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Preliminary Closure/Post-Closure Plan 216-B-3 Pond

April 1987

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Prepared by:
U.S. Department of Energy
Richland Operations Office
Hanford Site
Richland, Washington

216-B-3 Pond Preliminary Closure/Post-Closure Plan

PLEASE RETURN TO:
ENVIRONMENTAL DIVISION
RESOURCE CENTER

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
4. 1324-N surface impoundment
5. 1706-KE waste treatment system.

The following facilities are known to have received hazardous waste. These facilities will continue to operate, receiving only nonregulated waste as described in separate closure/post-closure plans:

1. 216-B-3 pond
2. 216-A-29 ditch
3. 216-B-63 trench
4. 2101-M pond
5. 100-D ponds
6. 1324-NA percolation pond (closure plan only)
7. 300 Area process trenches.

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

1. Solar evaporation basins
2. Solvent evaporator (closure plan only)
3. 1301-N Liquid Waste Disposal Facility.

Each separate permit application and closure/post-closure plan provides a complete description of hazardous waste management activities as is required in Washington Administrative Code (WAC), Chapter 173-303-806, Title 40, Code of Federal Regulations (CFR), Part 270, Subpart B, and

WAC 173-303-400 (40 CFR 265, Subpart G), respectively.* It is anticipated that each separate Part B Permit Application or closure/post-closure plan will be reviewed individually and will undergo subsequent revisions prior to acceptance by the Washington State Department of Ecology or the U.S. Environmental Protection Agency (EPA), Region X.

The following submittal contains the DOE-RL Closure/Post-Closure Plan for the 216-B-3 pond.

*At the time this document was prepared, the EPA had not authorized the State of Washington to regulate radioactive mixed wastes under the Resource Conservation and Recovery Act. In a July 3, 1986, Federal Register notice (51 FR 24504), the EPA indicated that currently authorized state programs do not apply to radioactive mixed wastes. Neither the EPA nor the State of Washington have regulations specifically addressing these wastes and it is uncertain how such wastes will be regulated. However, since the State of Washington has applied to EPA for authority to regulate radioactive mixed wastes, this plan has been written to existing State regulations on the assumption that the State will be authorized to regulate these wastes before the plan is acted upon. If this expectation does not occur, or if specific regulations addressing radioactive mixed wastes are adopted, this plan will be amended as necessary.

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1.0 PART A APPLICATION

1.1 INTRODUCTION

The 216-B-3 pond is an open, unlined pond that is used for disposal of potentially radioactive (low-risk) waste water from the Plutonium-Uranium Extraction Facility (PUREX), B Plant, 244-AR Vault, 200 East Area Powerhouse, 242-A evaporator, 241-AY and -AZ Tank Farms surface condensors, and the 283-E water treatment facility. This discharge is composed of process cooling water, nonprocess steam condensate, chemical storage and makeup tank overflows, demineralizer recharge effluents, and acid fractionator condensate.

In the past, demineralizer effluents were released sequentially from the anion and cation columns, which caused the effluent to be outside the pH 2.0 to 12.5 limits. Current practice is to regenerate the cation and anion columns concurrently. Mixing of the two effluent streams in the lines results in self-neutralization to a final pH of between 4 and 10.

Volume 2 of the U.S. Department of Energy - Richland Operations Office (DOE-RL) Part A Permit Application was prepared for submittal to the Washington State Department of Ecology (WDOE) and the U.S. Environmental Protection Agency (EPA), Region X, on August 15, 1986. This volume contained waste designation and treatment process information for the 216-B-3 pond, which is located east of the 200 East Area of the Hanford Site.

1.2 PART A APPLICATION

The following Part A Application contains waste process and designation codes for the 216-B-3 pond.

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 0 9 9 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 020-31

SQA-275

WA7890008967

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		

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 Refer to Sections V in the following chapters

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 Refer to Sections VI in the following chapters

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 Refer to Sections VI and VII in the following chapters

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A If the facility owner is also the facility operator as listed in Section VB 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 VB 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

Please print or type in the unshaded areas only
(Pica — or pica — are acceptable for entry type 1 or 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. — 4 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	O

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. PROCESS DESIGN CAPACITY 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. PROCESS DESIGN CAPACITY 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	T 0 4	1,140,000	E		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.

T04: The 216-B-3 Pond has historically received acid fractioner condensate and condenser cooling water, (both of which are nonregulated wastewaters) and demineralizer recharge effluents from the PUREX facility, via the 216-A-29 conveyance. Demineralizer recharge effluent pH monitoring revealed in February of 1986 that the demineralizer effluent was outside of the pH 2.0 to 12.5 limits. Immediate actions were taken to provide demineralizer effluent neutralization following identification of the out-of-tolerance pH levels. Acids and bases were discharged to this unit in series. This situation, as well as the large volumes of neutral process wastewaters that were released after acid/base discharge served to rapidly neutralize the corrosive discharges. Any acidic or basic waters that reached the soil were further neutralized by the calcareous nature of the soil.

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 measure 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	K054	900	P	T03 D80	
X-2	D002	400	P	T03 D80	
X-3	D001	100	P	T03 D80	
X-4	D002			T03 D80	included with above

CONTINUE ON PAGE 3

Continued from page 2

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

I.D. NUMBER (enter from page 1): W A 7 8 9 0 0 0 8 9 6 7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter codes)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter codes)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	D 0 0 2	4,327,900,000	G	T 0 4	
2		This quantity reflects total discharges to the facility, and not a volume			
3		of designated dangerous wastes. This facility does not currently and will			
4		not in the future receive discharges of regulated dangerous wastes.			
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
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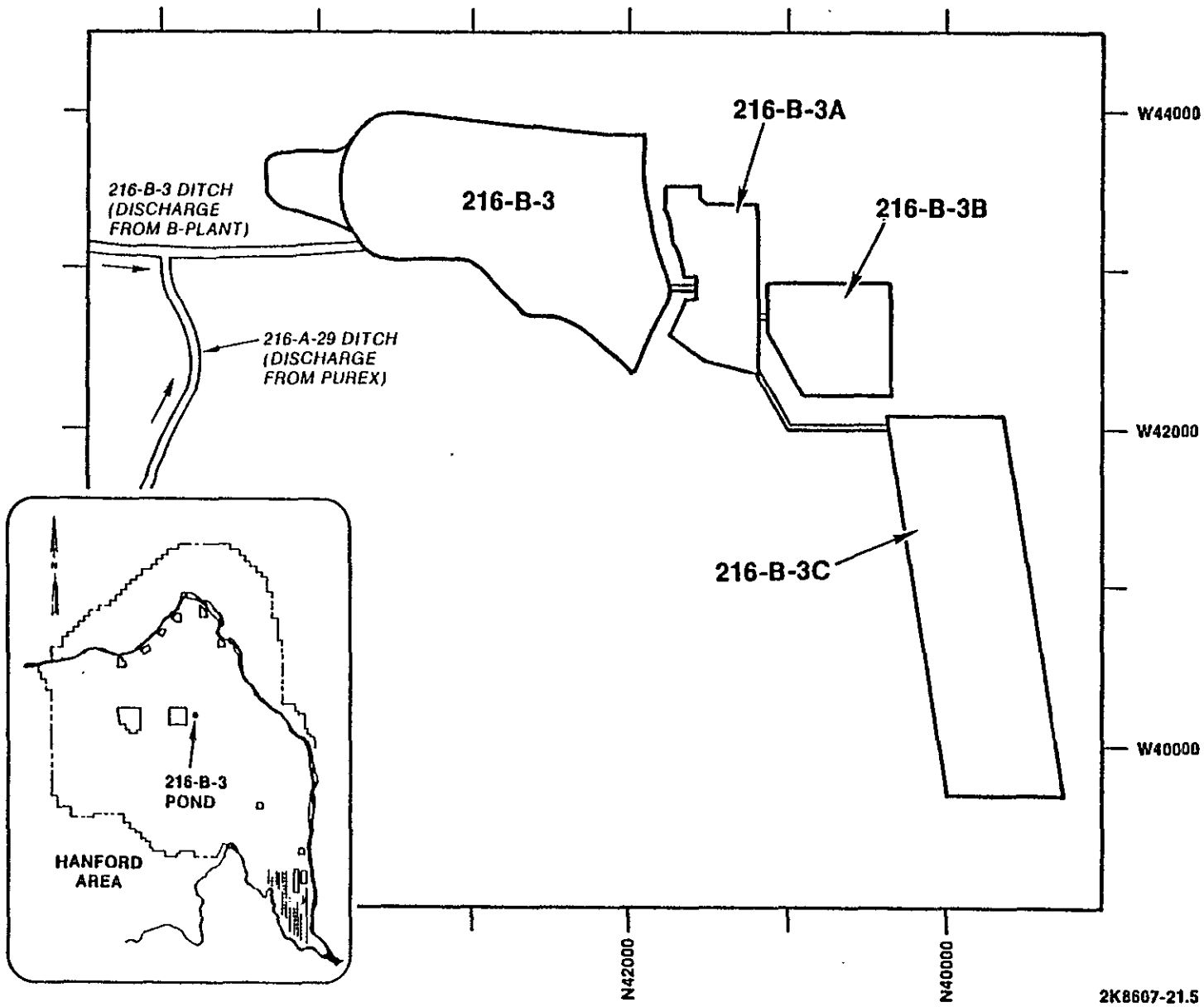
18					
19					
20					
21					
22					
23					
24					
25					
26					

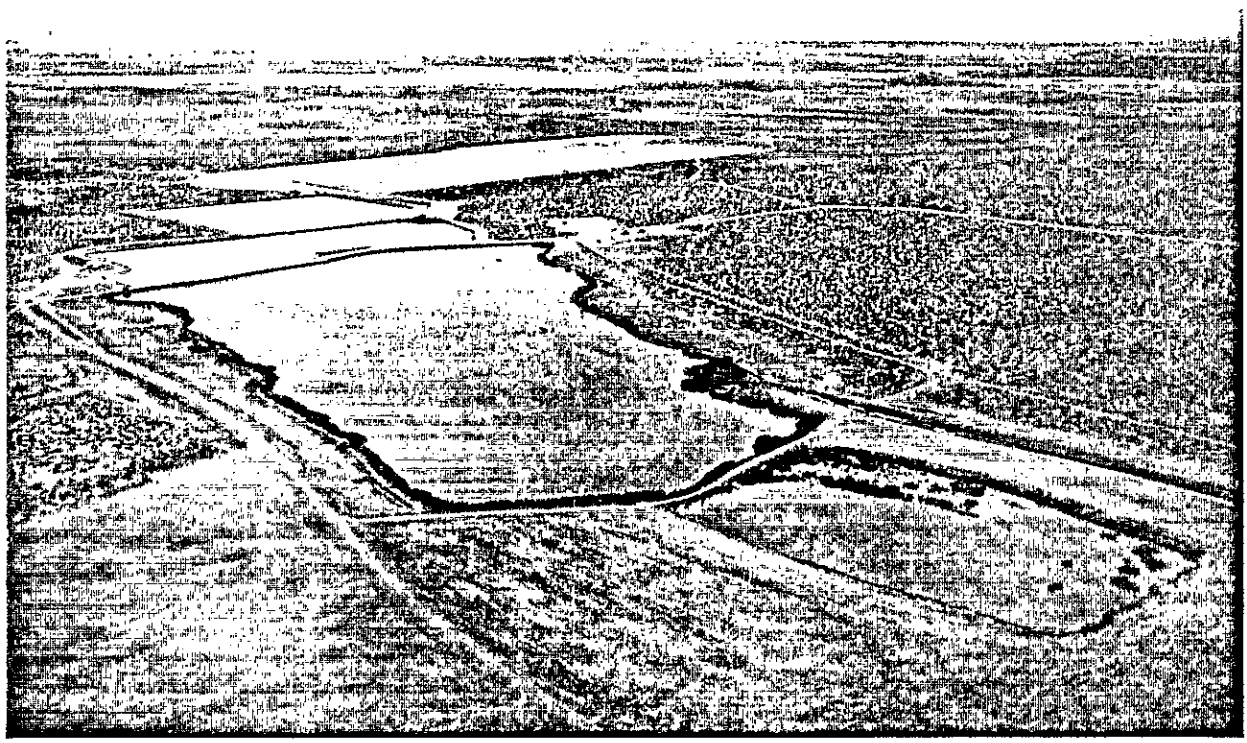
SECTION V - FACILITY DRAWINGS

216-B-3 POND


216-B-3A
216-B-3
216-B-3B
216-B-3C
216-B-3 DITCH
(DISCHARGE
FROM B-PLANT)
216-A-29 DITCH
(DISCHARGE
FROM PUREX)
W44000
W42000
W40000
N42000
N40000
216-B-3
POND
HANFORD
AREA
2K8607-21.5

SECTION VI - PHOTOGRAPHS

216-B-3 POND



Latitude	Longitude
46° 33′38.522″	119° 30′16.016″
46° 33′23.420″	119° 29′32.703″

PHOTO TAKEN 1985

2K8607-21.17

2.0 FACILITY DESCRIPTION

This section provides a general description of the hazardous waste management facility discussed in this closure/post-closure plan. This description is intended to provide the permit application reviewer/permit writer with an overview of the facility.

2.1 GENERAL DESCRIPTION

The Hanford Site is a 570-mi^2 (1,476-km^2) tract of semiarid land that is owned and operated by the DOE. This site is located northwest of the city of Richland, Washington, along the Columbia River. The city of Richland lies approximately 3 mi (4.8 km) from the southernmost portion of the Hanford Site boundary and is the nearest population center (fig. 2-1). In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for reactor, chemical separation, and related facilities for the production and purification of plutonium. A total of eight graphite-moderated reactors using Columbia River water for once-through cooling were built along the Columbia River. These reactors were operated from 1944 to 1971.

N Reactor, a dual-purpose reactor for production of plutonium and generation of steam for production of electricity, uses recirculating water coolant. N Reactor began operating in 1963 and remains in operation today.

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 located in the 200 Areas, situated on a plateau about 7 mi (11.2 km) from the river. The 300 Area, located north of Richland, contains the reactor fuel manufacturing facilities and the research and development laboratories. The 400 Area, 5 mi (8 km) northwest of the 300 Area, contains the Fast Flux Test Facility. The 1100 Area, north of Richland, contains buildings associated with maintenance and transportation functions for the Hanford Site. Administrative buildings and other research and development laboratories are found in the 3000 Area, also north of Richland. The Nonradioactive Dangerous Waste Landfill is located 2 mi (3.2 km) southeast of the 200 East Area in the 600 Area. The Nonradioactive Dangerous Waste Facility, which is located between the 200 East and West Areas on Route 3S, is also located in the 600 Area.

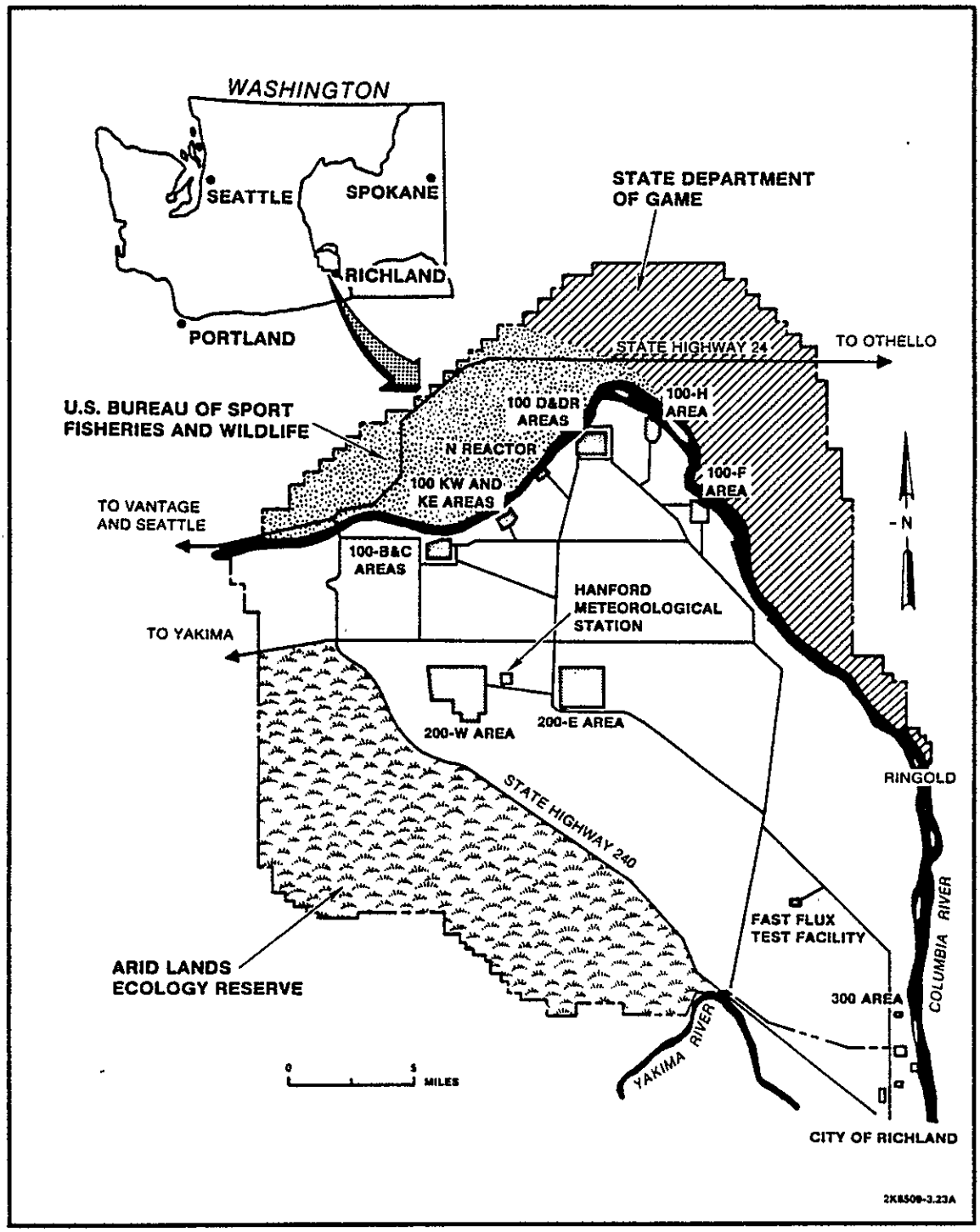


Figure 2-1. Surrounding Land Use.

2.2 216-B-3 POND

The 216-B-3 pond is an unlined pond, approximately 5 ft (1.5 m) deep, covering 39 acres (16 ha). This pond has been in service since 1945, and when the Plutonium Uranium Extraction (PUREX) facility is operating, receives about 22 million gal/d (83 million L/d). Man-made earthen diking with basalt rip-rap support is used at the pond perimeter for erosion control. The pond is located approximately 4,100 ft (1,250 m) east of the east perimeter fencing of 200 East Area. There are also three expansion ponds of 11 acres, 11 acres, and 41 acres (4.5, 4.5, and 16.8 ha), respectively.

All discharge to the 216-B-3 pond is from the 216-B-3-3 ditch and occurs at the southwest corner of the pond. The 216-B-3-3 ditch carries flow from the PUREX facility, B Plant, 200 East Area Powerhouse, 244-AR Vault, 242-A evaporator, 241-AY and -AZ Tank Farms surface condensors and 283-E water treatment facility. Approximately 2,000 ft (610 m) east of the 200 East Area perimeter fencing, the 216-B-3-3 ditch is joined by the 216-A-29 ditch. The 216-A-29 ditch flow consists of nonprocess steam condensates, chemical storage and makeup tank overflows, demineralizer recharge effluents, and acid fractionator condensates from the PUREX chemical sewer. A separate closure/port-closure plan is being submitted for the 216-A-29 ditch.

Flow to the pond cannot be diverted after entering the ditches. Prior to entering the 216-A-29 ditch, the PUREX chemical sewer flow may be diverted to a retention basin in the event of high radiation levels or the presence of hazardous chemicals. Prior to entering the 216-B-3-3 ditch, the PUREX cooling water line flow may be diverted to the Gable Mountain Pond, and both the PUREX and B Plant cooling water may be diverted to retention basins in the event of high radiation levels. The Gable Mountain Pond is being decommissioned and when decommissioning is completed (fall 1987), all of the cooling water from these plants will go to the 216-B-3 Pond.

2.3 TOPOGRAPHICAL MAPS

The map 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:

- Facility boundary
- Surrounding land use including the Saddle Mountain National Wildlife Refuge and the Washington State Game Reserve to the north and the Arid Lands Ecological Reserve located to the west. Land east of the Hanford Site across the Columbia River is primarily farmland or a part of the Washington State Game Reserve. The surrounding land area is also shown in figure 2-1

- Contours sufficient to show surface water flow. Because of the large facility size, contours are shown at intervals of 20 ft (6.1 m)
- Fire control facilities located on the Hanford Site
- Locations of access roads, internal roads, railroads, and perimeter gates and barricades
- Longitudes and latitudes.

Figure 2-2 illustrates wind roses for various locations on the Hanford Site. Winds are predominately from the west.

The location of the original 216-B-3 pond in relation to the 200 East Area is shown in figure 2-3.

Sources of discharge to the 216-B-3 pond are shown in figure 2-4.

A detailed layout of the entire 216-B-3 pond system and immediate discharge systems is shown in figure 2-5.

A water-table contour map of the uppermost aquifer showing the groundwater flow gradients for the Hanford Site facilities is located in appendix B. Further hydrology and geology information is discussed in section 5.0 of this closure/post-closure plan.

2.4 LOCATION INFORMATION

2.4.1 Seismic Consideration

The Hanford Site is not located within any of the political jurisdictions identified in appendix VI of 40 CFR 264 and WAC 173-303-420(3)(c) that are considered to be seismically active.

2.4.2 Floodplain Standard

The U.S. Army Corps of Engineers has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 1.4 million ft^3/s (4,000 m^3/s). The floodplain associated with the probable maximum flood is shown in figure 2-5 (Jamison 1982). The inundated area shown in figure 2-6 is greater than that which would be inundated during a 100-yr flood. The facility addressed in this closure/post-closure plan is located above the floodplain.

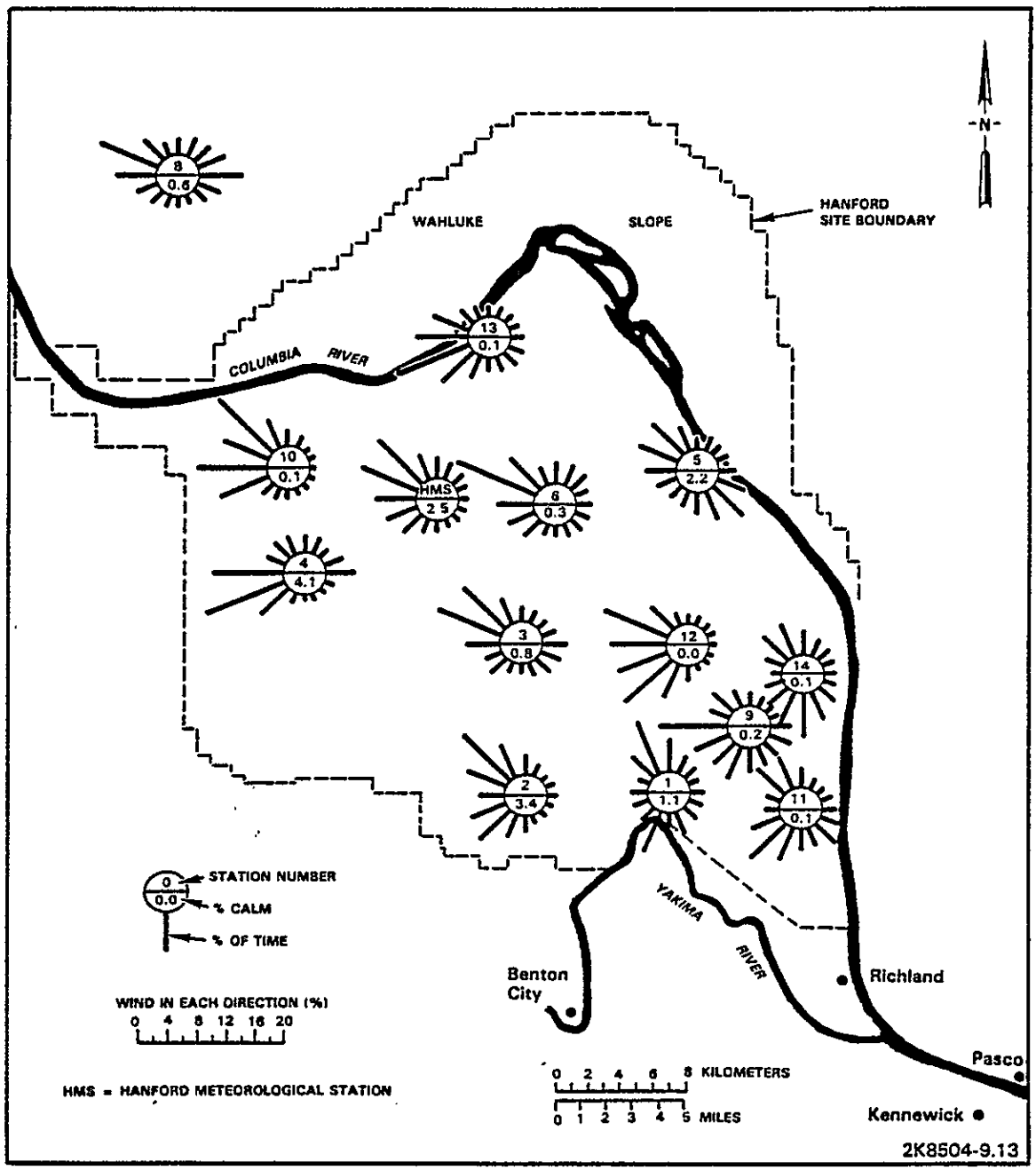


Figure 2-2. Wind Rose Telemetry Network.

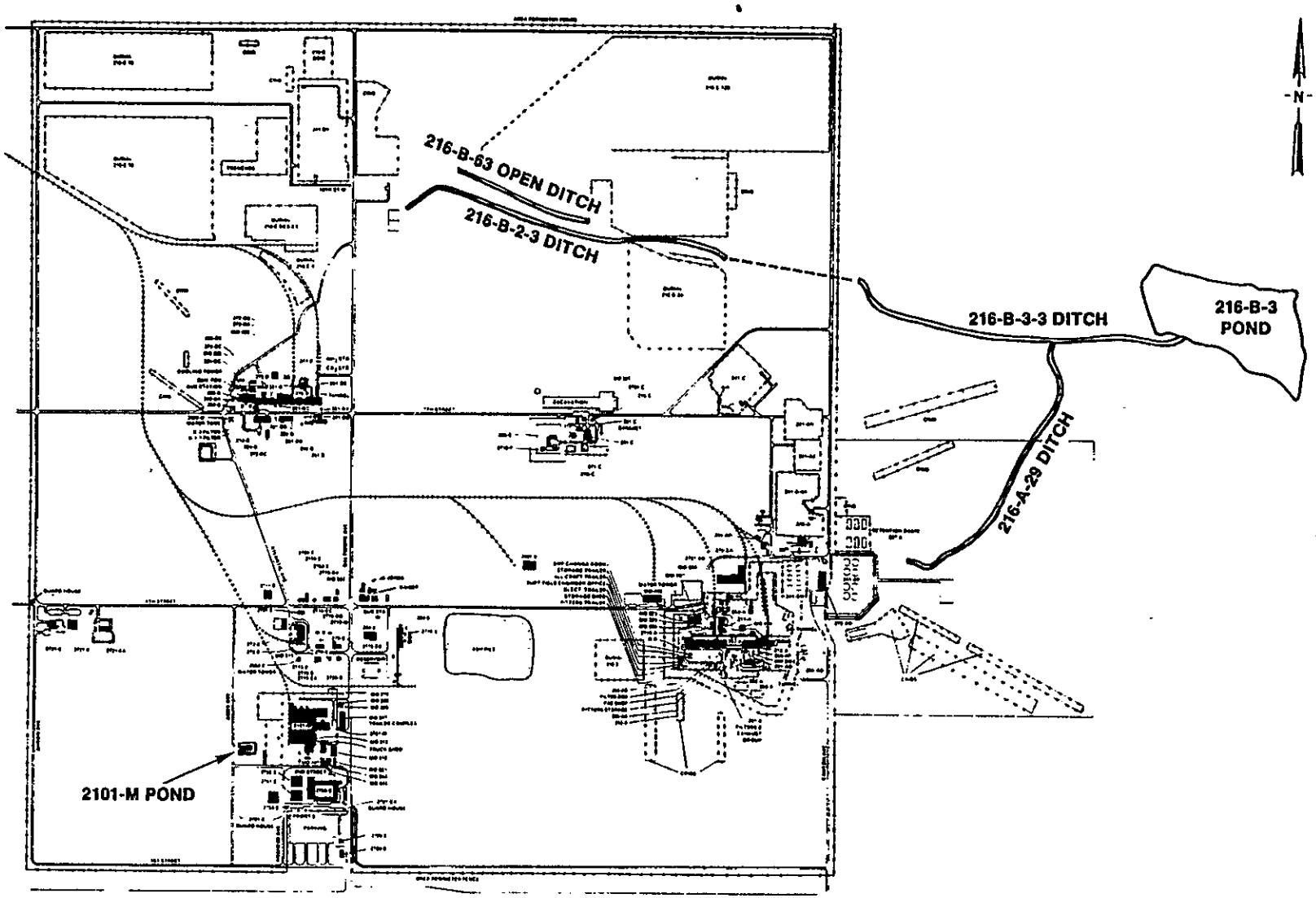


Figure 2-3. 200 East Area Site Plan.

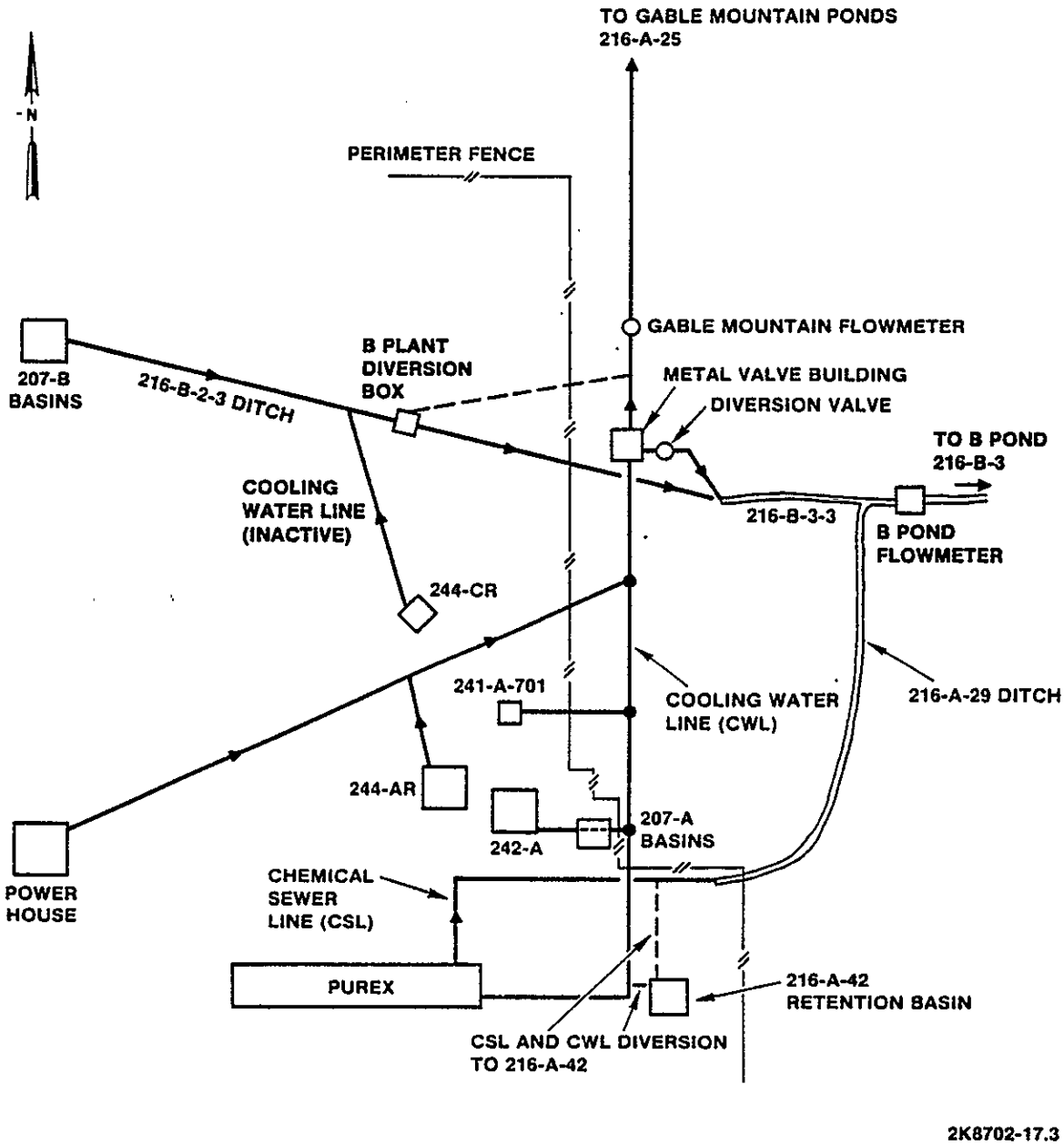


Figure 2-4. Flow to the 216-B-3 Pond.

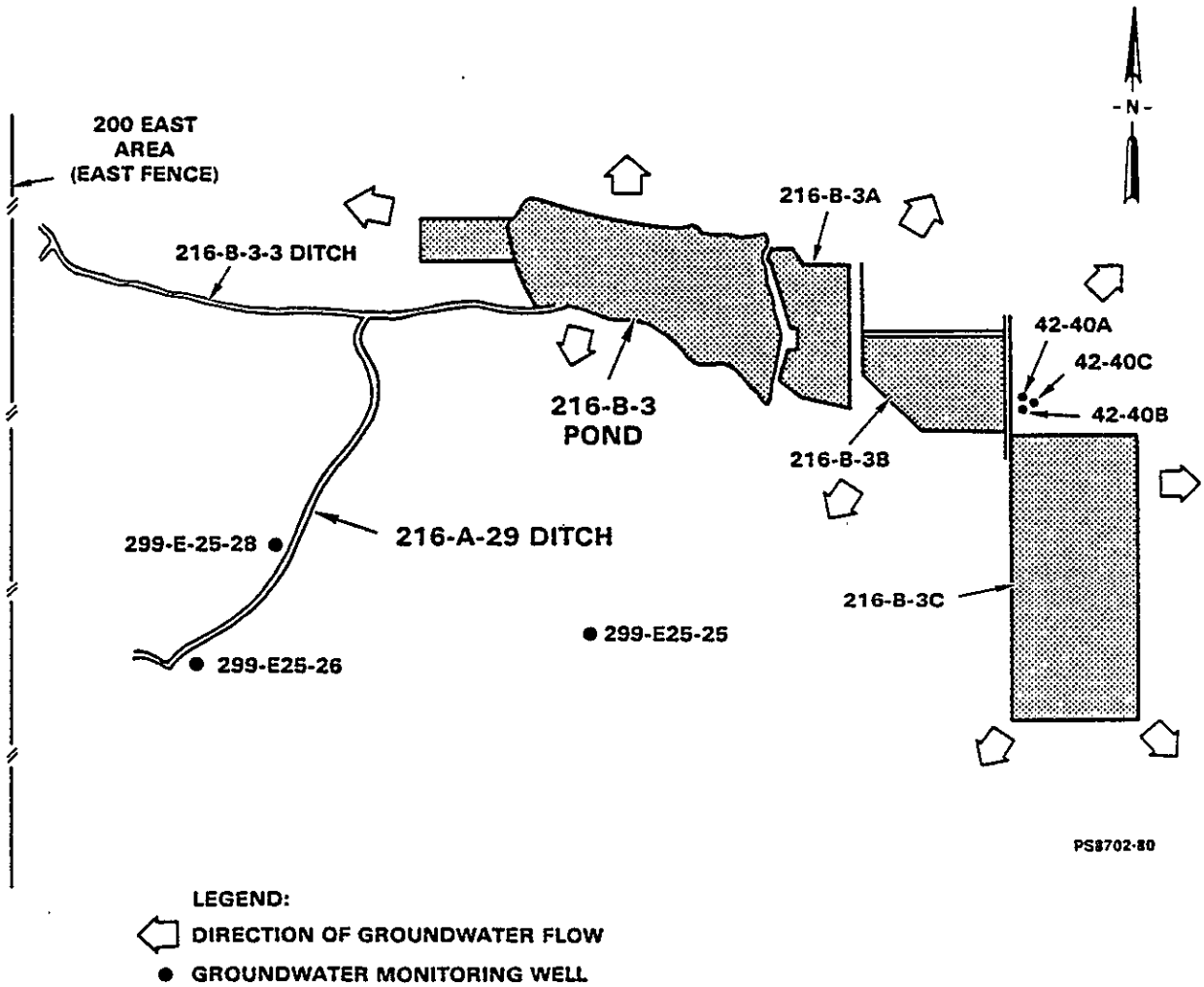


Figure 2-5. 216-A-29 Ditch and 216-B-3 Pond.

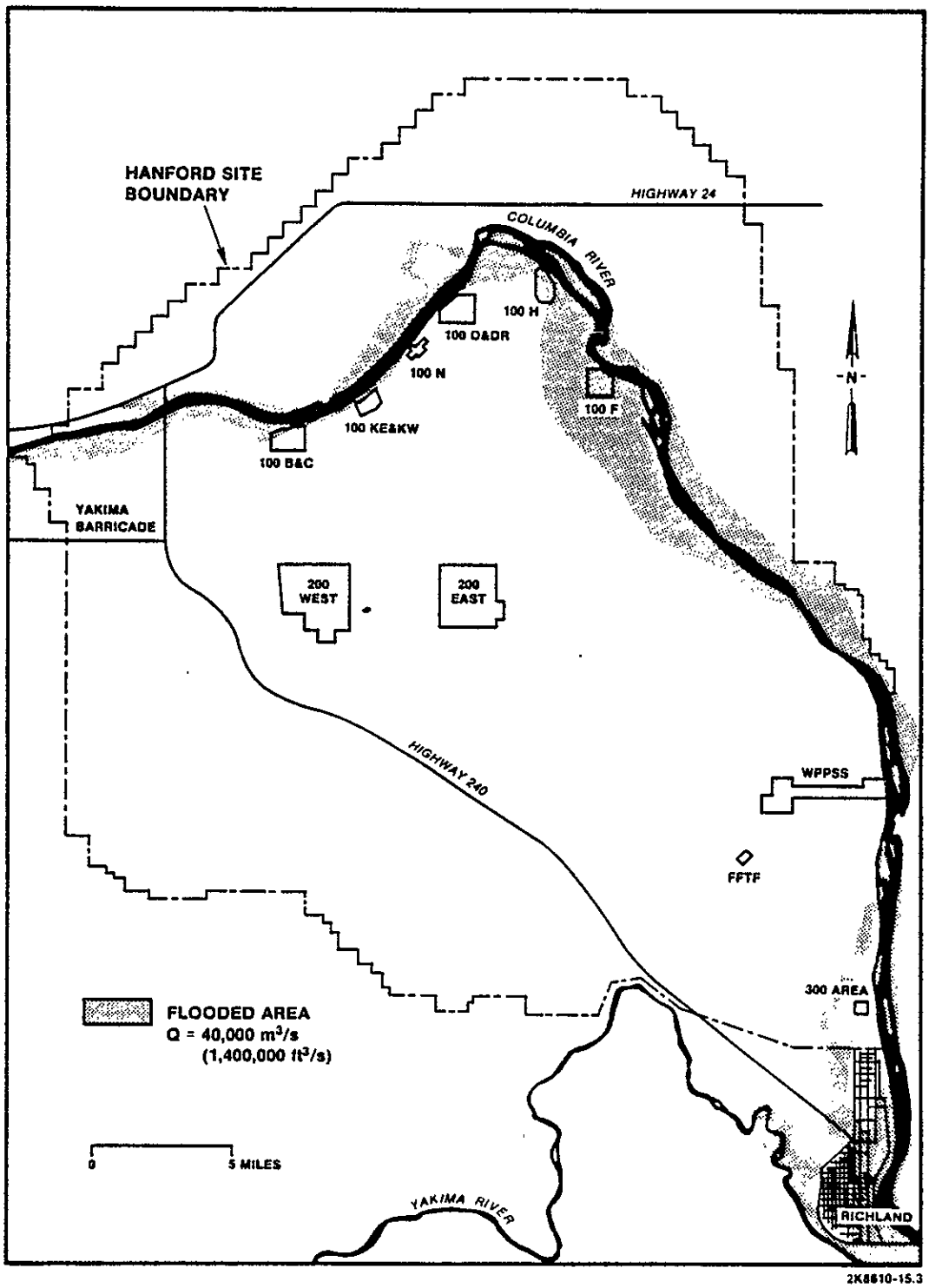


Figure 2-6. Inundated Area for the Probable Maximum Flood.

2.5 TRAFFIC INFORMATION

The 216-B-3 pond is located within the Hanford Controlled Access Area; these roadways cannot be accessed by the general public. The nearest public highway, Washington State Highway 240, is separated from the patrolled site areas by approximately 4 mi (6.4 km). The majority of traffic inside the Hanford Site boundaries consists of light-duty vehicles and buses used to transport the employees to the various operations sites located within Hanford Site.

Figure 2-7 shows the major roads throughout the Hanford Site. These roads are classified as either primary or secondary routes. The primary routes include Routes 4S, 10, 4N, 3, and the portion of 11A east of route 4N. Both primary and secondary routes are constructed of bituminous asphalt (usually 2 in. (5 cm) thick, but the thickness of the asphalt layer will vary with each road) with an underlying aggregate base. The aggregate base consists of various types and sizes of rock found on site.

The point of discharge into the 216-B-3 pond is located approximately 2 mi. (3.2 km) north of Route 4S, which is used by site personnel travelling between outer cities and the 200 Areas. The roads leading to this facility are outside the 200 East Area perimeter fencing. Vehicle traffic on the roads in the vicinity of the points of discharge is light and no effluent is transported via roadways to the pond.

2.6 REFERENCES

EPA, 1986, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Title 40, Code of Federal Regulations, Part 264, U.S. Environmental Protection Agency, Washington, D.C.

Jamison, J. D., 1982, Standardized Input for Hanford Environmental Impact Statements, Part II: Site Description, PNL-3509 PT 2, Pacific Northwest Laboratory, Richland, Washington.

WAC, 1986, "Siting Standards," Dangerous Waste Regulations, WAC 173-303-420(3)(c), Washington Administrative Code, Olympia, Washington.

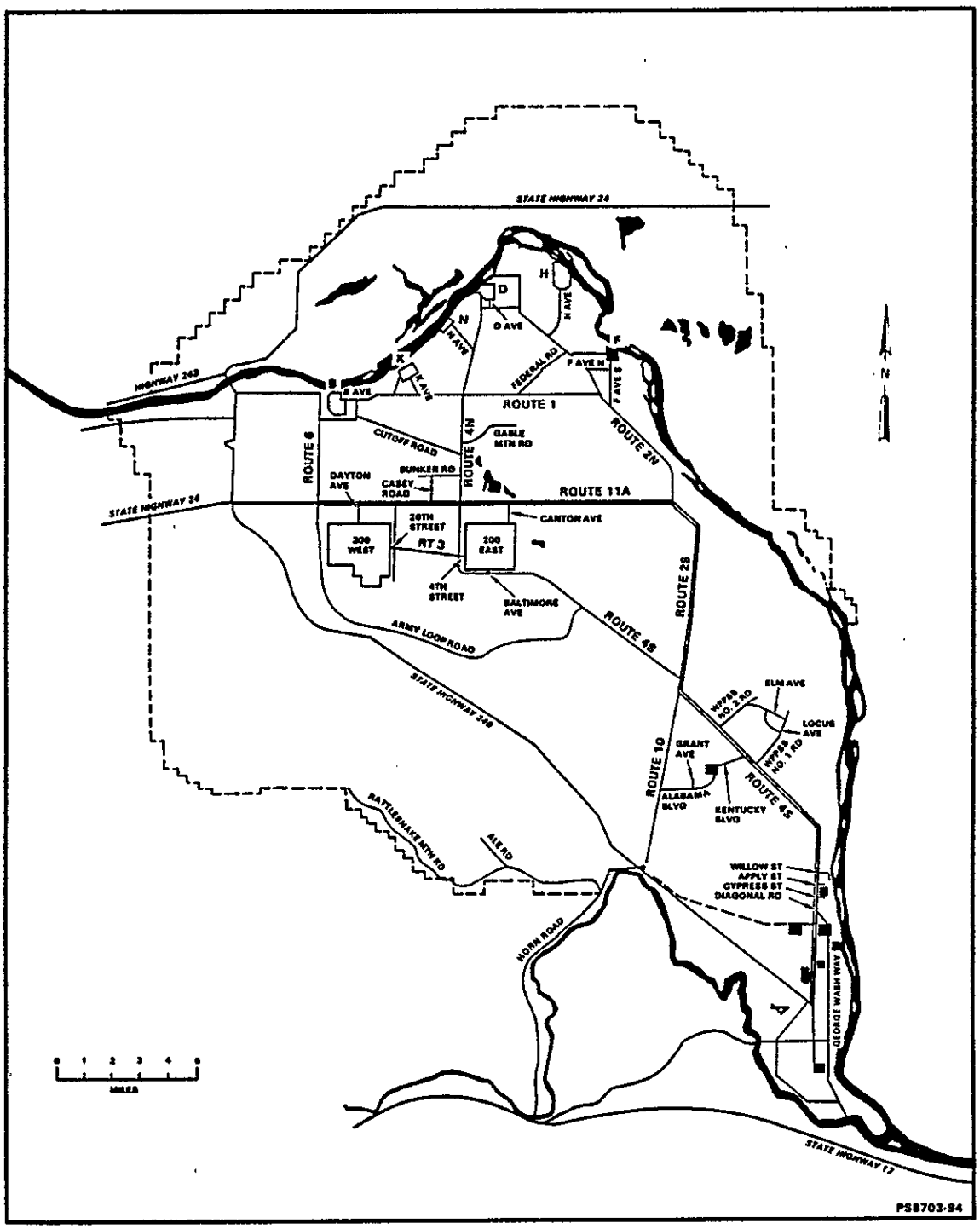


Figure 2-7. Hanford Site Roads.

3.0 WASTE CHARACTERISTICS

This section describes the chemical and physical characteristics of liquid waste discharge to the 216-B-3 pond. The 216-B-3 pond primarily receives waste water from the Plutonium-Uranium Extraction (PUREX) Plant and from B Plant. Specifically, these streams are B Plant cooling water, the PUREX chemical sewer, which is routed to the 216-B-3 pond via the 216-A-29 ditch, and PUREX Plant cooling water. (The 216-A-29 ditch is addressed in a separate closure plan.) Additional sources of waste water discharged to B Pond are cooling water from the 241-AY and -AZ Tank Farms surface condensers, 242-A evaporator cooling water and steam condensate, 244-AR Vault cooling water, the 284-E Powerhouse cooling water, and the 283-E Building water treatment filter backwash waste water. The pond, which receives an estimated 22 million gal (83 million L) of waste water daily, has been in service since 1945.

Prior to initiation of modifications in the PUREX Plant to eliminate hazardous waste discharges, the 216-B-3 pond received occasional batches of spilled material or off-specification chemicals and also routine corrosive effluent from a demineralizer regeneration system. Table 3-1 is a listing of known and potential discharges to this pond. The most frequent hazardous discharge to the pond was the effluent from demineralizer operations. These discharges of sodium hydroxide and sulfuric acid solutions occurred on a daily basis until February 1986, while PUREX was in service. Regeneration of the demineralizers, and thus discharges to the pond, occurred much less frequently while the plant was not operating. Sources of waste water other than the PUREX chemical sewer are nonhazardous effluents.

Seven of the eight discharge streams to the 216-B-3 pond have been sampled and analyzed for hazardous components. Preliminary data are provided in tables 3-2 through 3-8. The preliminary data indicate that these streams are not dangerous wastes as defined in WAC 173-303. The eighth stream, backwash from the 283-E Building water treatment filter, has not yet been sampled. This stream will likely not be found to be dangerous, as it contains water and alum, a flocculating agent. Further sampling and analytical efforts are underway for discharges to B Pond. A minimum of four sets of samples per stream are being collected a period of time (6 to 12 mo) sufficient to represent the variability of the waste over time.

Table 3-1. 216-B-3 Pond Known and Potential Discharges.

Waste	Date	Description
Demineralizer regenerant	1955 to February 1986	Characteristic (corrosive)
Aqueous makeup tank heels and off-specification batches	1955 to October 1984	Characteristic (corrosive and EP[a] toxic)
N Cell prestart testing (oxalic acid, nitric acid, hydrogen peroxide, calcium nitrate)	April 11, 1983 to December 7, 1983	Characteristic (corrosive)
Potassium permanganate, sodium carbonate solution	October 19, 1983	CERCLA[b]-reportable release
Hydrazine HN solution	June 6, 1984 September 13, 1984 October 2, 1984	CERCLA-reportable release
Potassium hydroxide	December 2, 1984	CERCLA-reportable release
Sodium nitrate	February 8, 1985	CERCLA-reportable release
Nitric acid	August 22, 1984 January 18, 1985 May 27, 1985 June 25, 1985 October 28, 1985	CERCLA-reportable release
Sodium hydroxide	February 26, 1984 November 19, 1984 August 6, 1985	CERCLA-reportable release
Cadmium nitrate	May 16, 1984 December 18, 1985	CERCLA-reportable release
Hydrazine	July 7, 1986	CERCLA-reportable release

[a]Extraction process.
[b]Comprehensive Environmental Response, Compensation, and Liability Act.

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Table 3-2. 216-B-3 Pond Preliminary Analytical Data from PUREX Chemical Sewer.

Analyte	Data (First sample, August 22, 1985)	Analyte	Data (First sample, August 22, 1985)
Aluminum	<1.5 E+02	Uranium	4.8 E−01
Silver	<1.0 E+01	Vanadium	<5.0 E+00
Barium	3.4 E+01	Zinc	4.7 E+01
Beryllium	<5.0 E+00	Chlorine	1.2 E+03
Calcium	1.9 E+04	CN	<1.0 E+01
Cadmium	7.0 E+00	Fluorine	2.8 E+02
Chromium	1.4 E+01	NO_3	8.4 E+02
Copper	8.0 E+01	PO_4	<1.0 E+03
Iron	<5.0 E+01	Sulfur	<1.0 E+03
Mercury	<1.0 E−01	SO_4	1.0 E+04
Potassium	6.1 E+02	Acetone	6.7 E+01
Magnesium	3.5 E+03	Diisobutylphtalate	2.0 E+01
Manganese	1.0 E+01	Amount (L/mo)	2.0 E+08
NH_4	4.5 E+02	pH	8.14
Sodium	3.1 E+03	Temperature (°C)	3.3 E+01
Nickel	1.6 E+01	Alpha activity (pCi/L)	4.9 E+02
Osmium	<3.0 E+02	Beta activity (pCi/L)	3.2 E+00
Lead	<3.0 E+01	Conductivity (µS/cm)	1.4 E+02
Antimony	<1.0 E+02	Total organic carbon	1.2 E+03
Tin	<3.0 E+02	Total organic halide	<1.0 E+02
Strontium	<3.0 E+02		

NOTE: Charges assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

Table 3-3. 216-B-3 Pond Preliminary Analytical Data from PUREX Cooling Water.

Analyte	Data (first sample, August 22, 1985)	Data (second sample, May 7, 1986)	Analyte	Data (first sample, August 22, 1986)	Data (second sample, May 7, 1986)
Aluminum	<1.5 E+02	<1.5 E+02	Strontium	<3.0 E+02	<3.0 E+02
Silver	<1.0 E+01	<1.0 E+01	Uranium	6.6 E-01	5.4 E-01
Barium	3.4 E+01	3.3 E+01	Vanadium	<5.0 E+00	<5.0 E+00
Beryllium	7.5 E+00	<5.0 E+00	Zinc	3.7 E+01	<5.0 E+00
Calcium	1.9 E+04	2.2 E+04	Chlorine	9.6 E+03	6.3 E+02
Cadmium	6.5 E+00	<2.0 E+00	CN	<1.0 E+01	<1.0 E+01
Chromium	<1.0 E+01	<1.0 E+01	Fluorine	2.5 E+02	<5.0 E+02
Copper	<1.0 E+01	<1.0 E+01	NO_3	<5.0 E+02	<5.0 E+02
Iron	1.7 E+02	<5.0 E+01	PO_4	<1.0 E+03	<1.0 E+03
Mercury	<1.0 E-01	<1.0 E-01	Sulfur	<1.0 E+03	<1.0 E+03
Potassium	8.4 E+02	9.1 E+02	SO_4	9.0 E+03	1.2 E+04
Magnesium	4.5 E+03		Diisobutylphtalate	1.4 E+01	<1.0 E+01
Manganese	2.2 E+01	<6.0 E+00	Amount (L/mo)	1.3 E+09	1.2 E+09
NH_4		<5.0 E+01	pH	8.28	8.15
Sodium	2.9 E+03	2.6 E+03	Temperature (°C)	3.4 E+01	2.0 E+01
Nickel	1.1 E+01	<1.0 E+01	Alpha activity (pCi/L)	7.5 E-01	1.3 E+00
Osmium	<3.0 E+02	<3.0 E+02	Beta activity (pCi/L)	2.2 E+01	1.6 E+01
Lead	<3.0 E+01		Conductivity (µS/cm)	1.2 E+02	1.4 E+01
Antimony	<1.0 E+02	<1.0 E+02	Total organic carbon	1.3 E+03	1.5 E+03
Tin	<3.0 E+02		Total organic halide	<1.0 E+02	8.3 E+00

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

Table 3-4. 216-B-3 Pond Preliminary Analytical Data from B Plant Cooling Water.

Analyte	Data (first sample, September 12, 1985)	Data (second sample, April 18, 1986)	Analyte	Data (first sample, September 12, 1985)	Data (second sample, April 18, 1986)
Aluminum	<1.5 E+02	<1.5 E+02	Strontium	<3.0 E+02	<3.0 E+02
Silver	<1.0 E+01	<1.0 E+01	Uranium	2.2 E−01	7.7 E−01
Barium	2.9 E+01	2.5 E+01	Vanadium	<5.0 E+00	<5.0 E+00
Beryllium	<5.0 E+00	<5.0 E+00	Zinc	1.2 E+01	6.8 E+01
Calcium	1.8 E+04	1.7 E+04	Chlorine	9.2 E+02	8.3 E+02
Cadmium	<2.0 E+00	<2.0 E+00	CN	<1.0 E+01	<1.0 E+01
Chromium	1.2 E+01	<1.0 E+01	Fluorine	<5.0 E+02	<5.0 E+02
Copper	1.0 E+01	<1.0 E+01	NO_3	<5.0 E+02	<5.0 E+02
Iron	7.8 E+01	6.5 E+01	PO_4	<1.0 E+03	<1.0 E+03
Mercury	<1.0 E−01	<1.0 E−01	Sulfur	<1.0 E+03	<4.0 E+02
Potassium	8.3 E+02	6.4 E+02	SO_4	9.2 E+03	1.2 E+04
Magnesium	3.9 E+03	4.4 E+03	Butyl alcohol	1.3 E+01	<1.0 E+01
Manganese	<5.0 E+00	6.0 E+00	Amount (L/mo)	2.9 E+08	3.1 E+08
NH_4	<2.0 E+01	5.4 E+01	pH	8.40	8.16
Sodium	2.7 E+03	2.3 E+03	Temperature (°C)	1.9 E+01	1.4 E+01
Nickel	<1.1 E+01	<1.0 E+01	Alpha activity (pCi/L)	2.5 E−00	6.0 E−01
Osmium	<3.0 E+02	<3.0 E+02	Beta activity (pCi/L)	3.0 E+00	3.2 E+00
Lead	<3.0 E+01		Conductivity (µS/cm)	1.3 E+02	1.3 E+01
Antimony	<1.0 E+02	<1.0 E+02	Total organic carbon	1.5 E+03	1.8 E+03
Tin	<3.0 E+02		Total organic halide	<1.0 E+02	6.6 E+00

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

Table 3-5. 216-B-3 Pond Preliminary Analytical Data from 241-AY and -AZ Tank Farms Surface Condensers Cooling Water.

Analyte	Data (First sample, August 22, 1985)	Analyte	Data (First sample, August 22, 1985)
Aluminum	<1.5 E+02	Uranium	6.4 E−01
Silver	<1.0 E+01	Vanadium	<5.0 E+00
Barium	3.3 E+01	Zinc	1.1 E+01
Beryllium	<5.0 E+00	Chlorine	<5.0 E+02
Calcium	2.0 E+04	CN	<1.0 E+01
Cadmium	<2.0 E+00	Fluorine	<5.0 E+02
Chromium	<1.0 E+01	NO_3	<5.0 E+02
Copper	7.9 E+01	PO_4	<1.0 E+03
Iron	<5.0 E+01	Sulfur	<1.0 E+03
Mercury	<1.0 E−01	SO_4	1.1 E+04
Potassium	9.0 E+02	Amount (L/mo)	5.8 E+07
Manganese	5.0 E+00	pH	8.20
NH_4	4.5 E+02	Temperature (°C)	1.5 E+01
Sodium	2.5 E+03	Alpha activity (pCi/L)	1.2 E+00
Nickel	<1.0 E+01	Beta activity (pCi/L)	8.9 E+00
Osmium	<3.0 E+02	Conductivity (µS/cm)	1.5 E+01
Antimony	<1.0 E+02	Total organic carbon	1.8 E+03
Strontium	<3.0 E+02	Total organic halide	7.9 E+00

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

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Table 3-6. 216-B-3 Pond Preliminary Analytical Data from 242-A Evaporator Cooling Water.

Analyte	Data (first sample, September 12, 1985)	Data (second sample, April 18, 1986)	Analyte	Data (first sample, September 12, 1985)	Data (second sample, April 18, 1986)
Aluminum	<1.5 E+02	<1.5 E+02	Strontium	<3.0 E+02	<3.0 E+02
Silver	<1.0 E+01	<1.0 E+01	Uranium	6.7 E-01	5.0 E-01
Barium	3.2 E+01	2.8 E+01	Vanadium	<5.0 E+00	<5.0 E+00
Beryllium	<5.0 E+00	<5.0 E+00	Zinc	5.0 E+01	5.8 E+01
Calcium	2.0 E+04	1.7 E+04	Chlorine	1.1 E+03	<5.0 E+02
Cadmium	2.0 E+00	<2.0 E+00	CN	<1.0 E+01	<1.0 E+01
Chromium	1.2 E+01	<1.0 E+01	Fluorine	2.5 E+02	<5.0 E+02
Copper	6.4 E+01	9.0 E+01	NO_3	3.6 E+03	<5.0 E+02
Iron	1.2 E+02	8.6 E+01	PO_4	<1.0 E+03	<1.0 E+03
Mercury	<1.0 E-01		Sulfur	<1.0 E+03	<1.0 E+03
Potassium	8.4 E+02	8.3 E+02	SO_4	9.5 E+03	9.3 E+03
Magnesium	4.3 E+03	4.0 E+03	Butyl alcohol	1.1 E+01	<1.0 E+01
Manganese	2.0 E+01	1.1 E+01	Amount (L/mo)	4.4 E+08	2.8 E+08
NH_4	<2.0 E+01	<5.0 E+01	pH	8.15	6.40
Sodium	2.7 E+03	2.3 E+03	Temperature (°C)	3.2 E+01	3.4 E+01
Nickel	1.6 E+01	1.0 E+01	Alpha activity (pCi/L)	6.2 E-01	1.0 E+00
Osmium	<3.0 E+02	3.0 E+02	Beta activity (pCi/L)	43.2 E+01	2.0 E+00
Lead	<3.0 E+01		Conductivity (µS/cm)	1.3 E+02	1.5 E+02
Antimony	<1.0 E+02	<1.0 E+02	Total organic carbon	2.5 E+03	2.1 E+03
Tin	<3.0 E+02		Total organic halide	<1.0 E+02	1.2 E+01

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

Table 3-7. 216-B-3 Pond Preliminary Analytical Data from 244-AR Vault Condensers Cooling Water.

Analyte	Data (first sample, June 24, 1986)	Analyte	Data (First sample, June 24, 1986)
Aluminum	<1.5 E+02	Strontium	<3.0 E+02
Silver	<1.0 E+01	Uranium	3.1 E−01
Barium	2.6 E+01	Vanadium	<5.0 E+00
Beryllium	<5.0 E+00	Zinc	2.6 E+01
Calcium	1.7 E+04	Chlorine	5.0 E+02
Cadmium	2.0 E+00	CN	<1.0 E+01
Chromium	<1.0 E+01	Fluorine	<5.0 E+02
Copper	<1.0 E+01	NO_3	<5.0 E+02
Iron	<5.0 E+01	PO_4	<1.0 E+03
Mercury	<1.0 E−01	Sulfur	<1.0 E+03
Potassium	7.2 E+02	SO_4	9.4 E+03
Magnesium	3.8 E+03	Amount (L/mo)	7.6 E+06
Manganese	<5.0 E+00	pH	6.20
NH_4	<5.0 E+01	Alpha activity (pCi/L)	4.0 E+00
Sodium	2.2 E+03	Beta activity (pCi/L)	8.9 E+00
Nickel	<1.0 E+01	Conductivity (µS/cm)	1.8 E+02
Osmium	<3.0 E+02	Total organic carbon	2.0 E+03
Antimony	<1.0 E+02	Total organic halide	1.6 E+01

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

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Table 3-8. 216-B-3 Pond Preliminary Analytical Data from 284-E Powerhouse Cooling Water.

Analyte	Date (first sample, September 13, 1985)	Data (second sample, May 15, 1986)	Analyte	Date (first sample, September 13, 1985)	Data (second sample, May 15, 1986)
Aluminum	2.3 E+02	2.6 E+02	Strontium	<3.0 E+02	<3.0 E+02
Silver	<1.0 E+01	<1.0 E+01	Uranium	4.7 E−01	9.8 E−01
Barium	2.8 E+01	3.7 E+01	Vanadium	<5.0 E+00	6.0 E+00
Beryllium	<5.0 E+00	<5.0 E+00	Zinc	1.5 E+01	1.0 E+01
Calcium	1.7 E+04	1.8 E+04	Chlorine	3.8 E+03	5.0 E+03
Cadmium	<2.0 E+00	<2.0 E+00	CN	<1.0 E+01	<1.0 E+01
Chromium	<1.0 E+01	<1.0 E+01	Fluorine	<5.0 E+02	<5.0 E+02
Copper	<1.0 E+01	<1.0 E+01	NO_3	5.2 E+02	5.2 E+02
Iron	1.9 E+02	1.9 E+02	PO_4	<1.0 E+03	<1.0 E+03
Mercury	<1.0 E−01	<1.0 E−01	Sulfur	<1.0 E+03	<1.0 E+03
Potassium	1.3 E+03	9.2 E+02	SO_4	3.2 E+04	2.8 E+04
Magnesium	3.5 E+03	4.0 E+03	Butyl alcohol	1.0 E+01	<1.0 E+01
Manganese	1.3 E+01	7.0 E+00	Amount (L/mo)	1.5 E+07	1.5 E+07
NH_4	<2.0 E+01	5.0 E+01	pH	10.10	10.38
Sodium	3.5 E+04	3.2 E+04	Temperature (°C)	2.1 E+01	1.8 E+01
Nickel	<1.0 E+01	<1.0 E+01	Alpha activity (pCi/L)	2.1 E−01	3.0 E+00
Osmium	<3.0 E+02	3.0 E+02	Beta activity (pCi/L)	3.6 E+00	6.5 E+00
Lead	<3.0 E+01		Conductivity (µS/cm)	2.4 E+02	2.5 E+01
Antimony	<1.0 E+02	<1.0 E+02	Total organic carbon	2.3 E+03	3.9 E+03
Tin	<3.0 E+02		Total organic halide	<1.0 E+02	3.5 E+01

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated

4.0 PROCESS INFORMATION

The 216-B-3 pond is unlined and uncovered, and is located approximately 4,100 ft (1,250 m) east of the 200 East Area fence. It disposes of effluent by percolation into the soil. The 216-B-3 pond system consists of four ponds: the main pond, 216-B-3, which covers 39 acres (16 ha); and three expansion ponds, 216-B-3A, -3B, and -3C, which cover 11 acres, 11 acres, and 41 acres (4.5, 4.5, and 16.8 ha), respectively.

The main pond is fed by the 216-B-3-3 ditch and overflows to the 216-B-3A lobe. This overflow is regulated by control structure 216-B-352, which is a concrete structure with two downward opening slide gates and built to permit overflow to the 216-B-3A lobe before reaching maximum pond height. Liquid from 216-B-3A lobe can overflow to 216-B-3B and/or 216-B-3C by control structures 216-B-353 and -354, which are identical to control structure 216-B-352.

The main pond is a natural depression with a 1,350-ft (410-m) dike across the east end and diking along the remaining perimeter. The first and second lobes (216-B-3A, -3B) were partially excavated and have 5-ft-high embankments for containment. The 216-B-3C pond was constructed by excavation of a pond to a minimum 5-ft (1.5-m) depth with trenches in the bottom to assist infiltration and inhibit vegetation growth.

The 216-B-3 pond receives cooling water from the 221-B Building (commonly called B Plant), 242-A evaporator, 241-AY and -AZ Tank Farms, PUREX, 244-AR Vault and 284-E Powerhouse. The 216-B-3 pond also receives discharges from the PUREX chemical sewer and can receive discharges from the B Plant chemical sewer.

4.1 COOLING WATER SOURCES

B Plant cooling water consists of effluent from coils of process tanks and vessels in 221-B Building (separation building). The water source for this stream is the general raw water line. This effluent is collected in two streams. Water with a potential for significant radiological contamination is collected by a 15-in. (38-cm) dia. header. High-risk effluent is continuously monitored for radiation and sampled at least 5 times per shift, and is automatically diverted to the 216-B-59 covered retention basin if specifications are exceeded. From this basin, water can be returned to the 221-B Building for reprocessing. The low-risk cooling water is collected by a 24-in. (61-cm) dia. header. The high- and low-risk streams are combined into a single discharge line downstream of the diversion point, and are then routed to the 207-B diversion basin. This facility consists of two 565,000-gal (2.1 million-L) retention basins.

Water is held in one basin for sampling while the other basin is filling. If the samples are determined to be within specification limits for radioactivity, the water is released to 216-B-2-3 ditch. Operating procedures require that effluent which exceeds specification be diverted to the 216-B-63 trench.

The 216-B-2-3 ditch is approximately 20 ft (6.1 m) wide, 6 to 8 ft (2 to 2.4 m) deep, and approximately 4,000 ft (1,200 m) long. It is uncovered and unlined. Effluent reaching the end of this ditch can be routed to the 216-A-25 (Gable Mountain) pond (currently planned to be decommissioned in September 1987) or the 216-B-3 pond via a diversion box. The 261-B-2-3 ditch will be replaced by a polyvinyl-chloride pipe in 1987. Effluent enroute to the 216-B-3 pond is fed into a discharge line that collects the other 216-B-3 pond influents, except for the PUREX chemical sewer, which is conveyed by 216-A-29 ditch. The systems used to route effluent to the 200 East Area ponds are diagrammed in figure 2-4.

Formerly, cooling water from cooling coils in process tanks, vessels, and pool cell heat exchangers in the 225-B Building (Waste Encapsulation and Storage Facility) and 244-CR Vault compressor discharge emptied into the 216-B-3 pond via the 216-B-2-3 ditch. The 225-B Building is currently shutdown and no longer produces waste water. 244-CR Vault compressor cooling water is no longer discharged to the 261-B-3 pond. The 225-B Building cooling water was collected by the same 15- and 24-in. (38-and 61-cm) lines used for the 221-B Building.

Cooling water from the 242-A evaporator is generated by the primary, intermediate, and aftercondensers (E-C-1, -2, and -3). Steam condensate from the 242-A evaporator is produced by E-A-1 reboiler and the vessel unit steam heater. The steam condensate stream is continuously monitored for radiation and sampled daily. If readings exceed specification, the stream is automatically diverted to tank 241-AW-102. Before being fed to the general discharge line, steam condensate is routed to the 207-A retention basins. Effluent that does not meet discharge specifications can be pumped to the 241-AW-102 feed tank from these basins. Flowrates of this stream are monitored with a weir located in the 242-A condenser room.

The 242-A evaporator cooling water stream is continuously monitored for radiation and sampled daily. If radiation levels exceed specification, an alarm sounds in the 242-A evaporator control room. The stream is piped directly into the general discharge line. Flowrate is monitored by an in-line, orfice-type turbine meter. The water source for this stream is the PUREX raw water line.

Waste cooling water is produced by surface condensers in the exhaust system for 241-AY and -AZ Tank Farms. This stream is continuously monitored for radiation and sampled weekly. If radiation levels exceed specification,

an alarm sounds in the 241-A-271 control house. Backup closed-loop cooling utilizing cooling towers is available in the event of contamination problems. The stream is piped directly into the general discharge line. Flowrate is monitored by an in-line turbine meter. The water source for this stream is the 200 East Area raw water line.

The PUREX cooling water is produced by various cooling coils and tube bundles, the condenser, and the air sampler vacuum pump. This stream also receives effluent from the railroad tunnel door drain. The discharge line feeding PUREX cooling water to the main discharge line passes through a diversion box. The effluent is continuously monitored for radiation, as well as sampled weekly. If a discharge specification is exceeded, the cooling water stream can be routed to the 216-A-42 retention basin. This is done automatically if high radiation is detected. An alarm also sounds in the 202-A (separation building) dispatchers' office. Flowrate is monitored by a differential pressure sensor in the 241-A-201 pump pit. The water source is the PUREX raw water line.

Cooling water from the 244-AR Vault consists of steam condensate from the vessel vent heater, compressor cooling water, swamp-cooler water, and heater steam condensate from the PUREX canyon (process area) and control room. It is monitored continuously for radiation and sampled daily. If the radiation specification is exceeded, an alarm sounds in the 244-AR Vault control room. The discharge line for the 244-AR Vault feeds into the discharge line for the 284-E powerhouse and 283-E Water Treatment Facility, located downstream of the powerhouse pond. 283-E Water Treatment Facility effluent consists of softener backflush. Flowrates are metered by an in-line magnetic meter.

284-E Powerhouse cooling water consists of quench water, basin flush, and boiler blowdown. The powerhouse is a coal-fired plant with five active boilers. Effluent from both facilities is routed to a point where it joins the discharge line carrying effluent from PUREX, 242-A evaporator (evaporator cooling water and steam condensate), and 241-AY and -AZ Tank Farms. This route is via two discharge lines and an open, unlined ditch. The ditch is approximately 2,000 ft (61 m) long. An operating procedure is being written to prevent discharge of regulated materials to the powerhouse ditch.

The discharge lines for all effluents entering 216-B-3 Pond, except the PUREX chemical sewer, join near a point where the combined streams discharge into 216-B-3-3 ditch. A small amount of flow is sent to the 216-A-25 pond via a diversion valve. This practice will be discontinued; 216-A-25 pond is planned to be decommissioned by September 1987. The 216-B-3-3 ditch is approximately 4,000 ft (1,200 m) long, 8 ft (2.4 m) wide, and 3 to 4 ft (1 to 1.2 m) deep. It is uncovered, unlined, and outside the 200 East Area fence. Much of the effluent entering the ditch infiltrates into the soil along its course. Flowrates for 216-B-3-3 ditch are monitored by a Parshall flume located past the intersection of the two ditches.

4.2 CHEMICAL SEWER SOURCES

The PUREX chemical sewer is routed to the 216-A-29 ditch by a 15-in. (38-cm) dia. vitrified-clay pipe by way of the 216-A-42E diversion box. The stream is monitored continuously for radiation and is sampled daily. The effluent can be routed to 216-A-42 retention basin if specifications are exceeded. If high radiation is detected, an alarm sounds in the 202-A dispatchers' office. Flowrate is measured by a velocity modified recording flowmeter.

The 216-A-29 ditch is 6,500 ft (1,980 m) long, 6 ft (2 m) wide, uncovered, and unlined except for 10 ft (3 m) of concrete spillway at the influent. It is located outside the 200 East Area fence and contains two small dam structures for flow control. Much of the effluent entering the ditch infiltrates into the soil along its course. A separate closure/post closure plan has been submitted for the 216-A-29 ditch.

The PUREX chemical sewer flows into the 216-B-3-3 ditch directly from the 216-A-29 ditch. Since 1984, a number of physical and administrative controls have been instituted at PUREX to avoid inadvertent release of regulated chemicals to the 216-A-29 ditch. Administrative controls consist of revisions to operating procedures and institution of coregeneration for demineralizer recharge effluent. Operating procedurers were first revised in 1984 and have been revised several times to ensure that hazardous chemicals are not improperly disposed of. These procedures, which specifically control chemical discharges to the PUREX chemical sewer (CSL), are continually reviewed and revised and include the following:

- PO-020-220, "Dispose of PUREX Chemicals"
- PO-020-260, "Add Neutracit-2/Neutrasorb and Spill Control Pillows for PUREX Chemical Spills"
- PO-020-285, "Neutralize and Dispose PUREX Chemical Spills"
- PO-040-050, "Perform Effluent Sampling and Monitoring Surveillance"
- PO-080-310, "Monitor and Sample Effluent Discharge"
- PO-080-320, "Start-up and Shut Down Chemical (CSL) Sampling System"
- PO-600-080, "Divert CSL, CWL, and SCD Effluents and Dispose of Diverted Solution."

An additional 42 procedures were modified to avoid inadvertent discharge of chemicals to the CSL.

Coregeneration of the demineralizer anion and cation units, which are located in the 211-A Building (chemical makeup tank farm), allows mixing of dilute sulfuric acid and dilute sodium hydroxide streams which causes the streams to neutralize each other, thus minimizing extreme pH discharges. This practice was instituted in 1986.

Physical barriers include monitors and alarms, containment dikes, locks and tags, and rerouting of potentially hazardous discharge lines to collection tanks. A continuous pH monitor with an alarm system was added to the CSL in November 1985. Liquid-level alarms were installed on selected high-risk tanks in the aqueous makeup (AMU) area in April 1986. Containment dikes were upgraded around certain tanks in 211-A (TK-11, -12, -20, -21, 40, -42, and -50) to minimize accidental discharge into the CSL from spillage; this upgrade was completed in December 1986. Locks and tags were installed on tank drains in the AMU area in July 1986. Overflow from U Cell was rerouted from the CSL to tanks U-3 and U-4 in November 1986.

Further upgrades are planned to reduce the risk of hazardous discharge to the CSL. A collection tank to hold and neutralize corrosive effluents from the demineralizer is planned for fiscal year 1989. This upgrade will include improved pH metering and automatic diversion capacity. All tank drains are being rerouted away from the CSL to collection tanks for reuse, rework, or disposal; liquid-level alarms in the dispatchers' office were added for all AMU tanks. These upgrades are in place and will become operational in 1987.

Under normal operating conditions, the B Plant chemical sewer (BCE) is sent to the 216-B-63 trench. If this trench were accidentally radiologically contaminated, operating procedures require the BCE to be sent to the 216-B-3 pond by way of the 216-B-2-3 ditch. Upon decontamination, the BCE would again be sent to the 216-B-63 trench. The water source for this stream is 70% steam condensate and 30% raw water. Average BCE flow volume ranges from 100,000 to 400,000 gal/d (378,000 to 1,408,000 L/d) under normal operating conditions. Maximum discharge temperatures for all individual sources are under 100 °F (38 °C) , except for the 221-B Pipe and Operating (P&O) Gallery steam condensate, which is 212 °F (100 °C). This source contributes 1,000 to 2,000 gal/d (3,780 to 7,560 L/d) under normal operating conditions.

Floor drains, funnel drains, and tank overflow/drainage and heating and cooling coils in 225-B were formerly discharged to the BCE. This facility is shutdown and does not produce waste. All the aforementioned drains and discharges have been covered or plugged.

Since 1984, a number of physical and administrative controls have been instituted at B Plant to prevent inadvertent release of regulated chemicals into the BCE. Administrative controls consist of revisions to operating procedures and institution of in-line neutralization for demineralizer effluent from 217-B Building (demineralized water unit building).

Operating procedures were revised to ensure that hazardous chemicals are not improperly disposed of. These procedures include the following:

- BO-001-016, "221-B Chemical Sewer Diversion to TK-10-1"
- BO-018-020, "Waste Handling and Concentration Chemical Sewer Handling"
- RHO-MA-111, Emergency Plan, section 3.10.1 "Radioactive Liquid Waste Discharges from 271-B"
- RHO-MA-139, Environmental Protection Manual, Part B, "Standards for Response to Nonroutine Releases."

The in-line newutralization of demineralizer effluent entails injection of sodium carbonate into the dilute sulfate effluent and injection of monosodium phosphate into the sodium hydroxide effluent. Additionally, the P&O gallery scale tanks are sampled for pH prior to discharge and are neutralized if found to be out of specification.

Physical barriers currently in place consist of locks and tags on the AMU tank drains and an upgraded radiation sampling and alarm/diversion capacity. The effluent stream is continuously monitored at the two locations for radiation and sampled weekly. An alarm is sounded in the 271-B Building (service building) if the radiation specification is exceeded. The stream is then automatically diverted to TK-10-1 tank. This upgrade was completed in December 1986. At the same time, a continuous pH meter and alarm was installed in the dispatchers' office. A specification is also written for analysis of the separable organic phases as part of the weekly sampling.

Further upgrades, consisting of physical barriers, are planned to minimize the risk of hazardous discharge into the BCE. Overflow alarms are planned for the AMU tanks and tanks in 211-B Building (cold chemical makeup tank farm) for fiscal year 1989. Secondary containment diking is planned for tanks in 211-B Building for fiscal year 1989. A waste-collection system for tank overflow is also planned for fiscal year 1989.

5.0 GROUNDWATER MONITORING

5.1 EXEMPTION FROM GROUNDWATER PROTECTION REQUIREMENTS

This section is not applicable because DOE-RL is not proposing to apply for an exemption from groundwater protection requirements at the 216-B-3 pond.

5.2 INTERIM STATUS PERIOD GROUNDWATER MONITORING DATA

No groundwater monitoring program for hazardous waste constituents is currently in place that is specific to the 216-B-3 pond, therefore no interim status groundwater monitoring data exists. Section 5.5 describes the proposed groundwater monitoring program for the 216-B-3 pond. Data obtained from this groundwater monitoring will be submitted to the WDOE and the EPA to satisfy the requirements for interim status groundwater monitoring as soon as such data are available.

5.3 REGIONAL HYDROGEOLOGY AND AQUIFER IDENTIFICATION

5.3.1 Hydrogeologic Setting

Groundwater has been monitored on the Hanford Site since the 1940s. While the main purpose of this monitoring was to track the movement of radionuclides in the groundwater, analysis of these groundwater monitoring data provides a sound overall view of the hydrogeology of the Hanford Site.

This hydrogeologic information, which was gathered from years of groundwater monitoring, was used to identify the uppermost aquifer and underlying hydraulically connected aquifers, and to establish groundwater flow direction under the 216-B-3 pond.

As a preface to the required discussion of the hydrogeologic properties underlying the 216-B-3 pond, the total regional and local meteorologic, geologic, and hydrologic properties of the Hanford Site are presented. The following is a summary of this information. This information was gathered from the documents listed in section 5.9. If more information is desired, these reports are available upon request.

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 5 mi (8 km)

south of the 100-N Area. Temperature and precipitation data from the old Hanford Townsite (located approximately 3 mi (4.8 km) downriver from N Reactor) are available for the period 1912 through 1943. (Stone et al. 1983).

Average monthly temperatures at HMS range from a low of 29.3 °F (-1.5 °C)in January to a high of 76.4 °F (24.7 °C) in July. The maximum monthly average temperature at the HMS during the winter is 44.5 °F (6.9 °C), and the minimum is 21.4 °F (-5.9 °C), both occurring during February. The maximum monthly average temperture at HMS during the summer is 81.8 °F (27.7 °C) in July, and the minimum is 63.0 °F (17.2 °C) in June. The annual average relative humidity at the HMS is 54%, with a maximum of about 75% during the winter months and a minimum of about 35% during the summer months.

Average annual precipitation at the HMS is 6.3 in. (16 cm). The months of November through February account for nearly one-half of the annual precipitation. Fewer than 1% of the days have rainfall greater than 0.5 in. (1.3 cm). The maximum 24-h rainfall event in a 100-yr period was predicted to be 2.0 in. (5 cm) (Stone et al. 1983). Total precipitation over the entire Pasco Basin is estimated at less than 8 in. (20 cm) annually. Mean annual runoff is generally less than 0.5 in. (1.3 cm) for most of the basin, and the basin-wide runoff coefficient, for all practical purposes, is zero (Leonhart 1979).

Average annual evaporation on the Hanford Site can exceed 60 in. (152 cm). Average annual lake evaporation ranges from approximately 39 to over 42 in. (99 to over 107 cm). Actual evapotranspiration for a 6-in. (15 cm) water-holding capacity soil (uncultivated) is approximately 7.5 to 8.5 in. (19 to 22 cm) (Leonhart 1979; Wallace 1978). Studies by Last et al. (1976), Brown and Isaacson (1977), and Jones (1978) suggest that much of the percolated water is subsequently lost by evapotranspiration.

In summary, the Hanford Site 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 latitude. 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 in (16 cm). The 100-yr, maximum-predicted rainfall event in a 24-h period is 2.0 in. (5 cm). Potential evapotranspiration rates greatly exceed annual precipitation rates, but much of this precipitation is received between November and February when evapotranspiration rates are low. The highest monthly average winds occur during the hot summer, creating higher evaporative potentials.

5.3.2 Regional Geologic Setting

5.3.2.1 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 (fig. 5-1). 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 that merge with the Horse Heaven Hills; and on the east by a broad monocline, locally known as the Jackass Mountain Monocline (fig. 5-2). 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 in the following sections.

5.3.2.2 Basement Rocks. The basement rocks underlying the basaltic lava flow 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 mi (160 to 240 km) away, and are inferred to exist locally in the central plateau area, perhaps 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 indicate a very deep conductive section, possibly representing these sediments (BWIP 1978). 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.

5.3.2.3 Columbia River Basalt Group. The regional geology surrounding the Pasco Basin is dominated by a tholeitic flood basalt province in the Columbia Plateau and adjacent Blue Mountains of Washington, northern Oregon, and adjacent Idaho (see fig. 5-1). The flood basalt province is a layered mass of more than 50,000 mi^3 (208,420 km^3) of basalt covering an area of more than 60,000 mi^2 (155,400 km^2). 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 (see fig. 5-1). Basin deformation and the development of fold systems in the Columbia Plateau started between 16 and 13 million yr before present and continued through Columbia River Basalt time (Bentley 1977).

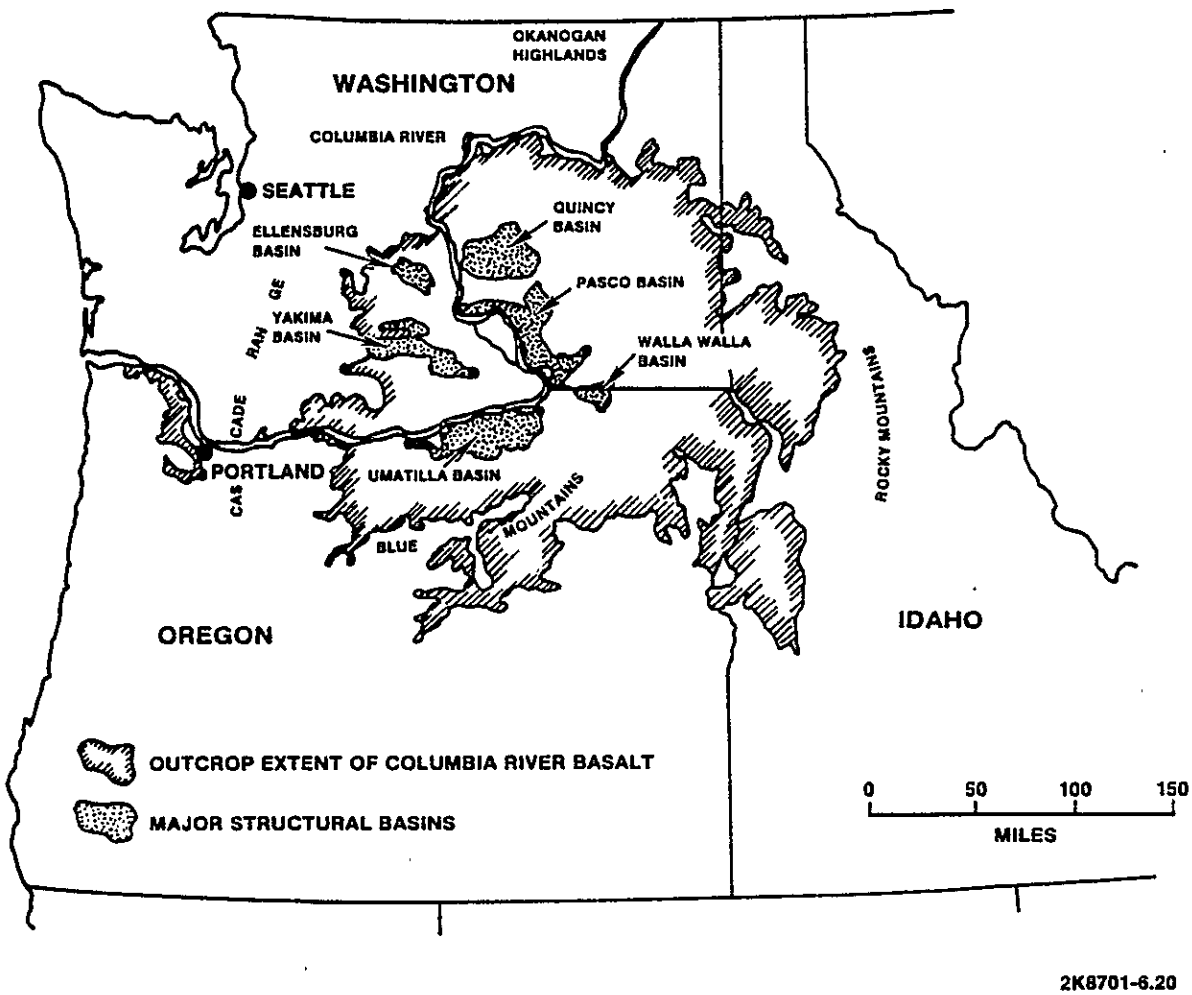

Figure 5-1. Geographic Extent of the Columbia River Basalt Group.

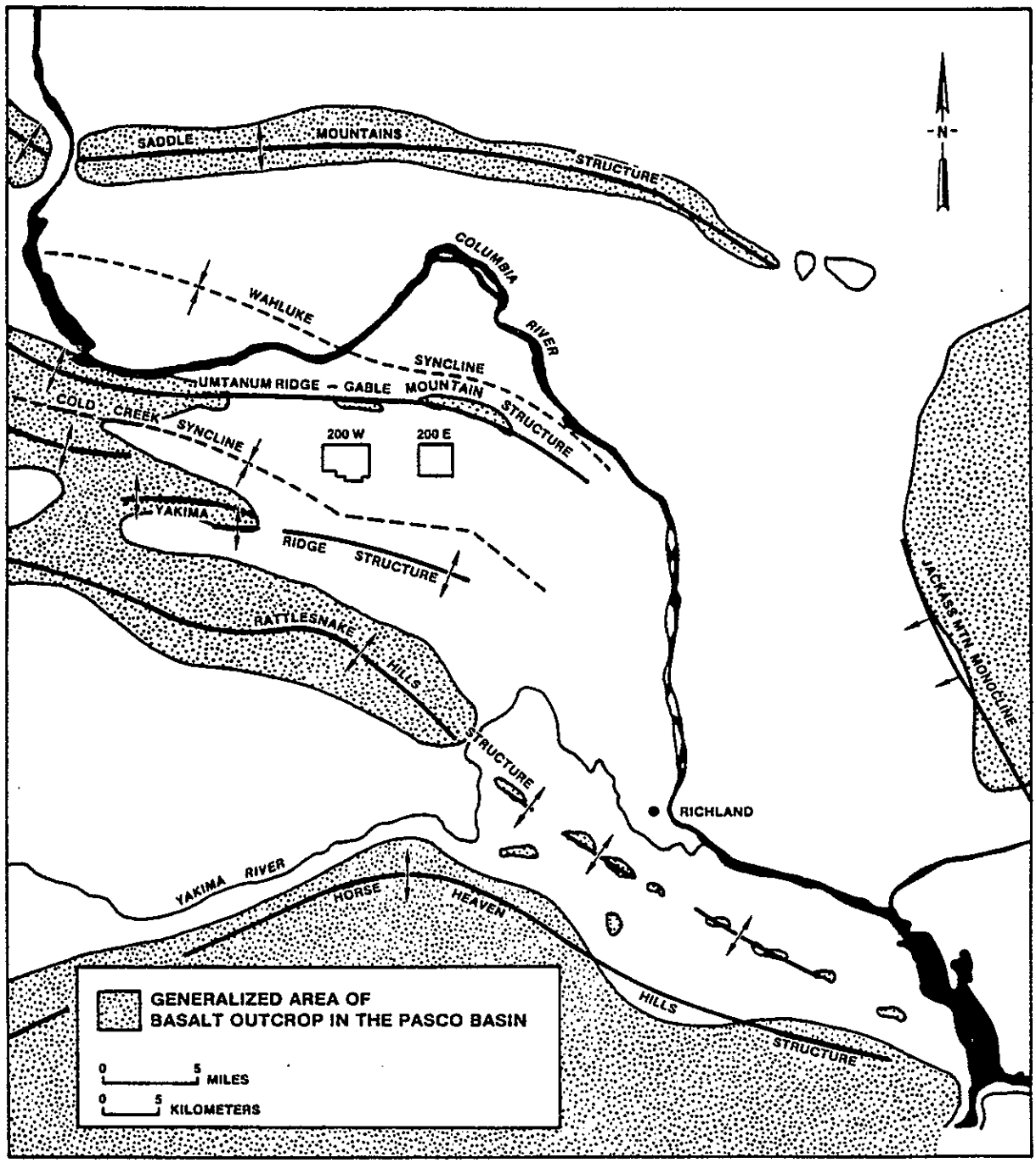

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Figure 5-2. Structural Geology of the Pasco Basin.

The basalts emanated from linear fissure systems in the eastern and southern portions of the Columbia Plateau (Swanson et al. 1975; Waters 1961). Most of the basalt was emplaced during a 3-million-yr volcanic pulse between 16 and 13 million yr before present during the Miocene Epoch (Baski and Watkins 1973). However, sporadic fissure eruptions continued until about 6 million yr before present (McKee et al. 1977).

The flood basalts are collectively designated the Columbia River Group, which has been subdivided into five formations (fig. 5-3) (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 ft (3,048 m) thick (Raymond and Tillson 1968) and perhaps as much as 19,000 ft (5,791 m) thick (BWIP 1978). In the Pasco Basin, a 5,000-ft-thick (1,524-m) 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 the Columbia River Basalt Group and older lavas, have been identified from geophysical logs obtained from a 10,655-ft-deep (3,248-m) borehole located along the western margin of the Pasco Basin (Swanson et al. 1978).

5.3.2.4 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 1.5 million yr 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 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 source was limited to the western half of the Columbia Plateau.

5.3.2.5 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

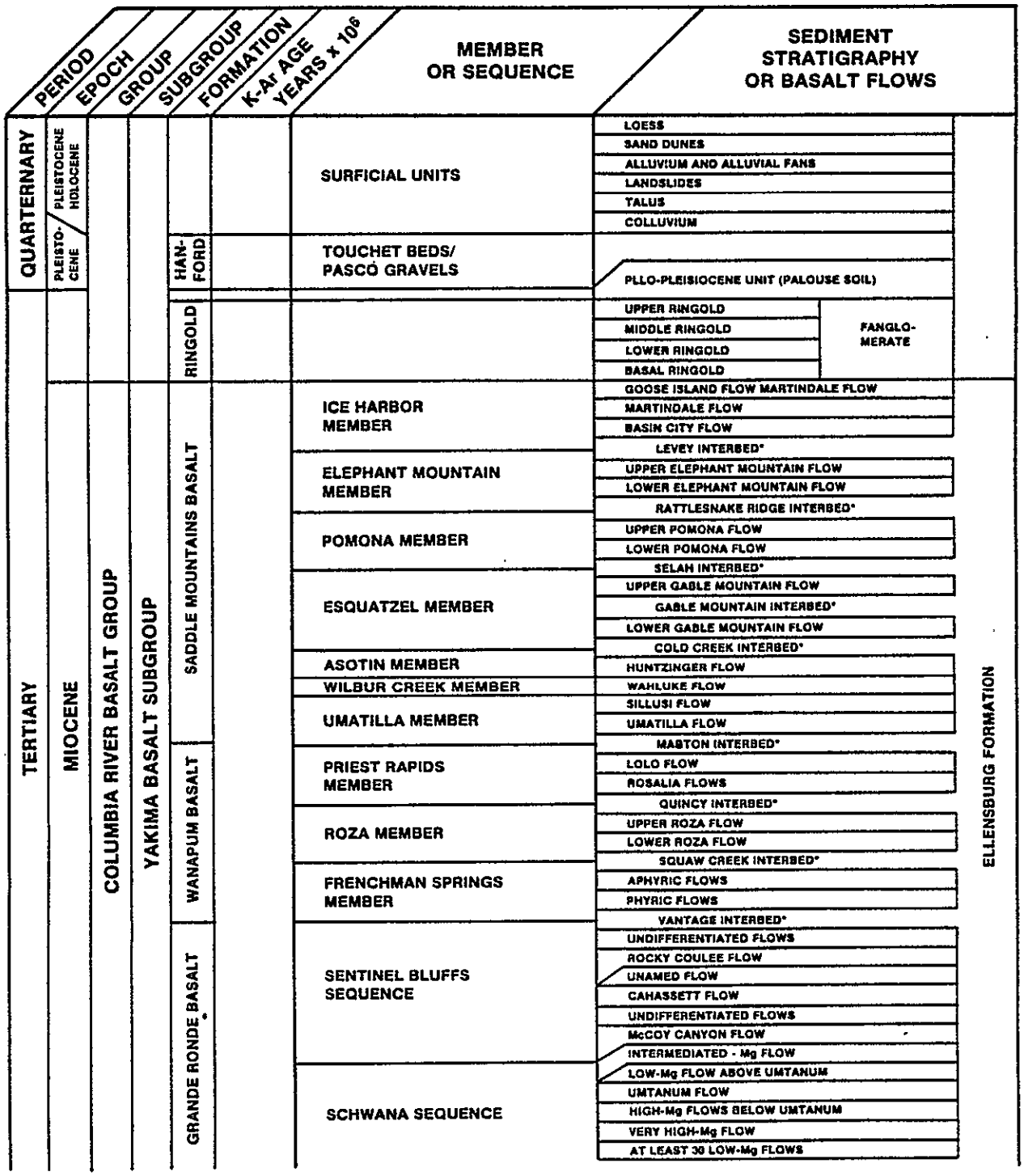

Figure 5-3. Stratigraphic Nomenclature of the Pasco Basin.

Basin, Yakima Basin, Pasco Basin, and Umatilla Basin (see fig. 5-1). Thick sequences of sediments transported from the surrounding highlands accumulated in these basins.

In the Pasco Basin, the Miocene-Pliocene Ringold Formation (Gustafson 1978) 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 ft (365 m).

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 (Brown 1959) (fig. 5-3 and 5-4).

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.

5.3.2.6 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 (Brown 1970) (see fig. 5-3 and 5-4). Elsewhere, the silt was not deposited or was eroded during Pleistocene catastrophic flooding. The silt is considered to be the equivalent of early loess deposits 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.

5.3.2.7 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 (see fig. 5-3 and 5-4). 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).

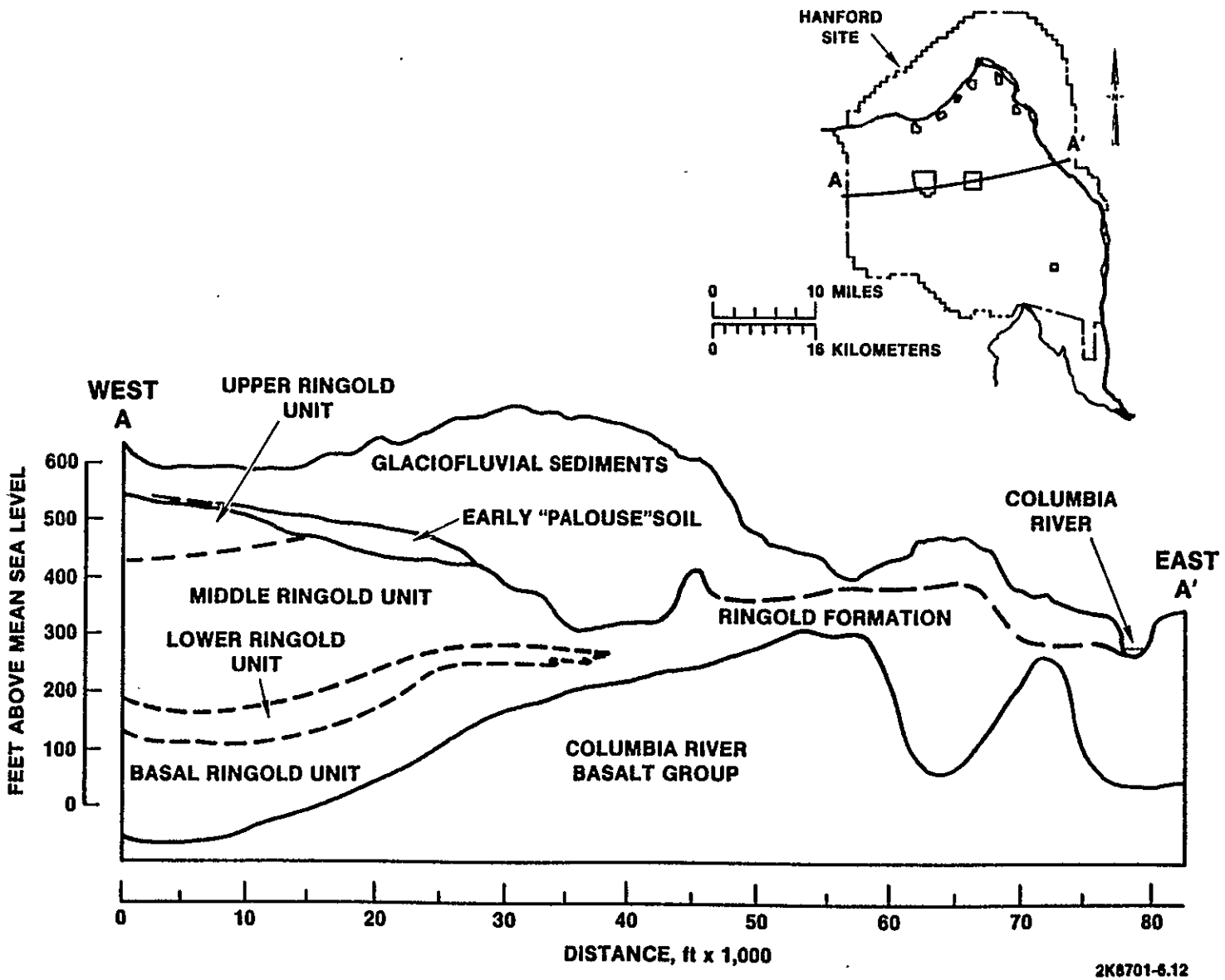

Figure 5-4. Generalized Geologic Cross Section Through the Hanford Site.

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 that 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.

5.3.2.8 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 ft (9 m) 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-ft (8-m) thick.

5.3.3 Geology of the 200 East Area Adjacent to 216-B-3 Pond

Beneath the 200 Areas, the Ringold Formation has been divided into four textural units: (1) sand and gravel of the basal Ringold member; (2) clay, silt, and fine sand with minor gravel lenses of the lower Ringold member; (3) occasionally cemented sand and gravel of the middle Ringold member; and (4) silt and fine sand of the upper Ringold member (Brown 1959).

The basal unit overlies the uppermost basalt flow. The silts and sands of the lower member were deposited in still-forming synclinal depressions. This low-energy fluvial/laustrine deposit is thickest in the Cold Creek Syncline. The unit pinches out on the flanks of the Umtanum-Gable Mountain Structure where it apparently was not deposited. The middle member is the thickest Ringold member beneath the 200 East Area. This member is characterized as a silty, sandy gravel. In general, the upper part of the middle Ringold is not indurated except for isolated cementation from calcium carbonate, while the lower part of the unit is moderately-to-well indurated. The upper Ringold member is not present beneath the 200 East Area, apparently stripped by erosional processes.

Above the Ringold member lies the Plio-Pleistocene Unit. Normal fluvial processes as well as Pleistocene catastrophic flooding apparently stripped much of this eolian silt and fine sand from beneath the 200 Areas (Tallman et al. 1979).

The Pasco gravels (Tallman et al. 1979) facies of the Hanford Formation is composed of poorly sorted, subrounded-to-angular clasts that commonly display forset bedding (Myers et al. 1979). These sediments indicate high-energy depositional environments. The Touchet Beds Facies consists of rhythmically bedded sequences of graded silt, sand, and minor gravel units. These deposits are limited to areas where slack-water conditions occurred during the impoundment of flood waters behind the Wallula Gap constriction (Tallman et al. 1979; Myers et al. 1979).

Eolian sediments consisting of both active and inactive sand dunes locally veneer the surface of the 200 Areas.

Figure 5-5 is a generalized geologic column for the 200 East Area.

5.3.4 Regional Hydrologic Setting

5.3.4.1 Surface Hydrology of the Hanford Site and Surrounding Pasco Basin. In the Pasco Basin, the Columbia River receives surface drainage from several adjacent basins. 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. Stream flow within the Pasco Basin is recorded as inflow at the U.S. Geological Survey gauge below Priest Rapids Dam and outflow at the gauge below McNary Dam. Average annual flow at these stations is 87 x 10^6 and 140 x 10^6 acre-ft/yr, (10 x 10^{12} and 17 x 10^{12} m^3/yr) respectively. A total gauged flow of approximately 45 x 10^6 acre-ft/yr (5.5 x 10^{10} m^3/yr) enters from tributaries, and an additional 2.3 x 10^5 acre-ft/yr (2.8 x 10^8 m^3/yr) 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 (fig. 5-6).

The section of the Columbia River along the Hanford Site Reach has been inventoried and was described in detail by 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 N Reactor also occur in the Hanford Reach.

West Lake, a shallow pond (3-ft (1 m) deep), is the only natural pond on the Hanford Site. The pond generally averages 10 acres (4 ha) 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).

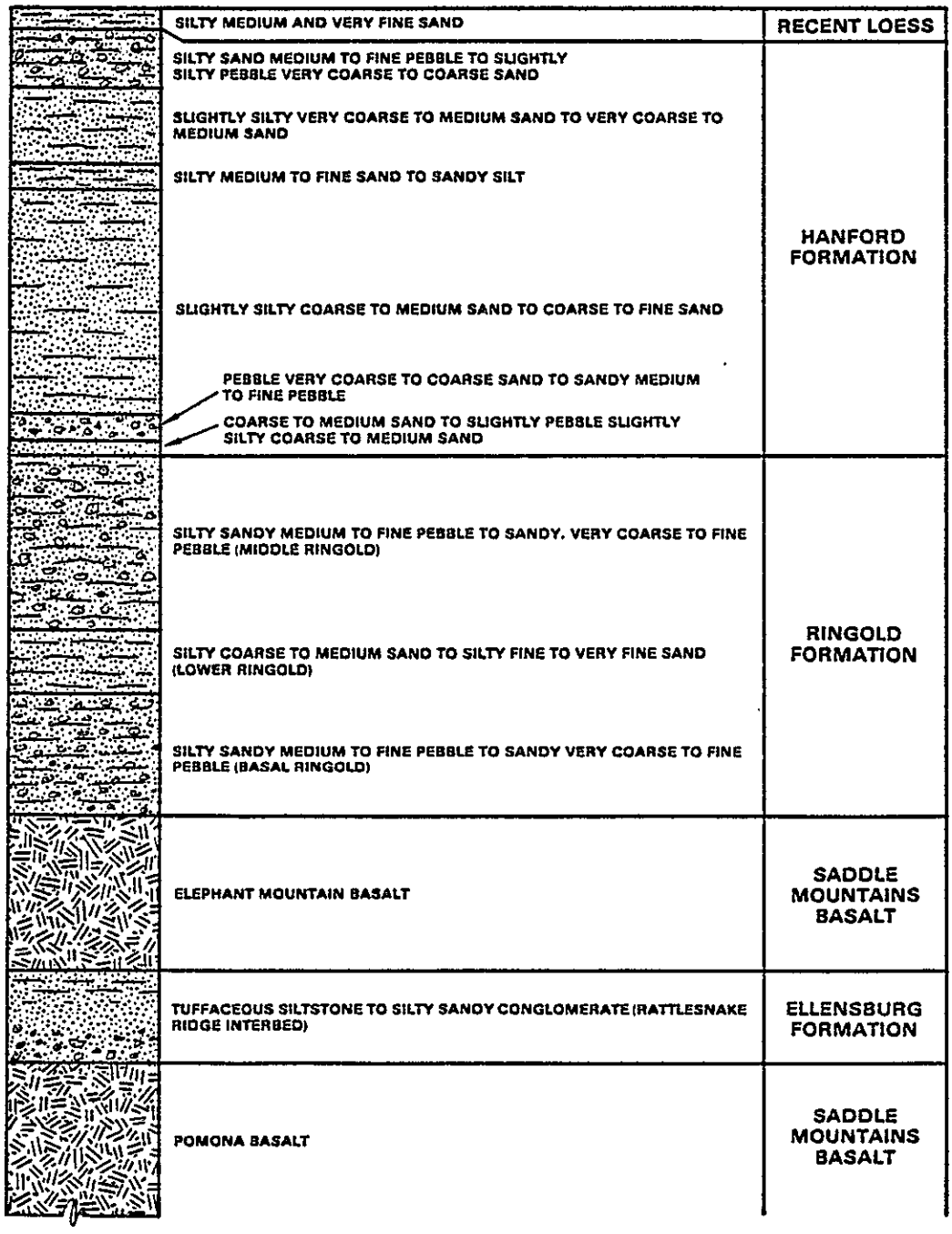

Figure 5-5. Generalized Stratigraphic Column for 200 East Area.

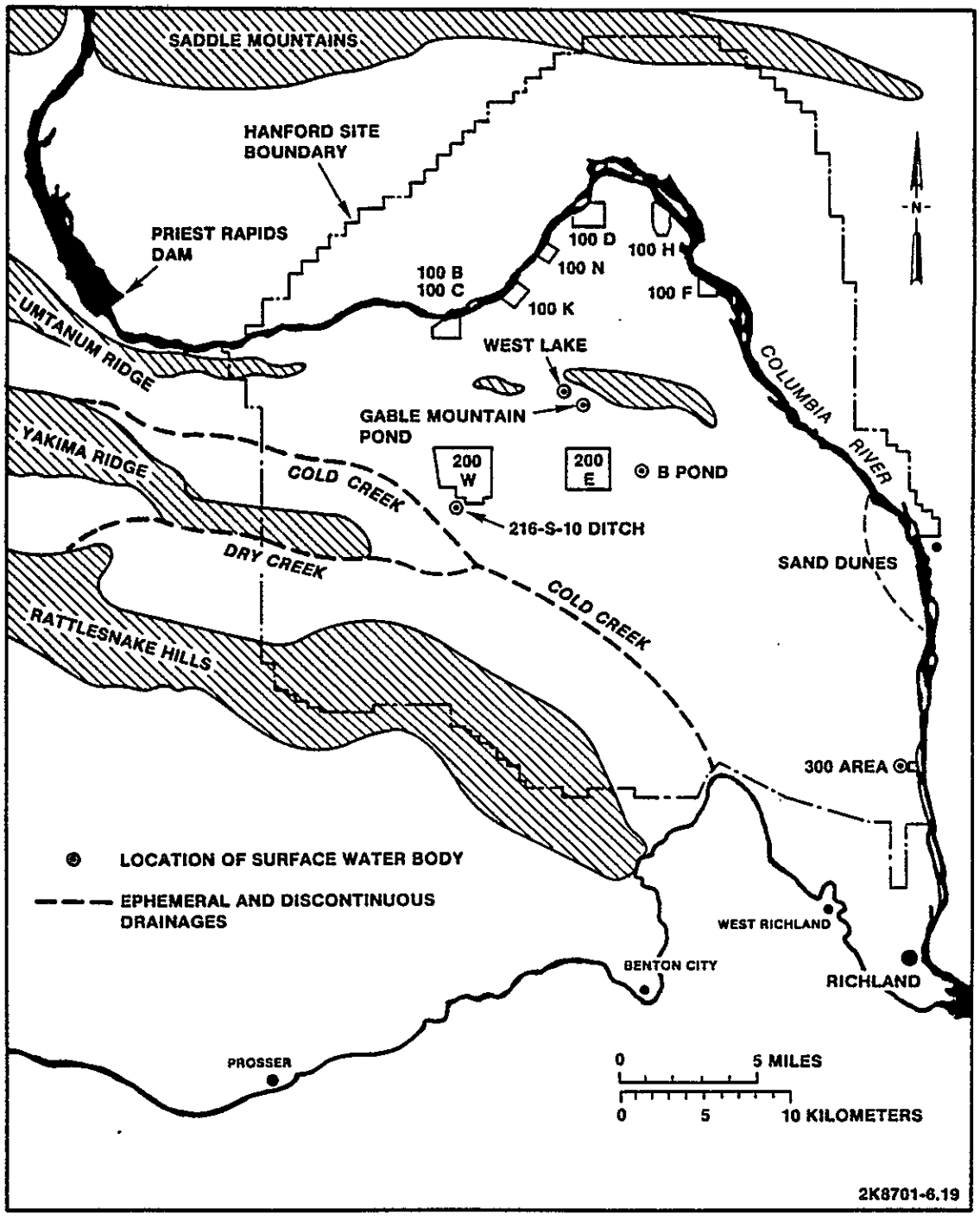

Figure 5-6. Surface Water Bodies Including Ephermal Streams on the Hanford Site.

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 fig. 5-6). The drainage system within the Cold Creek watershed may be described as ephemeral and discontinuous.

5.3.4.2 Aquifer Identification.

5.3.4.2.1 Background. The subsurface of the Hanford Reservation is underlain by various geologic units having widely different water-bearing properties. The rock types include: unconsolidated silts, sands and gravels; semiconsolidated lake and stream sediments; and dense basalts with interbeds separating individual flows. From a hydrologic standpoint the most permeable horizons are the sands and gravels of the Upper Ringold Formation and the Pasco Gravels. The water table over the western portion of the Hanford Reservation lies at the top of the Ringold Formation. However, between the high terrace plateaus and the Columbia River, the water table rises above the Upper Ringold and intersects the overlying Pasco Gravels.

The uppermost aquifer lies between the water table and the silts and clays of the Middle and Lower Ringold Formation. In general, groundwater in these unconsolidated and semiconsolidated sediments occurs under unconfined or water table conditions, although locally confined zones exist. Some semiconsolidated gravels and sands are locally found in the Lower Ringold Formation. These beds are usually separated from the overlying unconfined aquifer by a layer of silt and clay of vaiable thickness. These sands, where present, constitute the uppermost confined aquifer.

The Ringold Formation overlies a warped and severely deformed layer of basalt. The Columbia River basalt series within the Pasco Basin has, in general, a saucer-shaped synclinal structure. It is a layered sequence of flows that were extruded as highly fluid lava in Miocene and early Pliocene time. Narrow zones of rubbly, permeable scoria somewhat similar to flow breccia occur at the top of most flows and are quite permeable. Some of these permeable zones in the basalt constitute good confined-aquifer systems.

During the past 30 yr, wells have been drilled at the Hanford Site through these formations in order to:

- Provide water
- Provide quantitative data for evaluating the chemical and physical properties of the underlying material
- Measure hydrologic characteristics of the various aquifers and characterize the groundwater chemistry

- Determine engineering design
- Monitor waste disposal facilities
- Monitor the radiological status of the groundwater
- Determine stratigraphy and structural geology.

The Hanford Site water table map (appendix B) shows the location of some of the wells available for hydrologic measurements.

The aquifers in the Hanford Reservation have been studied extensively using data from existing wells, predictive mathematical studies, and regional hydrologic studies. All these data have been used in preparing the subsequent sections.

5.3.4.2.2 The Unconfined Aquifer. The unconfined aquifer consists of both glaciofluviatile sand and gravel deposits and the Ringold silts and gravels. Since these materials are very heterogeneous, often greater lithologic differences appear within a given bed than between beds (Gephart et al. 1979; Graham et al. 1981). The aquifer bottom is the basalt bedrock in some areas and silt/clay zones of the Ringold Formation in other areas. The impermeable boundaries of the unconfined aquifer within the Hanford Reservation and vicinity are the Rattlesnake Hills, Yakima Ridge, and Umtanum Ridge to the west and southwest. Gable Mountain and Gable Butte, as well as other small areas of basalt outcrop above the water table, also impede the groundwater flow. The Yakima River forms a hydraulic potential boundary which is mainly a discharge boundary for the aquifer. However, the groundwater flow from 1 to 3 mi (1.6 to 4.8 km) inland from the Columbia River is affected by seasonal river stage fluctuations. The flow pattern that originally prevailed in the unconfined aquifer was primarily to the east and northeast with discharge into the Columbia River. Natural recharge occurs at the foot of Rattlesnake Hills and Yakima Ridge. Surface flow sinks into the floor of the valley at the foot of the paralleling Rattlesnake Hills. The underflow is to a great extent interrupted by a buried extension of Yakima Ridge that parallels Rattlesnake Hills at a distance of about 2 mi (3.2 km) and which rises above the water table.

The regional water table is largely within the Ringold Formation and to a lesser extent in the Pasco Gravels. Geologic work has pointed to the existence of highly permeable sediment on portions of both the northern and southern flanks of Gable Mountain. A filled erosional channel extends southeastward from the western end of Gable Mountain toward the permeable zones of the Columbia River.

In 1944, before operations at the Hanford Site began, the hydraulic gradient in all but the south-westernmost portion of the Hanford Reservation was about 5 ft/mi (.9 m/km) (fig. 5-7). Waste disposal at Hanford raised the water table in the recharge sites and altered the existing hydraulic gradient (fig. 5-8). Local groundwater mounds formerly existed at each

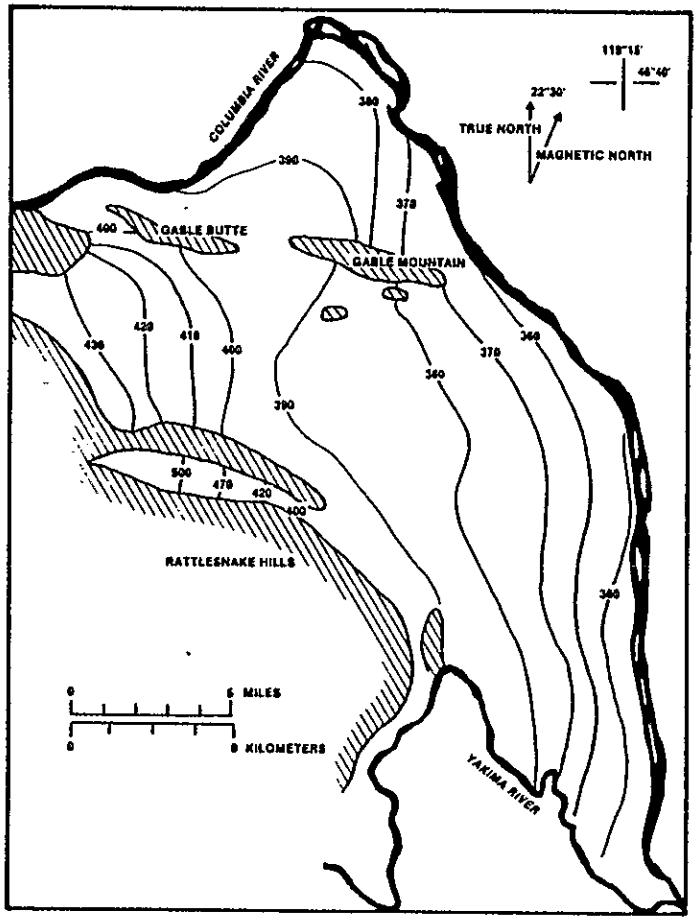

Figure 5-7. Hanford Site Water Table Map, 1944.

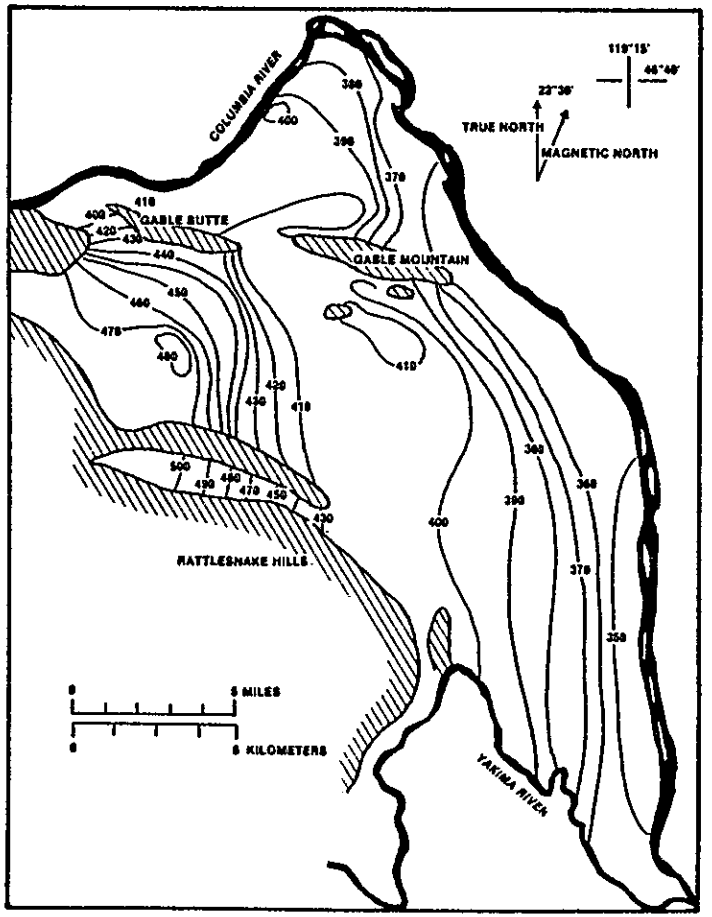

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Figure 5-8. Hanford Site Water Table Map, 1978.

reactor site along the Columbia River. The mound at the still active 100-N Area is the only one of these remaining. Recharge mounds are found under B Pond, U Pond, and Gable Mountain Pond, and a minor recharge mound exists under the 300 Area. The differential change in the Hanford Site water table between January 1944 and January 1975 is shown in figure 5-9. A Hanford Site water table map is shown in appendix B.

The natural recharge due to precipitation over the lowlands of the Hanford Reservation is not measurable since the evaporation potential during the summer months greatly exceeds total precipitation. Data on migration of moisture from natural precipitation in deep soils (below 30 ft (9 m)) show movement rates less than 1/2 in/yr (1.3 cm/yr) at one measurement site.

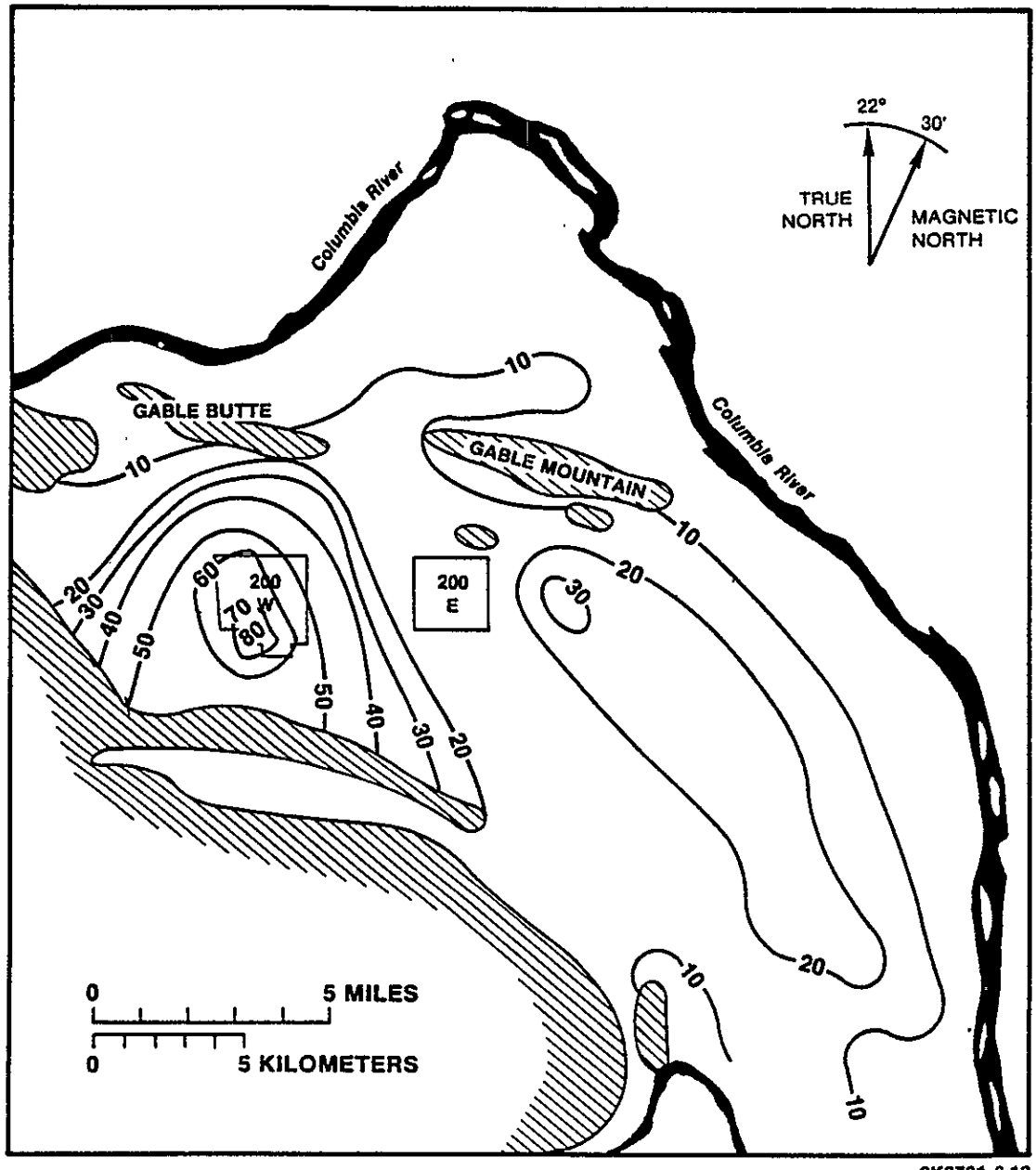
To hydrologically describe an aquifer, four parameters should be considered:

- Hydraulic conductivity: a quantity having the units of velocity that relate the flux of groundwater to the hydraulic gradient
- Aquifer thickness: the thickness of permeable sediment lying between the water table or an upper confining bed and lower confining bed
- Effective porosity: the fraction of porous media capable of transmitting water
- Storage coefficient: the volume of water that a unit decline in head releases from storage in a vertical column of aquifer of unit cross-sectional area.

For an unconfined aquifer, the storage coefficient approaches the effective porosity. Therefore, to describe the unconfined acquifer underlying the Hanford Reservation, measurement is needed of the hydraulic conductivity, aquifer thickness and storage coefficient.

Qualitatively, the hydraulic conductivity and storage coefficient distributions are a function of the different geologic formations in the unconfined aquifer. Ancestral Columbia River channels incised in the Ringold Formation are filled with more permeable glaciofluviatile sediments. Channels of permeable sediments have been identified and are reflected in the groundwater flow pattern of the region.

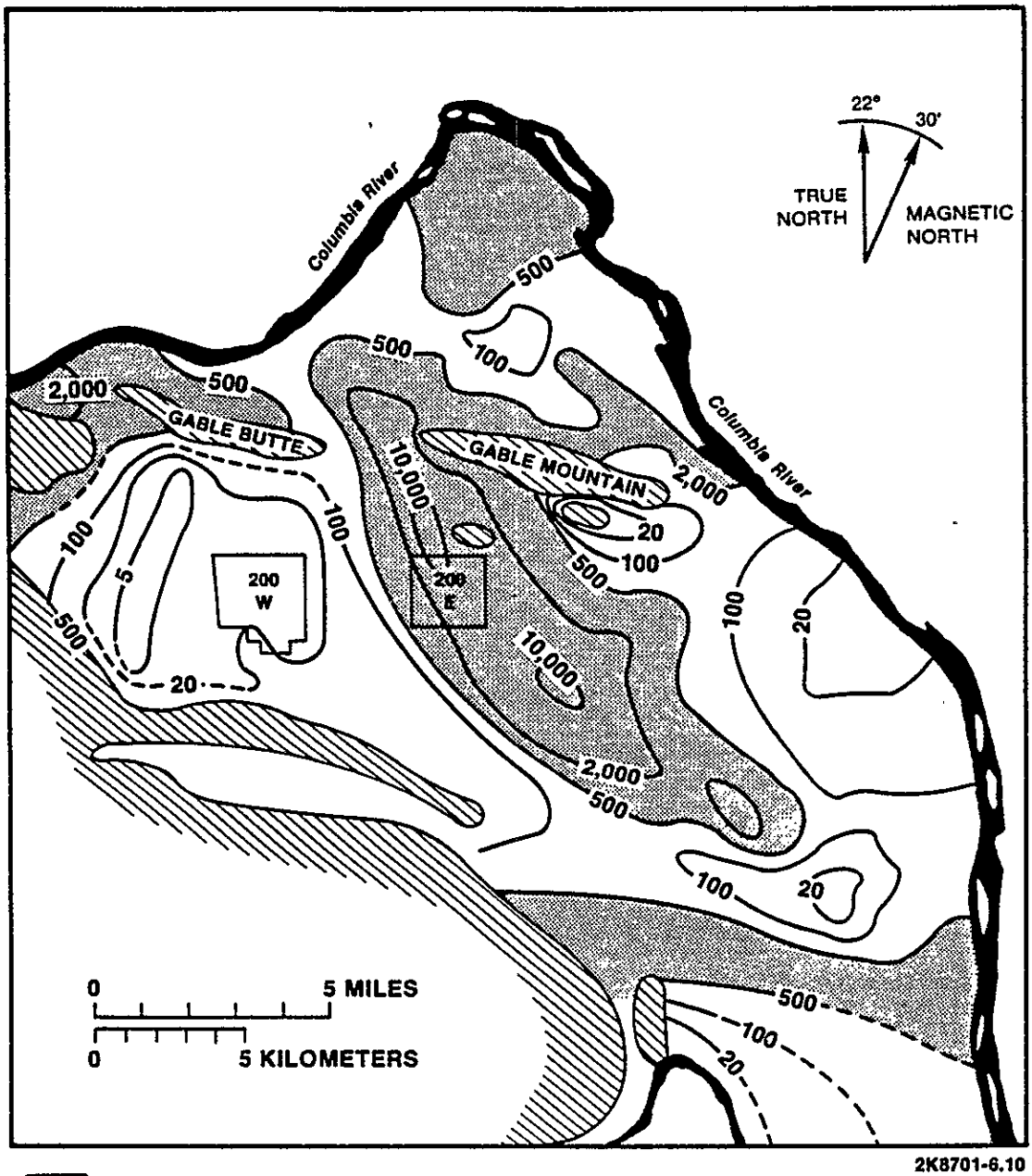
Quantitative measurements of the hydraulic conductivity have been made at several locations over the Hanford Reservation using a variety of techniques (fig. 5-10). Excluding clay zones, the values obtained for the Ringold Formation range from 10 to 7,000 ft/d (3 to 2,100 m/d). Hydraulic conductivities of glaciofluviatile sediments range from 500 to 20,300 ft/d (150 to 6,000 m/d) (Gephart et al. 1979) (table 5-1). The hydraulic conductivity distribution has been obtained using pumping test data and information from driller logs.



BASALT OUTCROP ABOVE WATER TABLE

10 WATER TABLE ELEVATION CHANGE IN FEET

Figure 5-9. Differential Change in the Hanford Site Water Table Between January 1944 and January 1975.



BASALT OUTCROP ABOVE WATER TABLE

HYDRAULIC CONDUCTIVITY IN EXCESS OF 500 ft/DAY

Figure 5-10. Areal Distribution of Hydraulic Conductivity from the Uppermost Aquifer at the Hanford Site.

Table 5-1. Representative Hydraulic Properties in the Uppermost Aquifer.

Stratigraphic interval	Hydraulic conductivity	
	ft/d	m/d
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

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Storage coefficient values were measured in the field by using pumping tests. For unconsolidated sediments, the storage coefficient ranges between 0.05 and 0.3. However, few measurements of the storage coefficient have been made to date at the Hanford Reservation. The bottom of the unconfined aquifer has been determined throughout the Hanford Reservation using data from wells. The surface depicting the aquifer bottom corresponds to basalt bedrock in some areas and silt-clay zones of the lower Ringold Formation in other areas. Ultimately, all groundwater in the unconfined aquifer flows into the Columbia River except for that small amount which is lost to the atmosphere by evapotranspiration.

The chemical quality of the groundwater in the unconfined aquifer is measured semiannually at seven locations. Sodium, calcium, and sulfate ions are measured as well as pH. Water from wells in the 300 Area is analyzed for chromium and flouride ions associated with fuel manufacturing operations. Nitrate ion, which is a waste product from the manufacturing and chemical separations operations, is monitored over the entire Hanford Reservation. Maps of the nitrate ion concentration near the water table of the unconfined aquifer are published semiannually.

The temperature of the groundwater in the unconfined aquifer has been measured on an intermittent basis. Local thermal anomalies may be caused by vertical flow within a well casing. In the past, 100 Area reactor groundwater mounds contained water on the order of 160 °F to 190 °F (70 °C to 90 °C).

5.3.4.2.3 The Confined Aquifers. A confined aquifer is one where the water-bearing stratum is overlain and underlain by relatively impermeable beds. Confined aquifers in the Hanford Reservation include (1) permeable sands and gravels in the lower part of the Ringold Formation overlain by thick silts and clays and (2) extensive interflow zones confined by individual basalt flows. The confining beds include sequences of individual basalt flows, where they are continuous and greater than about 50-ft thick, and the silts and clays of the lower part of the Ringold Formation. Within the basalt sequence, groundwater is transmitted primarily in the interflow zones, either in sedimentary beds or in the scoria and breccia zones forming the tops and bottoms of the flows. Some of the basalt flows in the Pasco Basin have been eroded, particularly in the anticlinal ridges. In some locations, the basalts are highly jointed and contain breccia, pillow, and palagonite complexes through which groundwater can move. The lower-most Ringold Formation silts and clays are of various thicknesses, and distinct hydraulic potential differences have been observed below the silts and clays. Hundreds of wells on the Hanford Reservation have been drilled to basalt. Most of these wells only barely penetrate the top basalt flows. In general, the hydraulic potential observed in the confined aquifer zones above the basalt is greater than in the overlying unconfined aquifer. However, the flow rates are expected to be quite small due to the low transmissivity range of this water-bearing zone.

In 1970 and 1971, 23 wells penetrating the sands in the lower Ringold Formation and the first few basalt flows and interbeds were pump tested and transmissivity values calculated. From these tests, values of transmissivity ranging between 2 and 8 ft^2/d (.2 and .7 m^2/d) were obtained for the confining beds and values between 50 and 2,000 ft^2/d (4 and 186 m^2/d) for the permeable horizons. The hydraulic conductivity of the confining beds ranges between 0.02 and 0.2 ft/d (.6 and 6 cm/d) and that of the aquifer, ranges between 2 and 30 ft/d (.6 and 9 m/d).

Some data on the aquifer properties of the various confined aquifers are available from the Atlantic Richfield Hanford Company deep-drilling project well ARH-DC-1 (fig. 5-11). At this well, the basalt from 362 to 1,200 ft (110 to 366 m) deep has a transmissivity of 695 ft^2/d (65 m^2/d). A sedimentary unit contained in this zone from 830 to 936 ft deep, has a transmissivity of 355 ft^2/d (33 m^2/d). A dense basalt zone from 960 to 1,090 ft (290 to 330 m) deep has a transmissivity of 0.2 ft^2/d (.02 m^2/d). There is one significant water-bearing zone, 10 ft (3 m) thick, occurring at 3,230 ft (985 m) deep with a transmissivity of 68 ft^2/d (6 m^2/d).

Water-bearing sedimentary interbeds are centered at 500, 650, and 900 ft (150, 200, and 275 m) and range from 25 to 100 ft (7.5 to 30 m) thick. The bed at 900 ft (275 m) is about 100 ft (30 m) thick consisting of well-sorted medium sand of moderate permeability. Its hydraulic conductivity is about 3.5 ft/d (1 m/d), making it the most productive aquifer penetrated by this well.

5.3.5 Hydrology Beneath the 216-B-3 Pond

The unconfined aquifer is affected by disposal of waste water to surface and subsurface disposal sites. The depth-to-ground water ranges from 180 to 310 ft (55 to 95 m) on the 200 Area plateau. The bottom of the unconfined aquifer is the uppermost basalt surface or, in some areas, the clays of the lower Ringold Formation. The thickness of the unconfined aquifer in the 200 Areas ranges from less than 50 to 200 ft (15 to 60 m). Beneath the unconfined aquifer is a confined aquifer system consisting of sedimentary interbeds or interflow zones that occur between dense basalt flows or flow units.

The sources of natural recharge to the unconfined aquifer are rainfall from areas of high relief to the west of the Hanford Site and the ephemeral streams, Cold Creek and Dry Creek. From the areas of recharge, the groundwater flows dowgradient and discharges into the Columbia River. This general flow pattern is modified by basalt outcrops and subcrops in the 200 Areas and by artificial recharge (see appendix B).

The unconfined aquifer beneath the 200 Areas receives artificial recharge from liquid disposal areas. Cooling water disposed to 200 Area ponds has formed ground-water mounds beneath three high-volume disposal

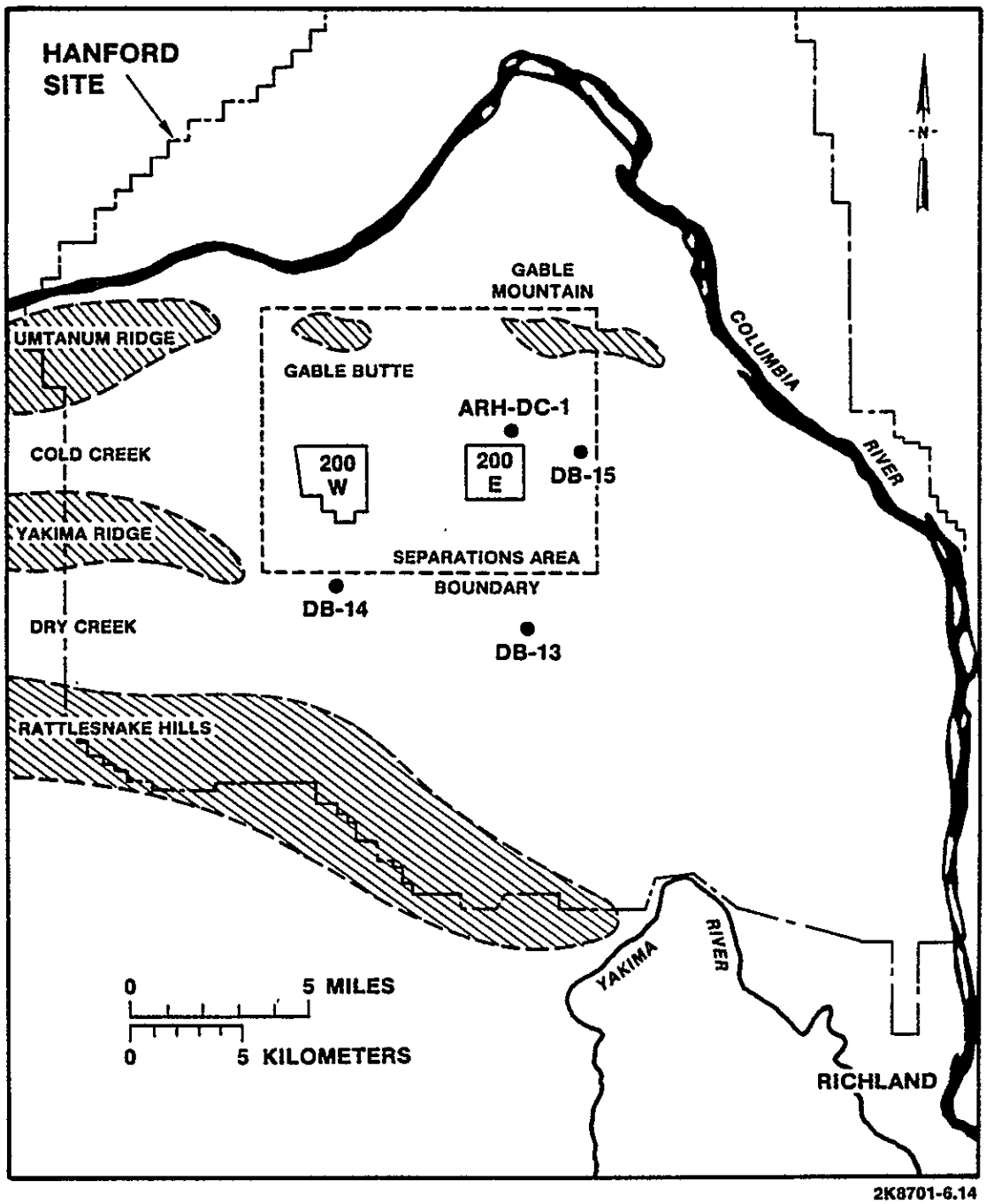


Figure 5-11. Location of Wells DB-13, DB-14, DB-15, and ARH-DC-1.

sites: U Pond in the 200 West Area, 216-B-3 Pond east of the 200 East Area, and Gable Mountain Pond north of the 200 East Area. The water table has risen approximately 65 ft (20 m) under U Pond and 30 ft (9 m) under 216-B-3 Pond compared with pre-Hanford conditions (Newcomb et al. 1972). During 1984, U Pond was deactiviated and part of Gable Mountain Pond was backfilled in preparation for deactivation (Law and Schatz 1986). The depth to the water table at 216-B-3 Pond in well 699-42-40A is approximately 120 ft (37 m) (Schatz and Jensen 1986). The depth to the top of basalt in well 699-42-40C is approximately 210 ft (64 m) (Graham et al. 1984), resulting in a 90-ft (27-m) saturated thickness of the unconfined aquifer beneath 216-B-3 pond.

5.4 CONTAMINANT PLUME DESCRIPTION

Four groundwater monitoring wells located within 1 mi (1.6 km) of 216-B-3 pond (fig. 5-12) have been sampled and analyzed for various chemical constituents. Well 699-42-40A was sampled in May and July of 1986 as part of a FY 1986 Hazardous Materials Monitoring Project (HMMP) conducted by PNL. Based on these analyses, none of the hazardous materials for which analyses were conducted, exceeded the drinking water standards of the EPA; nor were there concentrations significantly different from regional background wells established in the HMMP. The same is true for analyses performed on samples from wells 699-25-25, 26, and 28, drilled as part of the grouted waste disposal facility baseline monitoring program by Rockwell. The only exception is a 26 ppm iron concentration found in well 299-E25-25. All of these wells are considered downgradient monitoring wells for 216-B-3 pond.

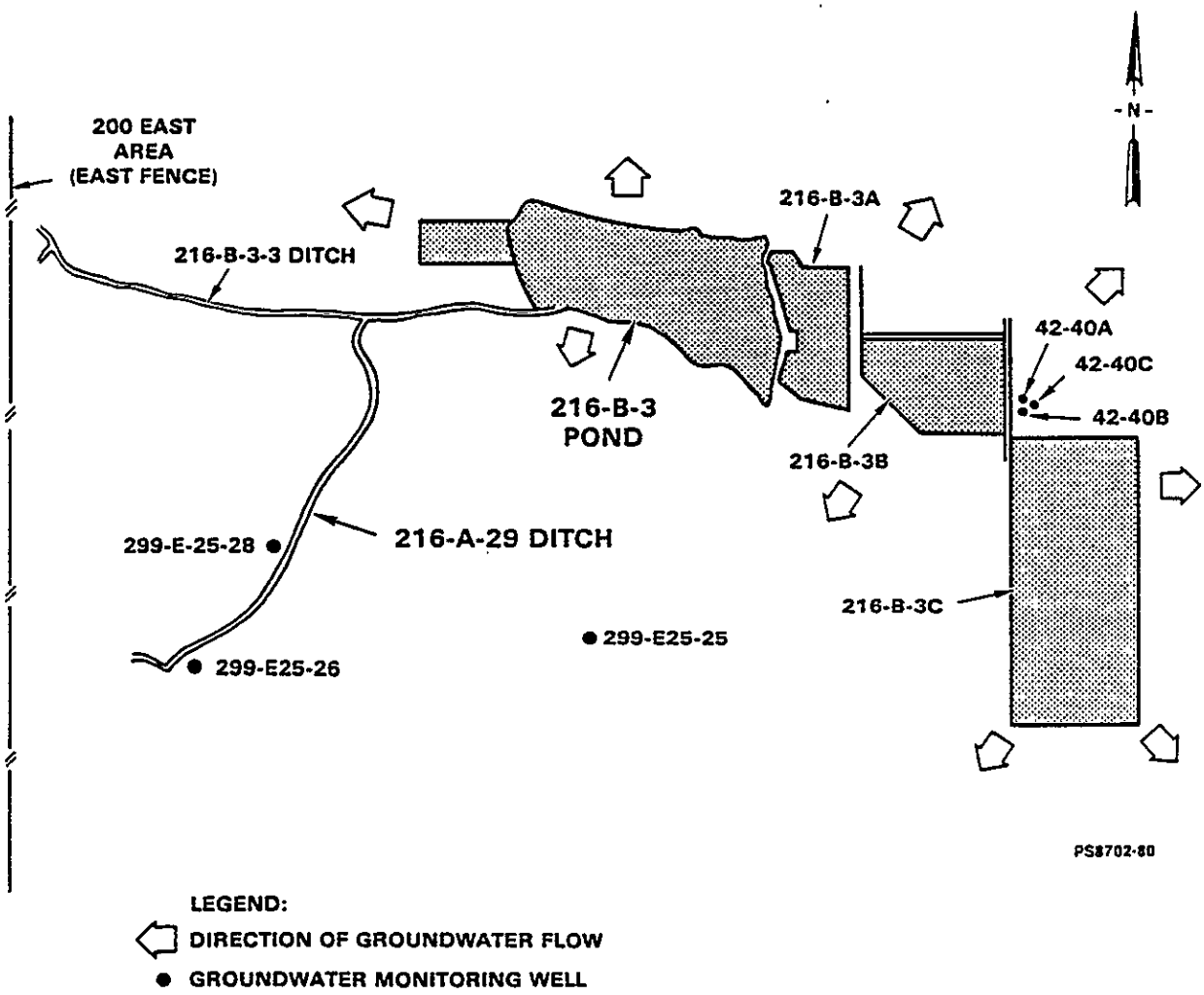
In summary, the limited existing hazardous constituent monitoring data indicate that the groundwater beneath 216-B-3 pond has not been contaminated with hazardous materials in excess of Federal and State guidelines.

Should the proposed groundwater monitoring program, as described in section 5.5, indicate contamination of the groundwater at the facility, further studies will be undertaken to characterize the plume of contamination at that time. This characterization would consider the extent of the plume, its rate of expansion, and the concentration of each hazardous waste constituent.

5.5 GROUNDWATER MONITORING PROGRAM

5.5.1 Purpose

The purpose of this section is to describe a detection-level groundwater monitoring program at the 216-B-3 pond in accordance with the Resource Conservation and Recovery Act (RCRA) as described in 40 CFR 265.91 and WAC 173-303-645. The scope for the program includes the characterization of the hydrogeology and the monitoring of groundwater beneath the 216-B-3 pond.



LEGEND:
DIRECTION OF GROUNDWATER FLOW
GROUNDWATER MONITORING WELL

Figure 5-12. Existing Groundwater Monitoring Wells in the Vicinity of 216-B-3 Pond.

5.5.2 Objectives

Five objectives have been established for the groundwater monitoring system planned for 216-B-3 pond:

- Determine if specific contaminants are present in the groundwater system around 216-B-3 pond in concentrations significantly different from regional background wells, established by the HMMP.
- Improve the limited understanding of the geology in the vicinity of 216-B-3 pond
- Develop a three-dimensional understanding of water potentials in the unconfined aquifer near 216-B-3 pond
- Construct a network of groundwater monitoring wells that will function in an environment of a rising and falling water table depending on future 216-B-3 pond disposal patterns
- Conduct hydraulic tests to obtain vertical distribution of aquifer properties (hydraulic conductivity, porosity, and storage coefficient) in the vicinity of 216-B-3 pond that will enable adequate design of monitoring wells.

5.5.3 Technical Approach

The project will be divided into two phases: (1) all activities associated with establishing a detection level hazardous materials monitoring system around 216-B-3 pond and, if required, (2) modification of the system based on information gained in Phase 1. Phase 1 activities consist of:

- Initial numerical modeling of the groundwater system using existing data
- Using modeling data, design appropriate monitoring wells
- Construct, test, and monitor wells
- Evaluate data to determine future actions regarding the monitoring system.

In order to meet the objectives stated, six monitoring sites around the 216-B-3 pond system are planned for Phase 1 (fig. 5-13). The sites are located around 216-B-3 pond system in a pattern that surrounds the site; the major focus is the original pond area where all flow from the 216-A-29 and 216-B-3-3 ditches initially enters the pond system.

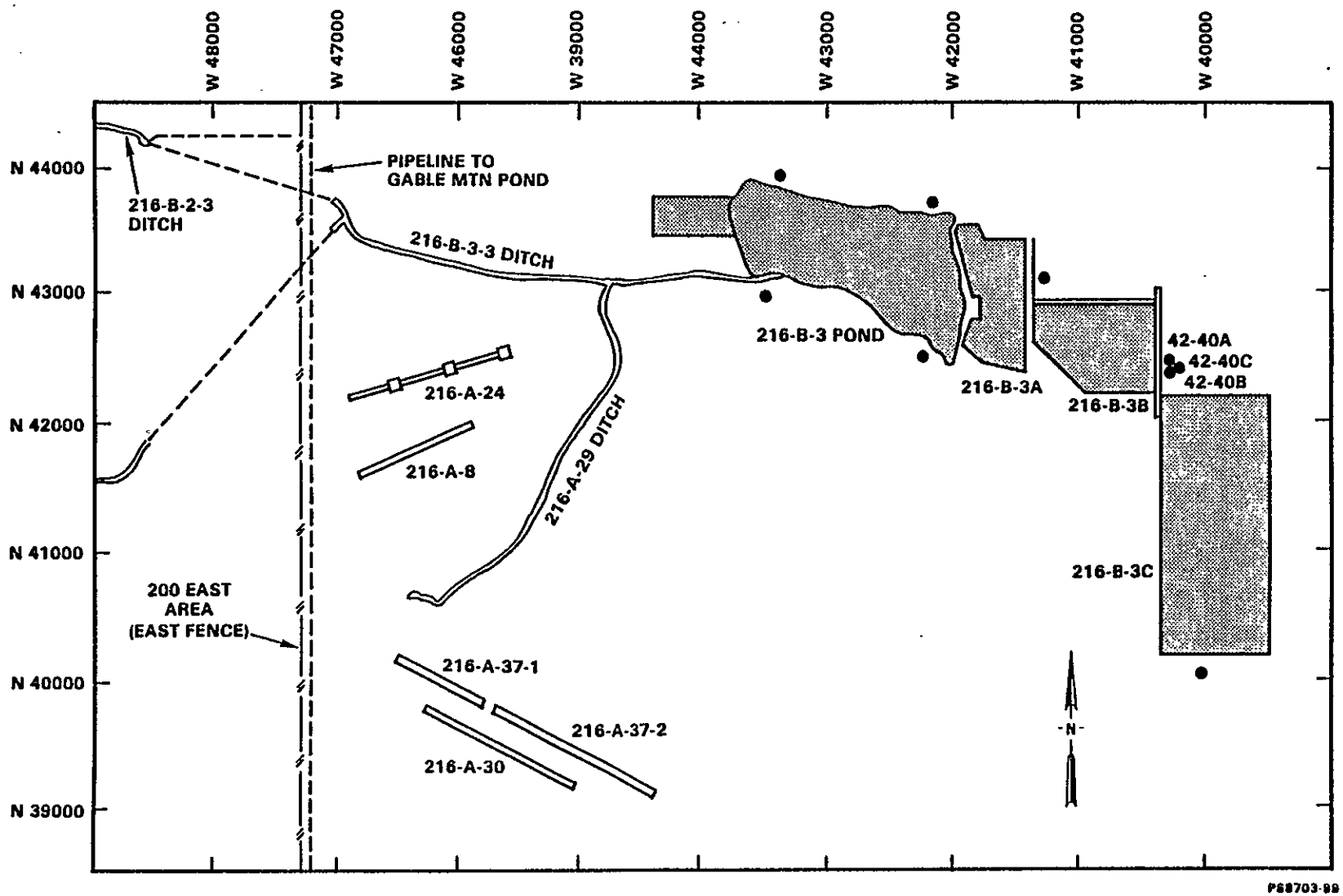


Figure 5-13. Planned Groundwater Monitoring Sites for 216-B-3 Pond.

Water potentials beneath the 261-B-3 pond are in the form of a mound; the resulting flow pattern is radially away from the pond in all directions (fig. 5-14). In this system, downgradient positions exist in all directions around the pond. Therefore, to evaluate the impact of the 216-B-3 pond on the groundwater, wells on the upgradient, western margins of the Hanford Site will be used as upgradient wells. These wells are part of the existing HMMP.

Since the 216-B-3 pond is a major artificial recharge area, there is a downward component of flow. To evaluate the downward component of flow and understand the flow system, the vertical water potential gradients must be determined and the anisotropy in hydraulic conductivity must be estimated. The first three sites to be drilled will be monitored at three levels: at the existing water table, at the top of basalt (or top of the Ringold clay, if present), and intermediate between these two positions. Evaluation of aquifer properties, hydraulic head measurements, and groundwater geochemistry data will be used to determine the design requirements for the remaining three sites.

The final well design for the three initial sites has not been determined but two concepts are being considered. A conservative approach is to install three separate wells at each site. An alternative approach is to install at each site three piezometers in a single, large-diameter well (multiple completion). With the latter approach, the adequacy of the seals between the separate samling points must be ensured. Testing of a similar multiple comletion well will permit finalization of the preferred well design and evaluation of the cost and scheduling requirements.

The construction of the wells at each site will be tailored to the conditions at each site. Preliminary numerical modeling of the hyrologic system (using existing data) will be used in the well designs, anticipating changes in water levels.

Characterization of sediments will be accommodated by collection of sediment samples during drilling. Sediment charcterization will consist of grain size, mineralogy, and hazardous material concentrations in the sediments.

Monitoring of the ground water will be initiated in the first calendar quarter following completion of each piezometer facility. Water-level measurements will be taken at the same time water samples are collected. The measurements will be taken with a calibrated steel tape and records kept in a field notebook.

To meet the requirements of a detection-level program, the sampling program will, at a minimum, consist of the following analyses:
(1) parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in WAC 173-303-645(5)

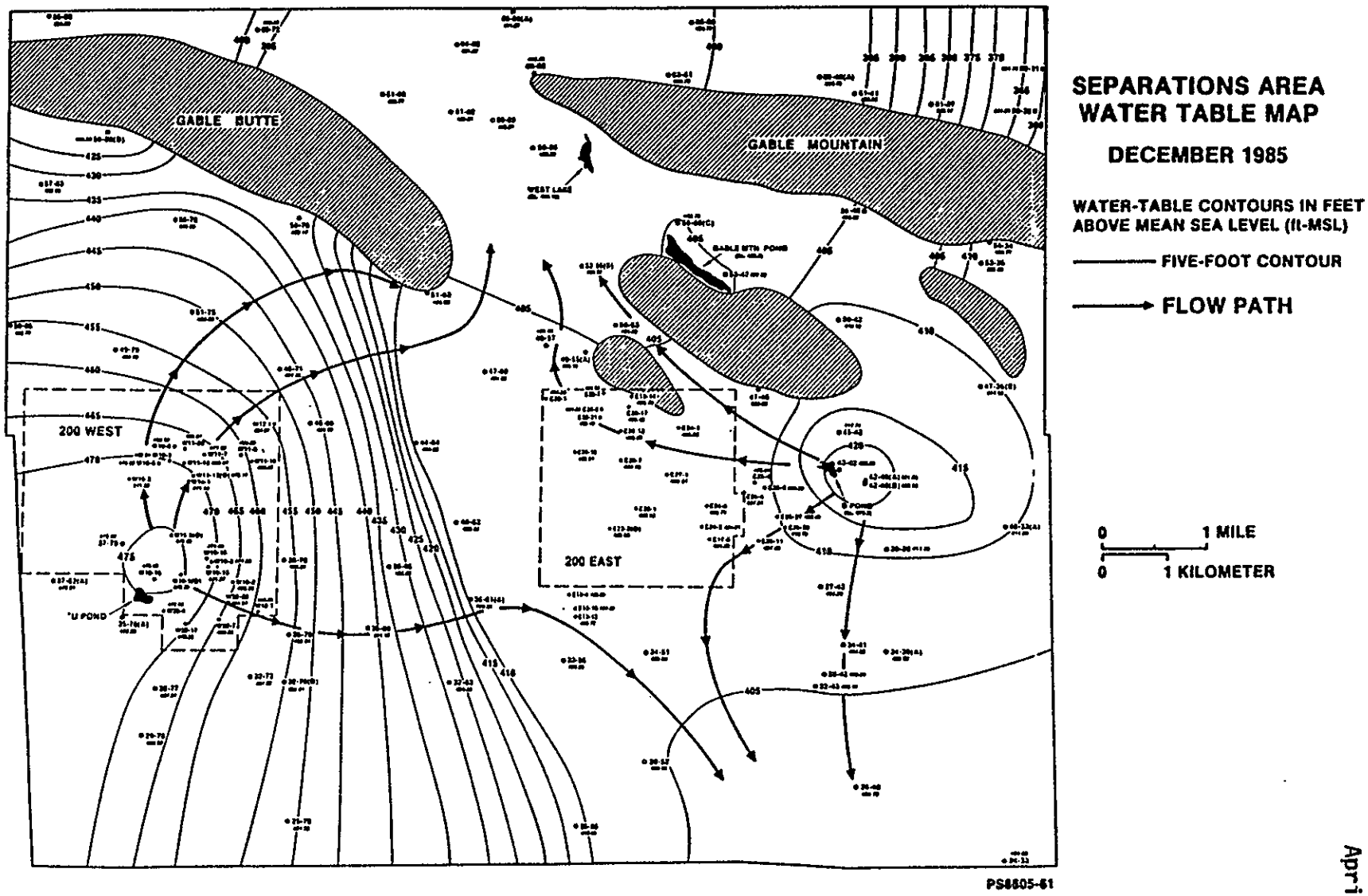


Figure 5-14. 200 Area Water Table Map Showing Directions of Groundwater Flow.

Table 1 (Table 5-2); (2) parameters for establishing groundwater quality, as defined in 40 CFR 265.92(b)(2), (Subpart F), viz., chloride, iron, manganese, phenels, sodium, and sulfate; and (3) parameters used as indicators of groundwater contamination, as outlined in 40 CFR 265.92(3) (Subpart F), viz., pH, specific conductance, total organic carbon, and total organic halogen.

Samples will be collected at least quarterly in the first year and then semiannually through the remaining active life of the pond. Sampling will be according to established written procedures as described in PNL-MA-580, Environmental Monitoring Procedures. Water-level measurements will be taken before sampling, and the wells will be purged according to the borehole volume removal procedure. Samples will be collected using dedicated sampling pumps appropriate for the analyses to be conducted.

Samples will be sealed and transported to the laboratory using the established chain-of-custody procedures as outlined in PNL-MA-580.

Quality assurance and quality control procedures will be the same as those described in the existing groundwater monitoring plans for other Hanford facilities (DOE 1986a,b,c).

Methods to be used for sample analysis, sample preservation, and data evaluation are the same as those in the existing Resource Conservation and Recovery Act (RCRA) groundwater monitoring plans for other Hanford facilities (DOE 1986a,b,c)).

Also in Phase 1, aquifer testing must be conducted at various depths to determine the vertical distribution of hydraulic conductivity in the aquifer near 216-B-3 pond. If any shallow wells are tested, the effects of partial penetration of the wells must be accounted for during interpretation of the tests. In addition to the vertical distribution, the spatial distribution of hydraulic conductivity (or transmissivity) near 216-B-3 pond needs to be established. There are a limited number of wells that have been tested near 216-B-3 pond (fig. 5-15) and the test results indicate that a wide range of estimated transmissivities exists in this area. These variations in aquifer hydraulic properties need to delineated to understand the impacts of 216-B-3 pond operation on the groundwater flow system.

Transient groundwater modeling simulations will be needed to determine the changes in water levels around 216-B-3 pond because of changes in waste volumes discharged to the pond. This fluctuating water table will impact the adequacy of monitoring wells around the pond. If future discharge volumes increase or decrease significantly, the water table could rise or fall leaving monitoring points "high and dry" or significantly below the water table. In order to predict changes in water levels, it will be necessary to determine the storage coefficient during aquifer tests. Determination of the storage coefficient requires pumping a well and

Table 5-2. Maximum Concentration of Constituents for Ground-water Protection in WAC 173-303-645(5), Table 1.

Constituent	Maximum concentration (mg/L)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01

PS87-3144-12

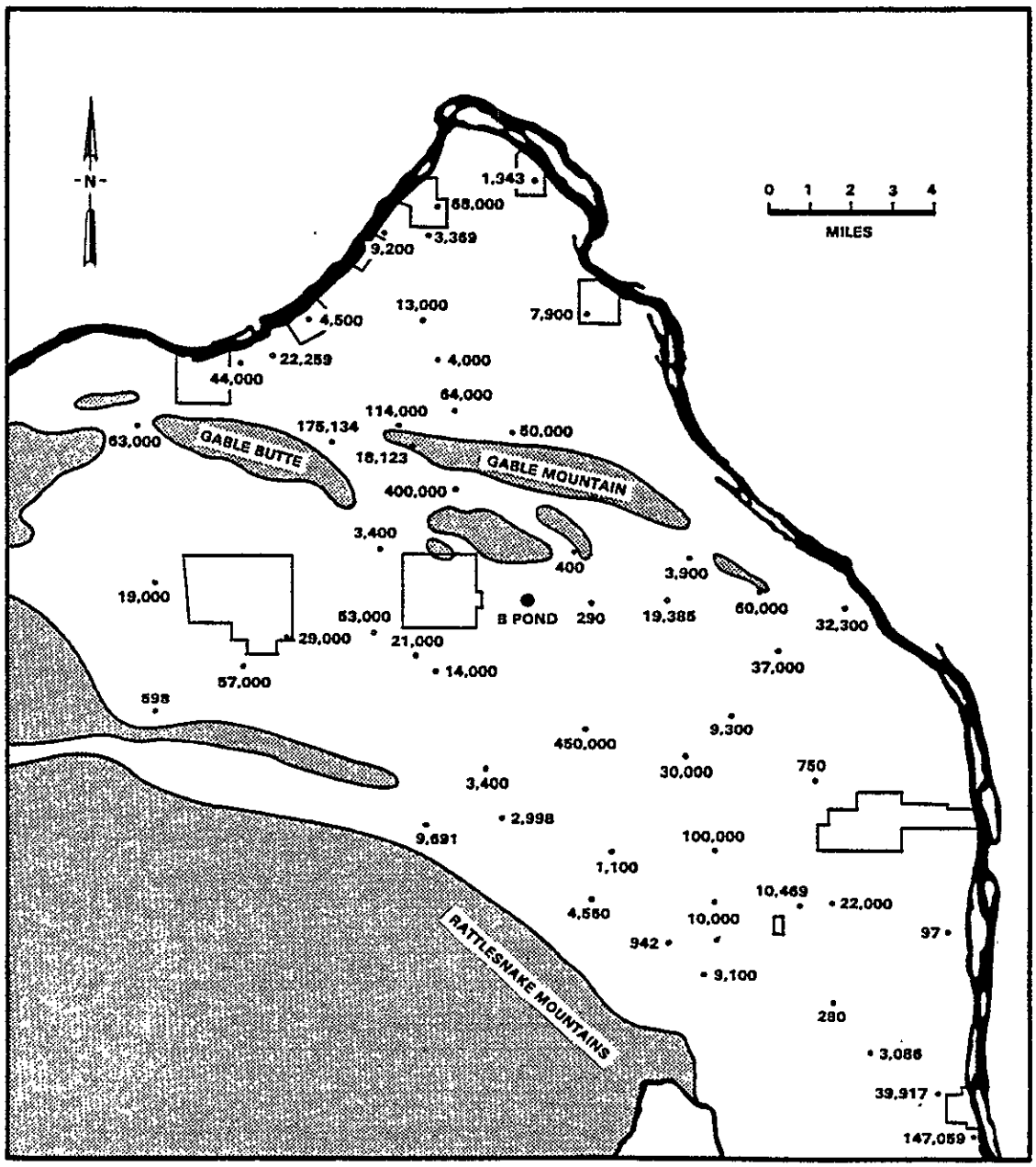


Figure 5-15. Map of Measured Transmissivities (in ft^2/d) Based on Aquifer Tests.

measuring drawdown in an observation well. This determination will be done at selected planned monitoring sites (fig. 5-13) by completing one well with the water table and intermediate-depth piezometers and then drilling an additional well nearby for the deep piezometer. When the second well penetrates the water table to the same depth as each monitoring piezometer, it will be used as the pumping well and the two piezometers used as observation points.

The amount of information to be collected near 216-B-3 pond to support groundwater modeling depends on the question that is being addressed with modeling. Hydraulic head, hazardous material monitoring, and aquifer test data near the pond will be collected first to determine the importance of vertical flow. The same data will need to be collected at an intermediate distance (within a mile) of 216-B-3 pond to model the potential movement of contaminants from the pond if present.

All wells will be installed using the cable-tool method, or other techniques as proven appropriate. The final well design will be established after initial groundwater modeling has offered some idea of expected water table fluctuations. In general, the wells will consist of a sand pack, a stainless steel well screen above and below the water table, and a stainless steel casing to the land surface. Screened intervals will typically be 15 to 20 ft near the water table and 10 ft at intermediate and deep positons. Cleanup of drilling and sampling equipment will be performed according to the methods described in section 6.1.4.

Phase 1 will conclude after completion of at least 1 yr of monitoring or a minimum of four sampling periods. An examination of the data obtained will then be used to evaluate the status of the ground water beneath 216-B-3 pond.

The Phase 2 program is dependent on the results of Phase 1. This phase could consist of continued monitoring at the same or different frequencies with the same or modified list of parameters. If additional sampling positions are deemed necessary, appropriate wells would be drilled during this phase.

5.5.4 Anticipated Deliverables

Interim reports on the results of the characterization work will be produced at the end of Phase 1 and Phase 2. The final report will be compiled at the end of the project. In general, each report will contain: (1) narrative descriptions of the local geologic units and groundwater flow, (2) geologic cross sections, (3) water table maps, (4) geological and drilling logs, (5) results of the various tests conducted, and (6) analytical results.

5.5.5 Schedules

A definitive schedule for providing characterization monitoring wells is currently being developed. Funding for well drilling has been identified for fiscal year 1988. Additional funding is being pursued for fiscal year 1989. Definitive schedules will be provided immediately upon availability.

5.6 DETECTION MONITORING PROGRAM

A groundwater detection monitoring program will be developed. This program will address:

- Indicator parameters to be sampled for
- A proposed groundwater monitoring system
- Background values for each proposed monitoring parameter
- Goundwater quality at point of compliance (quarterly)
- Groundwater flow rate and direction (annually)
- A description of proposed sampling, analysis and statistical procedures to be utilized in evaluating groundwater monitoring data (PNL 1986).

5.7 COMPLIANCE MONITORING PROGRAM

If verified groundwater monitoring data indicates the presence of dangerous constituents in the groundwater at the point of compliance, a compliance monitoring plan will be developed and submitted to the WDOE or EPA for approval as appropriate. This plan will provide:

- A description of the wastes previously handled at the facility
- A characterization of the contaminated groundwater
- A list of constituents that will be monitored (may include part of the WAC 173-303-9905 List)
- Proposed concentration limits for those constituents
- A description of the proposed groundwater monitoring system

- A description of proposed sampling, analysis, and statistical procedures to be used in evaluating groundwater monitoring data (PNL 1986)

- Continual evaluation of the Compliance Monitoring Program and corrective action.

5.8 CORRECTIVE ACTION PROGRAM

If, during the interim status groundwater monitoring program, dangerous constituents are measured in the groundwater in levels which exceed the concentration limits established in WAC 173-303-645(5), Table 1 (see table 5-2), or if the groundwater monitoring program indicates dangerous constituents in the groundwater at the facility boundary over upgradient levels, a corrective action program will be developed to satisfy the requirements of WAC 173-303-645(1).

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6.0 CLOSURE AND POST-CLOSURE REQUIREMENTS

The 216-B-3 pond is a facility that received regulated waste in the past. These past discharges originated from PUREX via the PUREX chemical sewer and the 216-A-29 ditch. Recently, however, high-liquid-level alarms have been installed on selected aqueous chemical makeup tanks, procedures have been established for coregeneration of the demineralizers to neutralize the regenerate solution prior to release, and the chemical sewer effluent is continuously monitored for pH. New and more restrictive administrative controls have also been implemented to further regulate effluent releases to the pond via the chemical sewer and ditch. As a result, the 216-B-3 pond currently receives a nonhazardous, nonregulated aqueous solution (for composition of discharge, see section 3.0), and all future discharges to the facility will be nonhazardous.

The purpose of this section is to demonstrate that DOE-RL is cognizant of the current and past practices relative to the 216-B-3 pond, 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 public or the environment. The general closure plan involves several steps, some of which have already been initiated as a demonstration of DOE-RL intent. The general steps are:

(1) Discontinue discharges of hazardous materials to the facility

(2) Sample site soils and sediments

(3) Analyze soil and sediment samples for hazardous components

(4) Close facility under RCRA (inventory removal/decontamination or alternate closure option).

The DOE-RL wishes to make clear that a commitment to close the facility under the RCRA does not necessarily preclude the use of the facility in its current capacity (i.e., as a receiver of nonregulated solutions). The intent of DOE-RL is to operate the facility while establishing that it is not a public or environmental hazard. Should investigation reveal that significant and nonlocalized contamination is present at depth, then DOE-RL will initiate physical closure of the facility or take other appropriate actions that are consistent with RCRA and the Atomic Energy Act. Should these actions become necessary, they will be conducted in accordance with common engineering practices, under the direction of a registered professional 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 216-B-3 Pond Closure/Post-Closure Plan are presented below. The locations of official copies of the 216-B-3 Pond Closure/Post-Closure Plan are shown in appendix C. The person responsible for storing and updating these copies is presented in appendix D. The certification of closure is provided in appendix E.

6.1 CLOSURE PLANS

6.1.1 Closure Performance Standard

The 216-B-3 pond will be closed in a manner that minimizes further maintenance and the post-closure escape of regulated waste to the extent necessary to protect human health and the environment. If necessary, a cover system will be designed for the facility (see section 6.1.5.2), which will prevent contaminant migration to the groundwater. A cover system will include a vegetative cover that is comprised of perennial grasses which are drought-tolerant and well-suited to the local Hanford Site soils. Revegetation will minimize future maintenance at the site and return the land to the appearance and use of surrounding land areas to the highest degree possible given the nature and extent of the previous dangerous waste activity (section 6.1.5.4).

6.1.2 Partial and Final Closure Activities

While DOE-RL does not anticipate any partial closure activities, the occurrence of contamination in the original pond, but not in the recently constructed lobes, could result in a plan for partial closure. The procedures and methods used to evaluate the facility to determine whether it contains chemical contaminants that are present at hazardous levels will conform to the procedures outline in EPA SW-846, Test Methods for Evaluating Solid Waste.

Characterization activities leading to final closure will follow a logical progression of increasing detail. As indicated previously in section 2.0, the 216-B-3 pond is comprised of four individual, but interconnected units. The unit of primary concern is the foremost unit, or original pond area, brought into service in 1945. The three remaining units have all been constructed since 1978. The original pond area will be sampled first. While it is recognized that all of the units comprising the facility must be sampled, the extent of sampling at the remaining three

units will be based in part on the results of the initial effort at the original pond. Provided below is an overview of the initial sampling effort planned. A more detailed and comprehensive characterization plan will be prepared for submittal to the appropriate regulatory authorities prior to initiating the actual characterization (sampling and analysis) activities.

Initially, shallow samples of the original pond's banks and bottom sediments will be obtained. A random sampling approach will be developed based on knowledge of the operational history of the pond and experience gained from other onsite sampling activities. A grid system will be established over the entire site and sampling points will be determined from random number tables. Samples will be obtained by soil auger (or other suitable method) to a maximum depth of 3 ft (~1 m) below grade. Sampling at points occurring within the deeper portions of the ponds (underwater depths of up to 20 ft (~6 m)) may prove difficult and specific methods and equipment may have to be developed. Samples will be composited from like depths to obtain an understanding of contaminant distribution with depth.

Throughout the sampling effort, a field log book will be maintained. All information pertinent to the sampling will be recorded in the log in sufficient detail that someone can reconstruct the sampling without reliance on the collector's memory.

The sample containers will be compatible with the waste, sufficiently durable to withstand handling and transport, and large enough to contain the optimum sample volume. Although sample analyses will be performed as soon as possible after sampling, appropriate steps will be taken to preserve the physical and chemical integrity of the sample during transport and storage prior to analysis. The method of sample preservation used will be based on the sample type and the analytical method to be employed. The analytical parameters will be based on the composition of the ditch influent and known receipts of characteristically hazardous waste (described in section 3.0).

The integrity of the samples will be ensured from collection to data reporting through appropriate chain-of-custody procedures. Labels will be affixed to each sample container and filled out at the time of collection. Sample label information will include the sample number, name of the collector, and the date, time and location of collection. Sample seals used to detect unauthorized tampering will contain the same information as the sample label. Chain-of-custody records will also accompany each sample to document possession from the time of collection.

If hazardous constituents are determined to be present above the established regulatory threshold in the initial sampling phase, additional sampling will be undertaken to define the extent of contamination both areally and at depth.

Background samples will also be obtained from selected locations surrounding the pond to establish background concentrations for the hazardous characteristics or constituents of concern. Background samples will be taken from areas unaffected by past operations at the site, and from geologic strata and depths similar to the samples obtained from the pond. All data generated by the sampling and analysis effort will be evaluated and retained. This evaluation will serve as the basis for a preliminary technical assessment to determine appropriate cleanup levels and evaluate remedial action alternatives. The assessment will be based on, and be consistent with, the Washington Department of Ecology's Final Cleanup Policy-Technical (July 10, 1984) and other RCRA requirements.

6.1.3 Maximum Waste Inventory

The 216-B-3 pond is known to have received hazardous waste discharges originating from the PUREX Plant. These discharges include both acidic and basic solutions from regeneration of the demineralizer, aqueous chemical makeup, N Cell testing wastes, and Comprehensive Environmental Response, Compensation and Liability Act-reportable releases. Although the post-November 1980 hazardous waste discharges to the pond are well known and documented, comparable information on similar releases occurring before that time is much less complete. As a result, the chemical inventory of the pond is currently unknown and will have to be determined during the course of the characterization activity. Once the maximum waste inventory has been determined, it will be reported to the appropriate regulatory authorities.

6.1.4 Inventory Removal, Disposal or Decontamination of Equipment

If contamination is found and determined to be extensive both areally and at depth, decontamination or inventory removal may be impractical. Should such conditions be found to exist, DOE-RL will initiate physical closure or take other appropriate actions that are consistent with RCRA. If physical closure is deemed necessary a final cover will be constructed as described in section 6.1.5.2.

If contamination above acceptable levels is found and determined to be relatively shallow and localized, it will be removed. The depth and extent of removal will be based on the analytical results of the sampling and characterization activity discussed in section 6.1.2 The success of the decontamination effort (i.e., inventroy removal) will be based on the technical assessment and determination of appropriate cleanup levels for the hazardous characteristics or constituents of concern. Post decontamination detection above the appropriate cleanup levels will necessitate further decontamination of the affected area. Once these levels are achieved, no further sampling and analyses will be required and decontamination efforts will cease. The sampling schemes and analytical methods applied to evaluate the characteristics or constituents of concern will conform to those contained in SW-846.

Should it be necessary to decontaminate portions of the pond, the decontamination effort will result in the generation of hazardous or dangerous (i.e., regulated) wastes requiring treatment and/or disposal. All regulated wastes generated by the decontamination effort will be containerized in plastic-lined, U.S Department of Transportation-specified 55-gal drums, or packaged in bulk according to procedures submitted to the appropriate regulating agencies for prior approval. All regulated wastes will be manifested and processed through the onsite Nonradioactive Dangerous Waste Storage Facility for shipment to an approved treatment and/or disposal unit. (Radioactive wastes will be processed and packaged as approprate and disposed of in accordance with current practices.)

It will be assumed that all tools and equipment used during the decontamination effort are contaminated with regulated waste. All reusable equipment will be washed or steam-cleaned in a designated area prepared to contain all residues generated during the cleaning process. Swab samples of the cleaned equipment and a representative sample of the cleaning residue will be analyzed for identified characteristics or constituents of concern and compared against the established cleanup values.

Successful equipment decontamination will be based on nondetection or a determination that the hazardous constituent concentrations are below the previously established cleanup levels. Equipment not meeting this criterion will undergo further decontamination and sampling verification. Cleaning residues will be judged against the same criterion. Any residues determined to be regulated will be prepared for processing through the onsite Nonradioactive Dangerous Waste Storage Facility if not contaminated with radionuclides or for onsite burial if radionuclides are present. Similarly, all other materials deemed regulated (e.g., plastic liner for decontamination residue containment and collection) will be appropriately packaged and processed for treatment and/or disposal at an approved facility.

The tools and equipment potentially used in the decontamination and/or final closure efforts include:

- Protective clothing
- Adhesives (tape and cements)
- Inert absorbent materials
- Drum-handling equipment
- Miscellaneous hand tools
- Rags and plastic materials
- Waste containers

- Solidifying agents
- Sampling tools and containers
- Heavy equipment.

Monitoring of employee exposures to hazardous chemicals, personal protection equipment, medical surveillance, record keeping, and health and safety training requirements will be determined by the appropriate safety organization in accordance with 29 CFR 1910 and other DOE guidance.

6.1.4.1 Closure of Containers. This section is not applicable to 216-B-3 pond.

6.1.4.2 Closure of Tanks. This section is not applicable to 216-B-3 pond.

6.1.4.3 Closure of Waste Piles. This section is not applicable to 216-B-3 pond.

6.1.4.4 Closure of Surface Impoundments. This section is not applicable to 216-B-3 pond.

6.1.4.5 Closure of Incinerators. This section is not applicable to 216-B-3 pond.

6.1.4.6 Closure of Land Treatment Facilities. This section is not applicable to the 216-B-3 pond.

6.1.5 Closure of Disposal Units

If hazardous constituents are determined to be present at concentrations or depths that render inventory removal impractical, then DOE-RL will initiate physical closure of the facility or take other appropriate actions that are consistent with RCRA and the Atomic Energy Act. If a determination for final closure is made, the final cover and its expected performance are described in section 6.1.5.2.

6.1.5.1 Disposal Impoundments. Should it be necessary to close the pond as a disposal unit, a method of dewatering may be required to eliminate the potential for pumping contaminated materials to the surface during the initial backfilling and early construction phases. One method employed under similar conditions onsite entailed the use of very coarse gravels and cobble applied to exposed pond sediments as the water was allowed to recede at a controlled rate. Contaminants were subsequently contained while excessive water was drained and evaporated from the otherwise saturated sediments. This and other techniques (e.g., chemical fixation, etc.) will be evaluated and the recommended approach formally transmitted to the appropriate regulatory agencies prior to undertaking this portion of the closure activity.

6.1.5.2 Cover Design. If the characterization activity indicates the presence of shallow and/or localized contamination above acceptable levels, it will be removed. As a result, no cover will be required. However, if deep, significant, and/or extensive contamination renders inventory removal impractical, then a final cover for the facility may be required such as described in the following sections.

6.1.5.2.1 Final Cover General Design Description. A multilayer cover may be used for closure of the 216-B-3 pond. The primary objective of a cover system design is prevention of water infiltration into underlying waste zones where contact may leach contaminants into the ground water. The cover will consist of 4-ft-deep (1.2-m) soil, revegetated and underlain by a woven synthetic geotextile fabric and 6 in. (15 cm) of gravel. The 4-ft (1.2-m) 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.

6.1.5.2.2 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 1950). 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 equal to zero). This basic law is fundamental to understanding the concept of a multilayer barrier.

The final cover intended for use at the pond is based on the soil water outflow law 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 that 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 if a coarse (gravel) layer had not been present.

6.1.5.2.3 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 amount of annual precipitation recorded at Hanford to date is approximately 11 in. (28 cm). There is a greater than 95% probability that the 11-in. (28-m) total will not be exceeded (fig. 6-1). This amount of precipitation has been established as a design criterion.

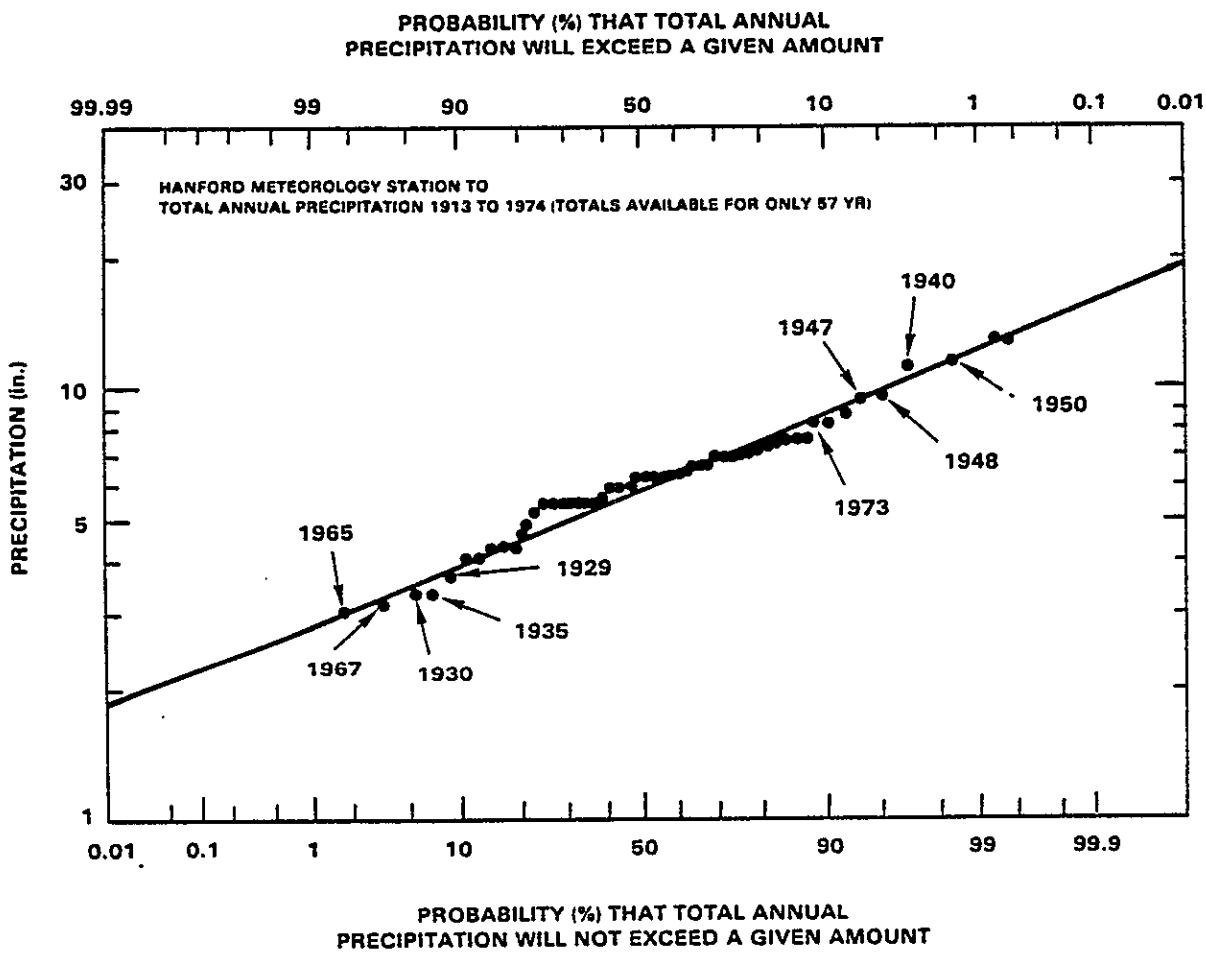
To meet the criteria of higher water-holding capacity and less permeability, the final cover soil will have to be obtained from selected sites outside of the immediate areas surrounding the pond. The most promising soil identified thus far belongs to the Esquatzel series. Esquatzel-series soils are typically deep and medium-textured, and exhibit moderate permeability and high water-holding capacity. Relatively uniform deposits of this soil type have been located approximately 6 mi (9 km) west of the 216-B-3 pond; however, further investigations and soil analyses are planned to locate a source of suitable materials as near to the pond as possible.

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: 0.8 to 2.5 in/h (2.0 to 6.3 cm/h)
- Water-holding capacity: 0.16 to 0.20 in/in (cm/cm) of soil

Based on the estimated minimum water-holding capacity of 0.16 in. water/in. soil, a nonlayered, 4-ft-deep (1.2-m) soil profile will retain 7.7 in. (20 cm) of water. However, as discussed in more detail in section 6.1.5.3, the water-holding capacity of a sandy loam soil underlain by coarse material (i.e., a capillary barrier) can be increased by a factor of at least 1.5. Applying this factor to the 7.7-in. minimum-water-holding capacity results in a total potential water-holding capacity of 11.6 in. (29 cm), or nearly 1 in. (2.5 cm) more than the maximum recorded amount of precipitation at the Hanford Site.

6.1.5.2.4 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-in. (6- to 12-mm) gravel is easily handled and provides a stable base over which the remainder of the barrier can be constructed. This size gravel is available onsite at the excessed concrete batch plant, or it can



REFERENCE: FINAL ENVIRONMENTAL STATEMENT ERDA-1538, WASTE MANAGEMENT OPERATIONS, HANFORD RESERVATION, RICHLAND, WASHINGTON P.II.3-E-33

2K8509-3.20

Figure 6-1. Total Annual Precipitation Probability Diagram.

be obtained from numerous sources offsite. The thickness of the gravel or capillary barrier will be at least 6 in. (15 cm). Barrier experience gained thus far has shown that this is the minimum thickness obtainable by use of heavy equipment during construction.

6.1.5.2.5 Geotextile for Final Cover. The distinctness of the textural change between the soil and the gravel layer will be maintained by use of 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) and exhibits the tested properties indicated in table 6-1. This product has been used in previous barrier construction at the Hanford Site to prevent soil fines from sifting into underlying gravel layers. This experience should prove useful during construction of the final cover at the pond.

6.1.5.2.6 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 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. This vegetative cover will be comprised of Siberian wheatgrass (Agropyron sibericum) and thickspike wheatgrass (Agropyron dasytachyum), both of which have been used routinely with good success at the Hanford Site. 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-ft-deep (1.2-m) 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 4 ft (1.2 m). Plant root penetration into the gravel layer is not expected to occur because of the gravel pore size and resultant lack of available moisture.

6.1.5.3 Minimization of Liquid Migration. 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, research on barriers has shown that multilayer cover systems are

Table 6-1. Properties of Mirafi Geotextile.

600X fabric	Unit	Test method	Typical values
Grab tensile strength	lb	ASTM D-1682-64	300 (135 kg)
Grab tensile elongation	%	ASTM D-1682-64	35 (maximum)
Burst strength	lb/in^2	ASTM D-3786-80	600 (42 kg/cm^2)
Trapezoid test strength	lb	ASTM D-1117-80	120 (54 kg)
Puncture resistance	lb	ASTM D-3787-80	130 (59 kg)

PST87-3144-9

effective in minimizing and preventing liquid migration into a buried waste zone in arid environments (Bone and Shruben 1984; Winograd 1981). Multilayer systems can use the natural material of rock and soil to provide a durable and long-lasting cover system that will fulfill the intent of the regulations, which is to prevent the entry of liquids into the closed waste confinement area.

The basis for the multilayer approach is the soil water outflow law which states that water will not move from a fine-pored soil into much larger pores 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 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 6-2 (from Miller 1973) 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 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 ensured 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 6-2, 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 of 1.5. As stated previously in section 6.1.5.2, a nonlayered 4-ft-deep (1.2-m) sandy loam soil profile will hold 7.7 in. (20 cm) of water, which is 2 in. (5 cm) more than the average annual precipitation and 3 in. (8 cm) less than the maximum-recorded precipitation. Utilizing this inferred increase in moisture retention capacity attributable to the presence of a capillary barrier, the estimated 7.7-in. total-water-retention capacity is increased to 11.6 in. (29 cm). Referring to figure 6-1, the probability that annual precipitation will exceed this amount is estimated to be less than 1%. 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 1%.

Table 6-2. Water Retention in Layered Soil Properties.

Soil material	Stored water[a] / Texture		
	Loamy sand	Loam	Silt loam
Soil underlain by sand layer (at 60-cm depth)	16.4 (3.3 in/ft)	17.4 (3.5 in/ft)	20.0 (4 in/ft)
Uniformly deep soil with no layer	6.7 (1.3 in/ft)	11.4 (2.3 in/ft)	16.7 (3.3 in/ft)
Ratio layered/uniform	·2.5	1.5	1.2

[a]Cm water/60-cm soil.

PS'87-1144-17

6.1.5.4 Maintenance Needs. Experience gained from Hanford Site stabilization since 1978 (approximately 800 acres) has shown that very little maintenance is required following the successful establishment of the vegetative cover. Successful establishment generally requires from 2 to 3 yr. 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, qualified personnel periodically evaluate seedling progress and recommend any necessary corrective actions. Herbicides are often used in the spring to selectively control annual broadleaf species that compete for available moisture and nutrients. Herbicide applications can be 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 rodent activity have been discovered, primarily in the form of burrows in the cover side slopes. This potential problem has been practically eliminated by decreasing the side slope angles to 3-to-1. The only other maintenance resulting from periodic surveillance has been the manual removal of deep-rooted shrubs that might penetrate the underlying waste zone. No additional backfilling has been required as a result of wind or water erosion. Maintenance of the final cover is not expected to be dissimilar from that experienced to date on other Hanford Site stabilization projects.

6.1.5.5 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 the Hanford Site. The greatest potential for erosion arises in the late winter when rapid snow melts might 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 approximately one ton of straw per acre. Mulching is an integral part of the revegetation process at Hanford and it has proven very effective 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 (324 ha)) stabilized to date.

6.1.5.6 Settlement and Subsidence. Localized settlement should not prove detrimental to the integrity of the multilayer cover and there is no reason to expect anything more than minor differential settlement of the backfill materials. Additionally, the geotextile will lend some support to the soil cover by providing load distribution over the area being closed.

Nevertheless, subsidence will be monitored through periodic surface measurements taken from permanent benchmarks and concrete perimeter posts. Possible maintenance actions are contained in the post-closure plan (section 6.2).

6.1.5.7 Cover Permeability. Since no bottom liners (clay or synthetic) have been used at the pond, 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 that correlate very closely to the Rupert series encountered at the ditch. These estimated properties are as follows:

- Textural class: loamy sand
- Unified class: SM
- Permeability: >10 in/h (>25 cm/h)
- Water-holding capacity: 0.03 to 0.05 in/in (cm/cm) 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 in/h (2.0 to 6.3 cm/h) compared to greater than 10.0 in/h (greater than 25 cm/h) 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 beneath the pond.

6.1.6 Continuance of Operations

Final closure may require that sediments be removed from only a portion of the pond. Should this be the case, the outfall may be permanently relocated or temporarily diverted to unaffected portions of the pond until all contaminated sediments have been removed. Throughout this time, groundwater monitoring will continue as described in section 5.0.

6.1.7 Schedule for Closure

All regulated waste will be removed within 90 d of initiating closure, and final closure will be complete within 180 d, subject to section 6.1.8. If a cover system is necessary, a detailed schedule for construction will be submitted to the appropriate regulatory authorities.

6.1.8 Extensions for Closure Time

If, before or during the start of the pond closure operations, it appears that closure may take more than 180 d, a petition will be made to the appropriate regulatory authority to extend the 180-d closure time. An

extension may be required if initial sampling and analysis indicates that pond contamination is extensive, or that further sampling/analysis and the removal of all contaminated soil will take longer than the currently anticipated 180-d closure time.

6.2 POST-CLOSURE PLAN

If the pond is closed as a disposal unit with the hazardous inventory remaining in place, the following post-closure plan will be implemented.

6.2.1 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 5 yr and annually for the remainder of the post-closure period:

- Evaluation of settlement/subsidence
- Evaluation of vegetative cover
- Evaluation of bench marks
- Evaluation of rodent intrusion
- Evaluation of erosion.

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

Maintenance action will be initiated within 90 d if the inspection reveals that the integrity of the final containment structure can potentially be breached. Potential breaches and possible maintenance actions are defined as follows:

- Settlement/subsidence greater than 18 in. (0.5 m) 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 settlement/subsidence area and relaying the multilayer action over the affected area. If, at 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.

- Vegetative cover less than 10% after 2 yr of closure will initiate maintenance action. Maintenance action will include reseeding and possible fertilizer application.

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

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

- Erosion damage that results in the loss of 18 in. (0.5 m) of the fine soil top layer will result in maintenance action. Maintenance action will include replacement of the fine soil at the affected area, reseeding, and performing other selected tasks that were performed during closure to ensure a vigorous vegetative growth.

6.2.2 Monitoring Plan

During the post-closure care period, groundwater monitoring will be conducted as described in section 5.0. There are no liners or leachate collection and removal systems at the 216-B-3 pond. All groundwater monitoring wells for the pond are within the controlled access area of the Hanford Site. All wells will be routinely inspected to ensure proper operation.

6.2.3 Maintenance Plan

During the post-closure care period, the maintenance operations are directed at maintaining the integrity of the waste containment system. Containment system experience since 1978 has shown that such containment systems will remain intact if the vegetative cover is successfully established. Invading plants, primarily Russian thistle (Salsola kali), with root systems that can extend into waste zones, pose the greatest potential problem. The active elimination of these invading species for 2 to 3 yr after seeding generally allows the vegetative cover enough time to become firmly established.

For 2 to 3 yr following closure, selective herbicides will be applied to the closure area to minimize the establishment of deep rooting, annual, broadleaf plants that compete with the grasses for moisture and nutrients. Selective herbicide applications can be discontinued following successful establishment of the perennial grass cover. Following establishment of the selected grass cover, manual removal of deep rooting shrubs may be periodically required.

Soil permeabilities and rainfall intensities at the Hanford Site 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 very 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. Vegetation typical of the arid Hanford Site environment is sufficient to prevent drifting sand from overrunning or obscuring the bench marks, and small enough in stature to permit easy observation. However, if a bench mark becomes physically damaged and needs to be replaced, that action will be completed within 90 d of the original observation.

6.2.4 Land Treatment

This section is not applicable to the 216-B-3 pond.

6.3 NOTICE IN DEED

6.3.1 Notice to Local Land Authority

The DOE-RL will file, within 90 d after the start of the 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 the Courthouse Building, Prosser, Washington, 99350.

(a) A survey plat indicating the location and dimensions of the ditch 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 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 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 human health or the environment.

(c) A record of the type, location, and quantity of hazardous wastes disposed of within the pond to the extent that the information exists will be submitted. During the post-closure this record will be submitted to the regulating authority.

6.3.2 Notice in Deed to Property

The DOE-RL will, in accordance with the state law, sign, notarize, and attach the following notation to the deed of the 216-B-3 pond area within 180 d 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 265.120 and/or WAC 173-303-303-610(10):

(a) The United States of America 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).

(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) The U.S. Department of Energy-Richland Operations Office has 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 the 216-B-3 pond and a record of the type, location and quantity of waste disposed within the area of the ditch.

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).

6.9 REFERENCES

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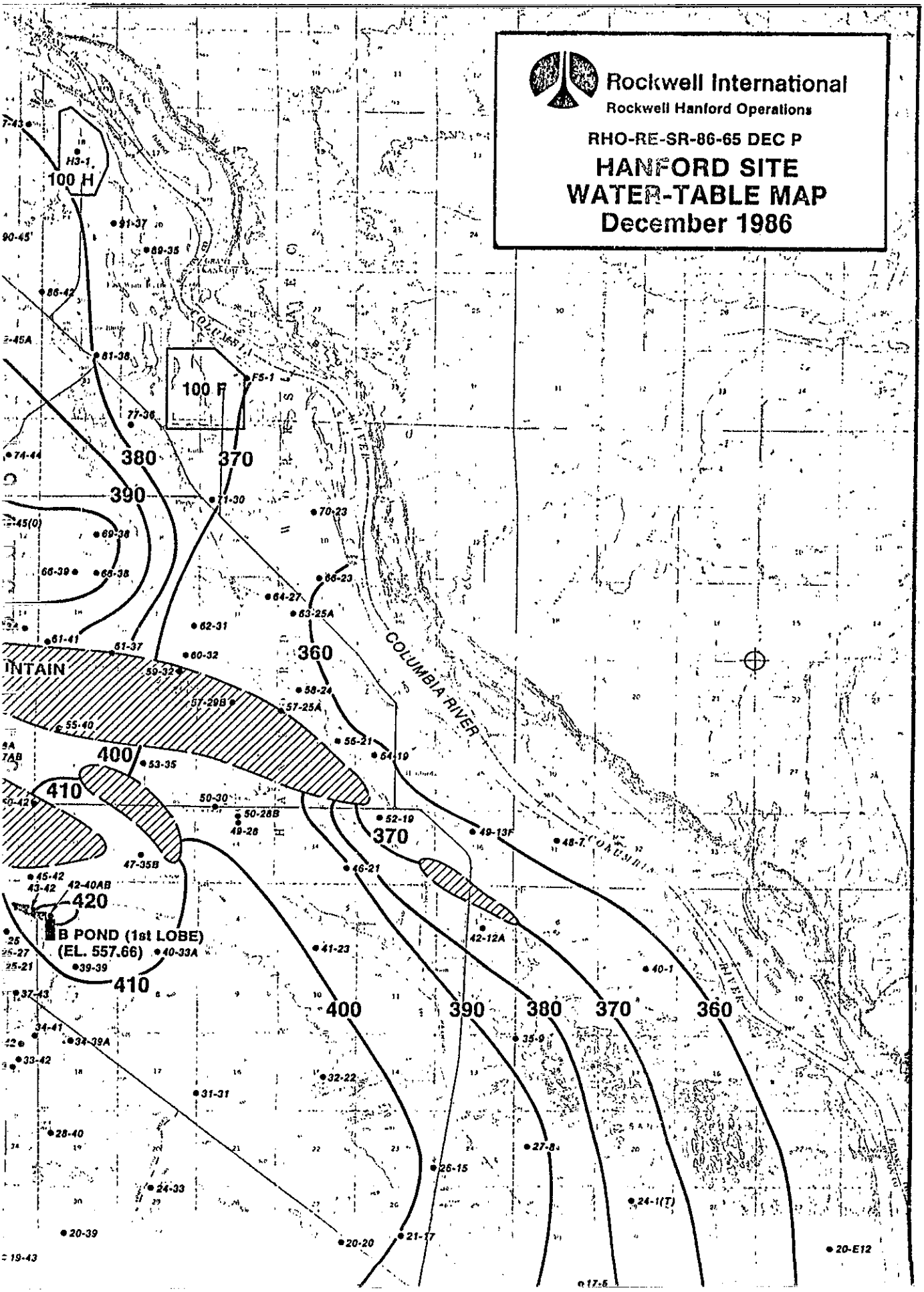
APPENDIX A
TOPOGRAPHIC MAP OF THE HANFORD SITE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HANFORD SITE
WATER-TABLE MAP
December 1986
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360
400
410
420
B POND (1st LOBE)
(EL. 557.66)
COLUMBIA RIVER
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H3-1
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91-37
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81-38
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64-27
63-25A
62-31
61-41
61-37
60-32
59-32
58-24
57-29B
57-25A
55-40
56-21
54-19
53-35
52-19
50-30
50-28B
49-26
49-13F
48-7
47-35B
46-21
45-42
43-42
42-40AB
42-12A
41-23
40-33A
39-39
40-1
37-43
34-41
34-39A
33-42
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32-22
31-31
28-40
27-8
26-15
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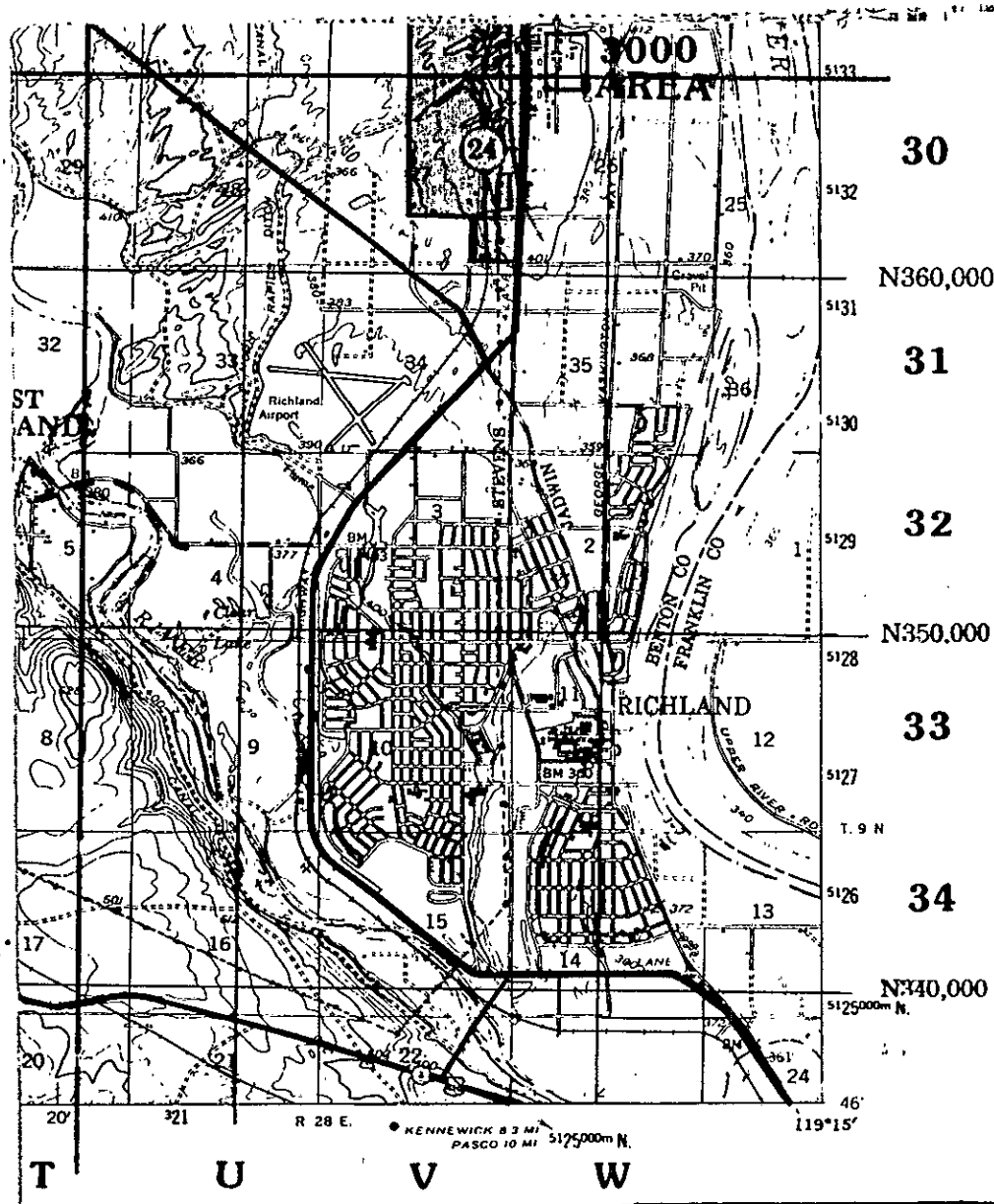
APPENDIX B
GROUNDWATER MAP OF THE HANFORD SITE



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U. S. Department of Energy
Richland Operations Office

Rockwell Hanford Operations
Richland, Washington 99352

M

HANFORD SITE MAP

SCALE	BLOCK, NO.	INDEX NO.
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DRAWING NO	SHEET NO.	SHEETS
H-6-951	1	1

APPENDIX C
LOCATION AND NUMBER OF COPIES OF 216-B-3 POND CLOSURE/POST-CLOSURE PLAN

APPENDIX C

LOCATION AND NUMBER OF COPIES OF 216-B-3 POND CLOSURE/POST-CLOSURE PLAN

Two copies of the 216-B-3 Pond Closure/Post-Closure Plan are official copies of the plan. These official copies are located at the following office:

U.S. Department of Energy - Richland Operations Office
Federal Building - Room 619
825 Jadwin Avenue
Post Office Box 550
Richland, Washington 99352
(509) 376-7387

APPENDIX D
PERSON RESPONSIBLE FOR STORAGE AND UPDATING OF COPIES OF 216-B-3 POND CLOSURE/POST-CLOSURE PLAN

APPENDIX D

PERSON RESPONSIBLE FOR STORAGE AND UPDATING OF COPIES OF 216-B-3 POND CLOSURE/POST-CLOSURE PLAN

If a permit modification is requested during the active life of the facility which changes the operating plans or facility design, the 216-B-3 Pond Closure/Post-Closure Plan will be modified at the same time. In all other cases, a request for modification of the 216-B-3 Pond Closure/Post-Closure Plan will be completed within 60 d after a change in operating plans, facility design or events that affect the 216-B-3 Pond Closure/Post-Closure Plan. The following office will be responsible for updating the official copies of the 216-B-3 Pond Closure/Post-Closure Plan.

U.S. Department of Energy - Richland Operation Office
Federal Building - Room 619
825 Jadwin Avenue
Post Office Box 550
Richland, Washington 99352
(509) 376-7387

APPENDIX E
CERTIFICATION OF CLOSURE

APPENDIX E

CERTIFICATION OF CLOSURE

is completed, the U.S. Department of Energy - Richland
(DOE-RL) will submit to the regulating authority both a
n and a certification by an independent registered
neer that the 216-B-3 pond has been closed in accordance
ations of the approved closure plan.

)SURE CERTIFICATION

ill self-certify with the following document or a document

ı authorized representative of the U.S. Department of
)erations Office located at the Federal Building,
, Richland, Washington, hereby state and certify that the
:he best of my knowledge and belief, has been closed in
ıe attached approved closure plan, and that the closure was
:). (Signature and date)

IEER CLOSURE CERTIFICATION

'll engage an independent, registered professional engineer
ıe 216-B-3 pond has been closed in accordance with this
ılan. The DOE-RL will require the engineer to sign the
. or a document similar to it:

certified professional engineer, hereby certify, to the
ge and belief, that I have made visual inspection(s) of
nd that closure of the aforementioned facility has been
dance with the attached approved closure plan.
state professional engineer license number, business
number)