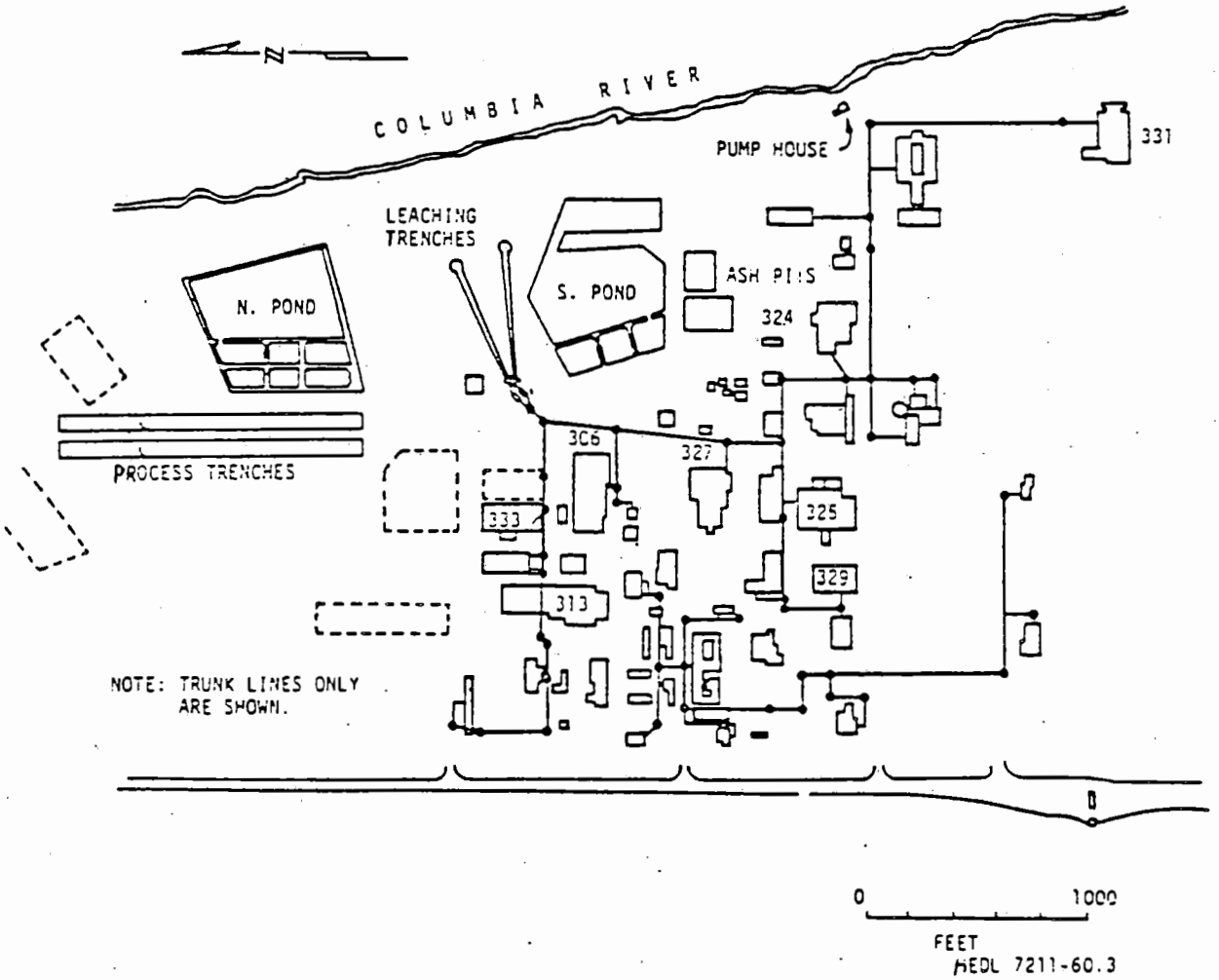

FIGURE 6-1. .300 Area Sanitary Sewer System.

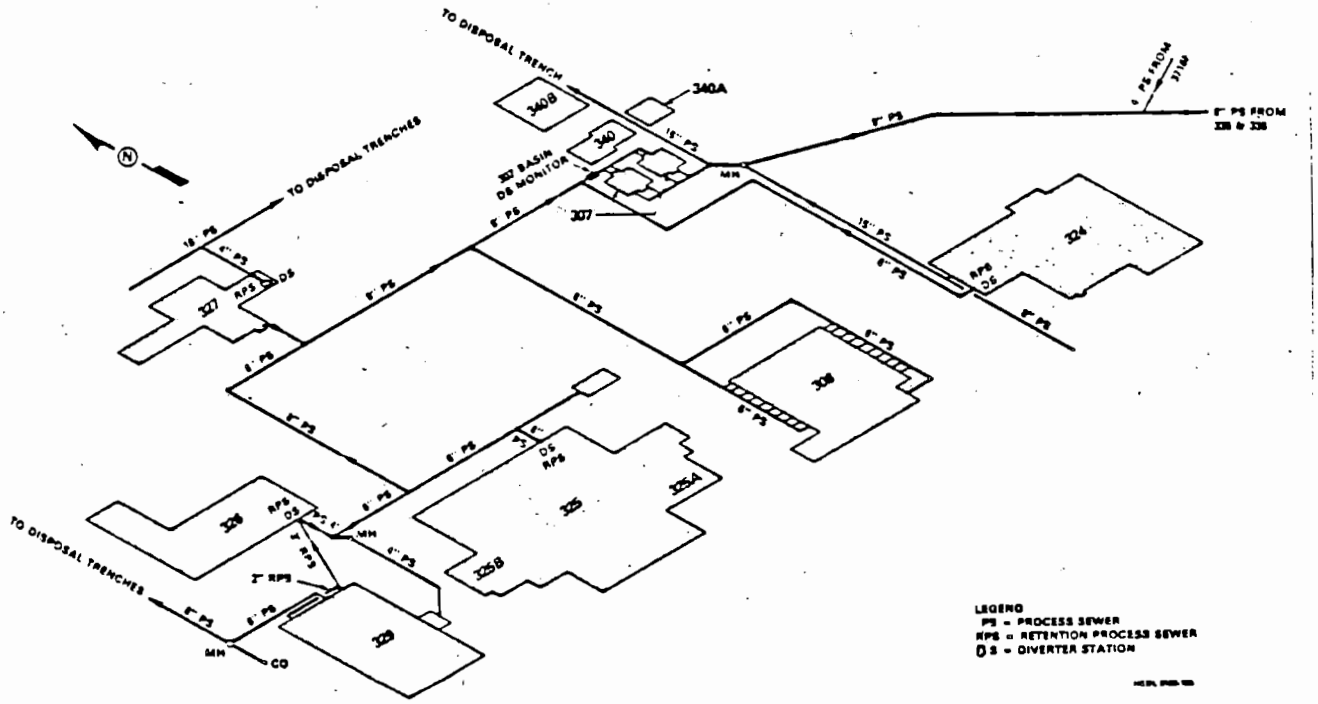

FIGURE 6-2. 300 Area Diversion Waste Sewer (Retention Process Sewer) and Process Sewer.

6.2 EQUIPMENT AND FACILITIES (continued)

6.2.1 400 Area Sanitary Sewer System

The 400 Area Sanitary Sewer System consists of 6, 8, 10 and 12-inch PVC or vitrified clay pipe mains, 18 manholes, a septic tank and dosing chamber and a leach field. The septic tank, dosing chamber and drainfield were installed as part of a FY1977 General Plant Project (V-656, Sanitary Sewer Modifications and Process Sewer System Installation).

The septic tank facility is multiple compartment type reservoir constructed of reinforced concrete and is located approximately 600 feet north of the 400 Area perimeter fencing. Raw sewage is collected by a distribution system in the 400 Area and is delivered to the septic tank via a 12-inch sewer main. The spectic tank is designed to collect approximately 60,000 gallons per day and was combined with a 2,500 gallon dosing chamber to provide surge flows to the drainfield. The dosing chamber is designed to be used also as a flow measuring device by monitoring a built-in dose counter.

The drainfield is located approximately 1,700 feet north of the 400 Area. The sub-system is constructed of 800 linear feet of 4-inch perforated PVC pipe set in multiple gravel trenches. Sewage effluent is delivered to the fiel via an 8-inch pipe from the dosinng chamber. Uniform distribution of effluent throughout the drainfield was to be provided by large surges of flow from the dosing chamber.

6.2.2 Diversion Waste System (DWS) or Retention Process System

Laboratory buildings in the 300 Area with a waste stream that could, by human error or equipment failure, become radioactively contaminated have been equipped with diverter stations. These diverter staions consist of

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2 EQUIPMENT AND FACILITIES (continued)

counting instruments and automatically operated valves which divert the liquid flow from the Process Sewer into the Radioactive Liquid Waste System and initiate alarms in the 325 Bldg. East Equipment room if the radioactivity exceeds the preset level of 5×10^{-5} μCi/ml. The 325 A and 324 Bldg. DWS diverts to a holding tank, then into the RLWS line. The systems in the buildings, upstream of the diverter stations, comprise the Diversion Waste System (Retention Process System). Downstream of the diverter stations is the Process Sewer. (See Figure 6-2.)

The portion of the Process Sewer which serves Buildings 324, 325, 326, 327, and 329, downstream of their diverters and lines from Buildings 308 and 309, which have no diverters, discharge into one of four 50,000-gallon concrete basins, the 307 Retention Basins. Two of these basins are provided with a coal tar epoxy coating to simplify decontamination if required. The other two have bare concrete surfaces and are used only in case of emergency.

The 307 Basins are equipped with an in-line β/γ detector which continuously monitors the waste stream before it enters the basin. An alarm is initiated in the 325 Building East Equipment Room, and the automatic basin discharge pump is deactivated when a radionuclide concentration above 5×10^{-5} μCi/ml is detected.

The first two basins are provided with a series of baffles which form a serpentine flow path. The flow through the basin by the serpentine route is long enough to allow a counting interval for the discharge pump to be shut down before contaminated liquid escapes from the basin. When no radioactivity is detected, the contents of the basin are automatically discharged to the Process Trenches. A continuous sampler is provided upstream of the basins to collect an integrated sample for laboratory analysis.

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6.2 EQUIPMENT AND FACILITIES (continued)

6.2.3 Radioactive Liquid Waste System (RLWS)

The Radioactive Liquid Waste System collects radioactively-contaminated liquid waste from a limited number of sinks and drains in Buildings 324, 325, 326, 327, and 329 into a network of stainless steel piping that leads to the 340 Building. The stainless steel piping is enclosed in fiberglass-reinforced plastic. At the 340 Building, the contaminated waste is stored in tanks, neutralized with sodium hydroxide, and pumped into railroad tank cars for shipment to the 200 Area waste treatment facility. The 309 Building TW tanks are connected to the 340 Facility through a direct-buried carbon steel line.

Two 15,000-gallon stainless steel tanks are located in the 340 underground vault. These tanks are equipped with agitators for use during neutralization. The tanks are also equipped with automatic pumps and valving for lifting the waste to six 8,000-gallon stainless steel tanks located in a nearby metal-walled building (340-A Building). The railroad tank cars are located in another nearby metal-walled building (340-B Building) which is equipped with loadout facilities. Auxiliary equipment, such as caustic pumps, a caustic storage tank, a filtered off-gas vent system, air compressors for air-operated instrumentation, air sampling system, liquid sampler, and radiation detectors are also provided in the 340 Facility.

Waste Management has at its disposal two stainless steel 20,000-gallon, and one 8,000 gallon railroad tank cars for shipment of radioactive liquid waste from FFTF and MASF. A loading station is provided in 340-B Building. Two other 20,000-gallon tank cars, normally used by UNC, are available in an emergency to provide additional hauling capacity.

Heavily shielded "bowling ball" casks are available for shipment of liquid which is too radioactive for acceptance in the RLWS.

.2 EQUIPMENT AND FACILITIES (continued)

RHO operates an evaporation facility in which the radioactive liquid waste from the 300 Facility is concentrated before being stored in underground tanks. Operating conditions in this facility require that all waste shipped from the 300 Area in tank cars be adjusted to pH 12 or greater before shipment. This neutralization is accomplished in the 340 Building underground tanks.

6.3 CRITERIA FOR DISPOSAL

.3.1 Sanitary Sewer

The Sanitary Sewer is the accepted system for disposal of liquid wastes from kitchens, lunch rooms, janitor closets, and drinking fountains. No radioactive or hazardous waste may be discharged into this system. This is the proper system for the disposal of janitorial chemicals that are being used in the manner for which they are designed. (Excess janitorial chemicals should not be put in any sewer unless MG-99 deems their constituents as not dangerous.) These wastes should be flushed into the Sanitary Sewer with copious amounts of water. Floor service water from controlled labs should be discharged to the Sanitary Sewer, provided that the floors were properly surveyed for radioactivity before application of the solution.

.2 Process Sewer

Laboratory and process liquid aqueous wastes which do not contain radionuclides in excess of 5×10^{-5} μCi/ml or materials deemed dangerous by MG-99 should be discharged to this system.

6.3.3 Diversion Waste System (DWS) or Retention Process System

This system should be used only for wastes which are not deemed dangerous by MG-99 and do not contain radioactivity but which come from a location in which

6.3 CRITERIA FOR DISPOSAL (continued)

such waste could become radioactively contaminated by mechanical failure or human error. If radioactivity in this system exceeds 5×10^{-5} μCi/ml, the liquid in the system will be diverted to the Radioactive Liquid Waste System.

6.3.4 Radioactive Liquid Waste System (RLWS)

Concentrations of gamma emitters up to 10 μCi/ml or total activities below 40 curies per month are within the normal operating conditions of the system. Larger amounts may result in excess radiation levels. Alpha and beta emitters in excess of 0.1 μCi/ml or in excess of one curie per month may cause serious contamination problems.

Oils and other organic materials which are immiscible with water, materials which may solidify, precipitate, or coagulate in the waste stream, and wastes containing significant non-colloidal solids must not be placed into the RLWS. Acetone in concentrations exceeding 5% at the point of entry may produce explosive gas concentrations and are excluded from the system.

Small quantities of radioactive liquid wastes, aqueous or organic, can be solidified by absorption in solid medium and then disposed of as solid waste. When this method is used, care must be taken to ensure that the amount of absorbent is sufficient so that no liquid will drain from the absorbent. Waste Systems Operations will assist in packaging such material, if requested.

Liquid wastes exceeding normal levels for alpha-emitters in the RLWS require special handling. If it is determined that they cannot be allowed in the RLWS, there is no liquid waste system into which they can be

6.3 CRITERIA FOR DISPOSAL (continued)

placed. If the quantities of such waste are too large to permit absorption and burial as solid waste, a chemical separation may be necessary to remove the alpha emitters from the waste and bring it within the criteria of the RLWS.

Liquid wastes exceeding normal levels for gamma emitters for the RLWS may be accepted on a scheduled basis, if such scheduling ensures acceptable exposures to personnel. Otherwise, such waste must be transported to RHO in special shielded casks.

In order to protect personnel, equipment, and the environment from contamination and excess radiation, it is important that close communication be maintained between the laboratory personnel and Waste Systems Operations (WSO) personnel. Factors of concern are volumes, dose rates from gamma emitters, and contamination potential from alpha and beta emitters. It is important that WSO be informed of any planned significant change in any of these factors.

To ensure safe and uninterrupted operation of the RLWS, the following controls must be exercised:

- Only personnel trained in use of the RLWS shall dispose of liquids into the RLWS in each building. This training is received in the Radiation Worker's course.
- Only liquids are to be placed in the system.
- Liquids with solids suspended should be allowed to settle; then the liquid may be decanted off or filtered and the solids disposed of as solid waste.
- Mixtures or solutions that may precipitate solids out when proper chemical conditions are reached should be tested for precipitation in water before placing in the RLWS. If there is some question, contact Waste Systems Operations for consultation.

6.3 CRITERIA FOR DISPOSAL (continued)

- No liquids may be placed in the RLWS that have a possibility of solidifying in the line. Examples are: paint, plastics, liquid rubber, epoxy, etc.
- Water insoluble solvents must not be placed in the system. These should be absorbed and disposed of as solid waste.
- Strong acids or bases should be washed down with copious amounts of water.
- Concentrations of beta-gamma emitters up to 10 μCi/ml may be placed in the system, provided that the total activity discharged does not exceed 40 curies with a period of 30 days.
- Concentrations of fissile material up to 0.1 μCi/ml may be discharged into the RLWS.
- Amounts of tritium up to 10 curies within a 30-day period may be discharged.
- When a transfer of 200 gallons or more is to be made, notify Waste Systems Operations (376-3012) prior to making the transfer.
- When disposal of any quantity of liquid reading greater than 500 mR/hr is to be made, approval of Waste Systems Operations must be obtained (376-3012) because the Retention Process diverter may be activated.
- A line manager should be assigned responsibility for each opening into the RLWS. The list of responsible personnel in each building should be kept up-to-date by the building administrator.

.5 Dangerous Liquid Waste

Non-radioactive dangerous wastes, as defined in MG-99, Section 8, (reactive, corrosive, ignitable, or toxic materials), must be specially handled. Instructions for packaging, handling, and disposal are in Section 10 of this manual.

APPENDIX A

HANFORD SITE MAP

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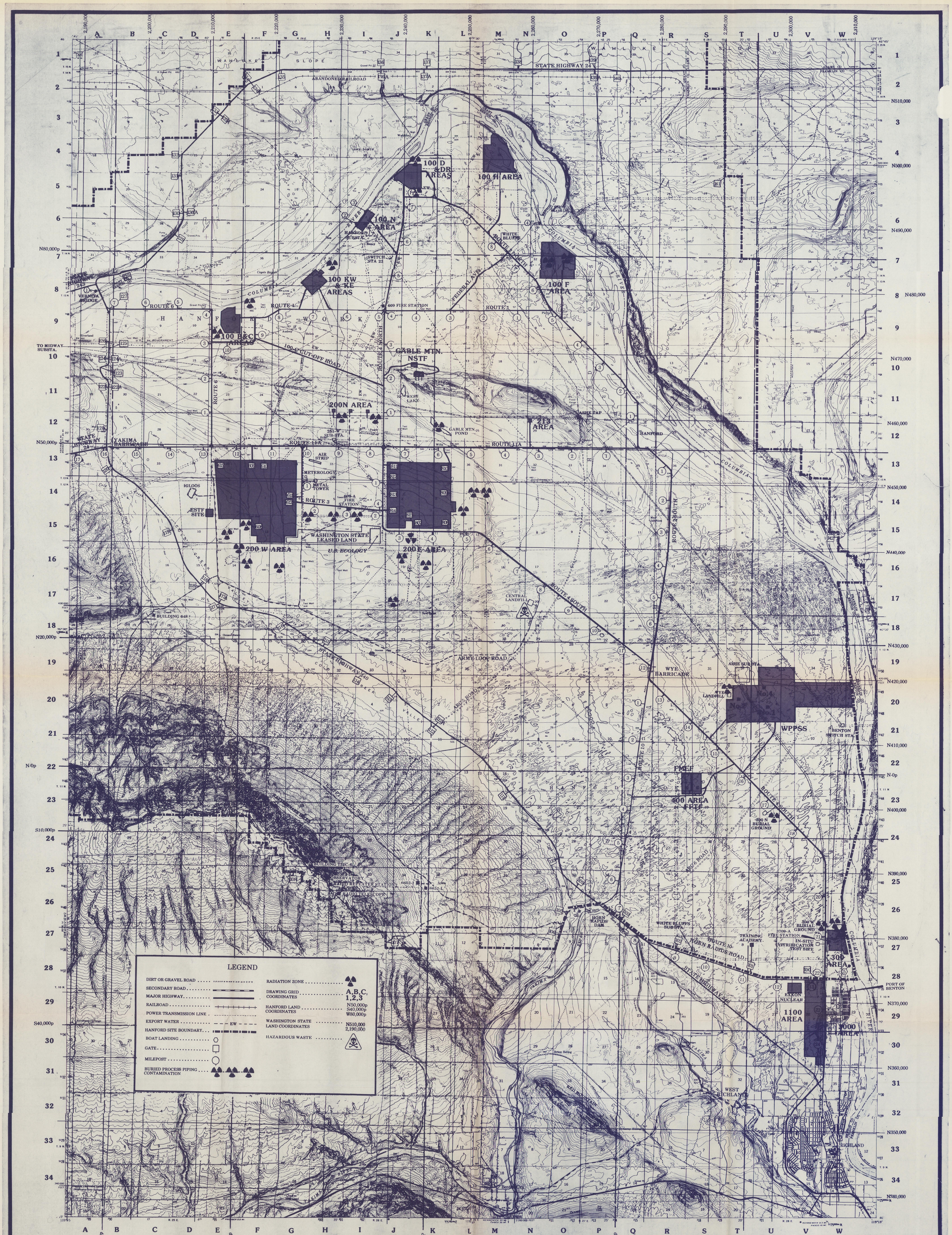

SITE PLAN

CONTOUR INTERVAL 20 FEET DATUM IS MEAN SEA LEVEL

1 1/2 0 1 2 3 4 MILES

3,000 0 3,000 6,000 9,000 12,000 15,000 18,000 21,000 FEET

THIS MAP WILL NOT BE USED FOR DETERMINING EXACT LOCATIONS

NO IMPACT LEVEL REQUIREMENTS

MICRO FFD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	LAST REV.
REVISION APPROVALS						REVISIONS	0
						DRAWING STATUS	

NEXT USED ON: END ITEM

DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
APPD	
APPD R.L. Mallett	1/18/85
APPD	
RESPONSIBLE ENGINEER R. MARTELL	1/18/85
DRAFTING APPD J.S. Mallett	1/18/85
CHECKED J.E. Cannon	1/18/85
DRAWN	1/18/85
CLASSIFICATION NONE	BY NOT REQ'D

U. S. Department of Energy
Richland Operations Office

Rockwell Hanford Operations
Richland, Washington 99352

M

HANFORD SITE MAP

SCALE	BL. DG. NO.	INDEX NO.
AS SHOWN	600 GEN	0100

DRAWING NO	SHEET NO.	SHEETS
H-6-951	1	1

APPENDIX B

300 AREA MAP

NEXT USED ON REFERENCE DRAWINGS		
DWG. NO.	REV. NO.	DRAWING TITLE OR INDEX NO.

CADFILE:003ØØSTAGE

BY-DATE	FOR	BY-DATE	FOR	CHK. BY DATE	REV. BY DATE	DESCRIPTION	REV. NO.
APVD.		APVD.					

REVISIONS

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U.S. DEPARTMENT OF ENERGY

HANFORD ENGINEERING DEVELOPMENT LABORATORY
WESTINGHOUSE HANFORD COMPANY

300 AREA GENERAL LAYOUT

SCALE	BLDG. NO.	INDEX NO.
NOTED	300G	0109

CLASSIFICATION	DWG. NO.	SHT. NO.	NO. SHTS.
NONE	H-3-53734	1	1

APPENDIX C

WHC ENVIRONMENTAL PROTECTION MANUAL, MG-99

3.0 LIQUID RADIOACTIVE WASTE

3.1 Policy

Westinghouse Hanford Company shall control liquid wastes in a manner that

- o assures the safety of the employes and the general public and meets DOE and other applicable federal, state, and local regulations
- o minimizes, to the extent practicable, releases to the environment
- o limits discharges to the environment in normal waste streams to less than the values listed in Appendix A of this manual on an annual average basis
- o maintains exposure to employes as low as reasonably achievable.

3.2 Radioactive Liquid Waste Streams

3.2.1 Introduction

A detailed 300 Area system description can be found in the Waste Management Manual, MG-75. Briefly, the RLWS serves a limited number of discharge points in the 324, 325, 326, 327, and 329 Buildings. Waste water either flows by gravity out of buildings or is collected in tanks and pumped into the RLWS. It flows through an encased line from the buildings to the 340 Receiving and Neutralization Tanks, is periodically loaded into railcars, and is shipped to the 200 Areas where it is offloaded and evaporated to a slurry for storage in waste tanks. FFTF collects radioactive waste water in a tank and periodically ships it to the 340-B Building for offloading to the receiving and neutralization tanks.

Throughout the system there are concerns for spill prevention and control, gamma radiation dose rates, radioactive contamination, solids and liquids that are immiscible in water, and fissile materials and chemicals that could harm the system. This procedure addresses those concerns.

3.2.2 Limits

a. Tank Car

1. pH>9
2. Fissile Material - <2.6 x 10^{-3} g/l
3. Separated Organic Phase - nondectable
4. Differential Thermal Analysis - No exothermic reaction below 350°F
5. Nitrite Ion (NO_2) - >600 ppm
6. Tritium - <3 x 10^{-3} uCi/ml

b. Storage Tanks, Basins, and Sumps.

Storage tanks, basins, and sumps which contain radioactive materials in excess of Appendix A concentrations shall be secondarily contained, monitored, and/or alarmed, as necessary, to preclude leakage to the environs.

c. Leak Rate of Encased or Direct Buried Lines.

Routine pneumatic or hydrostatic testing of encased or direct buried lines shall be conducted. Any indication of leakage shall be promptly repaired.

3.2.3 Operating Requirements

a. Tank Car Contents (Shipments to 200 Area)

1. pH - >9
2. Fissionable Material - <15 g*
3. Separated Organic Phase - nondectable

*Quantities in excess of 15 grams require Criticality Shipping Clearance and Nuclear Material Management approval.

4. Differential Thermal Analysis - No exothermic reaction below 350°F.
5. Nitrite Ion (NO_2)- >600 ppm
6. Tritium - <0.2 Ci
7. Alpha Emitters - <0.02 uCi/ml
8. Beta Emitters - <10 uCi/ml
9. Dose rate (@ 3 ft from side of car) - <1 R/hr

b. Tank Car Contents (Shipments to 300 Area)

1. Fissionable Material - <15 g
2. Separated Organic Phase - nondetectable
3. Beta Emitters - <10 uCi/ml
4. Dose rate - 200 mR/hr at contact

c. Shipping

1. Removable contamination on the external surfaces of the tank car shall not exceed 10 pCi/cm^2 beta or 2 pCi/cm^2 alpha.

2. Tank car analytical results shall be obtained prior to shipment.

3. Tank cars shall not be used unless they have passed RHO preventive maintenance inspection.

4. Organics and other liquid wastes incompatible with the RLWS shall be packaged for disposal in accordance with the requirements of the HEDL Packaging and Shipping Committee and Waste Systems.

d. Loadout Facility

Dose rates to personnel in the loadout facility shall be maintained as low as reasonably achievable.

e. Facility Requirements

Building Administrators or other responsible personnel of all facilities which discharge to the RLWS shall institute administrative and operating procedures necessary to achieve the following:

1. minimize the entry to the system of insoluble particles which are not colloidal or of oils immiscible with water.

2. ensure discharges to the RLWS are compatible with the operational controls specified in 3.2.3.a.

3. provide notification in writing and obtain Waste Systems concurrence prior to discharging to the RLWS materials or quantities in excess of the following:

   - Fissionable Materials - 1 g/month
   - Alpha Emitters - 0.02 uCi/ml or 0.1 Ci/month.
   - Beta Emitters - 10 uCi/ml or 100 Ci/month.
   - 500 gallons/day
   - Radioactive materials with low beta energy which might not be detected in normal radiochemical analysis (e.g., ^{3}H, ^{14}C, ^{35}S, ^{45}Ca, ^{99}Tc, ^{147}Pm) - 1 mCi/month

4. ensure storage tanks, basins, and sumps are operated, maintained, and alarmed to prevent the release of radioactive materials to uncontrolled areas in excess of Appendix A concentrations.

f. Operating Manuals and Procedures

1. Building Administrators or other responsible persons in all facilities with connections to the RLWS shall develop a document which provides a clear, concise description of the RLWS within the building, applicable administrative controls and operating procedures, and any other information necessary to adequately describe the system.

2. Waste Systems Engineering shall develop and maintain a manual which

   - o describes the RLWS, its limitations and capabilities.
   - o provides one-line drawings of the entire system and reference print numbers.
   - o imposes requirements that ensure the user has the necessary control over waste content and discharge rate to comply with this operating guide.
   - o imposes requirements for record keeping by the user to provide data necessary for reliable system operation and auditability.

g. Training

Waste Systems shall specify the minimum acceptable training for both loadout Facility and Building RLWS operators including:

- o scope and content of training
- o method of demonstrating proficiency
- o qualifying organization
- o requalification period and requirements.

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h. Testing of RLWS Lines

1. The annular space surrounding encased, "buried" RLWS piping shall be pneumatically tested annually. Direct buried RLWS piping shall be hydrostatically tested at least annually.

2. Facility RLWS piping and associated storage tanks, basins, and sumps shall be visually inspected annually. Facility RLWS piping and associated storage tanks, basins, and sumps which cannot be visually inspected shall be hydrostactically tested annually.

3. For in-cell piping at the FFTF, the annual inspection may be performed upon routine cell entry provided no other indications of leakage are present.

i. Sampling

Representative samples shall be obtained and analyzed prior to

- shipping a tank car
- discharging a basin, holdup tank, or storage tank to the loadout facility

j. Instrument Monitoring

1. Gamma dose rate monitors installed on RLWS lines and tanks shall be operated, maintained, and calibrated as specified by Waste Systems Operations.

2. Gamma dose rate alarm settings on facility monitors shall be set as low as practicable consistent with the operating requirements of the facility. In no case should the alarm setting exceed 1.0 R/hr.

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k. Notifications

The following list is not all inclusive but is intended to convey the types of information which must be relayed to various HEDL operating groups.

1. Environmental and Radiological Engineering shall be promptly notified of:

   - o any spill of radioactive liquid
   - o failure of any portion of the system to satisfactorily pass a hydrostatic test or visual inspection.
   - o tank car radiation or contamination levels in excess of allowable limits.
   - o significant discrepancies between batch transfer estimated curies or volumes and actual data.

2. Building Administrators shall be promptly notified of:

   - o changes in permissible waste content
   - o failure of equipment or other occurrences which would restrict loadout facility operations.

3. Waste Systems Operation shall be promptly notified of:

   - o valid alarms on RLWS gamma monitors
   - o inadvertent release of undesirable materials to the RLWS
   - o tank car sample results which indicate a failure to meet the criteria of 3.2.3.a.
   - o failure of equipment which would limit RLWS operations.

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3.2.4 Records

a. Waste Systems Operation shall maintain records of:

- o operations at the 340 Complex
- o analytical data on 340 tanks and tank car shipments to RHO
- o 340 Complex operating personnel qualifications
- o visual inspections and/or hydrostatic tests of 340 Complex piping and of RLWS piping outside building.
- o batch transfers
- o loadout facility piping visual inspections and/or hydrostatic tests.

b. Operational Safety shall maintain records of:

- o waivers from safety-related requirements,
- o the location of accidental releases of radioactive liquids to the ground, a determination of the radionuclide identities, and the amount of nuclides releases.

c. Building Administrators shall maintain records of:

- o visual inspections and/or hydrostatic testing of facility-related RLWS piping
- o operator training and qualification
- o RLWS locked valve status.

3.3 Diversion Waste System (DWS)

3.3.1 Introduction

The Diversion Waste System (DWS) accepts laboratory wastes which are normally uncontaminated by radionuclides but which have the potential for such contamination. Diverters installed in various buildings served by the system direct the wastes to the RLWS if contamination is detected, otherwise are discharged to the Process Sewer. For this reason, this waste should meet the requirements for discharge to the Process Sewer (see Section 6).

3.3.2 Limits

Radioactivity in liquid waste discharged to ground in or near the 300 or 400 Areas shall not exceed Appendix A concentration guides when averaged over one year.

3.3.3 Operating Requirements

a. Radioactivity

Liquid wastes which are known to contain radioactive materials in excess of Appendix A concentrations shall not be discharged to the DWS.

b. Discharges from Individual Buildings

1. Waste water diverters shall be set to divert waste water flow from the Process Sewer to the Radioactive Liquid Waste System at a concentration of 5×10^{-5} uCi/ml.

2. Waste Systems Operation shall:

- ensure that waste water diverters are operated, maintained, calibrated, and periodically checked to ensure the desired system reliability.
- label as necessary DWS lines and connections.
- train personnel in the proper use of the system.

3. Building Administrators or other responsible individuals shall develop procedures to administratively control the system.

c. Hydrostatic Testing

Waste Systems Operation shall ensure that exposed facility DWS piping is visually inspected for leakage annually. Facility DWS piping which cannot be visually inspected shall be pneumatically or hydrostatically tested annually.

d. Sampling

1. Building Administrators or other responsible persons shall ensure that water samples are obtained and analyzed monthly for basins which may become contaminated (e.g., 3730 Basin).

2. Building Administrators shall ensure that a grab sample is obtained and analyzed when a diversion to the RLWS occurs.

e. Notifications

The following list is not all inclusive but is intended to convey the types of information which must be relayed to the various HEDL operating groups.

1. Environmental and Radiological Engineering shall be notified of the following:

   - failure of a diverter to source check or operationally check satisfactorily.
   - all diverts, cause, activity, etc.
   - inadvertent release of nonradioactive hazardous materials (see Section 6) in significant concentrations to the DWS.

2. Waste Systems shall be promptly notified of:

   - all diverts

o loss of diverter capability.

3.3.4 Records

Records shall be maintained by the following organizations of the following diverter-related information:

1. OHP - Diverter source checks

2. Waste Systems Operations - all diverts, cause, corrective action, and activity released.

3. Laboratory Maintenance - diverter calibration, maintenance, and repair data.

3.4 References

1. DOE-RL 5480.2, "Radioactive Waste Management."

2. DOE-Order 5480.1A, "Environmental Protection, Safety and Health Protection Program for DOE Operations.

8.0 DANGEROUS WASTE CONTROL

8.1 Policy

Materials obtained for use in the laboratory may ultimately become dangerous wastes or may be released to the environment. It is WHC's policy to minimize the amount of dangerous waste generated, to minimize the impact to the environment in the event of an accidental release, and to comply with the State of Washington Dangerous Waste Regulations and other DOE imposed requirements.

8.2 Introduction

8.2.1 Dangerous wastes include those discard materials which could adversely affect persons, plants, or animals if released to the environment.

8.2.2 PCB (polychlorinated biphenyl) is managed in accordance with the Toxic Substances Control Act. WHAN-M-11, "Industrial Safety," Section 13.5, describes the PCB control program including disposal of PCB equipment.

8.2.3 Asbestos control is described in Section 12.8 of WHAN-M-11. Conformance with WHAN-M-11 requirements will satisfy Dangerous Waste Control requirements also.

8.2.4 This standard is directed to protection of the environment. Guidance for the protection of workers is provided in WHAN-M-11, "Industrial Safety."

8.3 Terminology

a. The State of Washington has developed regulations to implement the federal government hazardous waste programs, WAC 173-303. The state designates these materials as dangerous wastes. Extremely hazardous wastes and dangerous wastes are the two waste subcategories in the state dangerous waste program.

b. Solid waste, as defined by the EPA, includes solid, liquid, semi-solid and contained gaseous material that might be buried or discharged to the ground.

8.4 Dangerous Waste

8.4.1 Introduction

a. Wastes are categorized as either

- extremely hazardous waste (EHW)
- dangerous waste (DW), or
- undesignated waste

b. Undesignated wastes are those waste materials which are not designated as either extremely hazardous waste or dangerous waste using the identification procedure in Section 8.5.

c. Both the waste category and the Dangerous Waste Number may be determined by use of the flow chart (Figure 8-1) and the identification procedure in Section 8.5.

8.4.2 Use of The Dangerous Waste Flow Chart

a. Figure 8-1 is designed to aid the waste generator in determining whether a waste material is designated as a dangerous waste.

b. Obtain Waste Systems Engineering (WSE) approval prior to disposing of these materials as nonhazardous waste.

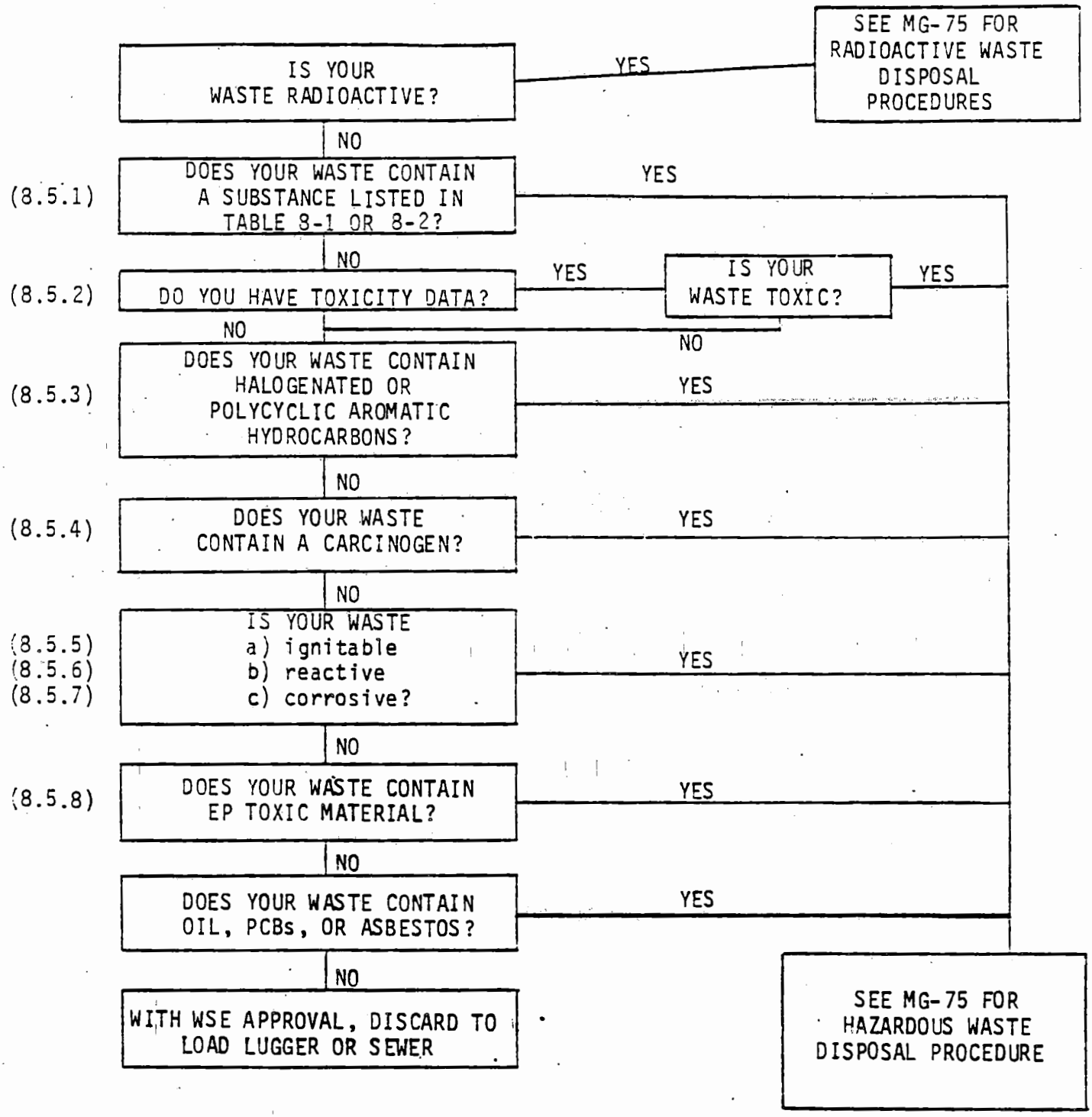
8.5 Identification of Dangerous Wastes

8.5.1 Dangerous Wastes Lists

Waste containing any of the chemicals listed in Table 8-1 or Table 8-2 shall be marked with the appropriate dangerous waste numbers and hazard designation.

8.5.2 Toxic Wastes

The toxic category for each constituent in a waste may be determined directly from Table 8-3 or by obtaining data from the NIOSH Registry (contact Environmental and Radiological Engineering to obtain NIOSH Registry data) and checking these data against the toxic category table, below. If data



DANGEROUS WASTE FLOW CHART

FIGURE 8-1

is available for more than one of the four toxicity criteria (aquatic, oral, inhalation, or dermal), then the data of severest toxicity shall be assigned to the constitutent. If the Equivalent Concentration exceeds 0.01%, the waste shall be designated EHW (WT01). If the Equivalent Concentration lies between 0.001% and 0.01%, the waste shall be designated DW (WT02). Below 0.001% Equivalent Concentration, toxicity will not be the determining factor in selecting the disposal procedure.

8.5.3 Persistent Wastes

Waste containing halogenated hydrocarbons shall be designated EHW (WP-01) if the sum of the concentrations of these materials exceeds 1.0%. If the summed concentration lies between 0.01% and 1.0%, the waste shall be designated DW (WP-01). Waste containing polycyclic aromatic hydrocarbons shall be designated EHW (WP-03) if the sum of the concentrations of these materials exceeds 1.0%. Wastes containing less than 1.0% polycyclic aromatic hydrocarbons and less than 0.01% halogenated hydrocarbons will not be controlled because of persistent chemical content.

8.5.4 Carcinogenic Wastes

Wastes containing IARC positive carcinogens in concentrations exceeding 1.0% shall be designated EHW (WC01). Wastes containing IARC positive carcinogens in concentrations between 0.01% and 1.0% or total IARC positive and suspected carcinogens in concentrations exceeding 1.0% shall be designated DW (WC-02). In lesser concentrations the waste will not be controlled because of the carcinogens present in it.

8.5.5 Ignitable Wastes

a. A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has a flash point less than 60 degrees C (140 degrees F), as determined by a Pensky-Marrtens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80, or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78;

(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard;

(3) It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation; or,

(4) It is an oxidizer as defined in 49 CFR 173.151.

b. Waste that exhibits the characteristic of ignitability, but is not designated as a dangerous waste under any of the sections above, shall be designated DW, and shall be assigned the dangerous waste number of D001.

8.5.6 Corrosive Wastes

a. A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has any one or more of the following properties:

(1) It is aqueous, and has a pH less than or equal to 2, or greater than or equal to 12.5,

(2) It is liquid, and corrodes steel (SAE 1020) at a rate greater than 0.250 inch (6.35 mm) per year at a test temperature of 55 degrees C (130 degrees F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods, or

(3) It is solid or semi-solid, and when mixed with an equal weight of water results in a solution, the liquid portion of which has a pH $\leq$ 2 or $\geq$ 12.

b. A solid waste that exhibits the characteristic of corrosivity, but is not designated as a dangerous waste under any of the sections above, shall be designated DW, and shall be assigned the dangerous waste number of D002.

8.5.7 Reactive Wastes

a. A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

(1) It is normally unstable and readily undergoes violent change without detonating;

(2) It reacts violently with water;

(3) It forms potentially explosive mixtures with water;

(4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment;

(5) It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5 can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment;

(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source of if heated under confinement;

(7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure; or

(8) It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53, or a Class B explosive as defined in 49 CFR 173.88.

b. A solid waste that exhibits the characteristic of reactivity, but is not designated as dangerous waste under any of the sections above, shall be designated DW, and shall be assigned the dangerous waste number of D003.

8.5.8 Extraction Procedure (EP) Toxicity

a. A waste exhibits the characteristic of EP toxicity if the extract from a representative sample of the waste contains any of the contaminants listed in the EP toxicity list (Table 8-4) at concentrations equal to or greater than the respective value given in the list. When the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this subsection.

b. A waste that exhibits the characteristic of EP toxicity, but is not designated as a dangerous waste under any of the sections above, has the dangerous waste number specified in the list which corresponds to the toxic contaminant causing it to be dangerous.

c. EP toxicity list. Two levels of concentration are established for the contaminants listed. Any waste containing one or more contaminants with concentrations in the EHW range shall cause that waste to be designated EHW. Any waste containing contaminants which occur at concentrations in the DW range only (i.e., no EHW contaminants), shall be designated DW.

8.6 WHC Dangerous Waste Control Procedures

WHC dangerous waste control procedures are developed by Waste Systems Engineering; these procedures are contained in MG-75, "Waste Management Manual."

8.7 Operating Requirements

8.7.1 Acquisition of Dangerous Materials

a. Managers shall establish controls on the acquisition of dangerous materials which ensure that:

1. the least dangerous material is being used considering suitability, costs, personnel safety, and environmental protection.

2. the on-hand quantity of dangerous material is kept to a practical minimum.

3. the manager becomes aware of the acquisition of dangerous materials.

4. the handling, storage, and disposal procedures in place for these materials comply with this manual, WHAN-M-11, "Industrial Safety" and MG-75, "Waste Management."

b. Requisitions for the purchase of known and suspected carcinogens shall be approved by the Manager, Industrial Safety and Fire Protection. Known or suspected carcinogens are identified in Tables 8-1 and 8-2 by the symbol "+" in the "Reason for Designation" column.

c. Purchase of materials that contain Endrin; Lindane; Methoxychlor; Toxaphene; 2,4-D; or 2,4,5-TP Silvex shall be approved by Environmental and Radiological Engineering.

8.7.2 Use and Storage of Hazardous Materials

The use and storage of hazardous materials other than herbicides, pesticides, and rodenticides are governed by the requirements of WHAN-M-11, "Industrial Safety," Chapter 5.

8.7.3 Herbicide and Pesticide Control

a. Small spray cans of pesticides intended for office use are exempt from the requirements of this procedure.

b. Herbicides and pesticides shall be stored in tightly sealed, unbreakable, properly labeled containers only in locations approved by Environmental and Radiological Engineering.

c. Bulk quantities which are diluted to application concentrations shall be limited to those which will be used in the immediate future. Storage of dilute solutions should be avoided.

d. Care shall be taken to avoid contamination of either groundwater or the Columbia River.

e. "Restricted Use" pesticides and herbicides shall be applied by RHO personnel. Other pesticides and herbicides may be applied by WHC personnel.

f. Empty pesticide and herbicide containers shall be disposed of as directed on the container label or disposed of as hazardous waste.

8.8 Spills Involving Dangerous Materials or Petroleum Products

The Building Administrator or other responsible individuals shall immediately notify Environmental and Radiological Engineering (6-3132), Industrial Safety and Fire Protection (6-3070), and Waste Systems Engineering (6-3231) of deliberate discharge or accidental loss involving dangerous materials or petroleum products. For spills which may expose personnel or the environs, call 6-5000.

8.9 Contingency Plans and Emergency Procedures

The risk and consequences of a spill shall be evaluated for each location where dangerous materials listed in Table 8-5 are used, handled or stored. Provisions for containment, contingency plans, and emergency procedures shall be provided. The degree of containment and extent of contingency planning shall be commensurate with the threat to employes and the threat of loss to the environs. Plans shall include decontamination of the spill site and disposal of spilled material, and protective clothing and respiratory protection needed. Secondary containment shall be provided to prevent the loss of dangerous materials in a way that would contaminate the groundwater.

8.10 Requirements Governing the Disposal of Dangerous Materials

8.10.1 Prohibition on Disposal via the Radioactive Liquid Waste System, Process Sewer, Sanitary Waste System, Diversion Waste System, or Dry Wells.

1. Dangerous Wastes, as described in Section 8.4 "Designation of Dangerous Waste," shall not be disposed of via the:

   - Radioactive Liquid Waste System (unless it is also radioactive),
   - Process Sewer
   - Sanitary Waste System
   - Diversion Waste System
   - Dry Wells

2. Additional information regarding discharges to these systems is contained in Section 6, "Nonradioactive Liquid Waste," or Section 2, "Liquid Radioactive Waste."

8.10.2 Prohibition on Disposal as "Common Trash"

Dangerous wastes that are described in section 8.4 "Designation of Dangerous Waste," shall not be disposed of as "common trash".

8.10.3 Disposal of empty containers that previously held Dangerous Wastes.

1. Containers are considered to be empty when all wastes have been taken out which can be removed using practices commonly used to remove materials from that type of container and when the lessor of the following quantities remain:

   a. less than one-inch remains at the bottom of the container, or

   b. less than 1% of the containers total volume. (<.3% for containers > 110 gallons)

2. A compressed gas cylinder is empty when the pressure inside the container equals or nearly equals atmospheric pressure.

3. Empty containers shall be disposed of in accordance with the requirements specified in MG-75, "Waste Management Manual."

8.10.4 Packaging and Shipping of Hazardous Materials, including Dangerous Wastes.

(1) Waste Systems Engineering shall:

- represent HEDL in all dealings with the waste contractor in matters pertaining to the disposal of dangerous wastes.

- establish the packaging and labeling requirements for dangerous wastes.

(2) Shipments of hazardous materials, including dangerous wastes, shall comply with the requirements of MG-137, "Hazardous Materials Packaging and Shipping."

(3) Wastes which are radioactive shall be segregated from other dangerous waste to the extent practicable.

(4) Wastes that are both radioactive and hazardous in some other way shall be managed as radioactive after all reasonable and practical means of mitigating the non-radioactive hazards have been completed.

8.10.5 Operation of 3718-F, 221-T And 105 DR Alkali Metal Treatment Facilities

a. Alkali Metal Treatment Facilities shall be inspected to prevent malfunctions and deterioration, operator errors, and discharges which may cause or lead to the release of dangerous waste constituents to the environment. MG-75, "Waste Management" contains the specific requirements for the content of these plans.

b. Alkali Metal Treatment Facilities shall develop emergency procedures to lessen the potential impact on public health and the environment in the event of an unplanned release. MG-75, "Waste Management" contains the specific requirements for the content of these procedures.

8.11 Training

a. Waste Generator Training

Dangerous waste generators shall receive initial training and annual retraining which ensures:

(1) compliance with the dangerous waste management procedures.

(2) knowledge of emergency procedures related to dangerous waste releases.

(3) knowledge of handling, segregation, and packaging procedures.

b. Waste Systems Operation Training

Waste Systems Operation personnel who transport, handle, package, repackage, or work in a facility where dangerous wastes are held prior to transport to the Waste Contractor, treated, or stored shall receive initial training and annual retraining which ensures:

(1) compliance with the dangerous waste management procedures.

(2) knowledge of emergency procedures related to dangerous waste releases during transport, packaging, treatment, or storage facility.

(3) knowledge of proper handling, packaging, transport, and storage procedures.

c. Records of Training and Retraining

Auditable records of Waste Generator and Waste Systems Operation personnel training and retraining shall be maintained by the cognizant supervisor or manager.

8.12 Records and Reports

Waste Systems Engineering shall maintain records and provide reporting data as necessary on WHC Dangerous Waste Generation, treatment, and disposal.

8.13 References

1. DOE 5480.1A, "Environmental Protection, Safety, and Health Protection Program for DOE Operations."

2. 40CFR162, "Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act."

3. 40CFR260, "Hazardous Waste Management System: General."

4. 40CFR261, "Identification and Listing of Hazardous Waste."

5. 40CFR262, "Standard Applicable to Generators of Hazardous Waste."

6. 40CFR761, "Polychlorinated Biphenyls Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions."

7. DOE-RL 5480.1 Chapter II, Part C, "Regulated Carcinogen or Suspected Carcinogen Materials."

8. WAC-173-303, "Dangerous Waste Regulations," State of Washington.

TABLE 8-1

ACUTELY DANGEROUS CHEMICAL PRODUCTS

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
P023	Acetaldehyde, chloro-	EHW	B H
U001	Acetaldehyde	EHW	C
U034	Acetaldehyde, trichloro-	EHW	H
P002	Acetamide, N-(aminothioxomethyl)-	EHW	B
P057	Acetamide, 2-fluoro-	EHW	B H
P058	Acetic acid, fluoro-, sodium salt	EHW	A H
U144	Acetic acid, lead salt	EHW	D EP
P066	Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-, methyl ester	EHW	B
U003	Acetonitrile	EHW	C I
P001	3-(alpha-Acetonyl-benzyl)-4-hydroxycoumarin and salts	EHW	A
P002	1-Acetyl-2-thiourea	EHW	B
U006	Acetyl chloride	EHW	C H O R
P003	Acrolein	EHW	X I
U007	Acrylamide	EHW	C
U008	Acrylic acid	EHW	C O I
U009	Acrylonitrile	EHW	C + I
P070	Aldicarb	EHW	B
P004	Aldrin	EHW	X H
P005	Allyl alcohol	EHW	B I
P006	Aluminum phosphide	EHW	B R
P007	5-(Aminomethyl)-3-isoxazoiol	EHW	B
P008	4-Aminopyridine	EHW	B
P009	Ammonium picrate	EHW	R
P119	Ammonium vanadate	EHW	B
U012	Aniline	EHW	C I
P010	Arsenic acid	EHW	B
P012	Arsenic (III) oxide	EHW	B +
P011	Arsenic (V) oxide	EHW	B
P011	Arsenic pentoxide	EHW	B
P012	Arsenic trioxide	EHW	B +
P038	Arsine, diethyl-	EHW	B
U015	Azaserine	EHW	C +
P054	Aziridine	EHW	B +
U010	Azirino(2',3':3,4)pyrrolo(1,2a)indole-4,7-dione, 6-amino-8[((aminocarbonyl)oxy) methyl]-1,1a,2,8,8a,8b-hexahydro-8a-metboxy-5-methyl-	EHW	B +
P013	Barium cyanide	EHW	A
U157	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-	EHW	H P
U017	Benzal chloride	EHW	D H
U018	Benz[a]anthracene	EHW	P +
U018	1,2-Benzanthracene	EHW	P +
U094	1,2-Benzanthracene, 7,12-dimethyl-	EHW	C P
U012	Benzenamine	EHW	C I
P024	Benzenamine, 4-chloro-	EHW	C H
U049	Benzenamine, 4-chloro-2-methyl-	EHW	H
U093	Benzenamine, N,N-dimethyl-4-(phenylazo)-	EHW	C +
U158	Benzenamine, 4,4-methylenebis(2-chloro-	EHW	H +
P077	Benzenamine, 4-nitro-	EHW	D ?
P028	Benzene, (chloromethyl)-	EHW	B H +
U019	Benzene	EHW	C + I
U038	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy, ethyl ester	EHW	H
U030	Benzene, 1-bromo-4-phenoxy-	EHW	H
U037	Benzene, chloro-	EHW	B H I
U190	1,2-Benzenedicarboxylic acid anhydride	EHW	C
U070	Benzene, 1,2-dichloro-	EHW	B H
U071	Benzene, 1,3-dichloro-	EHW	B H
U072	Benzene, 1,4-dichloro-	EHW	B H
U017	Benzene, (dichloromethyl)-	EHW	D H
U223	Benzene, 1,3-diisocyanatomethyl-	EHW	B R
U239	Benzene, dimethyl-	EHW	C I
U201	1,3-Benzenediol	EHW	C
U127	Benzene, hexachloro-	EHW	H
U056	Benzene, hexahydro-	EHW	C I
U188	Benzene, hydroxy-	EHW	C
U220	Benzene, methyl-	EHW	C I
U105	Benzene, 1-methyl-1-2,4-dinitro	EHW	C
U106	Benzene, 1-methyl-2,6-dinitro-	EHW	C
U055	Benzene, (1,methylethyl)-	EHW	C I
U169	Benzene, nitro-	EHW	C I
U183	Benzene, pentachloro	EHW	H
U185	Benzene, pentachloronitro-	EHW	D H +
U020	Benzenesulfonic acid chloride	EHW	D H O R
U020	Benzenesulfonyl chloride	EHW	D H O R
U207	Benzene, 1,2,4,5-tetrachloro-	EHW	D H
U023	Benzene, (trichloromethyl)-	EHW	H O R
P042	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-	EHW	B
P014	Benzenethiol	EHW	A
U021	Benzidine	EHW	B +
U022	Benzo[a]pyrene	EHW	P +
U022	3,4-Benzopyrene	EHW	P +
U197	p-Benzoquinone	EHW	C
U023	Benzotrichloride	EHW	H O R
U050	1,2-Benzphenanthrene	EHW	P +
P028	Benzyl chloride	EHW	B H +
P015	Beryllium dust	EHW	C +
U085	2,2'-Bioxirane	EHW	B I
U021	'1,1'-Biphenyl)-4,4'-diamine	EHW	B +
U073	(1,1'-Biphenyl-4,4'-diamine, 3,3'-dichloro-	EHW	H +
U095	(1,1'-Biphenyl)-4,4'-diamine, 3,3'-dimethyl-	EHW	C +
U024	Bis(2-chloroethoxy) methane	EHW	C H
U027	Bis(2-chloroisopropyl) ether	EHW	C H O
P016	Bis(chloromethyl) ether	EHW	B H +
U246	Bromine cyanide	EHW	C H
P017	Bromoacetone	EHW	C H
U225	Bromoform	EHW	H
U030	4-Bromophenyl phenyl ether	EHW	H
P018	Brucine	EHW	A
U128	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-	EHW	C H
U035	Butanoic acid, 4-[bis(2-chloroethyl) amino] benzene-	EHW	H +
U160	2-Butanone peroxide	EHW	B R
U053	2-Butenal	EHW	B I
U074	2-Butene, 1,4-dichloro-	EHW	C H I
U032	Calcium chromate	EHW	C + EP
P021	Calcium cyanide	EHW	B
P123	Camphene, octachloro-	EHW	X H
U178	Carbamic acid, methylnitroso-, ethyl ester	EHW	C +
U176	Carbamide, N-ethyl-N-nitroso-	EHW	C +
U177	Carbamide, N-methyl-N-nitroso-	EHW	C +
U219	Carbamide, thio-	EHW	C +
P103	Carbamimidoselenoic acid	EHW	B
U097	Carbamoyl chloride, dimethyl-	EHW	D H +
P022	Carbon bisulfide	EHW	D I ?
P022	Carbon disulfide	EHW	D I ?
U156	Carbonochloridic acid, methyl ester	EHW	B H I
U033	Carbon oxyfluoride	EHW	B H R
U211	Carbon tetrachloride	EHW	C H +
P095	Carbonyl chloride	EHW	B H
U033	Carbonyl fluoride	EHW	B H R
U035	Chlorambucil	EHW	H +
U036	Chlordane, technical	EHW	X H

TABLE 8-1

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
P033	Chlorine cyanide	EHW	A H
U026	Chlornaphazine	EHW	H +
P023	Chloroacetaldehyde	EHW	B H
P024	p-Chloroaniline	EHW	C H
U037	Chlorobenzene	EHW	B H I
U039	4-Chloro-m-cresol	EHW	H
U041	1-Chloro-2,3-epoxypropane	EHW	C H + I
U042	2-Chloroethyl vinyl ether	EHW	C H
U044	Chloroform	EHW	C H +
U046	Chloromethyl methyl ether	EHW	D H + I
U047	beta-Chloronaphthalene	EHW	D H
U048	o-Chlorophenol	EHW	D H
P026	1-(o-Chlorophenyl)thiourea	EHW	A H
P027	3-Chloropropionitrile	EHW	B H
U049	4-Chloro-o-toluidine, hydrochloride	EHW	H
U032	Chromic acid, calcium salt	EHW	C + EP
U050	Chrysene	EHW	P +
P029	Copper cyanides	EHW	B
U051	Creosote	EHW	B
U052	Cresols	EHW	B
U052	Cresylic acid	EHW	B
U053	Crotonaldehyde	EHW	B I
U055	Cummene	EHW	C I
P030	Cyanides (soluble cyanide salts), not elsewhere specified	EHW	A
P031	Cyanogen	EHW	B I
U246	Cyanogen bromide	EHW	C H
P033	Cyanogen chloride	EHW	A H
U197	1,4-Cyclohexadienedione	EHW	C
U056	Cyclohexane	EHW	C I
U057	Cyclohexanone	EHW	C I
U130	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexa-chloro-	EHW	X H
U058	Cyclophosphamide	EHW	C H + I
U240	2,4-D, salts and esters	EHW	B H
U060	DDD	EHW	C H +
U061	DDT	EHW	X H +
U142	Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta[c,d]-pentalen-2-one	EHW	X H
U062	Diallate	EHW	C H +
U133	Diamine	EHW	B + R
U063	Dibenz[a,h]anthracene	EHW	A P +
U063	1,2:5,6-Dibenzanthracene	EHW	P + A
U064	1,2:7,8-Dibenzopyrene	EHW	P +
U064	Dibenz[a,i]pyrene	EHW	P +
U066	1,2-Dibromo-3-chloropropane	EHW	C H +
U062	S-(2,3-Dichloroallyl)	EHW	C H +
	diisopropylthiocarbamate	EHW	C H +
U070	o-Dichlorobenzene	EHW	B H
U071	m-Dichlorobenzene	EHW	B H
U072	p-Dichlorobenzene	EHW	B H
U073	3,3'-Dichlorobenzidine	EHW	H +
U074	1,4-Dichloro-2-butene	EHW	C H I
U075	Dichlorodifluoromethane	EHW	H
U060	Dichloro diphenyl dichloroethane	EHW	C H +
U061	Dichloro diphenyl trichloroethane	EHW	X H +
U078	1,1-Dichloroethylene	EHW	C H +
U079	1,2-Dichloroethylene	EHW	D H
U025	Dichloroethyl ether	EHW	C H
U081	2,4-Dichlorophenol	EHW	D H
U082	2,6-Dichlorophenol	EHW	D H
U240	2,4-Dichlorophenoxyacetic acid, salts and esters	EHW	B H
P036	Dichlorophenylarsine	EHW	B H
U083	1,2-Dichloropropane	EHW	C H I
U084	1,3-Dichloropropane	EHW	C H
P037	Dieldrin	EHW	X H +
U085	1,2:3,4-Diepoxybutane	EHW	B I
P038	Diethylarsine	EHW	B
P039	O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate	EHW	A
U087	O,O-Diethyl-S-methyl-dithiophosphate	EHW	B
P041	Diethyl-p-nitrophenyl phosphate	EHW	A
P040	O,O-Diethyl O-pyrazenyl phosphorothioate	EHW	A
P043	Diisopropyl fluorophosphate	EHW	B H
P044	Dimethoate	EHW	A
U092	Dimethylamine	EHW	C I
U093	Dimethylaminoazobenzene	EHW	C +
U094	7,12-Dimethylbenz[a]anthracene	EHW	C P
U095	3,3'-Dimethylbenzidine	EHW	C +
U096	alpha,alpha-Dimethylbenzylhydroperoxide	EHW	C R
U097	Dimethylcarbamoyl chloride	EHW	D H +
U099	1,2-Dimethylhydrazine	EHW	C + I
P045	3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino)carbonyl] oxime	EHW	B
P071	O,O-Dimethyl O-p-nitrophenyl phosphorothioate	EHW	A
P082	Dimethylnitrosamine	EHW	B +
P046	alpha, alpha-Dimethylphenethylamine	EHW	C
U103	Dimethyl sulfate	EHW	C O +
P047	4,6-Dinitro-o-cresol and salts	EHW	B
P034	4,6-Dinitro-o-cyclohexylphenol	EHW	C
P048	2,4-Dinitrophenol	EHW	B
U105	2,4-Dinitrotoluene	EHW	C
U106	2,6-Dinitrotoluene	EHW	C
P020	Dinoseb	EHW	B
U109	1,2-Diphenylhydrazine	EHW	C
P035	Diphosphoramide, octamethyl	EHW	?
U110	Dipropylamine	EHW	C I
U111	Di-n-propylnitrosamine	EHW	C +
P039	Disulfoton	EHW	A
P049	2,4-Dithiobiuret	EHW	A
P109	Dithiopyrophosphoric acid, tetraethyl ester	EHW	A
P050	Endosulfan	EHW	X H
P088	Endothall	EHW	B
P051	Endrin	EHW	X H
P042	Epinephrine	EHW	B
U001	Ethanal	EHW	C
U174	Ethanamine, N-ethyl-N-nitroso-	EHW	C +
P046	Ethanamine, 1,1-dimethyl-2-phenyl-	EHW	C
U067	Ethane, 1,2-dibromo-	EHW	C H +
U076	Ethane, 1,1-dichloro-	EHW	D H
U077	Ethane, 1,2-dichloro-	EHW	D H
U114	1,2-Ethanediylbiscarbamodithioic acid	EHW	B
U131	Ethane, 1,1,1,2,2,2-hexachloro-	EHW	H
U024	Ethane, 1,1'-[methylenebis(oxy)] bis[2-chloro-	EHW	C H
U247	Ethane, 1,1,1-trichloro-2,2-bis(p-methoxy phenyl)	EHW	D H
U003	Ethanenitrile	EHW	C
U025	Ethane, 1,1'-oxybis[2-chloro-	EHW	C H
U184	Ethane, pentachloro-	EHW	A H
U208	Ethane, 1,1,1,2-tetrachloro-	EHW	H
U209	Ethane, 1,1,2,2-Tetrachloro-	EHW	H
U227	Ethane, 1,1,2-trichloro-	EHW	C H
P084	Ethenamine, N-methyl-N-nitroso	EHW	B +
U043	Ethene, chloro-	EHW	D H +
U042	Ethane, 2-chloroethoxy-	EHW	C H
U078	Ethene, 1,1-dichloro-	EHW	C H +
U079	Ethene, trans-1,2-dichloro-	EHW	D H
U210	Ethene, 1,1,2,2-tetrachloro-	EHW	C H
U006	Ethanoyl chloride	EHW	C H O R
P101	Ethyl cyanide	EHW	B

TABLE 8-1

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
U038	Ethyl 4,4'-dichlorobenzilate	EHW	D H
U114	Ethylenebis(dithiocarbamic acid), salts and esters	EHW	B
U067	Ethylene dibromide	EHW	C H
U077	Ethylene dichloride	EHW	D H
U115	Ethylene oxide	EHW	C I
P054	Ethylenimine	EHW	B +
U076	Ethylidene dichloride	EHW	D H
P097	Famphur	EHW	A
P056	Fluorine	EHW	B
P057	Fluoroacetamide	EHW	B H
P058	Fluoroacetic acid, sodium salt	EHW	A H
U122	Formaldehyde	EHW	C
P065	Fulminic acid, mercury (II) salt	EHW	R ?
U125	2-Furancarboxaldehyde	EHW	C I
U147	2,5-Furandione	EHW	C
U125	Furfural	EHW	C I
U126	Glycidylaldehyde	EHW	C +
U163	Guanidine, N-nitroso-N-methyl-N'nitro-	EHW	C +
P059	Heptachlor	EHW	X H +
U127	Hexachlorobenzene	EHW	H
U128	Hexachlorobutadiene	EHW	C H
U129	Hexachlorocyclohexane (gamma isomer)	EHW	H +
U130	Hexachlorocyclopentadiene	EHW	X H
P051	1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo, endo-1,4,5,8-dimethanonaphthalene	EHW	X H
P037	1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo, exo-1,4,5,8-dimethanonapnthalene	EHW	X H +
U131	Hexachloroethane	EHW	H
P060	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo, endo-dimethanonaphthalene	EHW	B H
P004	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo, exodimethanonaphthalene	EHW	B H
P060	Hexachlorohexahydro-endo, endo-dimethanonapnthalene	EHW	B H
U132	Hexachlorophene	EHW	C H
U243	Hexachloropropene	EHW	H
P062	Hexaethyl tetraphosphate	EHW	B
U133	Hydrazine	EHW	B + R
P116	Hydrazinecarbothioamide	EHW	B
U099	Hydrazine, 1,2-dimethyl-	EHW	C + I
U109	Hydrazine, 1,2-diphenyl-	EHW	C
P068	Hydrazine, methyl-	EHW	A I
P063	Hydrocyanic acid	EHW	A
P063	Hydrogen cyanide	EHW	A
P096	Hydrogen phosphide	EHW	B I
U135	Hydrogen sulfide	EHW	B I
U096	Hydroperoxide, 1-methyl-1-phenylethyl-	EHW	C R
U245	Indomethacin	EHW	B H
P064	Isocyanic acid, methyl ester	EHW	I ?
P007	3(2H)-Isoxazolone, 5-(aminomethyl)-	EHW	B
U142	Kepone	EHW	X H
U143	Lasiocarpine	EHW	C +
U144	Lead acetate	EHW	D EP
U129	Lindane	EHW	H +
U147	Maleic anhydride	EHW	C
U149	Malononitrile	EHW	C
U151	Mercury	EHW	EP
P092	Mercury, (acetato-O)phenyl-	EHW	B
P065	Mercury fulminate	EHW	R ?
U152	Methacrylonitrile	EHW	B I
U092	Methanamine, N-methyl-	EHW	C I
P016	Methane, oxybis(chloro)-	EHW	B H +
P112	Methane, tetranitro-	EHW	A R
U029	Methane, bromo-	EHW	H
U045	Methane, chloro-	EHW	H I
U046	Methane, chloromethyoxy-	EHW	D H + I
U068	Methane, dibromo-	EHW	C H +
U080	Methane, dichloro-	EHW	C H
U075	Methane, dichlorodifluoro-	EHW	H
U138	Methane, iodo-	EHW	H +
U211	Methane, tetrachloro-	EHW	C H +
P118	Methanethiol, trichloro-	EHW	H
U153	Methanethiol	EHW	B I
U225	Methane, tribromo	EHW	H
U121	Methane, trichlorofluoro-	EHW	H
U044	Methane, trichloro-	EHW	C H +
P059	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-	EHW	X H +
U036	4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-	EHW	X H
P066	Methomyl	EHW	B
P067	2-Methylaziridine	EHW	B + I
P068	Methyl hydrazine	EHW	A I
P064	Methyl isocyanate	EHW	I ?
P069	2-Methyllactonitrite	EHW	A
P071	Methyl parathion	EHW	A
U029	Methyl bromide	EHW	H
U045	Methyl chloride	EHW	H I
U156	Methyl chlorocarbonate	EHW	B H I
U226	Methylchloroform	EHW	C H
U157	3-Methylcholanthrene	EHW	H P
U158	4,4'-Methylenebis(2-chloroaniline)	EHW	H +
U132	2,2'-Methylenebis(3,4,6-trichlorophenol)	EHW	C H
U068	Methylene bromide	EHW	C H +
U080	Methylene chloride	EHW	C H
U122	Methylene oxide	EHW	C
U160	Methyl ethyl ketone peroxide	EHW	B R
U138	Methyl iodide	EHW	H +
U163	N-Methyl-N'-nitro-N-nitrosoguanidine	EHW	C + R
U010	Mitomycin C	EHW	B +
U165	Naphthalene	EHW	B
U047	Naphthalene, 2-chloro-	EHW	D H
U166	1,4-Naphthalenedione	EHW	C
U236	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl-(1,1'-biphenyl)-4,4'diyl)]-bis (azo)bis(5-amino-4-hydroxy)-,tetrasodium salt	EHW	H +
U166	1,4,Naphthaquinone	EHW	C
U167	1-Naphthylamine	EHW	B +
U168	2-Naphthylamine	EHW	B +
U167	alpha-Naphthylamine	EHW	B +
U168	beta-Naphthylamine	EHW	B +
U026	2-Naphthylamine, N,N'-bis(2-chloroethyl)-	EHW	H +
P072	alpha-Naphthylthiourea	EHW	B
P073	Nickel carbonyl	EHW	B
P074	Nickel cyanide	EHW	D R ?
P074	Nickel (II) cyanide	EHW	D R ?
P073	Nickel tetracarbonyl	EHW	B
P075	Nicotine and salts	EHW	B
P076	Nitric oxide	EHW	B
P077	p-Nitroaniline	EHW	D ?
U169	Nitrobenzene	EHW	C I
P078	Nitrogen dioxide	EHW	A
P076	Nitrogen (II) oxide	EHW	B
P078	Nitrogen (IV) oxide	EHW	A
P081	Nitroglycerine	EHW	R ?
U170	p-Nitrophenol	EHW	C
U171	2-Nitropropane	EHW	C I
U174	N-Nitrosodiethylamine	EHW	C +
P082	N-Nitrosodimethylamine	EHW	B +

TABLE 8-1

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
U176	N-Nitroso-N-ethylurea	EHW	C +
U177	N-Nitroso-N-methylurea	EHW	C +
U178	N-Nitroso-N-methylurethane	EHW	C +
P084	N-Nitrosomethylvinylamine	EHW	B +
U179	N-Nitrosopiperidine	EHW	C +
U111	N-Nitroso-N-propylamine	EHW	C +
P050	5-Norbornene-2,3,-dimethanol, 1,4,5,6,7,7-hexachloro, cyclic sulfite	EHW	X H
P085	Octamethylpyrophosphoramide	EHW	A
P087	Osmium oxide	EHW	B
P087	Osmium tetroxide	EHW	B
P088	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid	EHW	B
U058	2H-1,3,2-Oxazaphosphorine, 2-[bis(2-chloro- ethyl)amino]tetrahydro-, oxide 2-	EHW	C H I +
U115	Oxirane	EWH	C I
U041	Oxirane, 2-(chloromethyl)-	EHW	C H + I
P089	Parathion	EHW	X
U183	Pentachlorobenzene	EHW	H
U184	Pentachloroethane	EHW	A H
U185	Pentachloronitrobenzene	EHW	D H +
U242	Pentachlorophenol	EHW	A H
U188	Phenol	EHW	C
P034	Phenol, 2-cyclohexyl-4,6-dinitro-	EHW	C
P048	Phenol, 2,4-dinitro-	EHW	B
P047	Phenol, 2,4-dinitro-6-methyl-, and salts	EHW	B
P020	Phenol, 2,4-dinitro-o-(1-methylpropyl)-	EHW	B
P009	Phenol, 2,4,6-trinitro-, ammonium salt	EHW	R
U048	Phenol, 2-chloro-	EHW	D H
U039	Phenol, 4-chloro-3-methyl-	EHW	H
U081	Phenol, 2,4-dichloro-	EHW	D H
U082	Phenol, 2,6-dichloro-	EHW	D H
U170	Phenol, 4-nitro-	EHW	C
U242	Phenol, pentachloro-	EHW	A H
U212	Phenol, 2,3,4,6-tetrachloro-	EHW	C H
U230	Phenol, 2,4,5-trichloro-	EHW	A H
U231	Phenol, 2,4,6-trichloro-	EHW	A H
P036	Phenyl dichloroarsine	EHW	B H
P092	Phenylmercuric acetate	EHW	B
P093	N-Phenylthiourea	EHW	A
P094	Phorate	EHW	X
P095	Phosgene	EHW	B H
P096	Phosphine	EHW	B I
P041	Phosphoric acid, diethyl p-nitrophenyl ester	EHW	A
P044	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester	EHW	A
P043	Phosphorofluoridic acid, bis(1-methyl-ethyl)-ester	EHW	B H
P094	Phosphorothiac acid, O,O-diethyl S-(ethylthio)methyl ester	EHW	X
P097	Phosphorothioic acid, O,O-dimethyl O-[p-((dimethylamino)-sulfonyl) phenyl]ester	EHW	A
P089	Phosphorothioic acid, O,O-diethyl O-(p-ni-trophenyl)ester	EHW	X
P040	Phosphorothioic acid, O,O-diethyl O-pyra-zinyl ester	EHW	A
U189	Phosphorous sulfide	EHW	B I R
U190	Phthalic anhydride	EHW	C
U191	2-Picoline	EHW	C
P110	Plumbane, tetraethyl-	EHW	A
P098	Potassium cyanide	EHW	A
P099	Potassium silver cyanide	EHW	A
P070	Propanal, 2-methyl-2(methylthio)-O-[(methylamino)carbonyl]oxime	EHW	B
U194	1-Propanamine	EHW	C I
U110	1-Propanamine, N-propyl-	EHW	C I
U066	Propane, 1,2-dibromo-3-chloro-	EHW	C H +
U149	Propanedinitrile	EHW	C
P101	Propanenitrile	EHW	B
P027	Propanenitrile, 3-chloro-	EHW	B H
P079	Propanenitrile, 2-hydroxy-2-methyl-	EHW	A
U171	Propane, 2-nitro-	EHW	C I
U027	Propane, 2,2'oxybis[2-chloro-	EHW	C H O
P081	1,2,3-Propanetriol, trinitrate-	EHW	R ?
U235	1-Propanol, 2,3-dibromo-, phosphate (3:1)	EHW	D H
U126	1-Propanol, 2,3-epoxy-	EHW	C +
P017	2-Propanone, 1-bromo-	EHW	C H
P102	Propargyl alcohol	EHW	X
P003	2-Propenal	EHW	X
U007	2-Propenamide	EHW	C
U084	Propene, 1,3-dichloro-	EHW	C H
U243	1-Propene, 1,1,2,3,3,3-hexachloro-	EHW	H
U009	2-Propenenitrile	EHW	C + I
U152	2-Propenenitrile, 2-methyl-	EHW	B I
U008	2-Propenoic acid	EHW	C O I
P005	2-Propen-1-ol	EHW	B I
U233	Propionic acid, 2-(2,4,5-trichlorophenoxy)-	EHW	B H
U194	n-Propylamine	EHW	C I
U083	Propylene dichloride	EHW	C H I
P067	1,2-Propylenimine	EHW	B + I
P102	2-Propyn-1-ol	EHW	X
P008	4-Pyridinamine	EHW	B
P075	Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts	EHW	B
U196	Pyridine	EHW	C I
U179	Pyridine, hexahydro-N-nitroso-	EHW	C +
U191	Pyridine,2-methyl-	EHW	C
P111	Pyrophosphoric acid, tetraethyl ester	EHW	A
U201	Resorcinol	EHW	C
P103	Selenourea	EHW	B
U015	L-Serine, diazoacetate (ester)	EHW	C +
P104	Silver cyanide	EHW	C
U233	Silvex	EHW	B H
P105	Sodium azide	EHW	A
P106	Sodium cyanide	EHW	A
P107	Strontium sulfide	EHW	R
P108	Strychnidin-10-one, and salts	EHW	B
P018	Strychnidin-10-one, 2,3-dimethoxy-	EHW	A
P108	Strychnine and salts	EHW	B
U135	Sulfur hydride	EHW	B I
U103	Sulfuric acid, dimethyl ester	EHW	C O +
P115	Sulfuric acid, thallium (I) salt	EHW	B
U189	Sulfur phosphide	EHW	B I R
U232	2,4,5-T	EHW	B H +
U207	1,2,4,5-Tetrachlorobenzene	EHW	D H
U208	1,1,1,2-Tetrachloroethane	EHW	H
U209	1,1,2,2-Tetrachloroethane	EHW	H
U210	Tetrachlorothylene	EHW	C H
U212	2,3,4,6-Tetrachlorophenol	EHW	C H
P109	Tetraethyldithiopyrophosphate	EHW	A
P110	Tetraethyl lead	EHW	A
P111	Tetraethylpyrophosphate	EHW	A
P112	Tetranitromethane	EHW	A R
P062	Tetraphosphonic acid, hexaethyl ester	EHW	B
P113	Thallic oxide	EHW	B
P113	Thallium (III) oxide	EHW	B
P114	Thallium (I) selenide	EHW	C

TABLE 8-1

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
P115	Thallium (I) sulfate	EHW	B
P045	Thiofanox	EHW	B
P049	Thioimidodicarbonic diamide	EHW	A
U153	Thiomethanol	EHW	B I
P014	Thiophenol	EHW	A
P116	Thiosemicarbazide	EHW	B H +
U219	Thiourea	EHW	C+
P026	Thiourea, (2-chlorophenyl)-	EHW	A H
P072	Thiourea, 1-naphthalenyl-	EHW	B
P093	Thiourea, phenyl-	EHW	A
U220	Toluene	EHW	C I
U223	Toluene diisocyanate	EHW	B R
P123	Toxaphene	EHW	X H
U226	1,1,1-Trichloroethane	EHW	C H
U227	1,1,2-Trichloroethane	EHW	C H
U228	Trichloroethene	EHW	C H +
U228	Trichloroethylene	EHW	C H +
P118	Trichloromethanethiol	EHW	H
U121	Trichloromonofluoromethane	EHW	H
U230	2,4,5-Trichlorophenol	EHW	A H
U231	2,4,6-Trichlorophenol	EHW	A H
U232	2,4,5-Trichlorophenoxyacetic acid	EHW	B H +
U235	Tris(2,3-disbromopropyl) phosphate	EHW	D H
U236	Trypan blue	EHW	H +
U237	Uracil, 5[bis(2-chloromethyl)amino]-	EHW	B H +
U237	Uracil mustard	EHW	B H +
P119	Vanadic acid, ammonium salt	EHW	B
P120	Vanadium pentoxide	EHW	B
P120	Vanadium (V) oxide	EHW	B
U043	Vinyl chloride	EHW	D H +
P001	Warfarin	EHW	A
U239	Xylene	EHW	C I
P121	Zinc cyanide	EHW	C
P122	Zinc phosphide	EHW	B R

TABLE 8-2

MODERATELY DANGEROUS CHEMICAL PRODUCTS

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
U187	Acetamide, N-(4-ethoxyphenyl)-	DW	D +
U005	Acetamide, N-9H-fluoren-2-yl-	DW	?
U112	Acetic acid, ethyl ester	DW	D I
U214	Acetic acid, thallium(I) salt	DW	?
U002	Acetone	DW	D I
U004	Acetophenone	DW	D
U005	2-Acetylaminofluorene	DW	?
U150	Alanine, 3-[p-bis(2-chloroethyl)amino] phenyl-, L-	DW	+
U011	Amitrole	DW	D +
U014	Auramine	DW	+
U016	Benz[c]acridine	DW	+
U016	3,4-Benzacridine	DW	+
U014	Benzenamine, 4,4-carbonimidoylbis(N,N-dimethyl-	DW	+
U222	Benzenamine, 2-methyl-, hydrochloride	DW	D +
U181	Benzenamine, 2-methyl-5-nitro	DW	D
U028	1,2-Benzenedicarboxylic acid, [bis(2-ethyl-hexyl)] ester	DW	?
U069	1,2-Benzenedicarboxylic acid, dibutyl ester	DW	D
U088	1,2-Benzenedicarboxylic acid, diethyl ester	DW	?
U102	1,2-Benzenedicarboxylic acid, dimethyl ester	DW	?
U107	1,2-Benzenedicarboxylic acid, di-n-octyl ester	DW	?
U203	Benzene, 1,2-methylenedioxy-4-allyl-	DW	D +
U141	Benzene, 1,2-methylenedioxy-4-propenyl-	DW	D +
U090	Benzene, 1,2-methylenedioxy-4-propyl-	DW	D +
U234	Benzene, 1,3,5-trinitro-	DW	D R
U202	1,2-Benzisothiazolin-3-one, 1, 1-dioxide, and salts	DW	+
U120	Benzo[j,k]fluorene	DW	D
U091	(1,1'-Biphenyl)-4-'-diamine, 3,3'-dimeth-oxy-	DW	D +
U244	Bis(dimethylthiocarbomoyl) disulfide	DW	D
U028	Bis(2-ethythoxyl) phthalate	DW	?
U172	1-Butanamine, N-butyl-N-nitroso-	DW	D +
U031	1-Butanol	DW	D I
U159	2-Butanone	DW	D I
U031	n-Butyl alcohol	DW	D I
U136	Cacodylic acid	DW	D
U238	Carbamic acid, ethyl ester	DW	+
U215	Carbonic acid, dithallium(I) salt	DW	?
U059	Daunomycin	DW	+

TABLE 8-2

Dangerous Waste No.	Substance	WDOE Hazard Designation	Reason for Designation*
U221	Diaminotoluene	DW	?
U069	Dibutyl phthalate	DW	D
U192	3,5-Dichloro-N-(1,1-dimethyl-2-propynyl) benzamide	DW	?
U108	1,4-Diethylene dioxide	DW	D +
U086	N,N-Diethylhydrazine	DW	+
U088	Diethyl phthalate	DW	?
U089	Diethylstilbestrol	DW	+
U148	1,2-Dihydro-3-,6-pyridizinedione	DW	D
U090	Dihydrosafrole	DW	D +
U091	3,3'-Dimethoxybenzidine	DW	D +
U098	1,1-Dimethylhydrazine	DW	+ I
U101	2,4-Dimethylphenol	DW	D
U102	Dimethyl phthalate	DW	?
U107	Di-n-octyl phthalate	DW	?
U108	1,4-Dioxane	DW	D +
U117	Ethane, 1,1'-oxybis-	DW	D I
U218	Ethanethioamide	DW	+
U173	Ethanol, 2,2-(nitrosoimino)bis-	DW	+
U004	Ethanone, 1-phenyl-	DW	D
U112	Ethyl acetate	DW	D I
U113	Ethyl acrylate	DW	D I
U238	Ethyl carbamate (urethan)	DW	+
U116	Ethylene thiourea	DW	D +
U117	Ethyl ether	DW	DI
U118	Ethyl methacrylate	DW	I
U119	Ethyl methanesulfonate	DW	+
U139	Ferric dextran	DW	+
U120	Fluoranthene	DW	D
U123	Formic Acid	DW	D O
U124	Furan	DW	I
U213	Furan, tetrahydro-	DW	I
U124	Furfuran	DW	I
U206	D-Glucopyranose, 2-deoxy-2(3-methyl-3-nitrosoureido)-	DW	+
U086	Hydrazine, 1,2-diethyl-	DW	+
U098	Hydrazine, 1,1-dimethyl-	DW	+ I
U134	Hydrofluoric acid	DW	D O
U134	Hydrogen fluoride	DW	D O
U136	Hydroxydimethylarsine oxide	DW	D
U116	2-Imidazolidinethione	DW	D +
U137	Indeno[1,2,3-cd]pyrene	DW	+
U139	Iron dextran	DW	+
U140	Isobutyl alcohol	DW	D I
U141	Isosafrole	DW	D +
U145	Lead phosphate	DW	+
U146	Lead subacetate	DW	+
U148	Maleic hydrazide	DW	D
U150	Melphalan	DW	+
U119	Methanesulfonic acid, ethyl ester	DW	+
U123	Methanoic acid	DW	D O
U154	Methanol	DW	D I
U155	Methapyrilene	DW	D
U154	Methyl alcohol	DW	D I
U186	1-Methylbutadiene	DW	D I
U159	Methyl ethyl ketone	DW	D I
U161	Methyl isobutyl ketone	DW	D I
U162	Methyl methacrylate	DW	D I
U161	4-Methyl-2-pentanone	DW	+
U164	Methylthiouracil	DW	+
U059	5,12-Naphthacenedione, (8S-cis)-8-acetyl-10-[(3-amino-2,3,6-trideoxy-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-	DW	+
U172	N-Nitrosodi-n-butylamine	DW	D +
U173	N-Nitrosodiethanolamine	DW	+
U180	N-Nitrosopyrrolidine	DW	D +
U181	5-Nitro-o-toluidine	DW	D
U139	1,2-Oxathiolane, 2,2-dioxide	DW	+
U182	Paraldehyde	DW	D I
U186	1,3-Pentadiene	DW	D I
U187	Phenacetin	DW	D+
U101	Phenol, 2,4-dimethyl-	DW	D
U137	1,10-(1,2-phenylene)pyrene	DW	+
U145	Phosphoric acid, Lead salt	DW	+
U087	Phosphorodithioic acid, O,O-diethyl-S-methyl ester	DW	?
U192	Pronamide	DW	?
U193	1,3-Propane sultone	DW	+
U140	1-Propanol, 2-methyl-	DW	D I
U002	2-Propanone	DW	D I
U113	2-Propenoic acid, ethyl ester	DW	D I
U118	2-Propenoic acid, 2-methyl-, ethyl ester	DW	I
U162	2-Propenoic acid, 2-methyl-, methyl ester	DW	D I
U155	Pyridine, 2-[(2dimethylamino)-2-thenylamino]-	DW	D
U164	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-	DW	+
U180	Pyrrole, tetrahydro-N-nitroso-	DW	D +
U200	Reserpine	DW	?
U202	Saccharin and salts	DW	+
U203	Safrole	DW	D +
U204	Selenious acid	DW	O
U204	Selenium dioxide	DW	O
U205	Selenium disulfide	DW	R
U089	4,4'-Stilbenediol, alpha,alpha'-diethyl-	DW	+
U206	Streptozotocin	DW	+
U205	Sulfur selenide	DW	R
U213	Tetrahydrofuran	DW	I
U214	Thallium(1) acetate	DW	?
U215	Thallium(1) carbonate	DW	?
U216	Thallium(1) chloride	DW	?
U217	Thallium(1) nitrate	DW	?
U218	Thioacetamide	DW	+
U244	Thiran	DW	D
U221	Toluenediamine	DW	?
U222	O-Toluidine hydrochloride	DW	D +
U011	1H-1,2,4-Triazol-3-amine	DW	D +
U234	sym-Trinitrobenzene	DW	D R
U182	1,3,5-Trioxane, 2,4,5-trimethyl-	DW	D I
U200	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-,methyl ester	DW	?

* EHW = Extremely Hazardous Waste
DW = Dangerous Waste
X = Toxic, Category X
A = Toxic, Category A
B = Toxic, Category B
C = Toxic, Category C
D = Toxic, Category D
H = Persistent, Halogenated Hydrocarbon
O = Corrosive
P = Persistent, Polycyclic Aromatic Hydrocarbon
+ = IARC Animal or Human, Positive or Suspected Carcinogen
I = Ignitable
R = Reactive
EP = Extraction Procedure Toxicity

TABLE 8-3

TOXIC CATEGORY DESIGNATION

Category	TLM_{96} (Fish) or Aquatic (Fish) LC_{50} (ppm)	Oral (Rat) LD_{50} (mg/kg)	Inhalation (Rat) LC_{50} (mg/L)	Dermal (Rabbit) LD_{50} (mg/kg)
X	<.1	<.5	<.02	< 2
A	.1 - 1	.5 - 5	.02 - .2	2 - 20
B	1 - 10	5 - 50	.2 - 2	20 - 200
C	10 - 100	50 - 500	2 - 20	200 - 2000
D	100 - 1000	500 - 5000	20 - 200	2000 - 20,000

If the waste mixture contains one or more toxic constituents determine the equivalent concentration for the waste from the following formula:

$$\text{Equivalent Concentration}(\%) = X\% + \frac{A\%}{10} + \frac{B\%}{100} + \frac{C\%}{1000} + \frac{D\%}{10,000}$$

where (X,A,B,C,or D)% is the sum of all the concentration percentages for a particular toxic category.

Example 1. A person's waste mixture contains: Aldrin (X Category) - .01%; Diuron (B Cateogry) - 1%; Benzene (C Category) - 4%; Phenol (C Cateogry) - 2%; Cyclohexane (C Category) - 5%; Water (nontoxic) - 87%. His equivalent concentration (E.C.) would be:

$$E.C\ (\%) = .01\% + \frac{0\%}{10} + \frac{1\%}{100} + \frac{(4\% + 2\% + 5\%)}{1000} + \frac{0\%}{10,000}$$

$$= .01\% + 0\% + .01\% + .011\% + 0\% = .031\%$$

So his equivalent concentration equals .031%.

TABLE 8-4

EP TOXICITY LIST

Dangerous Waste Number	Contaminant	EHW Maximum Concentration In Extract (mg/L)	DW Maximum Concentration In Extract (mg/L)
D004	Arsenic	> 500	5 - 500
D005	Barium	> 10,000	100 - 10,000
D006	Cadmium	> 100	1 - 100
D007	Chromium	> 500	5 - 500
D008	Lead	> 500	5 - 500
D009	Mercury	> 20	0.2 - 20
D010	Selenium	> 100	1 - 100
D011	Silver	> 500	5 - 500
D012	Endrin	> 2	0.02 - 2
D013	Lindane	> 40	0.4 - 40
D014	Methoxychlor	> 1,000	10 - 1,000
D015	Toxaphene	> 50	0.5 - 50
D016	2,4-D	> 1,000	10 - 1,000

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TABLE 8-5

Dangerous waste constituents

Acetonitrile [Ethanenitrile]
Acetophenone (Ethanone, 1-phenyl)
3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts (Warfarin)
2-Acetylaminofluorene (Acetamide,N-9H-fluoren-2-yl)-)
Acetyl chloride (Ethanoyl chloride)
1-Acetyl-2-thiourea (Acetamide, N-(aminothioxomethyl)-)
Acrolein (2-Propenal)
Acrylamide (2-Propenamide)
Acrylonitrile (2-Propenenitrile)
Aflatoxins
Aldrin (1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a,8b-hexahydro-endo,exo-1,4:5,8-Dimethanonaphthalene)
Allyl alcohol (2-Propen-1-ol)
Aluminum phosphide
4-Aminobiphenyl ([1,1'-Biphenyl]-4-amine)
6-Amino-1,1a,2,8,8a,8b-hexahydro-8-(hydroxymethyl)-8a-methoxy-5-methyl-carbamate azirino[2',3':3,4]pyrrolo[1,2-a]indole-4,7-dione, (ester) (Mitomycin C) (Azirino[2'3':3,4]pyrrolo(1,2-a)indole-4,7-dione, 6-amino-8[((amino-carbonyl)oxy)methyl]-1,1a,2,8,8a,8b-hexahydro-8amethoxy-5-methy-)
5-(Aminomethyl)-3-isoxazolol (3(2H)-Isoxazolone, 5-(aminomethyl)-)-4 Aminopyridine (4-Pyridinamine)
Amitrole (1H-1,2,4-Triazol-3-amine)
Aniline (Benzenamine)
Antimony and compounds, N.O.S.*
Aramite (Sulfurous acid, 2-chloroethyl- 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester)
Arsenic and compounds, N.O.S.*
Arsenic acid (Orthoarsenic acid)
Arsenic pentoxide (Arsenic (V) oxide)
Arsenic trioxide (Arsenic (III) oxide)
Auramine (Benzenamine, 4,4-carbonimidoylbis[N,N-Dimethyl-monohydrochloride)
Azaserine (L-Serine, diazoacetate (ester))
Barium and compounds, N.O.S.*
Barium cyanide
Benz[c]acridine (3,4-Benzacridine)
Benz[a]anthracene (1,2-Benzanthracene)
Benzene (Cyclohexatriene)
Benzenearsonic acid (Arsonic acid, phenyl-)
Benzene, dichloromethyl- (Benzal chloride)
Benzenethiol (Thiophenol)
Benzidine ([1,1'-Biphenyl]-4,4'diamine)
Benzo[b]fluoranthene (2,3-Benzofluoranthene)
Benzo[j]fluoranthene (7,8-Benzofluoranthene)
Benzo[a]pyrene (3,4-Benzopyrene)
p Benzoquinone (1,4-Cyclohexadienedione)
Benzotrichloride (Benzene, trichloromethyl-)
Benzyl chloride (Benzene, (chloromethyl)-)
Beryllium and compounds, N.O.S.*
Bis(2-chloroethoxy)methane (Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-])
Bis(2-chloroethyl) ether (Ethane, 1,1'-oxybis[2-chloro-])
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)
Bis(2-chloroisopropyl) ether (Propane, 2,2'-oxybis[2-chloro-])
Bis(chloromethyl) ether (Methane, oxybis[chloro-])
Bis(2-ethylhexyl) phthalate (1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester)
Bromoacetone (2-Propanone, 1-bromo-)
Bromomethane (Methyl bromide)
4-Bromophenyl phenyl ether (Benzene, 1-bromo-4-phenoxy-)
Brucine (Strychnidin-10-one, 2,3-dimethoxy-)
2-Butanone peroxide (Methyl ethyl ketone, peroxide)
Butyl benzyl phthalate (1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester)
2-sec-Butyl-4,6-dinitrophenol (DNBP) (Phenol, 2,4-dinitro-6-(1-methylpropyl)-)
Cadmium and compounds, N.O.S.*
Calcium chromate (Chromic acid, calcium salt)
Calcium cyanide
Carbon disulfide (Carbon bisulfide)
Carbon oxyfluoride (Carbonyl fluoride)
Chloral (Acetaldehyde, trichloro-)
Chlorambucil (Butanoic acid, 4-[bis(2-chloroethyl)amino]benzene-)
Chlordane (alpha and gamma isomers) (4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3,4,7,7a-tetrahydro-) (alpha and gamma isomers)
Chlorinated benzenes, N.O.S.*
Chlorinated ethane, N.O.S.*
Chlorinated fluorocarbons, N.O.S.*
Chlorinated naphthalene, N.O.S.*
Chlorinated phenol, N.O.S.*
Chloroacetaldehyde (Acetaldehyde, chloro-)
Chloroalkyl ethers, N.O.S.*
P-Chloroaniline (Benzenamine, 4-chloro-)
Chlorobenzene (Benzene, chloro-)
Chlorobenzilate (Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-,ethyl ester)
p-Chloro-m-cresol (Phenol, 4-Chloro-3-methyl)
1-Chloro-2,3-epoxypropane (Oxirane, 2-(chloromethyl)-)
2-Chloroethyl vinyl ether (Ethene, (2-chloroethoxy)-)
Chloroform (Methane, trichloro-)
Chloromethane (Methyl chloride)
Chloromethyl methyl ether (Methane, chloromethoxy-)
2-Chloronaphthalene (Naphthalene, beta-chloro-)
2-Chlorophenol (Phenol, o-chloro-)
1-(o-Chlorophenyl)thiourea (Thiourea, (2-chlorophenyl)-)
3-Chloropropionitrile (Propanenitrile, 3-chloro-)
Chromium and compounds, N.O.S.*
Chrysene (1,2-Benzphenanthrene)
Citrus red No. 2 (2-Naphthol, 1-[(2,5-dimethoxyphenyl)azo]-)
Coal tars

TABLE 8-5

Copper cyanide
Creosote (Creosote, wood)
Cresols (Cresylic acid) (Phenol, methyl-)
Crotonaldehyde (2-Butenal)
Cyanides (soluble salts and complexes), N.O.S.*
Cyanogen (Ethanedinitrile)
Cyanogen bromide (Bromine cyanide)
Cyanogen chloride (Chlorine cyanide)
Cycasin (beta-D-Glucopyranoside, (methyl-ONN-azoxy)methyl-)
2-Cyclohexyl-4,6-dinitrophenol (Phenol, 2-cyclohexyl-4,6-dinitro-)
Cyclophosphamide (2H-1,3,2,-Oxazaphosphorine, [bis(2-chloroethyl)amino]-tetrahydro-, 2-oxide)
Daunomycin (5,12-Naphthacenedione, (8S-cis)-8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-)
DDD (Dichlorodiphenyldichloroethane) (Ethane, 1,1-dichloro-2,2-bis(p chlorophenyl)-)
DDE (Ethylene, 1,1-dichloro-2,2-bis(4-chlorophenyl)-)
DDT (Dichlorodiphenyltrichloroethane) (Ethane, 1,1,1-trichloro-2,2-bis(p-chlorophenyl)-)
Diallate (S-(2,3-dichloroallyl) diisopropylthiocarbamate)
Dibenz[a,h]acridine (1,2,5,6-Dibenzacridine)
Dibenz[a,j]acridine (1,2,7,8-Dibenzacridine)
Dibenz[a,h]anthracene (1,2,5,6-Dibenzanthracene)
7H-Dibenzo[c,g]carbazole (3,4,5,6-Dibenzcarbazole)
Dibenzo[a,e]pyrene (1,2,4,5-Dibenzpyrene)
Dibenzo[a,h]pyrene (1,2,5,6-Dibenzpyrene)
Dibenzo[a,i]pyrene (1,2,7,8-Dibenzpyrene)
1,2-Dibromo-3-chloropropane (Propane, 1,2-dibromo-3-chloro-)
1,2-Dibromoethane (Ethylene dibromide)
Dibromomethane (Methylene bromide)
Di-n-butyl phthalate (1,2-Benzenedicarboxylic acid, dibutyl ester)
o-Dichlorobenzene (Benzene, 1,2-dichloro-)
m-Dichlorobenzene (Benzene, 1,3-dichloro-)
p-Dichlorobenzene (Benzene, 1,4-dichloro-)
Dichlorobenzene, N.O.S.* (Benzene, dichloro-, N.O.S.*)
3,3'-Dichlorobenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-)
1,4-Dichloro-2-butene (2-Butene, 1,4-Butene, 1,4-dichloro-)
Dichlorodifluoromethane (Methane, dichlorodifluoro-)
1,1-Dichloroethane (Ethylidene dichloride)
1,2-Dichloroethane (Ethylene dichloride)
trans-1,2-Dichloroethene (1,2-Dichloroethylene)
Dichloroethylene, N.O.S.* (Ethene, dichloro-, N.O.S.*)
1,1-Dichloroethylene (Ethene, 1,1-dichloro-)
Dichloromethane (Methylene chloride)
2,4-Dichlorophenol (Phenol, 2,4-dichloro-)
2,6-Dichlorophenol (Phenol, 2,6-dichloro)
2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters (Acetic acid, 2,4-dichlorophenoxy-, salts and esters)
Dichlorophenylarsine (Phenyl dichloroarsine)
Dichloropropane, N.O.S.* (Propane, dichloro-, N.O.S.*)
1,2-Dichloropropane (Propylene dichloride)
Dichloropropanol, N.O.S.* (Propanol, dichloro-, N.O.S.*)
Dichloropropene, N.O.S.* (Propene, dichloro-, N.O.S.*)
1,3-Dichloropropene, (1-Propene, 1,3-dichloro-)
Dieldrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octa-hydro-endo, exo-1,4:5,8-Dimethanonaphthalene)
1,2:3,4-Diepoxybutane (2,2'-Bioxirane)
Diethylarsine (Arsine, diethyl-)
N,N-Diethylhydrazine (Hydrazine, 1,2-diethyl)
O,O-Diethyl S-methyl ester of phosphorodithioic acid (Phosphorodithioic acid, O,O-diethyl S-methyl ester
O,O-Diethylphosphoric acid, O-p-nitrophenyl ester (Phosphoric acid, diethyl p-nitrophenyl ester)
Diethyl phthalate (1,2-Benzenedicarboxylic acid, diethyl ester)
O,O-Diethyl O-2-pyrazinyl phosphorothioate (Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
Diethylstilbesterol (4,4'-Stilbenediol, alpha,alpha-diethyl, bis(dihydrogen phosphate, (E)-)
Dihydrosafrole (Benzene, 1,2-methylenedioxy-4-propyl-)
3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alcohol (1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-)
Diisopropylfluorophosphate (DFP) (Phosphorofluoridic acid, bis(1-methylethyl) ester)
Dimethoate (Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
3,3'-Dimethoxybenzidine ([1,1'-Biphenyl]-4,4'diamine, 3-3'dimethoxy-)
p-Dimethylaminoazobenzene (Benzenamine, N,N-dimethyl-4-(phenylazo)-)
7,12-Dimethylbenz[a]anthracene (1,2-Benzanthracene, 7,12-dimethyl-)
3,3'Dimethylbenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-)
Dimethylcarbamoyl chloride (Carbamoyl chloride, dimethyl-)
1,1-Dimethylhydrazine (Hydrazine, 1,1-dimethyl-)

TABLE 8-5

1,2-Dimethylhydrazine (Hydrazine, 1,2-dimethyl-)
3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino) carbonyl]oxime (Thiofanox)
alpha,alpha-Dimethylphenethylamine (Ethanamine, 1,1-dimethyl-2-phenyl)
2,4-Dimethylphenol (Phenol, 2,4-dimethyl-)
Dimethyl phthalate (1,2-Benzenedicarboxylic acid, dimethyl ester)
Dimethyl sulfate (Sulfuric acid, dimethyl ester)
Dinitrobenzene, N.O.S.* (Benzene, dinitro-, N.O.S.*
4,6-Dinitro-o-cresol and salts (Phenol, 2,4-dinitro-6-methyl-, and salts)
2,4-Dinitrophenol (Phenol, 2,4-dinitro-)
2,4-Dinitrotoluene (Benezene, 1-methyl-2,4-dinitro-)
2,6-Dinitrotoluene (Benzene,1-methyl-2,6-dinitro-)
Di-n-octyl phthalate (1,2-Benzenedicarbozylic acid, dioctyl ester)
1,4-Dioxane (1,4-Diethylene oxide)
Diphenylamine (Benzenamine, N-Phenyl-)
1,2-Diphenylhydrazine (Hydrazine, 1,2-diphenyl-)
Di-n-propylnitrosamine (N-Nitroso-di-n-propylamine)
Disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate)
2,4-Dithiobiuret (Thioimidodicarbonic diamide)
Endosulfan (5-Norbornene, 2,3-dimethanol, 1,4,5,6,7,7-hexachloro-, cyclic sulfite)
Endrin and metabolites (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalene, and metabolites)
Ethyl carbamate (Urethan) (Carbamic acid, ethyl ester)
Ethyl cyanide (propanenitrile)
Ethylenebisdithiocarbamic acid, salts and esters (1,2-Ethanediylbiscarbamodithioic acid, salts and esters.
Ethyleneimine (Aziridine)
Ethylene oxide (Oxirane)
Ethylenethiourea (2-Imidazolidinethione)
Ethylmethacrylate (2-Propenoic acid, 2-methyl-, ethyl ester)
Ethyl methanesulfonate (Methanesulfonic acid, ethyl ester)
Fluoranthene (Benzo[j,k]fluorene)
Fluorine
2-Fluoroacetamide (Acetamide, 2-fluoro-)
Fluoroacetic acid, sodium salt (Acetic acid, fluoro-, sodium salt)
Formaldehyde (Methylene, oxide)
Formic acid (Methanoic acid)
Glycidylaldehyde (1-Propanol-2-3-epoxy)
Halomethane, N.O.S.*
Heptachlor (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-)
Heptachlor epoxide (alpha, beta, and gamma isomers) (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a,4,7,7-tetrahydro-, alpha, beta and gamma isomers)
Hexachlorobenzene (Benzene, hexachloro-)
Hexachlorobutadiene (1,3-Butadiene, 1,1,2,3,4,4-hexachloro-)
Hexachlorocyclohexane (all isomers) (Lindane and isomers)
Hexachlorocylopentadiene (1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-)
Hexachloroethane (Ethane, 1,1,1,2,2,2-hexachloro-)
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo,endo-dimethanonaphthalene (Hexachlorohexahydro-endo,endo-dimethanonaphthalene)
Hexachlorophene (2,2'-Methylenebis(3,4,6-trichlorophenol))
Hexachloropropene (1-Propene, 1,1,2,3,3,3-hexachloro-)
Hexaethyl tetraphosphate (Tetraphosphoric acid, hexaethyl ester)
Hydrazine (Diamine)
Hydrocyanic acid (Hydrogen cyanide)
Hydrofluoric acid (Hydrogen fluoride)
Hydrogen sulfide (Sulfur hydride)
Hydroxydimethylarsine oxide (Cacodylic acid)
Indeno(1,2,3-cd)pyrene (1,10-(1,2-phenylene)pyrene)
Iodomethane (Methyl iodide)
Iron Dextran (Ferric dextran)
Isocyanic acid, methyl ester (Methyl isocyanate)
Isobutyl alcohol (1-Propanol, 2-methyl-)
Isosafrole (Benzene, 1,2-methylenedioxy-4-allyl-)
Kapone (Decachlorooctahydro-1,3,4-Methano-2H-cyclobuta[cd]pentalen-2-one)
Lasiocarpine (2-Butenoic acid, 2-methyl-,7-[(2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy)methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester)
Lead and compounds, N.O.S.*
Lead acetate (Acetic acid, lead salt)
Lead phosphate (Phosphoric acid, lead salt)
Lead subacetate (Lead, bis(acetato-O)tetrahydroxytri-)
Maleic anhydride (2,5-Furandione)
Maleic hydrazide (1,2-Dihydro-3,6-pyridazinedione)
Malononitrile (Propanedinitrile)
Melphalan (Alanine, 3-[p-bis(2-chloroethyl)amino]phenyl-,L-)
Mercury Fulminate (Fulminic acid, mercury

TABLE 8-5

salt)
Mercury and compounds, N.O.S.*
Methacrylonitrile (2-Propenenitrile, 2-methyl-)
Methanethiol (Thiomethanol)
Methapyrilene (Pyridine, 2-[(2-dimethylaminoethyl)-2-thenylamino-)
Methiolonyl (Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-,methyl ester
Methoxychlor (Ethane, 1,1,1-trichloro-2,2'-bis(p-methoxyphenyl)-)
2-Methylaziridine (1,2-Propylenimine)
3-Methylcholanthrene (Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-)
Methyl chlorocarbonate (Carbonochloridic acid, methyl ester)
4,4'-Methylenebis(2-chloroaniline) (Benzenamine, 4,4'-methylenebis-(2-chloro-)
Methyl ethyl ketone (MEK) (2-Butanone)
Methyl hydrazine (Hydrazine, methyl-)
2-Methyllactonitrile (Propanenitrile, 2-hydroxy-2-methyl-)
Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)
Methyl methanesulfonate (Methanesulfonic acid, methyl ester)
2-Methyl-2-(methylthio)propionaldehyde-o-(methylcarbonyl) oxime (Propanal,2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime)
N-Methyl-N'-nitro-N-nitrosoguanidine (Guanidine, N-nitroso-N-methyl-N'nitro-)
Methyl parathion (O,O-dimethyl O-(4-nitrophenyl) phosphorothioate)
Methylthiouracil (4-1H-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-)
Mustard gas (Sulfide, bis(2-chloroethyl)-)
Naphthalene
1,4-Naphthoquinone (1,4-Naphthalenedione)
1-Naphthylamine (alpha-Naphthylamine)
2-Naphthylamine (beta-Naphthylamine)
1-Naphthyl-2-thiourea (Thiourea, 1-naphthalenyl-)
Nickel and compounds, N.O.S.*
Nickel carbonyl (Nickel tetracarbonyl)
Nickel cyanide (nickel (II) cyanide)
Nicotine and salts, Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts)
Nitric oxide (Nitrogen (II) oxide)
p-Nitroaniline (Benzenamine, 4-nitro-)
Nitrobenzine (Benzene, nitro-)
Nitrogen dioxide (Nitrogen (IV) oxide)
Nitrogen mustard and hydrochloride salt (Ethanamine, 2-chloro-, N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
Nitrogen mustard N-Oxide and hydrochloride salt (Ethanamine, 2-chloro-, N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
Nitroglycerine (1,2,3-Propanetriol, trinitrate)
4-Nitrophenol (Phenol, 4-nitro-)
4-Nitroquinoline-1-oxide (Quinoline, 4-nitro-1-oxide-)
Nitrosamine, N.O.S.*
N-Nitrosodi-n-butylamine (1-Butanamine, N-butyl-N-nitroso-)
N-Nitrosodiethanolamine (Ethanol, 2,2'-(nitrosoimino)bis-)
N-Nitrosodiethylamine (Ethanamine, N-Ethyl-N-nitroso-)
N-Nitrosodimethylamine (Dimethylnitrosamine)
N-Nitroso-N-ethylurea (Carbamide, N-ethyl-N-nitroso-)
N-Nitrosomethylethylamine (Ethanamine, N-methyl-N-nitroso-)
N-Nitroso-N-methylurea (Carbamide, N-methyl-N-nitroso-)
N-Nitroso-N-methylurethane (Carbamic acid, methylnitroso-, ethyl ester)
N-Nitrosomethylvinylamine (Ethenamine, N-methyl-N-nitroso-)
N-Nitrosomorpholine (Morpholine, N-nitroso-)
N-Nitrosonornicotine (Nornicotine, N-nitroso-)
N-Nitrosopiperidine (Pyridine, hexahydro-, N-nitroso-)
Nitrosopyrrolidine (pyrrole, tetrahydro-, N-nitroso-)
N-Nitrososarcosine (Sarcosine, N-nitroso-)
5-Nitro-o-toluidine (Benzenamine, 2-methyl-5-nitro-)
Octamethylpyrophosphoramide (Diphosphoramide, octamethyl-)
Osmium tetroxide (Osmium (VIII) oxide)
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid (Endothal)
Paraldehyde (1,3,5-Trioxane, 2,4,6-trimethyl-)
Parathion (Phosphorothioic acid, O,O-diethyl O-(p-nitrophenyl) ester
Pentachlorobenzene (Benzene, pentachloro-)
Pentachloroethane (Ethane, pentachloro-)
Pentachloronitrobenzene (PCNB) (Benzene, pentachloronitro-)
Pentachlorophenol (Phenol, pentachloro-)
Phenacetin (Acetamide, N-(4-ethoxyphenyl)-)
Phenol (Benzene, hydroxy-)
Phenylenediamine (Benzenediamine)
Phenylmercury acetate (Mercury, acetatophenyl-)
N-Phenylthiourea (Thiourea, phenyl-)
Phosgene (Carbonyl chloride)
Phosphine (Hydrogen phosphide)
Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester (Phorate)
Phosphorothioic acid, O,O-dimethyl O-[p-((dimethylamino)sulfonyl)phenyl] ester (Famphur)
Phthalic acid esters, N.O.S.* (Benzene, 1,2-dicarboxylic acid, esters, N.O.S.*
Phthalic anhydride (1,2-Benzenedicarboxylic acid anhydride)
2-Picoline (Pyridine, 2-methyl-)

TABLE 8-5

Polychlorinated biphenyl, N.O.S.*
Potassium cyanide
Potassium silver cyanide (Argentate(1-), dicyano-, potassium)
Pronamide (3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)benzamide)
1,3-Propanesultone (1,2-Oxathiolane, 2,2-dioxide)
n-Propylamine (1-Propane)
Propylthiouracil (Undecamethylenediamine, N,N'-bis(2-chlorobenzyl)-, dihydrochloride)
2-Propyn-1-ol (Propargyl alcohol)
Pyridine
Reserpine (Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester)
Resorcinol (1,3-Benzenediol)
Saccharin and salts (1,2-Benzoisothiazolin-3-one, 1,1-dioxide, and salts)
Safrol (Benzene, 1,2-methylenedioxy-4-allyl-)
Selenious acid (Selenium dioxide)
Selenium and compounds, N.O.S.*
Selenium sulfide (Sulfur selenide)
Selenourea (Carbamimidoselenoic acid)
Silver and compounds, N.O.S.*
Silver cyanide
Sodium cyanide
Streptozotocin (D-Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-)
Strontium sulfide
Strychnine and salts (Strychnidin-10-one, and salts)
1,2,4,5-Tetrachlorobenzene (Benzene, 1,2,4,5-tetrachloro-)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Dibenzo-p-dioxin, 2,3,7,8-tetrachloro-)
Tetrachloroethane, N.O.S.* (Ethane, tetrachloro-, N.O.S.*)
1,1,1,2-Tetrachlorethane (Ethane, 1,1,1,2-tetrachloro-)
1,1,2,2-Tetrachlorethane (Ethane, 1,1,2,2-tetrachloro-)
Tetrachlorethylene (Ethane, 1,1,2,2-tetrachloro-)[1]
Tetrachloromethane (Carbon tetrachloride)
2,3,4,6-Tetrachlorophenol (Phenol,2,3,4,6-tetrachloro-)
Tetraethyldithiopyrophosphate (Dithiopyrophosphoric acid, tetraethyl-ester)
Tetraethyl lead (Plumbane, tetraethyl-)
Tetraethylpyrophosphate (Pyrophosphoric acide, tetraethyl ester)
Tetranitromethane (Methane, tetranitro-)
Thallium and compounds, N.O.S.*
Thallic oxide (Thallium (III) oxide)
Thallium (I) acetate (Acetic acid, thallium (I) salt)
Thallium (I) carbonate (Carbonic acid, dithallium (I) salt)
Thallium (I) chloride
Thallium (I) nitrate (Nitric acid, thallium (I) salt)
Thallium selenite
Thallium (I) sulfate (Sulfuric acid, thallium (I) salt)
Thioacetamide (Ethanethioamide)
Thiosemicarbazide (Hydrazinecarbothioamide)
Thiourea (Carbamide thio-)
Thiuram (Bis(dimethylthiocarbamoyl) disulfide)
Toluene (Benzene, methyl-)
Toluenediamine (Diaminotoluene)
o-Toluidine hydrochloride (Benzenamine, 2-methyl-, hydrochloride)
Tolylene diisocyanate (Benzene, 1,3-diisocyanatomethyl-)
Toxaphene (Camphene, octachloro-)
Tribromomethane (Bromoform)
1,2,4-Trichlorobenzene (Benzene, 1,2,4-trichloro-)
1,1,1-Trichloroethane (Methyl chloroform)
1,1,2-Trichloroethane (Ethane, 1,1,2-trichloro-)
Trichloroethene (Trichloroethylene)
Trichloromethanethiol (Methanethiol, trichloro-)
Trichloromonofluoromethane (Methane, trichlorofluoro-)
2,4,5-Trichlorophenol (Phenol, 2,4,5-trichloro-)
2,4,6-Trichlorophenol (Phenol, 2,4,6-trichloro-)
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) (Acetic acid, 2,4,5-trichlorophenoxy-)
2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex) (Porpionoic acid, 2-(2,4,5-trichlorophenoxy)-)
Trichloropropane, N.O.S.* (Propane, trichloro-, N.O.S.*
1,2,3-Trichloropropane (Propane, 1,2,3-trichloro-)
O,O,O-Triethyl phosphorothioate (Phosphorothioic acid, O,O,O-triethyl ester)
sym-Trinitrobenzene (Benzene, 1,3,5-trinitro-)
Tris(1-aziridinyl) phosphine sulfide (Phosphine sulfide, tris(1-aziridinyl-)
Tris(2,3-dibromopropyl) phosphate (1-Propanol, 2,3-dibromo-, phosphate)
Trypan blue (2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl(1,1'-biphenyl)-4,4'-diyl)bis(azo)]bis(5-amino-4-hydroxy-, tetrasodium salt)
Uracil mustard (Uracil 5-[bis(2-chlorethyl)amino]-)
Vanadic acid, ammonium salt (ammonium vanadate)
Vanadium pentoxide (Vanadium (V) oxide)
Vinyl chloride (Ethane, chloro-)
Zinc cyanide
Zinc phosphide

*The abbreviation N.O.S. signifies those members of the general class "not otherwise specified" by name in this listing.

APPENDIX D

WASTE MANAGEMENT MANUAL, MG-75

9011/3/4 0237

APPENDIX E

HAZARDOUS WASTE GROUND-WATER MONITORING PLAN

SUMMARY

This document contains site-specific ground-water monitoring plans for one nonradioactive hazardous waste facility and one radioactive mixed waste facility at the U.S. Department of Energy's (USDOE) Hanford Site. The hazardous waste facility covered is the 300 Area Process Trenches. The radioactive mixed waste facility included in this document is the 183-H Solar Evaporation Basins. These monitoring plans are based upon the ground-water monitoring requirements for interim status facilities, as described in Washington State's dangerous waste regulations. For a third facility, the Nonradioactive Hazardous Waste (NRHW) Trenches at the Central Landfill, this document contains notification of the USDOE's intention to apply for a waiver from ground-water monitoring and also a brief description of the technical justification for this request.

The monitoring programs for the 183-H Solar Evaporation Basins and the 300 Area Process Trenches are full-scale assessment programs. Routine ground-water monitoring conducted at these facilities has indicated that they have caused contamination of the ground water. Therefore, the monitoring programs for these facilities are designed to assess the situation and determine the extent of contamination.

This document also includes supporting information concerning the Hanford Site and the proposed procedures to be used for these monitoring programs.

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ABBREVIATIONS

FFTF	-	Fast Flux Test Facility
FMEF	-	Fuels and Materials Examination Facility
MASF	-	Maintenance and Storage Facility
NRHW	-	Nonradioactive Hazardous Waste
PNL	-	Pacific Northwest Laboratory
RHO	-	Rockwell Hanford Operations
UNC	-	UNC Nuclear Industries
USDOE	-	U.S. Department of Energy
UST	-	U.S. Testing Company, Inc.
WAC	-	Washington Administrative Code
WHC	-	Westinghouse Hanford Company
WPPSS	-	Washington Public Power Supply System

INTRODUCTION

This document contains ground-water monitoring plans for two waste facilities at the USDOE's Hanford Site, which is shown in Figure 1. It also contains notification of the USDOE's intention to file for a waiver for a third facility. The three facilities include two nonradioactive hazardous waste facilities (the 300 Area Process Trenches and the NRHW Trenches at the Central Landfill) and one radioactive mixed waste facility (the 183-H Solar Evaporation Basins). Locations of these facilities are shown in Figure 2.

This document includes ground-water monitoring plans for the following two facilities: the 300 Area Process Trenches and the 183-H Solar Evaporation Basins. These monitoring plans are based upon the ground-water monitoring requirements for interim status facilities, as set forth in Washington State's dangerous waste regulations. These regulations are contained in Chapter 173-303 of the Washington Administrative Code (WAC). A guidance

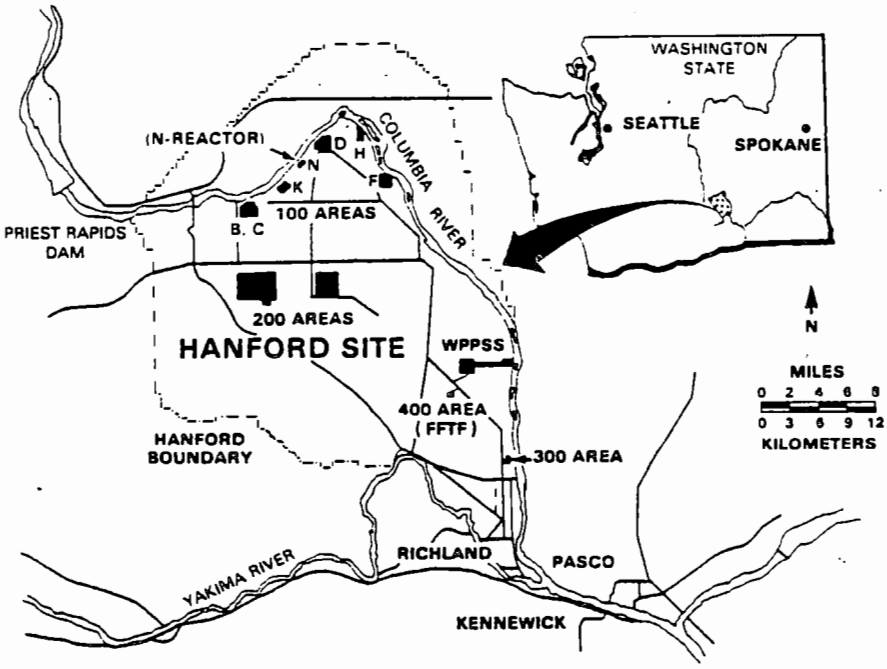


FIGURE 1. The Hanford Site

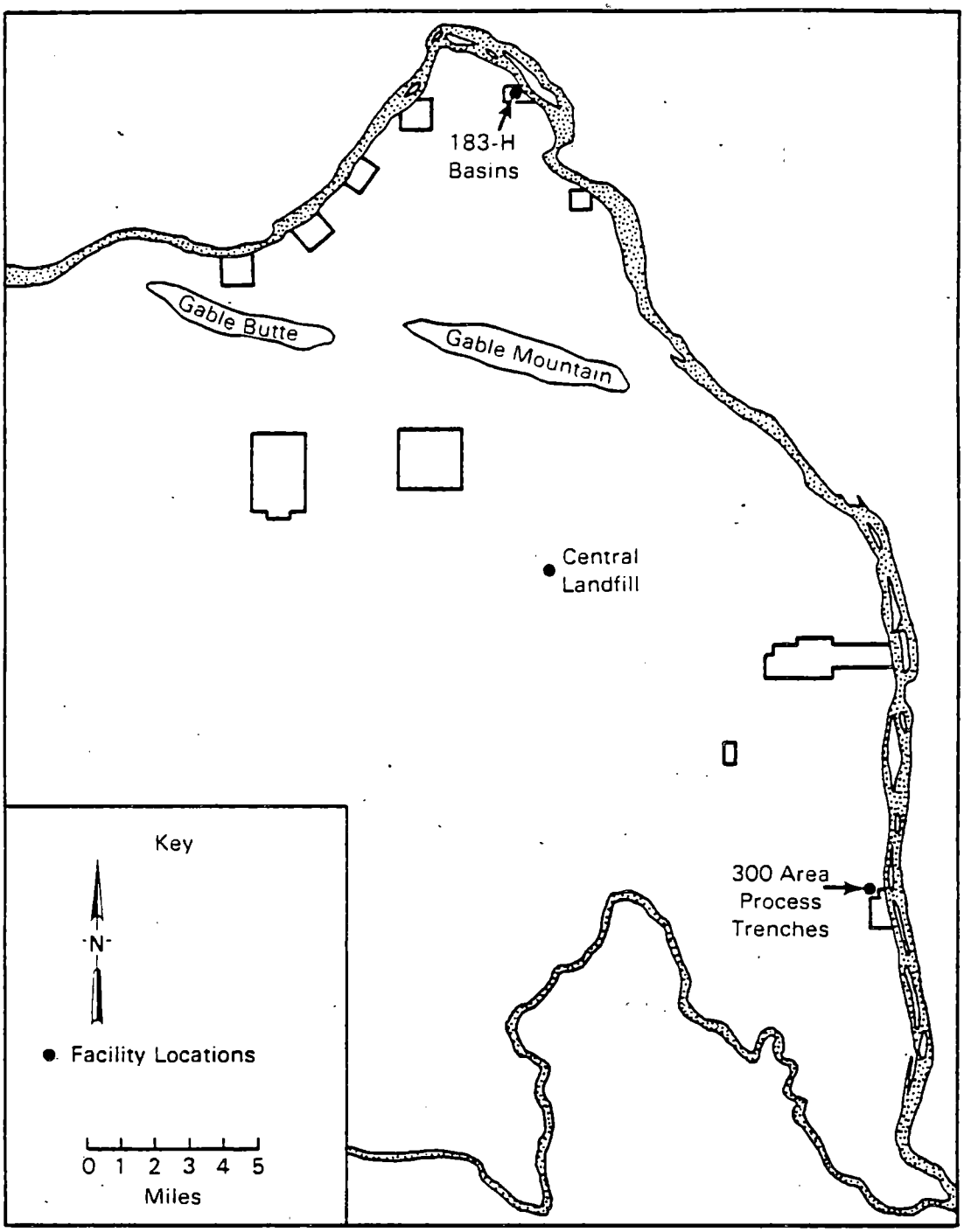


FIGURE 2. Locations of Facilities Covered by this Document

document for interim status facilities issued by the U.S. Environmental Protection Agency (1983) has been used as a reference during preparation of the monitoring plans.

While compliance monitoring at these facilities is a new effort, it should be noted that ground-water monitoring is and has been a major activity on the Hanford Site since the 1940's. Ground-water monitoring has been conducted on two scales: 1) facility-specific monitoring conducted by the USDOE contractors which operate the facilities, and 2) site-wide surveillance conducted by the USDOE's Pacific Northwest Laboratory (PNL). Although past work on both scales has focused mainly on monitoring of radionuclides in the ground water, the knowledge that has been gained concerning the hydrogeology of the site is directly applicable to this new effort and has been used in determining the appropriate scope of monitoring at each of the three facilities discussed herein.

This document contains a chapter on each of the three facilities mentioned above. As indicated previously, two of the chapters contain ground-water monitoring plans. The other chapter (on the NRHW Trenches at the Central Landfill) does not contain ground-water monitoring plans. Instead, it contains notification of the USDOE's intention to apply for a waiver for this facility.

This document also contains supporting information, including a description of the site's operations and hydrogeology. The final chapter in this document includes the methods that will be used in implementing the ground-water monitoring plans.

SITE DESCRIPTION

The Hanford Site, which is operated by the USDOE, is located in south-central Washington. The site, shown in Figure 1, occupies 570 square miles of the Pasco Basin. A brief description of the site's climate and main physiographic features is contained in the following paragraph.

The site receives about 6.3 in. of precipitation annually, of which about 40% occurs during the winter months. The desert plains on which the site is situated rise gradually from an altitude of about 400 ft above mean sea level (msl) in the southeastern part of the site to about 700 ft in the northwestern part (Newcomb, Strand and Frank 1972). In places along the boundaries and in the center of the site, bedrock (basalt) anticlines or ridges rise above the plains. The Columbia River flows through the northern part of the site and forms part of its eastern boundary, and the Yakima River flows along a portion of the site's southern boundary. The cities of Richland, Pasco, and Kennewick, known as the Tri-Cities, are situated on the Columbia River downstream of the site and have a combined population of about 90,000.

SITE OPERATIONS

The Hanford Site was established in 1943 under the Manhattan Project to produce plutonium for nuclear weapons. At one time, nine production reactors were in operation at the site, but only one of these (N Reactor) is currently operating. The N Reactor is a dual purpose reactor, producing both plutonium for weapons and steam for power production. Another onsite reactor, the Fast Flux Test Facility (FFTF), is used for research. At present, the main USDOE-sponsored activities at the site include reactor operation, fuel fabrication and reprocessing, waste management, and energy-related research and development.

Four main operating areas exist onsite. The six "100 Areas" contain N Reactor and the eight deactivated production reactors. The fuel reprocessing and waste management facilities are located in the "200 Areas," on a plateau at the center of the site. The "300 Area" contains fuel fabrication

facilities and research laboratories, and the "400 Area" contains the FFTF. The "600 Area" encompasses all of the site not included in the four operating areas (Price et al. 1984).

Principal USDOE contractors operating at Hanford are:[a]

-Rockwell Hanford Operations (RHO)--responsible for fuel reprocessing, waste management, and some site-support services.

-Battelle Memorial Institute (BMI)--responsible for managing PNL for the USDOE. PNL activities include research and development in many fields and also some site-support services, including environmental surveillance of the Hanford Site.

-UNC Nuclear Industries (UNC)--responsible for fabricating fuel and managing the N Reactor.

-Westinghouse Hanford Company (WHC)--responsible for managing the Hanford Engineering Development Laboratory and the FFTF. WHC is also the administrative landlord for the 300 Area.

Non-USDOE facilities located on the Hanford Site include the Washington Public Power Supply System (WPPSS) generating station adjacent to the N Reactor, the WPPSS #2 power reactor, and a burial site, operated by U.S. Ecology, for commercially generated, low-level radioactive waste.

GEOLOGY AND HYDROLOGY OF THE SITE

Since establishment of the Hanford Site in the 1940's, many studies have been conducted concerning the site's geology and hydrology. Over 2,000 wells have been drilled onsite, and the drilling logs from these wells have contributed greatly to knowledge of the site's subsurface. Recent studies conducted by RHO under the Basalt Waste Isolation Project (BWIP) have further strengthened this body of knowledge (Gephart et al. 1979; Myers, Price et al. 1979). Brief descriptions of the general geology and hydrology of the site are contained in the next two sections, and further detail concerning local characteristics at each of the hazardous waste facilities is

(a) This information was taken from Price et al. (1984).

included in their respective chapters. For the reader desiring more information on this subject, Appendix A contains an essay summarizing the results of studies on the geohydrology of the area.

Geology

The main geologic units beneath the Hanford Site include, in descending order, eolian sediments, glaciofluvial sediments, the Ringold Formation, and the Columbia River basalt group. A generalized geologic cross section of the site is shown in Figure 3, and characteristics of the geologic units are discussed below.

In some places on the Hanford Site, eolian sediments have been deposited on the surface. These silts and very fine sands form dunes that cover fairly extensive portions of the site.

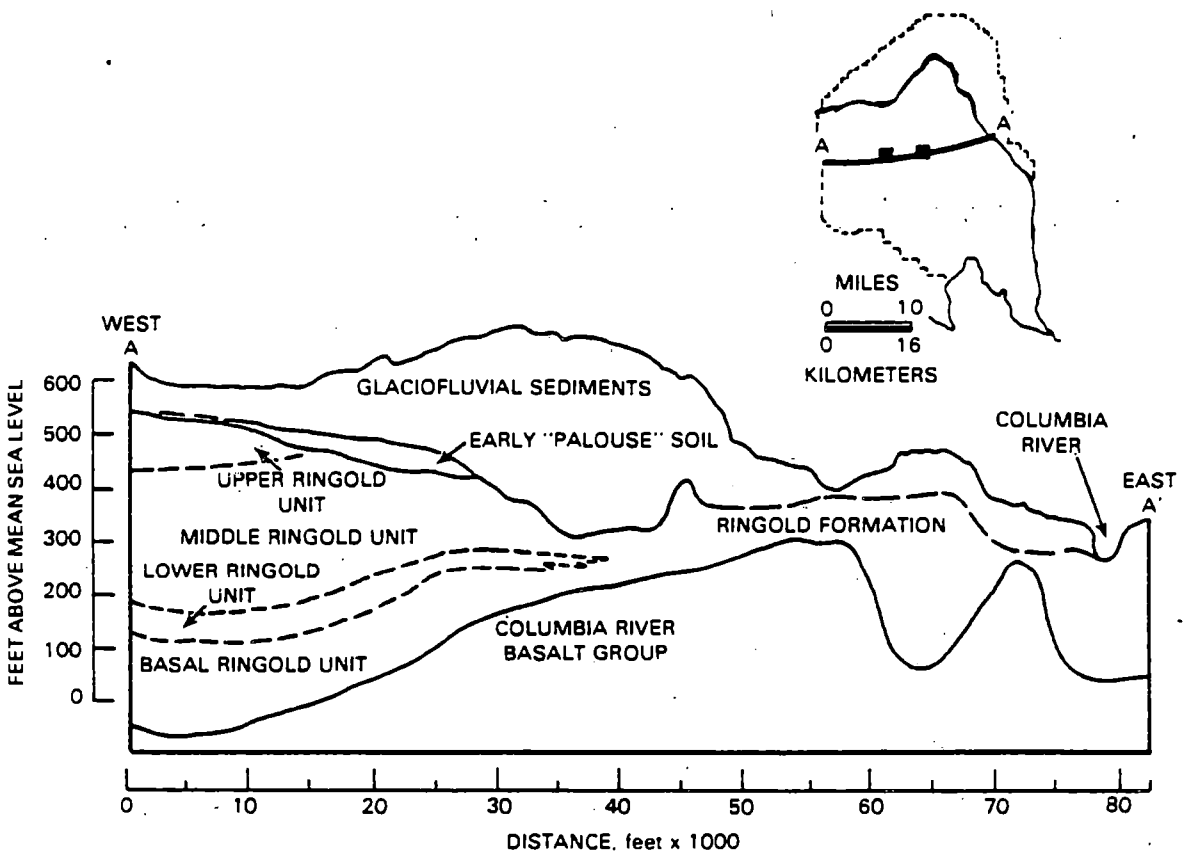


FIGURE 3. Generalized Geologic Cross Section of the Hanford Site (Modified from Tallman et al. 1979)

Beneath the eolian sediments is a series of coarse clastic deposits laid down by the ancestral Columbia River when it was swollen by glacial meltwater. These glaciofluvial sediments consist of gravels and sands, with some intermixed and interlayered silt as well as cobbles and boulders (Newcomb, Strand and Frank 1972). The glaciofluvial sediments are also known as the Hanford Formation.

The Ringold Formation lies beneath the glaciofluvial sediments. With the exception of a weakly-consolidated conglomerate member, the Ringold Formation consists mainly of layered silts, clays, and fine sands deposited in a lacustrine environment. Distinctive lithologic zones within this formation include the following: 1) blue and green silts and clays of the lower Ringold, and 2) a conglomerate consisting of well-rounded pebbles and cobbles, with medium to fine sand filling the interstitial spaces. In some areas of the site, sediments of the upper Ringold Formation were reworked by the wind and redeposited as a silt layer called the Palouse soil (Newcomb, Strand and Frank 1972).

Beneath the Ringold Formation is the Columbia River basalt group, which is the bedrock beneath the site. This formation is a thick series of lava flows extruded from fissures. The individual flows range in thickness from about 10 to 150 ft. The basalts were originally flat lying but have been warped and folded, producing anticlines that, in some places, rise above the water table and crop out at the land surface (Newcomb, Strand and Frank 1972).

Hydrology

Both confined and unconfined aquifers are present beneath the Hanford Site. The confined aquifers, in which the ground water is under pressure greater than that of the atmosphere, are found mainly within the Columbia River basalts. The unconfined or water-table aquifer is the uppermost aquifer, and it consists primarily of the Ringold Formation and to a lesser extent the glaciofluvial sediments (Gephart et al. 1979). Being closest to the surface, the unconfined aquifer is most likely to be affected by onsite

operations and waste disposal practices. Therefore, the routine Ground-Water Surveillance Program for the site (conducted by PNL) and the monitoring programs described in this document are focused on the unconfined aquifer.

The saturated portion of the unconfined aquifer reaches a thickness of over 230 ft in some areas and pinches out along the flanks of the basalt anticlines. The bottom of the aquifer is the top of the basalt, or in some places, the clay zones of the lower unit of the Ringold Formation (Graham et al. 1981). On the Hanford Site, the depth to the water table ranges from less than 1 ft near the Columbia River to over 350 ft in the center of the site. Studies have shown that the natural recharge through the thick unsaturated zone is minimal. Some natural recharge occurs along the base of the bordering anticlines where precipitation and runoff infiltrate to the water table (Gephart et al. 1979). In addition, the aquifer is artificially recharged by the waste and cooling water released onsite.

Changes in the water-table surface during the past 40 years are the result of disposal to the ground of large volumes of waste water and process cooling water. Ground-water mounds created by the discharge of water exist near the 200 Areas (Figure 4). These mounds interrupt the general flow pattern in the aquifer, from the recharge areas in the west to the discharge areas (primarily the Columbia River) in the east.

The unconfined aquifer is hydraulically connected to and interacts with the Columbia River. Seasonal and diurnal fluctuations of the river stage lead to corresponding changes in the water table near the river. The ground-water flow system near the river is therefore complex and can be difficult to characterize. Design of ground-water monitoring programs for facilities near the river must be based on an understanding of how the local flow system is affected by the aquifer/river interactions.

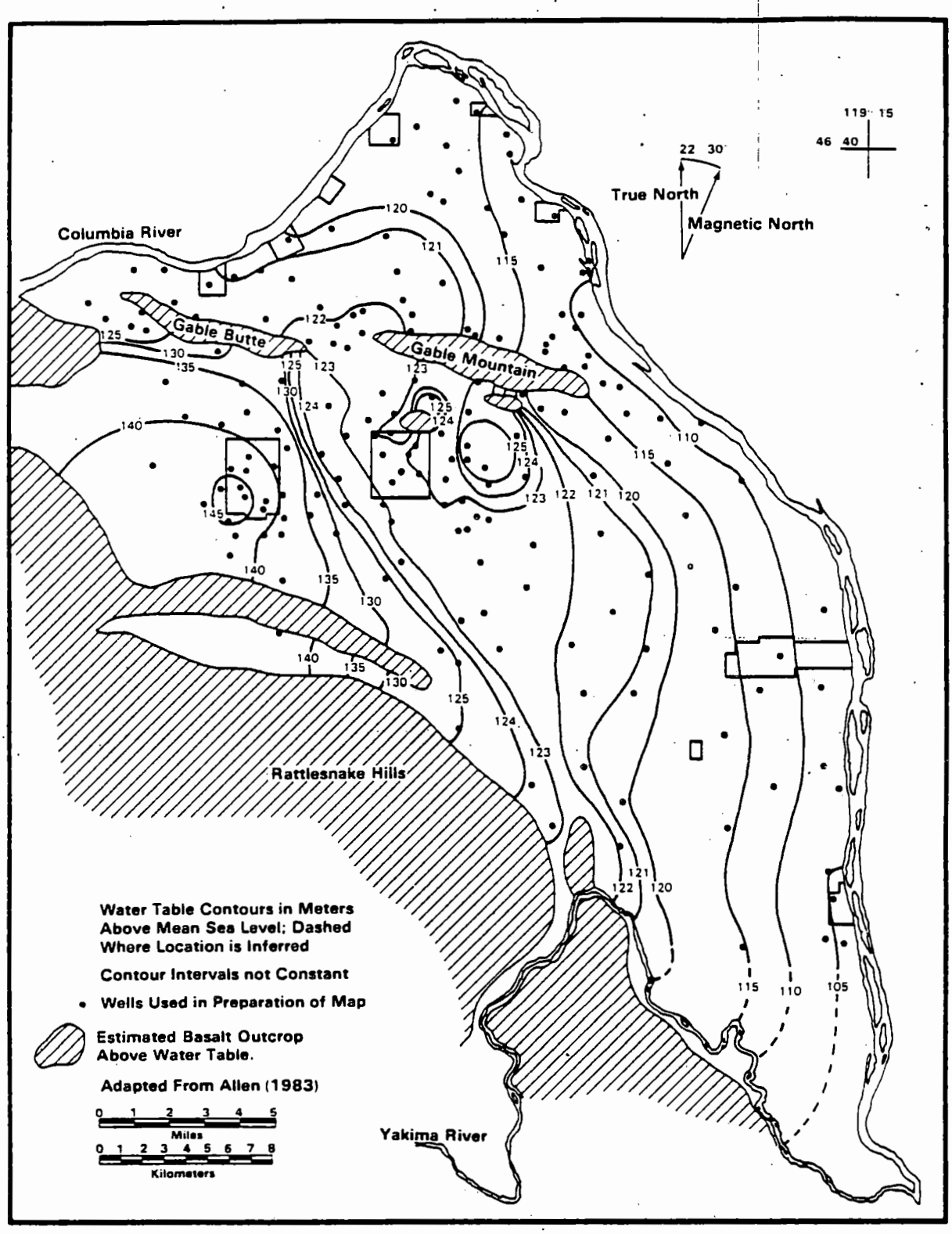


FIGURE 4. Water-Table Elevations - December, 1983

183-H SOLAR EVAPORATION BASINS

The 183-H Solar Evaporation Basins are located in the northern part of the Hanford Site at the 100-H Area (Figure 2). This area, which encompasses approximately 320 acres, is the site of a retired plutonium-production reactor. The old reactor building is near the center of the area, and the 183-H basins are located between the reactor and the Columbia River. Figure 5 is a map of the 100-H Area, showing the main facilities and the existing monitoring wells.

The 100-H reactor began operating in October 1949 and was deactivated in April 1965 (U. S. Energy Research & Development Administration 1975). Since shutdown of the reactor, activities at the 100-H Area have been very limited, consisting primarily of storage of radioactive mixed wastes at the 183-H basins. The retired facilities at the 100-H Area, including the old reactor building and ancillary facilities, are slated for decommissioning. This effort is currently in progress and may be completed as soon as 1988.

OPERATIONAL HISTORY OF THE 183-H BASINS

The 183-H facility is managed by UNC. It is composed of four separate concrete basins which were originally used for water treatment. In the early 1970's these basins were designated for use as evaporation basins for radioactive mixed wastes. The primary wastes stored in the basins are those produced by UNC at the 300 Area during fabrication of reactor fuel, although very small amounts of other wastes have been discharged to the basins after being checked for compatibility (Greager 1982).

Radioactive mixed wastes were first discharged to the facility in June 1973. At that time, only basin #1 was in use. After two months in service, use of the basin was postponed for over a year because of operational problems at the 300 Area. Usage of basin #1 was resumed in January 1975 but was discontinued again in August 1978, after nitrate contamination was discovered in the ground water and was attributed to seepage of wastes from this unlined basin. At that time, basin #1 was permanently removed from service, and

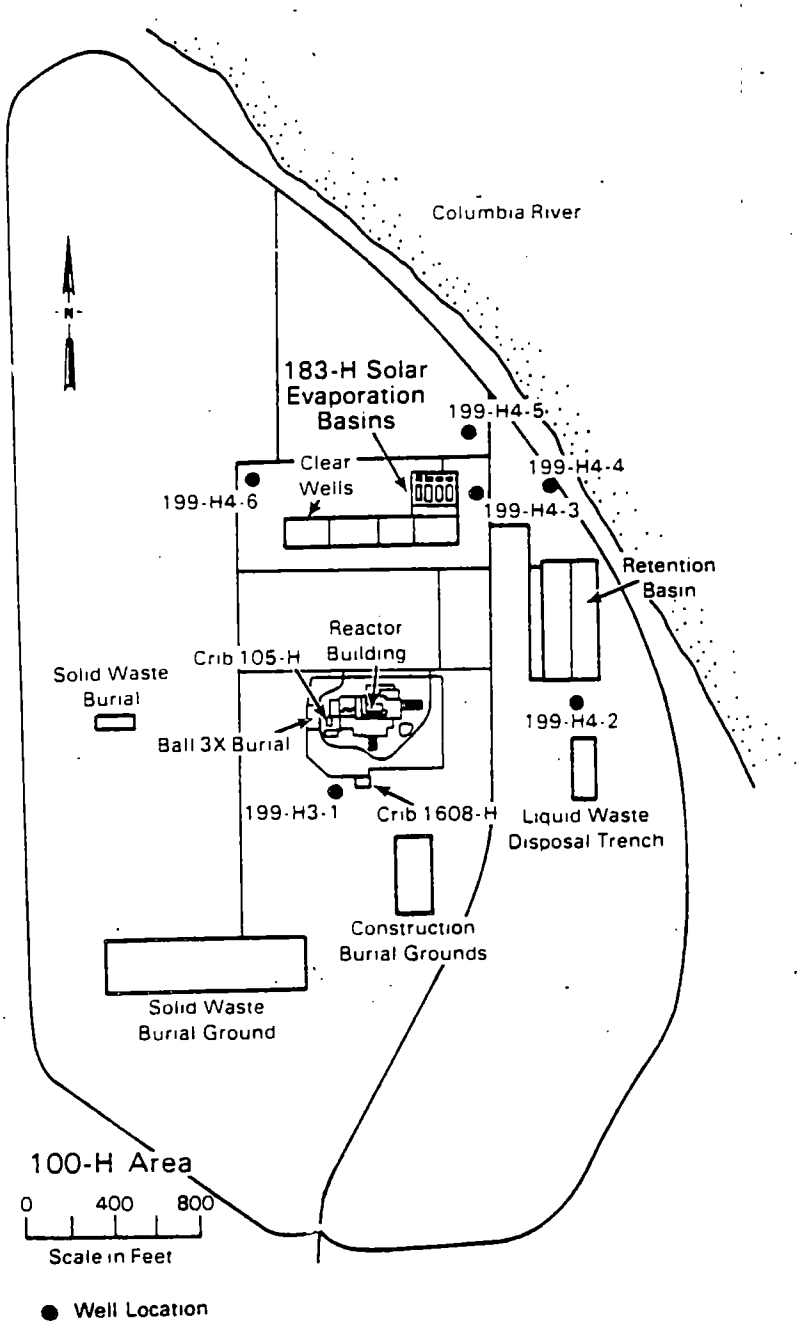


FIGURE 5. Map of the 100-H Area Showing Main Facilities and Monitoring Wells

usage of basins #2 and #3 (which are lined with urethane) was initiated. Filling of those two basins to capacity led to use of basin #4, which has butyl and hypalon liners, starting in late 1982 (Greager 1982).

Plans are now being made to begin treatment of the wastes so that discharge to the 183-H basins can be discontinued. These closure plans are discussed under a subsequent section of this chapter.

Description of the Facility

The four 183-H basins are composed of concrete and are surrounded by an earthen berm. Figure 6 contains a schematic cross section showing the facility's dimensions and relationship to the water table. Each basin has a shallow section and a deep section, as shown on the plan view of the facility in Figure 7. Thickness of the concrete floor is 6 in. in the deep section and 1 ft in the shallow section. The walls of the shallow section are 1 ft thick, while those of the deep section (and also between basins) are 2 ft thick at the bottom and 1 ft thick at the maximum fill level. Maximum allowable depth of the wastes in each basin is 12 ft, for a capacity of approximately 450,000 gallons per basin (Greager 1982).

Before being used for storage of radioactive mixed wastes, the basins were modified by permanently plugging the drains, installing a pipeline to be used in filling the basins, and, except for basin #1, coating the walls and floors with a synthetic liner. A urethane liner was used for basins #2 and #3, but butyl and hypalon liners were used for basin #4. The different liners were used in basin #4 because minor seepage through the wall between basins #3 and #4 had been observed and was thought to indicate either permeability or degradation of the urethane lining of basin #3 (Greager 1982).

Nature of Disposed Wastes

The primary wastes discharged to the basins are the neutralized radioactive mixed wastes routinely produced during the fuel fabrication process. Nitrate, sulfate, and copper are present in the wastes in high concentrations; other materials, such as fluoride, hexavalent chromium and enriched uranium, are present in smaller amounts. The composition of the routine wastes discharged to the basins in CY 1983 is given in Table 1.

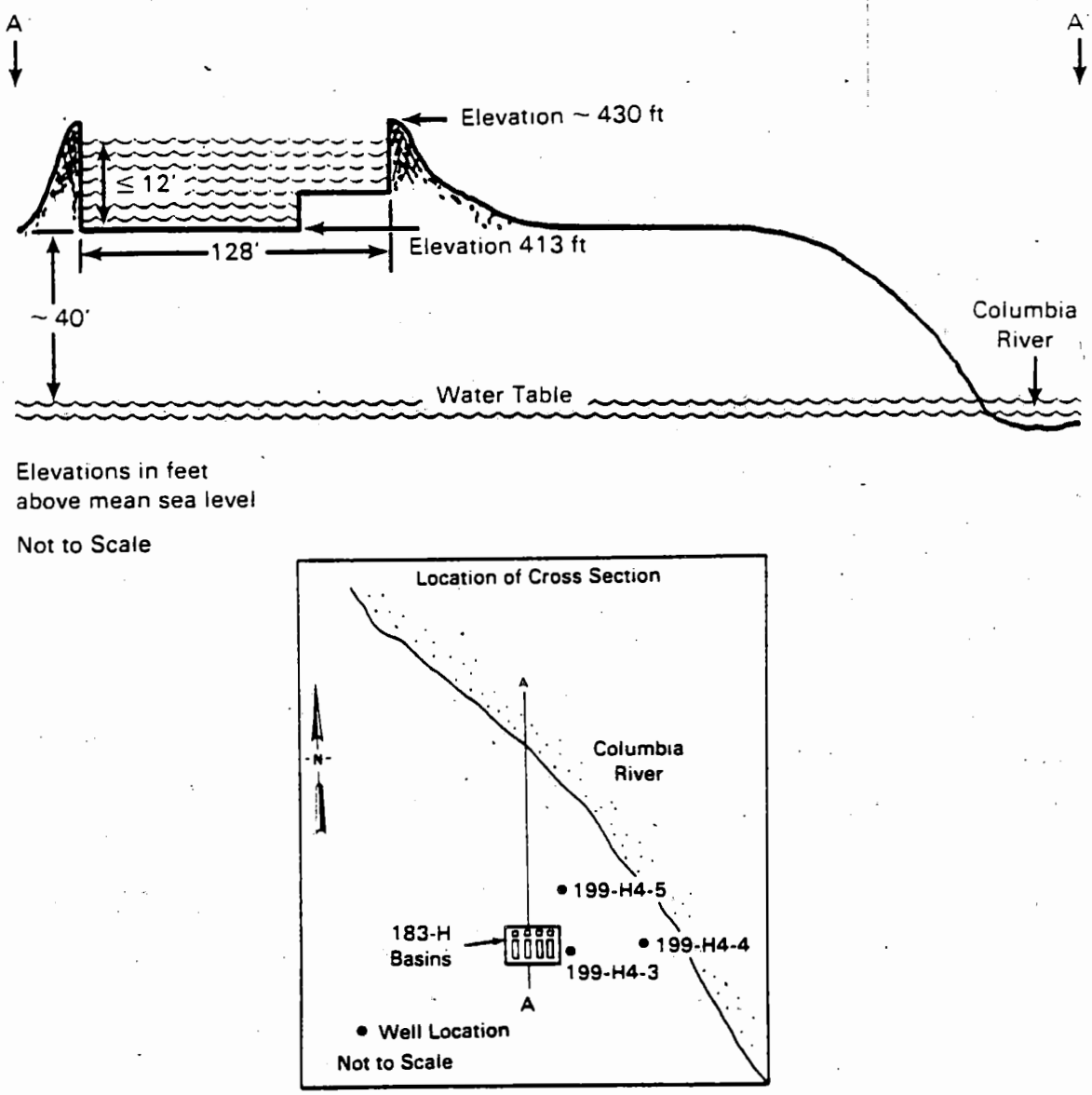


FIGURE 6. Schematic Cross Section of the 183-H Basins

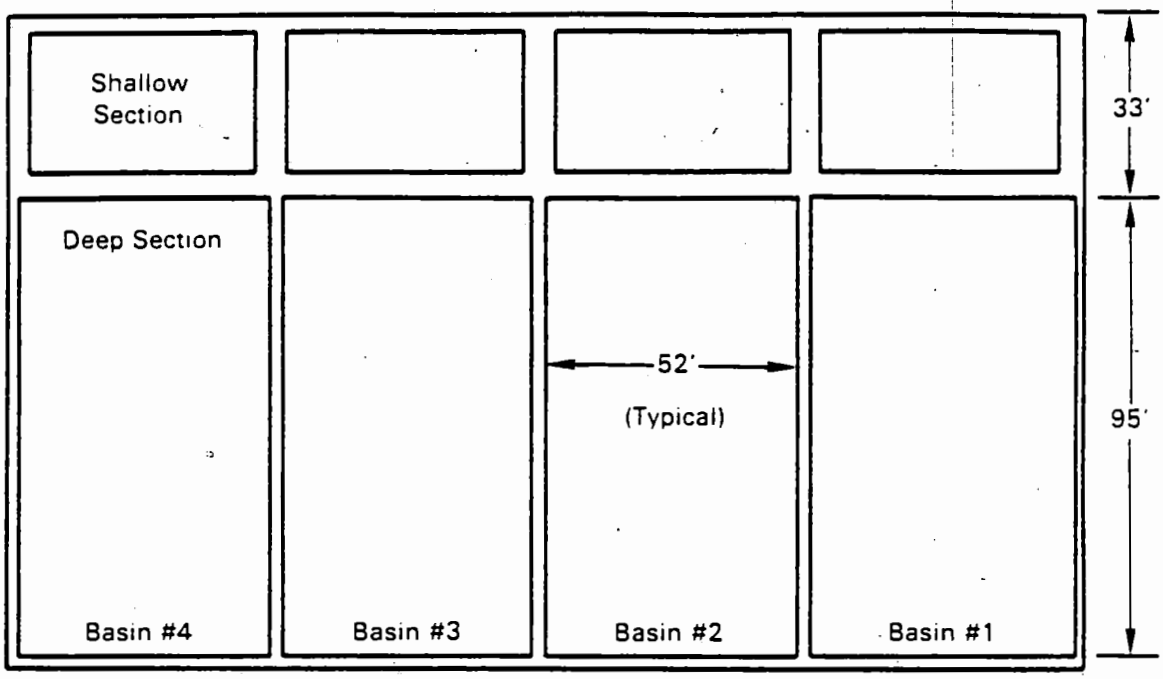


FIGURE 7. Plan View of the 183-H Basins

The total volume of routine wastes from the fuel fabrication process discharged to the 183-H basins since 1973 is 1,739,000 gallons. The annual amount discharged has risen fairly steadily over time, with the most recent figure (for CY 1983) being 406,000 gallons (Rokkan 1984).

In the past, other wastes have been sent to the basins on a nonroutine basis. These wastes may have contained the following constituents of interest:

- Cadmium and compounds
- Copper and compounds
- Chromium and compounds
- Cyanide and compounds
- Lead and compounds
- Mercury and compounds
- Nickel and compounds
- Barium perchlorate
- Hydrazine
- Oxalic acid
- Vanadium pentoxide

TABLE 1. Quantities of Materials Discharged to the 183-H Basins (from Rokkan 1984)

Material	Pounds
Ammonium ion	762
Fluoride ion	22,700
Nitrate ion	451,000
Chromium	116
Copper	72,600
Manganese	383
Sulfate ion	122,000
Uranium (Enriched)	631

Current Status of the Facility

As previously mentioned, basin #1 was taken out of service in 1978, but the other three basins are still in operation. The depth of wastes in the operating basins is close to the maximum allowable depth of 12 ft. Basin #1 still contains a sludge that was left after the pumpable wastes were removed in 1978 (Greager 1982).

Radioactive mixed wastes from the fuel fabrication process are still being sent to the basins. Plans are now being made to begin treating the wastes and to close the 183-H basins. These plans, still in draft form, are summarized in the following section.

Draft Closure Plan

UNC Nuclear Industries is proceeding with plans to construct a waste acid treatment facility. This facility will eliminate the need for storing the nonradioactive mixed wastes in the 183-H basins. After the treatment facility is completed, the fuel fabrication wastes will be treated there and will then be sent to RHO for treatment and disposal in the proposed grout facility. This procedure will result in solidification of all of the wastes.

The current draft of the closure plan calls for removal and disposal of all wastes from basin #1 by September 30, 1985. The final shipment of neutralized waste to the 183-H basins (basins #2, #3, and #4) is scheduled to occur in April 1986, after which all neutralized waste will be sent to RHO for disposal. If use of the 183-H basins is discontinued in April 1986, all wastes in basins #2, #3, and #4 will be removed and sent to RHO for disposal by September 30, 1987. After all wastes have been removed from the basins, the concrete walls will be collapsed and the basins buried in place.

LOCAL GEOLOGY AND HYDROLOGY

Knowledge of the local hydrogeology of the 100-H Area has been gained mainly through installation of ground-water monitoring wells for the routine Ground-Water Surveillance Program conducted by PNL. Most of the wells in the 100-H Area penetrate only the uppermost geologic formations, but one has been drilled to the basalt bedrock. The drilling log for this deep well (199-H4-2) has more detailed descriptions of the sediments penetrated than the logs for the other wells in the area. Therefore, the following interpretation of the local geology is based mainly on the log of this deep well, although the logs of other wells in the vicinity have been used to provide additional detail and to verify the information in the log of 199-H4-2. The drilling logs for the six existing wells at the 100-H Area are in Appendix B.

Geology

A generalized geologic column for the 100-H Area is contained in Figure 8. As shown in the figure, three geologic formations are present in this area. They are, in descending order, the glaciofluvial sediments, the Ringold Formation, and the Columbia River basalts. These formations are described in general terms in a preceding chapter of this report entitled "Site Description." Figures 9 and 10 show two geologic cross sections in the 100-H Area and their locations, including the wells and their completion intervals.

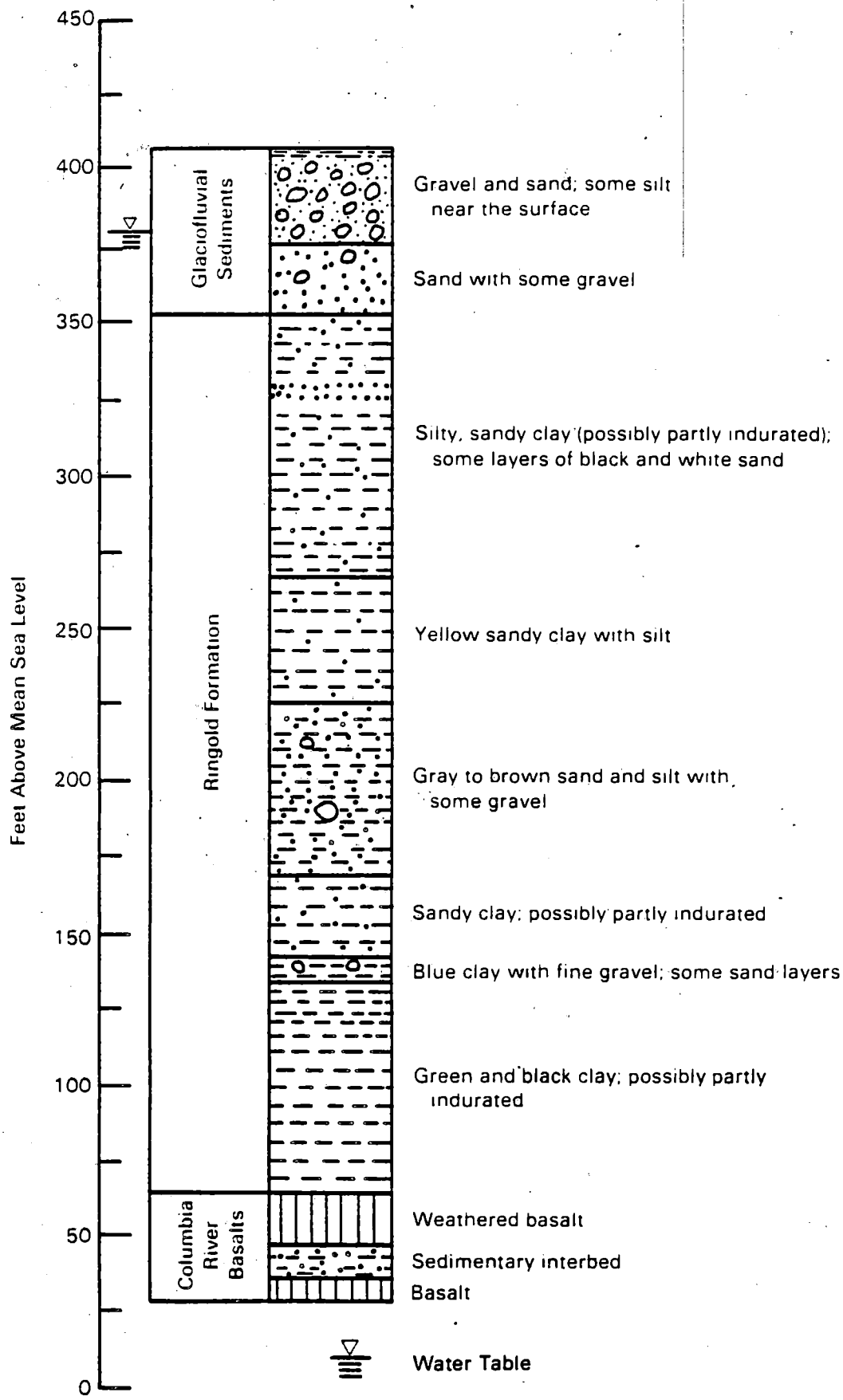


FIGURE 8. Generalized Geologic Column for the 100-H Area

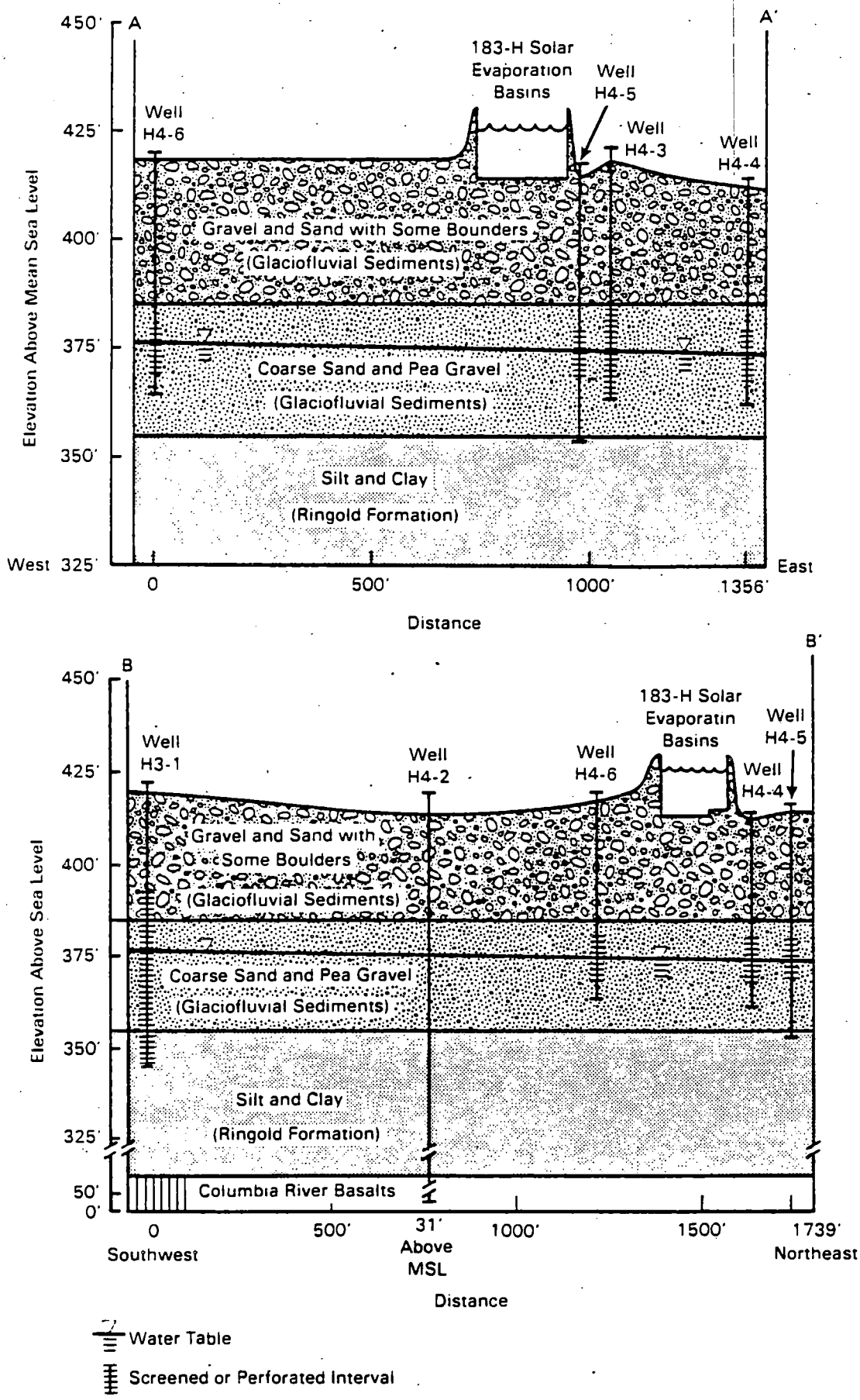


FIGURE 9. Geologic Cross Sections of the 100-H Area

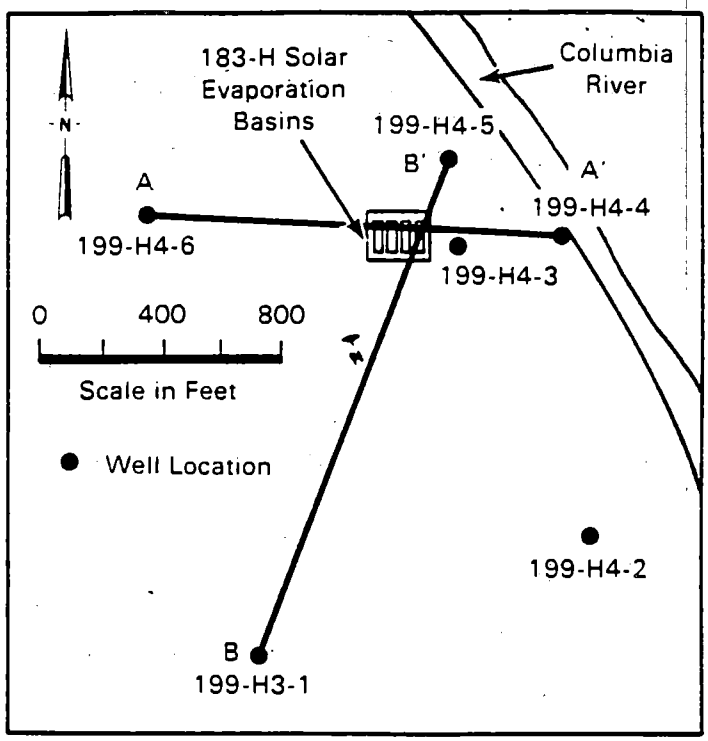


FIGURE 10. Location of Cross Sections in Figure 9

The glaciofluvial sediments in this area consist of unconsolidated gravels and sands, with some boulders and cobbles. A few of the drilling logs also indicate the presence of a small amount of intermixed silt in this formation.

Beneath the glaciofluvial sediments is the Ringold Formation. The contact between the two formations can usually be distinguished on the drilling logs because the Ringold Formation typically has a much higher content of fine materials and of quartz-rich materials. At the 100-H Area, the contact is indicated by a change from sandy materials to clays at a depth of about 50 to 60 ft below land surface. According to the drilling logs (Appendix B), the Ringold Formation is composed almost entirely of a series of clay layers in this area and lacks the more permeable conglomerate unit present in other areas of the Hanford Site. Some of the clay layers are apparently partly indurated.

The contact between the Ringold Formation and the underlying basalts is at a depth of about 350 ft below land surface. The thickness of the Ringold Formation is therefore about 300 ft in this area.

Hydrology

Both unconfined and confined aquifers are present beneath the 100-H Area. The uppermost aquifer, which is unconfined, is the most likely to be affected by the 183-H basins. In fact, the potential for the confined aquifers to be contaminated by this facility is probably very low, because of three factors: their depth, the large thickness of clay separating them from the unconfined aquifer, and an observed higher head in the uppermost confined aquifer than in the unconfined aquifer. The discussion of hydrology that follows is therefore primarily concerned with the unconfined aquifer.

In many parts of the Hanford Site, the unconfined aquifer is found primarily in the Ringold Formation and, to a lesser extent, in the glaciofluvial sediments. At the 100-H Area, the upper portion of the unconfined aquifer is in the glaciofluvial sediments and the lower part of the aquifer (probably partially confined) is in the clays which compose the Ringold Formation in this area. The water table is at a depth of about 40 ft below land surface, and the clays begin at a depth of 50 to 60 ft.

The hydraulic conductivity of the glaciofluvial sediments is about 1,000 times that of the Ringold clay (Bierschenk 1959). Therefore, only the upper 10 to 20 ft of the aquifer is active in transmitting water in this area; and the top of the Ringold clay may be considered as the effective base of the aquifer. Based on the few quantitative hydrologic tests made in and adjacent to the 100-H Area, aquifer transmissivity is on the order of 3,000 square ft per day with a resultant hydraulic conductivity of about 200 ft per day.

The deep well drilled at the 100-H Area also reveals the presence of a confined aquifer within the basalt layer penetrated by the well. The piezometric surface for the confined aquifer tapped by this well is above the

land surface, but the casing has been extended so that the well does not flow. The head of this uppermost confined aquifer is therefore higher than the head of the unconfined aquifer.

The hydrologic situation in this area is complex and difficult to fully characterize because of the proximity of the Columbia River. Studies conducted at the Hanford Site have shown that the diurnal and seasonal fluctuations of the river stage (caused by changes in the discharge rate at the dams upstream) have a marked effect on the unconfined aquifer near the river (Raymond and Brown 1963; Prater et al. 1984). These studies have shown that water levels within wells near the river fluctuate in response to changes in the river stage. The water level in wells near the river rises when the river stage is high and river water enters the banks as "bank storage." This trend later reverses, and the bank-stored water re-enters the river. As a result of this phenomenon, concentrations of contaminants in wells near the river also vary with the river stage on a seasonal basis. The concentrations decline in the spring when the river rises and river water enters the bank; this trend reverses in the fall when the river stage drops (Prater et al. 1984). The character of the changes in the unconfined aquifer due to the river's fluctuations depend greatly upon the local geology and must therefore be studied on a case-by-case basis. Although some information has already been acquired concerning the hydrologic system at the 100-H Area, the knowledge of changes in this system over time is incomplete.

The water-table map in Figure 11 gives an indication of the current conditions at the 100-H Area. This map was prepared using measurements taken in December 1984. The contours on this map indicate that the general direction of ground-water flow at the 100-H Area is from the west toward the east (or toward the Columbia River, into which the unconfined aquifer discharges). Given this general flow direction, the 183-H basins have two nearby upgradient wells (199-H3-1 and 199-H4-6) and three downgradient wells (199-H4-3, 199-H4-4, and 199-H4-5).

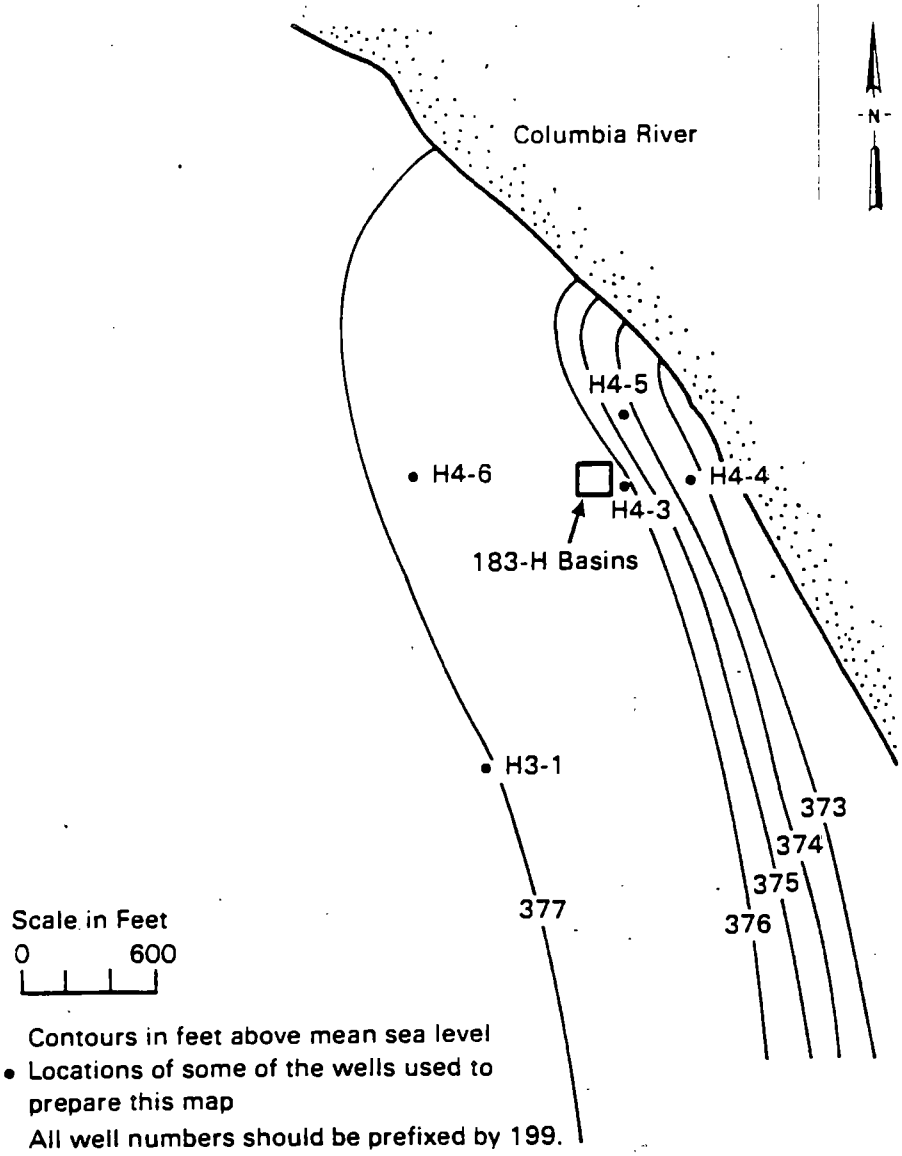


FIGURE 11. Water-Table Map for the 100-H Area (December 31, 1984)

PAST AND PRESENT GROUND-WATER SURVEILLANCE AT THE 100-H AREA

The ground water at the 100-H Area is monitored on a routine basis under the Ground-Water Surveillance Program conducted by PNL. The data obtained through this effort provide some indication of the effects of the 183-H basins on the ground water and are summarized in this section.

Existing Monitoring Wells and Historical Analytical Data

There are currently five monitoring wells at the 100-H Area: 199-H3-1, 199-H4-3, 199-H4-4, 199-H4-5, and 199-H4-6. Locations of these wells are shown in Figure 5. A few other monitoring wells have been installed in this area over the years but have been abandoned and filled in for various reasons. These five wells are relatively shallow and are used to monitor the unconfined aquifer. Another existing well in the 100-H Area, 199-H4-2, was drilled into the basalts and is currently being used in a study of the confined aquifer's piezometric surface.

Of the five wells used to monitor the unconfined aquifer in this area, only two (199-H3-1 and 199-H4-3) have a significant amount of historical monitoring data. The other three were installed in the spring of 1983, and sampling of them was initiated in December 1983. These wells have therefore not been sampled long enough to determine with certainty any trends in the data.

Well 199-H3-1 has been sampled since 1962, but until recently the analyses were limited to tritium and nitrate. Tritium has not been discharged to the 183-H basins, and therefore nitrate is the only one of these two parameters that can be used in determining the effect of the basins on the ground water.

Samples from well 199-H4-3 have been analyzed for a much wider range of constituents, because this well was installed for the specific purpose of monitoring the 183-H basins. Analyses have been conducted for many constituents of the wastes discharged to the facility. A large body of historical data from this well exists for the following parameters: nitrate, uranium, hexavalent chromium, and fluoride. Samples from this well have also been analyzed for a number of other parameters (including pH, several radionuclides, and some water-quality parameters), but the historical data are somewhat limited for these.

Results of Past Monitoring

The data collected under the routine surveillance effort (as described above) are reviewed soon after collection to identify changes in the status of the ground water that may indicate contamination from Hanford facilities. This routine review process led to the discovery in June of 1977 that nitrate and hexavalent chromium levels in well 199-H4-3 were increasing. Subsequent investigation indicated that basin #1 (which was the only basin in use at the time) was apparently leaking. While corrective actions were initiated to remove the source of contamination, the collection of monitoring data was continued and in fact increased. The frequency of sample collection was changed from quarterly to monthly to provide a more continuous record and a better indication of the success of the corrective actions. As shown in Table 2, the concentrations of nitrate and hexavalent chromium peaked in this well in 1978 and then declined sharply as the corrective actions took

TABLE 2. Annual Average Concentrations of Nitrate and Hexavalent Chromium in Well 199-H4-3

Year	Nitrate (as NO_3^-), mg/ℓ	Hexavalent Chromium, mg/ℓ
1974	29	0.25
1975	29	0.99
1976	210	1.4
1977	2,000	---(a)
1978	4,800	4.3
1979	1,800	2.6
1980	1,000	3.2
1981	1,000	1.9
1982	1,200	2.1
1983	1,000	2.7
1984	920	2.0

(a) No analysis was performed for this parameter.

effect. Since then, the concentrations of these contaminants in this well have remained fairly stable, although they are still above preoperational levels. Concentrations of fluoride and uranium in this well have shown a general decline with time and a possible slight increase recently (Table 3).

The nitrate data collected for well 199-H3-1 have revealed a similar pattern to the one observed in the nitrate and chromium data for well 199-H4-3. As shown in Table 4, the nitrate concentrations in this well peaked in 1978 and subsequently declined. The concentrations have been fairly stable until 1984, when an increase apparently occurred. Although this well is (at least part of the time) upgradient from the 183-H basins, it appears that it may be affected by this facility. All other waste disposal facilities at the 100-H Area were taken out of service shortly after shutdown of the reactor in 1965 and therefore should not have caused the peaks observed in 1978 and 1984.

TABLE 3. Annual Average Concentrations of Fluoride and Annual Average Activity of Uranium in Well 199-H4-3

Year	Fluoride, mg/ℓ	Uranium, pCi/ℓ
1974	0.8	---[a]
1975	0.2	---
1976	0.4	---
1977	0.16	230
1978	0.38	140
1979	0.14	130
1980	0.14	87
1981	0.12	66
1982	0.13	65
1983	0.13	99
1984	0.2	120

(a) No analysis was performed for this parameter.

TABLE 4. Annual Average Concentrations of Nitrate in Well 199-H3-1

Year	Nitrate (as NO_3^-), mg/ℓ
1971	8.5
1972	11
1973	17
1974	20
1975	29
1976	26
1977	39
1978	69
1979	52
1980	41
1981	52
1982	42
1983	48
1984	74

As mentioned previously, only limited data have been collected from wells 199-H4-4, 199-H4-5, and 199-H4-6. The analytical data from these wells (and 199-H4-3) for nitrate, hexavalent chromium, and uranium are listed in Tables 5, 6, and 7 respectively.

These data, although limited, do provide some information. Concentrations of all three parameters in wells 199-H4-3 and 199-H4-4 indicate contamination from the 183-H basins. Concentrations of nitrate and chromium in wells 199-H4-5 and 199-H4-6, although much lower than in the other two wells, may indicate some contamination from the basins. More analytical data must be collected before definitive statements can be made concerning these wells.

TABLE 5. Concentrations of Nitrate as NO_3^- (mg/ℓ) in Samples from Four Wells Near the 183-H Basins

Well Number	Sample Date 12/13/83	02/22/84	05/23/84	09/19/84
199-H4-3	340	1,200	960	610
199-H4-4	380	85	220	620
199-H4-5	3.1	0.48	15	57
199-H4-6	25	17	26	32

TABLE 6. Concentrations of Hexavalent Chromium (mg/ℓ) in Samples from Four Wells Near the 183-H Basins

Well Number	Sample Date 12/13/83	02/22/84	05/23/84	09/19/84
199-H4-3	2.7	3.1	2.8	1.1
199-H4-4	1.4	0.93	1.13	0.71
199-H4-5	0.024	0.008	0.44	0.41
199-H4-6	0.09	0.21	0.092	0.048

TABLE 7. Activity of Uranium (pCi/ℓ) in Samples from Four Wells Near the 183-H Basins

Well Number	Sample Date 12/13/83	02/22/84	05/23/84	09/19/84
199-H4-3	52	110	120	120
199-H4-4	49	15	16	26
199-H4-5	6.7	6.7	6.7	6.7
199-H4-6	6.7	6.7	6.7	6.7

Preliminary Assessment

Leakage from the 183-H basins has resulted in ground-water contamination at the 100-H Area. Although the situation has improved markedly as a result of corrective actions taken in 1978, the concentrations of chromium and nitrate in well 199-H4-3, which is closest to the facility, have not yet dropped to preoperational levels. If the source of contamination were completely removed by the corrective actions, the concentrations of these

contaminants should have already dropped to preoperation levels, at least in this nearest well. Since they have not, it appears that wastes may still be leaking at a very low rate from the facility. The most likely source is basin #1, since it is possible that precipitation falling in the basin may leach contaminants from the sludge and then percolate into the ground.

The extent of the contamination plume cannot easily be determined on the basis of the existing analytical data. Plume boundaries cannot be drawn unless some of the wells are outside of the plume. Based on the analytical data collected so far, all of the downgradient wells and perhaps even the upgradient wells may be within the plume. More work, as outlined in the next section, has been initiated to fully assess the situation.

PROPOSED WORK

As mentioned previously, the ground-water flow system at the 100-H Area is complex and has not yet been fully characterized. Valuable information on the flow system and the possible extent of contamination can be provided by hydrologic modeling; therefore, modeling is proposed as one of the first steps in a more detailed assessment of ground-water contamination at the 100-H Area.

Hydrologic Modeling

Modeling ground-water flow in and adjacent to the 100-H Area, taking into account the effects of bank storage, will provide the following:

- Information on the probable extent of contamination from the 183-H basins.
- Guidance for placing additional monitoring wells, if they are needed for characterizing the extent of the existing contamination plume through sampling and analysis.

Scope

The modeling effort will be conducted in two phases. The first phase will consist of data collection and the second phase will involve modeling the ground-water flow system. In the data collection phase, data will be

gathered near the 183-H basins as well as in the region surrounding the 100-H Area. The data will be gathered from existing sources, where possible, and directly from the site, where necessary. The second phase will involve two-dimensional modeling of ground-water flow near the 100-H Area, taking into account the variation of river stage due to seasonal fluctuations and changes in the discharge rate at Priest Rapids Dam upstream. The results of modeling, combined with data on existing contamination, will provide guidance concerning the need for and best locations of any additional monitoring wells.

Approach for the First Phase

Information about the area around the 183-H basins that will be needed for modeling includes: the local hydrogeology, response between the river and ground water, aquifer properties, background contamination data, and data from the source term. Specific data to be considered include: water-level measurements, data from aquifer tests, drilling logs or geologic logs from boreholes, geophysical logs, analytical data for water samples from wells and springs, and volumes and types of wastes discharged to the 183-H basins.

Hydrogeologic information needed to characterize ground-water flow in the 100-H Area consists of hydrostratigraphy for the unconfined aquifer and available aquifer test data from near the 100-H Area. Some of this information can be obtained from published references such as Brown (1962). Characterizing the hydrostratigraphy beneath the 100-H Area consists of determining relative contributions to the saturated thickness of the unconfined aquifer from the glaciofluvial sediments and the Ringold Formation, which typically exhibit different hydraulic conductivities (Graham et al. 1981). The available aquifer test data from within an arbitrary 5 mile radius of 100-H Area (on the Hanford Site) will provide an estimate of the distribution of transmissivity (or hydraulic conductivity) and the storage coefficient. Table 8 lists the reported aquifer tests.

Both continuous and periodic water-level measurements will be used for determining the effect of river stage on the local ground-water system around the 100-H Area. The continuous and periodic monitoring was implemented in

TABLE 8. List of Aquifer Tests Performed on Wells at Hanford within Five Miles of 100-H Area

Well	Date(s)
699-77-54	07-23-57, 09-25-69
699-92-49	nd
699-93-5	nd
699-96-49	nd
699-97-47	nd
699-97-51A	nd
699-98-49	nd
199-H3-1	08-10-83

(nd) denotes no date indicated in records

January 1985 so that a data base will be available for modeling. The following three wells near the 183-H basins are being monitored using continuous water-level recorders: 199-H4-4, 199-H4-5 and 199-H4-6.

The wells selected for continuous monitoring are arranged in a triangle near the 183-H basins, as shown in Figure 5. The data obtained from this type of setup can be used to determine changes in the slope and the direction of the water-table surface in response to changes in river stage at the 100-H Area. The data will also allow determination of whether fluctuations in river stage change the local ground-water gradient or whether the water-table surface rises and lowers without a significant change in the local gradient.

To facilitate interpretation of data from the continuous recorders, it will be necessary to directly measure fluctuations of Columbia River stage with time. The river-stage data will be collected as close to the 100-H Area as possible.

To supplement data from the continuous recorders, water-level measurements are being taken in the following wells on a bimonthly basis:

699-85-40A	699-90-45
699-88-41	699-91-37
699-89-35	699-97-43
699-90-34	699-99-42

In order to interpret the aquifer-test and water-level data, it will be necessary to review the drilling logs and construction information for the wells used in data collection. Essential information includes: exact location, depth of the well, casing elevation, the geologic or drilling log, the screened or perforated interval, and any other subsequent adjustments to the well.

A final activity of the data-collection phase of the modeling effort will be to study the available historical and current records for the contaminants of interest, such as nitrate and chromium. Background or existing concentrations from wells and springs along the river as well as information on types and quantities of wastes discharged to the 183-H basins will be reviewed.

Approach for the Second Phase

The second phase of the modeling effort consists of two-dimensional modeling of the ground-water flow system near the 100-H Area. Input data for the second phase of the investigation include: hydrogeology of the 100-H Area and adjacent portion of the Hanford Site, continuous and periodic water-level measurements, drilling logs and construction information for wells used to define hydrogeologic properties and measure water levels, historical and current concentration data for the contaminants of interest, and potential sources of contamination at the 100-H Area in addition to the 183-H basins.

A key aspect of the second phase of the investigation will be to analyze pathlines from the 183-H basins to consider the extent of changes in the ground-water gradient due to fluctuation of river stage. Measured con-

taminant concentrations will be combined with the pathline analysis to estimate the extent of the existing plume. The pathlines will be used to determine optimum placement of any additional monitoring wells.

Wells to be Sampled

Concurrent with the modeling effort described in the previous section, an intensive sampling program will be initiated at the 100-H Area. This sampling program, which will utilize the existing wells pending receipt of the modeling results, has been designed to better define the extent of ground-water contamination at the 100-H Area caused by the 183-H basins.

All five of the shallow wells at the 100-H Area will be sampled. These wells are all completed in the unconfined aquifer, but the construction and completion details are somewhat varied. Three of the wells (199-H4-4, 199-H4-5, and 199-H4-6) were drilled recently and were completed with stainless steel screens. The two older wells (199-H3-1 and 199-H4-3) were completed using perforations rather than screens. Appendix B contains the structural diagrams for all five wells. Drilling logs for all five of these wells (and also 199-H4-2, the deep well) are also contained in Appendix B.

Wells 199-H4-6 and 199-H3-1 have been tentatively chosen as upgradient wells for determining background water quality. The hydrologic modeling effort and further sampling will help determine whether or not they can be used for this purpose. All three of the other wells that will be sampled (199-H4-3, 199-H4-4, and 199-H4-5) are downgradient wells. Figure 12 is a map showing the locations of all five wells in the sampling network and also the general direction of ground-water flow.

The varied construction of the wells in the sampling network described above may introduce some bias to the analytical data. This bias is expected to be small and is probably not sufficient to warrant constructing a totally new network. Comparisons currently being conducted by PNL using sampling equipment (including wells) constructed of different materials should provide more information on this subject.

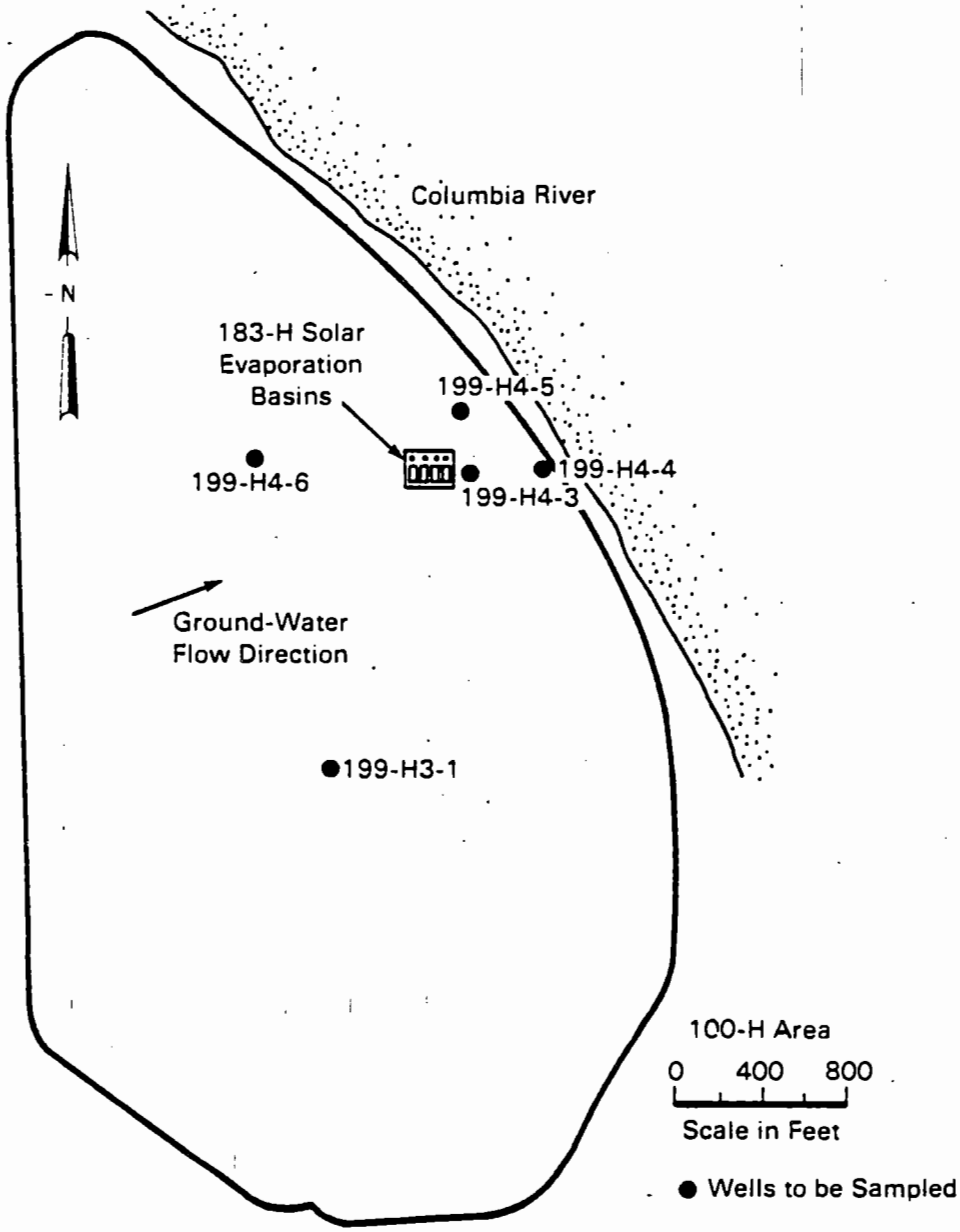


FIGURE 12. Location of 100-H Area Wells to be Sampled

Because of the proximity of the 183-H basins and the surrounding wells to the river, samples will be collected on a monthly basis rather than on a quarterly basis. As mentioned previously, the concentrations of contaminants in wells near the river have been shown to fluctuate seasonally in response to changes in river stage. Therefore, monthly sampling is considered necessary for the first year. Depending on results of sampling obtained in the first year, subsequent sampling may be changed to bimonthly or quarterly. Procedures to be used for sample collection and preservation are contained in another chapter of this document entitled "Methods."

Samples will also be collected from springs on the riverbank at the 100-H Area. Because these springs are not present when the river stage is high, they are difficult to sample on a regular basis. However, when possible, the springs will be sampled according to the same schedule as the wells.

Analyses to be Performed

A list of proposed analytical parameters for the ground-water samples collected from wells near the 183-H basins is contained in Table 9. This list includes those constituents required, as a minimum, by state and federal regulations for an assessment-type program as well as listed or unlisted wastes specific to this facility.[a] As indicated in the footnote in Table 9, many of the compounds do not have approved analytical methods; where possible, the components will be analyzed separately.

The list of site-specific parameters in Table 9 was compiled based on information regarding past and present discharges to the facility provided by the facility managers. In an effort to ensure that no other hazardous wastes have entered the ground water from this facility (and to provide information needed for completing a Part B permit application), selected samples will also be analyzed for the list of constituents contained in WAC 173-303-9905.[b] Each month, samples from all five wells at this facility

(a) Lists consulted include 40 CFR Part 261, Sections 261.31, 261.32, 261.33; 40 CFR Part 261, Appendix VIII; WAC 173-303-9903, -9904, -9905.
(b) See Appendix C for the details of this analysis.

TABLE 9. Proposed Analytical Parameters for the Ground-Water Samples (183-H Basins)

Required Constituents (Drinking Water Parameters)

Arsenic	Lindane
Barium	Methoxychlor
Chromium	Toxaphene
Cadmium	2,4-D
Fluoride	2,4,5-TP Silvex
Lead	Radium
Mercury	Gross Alpha
Nitrate (as N)	Gross Beta
Selenium	Coliform Bacteria
Silver	
Endrin	

Site-Specific Parameters

Chromium compounds -	chromic acid	Listed
	potassium dichromate	Unlisted[a]
	sodium dichromate	Unlisted[a]
	sodium chromate	Unlisted[a]
Cyanide		Listed
and compounds -	potassium cyanide	Listed[a]
	cuprous cyanide	Listed[a]
	sodium cyanide	Listed[a]
Hydrazine		Listed
Mercury compounds -	mercuric nitrate	Unlisted[a]
	mercuric chloride	Unlisted[a]
Nickel		Listed
Vanadium pentoxide		Listed[a]
Copper		Unlisted
Ammonium ion		Unlisted
Manganese		Unlisted
Sulfate ion		Unlisted
Barium compound -	barium perchlorate	Unlisted[a]

(a) No approved analytical method is currently available for this compound; components will be analyzed separately where possible.

will be analyzed for the parameters in Table 9. In addition, samples from one upgradient well and one downgradient well will be analyzed for the -9905 list. To provide information on the variability of the data, some field replicate samples will be collected and analyzed each month.

Additional information on sample analysis (including preservation methods and quality control) is contained in the chapter of this document entitled "Methods."

DATA EVALUATION AND REPORTING

The analytical data received from the laboratory will be handled and evaluated according to the procedures described in the "Methods" chapter of this document. Reporting procedures are described below.

At the end of the first year of sampling, a written assessment of the status of the ground water will be prepared, provided that such an evaluation can be made with the data collected. During the first year, the results of monthly sampling will be available soon after completion of the analyses.

SCHEDULE OF IMPLEMENTATION

The modeling effort described in a preceding section of this chapter has begun. Results of this effort will be available by July 31, 1985. After the modeling results are obtained, they will be reviewed to determine the best locations for any new wells needed to define the extent of contamination.

Sampling of the existing wells (and springs, if possible) will begin in June 1985. Sampling of any new wells that are installed will begin as soon as possible after their completion.

300 AREA PROCESS TRENCHES

The 300 Area is located in the southeast corner of the Hanford Site, approximately 1 mile north of the city limits of Richland, Washington. The area covers about 400 acres and is bordered on the east by the Columbia River and on the west by Stevens Drive, the main north-south Hanford Site highway (Paglieri 1975). The 300 Area Process Trenches are located in the northern part of the 300 Area (Figure 2). Figure 13 is a map showing the locations of the main facilities (including the process trenches) and the existing monitoring wells.

The two process trenches are each 1,500 ft long. They are 10 ft wide at the bottom and about 34 ft wide at the top. The north end of the west trench opens into a natural depression. They are unlined trenches with a 1:1 side slope, and the bottom of the trenches is about 20 ft above the water table (Figure 14).

The main activities in the 300 Area support nuclear research and development, including programs such as reactor fuels fabrication, liquid metal technology, peaceful uses of plutonium, and life sciences research. Administration offices for WHC and UNC, as well as several laboratories, are also housed in the 300 Area.

OPERATIONAL HISTORY OF 300 AREA PROCESS TRENCHES

The 300 Area Process Trenches were first put into service in May of 1975. They were built to replace the 300 Area Process Ponds, which were being decommissioned.

Routinely Disposed Wastes

Starting in 1975, the process trenches were the main facility for disposal of most liquid wastes generated in the 300 Area. A variety of chemical wastes was included in these process wastes, although no large quantities of any one of these chemicals were disposed. A listing of the chemicals potentially discharged to the facility is found in Table 10. However, WHC

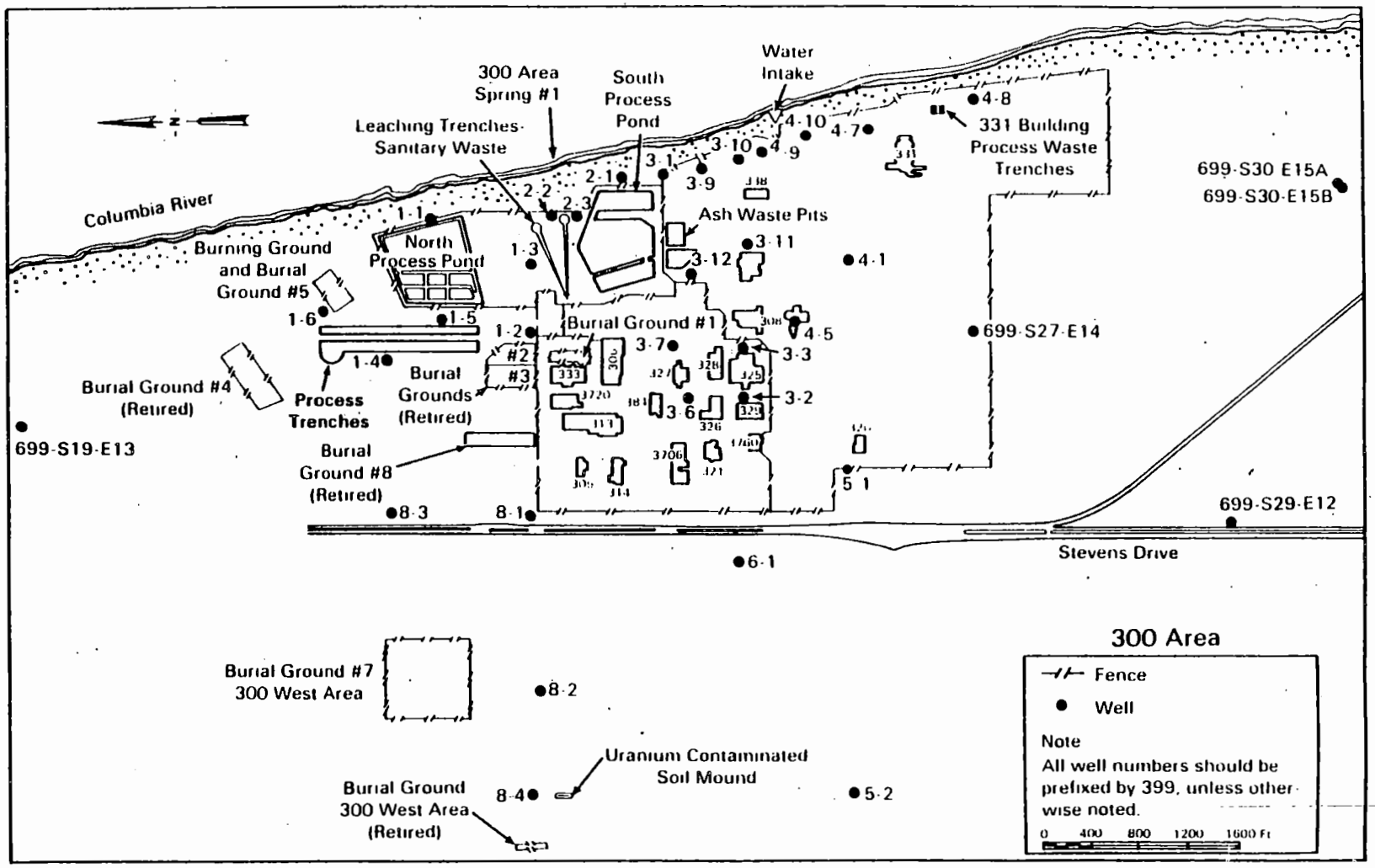
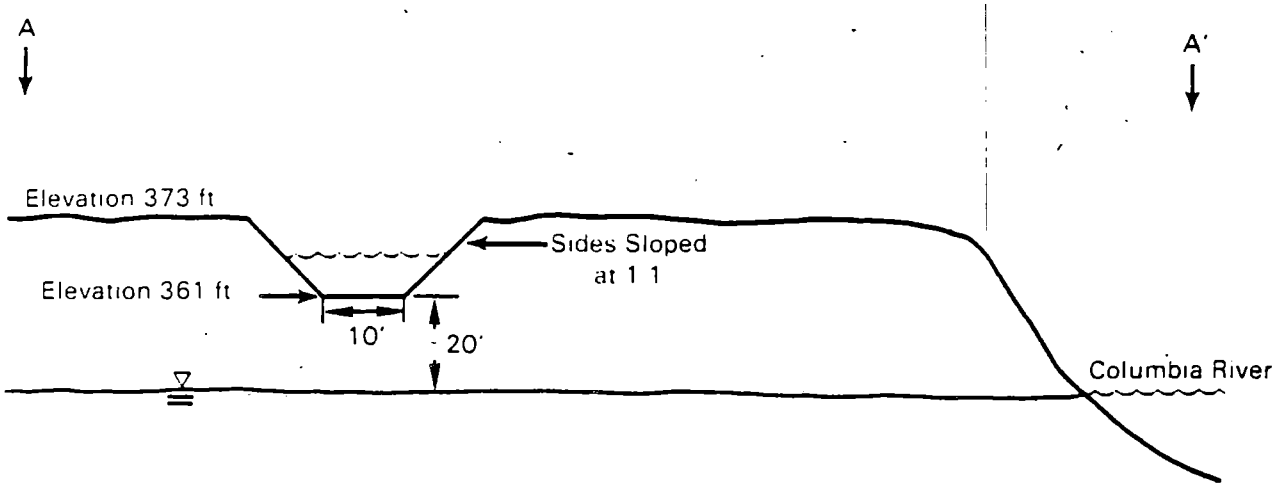


FIGURE 13. 300 Area Map



Water Table

Elevations are in feet
above mean sea level

Not to Scale

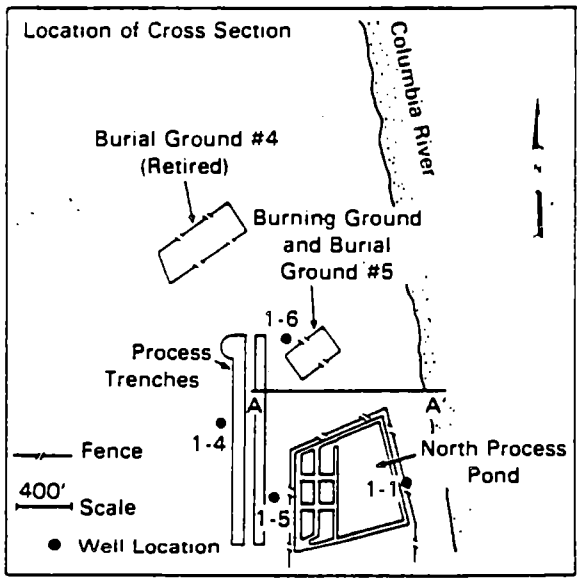


FIGURE 14. Schematic Cross Section of the 300 Area Process Trenches

TABLE 10. Wastes Potentially Discharged to the 300 Area Process Trenches

Cadmium

Chromium

Lead

Mercury

Hydrofluoric Acid

Tetrachloromethane (Carbon Tetrachloride)

Antimony

Arsenic

Barium

Benzene

Chlorinated Benzenes

Dioxane

Dioxin

Formaldehyde

Formic Acid

Hexachlorophene

Hydrazine

Hydrocyanic Acid

Methyl Ethyl Ketone

Naphthalene

Nickel

Phenol

Pyridine

Selenium and compounds - Selenium Sulfide

Silver

Thiourea

Toluene

Trichloroethane (Methyl Chloroform)

Trichloroethane (Ethane 1,1,2-trichloro-)

Trichloroethene (Trichloroethylene)

Copper

Perchloroethylene

Nitric Acid

Sulfuric Acid

Sodium Hydroxide

Ammonium Bifluoride

Aluminum Nitrate

Sodium Chloride

Ethylene Glycol

Sodium Nitrate

Xylene

Kerosene

Tributylphosphate - Paraffin Hydrocarbon Solvents

Degreasing Solvents

Detergents

Photochemicals

(administrative landlord of the 300 Area) has recently indicated that dangerous wastes are no longer disposed to the 300 Area Process Trenches, effective February 1, 1985.

Unplanned Releases

Two incidents of unplanned releases of perchloroethylene to the process trenches have occurred in the recent past. In November 1982, approximately 120 gallons of perchloroethylene were accidentally released to the process trenches. Peak concentrations of the contaminant were tracked in nearby wells for four months following the spill. The highest concentration of perchloroethylene was found in well 399-1-5, which is closest to and lies in the downgradient direction from the process trenches. Decreasingly lower peaks were observed in other wells which lie roughly in a line leading away from the trenches toward the river in the downgradient direction.

The second incident occurred in July of 1984, when approximately 20 gallons of perchloroethylene were released to the process trenches. As with the first incident, sample analyses showed the highest contamination in well 399-1-5 and the same pattern in nearby wells of decreasing contamination with increasing distance (Raymond 1984). More information on these two spills can be found in the section of this chapter entitled "Past and Present Ground-Water Surveillance at the 300 Area."

LOCAL GEOLOGY AND HYDROLOGY

A number of wells have been installed in and around the 300 Area since the 1940's. Drilling logs exist for most of these wells and have been used to describe the local hydrogeology. Onsite excavations for various construction projects have also contributed to knowledge of subsurface formations. An extensive study of the hydrogeology of the 300 Area was conducted by PNL in 1977 to 1978 (Lindberg and Bond 1979).

Geology

Figure 15 shows two geologic cross sections of the 300 Area. The locations of these cross sections are shown in Figure 16. As shown, there are four geologic formations underlying this region. They are, in

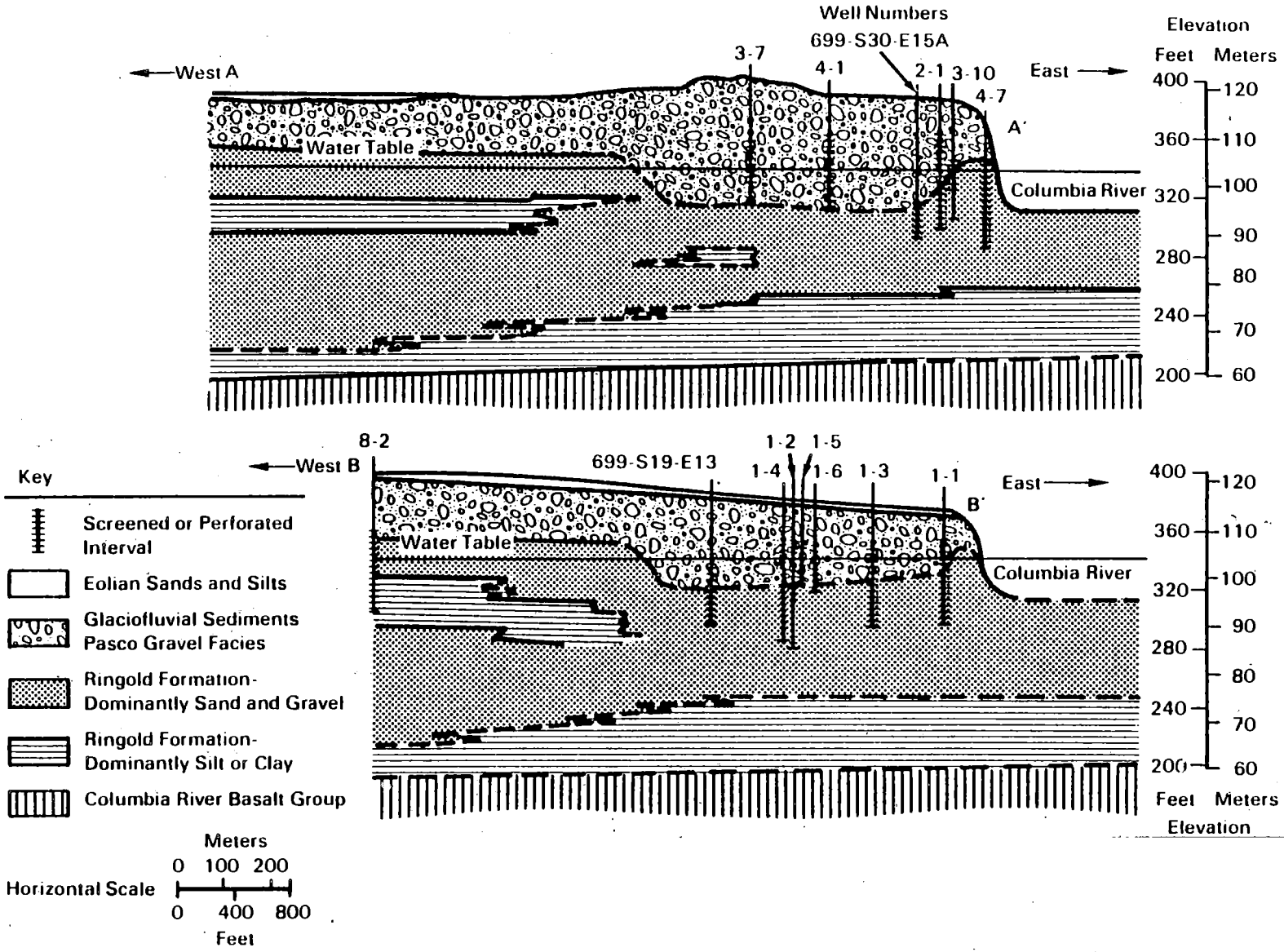


FIGURE 15. Geologic Cross Sections of the 300 Area (Modified from Lindberg and Bond 1979)

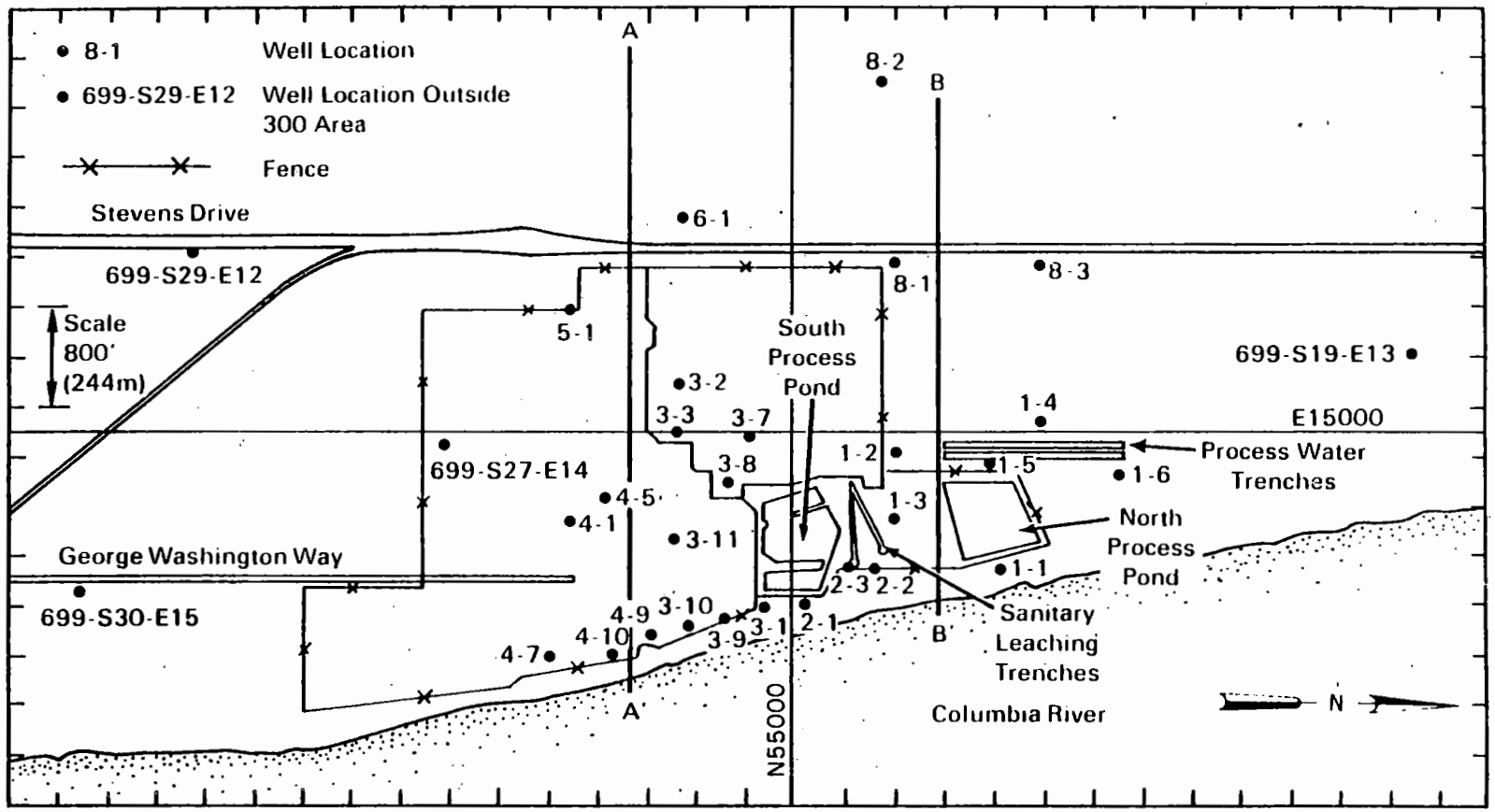


FIGURE 16. Location of Cross Sections in Figure 15

descending order, the eolian sediments, the glaciofluvial deposits, the Ringold Formation, and the Columbia River basalt group. General descriptions of these formations are contained in an earlier chapter of this document entitled "Site Description." Their characteristics in the local area of the 300 Area Process Trenches are discussed below.

The eolian sediments in the 300 Area consist mainly of wind-transported sands and silts, deposited in dunes up to 10 ft in depth. These sands and silts increase in depth to the southwest and immediately north of the 300 Area (Lindberg and Bond 1979).

Underneath the eolian sediments lie the glaciofluvial deposits, which are distinguished from the eolian sediments by less sand and silt and more gravel. Excavations and drilling logs indicate the presence of an old Columbia River channel cut into the Ringold Formation underlying the 300 Area. This channel is filled with glaciofluvial sediments and is separated from the river by a dike of Ringold sediments. The glaciofluvial deposits in the 300 Area range from about 50 to 90 ft thick (Lindberg and Bond 1979).

The Ringold Formation lies below the glaciofluvial deposits and is delineated by an increase in fine-grained materials. In the 300 Area, the contact between the two formations is indicated by increasing amounts of silt and some clay. The thickness of the Ringold Formation beneath the 300 Area is approximately 150 ft (Lindberg and Bond 1979).

The Columbia River basalt group is present beneath the entire Hanford Site. In the 300 Area, the contact between the Ringold Formation and the basalts is at about 200 ft below the land surface (Lindberg and Bond 1979).

Hydrology

Ground water occurs in both confined and unconfined aquifers beneath the 300 Area. The confined aquifers are contained mainly in the basalt formation, with the boundary between the confined and unconfined aquifers being the lowermost silt and clay member of the Ringold Formation. The low permeability of this silt and clay member permits little if any communication between the aquifers. A semiconfined zone in the lower Ringold Formation is

also known to exist beneath at least part of the 300 Area (Lindberg and Bond 1979). However, because this semiconfined zone has a higher head it is not expected to contain any contamination from the process trenches.

In the 300 Area the unconfined aquifer occurs in the Ringold Formation and the glaciofluvial sediments. The water table is 30 to 40 ft below the land surface, and the saturated aquifer thickness is about 90 ft (Lindberg and Bond 1979).

On most of the Hanford Site, natural recharge of the unconfined aquifer occurs at the northwest margin of the Pasco Basin and artificial recharge occurs at the 200 Areas, near the center of the site. Ground water flows from these recharge areas toward the Columbia River in a general southeasterly direction. However, in the southeast corner of the Hanford Site, ground-water recharge is mainly from the Yakima River. The 300 Area is located approximately at the point where these two ground-water sources meet. As a result, ground water enters the 300 Area from the northwest, west, and southwest (Lindberg and Bond 1979).

Near the process trenches, ground water flows toward the river to the southeast and the east, as shown by a recent water-table map (Figure 17). Exact direction of ground-water flow at any given time is influenced by both natural and man-made influences. One of these influences is the level of water in the Columbia River. It is documented in Lindberg and Bond (1979) that when the river level rises during spring runoff, bank storage occurs and causes a reversed water-table gradient in the 300 Area. During these times, ground water tends to flow to the southeast in a direction roughly subparallel to the river. When the river level drops, the natural gradient is restored and ground water flows more directly to the east, in a direction almost perpendicular to the river.

As mentioned earlier, an ancestral Columbia River channel underlies the 300 Area. This channel joins the present channel of the river about 2 miles north and about 1 mile south of the 300 Area. Changes in the hydraulic gradient in this area generally result in rapid changes in ground-water elevations, probably due to the high permeability of the sediments filling the old river channel (Lindberg and Bond 1979).

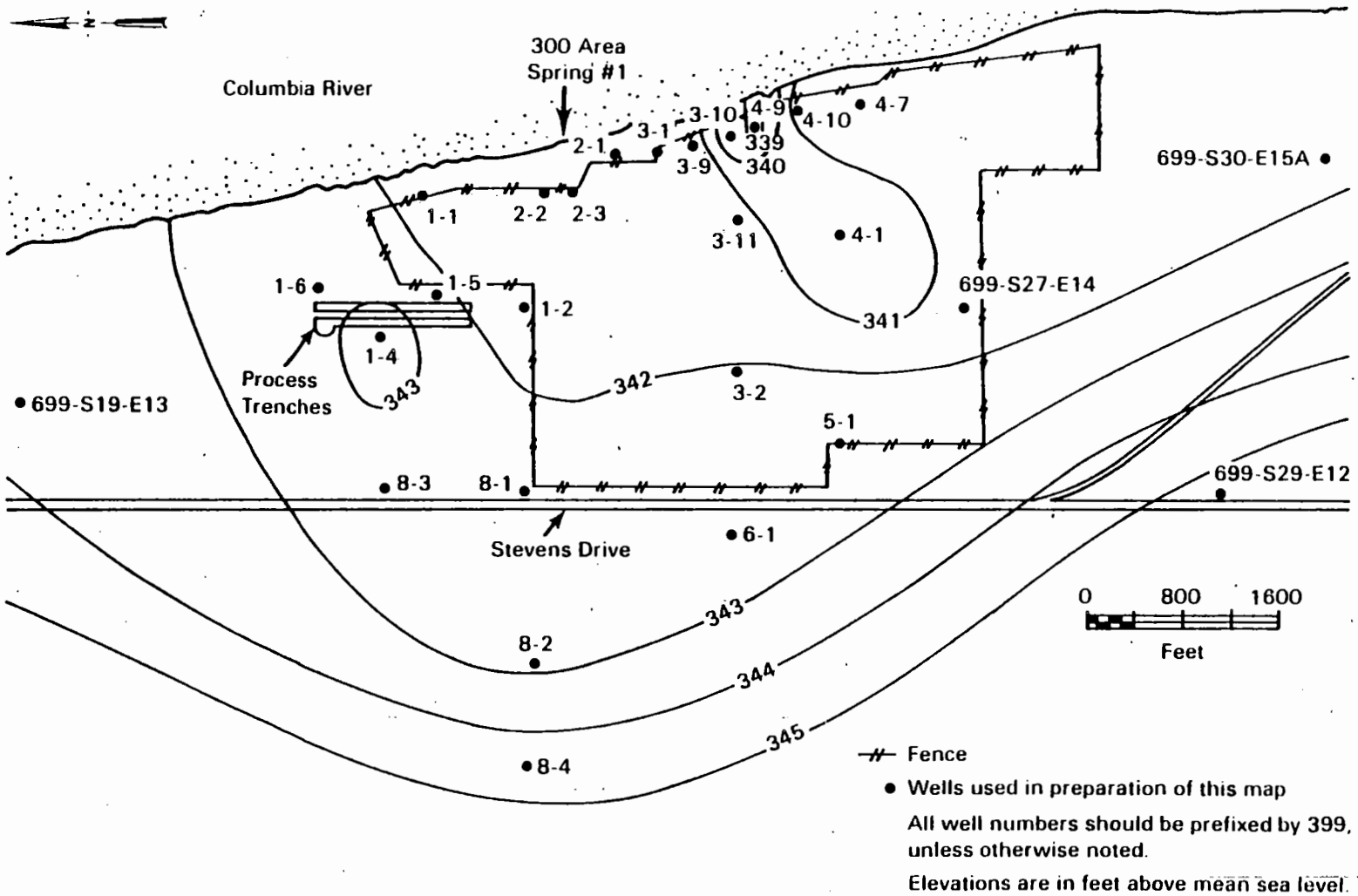


FIGURE 17. 300 Area Water-Table Map (December 17-18, 1984)

Another influence on ground-water levels and flow direction is the process trenches, into which approximately one million gallons of waste water per day are disposed. This large volume of waste water percolates quickly to the ground water and creates a low mound in the water-table surface under the process trenches (Figure 17). This mound increases the water-table gradient, creating a greater head for the waste water as it flows toward the river.

Some aquifer tests have been done in wells in the 300 Area, although none of the wells tested were pumped for more than 8 hours. Calculated transmissivities based on recovery data from these tests range from 40,000 ft^2/day at well 399-8-2 to 102,000 ft^2/day at well 399-8-1. At well 399-1-4, transmissivity was calculated to be 65,400 ft^2/day.

PAST AND PRESENT GROUND-WATER SURVEILLANCE AT THE 300 AREA

There are more than 25 monitoring wells in the 300 Area. Most of these wells are sampled on a quarterly basis under the routine Ground-Water Surveillance Program conducted by PNL. The samples are analyzed chiefly for nitrate but also for several other constituents including cobalt-60, cesium-137, ruthenium-106, uranium, strontium-90, gross alpha, gross beta, chromium and fluoride.

As described under "Operational History of the 300 Area Process Trenches," two unplanned releases of perchloroethylene to the process trenches have occurred in the recent past, one in November 1982 and the second in July 1984. Ground-water monitoring that was undertaken to track these spills has provided a substantial body of data concerning the movement of contaminants in the 300 Area ground-water system.

After the first spill, several wells in the downgradient direction from the trenches were sampled. Results from sampling of wells 399-1-5 and -1-2 are shown in Figure 18. The highest concentration of perchloroethylene was 1,840 ppb, found in well 399-1-5, which is the closest downgradient well. Well 399-1-2 showed a lower peak concentration of 1,050 ppb about five days

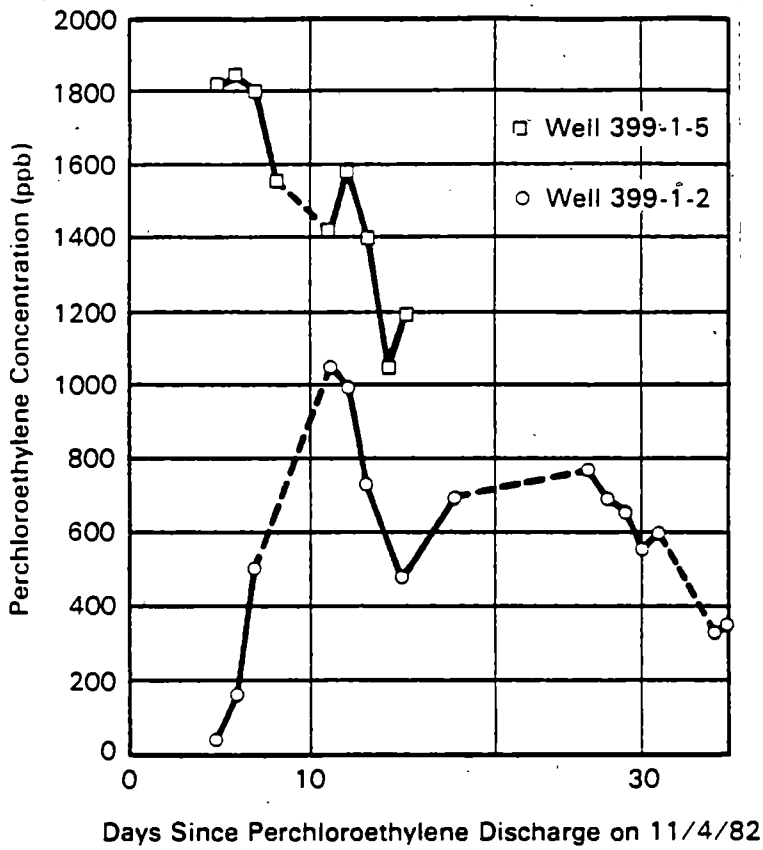


FIGURE 18. Perchloroethylene Concentrations in Selected 300 Area Wells

later. Results from well 399-1-3 (not shown) indicated a higher peak concentration than in well 399-1-2, but at five to ten days later. This may be due to well 399-1-3 being located further from the trench but more in line with the downgradient direction than well 399-1-2. Moving the sampling points to follow the movement of the contaminant led to sampling of wells 399-2-1, -2-2, -3-1, -4-7, and -4-10 at various times during the four months after the spill. Results of this sampling indicated lower peak concentrations of perchloroethylene with increasing distance from the trenches in the downgradient direction. A few samples collected from wells 399-8-3 and 699-S27-E14 showed less than detectable concentrations of perchloroethylene.

Ground-water monitoring after the second spill showed the same general trends as noted above. Results from sampling of wells 399-1-5 and -1-3 are shown in Figure 19. Again, the highest peak concentration (690.60 ppb) was

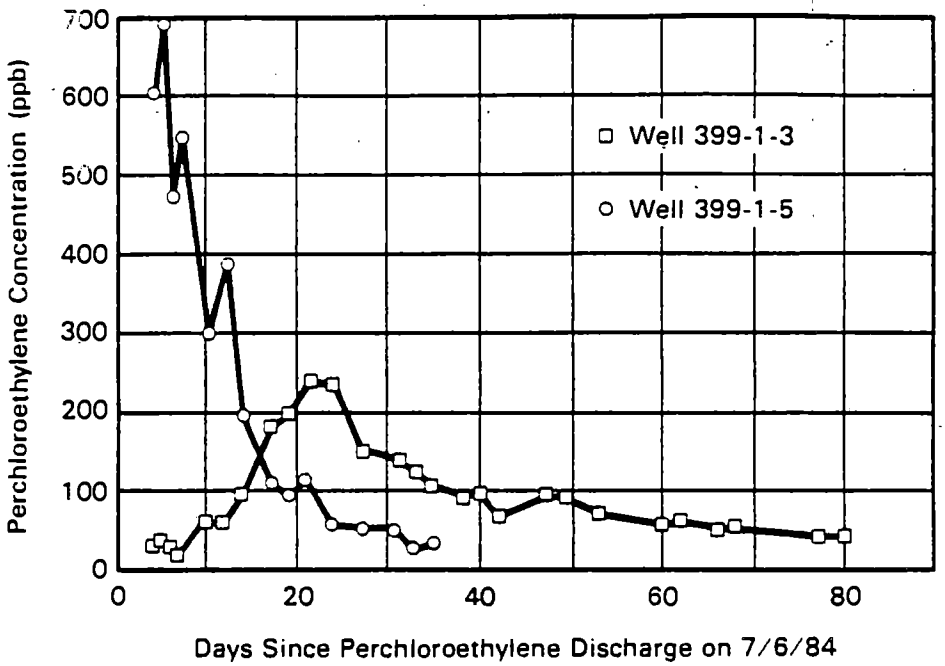


FIGURE 19. Perchloroethylene Concentrations in Selected 300 Area Wells

found in well 399-1-5 five days after the spill, with the peak concentration in well 399-1-3 (242.10 ppb) following 16 days later. Sampling of wells 399-1-2, -2-1, and -2-2 indicated the same general pattern as with the first spill, of diminishing contaminant concentration with distance from the source. Movement of the contaminant peak was estimated at 35 ft per day (Raymond 1984).

Effects on the Columbia River

During the two perchloroethylene spill incidents, samples were collected from the 300 Area spring #1 and the river. During the first incident, river samples were collected in the mainstream of river flow and at the 300 Area water intake. Spring samples were also collected. The maximum concentration of perchloroethylene found in the spring samples was 270 ppb; all of the river samples showed less than detectable concentrations. During the second incident, river samples were collected approximately 100 yards downstream from spring #1 and about 10 yards offshore. These samples showed

a maximum concentration of perchloroethylene of 18.20 ppb. Most of the samples were below 2 ppb. Samples from spring #1 showed a maximum of 79.60 ppb, with most below 5 ppb. Because of the difficulty in determining what effect diurnal changes in river level might have on spring and river samples, the results of sampling can be hard to interpret. However, this sampling did indicate that low levels of perchloroethylene had reached the spring and river sampling sites approximately 35 days after the spill occurred (Raymond 1984).

Preliminary Assessment

Routine surveillance and spill monitoring indicate that the ground water beneath the 300 Area has been contaminated by wastes disposed in the 300 Area Process Trenches. Because of past monitoring, the areal extent of contamination is approximately defined. Samples collected during the first perchloroethylene spill from some wells (such as 399-8-3 and 699-S27-E14) showed less than detectable concentrations, so it is expected that these wells will lie outside the contaminant plume.

Because it is already known that contaminants are present in the ground water, the monitoring plan developed for the 300 Area is a detailed assessment level program. Analytical results for samples taken from selected 300 Area wells will be used to define the extent and concentrations of hazardous waste constituents in the ground water.

WELLS AND SPRINGS TO BE SAMPLED

Sampling of a minimum of one upgradient and three downgradient wells is required for assessment of the ground-water quality at each hazardous waste site. The purpose of sampling the upgradient well is to determine background levels of hazardous wastes and hazardous waste constituents in the

ground water. The downgradient wells are necessary for determination of the rate and extent of contamination as well as the contaminant concentrations. The following wells will be sampled in and around the 300 Area:

399-1-1	399-1-2
399-1-3	399-1-4
399-1-5	399-1-6
399-2-1	399-3-7
399-3-10	399-4-1
399-8-2	399-4-7
699-S19-E13	699-S30-E15A

Locations of all of the wells listed above are shown in Figure 20. Wells 399-8-2 and 699-S19-E13 will be the upgradient wells used to determine background levels of contaminants. Wells 399-3-7 and 699-S30-E15A are included in the list because they are expected to be outside any contaminant plume, and will therefore be useful in determining the areal extent of contamination. Based on past surveillance data, the remainder of the chosen wells are expected to show contamination of varying degrees, and will provide spatial information on contaminant concentrations. They have been chosen to cover both expected downgradient directions. Other existing wells may be substituted for wells on this list if sample results indicate that other wells will provide better information.

In the 300 Area, several springs exist along the Columbia River shoreline. One of these springs, known as 300 Area spring #1 (shown on Figure 20), is located in a general downgradient direction from the process trenches. Seasonal and diurnal fluctuations in river level make these springs difficult to sample because they are covered up when the water level in the river is high. However, 300 Area spring #1 will be sampled according to the same schedule as the wells whenever river stage permits.

Wells in the 300 Area are of varied depth and construction. Construction details for the wells to be sampled are shown on the structural diagrams in Appendix B. Drilling logs for all these wells except 399-3-7 (for which no log exists) are also contained in Appendix B.

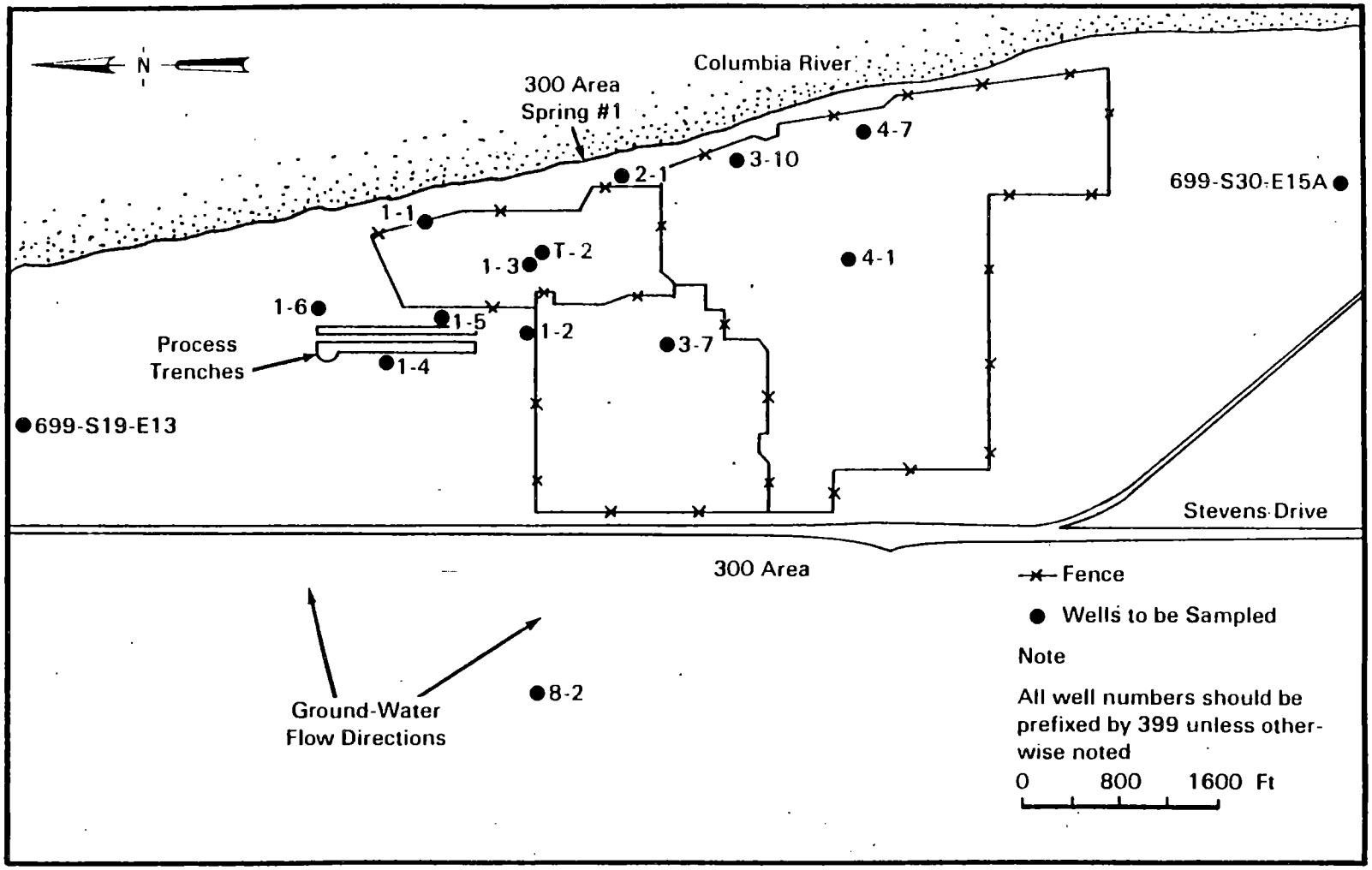


FIGURE 20. Location of 300 Area Wells to be Sampled

In order to determine if contaminants are present at the bottom of the aquifer, a deep well will be installed near well 399-1-3 (Figure 13). This well will be drilled down to the top of the uppermost silt and clay layer of the Ringold Formation. It will be approximately 135 ft deep and will be screened over the bottom 20 ft. Stainless steel casing and screen will be used in constructing this well because of the solvents that may be present in the ground water. Completion details are shown in Figure 21. If contaminants are found near the bottom of the aquifer in this well, other wells may need to be installed to determine the extent of the contamination.

Not much information exists on the subject of vertical flow components in the 300 Area and how they may affect different contaminants in the flow system. In order to determine whether vertical flow is a factor in this area, head measurements will be taken in wells 399-T-1 and 399-T-2 (when complete). Comparison of the head measurements in these two wells, which will be very close to each other but completed at different depths in the aquifer, should provide some information on the vertical flow components which may be present.

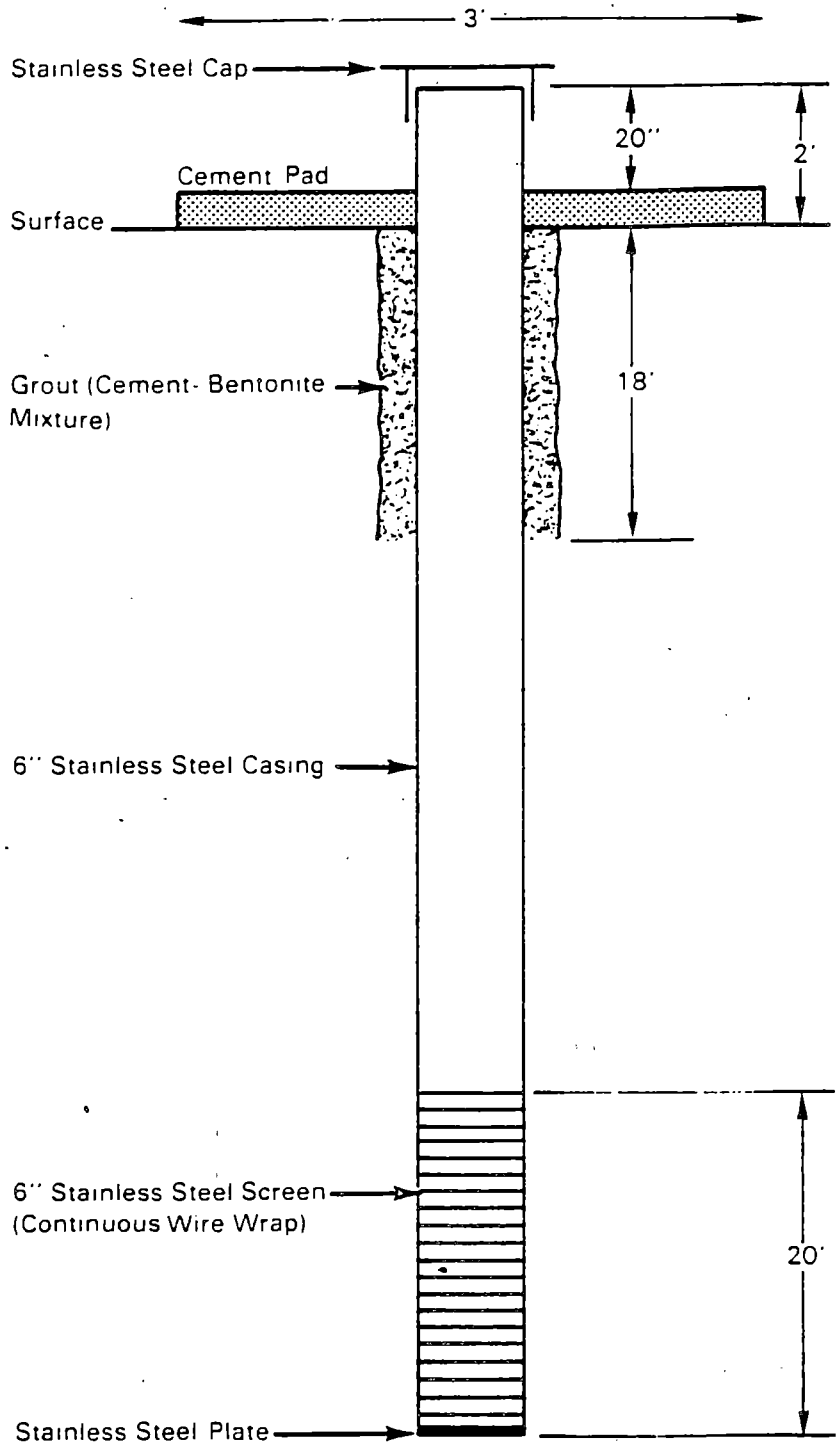
Although the varied construction of the wells in the sampling network may introduce some bias to the analytical data obtained, this bias is expected to be small. It is probably not sufficient to warrant construction of a totally new network. Comparisons currently being conducted by PNL using sampling equipment (including wells) constructed of different materials should provide more information on this subject.

Procedures to be used for sample collection and preservation are included in the chapter entitled "Methods."

SAMPLE ANALYSES

A list of the proposed analytical parameters for the ground-water samples collected from wells near the 300 Area Process Trenches is included in Table 11. The list includes those constituents required, as a minimum, by state and federal regulations, as well as listed or unlisted wastes specific

Proposed Design for
Well 399-T-2



*Not to Scale

FIGURE 21. Design of Proposed Deep Well 399-T-2

TABLE 11. Proposed Analytical Parameters for the Ground-Water Samples (300 Area Process Trenches)

Required Constituents (Drinking Water Parameters)

Arsenic	Nitrate (as N)	2,4-D
Barium	Selenium	2,4,5-TP Silvex
Cadmium	Silver	Radium
Chromium	Endrin	Gross alpha
Fluoride	Lindane	Gross beta
Lead	Methoxychlor	Coliform bacteria
Mercury	Toxaphene	

Site-Specific Constituents

Hydrofluoric Acid[a]	Listed
Hydrogen Sulfide	Listed
Tetrachloromethane (Carbon Tetrachloride)	Listed
Antimony	Listed
Benzene	Listed
Chlorinated Benzenes	Listed
Dioxane	Listed
Dioxin	Listed
Formaldehyde	Listed[b]
Formic Acid	Listed[b]
Hexachlorophene	Listed
Hydrazine	Listed
Hydrocyanic Acid	Listed[b]
Methyl Ethyl Ketone	Listed
Naphthalene	Listed
Nickel	Listed

(a) Considered by EPA to be unstable in water (Geo Trans, Inc., 1983); no analysis planned.
(b) No approved analytical method is currently available for this compound; components will be analyzed separately where possible.
(c) When listing the chemicals discharged at the facility, the facility operators indicated these general categories of chemicals as well as some specific chemicals. No analysis is currently planned, pending further guidance.

TABLE 11. Proposed Analytical Parameters for the Ground-Water Samples (300 Area Process Trenches) (contd)

Site-Specific Constituents (contd)	
Phenol	Listed
Pyridine	Listed
Selenium compound - Selenium Sulfide	Listed[b]
Thiourea	Listed
Toluene	Listed
1,1,1-Trichloroethane (Methyl Chloroform)	Listed
Trichloroethane (Ethane 1,1,2-trichloro-)	Listed
Trichloroethene (Trichloroethylene)	Listed
Copper	Unlisted
Perchloroethylene	Listed
Nitric Acid	Unlisted[b]
Sulfuric Acid	Unlisted[b]
Sodium Hydroxide	Unlisted[b]
Ammonium Bifluoride	Unlisted[b]
Aluminum Nitrate	Unlisted[b]
Sodium Chloride	Unlisted[b]
Ethylene Glycol	Unlisted
Sodium Nitrate	Unlisted[b]
Xylene	Listed
Kerosene	Unlisted
Tributylphosphate - Paraffin Hydrocarbon Solvents	Unlisted[c]
Degreasing Solvents	(c)
Detergents	(c)
Photochemicals	(c)

(a) Considered by EPA to be unstable in water (Geo Trans, Inc., 1983); no analysis planned.
(b) No approved analytical method is currently available for this compound; components will be analyzed separately where possible.
(c) When listing the chemicals discharged at the facility, the facility operators indicated these general categories of chemicals as well as some specific chemicals. No analysis is currently planned, pending further guidance.

to this facility.[a] As indicated in the footnote to Table 11, many of the compounds do not have approved analytical methods; where possible, the components will be analyzed separately.

The list of site-specific parameters in Table 11 was compiled based on information regarding past and present discharges to the facility provided by the facility managers. In an effort to ensure that no other hazardous wastes have entered the ground water from this facility (and to provide information needed for completing a Part B permit application), a much more extensive analysis will be conducted on samples collected from one upgradient well and one downgradient well at this facility. These samples will be analyzed for all constituents listed in WAC 173-303-9905, for which an analytical procedure is presently available (see Appendix C for this list).

Regulations for interim status facilities require quarterly sampling and analysis during the first year of monitoring. However, because of the changeable hydrological situation in the 300 Area, specifically the seasonal and diurnal changes in ground-water levels and contaminant concentrations, the proposed plan calls for monthly monitoring of the parameters in Table 11. During the first year of sampling, some replicate analyses will be performed on selected samples for the parameters in Table 11. The purpose of the replicate analyses is to provide information on the variability of the data. After the first year, sampling frequency may be changed to bimonthly or quarterly, and the number of replicate analyses may be reduced, depending on what the first-year results show.

Water-table elevation will be measured in each well every time a sample is collected. From these measurements, the hydraulic gradient will be determined.

Additional details on analytical methodologies (including sample preservation and quality control) are included in the "Methods" chapter of this document.

(a) Lists consulted include 40 CFR Part 261, Sections 261.31, 261.32, 261.33; 40 CFR Part 261, Appendix VIII; WAC 173-303-9903, -9904, -9905.

DATA EVALUATION AND REPORTING

The analytical data received from the laboratory will be handled and evaluated according to the procedures described in the "Methods" chapter of this document. Reporting procedures are described below.

At the end of the first year of sampling, a written assessment of the status of the ground water will be prepared, provided that such an evaluation can be made with the data collected. During the first year, the results of monthly sampling will be available soon after completion of the analyses.

SCHEDULE OF IMPLEMENTATION

The following schedule will be used to implement this program:

- Sampling of existing wells will begin in June 1985.
- Installation of a deep well will be completed by August 1, 1985.
- Sampling of the deep well will begin as soon as possible after its completion.

CENTRAL LANDFILL

The Central Landfill is located near the center of the site, about 4 miles southeast of the 200 East Area (Figure 2). The landfill is managed for the USDOE by RHO.

A part of the landfill is set aside specifically for hazardous solid wastes, most of which are contained in plastic drums or 55 gallon barrels. This northernmost portion of the landfill is referred to as the NRHW Trench site.

Under the provisions of WAC 173-303-910, the USDOE has elected to apply for a waiver to the requirement for providing ground-water monitoring at the NRHW site. The waiver will be requested under the provisions of WAC 173-303-645(b) iii, citing no potential for migration of contaminants from the NRHW Trench site to the underlying aquifer during operational and post-closure periods.

The USDOE will submit the request for a waiver to the Washington Department of Ecology no later than July 15, 1985. This request will provide documentation of work conducted at Hanford showing that there is no potential for migration of wastes from the NPHW Trench site to the aquifer during operational and post-closure periods. The physical environment at Hanford is not conducive to migration since the Hanford Site is located in an arid region. The depth to ground water is approximately 125 ft at the site of the landfill. There is no water supply available at the NRHW Trench site or environs, and water is not used in any manner in the operation of the trenches.

The request for a waiver will address the elements of geology, soils, hydrology, and meteorology of the NRHW Trench site, and will discuss and reference Hanford documents dealing with investigations and studies of the vadose zone and their application to waste management.

METHODS

This chapter contains the procedures that will be used in implementing the ground-water monitoring programs described in the preceding chapters. The first section of this chapter includes field procedures. Analytical procedures (with information on sample preservation) are contained in the second section. Quality-control and chain-of-custody procedures are described in the third and fourth sections, respectively. Data evaluation procedures are in the final section.

FIELD PROCEDURES

These procedures apply to samples that will be analyzed for hazardous waste constituents. Radiological sampling procedures are covered in PNL-MA-580, Environmental Monitoring Procedures (Occupational and Environmental Protection Department 1984).

These sampling procedures were written under the assumptions noted below. If the conditions differ from those assumed, then corresponding changes will be made in the procedures.

- These procedures are not meant to be all-inclusive and are not intended to replace proper field training for equipment used herein.
- Each well to be sampled will probably have two pumps installed in it, one being a 3/4 horsepower submersible pump for purging and some sample collection, and one being a bladder or similar type pump suitable for organic sample collection.
- Manufacturer's operating guidelines and maintenance instructions for these pumps will be used to supplement these procedures.
- These procedures are subject to change based on information obtained from sample results.

The precautions and procedures in the following two sections are intended for use by PNL's radiation protection technologists, who will be responsible for collecting the samples.

Sampling Precautions

- Do not smoke, eat, or handle any objects not necessary for sampling while performing sampling procedures.
- Do not sample downwind of any potential volatile organics sources such as car exhausts, open fuel tanks, etc. These could result in contamination of the sample. If any such sources are unavoidable, make a note of them in the field logbook.
- Leave caps on the sample containers until just before filling.
- Avoid handling the teflon bottle cap liners. Do not use any liner which falls out of the cap and onto the ground.
- Gloves should be worn when taking samples, especially those with added preservative.

Sampling Procedures

1. Take water-level measurement according to the procedure below.
2. Check to see that the hose bibb for the submersible pump is open. Never operate the pump with the outlet valve closed! Air pushed ahead of the water rising in the pipe column must have room to escape or serious damage will occur.
3. Plug the power cord into one of the 230-volt outlets on the generator and into the outlet at the well head. CAUTION: Be sure the power switch to the 230-volt outlets is turned off!
4. Start the electric generator.
5. Turn power switch on to begin pumping process. Be sure not to handle energized power cords. If the pump does not work properly, indicated by lack of air flow out the discharge hose or by the generator "lugging" down, immediately turn the switch off. After waiting a few seconds turn the switch on and off several times rapidly, finally pausing in the ON position to determine if the pump has started to function properly.

6. Repeat this procedure several times. If the submersible pump still does not work, it needs to be repaired. If the breakers or fuses on the generator go off, an electrical short in the system is indicated and repair is needed.

7. See Note below if a well "pumps dry."

8. After the water begins to flow from the outlet, pump the well for the length of time indicated in Table 12 (or for an adjusted pumping time as explained in Table 12), and until pH, temperature, and conductivity stabilize. Measure the pH, temperature, and conductivity of the discharged water at least three times during purging, according to the appropriate procedure below. pH will be considered stable when two consecutive measurements agree within .2 pH units. Temperature will be considered stable when two consecutive measurements agree within .2°C. Conductivity will be considered stable when two consecutive measurements agree within 10 μmhos. If pH, temperature, and conductivity do not stabilize within purge time, contact the Environmental Monitoring staff for instructions before collecting sample.

9. Enter time, date, and initials on all sample labels. Record information in field logbook as it becomes available.

10. Fill the sample containers which can be filled with the submersible pump. Attach a sample seal to each container and place in a cool, dark container (cooler).

11. Turn on the air compressor.

12. Attach the compressed gas source to the bladder pump pressure inlet on the face of the controller panel, using female portion of coupling supplied.

13. Connect either end of the red controller air hose to the pump supply on the right side of the control panel. Connect the other end of the controller air hose to the quick-connect nipple located in the well cap assembly.

TABLE 12. Calculated Pumping Times

Well Number	Calculated Time (min.)
(199) H3-1	24
H4-3	5*
H4-4	4*
H4-5	8*
H4-6	5*
(399) 1-1	30
1-2	42
1-3	25
1-4	34
1-5	4*
1-6	6*
2-1	32
3-7	60
3-10	18
4-1	35
4-7	35
8-2	33
(699) S30-E15A	9*
S19-E13	12*

* All wells will be pumped a minimum of 15 minutes, even if the calculated time is less.

Note: These pumping times are based on voiding three bore-volumes of water from the well at a pumping rate of 10 gpm. To calculate an adjusted pumping time based on a field measurement of flow rate:

1. [size of container (gal) ÷ # seconds to fill] x 60 = new pumping rate.
2. [calculated time (Table 12) x 10] ÷ new pumping rate = new pumping time.

14. Attach the appropriate extension line to the bladder pump sample collection line.

15. Five to fifteen pumping cycles are required to purge the air from the bladder pump and tubing. Full water flow from the sample supply tube should then begin. After water flows from the outlet tube, run the bladder pump for at least five minutes.

16. To reduce the water flow rate during sample collection, turn the throttle control on the left side of the control panel in the counter-clockwise direction. For increased flow rate during well purging, turn the throttle control clockwise.

17. To optimize pumping efficiency for a specific well depth, refer to the manufacturer's operating instructions.

18. Unscrew the cap from the sample bottle, being careful not to touch the lip of the bottle or inside of the teflon liner. Also avoid touching the mouth of the discharge tap, and avoid splashing or agitating the water while the bottle is being filled.

19. Fill the sample bottle slowly by placing the outlet tube against the inner side of the sample bottle to prevent entrapment of any air bubbles. NOTE: For those bottles requiring no headspace, the bottle should be filled completely such that a meniscus forms. Place the cap on immediately, turn the bottle upside down, tap it a few times and check for air bubbles in the sample. If a bubble exists, discard the sample and repeat the sampling procedures until an air-free sample is obtained.

20. As each container is filled, attach a sample seal to the container and place in a cool, dark container (cooler).

21. Turn off the air compressor.

22. Turn the power switch off and then turn off the generator. Unplug the power cord.

23. Complete the Chain-of-Custody and Sample Analysis Request forms.

24. Survey the sample bottle with a Geiger-Muller instrument. If the count is >200 c/m, record in the field logbook and remember that Radiation Work Procedures apply. Notify the Environmental Monitoring supervisor for instructions concerning sample disposition.

25. Deliver the sample to the appropriate laboratory for analysis as soon as possible, following chain-of-custody procedures. If it can not be delivered to the lab the same day, store the sample in a refrigerator which maintains a constant temperature of 4°C.

NOTE: If the well pumps dry while purging, it does not generally mean that a sample cannot be collected. Some wells pump down after a period of time. However, a sample can still be obtained by following these steps:

1. Turn off the submersible pump when the well pumps dry.
2. Wait for the well to recharge. This should be about 15 minutes, but may take as long as 30 minutes.
3. Check with the electrical tape to ensure that water is covering the bladder pump.
4. Turn the bladder pump on. Run the pump for 3 minutes and then collect the sample.

Water Level Measurement Procedure

Graduated Steel Tape Method

1. Chalk the one-foot section of steel tape below the zero reading point.
2. Lower the steel tape from the measuring point to the estimated water level (hold point). Values for the measuring point and estimated water level can be found in Hanford Wells (McGhan, Mitchell and Argo 1985). An electric tape may be used to find approximate water level.
3. Remove the steel tape and check the wetted portion below the zero reading point.
4. Add the unwetted length (of the chalked portion of tape) to the hold point to obtain the depth to water measurement.

5. If the chalked portion is not wet, repeat until the water level is marked on the chalked portion of the tape.

6. Repeat the procedure until two steel tape measurements agree within ±0.05 ft.

7. Record the depth to water measurements, time of measurements, measuring device, and the person taking the measurements in the field logbook.

Electric Tape Method

1. Lower the electric tape from the measuring point into the borehole until the water indicator sounds.

2. Mark the electric tape at the measuring point and identify the nearest graduation on the electric tape.

3. If the water level is deeper than the nearest graduation marked on the tape, the difference is added to the depth identified to obtain the true depth to water.

4. If the water level is shallower than the nearest graduation marked on the tape, the difference is subtracted from the depth identified to obtain the true depth to water.

5. Record the depth to water measurements, time of measurements, measuring device, and the person taking the measurements in the field logbook.

Conductivity Calibration Procedure--Internal standard

1. Empty the sample cup. Rinse out with distilled or D.I. water. Dry the cell thoroughly.

2. Turn the range switch to TEST.

3. Press the operate button.

4. With the small screwdriver supplied, adjust the CALIBRATE until the meter or display reads eight.

NOTE: Use as a rough calibration or battery check.

Conductivity Calibration Procedure--Standard solution

1. Empty the sample cup. Rinse out with distilled or D.I. water.
2. Fill the cup with standard solution.
3. Turn the RANGE selector switch to the correct range.
4. Press the operate button.
5. With the small screwdriver supplied, adjust the CALIBRATE until the meter or display reads the solution value.

   NOTE: Do not return conductivity standards to its container. Always discard it.

Conductivity Measurement Procedure

1. Remove the cap on top of the sample cup.
2. Rinse the cup with the sample to be tested and dump it several times. Then fill the cup with the sample.
3. Turn the conductivity range switch to the correct range.

	Range in µmhos
X1.	0 - 10
X10.	0 - 100
X100.	0 - 1,000
X1,000.	0 - 10,000

4. Turn the MODE switch to CONDUCTIVITY.
5. Press the OPERATE button on the side of the case.
6. Read the conductivity on the meter on the digital display to the nearest µmho and record in field logbook. Multiply the meter reading times the scale factor to obtain the correct placement of the decimal point.
7. After reading, dump the sample and refill with tap water.
8. Replace the cap.

pH Calibration Procedure

1. Wash the sample cup with distilled water.
2. Fill the cell with 4.0 buffer solution.
3. Turn the MODE switch to pH.
4. Press the OPERATE pushbutton. Adjust the ZERO to make the display read 4.00 pH on the upper meter scale or the digital display. Use the small screwdriver provided.
5. Discard the buffer. Wash the cell 2 times with distilled or D.I. water.
6. Fill the cell with 10.00 buffer solution.
7. Adjust the SLOPE to make the display read 10.00 pH.
8. Rinse the cell again and refill with 4.0 pH buffer solution. Recheck the 4.0 pH value and make a minor adjustment to the ZERO if necessary.
9. Single buffer calibration. After the SLOPE is calibrated the first time, it may be left alone for subsequent calibration. Recheck the slope as desired.

   Calibrate with a buffer that is close to the range of interest. If the process pH is from 6.0 to 9.0, use a 7.0 buffer for single point calibration.

   With buffer solution in the cell, recalibrate the STD only to make the display read the desired value.

   NOTE: Do not return pH standard to it's container. Always discard it.

pH Measurement Procedure

1. Remove the cap on the top of the sample cup.
2. Rinse the cup with the sample to be tested several times. Then fill the cup with the sample.
3. Turn the MODE selector switch to pH.
4. Press the OPERATE pushbutton on the side of the case.

5. Read the pH on the upper meter scale or on the digital display to the nearest tenth of a unit and record in field logbook.

6. Dump the sample and refill with tap water.

7. Replace the cap.

SAMPLE ANALYSIS

A contract is in place with UST for the analytical work under this plan. This company currently operates a radiological analytical laboratory in Richland, Washington, as well as a facility in Hoboken, New Jersey, that deals extensively in nonradiological analyses. The nonradiological facility in New Jersey is involved in the Contract Lab Program administered by the Environmental Protection Agency and is capable of handling all state-of-the-art methodologies currently available for hazardous waste analysis. All of the necessary capabilities, equipment and methodologies used at the nonradiological facility are being expanded to the Richland facility to allow local analysis of the samples to be collected under this plan. This expanded capability at Richland will enable the Richland facility to handle all analytical work proposed in this plan by mid-Summer of 1985. All samples collected for this effort will be delivered to the Richland facility; analyses unavailable in Richland during this startup period will be performed at UST's Hoboken facility. The Richland facility will utilize all protocols and procedures currently in use at the New Jersey facility.

Table 13 references the analytical methods to be used for each of the constituents that will be analyzed. When available, methods described in SW-846 (U.S. Environmental Protection Agency 1982) will be used. In instances where a method is not available in SW-846, an appropriate method is listed from one of the standard references. In cases where a standard method is not available for a constituent, and a method is being developed by the laboratory, the method will be included as a supplement to this plan

TABLE 13. Analytical Methods

Constituent	Collection/ Preservation[a]	Method	Detection Limit, µg/ℓ (ppb)
Chromium			10
Lead			30
Nickel			10
Vanadium			5
Copper	P[b], HNO_3 to pH <2	SW-846	10
Manganese		#6010	5
Cadmium			2
Barium			6
Antimony			100
Silver			10
Sodium			100
Aluminum			150
Iron			50
Potassium			100
Mercury	P, HNO_3 to pH <2	SW-846 #7470	.1
Arsenic	P, HNO_3 to pH <2	SW-846 #7060	5
Selenium	P, HNO_3 to pH <2	SW-846 #7740	5
Tetrachloromethane			
Benzene			
Dioxane			
Methylethyl Ketone	G, silicon/teflon	SW-846	10
Pyridine	septa, no headspace	#8240	
Toluene			

(a) All samples will be cooled to 4°C upon collection.
(b) P = plastic, G = glass.
(c) In-house analytical method.
(d) Detection level shall be consistent with good laboratory practice and EPA approved analytical procedures and shall not exceed 1 ppm.
(e) IC = Ion Chromatography.
(f) GC/FID = Gas Chromatography/Flame Ionization Detection.

TABLE 13. Analytical Methods (contd)

Constituent	Collection/ Preservation[a]	Method	Detection Limit, µg/ℓ (ppb)
1,1,1-trichloroethane 1,1,2-trichloroethane 1,1,2-trichloroethylene Perchloroethylene	G, silicon/teflon septa, no headspace	SW-846 #8240	10
Xylene Hydrazine Hexachlorophene Naphthalene Phenol Chlorinated benzenes	G, teflon cap	SW-846 #8270	10
Cyanide	P, NaOH to pH > 12	SW-846 #9010	10
Sulfide	P, 2 mℓ zinc acetate + NaOH to pH > 9	SW-846 #9030	100
Thiourea	G, None	SW-846 #8330	--[d]
Formate	P, None	IC[c,e]	100
Radium	P, HNO_3 to pH < 2	EPA Method #903.0	1 pCi/ℓ
Gross alpha Gross beta	P, HNO_3 to pH < 2	EPA Method 680/4-75-001	4 pCi/ℓ 8 pCi/ℓ
Coliform bacteria	P, none	Std. Methods #908C	3 mpn (most probable number)

(a) All samples will be cooled to 4°C upon collection.
(b) P = plastic, G = glass.
(c) In-house analytical method.
(d) Detection level shall be consistent with good laboratory practice and EPA approved analytical procedures and shall not exceed 1 ppm.
(e) IC = Ion Chromatography.
(f) GC/FID = Gas Chromatography/Flame Ionization Detection.

TABLE 13. Analytical Methods (contd)

Constituent	Collection/ Preservation[a]	Method	Detection Limit, µg/ℓ (pbb)
Total organic halogen	G, silicon/teflon septa, no headspace	SW-846 #9020	0.1 ppm
Total organic carbon	G, H_2SO_4 to pH 2	Std. Methods #505	1 ppm
Specific conductance	Field measurement	See pg.	1 µmho
pH	Field measurement	See pg.	0.01 pH unit
Chloride, Fluoride, Sulfate, Phosphate, Nitrate	P, None	IC[e,c]	100
Perchlorate	P, None	IC[e,c]	--[d]
Kerosene	G, None	GC/FID[f,c]	--[d]
Ammonium	G, H_2SO_4 to pH < 2	Std. Methods #417-A-E	--[d]
Ethylene glycol	G, None	GC/FID[f,c]	--[d]
Endrin, Lindane, Methoxychlor, Toxaphene	G, None	SW-846 #8080	1
2,4-D, 2,4,5-TP Silvex	G, None	SW-846 #8150	1
Dioxin	G, None		0.1 ppb

(a) All samples will be cooled to 4°C upon collection.
(b) P = plastic, G = glass.
(c) In-house analytical method.
(d) Detection level shall be consistent with good laboratory practice and EPA approved analytical procedures and shall not exceed 1 ppm.
(e) IC = Ion Chromatography.
(f) GC/FID = Gas Chromatography/Flame Ionization Detection.

when it becomes available. Table 13 also lists appropriate preservation methods; shipment considerations are not included, as samples will be delivered by the sample collector directly to the analytical lab and no shipment will be involved.

QUALITY CONTROL

The quality-control effort will include checks performed on the laboratory through submission of blanks, spikes and replicate samples as well as the analytical laboratory's routine quality-control procedures. A field blank and transfer blank will be submitted with each sample submitted for volatile organic analysis. In addition, during the first few months of sampling, blanks and replicates will be used to test for various types of possible variation in the data. Details of this testing will be provided in supplements to this plan; any routine replication or blank submission determined necessary as a result of this testing will be included in the plan.

Inorganic analyses will be performed primarily using Inductively Coupled Plasma Emission Spectrometry (ICAP), Ion Chromatography and Graphite Furnace Atomic Absorption (GFAA). The following general quality-control procedures will be standard for all inorganic analyses:

- standard curve - daily
- verification of standard (to ± 30%) - every 20 samples
- blank - each extraction batch
- random matrix spike for 10% of samples.

Organic analyses will be performed primarily using Gas Chromatography and Gas Chromatography/ Mass Spectrometry. The following general quality-control procedures will be standard for all organic analyses:

- 5-point curve - verify every 12 hours
- random matrix spike for 10% of samples
- blank - every extraction batch
- internal standards and surrogates

For additional quality control procedures specific to individual methods, see the methods referenced in Table 13.

CHAIN-OF-CUSTODY PROCEDURES

To ensure the integrity of the samples from time of collection through data reporting, the history of the custody of each sample will be documented. A sample is considered to be under a person's custody if it is: 1) in his physical possession, 2) in his view after he has taken possession, 3) secured by him so that no one can tamper with the sample, or 4) secured by him in an area which is restricted to authorized personnel. Anyone having custody of samples must comply with the procedures described below.

Sample Labels

Gummed paper labels will be filled out and affixed to the sample container at the time of sample collection. The sample label will be a variation of the label presently used for the radiological Ground-Water Surveillance Program conducted by PNL. The label to be used is shown in Figure 22. The well number noted on the label identifies the well location.

Sample Seals

Gummed paper seals will be attached to the samples immediately upon sample collection, before the samples leave the custody of the sampling personnel. The seal will be attached in such a way that it is necessary to break it in order to open the sample container.

Field Logbook

A field logbook will be utilized to record (in black ink) all pertinent information about each sample collected. It will be a bound book, with consecutively numbered pages. A sample page from the logbook is shown in Figure 23. The logbook will be kept in a locked cabinet when not in field use.

Chain-of-Custody Form

A Chain-of-Custody Form will accompany all samples from the time they are collected until they are disposed of after analysis and reporting. One form will be used for as many samples as possible. The form to be used is shown in Figure 24. Each sample handler who signs the form will return a copy of the form to the sample collection organization.

(sample number)	WATER	(list of analyses)
GROUNDWATER	RAW GRAB	
(well number)	(frequency)	
	LAB: _____	
	DATE/TIME: _____	
SAMPLE SIZE: _____		
COLLECTOR: _____		

FIGURE 22. Sample Label

Well Number Date

Pumping Time for Submersible

Precalculated at 10 gpm -

Calculated in field -

Bladder pump rate

Time Submersible On - Time Bladder On -

Samples Collected:

Sample No.	Volume	Pump Type	Collector

Field Measurements:

Water Level

E-tape - Held

Steel tape - Wet

Level

Time

pH

Cond.

Temp.

Field Observations

Data Recorder

FIGURE 23. Sample Field Logbook Page

CHAIN-OF-CUSTODY

Project Number:

Company Contact's Name: _____ Telephone: _____

Samples Collected by: _____

Date Sampled: _____ Time Sampled: _____

Sample Location: _____

Remarks: _____

_____

_____

Method of Shipment: _____

Sample Identification	Type and Size Container
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Chain of Possession

Relinquished by:	Received by:	Date/Time:
_____	_____	_____
Relinquished by:	Received by:	Date/Time:
_____	_____	_____
Relinquished by:	Received by:	Date/Time:
_____	_____	_____
Relinquished by:	Received by:	Date/Time:
_____	_____	_____

FIGURE 24. Sample Chain-of-Custody Form

Sample Analysis Request Form

A Sample Analysis Request Form will accompany all samples delivered to the lab. The form to be used is shown in Figure 25. The field portion of the form will be completed by the sample collector; the laboratory portion will be completed by laboratory personnel.

Sample Delivery to the Laboratory

Samples will be delivered directly to the laboratory on the day of collection. (No shipping will be necessary, due to the lab's proximity to the facility.) All samples will be accompanied by a Chain-of-Custody Form (Figure 24) and a Sample Analysis Request Form (Figure 25). The samples will be delivered only to authorized laboratory personnel.

Receipt and Logging of Samples

Procedures to be used for sample receipt and log-in are contained in the following two sections.

Sample Receipt

All samples delivered to the laboratory are to be accepted by the Receiving Department in the following manner:

- The sample cooler shall be removed from the delivery vehicle and brought into the receiving area.
- The sample cooler shall be checked for any obvious damage.
- The Chain-of-Custody and Sample Analysis Request forms shall be signed by receiving personnel.
- If custody of the cooler is transferred from the person receiving shipment to one or more intermediates prior to delivery to the Sample Custodian, a Chain-of-Custody Form must be completed, and must reflect every change of custody.
- The sample containers shall be delivered to the Sample Custodian or designated alternate who will sign the Chain-of-Custody Form. He will then return one copy to the sender and will retain the remaining copies.

SAMPLE ANALYSIS REQUEST

Pacific Northwest Laboratory
P O Box 999
Richland WA 99352

United States Testing Company, Inc.
2800 George Washington Way
Richland WA 99352

Collector _____
Date /Time Sampled _____
Company Contact _____

Received by _____
Title _____
Date _____ Time _____

CHAIN OF CUSTODY NO. _____

SAMPLE ID _____

UST SAMPLE ID _____

COMMENTS

	CODE	CONSTITUENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	725	ICP METALS 6010														
2	726	ICP METALS 6010 ENHANCED														
3	A20	ARSENIC														
4	A21	MERCURY														
5	A22	SELENIUM														
6	A23	THALLIUM														
7	A24	THIOUREA 8330														
8	727	METHOD 8330 ENHANCED														
9	728	PESTICIDES 8080														
10	729	PESTICIDES 8080 ENHANCED														
11	730	VOA METHOD 8240														
12	731	VOA METHOD 8240 ENHANCED														
13	732	A/B/N 8270														
14	733	A/B/N 8270 ENHANCED														
15	C61	TETRETHLYPYROPHOSPHATE														
16	C62	CHLOROBENZILATE														
17	C63	CARBOPHENOTHION														
18	734	PESTICIDES METHOD 8140														
19	C68	TOX														
20	C69	TOC														
21	C70	CYANIDE														
22	C71	FORMALIN														
23	735	NITRATE, SULPHATE,.... (IC)														
24	C77	PERCHLORATE														
25	C78	SULFIDE														
26	C79	KEROSENE														
27	C80	AMONIUM ION														
28	C81	ETHYLENE GLYCOL														
29	109	COLIFORM BACTERIA														
30	181	RADIUM														
31	112	ALPHA														
32	111	BETA														
33	C86	DIOXIN														
34	C87	CITRUS RED #2														
35	C88	CYANOGEN BROMIDE														
36	C89	CYANOGEN CHLORIDE														
37	C90	PARALDEHYDE														
38	C91	STRYCHNINE														
39	C92	MALEIC HYDRAZIDE														
40	C93	NICOTINIC ACID														
41	736	DIRECT ACQUEOUS INJECTION														
42	738	HERBICIDE 2,4-D, 2,4,5-TP SILVEX														
43	737	HERBICIDE 8150 ENHANCED														

DR2:[7,1]196

FIGURE 25. Sample Analysis Request Form

- The sample container is now the responsibility of the Sample Custodian or designated alternate. This individual must log the sample in and open the case file.

Log-In

Upon notification of sample receipt, the Sample Custodian or designated alternate will proceed with sample inspection and log-in as follows:

- Examine the shipping container(s) and record in the Sample Log-In Form:
  - Presence/absence of custody seal(s) on the shipping container(s)
  - Condition of custody seal(s)
- Open shipping container(s), remove the enclosed sample documents and record in the Sample Log-In Form:
  - Presence/absence of Chain-of-Custody Form(s)
- Remove sample containers and record in Sample Log-In Form:
  - Condition of samples (intact, broken, leaking, etc.)
  - Presence/absence of sample labels
  - Any disagreement with Chain-of-Custody Form(s)

If discrepancies are found, contact the sender for clarification and notify the appropriate lab personnel.

- Once all samples have been properly logged in, a copy of the Sample Log-In Form will be sent to the sender.

Figure 26 presents an example of a properly completed Sample Log-In Form.

Assignment of Sample for Analysis

The following requirements for assignment of the samples will be followed:

- An internal numbering system shall be used for identification of all samples.

NUMBER:

UST-RD SAMPLE LOG-IN FORM

****

DATE:
TIME:

COOLER ID :
CLIENT SAMPLE ID :
UST-RD ID :
NUMBER OF BOTTLES IN COOLER :
IS CHAIN OF CUSTODY FORM PRESENT? :
CHAIN OF CUSTODY NUMBER :
IS SAMPLE ANALYSIS REQUEST FORM PRESENT? :

* IS THE CUSTODY SEAL ON THE COOLER INTACT? :

* ARE THE CUSTODY SEALS ON THE BOTTLES INTACT? :

* DO THE SAMPLE LABELS AGREE WITH THE CHAIN OF CUSTODY SHEET? :

* DO THE SAMPLE LABELS AGREE WITH THE SAMPLE ANALYSIS REQUEST SHEET? :

****

* IF ANSWER IS 'NO', PLEASE EXPLAIN BELOW IN DETAIL

SAMPLES LOGGED IN BY_____

REVIEWED BY SAMPLE CUSTODIAN _____
GOVIND RAO

FIGURE 26. Sample Log-In Form

- Internal sample numbers shall be assigned by the Sample Custodian and shall be recorded in the Sample Log-In Form alongside the corresponding collector's sample number.
- Properly labeled sample containers shall be placed in the secure storage area.

DATA HANDLING AND EVALUATION PROCEDURES

The analytical data provided by the laboratory will be entered into the Hanford Ground-Water Data Base maintained by PNL. This computerized data base is used to store water-quality data, hydrographs, well-structure descriptions, and drilling logs for the monitoring wells at the Hanford Site. Once entered into the data base, the analytical data can be accessed for manipulation and evaluation using various programs, or they can be printed out in a number of different formats.

Evaluation of the data will be conducted using appropriate statistical and graphical techniques. Although the regulations stipulate use of a particular version of the Student's t-test to compare results from upgradient and downgradient wells, this version of the test has certain flaws which make it less than optimum for this application. The performance of the t-test has been studied, and the results strongly suggest that the test will render false positive results (JRB Associates 1983). The reasons for this problem are discussed below.

First, the regulations require replicate measurements from each sample. Experience has shown that the replicate measurements frequently provide redundant information, i.e., the replicates are not statistically independent. The effect of this is to overspecify the degrees of freedom, a parameter needed when judging the statistical significance of the calculated t statistic. The end result is that the test tends to indicate a significant difference between upgradient and downgradient wells when that is really not the case.

Second, the t-test does not take into account spatial variation in upgradient well concentrations if only one upgradient well is sampled (the minimum requirement). The end result will be the same as in the previous paragraph, i.e., a tendency to falsely conclude from the test that the facility is leaking. This results because the variance of the estimated upgradient mean will be underestimated.

In addition to the problem of false positive test results, the test may not detect contamination because temporal (e.g., seasonal) variation in upgradient concentrations is not effectively taken into account. The pooling of quarterly data as specified in the regulations averages over the seasons, which has the effect of reducing the sensitivity (power) of the t-test to detect contamination.

Finally, the t-test requires the measurements to be at least approximately normally distributed. When this is not the case the performance of the t-test can be adversely affected, particularly if the number of measurements taken at upgradient and downgradient wells are far from being equal. This problem can be overcome by using a suitable nonparametric test or by an appropriate transformation of the data before computing the t-test. Other problems with the t-test are discussed in JRB Associates (1983).

Because of these problems with the t-test, other data evaluation techniques may be more appropriate for use in this effort. The applicability of these other techniques cannot be determined with certainty until the data are available for examination. However, some of the techniques that may be appropriate are discussed below.

Methods involving graphical depiction of the data may be useful. One such method involves plotting the concentration data for each well over time. Another graphical method involves producing quality-control charts with upper and lower warning/action limits.

Other data evaluation techniques that may be used involve tests for long-term trends. Two of these tests are the Mann-Kendall test and the seasonal Kendall test (Van Belle and Hughes 1984).

Tests for outliers can also be conducted. This type of test is routinely conducted on data entered into the Hanford Ground-Water Data Base. The test is embodied in a computer program called SCREEN. SCREEN detects whether a new analytical data point for a well conforms to the trend set by that well's recent history. Using the trend, the program computes the next predicted value and sets an upper and lower limit of 2.09 standard deviations. Exactly 95% of the values are expected to fall within these limits. When a new data point is received, SCREEN computes the position of the data point and determines whether it is above, below or within the limits. It also predicts the time when the concentration in that well is expected to exceed a critical safety limit or fall below a sensor detection limit.

The techniques mentioned above (as well as others that may be useful) will be checked for applicability when the evaluation of the data is initiated.

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APPENDIX A

GEOHYDROLOGY OF THE HANFORD SITE

A.0 GEOHYDROLOGY

This chapter briefly summarizes the geohydrologic setting and character of the region and area. Sections A.1 through A.6 provide a discussion of the regional setting, site topographic expression, structure, stratigraphy, surface water hydrology and groundwater hydrology.

Numerous geologic and hydrologic studies have been carried out at Hanford since the early 1940's when the site was first selected for development of nuclear technology. Extensive geologic and hydrologic studies were undertaken as part of the licensing procedures for the Washington Public Power Supply System reactors and the proposed Puget Sound Power and Light Skagit/Hanford Nuclear Project. In addition to these recent studies, the hydrogeologic system at Hanford is monitored under guidelines from the U.S. Department of Energy. Geologic studies of the Pasco Basin are being carried out under the Basalt Waste Isolation Program (BWIP). These studies are refining conceptual models of the local geology and seismology. However, much of the more recently developed information is unpublished and not presently referenceable. In the future, this material will be incorporated into the existing data base as it becomes available.

A.1 REGIONAL SETTING

The geologic region containing the Hanford Site covers a portion of the Pacific Northwest that includes Washington, Oregon, and adjoining areas of Idaho and British Columbia. The physiographic pattern of the study region, a part of the North American Cordilleran system, is a complex arrangement of mountain ranges, plateaus, and basins. These features are the result of extensive Cenozoic (the past 65 million years) volcanic activity and the accumulation of thick sedimentary deposits in the structurally negative areas.

The Hanford Site is centrally located in the Pasco Basin, which in turn is near the center of the Columbia Plateau. To the east and north, the plateau is bounded by old, PreCambrian [ended about 570 million years before present (mybp)], and Paleozoic (about 225 to 570 mybp) rocks. To the west and south, almost all deposits are Cenozoic (from 0.01 to 65 mybp). The Columbia Plateau was formed during Miocene time (5 to 23 mybp) when vast outpourings of basalt lavas blanketed central Washington (USNRC, 1982).

Bounding the Columbia Plateau on the west are the Cascade Mountains, the dominant physiographic feature in the region. Topography in the plateau country east of the Cascade Mountains is relatively subdued compared with surrounding mountainous regions. The major topographic features of the plateau are generally east-west trending folds, anticlinal ridges and monoclines, and intervening basins. These structures are transected by rivers that locally have cut deep gorges into the layered basalt sequence.

A.2 SITE TOPOGRAPHY

The topography of the site has been created by the geologic structures within the region and the erosion of surficial geologic materials. The Pasco Basin is a gently undulatory plain mantled with Pleistocene glaciofluvial flood deposits and Holocene eolian deposits. This low-relief plain is bounded on three sides by the pronounced topographic/structural ridges of the Saddle

Mountains to the north, Umtanum and Yakima Ridges to the west, and the Rattlesnake and Horse Heaven Hills to the south. The eastern topographic boundary of the basin is indistinct, with major relief being sand dunes and coulees.

A.3 STRUCTURE

Geologic structures in the region of the site have been produced by tectonic deformation of the original near-horizontal basalt flows. Deformation began in upper Miocene prior to cessation of the basaltic lava outpourings. The downwarping of the Pasco Basin and the formation of prominent folds, anticlines and monclines was well developed in late Miocene time 10.5 mybp), and the basin was filled by Ringold sediments and later by Pliocene-Pleistocene gravels of the Hanford Formation.

The basin is bounded by prominent ridges; to the north the Saddle Mountains, Umtanum and Yakima Ridges to the west and by Rattlesnake Hills and the Horse Heaven Hills to the south. To the east, the buried basalt surface slopes gradually upward, forming a gradational boundary. Gable Mountain and Gable Butte are asymmetrical anticlines of basalt protruding through the surficial materials. Umtanum and Yakima Ridges plunge beneath the Quaternary-Tertiary sediments of the basin and die out beneath it. Evidence exists that Gable Mountain and Gable Butte are structural extensions of Umtanum Ridge.

Faults associated with the Gable Mountain anticline include the South and Central faults. Movement has been inferred to have occurred on the south fault in late Pleistocene time on the basis of deformation observed in clastic dikes present along the fault. The Central fault has displaced overlying Missoula Gravels (dated at 13,000-17,500 ybp) a maximum of 0.06 m (0.2 ft)(Myers and Price, 1979).

A.4 STRATIGRAPHY

The stratigraphy of the Pasco Basin consists of three basic units of highly contrasting lithology and origin. The lowermost unit that can be identified in the region is one of basalt flows, which are overlain in the Pasco Basin by the sands, silts, and gravels of the Ringold Formation. Above the Ringold Formation are the uncemented gravels of the Hanford Formation which are covered within 1.5 to 3 m (5 to 10 ft) of the ground surface by eolian sand.

The basalt flows of the plateau are generally separated by interbeds of volcanoclastic sediments. Most of the younger flows have been named and age dated, and their areal extent has been mapped. The stratigraphic section illustrating the succession of flows and overlying formations is shown in Figure A.1. Total thickness of basalt at Pasco Basin is at least 3,000 m (10,000 ft)(Blume and Associates, 1971a,b), only the upper portion of these flows has been studied in detail. Age determinations of basalt flows range from lower Miocene (6.5 mybp) to upper Miocene (6 mybp)(Rockwell Hanford Operations, 1979).

The Ringold Formation consists of fine to coarse sediments containing gravels deposited by a through-flowing stream during the late Miocene and early Pliocene (10.5 to 3.3 mybp). Its thickness in the area is about 300 m (980 ft). However, south and west of the Columbia River significant portions

of these sediments have been eroded away. In some locations, the surface of the Ringold Formation is capped by a relatively thick accumulation of caliche (calcium carbonate). The formation characteristically contains clays in the lower portion, locally consolidated and semiconsolidated silts, sands and gravels in the middle portion, and silts and sands in the upper portion.

The Hanford Formation unconformably overlies the Ringold Formation in the Pasco Basin. The formation consists of uncemented granular material ranging in size from boulders to silt. The uppermost gravels are assigned an age of 13,000 ybp, and the age of the lowermost is uncertain but could be as old as 3.3 mybp.

A.5 SURFACE WATER

The Columbia River, which flows through the northern part of the Site and along the eastern boundary, and the Yakima River, which flows along the southern boundary, are the dominant streams in the area. The historical flow rates of the Columbia River range from 4500 to 18,000 m-3/s (160,000 to 650,000 cfs) during the runoff in spring and early summer, to 1000 to 4500 m-3/s (36,000 to 160,000 cfs) during the low flow period of late summer and winter (Jamison, 1982). The average annual Columbia River flow in the Hanford reach is about 34,000 m-3/s (120,000 cfs). Maximum Columbia River floods of historical record occurred in 1894 and 1948, and had flows of 21,000 m-3/s (740,000 cfs) and 20,000 m-3/s (710,000 cfs) respectively (DOE, 1982). Floods of this size would inundate part of the 100-F Area but would be of little consequence to the remainder of the Site. The likelihood of floods of this magnitude recurring has been reduced by the construction of several flood control/water storage dams upstream of the Site.

The probable maximum flood would produce a flow of 40,000 m-3/s (1,420,000 cfs). Flood elevations at the 100-N and 300 Areas would be about 139 m (423 ft) and 117 m (383 ft) respectively (ERDA, 1976) This flood would not affect the central part of the Site where most of the low and high-level wastes are now stored, and which has an elevation greater than 152 m (500 ft).

There have been and still exist a number of cribs, ponds and ditches on the 200 Areas' plateau. The ponds and ditches receive cooling water from the 200 Areas and constitute an artificial source of groundwater recharge. Process and steam condensate which are discharged to subsurface cribs and constitute another source of artificial recharge to the underlying aquifer system. The effluents discharged to the cribs at times contain relatively low concentrations of radionuclides.

A.6 GROUNDWATER

A detailed description of the geohydrologic units that underlie the Hanford Site is found in Gephart (1979). Figure A.2 is a map showing the locations of the wells on the Hanford Site used to develop this description. The geological formations of the Hanford Site have been divided into seven geohydrologic units according to hydrologic character and properties (Figure A.3).

The unsaturated (vadose) zone lies between the ground surface and the water table. The springs along the flanks of the Rattlesnake Hills are thought to issue from zones of perched groundwater within the vadose zone

(Gephart, 1979) Within the Hanford Site, the unsaturated zone ranges in thickness from less than one foot near the Columbia River to about 330 feet beneath the 200 Area plateau. The thickest unsaturated zone located in the eastern portion of the Pasco Basin has been encountered during the drilling of a well in the NW1/4, SW1/4, Section 27, T11N, R29E where the water table was reached at a depth of 456 feet below the surface. The unsaturated zone is primarily composed of sediments of the Hanford and/or Ringold Formations, depending on the position of the water table in a given area at a given time.

Sources of natural recharge to the unconfined aquifer are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima and Columbia Rivers. The movement of precipitation through the unsaturated zone is of considerable interest because it represents a potential route for the transfer of materials from shallow-land burial sites to the groundwater. A number of studies have been conducted at several locations on the Site to try to define the movement of water in the vadose zone (Hsieh, et al. 1973a, 1973b; Isaacson, et al. 1974a, 1974b; Brownell, et al. 1975; Last, et al. 1976; Jones, 1978; Brown and Isaacson, 1977; Brodzinski, et al. 1983; Kirkham and Gee, 1984; Heller, et al 1984; Jones and Gee, 1984; and Jones, et al. 1984).

The conclusions made from these studies are varied. Some investigators found no downward percolation of precipitation, and that all the moisture penetrating the soil is removed by evapotranspiration, while others have observed downward water movement below the root zone where soils are coarse textured and precipitation is above normal. The penetration of plant roots enhances the removal of moisture from near-surface soil through the process of transpiration (Hinds, 1975; Cline, et al. 1977; Kirkham and Gee, 1984). Rainfall infiltration into the soil has been reported down to depths of 7.6 m (Jones and Gee, 1984), 6m (Brown and Isaacson, 1977), and 4 m (Brodzinski et al. 1983).

When soils are coarse textured and not vegetated, precipitation can drain through the vadose zone to the groundwater. At some shallow burial sites at Hanford, the soil is kept bare by repeated herbicide applications. Based on bare soil lysimeter studies, Jones and Gee (1984) estimated the annual recharge rate of precipitation to groundwater to range from 0 to 5 cm/yr. The recharge rates are affected by differences in soil texture, permeability characteristics and variation in climate. Kirkham and Gee (1983) reported both calculated and measured drainage below the root zone of more than 5 cm during a year with 50% greater than average rainfall.

The unconfined aquifer consists of the Hanford and Ringold Formations, except along the Columbia River where Holocene alluvium is thick enough to extend below the water table. Large differences in hydraulic conductivity appear between the Hanford Formation and the middle Ringold unit, the two major geologic units of the unconfined aquifer. The Hanford Formation normally exhibits a hydraulic conductivity between 1000 and 10,000 feet per day; whereas the middle Ringold averages 130 feet per day (Gephart, 1979). The great range of conductivities found in the Ringold Formation may be due in part to the reworking of older Ringold sediments by streams of Hanford or glaciofluvial age which removed finer grained sediments and cementation , thereby increasing the overall hydraulic conductivity of the formation. This situation may exist at wells, identified as completed in Ringold sediments,

where hydraulic conductivities are in excess of 7000 feet per day. These permeable channels are reflected in the groundwater flow pattern of the region. Field measured hydraulic conductivity values have been determined from well tests throughout the Hanford Site, selected tests are shown in Table A.1.

There are limited data available on storage coefficients and specific yields at the Hanford Site. Those presented in Table A.1 are extracted from reports and are estimates for the unconfined aquifer. Newcomb, et al (1972) provide an areal estimate of 0.11 for the storage coefficient in the 200 West area. This estimate is based on the growth of the groundwater mounds between 1948 and 1953 and the water disposal rate during this period. The values estimated for the Hanford unconfined aquifer range 0.006 to 0.35. Use of these values should take into account the quality of the measurements, which is considered poor.

A limited number of measurements of porosity have been made at Hanford. In general, porosity values have been obtained by calculation using the bulk density of core samples and the particle density of the sediments. Routson and Fecht (1979) present soil properties from twelve Hanford wells which include bulk density measurements. Resulting porosity values range between 0.40 and 0.42 for sediments in the upper portions of the vadose zone and between 0.33 and 0.36 for sediments near the water table.

Maps of the groundwater tables for 1944 and 1978 (Figures A.4, A.5) for the Hanford Site reflect the direction of groundwater flow and the effects of natural and artificial recharge and withdrawal.

The base of the aquifer is defined by either the silt and clay sediment of the lower Ringold unit or the basalt surface. The thickness of the aquifer ranges from zero to 300 feet. Where the Hanford Formation extends below the water table, it is generally composed of coarse sand, gravel, and cobbles with occasional finer grained sediments. The Ringold Formation is divided into an upper, middle and lower unit, each having different textures as previously shown in Figure A.3. The unconfined aquifer is dominated by the middle Ringold, composed of sorted sands and gravels of varying cementation. The degree of cementing properties of this unit; i.e., the less the unit is cemented, the higher its hydraulic conductivity.

The lateral boundaries of the unconfined aquifer are identified by the anticlinal basalt structures which rim the Pasco Basin. These include the Saddle Mountains to the north, Umtanum and Yakima Ridges on the west, Rattlesnake and Horse Heaven Hills on the south, and on the east by a broad monocline. The water table lies within the basalt in areas where the unconfined aquifer thins over bedrock; the most notable of these sites being Gable Mountain and Gable Butte located just north of the 200 areas.

The confined aquifers underlying the Hanford Site have been lumped into three major groups according to the basalt flows in which they lie: Saddle Mountains; Wanapum; or Grand Ronde basalts. The aquifers lying within each basalt sequence tend to have similar hydrologic properties with groundwater flow occurring primarily horizontally in the interbeds between the individual flows and vertically where fractures or other structures are present. Although understanding the confined aquifer system is essential to understanding the regional hydrology, these aquifers play a minor role in the

movement of any contaminants from the near surface. Because of this, comments on the confined system are retricted to the uppermost sequence of confined aquifers, those of the Saddle Mountains basalt.

Groundwater in the Saddle Mountains confined aquifers occurs principally in the interbeds and interflows separating individual basalt flows. Flow rates are relatively small; hydraulic conductivities range between 0.3 and 33 m/day (1 and 100 ft/day)(Gephart et al, 1979). The groundwater flow in these aquifers is generally to the southeast across the Pasco Basin with discharge to the Columbia River. Figure A.6 is a potentiometric map for the uppermost confined aquifer based on data through 1970. This map depicts the general groundwater flow and also shows that in places, the hydraulic potential in the confined aquifer is greater than in the overlying unconfined aquifer (compare Figures A.4 and A.6. The main exception to this is in the vicinity of the 200 area groundwater mounds discussed earlier.

Minor amounts of groundwater are being produced from wells at the Fast Flux Test Facility (FFTF) and at WNP-1, -2, -4. These are the major production wells at the Hanford Site. The WNP facilities have a reported groundwater useage of 946 m-3 (9,250,000 gal) per month or 22.7 lpm (6 gpm) WPPSS, 1981), most of which comes from aquifer interbeds in the basalts.

TABLE A.1 Results of Pumping Tests from Selected Wells Completed Within the Unconfined Aquifer (after Gephart et al., 1979)

Hanford Well Coord.	Unit Tested	Hydraulic Cond. (ft/d)	Transmissivity (ft-2/d)	Coefficient of Storage
1-K-10	MR	53	4,500	0.04
6-31-53	MR	120	14,000	0.06
6-36-61	MR	43	2,800	0.05
6-43-89	MR?	85	19,000	0.016
6-55-50	H	9,100	594,000	0.07
6-62-43	H	1,700	50,000	0.06
6-77-54	MR	175	13,000	0.03

For locations of wells refer to Figure A.2.
Unit Tested
MR = Middle Ringold
H = Hanford Formation

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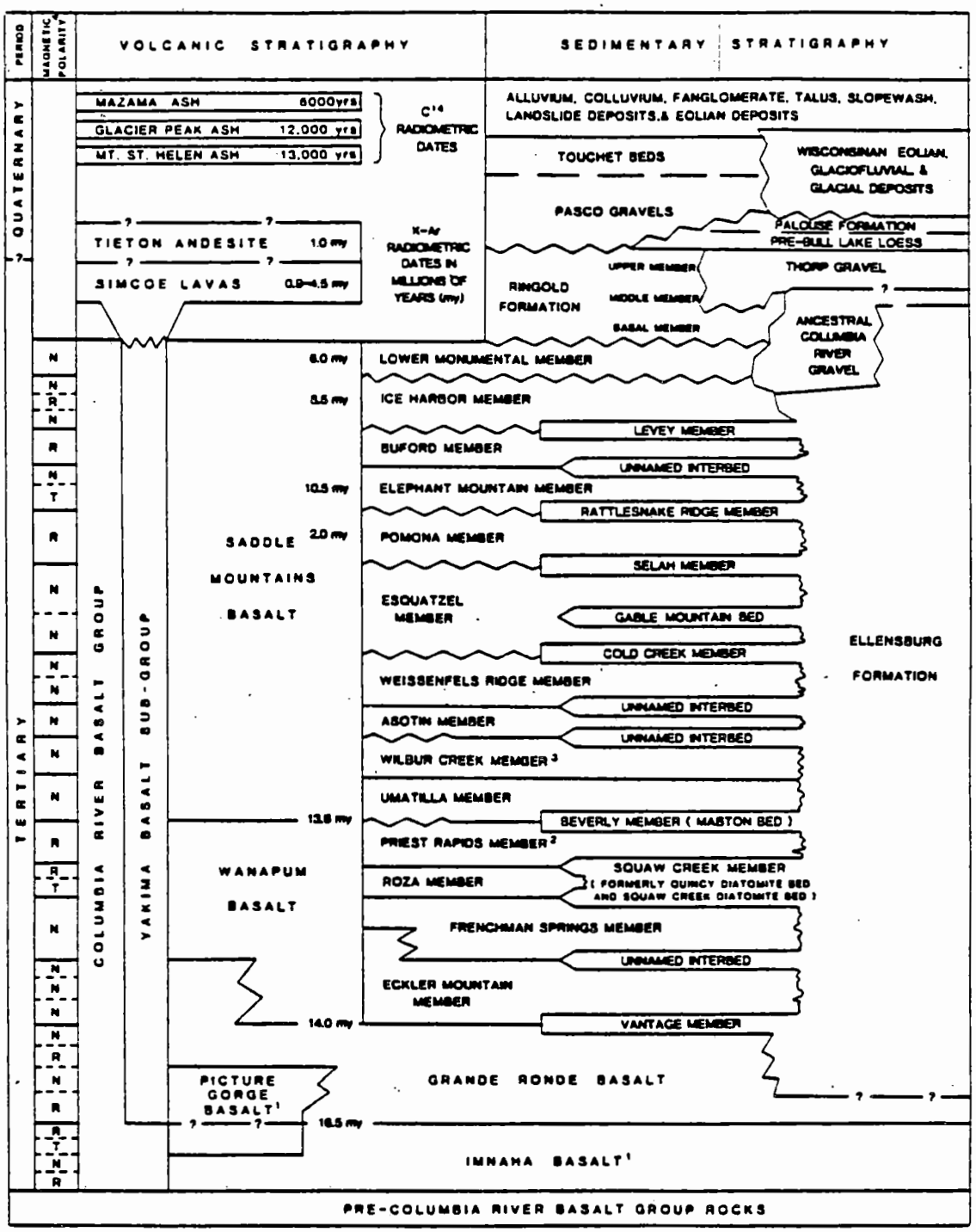


MODIFIED FROM ROCKWELL, 1979, TABLE III-1; USGS BULL 1457-G, 1979, FIG. 2, p. G7

1. THE IMNAHA & PICTURE GORGE BASALTS ARE NOWHERE KNOWN TO BE IN CONTACT.
2. PRIEST RAPIDS MEMBER UNDERLIES, LOCALLY WITH EROSIONAL UNCONFORMITY, THE UMATILLA MEMBER.
3. WILBUR CREEK MEMBER UNDERLIES, LOCALLY WITH EROSIONAL UNCONFORMITY, THE ASOTIN MEMBER.
4. MAGNETIC POLARITY: N (NORMAL), R (REVERSED), T (TRANSITIONAL).

FIGURE A.1. Late Cenozoic Stratigraphy of the Columbia Plateau (WPPSS 1981)

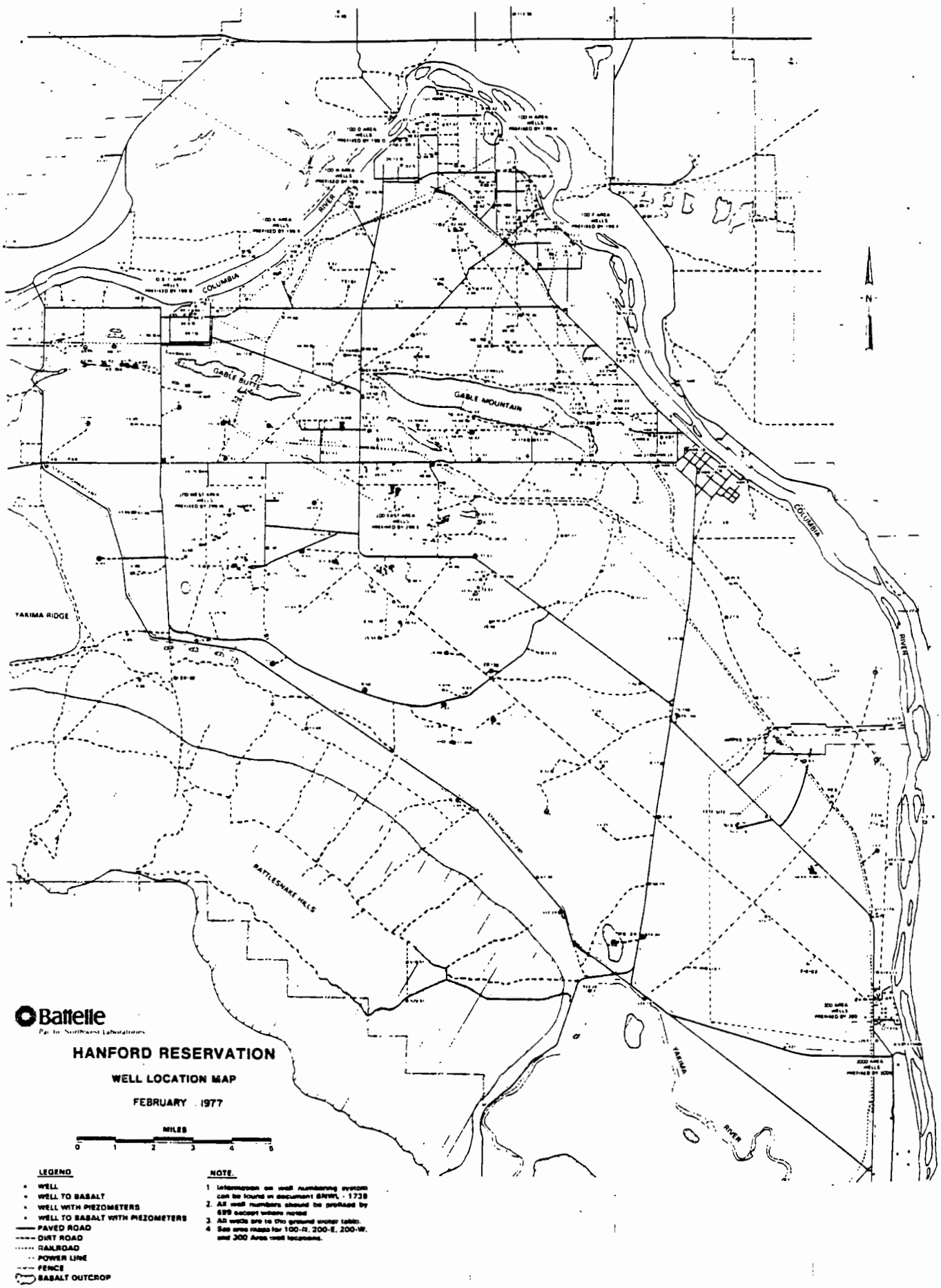


FIGURE A.2. Location of Wells on the Hanford Site

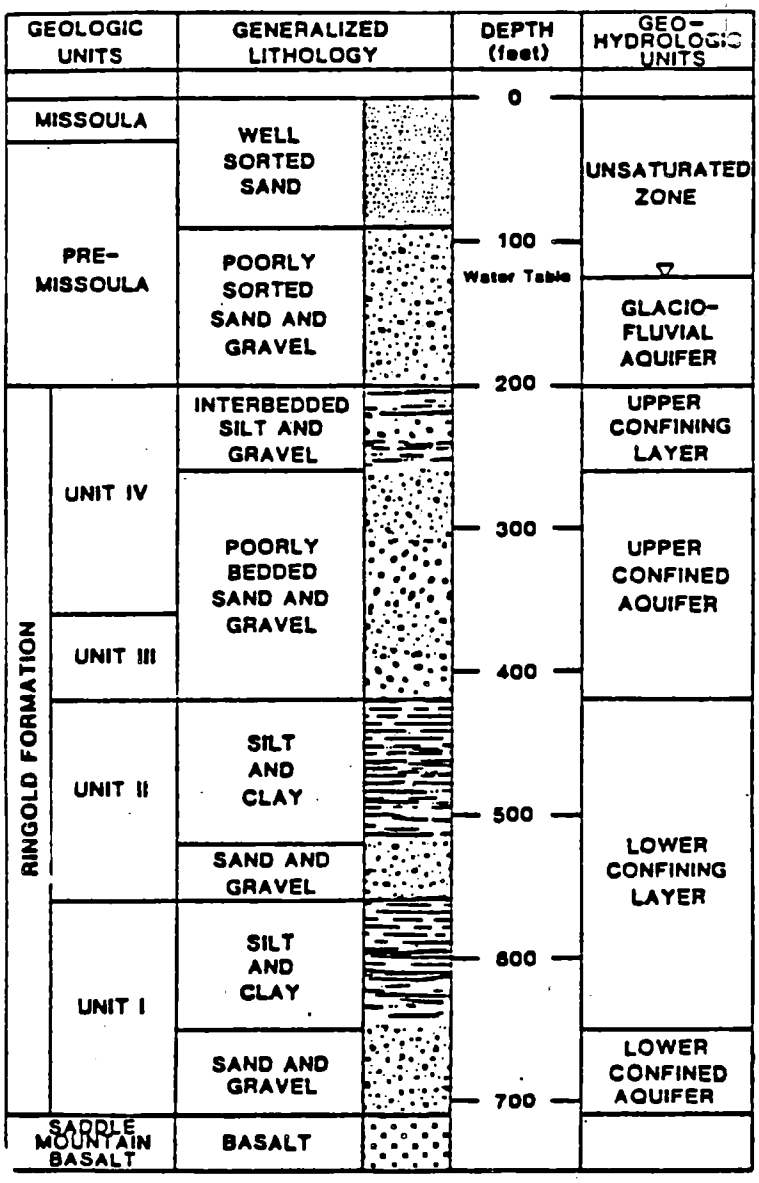


FIGURE A.3. Generalized Geologic and Geohydrologic Column (Puget Sound Power and Light Company 1981a)

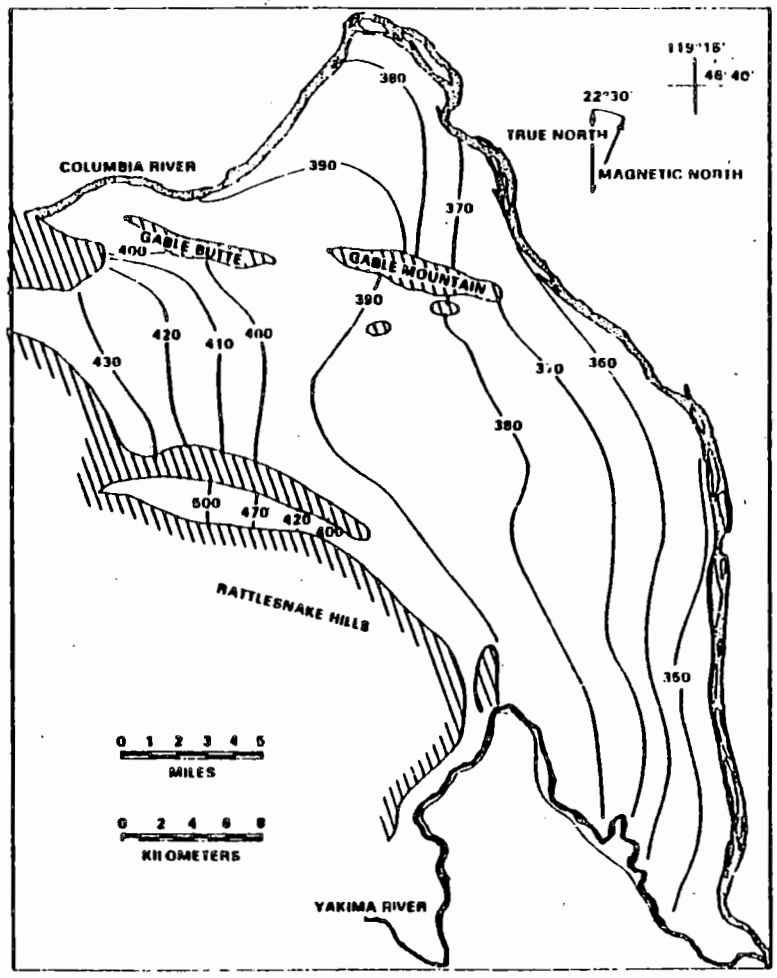


FIGURE A.4. Hanford Site Water-Table Map, 1944

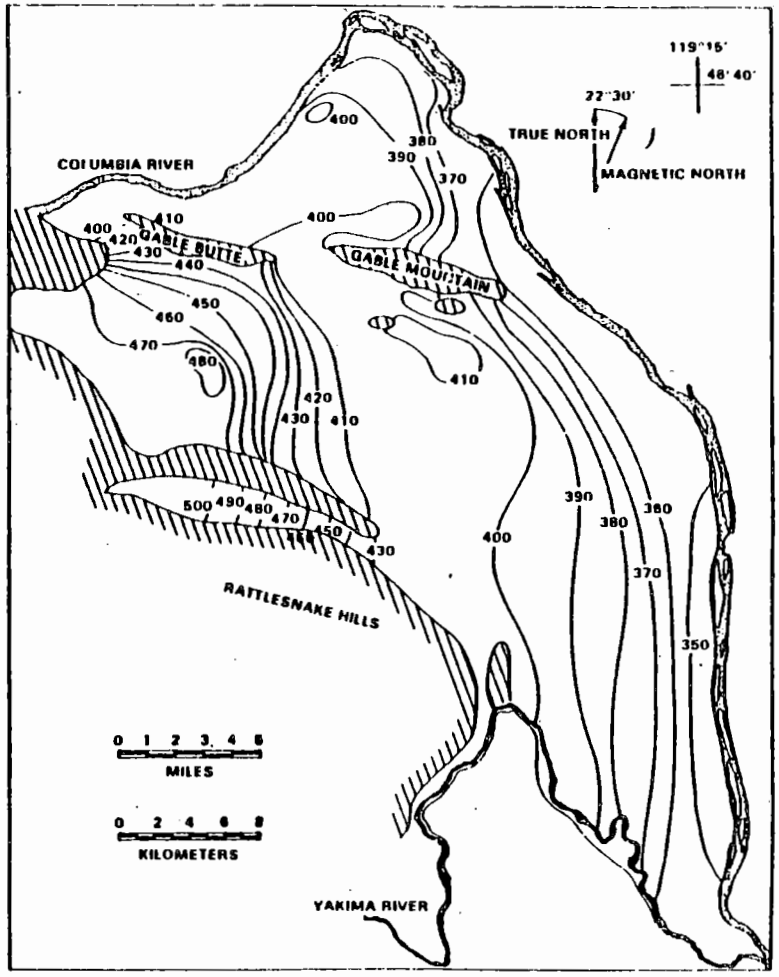


FIGURE A.5. Hanford Site Water-Table Map, 1978

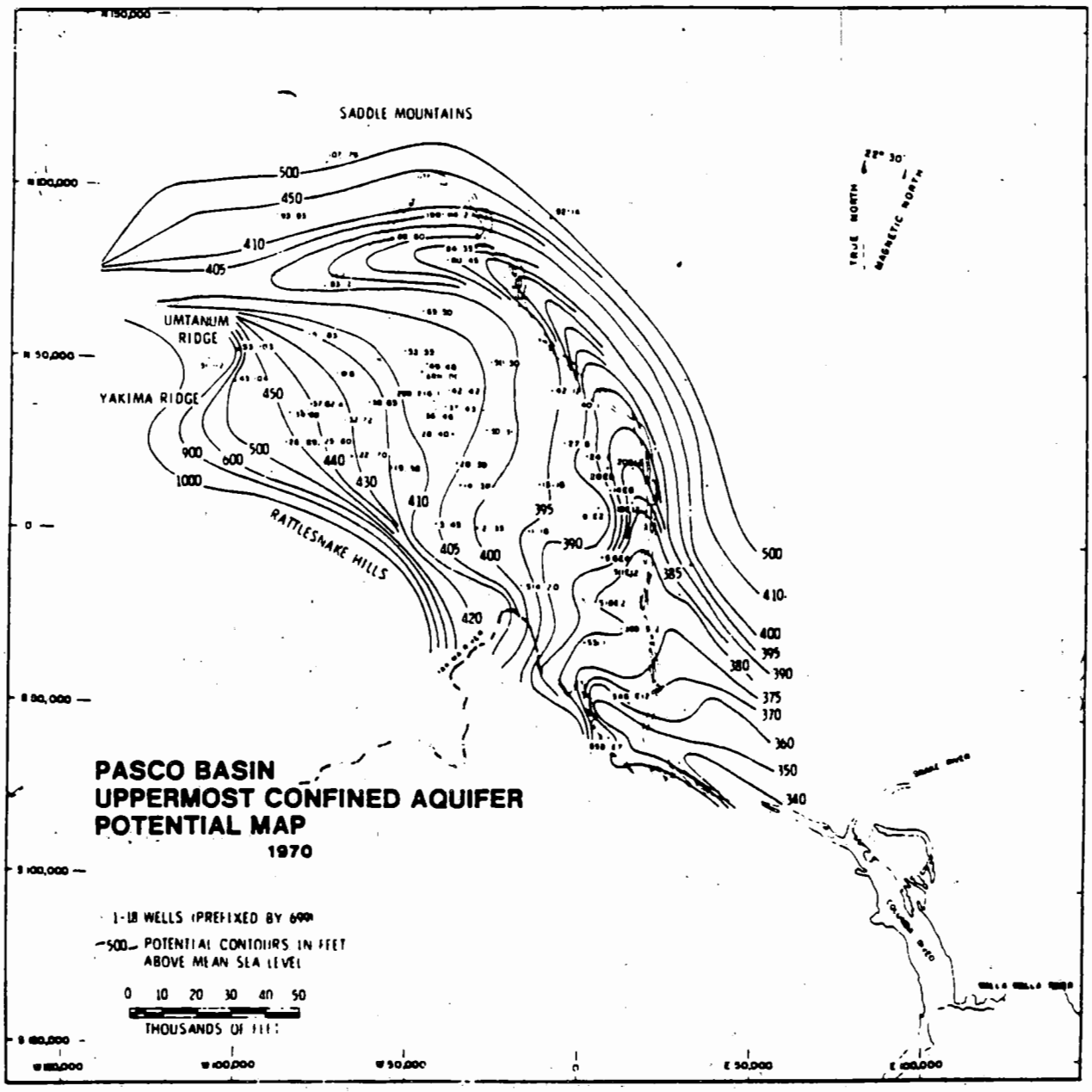


FIGURE A.6. Uppermost Confined Aquifer Potential Map for the Hanford Site, 1970

APPENDIX B

ADDITIONAL WELL INFORMATION

WELL NO. 1 H3 1 TOTAL DEPTH= 75.00

DATE: 082460
DRILLER:
FORMAN: ST GEORGE

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	10 INCH MINUS ROCK AND GRAVEL
20.	COBBLES AND SILTY SAND
30.	GRAVEL AND SILTY SAND
35.	SMALL GRAVEL AND SILTY SAND
50.	GRAVEL AND SILTY SAND

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
60.	BROWN SANDY CLAY
65.	SANDY CLAY WITH BASALT
70.	SAND WITH A LITTLE CLAY
75.	SANDY CLAY AND BASALT
45.	**COMMENT** WATER TABLE AT -45 FEET

WELL NO. 1 H4 2 TOTAL DEPTH= 386.00

DATE: 032852
DRILLER:
FORMAN: ROW

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
10.	GRAVEL, SAND AND SILT, WATER TABLE AT -3 FEET
31.	GRAVEL AND SAND; CAVES
35.	GRAVEL AND SAND; CAVES
37.	GRAVEL AND SAND
50.	SAND AND SOME GRAVEL; CAVES AND RUNS
53.	SAND AND GRAVEL
55.	SAND AND SOME GRAVEL
59.	SAND AND GRAVEL

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
65.	HEAVY SILT, REDDISH BROWN
70.	SILTY CLAY AND ROTTEN SANDSTONE
75.	CLAY, SILT, SANDSTONE, CALICHE AND SAND
85.	CLAY, ROTTEN SANDSTONE AND SAND
90.	SAND AND SILT LIKE SANDSTONE
95.	SAND, SILT AND CALICHE
100.	SANDY CLAY AND SILT
110.	SANDY CLAY, SILT AND CHIPS OF BASALT
125.	SANDY CLAY, SILT AND CALICHE
135.	SANDY CLAY, SILT AND CHIPS OF BASALT
145.	HEAVY SANDY CLAY AND SILT
150.	HEAVY SANDY CLAY, SILT, SOME BASALT GRAVEL AND CHIPS
165.	LAYERS OF HEAVY CLAY, SILT, THEN HEAVY LAYER OF BLACK AND WHITE SAND
170.	SANDY CLAY, SILT AND BASALT CHIPS
175.	REDDISH BROWN CLAY, YELLOW SANDY CLAY AND SILT
185.	YELLOW SANDY CLAY AND SILT
190.	YELLOW SANDY CLAY AND SILT W/BASALT GRAVEL; THIS SAND AND SILTY CLAY FORMATION BRIDGES THE HOLE OVER
192.	GRAVEL THE SIZE OF GOLF BALLS, LOT OF GRAY SAND; CAVES AND RUNS UP HOLE
200.	1' GRAY SAND, BROWN SANDY SILT; SAND COMES IN
205.	WHITISH SANDY ASH AND SOME ROCK CHIPS
210.	BROWN SAND, SILT AND MUD
230.	GRAY MUCK AND VERY FINE SAND; 215'-230' GRAY CALICHE MUD; SAND COMES IN
235.	NO RECORD; MUCK AND SAND COME IN HOLE
245.	SAND, SOME SILT, AND BASALT CHIPS; SAND RUNNING IN
250.	4' SAND AND 1' CLAY
270.	SLICK CLAY, GRAY ASH, SHALE AND SANDSTONE; AT 265' MORE GRAY ASH
272.	BLUE CLAY W/GRAVEL EMBEDDED IN IT
274.	SANDY WHITE MUD; SAND WILL PUMP BACK UP THE PIPE
275.	BLUE CLAY W/GRAVEL
277.	BLUE SHALE, FINE GRAVEL AND LAYER SAND

280.	GREEN CLAY AND FINE GRAVEL
290.	BLACK STIFF MUD; VOLCANIC MUD
295.	BLACK MUD
300.	BLACK MUD AND SHALE; HARD SHALE FORMATION ABOUT 1' THICK AT 300'
325.	BLACK MUD
330.	BLACK MUD LIKE SHALE; GET PIECES OF HARD GRAY SHALE WHEN DRY, BLACK WHEN WET
331.	ACTS LIKE BASALT
334.	SHALE; TOUGH AS HELL
335.	HARD BLACK SHALE
340.	BLACK SHALE, GREEN CLAY; THIS LOOKS LIKE ROTTEN BASALT
355.	GREEN, BLACK AND WHITE SHALE OR CLAY

COLUMBIA RIVER BASALT GROUP

DEPTH	MATERIALS PENETRATED
365.	BASALT, ROTTEN OR WEATHERED
370.	BASALT

UNKNOWN SEDIMENTARY MEMBER

DEPTH	MATERIALS PENETRATED
380.	ASH, SAND, SILT, BLUE CLAY, SHALE, GRAVEL AND SANDSTONE; SAND CAME IN

COLUMBIA RIVER BASALT GROUP

DEPTH	MATERIALS PENETRATED
381.	TOP OF SECOND LAYER OF BASALT
385.	BASALT
386.	BASALT AND BLUE MUD

WELL NO. 1 H4 3 TOTAL DEPTH= 55.00

DATE: 051774
DRILLER:
FORMAN: BAKER

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	60% GRAVEL, 40% SAND
10.	50% GRAVEL, 50% SAND
15.	60% GRAVEL, 40% SAND
40.	60% SAND, 40% GRAVEL
43.	BOULDER
49.	SAND, GRAVEL, COBBLES

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
50.	CONGLOMERATE
55.	CONGLOMERATE AND CALICHE
39.	**COMMENT** WATER TABLE AT -39 FEET

WELL NO. 1 H4 4 TOTAL DEPTH= 55.00

DATE: 060183
DRILLER: TROY
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	LARGE TO SMALL GRAVEL, MEDIUM TO COARSE SAND
10.	LARGER TO MEDIUM GRAVEL, COARSE SAND, WET
15.	MEDIUM TO SMALL GRAVEL, SAND
20.	SMALL GRAVEL, COARSE FINE SAND, 1 OR 2 LARGE GRAVEL
55.	SAND & GRAVEL MIX (FINE TO EXTRA FINE) STATIC WATER AT 36' FROM WELL HEAD

WELL NO. 1 H4 5 TOTAL DEPTH= 60.00

DATE: 042783
DRILLER: TROY
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	70% MEDIUM GRAVEL, 20% SMALL GRAVEL (2"TO 5"), 5% FINE SAND, 3% TOP SOIL,2% ASH
10.	70% MEDIUM GRAVEL, 20% SMALL GRAVEL AND 10% SAND (RIVER BOTTOM SAND & GRAVEL), WET
12.	80% EXTRA LARGE GRAVEL (8" TO 15")
20.	LIGHT COLOR LARGER TO MEDIUM RIVER GRAVEL
22.	LARGE, MEDIUM, SMALL AND FINE GRAVEL, COARSE SAND, LARGE BOULDER (2' TO 18" AT 21')
35.	SAND, GRAVEL, COBBLES, BOULDERS
40.	SAND & GRAVEL, OUT OF BOULDERS AT 36'
48.	SAND, GRAVEL & SOME COBBLES, WATER BEARING 36' TO 48'

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
60.	BROWN SANDY SILT

WELL NO. 1 H4 6 TOTAL DEPTH= 54.00

DATE: 051283
DRILLER: BIGHAM
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	SAND, GRAVEL & COBBLES
10.	SAND, GRAVEL & COBBLES, BOULDER AT 14'
15.	MEDIUM TO SMALL GRAVEL WITH A LITTLE COARSE SAND MIXED IN, WET
20.	SMALL-MEDIUM-LARGE GRAVEL, WITH FINE SILT AND MEDIUM SAND
25.	SAME AS ABOVE, LARGE BOULDER
30.	LARGE BOULDER
35.	MEDIUM GRAVEL, LARGE GRAVEL & BOULDERS
36.	LARGE GRAVEL, ROCKS & A LITTLE COARSE SAND
45.	LIGHT, MEDIUM, COARSE, SAND & PEA GRAVEL
50.	SMALL GRAVEL, COARSE SAND & SOME WATER
54.	SMALL GRAVEL, PEA GRAVEL, COARSE AND FINE SAND, STATIC WATER AT 41' FROM WELL HEAD

WELL NO. 3 1 1 TOTAL DEPTH= 77.00

DATE: 110848
DRILLER: RUMLEY
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	ROCKS AND BOULDERS, CAVING
20.	ROCKS, BOULDERS AND SOME SAND
35.	SAND, ROCKS AND BASALT BOULDERS
42.	FINE BLACK SAND, WATER AT 42'
45.	COARSE GRAVEL, BASALT AND SAND
48.	GRAVEL, BASALT AND SAND

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
55.	FINE SAND, GRAVEL, BASALT AND ROCKS
58.	FINE SAND, GRAVEL AND BASALT
60.	FINE WATER SAND, AND SOME ROCKS
67.	FINE WATER SAND, ROCKS AND GRAVEL
73.	SAND, GRAVEL AND BASALT
77.	COARSE BLACK SAND

WELL NO. 3 1 2 TOTAL DEPTH= 101.00

DATE: 033050
DRILLER:
FORMAN: ROW

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
7.	BROWN BLOW SAND

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
13.	BOULDERS, GRAVEL, SAND & SILT
28.	COARSE BLACK SAND & FINE GRAVEL, NO SILT
30.	MOSTLY GRAVEL; ADDED TOP BLOW SAND SOIL TO DRILL
38.	GRAVEL, SAND & NO SILT
40.	GRAVEL, CLAY & SAND
50.	GRAVEL; CAVES, NO SILT OR CLAY, WATER TABLE AT -42 FEET
55.	COARSE BLACK SAND, GRAVEL
60.	GRAVEL, BLACK SAND

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
75.	GRAVEL, SAND & SOME SILT
80.	GRAVEL, SAND, VOLCANIC MUD
85.	BLACK SAND, GRAVEL; CAVES
92.	FINE SAND, SOME FINE GRAVEL, SOME VOLCANIC MUD; CAVES
93.	FINE SAND, GRAVEL; CAVES
95.	FINE SAND, SOME FINE GRAVEL, SOME VOLCANIC MUD; CAVES
99.	FINER SAND, SOME GRAVEL; CAVES
101.	SAND, GRAVEL, LAVA MUD

WELL NO. 3 1 3 TOTAL DEPTH= 102.50

DATE: 041950
DRILLER: ROW
FORMAN:

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	BLOWN SAND

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
11.	BOULDERS
20.	BOULDERS, SILT & SAND
25.	BLACK SAND, VERY LITTLE SILT, GRAVEL
30.	BLACK SAND, NO SILT
34.	**COMMENT** WATER TABLE AT -34 FT.
44.	GRAVEL, SAND, AND WATER
49.	GRAVEL, SAND, LESS WATER

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
50.	GRAVEL, SAND, LOTS OF SILT & LITTLE WATER
54.	SAND & SILT; VERY LITTLE GRAVEL
70.	ALTERNATING LAYERS OF GRAVEL & SILT & SAND
103.	SAND, SILT, GRAVEL

WELL NO. 3 1 4 TOTAL DEPTH= 101.00

DATE: 050150
DRILLER: ROW
FORMAN:

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	BLOWN SAND & SILT

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
10.	GRAVEL, SAND & SILT
12.	GRAVEL, SAND, SILT & BOULDERS
15.	BOULDERS, GRAVEL, SAND & SILT
25.	GRAVEL, SAND, SILT
38.	**COMMENT** WATER TABLE AT -38 FT.
40.	GRAVEL, SAND, SOME GRAY SILT; CAVES
45.	GRAVEL, SAND, SILT & A SHOWING OF WATER

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
51.	GRAVEL, SAND, TAN COLORED SILT
60.	BLUISH BLACK MUD; GRAVEL & SAND
74.	GRAVEL, SAND, SILT; HARD FORMATION
101.	SMALL GRAVEL, SAND, VERY LITTLE SILT

WELL NO. 3 1 5 TOTAL DEPTH= 45.00

DATE: 022075
DRILLER: BIGHAM
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
3.	SAND & GRAVEL
6.	SAND
9.	SAND, GRAVEL, COBBLES
30.	25% SAND, 25% GRAVEL, 50% COBBLES
45.	50% SAND, 50% GRAVEL

WELL NO. 3 1 6 TOTAL DEPTH= 44.00

DATE: 022775
DRILLER: BIGHAM
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	50% SAND, 50% GRAVEL
30.	25% SAND, 25% GRAVEL, 50% COBBLES
33.	**COMMENT** WATER TABLE AT -33 FT.
42.	50% SAND, 50% GRAVEL

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
44.	SILTY BROWN SAND

WELL NO. 3 2 1 TOTAL DEPTH= 75.00

DATE: 102848
DRILLER: RUMLEY
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
8.	BOULDERS, BASALT ROCKS, GRAVEL
13.	BASALT ROCKS, GRAVEL & SAND
29.	ROCKS, BOULDERS, BASALT GRAVEL
42.	GRAY SAND, ROCKS & BOULDERS
45.	GRAY SAND, GRAVEL & BASALT ROCKS

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
50.	FINE SAND, CLAY & SILT
60.	FINE SAND, BASALT ROCK & GRAVEL
70.	FINE SAND & SOME BLUE CLAY
75.	FINE SAND & BASALT ROCK

WELL NO. 3 3 10 TOTAL DEPTH= 65.00

DATE: 090176
DRILLER: BIGHAM
FORMAN:

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
40.	SAND, GRAVEL, COBBLES
55.	SILT, SAND & GRAVEL

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
57.	BROWN CLAY
65.	FINE SAND

WELL NO. 3 4 1 TOTAL DEPTH= 101.00

DATE: 021251
DRILLER: FORD
FORMAN:

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
1.	TOPSOIL

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	BOULDERS, GRAVEL, SILT & SAND
10.	GRAVEL, SILT & SAND
16.	BOULDERS, SAND, COARSE GRAVEL & SILT
21.	GRAVEL, SAND & A LITTLE SILT
23.	COARSE GRAVEL, SAND & SILT
63.	GRAVEL, SAND & VERY LITTLE SILT

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
75.	SAND & WATER BEARING GRAVEL
83.	GRAVEL & COARSE SAND
86.	GRAVEL, SILT & WHITE SAND
101.	GRAVEL & WHITE SAND
50.	**COMMENT** WATER TABLE AT -50 FT.

WELL NO. 3 4 7 TOTAL DEPTH= 155.00

DATE: 110861
DRILLER: OWENS
FORMAN:

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	SAND

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
20.	GRAY SAND & COBBLES
30.	GRAY SAND, GRAVEL & COBBLES
35.	GRAY SAND & GRAVEL TO 3"
36.	**COMMENT** WATER TABLE AT -36 FT.
60.	CLEAN LOOSE COBBLES & GRAVEL

INGOLD FORMATION

DEPTH	MATERIALS PENETRATED
75.	LOOSE GRAVEL
80.	LOOSE, GRAY COBBLES & GRAVEL
85.	CEMENTED COBBLES
95.	CEMENTED GRAVEL & COBBLES
100.	CEMENTED GRAVEL
105.	COBBLES & GRAVEL
118.	GRAY CEMENTED COBBLES & GRAVEL
125.	BLUE SILTY CLAY
135.	HARD, BLUE CLAY
155.	BLUE CLAY

WELL NO. 3 8 2 TOTAL DEPTH= 119.00

DATE: 051550
DRILLER:
FORMAN: ROW

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
2.	BLOWN SAND

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
14.	GRAVEL, SAND AND SILT
15.	GRAVEL
28.	GRAVEL, SAND, SILT
30.	GRAVEL, SAND AND VERY LITTLE SILT
40.	GRAVEL AND COARSE SAND
53.	GRAVEL, COARSE SAND AND VERY LITTLE SILT

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
53.	**COMMENT** WATER TABLE AT -53 FEET
65.	GRAVEL, SAND, SOME SILT AND WATER
70.	SAND AND SILT
73.	YELLOW CLAY
82.	BLUE SHALE
97.	GRAYISH BLACK VOLCANIC MUD
99.	BROWN MUD
100.	GRAVEL
104.	GRAVEL AND SAND
105.	FINE GRAVEL AND SAND
106.	GRAVEL
111.	SAND AND MUD
112.	GRAVEL AND SAND
119.	GRAVEL, SAND, VERY LITTLE SILT

WELL NO. 6 S30E15A TOTAL DEPTH= 80.00

DATE: 101571
DRILLER:
FORMAN: EVANS

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
9.	SAND & GRAVEL 1/4"-TO BOULDERS
20.	SAND & 1/4" GRAVEL TO COBBLES
35.	COARSE TO FINE BLACK SAND & 1 1/2 GRAVEL, WATER TABLE AT -21.0 FEET
40.	COARSE BLACK SAND TO FINE SAND, & 1" GRAVEL
50.	COARSE BLACK SAND TO FINE SAND W/COARSE GRAVEL
54.	COARSE BLACK SAND W/COARSE GRAVEL
55.	COARSE BLACK SAND & GRAVEL & BOULDERS
60.	BLACK SAND
65.	BLACK SAND COARSE TO FINE W/1 1/2" GRAVEL

RINGOLD FORMATION

DEPTH	MATERIALS PENETRATED
68.	FINE BROWN SAND W/COARSE BLACK SAND & SILT W/2" GRAVEL
75.	FINE BROWN SAND W/SILT & SOME 4" GRAVEL
80.	FINE BROWN SAND

WELL NO. 6 S19 E13 TOTAL DEPTH= 80.00

DATE: 110371
DRILLER:
FORMAN: BIGHAM

EOLIAN SEDIMENTS

DEPTH	MATERIALS PENETRATED
5.	75% FINE BROWN SAND, 25% SILT
15.	BROWN FINE SAND, SOME SILT

GLACIOFLUVIAL SEDIMENTS

DEPTH	MATERIALS PENETRATED
25.	25% SAND, 50% MEDIUM GRAVEL, 25% SMALL COBBLES (HIT GRAVEL TO 2" AT 16'
45.	30% SAND, 40% GRAVEL, 30% COBBLES
65.	20% SAND, 70% GRAVEL, 10% COBBLES, WATER TABLE AT -48 FEET
70.	40% SAND, 60% GRAVEL
75.	30% SAND, 70% GRAVEL

INGOLD FORMATION

DEPTH	MATERIALS PENETRATED
80.	10% SILT, 40% SAND, 50% GRAVEL, HOLE FILLED IN FIVE FEET AFTER PERFORATING

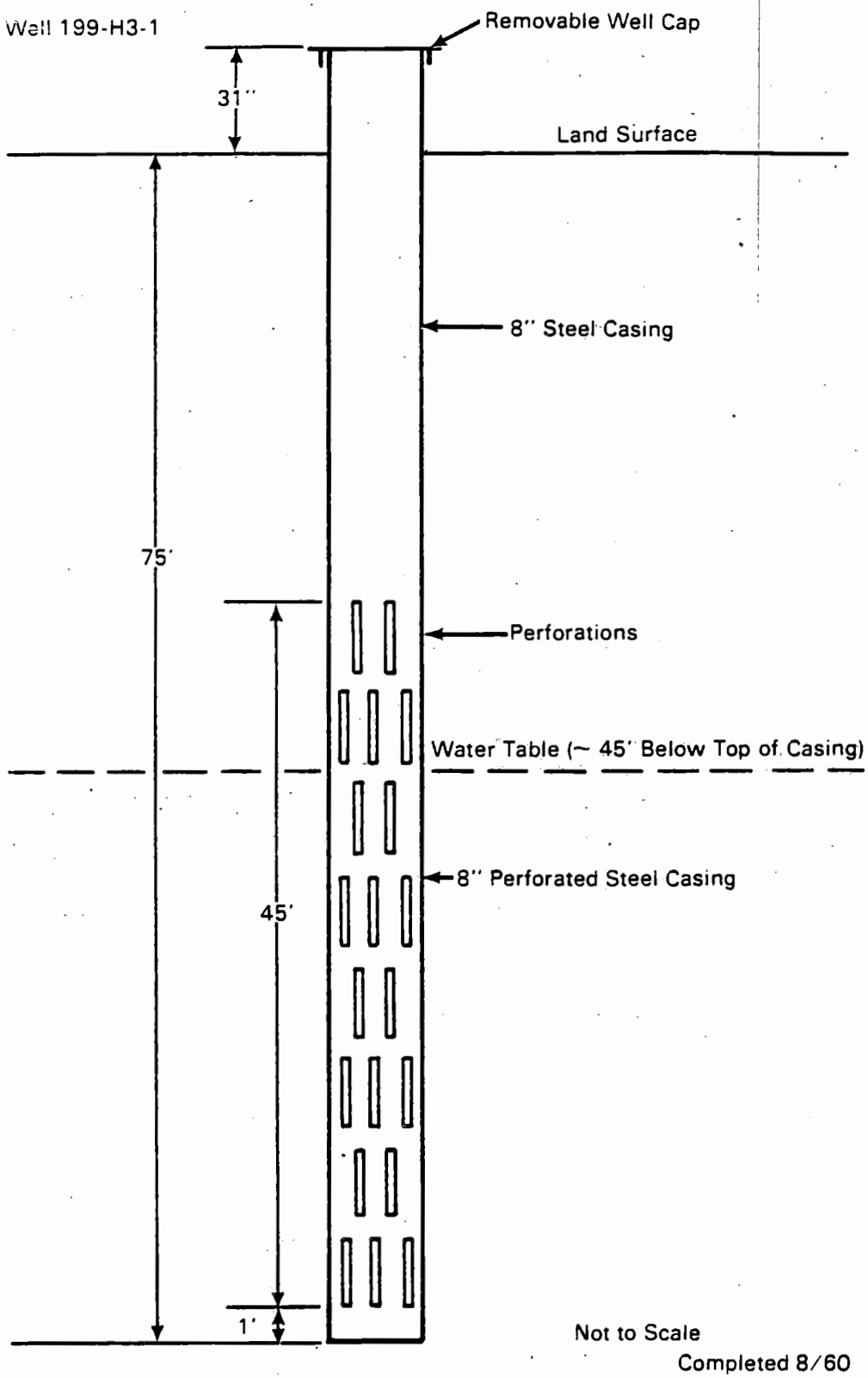


FIGURE B.1. Structural Diagram for Well 199-H3-1

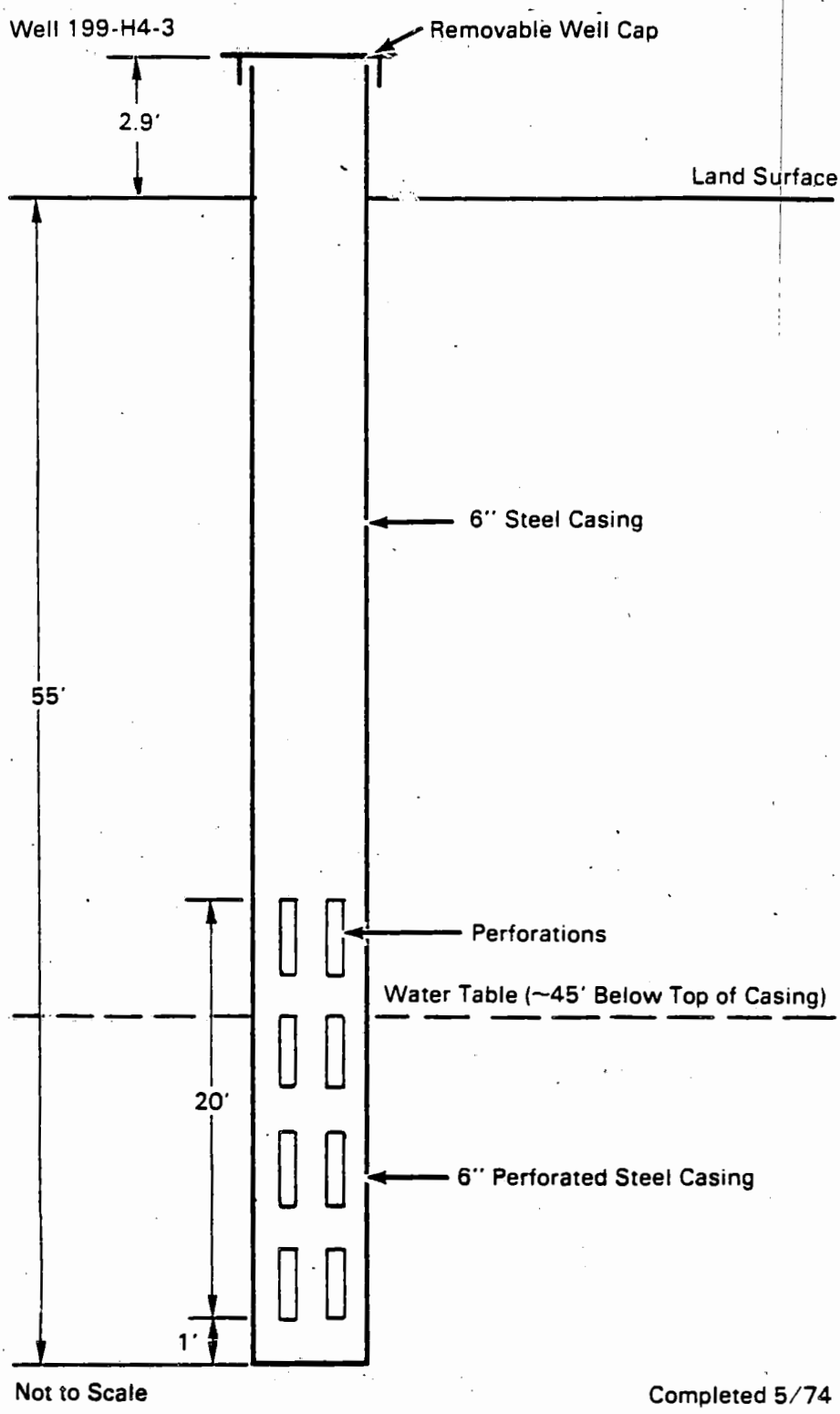


FIGURE B.2. Structural Diagram for Well 199-H4-3

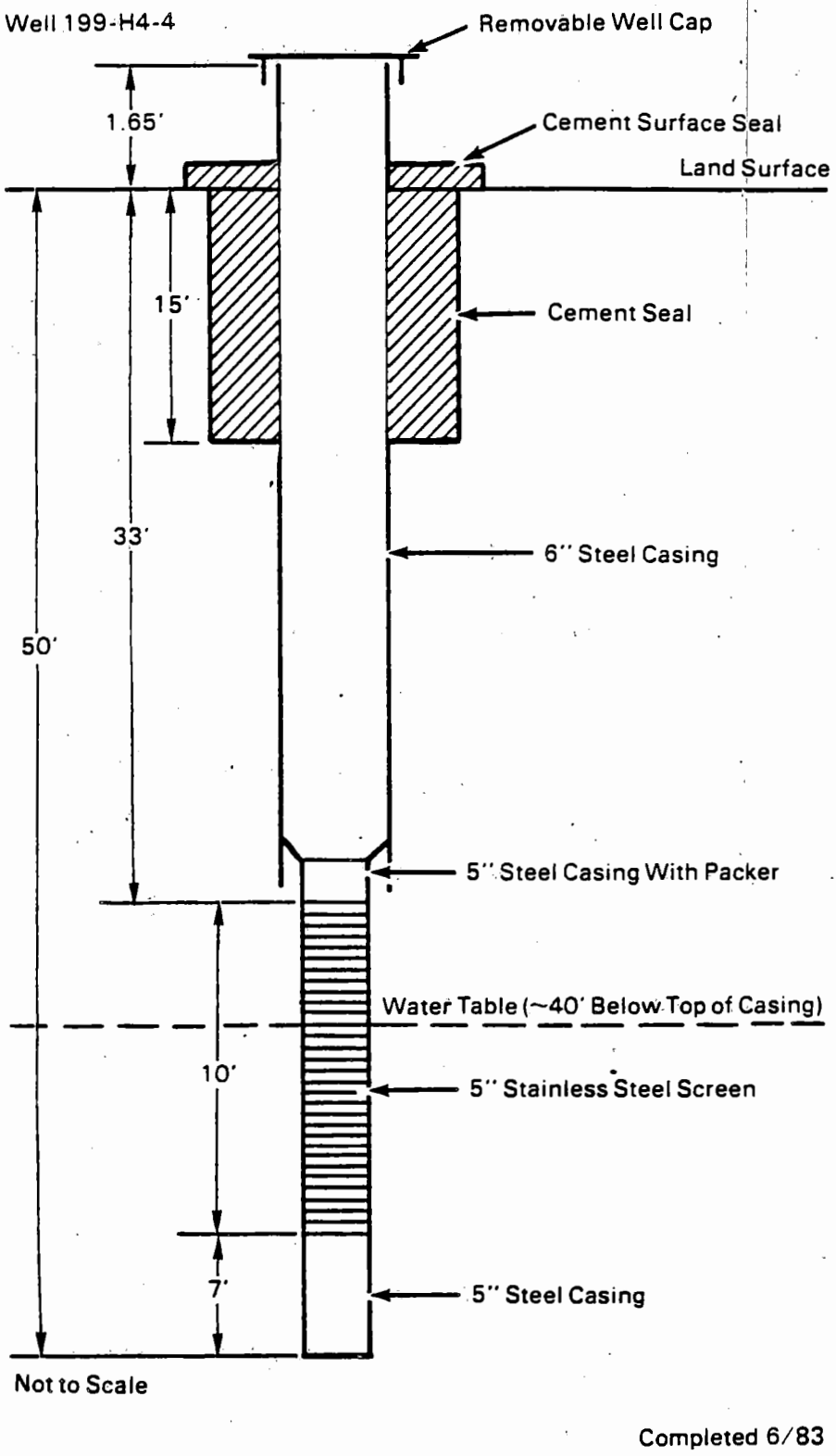


FIGURE B.3. Structural Diagram for Well 199-H4-4

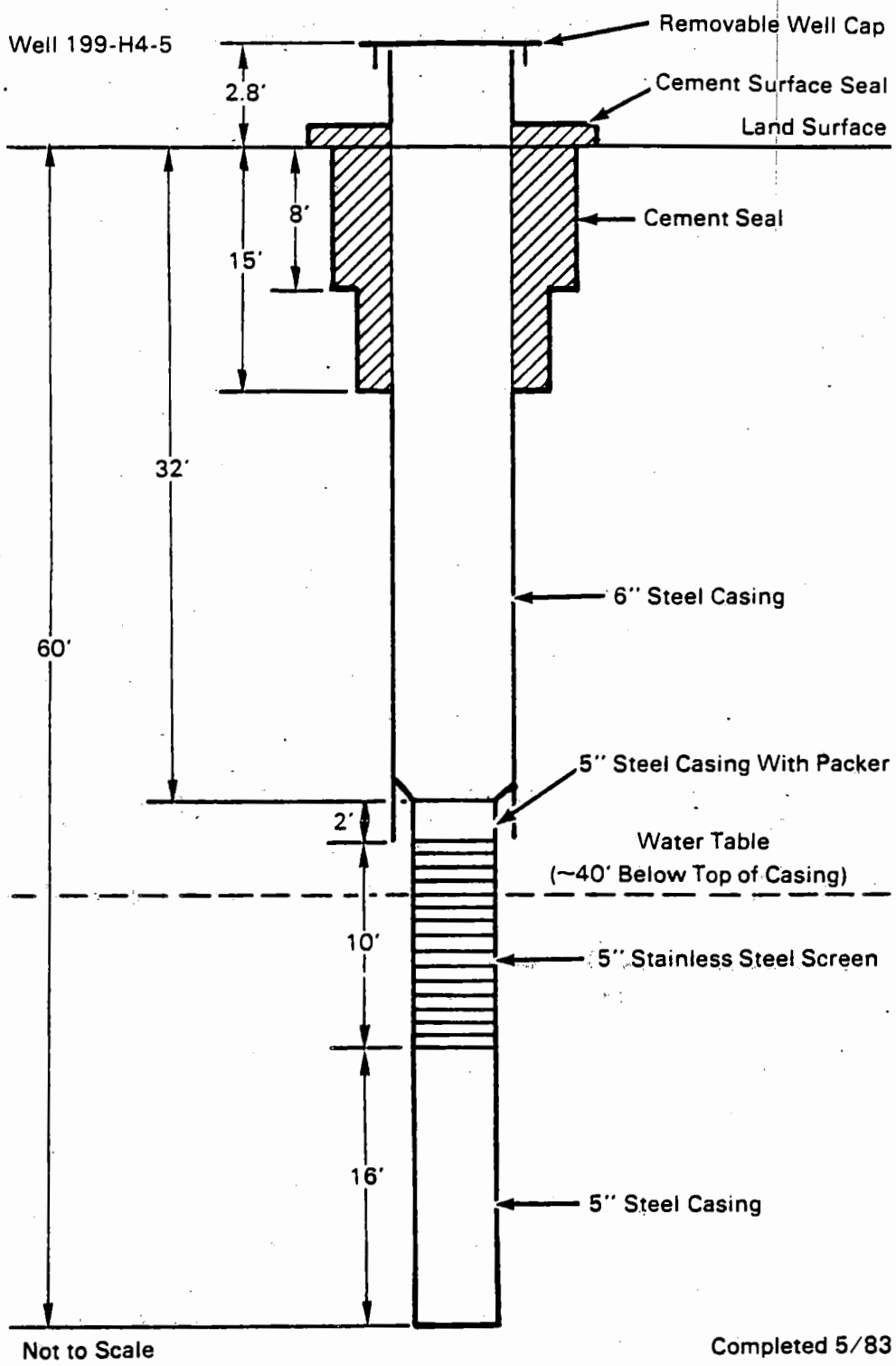


FIGURE B.4. Structural Diagram for Well 199-H4-5

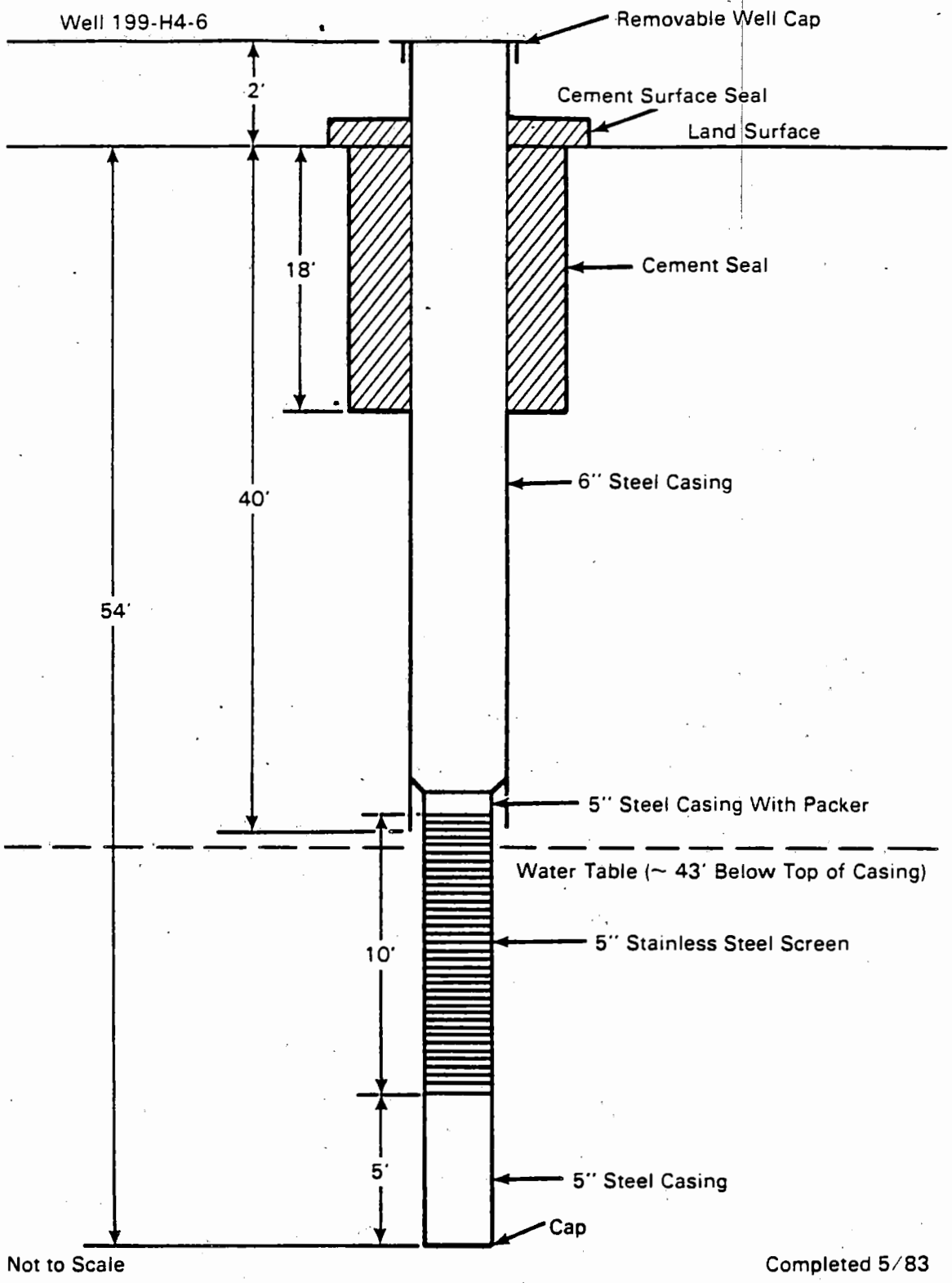


FIGURE B.5. Structural Diagram for Well 199-H4-6

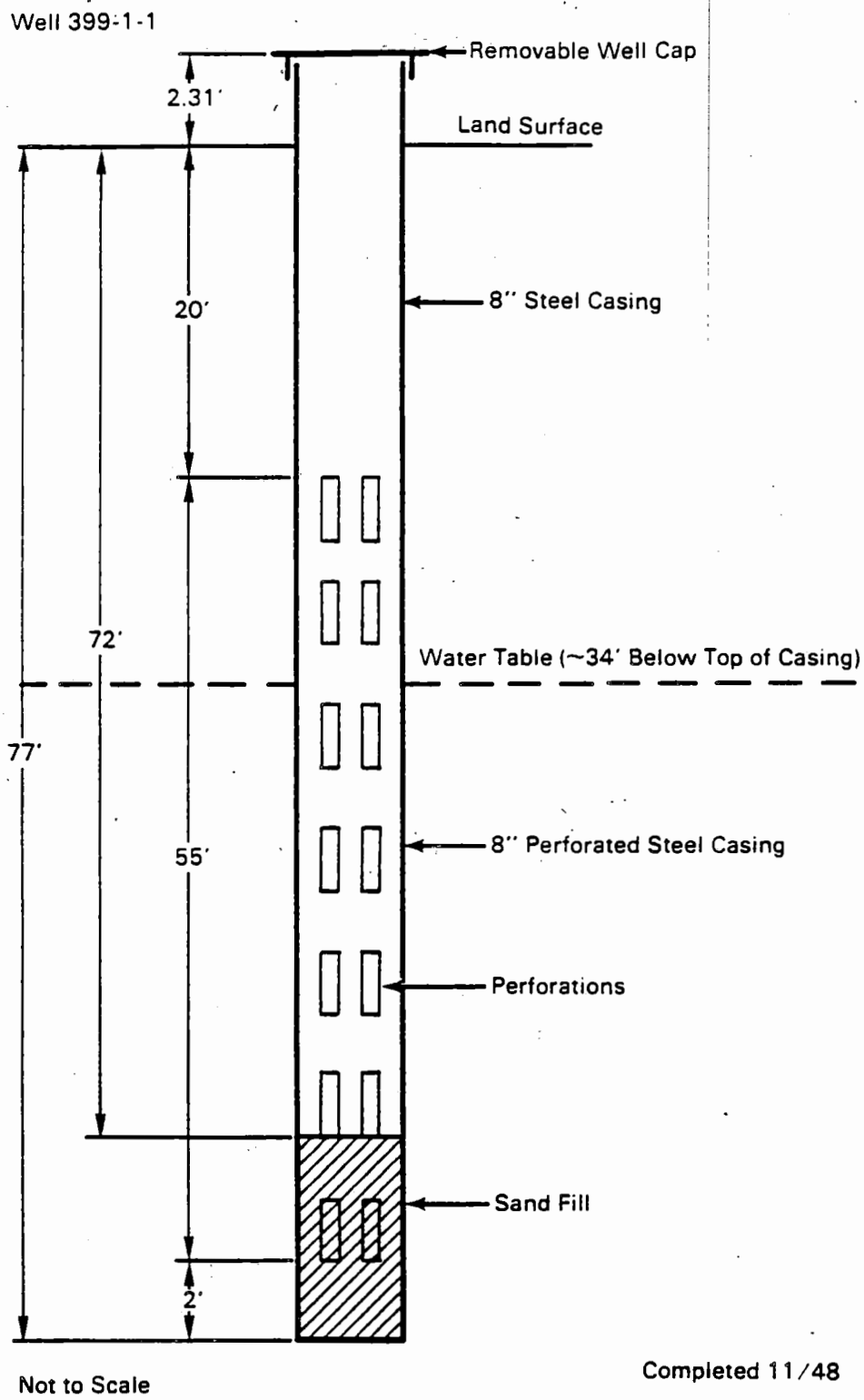


FIGURE B.6. Structural Diagram for Well 399-1-1

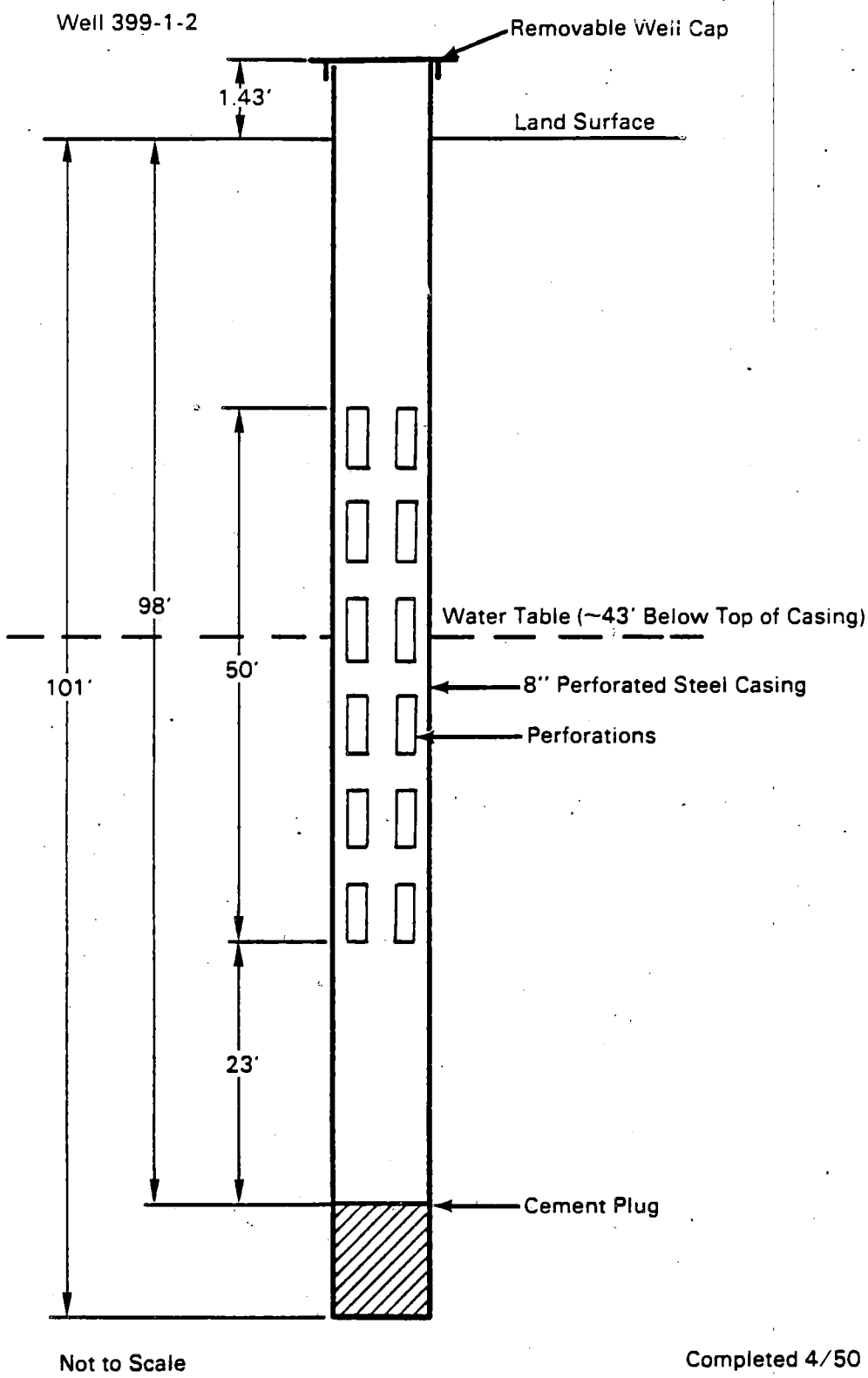


FIGURE B.7. Structural Diagram for Well 399-1-2

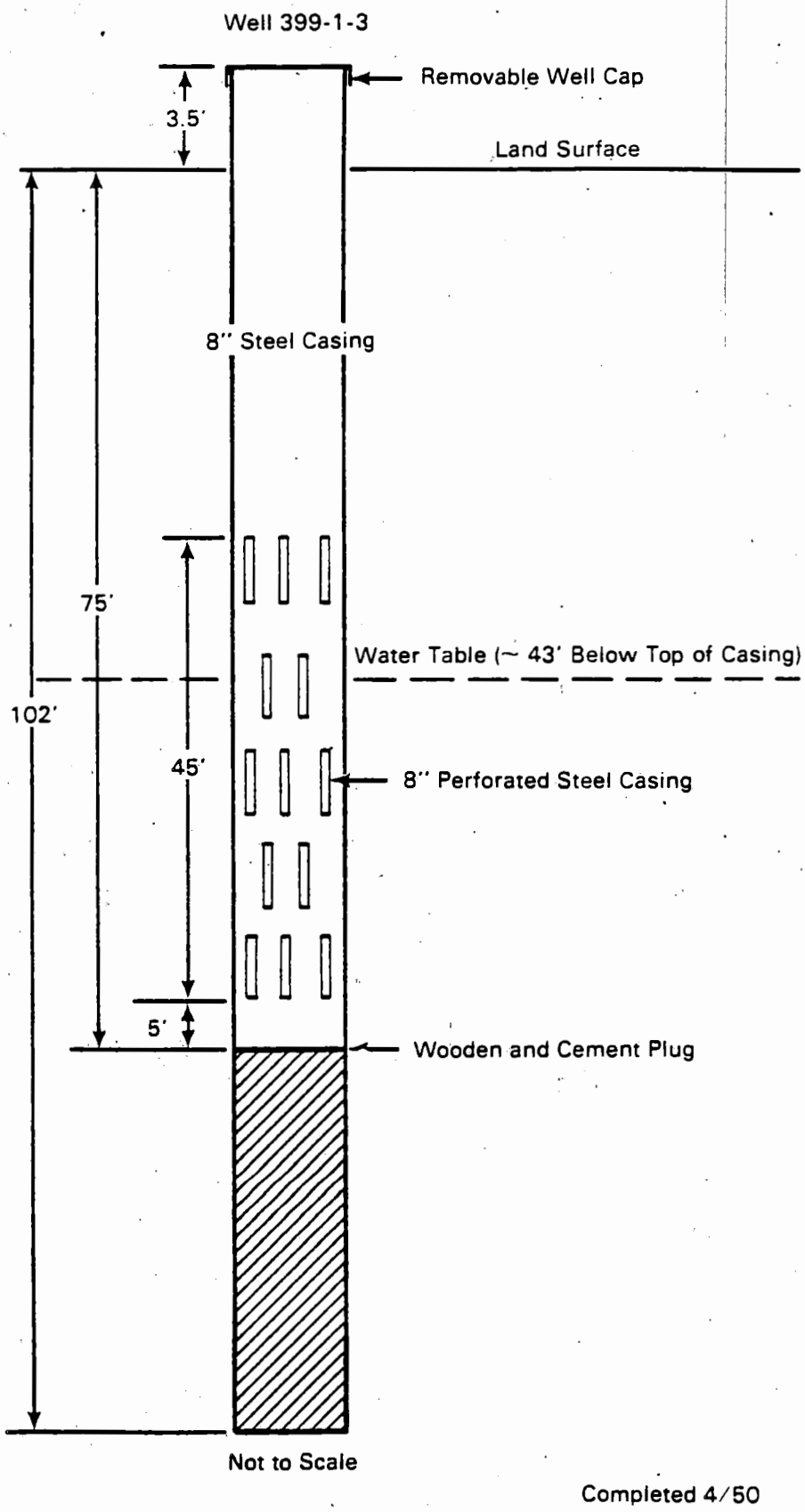


FIGURE B.8. Structural Diagram for Well 399-1-3

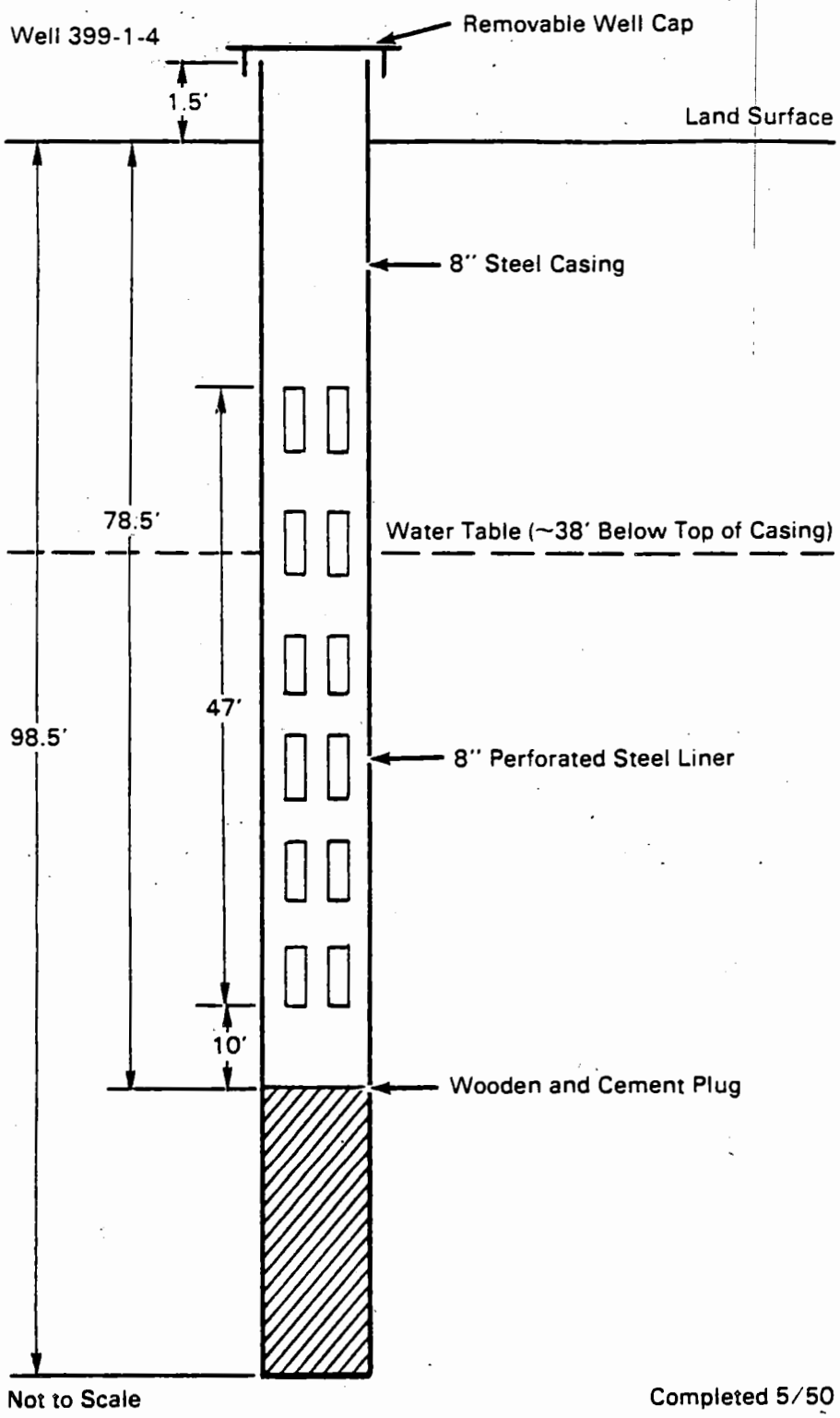


FIGURE B.9. Structural Diagram for Well 399-1-4

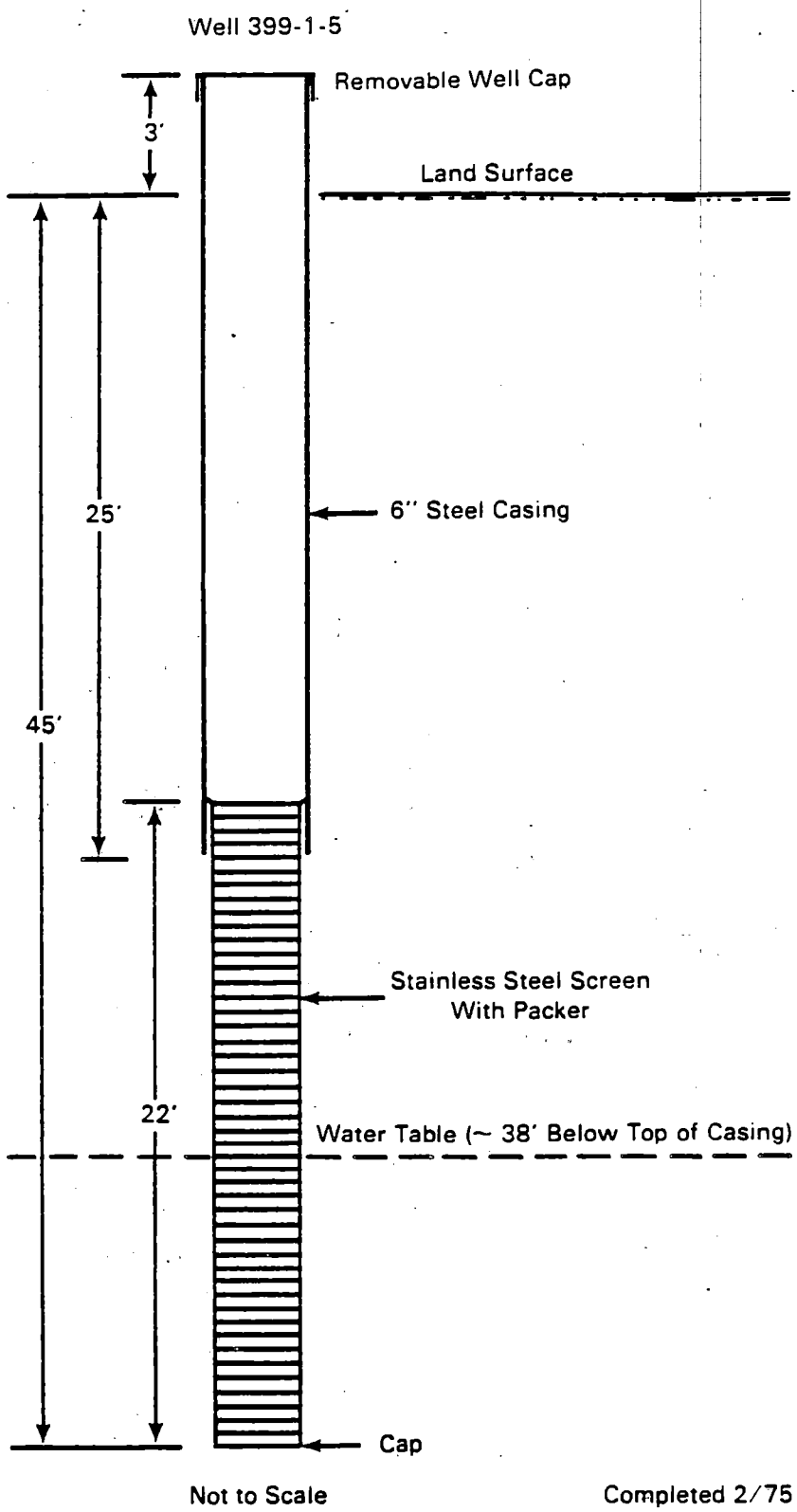


FIGURE B.10. Structural Diagram for Well 399-1-5

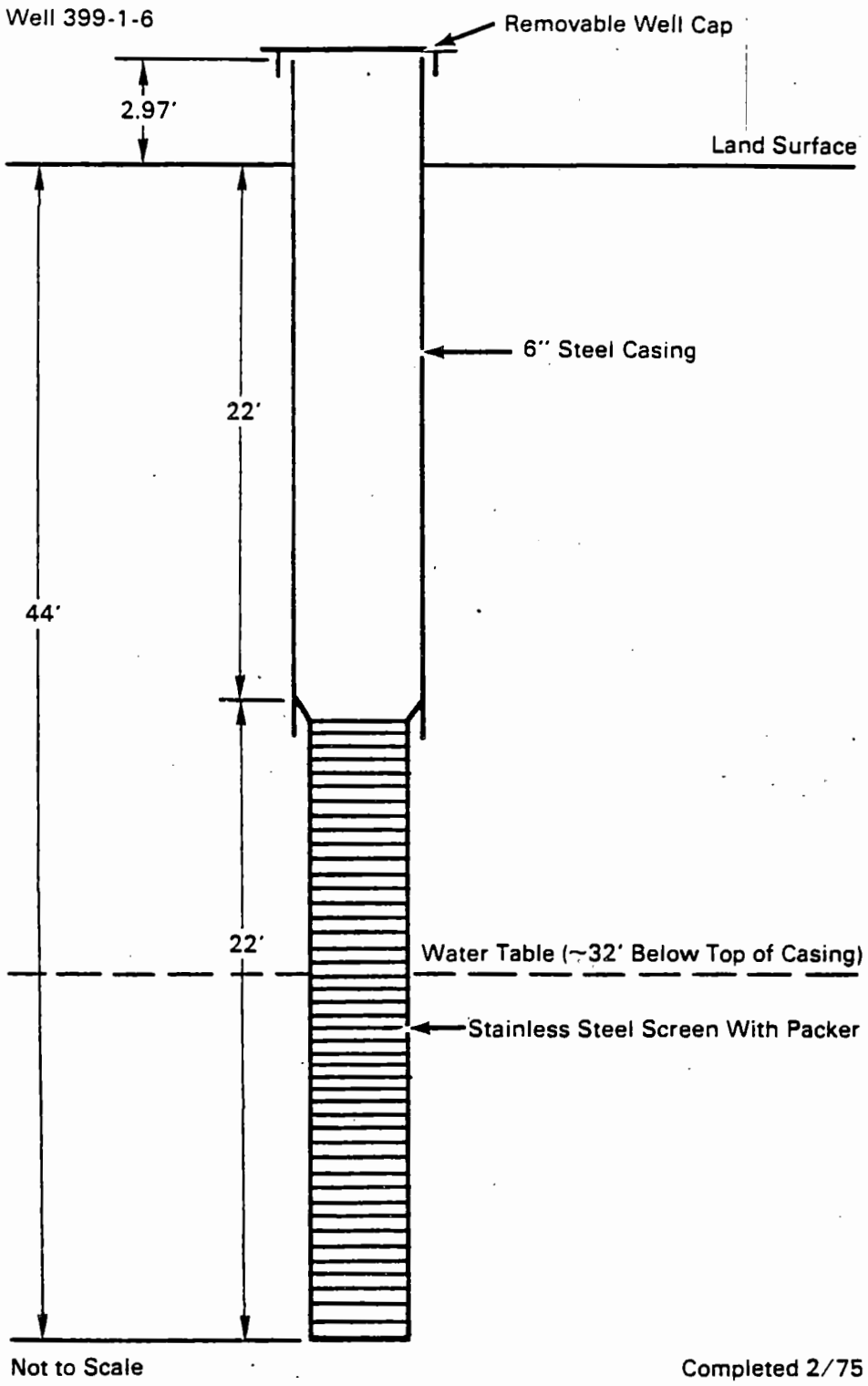


FIGURE B.11. Structural Diagram for Well 399-1-6

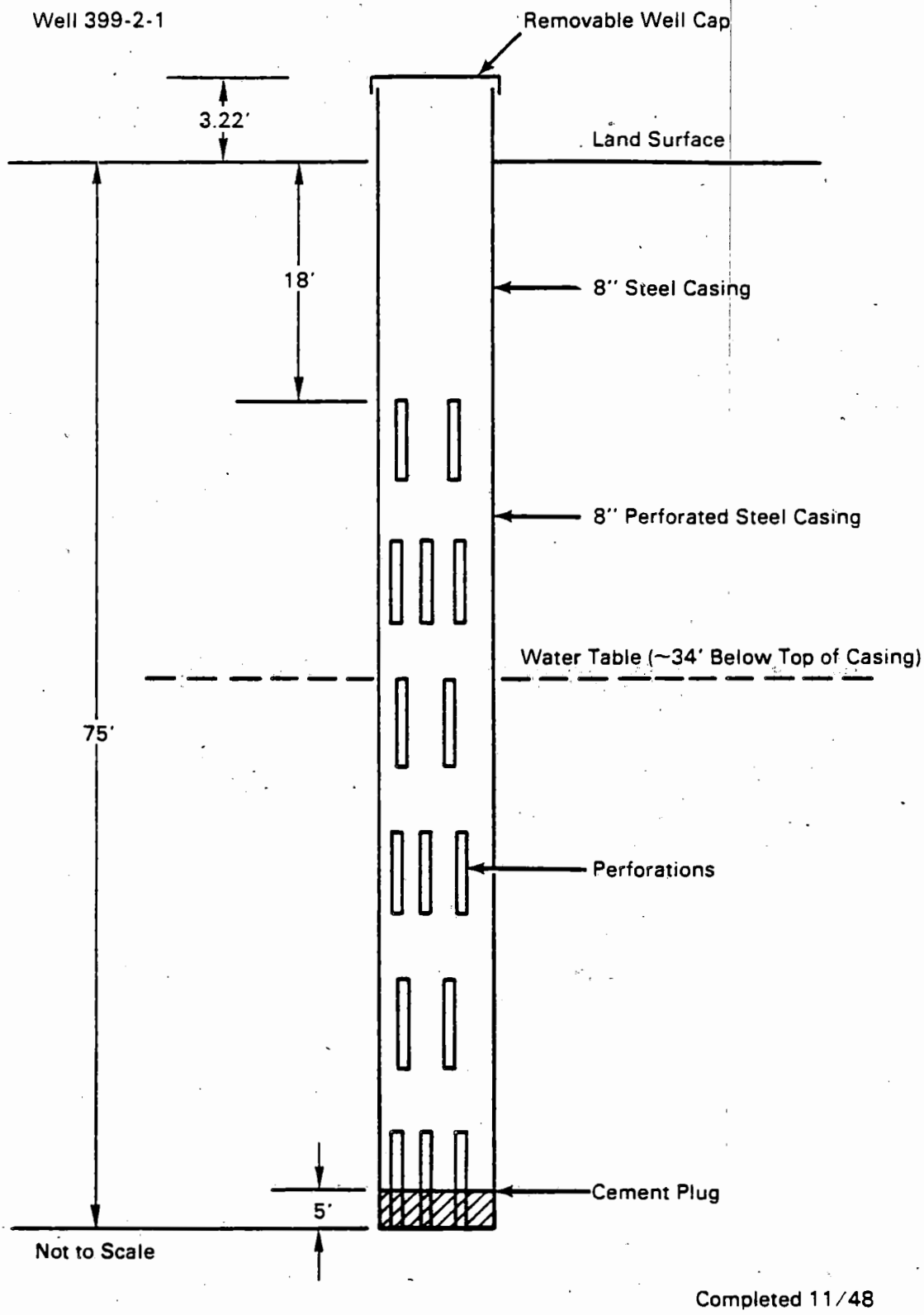


FIGURE B.12. Structural Diagram for Well 399-2-1

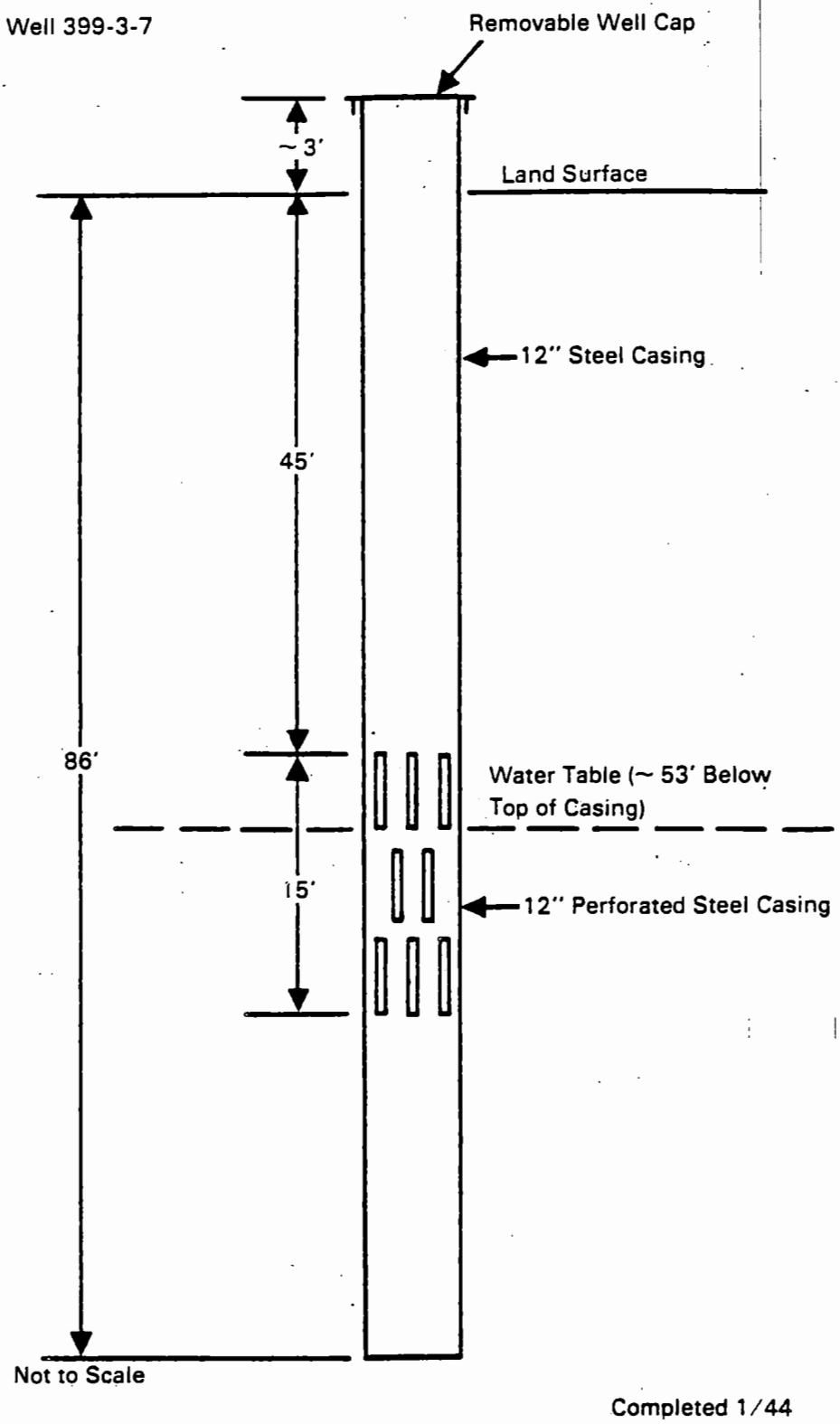
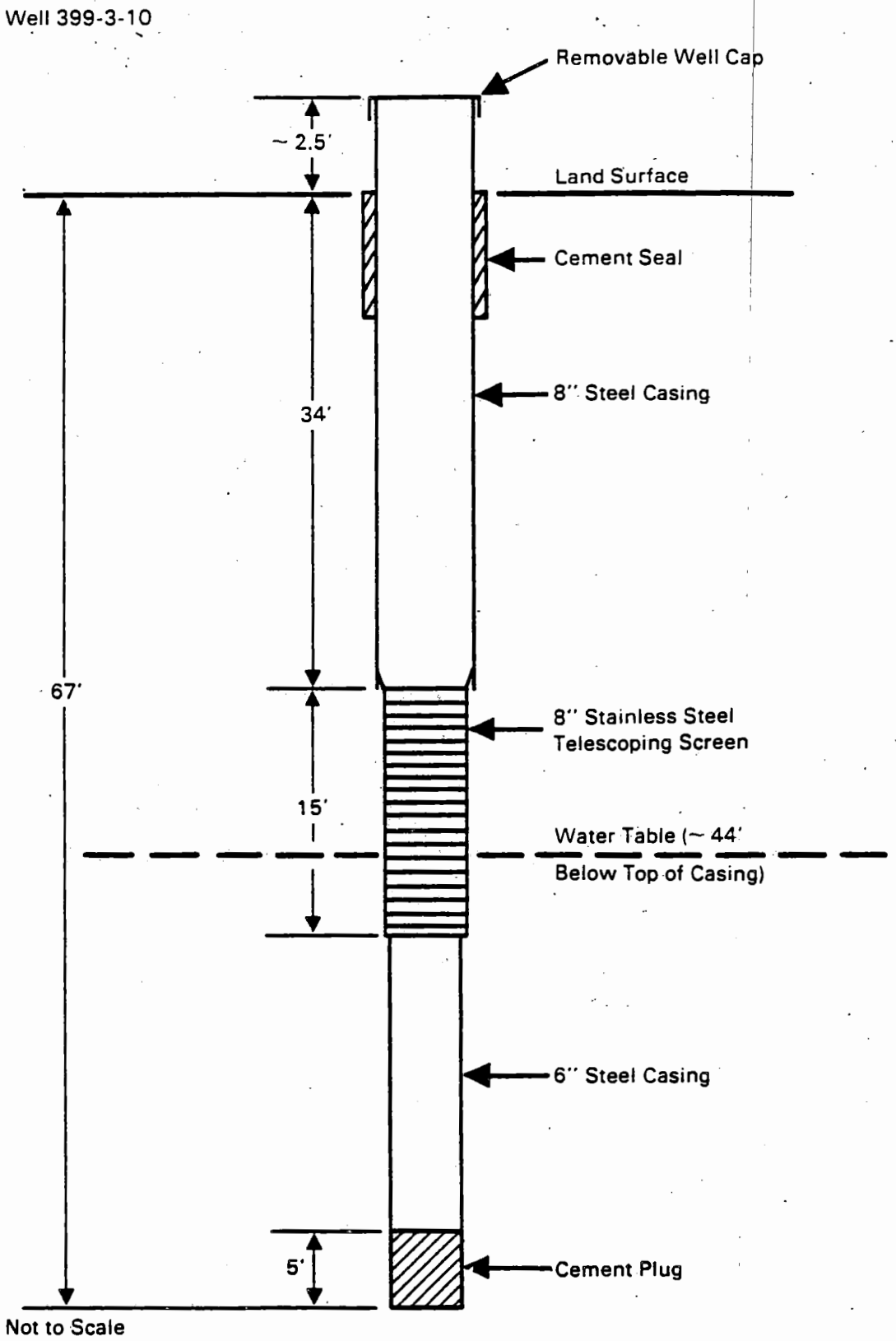


FIGURE B.13. Structural Diagram for Well 399-3-7



Completed 9/76

FIGURE B.14. Structural Diagram for Well 399-3-10

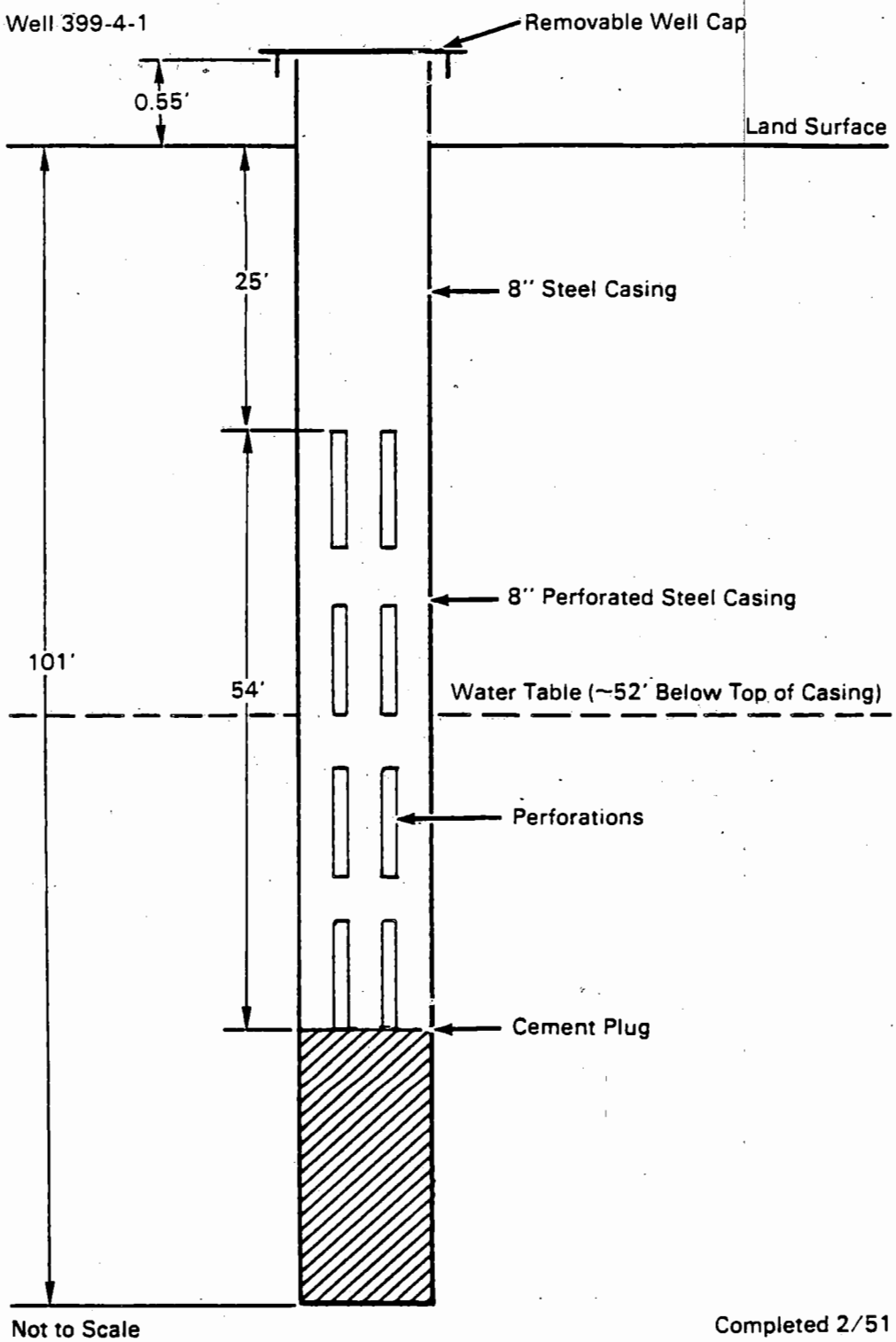


FIGURE B.15. Structural Diagram for Well 399-4-1

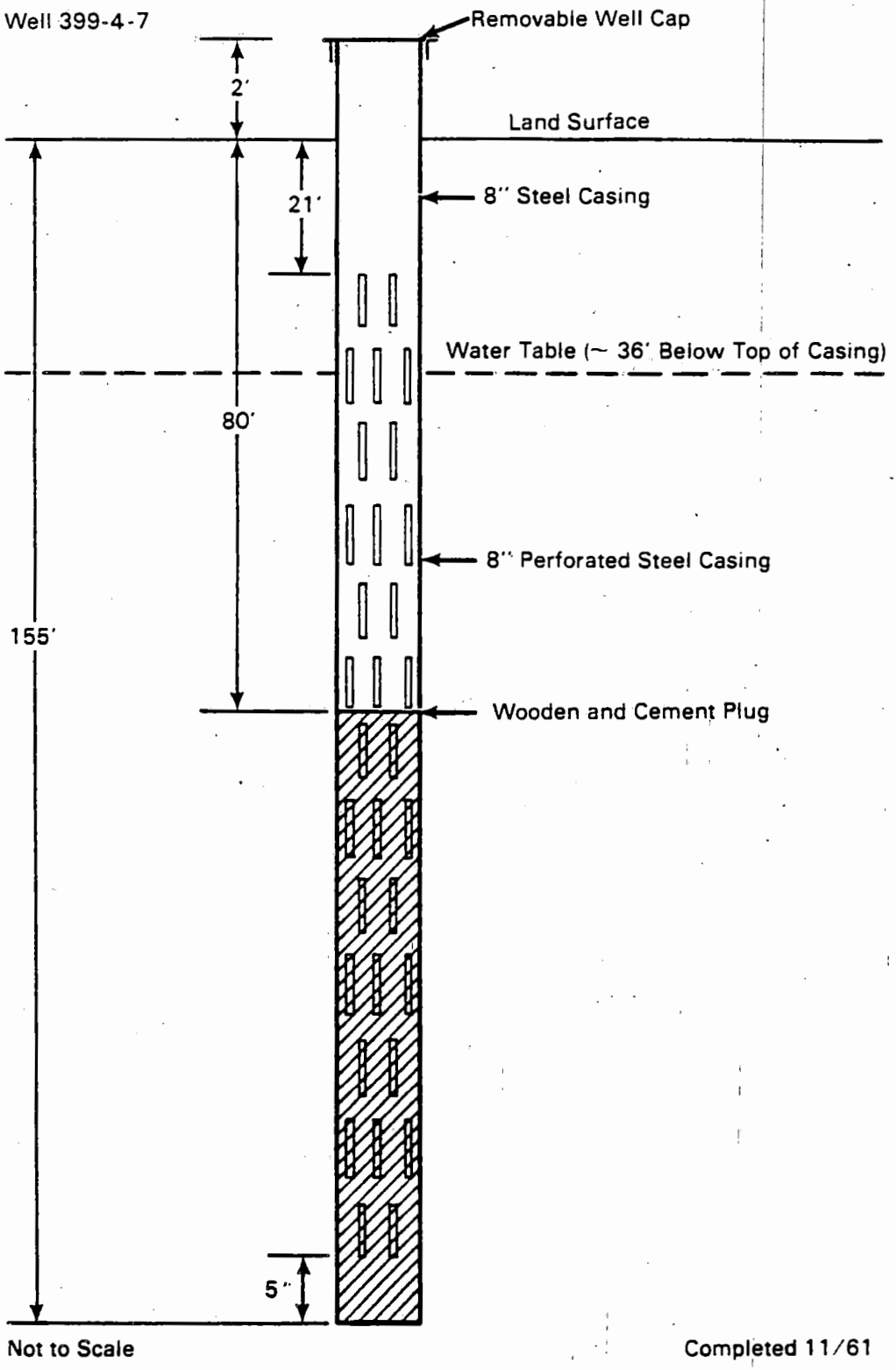


FIGURE B.16. Structural Diagram for Well 399-4-7

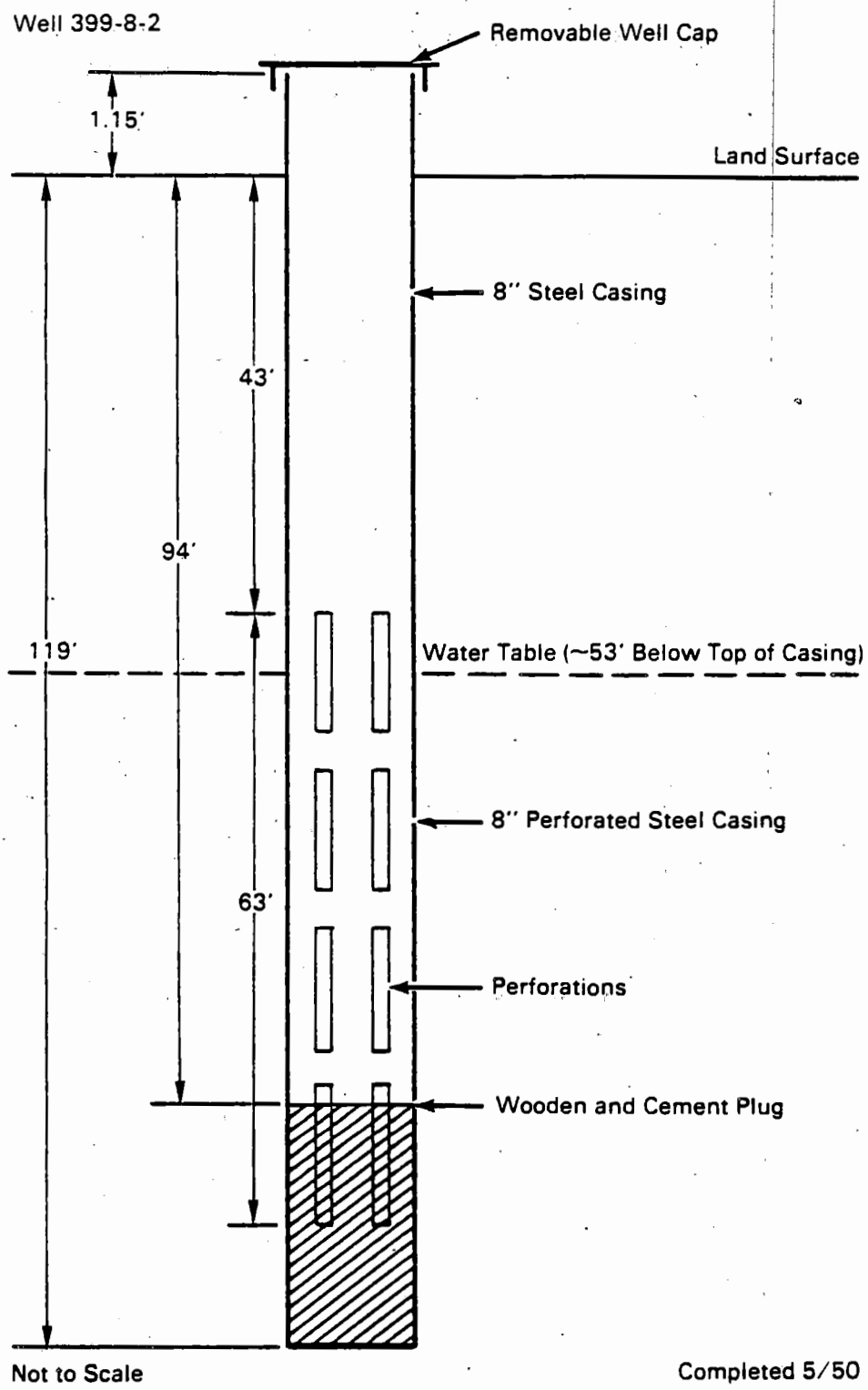


FIGURE B.17. Structural Diagram for Well 399-8-2

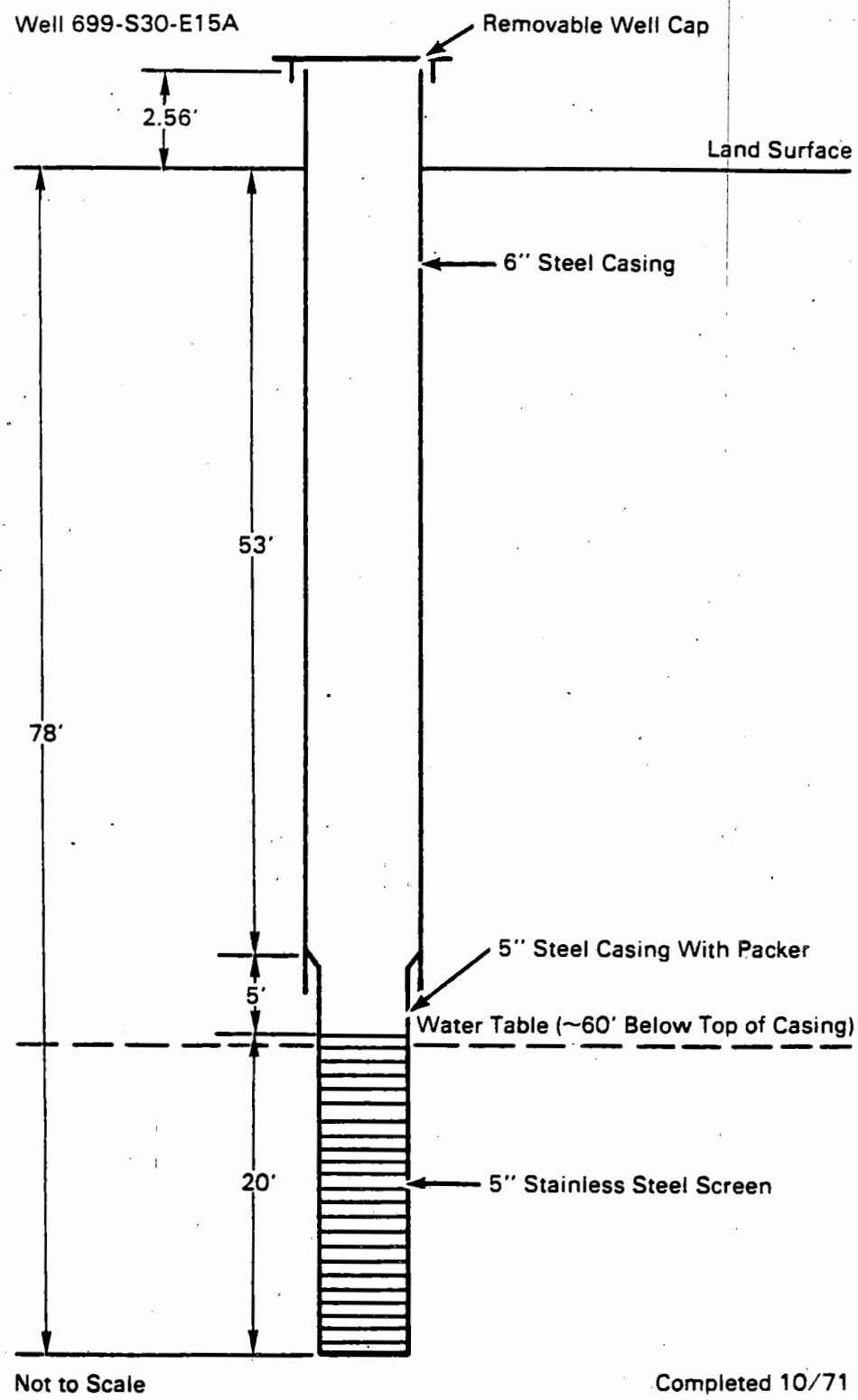


FIGURE B.18. Structural Diagram for Well 699-S30-E15A

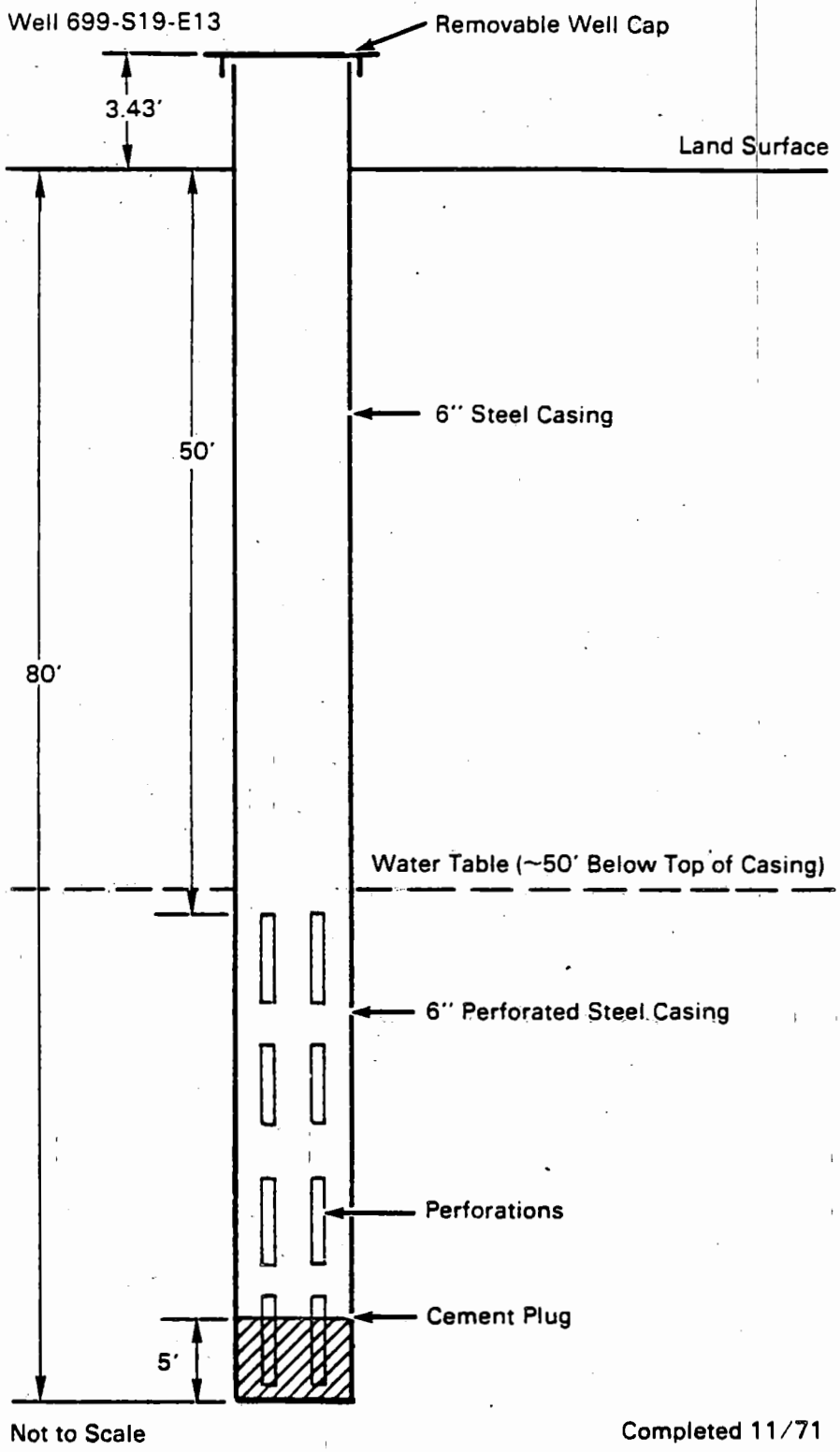


FIGURE B.19. Structural Diagram for Well 699-S19-E13

APPENDIX C

LIST OF DANGEROUS WASTE
CONSTITUENTS IN WAC 173-303-9905

APPENDIX C

LIST OF DANGEROUS WASTE CONSTITUENTS IN WAC 173-303-9905

This appendix identifies the approach to be taken to analyze for the list of dangerous waste constituents contained in WAC 173-303-9905. U.S. Testing Company, Inc. will conduct analyses for those constituents on the list for which methodology is currently available.

Table C.1 contains a numbered list of all of the WAC 173-303-9905 constituents, the specific method to be used for analysis, and reference to one of several other tables (C.2 through C.10) which associates each constituent with an analytical category. Where available, SW-846 (USEPA, July 1982 "Test Methods for Evaluating Solid Waste) methods will be used. Where SW-846 does not provide sufficient information to analyze for a particular constituent, another standard method is listed. Two categories of compounds will not be analyzed directly:

1. constituents unstable in water
2. constituents for which no analytical method is available.

The following approach will be taken when analyzing for volatile and semivolatile constituents (Tables C.2 and C.3). A quantitative analysis will be performed by GC/MS on those compounds from these lists which are also on the Priority Pollutant list (40 CFR Part 122). All other 9905 compounds will be searched for by NBS Library computer search of all peaks in the chromatogram of the sample which are greater than 20% of the nearest internal standard. Quantitation of the tentatively identified peak will be against the nearest internal standard, and the response factor will be assumed to be 1. Rigorous quantitation of tentatively identified compounds will be performed upon request, and the analyses are subject to the availability of standards.

Chain-of-custody and general quality control procedures will be those detailed in the "Methods" section of the plan. For additional quality control procedures specific to individual methods, see the methods referenced in Table C.1.

TABLE C.1. Dangerous Waste Constituents List

	Constituent	Method[a]	Table
1	Acetonitrile	SW-846, 8270	C.3
2	Acetophenone	SW-846, 8270	C.3
3	Warfarin	SW-846, 8270	C.3
4	2-Acetylaminofluorene	SW-846, 8270	C.3
5	Acetyl chloride	Unstable	C.8
6	1-Acetyl-2-thiourea	SW-846, 8330	C.10
7	Acrolein	SW-846, 8240	C.2
8	Acrylamide	GC/MS, Dir. Inj.	C.4
9	Acrylonitrile	SW-846, 8240	C.2
10	Aflatoxins	Exotic	C.9
11	Aldrin	SW-846, 8080	C.6
12	Allyl alcohol	GC/MS, Dir. Inj.	C.4
13	Aluminum phosphide	Unstable	C.8
14	4-Aminobiphenyl	SW-846, 8270	C.3
15	Mitomycin C	Exotic	C.9
16	5-(Aminomethyl)-3-isoxazolol	SW-846, 8270	C.3
17	Amitrole	SW-846, 8270	C.3
18	Aniline	SW-846, 8270	C.3
19	Antimony and compounds	SW-846, 6010	C.5
20	Aramite	SW-846, 8270	C.3
21	Arsenic and compounds	SW-846, 7060	C.5
22	Arsenic acid	SW-846, 7060	C.5
23	Arsenic pentoxide	SW-846, 7060	C.5
24	Arsenic trioxide	SW-846, 7060	C.5
25	Auramine	SW-846, 8270	C.3
26	Azaserine	Exotic	C.9
27	Barium and compounds	SW-846, 6010	C.5
28	Barium cyanide	SW-846, 6010	C.5
29	Benz(c)acridine	SW-846, 8270	C.3
30	Benz(a)anthracene	SW-846, 8270	C.3
31	Benzene	SW-846, 8240	C.2
32	Benzenearsonic acid	SW-846, 7060	C.5
33	Benzene, dichloromethyl	SW-846, 8270	C.3
34	Benzenethoil	SW-846, 8270	C.3
35	Benzidine	SW-846, 8270	C.3
36	Benzo(b)fluoranthene	SW-846, 8270	C.3
37	Benzo(j)fluoranthene	SW-846, 8270	C.3
38	Benzo(a)pyrene	SW-846, 8270	C.3
39	p Benzoquinone	SW-846, 8270	C.3
40	Benzotrichloride	Unstable	C.8
41	Benzyl chloride	SW-846, 8270	C.3
42	Beryllium and compounds	SW-846, 6010	C.5
43	Bis(2-chloroethoxy)methane	SW-846, 8270	C.3
44	Bis(2-chloroethyl) ether	SW-846, 8270	C.3
45	Chlornaphazine	SW-846, 8270	C.3
46	Bis(2-chloroisopropyl) ether	SW-846, 8270	C.3

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
47	Bis(chloromethyl) ether	SW-846, 8240	C.2
48	Bis(2-ethylhexyl) phthalate	SW-846, 8270	C.3
49	Bromoacetone	SW-846, 8240	C.2
50	Methyl bromide	SW-846, 8240	C.2
51	4-Bromophenyl phenyl ether	SW-846, 8270	C.3
52	Brucine	Exotic	C.9
53	2-Butanone peroxide	Unstable	C.8
54	Butyl benzyl phthalate	SW-846, 8270	C.3
55	2-sec-Butyl-4,6-dinitrophenol	SW-846, 8270	C.3
56	Cadmium and compounds	SW-846, 6010	C.5
57	Calcium chromate	SW-846, 6010	C.5
58	Calcium cyanide	SW-846, 9010	C.10
59	Carbon disulfide	SW-846, 8240	C.2
60	Carbon oxyfluoride	Unstable	C.8
61	Chloral	GC/MS, Dir. Inj.	C.4
62	Chlorambucil	Exotic	C.9
63	Chlordane	SW-846, 8080	C.6
64	Chlorinated benzenes	SW-846, 8270	C.3
65	Chlorinated ethane	SW-846, 9020	C.7
66	Chlorinated fluorocarbons	SW-846, 9020	C.7
67	Chlorinated naphthalene	SW-846, 9020	C.7
68	Chlorinated phenol	SW-846, 9020	C.7
69	Chloroacetaldehyde	GC/MS, Dir. Inj.	C.4
70	Chloroalkyl ethers	SW-846, 8270	C.3
71	P-Chloroaniline	SW-846, 8270	C.3
72	Chlorobenzene	SW-846, 8240	C.2
73	Chlorobenzilate	AOAC - 6.431	C.6
74	p-Chloro-m-cresol	SW-846, 8270	C.3
75	1-Chloro-2,3-epoxypropane	SW-846, 8270	C.3
76	2-Chloroethyl vinyl ether	SW-846, 8240	C.2
77	Chloroform	SW-846, 8240	C.2
78	Methyl chloride	SW-846, 8240	C.2
79	Chloromethyl methyl ether	SW-846, 8240	C.2
80	2-Chloronaphthalene	SW-846, 8270	C.3
81	2-Chlorophenol	SW-846, 8270	C.3
82	1-(o-Chlorophenyl)thiourea	SW-846, 8330	C.10
83	3-Chloropropionitrile	GC/MS, Dir. Inj.	C.4
84	Chromium and compounds	SW-846, 6010	C.5
85	Chrysene	SW-846, 8270	C.3
86	Citrus red No. 2	AOAC - 34.015 B	C.10
87	Coal tars	SM-505	C.7
88	Copper cyanide	SW-846, 6010	C.5
89	Creosote	SM-505	C.7
90	Cresols	SW-846, 8270	C.3
91	Crotonaldehyde	SW-846, 8240	C.2
92	Cyanides	SW-846, 9010	C.10

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
93	Cyanogen	GC/MS, Dir. Inj.	C.4
94	Cyanogen bromide	AOAC - 34.015 B	C.10
95	Cyanogen chloride	AOAC - 34.015 B	C.10
96	Cycasin	Exotic	C.9
97	2-Cyclohexyl-4,6-dinitrophenol	SW-846, 8270	C.3
98	Cyclophosphamide	Exotic	C.9
99	Daunomycin	Exotic	C.9
100	DDD	SW-846, 8080	C.6
101	DDE	SW-846, 8080	C.6
102	DDT	SW-846, 8080	C.6
103	Diallate	Exotic	C.9
104	Dibenz(a,h)acridine	SW-846, 8270	C.3
105	Dibenz(a,j)acridine	SW-846, 8270	C.3
106	Dibenz(a,h)anthracene	SW-846, 8270	C.3
107	7H-Dibenzo(c,g)carbazole	SW-846, 8270	C.3
108	Dibenzo(a,e)pyrene	SW-846, 8270	C.3
109	Dibenzo(a,h)pyrene	SW-846, 8270	C.3
110	Dibenzo(a,i)pyrene	SW-846, 8270	C.3
111	1,2-Dibromo-3-chloropropane	SW-846, 8240	C.2
112	1,2-Dibromoethane	SW-846, 8240	C.2
113	Dibromomethane	SW-846, 8240	C.2
114	Di-n-butyl phthalate	SW-846, 8270	C.3
115	Benzene, 1,2-dichloro	SW-846, 8270	C.3
116	Benzene, 1,3-dichloro	SW-846, 8270	C.3
117	Benzene, 1,4-dichloro	SW-846, 8270	C.3
118	Dichlorobenzene	SW-846, 9020	C.7
119	3,3'-Dichlorobenzidine	SW-846, 8270	C.3
120	1,4-Dichloro-2-butene	SW-846, 8240	C.2
121	Dichlorodifluoromethane	SW-846, 8240	C.2
122	1,1-Dichloroethane	SW-846, 8240	C.2
123	1,2-Dichloroethane	SW-846, 8240	C.2
124	trans-1,2-Dichloroethene	SW-846, 8240	C.2
125	Dichloroethylene	SW-846, 9020	C.7
126	1,1-Dichloroethylene	SW-846, 8240	C.2
127	Methylene chloride	SW-846, 8240	C.2
128	2,4-Dichlorophenol	SW-846, 8270	C.3
129	2,6-Dichlorophenol	SW-846, 8270	C.3
130	2,4-D	SW-846, 8150	C.6
131	Dichlorophenylarsine	SW-846, 7060	C.5
132	Dichloropropane	SW-846, 9020	C.7
133	1,2-Dichloropropane	SW-846, 8240	C.2
134	Dichloropropanol	GC/MS, Dir. Inj.	C.4
135	Dichloropropene	SW-846, 9020	C.7
136	1,3-Dichloropropene	SW-846, 8240	C.2
137	Dieldrin	SW-846, 8080	C.6
138	1,2:3,4-Diepoxybutane	Unstable	C.8

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
139	Diethylarsine	SW-846, 7060	C.5
140	N,N-Diethylhydrazine	SW-846, 8240	C.2
141	Carbophenothion	AOAC - 29.039	C.6
142	O,O-Diethylphosphoric acid, O-p-nitrophenyl ester	Exotic	C.9
143	Diethyl phthalate	SW-846, 8270	C.3
144	Thionazin	Exotic	C.9
145	Diethylstilbesterol	SW-846, 8330	C.10
146	Dihydrosafrole	SW-846, 8270	C.3
147	3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alchol	Exotic	C.9
148	Diisopropylfluorophosphate	Unstable	C.8
149	Dimethoate	SW-846, 8140	C.6
150	3,3'-Dimethoxybenzidine	SW-846, 8270	C.3
151	p-Dimethylaminoazobenzene	SW-846, 8270	C.3
152	7,12-Dimethylbenz(a)anthracene	SW-846, 8270	C.3
153	3,3'Dimethylbenzidine	SW-846, 8270	C.3
154	Dimethylcarbamoyl chloride	Unstable	C.8
155	1,1-Dimethylhydrazine	SW-846, 8240	C.2
156	1,2-Dimethylhydrazine	SW-846, 8240	C.2
157	Thiofanox	SW-846, 8270	C.3
158	alpha,alpha-Dimethylphenethylamine	SW-846, 8270	C.3
159	2,4-Dimethylphenol	SW-846, 8270	C.3
160	Dimethyl phthalate	SW-846, 8270	C.3
161	Dimethyl sulfate	Unstable	C.8
162	Dinitrobenzene	SW-846, 8270	C.3
163	4,6-Dinitro-o-cresol and salts	SW-846, 8270	C.3
164	2,4-Dinitrophenol	SW-846, 8270	C.3
165	2,4-Dinitrotoluene	SW-846, 8270	C.3
166	2,6-Dinitrotoluene	SW-846, 8270	C.3
167	Di-n-octyl phthalate	SW-846, 8270	C.3
168	1,4-Dioxane	SW-846, 8240	C.2
169	Diphenylamine	SW-846, 8270	C.3
170	1,2-Diphenylhydrazine	SW-846, 8270	C.3
171	Di-n-propylnitrosamine	SW-846, 8270	C.3
172	Disulfoton	SW-846, 8140	C.6
173	2,4-Dithiobiuret	Exotic	C.9
174	Endosulfan	SW-846, 8080	C.6
175	Endrin	SW-846, 8080	C.6
176	Ethyl carbamate	GC/MS, Dir. Inj.	C.4
177	Ethyl cyanide	GC/MS, Dir. Inj.	C.4
178	Ethylenebisdithiocarbamic acid	Exotic	C.9
179	Ethyleneimine	SW-846, 8270	C.3
180	Ethylene oxide	GC/MS, Dir. Inj.	C.4

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
181	Ethylenethiourea	SW-846, 8330	C.10
182	Ethylmethacrylate	GC/MS, Dir. Inj.	C.4
183	Ethyl methanesulfonate	SW-846, 8270	C.3
184	Fluoranthene	SW-846, 8270	C.3
185	Fluorine	Unstable	C.8
186	2-Fluoroacetamide	Exotic	C.9
187	Fluoroacetic acid	GC/MS, Dir. Inj.	C.4
188	Formaldehyde	Ion Chrom. (In-house)	C.10
189	Formic acid	Ion Chrom. (In-house)	C.10
190	Glycidylaldehyde	GC/MS, Dir. Inj.	C.4
191	Halomethane	SW-846, 9020	C.7
192	Heptachlor	SW-846, 8080	C.6
193	Heptachlor epoxide	SW-846, 8080	C.6
194	Hexachlorobenzene	SW-846, 8270	C.3
195	Hexachlorobutadiene	SW-846, 8270	C.3
196	Lindane and isomers	SW-846, 8080	C.6
197	Hexachlorocylopentadiene	SW-846, 8270	C.3
198	Hexachloroethane	SW-846, 8270	C.3
199	Hexachlorohexahydro-endo,endo-dimethanonaphthalene	Exotic	C.9
200	Hexachlorophene	SW-846, 8270	C.3
201	Hexachloropropene	SW-846, 8270	C.3
202	Hexaethyl tetraphosphate	Exotic	C.9
203	Hydrazine	SW-846, 8270	C.3
204	Hydrocyanic acid	SW-846, 9010	C.10
205	Hydrofluoric acid	Unstable	C.8
206	Hydrogen sulfide	SW-846, 8240	C.2
207	Hydroxydimethylarsine oxide	SW-846, 7060	C.5
208	Indeno(1,2,3-cd)pyrene	SW-846, 8270	C.3
209	Iodomethane	SW-846, 8240	C.2
210	Iron Dextran	Exotic	C.9
211	Methyl isocyanate	Unstable	C.8
212	Isobutyl alcohol	GC/MS, Dir. Inj.	C.4
213	Isosafrole	SW-846, 8270	C.3
214	Kepone	SW-846, 8080	C.6
215	Lasiocarpine	Exotic	C.9
216	Lead and compounds	SW-846, 6010	C.5
217	Lead acetate	SW-846, 6010	C.5
218	Lead phosphate	SW-846, 6010	C.5
219	Lead subacetate	SW-846, 6010	C.5
220	Maleic anhydride	Unstable	C.8
221	Maleic hydrazide	AOAC - 29.129	C.10
222	Malononitrile	SW-846, 8270	C.3
223	Melphalan	SW-846, 8270	C.3
224	Mercury Fulminate	SW-846, 7470	C.5
225	Mercury and compounds	SW-846, 7470	C.5

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
226	Methacrylonitrile	SW-846, 8240	C.2
227	Methanethiol	SW-846, 8240	C.2
228	Methapyrilene	SW-846, 8270	C.3
229	Metholonyl	SW-846, 8270	C.3
230	Methoxychlor	SW-846, 8080	C.6
231	2-Methylaziridine	SW-846, 8270	C.3
232	3-Methylcholanthrene	SW-846, 8270	C.3
233	Methyl chlorocarbonate	Unstable	C.8
234	4,4'-Methylenebis	SW-846, 8270	C.3
235	Methyl ethyl ketone	SW-846, 8240	C.2
236	Methyl hydrazine	GC/MS, Dir. Inj.	C.4
237	2-Methyllactonitrile	SW-846, 8270	C.3
238	Methyl methacrylate	SW-846, 8270	C.3
239	Methyl methanesulfonate	SW-846, 8270	C.3
240	2-Methyl-2-(methylthio)propionaldehyde -o-(methylcarbonyl) oxime	SW-846, 8270	C.3
241	N-Methyl-N'-nitro-N-nitrosoguanidine	Exotic	C.9
242	Methyl parathion	SW-846, 8140	C.6
243	Methylthiouracil	SW-846, 8270	C.3
244	Mustard gas	Exotic	C.9
245	Naphthalene	SW-846, 8270	C.3
246	1,4-Naphthoquinone	SW-846, 8270	C.3
247	1-Naphthylamine	SW-846, 8270	C.3
248	2-Naphthylamine	SW-846, 8270	C.3
249	1-Naphthyl-2-thiourea	SW-846, 8330	C.10
250	Nickel and compounds	SW-846, 6010	C.5
251	Nickel carbonyl	SW-846, 6010	C.5
252	Nickel cyanide	SW-846, 6010	C.5
253	Nicotine and salts	AOAC - 43.444	C.10
254	Nitric oxide	Exotic	C.9
255	p-Nitroaniline	SW-846, 8270	C.3
256	Nitrobenzine	SW-846, 8270	C.3
257	Nitrogen dioxide	Unstable	C.8
258	Nitrogen mustard and hydrochloride salt	Exotic	C.9
259	Nitrogen mustard N-Oxide and hydrochloride salt	Exotic	C.9
260	Nitroglycerine	Exotic	C.9
261	4-Nitrophenol	SW-846, 8270	C.3
262	4-Nitroquinoline-1-oxide	Exotic	C.9
263	Nitrosamine	SM-417	C.7
264	N-Nitrosodi-n-butylamine	SW-846, 8270	C.3
265	N-Nitrosodiethanolamine	SW-846, 8270	C.3
266	N-Nitrosodiethylamine	SW-846, 8270	C.3
267	N-Nitrosodimethylamine	SW-846, 8270	C.3
268	N-Nitroso-N-ethylurea	SW-846, 8330	C.3

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
269	N-Nitrosomethylethylamine	SW-846, 8270	C.3
270	N-Nitroso-N-methylurea	SW-846, 8330	C.10
271	N-Nitroso-N-methylurethane	SW-846, 8270	C.3
272	N-Nitrosomethylvinylamine	SW-846, 8270	C.3
273	N-Nitrosomorpholine	SW-846, 8270	C.3
274	N-Nitrosonornicotine	SW-846, 8270	C.3
275	N-Nitrosopiperidine	SW-846, 8270	C.3
276	Nitrosopyrrolidine	SW-846, 8270	C.3
277	N-Nitrososacrosine	Exotic	C.9
278	5-Nitro-o-toluidine	SW-846, 8270	C.3
279	Octamethylpyprophosphoramide	Exotic	C.9
280	Osmium tetroxide	SW-846, 6010	C.5
281	Endothol	Exotic	C.9
282	Paraldehyde	Exotic	C.9
283	Parathion	SW-846, 8140	C.6
284	Pentachlorobenzene	SW-846, 8270	C.3
285	Pentachloroethane	SW-846, 8240	C.2
286	Pentachloronitrobenzene	SW-846, 8270	C.3
287	Pentachlorophenol	SW-846, 8270	C.3
288	Phenacetin	SW-846, 8270	C.3
289	Phenol	SW-846, 8270	C.3
290	Phenylenediamine	SW-846, 8270	C.3
291	Phenylmercury acetate	SW-846, 7470	C.5
292	N-Phenylthiourea	SW-846, 8330	C.10
293	Phosgene	Unstable	C.8
294	Phosphine	Exotic	C.9
295	Phorate	Unstable	C.8
296	Famphur	Unstable	C.8
297	Phthalic acid esters	SW-846, 8270	C.3
298	Phthalic anhydride	Unstable	C.8
299	2-Picoline	SW-846, 8270	C.3
300	Polychlorinated biphenyl	SW-846, 8080	C.6
301	Potassium cyanide	SW-846, 9010	C.10
302	Potassium silver cyanide	SW-846, 6010	C.5
303	Pronamide	SW-846, 8270	C.3
304	1,3-Propanesultone	Exotic	C.9
305	n-Propylamine	GC/MS, Dir. Inj.	C.4
306	Propylthiouracil	Exotic	C.9
307	2-Propyn-1-ol	GC/MS, Dir. Inj.	C.4
308	Pyridine	SW-846, 8240	C.2
309	Reserpine	SW-846, 8270	C.3
310	Resorcinol	SW-846, 8270	C.3
311	Saccharin and salts	Exotic	C.9
312	Safrol	SW-846, 8270	C.3
313	Selenious acid	SW-846, 7740	C.5

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
314	Selenium and compounds	SW-846, 7740	C.5
315	Selenium sulfide	SW-846, 7740	C.5
316	Selenourea	SW-846, 7740	C.5
317	Silver and compounds	SW-846, 6010	C.5
318	Silver cyanide	SW-846, 6010	C.5
319	Sodium cyanide	SW-846, 9010	C.10
320	Streptozotocin	Exotic	C.9
321	Strontium sulfide	SW-846, 6010	C.5
322	Strychnine and salts	AOAC - 38.068	C.10
323	1,2,4,5-Tetrachlorobenzene	SW-846, 8270	C.3
324	TCDD	SW-846, 8270	C.3
325	Tetrachloroethane	SW-846, 8240	C.2
326	1,1,1,2-Tetrachlorethane	SW-846, 8240	C.2
327	1,1,2,2-Tetrachlorethane	SW-846, 8240	C.2
328	Tetrachlorethylene	SW-846, 8240	C.2
329	Tetrachloromethane	SW-846, 8240	C.2
330	2,3,4,6-Tetrachlorophenol	SW-846, 8270	C.3
331	Tetraethyldithiopyrophosphate	Unstable	C.8
332	Tetraethyl lead	SW-846, 6010	C.5
333	Tetraethylpyrophosphate	Exotic	C.9
334	Tetranitromethane	Exotic	C.9
335	Thallium and compounds	SW-846, 7840	C.5
336	Thallic oxide	SW-846, 7840	C.5
337	Thallium (1) acetate	SW-846, 7840	C.5
338	Thallium (1) carbonate	SW-846, 7840	C.5
339	Thallium (1) chloride	SW-846, 7840	C.5
340	Thallium (1) nitrate	SW-846, 7840	C.5
341	Thallium selenite	SW-846, 7840	C.5
342	Thallium (1) sulfate	SW-846, 7840	C.5
343	Thioacetamide	Exotic	C.9
344	Thiosemicarbazide	Exotic	C.9
345	Thiourea	SW-846, 8330	C.10
346	Thiuram	SW-846, 8270	C.3
347	Toluene	SW-846, 8240	C.2
348	Toluenediamine	SW-846, 8270	C.3
349	o-Toluidine hydrochloride	SW-846, 8270	C.3
350	Tolulene diisocyanate	Unstable	C.8
351	Toxaphene	SW-846, 8080	C.6
352	Bromoform	SW-846, 8240	C.2
353	1,2,4-Trichlorobenzene	SW-846, 8270	C.3
354	1,1,1-Trichloroethane	SW-846, 8240	C.2
355	1,1,2-Trichloroethane	SW-846, 8240	C.2
356	Trichloroethene	SW-846, 8240	C.2
357	Trichloromethanethiol	SW-846, 8240	C.2
358	Trichloromonofluoromethane	SW-846, 8240	C.2
359	2,4,5-Trichlorophenol	SW-846, 8270	C.3

TABLE C.1. Dangerous Waste Constituents List (contd)

	Constituent	Method[a]	Table
360	2,4,6-Trichlorophenol	SW-846, 8270	C.3
361	2,4,5-T	SW-846, 8150	C.6
362	2,4,5-TP (Silvex)	SW-846, 8150	C.6
363	Trichloropropane	SW-846, 8240	C.2
364	1,2,3-Trichloropropane	SW-846, 8240	C.2
365	0,0,0-Triethyl phosphorothioate	SW-846, 8270	C.3
366	sym-Trinitrobenzene	SW-846, 8270	C.3
367	Tris(1-aziridinyl) phosphine sulfide	Unstable	C.8
368	Tris(2,3-dibromopropyl) phosphate	SW-846, 8270	C.3
369	Trypan blue	Exotic	C.9
370	Uracil mustard	Exotic	C.9
371	Vanadic acid, ammonium salt	SW-846, 6010	C.5
372	Vanadium pentoxide	SW-846, 6010	C.5
373	Vinyl chloride	SW-846, 8240	C.2
374	Zinc cyanide	SW-846, 6010	C.5
375	Zinc phosphide	Unstable	C.8

(a) SW-846: Environmental Protection Agency. 1982. Test Methods for Evaluating Solid Waste - Chemical/Physical Methods, SW-846. EPA, Washington. D.C.

SM: American Public Health Association. 1985. Standard Methods for the Examination of Water and Wastewater. APHA, Washington, D.C.

AOAC: Journal of the Association of Official Analytical Chemists.

TABLE C.2. Volatile Organics

7 Acrolein
9 Acrylonitrile
31 Benzene
47 Bis(chloromethyl)ether
49 Bromoacetone
50 Methyl bromide
59 Carbon disulfide
72 Chlorobenzene
76 2-Chloroethyl vinyl ether
77 Chloroform
78 Methyl chloride
79 Chloromethyl methyl ether
91 Crotonaldehyde
111 1,2-Dibromo-3-chloropropane
112 1,2-Dibromoethane
113 Dibromomethane
120 1,4-Dichloro-2-butene
121 Dichlorodifluoromethane
122 1,1-Dichloroethane
123 1,2-Dichloroethane
124 trans-1,2-Dichloroethene
126 1,1-Dichloroethylene
127 Methylene chloride
133 1,2-Dichloropropane
136 1,3-Dichloropropene
140 N,N-Diethylhydrazine
155 1,1-Dimethylhydrazine
156 1,2-Dimethylhydrazine
168 Dioxane
206 Hydrogen sulfide
209 Iodomethane
226 Methacrylonitrile
227 Methanethiol
235 Methyl ethyl ketone
285 Pentachloroethane
308 Pyridine
325 Tetrachloroethane
326 1,1,1,2-Tetrachlorethane
327 1,1,2,2-Tetrachlorethane
328 Tetrachlorethylene
329 Tetrachloromethane
347 Toluene
352 Bromoform
354 1,1,1-Trichloroethane
355 1,1,2-Trichloroethane
356 Trichloroethane
357 Trichloromethanethiol
358 Trichloromonofluoromethane
363 Trichloropropane
364 1,2,3-Trichloropropane
373 Vinyl chloride

TABLE C.3. Semi-Volatile Organics

1 Acetonitrile
2 Acetophenone
3 Warfarin
4 2-Acetylaminofluorene
14 4-Aminobyphenyl
16 5-(Aminomethyl)-3-ioxazolol
17 Amitrole
18 Aniline
20 Aramite
25 Auramine
29 Benz[c]acridine
30 Benz[a]anthracene
33 Benzene, dichloromethyl-
34 Benzenethoil
35 Benzidine
36 Benzo[b]fluoranthene
37 Benzo[j]fluoranthene
38 Benzo[a]pyene
39 p Benzoquinone
41 Benzyl chloride
43 Bis(2-chloroethoxy)methane
44 Bis(2-chloroethyl) ether
45 Chlornaphazine
46 Bis(2-chloroisopropyl)ether
48 Bis(2-ethylhexyl) phthalate
51 4-Bromophenyl phenyl ether
54 Butyl benzyl phthalate
55 2-sec-Butyl-4,6-dinitrophenol
64 Chlorinated benzenes
70 Chloroalkyl ethers
71 p-chloroaniline
74 p-Chloro-m-cresol
75 1-Chloro-2,3-epoxypropane
80 2-Chloronaphthalene
81 2-Chlorophenol
85 Chrysene
90 Cresols
97 2-Cyclohexyl-4,6-dinitrophenol
104 Dibenz[a,h]acridine
105 Dibenz[a,j]acridine
106 Dibenz[a,h]anthracene
107 7H-Dibenzo[c,g]carbazole
108 Dibenzo[a,e]pyrene
109 Dibenzo[a,h]pyrene
110 Dibenzo[a,i]pyrene
114 Di-n-butyl phthalate
115 1,2-Dichlorobenzene
116 1,3-Dichlorobenzene
117 1,4-Dichlorobenzene
119 3,3'-Dichlorobenzidine
128 2,4-Dichlorophenol
129 2,6-Dichlorophenol
143 Diethyl phthalate
146 Dihydrosafrole
150 3,3'-Dimethoxybenzidine
151 p-Dimethylaminoazobenzene
152 7,12-Dimethylbenz[a]anthracene
153 3,3'-Dimethylbenzidine
157 Thiofanox
158 alpha,alpha-Dimethlphenethylamine
159 2,4-Dimethylphenol
160 Dimethyl phthalate
162 Dinitrobenzene
163 4,6-Dinitro-o-cresol and salts
164 2,4-Dinitrophenol
165 2,4-Dinitrotoluene
166 2,6-Dinitrotoluene
167 Di-n-octyl phthalate
169 Diphenylamine
170 1,2-Diphenylhydrazine
171 Di-n-propylnitrosamine
179 Ethyleneimine
183 Ethyl methanesulfonate
184 Fluoranthene
194 Hexachlorobenzene
195 Hexachlorobutadiene
197 Hexachlorocyclopentadiene
198 Hexachloroethane
200 Hexachlorophene
201 Hexachloropropene
203 Hydrazine
208 Indeno(1,2,3-cd)pyrene
213 Isosafrole
222 Malononitrile
223 Melphalan
228 Methapyrilene
229 Metholonyl
231 2-Methylaziridine
232 3-Methylcholanthrene
234 4,4'-Methylenebis(2-chloroaniline)
237 2-Methyllactonitrile
238 Methyl methacrylate
239 Methyl methanesulfonate
240 2-Methyl-2-(methylthio) propionaldehyde-o-(methylcarbonyl) oxime

TABLE C.3. Semi-Volatile Organics (contd)

243 Methylthiouracil
245 Naphthalene
246 1,4-Naphthoquinone
247 1-Naphthylamine
248 2-Naphthylamine
255 p-Nitroaniline
256 Nitrobenzine
261 4-Nitrophenol
264 N-Nitrosodi-n-butylamine
265 N-Nitrosodiethanolamine
266 N-Nitrosodiethylamine
267 N-Nitrosodimethylamine
269 N-Nitrosomethylethylamine
271 N-Nitroso-N-methylurethane
272 N-Nitrosomethylvinylamine
273 N-Nitrosomorpholine
274 N-Nitrosonornicotine
275 N-Nitrosopiperidine
276 Nitrosopyrrolidine
278 5-Nitro-o-toluidine
284 Pentachlorobenzene
286 Pentachloronitrobenzene
287 Pentachlorophenol
288 Phenacetin
289 Phenol
290 Phenylenediamine
297 Phthalic acid esters
299 2-Picoline
303 Pronamide
309 Reserpine
310 Resorcinol
312 Safrol
323 1,2,4,5-Tetrachlorobenzene
324 2,3,7,8-TCDD
330 2,3,4,6-Tetrachlorophenol
346 Thiuram
348 Toluenediamine
349 o-Toluidine hydrochloride
353 1,2,4-Trichlorobenzene
359 2,4,5-Trichlorophenol
360 2,4,6-Trichlorophenol
365 O,O,O-Triethyl phosphorothioate
366 sym-Trinitrobenzene
368 Tris(2,3-dibromopropyl) phosphate

TABLE C.4. Organics by GC/MS Direct Injection

8 Acrylamide
12 Allyl alcohol
61 Chloral
69 Chloroacetaldehyde
83 3-Chloropropionitrile
93 Cyanogen
134 Dichloropropanol
176 Ethyl carbamate
177 Ethyl cyanide
180 Ethylene oxide
182 Ethyl methacrylate
187 Fluoroacetic acid
190 Glycidylaldehyde
212 Isobutyl alcohol
236 Methyl hydrazine
305 n-Propylamine
307 2-Propyn-1-ol

TABLE C.5. Constituents that Only Require Analysis for Metal Species

19. Antimony, NOS
21. Arsenic and compounds, NOS
22. Arsenic acid
23. Arsenic pentoxide
24. Arsenic trioxide
27. Barium and compounds, NOS
28. Barium cyanide
32. Benzenearsonic acid
42. Beryllium and compounds, NOS
56. Cadmium and compounds, NOS
57. Calcium chromate
84. Chromium and compounds, NOS
88. Copper cyanide
131. Dichlorophenylarsine
139. Diethylarsine
207. Hydroxydimethylarsine oxide
216. Lead and compounds, NOS
217. Lead acetate
218. Lead phosphate
219. Lead subacetate
224. Mercury fulminate
225. Mercury and compounds, NOS
250. Nickel and compounds, NOS
251. Nickel carbonyl
252. Nickel cyanide
280. Osmium tetroxide
291. Phenylmercury acetate
302. Potassium silver cyanide
313. Selenious acid
314. Selenium and compounds, NOS
315. Selenium sulfide
316. Selenourea
317. Silver and compounds, NOS
318. Silver cyanide
321. Strontium sulfide
332. Tetraethyl lead
335. Thallium and Compounds, NOS
336. Thallic oxide
337. Thallium acetate
338. Thallium carbonate
339. Thallium chloride
340. Thallium nitrate
341. Thallium selenite
342. Thallium sulfate
371. Vanadic acid, ammonium salt
372. Vanadium pentoxide
374. Zinc cyanide

TABLE C.6. Pesticides/Herbicides

11 Aldrin
63 Chlordane
73 Chlorobenzilate
100 DDD
101 DDE
102 DDT
130 2,4-D
137 Dieldrin
141 Carbophenothion
149 Dimethoate
172 Disulfoton
174 Endosulfan
175 Endrin
192 Heptachlor
193 Heptachlor epoxide
196 Lindane and isomers
214 Kepone
230 Methoxychlor
242 Methyl parathion
283 Parathion
300 Polychlorinated biphenyl
351 Toxaphene
361 2,4,5-T
362 2,4,5-TP Silvex

TABLE C.7. Compounds To Be Analyzed By Class

TOX:

65 Chlorinated ethane
66 Chlorinated fluorocarbons
67 Chlorinated naphthalene
68 Chlorinated phenol
118 Dichlorobenzene
125 Dichloroehtylene
132 Dichloropropane
135 Dichloropropene
191 Halomethane

TOC:

87 Coal tars
89 Creosote

Ammonium:

263 Nitrosamine

TABLE C.8. Constituents Unstable in Water

5 Acetyl chloride
13 Aluminum phosphide
40 Benzotrichloride
53 2-butanone peroxide
60 Carbon oxyfluoride
138 1,2:3,4-diepoxybutane
148 Diisopropylfluorophosphate
154 Dimethylcarbamoyl chloride
161 Dimethyl sulfate
185 Fluorine
205 Hydrofluoric acid
211 Methyl isocyanate
220 Maleic anhydride
233 Methyl chlorocarbonate
257 Nitrogen dioxide
293 Phosgene
295 Phorate
296 Famphur
298 Phthalic anhydride
331 Tetraethyldithiopyrophosphate
350 Toluene diisocyanate
367 Tris (1-aziridinyl) phosphine sulfide
375 Zinc phosphide

TABLE C.9. Constituents For Which No Analysis Is Available

10 Aflatoxins
15 Mitomycin C
26 Azaserine
52 Brucine
62 Chlorambucil
96 Cycasin
98 Cyclophosphamide
99 Daunomycin
103 Diallate
142 O,O-diethylphosphoric acid, o-p-nitrophenyl ester
144 Thionazin
147 3,4-dihydroxy-alpha-(methylamino) methyl benzyl alcohol
173 2,4-dithiobiuret
178 Ethylenebisdithiocarbamic acid
186 2-fluoroacetamide
199 Hexachlorohyxahydro-endo, endo-dimethanonaphthalene
202 Hexaethyl thetrphosphate
210 Iron dextran
215 Lasiocarpine
241 N-methyl-N'-nitro-N-nitrosoguanidine
244 Mustard gas
254 Nitric oxide
258 Nitrogen mustard - HCl salt
259 Nitrogen mustard N-oxide and HCl salt
260 Nitroglycerin
262 4-nitroquinoline
277 N-nitrososacrosine
279 Octamethylpyrophosphoramide
281 Endothol
282 Paraldehyde
294 Phosphine
304 1,3-propanesultone
306 Propylthiouracil
311 Saccharin and salts
320 Streptozotocin
333 Tetraethylpyrophosphate
334 Tetranitromethane
343 Thioacetamide
344 Thiosemicarbazide
369 Trypan blue
370 Uracil mustard

TABLE C.10. Miscellaneous Organics and Inorganics

86	Citrus red No. 2
92	Cyanide
58	Calcium cyanide
204	Hydrocyanic acid
301	Potassium cyanide
319	Sodium cyanide
94	Cyanogen bromide
95	Cyanogen chloride
188	Formaldehyde
189	Formic acid
221	Maleic hydrazide
253	Nicotine and salts
322	Strychnine
345	Thiourea
6	1-Acetyl-2-thiourea
82	1-(o-Chlorophenyl)thiourea
145	Diethylstilbesterol
181	Ethylenethiourea
249	1-Naphthyl-2-thiourea
268	N-Nitroso-N-ethylurea
270	N-Nitroso-N-methylurea
292	N-Phenylthiourea

APPENDIX F

CORRESPONDENCE FROM PUMP MANUFACTURER

0142047/1106

WELL WIZARD™
Dedicated Monitoring System

RECEIVED
SEP 12 1985

September 10, 1985

Ms. Christy Batson
Batelle Northwest
Rockwell Receiving
1166 Building
Richland, WA 99352

Dear Ms. Batson:

Investigations have confirmed the existence of low levels of chlorinated hydrocarbon contaminants in some groundwater sampling pumps produced by QED Environmental Systems, Inc.

The specific contaminants involved are 1,1,1-trichloroethane, tetrachloroethene, and methylene chloride. Concentration levels in the sample pump discharge of up to several hundred parts per billion have been encountered; the concentration level present in samples is markedly reduced by purging water through the pump immediately prior to sample collection.

Pump contamination is most directly indicated by elevated concentration levels of the three contaminants in analysis of the initial discharge of the pump, without any purging during the previous two days. Subsequent sampling of the well with a clean sampling device is expected to yield samples without detectable levels of the three contaminants.

QED Environmental Systems, Inc. is currently working with Batelle Northwest to rectify any contamination problems they may have with pumps at their site.

Very truly yours,

David A. Fischer
Manager-Technical Services

DAF/kw

Q.E.D. environmental systems inc. 1254 N. Main Street • P.O. Box 7209
Ann Arbor, MI 48107 • (313) 995-2547

APPENDIX G

VOLATILE AND SEMI-VOLATILE ORGANICS FROM THE 9905 LIST

VOLATILE AND SEMI-VOLATILE ORGANICS FROM THE 9905 LIST

Volatile Organics

Acrolein
Acrylonitrile
Benzene
Bis(chloromethyl)ether
Bromoacetone
Methyl bromide
Carbon disulfide
Chlorobenzene
2-Chloroethyl vinyl ether
Chloroform
Methyl chloride
Chloromethyl methyl ether
Crotonaldehyde
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
1,4-Dichloro-2-butene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
trans-1,2-Dichloroethene
1,1-Dichloroethylene
Methylene chloride
1,2-Dichloropropane
1,3-Dichloropropene
N,N-Diethylhydrazine
1,1-Dimethylhydrazine
1,2-Dimethylhydrazine
Dioxane
Hydrogen sulfide
Iodomethane
Methacrylonitrile
Methanethiol
Methyl ethyl ketone
Pentachloroethane
Pyridine
Tetrachloroethane
1,1,1,2-Tetrachlorethane
1,1,2,2-Tetrachlorethane
Tetrachlorethylene
Tetrachloromethane
Toluene
Bromoform
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethane
Trichloromethanethiol
Trichloromonofluoromethane
Trichloropropane
1,2,3-Trichloropropane
Vinyl chloride

VOLATILE AND SEMI-VOLATILE ORGANICS FROM THE 9905 LIST

(Continued)

Semi-Volatile Organics (Continued)

Methylthiouracil
Naphthalene
1,4-Naphthoquinone
1-Naphthylamine
2-Naphthylamine
p-Nitroaniline
Nitrobenzine
4-Nitrophenol
N-Nitrosodi-n-butylamine
N-Nitrosodiethanolamine
N-Nitrosodiethylamine
N-Nitrosodimethylamine
N-Nitrosomethylethylamine
N-Nitroso-N-methylurethane
N-Nitrosomethylvinylamine
N-Nitrosomorpholine
N-Nitrosonornicotine
N-Nitrosopiperidine
Nitrosopyrrolidine
5-Nitro-o-toluidine
Pentachlorobenzene
Pentachloronitrobenzene
Pentachlorophenol
Phenacetin
Phenol
Phenylenediamine
Phthalic acid esters
2-Picoline
Pronamide
Reserpine
Resorcinol
Safrol
1,2,4,5-Tetrachlorobenzene
2,3,7,8-TCDD
2,3,4,6-Tetrachlorophenol
Thiuram
Toluenediamine
o-Toluidine hydrochloride
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
O,O,O-Triethyl phosphorothioate
sym-Trinitrobenzene
Tris(2,3-dibromopropyl) phosphate

VOLATILE AND SEMI-VOLATILE ORGANICS FROM THE 9905 LIST

(Continued)

Semi-Volatile Organics

Acetonitrile
Acetophenone
Warfarin
2-Acetylaminofluorene
4-Aminobyphenyl
5-(Aminomethyl)-3-ioxazolol
Amitrole
Aniline
Aramite
Auramine
Benz[c]acridine
Benz[a]anthracene
Benzene, dichloromethyl-
Benzenethoil
Benzidine
Benzo[b]fluoranthene
Benzo[j]fluoranthene
Benzo[a]pyene
p Benzoquinone
Benzyl chloride
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl) ether
Chlornaphazine
Bis(2-chloroisopropyl)ether
Bis(2-ethylhexyl) phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
2-sec-Butyl-4,6-dinitrophenol
Chlorinated benzenes
Chloroalkyl ethers
p-chloroaniline
p-Chloro-m-cresol
1-Chloro-2,3-epoxypropane
2-Chloronaphthalene
2-Chlorophenol
Chrysene
Cresols
2-Cyclohexyl-4,6-dinitrophenol
Dibenz[a,h]acridine
Dibenz[a,j]acridine
Dibenz[a,h]anthracene
7H-Dibenzo[c,g]carbazole
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Di-n-butyl phthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
2,6-Dichlorophenol

Diethyl phthalate
Dihydrosafrole
3,3'-Dimethoxybenzidine
p-Dimethylaminoazobenzene
7,12-Dimethylbenz[a]anthracene
3,3'-Dimethylbenzidine
Thiofanox
alpha,alpha-Dimethlphenethylamine
2,4-Dimethylphenol
Dimethyl phthalate
Dinitrobenzene
4,6-Dinitro-o-cresol and salts
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
Diphenylamine
1,2-Diphenylhydrazine
Di-n-propylnitrosamine
Ethyleneimine
Ethyl methanesulfonate
Fluoranthene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Hexachlorophene
Hexachloropropene
Hydrazine
Indeno(1,2,3-cd)pyrene
Isosafrole
Malononitrile
Melphalan
Methapyrilene
Metholonyl
2-Methylaziridine
3-Methylcholanthrene
4,4'-Methylenebis(2-chloroaniline)
2-Methyllactonitrile
Methyl methacrylate
Methyl methanesulfonate
2-Methyl-2-(methylthio) propionaldehyde-o-(methylcarbonyl) oxime

APPENDIX H

LOCATION OF OFFICIAL COPIES OF THE CLOSURE AND POST-CLOSURE PLAN

9011180406

APPENDIX H

LOCATION OF OFFICIAL COPIES OF THE CLOSURE AND POST-CLOSURE PLAN

Two copies of the 300 Area Process Trenches Closure/Post-Closure Plan are official copies of the closure plan. These official copies are located at the following office:

U.S. Department of Energy-Richland Operations Office
Federal Building
825 Jadwin Avenue
P.O. Box 550
Richland, WA 99352

APPENDIX I

PERSON RESPONSIBLE FOR STORAGE AND UPDATING COPIES OF THE CLOSURE/POST-CLOSURE PLAN

APPENDIX I

PERSON RESPONSIBLE FOR STORAGE AND UPDATING COPIES OF CLOSURE/POST-CLOSURE PLAN

The following office will be responsible for updating the official copies of the Closure/Post-Closure Plan for the 300 Area Process Trenches:

Chief
Radiological and Environmental Safety Branch
Environment, Safety and Health Division
U.S. Department of Energy - Richland Operations Office
Federal Building - Room 619
825 Jadwin Avenue
P.O. Box 550
Richland, WA 99352
(509) 376-7387

APPENDIX J

CERTIFICATION OF CLOSURE FOR THE 300 AREA PROCESS TRENCHES

APPENDIX J

CERTIFICATION OF CLOSURE FOR THE 300 AREA PROCESS TRENCHES

When closure is completed, DOE-RL will submit to the regulating authority both a self-certification and a certification by an independent registered professional engineer that the 300 Area Process Trenches have been closed in accordance with the specification of the approved plan.

Owner/Operator Closure Certification

The DOE-RL will self-certify with the following document or a document similar to it:

> I, (name), an authorized representative of the U.S. Department of Energy-Richland Operations Office located at the Federal Building, 825 Jadwin Avenue, Richland, Washington, hereby state and certify that the 300 Area Process Trenches, to the best of my knowledge and belief, have been closed in accordance with the attached approved closure plan, and that the closure was completed on (date). (Signature and date)

Professional Engineer Closure Certification

The DOE-RL will engage an independent registered professional engineer to certify that the facility has been closed in accordance with this approved closure plan. The DOE-RL will require the engineer to sign the following document or a document similar to it:

> I, (name), a certified professional engineer, hereby certify, to the best of my knowledge and belief, that I have made visual inspection(s) of the 300 Area Process Trenches and that closure of the aforementioned facilities has been performed in accordance with the attached approved closure plan. (Signature, date, state professional engineer license number, business address, and phone number)