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TECHNICAL SUMMARY OF GROUNDWATER QUALITY PROTECTION PROGRAM AT THE SAVANNAH RIVER SITE (1952-1986) (U)

by

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VOLUME I

TECHNICAL SUMMARY OF GROUNDWATER QUALITY PROTECTION PROGRAM AT THE SAVANNAH RIVER SITE (1952-1986) (U)

VOLUME I--SITE GEOHYDROLOGY AND WASTE SITES

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SAFETY · RESPONSIBILITY · SECURITY
SRS
SAVANNAH RIVER SITE

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SECTION 1 SUMMARY

This report provides information regarding the status of and groundwater quality at the waste sites at the Department of Energy's (DOE) Savannah River Site (SRS). Required by the settlement agreement between the South Carolina Department of Health and Environmental Control (SCDHEC) and DOE, this report is an update of the information previously supplied to SCDHEC in a document titled *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant* (Christensen and Gordon, 1983). The original draft of this report was sent to SCDHEC on June 1, 1987. This document is the final edited version of that draft and contains information that is complete through the end of 1986.

Specific information provided for each waste site at SRS includes its location, size, inventory (when known), and history. Many waste sites at SRS are considered to be of little environmental concern because they contain nontoxic or inert material such as construction rubble and debris. Other waste sites, however, either are known to have had an effect on groundwater quality or are suspected of having the potential to affect groundwater. Monitoring wells have been installed at most of these sites; monitoring wells are scheduled for installation at the remaining sites. Results of the groundwater analyses from these monitoring wells, presented in the appendices, are used in the report to help identify potential contaminants of concern, if any, at each waste site.

Since the 1983 report was published, 12 additional waste sites have been identified at SRS. These sites apparently have not been used for many years; they are generally trash or rubble piles that do not appear to contain any chemical or radioactive waste.

The list of actions proposed for each waste site in Christensen and Gordon's 1983 report are summarized, and an update is provided for each site. Planned actions for the future are also outlined.

From 1983 through 1986, many improvements were made in the groundwater protection program at SRS. These improvements include the installation of several hundred additional monitoring wells, implementation of an M-Area groundwater remediation program, closure of 22 individual waste management units, removal from service of many waste management units, improvements in well installation and sampling procedures, and installation of dikes around chemical storage facilities.

Since publication of the 1983 report, remedial actions have been taken at the waste sites that appeared to pose the most serious threats to groundwater. The Chemicals, Metals, and Pesticides (CMP) Pits were excavated and capped, and the M-Area Settling Basin was removed from service and subsequent chlorocarbon cleanup begun. Plans are currently being developed for a wastewater treatment facility to replace the F- and H-Area Seepage Basins. Additional wells have been installed at these basins, and improved sampling techniques have shown that much of the previously suspected metals contamination apparently resulted from the sampling method itself and not from the basins.

Additional improvements in the SRS groundwater protection program are planned, including the installation of additional groundwater monitoring wells and the removal from service or closure of more waste sites.

SECTION 2 INTRODUCTION

2.01 PURPOSE

This report provides information regarding waste sites at the Savannah River Site (SRS) and the effect of these sites on groundwater quality. Complete and accurate through 1986, this report is intended as a technical document and does not address regulatory issues or policy.

A settlement agreement between the South Carolina Department of Health and Environmental Control (SCDHEC) and the Department of Energy (DOE), signed June 20, 1986, requires this report to be filed with SCDHEC. Specifically, the agreement requires updates of the *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant* to be submitted to SCDHEC every 2 years beginning June 1, 1987. The agreement specifies that the updates must summarize assessments, monitoring data, prioritization, action plans, and schedules. The Radioactive Waste Burial Grounds and other areas in which radioactive waste material is located are excluded from the agreement. However, in order to provide a complete reference manual of the waste sites and groundwater monitoring program at SRS, this report contains a discussion of all known waste sites.

2.02 REPORT ORGANIZATION

Sections 1 through 4 of this report contain general information regarding SRS, its environment, and waste sites. Sections 5 through 15 contain details of the status and groundwater quality of each waste site. Waste sites are grouped geographically; each plant operating area constitutes a section.

A summary of the history, location, and contents of each waste site is given in a subsection of its operating area section. Groundwater conditions, including flow direction, velocity, and discharge location, are also given for each site. The velocities are estimated from local gradients and hydraulic properties of the subsurface and have not been confirmed in the field.

The results of water-quality analyses from site monitoring wells are compared to drinking water standards to aid in identifying contaminants of concern. Drinking water standards are not related to background water quality, but they are frequently used as a basis for comparison. Lengthy data tables, such as those for the groundwater monitoring data, are included as appendices in Volume II.

Plans for additional actions and their tentative scheduling are given in Section 16. Actions given in this section have been updated through the end of 1988 to reflect measures taken after the time the initial draft of this report was submitted to SCDHEC.

2.03 GROUNDWATER PROTECTION PROGRAM AT THE SAVANNAH RIVER SITE

SRS has been dedicated to environmental protection since its inception. Both philosophy and technique for protecting groundwater quality have advanced considerably through the years of plant operation. Initially, a groundwater monitoring program was instituted to identify any groundwater contamination caused by radioactivity resulting from plant operations. More recently, concern over nonradioactive wastes and their potential threats to groundwater quality has stimulated the expansion of the monitoring program to include all waste sites judged to have potential to contaminate groundwater. The *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant* (Christensen and Gordon, 1983) described SRS's waste sites and identified those sites needing monitoring wells. Since that time all of those sites except one (H-Area Acid/Caustic Basin) have had monitoring wells installed. This brings the total to 96 of the 175 single waste management units at SRS that are included in the groundwater monitoring program.

Groundwater protection activities have grown rapidly at SRS since 1983. Besides waste-site monitoring, the program has expanded in the areas of waste handling, plans for waste-site closure, improvements in well installation specifications, sampling and analytical procedures, water production management, and regional hydrologic studies.

SECTION 3 CHARACTERIZATION OF SITE GEOLOGY AND HYDROLOGY

3.01 PHYSIOGRAPHY

The Savannah River Site (SRS) occupies more than 200,000 acres of the Atlantic Coastal Plain, a seaward-dipping, seaward-thickening wedge consisting primarily of terrigenous sediments at the site. SRS lies mostly on the Aiken Plateau (Cooke, 1936), which is bounded by the Fall Line, the Savannah and Congaree rivers, and an elevation break (Figure 3-1). The Aiken Plateau slopes from an elevation of 650 ft msl (mean sea level) at the Fall Line to a minimum elevation of 250 ft msl. The surface of the Aiken Plateau is extensively dissected and is characterized by broad, interfluvial areas with narrow, steep-sided valleys. Local relief is as much as 300 ft (Siple, 1967). The plateau is generally well drained although small, poorly drained depressions occur.

3.02 HYDROSTRATIGRAPHY

3.02.01 Summary

Since 1986 the nomenclature and grouping applied to the hydrostratigraphic units beneath SRS have been updated and clarified. This report uses the older terminology of Siple (1967), which was prevalent at the time period covered by the report. To facilitate use of this document, current nomenclature also has been provided throughout this section, usually in parentheses following Siple's terminology. The correlation between Siple's terminology and current terminology is graphically presented in Figure 3-2.

SRS is underlain by locally discontinuous strata of sand, silt, and clay. A thin calcareous zone, not present in the northwest region of SRS, has been observed in cores from many SRS wells. Three strata function as aquitards beneath most of the plant site: the informally named "tan clay" (now known as the Upper Eocene Stage of the Dry Branch Formation); the informally named "green clay" (now known as the Caw Caw Member of the Santee Formation); and clay-rich units in what has been known as the Ellenton Formation (currently known as the Snapp Member of the Williamsburg Formation and the Ellenton Member of the Rhems Formation). The clay units are not present everywhere, and their lithology is locally variable. A typical geologic cross section through SRS is presented in Figure 3-3; a typical geologic column at SRS is shown in Figure 3-4.

3.02.02 Tuscaloosa Formation (Cretaceous System)

Use of the term *Tuscaloosa* for the Upper Cretaceous Lumbee Group sediments at SRS was the practice for many years; however, it should be noted that the unit beneath SRS is appreciably younger than the Tuscaloosa type section in Alabama. The lithologies and environments of deposition also differ between the two units. Therefore, the term *Tuscaloosa* in this report is used as a hydrostratigraphic term and not as a formal stratigraphic term.

The Tuscaloosa Formation, comprising in current stratigraphic nomenclature the Cape Fear, Middendorf, and Black Creek formations and the Steel Creek Member of the Peedee Formation, primarily consists of fluvial and estuarine deposits of well-sorted sand and gravel with occasional lenses of silt and clay. Near SRS, the Tuscaloosa Formation chiefly consists of quartz, feldspars, and mica derived from weathering of the igneous and metamorphic rocks of the Piedmont province to the northwest. Beneath SRS, the Tuscaloosa Formation rests directly on a clayey saprolite and is conformably overlain by the Ellenton Formation.

The Tuscaloosa Formation beneath SRS is divided into five units (Figure 3-2): the uppermost unit (the top of the Peedee Formation) is clay, sandy clay, or clayey sand and is approximately 65 ft thick; the upper aquifer unit (the bottom of the Peedee Formation and the top of the Black Creek Formation) is medium-to-coarse sand and is approximately 165 ft thick; the middle unit (the middle of the Black Creek Formation) is characterized by one or more clay lenses and is approximately 40 ft thick; the lower aquifer unit (the bottom of the Black Creek Formation and the Middendorf Foundation) is medium-to-coarse sand and is approximately 330 ft thick; the lowest unit (the Cape Fear Formation) is sandy clay and ranges from 30 to 180 ft thick. The two aquifer units are often discussed as a single aquifer; however, they are usually hydraulically separate beneath SRS.

Water yield from the Tuscaloosa Formation is large; industrial wells in this aquifer often yield more than 1,000 gpm of good quality water. Almost all water production is from the continuous sand layers in the two producing horizons.

3.02.03 Ellenton Formation (Paleocene-Eocene Black Mingo Group)

The Ellenton Formation, named for a town formerly located within SRS boundaries, is known only from corings; no Ellenton sediments are known in outcrop. Generally, the upper part of the Ellenton Formation (now known as the Snapp Member of the Williamsburg Formation) is silty quartz sand interbedded with clay, and the lower part of the Ellenton Formation (now known as the Ellenton Member of the Rhems Formation) is poorly sorted silty and clayey quartz sands interbedded with clays. The Ellenton sands are hydraulically well connected in places to the Tuscaloosa Formation below. The Ellenton Formation is unconformably overlain by the Congaree Formation.

Although some of the sand lenses in the Ellenton Formation are as permeable as the sand units in the Tuscaloosa, they are not as thick and are not often developed for wells. As aquifers, the sand lenses typically exhibit a large initial yield followed by a rapidly diminishing flow. Lateral water flow within the Ellenton Formation beneath SRS is generally limited.

3.02.04 Congaree Formation (Lower Middle Eocene Stage)

The Congaree Formation was considered a part of the McBean Formation during the construction of SRS; however, it is a hydraulically distinct unit. Heads in the Congaree aquifer are 50 to 80 ft beneath those of the overlying McBean aquifer, and lateral groundwater flow directions in the Congaree aquifer are sometimes the opposite of those in the McBean.

The Congaree Formation beneath SRS consists primarily of nearshore marine deposits of well-sorted sand with some clay layers. Locally it may be glauconitic or calcareous. The sediments consist primarily of well-sorted quartz sand.

The Congaree Formation of previous SRS literature is divided into three units: the upper unit (known as the Caw Caw Member of the Santee Formation in current nomenclature) is dense, occasionally indurated clay, nominally 3 ft thick, known informally as the "green clay"; the middle unit is sand and approximately 115 ft thick; the lower unit is pisolitic clay, approximately 3 ft thick. The "green clay" is generally continuous in the central part of SRS (except where absent because of deeply incised stream valleys) and is known to be discontinuous in the northwest part of SRS. Beneath some parts of SRS the sand unit of the Congaree Formation is hydraulically divided into two aquifers.

Water yield from the Congaree Formation is often large, second only to the Tuscaloosa. Wells for industries and large municipalities screened in this formation often yield more than 400 gpm. Water yield is usually poor near the Fall Line, where the Congaree Formation thins and becomes less permeable.

3.02.05 McBean Formation (Middle Eocene Santee Limestone and Late Eocene Jacksonian Dry Branch Formation)

The McBean Formation beneath SRS consists primarily of nearshore marine deposits of clayey or calcareous sands. The sediments consist primarily of terrigenous clays and quartz sand, occasionally with biogenic limestone. The upper part of the McBean Formation (now known as the Dry Branch Formation) is characterized by moderate clay percentages in the sands. The lower part of the McBean Formation (now known as the

Santee Limestone) is characterized by variable carbonate content, the percentage of carbonate increasing to the southeast. The McBean Formation is approximately 80 ft thick in the central region of SRS. Water yield from the McBean Formation ranges from small to moderate and is often adequate for domestic needs.

3.02.06 Barnwell Formation (Upper Eocene Tobacco Road Sand)

The Barnwell Formation is exposed in numerous uplands at SRS. Its type locality is southeast of the plant site.

The Barnwell Formation of former SRS literature consists primarily of nearshore or estuarine deposits of clayey sand and sandy clay and corresponds in current nomenclature to the Tobacco Road Sand Formation and the top part of the Dry Branch Formation, both of the Barnwell Group. The sediments consist primarily of greatly weathered limestones mixed with terrigenous clays and quartz sand. The internal stratigraphy of the Barnwell Formation is highly variable because of original variations in deposition as well as erosion. The Barnwell Formation is divided into the following units: an upper unit of clayey sand, 0 to 100 ft thick; a middle unit of silty sand, 0 to 40 ft thick; and a bottom unit (the Upper Eocene Stage of the Dry Branch Formation) consisting of two thin clays with sand between, informally named the "tan clay," which is 10 to 16 ft thick.

Because of the poor sorting and large amounts of clay and silt in the Barnwell Formation, it is not often used as an aquifer. However, occasional sand lenses with little clay can provide water yields adequate for domestic use.

3.02.07 Hawthorn Formation and Surficial Sediments ("Upland Unit")

In the vicinity of SRS, the Hawthorn Formation consists primarily of sandy, dense clay that contains coarse gravel, limonitic nodules, and kaolinitic particles. The structure is complex, consisting of numerous intersecting soil fractures interpenetrating the clay. These fractures consist of iron oxide-indurated quartz sand walls and are filled with silty or sandy clay. The formation is bounded top and bottom with erosional unconformities. In current stratigraphic terminology, the Hawthorn Formation is included in the informally named "Upland unit" and the top of the Tobacco Road Sand Formation. The permeability of the Hawthorn Formation is quite small, and sustained water production from this formation is unknown. The Hawthorn Formation is usually above the water table at SRS; in fact, it is often absent at SRS, probably because of erosion.

Surficial sediments at SRS consist primarily of terrace deposits and alluvium. The terrace deposits are not more than 35 ft thick, and their origin is problematic. The deposits identified as terrace deposits are near the surface. Alluvial deposits are of fluvial origin and are not more than 35 ft thick. They occur irregularly and discontinuously near the surface. Although these sediments are moderately permeable, they do not serve as aquifers.

3.02.08 Groundwater Flow Beneath SRS

The direction of groundwater movement beneath SRS is governed largely by the depths of incisions of the creeks that dissect the Aiken Plateau. Small creek valleys govern the groundwater flow directions in the shallow sediments. The valleys of major tributaries of the Savannah River govern flow direction in the sediments of intermediate depth, and the valley of the Savannah River governs the flow in the deep sediments. Groundwater in the Tuscaloosa Formation flows either downdip toward the Atlantic Ocean or toward the Savannah River, and that in the Congaree Formation flows toward Upper Three Runs Creek or the Savannah River, depending on location. Lateral water flow within the McBean Formation beneath SRS is generally toward outcrops in numerous incised stream valleys, which divide the McBean Formation into several regions that are hydraulically separate. Groundwater flow within the Barnwell Formation beneath SRS is generally controlled by local topography and erosional boundaries. The Barnwell Formation is often absent and, like the McBean, is dissected into numerous regions that are hydraulically separate.

In the northwest part of SRS, groundwater head decreases with depth, providing the potential for recharge from the surface to penetrate to the deeper formations. However, in and near the valleys of Upper Three Runs Creek and the Savannah River, the water levels above the Paleocene confining units are drawn down by natural discharge more than those in the deeper formations. Thus, a head reversal in the central part of SRS causes the vertical groundwater gradients to be upward.

Water levels in wells sampling the Cretaceous sands do not respond quickly to rainfall; however, a long-term relationship probably exists between water level and recharge by rainfall. Decreases in water levels during the past several years cannot be completely accounted for by decreases in rainfall. Pumping for irrigation in Allendale and Barnwell counties has increased greatly during this period. In addition, pumping at SRS has also increased. The head reversal near the central part of the site has not disappeared because of the falling water levels, but it has decreased.

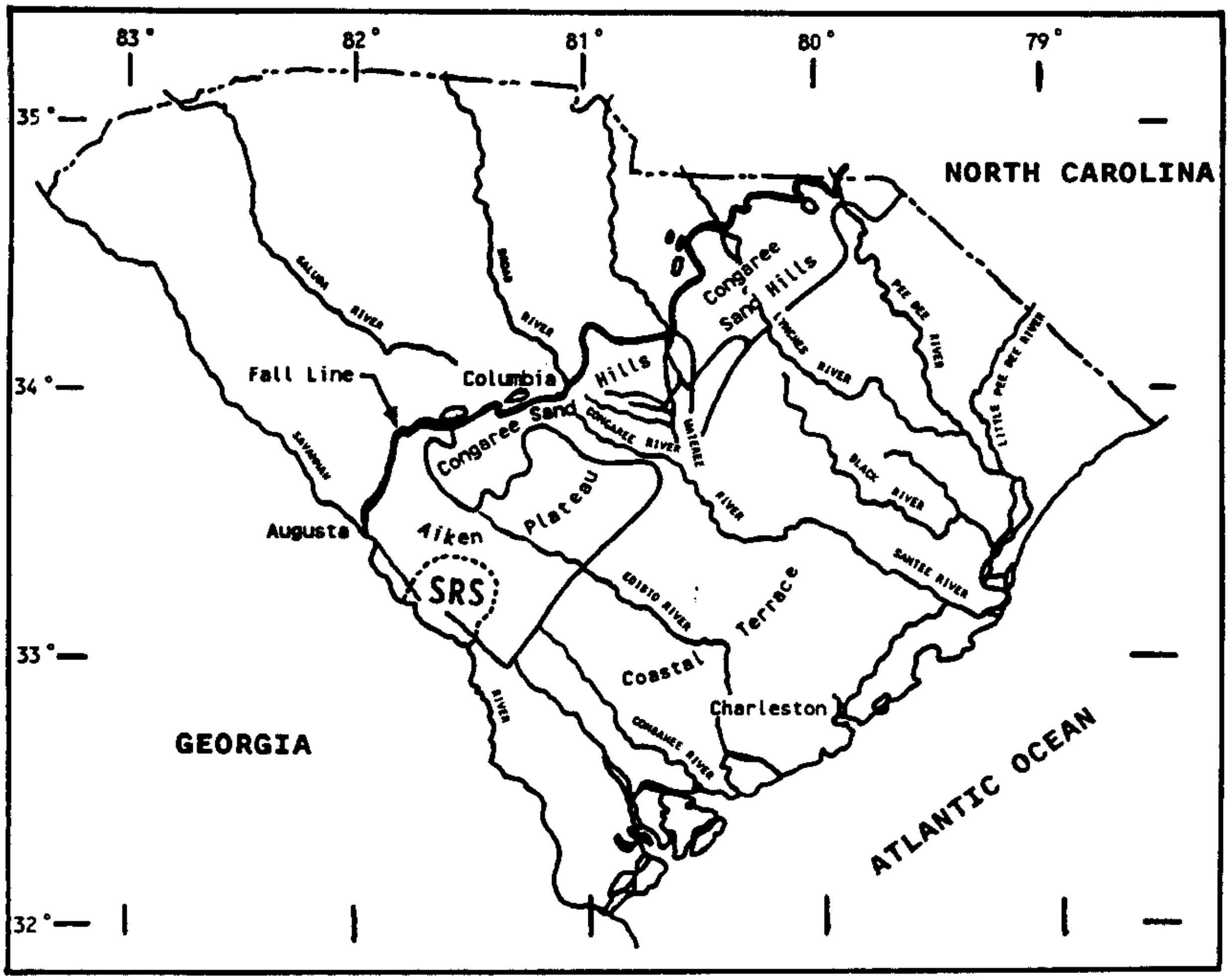


FIGURE 3-1. Physiography of the Savannah River Region

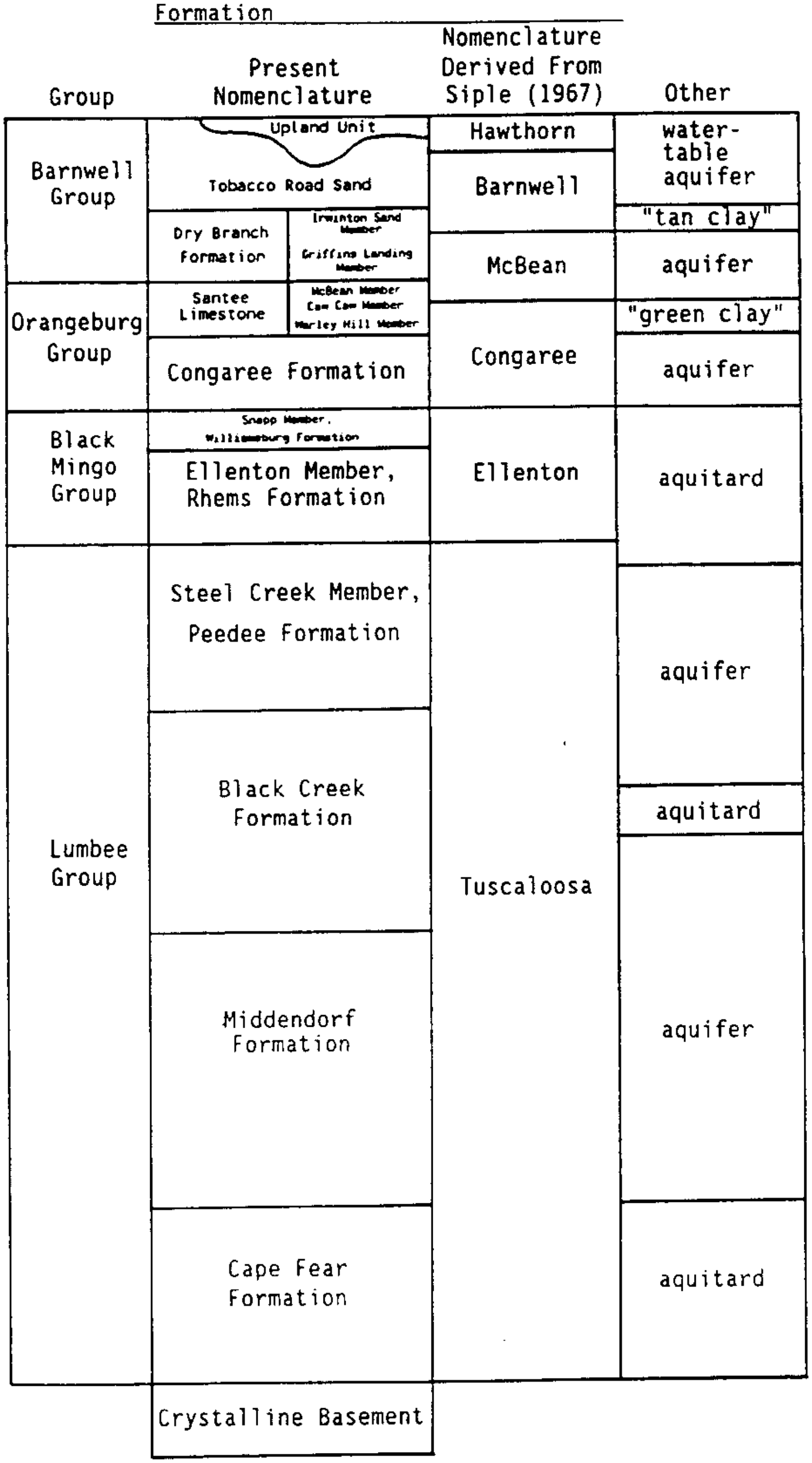


FIGURE 3-2. Coastal Plain Sediments at the Savannah River Site

Nomenclature Derived from Siple (1967)

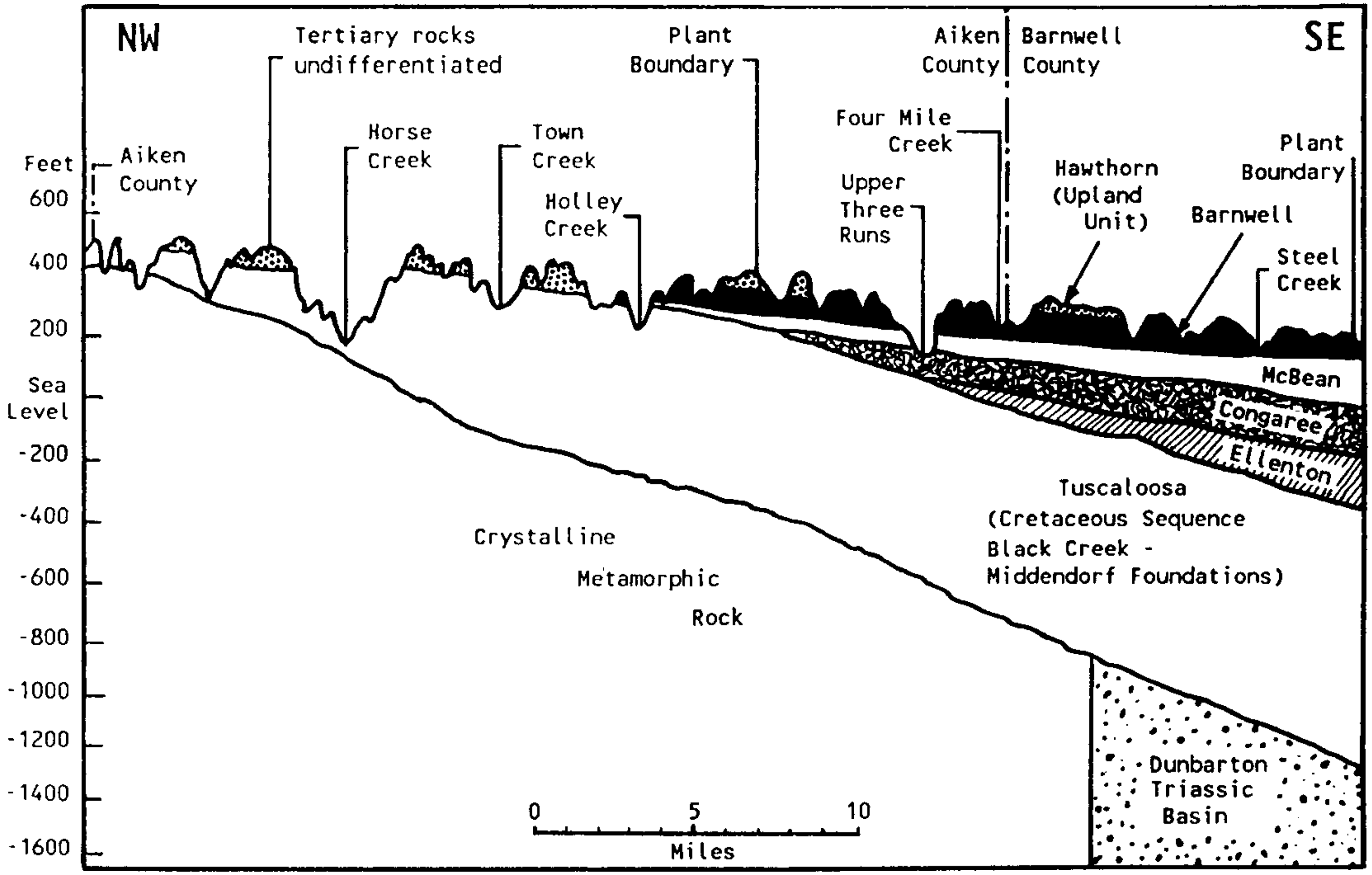


FIGURE 3-3. Generalized Northwest (NW) to Southeast (SE) Geologic Profile Across the Savannah River Site

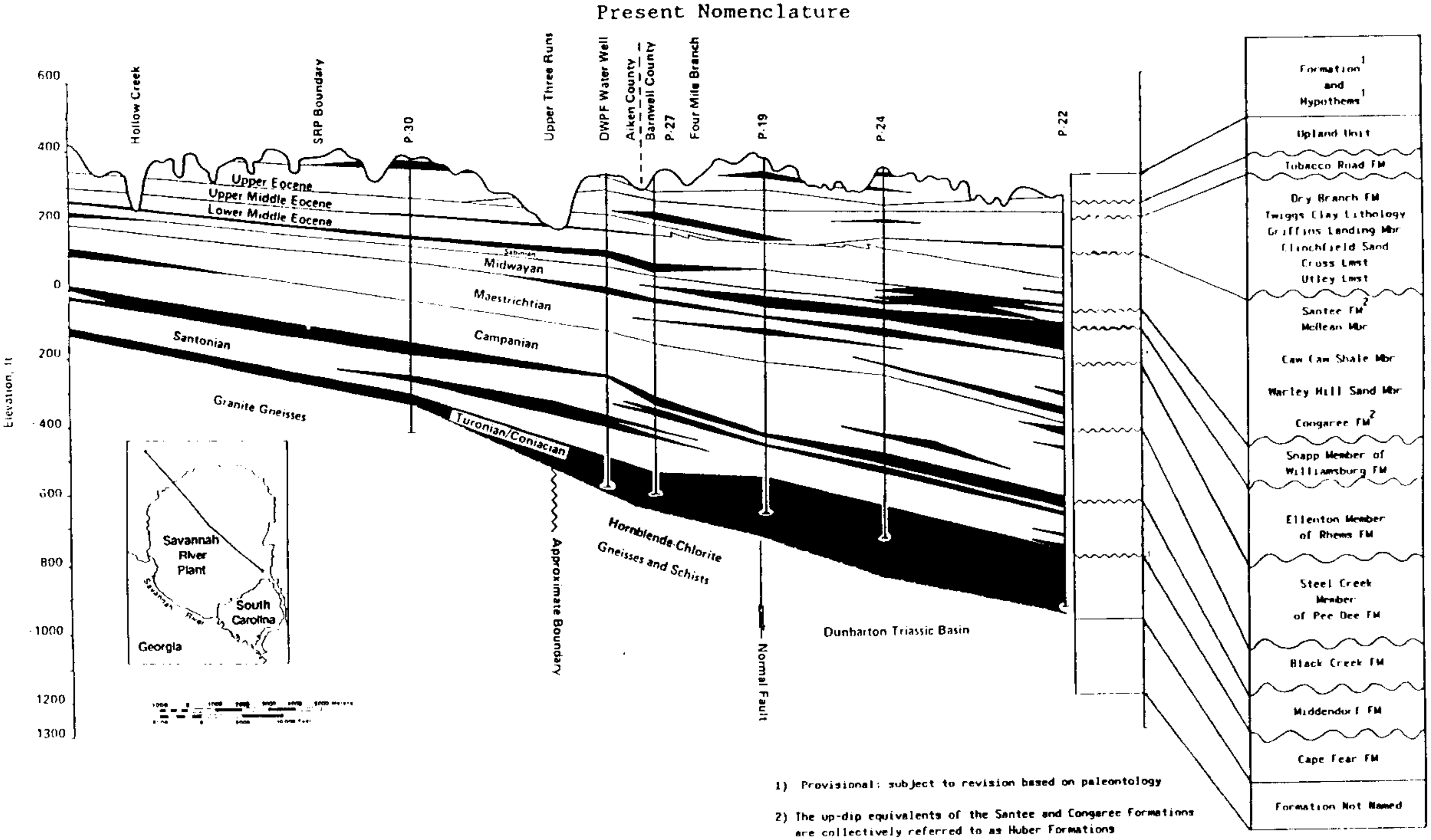


FIGURE 3-3 (cont.). Generalized Northwest (NW) to Southeast (SE) Geologic Profile Across the Savannah River Site

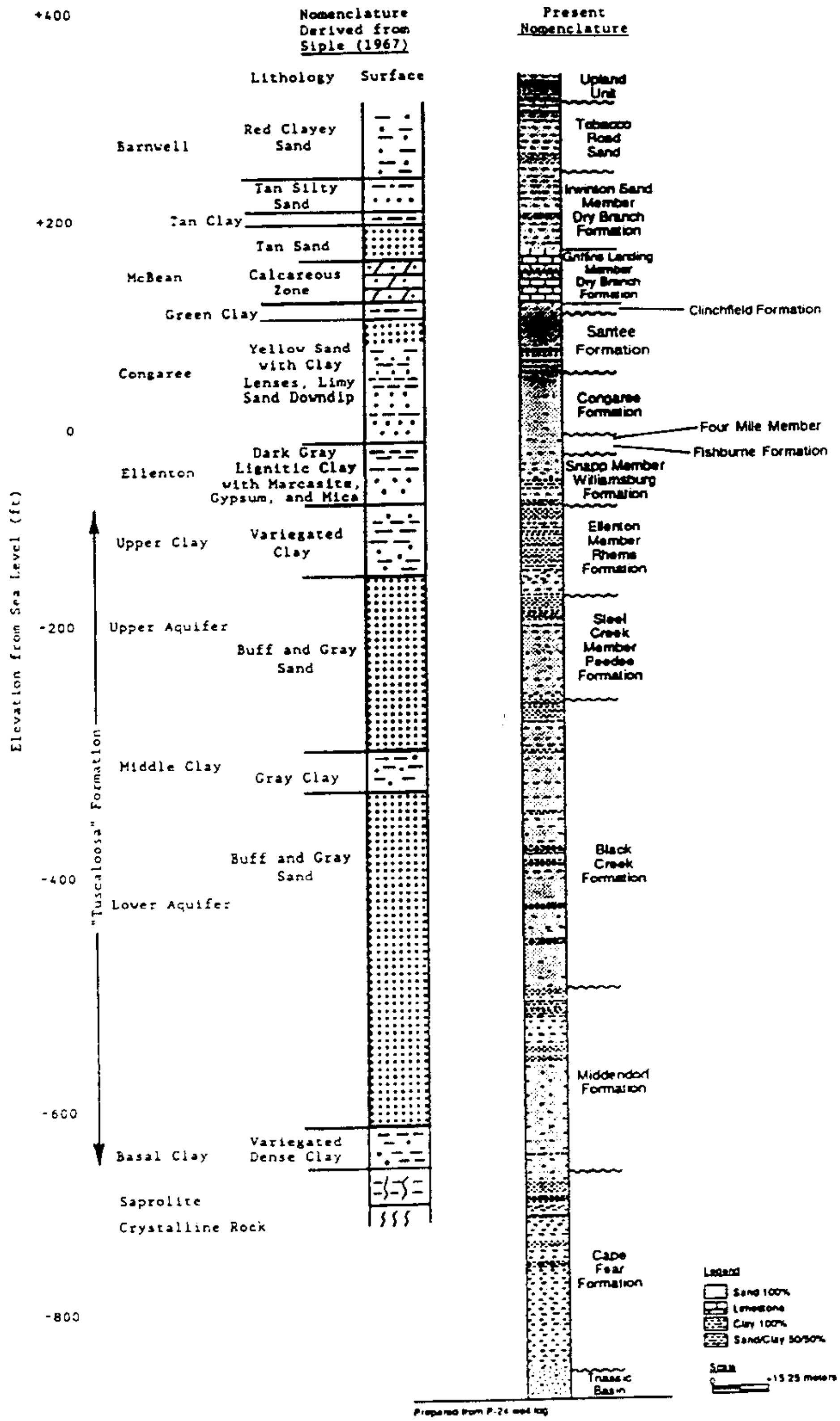


FIGURE 3-4. Tentative Correlation of Stratigraphic Terminology of the Southwestern Coastal Plain

SECTION 4 IDENTIFICATION OF WASTE SITES

At the Savannah River Site (SRS), 175 single waste management units have been identified and grouped into 128 waste sites. The majority of the waste sites are small, single-unit sites that contain wastes of little environmental concern such as concrete, brick, scrap metal, glass, tires, or roofing materials. Several waste sites comprise multiple units; for example, the Chemicals, Metals, and Pesticides (CMP) Pits are seven adjacent waste burial pits, and the seven units are treated in this report as one waste site. Similarly, the four H-Area Seepage Basins are adjacent and receive the same wastewater; consequently, these four single waste management units are reported as one waste site. Some of the waste sites predate the construction of SRS and contain household trash.

The settlement agreement between the Department of Energy (DOE) and the South Carolina Department of Health and Environmental Control (SCDHEC) identifies 12 waste sites that were not included in the *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant* (Christensen and Gordon, 1983) because these sites were not known to exist at that time. These sites are identified in the settlement agreement as follows:

- Gunsite 720 Rubble Pit
- Rubble Pile at Cemetery Road
- Rubble Pile at Brag Bray Road
- Rubble Pile at Boundary Marker 63
- Rubble Pile at Boundary Marker 58
- Rubble Pile at Road 781.1
- Gunsite 113 Rubble Pile
- Rubble Pile between Brag Bray and Cemetery roads
- Open Scrap Pit
- Scrap Metal Pile
- Hazardous Waste Storage Building (Building 709-4G)
- Rubble Disposal Near Building 080-16G

Ten of these sites are addressed in this report. Two of these sites, the rubble pile at boundary marker 63 and the rubble pile at boundary marker 58, are not addressed because they contain household trash that is not related to SRS operations and are located outside the

SRS property boundary. These two sites will no longer be considered SRS waste sites.

Two of the listed waste sites have been assigned building numbers, and two of those sites have been renamed. The Open Scrap Pit is now the Risher Road Metal Pit (Building 631-17G), and the Rubble Disposal Near Building 080-16G is now named the Miscellaneous Rubble Pile. The Scrap Metal Pile has been assigned building number 631-17G.

Fourteen other waste sites have been added to this updated report to provide a complete reference of known SRS waste sites. These sites are as follows:

L New F-Area Retention Basin

L F-Area Tank Farm

L New H-Area Retention Basin

L H-Area Tank Farm

L C-Area Earthen Basin

L K-Area Earthen Basin

L L-Area Earthen Basin

L P-Area Earthen Basin

L R-Area Earthen Basin

L L-Area Rubble Pile

L R-Area Rubble Pile

L SREL Rubble Pile

L Forestry Rubble Pit

L D-F Steamline Erosion Control Site

The F-Area and H-Area tank farms and new retention basins are currently in use. The remaining sites either never received waste or received only inert waste of little or no environmental concern.

Table 4-1 lists the waste sites and building numbers for each unit at each site. Also given on the table are the monitoring well designations for each site where applicable.

TABLE 4-1

Savannah River Site (SRS) Waste Sites

Waste Site	Building Number	Well Series
A/M Area		
Savannah River Laboratory Seepage Basins	904-53G1 904-53G2 904-54G 904-55G	ASB
A-Area Motor Shop Oil Basin	904-101G	AOB
Metals Burning Pit	731-4A	ABP
Miscellaneous Chemical Basin	731-5A	None
A-Area Coal Pile Runoff Containment Basin	788-3A	ACB
A-Area Burning/Rubble Pits	731-A 731-1A	ARP
A-Area Ash Piles	788-A 788-2A	None
Metallurgical Laboratory Basin	904-110G	AMB
M-Area Settling Basin and Lost Lake	904-51G 904-112G	MSB
Silverton Road Waste Site	731-3A	SRW
A-Area Rubble Pile	731-6A	None
A-Area Rubble Pit	731-2A	None
C Area		
C-Area Reactor Seepage Basins	904-66G 904-67G 904-68G	CSB

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
C Area (cont.)		
C-Area Coal Pile Runoff Containment Basin	189-C	CCB
C-Area Ash Piles	188-C 188-1C 188-2C	None
C-Area Burning/Rubble Pit	131-C	CRP
C-Area Asbestos Pits	080-21G 080-22G	None
C-Area Erosion Control Site	131-1C	None
C-Area Earthen Basin	None	None
Central Shops (CS) Area		
Hydrofluoric Acid Spill Area	631-4G	CSA
Ford Building Seepage Basin	904-91G	HXB
Fire Department Training Facility	904-113G	CSO
Hazardous Waste Storage Facility	709-G	HWS
CS-Area Burning/Rubble Pits	631-1G 631-5G 631-6G	CSR
SRL Oil Test Site	080-16G	None
Miscellaneous Rubble Pile	None	None
Ford Building Waste Site	643-11G	None
Sanitary Sewage Sludge Lagoon	080-24G	None
CS-Area Scrap Lumber Pile	631-2G	None

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
Central Shops (CS) Area (cont.)		
CS-Area Rubble Pits	631-3G 631-7G	None
CS Oil Storage Pad	080-15G	None
D Area and TNX		
D-Area Oil Disposal Basin	631-G	DOB
D-Area Coal Pile Runoff Containment Basin	489-D	DCB
D-Area Burning/Rubble Pits	431-D 431-1D	DBP
TNX Burying Ground	643-5T	None
D-Area Ash Basins	488-D 488-1D 488-2D	None
New TNX Seepage Basin	904-102G	YSB
Old TNX Seepage Basin	904-76G	XSB
D-Area Asbestos Pit	080-20G	None
D-Area Rubble Pit	431-2D	None
D-Area Waste Oil Facility	484-D	None
TNX Storage Area	None	None
F Area		
F-Area Seepage Basins	904-41G 904-42G 904-43G	F, FSB
Old F-Area Seepage Basin	904-49G	FNB

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
F Area (cont.)		
F-Area Acid/Caustic Basin	904-74G	FAC
F-Area Coal Pile Runoff Containment Basin	289-F	FCB
F-Area Ash Basins	288-F 288-1F	None
F-Area Burning/Rubble Pits	231-F 231-1F	FBP
F-Area Scrap Lumber Pile	231-3F	None
F-Area Retention Basin (Old)	281-3F	None
F-Area Retention Basin (New)	281-8F	None
F-Area Rubble Pits	231-2F 231-4F	None
F-Area Erosion Control Site	080-28G	None
F-Area Tank Farm	241-F	FTF
H Area		
H-Area Seepage Basins	904-44G 904-45G 904-46G 904-56G	H, HSB
H-Area Retention Basin (Old)	281-3H	HR3
H-Area Retention Basin (New)	281-8H	HR8
H-Area Acid/Caustic Basin	904-75G	None
H-Area Coal Pile Runoff Containment Basin	289-H	HCB
H-Area Ash Basin	288-H	None
H-Area Erosion Control Site	080-25G	None

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
H Area (cont.)		
H-Area Tank Farm	241-H	HTF, 241-H
K Area		
K-Area Reactor Seepage Basin	904-65G	KSB
K-Area Retention Basin	904-88G	KRB
K-Area Acid/Caustic Basin	904-80G	KAC
K-Area Coal Pile Runoff Containment Basin	189-D	KCB
K-Area Burning/Rubble Pit	131-K	KRP
K-Area Bingham Pump Outage Pit	643-1G	None
K-Area Ash Basin	188-K	KAB
K-Area Earthen Basin	None	None
L Area		
L-Area Reactor Seepage Basin	904-64G	LSB
L-Area Acid/Caustic Basin	904-79G	LAC
L-Area Oil and Chemical Basin	904-83G	LCO
L-Area Ash Basin	188-L	None
L-Area Burning/Rubble Pit	131-L	LRP
L-Area Bingham Pump Outage Pits	643-2G 643-3G	None
L-Area Rubble Pits	131-1L 131-3L 131-4L	None
Gas Cylinder Disposal Facility	131-2L	None

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
L Area (cont.)		
L-Area Erosion Control Site	080-26G	None
L-Area Rubble Pile	None	None
L-Area Earthen Basin	None	None
P Area		
P-Area Reactor Seepage Basins	904-61G 904-62G 904-63G	PSB
P-Area Acid/Caustic Basin	904-78G	PAC
P-Area Coal Pile Runoff Containment Basin	189-P	PCB
P-Area Ash Basin	188-P	None
P-Area Bingham Pump Outage Pit	643-4G	None
P-Area Burning/Rubble Pit	131-P	PRP
P-Area Erosion Control Site	131-1P	None
P-Area Earthen Basin	None	None
R Area		
R-Area Acid/Caustic Basin	904-77G	RAC
R-Area Burning/Rubble Pits	131-R 131-1R	RRP
R-Area Bingham Pump Outage Pits	643-8G 643-9G 643-10G	None
R-Area Ash Basin	188-R	None
R-Area Asbestos Pit	080-1R	None

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
R Area (cont.)		
R-Area Reactor Seepage Basins	904-57G 904-58G 904-59G 904-60G 904-103G 904-104G	RSA RSB RSC RSD RSE
R-Area Rubble Pit	131-2R	None
R-Area Earthen Basin	None	None
R-Area Rubble Pile	None	None
Other Waste Sites		
Road A (Baxley Road) Chemical Basin	904-11G	BRD
CMP Pits	080-17G 080-17.1G 080-18G 080-18.1G 080-18.2G 080-18.3G 080-19G	CMP
Gunsite 51 Rubble Pile	080-29G	None
Gunsite 72 Rubble Pile	080-31G	None
Gunsite 102 Rubble Pile	080-30G	None
SREL Rubble Pile	631-10G	None
Cemetery Road Rubble Pile	631-11G	None
Rubble Pile between Cemetery Road and Brag Bray Road	631-12G	None
Rubble Pile at Road 781.1	631-13G	None
Brag Bray Road Rubble Pile	631-14G	None

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
Other Waste Sites (cont.)		
Gunsite 113 Rubble Pile	631-15G	None
Gunsite 720 Rubble Pit	631-16G	None
Risher Road Metal Pit	631-17G	None
Substation 51 Erosion Control Site	080-27G	None
Scrap Metal Pile	631-18G	None
3G Pumphouse Erosion Control Site	631-8G	None
Forestry Rubble Pile	631-9G	None
D-F Steamline Erosion Control Site	None	None
Radioactive Waste Burial Grounds	643-G 643-7G 643-28G	BG, MGA, MGC, MGE, MGG, MGI
Sanitary Landfill	740-G	LFW
40-Acre Hardwood Sewage Sludge Site	761-G	SSS
Lower Kato Road Sewage Sludge Site	761-1G	SSS
Orangeburg Sewage Sludge Site (Sandy Clay)	761-2G	SSS
Sandy (Lucy) Sewage Sludge Site	761-3G	SSS
K-Area Borrow Pit Sewage Sludge Site	761-4G	SSS
Par Pond Borrow Pit Sewage Sludge Site	761-5G	SSS

TABLE 4-1 (cont.)

Waste Site	Building Number	Well Series
Other Waste Sites (cont.)		
Kato Road Sewage Sludge Site	761-6G	SSS
Road F Sewage Sludge Site	761-7G	SSS
Second Par Pond Sewage Sludge Site	761-8G	SSS
Forestry Rubble Pit	761-9G	None

SECTION 5 A/M AREA

5.01 GENERAL INFORMATION

5.01.01 General Area Description

A/M Area is located in the northwest part of SRS as shown in Figure 5-1. Surface elevations across A/M Area range approximately from 350 to 380 ft msl. Surface drainage is toward Tims Branch, located approximately 5,000 ft to the east, and toward valleys to the northwest and southwest that lead to the Savannah River.

There are 17 waste sites in A/M Area as indicated in Figures 5-2 and 5-3.

- L The Savannah River Laboratory (SRL) Seepage Basins (4 basins)
- L The A-Area Motor Shop Oil Basin
- L The A-Area Metals Burning Pit
- L The A-Area Miscellaneous Chemical Basin
- L The A-Area Coal Pile Runoff Containment Basin
- L The A-Area Burning/Rubble Pits (2 pits)
- L The A-Area Ash Piles (2 piles)
- L The A-Area Metallurgical Laboratory Seepage Basin
- L The M-Area Settling Basin
- L The Silverton Road Waste Site
- L The A-Area Rubble Pit (see Section 15)
- L The A-Area Rubble Pile (see Section 15)

5.01.02 General Hydrologic Conditions

By the end of 1986, 83 A/M-Area waste-site monitoring wells had been installed to monitor groundwater quality at the sites. Sixty-one of the 83 wells are currently being monitored. The remaining 22 wells are either inactive or abandoned, as discussed in the following specific waste-site sections. Based on the surface geologic map presented by Siple (1967), these monitoring wells were installed in the sediments of the Hawthorne/Barnwell formations. Section 3 contains detailed information concerning the hydrostratigraphy beneath SRS.

The water-table elevation in A/M Area has ranged from 280 to 220 ft msl, and the vadose zone has been approximately 95 to 145 ft thick. As shown in Figure 5-4, A/M Area is on a water-table mound, and near-surface groundwater flows radially from the site.

Because of the lithologic similarity of the A/M-Area geologic sediments, especially the near-surface formations, the Hawthorn, Barnwell, and McBean formations cannot easily be differentiated and are generally grouped as one (Huber et al., 1987b). These interbedded sands, silts, clays, and gravels are of Tertiary age. Extensive hydraulic testing of the Tertiary sediments has been conducted in A/M Area. Using the results of these tests and assuming an effective porosity of the sediments of 0.20, a horizontal near-surface groundwater flow velocity of approximately 90 ft/yr per percent gradient has been estimated (Huber et al., 1987b). The horizontal flow direction and estimated flow velocity for the water table at each A/M-Area waste site are discussed in the following specific waste-site sections.

5.01.03 Migration Potential of Dissolved Chemical Constituents from A/M Area

The potential for any dissolved constituents from a waste site to be naturally discharged to nearby surface water through the groundwater system depends on the location of the waste site, the hydraulic gradient, and the flow path between the waste site and the discharge point. Horizontal and vertical groundwater flow velocities depend upon the medium through which the groundwater travels (i.e., sand, silt, or clay). Similarly, the horizontal and vertical movements of dissolved chemical constituents are affected by interactions with the soil/sediment medium (retardation).

The nearest plant boundary to A/M Area is approximately 0.5 mi to the northwest. A/M Area is on a water-table mound, with radial flow to the east toward Tims Branch, to the southwest toward the Savannah River, and to the north and west toward apparent drainage into lower aquifers (Figures 5-4 and 5-5). Monitoring of organic plumes in A/M Area indicates that most of the water-table water migrates downward into lower aquifers.

The primary aquifers below the water table at the site are the Congaree and the Tuscaloosa. The potentiometric map of the Congaree Aquifer (Figure 5-6) shows the horizontal flow direction to the east and south toward Upper Three Runs Creek. The flow direction in the underlying Tuscaloosa Aquifer (Figure 5-7) is to the south toward the Savannah River.

In June 1981, groundwater monitoring data indicated that chlorinated hydrocarbon contamination existed beneath the M-Area Settling

Basin. In addition to the waste-site monitoring wells, a network of plume assessment wells was established to identify the extent, concentration, distribution, and migration rate of the chlorinated hydrocarbon plume. This network includes some of the MSB series wells (MSB 9A and on), some of the ASB series wells (ASB 7 and on), and the AC well clusters.

Analytical results from these plume assessment wells demonstrate that degreaser solvents (trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane) are present in the groundwater under A/M Area. Based on these data and past waste disposal practices, the following sites have been identified as the primary sources of contamination: the M-Area Settling Basin, the process sewer line to this basin, National Pollutant Discharge Elimination System (NPDES) outfalls A-5 and A-14, the solvent storage tanks, and some of the Savannah River Laboratory (SRL) research facilities (Pickett et al., 1987a).

A groundwater remediation program was established in February 1983 using a 20-gpm air stripper and one recovery well. The program has been expanded and now uses a 400-gpm air stripper and 11 recovery wells (RWM Series). An estimated 100,000 lb of degreaser solvents had been removed from the groundwater through the end of 1986 (see the *1986 Groundwater Quality Assessment Annual Report*).

More information on the chlorinated hydrocarbon plume and groundwater remediation program is contained in the *1986 Groundwater Quality Assessment Annual Report*, the *Closure Plan for the M-Area Settling Basin and Facility at the Savannah River Plant* (Colven et al., 1985) submitted to the South Carolina Department of Health and Environmental Control (SCDHEC), and the *M-Area Settling Basin and Vicinity* Environmental Information Document (Pickett et al., 1987a).

5.02 SAVANNAH RIVER LABORATORY (SRL) SEEPAGE BASINS

5.02.01 Summary

The Savannah River Laboratory (SRL) Seepage Basins are in the northwest section of SRS, east of Road 1-A and across from the A-Area fence line. The basins were used for the disposal of low-level radioactive wastewater from the laboratories in Buildings 735-A and 773-A. The four basins are currently open and inactive.

Basins 1 (Building 904-53G1) and 2 (Building 904-53G2) were placed in operation in 1954. Basins 3 (Building 904-54G) and 4 (Building 904-55G) were added in 1958 and 1960, respectively, to provide additional capacity. Wastewater flowed sequentially from Basin 1 to Basin 4 in cascade via overflow channels. Basin 4 has no overflow or outlet. When the basins were in operation, only wastewater with radioactivity less than 100 d/m/mL alpha and/or 50 d/m/mL beta-gamma was discharged to the basins. An exception to this practice was made in 1971 when 0.68 Ci of curium from a leaking separator pit in Building 776-A was disposed to the basins (Waters, 1972). Approximately 34 million gal of wastewater were discharged to the basins over their operating life (Fowler et al., 1987). The basins were taken out of service in 1982.

An extensive program to characterize the basins was conducted in 1983. Analytical results indicate elevated levels of mercury, manganese, iron, and radioactivity in the basin water. Soil core analyses indicate elevated concentrations of metals and radioactivity in the top 3 in. of the core. At depths of 1 to 2 ft, concentrations were consistent with background levels except for tritium and arsenic. The top increment or maximum total concentration in each soil core did not exceed Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24) (Bransford et al., 1984).

Comparisons of monitoring results among the site wells indicate that the SRL Seepage Basins have had no apparent effect on local groundwater quality except for a slight increase in radioactivity in sidegradient well ASB 3A. Although well ASB 3A is sidegradient relative to the basins, its proximity to Basin 4 (less than 35 ft) indicates that seepage from the basins may have influenced groundwater quality near this well. Average radioactivity reported for sidegradient well ASB 1A and downgradient wells ASB 4 through ASB 6A was less than that reported for upgradient well ASB 2A. Manganese excursions were reported for wells ASB 1A and 2A, and isolated excursions of gross alpha and total radium activity were reported for well ASB 2A. Groundwater samples from downgradient wells ASB 4 through 6A met drinking water standards except for iron and total dissolved solids (TDS) in well ASB 4, trichloroethylene in well ASB 5A, and an excursion of total radium in well ASB 4 and in well ASB 6A.

5.02.02 Waste-Site Description and Nature of Disposal

The four Savannah River Laboratory (SRL) Seepage Basins are just outside the A-Area fence line and east of Road 1-A, about 4,000 ft southeast of the nearest plant boundary. The construction of Basins 1 (Building 904-53G1), 2 (Building 904-53G2), and 3 (Building 904-54G) primarily involved excavating the natural soils below grade to form the surrounding dikes. Basin 4 (Building 904-55G) required substantial filling at the northeast end, adjacent to a tributary of Tims Branch, to build both the basin floor and the containment dike. The SRL Seepage Basins are surrounded by a 6.5-ft-high fence (Figure 5-8).

The first two basins were constructed and placed into operation in 1954. Basin 1 is 130 ft by 62 ft by 6.5 ft deep and has a volume capacity of 400,000 gal. Basin 2 is 130 ft by 130 ft by 6.5 ft deep, with a volume capacity of 845,000 gal. Basins 3 and 4 were added in 1958 and 1960, respectively. Basin 3 is 175 ft by 125 ft by 8.9 ft deep and has a volume capacity of 1.437 million gal. Basin 4 is 308 ft by 150 ft by 11 ft deep, with a volume capacity of 3.88 million gal.

The basins are connected sequentially in cascade via overflow channels. The final basin, however, has no overflow. Any fluid losses from the basins were predominantly from seepage through their earthen floors. Wastewater seldom entered Basin 4 because the first three basins had sufficient volumes and seepage rates to accommodate the incoming wastewater volumes (Fowler et al., 1987).

SRL used the seepage basins to dispose of low-level radioactive wastewater generated in the laboratories in Buildings 735-A and 773-A. Wastewater originating from laboratory sinks and fume hood sinks was collected from building drains in one of four 5,800-gal underground holding tanks. When a tank was full, wastewater was diverted to the next tank, and the filled tank was taken offline for waste analysis. Wastewater containing less than 100 d/m/mL alpha and/or 50 d/m/mL beta-gamma was discharged to Basin 1. If the wastewater exceeded these activity limits, the tank contents were transferred to a tanker and shipped to the F-Area Separations Facility for treatment (Fowler et al., 1987).

An exception to this practice was made in late 1971, when wastewater containing curium leaked from a separator pit in Building 773-A. Some of this wastewater flowed through a trench to Building 776-A. Most of the contaminated trench water was recovered and disposed to the high-level waste system, but approximately 0.68 Ci of curium was released to the SRL Seepage Basins (Waters, 1972).

During their 28-yr loading history, approximately 34 million gal of wastewater were discharged to the basins (Table 5-1). An additional 1 million gal were shipped to F Area for treatment. Wastewater pH has been checked periodically since 1954; however, monitoring records date back only to 1978. Wastewater pH was raised to 3.0 starting in March 1980. The average radioactivity of the wastewater discharged to the basins was approximately 50 d/m/mL for both alpha and beta-gamma. A summary of the historical discharges of radionuclides to the SRL Seepage Basins is presented in Table 5-2. The estimated average annual and 28-yr total chemical loadings to the basins are given in Table 5-3. These estimates are based on the discharge volume of wastewater to the basins from the laboratory waste tanks and the concentrations of chemicals in the wastewater as analyzed in October and November 1982 and reported in Table 5-4. Extraction Procedure (EP) toxicity tests performed on wastewater collected and analyzed in 1979 show that metals concentrations were below Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24) (Fowler et al., 1987).

Organic contaminants in the wastewater consisted of low levels of water-soluble chemicals, such as alcohols and acetone, used in the laboratories. No significant quantities of chlorinated organic solvents were reported to have been disposed to the basins; the standard laboratory practice was to place spent chlorinated solvents in 1-gal containers for disposal (Fowler et al., 1987).

The four basins were taken out of service in October 1982 and are currently open and inactive.

5.02.03 Groundwater Monitoring Program

Eleven wells (ASB Series) have been installed at the SRL Seepage Basins to monitor the water-table elevation and groundwater quality. Wells ASB 1 through ASB 6 (except for ASB 4) were installed in the first quarter of 1981 using galvanized steel casings and 20-ft screens. Well ASB 3A, which replaced well ASB 3, and well ASB 4 were constructed in the fourth quarter of 1981 using PVC casings and 30-ft screens. Because of possible water-quality interferences from the galvanized steel, the remaining galvanized wells were replaced by wells constructed with PVC casings and 30-ft screens in the first quarter of 1984. Six active water-table wells currently monitor the SRL Seepage Basins (Figure 5-8).

The SRL Seepage Basins wells were included in the SRS quarterly groundwater monitoring program in 1982. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. Wells ASB 1A through 6A and additional ASB series wells have also been sampled under the volatile organics plume definition program.

5.02.04 Site-Specific Hydrology

Measurements obtained from the SRL Seepage Basins wells from May 1982 through 1984 indicate that the water-table elevation was 244 to 241 ft msl and that the vadose zone was approximately 105 ft thick. As shown in the hydrograph for the seepage basins wells (Figure 5-9), the water-table elevations for the fourth quarter of 1986 ranged from 241 to 239 ft msl; the vadose zone was approximately 95 to 109 ft thick.

A water-table elevation contour map for the fourth quarter of 1985 (Figure 5-8) indicates that the water-table flow diverges beneath the basins. The horizontal, near-surface groundwater flow direction ranged from west to north, with an approximate gradient of 0.007 ft/ft. The water-level data (Figure 5-9) indicate that this has been the general flow direction and gradient since 1985, although minor changes in both have occurred. With respect to the basins, well ASB 2A generally has been upgradient, wells ASB 1A and ASB 3A sidegradient, and wells ASB 4 through ASB 6A downgradient.

5.02.05 Waste-Site Content Characterization Data

Basins 1 through 3 are currently one-quarter full of standing water, and Basin 4 is dry. Table 5-5 summarizes results from analyses performed on water from the basins. The sampling date for the basin water was not reported but is assumed to have been after the basins were taken out of service in October 1982 (Fowler et al., 1987). Metals concentrations were low except for mercury in Basin 1 (0.0031 mg/L), manganese in Basins 1 through 3 (0.063 to 0.185 mg/L), and iron in Basins 2 and 3 (0.345 to 0.462 mg/L). Elevated activities of gross alpha, nonvolatile beta, and total radium were observed, with recorded maximum values of 93, 379, and 19 pCi/L, respectively. The water pH ranged from 5.5 to 5.6.

Annual average gross alpha, nonvolatile beta, and tritium activities in water from Basin 1 from 1961 through 1986 are presented in Table 5-6. Disregarding the gross alpha and nonvolatile beta activities for 1983 and 1984, which are believed to be reported in pCi/L rather than pCi/mL, radioactivity in the basin water peaked in the early 1970s and generally has been declining since.

5.02.06 Soil/Sediment Characterization Data

A comprehensive soil sampling program was implemented in early 1983 (Bransford et al., 1984). Five soil cores were collected from each basin: one central sampling location and four corner locations (Figure 5-10). Cores were obtained to depths of 20 ft. Samples were analyzed for radionuclides, cations, anions, Extraction Procedure (EP) toxicity tests (metals only), and organic compounds. The results from the soil analysis program are summarized in Table 5-7.

The analytical results indicate that the levels of several metals and radionuclides were above background in the top 3 in. of the cores. Concentrations decreased to background levels of less than 100 μg/g within the top 1 to 2 ft except for arsenic and tritium. Concentrations of analytes at depths of 2 to 20 ft are consistent with background levels. EP toxicity tests performed on the soil cores demonstrate that the top increment or maximum total metals concentrations in each core did not exceed Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24). Radioactive constituents, except for tritium, also are concentrated in the top 2 ft of the basin sediments (Fowler et al., 1987).

5.02.07 Groundwater Monitoring Results

The groundwater monitoring data from 1982 through 1986 for the SRL Seepage Basins wells are given in Appendix C. Groundwater characterization data since July 1984 are summarized in Table 5-8.

As discussed in Section 5.02.04 and shown in Figure 5-8, the general groundwater flow direction is divergent beneath the SRL Seepage Basins, ranging from west to north. Relative to the basins, well ASB 2A generally has been upgradient, wells ASB 1A and ASB 3A sidegradient, and wells ASB 4 through ASB 6A downgradient.

Comparisons of the monitoring results among the site wells were used to evaluate the effect of the SRL Seepage Basins on groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Based on the materials disposed at this site (Section 5.02.02), the indicator parameters most likely to show the effect from the basins are conductivity and radioactivity.

The monitoring data summarized in Table 5-8 indicate that the SRL Seepage Basins have had no apparent effect on local groundwater quality except for an influence on sidegradient well ASB 3A, which is adjacent to the basins. Average radionuclide activities in sidegradient well ASB 1A and downgradient wells ASB 4 through ASB 6A were less than those in upgradient well ASB 2A. Average conductivity levels in all six site wells (41.8 to 69.0 μmhos/cm) were consistently low.

Groundwater samples from sidegradient well ASB 1A and upgradient well ASB 2A have been below drinking water standards for dissolved chemical and radioactive constituents except for manganese in both wells and an isolated excursion each of gross alpha and total radium in upgradient well ASB 2A. Manganese levels in sidegradient well ASB 1A (0.020 to 0.120 mg/L) and upgradient well ASB 2A (0.046 to 0.074 mg/L) ranged above the drinking water standard of 0.05 mg/L. Gross alpha (4.0 to 20.0 pCi/L) and total radium (4.0 to 6.0 pCi/L) activities in upgradient well ASB 2A exceeded their respective drinking water standards of 15 pCi/L and 5 pCi/L in an isolated excursion of each parameter. Radionuclide activities in sidegradient well ASB 1A remained below drinking water standards over the monitoring period.

Groundwater quality in sidegradient well ASB 3A has apparently been influenced by radioactivity from the SRL Seepage Basins. Figures 5-11 and 5-12 are graphic comparisons of average gross alpha, nonvolatile beta, and total radium activities among the site wells. Groundwater samples from sidegradient well ASB 3A met drinking water standards except for gross alpha and total radium. Gross alpha activity in sidegradient well ASB 3A (<2.0 to 22.9 pCi/L) exceeded the drinking water standard of 15 pCi/L in three excursions. Total radium activity in sidegradient well ASB 3A (<1.0 to 11.0 pCi/L) exceeded the drinking water standard of 5 pCi/L in two excursions. The proximity of well ASB 3A to Basin 4 (less than 35 ft), in addition to the elevated radioactivity levels reported for this well, indicate that the basins have influenced groundwater quality near well ASB 3A.

Groundwater samples from downgradient wells ASB 4 through ASB 6A met drinking water standards except for iron and total dissolved solids (TDS) in well ASB 4, trichloroethylene in well ASB 5A, and an excursion of total radium in well ASB 4 and in well ASB 6A. Iron levels in downgradient well ASB 4 (0.366 to 1.690 mg/L) consistently exceeded the drinking water standard of 0.3 mg/L; iron concentrations as high as 0.52 mg/L are generally consistent with iron concentrations reported as naturally occurring in Barnwell Formation groundwater (Appendix B). A single excursion of TDS (3,542 mg/L) was reported for well ASB 4. Trichloroethylene in well ASB 5A was detected at a concentration of 0.185 mg/L, exceeding the drinking water standard of 0.005 mg/L. Total radium activity in downgradient wells ASB 4 (3.8 to 6.0 pCi/L) and ASB 6A (<1.0 to 7.0 pCi/L) exceeded the drinking water standard of 5 pCi/L in an isolated excursion for each well. As shown in Figure 5-12, average total radium activity in the downgradient wells was less than the average total radium activity in the upgradient well.

Groundwater pH in the site wells ranged from 3.9 to 5.5; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

5.02.08 Planned Action

The SRL Seepage Basins are inactive. As indicated in Section 16, a site assessment has been completed, and a closure plan is scheduled for development in 1988. Groundwater monitoring will continue at the site.

5.03 A-AREA MOTOR SHOP OIL BASIN

5.03.01 Summary

The A-Area Motor Shop Oil Basin (Building 904-101G) was placed in service in 1977. The basin received liquid waste from the 716-A Motor Shop, including oils, grease, kerosene, ethylene glycol, and soapy water. These liquids were discharged through an oil skimmer before being released to the basin. The basin was deactivated in August 1983. The site is currently inactive and open (Huber et al., 1987b).

The configuration of the water table beneath the basin cannot be accurately defined because there are only two site monitoring wells, and the water-table elevations in these wells have been nearly identical. Monitoring results from wells AOB 1 and AOB 2 were compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards to assess local groundwater quality. Groundwater samples from these wells met the drinking water standards except for trichloroethylene and a single excursion of chromium in well AOB 1.

5.03.02 Waste-Site Description and Nature of Disposal

The Motor Shop Oil Basin (Building 904-101G) is southeast of the railroad tracks adjacent to Building 715-A (Figure 5-13). The basin is approximately 205 ft long by 35 ft wide by 6 ft deep, resulting in a storage volume of about 43,000 ft^3 (322,000 gal). Ground surface elevation in the vicinity of the basin is about 345 ft msl (Figure 5-13). The ground surface slopes to the east toward Tims Branch, approximately 0.75 mi from the site.

The Motor Shop Oil Basin was placed in operation in 1977 and received wastewater from the 716-A Motor Shop heavy equipment and motor washing facilities via an underground drain line. The wastewater comprised engine oil, grease, kerosene, ethylene glycol, and soapy water. Effluent from the 716-A Motor Shop was discharged through an oil skimmer before being released to the basin. The Motor Shop Oil Basin was deactivated in August 1983 when discharges to the basin were terminated and the drain line was capped (Huber et al., 1987b).

The basin is currently inactive but continues to collect rainwater. Less than 100 gal of liquid remain in the Motor Shop Oil Basin.

5.03.03 Groundwater Monitoring Program

Two wells (AOB 1 and AOB 2) were installed to monitor the water-table elevation and groundwater quality at the Motor Shop Oil Basin (Figure 5-13). Wells AOB 1 and AOB 2 were installed in May 1983 using PVC casings and 30-ft screens.

The AOB wells were included in the SRS quarterly groundwater monitoring program in the first quarter of 1984. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The AOB wells also have been monitored under the volatile organics plume definition program.

5.03.04 Site-Specific Hydrology

Measurements obtained from the Motor Shop Oil Basin wells since February 1984 indicate that the water-table elevation has steadily declined since the fourth quarter of 1984. A hydrograph for the Motor Shop Oil Basin wells (Figure 5-14) shows that the water table for the fourth quarter of 1986 was at an elevation of approximately 240 ft msl and that the vadose zone was approximately 105 ft thick.

A water-table elevation contour map cannot be drawn because only two wells monitor the site. In addition, these two wells have had nearly identical water-level elevations. Based on the general 1986 water-table map for A/M-Area (Figure 5-4), the basin is near a groundwater divide.

5.03.05 Waste-Site Content Characterization Data

A liquid sample taken from the Motor Shop Oil Basin was analyzed for acid-base/neutral organics, volatile organics, Extraction Procedure (EP) toxicity parameters, metals, oil and grease, kerosene, ethylene glycol, pH, conductivity, and flashpoint. Analytical results are summarized in Table 5-9, which indicates that metal concentrations were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24). Trace quantities of ethylene glycol, kerosene, and oil were found. Most of the acid-base/neutral organics were at or below analytical detection limits (Huber et al., 1987b).

5.03.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the Motor Shop Oil Basin.

5.03.07 Groundwater Monitoring Results

The groundwater monitoring data from 1984 through 1986 for the Motor Shop Oil Basin are included in Appendix C. Groundwater characterization data since July 1984 are summarized in Table 5-10.

Because of the uncertainty of the hydraulic positioning of wells AOB 1 and AOB 2 with respect to the basin (Section 5.03.04), groundwater monitoring results were compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards to assess groundwater quality at the site.

Groundwater samples from wells AOB 1 and AOB 2 met drinking water standards for dissolved chemical constituents and radioactivity with the exception of chromium and trichloroethylene in well AOB 1. Chromium levels in well AOB 1 (<0.004 to 0.055 mg/L) exceeded the drinking water standard of 0.05 mg/L in a single excursion. Trichloroethylene levels in well AOB 1 (0.006 to 0.046 mg/L) consistently exceeded the drinking water standard of 0.005 mg/L. Well AOB 1 is near the A-14 outfall, a known source of volatile organics.

Conductivity levels ranged from 29 to 51 μmhos/cm in well AOB 1 and from 22 to 42 μmhos/cm in well AOB 2. Total organic carbon (TOC) levels in wells AOB 1 and AOB 2 remained below 9.25 mg/L except for a value of 16.6 mg/L reported for well AOB 1. Total organic halogen (TOH) concentrations ranged from 0.072 to 0.260 mg/L in well AOB 1 and from <0.005

to 0.027 mg/L in well AOB 2. Groundwater pH ranged from 4.0 to 5.2 in the site wells. This range is consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

5.03.08 Planned Action

The A-Area Motor Shop Oil Basin is inactive. As indicated in Section 16, a site assessment is scheduled for 1988, from which a closure plan will be developed. Groundwater monitoring will continue at this site.

5.04 A-AREA METALS BURNING PIT

5.04.01 Summary

The A-Area Metals Burning Pit (Building 731-4A) received lithium-aluminum alloy and other reactive metals beginning in 1952. The metals were burned periodically until 1974, when the pit was backfilled and graded. The site currently is inactive and covered with vegetation (Pickett et al., 1987c).

The groundwater monitoring data indicate that there has been little apparent influence on groundwater quality from the Metals Burning Pit. Groundwater samples from all four site wells consistently met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards for dissolved chemical constituents and radioactivity except for trichloroethylene in wells ABP 2A, ABP 3, and ABP 4 and an isolated excursion of iron in well ABP 1A.

5.04.02 Waste-Site Description and Nature of Disposal

The Metals Burning Pit (Building 731-4A) covers 1.1 acres approximately 1.25 mi northwest of the intersection of SRS Roads D and 2 and less than 50 ft to the west of SRS Road C-1 (Figure 5-15). The pit is approximately 2 mi southeast of the nearest plant boundary. The ground surface elevation at the site ranges approximately from 350 to 375 ft msl, and surface drainage is to the east toward a tributary of Tims Branch.

Beginning in 1952, the Metals Burning Pit received lithium-aluminum alloy and other reactive metals generated by M-Area operations. Photographs taken in 1973 and 1974 show waste material piled about 5 ft high. The reactive metals were burned periodically in the pit until 1974, when the pit was backfilled and graded (Pickett et al., 1987c). The site is currently inactive and covered with vegetation.

5.04.03 Groundwater Monitoring Program

Six wells (ABP Series) have been installed to monitor the water-table elevation and groundwater quality at the Metals Burning Pit. Monitoring wells ABP 1 through ABP 3 were installed in August 1983, and well ABP 4 was added to the network in June 1984. Monitoring wells ABP 1 and ABP 2 were abandoned during the third and second quarters of 1984, respectively. These wells were replaced in August 1984 by wells ABP 1A and ABP 2A. All of the site wells were constructed using PVC casings and 30-ft screens. The currently monitored wells are shown in Figure 5-15.

Monitoring well ABP 3 was included in the SRS quarterly groundwater monitoring program during the first quarter of 1984. Wells ABP 1A, ABP 2A, and ABP 4 were incorporated into this program in the first quarter of 1985. Plantwide, samples collected for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The ABP wells have also been monitored under the volatile organics plume definition program.

5.04.04 Site-Specific Hydrology

Measurements obtained from the Metals Burning Pit wells since the second quarter of 1984 indicate that the water-table elevation has been approximately 229 to 222 ft msl and that the vadose zone has been approximately 130 to 145 ft thick. A hydrograph for the Metals Burning Pit wells (Figure 5-16) shows that the water-table elevation for the fourth quarter of 1986 ranged approximately from 225 to 222 ft msl. The hydrograph indicates that the water-table elevation has been declining since May 1985.

A water-table elevation contour map for the second quarter of 1985 is shown in Figure 5-15. Wells ABP 1A, 2A, and 4 are screened below the water-table, which possibly results in artificially low water-table elevation measurements in these wells. The available information indicates that the groundwater flow direction is to the southwest, with an approximate gradient of 0.01 ft/ft. The hydrograph indicates that this has been the predominant flow direction and gradient, although minor fluctuations have occurred. In general, well ABP 3 has been upgradient, well ABP 4 downgradient, and wells ABP 1A and ABP 2A sidegradient relative to the pit. Using a horizontal groundwater flow velocity estimated for the Tertiary sediments of approximately 90 ft/yr per percent gradient (Section 5.01.02), the resulting groundwater flow velocity beneath the basin has been approximately 90 ft/yr.

5.04.05 Waste-Site Content Characterization Data

The contents of the Metals Burning Pit have not been sampled. Section 5.04.02 contains information concerning the nature of the materials disposed at the site.

5.04.06 Soil/Sediment Characterization Data

Soil/sediments at the Metals Burning Pit have not been sampled.

5.04.07 Groundwater Monitoring Results

Groundwater monitoring data from 1984 through 1986 are presented in Appendix C. Groundwater chemical characterization data since July 1984 are summarized in Table 5-11.

As shown in Figure 5-15, well ABP 4 has been downgradient, well ABP 3 upgradient, and wells ABP 1A and ABP 2A sidegradient relative to the pit. Comparisons of the monitoring results between upgradient well ABP 3 and the remaining site wells were used to assess the effect of the site on local groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Based on the nature of the materials disposed at the site (Section 5.04.02), indicator parameters for the site are metals, conductivity, and pH.

The groundwater data summarized in Table 5-11 indicate that groundwater quality in all four site wells has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for trichloroethylene in wells ABP 2A, ABP 3, and ABP 4 and a single excursion of iron in well ABP 1A. Trichloroethylene concentrations in sidegradient well ABP 2A (0.019 to 0.030 mg/L), upgradient well ABP 3 (0.045 to 0.071 mg/L), and downgradient well ABP 4 (0.004 to 0.006 mg/L) generally were above the drinking water standard of 0.005 mg/L. Because trichloroethylene is present in the upgradient and sidegradient wells, the observed levels in the groundwater may be attributable to a source other than the Metals Burning Pit. Iron concentrations in sidegradient well ABP 1A (0.030 to 0.892 mg/L) exceeded the drinking water standard of 0.3 mg/L in March 1985. Iron concentrations as high as 0.52 mg/L are generally consistent with iron levels reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

Groundwater pH ranged from 3.8 to 5.6 in the site wells; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B). Conductivity levels in the site wells (12 to 39 μmhos/cm) were comparable to background levels (Appendix B).

A comparison of the monitoring results from downgradient well ABP 4 with those from upgradient well ABP 3 shows no apparent increase in indicator parameter levels. Conductivity ranges were similar between well ABP 4 (18 to 30 µmhos/cm) and well ABP 3 (12 to 39 µmhos/cm). The concentrations of metals showed no apparent increase in downgradient well ABP 4 compared to those in upgradient well ABP 3. Additionally, the pH range in downgradient well ABP 4 (3.8 to 5.1) was similar to that of upgradient well ABP 3 (4.3 to 5.2). These similarities indicate that the Metals Burning Pit has had little apparent influence on local groundwater quality.

5.04.08 Planned Action

The Metals Burning Pit is inactive. As indicated in Section 16, a site assessment is currently being conducted and is scheduled for completion in 1989, from which a closure plan will be developed. Groundwater monitoring will continue at this site.

5.05 MISCELLANEOUS CHEMICAL BASIN

5.05.01 Summary

The Miscellaneous Chemical Basin (Building 731-5A) is east of SRS Road C-1 across from the Metals Burning Pit. The basin received wastes from approximately 1956 until 1974. The history and nature of disposal at the site are uncertain. It is assumed that the site was used to dispose of waste solvents and possibly waste oil (Pickett et al., 1987c). Soil/sediment samples taken in January 1986 show elevated levels of halogenated organics indicative of solvents used in M-Area metal-finishing operations. Groundwater monitoring wells are scheduled for installation at this site in 1987.

5.05.02 Waste-Site Description and Nature of Disposal

The Miscellaneous Chemical Basin (Building 731-5A) is within the confines of an old borrow pit at an elevation of approximately 340 ft msl, east of SRS Road C-1 and the Metals Burning Pit (Figure 5-3) and approximately 450 ft west of SRS Road D. The ground surface slopes southeast toward Tims Branch, located approximately 1 mi from the site. The nearest plant boundary is approximately 2 mi to the northwest.

The origin of the Miscellaneous Chemical Basin is uncertain (Pickett et al., 1987c), but the basin presumably was used to dispose of waste solvents and perhaps used oil. Aerial photographs indicate that the site was used as early as 1956. The site was deactivated in 1974. A 1974 ground-level photograph of the site shows a small, discolored, sandy area inside a shallow berm, possibly caused by the disposal of waste oil. Partially filled drums may have been emptied at this site and the empty drums discarded at the nearby Metals Burning Pit (Pickett et al., 1987c). The area has been regraded and is covered with low-growing weeds and grass.

5.05.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the Miscellaneous Chemical Basin. Groundwater monitoring wells are scheduled for installation in 1987.

5.05.04 Site-Specific Hydrology

Groundwater monitoring wells have not been installed at the Miscellaneous Chemical Basin; therefore, groundwater conditions beneath the site are undefined. Measurements obtained from the nearby Metals Burning Pit wells indicate that the near-surface horizontal groundwater flow direction is to the southwest (Section 5.04.04).

5.05.05 Waste-Site Content Characterization Data

An inventory of the materials disposed in this basin was not maintained. Section 5.05.02 presents information on the nature of materials believed to have been disposed at the site.

5.05.06 Soil/Sediment Characterization Data

An analysis of the surface soils at the Miscellaneous Chemical Basin was conducted in January 1986. Cylinders of soil (6 in. long by 1 in. in diameter) were collected on a grid encompassing the basin, starting at a depth of 16 in. below ground surface. The location of the basin, now covered by regraded soil, was defined using the 1974 photographs and comparing the current site to the undisturbed terrain in the background of the photographs. The soil samples were degassed, and the gas was tested for volatile chlorinated hydrocarbons. The following compounds exceeded soil background levels: trichloromethane, ranging from 0.03 to 2.1 ng/g; tetrachloroethylene, ranging from 0.01 to 296 ng/g; trichloroethylene, ranging from 0.01 to 35 ng/g; and trans-1,2-dichloroethylene, ranging from 2 to 48 ng/g.

The results of the tetrachloroethylene analyses are shown in Figure 5-17. These results indicate that some of the degreasing solvents used in the M-Area metal finishing operations were probably discarded at this site (Pickett et al., 1987c).

5.05.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the Miscellaneous Chemical Basin.

5.05.08 Planned Action

The Miscellaneous Chemical Basin is inactive. As indicated in Section 16, a site assessment, from which a closure plan will be developed, is currently being conducted and is scheduled for completion in 1989. Groundwater monitoring wells are scheduled for installation at this site in 1987.

5.06 A-AREA COAL PILE RUNOFF CONTAINMENT BASIN

5.06.01 Summary

The A-Area Coal Pile Runoff Containment Basin (CPRB; Building 788-3A) receives runoff from the A-Area coal storage pile (Christensen and Gordon, 1983). The basin influent data and a comparison of groundwater monitoring data among the downgradient and upgradient wells indicate that the A-Area CPRB has had no apparent influence on local groundwater quality. Groundwater quality in the four site wells has been characterized by low dissolved chemical constituent concentrations compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for a single excursion of radium in well ACB 4A.

5.06.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses. The A-Area coal supply is stored in an open pile. The coal is generally moderate-to-low sulfur coal (1-2%) received via rail from Kentucky, Pennsylvania, and Virginia. Coal is placed on a hopper, sprayed with water to control coal dust, and loaded onto a pile at the A-Area facility (Christensen and Gordon, 1983).

The facility generally contains a 90-day reserve of coal. The coal pile is not rotated, resulting in long-term exposure of the unused coal to the environment. This weathering allows for the formation of sulfuric acid caused by the oxidation of sulfur in the coal. Rainfall washes the acid from the coal pile into the coal pile runoff containment basins via gravity flow ditches and sewers.

Prior to the construction of the coal pile runoff containment basins, runoff from coal storage piles flowed to nearby streams onsite. The National Pollutant Discharge Elimination System (NPDES) permit issued in 1977 specifies limits on pH and suspended solids for the coal pile runoff up to the maximum 24-hr, 10-yr recurrence event (5.9 in. for SRS). Suspended solids are limited to 50 mg/L, and pH is limited to between 6 and 9. To achieve compliance, the A-Area CPRB was constructed in 1981 to contain coal pile runoff and prevent direct discharge to Tims Branch, a tributary of Upper Three Runs Creek. This containment basin allows for the passive equalization of runoff prior to its seepage into the subsurface, where it can undergo natural renovation. There has been minimal discharge from the A-Area CPRB to Tims Branch.

The A-Area CPRB (Building 788-3A) is on an east-trending slope, with elevations across the basin ranging approximately from 345 to 355 ft msl (Figure 5-18). Surface drainage is to the east toward Tims Branch, a tributary to Upper Three Runs Creek. The basin is approximately 525 ft southeast of the A-Area coal pile storage facility and is approximately 1.4 acres in size, with a maximum depth of about 4 ft. The total runoff containment volume is about 190,000 ft^3 (1.4 million gal). The coal pile that drains to this containment basin covers approximately one acre and typically contains 10,000 tons of moderate-to-low sulfur (1-2%) coal.

Coal pile runoff samples were collected on October 2, 1985, to characterize the A-Area CPRB influent and to establish indicator parameters to identify the effects of the A-Area CPRB on groundwater quality. The first individual grab sample was collected 15 to 30 min after the beginning of a storm and the second several hours after the end of the storm. In addition, a composite sample was taken during the entire period between the two individual sampling times.

The A-Area CPRB influent characterization data are presented in Table 5-12. Elevated levels of conductivity, total dissolved solids (TDS), iron, and sulfate and low pH are typical of coal pile runoff and are the indicator parameters used to assess the effect of the basin on groundwater quality. The analytical results in Table 5-12 indicate that the dissolved metals concentrations were low.

5.06.03 Groundwater Monitoring Program

Eight wells (ACB Series) have been installed to monitor the water-table elevation and groundwater quality at the A-Area CPRB. Wells ACB 1 through ACB 4 were installed in 1980 and 1981 using galvanized steel casings and 20-ft screens. Because of possible water-quality interferences from the galvanized steel, a second set of four monitoring wells (ACB 1A through ACB 4A), adjacent to the original wells, was installed in early 1984 (Figure 5-18). These wells were constructed using PVC casings and 30-ft screens. Wells ACB 1 through ACB 4 were subsequently abandoned.

The ACB wells have been part of the SRS quarterly groundwater monitoring program since its inception in 1982. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The ACB wells have also been monitored under the volatile organics plume definition program.

5.06.04 Site-Specific Hydrology

Water-table elevation measurements were obtained from wells ACB 1 through ACB 4 and their replacement wells, ACB 1A through ACB 4A. The screen in well ACB 1 was installed above the water table; therefore, the well was usually dry and inoperative. A hydrograph for the wells is shown in Figure 5-19. As illustrated, well ACB 2 maintained a higher water elevation than wells ACB 3 and ACB 4, indicating that the general water-table flow direction was to the west. The water-table elevation data from the newer wells (since November 1983) suggest a water table with a lower gradient and a more variable horizontal flow direction. The water-table elevation for the fourth quarter of 1986 was approximately 242 ft msl, and the vadose zone was approximately 105 to 115 ft thick.

A water-table elevation contour map for the second quarter of 1985 is presented in Figure 5-18. As shown, the horizontal flow direction was to the northwest, with well ACB 1A downgradient of the basin. The gradient was low (approximately 0.001 ft/ft), resulting in water-table flow direction changes from minor elevation fluctuations. The hydrograph (Figure 5-19) indicates that well ACB 1A generally has been downgradient of the basin and well ACB 4A upgradient to sidegradient of the basin since the second quarter of 1985. Using a horizontal groundwater flow velocity estimated for the Tertiary sediments of 90 ft/yr per percent gradient (Section 5.01.02), the resulting groundwater flow velocity beneath the basin has been approximately 9 ft/yr.

5.06.05 Waste-Site Content Characterization Data

The contents of the A-Area CPRB have not been sampled. Section 5.06.02 contains information on the basin influent characterization data.

5.06.06 Soil/Sediment Characterization Data

The A-Area CPRB soil/sediments have not been sampled.

5.06.07 Groundwater Monitoring Results

The groundwater monitoring results from 1982 through 1986 are included in Appendix C. Samples obtained since the first quarter of 1984 are from the newer, PVC-cased wells. Groundwater chemical characterization data since July 1984 are summarized in Table 5-13.

As discussed in Section 5.06.04, the water table has remained relatively flat, with a general flow direction to the northwest (Figure 5-18) since 1983. As observed in the hydrograph (Figure 5-19), wells ACB 1A and ACB 4A generally have been downgradient and upgradient to sidegradient of the basin, respectively, although apparent low-gradient flow reversals have occurred.

Comparisons of the monitoring results between well ACB 4A and the remaining site wells were used to evaluate the effect on the groundwater from the A-Area CPRB. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters for the site are pH, sulfate, conductivity, iron, and total dissolved solids (TDS).

The groundwater monitoring data summarized in Table 5-13 indicate that the A-Area CPRB has had no apparent influence on local groundwater quality. Groundwater quality in all four site wells has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for a single excursion of radium in well ACB 4A. Relatively low TDS concentration ranges of 10 to 286 mg/L were reported for the site wells compared to the drinking water standard of 500 mg/L. The low conductivity levels reported for all four site wells (22 to 69 μmhos/cm) provide further indication that the A-Area CPRB has had no apparent influence on groundwater quality.

Sulfate levels in groundwater samples from the site wells have been consistently below the secondary drinking water standard of 250 mg/L, with all reported concentrations below 22 mg/L. Iron concentrations (0.016 to 0.158 mg/L) also met the secondary drinking water standard (0.3 mg/L). The levels of organics in the local groundwater have been relatively low, as indicated by the levels of dissolved organic carbon (DOC; below 35 mg/L), total organic carbon (TOC; below 40 mg/L), total organic halogens (TOH; below 0.03 mg/L), phenols (below 0.007 mg/L), GC Scan (below 40 μg/L), and extractable pesticides (all reported levels less than detection limits). Total radium activity was over the drinking water standard of 5 pCi/L in well ACB 4A (6.0 pCi/L) in a single excursion. All other reported radionuclide activities were less than drinking water standards.

Groundwater pH values ranged from 4.0 to 5.7 in the site wells. These pH values are consistent with pH levels reported as naturally occurring in groundwater from the Barnwell Formation (Appendix B).

Concentrations of the site indicator parameters (TDS, conductivity, sulfate, iron, and pH) in the groundwater have not shown any consistent increasing or decreasing trends over the monitoring period.

5.06.08 Planned Action

The A-Area CPRB is active, and continued use is planned. As indicated in Section 16, a site assessment is scheduled for completion in 1989. Groundwater monitoring will continue at the site.

5.07 A-AREA BURNING/RUBBLE PITS

5.07.01 Summary

Burnable wastes such as paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents were received and incinerated in the two A-Area Burning/Rubble Pits (Buildings 731-A and 731-1A) from 1951 to 1973, at which time the pits were covered with a layer of soil. Rubble wastes (including paper, wood, cans, and empty galvanized steel barrels and drums) were then disposed in the pits until they reached capacity and were capped with soil in 1979. The site is currently covered and inactive (Huber et al., 1987c).

A comparison of the groundwater monitoring results among the site wells indicates that the A-Area Burning/Rubble Pits have had no apparent effect on local groundwater quality. Groundwater quality at the A-Area Burning/Rubble Pits has been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for a single excursion each of lead (0.346 mg/L) in well ARP 2 and of total radium (6.0 pCi/L) in well ARP 4. Trichloroethylene levels in downgradient well ARP 1A (0.004 to 0.011 mg/L) and upgradient well ARP 3 (<0.001 to 0.067 mg/L) occasionally exceeded the drinking water standard (0.05 mg/L). Total organic halogen (TOH) levels were below 0.09 mg/L in the site wells.

5.07.02 Waste-Site Description and Nature of Disposal

The A-Area Burning/Rubble Pits (Building 731-A and 731-1A) are on an east-trending slope, with surface drainage toward Tims Branch. The ground surface elevation ranges approximately from 340 to 350 ft msl (Figure 5-20). The pits were rectangular, with approximate dimensions at the time of construction of 179 ft wide by 328 ft long by 10 ft deep (Building 731-A) and 31 ft wide by 572 ft long by 10 ft deep (Building 731-1A). The original combined capacity of the pits was 764,440 ft^3. A-Area Ash Pile 788-2A, which is currently active, is close to backfilled pit 731-A (Ross and Green, 1983) (Section 5.08.02).

The A-Area Burning/Rubble Pits were constructed in 1951 to collect burnable waste generated at the plant. The wastes collected for the A-Area pits for monthly incineration included paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents. Disposal of chemically contaminated oils was not allowed at the A-Area Burning/Rubble Pits (Huber et al., 1987c).

In 1973, the plantwide procedure of burning waste ceased, and the A-Area Burning/Rubble Pits were converted to receive only rubble by placing a layer of soil over the incinerated waste. Rubble waste disposed in the pits included paper, lumber, cans, and empty galvanized steel barrels and drums. Rubble disposal continued until 1978, when the pits reached capacity and were backfilled (Huber et al., 1987c). The A-Area Burning/Rubble Pits are currently inactive.

5.07.03 Groundwater Monitoring Program

Five wells (ARP Series) were installed to monitor the water-table elevation and groundwater quality at the A-Area Burning/Rubble Pits. Wells ARP 1 through ARP 3 were installed in December 1983. Because of problems in the development of well ARP 1, it was replaced by well ARP 1A in the first quarter of 1984. Well ARP 4 was installed in June 1984. All of the ARP series wells were constructed using PVC casings and 30-ft screens. Currently monitored wells are shown in Figure 5-20.

Wells ARP 1A through ARP 4 were included in the SRS quarterly groundwater monitoring program in the second quarter of 1984. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The ARP wells have also been monitored as part of the volatile organics plume definition program.

5.07.04 Site-Specific Hydrology

Measurements obtained from the A-Area Burning/Rubble Pits wells since late 1984 indicate that the water-table elevation has been declining since January 1985. A hydrograph for the site wells is presented in Figure 5-21. As shown on the hydrograph, the water-table elevation for the fourth quarter of 1986 ranged approximately from 222 to 218 ft msl, and the vadose zone was approximately 120 to 130 ft thick. A water-table elevation contour map for the second quarter of 1986 is shown in Figure 5-20. As shown, the horizontal water-table flow direction was to the west, with an approximate hydraulic gradient of 0.005 ft/ft. The hydrograph indicates that this has been the predominant flow direction, although minor flow direction and gradient changes have occurred. Relative to the pits, well ARP 3 has been upgradient, well ARP 1A downgradient, and wells ARP 2 and ARP 4 sidegradient.

Using a horizontal groundwater flow velocity estimated for the Tertiary sediments of 90 ft/yr per percent gradient (Section 5.01.02), the resulting groundwater flow velocity beneath the basin has been approximately 45 ft/yr.

5.07.05 Waste-Site Content Characterization Data

The contents of the A-Area Burning/Rubble Pits have not been sampled. Section 5.07.02 contains information on the materials incinerated and discharged at the waste site.

5.07.06 Soil/Sediment Characterization Data

The A-Area Burning/Rubble Pits soil/sediments have not been sampled.

5.07.07 Groundwater Monitoring Results

The groundwater monitoring data from 1984 through 1986 are included in Appendix C. Groundwater chemical characterization data since July 1984 are summarized in Table 5-14. Because A-Area Ash Pile 788-2A is close to backfilled Burning/Rubble Pit 731-A (Ross and Green, 1983), the groundwater monitoring results are indicative of the effects of the ash pile as well (Section 5.08.07).

A comparison of groundwater monitoring data between upgradient well ARP 3 and the remaining A-Area Burning/Rubble Pits wells was used to evaluate the effect on the groundwater from the site. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Based on the nature of the materials disposed at the site, the indicator parameters for the pits are conductivity, total organic carbon (TOC), and total organic halogens (TOH).

The groundwater monitoring data summarized in Table 5-14 indicate that the A-Area Burning/Rubble Pits have had no apparent effect on local groundwater quality. Groundwater samples from all four monitoring wells have consistently met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards for dissolved chemical constituents and radioactivity except for an excursion of lead in sidegradient well ARP 2 (0.346 mg/L) and of total radium in sidegradient well ARP 4 (6.0 pCi/L). The drinking water standards for lead and radium are 0.05 mg/L and 5 pCi/L, respectively. Radioactivity is not known to be related to past site activities. Occasional excursions of trichloroethylene above the drinking water standard (0.05 mg/L) occurred in downgradient well ARP 1A and upgradient well ARP 3. The highest recorded concentration of trichloroethylene (0.067 mg/L) was in upgradient well ARP 3, indicating a source other than the burning/rubble pits. Low conductivity levels, ranging from 15 to 69 µmhos/cm, were reported for the A-Area Burning/Rubble Pits wells.

Similarly, TOC and TOH concentrations in the downgradient well were comparable to levels reported for the remaining site wells. TOC levels ranged from 0.18 to 7.0 mg/L in downgradient well ARP 1A and from 0.29 to 5.0 mg/L in the remaining site wells except for a single reading of 25.0 mg/L in upgradient well ARP 3. TOH levels ranged from <0.005 to 0.035 mg/L in the downgradient well and from <0.005 to 0.085 mg/L in the remaining site wells. The indicator parameters (TOC, TOH, and conductivity) have not shown any consistent increasing or decreasing trends over the monitoring period.

Groundwater pH ranged from 3.9 to 5.6 in the site wells; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in SRS groundwaters (Appendix B).

5.07.08 Planned Action

The A-Area Burning/Rubble Pits are inactive. As indicated in Section 16, a site assessment is scheduled for completion in 1989. Groundwater monitoring will continue at this site.

5.08 A-AREA ASH PILES

5.08.01 Summary

The two A-Area Ash Piles (Buildings 788-A and 788-2A) received dry ash from the A-Area powerhouse. A-Area Ash Pile 788-A is presently on standby (Gordon et al., 1987); A-Area Ash Pile 788-2A is currently active and receives approximately 5,000 yd^3 of dry ash per year (Christensen and Gordon, 1983).

Soil/sediment characterization has not been performed at either of the A-Area Ash Piles. Groundwater monitoring has not been conducted at Ash Pile 788-A. Ash Pile 788-2A is close to backfilled A-Area Burning/ Rubble Pit 731-A (Ross and Green, 1983) and is monitored by the four ARP series wells. The groundwater monitoring results from this site indicate that Ash Pile 788-2A has had no apparent effect on local groundwater quality. Indicator parameter levels were consistent among upgradient well ARP 3 and the other site wells.

5.08.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses, which produces dry ash. The A-Area powerhouse disposes of its ash in the two A-Area Ash Piles (Buildings 788-A and 788-2A) located southeast and south of the A-Area perimeter fence, respectively (Figures 5-2 and 5-3). Building 788-A covers approximately 150,700 ft^2 and is currently on standby (Gordon et al., 1987). Building 788-2A covers approximately 53,820 ft^2 and is close to backfilled Burning/Rubble Pit 731-A (Figure 5-20) (Ross and Green, 1983). This ash pile is active and receives approximately 5,000 yd^3 of ash per year (Christensen and Gordon, 1983). Surface drainage from this area is to the east toward Tims Branch.

A study was conducted in 1977 to identify trace metals present in the fly and bottom ash disposed to the SRS ash piles and basins. Table 5-15 lists typical trace metal concentrations obtained for fly and bottom ash. These results indicate elevated levels of barium, strontium, manganese, zinc, vanadium, cerium, and chromium in the ash (Horton et al., 1977).

5.08.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at Ash Pile 788-A. Ash Pile 788-2A is close to Burning/Rubble Pit 731-A and is monitored by the four wells of the ARP Series. Section 5.07.03 contains the installation data for these wells.

5.08.04 Site-Specific Hydrology

As shown in Figure 5-4, the general horizontal water-table flow direction under Ash Pile 788-A is to the west-southwest. As discussed in Section 5.07.04, water-table elevations in the ARP wells surrounding Ash Pile 788-2A indicate that the horizontal groundwater flow direction in this area is to the west, making well ARP 3 upgradient, well ARP 1A downgradient, and wells ARP 2 and 4 sidegradient relative to the ash pile (Figure 5-20).

5.08.05 Waste-Site Content Characterization Data

The contents of the A-Area Ash Piles have not been sampled. Section 5.08.02 contains information on the nature of the materials disposed at the site.

5.08.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the A-Area Ash Piles.

5.08.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at Ash Pile 788-A. Because Ash Pile 788-2A is close to backfilled Burning/Rubble Pit 731-A, it is monitored by the four ARP series wells. Groundwater chemical characterization data since July 1984 are summarized in Table 5-14.

Relative to Ash Pile 788-2A, well ARP 3 is upgradient, well ARP 1A downgradient, and wells ARP 2 and 4 sidegradient. The groundwater monitoring results, as they relate to the A-Area Burning/Rubble Pits, are discussed in Section 5.07.07. Indicator parameters for identifying the effect of the ash pile on local groundwater quality are barium, manganese, chromium, and zinc. A comparison between the groundwater monitoring data from upgradient well ARP 3 and those from the other site wells was used to evaluate the effect of the ash pile on groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality.

The groundwater monitoring results in Table 5-14 indicate that the ash pile has had no apparent effect on groundwater quality. The indicator parameter levels have not been elevated relative to drinking water standards. Barium concentrations in downgradient well ARP 1A (<0.004 to 0.011 mg/L) were comparable to those in the other site wells (0.004 to 0.007 mg/L). Chromium concentrations in all of the site wells were less than detection limits. Manganese concentrations ranged from 0.012 to 0.018 mg/L in downgradient well ARP 1A and from 0.003 to 0.034 mg/L in the upgradient and sidegradient wells. Zinc concentrations were also comparable, ranging from 0.012 to 0.016 mg/L in downgradient well ARP 1A and from 0.012 to 0.288 mg/L in the other site wells.

As discussed in Section 5.07.07, groundwater samples from all four monitoring wells consistently met South Carolina and federal drinking water standards for dissolved chemical constituents except for a single excursion each of lead in sidegradient well ARP 2 (0.346 mg/L) and of total radium in sidegradient well ARP 4 (6.0 pCi/L) and occasional excursions of trichloroethylene in downgradient well ARP 1A and upgradient well ARP 3 (up to 0.067 mg/L). These constituents are not known to be related to the ash pile.

The pH in the site wells ranged from 3.9 to 5.6; pH values as low as 4.0 are generally consistent with pH levels reported as naturally occurring in SRS groundwater (Appendix B).

5.08.08 Planned Action

A-Area Ash Pile 788-A is currently on standby, and no further action is planned at this time. A-Area Ash Pile 788-2A is currently active, and continued use is planned. Groundwater monitoring will continue at this site. No additional action is scheduled.

5.09 METALLURGICAL LABORATORY SEEPAGE BASIN

5.09.01 Summary

From 1956 to 1985, the Metallurgical Laboratory Seepage Basin (Building 904-110G) received waste effluent from metal finishing operations conducted at the 723-A Metallurgical Laboratory. The wastewater contained various chemicals used in metallographic sample preparations, rinse waters, and nitric acid. Wastewater from the Metallurgical Laboratory is now discharged to a new wastewater treatment facility. The basin is currently inactive and contains water (Johnson et al., 1987a).

Metallurgical Laboratory Seepage Basin soil/sediments and basin water were sampled in October 1984 as part of a site characterization program. The soil/sediment analytical results indicate elevated levels of aluminum, iron, zinc, cyanide, and mercury in the basin sediments and in the soils underlying the inlet sewer pipeline relative to background concentrations. Extraction Procedure (EP) toxicity test results indicate that extractable metal concentrations were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24). The basin water was characterized by low concentrations of chemical constituents except for iron (0.769 mg/L). The basin water was acidic, with a pH of 3.7.

The horizontal groundwater flow direction and hydraulic gradient beneath the site have fluctuated. Generally, well AMB 1A has been downgradient, well AMB 2 sidegradient, and well AMB 3A upgradient relative to the basin. The groundwater monitoring data indicate that the Metallurgical Laboratory Seepage Basin has had little apparent effect on local groundwater quality. Groundwater quality in the site wells has been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for organic halogens and radioactivity. Trichloroethylene levels were elevated in all three site wells. Because trichloroethylene was elevated in the upgradient well and only a small amount of trichloroethylene was discharged to the basin, the observed trichloroethylene levels in the groundwater may be attributable to a source other than the basin.

Gross alpha (up to 138 pCi/L) and total radium (up to 16 pCi/L) activities in well AMB 1A were above their respective drinking water standards of 15 pCi/L and 5 pCi/L in September and November 1984. Total radium activity in well AMB 3A (19 pCi/L) was also above the drinking water standard in November 1984. Radioactivity levels in the site wells have consistently met drinking water standards since November 1984. Radioactivity is not known to be related to past site activities.

5.09.02 Waste-Site Description and Nature of Disposal

The Metallurgical Laboratory Seepage Basin (Building 904-110G) is in an area of relatively low topographic relief, with surface elevations ranging between 370 and 375 ft msl (Figure 5-22). The land surface around the basin slopes gently to the south-southeast toward Tims Branch, and local surface drainage is toward a Carolina bay, which is at an elevation of 358 ft msl. The basin and surrounding area are underlain by clay, silt, and sand, with a higher percentage of clay in the shallow depths (0 to 10 ft). The basin is about 100 ft long by 40 ft wide by 5 ft deep, providing a storage capacity of 20,000 ft^3 (150,000 gal).

From 1956 through 1985, the Metallurgical Laboratory Seepage Basin received waste effluent from various metal finishing operations performed at the 723-A Metallurgical Laboratory. All of the wastewater was discharged through the laboratory drains, which flowed to an underground process sewer pipeline leading to the basin. The discharge flow to the basin averaged 1,000 gal/day. During periods of heavy rain, the basin overflowed through a drainage canal to the nearby Carolina bay.

The wastewater generated from the operations in the Metallurgical Laboratory included rinse waters, nitric acid, and various chemicals used in metallographic sample preparation. A detailed inventory of the waste effluent to the basin was not maintained; however, processes that may have discharged wastes to the basin include plating, degreasing, pickling, and other unit operations that use metals, solvents, acids, and petroleum products. An estimated inventory of the materials discharged to the basin is given in Table 5-16. Prior to 1983, listed hazardous substances were released to the basin in trace amounts. Since 1983, these substances have been bottled and stored (Johnson et al., 1987a).

5.09.03 Groundwater Monitoring Program

Five wells (AMB Series) have been installed at the Metallurgical Laboratory Seepage Basin to monitor the water-table elevation and groundwater quality. Wells AMB 1 through AMB 3 were installed in the second quarter of 1983. Wells AMB 1 and AMB 3 were abandoned and replaced by wells AMB 1A and AMB 3A in the second quarter of 1984. All five wells were constructed using PVC casings and 30-ft screens. The locations of the currently monitored wells are shown in Figure 5-22.

Metallurgical Laboratory Seepage Basin wells AMB 1 through AMB 3 were included in the SRS quarterly groundwater monitoring program in the first quarter of 1984. Wells AMB 1A and AMB 3A were included in the program during the second quarter of 1984. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The AMB wells have also been monitored under the volatile organics plume definition program.

5.09.04 Site-Specific Hydrology

Measurements obtained from the Metallurgical Laboratory Seepage Basin monitoring wells since the first quarter of 1984 indicate that the water-table elevation has been steadily declining since the first quarter of 1985. A hydrograph for the basin wells is presented in Figure 5-23. As shown in the hydrograph, the water-table elevation for the fourth quarter of 1986 was approximately 238 ft msl, and the vadose zone was approximately 135 ft thick. A water-table elevation contour map for the third quarter of 1986 is presented in Figure 5-22. As illustrated, the horizontal groundwater flow direction was to the southwest, with well AMB 1A downgradient of the basin, well AMB 3A upgradient, and well AMB 2 sidegradient. The hydrograph indicates that this has been the general flow direction, although flow direction changes have occurred. Prior to the first quarter of 1985, well AMB 2 was downgradient of the basin. The hydraulic gradient beneath the basin has been approximately 0.002 ft/ft, reflecting the flat nature of the water table in this area. As a result of the low gradient, minor fluctuations in the water-table elevation have induced flow direction changes.

Using a horizontal groundwater flow velocity estimated for the Tertiary sediments of 90 ft/yr per percent gradient (Section 5.01.02), the resulting groundwater flow velocity beneath the basin has been approximately 18 ft/yr.

5.09.05 Waste-Site Content Characterization Data

In October 1984, a composite water sample was taken from the four corners of the Metallurgical Laboratory Seepage Basin and analyzed for substances listed under Resource Conservation and Recovery Act (RCRA) criteria (40 CFR 265.92). The chemical concentration data are presented in Table 5-17. As shown in the table, the chemical concentrations of most constituents were low except for iron (0.769 mg/L). The basin water was acidic, with a pH reading of 3.7 (Johnson et al., 1987a).

5.09.06 Soil/Sediment Characterization Data

Soil/sediment samples were obtained in October 1984 from in and around the Metallurgical Laboratory Seepage Basin. Samples of basin sediments and underlying soils were collected from three areas within the basin, and four soil samples were taken from around the basin. The samples were taken to a depth of 25 ft below ground surface, corresponding to 20 ft below the bottom of the basin. Nine soil samples were taken to a depth of 0.25 ft below the inlet sewer pipeline; one additional sample was collected 3 ft from the pipeline to provide background values. Figures 5-24 and 5-25 show the locations of the soil/sediment samples in relation to the basin and the pipeline.

Table 5-18 summarizes the analytical data from the soil/sediment analyses. In the soil/sediment samples taken from in and around the basin, none of the organic chemical concentrations were significantly above background levels. Di-n-butyl phthalate was present in the laboratory blanks; therefore, sample concentrations possibly are a result of laboratory contamination. Extraction Procedure (EP) toxicity tests performed on the three basin sediment samples indicate that extractable metal concentrations were less than RCRA hazardous waste classification criteria (40 CFR 261.24). Concentrations of aluminum and iron were elevated in the top layer of these samples; the concentrations progressively decreased with depth. Cyanide was detected in the top layer of the basin sediments only (Johnson et al., 1987a).

Table 5-18 also summarizes analytical data from the soil below (0.0 to 0.25 ft) the inlet sewer pipeline. These data indicate that the pipeline soil had a lower pH (2.7 to 4.5) than either the basin sediment (4.2 to 6.1) or the soil from around the basin (4.1 to 5.3). The pipeline soil also had concentrations of aluminum, zinc, mercury, and cyanide above background levels. Both dichloromethane and di-n-butyl phthalate were present in the laboratory blanks for these samples, making the results for these constituents suspect. All remaining parameters for the pipeline soil were of the same order of magnitude as the soils and sediments from within and around the basin. The lower pH values observed in these samples suggest that some leakage from the inlet pipeline may have occurred (Johnson et al., 1987a).

5.09.07 Groundwater Monitoring Results

Groundwater monitoring results from 1984 through 1986 are presented in Appendix C. Groundwater chemical characterization data since July 1984 are summarized in Table 5-19.

As discussed in Section 5.09.04, the groundwater flow direction beneath the basin has fluctuated because of the flat nature of the water table in this area. Relative to the basin, well AMB 1A generally has been downgradient, well AMB 2 sidegradient, and well AMB 3A upgradient; although prior to 1985, well AMB 2 was downgradient.

Comparisons of the monitoring results among the site wells were used to evaluate the effect on local groundwater quality from the Metallurgical Laboratory Seepage Basin. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. The indicator parameters are those chemicals discharged to the site, including sodium, iron, chloride, and nitrate.

The monitoring results summarized in Table 5-19 indicate that the Metallurgical Laboratory Seepage Basin has had little apparent effect on local groundwater quality. Groundwater quality in all three site wells has been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for trichloroethylene in all three site wells and occasional excursions of carbon tetrachloride in well AMB 2 and radioactivity in wells AMB 1A and 3A.

Trichloroethylene levels in wells AMB 1A (0.006 to 0.029 mg/L), AMB 2 (0.010 to 0.152 mg/L), and AMB 3A (0.003 to 0.008 mg/L) generally exceeded the drinking water standard of 0.005 mg/L. Carbon tetrachloride concentrations in well AMB 2 (0.004 to 0.011 mg/L) were consistently above the detection limit and ranged over the drinking water standard of 0.005 mg/L. Gross alpha (up to 138 pCi/L) and total radium (up to 16 pCi/L) activities in well AMB 1A were above their respective drinking water standards of 15 and 5 pCi/L in both September and November 1984. Total radium activity in well AMB 3A (19 pCi/L) was also above the drinking water standard in November 1984. Radionuclide activities have consistently met drinking water standards in all of the site wells since November 1984. Radioactivity is not known to be related to past site activities.

Concentrations of the indicator parameters were comparable between the upgradient well and the other site wells. Chloride levels ranged from 3.1 to 4.0 mg/L in the downgradient well and from 2.4 to 4.4 mg/L in the other site wells. Iron concentrations in the downgradient well (0.012 to 0.087 mg/L) were less than those in the sidegradient and upgradient wells (0.017 to 0.194 mg/L). Sodium (up to 8.06 mg/L) and nitrate (up to 0.95 mg/L) levels in the downgradient well were also similar to those in the other site wells (up to 8.20 and 2.05 mg/L, respectively). Concentrations of the indicator parameters have not shown any increasing or decreasing trends over time.

Groundwater pH in the site wells ranged from 3.6 to 7.6; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B). Average conductivity values in the site wells (37.7 to 57.1 μmhos/cm) were low.

5.09.08 Planned Action

The Metallurgical Laboratory Seepage Basin is inactive. As indicated in Section 16, a site assessment is currently being conducted and is scheduled for completion in 1988. A closure plan is scheduled for completion in 1989. Groundwater monitoring will continue at this site.

5.10 M-AREA SETTLING BASIN

5.10.01 Summary

The M-Area Settling Basin (Building 904-51G) is an unlined earthen basin constructed in 1958 to contain uranium discharges. The basin received waste effluent from three production buildings and two support laboratories that performed metal finishing operations. The basin overflowed to a ditch, which directed the overflow to a Carolina bay (Lost Lake, Building 904-112G) and an adjacent seepage area. The wastewater contained metal degreasing agents, acids, caustics, and metals. The site was removed from service on July 16, 1985, and is now inactive (Pickett et al., 1987a).

The basin is characterized by a chemocline in the water at a depth of 4 ft and a 2-ft-thick layer of hydroxide sludge on the bottom of the basin, which contains elevated metal and organic concentrations. Low-level organic contamination is present in the soils under the basin. Metals concentrations above background levels are contained within the top 2 ft of soil except for uranium and nickel, which are found at depths up to 6 ft. Soils beneath the overflow ditch and natural seepage area exhibit constituent levels similar to the soils beneath the settling basin. Metals concentrations were slightly above M-Area background levels in the soils beneath Lost Lake and the process sewer line leading to the basin. The Lost Lake soil samples do not contain detectable chlorinated hydrocarbons. Additional samples taken adjacent to the settling basin show no evidence of horizontal movement of contaminants in the vadose zone (Pickett, 1985).

Based on the nature of the materials disposed at the M-Area Settling Basin, the indicator parameters for groundwater monitoring are trichloroethylene, tetrachloroethylene, nitrate, sodium, metals, gross alpha, and total radium. All of the indicator parameters were elevated in the waste-site monitoring wells compared to the concentrations detected in the area background wells and South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards, indicating that the M-Area Settling Basin has affected groundwater quality in the area.

5.10.02 Waste-Site Description and Nature of Disposal

The M-Area Settling Basin (Building 904-51G) is an unlined earthen basin southwest of A/M Area and west of Road D. Constructed in 1958, the original dimensions of the basin were 331 ft by 279 ft at the top of the berm. The sides sloped at a 20° angle to the basin floor, which had original dimensions of 280 ft by 228 ft. The basin was 15 ft deep with 2 ft of freeboard, resulting in an approximate 8-million-gal capacity. The ground surface elevation at the site is fairly flat, ranging approximately from 340 to 350 ft msl. Surface drainage is to the southeast toward a tributary of Tims Branch (Figure 5-26).

The M-Area Settling Basin was placed in service in 1958 to prevent enriched uranium discharges to surface streams. Prior to 1958, M-Area process wastes from the fuel and target facilities, which perform aluminum forming and metal finishing operations, were discharged through outfall A-14 to Tims Branch (Marine and Bledsoe, 1985).

Originally, the basin received process waste from Building 321-M only. The wastewater was discharged to the basin through a 30-in.-diameter, underground clay-tile sewer line. The inlet sewer line enters the basin through its north side, approximately 50 ft from the northeast corner (Figure 5-26).

In 1973 and 1976, process waste streams from Building 313-M were rerouted from the outfall to the basin inlet pipeline to further reduce the amount of uranium discharged to Tims Branch. Beginning in May 1982, all process wastes from the fuel and target fabrication facilities (Buildings 321-M, 313-M, and 320-M) and wastes from the laboratories in Buildings 320-M and 322-M were routed to the settling basin (Marine and Bledsoe, 1985).

In the M-Area fuel and target fabrication facilities, the fuel and target elements were degreased with chlorinated hydrocarbons at several stages during processing. Although 50 to 90% of the solvents used during degreasing operations are assumed to have evaporated, Christensen and Brendell (1981) estimate that approximately 2 million lb of solvents were released to the M-Area Settling Basin (Table 5-20). The elements are cleaned with acids (nitric, phosphoric, sulfuric) and caustics (sodium hydroxide), which form components of the basin influent, along with hydroxide precipitates of aluminum, uranium, nickel, lead, and other metals (Pickett et al., 1987a). Combined flowmetering/proportional samplers located at the inlet and outlet of the basin measured average influent and effluent physical and chemical parameters. Table 5-21 presents analytical results from samples collected in 1985.

Approximately 2 years after the basin was put in service, it became partially plugged. Basin overflow was directed through a ditch to Lost Lake (Building 904-112G) (Figure 5-26). The ditch is 920 ft long and was originally 8 ft wide at the bottom with a 2:1 side slope. The overflow ditch slopes to an elevation of approximately 344 ft msl at its discharge point (Pickett, 1985).

A seepage area, covering approximately 3 acres, developed between the ditch and Lost Lake (Figure 5-26). Vegetation in the area was not cleared so the exact boundary of the area is unknown, but high-water marks suggest a boundary at the 342-ft contour. Wastewater not absorbed in the seepage area flowed to Lost Lake, a Carolina bay covering 10 to 25 acres depending on the water level. Lost Lake has no outlet, and wastewater either evaporated or seeped into the ground. The boundary of Lost Lake, based on high-water marks, is at the 340-ft contour line. Prior to receiving overflow from the M-Area Settling Basin, Lost Lake was dry except during periods of wet weather. It remained relatively dry until 1982, when M-Area wastewaters were diverted from outfall A-14 to the basin, and the average daily inflow increased (Marine and Bledsoe, 1985). Non-contact cooling water discharges were diverted back to the outfall in late 1982.

Discharges to the basin were stopped in May 1985. The M-Area Settling Basin currently contains water, but the seepage area has dried out. Lost Lake alternates between wet and dry periods, depending upon precipitation.

5.10.03 Groundwater Monitoring Program

Four monitoring wells (MSB 1 through MSB 4) were installed around the M-Area Settling Basin from November 1979 to March 1980. In February 1981, four additional monitoring wells (MSB 5 through MSB 8) were installed around Lost Lake. These eight monitoring wells were constructed with galvanized steel casings and 20-ft screens. Because the galvanized steel was suspected of interfering with the groundwater monitoring results, these wells were replaced in late 1982 and early 1983 by wells MSB 1A through MSB 8A, which were constructed using PVC casings and 30-ft screens. Wells MSB 1A through 4A were installed adjacent to the corresponding original wells. Wells MSB 5A through 8A were installed at higher surface elevations than the original wells because of the higher water level in Lost Lake resulting from the increased wastewater flow. The original wells were then grouted and abandoned. The locations of the currently monitored wells are shown in Figure 5-27.

Originally, monitoring well MSB 1 was designated the upgradient (background) well for the facility. Subsequent monitoring results indicate that well MSB 1 and its successor, MSB 1A, were affected by the basin. In September 1985, two water-table wells, designated MSB 29D and MSB 43D, were installed approximately 1.5 mi north to northwest of the M-Area Settling Basin to provide background water-quality data (Figure 5-4).

Monitoring wells MSB 1A through MSB 8A were included in the SRS quarterly groundwater monitoring program in 1982. Prior to that time, samples were collected irregularly according to sampling and analytical procedures determined by the current technology and regulatory guidance. Background wells MSB 29D and MSB 43D were added to the quarterly monitoring program in the second quarter of 1986. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program. The MSB waste-site monitoring wells and many additional MSB series wells are also monitored as part of the volatile organics plume definition program.

5.10.04 Site-Specific Hydrology

Measurements obtained from the M-Area Settling Basin and Lost Lake wells since the first quarter of 1980 indicate that the water-table elevation has been approximately 247 to 232 ft msl and that the vadose zone has been approximately 105 ft thick. Hydrographs for wells MSB 1 through MSB 8 and MSB 1A through MSB 8A are shown in Figures 5-28 and 5-29. As shown in the hydrographs, the water-table elevation for the fourth quarter of 1986 ranged from 237 to 232 ft msl. The hydrograph indicates that the water-table elevation has been declining since the second quarter of 1985.

A water-table elevation contour map for the first quarter of 1985 is presented in Figure 5-27. As shown, the horizontal flow direction was to the southwest. Relative to the basin, well MSB 2A has been generally upgradient, wells MSB 1A and MSB 3A sidegradient, and wells MSB 4A through MSB 8A downgradient. The hydrographs show that changes in flow direction have occurred, with well MSB 1 originally being the upgradient well for the site. The hydraulic gradient beneath the area has been low (0.002 ft/ft), reflecting the relatively flat nature of the water table in this area.

Using a horizontal groundwater flow velocity estimated for the Tertiary sediments of 90 ft/yr per percent gradient (Section 5.01.02), the resulting horizontal groundwater flow velocity beneath the basin has been approximately 18 ft/yr.

5.10.05 Waste-Site Content Characterization Data

Two characterization studies of the M-Area Settling Basin have been performed: Hollod wrote an initial characterization study in 1982 from data collected in 1981, and Pickett authored an extended characterization study in 1985. In addition, many other sampling programs have been carried out at the site.

Hollod's 1982 study determined that the basin water was vertically stratified, with a chemocline occurring at a depth of approximately 4 ft (Figure 5-30). Thirty-two basin water samples were collected at 16 locations. At each location a sample was taken at a depth of 1 ft below the water surface and another at 1 ft above the basin floor. The analytical results from these samples are presented in Table 5-22. As shown on the table, concentrations of inorganic constituents were 2 to 20 times less in the water above the chemocline than those in the water below the chemocline. Significant differences were observed in density and conductivity values and dissolved oxygen and sodium concentrations (Hollod, 1982).

Pickett's 1985 study confirmed the presence of a chemocline at a depth of 4 ft. Eighteen basin water samples were analyzed: six 2-ft-deep samples and twelve 8-ft-deep samples, the number of samples corresponding to the relative volume of water in each layer (Figure 5-31). Table 5-23 presents the results from these samples, which confirm those from the 1982 study. Both studies demonstrate that metal concentrations tend to be higher in the water below the chemocline.

The organic compounds detected in the basin water samples along with the maximum concentrations determined for each are given in Table 5-24. The three degreasing agents historically used in M-Area processes (1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene) are present in comparatively high concentrations.

The 1985 study also analyzed three water samples from Lost Lake (Figure 5-32). Average metals concentrations in these samples were equal to or less than those in the settling basin with the exceptions of manganese and magnesium. The average manganese concentration in Lost Lake was 0.032 mg/L as compared to 0.005 mg/L for basin water above the chemocline and 0.019 mg/L for basin water below the chemocline. The average magnesium concentration in Lost Lake was 0.155 mg/L, about half that of the basin water above the chemocline (0.300 mg/L) but higher than that of the basin water below the chemocline (0.101 mg/L). Organic compounds detected in the Lost Lake water samples are listed in Table 5-24. None of the degreasing solvents used in M Area and present in the settling basin liquid were detected in the Lost Lake samples (Pickett, 1985).

The 1982 characterization study also confirmed the presence of a 1 to 2 ft thick green sludge layer at the bottom of the basin, which had been previously reported during scouting tests of the basin (Coker, 1979; Rabon and Pickett, 1987). Analysis determined that the sludge comprises oil, grease, detritus, and precipitates, with flocculent nickel precipitates causing the green color. The study determined from a limited number of samples that the sludge contained the highest concentrations of the major inorganic constituents, i.e., nickel, uranium, mercury, sodium, aluminum, phosphate, and sulfate (Hollod, 1982).

Eight basin sludge samples were taken during the 1985 characterization program (Figure 5-31). The sludge averaged 2 ft thick, although it was thicker near the inlet and in the center of the basin and thinner around the basin edges. The 1985 analyses confirm that the sludge is composed primarily of metal, hydroxide, and phosphate precipitates and biogenic organic sediments. The sludge is approximately 6% solids by weight: 30% aluminum hydroxide, 8% organic carbon, and 3% phosphate on a dry weight basis (Pickett, 1985). Tables 5-25 and 5-26 present the analytical results from the sludge samples, which demonstrate that the sludge contains much higher concentrations of metals and ions than those found in the basin liquid (see Table 5-23). The sludge also contains a much lower inventory of degreaser solvents (2.2 lb) than that found in the basin liquid (approximately 176 lb; Pickett, 1985).

Sludge similar to that found in the basin is also found in the bottom of the overflow ditch and the bottom of the natural seepage area (Pickett, 1985). An analysis of the sludges from these areas is given in Tables 5-25 and 5-26. A comparison of the sludges shows that the metallic and organic concentrations generally are lower in the overflow ditch sludge and the seepage area sludge than those in the M-Area Settling Basin sludge. Degreaser solvent concentrations are lowest in the seepage area sludge.

Radioactivity in the seepage area sludge also was lower than that recorded for the basin sludge. Gross alpha activity averaged 2,960 pCi/g in the basin sludge, 1,400 pCi/g in the overflow ditch sludge, and

1,110 pCi/g in the seepage area sludge. Similarly, nonvolatile beta activity was 8,500 pCi/g in the basin sludge and 1,430 pCi/g in the seepage area sludge; total radium activity was 12.4 pCi/g in the basin sludge and 5.4 pCi/g in the seepage area sludge.

5.10.06 Soil/Sediment Characterization Data

A 1981 remote television camera inspection revealed that the inlet process sewer line was cracked and misaligned, allowing wastewater to leak into the soil below. In late 1983, the sewer line was lined with PVC. In 1985, 10 soil cores were taken to a depth of 6 ft below the sewer line from two areas where a soil gas survey indicated that cracks in the line had occurred. Figure 5-33 shows the locations of the process sewer line sampling points.

Table 5-27 presents the average inorganic concentrations by depth interval in soil beneath the process sewer line. Of the metals analyzed, lead, nickel, uranium, and zinc are present at elevated concentrations, particularly in the top 2 ft of soil. Average organic concentrations are presented in Table 5-28, which shows that concentrations of bis (2-ethylhexyl) phthalate, tetrachloroethylene, and 1,1,1-trichloroethane (1,1,1-TCE) were elevated in the soil at depths up to 6 ft. Tetrachloroethylene concentrations up to 764 μg/g were detected, indicating that leaks in the process sewer line were a major source of degreaser solvent contamination. Soil cores taken 1 ft to either side of the process sewer line show no evidence of horizontal movement of either inorganic or organic parameters (Pickett, 1985).

Two soil core studies performed in 1982 (Hollod et al., 1982; Rabon and Pickett, 1987) determined that the top of the soil column beneath the basin is contaminated by zinc, lead, mercury, copper, and uranium at depths of 1.5 to 2 ft. Nickel concentrations reached background levels at a depth of approximately 1 ft. Concentrations of the three degreasing agents in the soil beneath the basin were vertically and horizontally variable. The highest concentrations were found in the shallow soil near the inlet. Two phthalate compounds were also detected in soil beneath the basin. These compounds are used as defoaming agents, pump lubricants, and degreasing solvents and probably originated from the M-Area metal finishing operations (Pickett, 1985).

For the 1985 extended characterization study, four 6-ft-deep soil/sediment cores were taken from the bottom of the M-Area Settling Basin. Figure 5-31 depicts the locations of the sampling points, and Tables 5-29 and 5-30 list the average concentrations of inorganic and organic parameters in the soil beneath the basin. The 1985 characterization study confirmed the average concentrations of the inorganics and metals in the basin soils found in Hollod's study (1982). Except for uranium and nickel, all metals reached background levels in the top 2 ft of soil. In the 5-to-6-ft soil depth interval, uranium was found in concentrations up to 103 μg/g, and nickel was found in concentrations up to 61.2 μg/g (Pickett, 1985).

As shown in Table 5-30, elevated concentrations of tetrachloroethylene, bis (2-ethylhexyl) phthalate, and di-n-octyl phthalate were detected in the basin soil samples. Toluene was detected at concentrations only slightly above M-Area background levels.

The results of degreaser solvent analyses from the basin soil in the 1985 study were substantially different from those determined by Hollod in 1982. In 1985, none of the three degreaser solvents were detected at depths below 2 ft, and the maximum concentrations determined for each were lower than those recorded by Hollod in 1982. A comparison of the results from the 1985 organic analyses with those of the 1982 organic analyses suggests that significant migration of the degreaser solvents occurred between the two sampling times (Pickett, 1985).

Four 21-ft-deep soil cores were collected adjacent to the basin at varying distances from the basin water during the 1985 characterization program (Figure 5-31). Organic and inorganic constituents were below background levels, indicating that horizontal movement of contaminants in the vadose zone has not occurred (Pickett, 1985).

Sixteen locations along the overflow ditch were sampled to a depth of 3.5 ft during the 1985 program. Eight cores were taken along the centerline, and eight cores were made along two traverses of the centerline (Figure 5-34). Average inorganic concentrations by depth interval are given in Table 5-31; average organic concentrations by depth interval are given in Table 5-32. Average concentrations of chromium, copper, lead, magnesium, manganese, nickel, uranium, and zinc were elevated in the top 6 in. of soil. At depths below 6 in., all analytes except nickel and uranium reached background levels. Low levels of organic contamination were also found in the top 6 in. of soil from beneath the overflow ditch (Table 5-32), but most constituent concentrations dropped below detection limits in the deepest (2.5 to 3.5 ft) samples (Pickett, 1985).

In November 1982, soil cores ranging from 1 to 2 ft deep were taken from five locations in the seepage area. The analytical results indicate that metals concentrations were elevated in the top 1.2 ft of soil. The top 1 ft of soil also contained elevated levels of degreaser solvents, particularly 1,1,1-trichloroethane (1,1,1-TCE; 8.59 μg/g) (Christensen and Pickett, 1987).

For the 1985 extended characterization study, 18 seepage area locations were sampled: 16 cores were taken to a depth of 1 ft; 2 cores, close to the overflow ditch, were taken to a depth of 6.5 ft (Figure 5-34). The analytical results from these samples are presented in Tables 5-33 and 5-34. Manganese, magnesium, nickel, and uranium were elevated in the 1-ft-deep samples. Degreaser solvent concentrations were low: trichloroethylene and 1,1,1-trichloroethane (1,1,1-TCE) were not detected, and tetrachloroethylene was detected only once (0.019 μg/g) (Pickett, 1985).

Four locations in Lost Lake were sampled in 1982 at depths of 1 ft (Christensen and Pickett, 1987). Metals concentrations reached background levels in the top 6 in. of soil. Degreaser solvent concentrations were less than detection limits below the top 2 in. of soil. The highest organic concentration in the top 2 in. of soil was 0.068 μg/g of 1,1,1-trichloroethane (1,1,1-TCE).

During the 1985 characterization program, soil/sediment samples were taken from four areas of Lost Lake (Figure 5-32): the area above the high-water mark (342 to 340 ft msl contour), the occasionally wet area (340 to 338 ft msl contour), the usually wet area (338 to 336 ft msl contour), and the area that is almost always wet (less than 336 ft msl contour). The soil underlying the normal water line was sampled approximately twice per acre; the soil above the normal water line was sampled approximately once per acre (Pickett, 1985). The analytical results are given in Tables 5-35 and 5-36.

The concentrations of inorganic parameters in the samples taken from the area above the high-water mark and from the occasionally wet area were generally equal to or less than background levels. Soil samples taken from the residual white deposit denoting the high-water mark exhibited levels of nickel, lead, uranium, and phosphate in the top (0.0-to-0.1-ft) interval that were slightly above background levels (Pickett, 1985).

Although Lost Lake does not have the green sludge characteristic of the settling basin, overflow ditch, and seepage area, the top 6 in. of soil from the usually wet and always wet zones had high organic carbon concentrations indicative of biogenic origin. The usually wet area exhibited lead and manganese concentrations slightly above background levels in the top 6 in. of soil. Barium, copper, nickel, and zinc were slightly above background levels in the top 1.5 ft of soil in this area. Uranium values were usually less than the detection limit.

The area that is almost always wet exhibited lead and manganese concentrations in the 0.0- to 1.5-ft interval that were above M-Area background levels and above the lead and manganese levels observed in the usually wet area. Barium, copper, nickel, and zinc levels in this area were higher than M-Area background levels and the usually wet area levels in the 0.0- to 1.5-ft interval. Uranium levels were less than the detection limit.

5.10.07 Groundwater Monitoring Results

The groundwater data for waste-site monitoring wells MSB 1 through MSB 8, MSB 1A through MSB 8A, and the two background wells (MSB 29D and MSB 43D) from 1980 through 1986 are included in Appendix C. Groundwater chemical characterization data since July 1984 are summarized in Table 5-37.

A comparison of groundwater monitoring data among M-Area Settling Basin monitoring wells MSB 1A through MSB 8A and background wells MSB 29D and MSB 43D was used to evaluate the effects on the groundwater from the basin and associated areas. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Based on the materials disposed in the M-Area Settling Basin, the indicator parameters most likely to show the effect from the basin are conductivity, nitrate, sodium, tetrachloroethylene, trichloroethylene, metals, and radioactivity.

Monitoring data from wells MSB 1A through MSB 8A indicate that the M-Area Settling Basin has affected groundwater quality at the site. Trichloroethylene and tetrachloroethylene contamination was present in seven of the eight monitoring wells, reflecting the known degreaser solvent contamination. Total radium, gross alpha, nitrate, total dissolved solids (TDS), and 1,1,1-trichloroethane (1,1,1-TCE) levels were above drinking water standards in several of the wells. Chloroform concentrations were consistently above the drinking water standard for trihalomethanes in well MSB 4A. Sodium, conductivity, and nonvolatile beta levels were elevated in several of the wells. Isolated excursions of iron, manganese, sulfate, lead, and endrin were recorded. Chemical concentrations and radioactivity in the background wells (MSB 29D and MSB 43D) were below federal and state primary and secondary drinking water standards except for total radium in well MSB 29D.

Tetrachloroethylene and trichloroethylene concentrations in the background wells (MSB 29D and MSB 43D) were less than the detection limit for these compounds (0.005 mg/L). Tetrachloroethylene levels in wells MSB 1A (0.048 to 0.236 mg/L), MSB 2A (0.017 to 0.277 mg/L), MSB 3A (34.5 to 313 mg/L), MSB 4A (0.660 tc 6.35 mg/L), MSB 5A (0.020 to 0.069 mg/L), MSB 7A (0.006 to 0.131 mg/L), and MSB 8A (0.029 to 0.528 mg/L) ranged above the background level. Trichloroethylene levels generally exceeded the federal drinking water standard of 0.005 mg/L in wells MSB 1A (0.163 to 0.367 mg/L), MSB 2A (0.138 to 0.428 mg/L), MSB 3A (29.2 to 161 mg/L), MSB 4A (0.280 to 5.47 mg/L), MSB 5A (0.005 to 0.048 mg/L), MSB 7A (0.002 to 0.050 mg/L), and MSB 8A (0.008 to 0.121 mg/L).

1,1,1-Trichloroethane (1,1,1-TCE) concentrations were below the drinking water standard of 0.2 mg/L except in well MSB 3A, in which concentrations ranged up to 6.54 mg/L, and in well MSB 4A, in which concentrations were consistently over the drinking water standard (0.290 to 0.448 mg/L). Chloroform concentrations in well MSB 4A (0.184 to 0.627 mg/L) were also consistently over the South Carolina and federal primary drinking water standard for trihalomethanes (0.100 mg/L).

The background wells for the M-Area Settling Basin contained an average sodium concentration of 2.8 mg/L. Wells MSB 1A through MSB 8A had sodium concentrations above the background level, with maximum sodium concentrations in these wells ranging from 3.13 to 734 mg/L. Nitrate concentrations in the background wells averaged 1.6 mg/L, well below the federal primary drinking water standard of 10 mg/L. Nitrate levels in well MSB 1A (1.77 to 4.24 mg/L) and MSB 7A (4.15 to 9.04 mg/L) were above the background level but below the drinking water standard. Nitrate concentrations in well MSB 2A and MSB 5A ranged above the drinking water standard with maximum concentrations of 19.75 and 18.5 mg/L, respectively. Wells MSB 3A, MSB 4A, and MSB 8A contained nitrate at levels consistently above the drinking water standard, with respective ranges of 19.0 to 143 mg/L, 116 to 330 mg/L, and 11.9 to 48.3 mg/L.

The drinking water standard for gross alpha is 15 pCi/L. Gross alpha activity ranged over the drinking water standard in wells MSB 2A (up to 30.4 pCi/L), MSB 3A (up to 92.0 pCi/L), MSB 7A (up to 26.0 pCi/L), and MSB 8A (up to 57.8 pCi/L). Gross alpha activities were consistently over the drinking water standard in well MSB 4A, with activities ranging from 16.0 to 88.3 pCi/L.

Total radium activities were over the drinking water standard of 5 pCi/L in six of the waste-site monitoring wells. Total radium activity occasionally exceeded the drinking water standard in wells MSB 1A (up to 6.0 pCi/L), MSB 2A (up to 22.1 pCi/L), MSB 7A (up to 6.0 pCi/L), and MSB 8A (up to 13 pCi/L). Wells MSB 3A (8.0 to 92.0 pCi/L) and MSB 4A (19.0 to 47.4 pCi/L) had total radium activities that consistently exceeded the drinking water standard. Background well MSB 29D also had total radium activity consistently over the drinking water standard (8.3 to 8.8 pCi/L), but background well MSB 43D had low total radium activity averaging 0.8 pCi/L.

Nonvolatile beta activities ranged from 4.3 to 7.0 pCi/L in well MSB 29D and were consistently less than the detection limit in well MSB 43D. Wells MSB 1A through MSB 5A, MSB 7A, and MSB 8A had average nonvolatile beta activities over the background value, with activities ranging from 8.0 to 297 pCi/L.

Lead excursions above the federal primary drinking water standard of 0.05 mg/L were reported for wells MSB 1A (0.07 mg/L) and MSB 2A (0.052 mg/L and 0.083 mg/L). Manganese concentrations were above the federal secondary drinking water standard of 0.05 mg/L in well MSB 3A (0.155 to 0.385 mg/L). Three sulfate excursions (266 mg/L, 466 mg/L, and 504 mg/L) were reported for well MSB 4A. A single excursion of iron (0.805 mg/L) above the federal secondary drinking water standard of 0.3 mg/L was reported for well MSB 7A. Wells MSB 3A and MSB 4A each reported an endrin excursion of 0.00022 mg/L. The drinking water standard for endrin is 0.0002 mg/L.

The background wells had an average conductivity of 32.2 μmhos/cm. Conductivity in all of the waste-site monitoring wells ranged above this value, with values for wells MSB 3A (up to 1,410 μmhos/cm), MSB 4A (up to 3,800 μmhos/cm), MSB 5A (195 μmhos/cm), and MSB 8A (up to 420 μmhos/cm) particularly elevated.

The pH values ranged from 3.5 to 6.4 in the waste-site monitoring wells and from 3.7 to 5.2 in the background wells. As indicated by the low background values, pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in SRS groundwaters (Appendix B).

5.10.08 Planned Action

Discharges to the M-Area Settling Basin were stopped in May 1985. Groundwater monitoring will continue at the site. The site characterization studies have been completed, and a closure plan has been submitted to the South Carolina Department of Health and Environmental Control (SCDHEC). The basin will be closed according to SCDHEC regulations and approval.

5.11 SILVERTON ROAD WASTE SITE

5.11.01 Summary

The Silverton Road Waste Site (Building 731-3A) probably was used as a trash dump before the construction of SRS, but the exact start-up date is unknown. Visual inspection and photographs of the site indicate that construction debris, tires, metal shavings, drums, tanks, and possibly asbestos were disposed at the site. The site stopped receiving waste in 1974, when it was covered with soil (Scott et al., 1987a).

The groundwater monitoring data indicate that the Silverton Road Waste Site has had some effect on local groundwater quality, as evidenced by the elevated levels of organic solvents in the downgradient water-table wells. Groundwater samples from the water-table wells met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards for dissolved chemical constituents and radioactivity except for isolated excursions of manganese, iron, and zinc and elevated levels of carbon tetrachloride and trichloroethylene. Elevated levels of trichloroethylene also were recorded in well SRW 16A, which is screened approximately 100 ft lower than the water-table wells. Well SRW 16A is upgradient of and approximately 1,000 ft from the waste site, suggesting a source other than the waste site for the trichloroethylene in this zone.

5.11.02 Waste-Site Description and Nature of Disposal

The Silverton Road Waste Site (Building 731-3A) covers approximately 200 ft by 700 ft southwest of Road C-1.1, approximately 1 mi southeast of the nearest plant boundary. The ground surface elevation ranges approximately from 310 to 330 ft msl, and the ground slopes to the southwest toward the Savannah River Swamp, approximately 1 mi from the site (Figure 5-35).

The Silverton Road Waste Site probably was used as a trash dump before the construction of SRS, but the exact start-up date is unknown. Disposal records were not kept, but visual inspection and photographs show that metal shavings, construction debris, tires, drums, tanks, and possibly asbestos were deposited on the ground to a depth of 6 ft. Liquid wastes are not known to have been disposed at the site. The site was taken out of service in 1974, and the area was bulldozed, graded, and seeded (Scott et al., 1987a).

5.11.03 Groundwater Monitoring Program

Thirty-one wells (SRW Series) have been installed to characterize the hydrologic conditions and to monitor the groundwater quality at the Silverton Road Waste Site. Water-table wells SRW 1 through SRW 6 were installed in 1981 and have 30-ft screens. Water-table wells SRW 7 through SRW 11 were added in 1982 and also have 30-ft screens except for wells SRW 7 and SRW 8, which were constructed with 20-ft screens.

Nineteen cluster wells were installed at the site in 1983 and 1984. Four additional wells were added to existing water-table wells SRW 2 and SRW 9, making a three-well cluster at each site. Three-well clusters were also established at five additional sites (SRW 12 through SRW 16). In the well clusters, wells with a C designator or without a letter designator were installed as water-table wells (Figure 5-35). These wells have 30-ft screens except for well SRW 12C, which has a 20-ft screen. B-designated wells are screened below the water table at elevations ranging from 146.3 to 169.9 ft msl (Figure 5-36). These wells have 10-ft screens. A-designated wells have 10-ft screens set at elevations ranging from 88.6 to 124.3 ft msl except for well SRW 16A, which has a 30-ft screen set between 119.4 and 144.1 ft msl (Figure 5-37). Well SRW 14A has two screens: the top, 10-ft screen is set between 113.9 and 123.7 ft msl; the second, 3-ft screen is set between 107.9 and 110.9 ft msl.

In the third quarter of 1984, water-table well SRW 3 was replaced by well SRW 3A, which also has a 30-ft screen. All of the SRW wells were constructed with PVC casings.

Wells SRW 1 through SRW 6 were included in the SRS quarterly groundwater monitoring program in 1982. Wells SRW 7 through SRW 11 were added to the program in the third quarter of 1984. The additional water-table cluster wells (SRW 12C through SRW 16C) were included in the third quarter of 1985, and the wells screened at deeper intervals were added in the fourth quarter of 1985. Quarterly monitoring data were collected from well SRW 3 through the third quarter of 1984; well SRW 3A was included in the quarterly monitoring program in the first quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

5.11.04 Site-Specific Hydrology

Hydrographs of the SRW wells are presented in Figures 5-38 through 5-43. The water-table elevation has ranged approximately from 233 to 197 ft msl, and the vadose zone has been approximately 100 to 110 ft thick. As shown in Figures 5-38 through 5-40, the water-table elevation generally increased from 1982 to 1984, but has been declining since that time. Well SRW 2 had a water elevation significantly higher than the other wells prior to the second quarter of 1986, suggesting that it may have been equilibrating to a perched water zone.

A water-table elevation map for the first quarter of 1986 (Figure 5-35) indicates that the horizontal groundwater flow direction was southwest toward the Savannah River Swamp. The hydrographs indicate that this has been the predominant flow direction, although minor changes in flow direction have occurred. Relative to the site, wells SRW 2, SRW 3A, and SRW 16C are upgradient; wells SRW 5, SRW 6, SRW 7, SRW 8, SRW 9, SRW 10, SRW 11, and SRW 12C are downgradient; and wells SRW 1, SRW 4, SRW 13C, SRW 14C, and SRW 15C are sidegradient.

The hydraulic gradient beneath the site has been approximately 0.006 ft/ft. Using a horizontal groundwater flow velocity estimated for the Tertiary sediments in the A/M Area of approximately 90 ft/yr per percent gradient (Section 5.01.02), the resulting water-table flow velocity beneath the site has been approximately 54 ft/yr.

The hydrographs of the wells screened in the two lower depth intervals (Figures 5-41 through 5-43) and the potentiometric maps of these two zones (Figures 5-36 and 5-37) indicate that little hydrostatic difference exists between the zones. A comparison of these potentiometric maps with that of the water table indicates that a hydraulic head difference of about 5 ft exists between the water table and these lower zones. The horizontal flow direction and gradient of these lower zones are similar to those of the water table.

5.11.05 Waste-Site Content Characterization Data

The contents of the Silverton Road Waste Site have not been sampled. A terrain conductivity study was performed in August 1981. Three traverses were made, and anomalously high conductivity zones were found both throughout the site and in an area southwest of the site. The high conductivity values reported for the waste site itself are believed to be caused by the metal products buried there (i.e., tanks, metal shavings, and drums). Further geologic investigations of and groundwater monitoring data from the high conductivity area southwest of the site suggest that these high values are caused by an increased clay content in the subsurface sediments and are not indicative of a contamination plume in the groundwater (Geraghty & Miller, 1985).

5.11.06 Soil/Sediment Characterization Data

In 1983 five soil borings were taken to a depth of 100 ft within the waste disposal area and analyzed for chlorinated organic solvents. The locations of the borings are shown in Figure 5-44. Results of the chlorinated organic solvent analyses were inconclusive because the laboratory blanks for the sample run showed significant contamination (Scott et al., 1987a).

5.11.07 Groundwater Monitoring Results

Groundwater monitoring data from 1982 through 1986 are presented in Appendix C. Groundwater chemical characterization data since July 1984 are summarized in Tables 5-38 through 5-40. A comparison of the monitoring results from the upgradient wells with those of the other site wells was used to assess the effect of the site on local groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality.

Monitoring results from the water-table wells are summarized in Table 5-38. As shown in Figure 5-35, wells SRW 2, SRW 3A, and SRW 16C are upgradient; wells SRW 1, SRW 4, SRW 13C, SRW 14C, and SRW 15C are sidegradient; and wells SRW 5, SRW 6, SRW 7, SRW 8, SRW 9, SRW 10, SRW 11, and SRW 12C are downgradient relative to the site. The groundwater samples from the upgradient water-table wells consistently met South Carolina and federal drinking water standards except for manganese in well SRW 16C (0.016 to 0.07 mg/L). Because this well is upgradient of and approximately 1,000 ft from the site, a source of manganese other than the Silverton Road Waste Site is suspected. Total radium activity in well SRW 2 was equal to the drinking water standard (5 pCi/L) on one occasion. Radioactivity is not known to be related to past site activities. Organic solvent concentrations generally were less than detection limits except for well SRW 2 in which low levels of halogenated organics were detected. As discussed in Section 5.11.04, well SRW 2 may be sampling a perched water zone.

The groundwater in the sidegradient water-table wells (SRW 1, SRW 4, SRW 13C, SRW 14C, and SRW 15C) consistently met South Carolina and federal drinking water standards except for an isolated iron excursion in well SRW 1 (0.707 mg/L) and one in SRW 4 (0.372 mg/L). Iron concentrations in these two wells have been below the drinking water standard since the second quarter of 1985. Organic solvent concentrations generally were less than detection limits in these wells. A low concentration of 1,1,1-trichloroethane (1,1,1-TCE; 0.003 mg/L) was detected in well SRW 14C. Chloroform was detected in two of the sidegradient wells; the highest concentration (0.015 mg/L) was detected in well SRW 4. The South Carolina and federal primary drinking water standard for trihalomethanes is 0.100 mg/L.

Groundwater quality in the downgradient water-table wells has been characterized by elevated organic solvent concentrations, suggesting that the Silverton Road Waste Site has had some effect on local groundwater quality. Carbon tetrachloride concentrations exceeded the drinking water standard in wells SRW 6, SRW 7, and SRW 11 (up to 0.012 mg/L). These three wells are closely grouped just downgradient of the western corner of the site (Figure 5-35). Trichloroethylene levels were consistently above the drinking water standard in wells SRW 7 and SRW 11, with values up to 0.016 mg/L. Trichloroethylene concentrations ranged above the drinking water standard (up to 0.011 mg/L) in wells SRW 5, SRW 6, SRW 8, and SRW 9. Wells SRW 10 and SRW 12C were the only downgradient water-table wells that did not experience trichloroethylene excursions. Tetrachloroethylene was detected in every downgradient well in concentrations up to 0.008 mg/L. Chloroform was detected in every downgradient well except SRW 10. The chloroform concentrations in the other downgradient wells ranged from <0.001 to 0.024 mg/L. These concentrations are below the drinking water standard for trihalomethanes but range above the concentrations reported for the upgradient and sidegradient wells. 1,1,1-Trichloroethane (1,1,1-TCE) was detected in concentrations below the drinking water standard in all of the downgradient wells except SRW 5 and SRW 12C, in which concentrations were less than the detection limit. Total organic halogen (TOH) concentrations ranged from <0.005 to 0.148 mg/L in the downgradient wells and from <0.005 to 0.065 mg/L in the upgradient and sidegradient wells.

Iron and zinc excursions above their respective drinking water standards of 0.3 mg/L and 5 mg/L were also recorded for the downgradient water-table wells. A single iron excursion (1.53 mg/L) was recorded for well SRW 11; well SRW 5 had iron concentrations that frequently exceeded the drinking water standard, ranging from 0.019 to 1.38 mg/L. Isolated zinc excursions were recorded for wells SRW 7 (12.1 mg/L) and SRW 11 (6.69 mg/L). Both zinc excursions occurred in the third quarter of 1984, and subsequent zinc concentrations in these wells have met the drinking water standard.

Conductivity in the water-table wells was low, ranging from 13 to 115 μmhos/cm in the upgradient and sidegradient wells and from 12 to 76 μmhos/cm in the downgradient wells. The pH of the groundwater in the water-table wells ranged from 3.6 to 6.4; pH levels as low as 4.0 are generally consistent with pH values reported as naturally occurring in SRS groundwaters (Appendix B).

Groundwater monitoring results for the B-designated wells are summarized in Table 5-39. As shown in Figure 5-36, wells SRW 2B and SRW 16B are upgradient; wells SRW 13B, SRW 14B, and SRW 15B are sidegradient; and wells SRW 9B and SRW 12B are downgradient relative to the site. The groundwater samples from these wells have consistently met South Carolina and federal drinking water standards.

All organic halogen concentrations in the B-designated wells were below detection limits except for chloroform (0.001 mg/L) and 1,1,1-trichloroethane (1,1,1-TCE; 0.003 mg/L) in downgradient well SRW 12B. The detected concentrations were well below the respective drinking water standard for each constituent. Conductivity and pH values were consistent among the site wells. Conductivity ranged from 12 to 26 μmhos/cm in the downgradient wells and from 17 to 34 μmhos/cm in the upgradient and downgradient wells. pH values ranged from 3.9 to 5.6 in these wells; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in SRS groundwaters (Appendix B).

Groundwater monitoring results for the A-designated wells are summarized in Table 5-40. As shown in Figure 5-37, wells SRW 2A and SRW 16A are upgradient; wells SRW 13A, SRW 14A, and SRW 15A are sidegradient; and wells SRW 9A and SRW 12A are downgradient relative to the site. The groundwater samples from these wells have consistently met South Carolina and federal drinking water standards except for two excursions of trichloroethylene in upgradient well SRW 16A.

Organic solvent concentrations have been below detection limits in the A-designated wells except for isolated concentrations detected in the upgradient and sidegradient wells. Trichloroethylene concentrations exceeded the drinking water standard (0.005 mg/L) twice in upgradient well SRW 16A (up to 0.007 mg/L); both excursions occurred in the last half of 1986. Halogenated organic concentrations in the downgradient wells consistently have been below detection limits, suggesting that the source of organics in this monitoring zone is not the Silverton Road Waste Site.

Conductivity values for the A-designated wells were low, ranging from 16 to 36 μmhos/cm. pH values ranged from 3.7 to 5.6; pH values as low as 4.0 are generally consistent with pH values reported as naturally occurring in SRS groundwaters (Appendix B).

5.11.08 Planned Action

The Silverton Road Waste Site is inactive. As indicated in Section 16, a site assessment is planned for late 1989 or 1990. Groundwater monitoring will continue at this site.

TABLE 5-1

Discharges of Low-Level Wastewater to the Savannah River Laboratory (SRL) Seepage Basins

Period	Volume (gal)
1954-1971	24,283,500
1972	1,773,750
1973-1977	4,196,800
1978-1982	3,748,100
Total (1954-1982)	34,002,150

Note: Data are from Fowler et al. (1987).

TABLE 5-2

Radioactive Releases to the Savannah River Laboratory (SRL) Seepage Basins

Radionuclide	Total Release (Ci)
^{3}H	243
$^{89,90}Sr$	0.4
^{137}Cs	4.7
Natural U	0.022
^{238}Pu	0.009
^{239}Pu	0.003
^{241}Am	0.001
$^{242,244}Cm$	0.001*
$^{103,106}Ru$	1.4
^{60}Co	0.1
$^{141,144}Ce$	2.7
Alpha (unidentified)	4.2
Beta-gamma (unidentified)	1.4

Note: Data are from Zeigler et al. (1987).

* This value does not include the curium (0.68 Ci) released to the SRL Seepage Basins in 1971 as the result of a separator pit leak.

TABLE 5-3

Historical Loadings to the Savannah River Laboratory (SRL) Seepage Basins

Constituent	Concentration (mg/L)*	Annual Load (kg/yr)	28-Year Total (kg)
Aluminum	2.3	10	295
Arsenic	<0.1	0.5	13
Boron	2.2	10	283
Barium	0.5	2.3	64
Beryllium	<0.003	<0.01	<0.4
Bismuth	<0.05	<0.2	<6.4
Calcium	37.0	170	4,800
Cadmium	<0.01	<0.05	<1.3
Cobalt	<0.01	<0.05	<1.3
Chromium	9.5	44	1,220
Copper	0.4	1.8	52
Iron	5	23	643
Mercury	0.2	1	26
Lanthanum	0.04	0.2	5
Lithium	0.7	3.2	90
Magnesium	6.3	29	810
Manganese	3.4	16	438
Molybdenum	0.02	0.1	2.6
Sodium	189	869	24,500
Nickel	5.2	24	670
Phosphorus	30	138	3,860
Lead	4	18	515
Ruthenium	<0.05	<0.2	<6.4
Silicon	8.5	39	1,095
Tin	<0.05	<0.2	<6.4
Strontium	0.11	0.5	14
Titanium	0.09	0.4	12
Uranium	2.9	13	373
Vanadium	0.03	0.1	3.9
Yttrium	<0.01	<0.05	<1.3
Ytterbium	0.28	1.3	36
Zinc	1.7	7.8	219
Zirconium	0.06	0.28	7.8
Chlorine	148	680	19,000
Nitrate	600	2,760	77,000

Note: Data are from Fowler et al. (1987).

* These analyses were performed October 1, 1982.

TABLE 5-4

Analysis of Low-Level Waste from the Collection Tanks in Building 776-A

Constituent	Concentration (mg/L) Tank E*	Tank D	Tank F	Tank
Aluminum	2.32	4.81	4.96	2.91
Arsenic	<0.1	<0.1	0.115	<0.1
Boron	2.18	3.57	3.64	3.53
Barium	0.47	0.110	2.79	0.213
Beryllium	<0.003	0.0034	0.0037	<0.003
Bismuth	<0.05	0.0698	0.0699	<0.05
Calcium	36.9	20.5	18.7	16.9
Cadmium	<0.01	0.0139	0.0116	0.0125
Cobalt	<0.01	2.07	5.40	0.470
Chromium	9.52	4.84	0.522	0.687
Copper	0.408	0.295	0.227	0.151
Iron	5.07	6.24	6.73	2.87
Mercury	0.239	1.06	0.852	0.288
Lanthanum	0.039	0.603	12.3	1.10
Lithium	0.669	0.528	0.731	0.688
Magnesium	6.26	1.98	1.31	1.17
Manganese	3.42	0.876	2.46	1.95
Molybdenum	0.0249	0.062	0.0997	0.0394
Sodium	189	106	368	53.8
Nickel	5.17	1.06	3.33	0.880
Phosphorus	30.1	0.54	16.0	3.06
Lead	3.95	1.09	6.68	1.28
Ruthenium	<0.05	<0.05	0.0632	<0.05
Silicon	8.51	14.7	15.5	10.1
Tin	<0.05	0.106	0.0954	<0.05
Strontium	0.113	2.66	0.108	0.0781
Titanium	0.085	0.180	0.211	0.160
Uranium	2.90	8.12	8.52	2.94
Vanadium	0.0277	0.0702	0.118	0.0582
Yttrium	<0.01	0.0145	0.0245	0.0123
Ytterbium	0.275	0.330	1.02	0.249
Zinc	1.65	0.442	0.655	0.320
Zirconium	0.0607	0.213	0.531	0.0842

Note: Data are from Fowler et al. (1987).

* These analyses were performed in October 1982; the others were performed in November 1982.

TABLE 5-5

Results of Basin Water Analyses for the Savannah River Laboratory (SRL) Seepage Basins

Parameter	Units	Basin 1	Basin 2	Basin 3
Color	CU	0	10	15
Corrosivity	NA	No	No	No
pH	pH	5.6	5.5	5.5
Conductivity	μmhos/cm	109	110	88
Total dissolved solids	mg/L	96	130	92
Turbidity	NTU	2.8	3.8	3.5
Silver	mg/L	0.008	0.006	<0.005
Arsenic	mg/L	0.010	0.013	0.011
Barium	mg/L	0.031	0.039	0.080
Beryllium	mg/L	0.003	0.004	<0.002
Cadmium	mg/L	<0.002	<0.002	<0.002
Chromium	mg/L	0.008	<0.004	<0.004
Copper	mg/L	0.017	0.011	0.038
Iron	mg/L	0.251	0.345	0.462
Mercury	mg/L	0.0031	0.0011	<0.0002
Manganese	mg/L	0.110	0.185	0.063
Sodium	mg/L	4.440	4.990	5.100
Nickel	mg/L	0.029	0.220	0.036
Lead	mg/L	0.023	0.014	<0.005
Selenium	mg/L	<0.001	<0.001	<0.001
Zinc	mg/L	0.075	0.029	0.021
Chlorine	mg/L	12.90	10.21	6.99
Cyanide	mg/L	0.012	<0.005	<0.005
Fluoride	mg/L	0.15	0.15	0.23
Surfactants	mg/L	0.096	0.108	0.114
Hydrogen sulfate	mg/L	<1	<1	<1
Gross alpha	pCi/L	93	72	26
Nonvolatile beta	pCi/L	102	336	379
Total radium	pCi/L	19	8	<1
Dissolved oxygen content	mg/L	8.00	8.00	12.12
GC Scan	μg/L	70	<40	2,280
Total organic carbon	mg/L	11.0	8.0	17.0
Total organic halogens	mg/L	0.02	0.44	0.25
Endrin	μg/L	<0.04	<0.04	<0.04
Lindane	μg/L	<1	<1	<1
Methoxychlor	μg/L	<20	<20	<20
Toxaphene	μg/L	<1	<1	<1
2,4-D	μg/L	<20	<20	<20
2,4,5-TP	μg/L	<2	<2	<2

Note: Basin 4 did not contain any water. Data are from Fowler et al. (1987).

TABLE 5-6

Annual Average Radioactivity in Savannah River Laboratory (SRL) Seepage Basin 1 Water

Year	Average Activity (pCi/mL) Gross Alpha	Nonvol. Beta	Tritium
1961	0.85	8.9	2,850
1962	0.45	66	4,800
1963	0.25	70.5	1,250
1964	0.35	61.5	710
1965	0.17	76.5	890
1966	0.6	8	3,500
1967	0.4	6	3,900
1968	5.02	29.5	3,800
1969	12.4	39.5	1,210
1970	88.3	399	855
1971	48.2	32	820
1972	25.6	8.5	2,500
1973	35.6	36	1,400
1974	12.8	9.95	1,850
1975	0.461	0.773	1,920
1976	0.282	0.604	587
1977	0.190	0.480	250
1978	0.910	0.600	120
1979	0.310	0.300	180
1980	0.190	0.240	190
1981	0.120	0.170	210
1982	0.270	0.450	32
1983	38*	410*	16
1984	67*	890*	8.8
1985	0.018	0.650	3.2
1986	0.043	6.10	41

Note: Prior to 1973, means were reported for 6-month intervals. Values given in this table prior to 1973 are the average of the 6-month values.

* These concentrations are believed to be in pCi/L, not pCi/mL.

TABLE 5-7

Soil Core Data for the Savannah River Laboratory (SRL) Seepage Basins

Basin 1

Analyte	Concentrations (μg/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
Arsenic	2.52	4.05	3.31	0.13	2.83
Barium	11.6	25.8	24.5	<2.0	7.3
Cadmium	1.30	4.30	2.64	<0.20	0.40
Chromium	69.5	249.0	136.1	1.2	53.4
Copper	31.72	79.68	49.39	0.84	12.82
Lead	32.2	84.3	55.0	1.5	17.2
Mercury	8.8	26.7	16.9	<0.2	3.5
Nickel	22.8	142.7	64.4	0.5	11.2
Selenium	<0.05	<0.05	<0.05	<0.05	<0.05
Silver	1.31	28.60	16.47	<0.02	5.12
Zinc	33.0	160.0	77.2	1.0	16.6

Analyte	Concentrations (pCi/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
^{241}Am	0.19	100.0	25.9	0.02	1.8
^{137}Cs	670	2,060	1,086	0.25	107
^{60}Co	1.37	8.69	4.92	<0.02	0.17
^{242}Cm	<0.04	5.4	1.66	<0.01	0.22
$^{243,244}Cm$	13.0	1,300	400	0.25	22.0
^{238}Pu	0.05	61.0	16.8	0.09	2.4
$^{239,240}Pu$	0.06	330	75.5	0.13	61.0
^{90}Sr	43.0	360	141	<0.07	48.0
^{3}H*	6.8	18.5	11.9	2.0	27.0
^{235}U	2.3	53.0	16.7	<0.01	2.3
^{238}U	22.0	420	159	0.1	22.0

* Assumes a moisture content of 0.3 and a bulk density of 1.6 g/cm^3.

TABLE 5-7 (cont.)

Basin 2

Analyte	Concentrations (μg/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
Arsenic	3.40	14.70	6.74	0.05	1.20
Barium	22.0	100.4	51.2	<2.0	30.0
Cadmium	1.14	14.38	6.77	<0.20	0.50
Chromium	30.2	307.7	140.2	<1.0	36.8
Copper	21.48	175.6	90.90	<0.50	3.52
Lead	16.4	173.2	84.1	1.4	6.0
Mercury	5.2	43.0	21.3	<0.2	1.5
Nickel	23.7	169.7	89.5	0.5	4.0
Selenium	<0.05	<0.05	<0.05	<0.05	<0.05
Silver	1.44	15.40	9.09	<0.02	0.28
Zinc	2.4	345.6	151.8	1.5	77.2

Analyte	Concentrations (pCi/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
^{241}Am	10.0	50.0	30.8	<0.02	11.0
^{137}Cs	453	2,470	1,448	<0.03	95.5
^{60}Co	4.5	284	82.0	<0.03	3.7
^{242}Cm	<0.1	1.2	0.6	<0.01	0.05
$^{243,244}Cm$	17.0	770	433	0.05	82.0
^{238}Pu	5.7	220	55.5	0.04	1.5
$^{239,240}Pu$	9.0	280	182	0.03	3.1
^{90}Sr	140	640	356	<0.05	19.0
^{3}H*	4.8	7.5	6.4	3.8	14.4
^{235}U	2.1	12.0	5.7	<0.01	0.10
^{238}U	36.0	190	91.4	0.03	2.7

* Assumes a moisture content of 0.3 and a bulk density of 1.6 g/cm^3.

TABLE 5-7 (cont.)

Basin 3

Analyte	Concentrations ($\mu g/g$) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
Arsenic	2.80	9.20	5.44	0.36	15.03
Barium	4.1	11.5	6.5	<2.0	2.6
Cadmium	0.22	0.85	0.62	<0.20	0.25
Chromium	12.4	35.8	24.6	1.8	35.5
Copper	3.20	14.00	9.56	0.90	4.30
Lead	4.5	13.8	8.0	1.6	7.7
Mercury	<0.2	2.9	1.5	<0.2	<0.2
Nickel	4.0	18.1	11.2	<0.8	4.0
Selenium	<0.10	<0.10	<0.10	<0.10	0.22
Silver	0.06	0.57	0.23	<0.02	0.06
Zinc	4.7	34.6	24.0	0.2	36.5

Analyte	Concentrations (pCi/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
^{241}Am	0.14	4.2	1.3	0.05	0.57
^{137}Cs	311	867	559	<0.05	42.0
^{60}Co	2.7	19.0	10.4	<0.02	1.6
^{242}Cm	<0.01	0.11	0.06	<0.01	0.12
$^{243,244}Cm$	1.9	75.0	35.0	<0.03	8.0
^{238}Pu	0.11	7.6	2.3	0.005	0.46
$^{239,240}Pu$	0.03	3.8	1.1	<0.001	0.48
^{90}Sr	39	6,900	1,435	<0.05	5.5
^{3}H*	1.1	2.0	1.6	1.0	3.1
^{235}U	1.7	9.9	4.2	0.004	0.22
^{238}U	11.0	30.0	15.7	0.08	2.2

* Assumes a moisture content of 0.3 and a bulk density of 1.6 g/cm^3.

TABLE 5-7 (cont.)

Basin 4

Analyte	Concentrations (μg/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
Arsenic	3.53	19.64	8.05	0.27	50.21
Barium	3.1	10.0	7.9	<2.0	11.6
Cadmium	0.32	0.54	0.40	<0.20	0.42
Chromium	16.9	41.7	30.7	3.7	56.0
Copper	4.00	14.80	10.24	1.10	7.40
Lead	2.9	7.1	4.9	0.9	8.9
Mercury	<0.2	0.8	0.4	<0.2	<0.2
Nickel	4.0	8.8	6.8	1.0	4.4
Selenium	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	0.03	0.58	0.30	<0.02	0.05
Zinc	11.7	35.0	23.5	1.1	55.5

Analyte	Concentrations (pCi/g) Top 3 in. Minimum	Maximum	Mean	2 to 20 ft deep Minimum	Maximum
^{241}Am	0.04	7.9	3.6	0.01	0.71
^{137}Cs	100	237	158	0.03	3.3
^{60}Co	0.67	2.9	1.9	<0.02	<0.05
^{242}Cm	<0.005	0.17	0.05	<0.02	0.23
$^{243,244}Cm$	5.9	66.0	33.0	0.07	9.3
^{238}Pu	0.11	1.3	0.65	0.01	0.11
$^{239,240}Pu$	0.14	1.0	0.57	<0.003	0.11
^{90}Sr	1.2	21	13.2	<0.05	22
^{3}H*	1.1	1.3	1.2	0.3	2.2
^{235}U	0.17	1.4	0.73	<0.01	0.08
^{238}U	2.3	10.0	5.4	0.1	0.5

Note: Data are from Fowler et al. (1987).

* Assumes a moisture content of 0.3 and a bulk density of 1.6 g/cm^3.

TABLE 5-8

Summary of Groundwater Quality: Well Concentration Ranges for the Savannah River Laboratory (SRL) Seepage Basins (7/84-12/86)

Constituent	SC and Federal DWS	ASB 1A	ASB 2A	ASB 3A	ASB 4
pH (pH)	6.5-8.5	4.3-5.5	4.1-5.1	4.7-5.4	4.7-5.5
Conductivity (µmhos/cm)	NA	35-75	38-80	35-92	38-84
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.008-0.012	0.017-0.018	0.021-0.026	0.017-0.020
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005	<0.005	<0.005
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.005	<0.005	<0.005	<0.005
Chloride (mg/L)	250	5.6-7.8	6.3-8.1	5.3-7.5	3.4-5.2
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004-0.032
Copper (mg/L)	1	<0.004	<0.004-0.008	<0.004	<0.004-0.007
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0	<5.0	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.12	<0.10-0.13	<0.10-0.12	<0.10-0.13
Iron (mg/L)	0.3	<0.004-0.032	0.034-0.068	0.033-0.085	0.366-1.690
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0003	<0.0002-0.0005	<0.0002-0.0003
Manganese (mg/L)	0.05	0.020-0.120	0.046-0.074	0.006-0.015	0.009-0.040
Sodium (mg/L)	NA	2.01-3.71	2.47-4.00	2.20-4.26	1.76-3.25
Nickel (mg/L)	NA	<0.004	<0.004	<0.004-0.004	0.011-0.025
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	<0.50	<0.50-0.60	<0.50	<0.50
Lead (mg/L)	0.05	<0.004-0.035	0.006-0.026	<0.004-0.018	<0.004-0.011
Phenols (mg/L)	NA	<0.002-0.011	<0.002-0.005	<0.002-0.007	<0.002-0.012
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0-11.0	<5.0	<5.0-8.0
Tetrachloroethylene (mg/L)	NA	<0.005	<0.005	<0.005	<0.005
TDS (mg/L)	500	20-40	22-30	16-40	70-3,542
TOC (mg/L)	NA	0.350-1.39	0.300-10.7	0.295-3.00	0.900-14.5
TOH (mg/L)	NA	<0.005-0.013	<0.005-0.013	<0.005-0.025	0.011-0.071
Trichloroethylene (mg/L)	0.005	<0.005	<0.005	<0.005	0.022
1,1,1-TCE (mg/L)	0.200	<0.005	<0.005	<0.005	<0.005
Zinc (mg/L)	5	<0.002-0.055	<0.002-0.129	0.019-0.304	0.053-0.086
Gross alpha (pCi/L)	15	<2.0-10.0	4.0-20.0	<2.0-22.9	3.7-12.0
Nonvol. beta (pCi/L)	NA	<3.0-7.0	<3.0-20.0	<3.0-21.0	<3.0-9.0
Total radium (pCi/L)	5	2.0-4.0	4.0-6.0	<1.0-11.0	3.8-6.0

TABLE 5-8 (cont.)

Constituent	SC and Federal DWS	ASB 5A	ASB 6A
pH (pH)	6.5-8.5	4.3-4.9	3.9-4.8
Conductivity (µmhos/cm)	NA	38-87	37-62
Silver (mg/L)	0.05	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001
Barium (mg/L)	1.0	0.010-0.016	0.007-0.010
Beryllium (mg/L)	NA	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005
Cadmium (mg/L)	0.010	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.005	<0.005
Chloride (mg/L)	250	8.1-11.7	6.4-8.1
Chromium (mg/L)	0.05	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.006	<0.004-0.015
Cyanide (mg/L)	0.2	<0.005	<0.005
DOC (mg/L)	NA	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.11	<0.10-0.12
Iron (mg/L)	0.3	<0.004-0.054	<0.004-0.049
Mercury (mg/L)	0.002	<0.0002-0.0004	<0.0002
Manganese (mg/L)	0.05	0.004-0.030	0.009-0.043
Sodium (mg/L)	NA	4.00-7.41	2.68-4.99
Nickel (mg/L)	NA	<0.004	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50
Nitrate (as N) (mg/L)	10	<0.50-1.15	<0.50-1.00
Lead (mg/L)	0.05	<0.004-0.014	<0.004-0.036
Phenols (mg/L)	NA	<0.002-0.003	<0.002-0.005
Selenium (mg/L)	0.01	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.005	0.008
TDS (mg/L)	500	30-60	<5-22
TOC (mg/L)	NA	0.334-0.669	0.481-1.265
TOH (mg/L)	NA	0.047-0.356	0.008-0.044
Trichloroethylene (mg/L)	0.005	0.185	<0.005
1,1,1-TCE (mg/L)	0.200	<0.005	<0.005
Zinc (mg/L)	5	0.005-0.268	<0.002-0.037
Gross alpha (pCi/L)	15	<2.0-7.0	<2.0-11.0
Nonvol. beta (pCi/L)	NA	<2.0-5.0	<3.0-11.0
Total radium (pCi/L)	5	2.0-4.0	<1.0-7.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-9

Motor Shop Oil Basin Water Analyses

Analyte	Units	Result
Arsenic	mg/L	0.007
Barium	mg/L	0.010
Cadmium	mg/L	0.003
Chromium	mg/L	<0.004
Lead	mg/L	0.006
Mercury	mg/L	0.0003
Selenium	mg/L	<0.001
Silver	mg/L	<0.0005
pH	NA	5.45
Conductivity	μmhos/cm	46.0
Flash point	NA	None
Oil and grease	mg/L	9
Ethylene glycol	μg/mL	<73.9
Kerosene	μg/mL	<68.5
Chloroform	μg/L	<1.0
Methylene chloride	μg/L	8.0
Toluene	μg/L	1.0
Anthracene	μg/L	115.0
Bis(2-ethylhexyl) phthalate	μg/L	25.0
Naphthalene	μg/L	13.0
Pyrene	μg/L	13.0

Note: Data are from Huber et al. (1987b).
NA = not applicable.

TABLE 5-10

Summary of Groundwater Quality: Well Concentration Ranges for the Motor Shop Oil Basin (7/84-12/86)

Constituent	SC and Federal DWS	AOB 1	AOB 2
pH (pH)	6.5-8.5	4.0-4.8	4.1-5.2
Conductivity (µmhos/cm)	NA	29-51	22-42
Silver (mg/L)	0.05	<0.0005	<0.0005
Arsenic (mg/L)	0.05	<0.001	<0.001
Barium (mg/L)	1.0	0.012-0.015	<0.004-0.006
Beryllium (mg/L)	NA	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001
Chloride (mg/L)	250	1.9-3.8	0.7-2.9
Chromium (mg/L)	0.05	<0.004-0.055	<0.004-0.005
Copper (mg/L)	1	0.005-0.009	0.005-0.006
Cyanide (mg/L)	0.2	<0.005	<0.005
DOC (mg/L)	NA	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004-0.00011	<0.00004-0.00007
Fluoride (mg/L)	1.6	<0.10-0.17	<0.10-0.17
Iron (mg/L)	0.3	0.015-0.228	0.025-0.232
Mercury (mg/L)	0.002	<0.0002-0.0007	<0.0002
Manganese (mg/L)	0.05	0.011-0.016	0.008-0.030
Sodium (mg/L)	NA	1.58-1.83	1.97-2.15
Nickel (mg/L)	NA	<0.004-0.028	<0.004-0.006
Nitrite (as N) (mg/L)	NA	<0.50	<0.50
Nitrate (as N) (mg/L)	10	1.25-1.33	1.55-1.82
Lead (mg/L)	0.05	0.005-0.010	0.006-0.011
Phenols (mg/L)	NA	<0.002-0.014	<0.002-0.006
Selenium (mg/L)	0.01	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	0.036-0.061	<0.001-0.003
TDS (mg/L)	500	12-48	52-62
TOC (mg/L)	NA	1.000-16.6	0.300-9.24
TOH (mg/L)	NA	0.072-0.260	<0.005-0.027
Trichloroethylene (mg/L)	0.005	0.006-0.046	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001
Zinc (mg/L)	5	0.013-0.022	0.059-0.066
Gross alpha (pCi/L)	15	3.0-5.0	1.1-3.0
Nonvol. beta (pCi/L)	NA	1.0-5.0	0.2-3.0
Total radium (pCi/L)	5	<1.0-3.0	0.6-3.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-11

Summary of Groundwater Quality: Well Concentration Ranges for the A-Area Metals Burning Pit (7/84-12/86)

Constituent	SC and Federal DWS	ABP 1A	ABP 2A	ABP 3	ABP 4
pH (pH)	6.5-8.5	3.9-5.6	4.0-5.2	4.3-5.2	3.8-5.1
Conductivity (µmhos/cm)	NA	14-24	12-21	12-39	18-30
Silver (mg/L)	0.05	<0.0004-0.0006	<0.0004-0.0015	<0.0005	<0.0004
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.001	<0.002
Barium (mg/L)	1.0	<0.004-0.006	<0.004	0.005-0.006	0.004-0.005
Beryllium (mg/L)	NA	---	---	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.001-0.003	<0.001	<0.001	<0.001-0.002
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002-0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001	<0.001-0.002	0.002-0.003
Chloride (mg/L)	250	1.1-6.6	1.0-4.6	1.1-4.9	1.1-6.1
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	---	---	0.006-0.015	---
Cyanide (mg/L)	0.2	---	---	<0.005	---
DOC (mg/L)	NA	---	---	<5.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.05-0.17	0.06-0.18	<0.10-0.18	0.06-0.19
Iron (mg/L)	0.3	0.030-0.892	<0.004-0.095	0.068-0.182	<0.004-0.139
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002	<0.0002-0.0006	<0.0002
Manganese (mg/L)	0.05	0.003-0.024	0.002-0.010	0.019-0.034	0.005-0.007
Sodium (mg/L)	NA	0.79-1.32	0.93-1.16	1.08-1.59	1.10-1.35
Nickel (mg/L)	NA	---	---	<0.004-0.005	---
Nitrite (as N) (mg/L)	NA	---	---	<0.50	---
Nitrate (as N) (mg/L)	10	<0.50	<0.50	<0.50	0.80-1.15
Lead (mg/L)	0.05	<0.004-0.009	<0.004-0.006	0.005-0.017	<0.006-0.039
Phenols (mg/L)	NA	<0.002-0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.001	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	0.003-0.004	0.003-0.004	0.003-0.007	0.003-0.004
TDS (mg/L)	500	---	---	24-50	---
TOC (mg/L)	NA	0.150-3.00	0.220-3.491	0.450-18.800	0.370-2.851
TOH (mg/L)	NA	<0.005-0.010	0.014-0.043	0.030-0.048	<0.005-0.017
Trichloroethylene (mg/L)	0.005	0.002-0.004	0.019-0.030	0.045-0.071	0.004-0.006
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001	<0.001
Zinc (mg/L)	5	---	---	0.065-0.084	---
Gross alpha (pCi/L)	15	<2.0-2.1	1.3	1.7-6.0	0.8-10.0
Nonvol. beta (pCi/L)	NA	<0.5	2.0	<0.5-18.0	1.0-9.0
Total radium (pCi/L)	5	0.6	0.5	0.5	<1.0-3.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-12

A-Area Coal Pile Basin Influent Characterization Data

Parameter	Units	Initial	Final	Composite
Time	NA	1050	1535	NA
Temperature	C	22.0	24.7	NA
Flow	gal/min	3-5	1-2	NA
pH	pH	2.80	2.56	2.66
Conductivity	µmhos/cm	850	1,400	1,316
Sulfate (as SO_4)	mg/L	225	381	376
Total suspended solids	mg/L	176	5	15
Total dissolved solids	mg/L	375	599	557
Phenols	mg/L	<0.001	<0.001	0.002
Acidity (as $CaCO_3$)	mg/L	73	200	135
Beryllium	mg/L	0.0055	0.0098	0.0093
Cadmium	mg/L	<0.006	<0.006	<0.006
Copper	mg/L	0.169	0.257	0.209
Chromium	mg/L	<0.02	<0.02	<0.02
Iron	mg/L	20.3	15.3	16.1
Lead	mg/L	0.0102	0.0041	0.0027
Mercury	mg/L	0.00014	0.00011	0.000010
Nickel	mg/L	<0.05	<0.05	<0.05
Selenium	mg/L	0.0070	0.0041	0.0075
Zinc	mg/L	0.332	0.419	0.411
Aluminum	mg/L	24.5	28.5	27.4
Manganese	mg/L	0.542	0.650	0.691
Magnesium	mg/L	5.56	6.37	5.96
Arsenic	mg/L	0.0105	0.0017	<0.001
Silver	mg/L	<0.001	<0.001	<0.001
Barium	mg/L	<0.03	<0.03	<0.03

Note: NA = not applicable.

TABLE 5-13

Summary of Groundwater Quality: Well Concentration Ranges for the A-Area Coal Pile Runoff Containment Basin (7/84-12/86)

Constituent	SC and Federal DWS	ACB 1A	ACB 2A	ACB 3A	ACB 4A
pH (pH)	6.5-8.5	4.2-5.6	4.3-5.7	4.0-5.4	4.0-5.1
Conductivity (µmhos/cm)	NA	30-52	31-69	22-38	22-40
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	<0.004	<0.004-0.006	<0.004	<0.004-0.004
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001	<0.005
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001	<0.001	<0.005
Chloride (mg/L)	250	2.4-5.8	2.9-7.5	1.9-5.8	1.9-6.6
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.006	<0.004	<0.004-0.010	<0.004-0.007
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0	7.0-32.4	<5.0-5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.12	<0.10	<0.10	<0.10-0.12
Iron (mg/L)	0.3	0.024-0.087	0.028-0.112	0.021-0.158	0.016-0.084
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0005	<0.0002-0.0012	<0.0002-0.0010
Manganese (mg/L)	0.05	<0.002-0.007	0.003-0.011	<0.002-0.028	0.007-0.012
Sodium (mg/L)	NA	4.16-6.36	6.74-7.99	3.94-4.52	2.24-2.69
Nickel (mg/L)	NA	<0.004	<0.004	<0.004-0.004	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	<0.50-0.93	<0.50	0.95-1.00	1.00-1.50
Lead (mg/L)	0.05	0.007-0.012	<0.004-0.007	<0.004-0.009	0.008-0.018
Phenols (mg/L)	NA	<0.002-0.005	<0.002-0.002	<0.002	<0.002-0.006
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0-10.0	5.0-21.0	2.5-5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001	<0.001	<0.005
TDS (mg/L)	500	24-152	32-82	72-286	10-202
TOC (mg/L)	NA	0.600-1.252	0.614-37.000	0.185-0.570	0.404-1.610
TOH (mg/L)	NA	<0.005-0.015	<0.005-0.025	<0.005-0.009	<0.005-0.011
Trichloroethylene (mg/L)	0.005	<0.001	<0.001	<0.001	<0.005
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001	<0.005
Zinc (mg/L)	5	0.010-0.025	0.010-0.013	0.004-0.029	0.005-0.016
Gross alpha (pCi/L)	15	<2.0	<2.0-9.0	<2.0-4.0	<2.0-5.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0-7.0	<3.0-4.0	<3.0-3.0
Total radium (pCi/L)	5	<1.0-2.0	<1.0-5.0	<1.0-2.0	4.0-6.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-14

Summary of Groundwater Quality: Well Concentration Ranges for the A-Area Burning/Rubble Pits and A-Area Ash Pile 788-2A (7/84-12/86)

Constituent	SC and Federal DWS	ARP 1A	ARP 2	ARP 3	ARP 4
pH (pH)	6.5-8.5	4.0-5.6	3.9-5.0	3.9-5.3	3.9-4.9
Conductivity (μmhos/cm)	NA	32-69	15-39	18-32	15-29
Silver (mg/L)	0.05	<0.0004	<0.0004	<0.0004	<0.0004
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	<0.004-0.011	0.004-0.007	0.005-0.006	0.005-0.006
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.001-0.001	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	0.003-0.006	<0.001	<0.001-0.001	<0.001
Chloride (mg/L)	250	1.6-5.0	<2.0-2.9	2.0-6.9	2.9-6.1
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.012	<0.004-0.073	<0.004	0.012
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	<5.0	<5.0	<5.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.13	0.02	0.09	0.02
Iron (mg/L)	0.3	0.011-0.068	0.004-0.047	0.016-0.053	0.014-0.068
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002-0.0003	<0.0002
Manganese (mg/L)	0.05	0.012-0.018	0.003-0.034	0.004-0.008	0.010-0.014
Sodium (mg/L)	NA	2.36-5.92	1.03-1.54	1.52-1.75	1.44-1.93
Nickel (mg/L)	NA	<0.004-0.009	<0.004-0.019	<0.004	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	0.51-0.55	0.58-0.63	0.40	0.48-0.50
Lead (mg/L)	0.05	<0.004-0.018	<0.005-0.346	0.007-0.029	<0.004-0.013
Phenols (mg/L)	NA	<0.002-0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0-13.0	<5.0-46.0	<5.0-5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001-0.003	0.001-0.003	<0.005-0.006	<0.001-0.002
TDS (mg/L)	500	34-36	22-26	14-32	---
TOC (mg/L)	NA	0.180-7.00	0.380-2.38	0.290-25.0	0.360-2.70
TOH (mg/L)	NA	<0.005-0.035	<0.005-0.035	0.011-0.085	<0.005-0.009
Trichloroethylene (mg/L)	0.005	0.004-0.011	<0.001-0.002	<0.001-0.067	0.002-0.003
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001	<0.001
Zinc (mg/L)	5	0.012-0.016	0.012-0.288	0.016-0.018	---
Gross alpha (pCi/L)	15	<2.0-8.0	<2.0-11.0	<2.0-10.0	<2.0-11.0
Nonvol. beta (pCi/L)	NA	<3.0-3.0	<3.0-7.0	<3.0-7.0	<3.0-18.0
Total radium (pCi/L)	5	<1.0-2.0	<1.0-4.0	<1.0-3.1	<1.0-6.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-15

Trace Elements in Different Types of Ash

Element	Ash Type (mg/L) Fly Ash (Electrostatic Precipitator)	Fly Ash (Mechanical Collector)	Bottom Ash
Barium	889	792	808
Strontium	579	589	333
Manganese	352	275	811
Zinc	280	116	95
Vanadium	218	166	140
Cerium	189	251	150
Chromium	171	140	160
Arsenic	164	55	4
Copper	130	93	67
Nickel	89	87	77
Gallium	72	32	20
Lanthanum	69	61	61
Cobalt	67	47	40
Lead	60	28	5
Bromine	47	12	3
Scandium	32	28	20
Thorium	23	24	25
Antimony	19	6	3
Molybdenum	18	11	7
Beryllium	16	12	9
Samarium	15	13	12
Selenium	15	6	3
Cesium	14	13	10
Uranium	13	8	8
Europium	11	12	8
Ytterbium	12	8	10
Terbium	2.5	2.1	2
Mercury	0.84	0.33	0.08
Cadmium	0.71	0.39	0.5

Note: Data, from Christensen and Gordon (1983), were collected in 1977.

TABLE 5-16

Estimated Inventory of Wastes Released from Building 723-A to the Metallurgical Laboratory Basin

Chemical	Total Release Over 30 Years	Release Rate Prior to Stoppage of Flow to the Basin
Acetone	20 L	Not released after 3/83
1,1,1-Trichloroethane	150 L	Released between 1978 and 1983
Trichloroethylene	6 L	Released over a 6-month period in 1978
Tetrachloromethane	500 L	Not released after 1978
Hydrofluoric acid	2 L	Not released after 3/83
Nitraad (as purchased is composed of HF, acetic acid, and fluoride salts)	140 L	Not released after 3/83
Potassium cyanide or sodium cyanide	<1 L	Not released after 1976
Cyanide (plating solution)	<4 L	Not released after 1976
Naphthalene	<1 L	0.1 L/yr
Hydrochloric acid	190 L	45 L/yr
Nitric acid (65%)	39,800 L	1,300 L/yr
Molybdic acid	10 g	1 g (rarely used)
Oxalic acid	23 L	10 L/yr
Phosphoric acid	53 L	1.6 L/yr
Picric acid	100 g	0.4 g/yr
Sulfuric acid	15 L	<4 L/yr
Sodium hydroxide	3 L	2 L/yr
Potassium hydroxide	30 L	8 L/yr
Trisodium phosphate	60 L	8 L/yr
Sodium sulfite	270,000 g	11,000 g/yr
Sodium carbonate/bicarbonate	45 L	8 L/yr
Ammonium persulfate	1 L	0.5 L/yr
Ethyl alcohol	1,300 L	420 L/yr
Kerosene	114 L	Not released after 2/85
Methyl methacrylate (koldweld resin)	150 L	6 L/yr
Ferric chloride	1,900 L	0.4 L/yr
Water (cooling water from corrosion test, rinse water from photo processing, and lab rinse-water)	3,800 L/day	3,800 L/day

Note: Data are from Christensen and Gordon (1983).

TABLE 5-17

Metallurgical Laboratory Basin Water Quality

Parameter	Units	Result
Color	CU	55
pH	S.U.	3.7
Calcium	mg/L	4.74
Chloride	mg/L	2.4
Cyanide	mg/L	13.0
Dissolved organic carbon	mg/L	9.1
Fluoride	mg/L	0.39
Iron	mg/L	0.769
Lead	mg/L	0.006
Magnesium	mg/L	0.388
Mercury	mg/L	0.24
Nickel	mg/L	0.012
Potassium	mg/L	1.01
Sodium	mg/L	3.06
Nitrate	mg/L	4.25
Sulfate	mg/L	10.0
Total dissolved solids	mg/L	40.0
Total organic carbon	mg/L	18.2
Turbidity	mg/L	6.0
Sp. conductivity	µmhos/cm	71.6
Surfactants	µg/L	185
Total organic halogens	µg/L	51
Zinc	mg/L	0.025

Note: Data are from Johnson et al. (1987a).

TABLE 5-18

Metallurgical Laboratory Basin Sediment and Soil Chemical Analysis

Basin (0 to 25 ft from ground level)

Parameter	Concentration Range Basin Sediment Layer	AMB 101-103	Soil Around Basin Layer	AMB 104-107
pH (S.U.)	1 to 8	4.2-6.1	1 to 8	4.1-5.3
Sp. cond. (μmhos/cm)	1 to 8	0.21-172.4	1 to 8	8.3-30.4
Calcium (μg/g)		34-962	1 to 8	27-334
Aluminum (μg/g)	1 to 8	1,900-24,500	1 to 8	850-31,600
Iron (μg/g)	1 to 8	6,900-38,600	1 to 8	440-36,200
Lead (μg/g)	1 to 8	4.45-15.7	1 to 8	4.1-137
Zinc (μg/g)	1 to 8	4.2-37.2	1 to 8	1.2-13.4
Chromium (μg/g)	1 to 8	7.45-61.4	1 to 8	2-148
Mercury (μg/g)	1 and 2	0.26-1.6	1 to 8	<0.2
Cyanide (μg/g)	1	<0.25-0.5	1 to 8	<0.25
Bis(2-ethylhexyl) phthalate (ng/g)	1	152-544	8	171-1,190
Diethyl phthalate (ng/g)	1	<150-284	8	<150
Di-n-butyl phthalate (ng/g)	1	<100-119	8	101-121

Process Sewer Line (0 to 3 in. from bottom of line)

Parameter	Units	Concentration Range AMB 108 A-D	AMB 109 A-D	AMB 110 A-D
pH	S.U.	2.7-4.0	2.7-3.1	3.3-4.5
Conductivity	μmhos/cm	85.2-157.7	0.6-620	28.7-108.3
Calcium	μg/g	108-260	88-124	97-208
Aluminum	μg/g	30,590-35,450	33,510-38,560	32,090-40,560
Iron	μg/g	24,690-33,380	30,910-37,540	31,160-36,010
Lead	μg/g	11.2-20.4	17.6-28.6	16.2-22.4
Zinc	μg/g	14.8-17.4	12.0-18.9	12.2-18.9
Chromium	μg/g	41.6-43.2	60.7-74.7	50.4-109.2
Mercury	μg/g	1.9-7.02	1.7-3.3	1.3-7.1
Cyanide	μg/g	0.40-0.72	0.4-8.1	0.3-2.4
Bis(2-ethylhexyl) phthalate	ng/g	505	150	174
Dichloromethane	ng/g	14	43	63
Diethyl phthalate	ng/g	<150	<150	<150
Di-n-butyl phthalate	ng/g	<100	<100	160

Note: Concentration ranges of selected parameters are presented for layers in which the chemicals are above detection limits. Data are from Johnson et al. (1987a).

TABLE 5-19

Summary of Groundwater Quality: Well Concentration Ranges for the Metallurgical Laboratory Seepage Basin (7/84-12/86)

Constituent	SC and Federal DWS	AMB 1A	AMB 2	AMB 3A
pH (pH)	6.5-8.5	4.5-5.5	3.6-5.0	4.5-7.6
Conductivity (μmhos/cm)	NA	27-51	32-54	34-280
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	<0.004-0.005	0.006-0.012	<0.004-0.010
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.001	0.004-0.011	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.005	<0.001
Chloride (mg/L)	250	3.1-4.0	2.4-4.3	3.5-4.4
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004
Copper (mg/L)	1	0.005-0.012	0.013-0.014	<0.004-0.004
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0	<5.0	<5.0-30.0
Endrin (mg/L)	0.0002	<0.00004	<0.00015	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10-0.11
Iron (mg/L)	0.3	0.012-0.087	0.017-0.194	0.042-0.146
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0006	<0.0002
Manganese (mg/L)	0.05	0.006-0.012	0.006-0.021	0.003-0.012
Sodium (mg/L)	NA	3.12-8.06	4.30-5.89	6.65-8.20
Nickel (mg/L)	NA	<0.004-0.004	<0.004-0.006	<0.004-0.005
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	<0.50-0.95	1.24-2.05	<0.50
Lead (mg/L)	0.05	<0.004-0.018	0.010-0.026	<0.004-0.006
Phenols (mg/L)	NA	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0-8.0
Tetrachloroethylene (mg/L)	NA	<0.001-0.003	0.003-0.025	<0.001
TDS (mg/L)	500	32-56	36-48	114-134
TOC (mg/L)	NA	0.410-5.860	0.410-0.529	0.260-9.200
TOH (mg/L)	NA	<0.005-0.073	0.085-0.312	<0.005-0.014
Trichloroethylene (mg/L)	0.005	0.006-0.029	0.010-0.152	0.003-0.008
1,1,1-TCE (mg/L)	0.200	<0.001	<0.005	<0.001
Zinc (mg/L)	5	0.024-0.054	0.025-0.029	0.012-0.016
Gross alpha (pCi/L)	15	<3.0-138.0	<2.0-11.0	<3.0-19.0
Nonvol. beta (pCi/L)	NA	1.4-146.0	<3.0-11.0	<2.0-15.0
Total radium (pCi/L)	5	<1.0-16.0	<1.0-3.0	<1 0-3.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-20

Chlorinated Solvent Releases to M-Area Process Sewers

Solvents	Years Used	Total Used	Released to Settling Basin (lb)	Released to Tims Branch (lb)
Trichloroethylene	1952-1970	3,700,000	317,000	383,000
Tetrachloroethylene	1962-1979	8,700,000	1,800,000	1,000,000
1,1,1-Trichloroethane	1979-1982	670,000	19,000	12,000

Note: Data are from Christensen and Brendell (1981).

TABLE 5-21

Average Influent and Effluent Parameters from the M-Area Settling Basin

Parameter	Units	Influent	Standard Deviation	Effluent	Standard Deviation	Removal Efficiency (%)
pH		11.0	1.2	10.4	0.50	---
Conductivity	µmhos/cm	7,060	5,300	2,490	860	64.7
Total dissolved solids	mg/L	4,560	2,000	2,250	810	50.7
Nitrate (as N)	mg/L	361	180	156	70	56.7
Phosphate (as P)	mg/L	52.0	25	23.2	7.6	55.4
Chlorine	mg/L	10.3	5.4	10.4	6.4	<1
Aluminum	mg/L	178	130	131	67	26.4
Copper	mg/L	0.124	0.10	0.0289	0.036	76.7
Lead	mg/L	0.407	0.50	0.110	0.31	71.0
Nickel	mg/L	5.95	5.0	0.573	0.98	90.4
Uranium	mg/L	50.9	70	66.7	51	<1
Potassium	mg/L	1,175	1,300	369	470	68.6
Cadmium	mg/L	<0.004	0.002	<0.003	0.001	>25.0
Chromium	mg/L	<0.037	0.037	<0.0060	0.0060	>83.8
Mercury	µg/L	<0.276	0.14	<0.215	0.024	>22.1
Iron	mg/L	1.48	1.0	0.228	0.44	84.6
Zinc	mg/L	0.141	0.065	<0.0241	0.03	>82.9
Manganese	mg/L	0.0340	0.020	0.00822	0.0091	75.8
Magnesium	mg/L	0.210	0.25	0.0513	0.042	75.6
Sodium	mg/L	430	190	462	148	<1
Calcium	mg/L	1.93	3.3	0.433	0.66	77.6
1,1,1-Trichloroethane	µg/L	144	79	151	67	<1
Trichloroethylene	µg/L	<10.9	15	<17.9	9.5	<1
Tetracloroethylene	µg/L	<10.0	12	<9.22	6.5	>7.8

Note: Data are from Pickett (1985) and were collected in winter/spring 1985.

TABLE 5-22

Physical and Chemical Characteristics of the M-Area Settling Basin Surface and Bottom Waters

		Surface--1 Ft Below Water Surface		Bottom--1 Ft Above Basin Floor	
Parameter	Units	Average	S.D.	Average	S.D.
Nitrogen	mg/L	15.8	0.8	173	20
Phosphorus	mg/L	1.6	0.2	39	6
Sulfate	mg/L	3.8	0.4	5.1	0.6
Potassium	mg/L	0.2	0	0.8	0.2
Copper	mg/L	0.01	0	0.05	0.02
Nickel	mg/L	1.3	0.1	1.6	0.1
Zinc	mg/L	0.01	0	0.01	0
Iron	mg/L	0.05	0	0.12	0.1
Uranium	mg/L	2.1	0.3	8.9	2.5
Chlorine	mg/L	3.0	0.1	7.1	0.4
Sodium	mg/L	42	3	716	135
Aluminum	mg/L	6.3	0.5	178	31
Organic carbon	mg/L	2.1	0.4	4.0	0
Dissolved oxygen	mg/L	11.6	0.3	6.2	0.9
pH	pH	9.7	0.2	11.9	0.2
Conductivity	µmhos/cm	191	12	3,127	506

Note: S.D. = standard deviation. The samples were collected at 16 locations in December 1981 (Hollod, 1982).

TABLE 5-23

Average Inorganic and Degreaser Solvent Concentrations in M-Area Settling Basin Water

Constituent	Concentration (mg/L) 2-Ft Depth	8-Ft Depth
Nitrate (as N)	174	351
Phosphate	0.02	0.07
Sulfate	10.0	63
Chlorine	20.2	87.8
Fluoride	0.75	6.5
Boron	<1.0	1.65
Ammonia (as N)	1.10	5.47
Sodium	531	1,815
Potassium	0.97	2.28
Aluminum	151	609
Iron	0.048	0.195
Copper	0.012	0.148
Nickel	0.029	0.165
Zinc	0.003	0.008
Uranium	1.4	1.8
Lead	0.042	0.223
Mercury	0.0007	0.0004
Arsenic	<0.001	0.001
Cadmium	0.003	0.014
Chromium	0.004	0.004
Silver	0.001	0.004
Barium	0.004	0.004
Magnesium	0.300	0.101
Manganese	0.005	0.019
Trichloroethylene	0.060	0.150
Tetrachloroethylene	0.023	0.079
1,1,1-Trichloroethane	6.95	0.640

Note: Except for barium, results for the 2-ft-deep samples are the average of 6 samples, and results for the 8-ft-deep samples are the average of 12 samples. Each barium result represents one analysis only. Data are from Pickett (1985).

TABLE 5-24

Maximum Concentrations of Organic Analytes Detected in M-Area Settling Basin and Lost Lake Water Samples

Analyte	Concentration (μg/L) Basin	Lost Lake
Acetone	6	9
Bis(2-ethylhexyl)phthalate*	203	17
Hydrocarbons (all molecular weights)	13	63
Trichlorofluoromethane	LTDL	11
Methylene chloride*	LTDL	28
Hexadecanoic acid	5	23
Octadecanoic acid	NA	6
Octadecatrienoic acid, methyl ester	NA	42
Octanoic acid	8	NA
Di-n-butyl phthalate	LTDL	10
Di-n-octyl phthalate	18	LTDL
Ethyloxirane	15	NA
Hexane*	12	70
Hexanedioic acid, dioctyl ester	300	13
Toluene	7	LTDL
Phthalates*	36	NA
Tetrachloroethylene	173	LTDL
Tetradecanoic acid	NA	15
Trichloroethylene	213	LTDL
1,1-Dichloroethylene	138	LTDL
1,1,1-Trichloroethane	23,770	LTDL
1,2-Dichloroethane	41	LTDL
2-Butoxyethanol	50	NA
2-Nitrophenol	38	LTDL
2,5-Furandone-3-ethyl-4-methyl	2	NA
3-Licosene	NA	17

Note: LTDL = less than detection limit; NA = not analyzed. Data are from Pickett (1985).

* Results for these constituents are suspect because of contamination present in the field blank, lab blank, or rinse water.

TABLE 5-25

Average Inorganic Concentrations in Sludge from the M-Area Settling Basin, the Overflow Ditch, and the Seepage Area

Inorganic	Concentration (μg/g) Settling Basin	Overflow Ditch	Seepage Area
Aluminum	103,000	91,300	76,800
Antimony*	17.6	8.09	7.54
Arsenic*	LTDL	0.355	LTDL
Barium*	157	139	69.0
Beryllium*	3.68	1.60	LTDL
Boron*	94.0	4.40	6.50
Cadmium	2.56	2.21	2.54
Calcium	27,700	40,300	20,700
Chloride	366	73.2	38.9
Chromium	110	206	36.8
Copper	231	146	82.3
Cyanide*	72.9	16.7	48.3
Fluoride*	LTDL	LTDL	23.4
Iron	5,900	2,530	2,060
Lead	441	280	111
Magnesium	4,290	2,370	1,740
Manganese	105	83	205
Mercury	1.32	4.01	0.818
Nickel	16,500	6,080	5,820
Nitrate (as N)	7,190	349	421
Nitrite (as N)	4,270	317	405
Potassium	170	122	147
Selenium*	LTDL	LTDL	0.13
Silver*	5.57	14.2	11.1
Sodium	44,200	7,490	5,290
Sulfate*	LTDL	254	294
Tin*	118	66.7	65.4
Titanium*	111	23.7	19.4
Total phosphates	25,600	26,000	16,200
Uranium	18,000	6,800	4,290
Zinc	231	87.2	68.4

Note: LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Averages for these inorganics are from limited analyses: two analyses for the settling basin, one analysis for the overflow ditch, and one analysis for the seepage area.

TABLE 5-26

Average Organic Concentrations (μg/g) in Sludge from the M-Area Settling Basin, the Overflow Ditch, and the Seepage Area

Organic	Settling Basin	Overflow Ditch	Seepage Area
Total organic carbon	87,600	129,000	75,500
Total organic halogens	11.8	14.3	10.2
Acetone	0.027	NA	0.015*
2(4H)-Benzofuranone-4,4,7A,CH3	NA	NA	0.200*
Bis(2-ethylhexyl)phthalate	19.7	4.28*	2.68*
Chlorotoluene	0.077*	NA	NA
6-Cyclohexyldodecane	5.43*	NA	NA
1,1-Dichloroethane	0.021	LTDL	LTDL
1,2-Dichloroethane	LTDL	LTDL	0.021
1,1-Dichloroethylene	0.064	LTDL	0.020
Diethyl phthalate	0.160	LTDL	LTDL
2,5-Dimethyl heptane	4.33*	NA	NA
Dimethyl disulfide	0.077*	NA	NA
Di-n-butyl phthalate	1.11	LTDL	0.470*
Heptadecane	76.3	NA	NA
Hexadecanoic acid, dioctyl ester	47.1*	NA	NA
2-Hexadecen-1-ol 3,7,11,15-tetramethyl	176*	NA	NA
Hexane	0.168	0.063*	0.091*
3-Licosene	2.40*	NA	NA
Methylene chloride	0.037	0.076	0.109
Pentachlorobiphenyl	NA	9.16*	0.300*
Pentadecane	12.5*	NA	NA
Phenanthrene	0.135	LTDL	LTDL
2-Propyl decane	4.94*	NA	NA
1,1,2,2-Tetrachloroethane	LTDL	LTDL	0.010
Tetrachloroethylene	4.19	0.069	0.021
Tetrachlorobiphenyl	NA	3.13*	0.600*
Tetradecane	7.11*	NA	NA
Toluene	0.017	LTDL	0.011
1,1,1-Trichloroethane	0.824	0.113	0.151
Trichloroethylene	0.189	0.013	0.010
Trichlorofluoromethane	LTDL	LTDL	0.013*
1,1,2-Trichloro-1,1,2-trifluoroethane	0.006*	NA	NA
1,1,2-Trichlorotrifluoromethane	0.009*	NA	NA
Tridecane	1.38*	NA	NA

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* These results are from one analysis only.

TABLE 5-27

Average Inorganic Concentrations (µg/g) in Soil Beneath the Process Sewer Line

Inorganic	Sample Depth (ft) 0.0-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0
Aluminum	8,560	7,300	8,150	7,640	7,450	5,520
Antimony*	NA	0.51	NA	NA	NA	0.46
Arsenic*	NA	1.63	NA	NA	NA	0.49
Barium*	NA	3.30	NA	NA	NA	2.50
Calcium	132	127	79.3	80.7	85.3	95.1
Chloride	8.01	8.55	14.1	21.4	24.4	22.5
Chromium	24.8	23.8	22.9	23.7	22.9	22.9
Copper	2.13	LTDL	LTDL	LTDL	LTDL	LTDL
Fluoride*	NA	1.1	NA	NA	NA	3.4
Iron	24,100	24,900	26,300	23,600	26,000	23,700
Lead	5.72	7.11	3.93	4.80	2.94	3.37
Magnesium	52.2	37.1	34.7	33.9	41.6	48.0
Manganese	13.2	10.8	10.2	11.9	10.3	12.3
Nickel	4.35	5.70	1.95	1.84	1.89	2.00
Nitrate	1.17	3.53	9.08	20.8	20.0	17.3
Nitrite*	NA	0.91	NA	NA	NA	0.23
Potassium	52.6	46.1	45.3	43.2	48.4	48.4
Silver*	NA	0.079	NA	NA	NA	LTDL
Sodium	157	221	136	125	115	105
Sulfate*	NA	189	NA	NA	NA	4.6
Total phosphates	279	296	196	165	137	140
Uranium	16.6	16.1	LTDL	LTDL	LTDL	10.7
Zinc	4.30	3.83	4.31	3.80	3.88	3.35

Note: NA = not analyzed; LTDL = All results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these inorganics are from one analysis only.

TABLE 5-28

Average Organic Concentrations (μg/g) in Soil Beneath the Process Sewer Line

	Sample Depth (ft)					
Organic	0.0-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0
Total organic carbon	1,780	1,240	789	859	849	805
Total organic halogens	18.8	14.8	20.8	75.8	137	27.2
Bis(2-ethylhexyl) phthalate*	NA	7.04	NA	LTDL	NA	0.900
Chlorobenzene	NA	LTDL	NA	0.011	NA	0.010
1-Chloro-2-methylbenzene*	0.058	NA	NA	NA	NA	NA
Di-n-butyl phthalate*	NA	0.360	NA	NA	NA	NA
Hexadecanoic acid, butyl ester*	NA	0.500	NA	NA	NA	0.360
Hexadecanoic acid, methyl ester*	NA	NA	NA	NA	NA	0.220
Hexane*	NA	NA	NA	NA	NA	0.120
13,16,14-Labdien-8-ol*	2.00	NA	NA	NA	NA	NA
Methylene chloride	NA	0.044	NA	0.044	NA	0.042
Octadecanoic acid, butyl ester*	NA	1.00	NA	NA	NA	NA
Octadecanoic acid, dichloromethyl ester*	NA	0.200	NA	NA	NA	NA
Tetrachloroethylene	NA	1.29	NA	76.7	NA	7.18
Toluene	NA	0.011	NA	LTDL	NA	LTDL
1,1,1-Trichloroethane	NA	0.063	NA	0.134	NA	0.193
Trichloroethylene	NA	0.010	NA	0.018	NA	0.015

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these organics are from one analysis only.

TABLE 5-29

Average Inorganic Concentrations (μg/g) in M-Area Settling Basin Soil

Inorganic	Sample Depth (ft) 0.0-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0
Aluminum	3,050	4,050	2,920	2,910	2,780	1,740
Antimony*	0.256	NA	NA	NA	0.361	NA
Arsenic*	0.128	NA	NA	NA	0.538	NA
Barium*	2.55	NA	NA	NA	2.90	NA
Boron*	5.90	NA	NA	NA	LTDL	NA
Calcium	133	171	171	195	254	210
Chloride	65.1	66.7	46.1	28.0	17.5	24.9
Chromium	14.1	18.5	12.0	11.9	12.1	11.4
Copper	2.23	2.93	LTDL	LTDL	LTDL	LTDL
Cyanide*	20.0	NA	NA	NA	8.80	NA
Fluoride*	4.40	NA	NA	NA	4.10	NA
Iron	11,500	17,000	13,400	11,200	12,600	10,500
Lead	11.0	10.0	3.99	4.14	4.70	3.11
Magnesium	19.2	20.6	18.0	17.5	21.0	21.0
Manganese	13.9	10.9	9.69	9.49	13.3	9.34
Mercury	LTDL	LTDL	LTDL	LTDL	0.258	LTDL
Nickel	14.7	6.31	3.45	2.35	11.1	24.3
Nitrate	35.3	35.7	11.0	22.4	25.2	40.9
Nitrite*	2.30	NA	NA	NA	7.90	NA
Potassium	40.4	47.5	34.9	33.7	32.7	28.3
Silver*	0.057	NA	NA	NA	0.113	NA
Sodium	1,100	1,220	734	665	485	600
Sulfate*	15.0	NA	NA	NA	61.1	NA
Total phosphates	321	435	327	326	224	175
Uranium	92.8	79.3	50.5	26.1	26.3	51.9
Zinc	4.56	2.95	3.24	3.36	2.90	5.58

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these inorganics are from one analysis only.

TABLE 5-30

Average Organic Concentrations ($\mu g/g$) in M-Area Settling Basin Soil

Organic	Sample Depth (ft) 0.0-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0
Total organic carbon	829	1,140	630	562	608	631
Total organic halogens	11.0	10.0	10.0	10.0	10.5	12.0
Acetone*	NA	NA	NA	NA	0.013	NA
Bis(2-ethylhexyl) phthalate*	LTDL	NA	NA	NA	0.960	NA
2-Butoxyethanol*	0.300	NA	NA	NA	0.300	NA
Chlorobenzene	0.012	LTDL	LTDL	LTDL	LTDL	LTDL
1,1-Dichloroethane	0.014	LTDL	LTDL	LTDL	LTDL	LTDL
1,1-Dichloroethylene	0.019	LTDL	LTDL	LTDL	LTDL	LTDL
Dimethyl phthalate*	0.200	NA	NA	NA	0.200	NA
Di-n-butyl phthalate*	0.360	NA	NA	NA	0.270	NA
Di-n-octyl phthalate*	LTDL	NA	NA	NA	0.970	NA
Hexane*	0.086	NA	NA	NA	0.103	NA
Methylene chloride	0.047	0.048	0.070	0.046	0.049	0.072
Nitro-1, methylimidazole*	NA	NA	NA	NA	0.100	NA
Tetrachloroethylene	6.14	0.276	LTDL	LTDL	LTDL	LTDL
Toluene	0.011	0.010	0.012	0.012	0.010	LTDL
1,1,1-Trichloroethane	0.014	LTDL	LTDL	LTDL	LTDL	LTDL
Trichloroethylene	0.070	LTDL	LTDL	LTDL	LTDL	LTDL
Trichloro-fluoromethane*	LTDL	NA	NA	NA	0.011	NA

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these organics are from one analysis only.

TABLE 5-31

Average Inorganic Concentrations (μg/g) in Soil Beneath and Around the Overflow Ditch

Inorganic	Sample Depth (ft) 0.0-0.5	0.5-1.5	1.5-2.5	2.5-3.5
Aluminum	26,200	15,000	13,900	13,000
Antimony*	3.41	21.2	NA	NA
Arsenic*	1.48	LTDL	NA	NA
Barium*	16.8	66.6	NA	NA
Boron*	9.30	LTDL	NA	NA
Cadmium	1.23	LTDL	LTDL	LTDL
Calcium	4,950	554	554	589
Chloride	42.9	11.7	12.8	7.09
Chromium	58.2	16.7	18.9	21.4
Copper	48.6	2.21	2.06	2.36
Cyanide*	0.300	0.280	NA	NA
Fluoride*	NA	1.90	NA	NA
Iron	7,760	13,100	14,000	14,800
Lead	91.5	8.73	6.85	7.80
Magnesium	277	93.3	81.6	71.8
Manganese	159	125	58.2	37.5
Mercury	0.971	0.202	0.201	LTDL
Nickel	969	19.6	17.9	20.7
Nitrate	147	28.6	38.2	44.3
Nitrite*	3.10	1.10	NA	NA
Potassium	110	103	100	90.0
Silver*	4.46	LTDL	NA	NA
Sodium	1,630	402	407	387
Sulfate*	35.4	15.4	NA	NA
Total phosphates	3,720	287	271	276
Uranium	1,140	24.2	29.3	32.0
Zinc	27.6	6.97	9.59	5.48

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these inorganics are from one analysis only.

TABLE 5-32

Average Organic Concentrations (μg/g) in Soil Beneath and Around the Overflow Ditch

	Sample Depth (ft)			
Organic	0.0-0.5	0.5-1.5	1.5-2.5	2.5-3.5
Total organic carbon	16,600	2,560	1,920	2,050
Total organic halogens	16.3	13.1	13.3	12.0
Bis(2-ethylhexyl) phthalate*	LTDL	2.53	NA	NA
1,1-Dichloroethane	0.213	LTDL	LTDL	LTDL
Di-n-butyl phthalate*	0.250	0.156	NA	NA
Di-n-octyl phthalate*	0.820	LTDL	NA	NA
Hexachlorobiphenyl*	3.11	NA	NA	NA
Hexane*	0.073	0.110	NA	NA
Methylene chloride	0.049	0.042	0.040	0.041
Pentachlorobiphenyl*	11.6	NA	NA	NA
Tetrachlorobiphenyl*	7.25	NA	NA	NA
Tetrachloroethylene	0.081	0.027	0.021	0.011
Toluene	0.013	0.011	0.010	LTDL
1,1,1-Trichloroethane	0.100	0.025	0.020	LTDL
Trichloroethylene	0.031	0.018	0.011	LTDL

Note: LTDL = all results were less than the detection limit; NA = not analyzed. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these organics are from one analysis only.

TABLE 5-33

Average Inorganic Concentrations (μg/g) in Seepage Area Soil

Inorganic	Sample Depth (ft) 0.0-1.0	1.5-2.5	2.5-3.5	3.5-4.5	4.5-5.5	5.5-6.5
Aluminum	12,100	8,140	9,820	6,480	5,480	7,520
Antimony*	2.72	NA	NA	NA	NA	NA
Arsenic*	1.33	NA	NA	NA	NA	NA
Barium*	52.4	NA	NA	NA	NA	NA
Calcium	795	485	786	480	527	557
Chloride	21.2	20.4	31.7	38.5	11.1	29.0
Chromium	8.19	13.6	12.3	17.4	21.0	7.50
Copper	2.28	LTDL	LTDL	LTDL	LTDL	LTDL
Fluoride*	3.20	NA	NA	NA	NA	NA
Iron	5,760	12,100	11,500	13,100	13,800	6,130
Lead	6.66	4.60	5.60	4.50	4.28	3.25
Magnesium	123	66.2	76.7	45.9	43.0	69.6
Manganese	208	43.3	50.3	38.5	43.9	115
Mercury	0.207	0.235	0.325	0.320	0.255	LTDL
Nickel	29.4	3.43	54.8	4.53	9.70	78.3
Nitrate	18.6	14.0	13.8	8.90	17.8	13.6
Nitrite*	1.70	NA	NA	NA	NA	NA
Potassium	109	101	96.8	77.0	58.9	52.5
Sodium	488	450	559	455	462	471
Sulfate*	34.3	NA	NA	NA	NA	NA
Titanium*	12.9	NA	NA	NA	NA	NA
Total phosphates	475	253	488	182	215	396
Uranium	86.2	LTDL	36.3	LTDL	16.7	54.7
Zinc	5.97	4.10	6.93	3.25	3.50	4.30

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these inorganics are from one analysis only.

TABLE 5-34

Average Organic Concentrations (μg/g) in Seepage Area Soil

Organic	Sample Depth (ft) 0.0-1.0	1.5-2.5	2.5-3.5	3.5-4.5	4.5-5.5	5.5-6.5
Total organic carbon	4,050	974	1,760	1,010	1,090	1,790
Total organic halogens	11.8	11.0	10.0	LTDL	10.0	12.0
Acetone*	0.024	NA	NA	NA	NA	NA
Bis(2-ethylhexyl) phthalate*	3.06	NA	NA	NA	NA	NA
Decanoic acid*	0.100	NA	NA	NA	NA	NA
Di-n-butyl phthalate*	0.110	NA	NA	NA	NA	NA
Hexane*	0.047	NA	NA	NA	NA	NA
Hexanoic acid*	0.800	NA	NA	NA	NA	NA
Methylene chloride	0.081	0.086	0.099	0.097	0.098	0.073
Octanoic acid*	0.300	NA	NA	NA	NA	NA
Tetrachloroethylene	0.105**	LTDL	LTDL	LTDL	LTDL	LTDL
Tetradecanoic acid*	0.200	NA	NA	NA	NA	NA
Toluene	0.013	LTDL	0.010	LTDL	LTDL	LTDL
Trichlorofluoromethane*	0.013	NA	NA	NA	NA	NA

Note: LTDL = all results were less than the detection limit; NA = not analyzed. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* Results for these organics are from one analysis only.

** Tetrachloroethylene was detected in only one sample from the top 6 in. of soil.

TABLE 5-35

Average Inorganic Concentrations (µg/g) in Lost Lake Soil

Inorganic	Sample Depth (ft) 0.0-0.5	0.5-1.5	1.5-2.5
Aluminum	14,300	20,000	12,300
Antimony	15.4	13.7	14.1*
Arsenic	0.137	0.210	0.140*
Barium	149	156	85.4*
Calcium	789	384	154
Chloride	21.8	22.7	6.08
Chromium	12.0	17.7	10.4
Copper	7.13	7.47	3.63
Cyanide	4.18	2.14	LTDL
Fluoride	0.423	0.530	0.860*
Iron	2,890	3,010	2,640
Lead	8.37	3.83	2.63
Magnesium	190	211	130
Manganese	111	80.0	66.9
Mercury	0.820	0.344	LTDL
Nickel	6.02	4.93	2.18
Nitrate	3.29	1.22	0.700
Nitrite	1.35	0.110	0.500*
Potassium	168	183	95.5
Sodium	242	165	60.5
Sulfate	32.4	25.7	40.7*
Tin	12.1	16.1	11.5*
Titanium	LTDL	14.0	11.5*
Total phosphates	251	141	112
Uranium	11.8	LTDL	LTDL
Zinc	7.53	7.83	2.05

Note: NA = not analyzed; LTDL = all results were less than the detection limit. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* These results are from one analysis only.

TABLE 5-36

Average Organic Concentrations ($\mu g/g$) in Lost Lake Soil

Organic	Sample Depth (ft) 0.0-0.5	0.5-1.5	1.5-2.5
Total organic carbon	8,140	4,460	4,030
Total organic halogens	11.3	12.6	12.7
Acetone	0.006*	NA	NA
Bis(2-ethylhexyl) phthalate	9.33*	8.92*	LTDL
Di-n-butyl phthalate	0.302	0.385	NA
Ethylbenzene	0.180*	LTDL	0.160*
2(2-Ethoxyethoxy) ethanol	0.610*	NA	0.150*
Hexane	0.130	0.084	0.263*
Methylene chloride	0.082	0.040	0.051
Methyl, ethyl, propyl-propanoic acid ester	0.130*	NA	0.100*
Toluene	0.012	0.010	LTDL
Trichlorofluoromethane	0.008*	LTDL	LTDL

Note: LTDL = all results were less than the detection limit; NA = not analyzed. Averages are rounded to three significant digits and were calculated assuming that values below the detection limit were equal to the detection limit. Data are from Pickett (1985).

* These results are from one analysis only.

TABLE 5-37

Summary of Groundwater Quality: Well Concentration Ranges for the M-Area Settling Basin, Lost Lake, and Background Wells (7/84-12/86)

Constituent	SC and Federal DWS	MSB 1A	MSB 2A	MSB 3A	MSB 4A
pH (pH)	6.5-8.5	3.8-5.2	3.5-4.4	3.8-6.4	4.1-5.5
Conductivity (µmhos/cm)	NA	43-77	30-83	210-1,410	375-3,800
Silver (mg/L)	0.05	<0.0005	<0.0005	0.0010	0.0005-0.0030
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.008-0.017	0.007-0.020	0.041-0.080	0.015-0.023
Beryllium (mg/L)	NA	<0.001	<0.001	0.002	<0.001
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005	<5.000	<1.000
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.005-0.064	<0.005	<5.000	0.184-0.627
Chloride (mg/L)	250	2.0-3.8	1.5-4.3	4.6-30.2	9.1-13.9
Chromium (mg/L)	0.05	<0.004	<0.004-0.008	<0.004	<0.004
Copper (mg/L)	1	0.031	0.022	0.020	0.005
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005-0.032	<0.005
DOC (mg/L)	NA	<5.0	4.6	<5.0-13.5	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004-0.00022	<0.00004-0.0002
Fluoride (mg/L)	1.6	<0.10-0.15	<0.10-0.20	0.34-0.64	0.12-0.20
Iron (mg/L)	0.3	0.011-0.155	0.011-0.067	0.019-0.142	0.046-0.174
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0003	<0.0002-0.0003	<0.0002-0.0002
Manganese (mg/L)	0.05	0.005-0.019	0.007-0.013	0.155-0.385	0.006-0.027
Sodium (mg/L)	NA	2.91-5.79	2.18-3.13	11.10-279.0	241.0-734.0
Nickel (mg/L)	NA	<0.004-0.018	<0.004-0.028	0.024-0.059	<0.004-0.028
Nitrate (as N) (mg/L)	10	1.77-4.24	1.83-19.75	19.0-143.0	116.0-330.0
Lead (mg/L)	0.05	0.008-0.070	0.011-0.083	<0.004-0.034	<0.004-0.030
Phenols (mg/L)	NA	<0.002	<0.002	0.004-0.018	<0.002-0.006
Selenium (mg/L)	0.01	<0.001	<0.001	<0.002-0.002	<0.001
Sulfate (mg/L)	250	<3.0-10.0	<3.0	<3.0-145.0	20.0-504.0
Tetrachloroethylene (mg/L)	NA	0.048-0.236	0.017-0.277	34.5-313	0.660-6.35
TDS (mg/L)	500	68-80	54-62	946	522-618
TOC (mg/L)	NA	0.242-2.00	0.415-1.14	1.50-30.0	0.960-6.70
TOH (mg/L)	NA	0.160-0.600	0.091-0.970	0.222-225.8	0.879-0.970
Trichloroethylene (mg/L)	0.005	0.163-0.367	0.138-0.428	29.2-161	0.280-5.47
1,1,1-TCE (mg/L)	0.200	<0.005-0.049	<0.005-0.039	<5.000-6.54	0.290-0.448
Zinc (mg/L)	5	0.026-0.081	0.024-0.028	0.106-0.120	<0.002-0.075
Gross alpha (pCi/L)	15	3.9-5.0	4.0-30.4	9.0-92.0	16.0-88.3
Nonvolatile beta (pCi/L)	NA	2.8-8.0	<3.0-14.6	14.6-128.0	24.0-297.0
Total radium (pCi/L)	5	2.0-6.0	2.0-22.1	8.0-92.0	19.0-47.4

TABLE 5-37 (cont.)

Constituent	SC and Federal DWS	MSB 5A	MSB 6A	MSB 7A	MSB 8A
pH (pH)	6.5-8.5	4.6-5.8	3.9-5.4	4.4-5.2	4.1-5.1
Conductivity (µmhos/cm)	NA	55-195	30-46	42-71	57-420
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	<0.0005
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.005-0.010	<0.004-0.006	0.007-0.010	0.007-0.016
Beryllium (mg/L)	NA	<0.001	<0.001	<0.001	<0.001
Carbon tetrachloride (mg/L)	0.005	<0.001-0.005	<0.001	<0.002	<0.010
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001-0.014	<0.001	<0.002	<0.010
Chloride (mg/L)	250	4.0-8.0	5.1-6.8	3.3-5.2	2.5-5.8
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004-0.010	<0.004
Copper (mg/L)	1	0.055	<0.004	0.009	0.006
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0	4.6	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004-0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.13	<0.10-0.21	<0.10	<0.10-0.14
Iron (mg/L)	0.3	0.015-0.031	0.031-0.040	0.034-0.805	0.022-0.047
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002-0.0002
Manganese (mg/L)	0.05	0.005-0.014	0.005-0.006	0.015-0.023	0.012-0.038
Sodium (mg/L)	NA	9.50-31.30	4.39-5.92	4.66-10.90	16.60-79.30
Nickel (mg/L)	NA	<0.004-0.009	<0.004-0.011	<0.004-0.011	<0.004-0.010
Nitrate (as N) (mg/L)	10	1.70-18.5	0.23	4.15-9.04	11.90-48.3
Lead (mg/L)	0.05	<0.005-0.014	<0.006-0.021	<0.004-0.014	0.008-0.013
Phenols (mg/L)	NA	<0.002-0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<3.0	<3.0	<3.0	3.0
Tetrachloroethylene (mg/L)	NA	0.020-0.069	<0.001-0.003	0.006-0.131	0.029-0.528
TDS (mg/L)	500	98-138	34-46	50-68	90-104
TOC (mg/L)	NA	0.392-2.214	0.970-3.60	0.387-2.70	0.468-1.385
TOH (mg/L)	NA	<0.005-0.079	<0.005-0.017	<0.005-0.154	0.064-0.302
Trichloroethylene (mg/L)	0.005	0.005-0.048	<0.001	0.002-0.050	0.008-0.121
1,1,1-TCE (mg/L)	0.200	0.008-0.055	<0.001	0.005-0.033	<0.010
Zinc (mg/L)	5	0.033-0.034	0.003-0.010	<0.002-0.051	<0.002-0.007
Gross alpha (pCi/L)	15	<2.0-10.3	<1.2-2.0	3.3-26.0	4.0-57.8
Nonvolatile beta (pCi/L)	NA	<3.0-33.0	<2.0-4.0	<3.0-17.0	3.0-203.0
Total radium (pCi/L)	5	<1.0-3.0	<1.0-2.0	2.0-6.0	4.0-13.0

TABLE 5-37 (cont.)

Constituent	SC and Federal DWS	MSB 29D	MSB 43D
pH (pH)	6.5-8 5	3.7-5.2	3.9-4.9
Conductivity (µmhos/cm)	NA	30-43	22-32
Silver (mg/L)	0.05	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002
Barium (mg/L)	1.0	<0.004-0.007	<0.004-0.004
Beryllium (mg/L)	NA	<0.001	<0.001
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005
Cadmium (mg/L)	0.010	<0.001	<0.001
Chloroform (mg/L)	0.100*	<0.005	<0.005
Chloride (mg/L)	250	2.3-4.5	2.3-4.0
Chromium (mg/L)	0.05	<0.004	<0.004
Copper (mg/L)	1	0.005-0.012	0.005
Cyanide (mg/L)	0.2	<0.005	<0.005
Endrin (mg/L)	0.0002	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.18	<0.10-0.16
Iron (mg/L)	0.3	0.022-0.075	0.019-0.033
Mercury (mg/L)	0.002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.004-0.005	0.021-0.025
Sodium (mg/L)	NA	3.69-4.31	1.58-1.97
Nickel (mg/L)	NA	<0.004	<0.004
Nitrate (as N) (mg/L)	10	2.07-2.20	0.95-1.20
Lead (mg/L)	0.05	0.017-0.034	0.015-0.022
Phenols (mg/L)	NA	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002
Sulfate (mg/L)	250	<3.0	<3.0
Tetrachloroethylene (mg/L)	NA	<0.005	<0.005
TOC (mg/L)	NA	<1.000-1.200	<1.000-2.500
TOH (mg/L)	NA	<0.005	<0.005
Trichloroethylene (mg/L)	0.005	<0.005	<0.005
1,1,1-TCE (mg/L)	0.200	<0.005	<0.005
Zinc (mg/L)	5	0.003-0.014	0.008-0.013
Gross alpha (pCi/L)	15	5.7-10.1	<3.0
Nonvolatile beta (pCi/L)	NA	4.3-7.0	<2.0
Total radium (pCi/L)	5	8.3-8.8	0.4-0.9

Note: DWS are the lower of South Carolina or federal primary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-38

Summary of Groundwater Quality: Well Concentration Ranges for the Silverton Road Waste Site Water-Table Wells (7/84-12/86)

Constituent	SC and Federal DWS	SRW 1	SRW 2	SRW 3	SRW 3A
pH (pH)	6.5-8.5	3.9-5.7	3.6-5.5	5.6	3.8-5.0
Conductivity (µmhos/cm)	NA	13-59	22-55	26	15-32
Silver (mg/L)	0.05	<0.0005	<0.0020-0.0050	---	0.0004
Arsenic (mg/L)	0.05	<0.002-0.002	<0.002-0.003	---	<0.002
Barium (mg/L)	1.0	0.005-0.008	0.006-0.016	---	0.004-0.006
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001-0.002	---	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	---	<0.002
Chloroform (mg/L)	0.100*	<0.001	0.014-0.019	---	<0.001
Chloride (mg/L)	250	2.3-6.5	2.7-6.8	---	1.6-10.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.005	<0.004
DOC (mg/L)	NA	<5.0	<5.0	---	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	---	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.18	<0.10-0.17	---	<0.10-0.21
Iron (mg/L)	0.3	0.024-0.707	0.016-0.082	0.070	0.008-0.172
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0002	---	<0.0002-0.0003
Manganese (mg/L)	0.05	0.016-0.017	0.004-0.010	---	0.009-0.027
Sodium (mg/L)	NA	1.17-2.30	1.50-5.16	---	1.47-1.70
Nitrate (as N) (mg/L)	10	<0.50-1.10	<0.50-1.55	---	<0.50-0.56
Lead (mg/L)	0.05	<0.004	0.017-0.039	---	0.004-0.018
Phenols (mg/L)	NA	<0.002	<0.002-0.002	---	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	---	<0.002
Sulfate (mg/L)	250	<5.0	<5.0-13.0	---	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001-0.002	---	<0.001
TDS (mg/L)	500	12-36	12-18	18	---
TOC (mg/L)	NA	0.443-3.915	0.283-8.531	---	0.259-5.007
TOH (mg/L)	NA	<0.005-0.065	<0.005-0.018	---	<0.005-0.012
Trichloroethylene (mg/L)	0.005	<0.001	<0.001-0.002	---	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	---	<0.001
Zinc (mg/L)	5	0.298-0.333	0.033-0.042	---	0.017-0.018
Gross alpha (pCi/L)	15	0.9-1.2	1.0-7.0	---	0.7-1.6
Nonvol. beta (pCi/L)	NA	1.0	2.0-5.0	---	1.0
Total radium (pCi/L)	5	1.1-2.0	1.0-5.0	---	0.5

TABLE 5-38 (cont.)

Constituent	SC and Federal DWS	SRW 4	SRW 5	SRW 6	SRW 7
pH (pH)	6.5-8.5	4.1-4.8	4.4-5.7	4.1-5.3	4.4-5.6
Conductivity (µmhos/cm)	NA	38-115	22-68	25-62	20-44
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.001
Barium (mg/L)	1.0	0.013-0.021	0.009-0.011	0.005-0.007	<0.004-0.009
Beryllium (mg/L)	NA	---	---	---	<0.002
Carbon tetrachloride (mg/L)	0.005	<0.001	0.004	<0.005-0.007	0.011-0.012
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	0.013-0.015	0.008-0.013	0.014-0.024	0.022-0.024
Chloride (mg/L)	250	4.4-6.3	4.6-5.4	3.8-5.7	3.0-4.6
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	---	---	---	<0.004
Cyanide (mg/L)	0.2	---	---	---	<0.005
DOC (mg/L)	NA	<5.0	5.5	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.23	<0.10-0.20	<0.10-0.10	<0.10-0.20
Iron (mg/L)	0.3	0.048-0.372	0.019-1.380	<0.004-0.130	0.016-0.230
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.005-0.044	0.008-0.040	0.002-0.012	0.003-0.029
Sodium (mg/L)	NA	4.46-5.51	1.83-2.05	3.02-3.48	1.76-2.00
Nickel (mg/L)	NA	---	---	---	<0.004
Nitrite (as N) (mg/L)	NA	---	---	---	<0.50
Nitrate (as N) (mg/L)	10	2.50-3.20	<0.50-0.56	1.50-1.86	<0.50-1.87
Lead (mg/L)	0.05	<0.004-0.018	<0.004-0.035	0.006-0.036	<0.004-0.030
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.001
Sulfate (mg/L)	250	<5.0-13.0	<5.0	<5.0	<5.0-14.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001-0.002	0.001-0.003	0.004-0.005
TDS (mg/L)	500	30-58	34-58	18-34	8-26
TOC (mg/L)	NA	0.502-17.508	0.260-18.12	0.372-6.193	0.450-4.86
TOH (mg/L)	NA	0.008-0.033	0.008-0.026	0.012-0.148	0.013-0.041
Trichloroethylene (mg/L)	0.005	<0.001	0.002-0.007	0.003-0.006	0.006-0.012
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	0.003	0.003
Zinc (mg/L)	5	0.034-0.042	0.178-0.203	0.044-0.102	0.059-12.100
Gross alpha (pCi/L)	15	<2.0-6.3	0.7-5.0	1.3-2.6	<2.0-7.0
Nonvol. beta (pCi/L)	NA	<3.0-3.0	1.0-15.0	2.0	<3.0
Total radium (pCi/L)	5	<1.0-3.5	0.3-1.3	0.8-2.0	<1.0-2.1

TABLE 5-38 (cont.)

Constituent	SC and Federal DWS	SRW 8	SRW 9	SRW 10	SRW 11
pH (pH)	6.5-8.5	5.1-6.4	4.3-5.6	4.1-5.3	4.3-5.8
Conductivity (µmhos/cm)	NA	23-76	15-44	21-44	18-36
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001-0.002	<0.001-0.001	<0.001
Barium (mg/L)	1.0	0.005-0.008	<0.004	0.005-0.008	<0.004-0.007
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Carbon tetrachloride (mg/L)	0.005	0.004	<0.001-0.001	0.002	0.011-0.012
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002-0.002	<0.002
Chloroform (mg/L)	0.100*	0.004	0.001-0.004	<0.001	0.010-0.015
Chloride (mg/L)	250	2.6-3.4	<2.0-3.4	2.5-4.6	3.0-4.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004	<0.004	0.006-0.010	<0.004-0.004
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0-8.0	<5.0	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.19	<0.10-0.20	<0.10-0.20	<0.10-0.18
Iron (mg/L)	0.3	0.032-0.237	0.015-0.137	0.020-0.088	0.035-1.530
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.002-0.013	<0.002-0.009	0.003-0.020	<0.002-0.020
Sodium (mg/L)	NA	1.73-2.97	1.43-1.69	1.66-2.65	1.67-1.97
Nickel (mg/L)	NA	<0.004	<0.004	0.004-0.005	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	0.45-2.17	0.43-1.40	0.55-1.85	<0.50-2.16
Lead (mg/L)	0.05	<0.004-0.012	<0.004-0.010	0.008-0.026	0.005-0.030
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0-7.5	<5.0
Tetrachloroethylene (mg/L)	NA	0.003-0.005	<0.001-0.003	<0.001-0.003	<0.005-0.008
TDS (mg/L)	500	20-78	<5-34	<5-18	10-24
TOC (mg/L)	NA	0.440-4.300	0.291-1.800	0.600-5.310	0.331-3.700
TOH (mg/L)	NA	<0.005-0.034	<0.005-0.012	<0.005-0.018	0.018-0.035
Trichloroethylene (mg/L)	0.005	0.004-0.011	0.005-0.007	0.002-0.004	0.009-0.016
1,1,1-TCE (mg/L)	0.200	0.003	<0.001-0.003	0.003	0.003
Zinc (mg/L)	5	0.087-1.130	0.026-3.070	0.028-1.190	0.037-6.690
Gross alpha (pCi/L)	15	<2.0-8.0	<2.0	<2.0	1.0-8.0
Nonvol. beta (pCi/L)	NA	<3.0-4.0	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	<1.0-2.0	0.6	0.9	<1.0-2.0

TABLE 5-38 (cont.)

Constituent	SC and Federal DWS	SRW 12C	SRW 13C	SRW 14C	SRW 15C
pH (pH)	6.5-8.5	4.6-5.5	4.1-5.8	4.3-5.3	4.1-5.5
Conductivity (µmhos/cm)	NA	12-24	21-35	16-30	18-27
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.001
Barium (mg/L)	1.0	<0.004	<0.004	<0.004	<0.004-0.004
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.001
Chloroform (mg/L)	0.100*	<0.001-0.001	<0.001-0.002	<0.001	<0.001
Chloride (mg/L)	250	2.9	4.0	4.0	2.0-2.8
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10	<0.10-0.11
Iron (mg/L)	0.3	0.006	0.038	0.013	0.007-0.036
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.004-0.007	0.022-0.023	0.019-0.026	0.013-0.015
Sodium (mg/L)	NA	1.26	2.23	1.61	<0.50-1.95
Nitrate (as N) (mg/L)	10	<0.50	0.75	0.50	0.48-0.52
Lead (mg/L)	0.05	0.005-0.010	<0.005-0.023	<0.005-0.029	0.006-0.009
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<3.0
Tetrachloroethylene (mg/L)	NA	<0.001-0.002	<0.001	<0.001	<0.001
TOC (mg/L)	NA	0.430-0.670	0.450-2.270	0.500-1.400	0.450-4.100
TOH (mg/L)	NA	<0.005-0.008	<0.005-0.005	<0.005-0.006	<0.005-0.009
Trichloroethylene (mg/L)	0.005	<0.001-0.002	<0.001	<0.001	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001-0.003	<0.001
Zinc (mg/L)	5	0.773-0.901	0.372-0.504	0.479-0.661	0.049-0.106
Gross alpha (pCi/L)	15	<1.0	<1.0	<2.0	1.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	<3.0	1.0-1.8
Total radium (pCi/L)	5	<1.0	0.6	<1.0	<1.0-1.1

TABLE 5-38 (cont.)

Constituent	SC and Federal DWS	SRW 16C
pH (pH)	6.5-8.5	4.5-5.2
Conductivity (μmhos/cm)	NA	19-24
Silver (mg/L)	0.05	<0.0020
Arsenic (mg/L)	0.05	<0.001
Barium (mg/L)	1.0	0.006-0.011
Carbon tetrachloride (mg/L)	0.005	<0.001
Cadmium (mg/L)	0.010	<0.001
Chloroform (mg/L)	0.100*	<0.001
Chloride (mg/L)	250	1.7-4.0
Chromium (mg/L)	0.05	<0.004-0.004
Endrin (mg/L)	0.0002	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.15
Iron (mg/L)	0.3	0.015-0.068
Mercury (mg/L)	0.002	<0.0002
Manganese (mg/L)	0.05	0.016-0.070
Sodium (mg/L)	NA	<0.50-1.61
Nitrate (as N) (mg/L)	10	0.27-0.29
Lead (mg/L)	0.05	0.020-0.028
Phenols (mg/L)	NA	<0.002
Selenium (mg/L)	0.01	<0.002
Sulfate (mg/L)	250	3.0-5.0
Tetrachloroethylene (mg/L)	NA	<0.001
TOC (mg/L)	NA	0.320-0.610
TOH (mg/L)	NA	<0.005
Trichloroethylene (mg/L)	0.005	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001-0.003
Zinc (mg/L)	5	0.018-0.035
Gross alpha (pCi/L)	15	1.7-1.8
Nonvol. beta (pCi/L)	NA	1.7-2.7
Total radium (pCi/L)	5	1.7-2.6

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-39

Summary of Groundwater Quality: Well Concentration Ranges for the Silverton Road Waste Site B-Designated Wells (10/85-12/86)

Constituent	SC and Federal DWS	SRW 2B	SRW 9B	SRW 12B	SRW 13B
pH (pH)	6.5-8.5	4.8-5.0	4.7-5.1	4.9-5.4	3.9-5.2
Conductivity (µmhos/cm)	NA	17-27	17-26	12-26	19-28
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	<0.004	0.005	<0.004	<0.004
Beryllium (mg/L)	NA	---	---	---	---
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001	<0.001-0.001	<0.001
Chloride (mg/L)	250	2.4	3.4	3.4	4.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	---	---	---	---
Cyanide (mg/L)	0.2	---	---	---	---
DOC (mg/L)	NA	---	---	---	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10	<0.10
Iron (mg/L)	0.3	0.052	0.016	0.023	0.030
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.012-0.013	0.009-0.011	0.004-0.005	0.011-0.013
Sodium (mg/L)	NA	1.63	1.51	1.12	1.61
Nickel (mg/L)	NA	---	---	---	---
Nitrite (as N) (mg/L)	NA	---	---	---	---
Nitrate (as N) (mg/L)	10	0.50	<0.50	<0.50	0.56
Lead (mg/L)	0.05	0.006-0.012	0.006-0.007	0.005-0.009	0.012-0.030
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001	<0.001	<0.001
TDS (mg/L)	500	---	---	---	---
TOC (mg/L)	NA	0.240-3.000	0.220-3.000	0.240	0.270-2.100
TOH (mg/L)	NA	<0.005	<0.005	<0.005	<0.005
Trichloroethylene (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001-0.003	<0.001
Zinc (mg/L)	5	0.041-0.061	1.660-1.800	0.264-0.387	0.087-0.208
Gross alpha (pCi/L)	15	0.8	<2.0	<1.0	<2.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	0.5	<1.0-1.2	<1.0	0.5

TABLE 5-39 (cont.)

Constituent	SC and Federal DWS	SRW 14B	SRW 15B	SRW 16B
pH (pH)	6.5-8.5	4.4-5.6	4.6-5.4	4.8-5.4
Conductivity (μmhos/cm)	NA	23-34	17-27	21-26
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	0.006	0.005	0.004
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001	<0.001
Chloride (mg/L)	250	2.3	3.5	2.3
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10
Iron (mg/L)	0.3	0.014	0.017	0.117
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.012	0.005-0.008	0.023-0.029
Sodium (mg/L)	NA	1.80	1.66	1.83
Nitrate (as N) (mg/L)	10	0.95	<0.50	0.70
Lead (mg/L)	0.05	<0.005-0.008	<0.005-0.015	0.014-0.015
Phenols (mg/L)	NA	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001	<0.001
TOC (mg/L)	NA	0.390	0.320	0.280-1.500
TOH (mg/L)	NA	<0.005	<0.005	<0.005
Trichloroethylene (mg/L)	0.005	<0.001	<0.001	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001
Zinc (mg/L)	5	0.059-0.137	0.063-0.069	0.132-0.265
Gross alpha (pCi/L)	15	<2.0	<2.0	<2.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	<1.0	<1.0-1.5	<1.0-1.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 5-40

Summary of Groundwater Quality: Well Concentration Ranges for the Silverton Road Waste Site A-Designated Wells (10/85-12/86)

Constituent	SC and Federal DWS	SRW 2A	SRW 9A	SRW 12A	SRW 13A
pH (pH)	6.5-8.5	4.2-4.7	4.1-5.1	4.3-4.9	3.7-4.9
Conductivity (µmhos/cm)	NA	17-25	19-28	16-36	19-32
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	<0.004	<0.004	0.005	<0.004
Beryllium (mg/L)	NA	---	---	---	---
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	<0.001	<0.001	<0.001
Chloride (mg/L)	250	<1.0	2.8	3.4	2.3
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	---	---	---	---
Cyanide (mg/L)	0.2	---	---	---	---
DOC (mg/L)	NA	---	---	---	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10	<0.10
Iron (mg/L)	0.3	0.005	0.107	0.011	0.018
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.003-0.004	0.003	0.003-0.004	0.004-0.007
Sodium (mg/L)	NA	1.47	1.46	1.40	1.66
Nickel (mg/L)	NA	---	---	---	---
Nitrite (as N) (mg/L)	NA	---	---	---	---
Nitrate (as N) (mg/L)	10	<0.50	0.78	0.83	0.90
Lead (mg/L)	0.05	0.008-0.024	0.012-0.026	0.018-0.038	0.016-0.024
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001	<0.001	<0.001
TDS (mg/L)	500	---	---	---	---
TOC (mg/L)	NA	0.340-1.700	0.230-5.000	0.300-2.000	0.210-1.500
TOH (mg/L)	NA	<0.005-0.008	<0.005	<0.005	<0.005
Trichloroethylene (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001-0.003	<0.001	<0.001	<0.001
Zinc (mg/L)	5	0.102-0.138	0.042-0.061	0.032-0.051	0.012-0.021
Gross alpha (pCi/L)	15	<2.0	<2.0	<1.0	<1.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	0.5	<1.0	0.5	<1.0

TABLE 5-40 (cont.)

Constituent	SC and Federal DWS	SRW 14A	SRW 15A	SRW 16A
pH (pH)	6.5-8.5	4.4-5.5	4.8-5.6	5.2-5.5
Conductivity (μmhos/cm)	NA	19-31	20-34	23-36
Silver (mg/L)	0.05	<0.0020	<0.0020	---
Arsenic (mg/L)	0.05	<0.002	<0.002	---
Barium (mg/L)	1.0	0.005	0.007	---
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	---
Chloroform (mg/L)	0.100*	<0.001-0.002	<0.001	<0.001
Chloride (mg/L)	250	2.9	3.5	---
Chromium (mg/L)	0.05	<0.004	<0.004	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	---
Fluoride (mg/L)	1.6	<0.10	<0.10	---
Iron (mg/L)	0.3	0.009	0.015	---
Mercury (mg/L)	0.002	<0.0002	<0.0002	---
Manganese (mg/L)	0.05	0.007-0.010	0.009-0.012	0.010
Sodium (mg/L)	NA	1.68	2.06	---
Nitrate (as N) (mg/L)	10	1.15	0.60	---
Lead (mg/L)	0.05	<0.005-0.009	<0.005-0.008	<0.005-0.006
Phenols (mg/L)	NA	<0.002	<0.002	---
Selenium (mg/L)	0.01	<0.002	<0.002	---
Sulfate (mg/L)	250	<5.0	<5.0	---
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001-0.005	<0.001
TOC (mg/L)	NA	0.280-4.200	0.300-1.100	0.320
TOH (mg/L)	NA	<0.005-0.008	<0.005	<0.005-0.006
Trichloroethylene (mg/L)	0.005	<0.001-0.002	<0.001	<0.001-0.007
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001
Zinc (mg/L)	5	0.042-0.665	0.133-0.171	0.064-0.120
Gross alpha (pCi/L)	15	<2.0	<2.0	1.3
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	---
Total radium (pCi/L)	5	<1.0	<1.0	<1.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

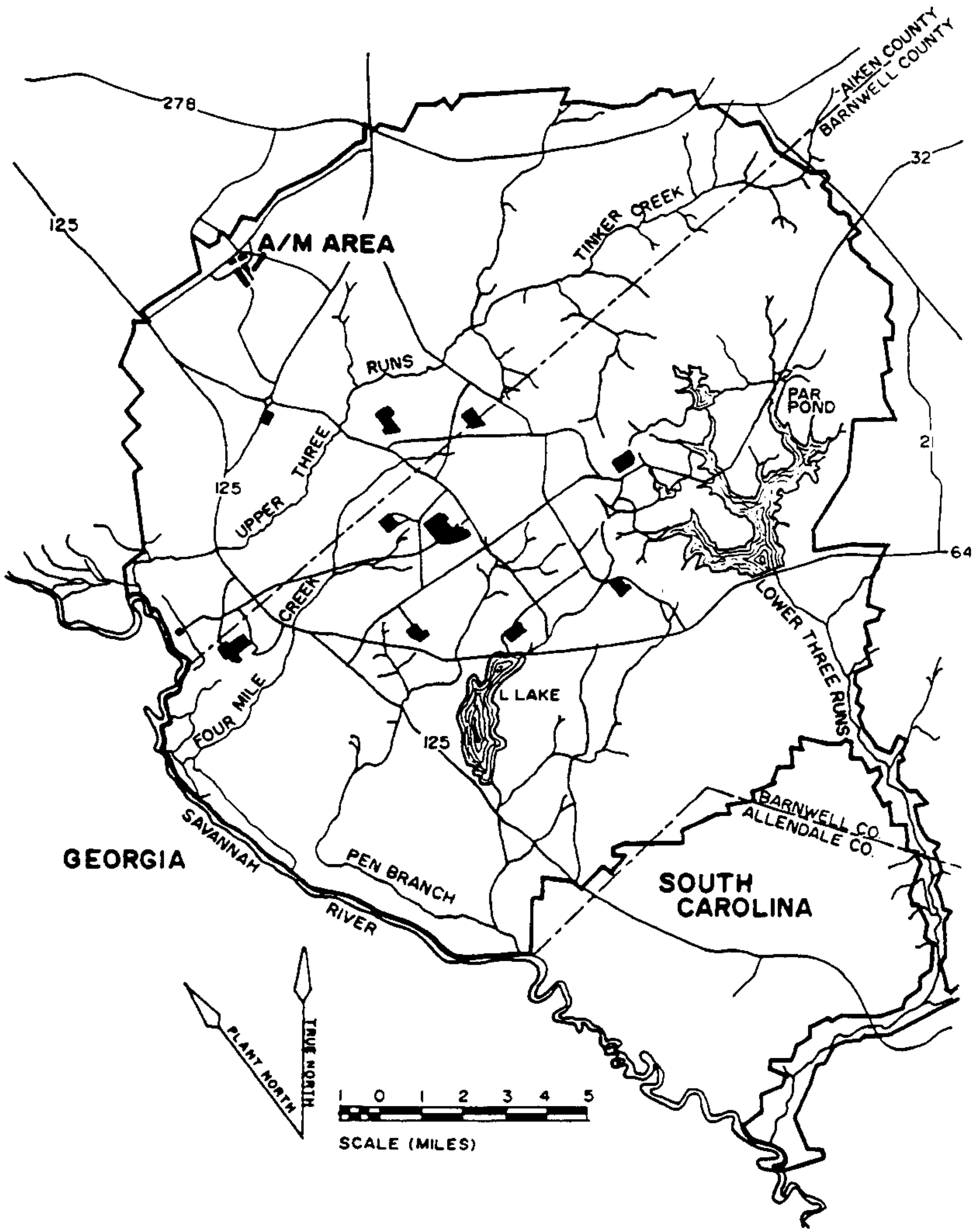


FIGURE 5-1. Location of A/M Area at SRS

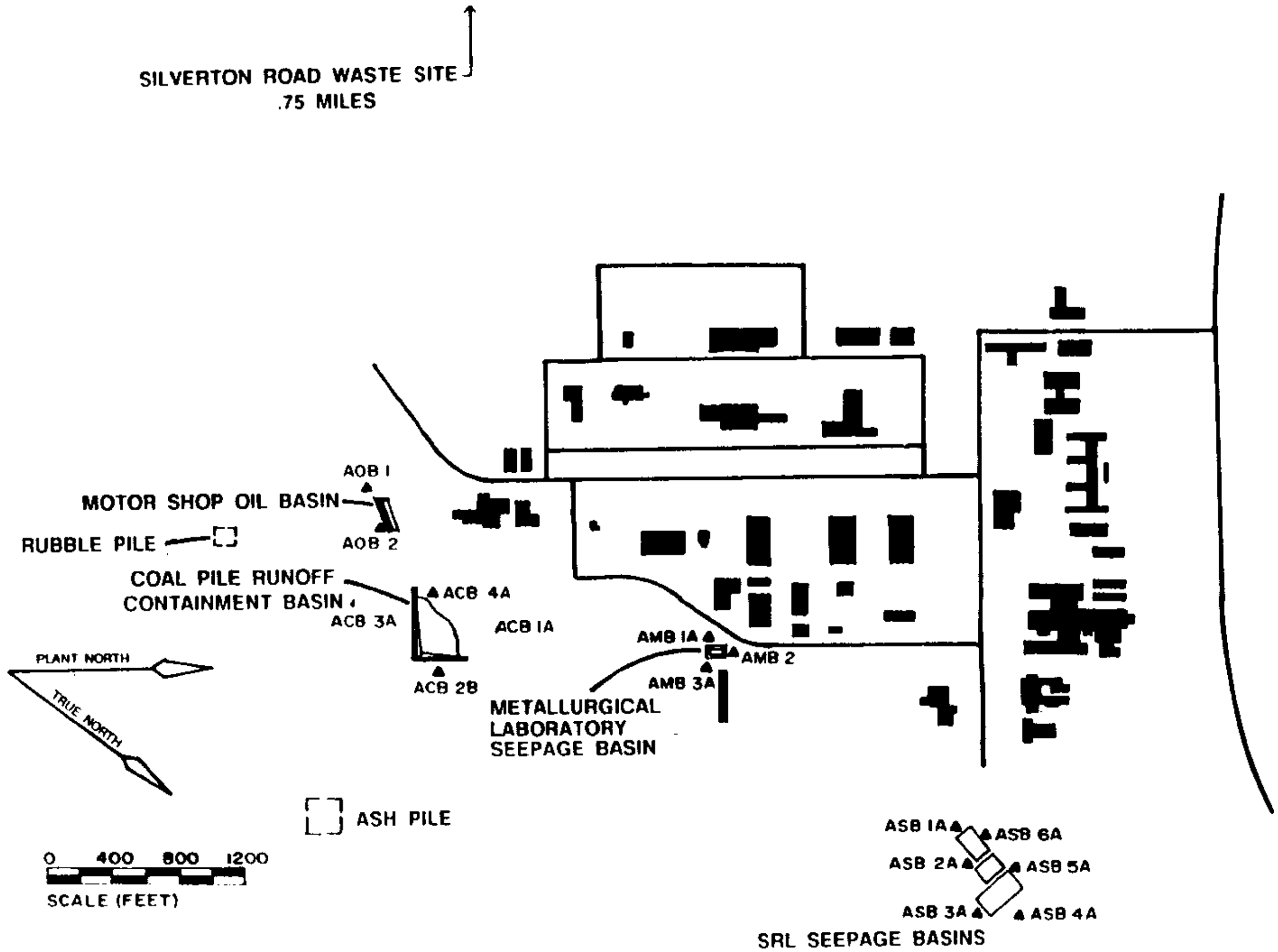


FIGURE 5-2. A/M-Area Waste Sites

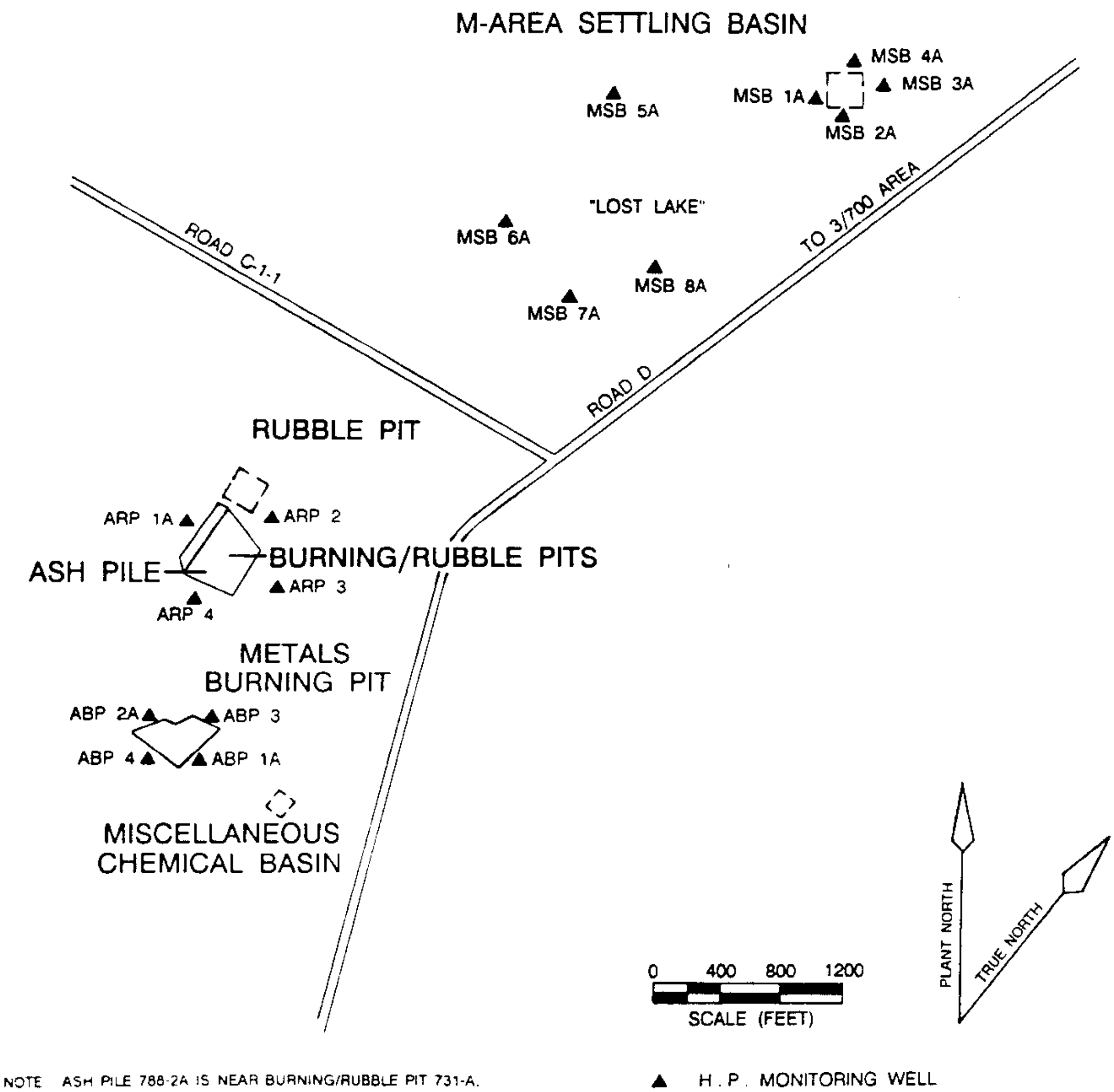


FIGURE 5-3. Additional A/M-Area Waste Sites

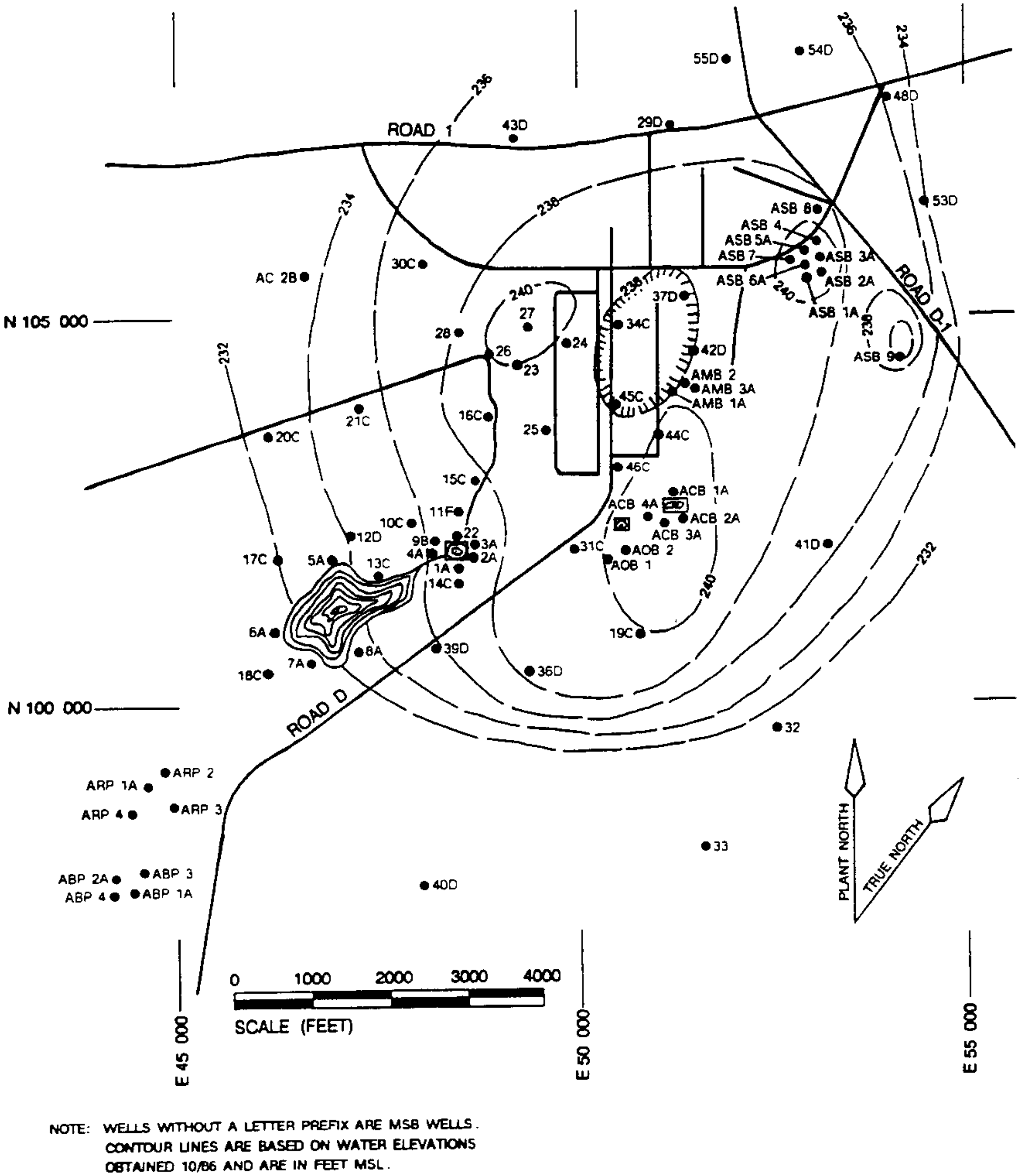


FIGURE 5-4. A/M-Area Water-Table Elevation Map

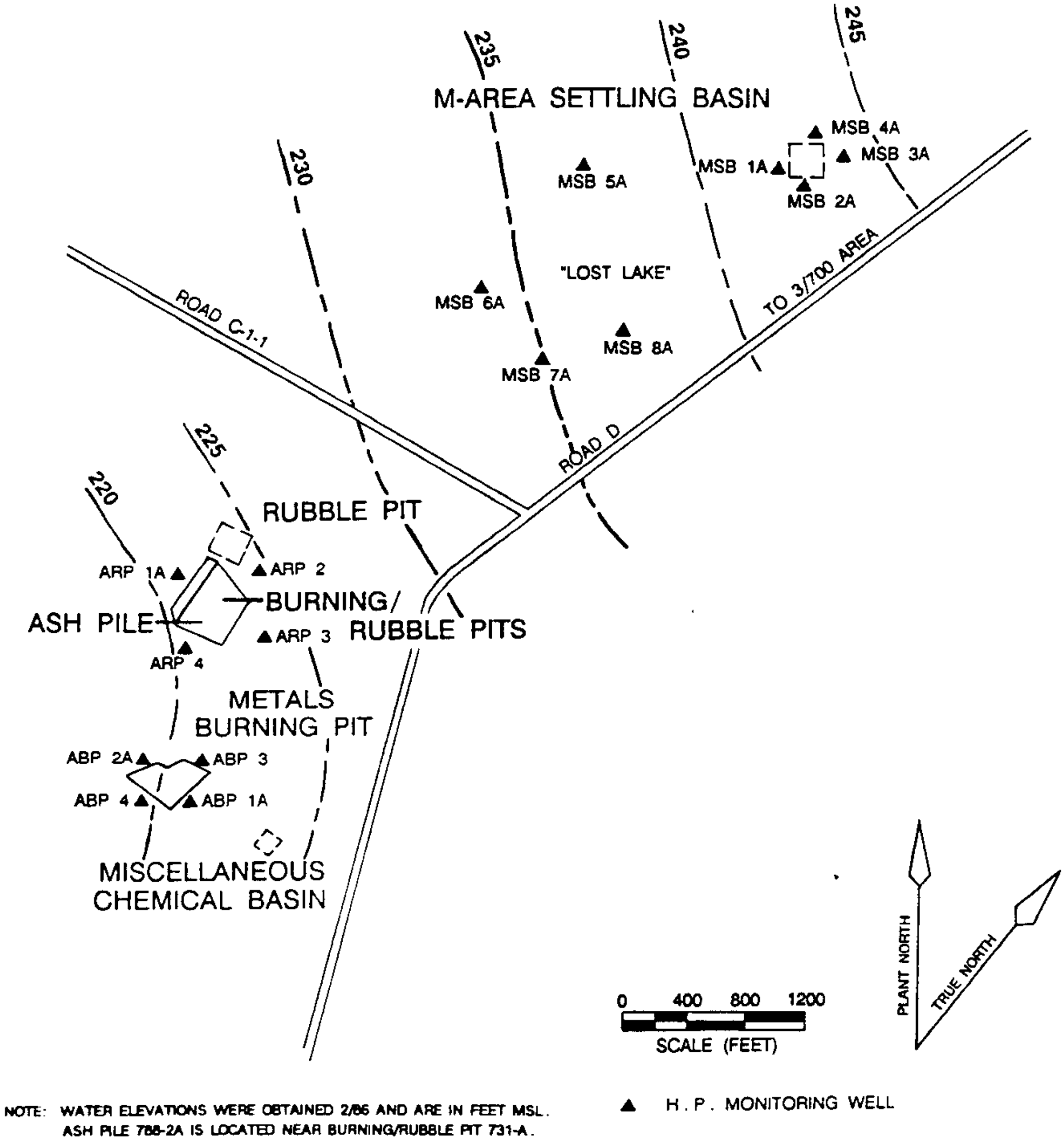


FIGURE 5-5. A/M-Area Water-Table Elevation Map for Additional A/M-Area Waste Sites

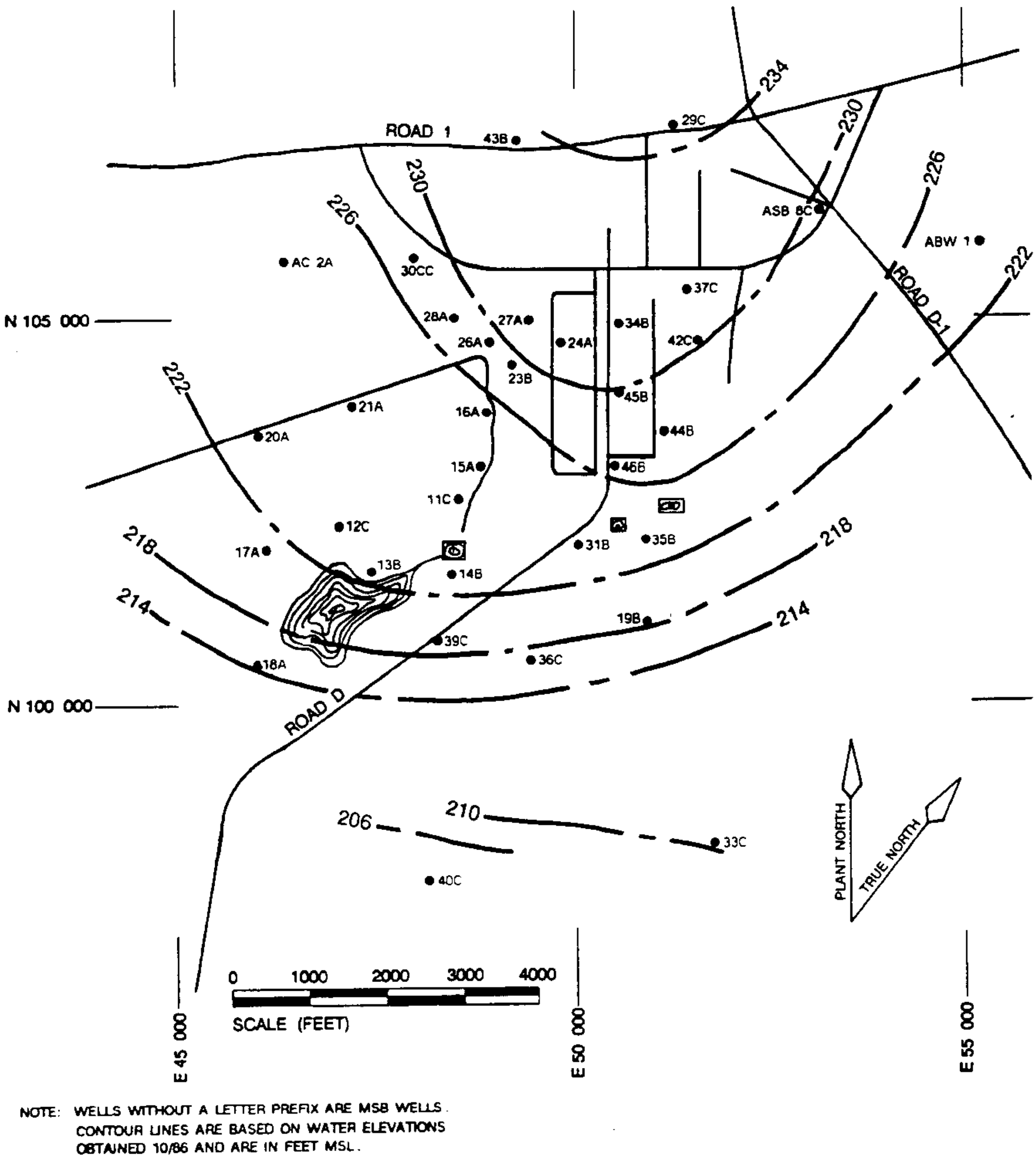
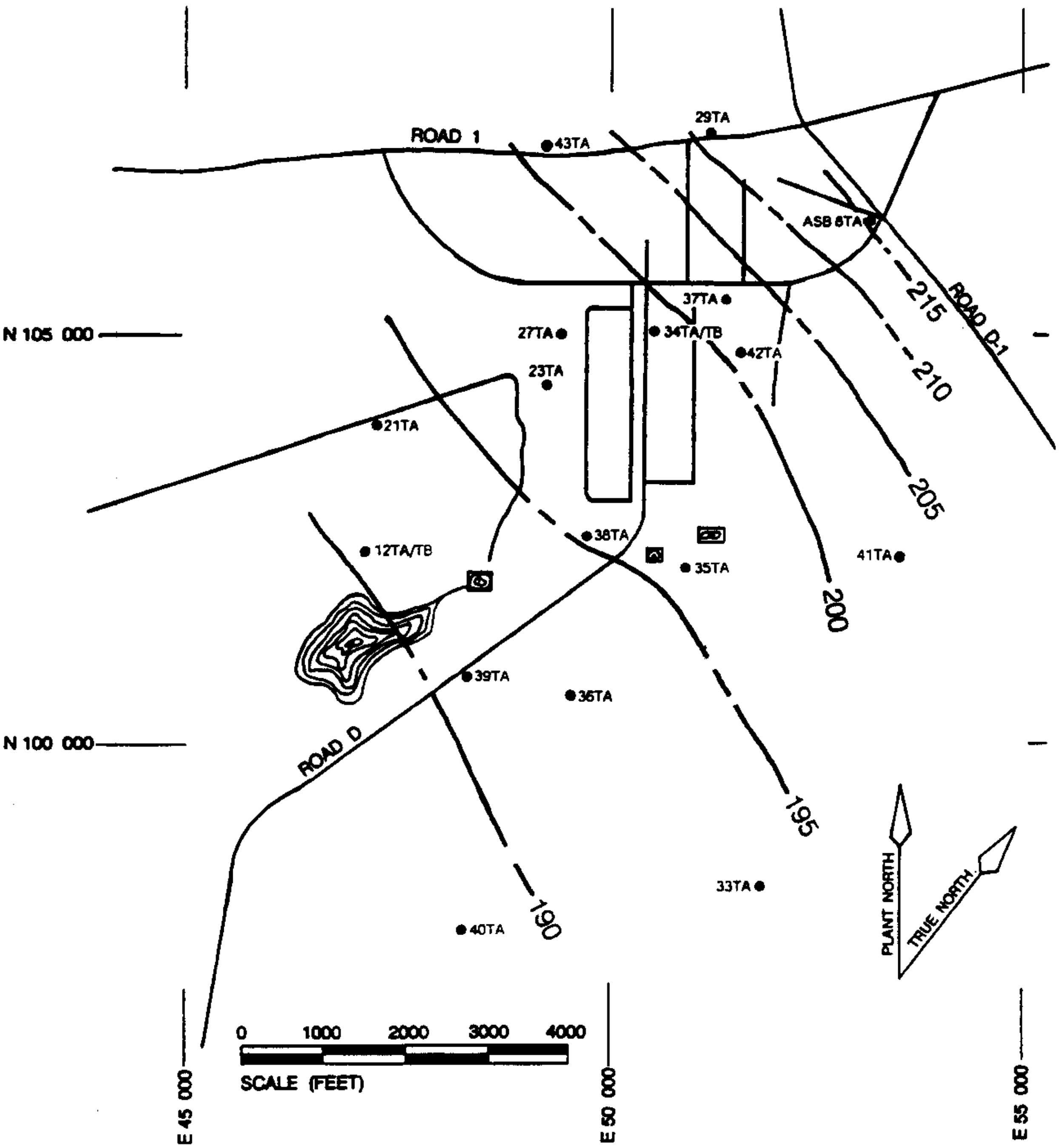


FIGURE 5-6. A/M-Area Congaree Aquifer Piezometric Contour Map



NOTE: WELLS WITHOUT A LETTER PREFIX ARE MSB WELLS.
CONTOUR LINES ARE BASED ON WATER ELEVATIONS
OBTAINED 12/86 AND ARE IN FEET MSL.

FIGURE 5-7. A/M-Area Tuscaloosa Aquifer Piezometric Contour Map

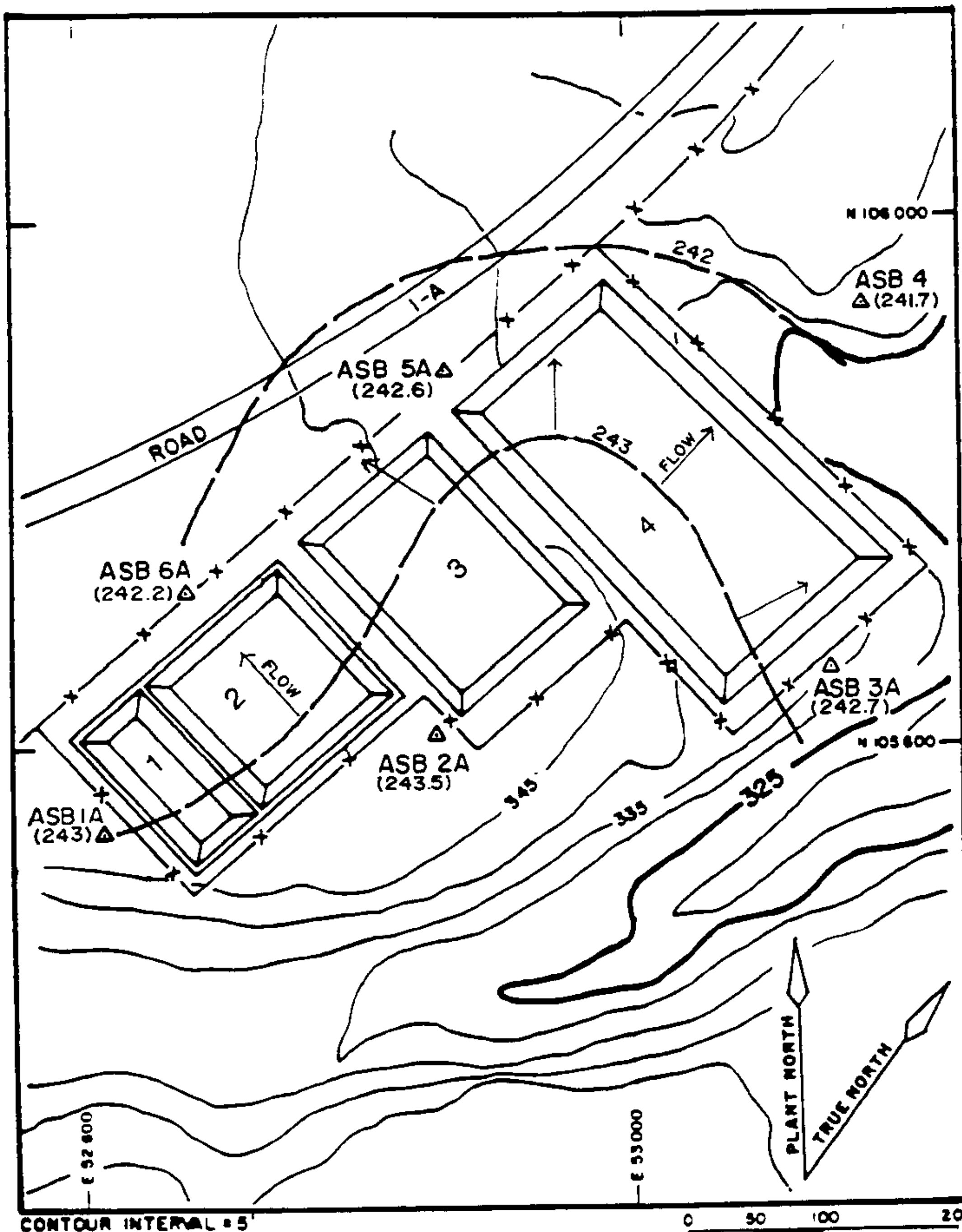


FIGURE 5-8. Savannah River Laboratory (SRL) Seepage Basins Water-Table Elevation Map

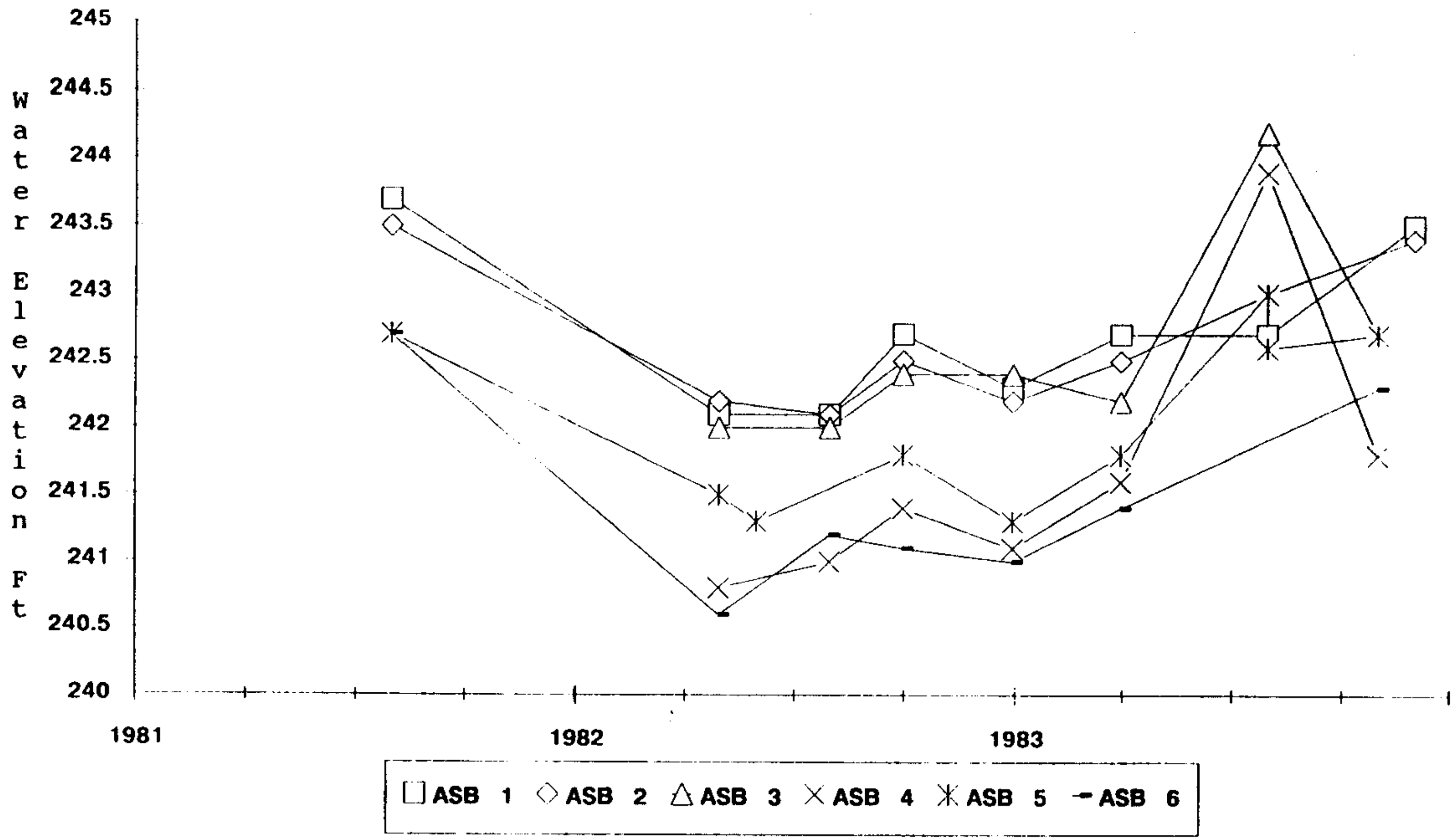


FIGURE 5-9. Hydrograph of the Savannah River Laboratory (SRL) Seepage Basins Wells

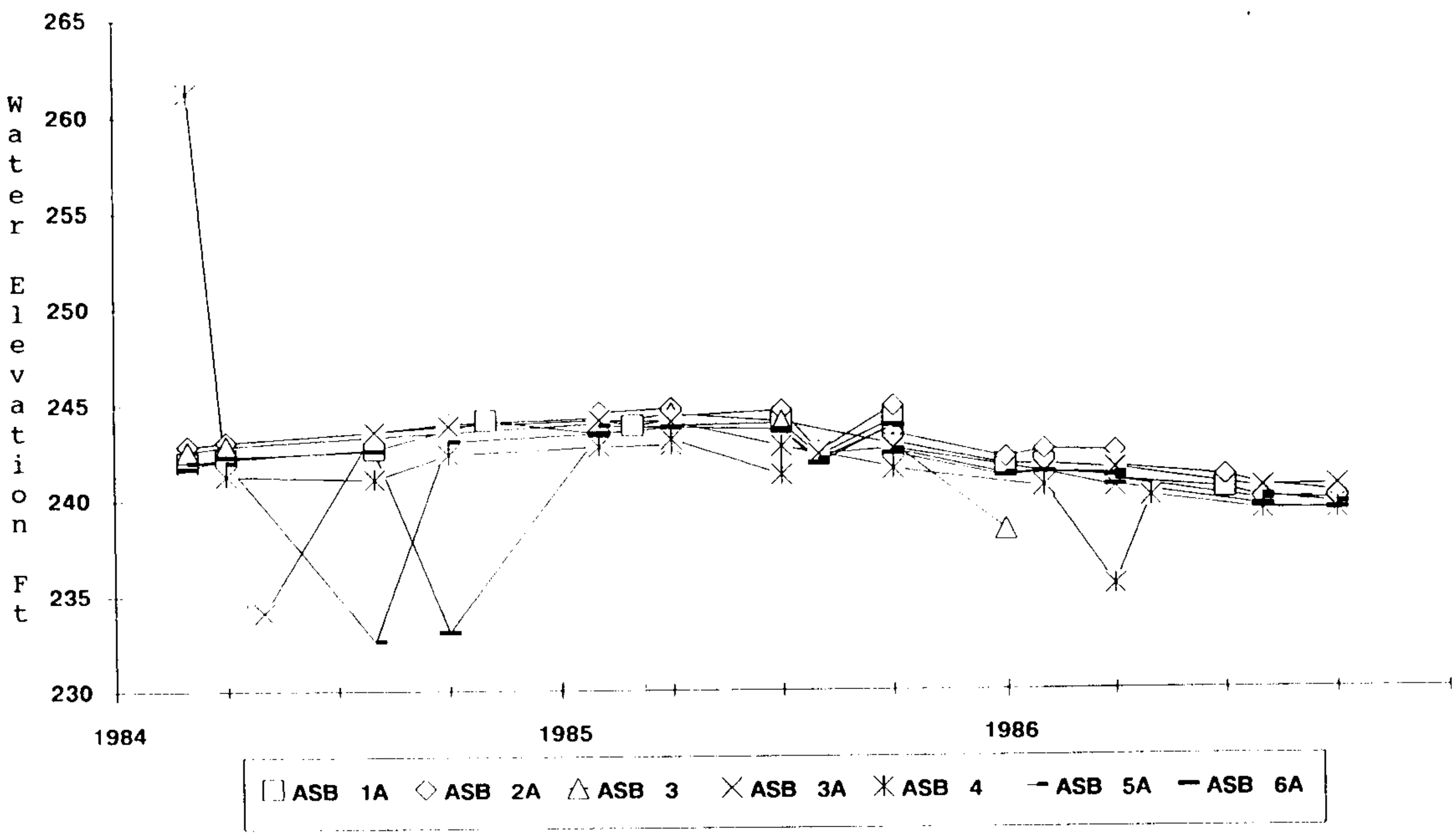


FIGURE 5-9 (cont.). Hydrograph of the Savannah River Laboratory (SRL) Seepage Basins Wells

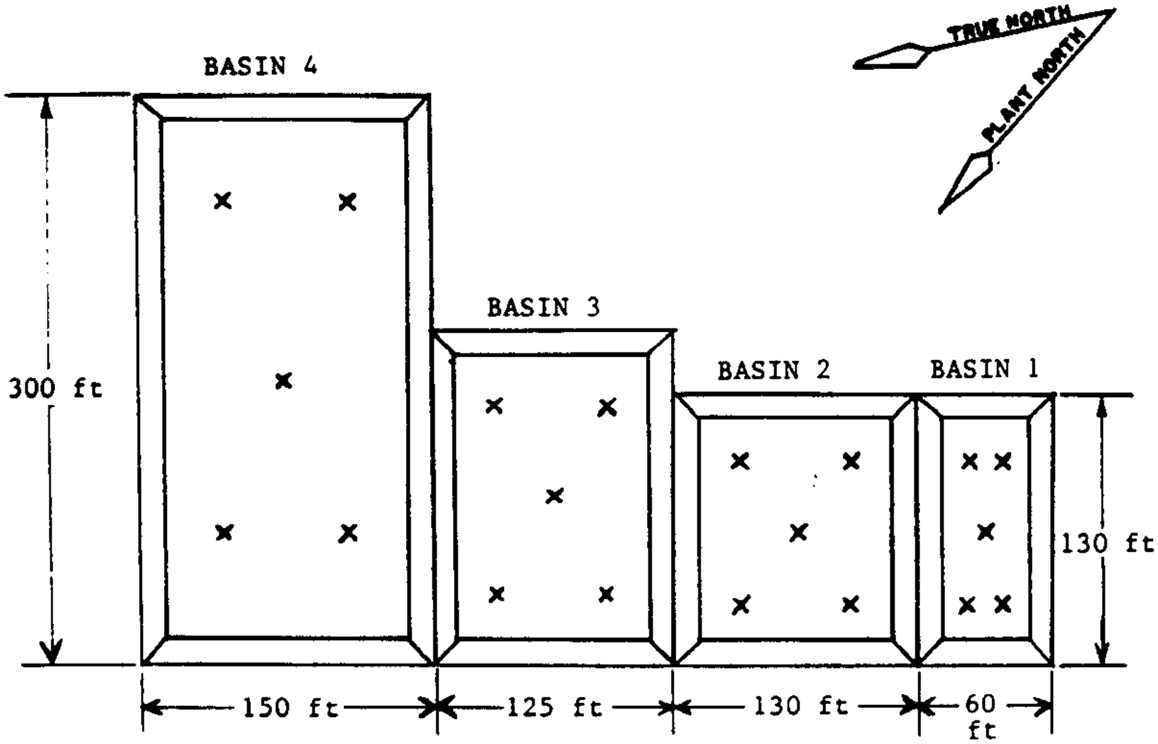


FIGURE 5-10. Soil Sampling Locations at the Savannah River Laboratory (SRL) Seepage Basins

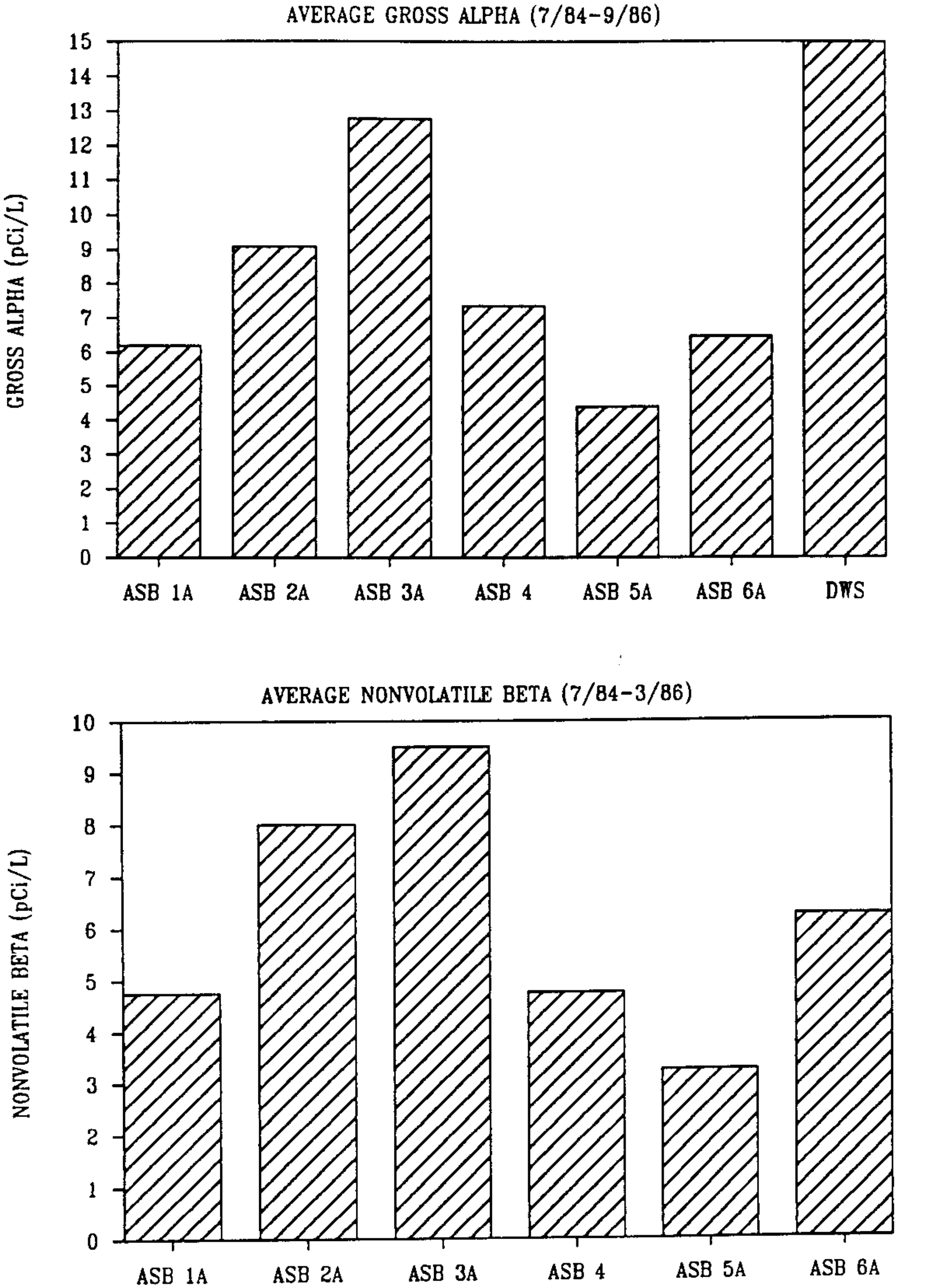


FIGURE 5-11. Average Gross Alpha and Nonvolatile Beta Activities in the Savannah River Laboratory (SRL) Seepage Basins Wells

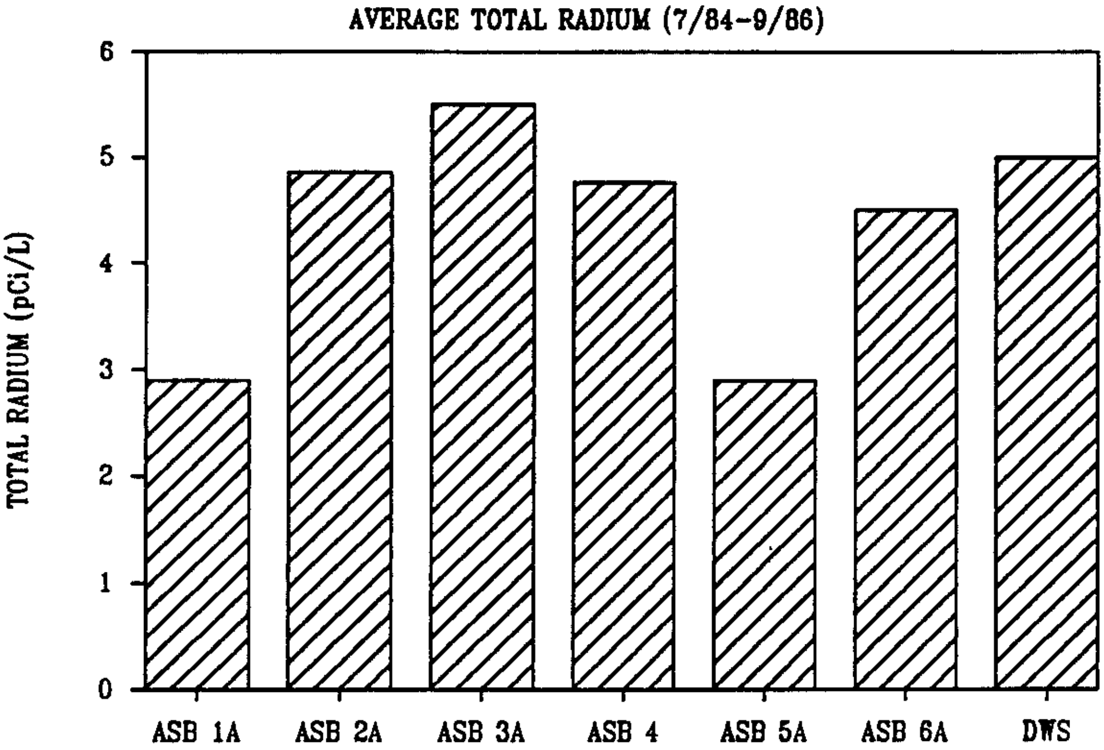


FIGURE 5-12. Average Total Radium Activities in the Savannah River Laboratory (SRL) Seepage Basins Wells

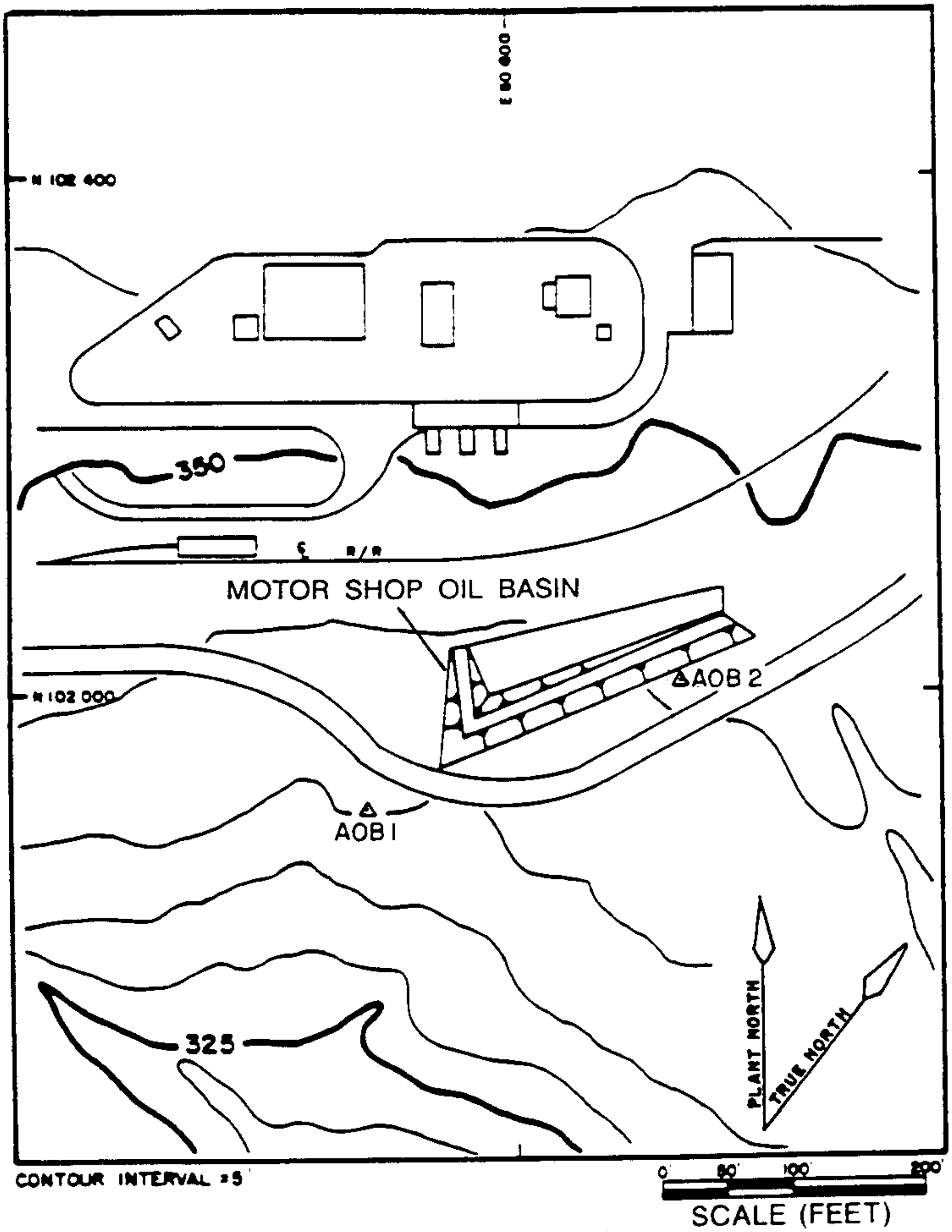


FIGURE 5-13. The A-Area Motor Shop Oil Basin

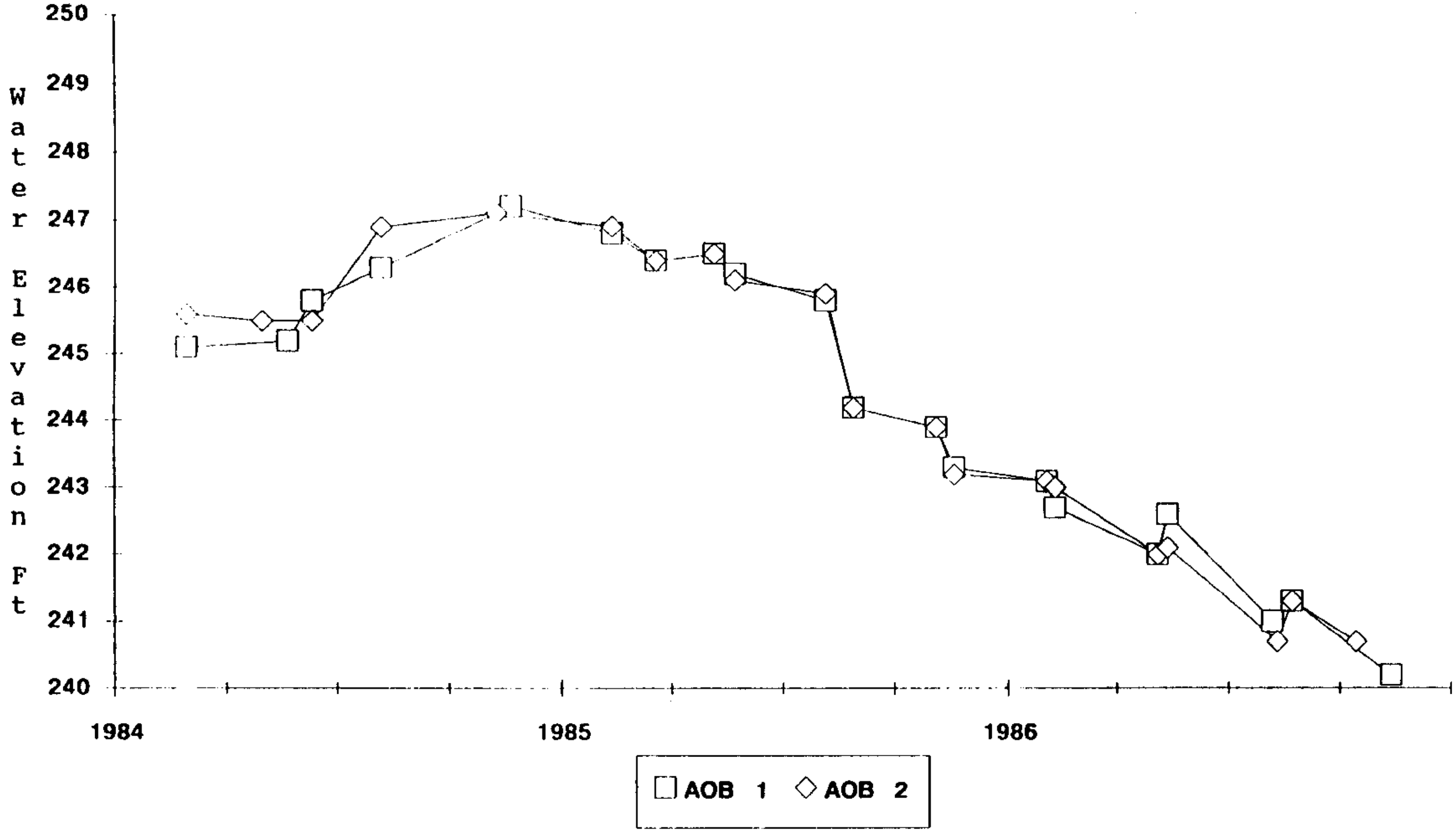


FIGURE 5-14. Hydrograph of the A-Area Motor Shop Oil Basin Wells

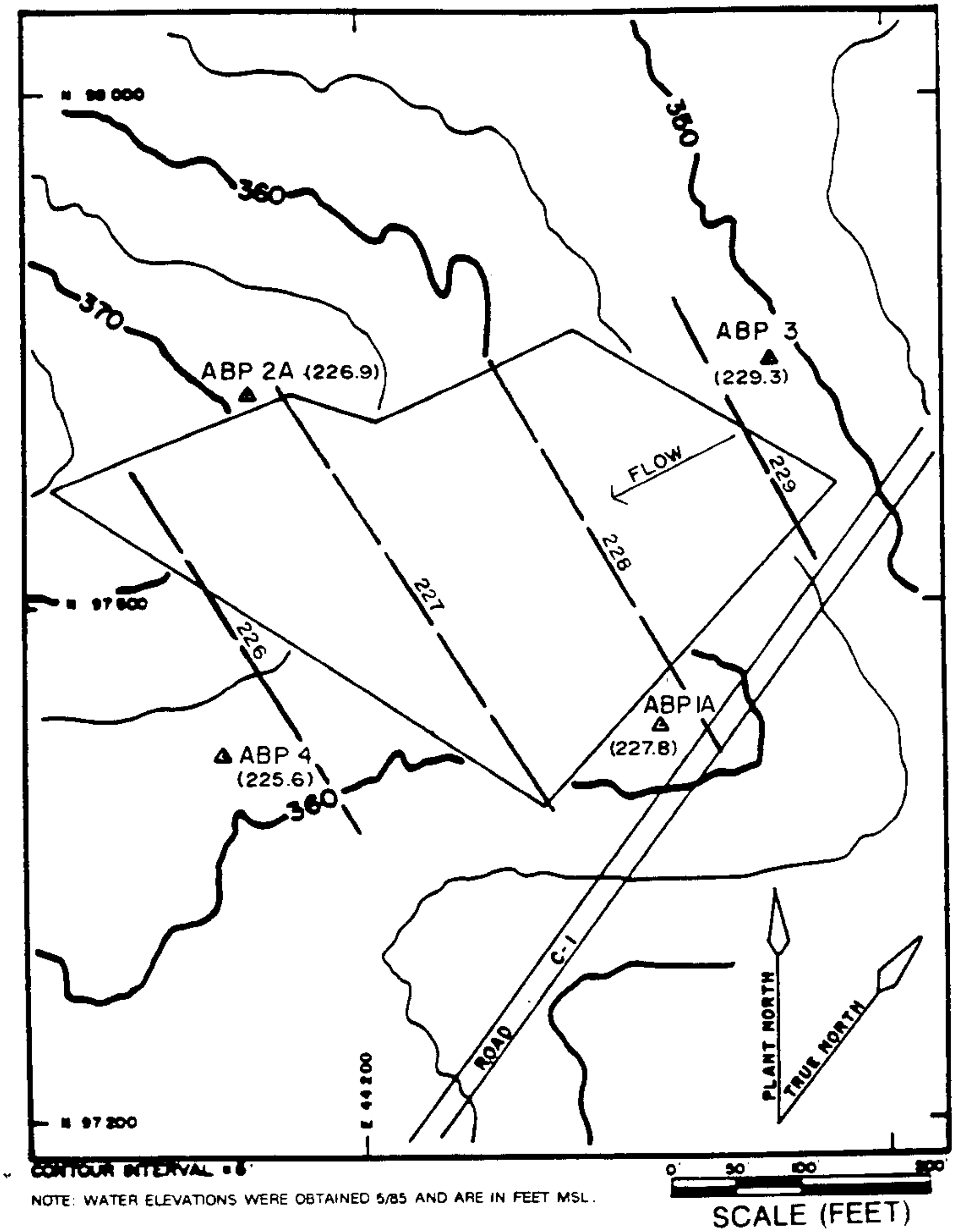
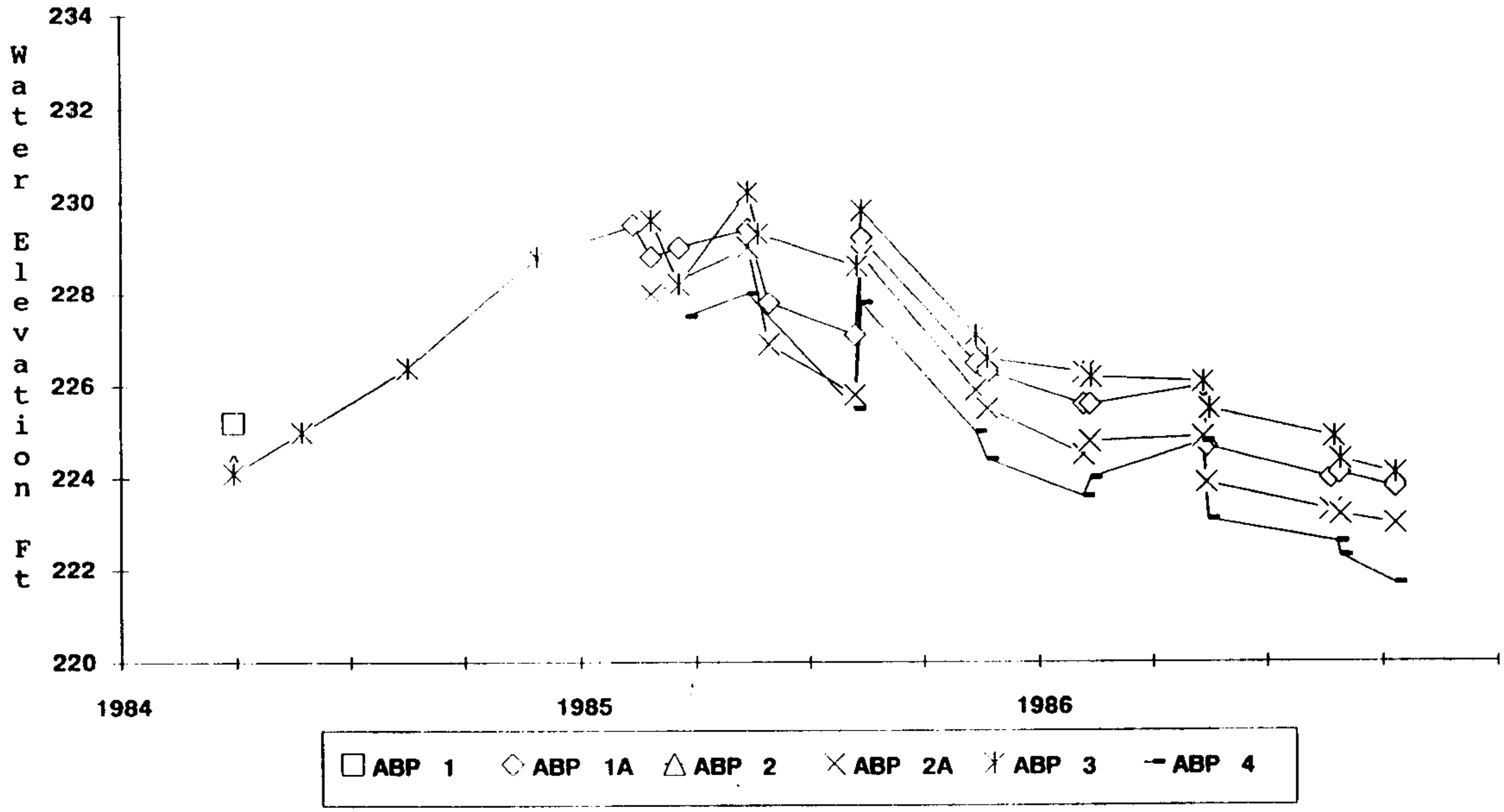


FIGURE 5-15. A-Area Metals Burning Pit Water-Table Elevation Map



NOTE: A WATER LEVEL OF 239.9 FEET OBTAINED FOR WELL ABP 4 ON 5/30/85 IS NOT PLOTTED.

FIGURE 5-16. Hydrograph of the A-Area Metals Burning Pit Wells

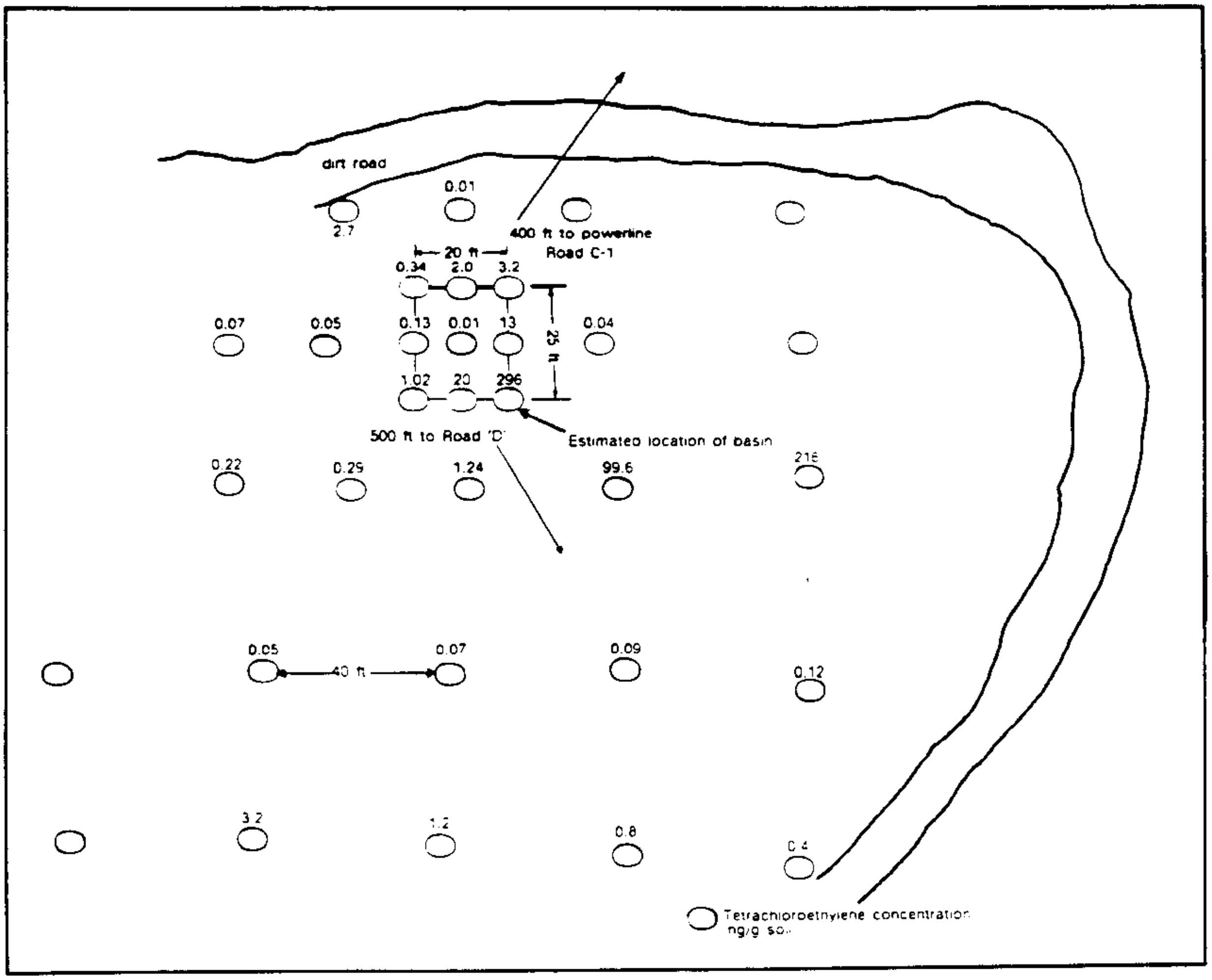


FIGURE 5-17. Soil Sampling Locations and Tetrachloroethylene Concentrations at the A-Area Miscellaneous Chemical Basin

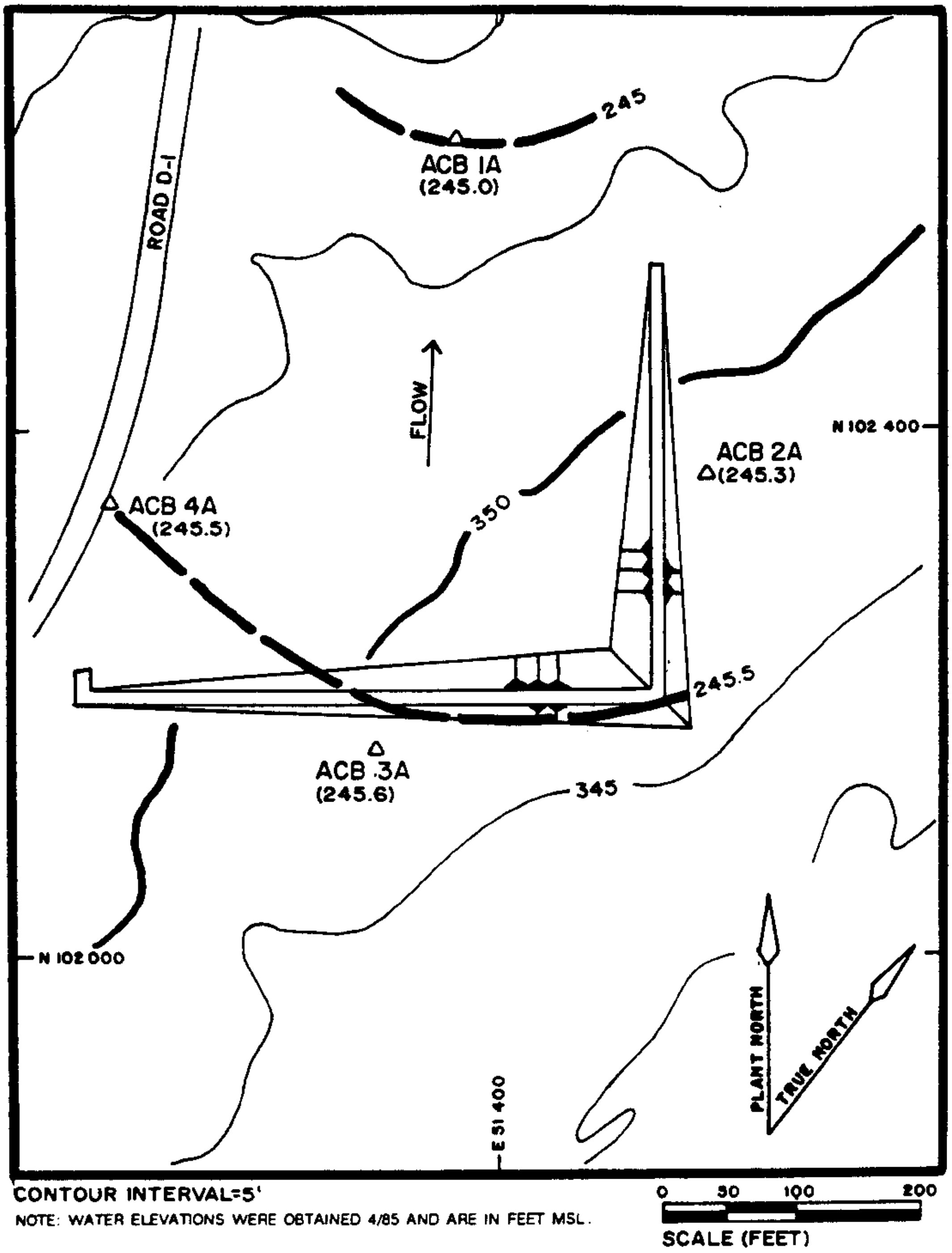


FIGURE 5-18. A-Area Coal Pile Runoff Containment Basin (CPRB) Water-Table Elevation Map

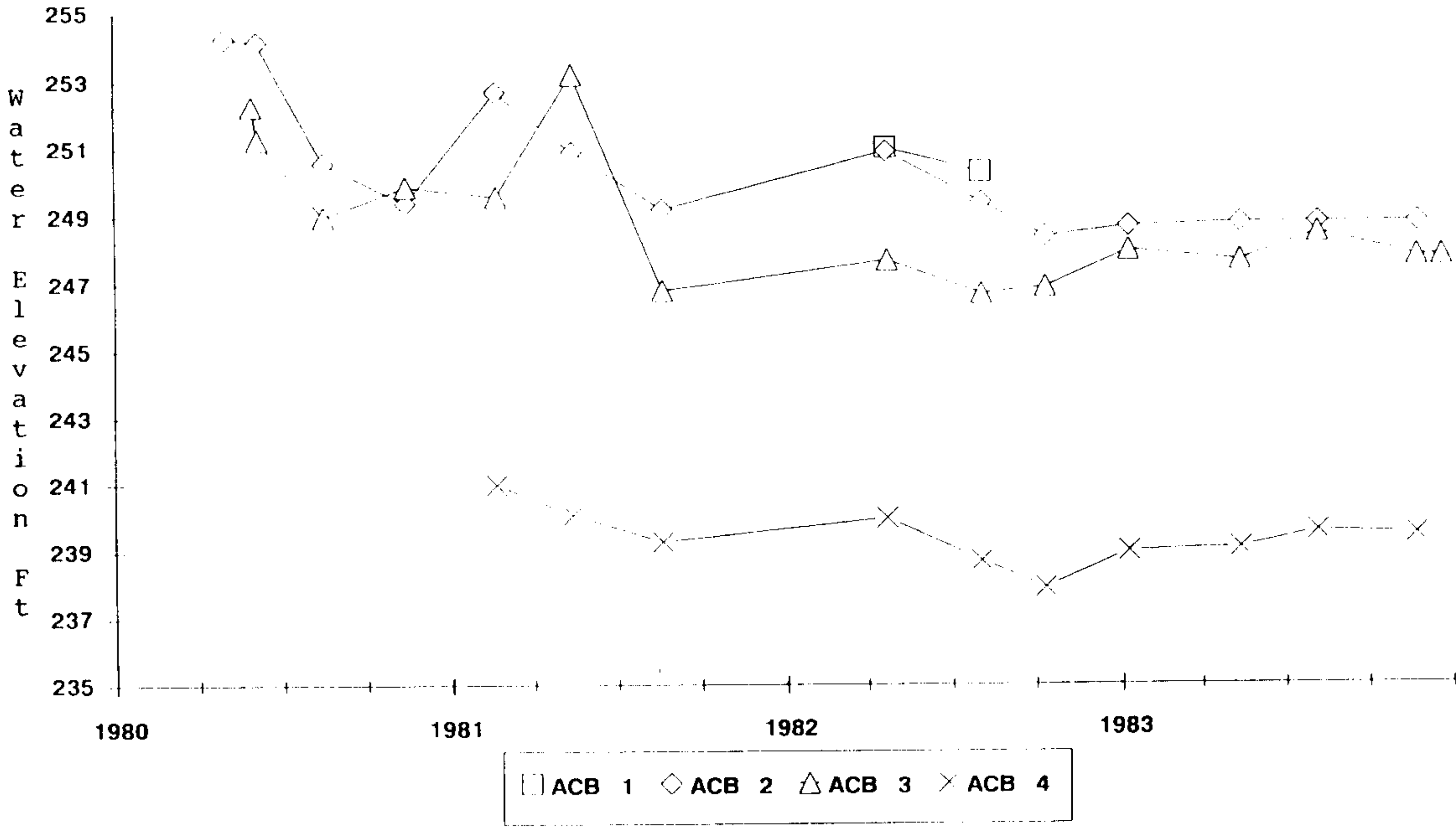


FIGURE 5-19. Hydrograph of the A-Area Coal Pile Runoff Containment Basin (CPRB) Wells

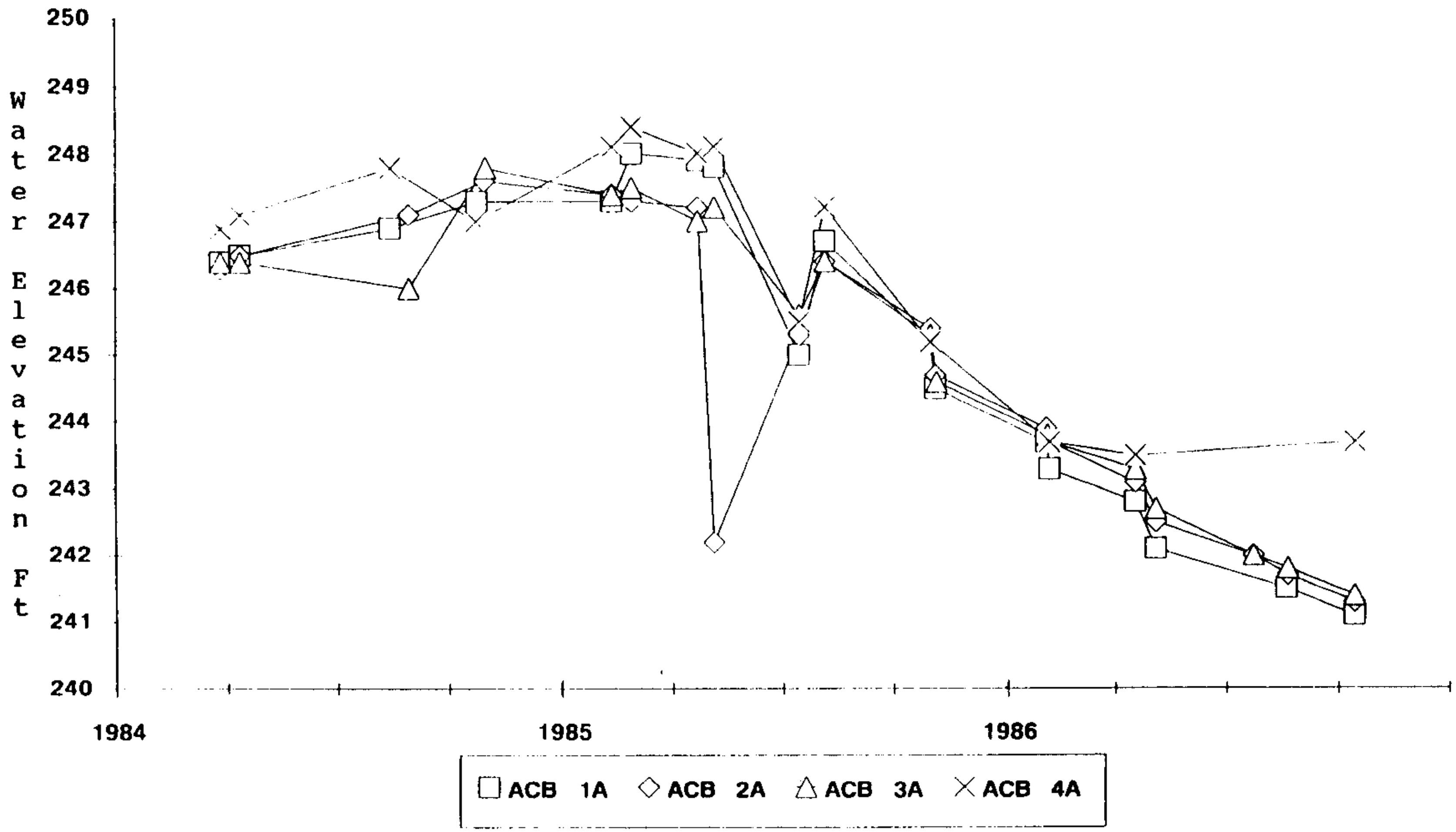


FIGURE 5-19 (cont.). Hydrograph of the A-Area Coal Pile Runoff Containment Basin (CPRB) Wells

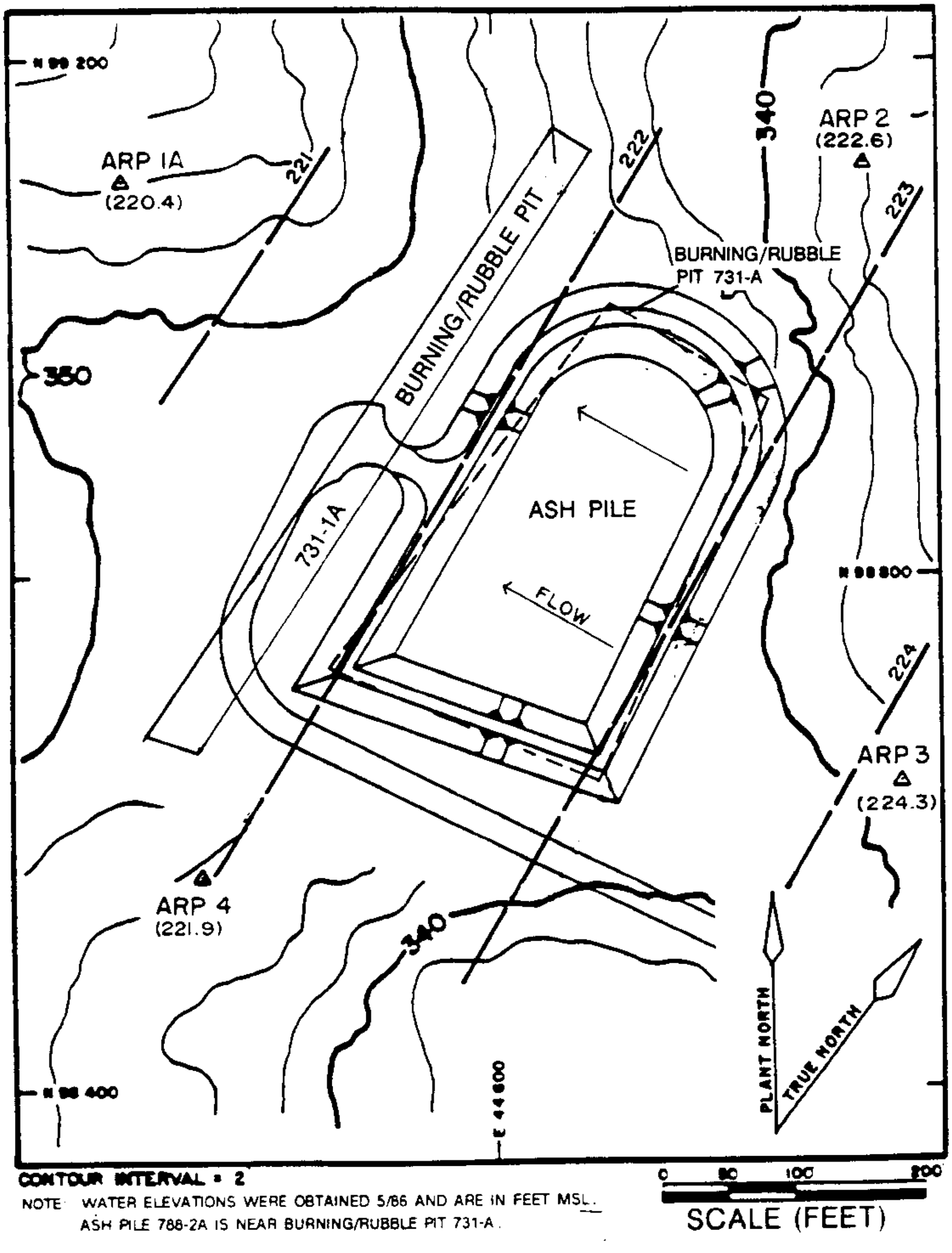


FIGURE 5-20. A-Area Burning/Rubble Pits and Ash Pile (788-2A) Water-Table Elevation Map

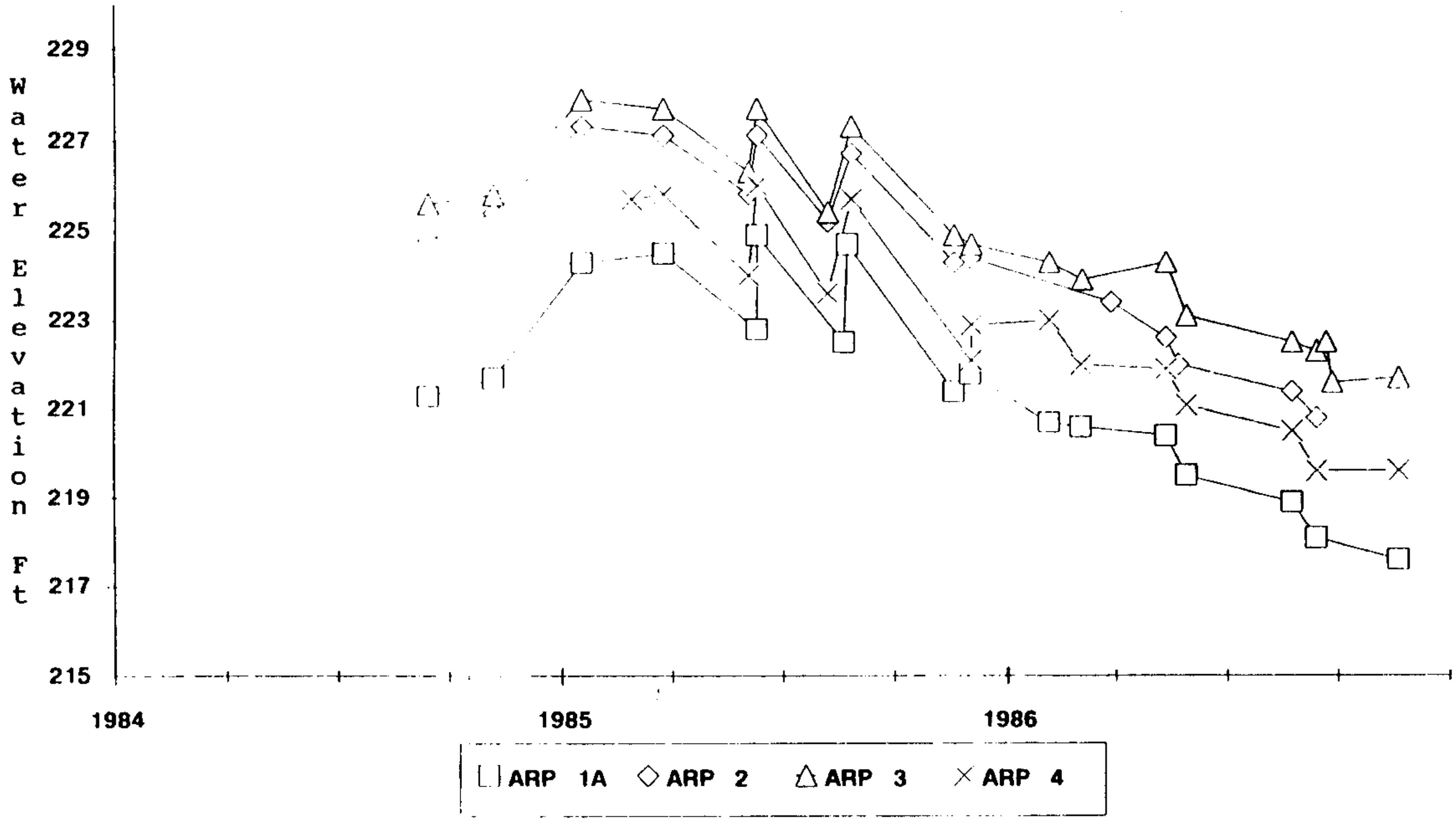


FIGURE 5-21. Hydrograph of the A-Area Burning/Rubble Pits Wells

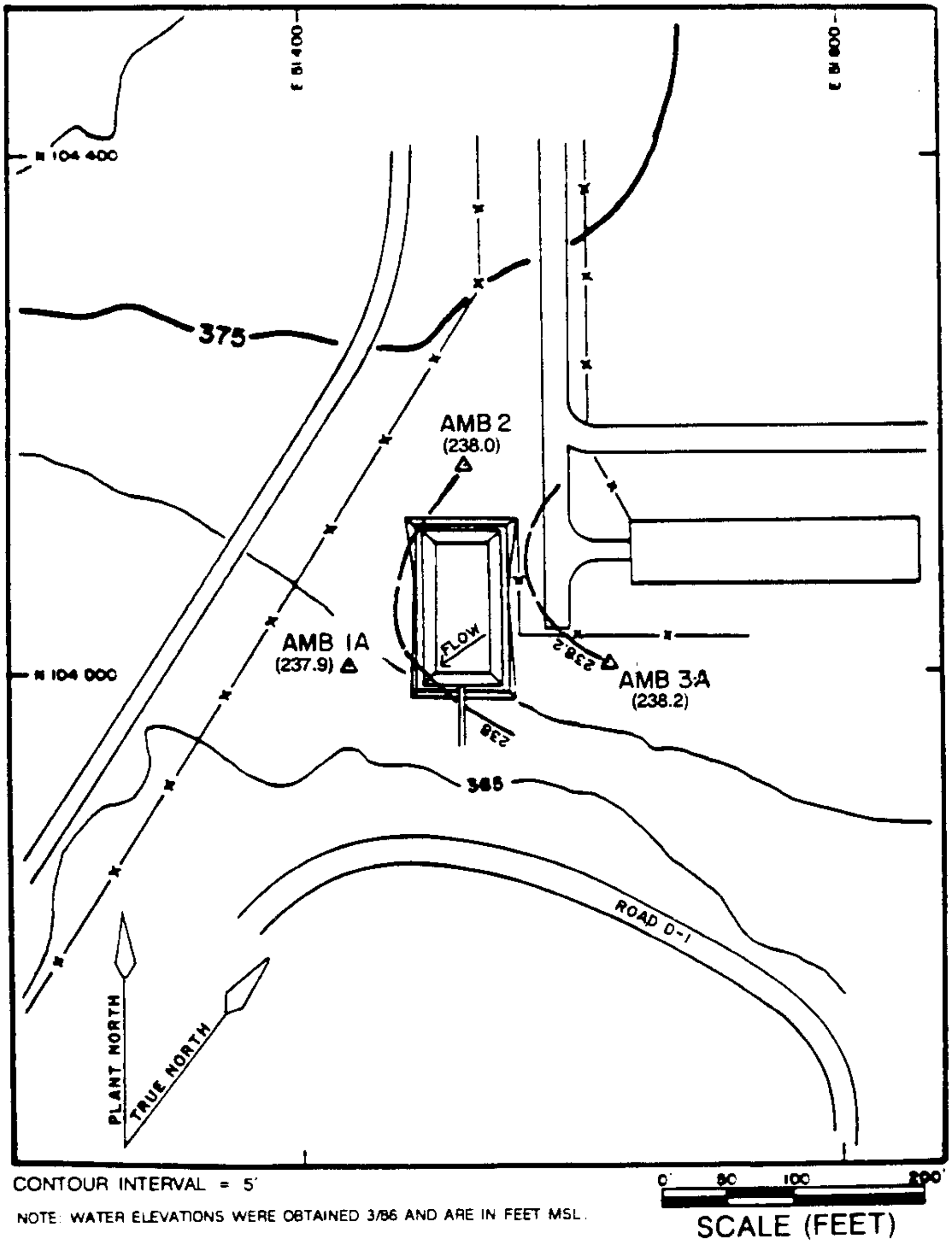


FIGURE 5-22. A-Area Metallurgical Laboratory Seepage Basin Water-Table Elevation Map

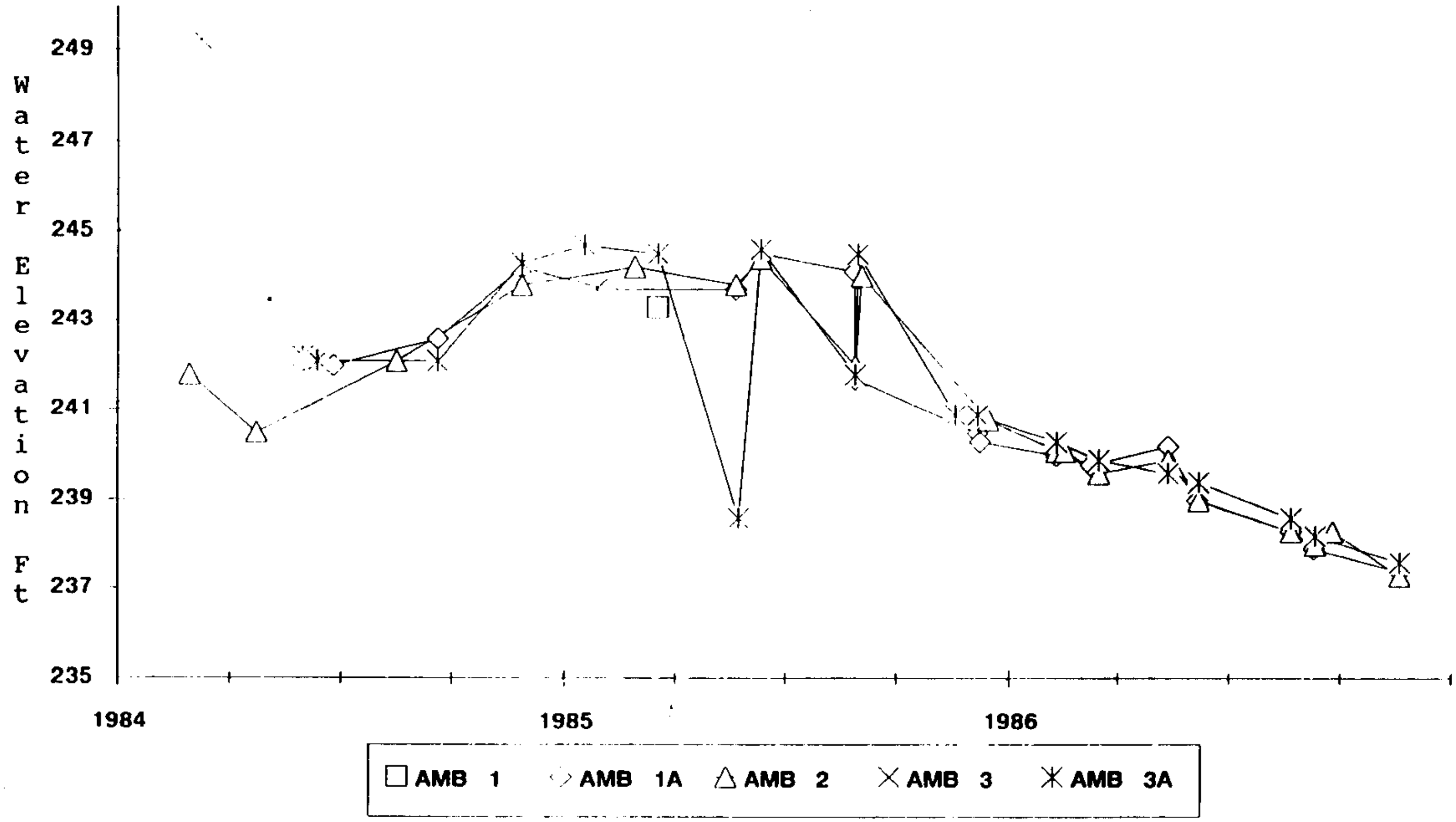


FIGURE 5-23. Hydrograph of the A-Area Metallurgical Laboratory Seepage Basin Wells

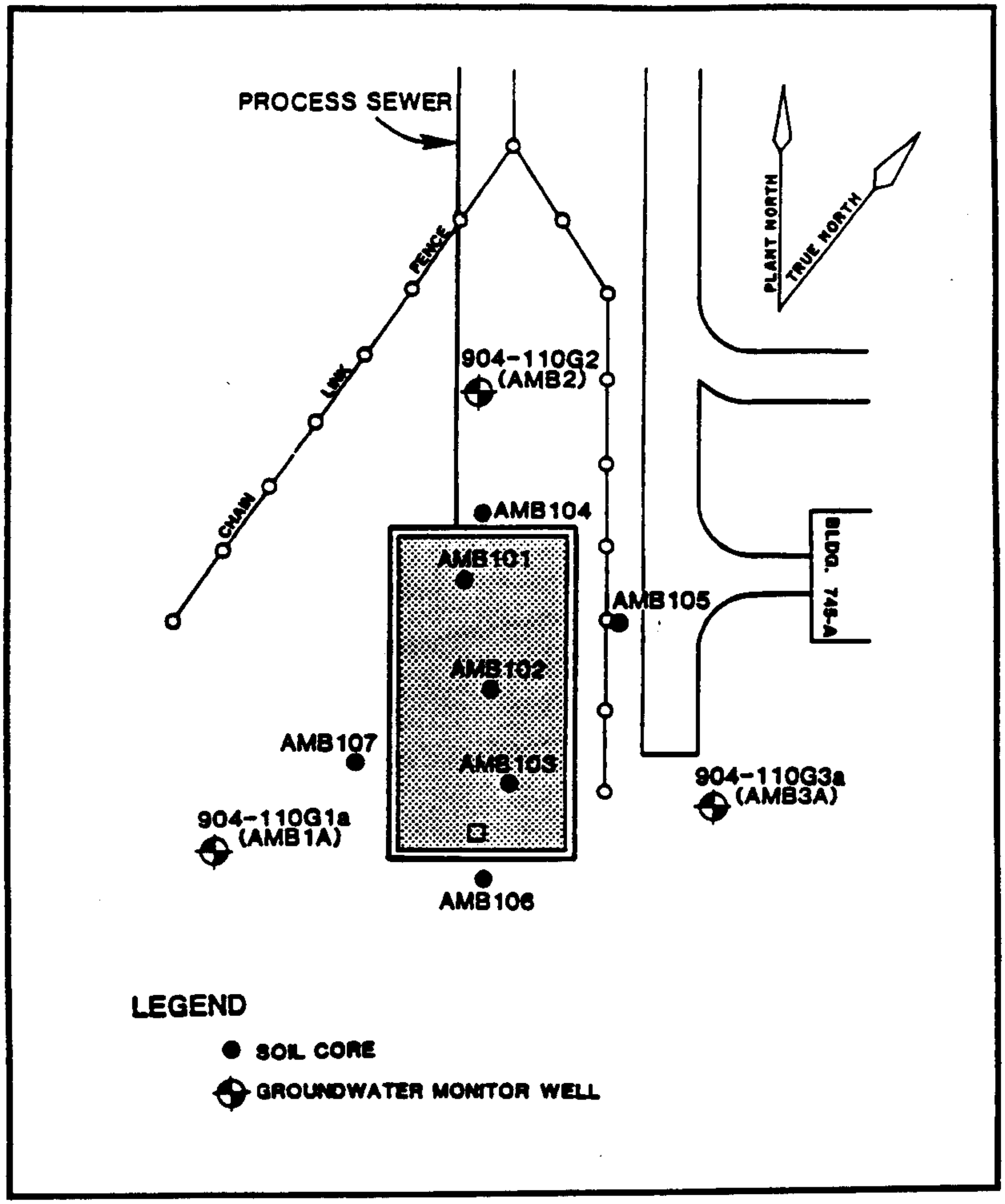


FIGURE 5-24. Soil Sampling Locations at the A-Area Metallurgical Laboratory Seepage Basin

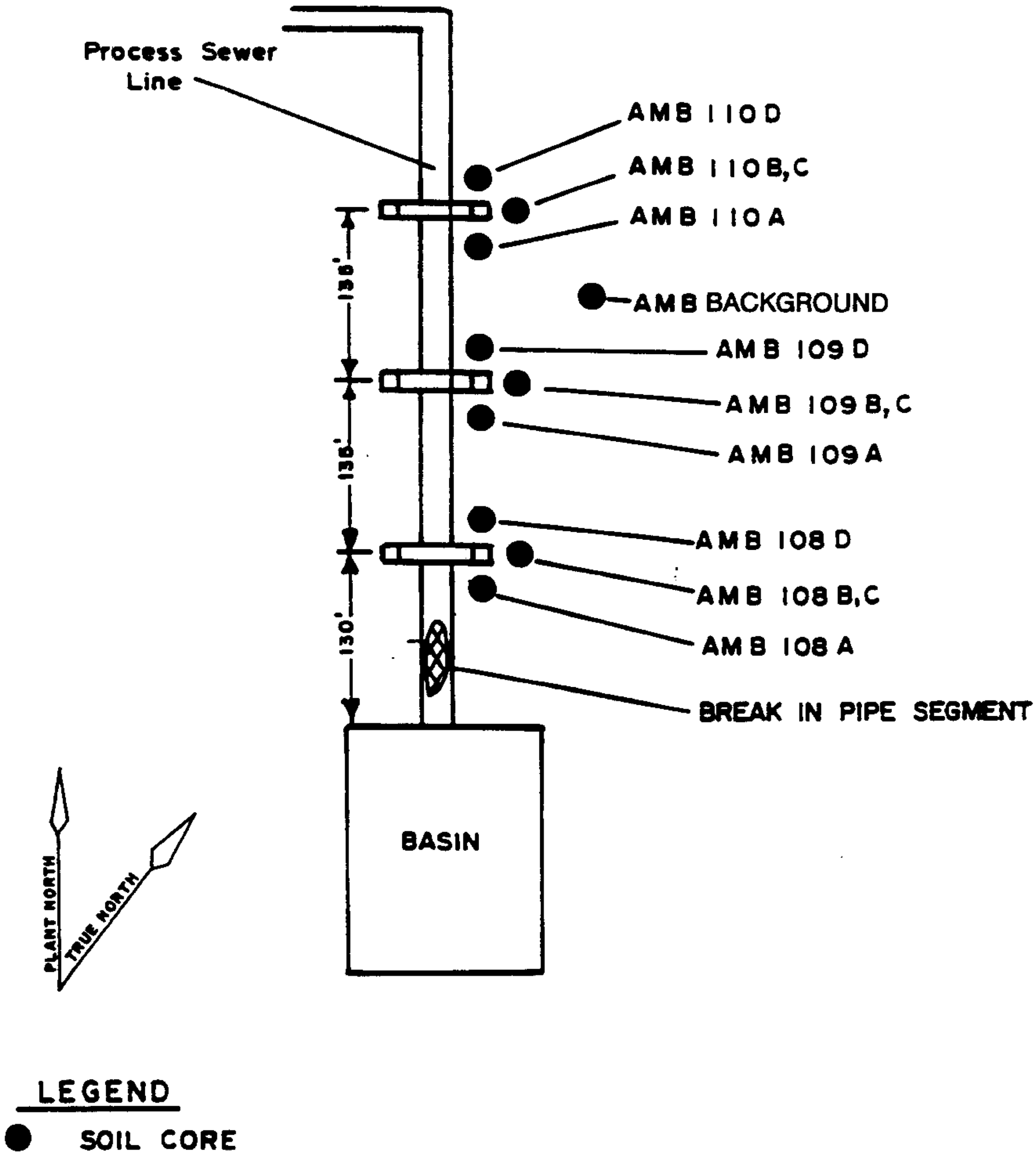


FIGURE 5-25. Soil Sampling Locations Along the A-Area Metallurgical Laboratory Seepage Basin Process Sewer Line

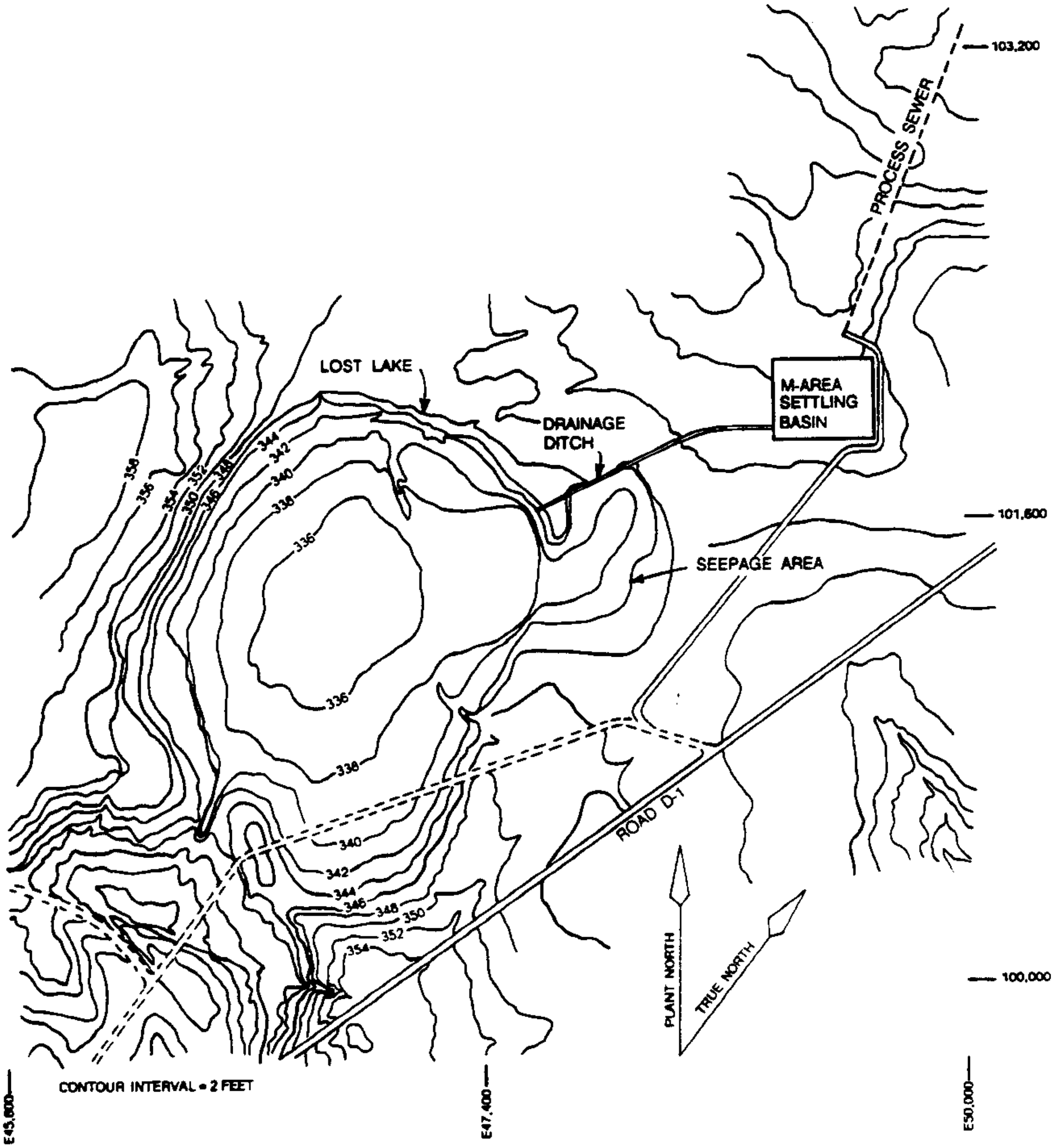


FIGURE 5-26. The M-Area Settling Basin and Vicinity

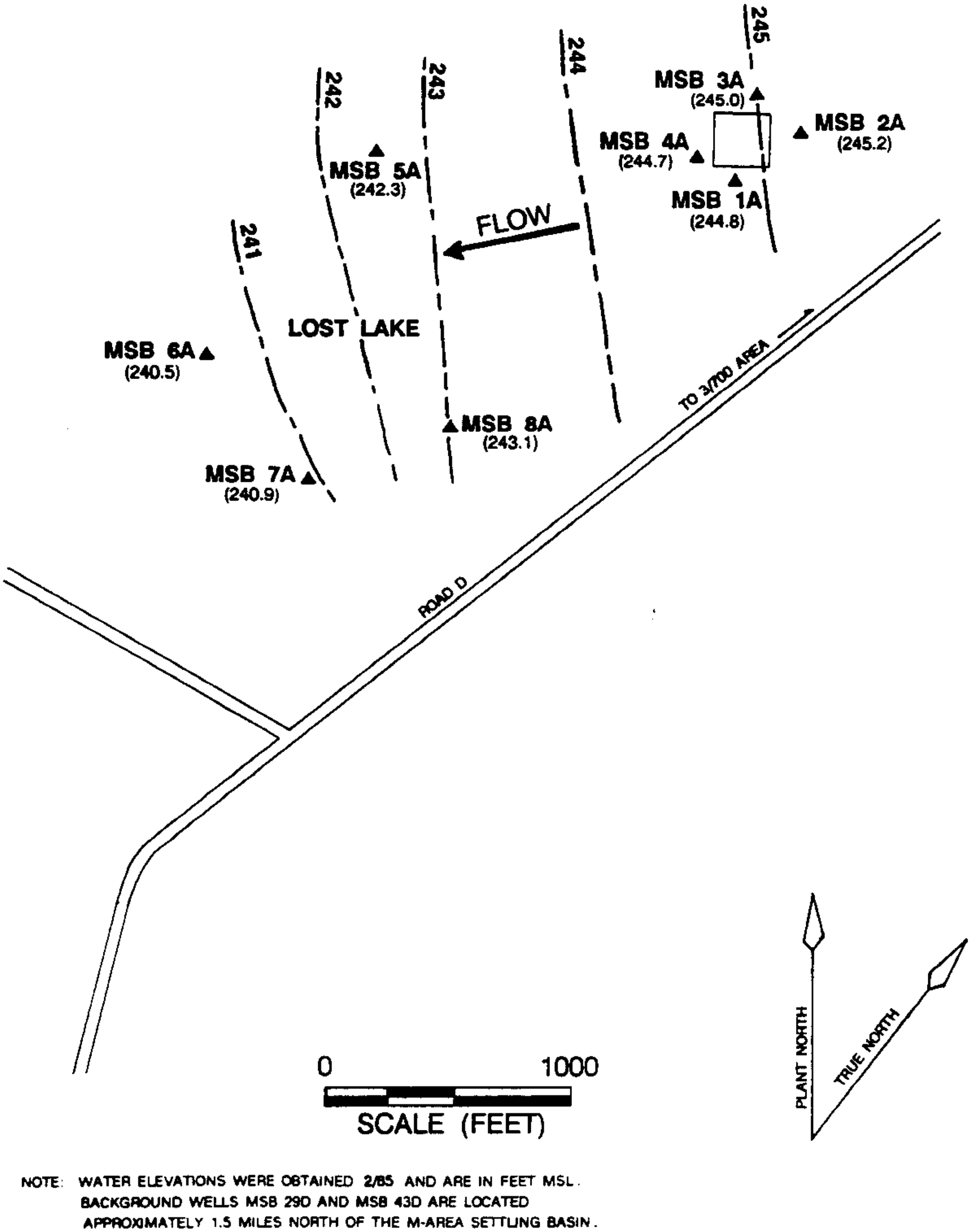


FIGURE 5-27. M-Area Settling Basin and Vicinity Water-Table Elevation Map

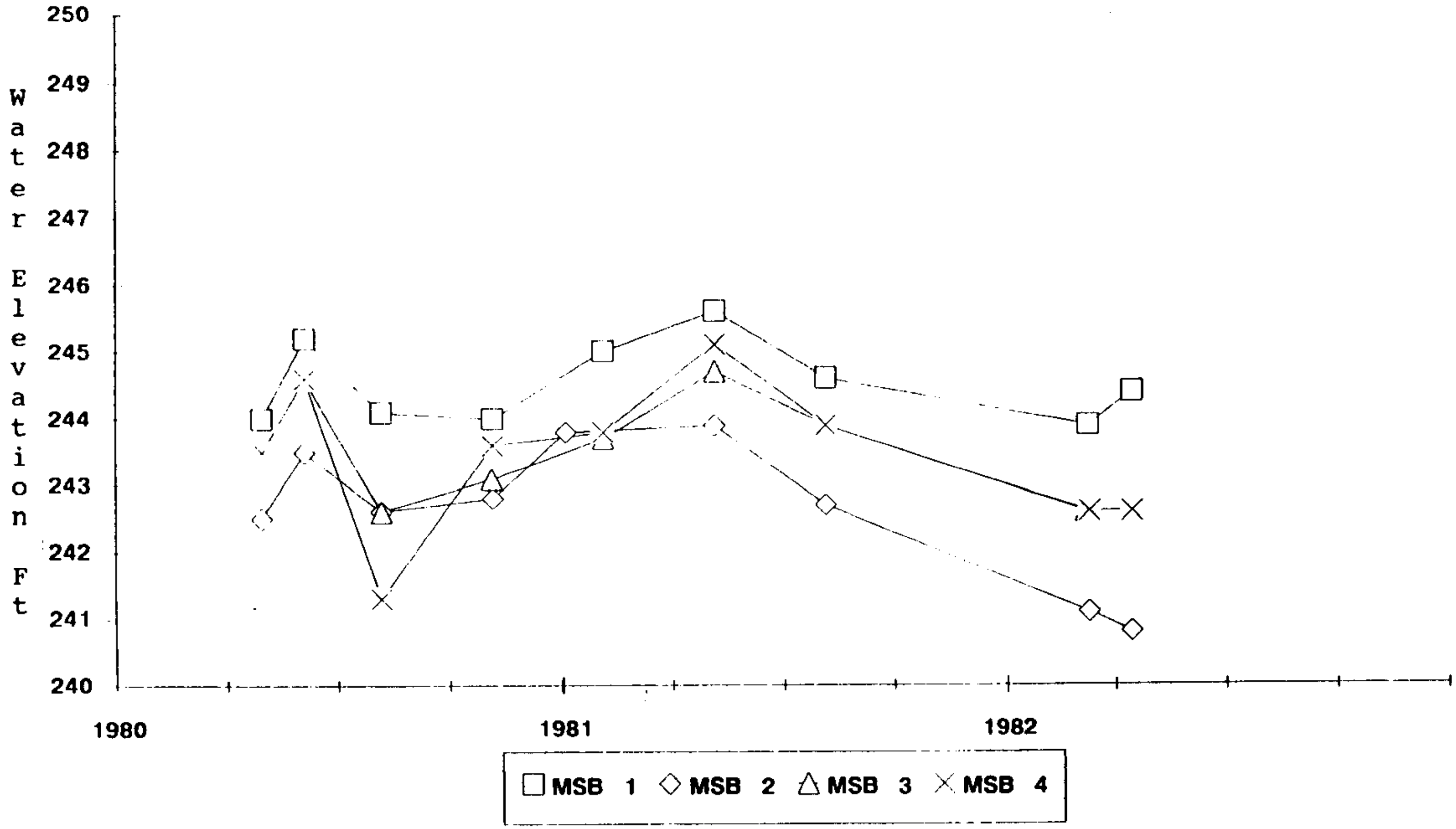


FIGURE 5-28. Hydrograph of M-Area Settling Basin Wells MSB 1 Through MSB 4 and MSB 1A Through MSB 4A

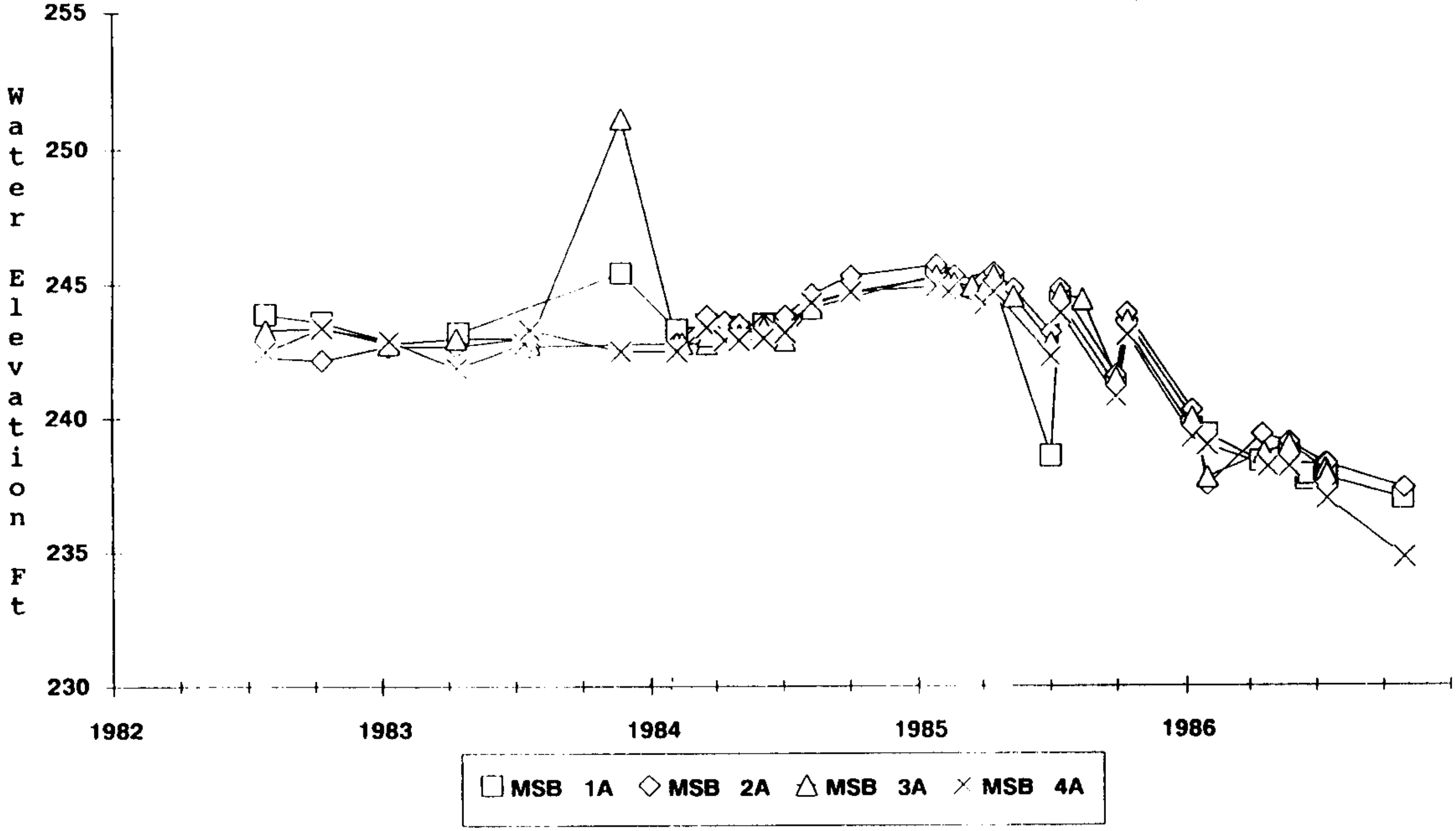


FIGURE 5-28 (cont.). Hydrograph of M-Area Settling Basin Wells MSB 1 Through MSB 4 and MSB 1A Through MSB 4A

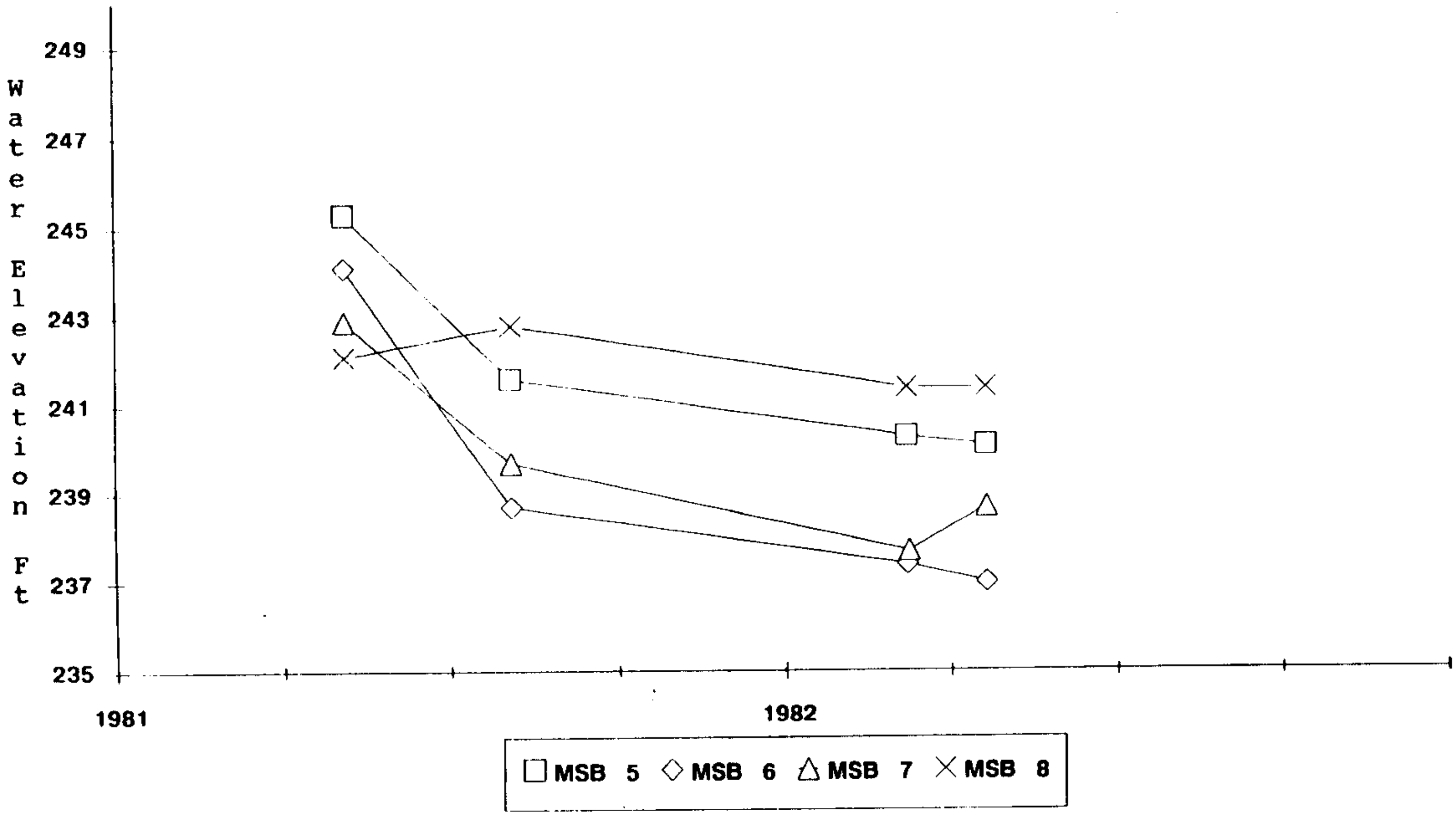


FIGURE 5-29. Hydrograph of M-Area Settling Basin Wells MSB 5 Through MSB 8 and MSB 5A Through MSB 8A

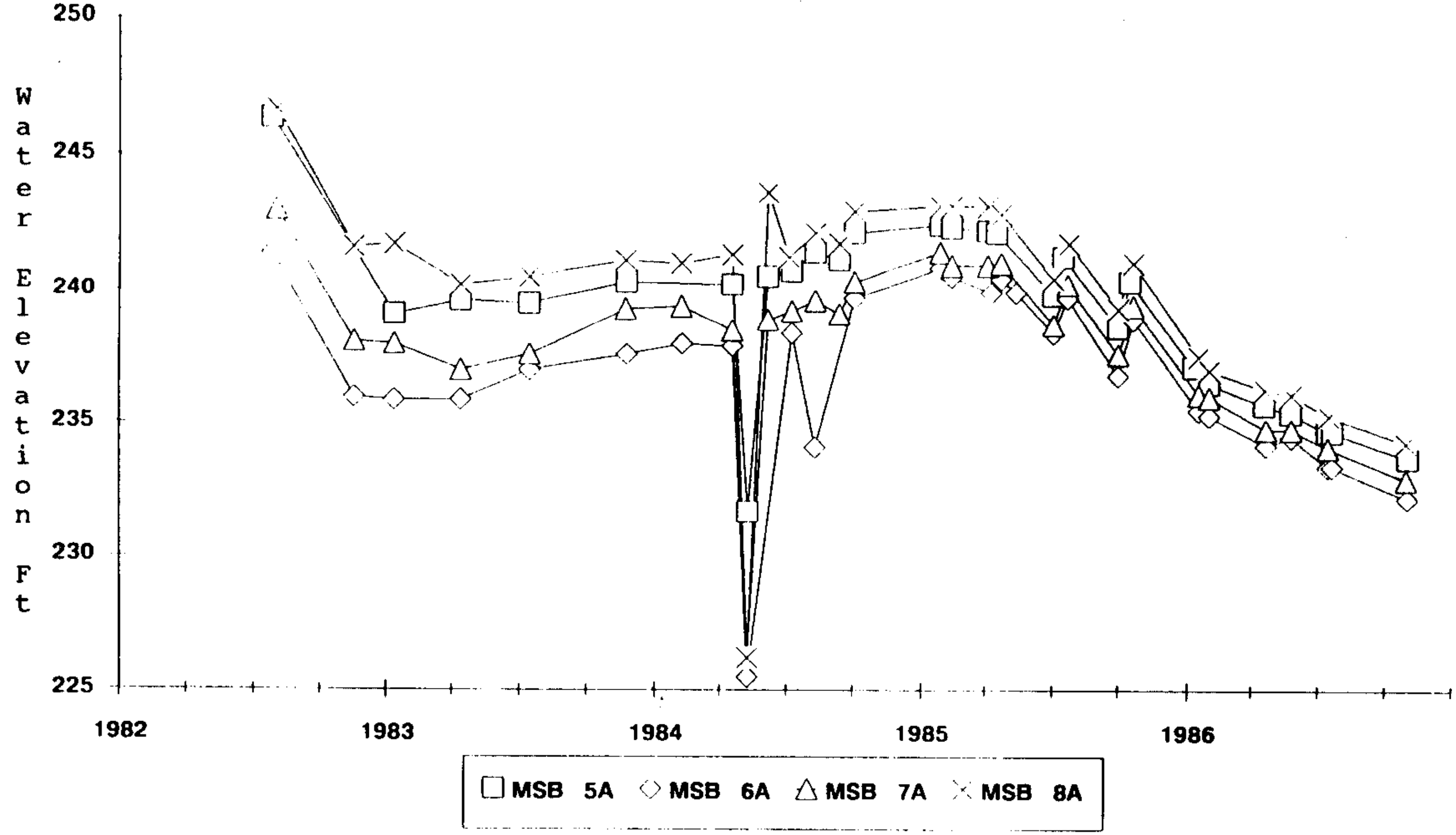


FIGURE 5-29 (cont.). Hydrograph of M-Area Settling Basin Wells MSB 5 Through MSB 8 and MSB 5A Through MSB 8A

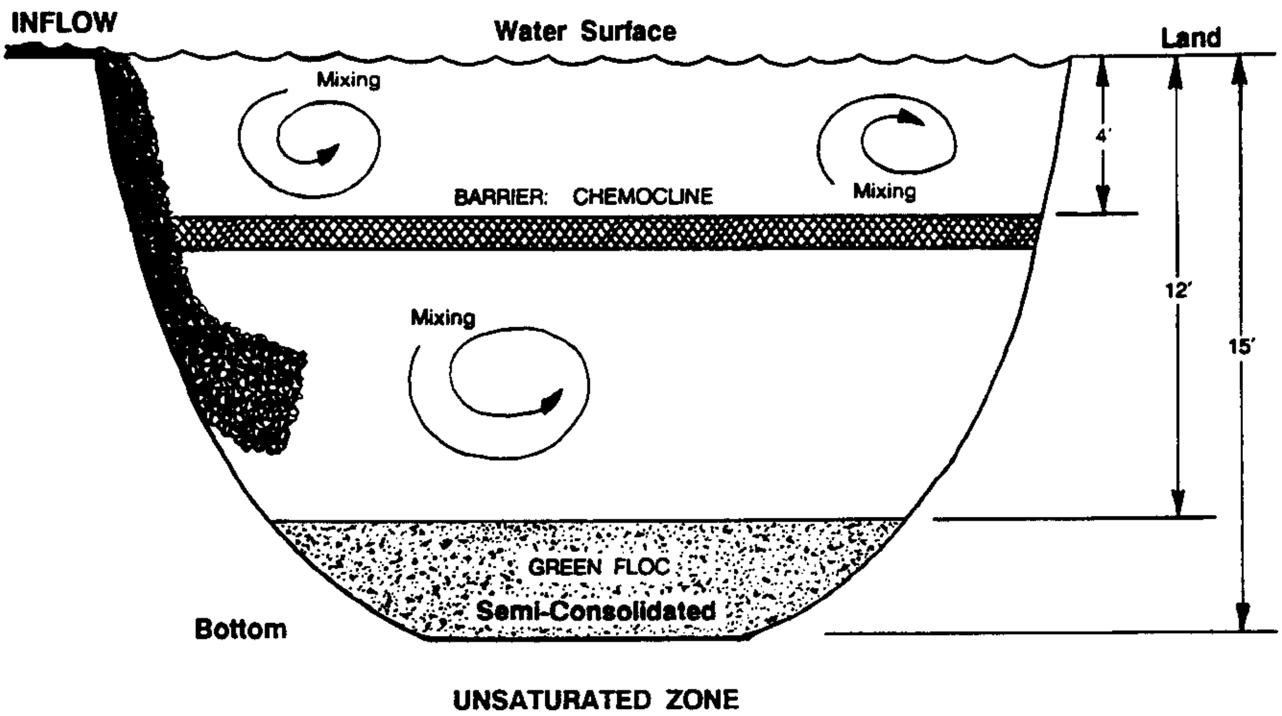


FIGURE 5-30. Water Profile in the M-Area Settling Basin

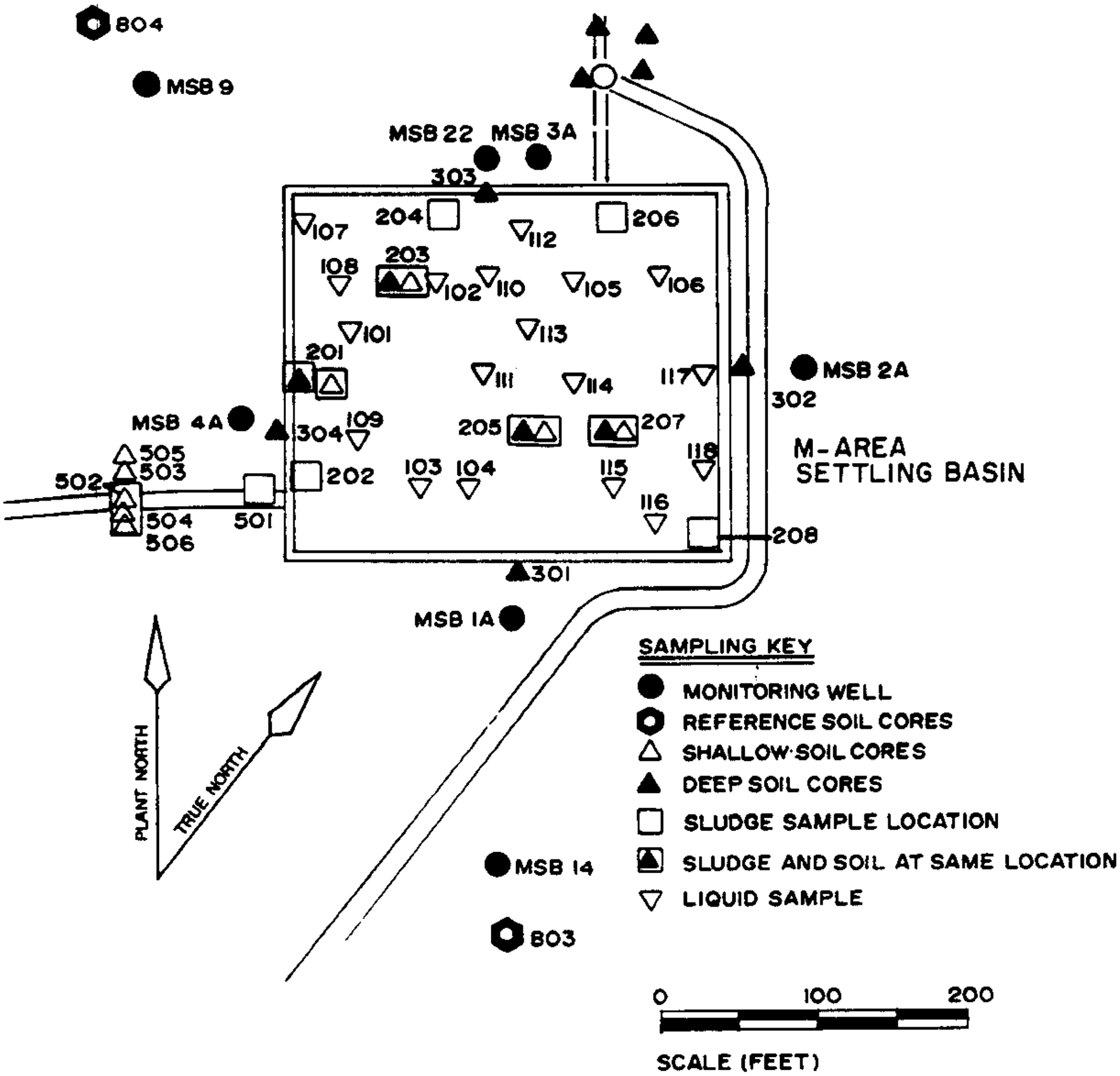


FIGURE 5-31. Soil Sampling Locations at the M-Area Settling Basin

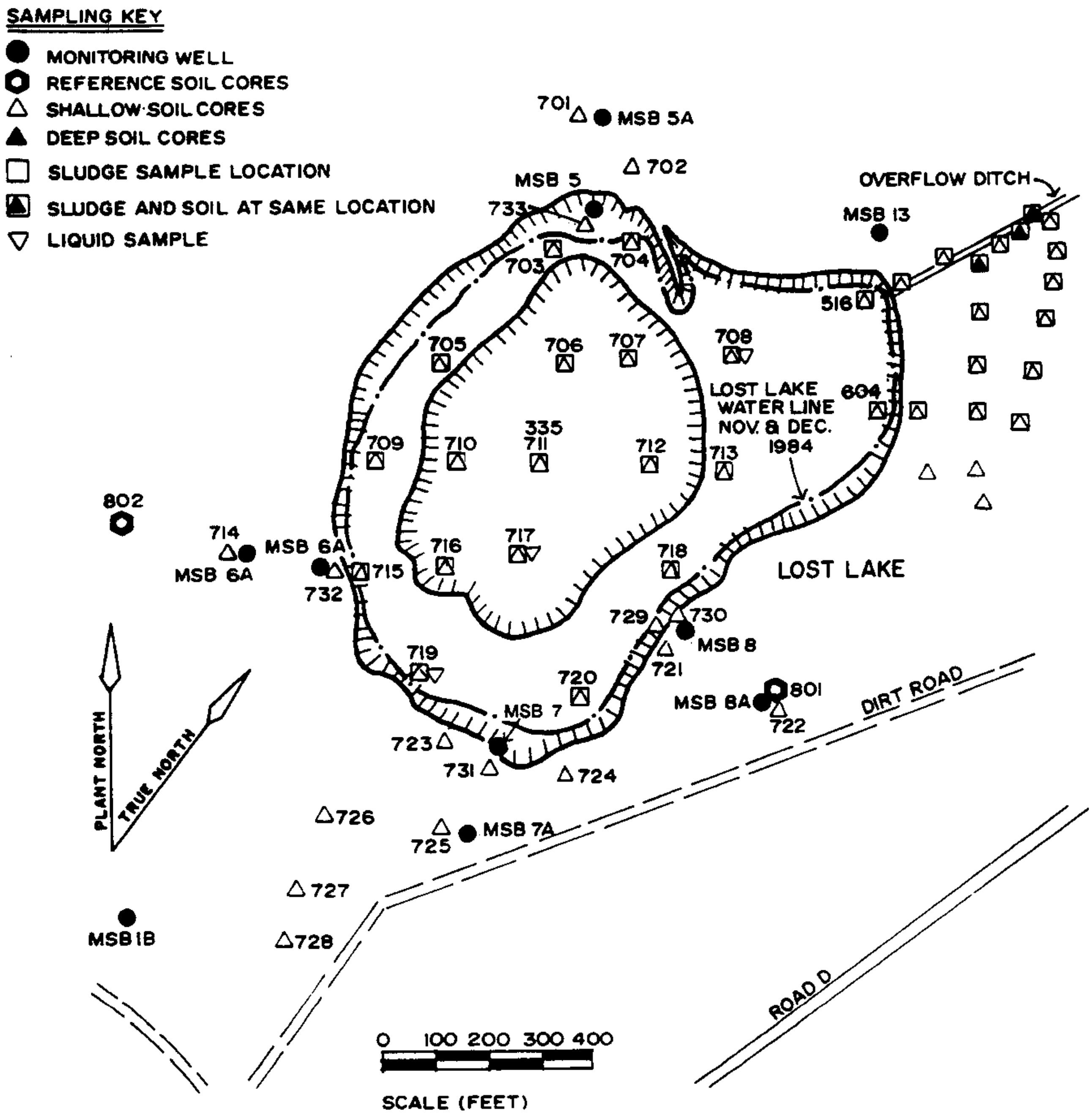


FIGURE 5-32. Soil Sampling Locations at Lost Lake

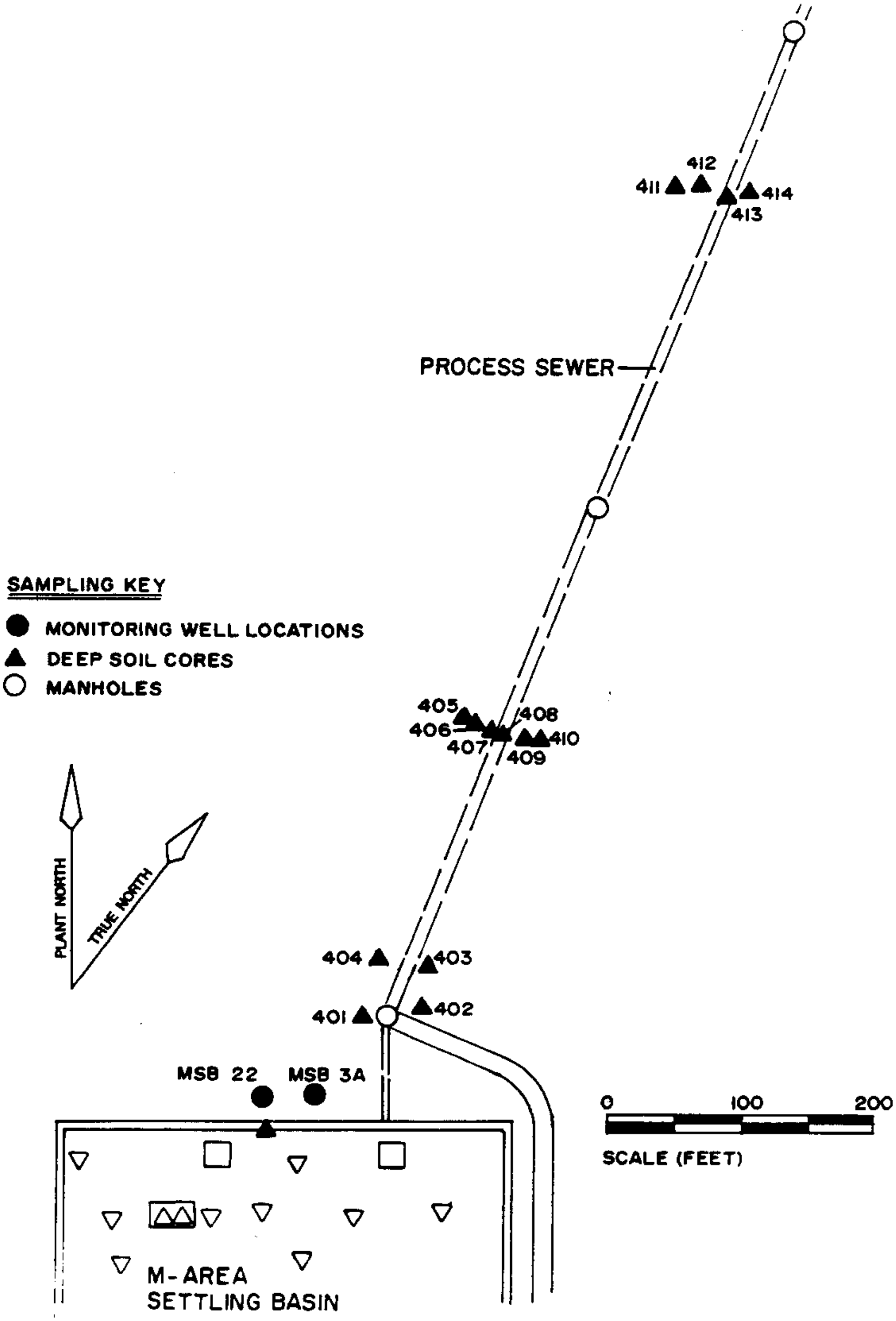


FIGURE 5-33. Soil Sampling Locations Along the Process Sewer Line

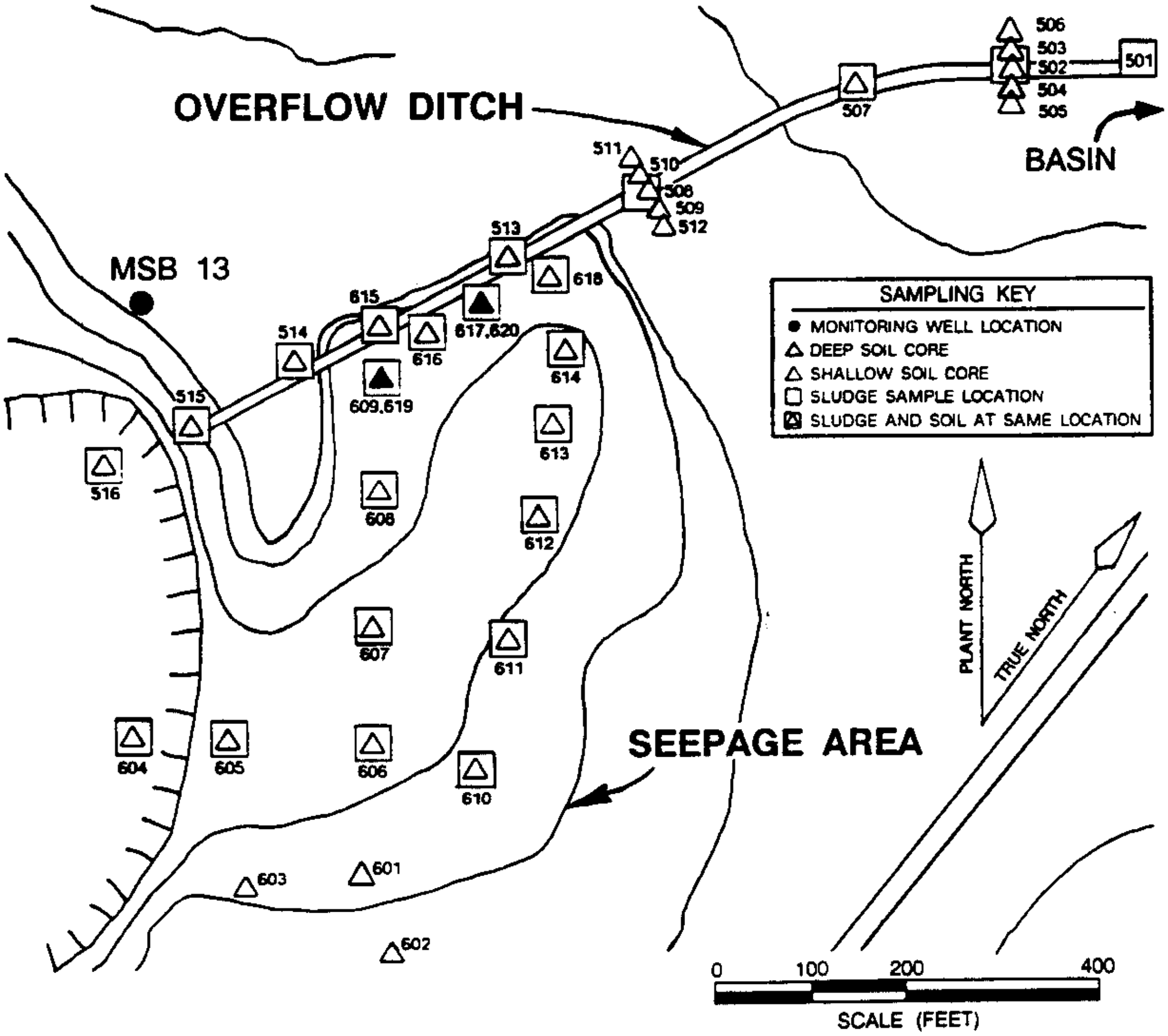


FIGURE 5-34. Soil Sampling Locations Along the Overflow Ditch and Seepage Area

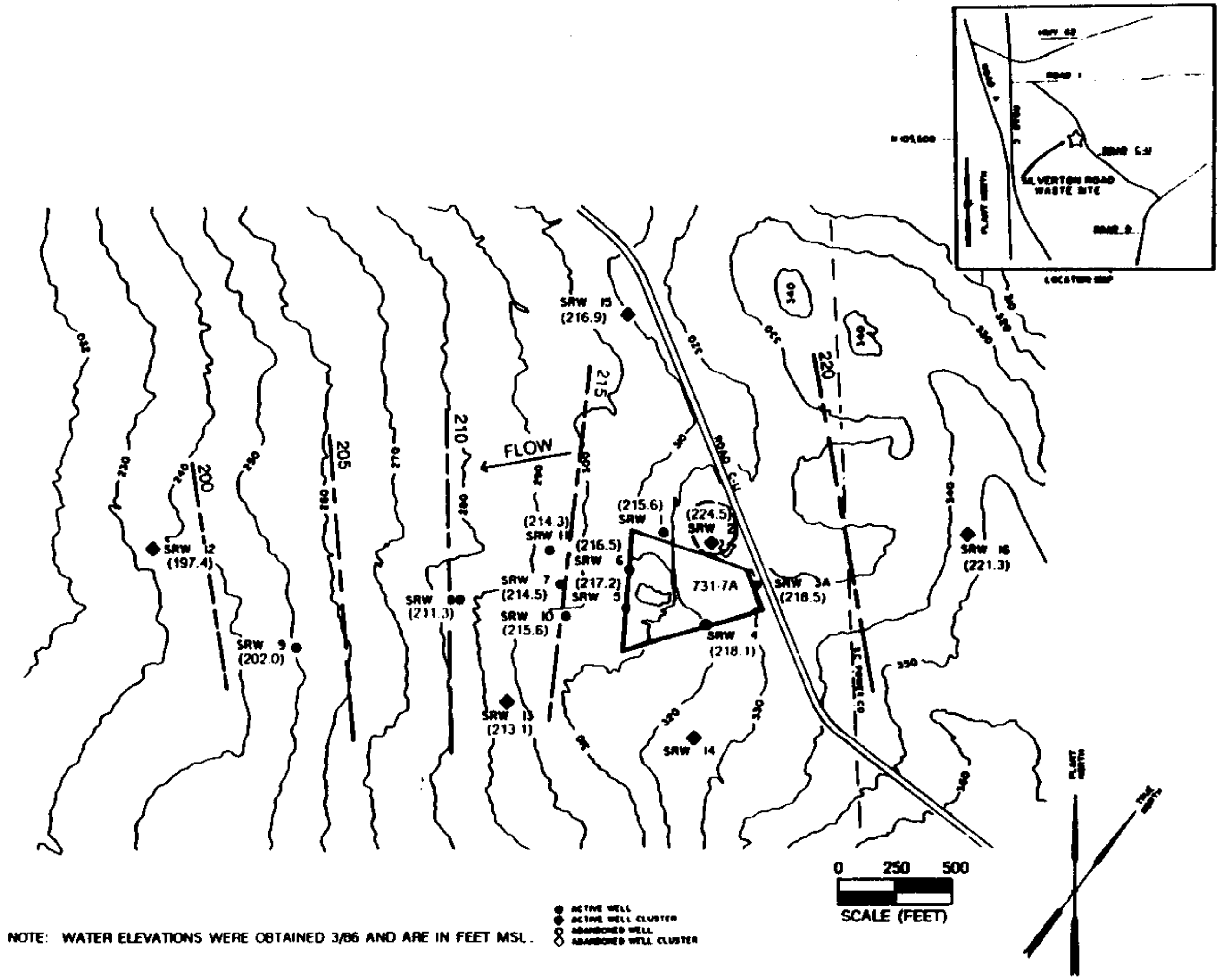


FIGURE 5-35. Silverton Road Waste Site Water-Table Elevation Map

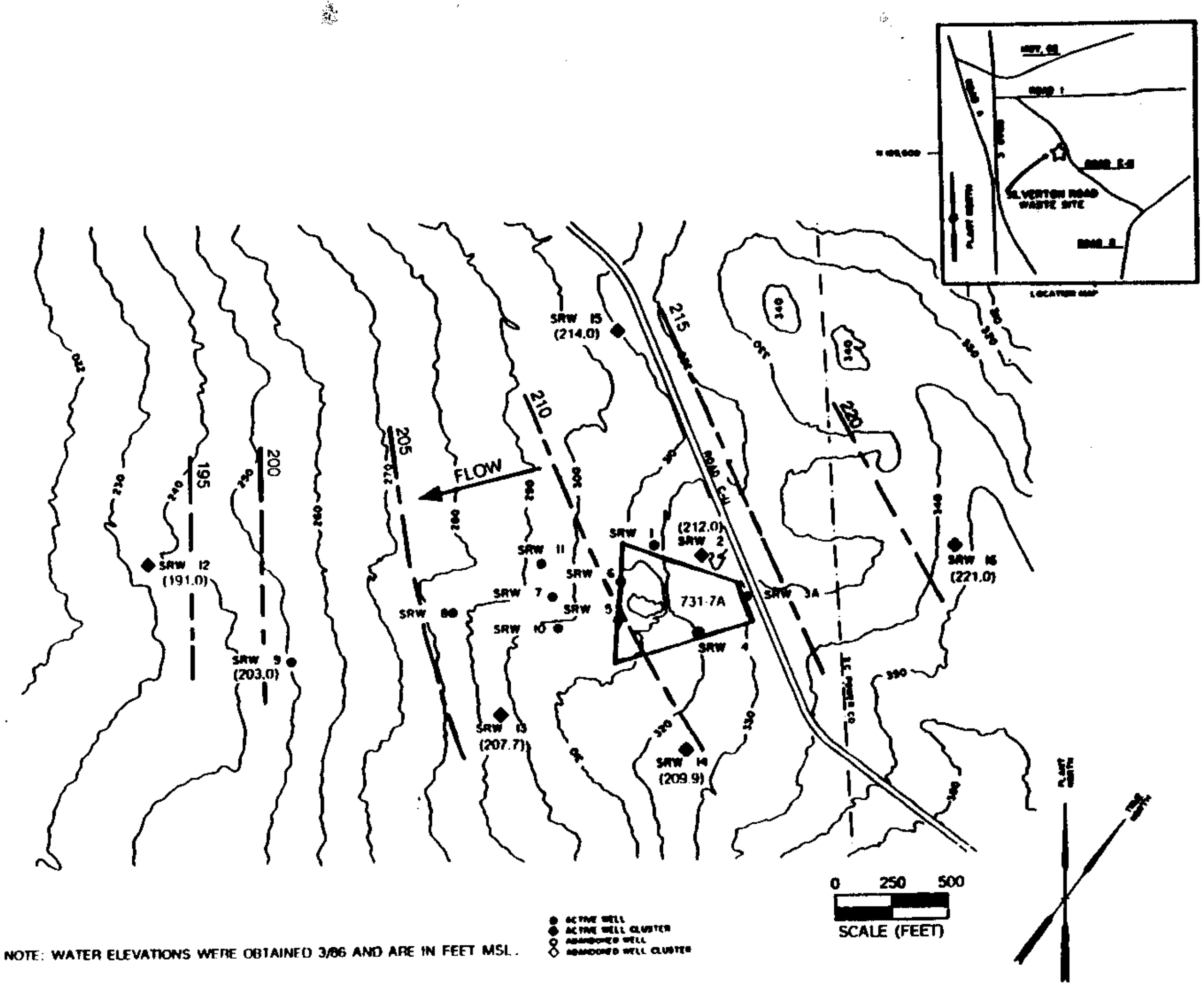


FIGURE 5-36. Silverton Road Waste Site B-Designated Wells Piezometric Map

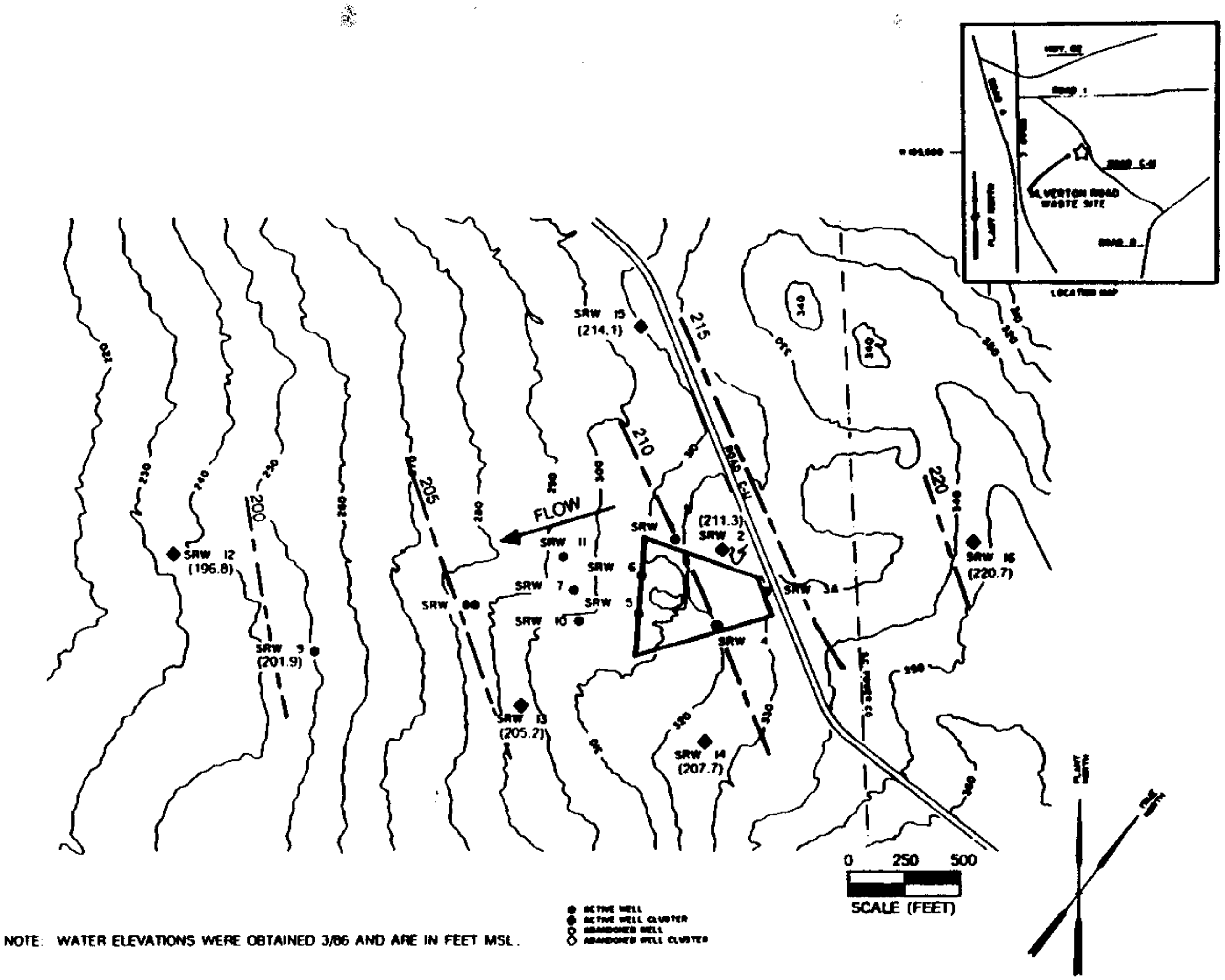


FIGURE 5-37. Silverton Road Waste Site A-Designated Wells Piezometric Map

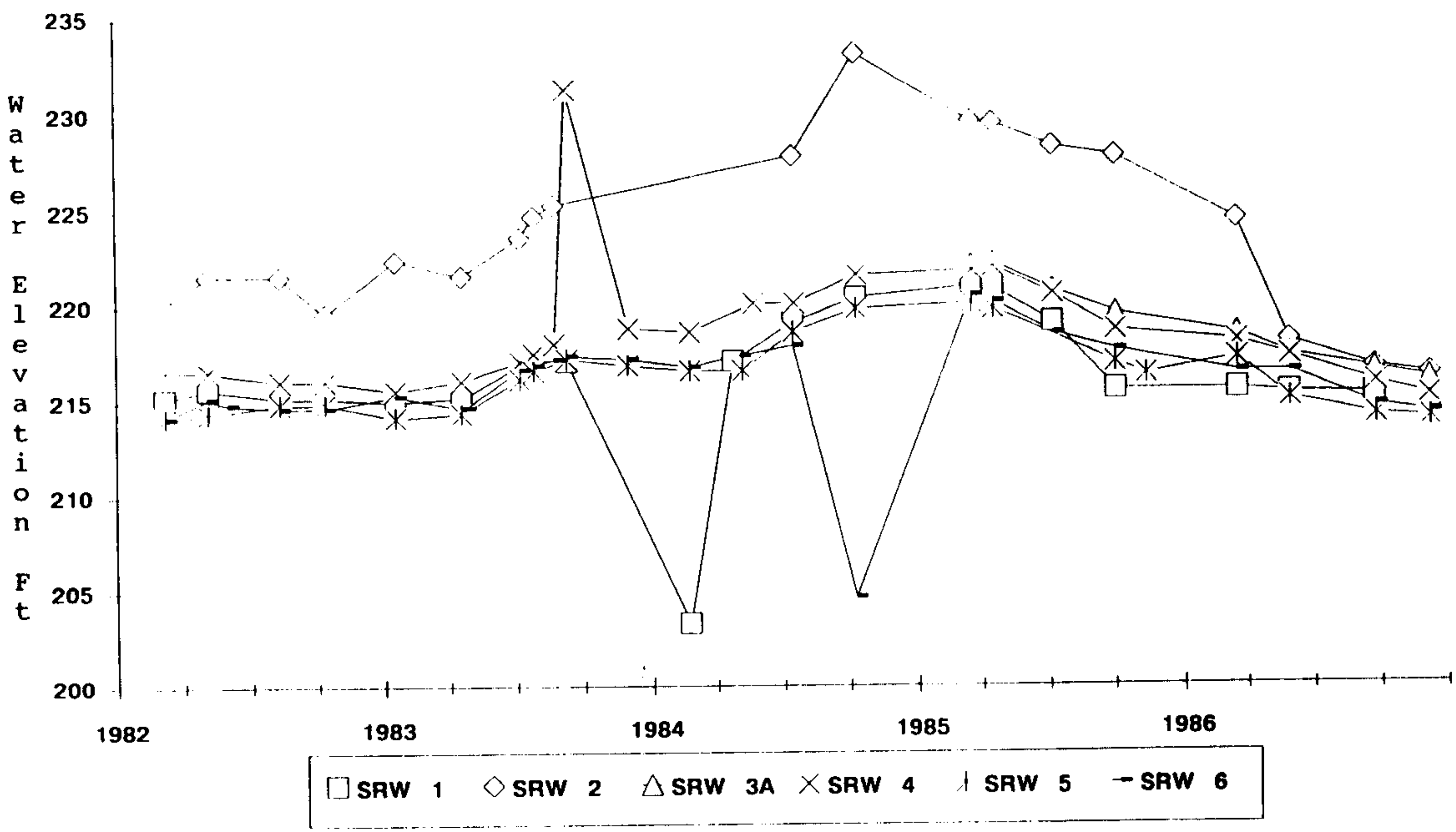


FIGURE 5-38. Hydrograph of Silverton Road Waste Site Wells SRW 1 Through SRW 6

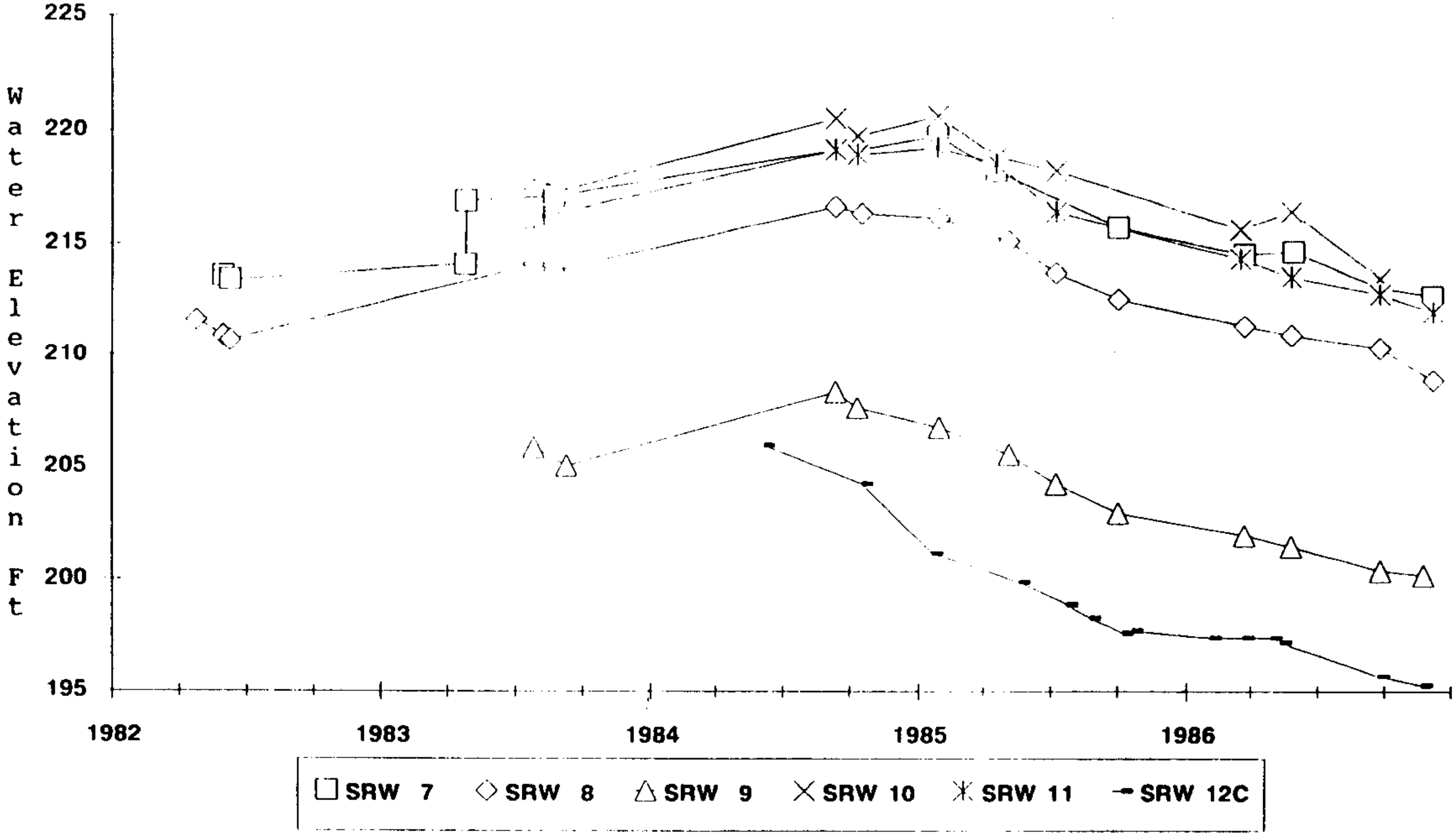


FIGURE 5-39. Hydrograph of Silverton Road Waste Site Wells SRW 7 Through SRW 12C

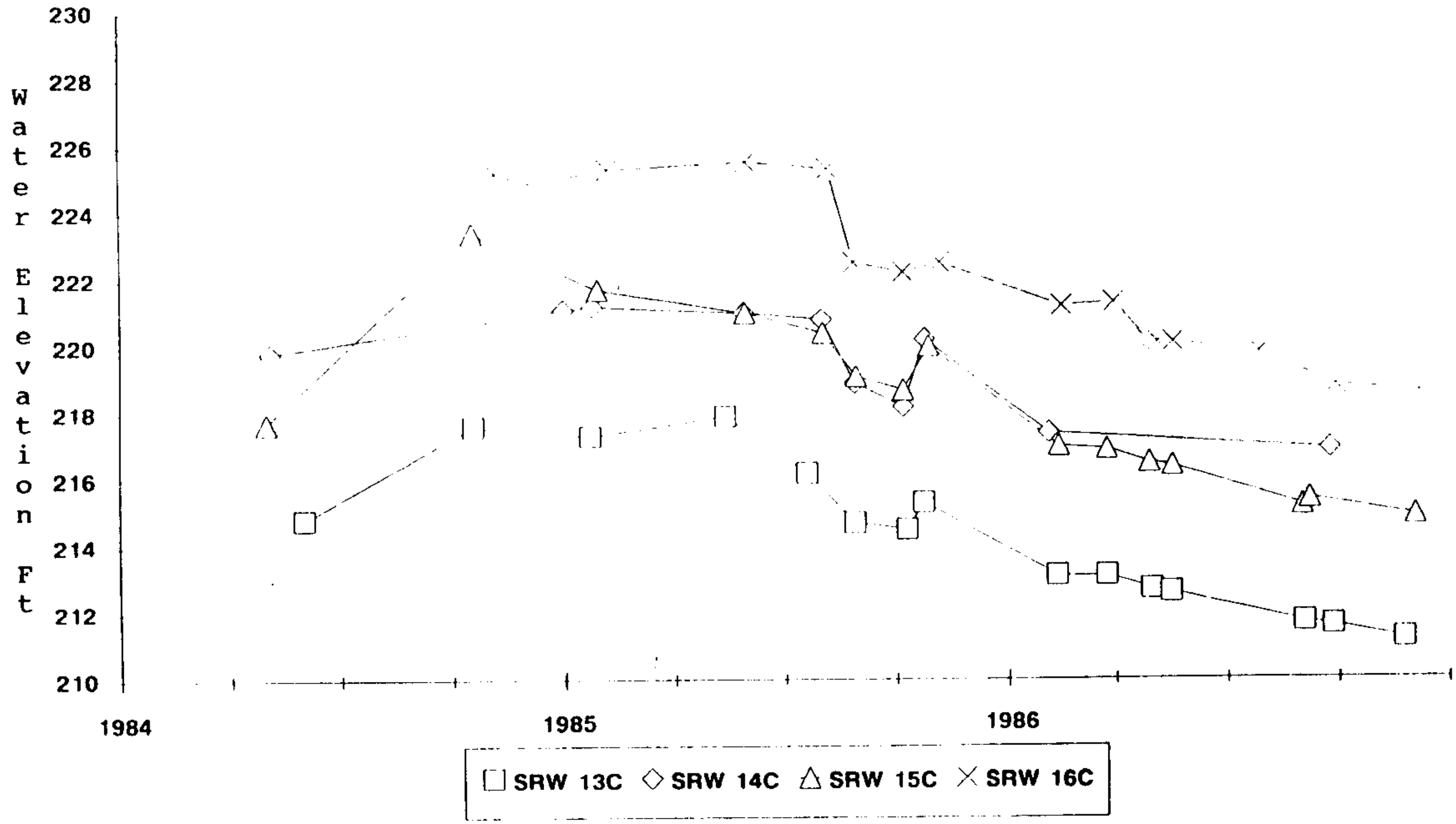


FIGURE 5-40. Hydrograph of Silverton Road Waste Site Wells SRW 13C Through SRW 16C

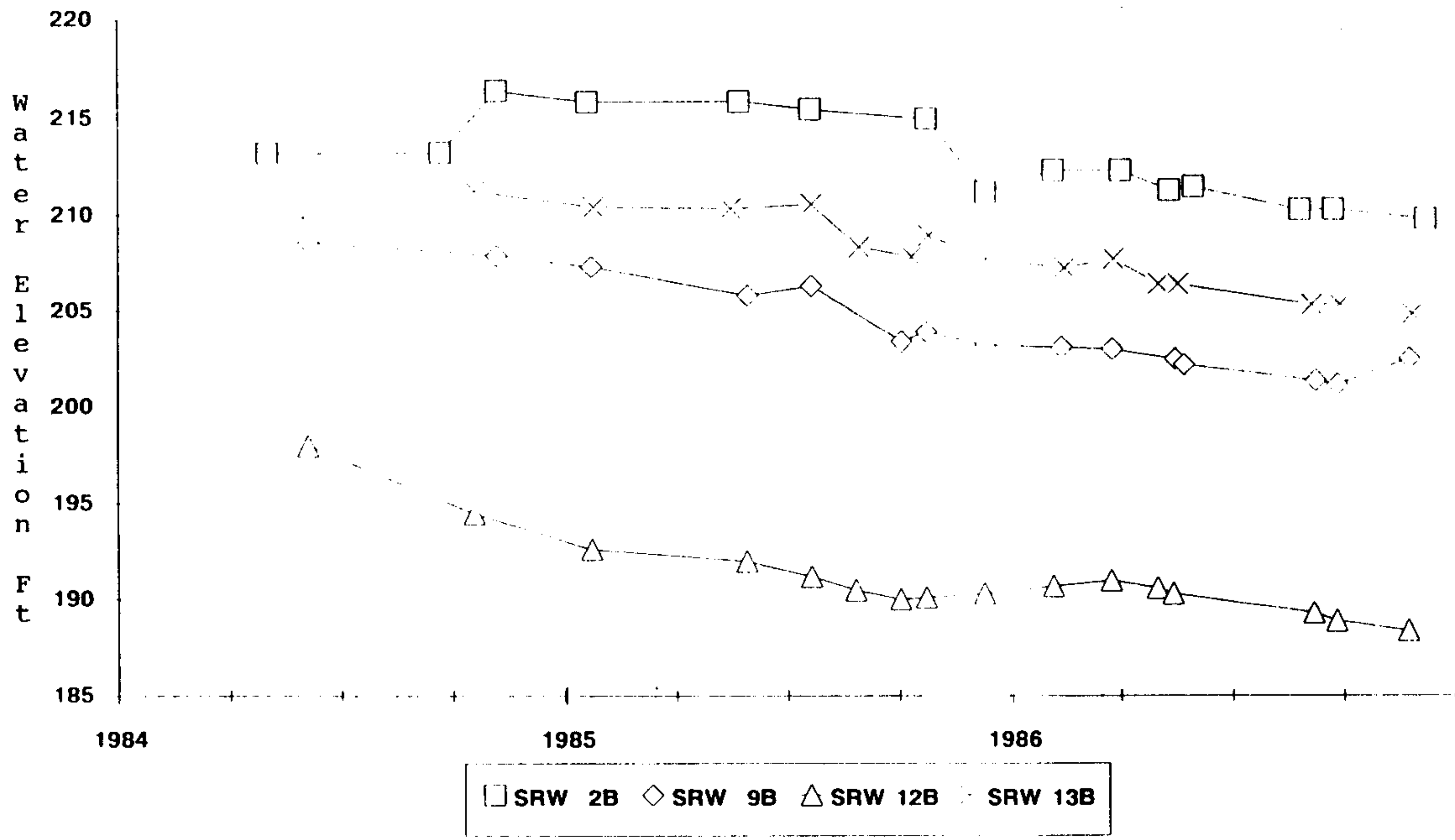


FIGURE 5-41. Hydrograph of Silverton Road Waste Site Wells SRW 2B Through SRW 13B

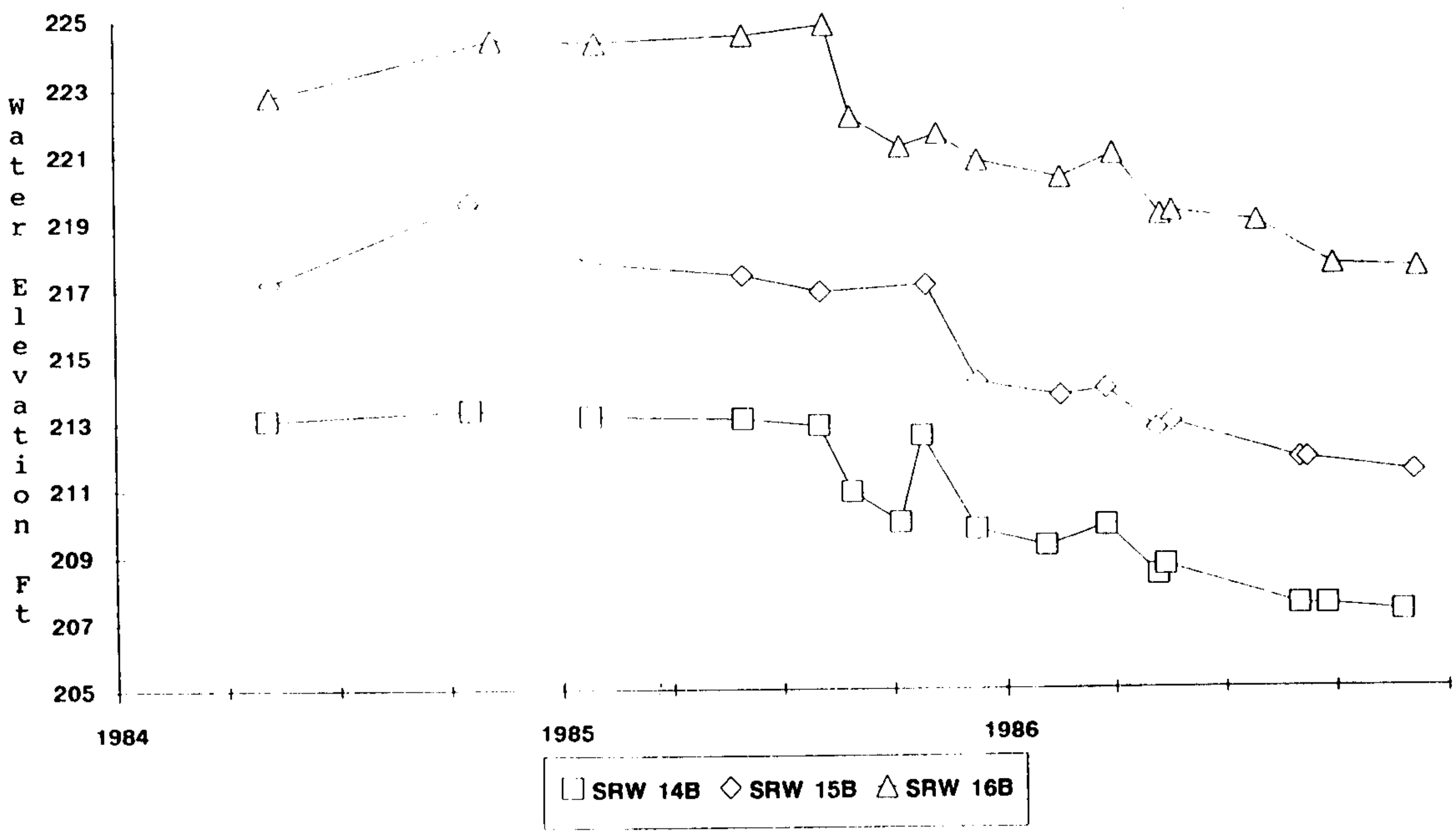


FIGURE 5-42. Hydrograph of Silverton Road Waste Site Wells SRW 14B Through SRW 16B

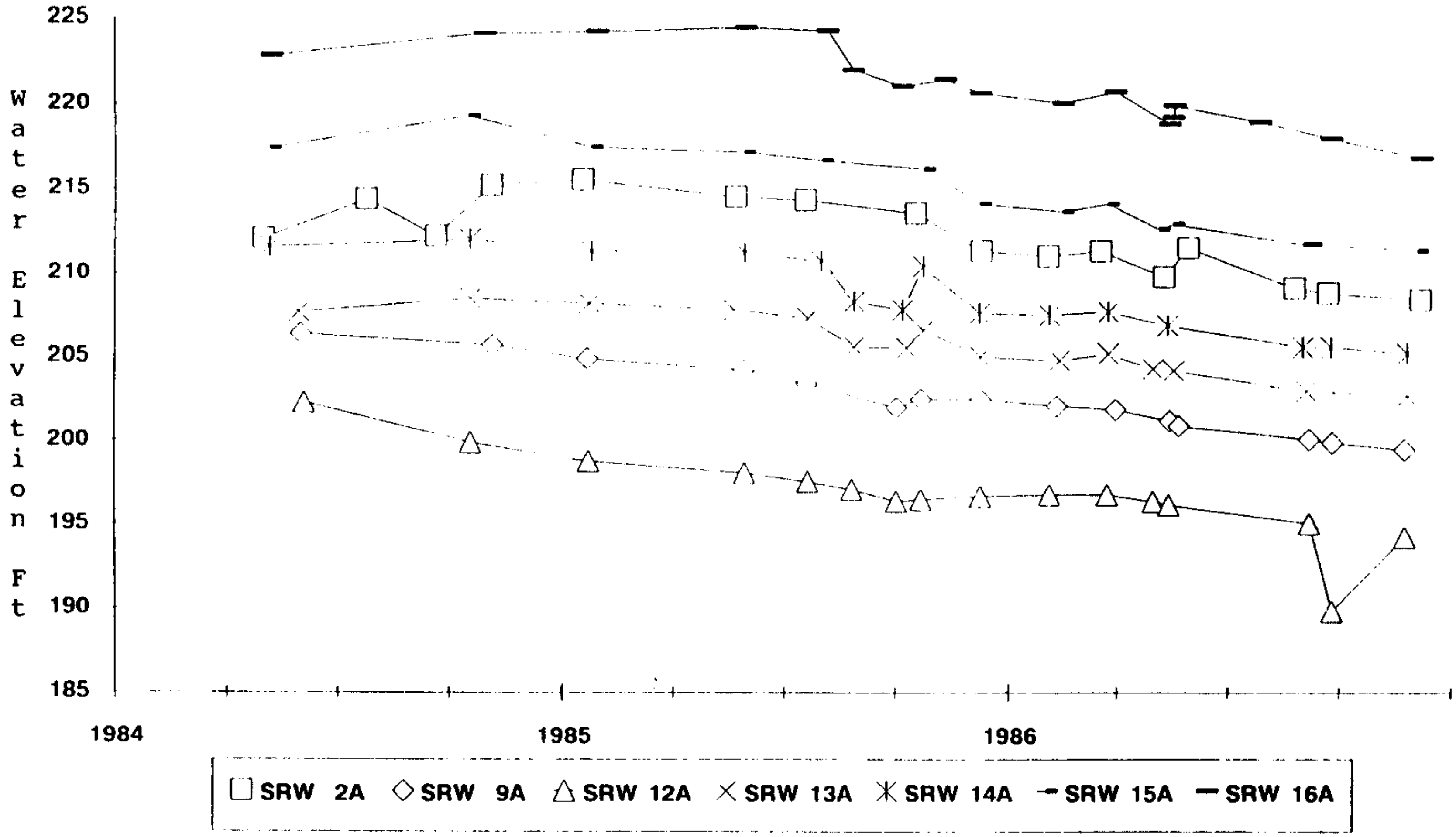


FIGURE 5-43. Hydrograph of Silverton Road Waste Site Wells SRW 2A Through SRW 16A

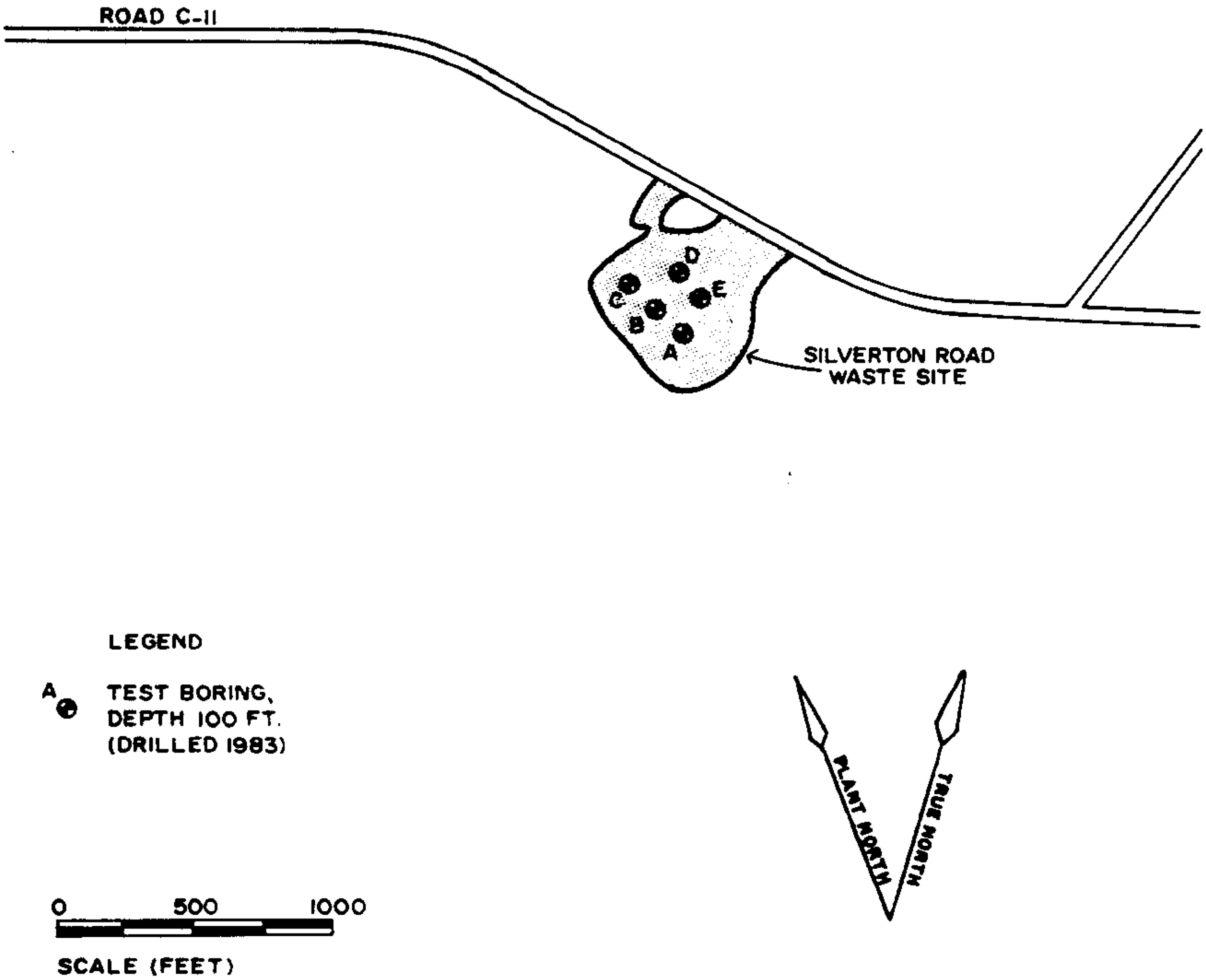


FIGURE 5-44. Soil Sampling Locations at the Silverton Road Waste Site

SECTION 6 C AREA

6.01 GENERAL INFORMATION

6.01.01 General Area Description

C Area is located near the central part of SRS as shown in Figure 6-1. Elevations across the area range approximately from 250 to 290 ft msl. Surface drainage is predominantly to the west toward a tributary of Four Mile Creek.

There are 12 C-Area waste sites as indicated in Figure 6-2:

L The C-Area Reactor Seepage Basins (3 basins)

L The C-Area Coal Pile Runoff Containment Basin

L The C-Area Ash Piles (3 piles)

L The C-Area Burning/Rubble Pit

L The C-Area Asbestos Pits (2 pits)

L The C-Area Erosion Control Site (see Section 15)

L The C-Area Earthen Basin (see Section 15)

6.01.02 General Hydrologic Conditions

By the end of 1986, 20 monitoring wells had been installed around the C-Area waste sites to delineate subsurface conditions and to monitor the water-table elevation and groundwater quality. Fourteen wells are currently being monitored. The remaining six wells have been abandoned. According to the surface geologic map presented by Siple (1967), the monitoring wells in C Area were installed in the Barnwell Formation. Section 3 contains a detailed discussion of the hydrostratigraphy beneath SRS.

The water-table elevation in C Area has ranged approximately from 230 to 205 ft msl, and the vadose zone has been approximately 50 to 80 ft thick. As shown in Figure 6-2, the general water-table flow direction beneath C Area is to the west toward a tributary of Four Mile Creek.

Mathematical modeling of the Barnwell Formation near the center of the plant in the Separations Areas indicates that the groundwater flow velocity ranges approximately from 15 to 60 ft/yr per percent gradient (Duffield et al., 1986; Parizek and Root, 1986). As shown in Figure 6-2, the hydraulic gradient of the water table is variable across C

Area. Therefore, the near-surface groundwater flow velocity across C Area will vary. The horizontal flow direction and estimated flow velocity for the water table at each C-Area waste site are discussed in the following specific waste-site sections.

6.01.03 Migration Potential of Dissolved Chemical Constituents from C Area

The potential for any dissolved constituents to be discharged from a waste site to nearby surface water from the groundwater system depends on the location of the waste site, the hydraulic gradient, and the flow path between the waste site and the discharge point. Horizontal and vertical groundwater flow velocities depend upon the distribution and hydraulic properties of the medium through which the groundwater travels (i.e., sand, silt, or clay). Similarly, interactions with the soil/sediment medium (retardation) will affect the horizontal and vertical movements of dissolved chemical constituents.

The nearest plant boundary from C Area is approximately 5.6 mi to the west. A number of incised tributaries and streams between C Area and the plant boundary represent regions of water-table discharge. Therefore, migration of dissolved waste constituents through the near-surface groundwater system to the plant boundary is not likely.

6.02 C-AREA REACTOR SEEPAGE BASINS

6.02.01 Summary

The three C-Area Reactor Seepage Basins (Buildings 904-66G, 904-67G, and 904-68G) received low-level radioactive purge water from the C-Area Disassembly Basin from 1957 until 1970 and from 1978 until the present. Although many radionuclides have been discharged to these basins, almost all of the radioactivity is due to ^{3}H, ^{90}Sr, ^{137}Cs, and ^{60}Co. Trace quantities of aluminum, iron, sodium, chloride, carbonate, nitrate, phosphate, sulfite, sulfate, oil, and grease have been discharged to the basins. The C-Area Reactor Seepage Basins are currently active and receive purge water when the C-Area reactor is operating (Stone and Christensen, 1983).

Basin water and soil/sediments have been analyzed for radioactive parameters only. Of the radionuclides detected in the basin water, ^{3}H, ^{51}Cr, $^{89,90}Sr$, and ^{137}Cs had the highest activities. The soil/sediment radioactivity data indicate that ^{137}Cs, ^{90}Sr, and ^{60}Co were the major radionuclides in the basin soil, with the maximum activities of these radionuclides occurring at a depth 0 to 2.5 ft. Radionuclide activities at depths from 2.5 to 20 ft were substantially lower.

The 1986 groundwater monitoring data indicate that upgradient well CSB 1A, sidegradient well CSB 6A, and downgradient well CSB 5A may have been affected by the leaching of well grout, as demonstrated by the elevated pH and conductivity in these wells. Groundwater in the background wells (upgradient well CSB 1A and sidegradient well CSB 6A) has met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for chromium and lead in upgradient well CSB 1A, radium and iron in sidegradient well CSB 6A, and trichloroethylene and tritium in both wells. Chromium, iron, and lead are not known to be related to past site activities.

Groundwater from downgradient wells CSB 2A through CSB 5A has met drinking water standards except for excursions of trichloroethylene in all four wells, iron in well CSB 3A, and manganese and lead in well CSB 2A. Tritium activities in downgradient wells CSB 2A through CSB 5A and radium activity in well CSB 5A exceeded drinking water standards. Tritium and radium activities above drinking water standards were also reported in sidegradient well CSB 6A. Nonvolatile beta activity remained below 16.0 pCi/L in all six C-Area Reactor Seepage Basins wells over the monitoring period.

6.02.02 Waste-Site Description and Nature of Disposal

C Area has used earthen seepage basins since 1957 to receive low-level radioactive water from the C-Area Disassembly Basin (Pekkala et al., 1987b). The three C-Area Reactor Seepage Basins (Buildings 904-66G, 904-67G, and 904-68G) are outside the C-Area perimeter fence on a southwest-trending slope where surface elevations range approximately from 280 to 290 ft msl (Figure 6-3). The nearest stream, a tributary of Four Mile Creek, is about 1,050 ft west of the basins. The nearest plant boundary is approximately 5.6 mi west of the site.

The physical dimensions of the C-Area Reactor Seepage Basins and other installation data are presented in Table 6-1. The basins were constructed by excavating below grade and backfilling around the sides at grade level to form earthen dike walls. Basin 1 is L-shaped; Basins 2 and 3 are rectangular. Overflow is sequential from Basin 1 to Basin 2 to Basin 3. Basin 3 does not discharge by overflow; rather, water evaporates or seeps from the basin (Stone and Christensen, 1983).

In December 1957, SRS began using the C-Area Reactor Seepage Basins for the disposal of low-level radioactive purge water from the C-Area Disassembly Basin. This water purge is necessary to keep the tritium activity in the disassembly basin water within a safe working range. Although many radionuclides have been discharged to the C-Area Reactor Seepage Basins, nearly all of the radioactivity is due to ^{3}H, ^{90}Sr, ^{137}Cs, and ^{60}Co. The radionuclide contaminants enter the disassembly basin water as a film of liquid on the irradiated components as they are discharged from the reactor tank to the disassembly basin, in the oxide corrosion film on the irradiated components, and, infrequently, from leaks in porous components. The inventory of radionuclides discharged to the C-Area Reactor Seepage Basins (corrected for radioactive decay through 1985) is shown in Table 6-2. Annual purge volumes discharged to the C-Area Reactor Seepage Basins from 1959 through 1986 are listed in Table 6-3.

In the late 1950s and early 1960s, purge water from the disassembly basin in the C-Area reactor building was pumped directly from the disassembly basin to the seepage basins. In the 1960s, mixed-bed deionizers were placed in service to reduce the ionic constituents in the water purged from the disassembly basin. The C-Area Reactor Seepage Basins remained in use from 1957 until 1970. From 1970 to 1978, the disassembly purge water was released through mixed-bed deionizers directly to plant streams.

The reactor seepage basins in C Area were reactivated in 1978 and receive purge water from the disassembly basin when the C-Area reactor is in operation. In normal practice, disassembly basin water is recirculated through sand filters to remove particulates. Particulates removed from the disassembly basin water are backwashed from the sand filter to the settler tank. Periodically, the particulate accumulation in the settler tank is transferred to a tank trailer and sent to the Separations Areas for concentration and storage.

After particulates in the recirculating disassembly basin water have been reduced by filtration, the basin water is pumped through mixed-bed deionizers to reduce ionic concentrations to meet procedural release limits. After the ionic concentrations have been reduced, the purge water is pumped to the reactor seepage basins.

During the purging operation, the deionizer effluents are monitored. Should radioactivity in the deionizer effluents approach the control limit, the deionizers are taken offline and regenerated.

In addition to purge water from the disassembly basin, the seepage basins receive low-level radioactive wastewater from other sources in the reactor area. This discharge water must meet the same control limits as disassembly basin purge water before it is released to the seepage basins.

Trace quantities of aluminum, iron, sodium, chloride, carbonate, nitrate, phosphate, sulfite, sulfate, oil, and grease have been discharged to the basins. These chemicals enter the disassembly basin water in small amounts through additives for pH control, filter promotion, and algae treatment and through minimal additions of wastewater to the settler tank from other sources in the reactor buildings. Concentrations of chemicals in C-Area Disassembly Basin purge water are given in Table 6-4.

The C-Area Reactor Seepage Basins will continue in service until no longer needed for discharge of disassembly basin purge water. Vegetation at the site is checked periodically for radioactivity and removed to the Radioactive Waste Burial Ground (Building 643-7G) if found to be contaminated. Vegetation is controlled with herbicides.

6.02.03 Groundwater Monitoring Program

Twelve wells (CSB Series) have been installed to monitor the water-table elevation and groundwater quality at the C-Area Reactor Seepage Basins. Six wells (wells CSB 1 through CSB 6) were installed in 1978 using galvanized steel casings and screens. Because of possible water-quality interference from the galvanized steel, these wells were abandoned in 1984 and replaced by wells CSB 1A through CSB 6A (Figure 6-3), which were constructed using PVC casings and 30-ft screens.

In 1978, wells CSB 1 through CSB 6 were added to the radioactive groundwater monitoring program at SRS, which monitors for gross alpha, nonvolatile beta, and tritium. Wells CSB 1A through CSB 6A remain under this program.

In 1983, wells CSB 1 through CSB 6 were sampled to characterize the groundwater quality at the C-Area Reactor Seepage Basins; however, groundwater samples at this time were not filtered prior to analysis. In 1986, the C-Area Reactor Seepage Basins wells were included in the SRS quarterly groundwater monitoring program. Groundwater samples acquired since the first quarter of 1986 have been filtered prior to analysis.

6.02.04 Site-Specific Hydrology

Measurements obtained from the C-Area Reactor Seepage Basins wells since May 1984 indicate that the water-table elevation has been declining since 1985. A hydrograph for the C-Area Reactor Seepage Basins wells is presented in Figure 6-4. The water-table elevation for the fourth quarter of 1986 was 208 ft msl, and the vadose zone was approximately 80 ft thick. Figure 6-3 indicates that the horizontal groundwater flow direction was to the southwest, consistent with local topography. The hydrograph (Figure 6-4) indicates that the horizontal flow direction has remained relatively consistent for the period of monitoring, although water-level fluctuations indicate that minor changes in flow direction and gradient have occurred. Relative to the basins, well CSB 1A has been upgradient, wells CSB 2A, CSB 3A, CSB 4A, and CSB 5A downgradient, and well CSB 6A sidegradient.

The hydraulic gradient of the water table beneath the seepage basins has been approximately 0.003 ft/ft. Using an estimated horizontal groundwater flow velocity range for the Barnwell Formation near the center of the plant of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the C-Area Reactor Seepage Basins has ranged approximately from 4.5 to 18 ft/yr.

6.02.05 Waste-Site Content Characterization Data

The C-Area Reactor Seepage Basins surface water has been sampled for radioactive parameters only. Gross alpha, nonvolatile beta, and specific radionuclide activities in C-Area Reactor Seepage Basins water from 1981 through 1985 are listed in Table 6-5, which shows that the highest activities are those for ^{3}H, ^{51}Cr, $^{89,90}Sr$, and ^{137}Cs. Average activities for ^{3}H, ^{51}Cr, $^{89,90}Sr$, and ^{137}Cs from 1981 through 1985 were 142,700 pCi/mL, 1.1 pCi/mL, 70 pCi/mL, and 0.72 pCi/mL, respectively. Gross alpha activity in the basin water during this period averaged 0.0165 pCi/mL; nonvolatile beta activity averaged 1.226 pCi/mL.

6.02.06 Soil/Sediment Characterization Data

Soil/sediment samples from the C-Area Reactor Seepage Basin were analyzed for radioactive constituents in 1976 and 1978.

In 1976, five composite soil cores approximately 0.3 ft deep were collected from the C-Area Reactor Seepage Basins. Maximum activities of ^{137}Cs and ^{90}Sr in these composite soil cores were 4,400 pCi/g and 85 pCi/g, respectively. In all three C-Area Reactor Seepage Basins, ^{137}Cs, ^{90}Sr, and ^{60}Co levels were highest at 0.0 to 2.5 ft depths and were substantially lower at 2.5 to 20 ft depths.

The results of 1978 sampling for radionuclides are presented in Table 6-6, and core locations are shown in Figure 6-5. The maximum radioactivity levels found in the Basin 1 soil cores were 2,090 pCi/g for ^{137}Cs (0.0 to 0.5 ft below ground surface), 1,870 pCi/g for ^{60}Co (0.0 to 0.5 ft below ground surface), and 140 pCi/g for ^{90}Sr (0.5 to 1.0 ft below ground surface). Basin 2 maximum soil core radioactivity levels were 800 pCi/g for ^{137}Cs, 30 pCi/g for ^{60}Co, and 140 pCi/g for ^{90}Sr, occurring 1.0 to 1.5 ft below ground surface. Maximum Basin 3 radioactivity levels were 11.0 pCi/g for ^{137}Cs and 2.0 pCi/g for ^{90}Sr, occurring 0.0 to 0.5 ft below ground surface.

6.02.07 Groundwater Monitoring Results

The 1983 and 1986 groundwater monitoring data for the C-Area Reactor Seepage Basins are included in Appendix D. Groundwater monitoring data are summarized in Table 6-7 and represent the results of four or fewer quarterly analyses. Because the C-Area Reactor Seepage Basins monitoring data base is limited, consistent trends in the data cannot be accurately identified. Instead, the monitoring results were compared to South

Carolina (R. 61-58) and federal (40 CFR 141-143) primary and secondary drinking water standards to assess general groundwater quality at the basins.

Monitoring well locations relative to the C-Area Reactor Seepage Basins are presented in Figure 6-3 along with the general groundwater flow direction. As shown in Figure 6-3 and discussed in Section 6.02.04, well CSB 1A is upgradient of the basins, well CSB 6A is sidegradient, and wells CSB 2A through CSB 5A are downgradient. However, as illustrated in Figure 6-6, the elevated pH levels reported for upgradient well CSB 1A (11.2 to 11.4), sidegradient well CSB 6A (10.0 to 11.6), and downgradient well CSB 5A (9.3 to 10.8) relative to the other C-Area Reactor Seepage Basins wells (5.1 to 6.5) suggest that these wells may have been affected by leaching of well grout. The elevated conductivity levels in upgradient well CSB 1A (93 to 1,600 μmhos/cm), sidegradient well CSB 6A (241 to 790 μmhos/cm), and downgradient well CSB 5A (100 to 510 μmhos/cm) relative to the other site wells (32 to 66 μmhos/cm) are also indicative of cement grout leaching (Figure 6-6).

The monitoring data (Table 6-7) show that groundwater near upgradient well CSB 1A and sidegradient well CSB 6A, two wells that are potentially being affected by the leaching of well grout as discussed above, has met South Carolina and federal drinking water standards for all tested parameters except chromium and lead in upgradient well CSB 1A, total radium and iron in sidegradient well CSB 6A, and trichloroethylene and tritium in both wells. Trichloroethylene concentrations in wells CSB 1A (0.003 to 0.006 mg/L) and CSB 6A (0.019 to 0.030 mg/L) exceeded the drinking water standard of 0.005 mg/L. Chloroform levels in upgradient well CSB 1A and sidegradient well CSB 6A remained below the trihalomethane drinking water standard of 0.100 mg/L. Carbon tetrachloride and 1,1,1-trichloroethane (1,1,1-TCE) levels in wells CSB 1A and CSB 6A also met the drinking water standards of 0.005 mg/L and 0.200 mg/L, respectively. Total organic halogens (TOH) concentrations in well CSB 1A ranged from 0.021 to 0.150 mg/L and in well CSB 6A from 0.011 to 0.081 mg/L. Chromium levels in upgradient well CSB 1A (0.030 to 0.061 mg/L) and sidegradient well CSB 6A (0.011 to 0.050 mg/L) ranged over or were equal to the drinking water standard of 0.05 mg/L. Lead levels in well CSB 1A (0.078 to 0.504 mg/L) were above the drinking water standard of 0.05 mg/L. Iron concentrations in well CSB 6A (0.004 to 0.008 mg/L) were below the drinking water standard of 0.3 mg/L except for an unusually high excursion (3.85 mg/L) reported in September 1986.

Radium activity in well CSB 6A (4.0 to 6.8 pCi/L), as measured in the nonradioactive monitoring program, ranged over the drinking water standard of 5 pCi/L. Tritium activity in sidegradient well CSB 6A (2,530 to 147,000 pCi/mL) and upgradient well CSB 1A (15 to 521 pCi/mL) exceeded the drinking water standard of 20 pCi/mL.

Annual maximum and average gross alpha, nonvolatile beta, and tritium activities as measured in the radioactive monitoring program for the

C-Area Reactor Seepage Basins wells from 1978 through 1986 are shown in Table 6-8. Average gross alpha activities in the C-Area Reactor Seepage Basins wells remained well below the drinking water standard of 15 pCi/L. The annual tritium activity averages reported in this program are consistent with the values reported in the nonradioactive monitoring program from 1978 through 1986 and are above the drinking water standard of 20 pCi/mL. As discussed in Section 6.02.02, radioactivity is related to past site activities.

The nonradioactive monitoring data for downgradient wells CSB 2A through CSB 5A show that groundwater at these wells has met South Carolina and federal drinking water standards except for trichloroethylene in all four downgradient wells, manganese and lead in downgradient well CSB 2A, and an isolated excursion of iron in downgradient well CSB 3A. Chloroform levels in downgradient wells CSB 2A (<0.001 to 0.011 mg/L), CSB 3A (0.002 mg/L), CSB 4A (<0.001 to 0.032 mg/L), and CSB 5A (<0.001 to 0.034 mg/L) were below the trihalomethane drinking water standard of 0.100 mg/L. Trichloroethylene concentrations in wells CSB 2A (<0.005 to 0.016 mg/L), CSB 3A (<0.005 to 0.023 mg/L), CSB 4A (0.006 to 0.030 mg/L), and CSB 5A (<0.005 to 0.788 mg/L) were occasionally greater than the drinking water standard of 0.005 mg/L. The 1,1,1-trichloroethane (1,1,1-TCE) levels in all four downgradient wells were below the drinking water standard of 0.200 mg/L. TOH levels ranged from 0.021 to 0.533 mg/L in the downgradient wells. Manganese levels in downgradient well CSB 2A (0.008 to 0.091 mg/L) ranged over the drinking water standard of 0.05 mg/L on a few occasions, and lead levels (<0.005 to 0.054 mg/L) exceeded the drinking water standard of 0.05 mg/L on one occasion. Manganese and lead are not known to be related to past C-Area Reactor Seepage Basins site activities. Iron in downgradient well CSB 3A (0.007 to 0.740 mg/L) was above the drinking water standard of 0.3 mg/L on one occasion. Iron concentrations as high as 0.52 mg/L are generally consistent with iron concentrations reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

Tritium activities in downgradient wells CSB 2A (6 to 403 pCi/mL), CSB 3A (43,000 to 191,000 pCi/mL), CSB 4A (4,330 to 89,800 pCi/mL), and CSB 5A (446 to 9,800 pCi/mL) were above the drinking water standard of 20 pCi/mL. Total radium activity in downgradient well CSB 5A (1.9 to 7.5 pCi/L) ranged over the drinking water standard of 5 pCi/L. As discussed above, tritium and radium activities over drinking water standards were also reported in sidegradient well CSB 6A. Nonvolatile beta activities remained below 16.0 pCi/L in all six C-Area Reactor Seepage Basins wells.

6.02.08 Planned Action

The C-Area Reactor Seepage Basins will continue in use, and groundwater monitoring will continue at the site. No additional characterization programs are planned for this waste site.

6.03 C-AREA COAL PILE RUNOFF CONTAINMENT BASIN

6.03.01 Summary

The C-Area Coal Pile Runoff Containment Basin (Building 189-C) received runoff from the area occupied by the C-Area coal storage pile (Christensen and Gordon, 1983). Chemical analyses of the C-Area Coal Pile Runoff Containment Basin (CPRB) influent and a comparison between groundwater samples from downgradient and upgradient wells indicate that the basin has had minimal influence on local groundwater quality. The coal storage pile was removed in the last quarter of 1985.

6.03.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses. The C-Area coal supply was stored in an open pile. The coal was generally moderate-to-low sulfur coal (1-2%) received by rail from Kentucky, Pennsylvania, and Virginia. Coal was placed on a hopper, sprayed with water to control dust, and loaded onto a pile at the C-Area facility (Christensen and Gordon, 1983).

The facility generally contained a 90-day reserve of coal. The coal pile was not rotated, resulting in long-term exposure of the unused coal to the environment. This weathering process resulted in the formation of sulfuric acid caused by the oxidation of sulfur in the coal. Rainfall washed the acid from the coal pile into the coal pile runoff containment basin via gravity flow ditches and sewers.

Prior to the construction of the coal pile runoff containment basins, runoff from coal storage piles flowed to nearby streams onsite. The National Pollutant Discharge Elimination System (NPDES) permit issued in 1977 specifies limits on pH and suspended solids for the coal pile runoff from rainfall up to the maximum 24-hr, 10-yr recurrence event (5.9 in. for SRS). Suspended solids are limited to 50 mg/L, and pH is limited to between 6 and 9. To achieve compliance, the C-Area CPRB was constructed in 1981 to contain coal pile runoff and prevent direct discharge to an unnamed tributary of Four Mile Creek. This containment basin allowed for the passive equalization of the rainwater runoff prior to its seepage into the subsurface, where it could undergo natural renovation. There has been minimal discharge from the C-Area CPRB to the tributary.

The C-Area CPRB is on a southwest-trending slope where surface elevations range from 260 to 270 ft msl across the basin (Figure 6-7). Surface drainage is to the southwest toward a small, unnamed tributary of Four Mile Creek. The basin is approximately 600 ft southeast of the coal storage area. The basin has bottom dimensions of 127 by 127 ft, top dimensions of 170 by 170 ft, and a maximum depth of about 5 ft. The total runoff containment volume is approximately 110,000 ft^3 (0.8 million gal) (Christensen and Gordon, 1983).

The coal pile that drained to this basin was removed in 1985. While in use, it typically contained 3,600 tons of moderate-to-low sulfur (1-2%) coal and occupied an area of approximately 22,500 ft^2. From 1983 to 1985, the coal pile contained less than 1,000 tons of coal (Christensen and Gordon, 1983).

Coal pile runoff samples were collected on October 2, 1985, to characterize the C-Area CPRB influent and to establish indicator parameters for identifying the effect of the basin on local groundwater quality. The first individual grab sample was taken 15 to 30 min after the beginning of a storm and the second several hours after the end of the storm. In addition, a composite sample was taken during the entire period between the two individual sampling times. However, the final grab sample could not be collected at the C-Area CPRB because runoff was no longer flowing to the basin. Therefore, the C-Area CPRB influent characterization data presented in Table 6-9 are for the initial grab sample and composite sample only. Review of these analytical results indicates that the dissolved metals concentrations were low. Elevated levels of conductivity, total dissolved solids (TDS), iron, sulfate, and low pH are typical of coal pile runoff (Table 6-9) and, therefore, are the indicator parameters most likely to show the effect of the CPRB on groundwater. Basin influent samples were not filtered prior to analysis and may have contained insoluble, particulate matter.

6.03.03 Groundwater Monitoring Program

Four wells (CCB 1 through CCB 4) were installed in the third quarter of 1981 to monitor the water-table elevation and groundwater quality at the C-Area CPRB (Figure 6-7). These wells were constructed using PVC casings and 30-ft screens.

In 1982, SRS initiated a quarterly groundwater monitoring program, which included the C-Area CPRB wells. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

6.03.04 Site-Specific Hydrology

Measurements obtained from the C-Area CPRB wells since April 1982 indicate that the water-table elevation was approximately 233 ft msl and that the vadose zone was approximately 45 ft thick until 1985 when a steady declining trend began. In the fourth quarter of 1986, the water-table elevation was approximately 225 ft msl and the vadose zone was approximately 55 ft thick. A hydrograph for the C-Area CPRB wells is presented in Figure 6-8. A water-table elevation contour map for the fourth quarter of 1985 (Figure 6-7) indicates that the flow direction was to the west-southwest, consistent with local topography. The hydrograph indicates that this has been the predominant flow direction for the period of monitoring, although water-level fluctuations indicate that minor changes in flow direction and gradient have occurred. Relative to the basin, well CCB 4 has been upgradient, well CCB 2 has been downgradient, and wells CCB 1 and CCB 3 have been sidegradient.

The hydraulic gradient of the water table beneath the basin has been approximately 0.005 ft/ft. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the basin has ranged approximately from 7.5 to 30 ft/yr.

6.03.05 Waste-Site Content Characterization Data

Sampling and analysis of the C-Area CPRB contents have not been conducted. Section 6.03.02 contains information on the basin influent characterization data.

6.03.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the C-Area CPRB.

6.03.07 Groundwater Monitoring Results

The groundwater monitoring data from 1982 through 1986 are included in Appendix D. Groundwater chemical characterization data since July 1984 are summarized in Table 6-10.

A comparison of monitoring data between upgradient well CCB 4 and the other C-Area CPRB wells was used to evaluate the effect of the C-Area CPRB on local groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Indicator parameters are pH, sulfate, iron, conductivity, and total dissolved solids (TDS).

The groundwater quality data listed in Table 6-10 indicate that the C-Area CPRB has had minimal influence on groundwater quality. The quarterly groundwater samples have consistently met South Carolina and federal drinking water standards. Low TDS levels were reported in upgradient well CCB 4 (20 mg/L) and in wells CCB 1, CCB 2, and CCB 3 (ranging from 18 to 28 mg/L) compared to the drinking water standard of 500 mg/L. Low conductivity levels were also reported in upgradient well CCB 4 (12 to 30 μmhos/cm) and wells CCB 1, CCB 2, and CCB 3 (12 to 39 μmhos/cm).

Sulfate and iron levels were well below the secondary drinking water standards of 250 mg/L and 0.3 mg/L, respectively. All sulfate concentrations were below 8.0 mg/L, while iron concentrations ranged from <0.004 to 0.181 mg/L. Organic levels in the groundwater were relatively low, as indicated by the levels of dissolved organic carbon (DOC; <5 mg/L), total organic carbon (TOC; below 41 mg/L), total organic halogens (TOH; below 0.035 mg/L), phenols (<0.002 mg/L), GC Scan (<40 μg/L), and extractable pesticides (all reported levels were less than detection limits). Groundwater pH ranged from 3.9 to 5.3 in upgradient well CCB 4 and from 3.7 to 5.5 in the other C-Area CPRB wells; pH values as low as 4.0 are generally consistent with the pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

The concentrations of the indicator parameters (TDS, conductivity, sulfate, iron, and pH) have not shown any consistent increasing or decreasing trends over the monitoring period.

6.03.08 Planned Action

The C-Area CPRB is currently inactive, and groundwater monitoring will continue. The site has undergone an assessment, and a closure plan will be developed. Section 16 provides additional information regarding the planned action for this waste site.

6.04 C-AREA ASH PILES

6.04.01 Summary

The three C-Area Ash Piles (Buildings 188-C, 188-1C, and 188-2C) received dry ash from the C-Area powerhouse until 1984. During operation, the C-Area Ash Piles received approximately 2,000 yd^3 of dry ash per year. These piles are now inactive and have been covered and seeded with grass to prevent erosion (Christensen and Gordon, 1983). Groundwater monitoring has not been conducted at the C-Area Ash Piles.

6.04.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal, which produces dry ash. The dry ash from the C-Area powerhouse was disposed in three C-Area Ash Piles located in two areas in the western portion of the C Area (Figure 6-2). The three dry ash piles are currently inactive and have been covered and seeded with grass to prevent erosion.

Horton, Dorsett, and Cooper conducted a study in 1977 to identify trace metals present in the fly and bottom ash disposed to the SRS ash piles and basins. Table 6-11 lists the typical trace metal concentrations obtained for fly and bottom ash. These results indicate significant levels of barium, strontium, manganese, zinc, vanadium, cerium, and chromium (Horton et al., 1977).

6.04.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the C-Area Ash Piles.

6.04.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the C-Area Ash Piles. Therefore, the water-table conditions beneath these waste sites are undefined.

6.04.05 Waste-Site Content Characterization Data

The contents of the C-Area Ash Piles have not been sampled. Section 6.04.02 contains information on the materials disposed at the site.

6.04.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the C-Area Ash Piles.

6.04.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the C-Area Ash Piles.

6.04.08 Planned Action

The C-Area Ash Piles are currently inactive, and the groundwater is not being monitored. An environmental assessment is planned for this site in 1987, as described in Section 16.

6.05 C-AREA BURNING/RUBBLE PIT

6.05.01 Summary

Burnable wastes such as paper, wood, plastics, rubber, oil, degreasers, and drummed solvents were received and incinerated in the C-Area Burning/Rubble Pit (Building 131-C) from 1951 to 1973, at which time the pit was covered with a layer of soil. Rubble wastes, including paper, wood, concrete, cans, and empty galvanized steel drums, were then disposed in the pit until the site reached capacity and was covered with soil. The site is currently inactive (Huber et al., 1987c).

The groundwater monitoring data indicate that the C-Area Burning/Rubble Pit has had no apparent effect on groundwater quality except for elevated levels of halogenated organics in upgradient well CRP 1 and downgradient well CRP 3. Well CRP 3 also has been affected by the leaching of well grout as indicated by the elevated pH and conductivity values reported for this well. Water quality in sidegradient wells CRP 2 and CRP 4 has been characterized by low dissolved chemical constituent and organic levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards.

Although well CRP 1 is upgradient of the pit, its proximity (approximately 20 ft) to the pit and the fact that halogenated organic compounds are related to past site activities suggest that the pit has been influencing water quality in this well. Downgradient well CRP 3, the only other well that apparently has been influenced by the site, is approximately 15 ft from the pit. Sidegradient wells CRP 2 and CRP 4 are approximately 400 ft and 200 ft from the C-Area Burning/Rubble Pit, respectively.

6.05.02 Waste-Site Description and Nature of Disposal

The C-Area Burning/Rubble Pit was constructed in 1951 to collect burnable waste from C Area, including paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents. The collected wastes were incinerated monthly. Disposal of chemically contaminated oils was not allowed at the C-Area Burning/Rubble Pit (Huber et al., 1987c).

In 1973, the plantwide procedure of burning waste ceased, and the C-Area Burning Pit was converted to receive only rubble by spreading a layer of soil over the incinerated waste. Rubble waste disposed at the C-Area Burning/Rubble Pit included paper, wood, concrete, cans, and empty galvanized steel drums. Rubble disposal continued until the pit reached its capacity in 1975 and was covered with a final layer of soil. Natural brush and grass have begun to grow over the site.

The C-Area Burning/Rubble Pit is on a gentle west-trending slope where surface elevations range approximately from 268 to 272 ft msl (Figure 6-9). The pit had nominal dimensions of 350 ft long by 25 ft wide by 10 ft deep, with a capacity of 87,500 ft^3. The nearest plant boundary to the C-Area Burning/Rubble Pit is approximately 5.5 mi to the west.

6.05.03 Groundwater Monitoring Program

Three wells (CRP 1 through CRP 3) were installed during the third quarter of 1983 to monitor the water-table elevation and groundwater quality at the C-Area Burning/Rubble Pit (Figure 6-9). A fourth well (CRP 4) was added during the second quarter of 1984. The wells were constructed using PVC casings and 30-ft screens.

In the fourth quarter of 1983, wells CRP 1 through CRP 3 were included in the SRS quarterly groundwater monitoring program. The fourth well was installed under this program. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

6.05.04 Site-Specific Hydrology

Measurements obtained from the C-Area Burning/Rubble Pit wells since June 1984 indicate that the water-table elevation has been steadily declining. In the fourth quarter of 1986, the water-table elevation was approximately 205 ft msl, and the vadose zone was about 65 ft thick. A hydrograph for the C-Area Burning/Rubble Pit wells is presented in Figure 6-10. A water-table elevation contour map for the fourth quarter of 1985 (Figure 6-9) indicates that the horizontal groundwater flow direction was to the west, consistent with local topography.

The water-level data indicate that this has been the predominant water-table flow direction and that, relative to the pit, well CRP 1 has been upgradient, well CRP 3 downgradient, and wells CRP 2 and CRP 4 sidegradient. The hydraulic gradient of the water table beneath the pit has been approximately 0.004 ft/ft. Using a groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the C-Area Burning/Rubble Pit has ranged approximately from 6.0 to 24 ft/yr.

6.05.05 Waste-Site Content Characterization Data

The contents of the C-Area Burning/Rubble Pit have not been sampled. Section 6.05.02 contains information on the materials incinerated or disposed at the waste site.

6.05.06 Soil/Sediment Characterization Data

In late 1985 and early 1986, soils were collected and analyzed for volatile organic constituents from thirty 18 to 24 in. deep auger holes (Figure 6-11). In addition, one sample from each foot interval to a depth of 60 ft was analyzed for volatile organics. The maximum concentrations in the samples were 1.7 μg/kg tetrachloroethylene and 768 μg/kg trichloroethylene (Price et al., 1987).

6.05.07 Groundwater Monitoring Results

The groundwater monitoring data from 1984 through 1986 are included in Appendix D. Groundwater chemical characterization data since July 1984 are summarized in Table 6-12.

Monitoring well locations relative to the C-Area Burning/Rubble Pit are presented in Figure 6-9, along with the predominant groundwater flow direction. Well CRP 3 is the only well downgradient of the pit. However, as illustrated in Figure 6-12, the elevated levels of pH (10.5 to 12.5) and sodium (3.36 to 8.16 mg/L) relative to the other wells suggest that this well is being affected by well grout leaching. Elevated conductivity, ranging from 1,200 to 3,800 µmhos/cm, and TDS levels, ranging from 620 to 798 mg/L, are also indicative of cement grout leaching. Figure 6-13 illustrates the relative differences in average conductivity and TDS values between downgradient well CRP 3 and the other C-Area Burning/Rubble Pit wells.

Because downgradient well CRP 3 apparently has been affected by well grout, comparisons of water quality between the upgradient and downgradient wells as a basis to assess the effect of the pit on groundwater quality are not possible. Instead, the groundwater monitoring results were compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) primary and secondary drinking water standards to evaluate groundwater quality at the pit. The indicator parameters for the site are total organic carbon (TOC), total organic halogens (TOH), chloroform, trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane (1,1,1-TCE) because organic solvents are related to past site activities (Section 6.05.02).

The groundwater monitoring data summarized in Table 6-12 indicate that the C-Area Burning/Rubble Pit has had no apparent effect on groundwater quality except for trichloroethylene in wells CRP 1 and CRP 3. Water quality in well CRP 1, located approximately 20 ft upgradient of the C-Area Burning/Rubble Pit, has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards for all tested parameters except trichloroethylene. Trichloroethylene concentrations in upgradient well CRP 1 (0.147 to 3.28 mg/L) have consistently exceeded the drinking water standard of 0.005 mg/L. TOH levels in well CRP 1 ranged from 0.461 to 3.70 mg/L. The 1,1,1-trichloroethane (1,1,1-TCE) levels in upgradient well CRP 1 (0.033 mg/L) remained below the drinking water standard of 0.200 mg/L. TOC levels in upgradient well CRP 1 have ranged from 0.345 to 4.40 mg/L. Conductivity in upgradient well CRP 1 ranged from 60 to 110 µmhos/cm.

The monitoring data indicate that downgradient well CRP 3 has apparently been affected by the leaching of well grout, as demonstrated by the elevated levels of sodium, pH, conductivity, and TDS (Figures 6-12 and 6-13). The organic chemical analysis data indicate that trichloroethylene levels (0.750 to 3.67 mg/L) have remained high in downgradient well CRP 3 compared to the drinking water standard of 0.005 mg/L. TOH levels in well CRP 3 ranged from 1.00 to 3.549 mg/L. TOC levels in downgradient well CRP 3 have ranged from 1.00 to 4.00 mg/L. The remaining tested parameters met drinking water standards except for chromium and lead. Chromium levels (0.032 to 0.065 mg/L) exceeded the drinking water standard of 0.05 mg/L on four occasions, while lead concentrations in well CRP 3 (0.031 to 1.31 mg/L) did not meet the drinking water standard of 0.05 mg/L on three occasions.

The monitoring data (Table 6-12) show that groundwater quality in sidegradient wells CRP 2 and CRP 4 has been characterized by low dissolved chemical constituent and organic levels compared to drinking water standards. Low conductivity was reported in well CRP 2 (15 to 63 μmhos/cm) and well CRP 4 (17 to 53 μmhos/cm). Notably, TOH levels in well CRP 2 (0.007 to 0.055 mg/L) and well CRP 4 (<0.005 to 0.005 mg/L) remained low compared to the levels reported in wells CRP 1 and CRP 3. Trichloroethylene levels (0.002 to 0.006 mg/L) in well CRP 2 exceeded the drinking water standard on one occasion, but have remained low relative to the levels reported for wells CRP 1 and CRP 3. Trichloroethylene levels in well CRP 4 remained well below the drinking water standard. The relative differences in average TOH and trichloroethylene concentrations among wells CRP 2 and CRP 4, the drinking water standards, and the influenced wells (wells CRP 1 and CRP 3) are illustrated in Figure 6-14.

Although well CRP 1 is upgradient of the C-Area Burning/Rubble Pit, its proximity (approximately 20 ft) to the pit and the fact that halogenated organics are attributable to past site activities suggest that the C-Area Burning/Rubble Pit has influenced water quality in this well. Downgradient well CRP 3, the only other well that apparently has been influenced by halogenated organics from the pit, is approximately 15 ft from the pit. The C-Area Burning/Rubble Pit wells that apparently have not been affected, wells CRP 2 and CRP 4, are approximately 400 ft and 200 ft from the pit, respectively.

6.05.08 Planned Action

The C-Area Burning/Rubble Pit is currently inactive, and groundwater monitoring will continue. A site assessment is planned for 1988 (see Section 16).

6.06 C-AREA ASBESTOS PITS

6.06.01 Summary

The two C-Area Asbestos Pits received asbestos-containing material typically consisting of used asbestos pipe insulation in polyethylene bags and asbestos-contaminated scrap piping. The quantities of materials containing asbestos in the pits are not known. The first C-Area Asbestos Pit (Building 080-21G) received asbestos-containing material from 1978 to 1980, at which time the construction of a second C-Area Asbestos Pit (Building 080-22G) allowed for closure of the first pit (Christensen and Gordon, 1983). The second Asbestos Pit received asbestos-containing material from 1980 to 1982, after which time it was covered with a layer of soil.

Surveillance and site maintenance for the closed pits consist of erosion control only. Groundwater monitoring has not been conducted at the C-Area Asbestos Pits because asbestos is regulated as an inhalation hazard, not as a water contaminant.

6.06.02 Waste-Site Description and Nature of Disposal

The C-Area Asbestos Pits are by Road A-6.2, northeast of Building 100-C (Figure 6-2). The pits were rectangular, each having original dimensions of 60 ft wide by 300 ft long, covering about 0.41 acres. The original C-Area Asbestos Pit (Building 080-21G) was opened in 1978. The construction of a second C-Area Asbestos Pit (Building 080-22G) in 1980 allowed for the simultaneous closure of the original pit (Christensen and Gordon, 1983). The second pit was active until 1982 when it was closed and subsequently covered with a layer of soil. Both pits have been graded and seeded.

The pits received asbestos-containing material typically consisting of used asbestos pipe insulation in polyethylene bags, scrap polyethylene sheeting, and asbestos-contaminated scrap piping. The quantities of asbestos-containing material in the C-Area Asbestos Pits are unknown.

6.06.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the C-Area Asbestos Pits.

6.06.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the C-Area Asbestos Pits. Therefore, water-table conditions beneath the waste sites are undefined.

6.06.05 Waste-Site Content Characterization Data

The contents of the C-Area Asbestos Pits have not been sampled. Section 6.06.02 contains information on the materials disposed in these waste sites.

6.06.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the C-Area Asbestos Pits.

6.06.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the C-Area Asbestos Pits.

6.06.08 Planned Action

The C-Area Asbestos Pits are currently inactive. A site assessment is scheduled for 1988 (see Section 16). No additional studies or actions are planned.

TABLE 6-1

Approximate Physical Dimensions of and Installation Data for the C-Area Reactor Seepage Basins

Basin	Shape	Area (acres)	Dimensions (ft)* Length	Width	Depth	Volume (ft^3)
1	L-shaped	0.33	394	36	7	93,800
2	Rectangular	0.29	296	43	10	124,830
3	Rectangular	0.30	148	89	13	171,310

* Dimensions given are for the centerline of each basin.

TABLE 6-2

Summary of Radioactive Releases to the C-Area Reactor Seepage Basins

Isotope	Release (Ci)*
^{3}H**	3.5E+04
^{35}S	7.7E-03
^{51}Cr	1.6E-03
^{60}Co	5.1E-02
^{89}Sr	7.1E-06
^{90}Sr	2.5E-01
$^{95}Zr, ^{95}Nb$	3.4E-04
$^{103,106}Ru$	1.6E-04
$^{124,125}Sb$	3.4E-03
^{134}Cs	1.5E-03
^{137}Cs	1.2E+00
$^{141,144}Ce$	1.1E-02
^{147}Pm	5.0E-03
Alpha emitters (unidentified)	3.8E-03

* Release values cumulative through 1985. All values are decay corrected through December 31, 1985.

** Most of the tritium is believed to have left the basins via the atmosphere or groundwater.

TABLE 6-3

Total Volumes Purged to the C-Area Reactor Seepage Basins

Year	Volumes Purged (L)
1959	7.570E+05
1960	3.000E+05
1961	1.136E+06
1962	8.500E+05
1963	6.370E+05
1964	8.030E+05
1965	1.064E+05
1966	5.160E+05
1967	1.010E+05
1968	9.198E+04
1969	1.908E+06
1970	2.080E+04
1978	1.448E+06
1979	1.449E+07
1980	9.276E+06
1981	1.894E+07
1982	1.588E+07
1983	1.599E+07
1984	3.497E+06
1985	1.385E+07
1986	7.107E+05
Total to 12/31/86	1.013E+08

TABLE 6-4

Typical Nonradioactive Analyses of Purge Water to the C-Area Seepage Reactor Basins (Effluent End of Second Deionizer in Series)

Constituent	Concentration (mg/L)
Cyanide	<0.005
Chloride	2.2
Nitrite	<0.5
Nitrate	<0.5
Surfactants	0.02
Turbidity	0
Sulfate	<5
Sulfide	<1
Dissolved organic carbon	4
Total organic carbon	2
Fluoride	0.10
Phenol	<0.002
Odor	0
Color	0
Total organic halogens	0.017
Corrosivity	No
Total dissolved solids	16.0
Phosphate	<0.02
pH (pH units)	6.5
Grease and oil	<5
Aluminum	<0.3
Calcium	0.03
Magnesium	0.01
Potassium	<0.05
Silver	<0.001
Arsenic	0.002
Barium	<0.1
Beryllium	<0.01
Cadmium	<0.001
Copper	<0.002
Iron	0.04
Mercury	<0.0002
Manganese	<0.02
Sodium	0.07
Lead	<0.002
Selenium	<0.002
Zinc	<0.010
Chromium	<0.003
Nickel	<0.003

TABLE 6-5

Radioactivity in C-Area Reactor Seepage Basins Water

Radionuclide	Concentration (pCi/mL) 1978	1979	1980	1981	1982	1983	1984	1985
^{51}Cr	---	0.86	3.5	2.4	0.10	0.48	0.06	2.5
$^{58,60}Co$	---	0.05	0.54	0.14	0.09	0.15	0.08	0.00
$^{89,90}Sr$*	---	---	---	**	34	140	100	6.4
$^{95}Zr, ^{95}Nb$	---	0.01	0.07	0.02	0.03	0.01	0.02	0.24
^{103}Ru	---	0.02	0.17	0.04	0.04	0.01	0.02	0.00
^{106}Ru	---	0.42	0.03	0.09	0.01	0.52	0.09	0.51
$^{124,125}Sb$	---	0.03	0.09	0.05	0.03	0.05	0.01	0.01
^{131}I	---	0.01	0.02	0.08	0.01	0.08	0.00	0.00
^{134}Cs	---	0.06	0.00	0.02	0.01	0.03	0.00	0.55
^{137}Cs	---	0.49	1.4	0.35	0.38	0.79	0.06	2.0
$^{141,144}Ce$	---	0.09	0.91	0.19	0.36	0.21	0.04	2.1
^{3}H	390	460	290	330,000	170,000	67,000	143,000	3,500
Gross alpha	2.0	2.4	5.9	0.031	0.011	0.020	0.018	0.0025
Nonvolatile beta	260	370	990	1.40	2.10	1.10	0.62	0.91

Note: Sampling was discontinued in 1986 because of reactor shutdown.

* Calculated from annual release values in purge water and purged volume.

** Less than sensitivity of analysis.

TABLE 6-6

Radioactivity in C-Area Reactor Seepage Basins Soil

Core Depth (ft)	Isotope	Test Hole Concentrations Basin 1 1	2	3	4	5	6	7
0.0-0.5	^{137}Cs	30	9	4	0.5	250	710	2,090
	^{60}Co	9	-	-	-	30	1,870	1,660
	^{90}Sr	NA	5	NA	NA	NA	70	NA
0.5-1.0	^{137}Cs	560	300	120	60	150	40	450
	^{60}Co	410	-	-	-	510	90	130
	^{90}Sr	NA	5	NA	NA	NA	140	NA
1.0-1.5	^{137}Cs	740	60	60	16	1,130	4	13
	^{60}Co	890	-	-	-	1,020	4	3
	^{90}Sr	NA	90	NA	NA	NA	4	NA
1.5-2.0	^{137}Cs	NA	NA	NA	NA	NA	NA	120
	^{60}Co	NA	NA	NA	NA	NA	NA	40
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
3.5-4.0	^{137}Cs	490	6	60	470	50	6	2
	^{60}Co	230	-	90	50	25	-	-
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
5.5-6.0	^{137}Cs	3	5	80	6	0.5	4	0.5
	^{60}Co	6	-	-	-	-	-	-
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
7.5-8.0	^{137}Cs	2	1	16	0.6	1	4	0.5
	^{60}Co	-	-	-	-	-	-	-
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
9.5-10.0	^{137}Cs	1	1	<0.2	1	0.3	5	0.2
	^{60}Co	-	-	-	-	-	-	-
	^{90}Sr	NA	6	NA	NA	NA	1	NA
11.5-12.0	^{137}Cs	NA	0.8	NA	NA	NA	1	NA
	^{60}Co	NA	-	NA	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
13.5-14.0	^{137}Cs	NA	0.2	NA	NA	NA	0.4	NA
	^{60}Co	NA	-	NA	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
15.5-16.0	^{137}Cs	NA	1	NA	NA	NA	<0.2	NA
	^{60}Co	NA	-	NA	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
17.5-18.0	^{137}Cs	NA	3	NA	NA	NA	0.4	NA
	^{60}Co	NA	-	NA	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA	NA	NA	NA
19.5-20.0	^{137}Cs	NA	0.6	NA	NA	NA	0.2	NA
	^{60}Co	NA	-	NA	NA	NA	-	NA
	^{90}Sr	NA	12	NA	NA	NA	<0.8	NA

TABLE 6-6 (cont.)

Core Depth (ft)	Isotope	Test Hole Concentrations Basin 2 8	9	10	11
0.0-0.5	^{137}Cs	25	40	610	60
	^{60}Co	-	-	20	-
	^{90}Sr	NA	NA	90	NA
0.5-1.0	^{137}Cs	80	40	13	310
	^{60}Co	-	-	5	4
	^{90}Sr	NA	NA	105	NA
1.0-1.5	^{137}Cs	70	40	4	800
	^{60}Co	-	-	-	30
	^{90}Sr	NA	NA	140	NA
1.5-2.0	^{137}Cs	100	NA	6	24
	^{60}Co	-	NA	-	-
	^{90}Sr	NA	NA	85	NA
3.5-4.0	^{137}Cs	260	0.4	0.8	3
	^{60}Co	-	-	-	-
	^{90}Sr	NA	NA	NA	NA
5.5-6.0	^{137}Cs	3	0.3	0.5	0.7
	^{60}Co	-	-	-	-
	^{90}Sr	NA	NA	NA	NA
7.5-8.0	^{137}Cs	4	<0.1	0.3	1
	^{60}Co	-	-	-	-
	^{90}Sr	NA	NA	NA	NA
9.5-10.0	^{137}Cs	0.4	<0.1	0.2	1
	^{60}Co	-	-	-	-
	^{90}Sr	NA	NA	<0.1	NA
11.5-12.0	^{137}Cs	NA	NA	<0.1	NA
	^{60}Co	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA
13.5-14.0	^{137}Cs	NA	NA	<0.1	NA
	^{60}Co	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA
15.5-16.0	^{137}Cs	NA	NA	<0.1	NA
	^{60}Co	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA
17.5-18.0	^{137}Cs	NA	NA	<0.1	NA
	^{60}Co	NA	NA	-	NA
	^{90}Sr	NA	NA	NA	NA
19.5-20.0	^{137}Cs	NA	NA	<0.1	NA
	^{60}Co	NA	NA	-	NA
	^{90}Sr	NA	NA	<0.8	NA

TABLE 6-6 (cont.)

Core Depth (ft)	Isotope	Test Hole Concentrations Basin 3 12	13	14	15	16
0.0-0.5	^{137}Cs					
	^{60}Co	5	2	11	2	4
	^{90}Sr	-	-	-	-	-
0.5-1.0	^{137}Cs	NA	NA	2	NA	NA
	^{60}Co	10	2	0.3	2	0.6
	^{90}Sr	-	-	-	-	-
1.0-1.5	^{137}Cs	NA	NA	2	NA	NA
	^{60}Co	0.5	<0.2	NA	2	1
	^{90}Sr	-	-	NA	-	-
1.5-2.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	NA	<0.2	NA	0.3	0.8
	^{90}Sr	NA	-	NA	-	-
3.5-4.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	0.4	1	<0.2	0.7	1
	^{90}Sr	-	-	-	-	-
5.5-6.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	0.6	0.5	0.2	0.7	1
	^{90}Sr	-	-	-	-	-
7.5-8.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	0.7	1	1	2	1
	^{90}Sr	-	-	-	-	-
9.5-10.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	0.4	0.8	0.4	0.8	0.8
	^{90}Sr	-	-	-	-	-
11.5-12.0	^{137}Cs	NA	NA	<0.8	NA	NA
	^{60}Co	NA	NA	0.4	NA	NA
	^{90}Sr	NA	NA	-	NA	NA
13.5-14.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	NA	NA	2	NA	NA
	^{90}Sr	NA	NA	-	NA	NA
15.5-16.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	NA	NA	<0.2	NA	NA
	^{90}Sr	NA	NA	-	NA	NA
17.5-18.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	NA	NA	1	NA	NA
	^{90}Sr	NA	NA	-	NA	NA
19.5-20.0	^{137}Cs	NA	NA	NA	NA	NA
	^{60}Co	NA	NA	0.2	NA	NA
	^{90}Sr	NA	NA	-	NA	NA
		NA	NA	<0.8	NA	NA

Note: Concentrations are in pCi/g dry weight. Core depths were taken in 15-cm intervals; therefore, depths in feet are approximate. NA = no analysis; - = not detected.

TABLE 6-7

Summary of Groundwater Quality: Well Concentration Ranges for the C-Area Seepage Basins (7/84-12/86)

Constituent	SC and Federal DWS	CSB 1A	CSB 2A	CSB 3A	CSB 4A
pH (pH)	6.5-8.5	11.2-11.4	5.7-6.2	5.4-6.5	5.1-6.5
Conductivity (µmhos/cm)	NA	93-1,600	40-66	39-60	32-49
Silver (mg/L)	0.05	<0.0020-0.0030	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.012-0.021	0.011-0.019	0.008-0.013	<0.004-0.005
Carbon tetrachloride (mg/L)	0.005	0.001	<0.001	0.001	<0.001
Cadmium (mg/L)	0.010	<0.001	<0.001	<0.001	<0.001
Chloroform (mg/L)	0.100*	<0.001-0.015	<0.001-0.011	0.002	<0.001-0.032
Chloride (mg/L)	250	3.5-6.8	2.9-6.2	2.8-4.0	2.8-3.4
Chromium (mg/L)	0.05	0.030-0.061	<0.004	<0.004	<0.004
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.27	<0.10-0.15	<0.10-0.18	<0.10-0.20
Iron (mg/L)	0.3	0.006-0.036	0.005-0.182	0.007-0.740	<0.004-0.073
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0003	<0.0002	<0.0002-0.0002
Manganese (mg/L)	0.05	<0.002	0.008-0.091	<0.002-0.043	0.020-0.040
Sodium (mg/L)	NA	4.63-7.19	5.04-5.87	2.16-3.21	3.98-10.90
Nitrate (as N) (mg/L)	10	0.63-1.55	0.70-1.52	0.84-1.15	0.63-0.76
Lead (mg/L)	0.05	0.078-0.504	<0.005-0.054	<0.005-0.022	<0.005
Phenols (mg/L)	NA	<0.002-0.068	<0.002-0.010	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0-12.5	<3.0-3.0	<3.0-4.0	<3.0-7.0
Tetrachloroethylene (mg/L)	NA	<0.001	0.003	0.002	<0.001
TOC (mg/L)	NA	1.60-6.42	<1.00-6.00	3.00-17.1	<1.00-10.9
TOH (mg/L)	NA	0.021-0.150	0.022-0.038	0.021-0.182	0.022-0.150
Trichloroethylene (mg/L)	0.005	0.003-0.006	<0.005-0.016	<0.005-0.023	0.006-0.030
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	0.003	0.003
Gross alpha (pCi/L)	15	0.0-2.9	1.6-1.9	0.3-2.8	0.9-1.3
Nonvol. beta (pCi/L)	NA	<2.0-2.5	2.6-3.3	3.0-3.3	<2.0-4.6
Tritium (pCi/mL)	20	15-521	6-403	43,000-191,000	4,330-89,800
Total radium (pCi/L)	5	<1.0	<1.0-2.5	1.6-2.2	<1.0

TABLE 6-7 (cont.)

Constituent	SC and Federal DWS	CSB 5A	CSB 6A
pH (pH)	6.5-8.5	9.3-10.8	10.0-11.6
Conductivity (µmhos/cm)	NA	100-510	241-790
Silver (mg/L)	0.05	<0.0020	<0.0020-0.0030
Arsenic (mg/L)	0.05	<0.001	<0.001
Barium (mg/L)	1.0	<0.004-0.018	<0.004-0.049
Carbon tetrachloride (mg/L)	0.005	<0.001	0.001
Cadmium (mg/L)	0.010	<0.001	<0.001
Chloroform (mg/L)	0.100*	<0.001-0.034	<0.001
Chloride (mg/L)	250	3.4-4.5	2.3-4.0
Chromium (mg/L)	0.05	<0.004-0.007	0.011-0.050
Endrin (mg/L)	0.0002	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.23-0.49	<0.10-0.36
Iron (mg/L)	0.3	0.006-0.028	0.004-3.850
Mercury (mg/L)	0.002	<0.0002-0.0003	<0.0002
Manganese (mg/L)	0.05	<0.002	<0.002-0.017
Sodium (mg/L)	NA	3.99-8.09	3.20-5.75
Nitrate (as N) (mg/L)	10	<0.50-1.43	1.15-1.20
Lead (mg/L)	0.05	<0.004-0.016	<0.005-0.045
Phenols (mg/L)	NA	<0.002-0.010	<0.002-0.019
Selenium (mg/L)	0.01	<0.002	<0.002
Sulfate (mg/L)	250	<3.0-20.0	4.0-20.0
Tetrachloroethylene (mg/L)	NA	0.003	0.003
TOC (mg/L)	NA	3.00-18.0	<1.00-10.9
TOH (mg/L)	NA	0.044-0.533	0.011-0.081
Trichloroethylene (mg/L)	0.005	<0.005-0.788	0.019-0.030
1,1,1-TCE (mg/L)	0.200	0.004	<0.005-0.005
Gross alpha (pCi/L)	15	0.5-2.1	0.1-4.3
Nonvol. beta (pCi/L)	NA	5.3-15.3	0.4-8.4
Tritium (pCi/mL)	20	446-9,800	2,530-147,000
Total radium (pCi/L)	5	1.9-7.5	4.0-6.8

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 6-8

Radioactivity in the C-Area Reactor Seepage Basins Wells (Annual Averages)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
CSB 1						
1978	0.03	0.16	2.10	2.60	5	7
1979	0.11	0.33	1.20	4.80	88	150
1980	0.39	0.81	0.61	7.00	33	37
1981	0.21	0.32	1.60	3.80	35	37
1982	0.08	0.41	5.40	6.90	44	52
1983	0.17	0.41	2.20	3.90	43	46
CSB 1A						
1984	0.46	0.77	3.30	3.90	52	85
1985	0.17	0.16	1.30	2.60	29	30
1986	0.10	0.22	2.90	4.60	30	40
CSB 2						
1978	0.47	0.82	6.80	8.30	9	12
1979	0.65	1.20	3.90	5.70	53	57
1980	1.40	2.10	9.20	19.00	120	350
1981	1.00	1.20	7.70	12.00	52	61
1982	1.20	2.70	9.60	25.00	38	48
1983	0.80	1.20	3.60	8.20	35	37
CSB 2A						
1984	0.26	0.48	1.90	5.00	350	790
1985	0.32	0.38	0.39	1.10	70	85
1986	0.40	0.87	1.60	2.60	64	79
CSB 3						
1978	0.03	0.49	0.48	2.10	150	210
1979	0.17	0.33	1.30	4.50	500	740
1980	0.72	1.70	0.68	7.80	710	770
1981	0.38	0.58	3.80	0.00	790	930
1982	0.85	1.60	3.30	17.00	1,600	1,800
1983	0.21	0.48	0.05	0.75	1,900	2,000
CSB 3A						
1984	0.34	0.77	2.20	3.00	58,000	140,000
1985	0.47	0.77	3.20	9.20	110,000	250,000
1986	0.48	0.98	3.60	7.00	82,000	120,000

TABLE 6-8 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
CSB 4						
1978	0.05	0.16	20.00	28.00	11	14
1979	0.04	0.17	12.00	21.00	82	97
1980	0.06	0.32	1.80	2.70	120	170
1981	0.00	0.16	2.40	3.90	62	80
1982	0.18	1.30	3.90	18.00	88	120
1983	0.07	0.29	8.50	25.00	63	74
CSB 4A						
1984	0.44	0.77	1.70	2.90	74,000	120,000
1985	0.64	1.40	1.40	2.60	84,000	93,000
1986	0.41	0.87	1.50	4.60	70,000	93,000
CSB 5						
1978	0.11	0.33	10.00	14.00	26	33
1979	0.02	0.17	0.02	1.70	370	480
1980	0.29	0.41	2.40	5.00	450	480
1981	0.08	0.24	1.70	3.10	460	480
1982	0.04	0.25	0.83	8.00	360	450
1983	0.03	0.15	0.16	1.60	180	200
CSB 5A						
1984	0.34	0.58	4.50	5.40	13,000	24,000
1985	0.17	0.31	4.20	5.90	11,000	13,000
1986	0.13	0.54	5.20	6.30	8,000	14,000
CSB 6						
1978	0.72	1.20	7.70	9.10	3,400	7,700
1979	0.98	1.60	3.90	8.10	40,000	88,000
1980	1.50	3.40	2.60	7.00	4,600	6,400
1981	0.71	0.97	1.40	8.20	1,700	3,500
1982	0.52	0.59	0.02	1.10	13,000	30,000
1983	0.12	0.29	1.30	5.30	160,000	250,000
CSB 6A						
1984	0.17	0.29	2.50	4.20	46,000	170,000
1985	0.07	0.19	2.60	7.40	4,100	5,100
1986	0.04	0.11	1.40	2.40	6,100	12,000

TABLE 6-9

C-Area Coal Pile Runoff Containment Basin Influent Characterization Data

Parameter	Units	Initial	Final	Composite
Time	NA	1155	1632	NA
Temperature	°C	24.0	No sample	NA
Flow	gal/min	1-2	No flow	NA
pH	pH	5.22	---	4.42
Conductivity	µmhos/cm	165	---	195
Sulfate (as SO_4)	mg/L	38.2	---	40.6
Total suspended solids	mg/L	85	---	27
Total dissolved solids	mg/L	140	---	130
Phenols	mg/L	<0.002	---	<0.006
Acidity (as $CaCO_3$)	mg/L	<1	---	50
Beryllium	mg/L	<0.001	---	0.0011
Cadmium	mg/L	<0.006	---	<0.006
Copper	mg/L	<0.02	---	0.169
Chromium	mg/L	<0.02	---	<0.02
Iron	mg/L	4.19	---	2.31
Lead	mg/L	0.0133	---	0.0149
Mercury	mg/L	0.00010	---	0.00024
Nickel	mg/L	<0.05	---	<0.05
Selenium	mg/L	0.0017	---	0.0017
Zinc	mg/L	<0.01	---	0.03
Aluminum	mg/L	3.20	---	2.61
Manganese	mg/L	1.81	---	1.52
Magnesium	mg/L	2.73	---	1.72
Arsenic	mg/L	0.0042	---	0.0034
Silver	mg/L	<0.001	---	<0.001
Barium	mg/L	<0.03	---	<0.03

Note: Samples were collected in October 1985. The final grab sample could not be taken because runoff was no longer flowing to the basin.
NA = not applicable.

TABLE 6-10

Summary of Groundwater Quality: Well Concentration Ranges for the C-Area Coal Pile Runoff Containment Basin (7/84-12/86)

Constituent	SC and Federal DWS	CCB 1	CCB 2	CCB 3	CCB 4
pH (pH)	6.5-8.5	3.7-5.5	3.7-5.2	3.7-5.4	3.9-5.3
Conductivity (µmhos/cm)	NA	18-26	17-39	12-26	12-30
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	0.0009
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.016	0.021	0.012	0.015
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloride (mg/L)	250	1.7-2.7	1.7-2.7	1.5-2.7	1.0-2.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.019	0.006-0.012	0.005-0.009	<0.004-0.010
DOC (mg/L)	NA	<5.0	<5.0	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.12	0.12	0.11	0.12
Iron (mg/L)	0.3	0.044-0.181	0.022-0.110	0.020-0.096	<0.004-0.100
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	<0.002	0.002-0.003	<0.002-0.006	<0.002-0.006
Sodium (mg/L)	NA	1.34-1.53	1.28-1.34	0.99-1.40	1.14-1.18
Nitrate (as N) (mg/L)	10	0.98	1.25	0.70	0.93
Lead (mg/L)	0.05	0.006	0.009	0.008	0.008
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0-7.0	<5.0-6.0
TDS (mg/L)	500	22-28	18-22	20	20
TOC (mg/L)	NA	0.840-1.484	0.480-1.177	0.243-40.500	0.520-0.553
TOH (mg/L)	NA	<0.005-0.034	<0.005-0.019	<0.005-0.011	<0.005
Zinc (mg/L)	5	0.010	0.029	0.028	0.015
Gross alpha (pCi/L)	15	<2.0	<2.0	<2.0	<2.0
Nonvol. beta (pCi/L)	NA	<3.0	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	<1.0	<1.0	<1.0	<1.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

TABLE 6-11

Trace Elements in Different Types of Ash

Element	Ash Type (mg/L) Fly Ash (Electrostatic Precipitator)	Fly Ash (Mechanical Collector)	Bottom Ash
Barium	889	792	808
Strontium	579	589	333
Manganese	352	275	811
Zinc	280	116	95
Vanadium	218	166	140
Cerium	189	251	150
Chromium	171	140	160
Arsenic	164	55	4
Copper	130	93	67
Nickel	89	87	77
Gallium	72	32	20
Lanthanum	69	61	61
Cobalt	67	47	40
Lead	60	28	5
Bromine	47	12	3
Scandium	32	28	20
Thorium	23	24	25
Antimony	19	6	3
Molybdenum	18	11	7
Beryllium	16	12	9
Samarium	15	13	12
Selenium	15	6	3
Cesium	14	13	10
Uranium	13	8	8
Europium	11	12	8
Ytterbium	12	8	10
Terbium	2.5	2.1	2
Mercury	0.84	0.33	0.08
Cadmium	0.71	0.39	0.5

Note: Data were collected in 1977. Source: Christensen and Gordon, 1983.

TABLE 6-12

Summary of Groundwater Quality: Well Concentration Ranges for the C-Area Burning/Rubble Pits (7/84-12/86)

Constituent	SC and Federal DWS	CRP 1	CRP 2	CRP 3	CRP 4
pH (pH)	6.5-8.5	5.3-7.3	4.0-5.9	10.5-12.5	3.6-5.5
Conductivity (µmhos/cm)	NA	60-110	15-63	1,200-3,800	17-53
Silver (mg/L)	0.05	<0.0020-0.0020	<0.0020-0.0020	0.0020-0.0040	<0.0004-0.0030
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.005-0.006	0.009-0.010	0.012-0.032	<0.004-0.010
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.010	<0.001	<0.005	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	0.048	<0.001	<0.005	0.002
Chloride (mg/L)	250	<2.0-2.5	1.7-3.2	4.6-6.4	1.8-2.5
Chromium (mg/L)	0.05	<0.004-0.015	<0.004-0.008	0.032-0.065	<0.004-0.009
Copper (mg/L)	1	<0.004	<0.004-0.010	<0.004-0.006	---
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	<5.0-12.0	<5.0	<5.0-10.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.11	0.08-0.88	<0.10-0.18	0.06-0.28
Iron (mg/L)	0.3	0.009-0.028	0.009-0.074	0.006-0.076	<0.004-0.052
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.003-0.015	0.014-0.021	<0.002-0.005	<0.002-0.003
Sodium (mg/L)	NA	1.32-2.43	1.43-2.25	3.36-8.16	1.06-1.60
Nickel (mg/L)	NA	<0.004	<0.004	<0.004	---
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	<0.50	<0.50-0.50	1.37-1.48	0.75-0.85
Lead (mg/L)	0.05	<0.004	0.008-0.012	0.031-1.310	<0.004-0.009
Phenol (mg/L)	NA	<0.002	<0.002	<0.002-0.031	<0.002-0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0-5.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001	<0.001-0.003	0.001	<0.001
TDS (mg/L)	500	44-328	14-38	620-798	---
TOC (mg/L)	NA	0.345-4.40	0.350-4.00	1.000-4.00	0.280-4.00
TOH (mg/L)	NA	0.461-3.700	0.007-0.055	1.000-3.549	<0.005-0.005
Trichloroethylene (mg/L)	NA	0.147-3.280	0.002-0.006	0.750-3.670	0.001
1,1,1-TCE (mg/L)	0.200	0.033	<0.001	<0.005	<0.001
Zinc (mg/L)	5	0.010-0.026	0.006-0.011	0.005-0.009	---
Gross alpha (pCi/L)	15	<2.0-12.0	<2.0-5.0	<2.0-14.0	<2.0-7.0
Nonvol. beta (pCi/L)	NA	<3.0-12.0	<3.0-7.0	<3.0-11.0	<3.0
Total radium (pCi/L)	5	<1.0-2.0	<1.0-2.0	<1.0-2.0	<1.0-2.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

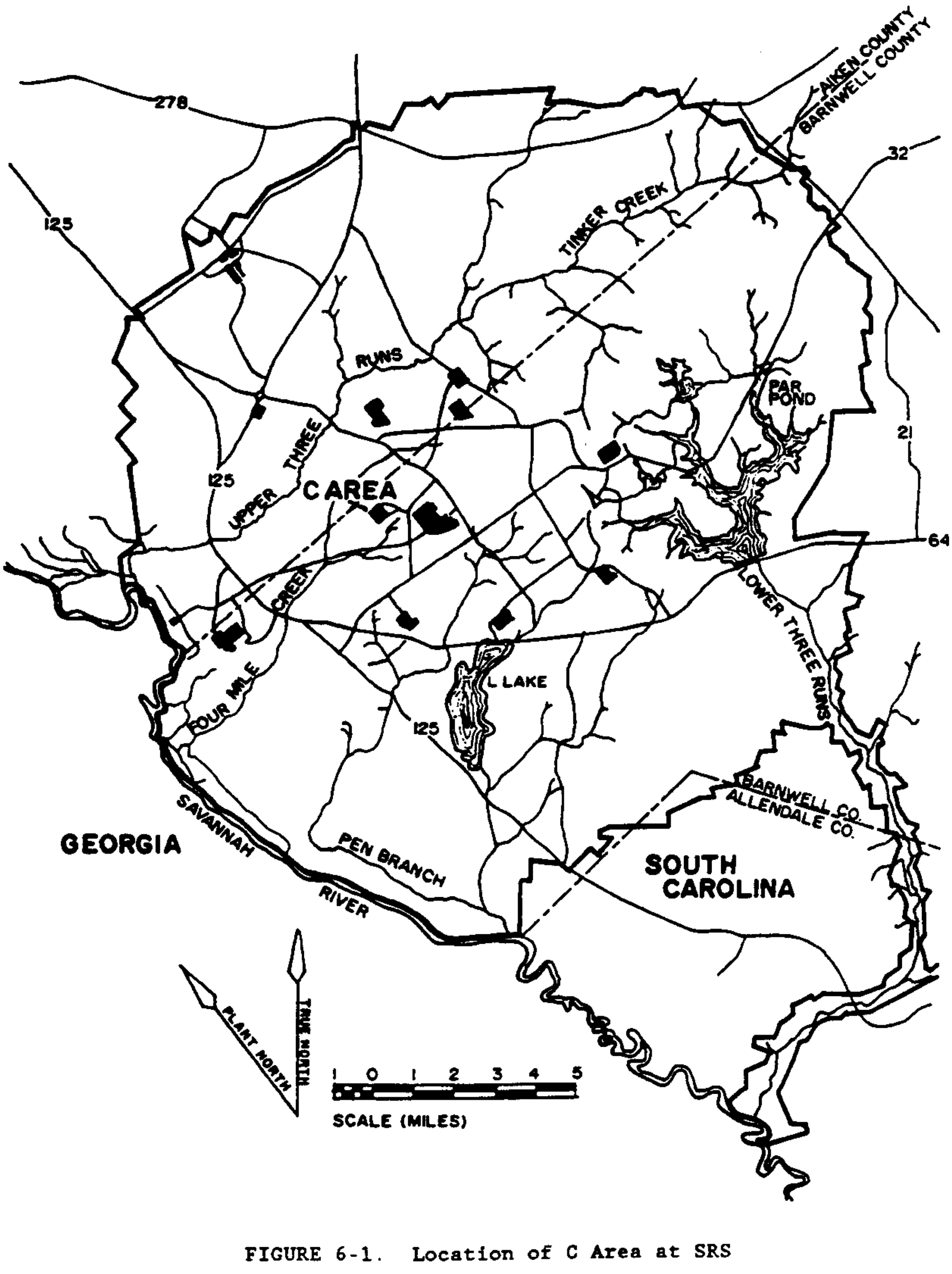


FIGURE 6-1. Location of C Area at SRS

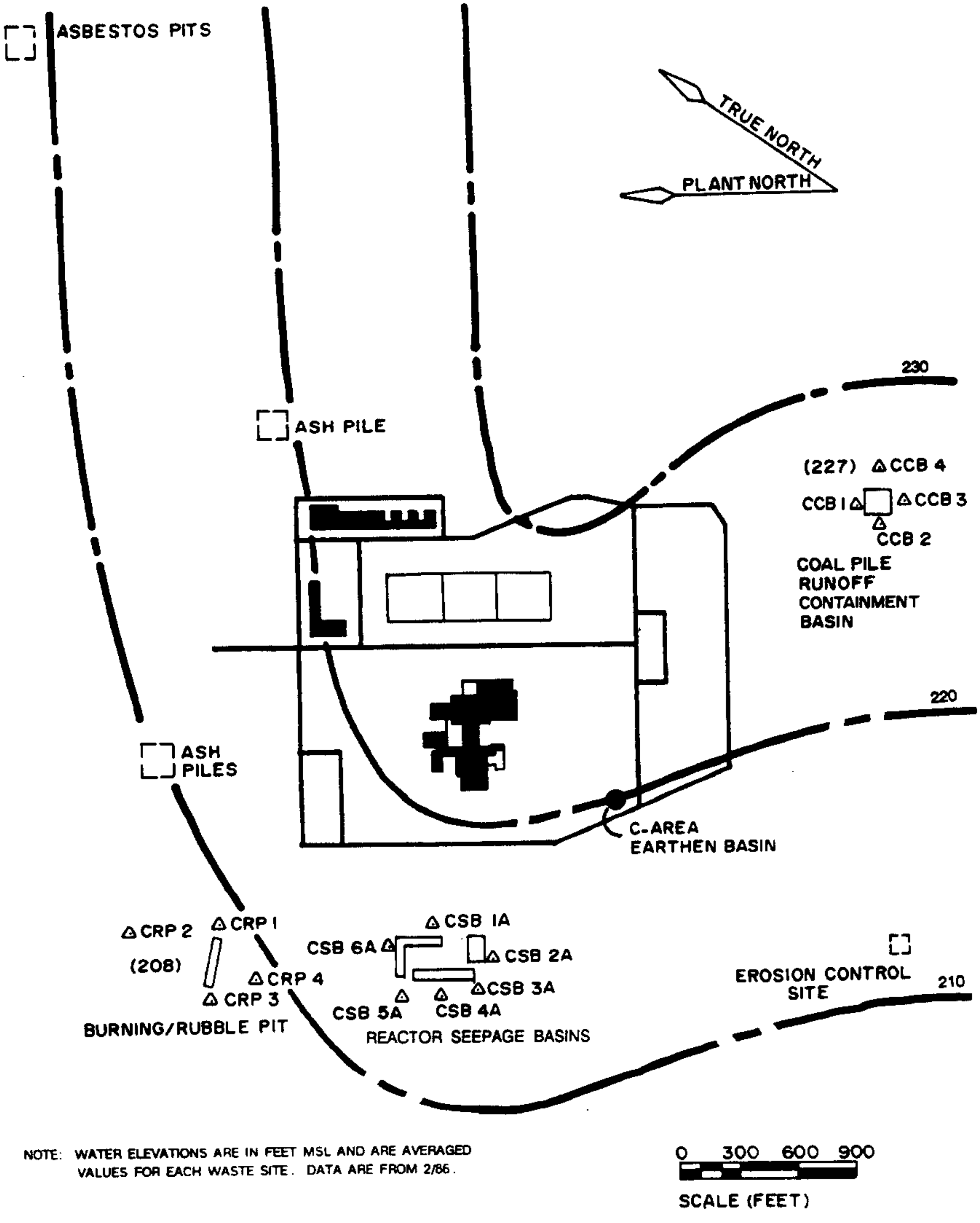


FIGURE 6-2. C-Area Water-Table Elevation Map

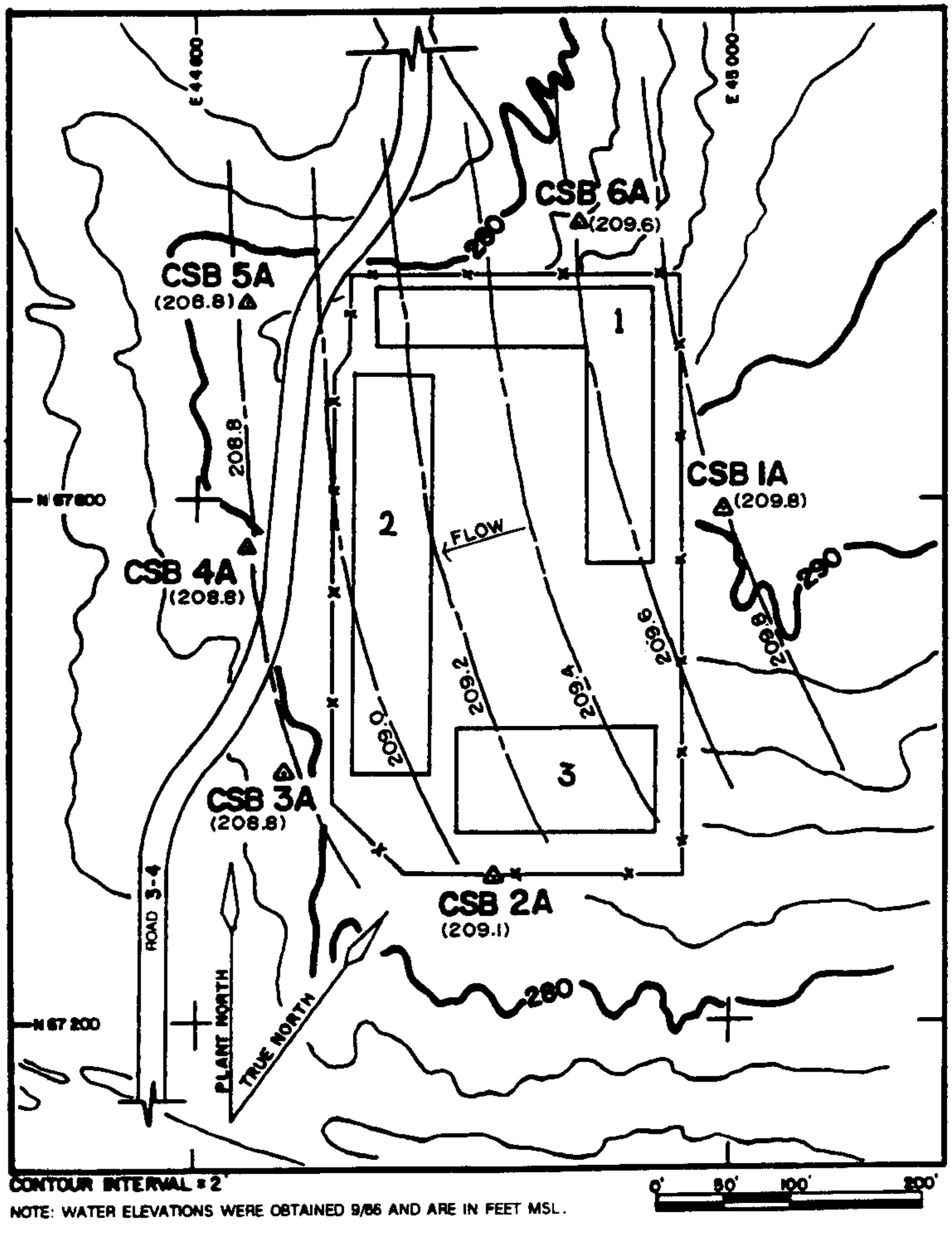


FIGURE 6-3. C-Area Reactor Seepage Basins Water-Table Elevation Map

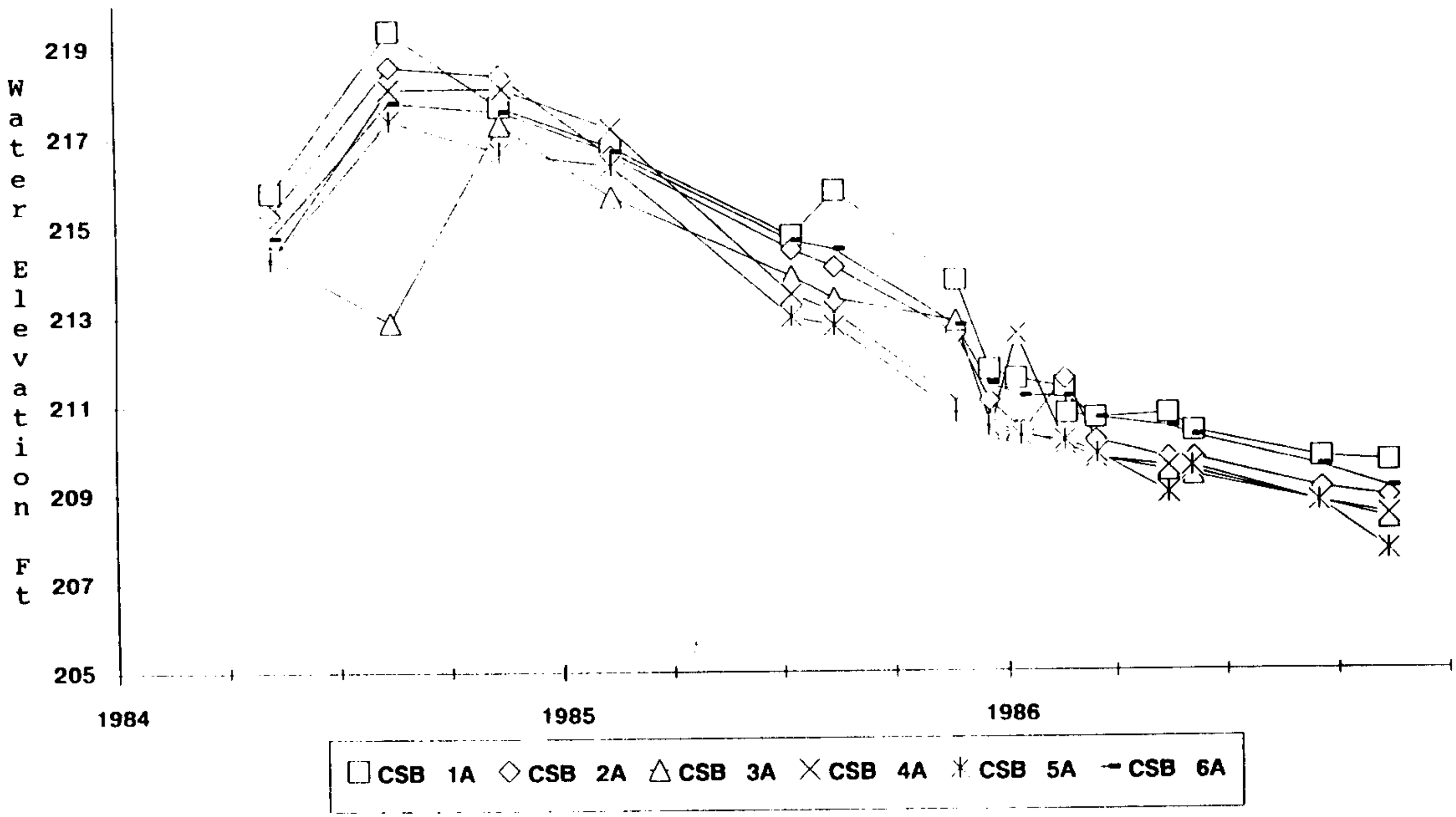


FIGURE 6-4. Hydrograph of the C-Area Reactor Seepage Basins Wells

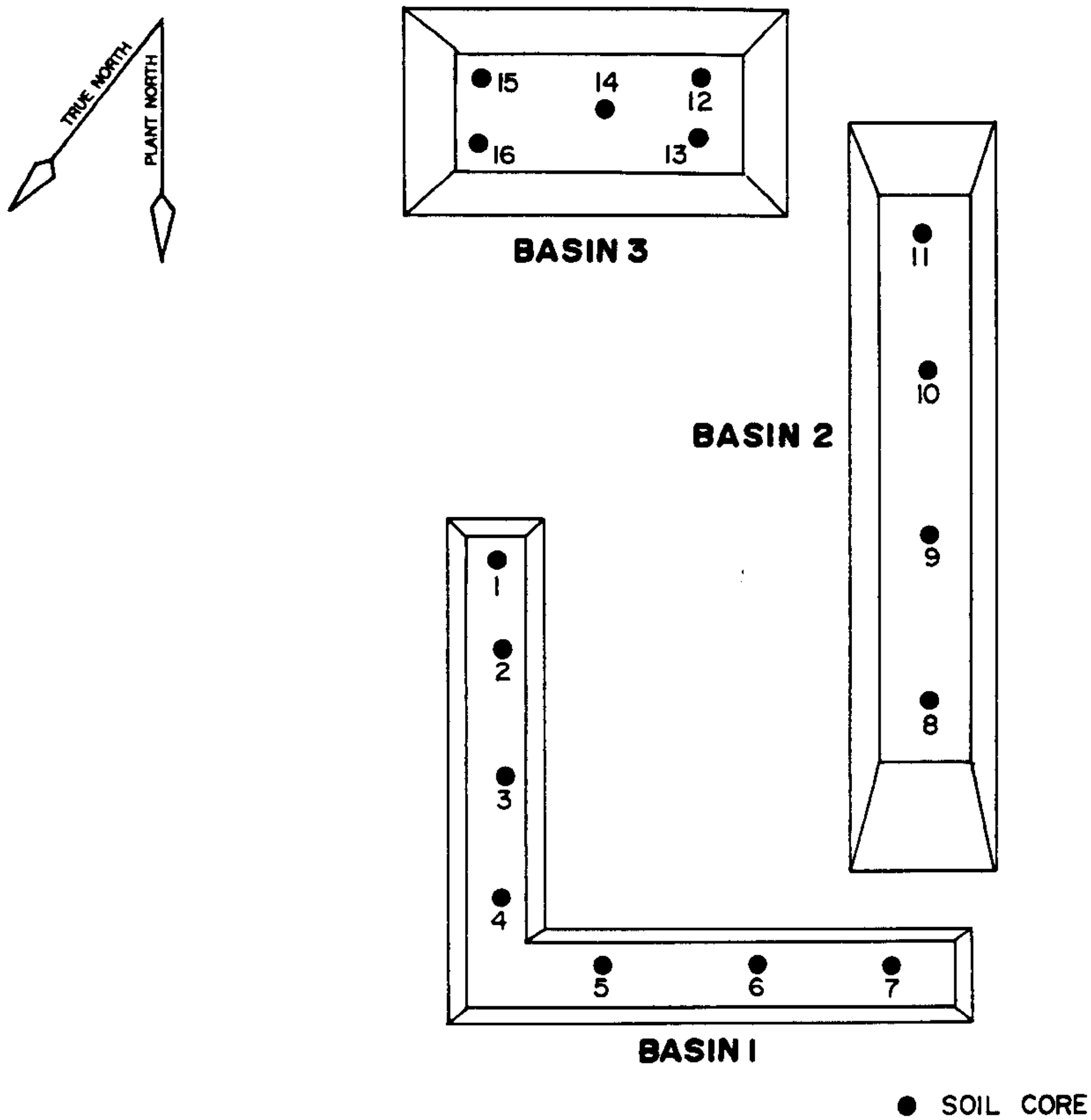


FIGURE 6-5. Soil Sampling Locations at the C-Area Reactor Seepage Basins

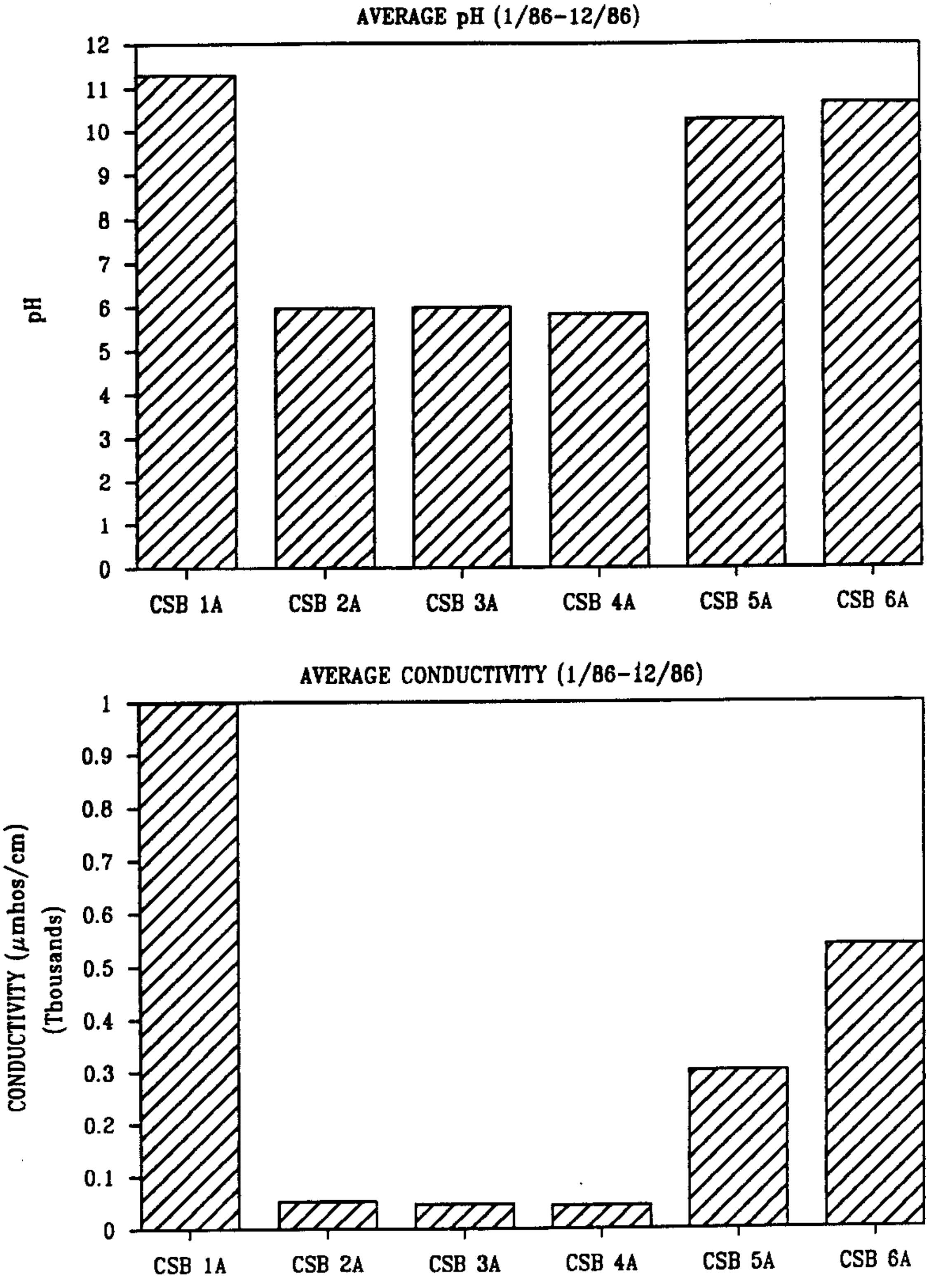


FIGURE 6-6. Average pH and Conductivity in the C-Area Reactor Seepage Basins Wells

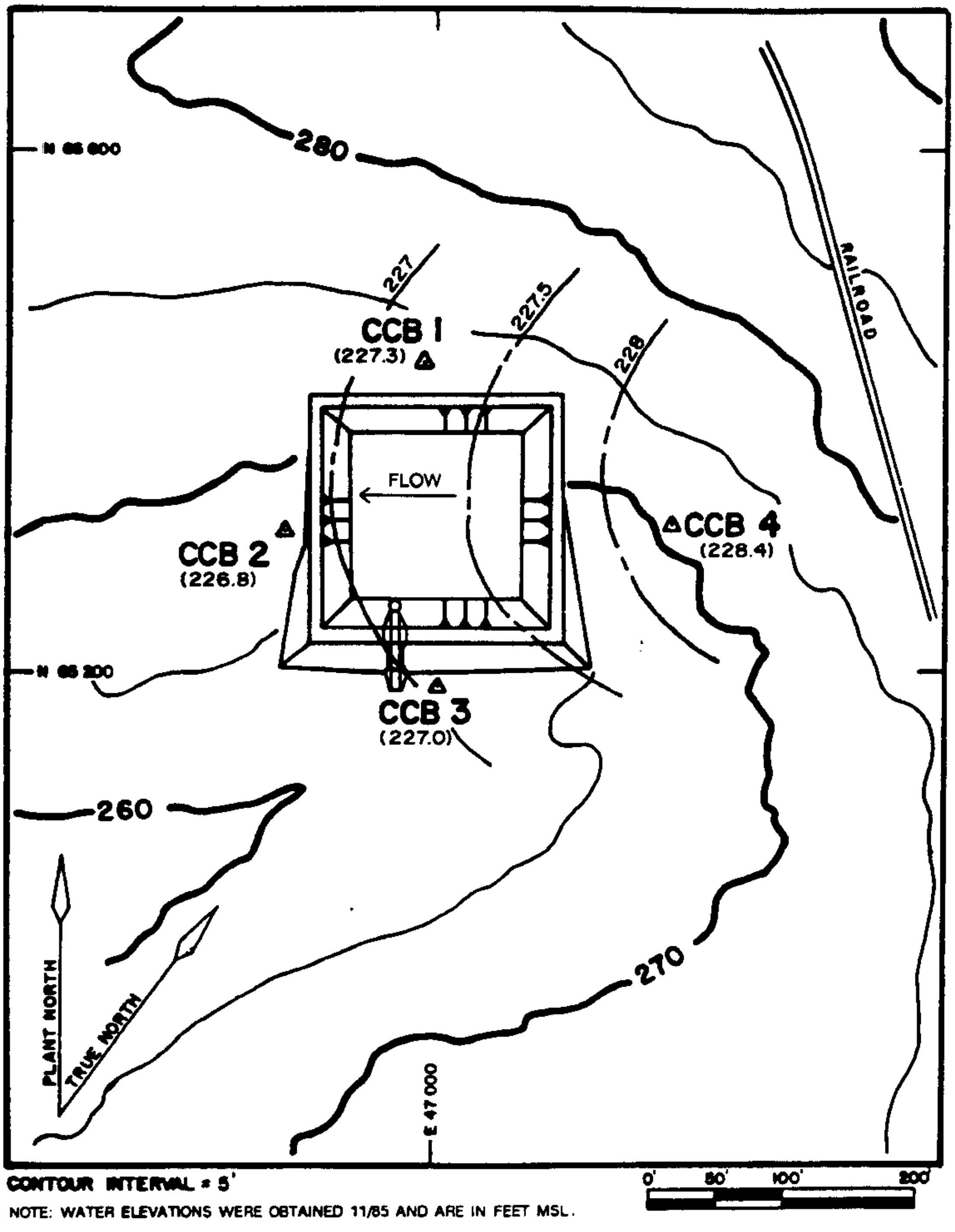


FIGURE 6-7. C-Area Coal Pile Runoff Containment Basin (CPRB) Water-Table Elevation Map

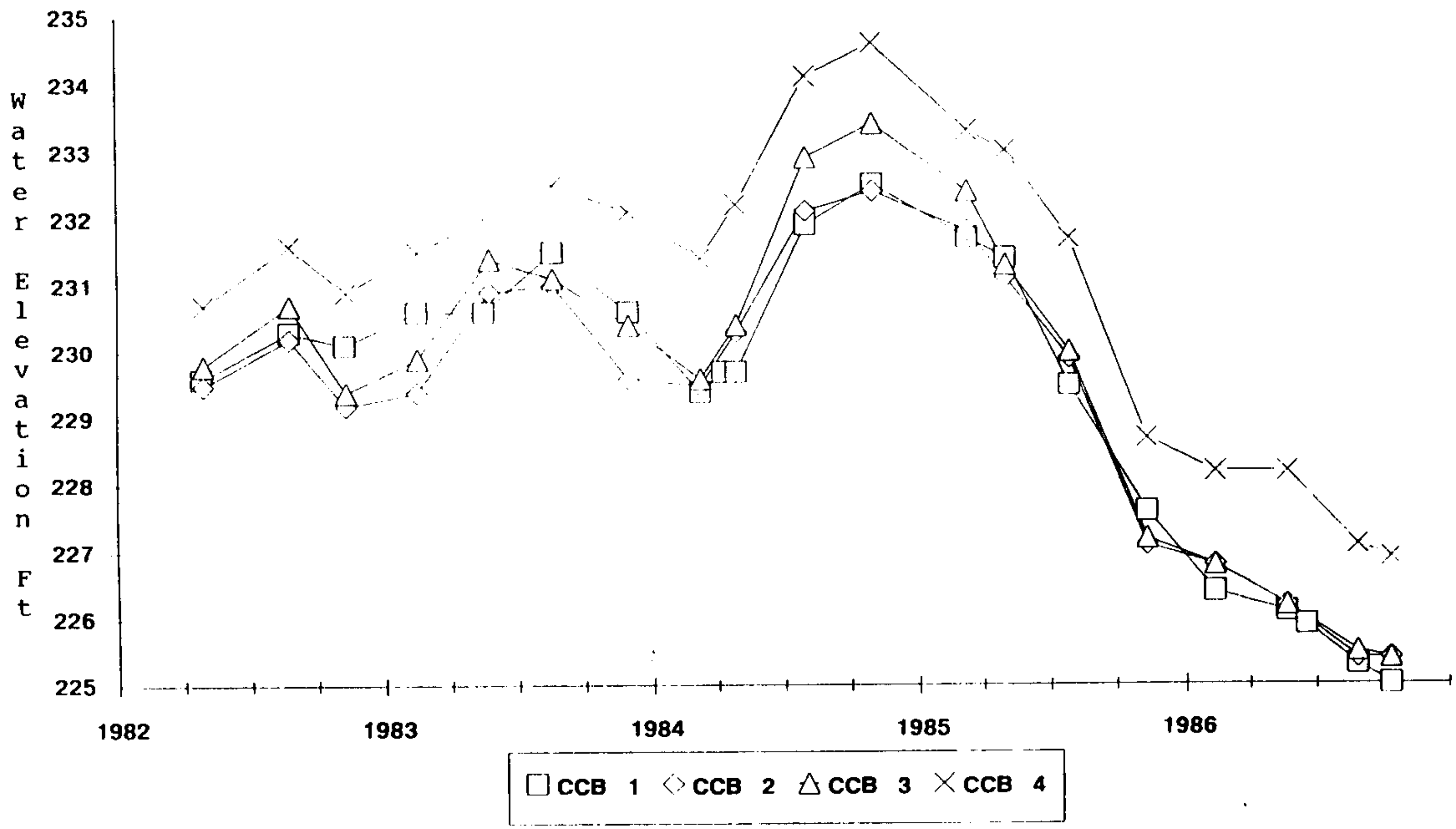
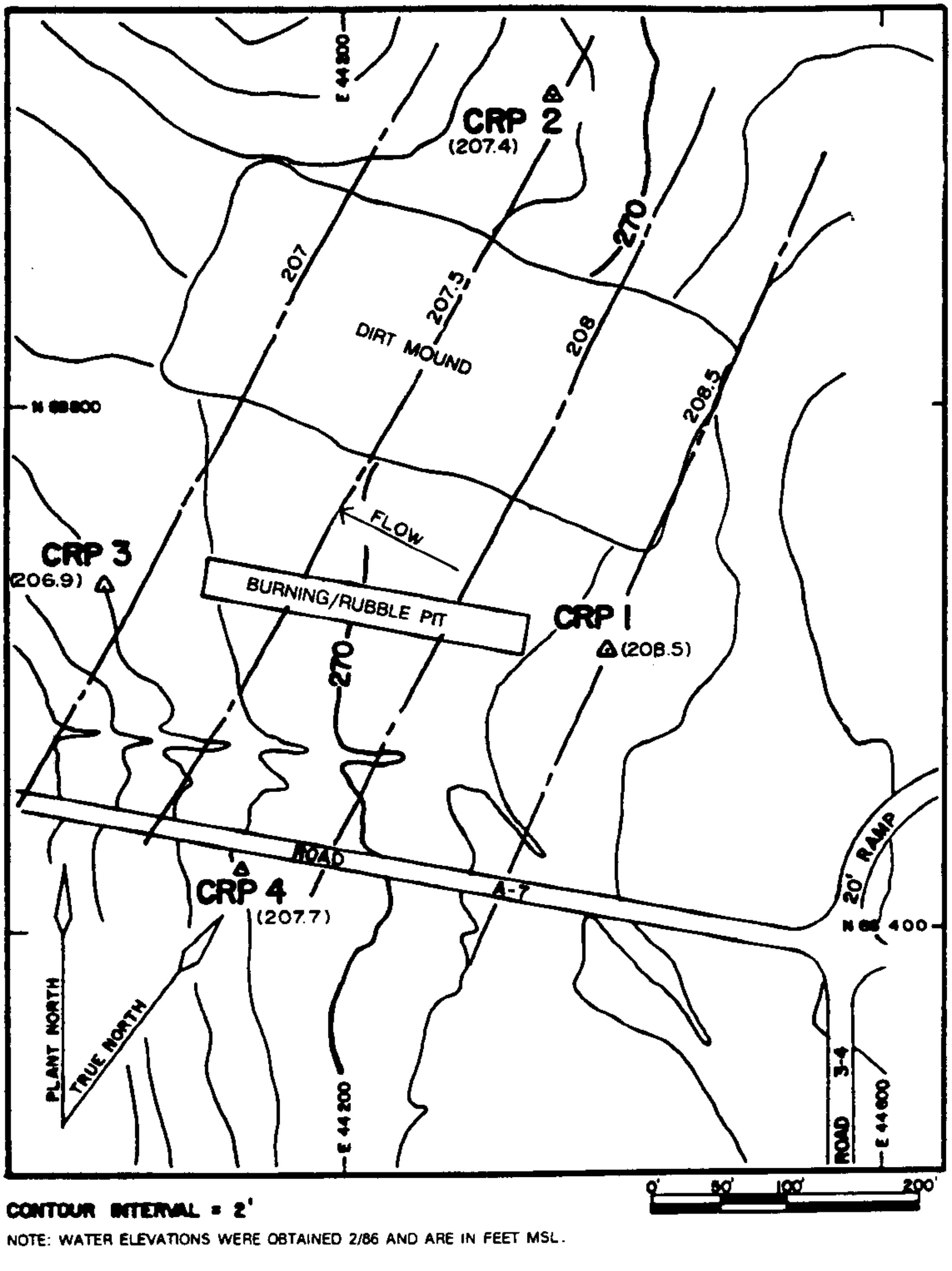


FIGURE 6-8. Hydrograph of the C-Area Coal Pile Runoff Containment Basin (CPRB) Wells



CONTOUR INTERVAL = 2'

NOTE: WATER ELEVATIONS WERE OBTAINED 2/86 AND ARE IN FEET MSL.

FIGURE 6-9. C-Area Burning/Rubble Pit Water-Table Elevation Map

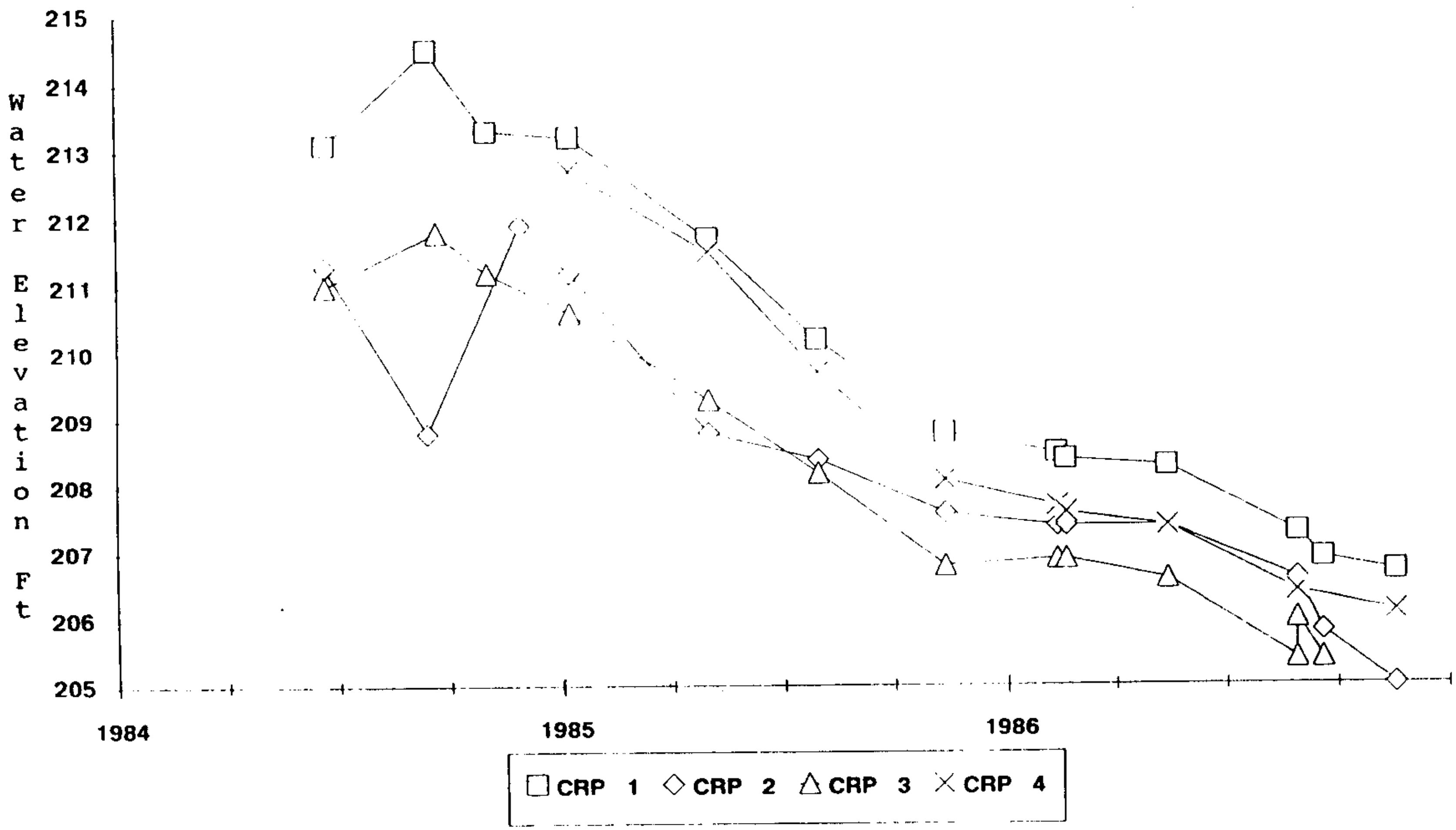


FIGURE 6-10. Hydrograph of the C-Area Burning/Rubble Pit Wells

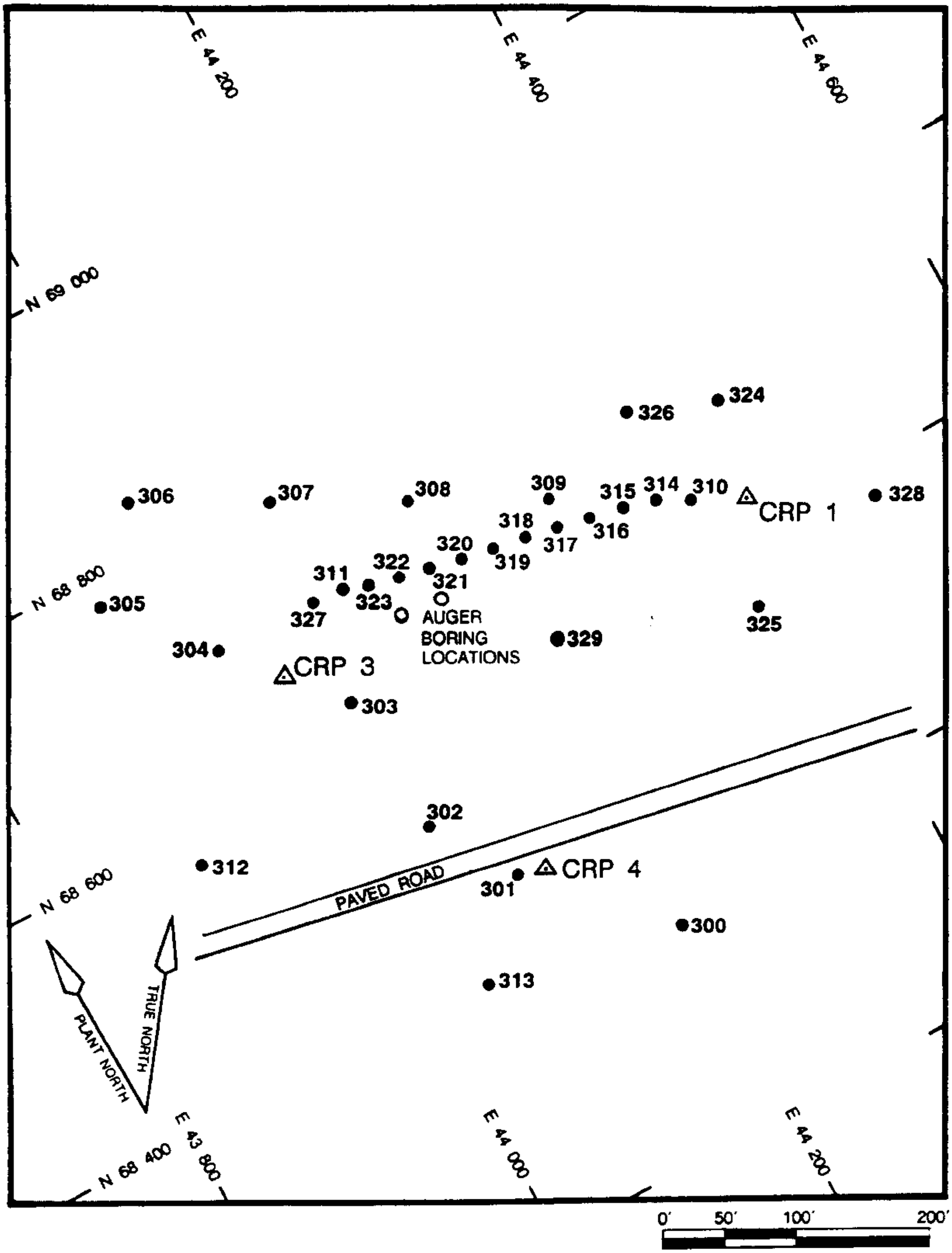


FIGURE 6-11. Soil Sampling Locations at the C-Area Burning/Rubble Pit

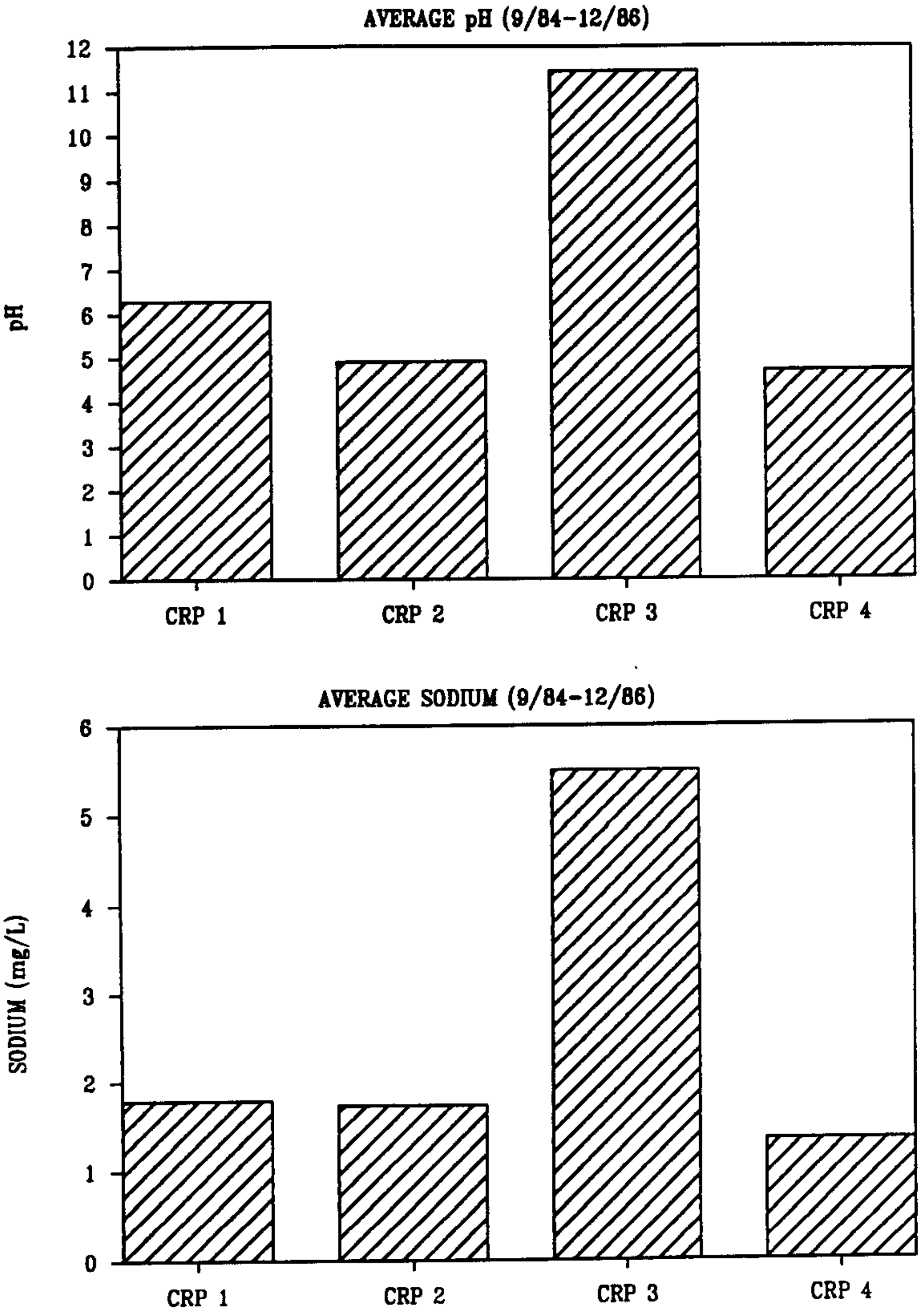


FIGURE 6-12. Average pH and Sodium Concentrations in the C-Area Burning/Rubble Pit Wells

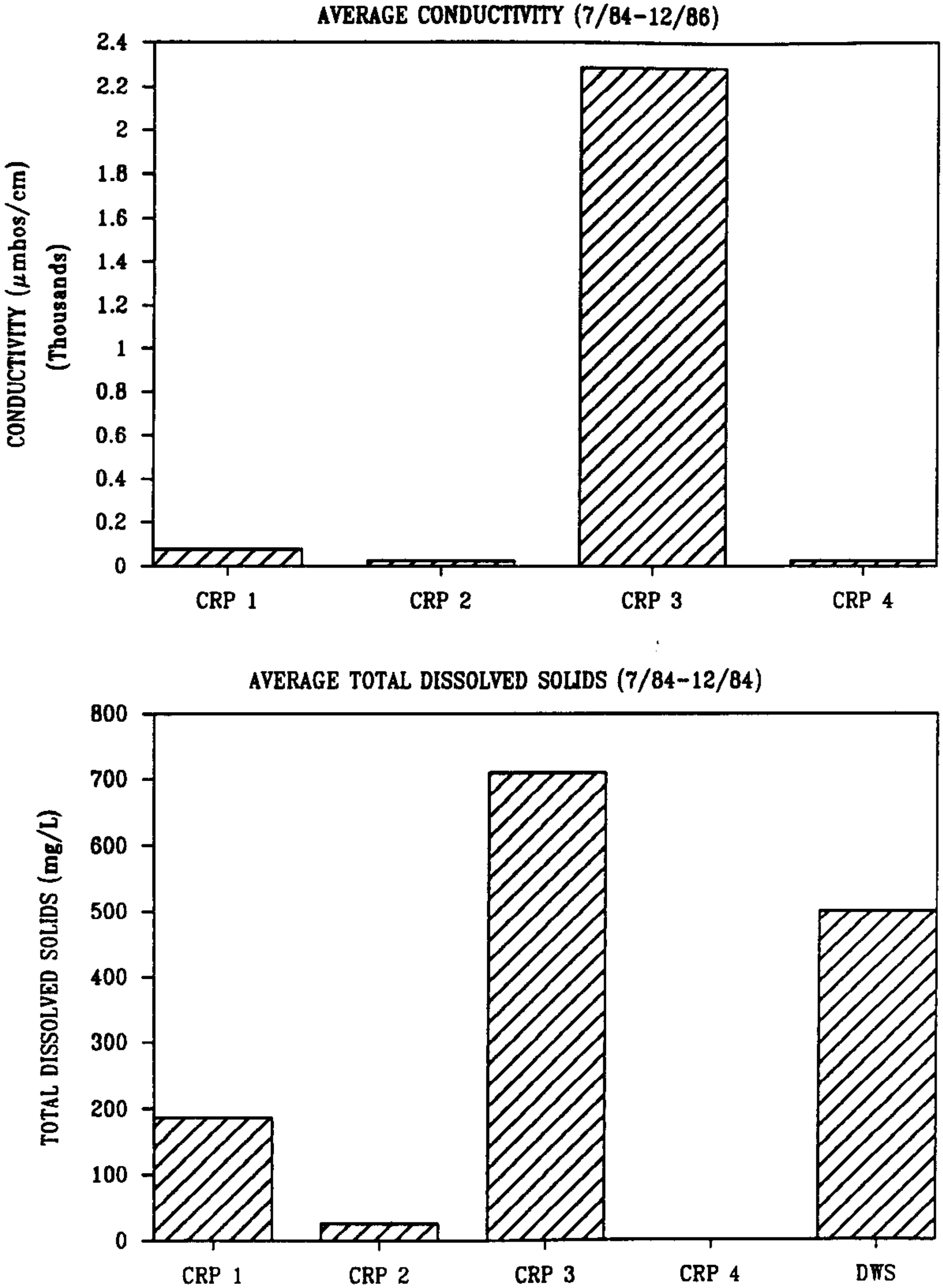


FIGURE 6-13. Average Conductivity and Total Dissolved Solids (TDS) in the C-Area Burning/Rubble Pit Wells

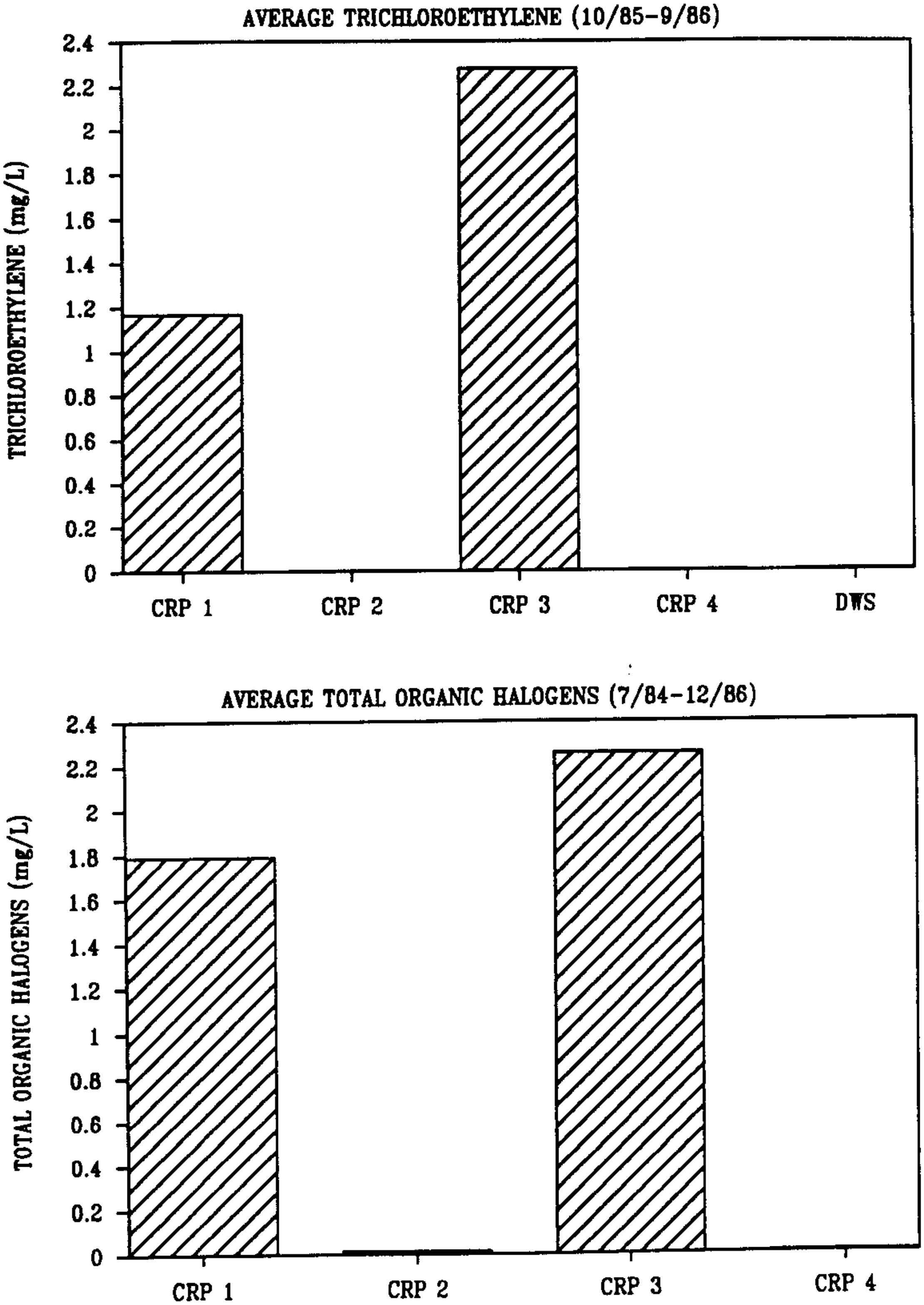


FIGURE 6-14. Average Trichloroethylene and Total Organic Halogens (TOH) in the C-Area Burning/Rubble Pit Wells

SECTION 7 D AREA AND TNX

7.01 GENERAL INFORMATION

7.01.01 General Area Description

D Area is located in the southwest part of SRS as shown in Figure 7-1. Ground surface elevations across D Area range approximately from 100 to 150 ft msl, decreasing to the west-southwest toward the Savannah River. Waste sites at the nearby TNX facility are included in this discussion, and the parameters given for D Area are also applicable to this facility.

There are 14 D-Area waste sites as indicated in Figures 7-2 and 7-3:

L The D-Area Oil Disposal Basin

L The D-Area Coal Pile Runoff Containment Basin

L The D-Area Burning/Rubble Pits (2 pits)

L The TNX Burying Ground

L The TNX Storage Area

L The D-Area Ash Basins (3 basins)

L The New TNX Seepage Basin

L The Old TNX Seepage Basin

L The D-Area Asbestos Pit

L The D-Area Waste Oil Facility (see Section 15)

L The D-Area Rubble Pit (see Section 15)

7.01.02 General Hydrologic Conditions

By the end of 1986, 34 monitoring wells had been installed around the D-Area waste sites to delineate the subsurface conditions and to monitor groundwater quality. Twenty-four of the 34 wells are currently being monitored. The remaining 10 wells have been abandoned, as discussed in the following specific waste-site sections. According to the surface geologic map presented by Siple (1967), the water-table monitoring wells in D Area were installed in the alluvial deposits of Pleistocene age. Section 3 contains detailed information concerning the hydrostratigraphy beneath SRS.

The water-table elevation in D Area has ranged from 130 to 95 ft msl, and the vadose zone has been approximately 5 to 20 ft thick, reflecting the flat nature of the water table in this area. Detailed studies of the hydraulic characteristics of the Pleistocene alluvial sediments have not been conducted. To estimate the horizontal flow velocity of the groundwater beneath the D-Area waste sites, the hydraulic characteristics of the Barnwell Formation were used. Mathematical modeling of the Barnwell Formation in the Separations Areas near the center of the plant indicates that the horizontal groundwater flow velocity ranges approximately from 15 to 60 ft/yr per percent gradient (Duffield et al., 1986; Parizek and Root, 1986). The horizontal flow direction and estimated flow velocity for the water table at each D-Area waste site are discussed in the following specific waste-site sections.

7.01.03 Migration Potential of Dissolved Chemical Constituents from D Area

The potential for any dissolved constituents to be naturally discharged from a waste site to nearby surface water from the groundwater system depends on the location of the waste site, the hydraulic gradient, and the flow path between the waste site and the discharge point. Horizontal and vertical groundwater flow velocities depend upon the medium through which the groundwater travels (i.e., sand, silt, or clay). Similarly, interactions with the soil/sediment medium (retardation) will affect the horizontal and vertical movements of dissolved chemical constituents.

The nearest plant boundary to D Area is the Savannah River, approximately 0.75 mi to the west. Natural discharge of the water table is to the Savannah River and to the nearby Savannah River Swamp. Therefore, any dissolved constituents from D-Area waste sites will migrate through the near-surface groundwater system to surface waters and are unlikely to contaminate offsite groundwaters.

7.02 D-AREA OIL DISPOSAL BASIN

7.02.01 Summary

The D-Area Oil Disposal Basin (Building 631-G) received waste oil products from D-Area operations from 1952 to 1975. In January 1975, the D-Area Oil Disposal Basin was closed and subsequently backfilled. Approximately 1 ft of standing oil remained in the basin when it was backfilled. The D-Area Oil Disposal Basin is currently inactive (Huber et al., 1987b).

The contents and soil/sediments of the D-Area Oil Disposal Basin have not been sampled. Four wells monitor the groundwater at the basin. Prior to the fourth quarter of 1984, well DOB 1 was generally downgradient, well DOB 3 upgradient, and wells DOB 2 and DOB 4 sidegradient relative to the basin. However, in the fourth quarter of 1984 a groundwater flow reversal apparently occurred beneath the D-Area Oil Disposal Basin. Currently, well DOB 1 is predominantly upgradient, well DOB 3 downgradient, and wells DOB 2 and DOB 4 sidegradient.

The monitoring data indicate that the basin has had an influence on groundwater quality in well DOB 1, as evidenced by the elevated conductivity (96 to 350 μmhos/cm) and total organic carbon (TOC) levels (2.00 to 18.2 mg/L) reported for this well compared to the remaining site wells. Conductivity and TOC levels in wells DOB 2 through DOB 4 ranged from 26 to 77 μmhos/cm and from 0.504 to 7.00 mg/L, respectively. Groundwater samples from the four site wells met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for iron in wells DOB 1 through DOB 3 and manganese and trichloroethylene in wells DOB 1 and DOB 2.

7.02.02 Waste-Site Description and Nature of Disposal

The D-Area Oil Disposal Basin (Building 631-G) began receiving waste oil products from D-Area operations in 1952. These products were not burned at the area powerhouse because they may have been contaminated with hydrogen sulfide. The basin also received liquids potentially contaminated with toxic chemicals. In 1973 open burning of waste ceased, and the D-Area Oil Disposal Basin received waste oils that were not acceptable for powerhouse incineration. It is possible that these waste oils contained chlorinated organic compounds and other organics. In January 1975 the D-Area Oil Disposal Basin was closed and backfilled with soil. Approximately 1 ft of standing oil remained in the basin when it was backfilled (Huber et al., 1987b).

The D-Area Oil Disposal Basin is approximately 3,000 ft north of D Area and directly south of SRS Road A-4.4. The basin measured approximately 383 ft in length by 54 ft in width by 7 ft in depth, with an approximate maximum storage capacity of 145,000 ft^3 (1.1 million gal). The ground surface elevation at the site is approximately 150 ft msl (Figure 7-3). Surface drainage is to the southwest toward a tributary of the Savannah River, approximately 1.3 mi from the site.

The D-Area Oil Disposal Basin is currently inactive. The site is covered with natural vegetation, including grass and bushes.

7.02.03 Groundwater Monitoring Program

Four wells (DOB 1 through DOB 4) were installed to monitor the water-table elevation and groundwater quality at the D-Area Oil Disposal Basin (Figure 7-4). Wells DOB 1, DOB 2, and DOB 3 were installed in May 1983, and well DOB 4 was installed in June 1984. All four wells were constructed using PVC casings and 30-ft screens.

Wells DOB 1 through DOB 3 were included in the SRS quarterly groundwater monitoring program in the first quarter of 1984, and well DOB 4 was included in the second quarter of 1984. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

7.02.04 Site-Specific Hydrology

Measurements obtained from the D-Area Oil Disposal Basin wells since March 1984 indicate that the water-table elevation has ranged from 146 to 139 ft msl and that the vadose zone has been approximately 5 to 10 ft thick. A hydrograph for the D-Area Oil Disposal Basin wells is presented in Figure 7-5. Water-table elevation contour maps for the second quarters of 1986 and 1984 (Figures 7-4 and 7-6) illustrate that the flow direction of the water table has been variable. Since the last quarter of 1984 the flow has generally been to the north, as shown in Figure 7-4. The hydraulic gradient since 1984 has been very low, ranging approximately from 0.002 to 0.003 ft/ft. Because of the flat nature of the water table, changes in flow direction have occurred with minor fluctuations of the water table. In general, since the last quarter of 1984 well DOB 1 has remained upgradient of the basin, despite the proximity of the tributary to the south. Using a groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of 15 to 60 ft/yr per percent gradient, the near-surface groundwater flow velocity beneath the basin has ranged approximately from 3 to 18 ft/yr.

7.02.05 Basin Content Characterization Data

The contents of the D-Area Oil Disposal Basin have not been sampled. Section 7.02.02 contains information concerning the nature of materials disposed to the basin.

7.02.06 Soil/Sediment Characterization Data

The D-Area Oil Disposal Basin soil/sediments have not been sampled.

7.02.07 Groundwater Monitoring Results

Groundwater monitoring data from 1984 through 1986 are presented in Appendix E. Groundwater chemical characterization data since July 1984 are summarized in Table 7-1.

Comparisons of groundwater monitoring data among the D-Area Oil Disposal Basin wells were used to evaluate the effect of the basin on the groundwater. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. The indicator parameters most likely to show the effect of the basin are conductivity, total organic carbon (TOC), and total organic halogens (TOH).

The water table beneath the D-Area Oil Basin has been relatively flat, and, as a result, changes in flow direction have occurred. Since the fourth quarter of 1984, well DOB 1 has been upgradient of the basin. Prior to that date, however, it was downgradient of the basin.

The monitoring data summarized in Table 7-1 indicate that the D-Area Oil Disposal Basin has had an influence on groundwater quality in well DOB 1, as indicated by the elevated conductivity and TOC levels reported for well DOB 1 compared to the levels reported for the other site wells. Conductivity in well DOB 1 ranged from 96 to 350 µmhos/cm. These conductivity values were consistently higher than the conductivity levels reported for wells DOB 2 through DOB 4 (26 to 77 µmhos/cm). TOC levels in well DOB 1 (2.00 to 18.2 mg/L) were generally higher than the TOC levels reported for wells DOB 2 through DOB 4 (below 8.0 mg/L). Figure 7-7 illustrates the relative differences in conductivity and TOC levels between well DOB 1 and the other site wells. TOH levels in well DOB 1 (<0.005 to 0.035 mg/L) were consistent with the levels reported for the remaining site wells (<0.005 to 0.053 mg/L).

Groundwater samples from all four site wells met South Carolina and federal primary and secondary drinking water standards except for iron excursions in wells DOB 1, DOB 2, and DOB 3 and manganese and trichloroethylene excursions in wells DOB 1 and DOB 2. Iron concentrations in wells DOB 1 (0.017 to 0.554 mg/L), DOB 2 (0.076 to 0.982 mg/L), and DOB 3 (0.017 to 0.848 mg/L) ranged above the drinking water standard of 0.3 mg/L. Iron levels as high as 0.52 mg/L are generally consistent with iron levels reported as naturally occurring in Barnwell Formation groundwater (Appendix B). Manganese levels in wells DOB 1 (0.003 to 0.074 mg/L) and DOB 2 (0.009 to 0.053 mg/L) ranged above the drinking water standard of 0.05 mg/L in an isolated occurrence for each well. Manganese is not known to be related to past site activities. Trichloroethylene concentrations in wells DOB 1 (0.009 mg/L) and DOB 2 (0.037 mg/L) were over the drinking water standard of 0.005 mg/L in October 1986. Tetrachloroethylene concentrations were elevated in well DOB 1 (0.012 mg/L). Chlorinated organic compounds are related to past site activities.

Groundwater pH ranged from 4.2 to 6.6 in the site wells. This pH range is generally consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

7.02.08 Planned Action

The D-Area Oil Basin is inactive. As indicated in Section 16, a site assessment is planned for 1988 from which a closure plan will be developed. Groundwater monitoring will continue at this site.

7.03 D-AREA COAL PILE RUNOFF CONTAINMENT BASIN

7.03.01 Summary

The D-Area Coal Pile Runoff Containment Basin (Building 489-D) receives runoff from the D-Area coal storage pile (Christensen and Gordon, 1983). The groundwater monitoring data indicate that seepage from the D-Area Coal Pile Runoff Containment Basin (CPRB) has influenced groundwater quality near downgradient wells DCB 4A and DCB 5A. The monitoring data also suggest that the D-Area coal storage pile has affected groundwater quality near well DCB 1A, which is approximately 200 ft directly downgradient of the coal storage pile and side-to-downgradient relative to the CPRB. Coal pile runoff does not seem to have had a notable effect on groundwater in side-to-downgradient well DCB 3A and upgradient well DCB 2A.

7.03.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses. The D-Area coal supply is stored in an open pile. The coal is generally moderate-to-low sulfur coal (1-2%) received by rail from Kentucky, Pennsylvania, and Virginia. Coal is placed on a hopper, sprayed with water to control coal dust, and loaded onto a pile at the D-Area facility (Christensen and Gordon, 1983).

The facility generally contains a 90-day reserve of coal. The coal pile is not rotated, resulting in long-term exposure of the unused coal to the environment. Weathering allows for the formation of sulfuric acid caused by the oxidation of sulfur materials in the coal. Rainfall washes the acid from the coal pile into the coal pile runoff containment basins via gravity flow ditches and sewers.

Prior to the construction of the coal pile runoff containment basins, runoff from the coal storage piles flowed to nearby surface water streams onsite. The National Pollutant Discharge Elimination System (NPDES) permit issued in 1977 specifies limits on pH and suspended solids for coal pile runoff up to the maximum 24-hr, 10-yr recurrence event (5.9 in. for SRS). Suspended solids are limited to 50 mg/L, and pH is limited to between 6 and 9. To achieve compliance, the D-Area Coal Pile Runoff Containment Basin (CPRB) was constructed in 1981 to contain coal pile runoff and prevent direct discharge to a small, unnamed tributary of Four Mile Creek. This containment basin allows for the passive equalization of runoff prior to seepage into the subsurface where it can undergo natural renovation. There has been minimal discharge from the D-Area CPRB to the Four Mile Creek tributary.

The D-Area CPRB (Building 489-D) is on a Savannah River terrace where ground surface elevations range approximately from 120 to 135 ft msl (Figure 7-8). Surface drainage is to the west toward a small, unnamed tributary of Four Mile Creek.

The D-Area CPRB is approximately 100 ft south of the coal storage pile area and 6,000 ft east of the Savannah River, the nearest plant boundary. Covering approximately 12.5 acres, the basin provides a maximum containment capacity of about 1,360,000 ft^3 (10.2 million gal). The basin bottom slopes to the south, causing the northern end usually to be dry. The coal pile that drains to this basin typically contains approximately 144,000 tons of moderate-to-low sulfur coal (1-2%) and covers 8.9 acres.

Coal pile runoff samples were collected on October 2, 1985, to characterize the D-Area CPRB influent and to establish indicator parameters for identifying the effects of the D-Area CPRB on the groundwater. The first individual grab sample was collected 15 to 30 min after the beginning of a storm and the second several hours after the end of the storm. In addition, a composite sample was taken during the entire period between the two individual sampling times.

The D-Area CPRB influent characterization data are presented in Table 7-2. These analytical results indicate that the dissolved metal concentrations were low except for cadmium and chromium. Elevated levels of conductivity, total dissolved solids (TDS), iron, and sulfate and low pH are typical of coal pile runoff and are the indicator parameters used to assess the effect of the basin on groundwater. Basin influent samples were not filtered prior to analysis and may have contained insoluble, particulate matter.

7.03.03 Groundwater Monitoring Program

Ten wells (DCB Series) have been installed to monitor the water-table elevation and groundwater quality at the D-Area CPRB. Wells DCB 1 through DCB 5 were installed in April 1980 using galvanized steel casings. Wells DCB 1 through DCB 4 were installed with 20-ft screens; well DCB 5 had a 15.4-ft screen. Because of possible water-quality interferences from the galvanized steel, these wells were abandoned and replaced by wells DCB 1A through DCB 5A in March 1984 (Figure 7-8). The replacement wells were constructed using PVC casings and 30-ft screens.

In 1982, a quarterly groundwater monitoring program was initiated at SRS. Monitoring and sampling of wells DCB 1 through DCB 5 began in April 1982. Monitoring and sampling of wells DCB 1A through DCB 5A began in May 1984. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

7.03.04 Site-Specific Hydrology

Measurements obtained from the D-Area CPRB wells since 1982 indicate that the water-table elevation has been about 127 to 114 ft msl and that the vadose zone has been approximately 7 ft thick. A hydrograph for the D-Area CPRB wells is presented in Figure 7-9. A water-table elevation contour map for the first quarter of 1986 (Figure 7-8) shows that the groundwater flow was to the south-southwest, consistent with local topography. The hydrograph indicates that this has been the predominant flow direction, with wells DCB 4A and DCB 5A downgradient, wells DCB 3A and DCB 1A sidegradient, and well DCB 2A upgradient of the basin. Fluctuations in water levels indicate that minor changes in flow direction and gradient have occurred.

The approximate hydraulic gradient of the water table beneath the basin has been approximately 0.01 ft/ft. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of approximately 15 to 60 ft/yr per percent gradient, the horizontal near-surface groundwater flow velocity beneath the basin has ranged approximately from 15 to 60 ft/yr.

7.03.05 Waste-Site Content Characterization Data

The contents of the D-Area CPRB have not been sampled. Section 7.03.02 contains information on the basin influent characterization data.

7.03.06 Soil/Sediment Characterization Data

The D-Area CPRB soil/sediments have not been sampled.

7.03.07 Groundwater Monitoring Results

The groundwater monitoring results from 1982 through 1986 are included in Appendix E. Groundwater chemical characterization data since July 1984 are summarized in Table 7-3.

Groundwater monitoring well locations relative to the D-Area CPRB and the predominant near-surface groundwater flow direction are presented in Figure 7-8. As discussed in Section 7.03.04 and illustrated in Figures 7-8 and 7-9, well DCB 2A has maintained an upgradient position, and wells DCB 4A and DCB 5A have remained downgradient with respect to the basin. Wells DCB 1A and DCB 3A have been side-to-downgradient relative to the D-Area CPRB.

A comparison of the monitoring data between upgradient well DCB 2A and the other D-Area CPRB wells was used to evaluate the effect of the basin on the groundwater. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters for the site are pH, sulfate, iron, conductivity, and total dissolved solids (TDS).

The groundwater data summarized in Table 7-3 show that the indicator parameter concentrations in downgradient wells DCB 4A and DCB 5A generally have been higher than those in upgradient well DCB 2A. Conductivity levels in downgradient wells DCB 4A (118 to 741 µmhos/cm) and DCB 5A (235 to 525 µmhos/cm) were consistently higher than the levels reported for upgradient well DCB 2A (38 to 58 µmhos/cm). Similarly, TDS concentrations in downgradient wells DCB 4A (392 to 414 mg/L) and DCB 5A (302 to 342 mg/L) have been greater than the TDS levels reported for the upgradient well (30 to 82 mg/L). Sulfate and iron concentrations also have been higher in the downgradient wells than in the upgradient well. Sulfate levels ranged from 127 to 290 mg/L in well DCB 4A and from 95.0 to 243 mg/L in downgradient well DCB 5A, while sulfate levels remained below 8.0 mg/L in background well DCB 2A. Iron levels ranged from 0.049 to 0.460 mg/L in downgradient well DCB 4A, from 0.416 to 3.83 mg/L in downgradient well DCB 5A, and from <0.004 to 0.394 mg/L in upgradient well DCB 2A.

Figures 7-10 through 7-12 illustrate more clearly the relative differences in average indicator parameter concentrations among the directly downgradient wells and the upgradient well. Although Figures 7-10 and 7-11 indicate that seepage from the D-Area CPRB has been influencing groundwater quality in downgradient wells DCB 4A and DCB 5A, they also show that average dissolved chemical constituent levels in these wells have remained low compared to South Carolina and federal primary and secondary drinking water standards. Figures 7-10 and 7-11 show that the average TDS and sulfate concentrations in downgradient wells DCB 4A and DCB 5A met the secondary drinking water standards of 500 mg/L and 250 mg/L, respectively. The average iron concentration in well DCB 4A also met the secondary drinking water standard (0.3 mg/L), although average iron levels in well DCB 5A exceeded this level.

Groundwater pH in wells DCB 2A, DCB 4A, and DCB 5A consistently ranged between 4.0 and 6.0. Figure 7-12 illustrates the relative similarity in groundwater pH among these three wells. Naturally acidic conditions, with pH values as low as 4.0, are characteristic of groundwater from the Barnwell Formation (Appendix B). Indicator parameter concentrations in upgradient well DCB 2A have remained consistently low for the period of record. In wells DCB 4A and DCB 5A, indicator parameter levels were equivalent to levels reported in the upgradient well until August 1984, after which time they consistently have remained higher, as discussed above. Manganese levels (up to 1.09 mg/L) in these three wells have exceeded the drinking water standard of 0.05 mg/L. Total radium in well DCB 4A (4.0 to 8.0 pCi/L) exceeded the drinking water standard of 5 pCi/L. Radioactivity is not known to be related to past site activities.

Groundwater from well DCB 3A, which is sidegradient relative to the basin, has been characterized by low indicator parameter levels compared to South Carolina and federal primary drinking water standards, as reflected by the low TDS levels (22 to 50 mg/L) compared to the secondary drinking water standard of 500 mg/L. Likewise, conductivity has been low, ranging from 55 to 83 µmhos/cm. Sulfate (below 35 mg/L) and iron (0.043 to 0.070 mg/L) levels also have remained consistently low compared to drinking water standards. Groundwater pH ranged between 4.3 and 5.0, which is consistent with naturally occurring pH levels reported for groundwater in the Barnwell Formation (Appendix B). Manganese levels (0.072 to 0.178 mg/L) consistently exceeded the drinking water standard of 0.05 mg/L.

A comparison of monitoring data between upgradient well DCB 2A and sidegradient well DCB 3A shows that the indicator parameter and dissolved chemical constituent concentrations from these wells have been similar. Figures 7-10 through 7-12 illustrate more clearly the relative similarities in average indicator parameter concentrations between these two wells. The low dissolved chemical constituent levels reported for well DCB 3A, in addition to the relative similarities in water quality between this well and upgradient well DCB 2A, indicate that groundwater near this well has not been influenced by coal pile runoff. Indicator parameter concentrations in well DCB 3A have not shown any consistent increasing or decreasing trends over the period of monitoring.

The monitoring data show that indicator parameter concentrations have been much higher in well DCB 1A compared to both drinking water standards and the other D-Area CPRB wells. Reported TDS concentrations for well DCB 1A (5,638 to 11,048 mg/L) have been consistently above the secondary drinking water standard of 500 mg/L. Likewise, the sulfate (480 to 7,486 mg/L) and iron (101 to 986 mg/L) levels in well DCB 1A did not meet the drinking water standards of 250 mg/L and 0.3 mg/L, respectively. Other parameters in well DCB 1A that have not met drinking water standards since the third quarter of 1984 are cadmium (0.020 to 0.046 mg/L), copper (0.674 to 1.57 mg/L), lead (<0.050 to 0.196 mg/L), zinc (5.56 to 12.1 mg/L), gross alpha (12.0 to 95.0 pCi/L), chromium (0.124 to 0.232 mg/L), manganese (22.6 to 40.2 mg/L), selenium (<0.001 to 0.021 mg/L), fluoride (1.05 to 2.45 mg/L), total radium (7.0 to 39.0 pCi/L), and trichloroethylene (0.088 mg/L).

Conductivity in well DCB 1A has been high relative to the other D-Area CPRB wells, ranging from 3,420 to 7,700 µmhos/cm, and groundwater pH has remained low (2.2 to 2.8). Figures 7-10 through 7-12 show more clearly the differences in dissolved chemical constituent levels between well DCB 1A and the other D-Area CPRB wells.

As Figure 7-8 indicates, well DCB 1A is approximately 200 ft hydraulically downgradient of the D-Area coal storage pile and about 20 ft north of the D-Area CPRB in a side-to-downgradient direction. The elevated coal pile runoff indicator parameter concentrations reported for well DCB 1A relative to the directly downgradient D-Area CPRB wells and the fact that this well is not directly downgradient of the basin indicate that the coal storage pile is influencing groundwater quality near well DCB 1A. Direct coal pile runoff effect is further evidenced by reports that the northern portion of the D-Area CPRB has remained essentially dry for the period of monitoring and by the relatively low water-table elevation of 4 to 7 ft below ground level near well DCB 1A. Indicator parameter concentrations in well DCB 1A have been consistently elevated and have not shown any increasing or decreasing trends over the period of monitoring.

Organics concentrations detected in wells DCB 2A, DCB 3A, DCB 4A, and DCB 5A have been relatively low, as indicated by the levels of dissolved organic carbon (DOC; below 8.0 mg/L), TOC (below 3.0 mg/L), TOH (below 0.045 mg/L), phenols (below 0.012 mg/L), and GC Scan (below 45 μg/L). Organic concentrations in well DCB 1A have been generally low, as indicated by the levels of DOC (7.9 to 12.0 mg/L), TOC (5.00 to 14.0 mg/L), phenols (<0.002 to 0.003 mg/L), and GC Scan (below 100 μg/L). However, trichloroethylene levels (up to 0.088 mg/L) have been above the drinking water standard (0.005 mg/L) in wells DCB 1A, DCB 3A, and DCB 5A. Extractable pesticide concentrations in all D-Area CPRB wells were below detection limits.

7.03.08 Planned Action

The D-Area CPRB is active, and continued use is planned. As indicated in Section 16, a site assessment is being conducted. Groundwater monitoring will continue at this site, and additional groundwater monitoring wells are scheduled for installation in 1988.

7.04 D-AREA BURNING/RUBBLE PITS

7.04.01 Summary

Burnable wastes such as paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents were received and incinerated in the D-Area Burning/Rubble Pits (Buildings 431-D and 431-1D) from 1951 to 1973, at which time the pits were covered with a layer of soil. Rubble wastes (including concrete, scrap metal, lumber, and telephone poles) were then disposed in the pits until 1978, when they reached capacity and were capped with soil. The site is currently inactive (Huber et al., 1987c).

The waste-site contents and soil/sediments have not been sampled at the D-Area Burning/Rubble Pits. The groundwater monitoring data indicate that the D-Area Burning/Rubble Pits have affected groundwater quality near downgradient well DBP 2 and sidegradient well DBP 4. A comparison of the monitoring results among the site wells indicates elevated levels of conductivity, iron, manganese, sulfate, lead, and total organic halogens (TOH) in these wells.

7.04.02 Waste-Site Description and Nature of Disposal

The D-Area Burning/Rubble Pits (Buildings 431-D and 431-1D) were constructed in 1951 to collect burnable wastes generated at the plant. The burnable wastes collected for monthly incineration at the D-Area pits included paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents. Disposal of chemically contaminated oils was not allowed at the D-Area Burning/Rubble Pits (Huber et al., 1987c).

In 1973 the plantwide procedure of burning waste ceased, and the D-Area Burning/Rubble Pits were converted to receive only rubble by placing a layer of soil over the incinerated waste. Rubble waste disposed in the pit included concrete, scrap metal, lumber, and telephone poles. Rubble disposal continued until 1978, when the pits reached capacity and were covered with a final layer of soil (Huber et al., 1987c).

The D-Area Burning/Rubble Pits are west of the D-Area perimeter fence on a south-trending slope, where ground surface elevations range from 124 to 134 ft msl (Figure 7-13). Surface drainage is to the west and south toward a tributary of the Savannah River. The pits had approximate dimensions of 50 ft wide by 272 ft long by 10 ft deep (Building 431-D) and 38 ft wide by 242 ft long by 10 ft deep (Building 431-1D) at the time of construction. The original combined capacity of the pits was approximately 228,000 ft^3.

7.04.03 Groundwater Monitoring Program

Four wells (DBP 1 through DBP 4) were installed to monitor the water-table elevation and groundwater quality at the D-Area Burning/Rubble Pits (Figure 7-13). Wells DBP 1 through DBP 3 were installed in September 1983, and well DBP 4 was installed in June 1984. The site wells were constructed using PVC casings and 30-ft screens.

Wells DBP 1 through DBP 3 were included in the SRS quarterly groundwater monitoring program beginning in the second quarter of 1984. Sampling began in the first quarter of 1985 for well DBP 4. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

7.04.04 Site-Specific Hydrology

Measurements obtained from the D-Area Burning/Rubble Pits wells since March 1984 indicate that the water-table elevation has been approximately 123 to 114 ft msl and that the vadose zone has been approximately 10 ft thick. A hydrograph of the D-Area Burning/Rubble Pits monitoring wells is presented in Figure 7-14.

A water-table elevation contour map for the first quarter of 1986 indicates that the near-surface groundwater flow direction was to the southeast (Figure 7-13). The hydrograph indicates that this has been the general flow direction, although minor changes in flow direction and gradient have occurred. Wells DBP 1 and DBP 3 have remained upgradient of the pits, well DBP 4 sidegradient, and well DBP 2 downgradient. Well DBP 4 is located between the Burning/Rubble Pits and a tributary to the Savannah River. Because of the shallow depth to the water table (10 ft), the water-table flow direction may be from the pit toward this tributary, especially during periods of recharge. This flow direction would place well DBP 4 directly downgradient of the pits.

The hydraulic gradient in the direction of flow indicated in Figure 7-13 has been approximately 0.01 ft/ft. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of between 15 and 60 ft/yr per percent gradient, the near-surface groundwater flow velocity beneath the D-Area Burning/Rubble Pits has ranged approximately from 15 to 60 ft/yr.

7.04.05 Waste-Site Content Characterization Data

The contents of the D-Area Burning/Rubble Pits have not been sampled. Section 7.04.02 contains information on the materials incinerated and disposed at the waste site.

7.04.06 Soil/Sediment Characterization Data

Soil/sediments from the D-Area Burning/Rubble Pits have not been sampled.

7.04.07 Groundwater Monitoring Results

The groundwater monitoring data from 1984 through 1986 are given in Appendix E. Groundwater chemical characterization data since July 1984 are summarized in Table 7-4.

Comparisons of groundwater monitoring data among the D-Area Burning/ Rubble Pits wells were used to evaluate the effect of the pits on the groundwater. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Based on the site waste inventory (Section 7.04.02), the indicator parameters most likely to show the effect of the pits are conductivity, total organic carbon (TOC), and total organic halogens (TOH).

The groundwater monitoring data summarized in Table 7-4 indicate that the D-Area Burning/Rubble Pits have been affecting groundwater quality in downgradient well DBP 2 and sidegradient well DBP 4. A comparison of the monitoring results among the site wells indicates elevated levels of conductivity, iron, manganese, sulfate, lead, and TOH in these wells.

Groundwater quality in upgradient wells DBP 1 and DBP 3 has been characterized by low dissolved chemical constituent levels compared to South Carolina and federal drinking water standards except for an excursion of trichloroethylene (0.014 mg/L) in well DBP 1. Average conductivity levels in upgradient wells DBP 1 (54.1 μmhos/cm) and DBP 3 (50.1 μmhos/cm) was low. TOC and TOH levels in the upgradient wells remained below 4.00 mg/L and 0.025 mg/L, respectively, over the monitoring period.

Groundwater quality in the vicinity of downgradient well DBP 2 and sidegradient well DBP 4 apparently has been influenced by the D-Area Burning/Rubble Pits. Conductivity levels in downgradient well DBP 2 (96 to 930 μmhos/cm) and sidegradient well DBP 4 (89 to 217 μmhos/cm) were elevated compared to the conductivity values reported for the upgradient wells (34 to 78 μmhos/cm). Figure 7-15 illustrates the relative differences in average conductivity levels among the upgradient wells and wells DBP 2 and DBP 4.

Iron levels in downgradient well DBP 2 (0.120 to 0.458 mg/L) and sidegradient well DBP 4 (0.026 to 0.317 mg/L) ranged above the drinking water standard of 0.3 mg/L. Although iron in these ranges is consistent with iron values as high as 0.52 mg/L reported as naturally occurring in Barnwell Formation groundwater (Appendix B), iron levels in the upgradient wells (0.029 to 0.116 mg/L) remained below the drinking water standard of 0.3 mg/L. Manganese levels in downgradient well DBP 2 (0.059 to 0.164 mg/L) and sidegradient well DBP 4 (0.387 to 2.26 mg/L) were above the drinking water standard of 0.05 mg/L and the manganese levels reported for the upgradient wells (0.008 to 0.031 mg/L). Figure 7-15 illustrates the relative differences in manganese levels among the upgradient wells and wells DBP 2 and DBP 4. As shown in Figure 7-16, sulfate levels in downgradient well DBP 2 (7.0 to 61.0 mg/L) and sidegradient well DBP 4 (28.0 to 112 mg/L) were elevated compared to the levels reported for the upgradient wells (<5.0 to 9.0 mg/L), although they remained below the drinking water standard of 250 mg/L. Lead in sidegradient well DBP 4 (0.009 to 0.066 mg/L) was over the drinking water standard of 0.05 mg/L in an isolated excursion.

Although well DBP 4 is sidegradient relative to the pits, the close proximity of well DBP 4 to the pits (less than 30 ft) and the fact that this well may temporarily be downgradient of the pits following periods of recharge (see Section 7.04.04) indicates that the pits have been influencing groundwater quality in well DBP 4.

TOH levels in downgradient well DBP 2 (0.019 to 0.035 mg/L) were higher than the TOH levels reported for the other site wells (<0.005 to 0.023 mg/L). The relative differences in TOH levels between downgradient well DBP 2 and the other site wells is illustrated in Figure 7-16. As discussed in Section 7.04.02, organic halogens are related to past site activities. TOC concentrations in all four site wells remained below 7.0 mg/L over the monitoring period.

Groundwater pH in the four site wells ranged from 3.5 to 5.2; pH levels as low as 4.0 are generally consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

7.04.08 Planned Action

The D-Area Burning/Rubble Pits are inactive. As indicated in Section 16, a site assessment is under way, from which a closure plan will be developed. Groundwater monitoring will continue at this site.

7.05 TNX BURYING GROUND

7.05.01 Summary

The TNX Burying Ground (Building 643-5T) contained waste buried in 1953, consisting of conduit, drums, steel, tin, and depleted uranium. From 1980 to 1984, the majority of the materials disposed at this site were removed to the Radioactive Waste Burial Grounds (Building 643-7G). An estimated 60 lb of uranyl nitrate remains buried at the site. The site is currently buried beneath asphalt, buildings, and transformer pads (Dunaway et al., 1987b). Groundwater monitoring and soil/sediment characterization have not been conducted at this site.

7.05.02 Waste-Site Description and Nature of Disposal

An experimental evaporator containing approximately 1,300 lb of uranyl nitrate exploded at the TNX facility in 1953. Debris (including conduit, drums, tin, structural steel, and depleted uranium) was buried at the TNX Burying Ground (Building 643-5T) because the Radioactive Waste Burial Ground (Building 643-G) was not yet in operation. No material was buried at the site after the Radioactive Waste Burial Ground became operational later in 1953. Most of the buried material at the TNX Burying Ground was excavated and sent to the New Burial Ground (Building 643-7G) from 1980 to 1984. An estimated 60 lb (5% of the initial inventory) of uranyl nitrate remains buried at the TNX Burying Ground (Dunaway et al., 1987b).

The remaining buried waste lies in three known burial sites and one suspected burial site. The three known sites are a trapezoidal area

(840 ft^2) beneath the transformer pad near Building 673-T, a rectangular area (325 ft^2) beneath Building 711-T, and an L-shaped area (2,800 ft^2) beneath an office trailer (Building 676-8T). A fourth suspected burial site is east of Building 673-T. The nearest plant boundary to the TNX Burying Ground is the Savannah River, approximately 0.25 mi to the west. The general location of the TNX Burying Ground is shown in Figure 7-3.

7.05.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the TNX Burying Ground.

7.05.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the TNX Burying Ground; therefore, near-surface groundwater conditions beneath the site are undefined.

7.05.05 Waste-Site Content Characterization Data

The contents of the TNX Burying Ground have not been sampled. Section 7.05.02 contains information on the nature of the materials disposed at the site.

7.05.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been performed at the TNX Burying Ground.

7.05.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted near the TNX Burying Ground.

7.05.08 Planned Action

The TNX Burying Ground is inactive. As indicated in Section 16, a site assessment is planned for 1988, from which a closure plan will be developed. Groundwater monitoring wells are scheduled for installation in 1988.

7.06 TNX STORAGE AREA

7.06.01 Summary

The TNX Storage Area is not a waste site but has been used for the storage of miscellaneous chemicals produced in Defense Waste Processing Facility (DWPF) experiments from 1977 to the present. There have been no recorded spills at the site (Christensen and Gordon, 1983). Groundwater monitoring and soil/sediment characterization have not been conducted at this site.

7.06.02 Waste-Site Description and Nature of Disposal

Excess simulated sludge, simulated salt solution, glass frit, and miscellaneous chemicals produced in Defense Waste Processing Facility (DWPF) experiments were stored in drums on pallets in the TNX Storage Area beginning in 1977 (Christensen and Gordon, 1983). In April 1982 an inventory of materials stored at the TNX Storage Area was prepared, as presented in Table 7-5.

Waste oils stored at the TNX Storage Area were transported to D Area for burning, and simulated salt solutions (supernate) were removed by the Savannah River Laboratory (SRL) for use in research. Hazardous materials were transported to the SRS Hazardous Waste Storage Facility (Building 710-U). SRS policy requires that used oils be analyzed for polychlorinated biphenyls (PCBs) prior to burning in the D-Area boilers. Waste oils from the TNX Storage Area were tested in June 1982 and found to be free of PCBs, with the exception of one drum containing 868 mg/L of PCBs. This drum was transported to salvage for proper disposal off-site (Christensen and Gordon, 1983). Table 7-6 summarizes the materials that were removed from the TNX Storage Area after the April 1982 inventory was taken.

In November 1982 another inventory of materials stored at TNX was prepared (Table 7-7). Calcine and frit continue to be stored at this site. Calcine is a brown metal oxide powder used to simulate waste tank sludge; frit is a white powdered borosilicate glass. The chemical components of each are given in Table 7-8.

A new section of the storage area was opened in 1982. This new TNX Storage Area is also within the TNX fence line and adjacent to the old storage area. Materials are stored in drums on pallets, which rest on crushed rock. Only nonhazardous materials are presently stored at the site, and no spills have been recorded (Christensen and Gordon, 1983). The general location of the TNX Storage Area is shown in Figure 7-3.

7.06.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the TNX Storage Area.

7.06.04 Site-Specific Hydrology

Groundwater monitoring wells have not been installed at the TNX Storage Area; therefore, near-surface groundwater conditions beneath the storage area are undefined.

7.06.05 Waste-Site Content Characterization Data

Sampling and analysis of the TNX Storage Area contents have not been conducted. Section 7.06.02 contains information on the nature of the materials stored at the site.

7.06.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the TNX Storage Area.

7.06.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the TNX Storage Area.

7.06.08 Planned Action

The TNX Storage Area is closed, and no action is planned for this site.

7.07 D-AREA ASH BASINS

7.07.01 Summary

The three D-Area Ash Basins (Buildings 488-D, 488-1D, and 488-2D) have received ash sluice water from the D-Area powerhouse since plant startup in 1951. The annual ash disposal rate into the D-Area Ash Basins was approximately 50,000 yd^3/yr from 1951 until 1983. The ash disposal rate into the D-Area Ash Basins has been 65,000 yd^3/yr since 1983 (Christensen and Gordon, 1983). All three D-Area Ash Basins are active and receiving ash sluice water.

7.07.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses, which produces dry ash. Ash sluice water from the D-Area powerhouse has been discharged to the D-Area Ash Basins since plant startup in 1951. The annual ash disposal rate into the D-Area Ash Basins was approximately 50,000 yd^3/yr until 1983 and has been approximately 65,000 yd^3/yr since 1983 (Christensen and Gordon, 1983).

The D-Area Ash Basins (Buildings 488-D, 488-1D, and 488-2D) are southwest of the D-Area perimeter fence on a west-trending slope (Figure 7-2). The ground surface elevation at the basins is about 128 ft msl. The nearest plant boundary to the D-Area Ash Basins is the Savannah River, approximately 0.7 mi to the west.

Ash sluice water contains fly and bottom ash. Horton, Dorsett, and Cooper conducted a study in 1977 to identify trace metals present in the fly and bottom ash disposed to the SRS ash basins and piles. Table 7-9 lists typical trace metal concentrations obtained for fly and bottom ash. These results indicate elevated levels of barium, strontium, manganese, zinc, vanadium, cerium, and chromium (Horton et al., 1977).

7.07.03 Groundwater Monitoring Program

Groundwater monitoring has not been performed at the D-Area Ash Basins.

7.07.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the D-Area Ash Basins; therefore, near-surface groundwater conditions beneath the waste site are undefined.

7.07.05 Waste-Site Content Characterization Data

The contents of the D-Area Ash Basins have not been sampled. Section 7.07.02 contains information concerning the nature of materials disposed to the basins.

7.07.06 Soil/Sediment Characterization Data

D-Area Ash Basin sludge was sampled in 1980. The results of Extraction Procedure (EP) toxicity tests performed on the basin sludge are presented in Table 7-10. These data show that extractable metal concentrations in the D-Area Ash Basin soil/sediments were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

7.07.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the D-Area Ash Basins.

7.07.08 Planned Action

The D-Area Ash Basins are active, and continued use is planned. No additional action is scheduled for this site.

7.08 NEW TNX SEEPAGE BASIN

7.08.01 Summary

The New TNX Seepage Basin (Building 904-102T) is in the southeast part of the TNX facility and receives waste discharges from pilot-scale processing tests conducted in the Defense Waste Processing Facility (DWPF) and from the plant Separations Areas. The basin has been in operation since 1980 and has received simulated, nonradioactive DWPF sludge, simulated, nonradioactive salt supernate, glass frit, other processing chemicals, and laboratory sink discharges (Dunaway et al., 1987a).

Six basin soil/sediment samples were taken during the last quarter of 1985. Aluminum, iron, sodium, arsenic, boron, beryllium, barium, chloride, chromium, copper, cyanide, fluoride, magnesium, manganese, ammonia, nitrate, nitrite, and sulfide concentrations were found above background levels. Not all elevated parameters were detected in all sediment samples. Extraction Procedure (EP) toxicity tests performed on the basin soil/sediment samples indicated extractable metal and organic levels less than 1% of Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

Discharges to the basin consist mainly of DWPF simulated sludge and salt supernate, the main constituents of which are iron hydroxide and sodium nitrate. Because of the insolubility of iron hydroxide and the solubility of sodium nitrate in water, the indicator parameters most likely to show the effect of the New TNX Seepage Basin are conductivity, sodium, and nitrate. The monitoring data indicate that the New TNX Seepage Basin has influenced groundwater quality in the vicinity of side-to-downgradient well YSB 3A and downgradient well YSB 4A, as evidenced by the elevated levels of conductivity, sodium, and nitrate reported for these two wells compared to upgradient well YSB 2A. Groundwater samples from the four site wells met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for a single excursion of gross alpha in well YSB 1A, total radium in well YSB 4A, iron in wells YSB 1A and YSB 4A, and nitrate in well YSB 3A.

7.08.02 Waste-Site Description and Nature of Disposal

The New TNX Seepage Basin (Building 904-102T) receives waste discharges from the pilot-scale chemical processing tests at the Defense Waste Processing Facilities (DWPF) and from the plant Separations Areas.

The New TNX Seepage Basin has been in operation since 1980 and is expected to remain in operation until the TNX Effluent Treatment Plant (ETP) begins operation.

The New TNX Seepage Basin is in the southeast section of the TNX facility at a surface elevation of about 145 ft msl (Figure 7-17). The basin consists of a small inlet section (6,880 ft^3) and a large seepage section (69,690 ft^3). An 8-in.-diameter underground vitrified pipe connects the southeast side of the inlet section to the northwest side of the seepage section. The large seepage section has an overflow pipe in its southeast wall that directs any basin overflow to a ditch that carries water from the D-Area sewage treatment plant.

From 1980 to 1983, simulated, nonradioactive DWPF sludge and simulated, nonradioactive salt supernate were the main waste constituents discharged to the basin. Since 1983, DWPF sludge has been the major component of the wastewater sent to the basin. The composition of the DWPF sludge and the salt supernate are given in Tables 7-11 and 7-12, respectively. In addition to the sludge and supernate, small amounts of glass frit and laboratory sink discharges were also sent to the basin along with other processing chemicals. Batch discharges to the New TNX Seepage Basin are neutralized prior to their release to the basin (Dunaway et al., 1987a).

A 12-week characterization program for the New TNX Seepage Basin was begun in January 1984 (Johnson et al., 1988). The results of the basin influent and effluent characterization are presented in Tables 7-13 and 7-14, respectively. Flow to the basin was variable, averaging 26 gpm. An average effluent flow rate from the New TNX Seepage Basin has not been identified. Water depth in the large section of the basin has varied between 6 and 10 ft, depending on precipitation and process discharges. The inlet section of the basin contains between 5 and 6 ft of sludge in the middle, and the water depth varies between 3 and 5 ft.

7.08.03 Groundwater Monitoring Program

Four wells (YSB 1 through YSB 4) were installed in the second quarter of 1980 to monitor the water-table elevation and groundwater quality at the New TNX Seepage Basin. These wells were constructed using galvanized steel casings and 20-ft screens. Because of possible water-quality interferences from the galvanized steel casings and screens, these wells were replaced by wells YSB 1A through YSB 4A in December 1983 (Figure 7-17). Wells YSB 1A through YSB 4A were constructed using PVC casings and 30-ft screens. Wells YSB 1 through YSB 4 have been abandoned.

7.08.04 Site-Specific Hydrology

Measurements obtained from the New TNX Seepage Basin wells since 1980 indicate that the water-table elevation has ranged approximately from 130 to 120 ft msl and that the vadose zone has been approximately 15 to 25 ft thick. A hydrograph for the New TNX Seepage Basin wells (Figure 7-18) shows that the water-level data from the newer, PVC-cased wells indicate water-table conditions different than those indicated by the data from the original wells. The data from the original wells (YSB 1 through YSB 4) indicate a general flow direction to the north, with well YSB 3 upgradient and YSB 1 downgradient. The water-level data from wells YSB 1A through YSB 4A indicate a general flow to the west, consistent with local topography (Figure 7-17). This difference in flow direction is probably attributable to the difference in screen-zone lengths and elevations between the old and new well series. As shown in Figures 7-17 and 7-18, wells YSB 2A and YSB 4A generally have been upgradient and downgradient of the basin, respectively. Wells YSB 1A and YSB 3A generally have been sidegradient of the basin; however, fluctuations in the water table have occasionally positioned these two wells downgradient of the basin.

The approximate hydraulic gradient of the water table beneath the basin has been 0.014 ft/ft since monitoring of the newer wells began. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation near the center of the plant of approximately 15 to 60 ft/yr per percent gradient, the horizontal near-surface groundwater flow velocity beneath the New TNX Seepage Basin has ranged approximately from 21 to 84 ft/yr.

7.08.05 Waste-Site Content Characterization Data

A 12-week characterization program conducted in the first quarter of 1984 (Johnson et al., 1988) provides data on the composition of the basin influent and effluent (Tables 7-13 and 7-14, respectively). A 1985 study conducted to aid in the design of the TNX Effluent Treatment Plant (ETP) indicates that the influent flow rate to the New TNX Seepage Basin averages 26 gpm, with variations occurring frequently.

7.08.06 Soil/Sediment Characterization Data

A soil/sediment characterization program was conducted during the last quarter of 1985 and involved the sampling and analysis of soil/sediments from the New TNX Seepage Basin and adjacent areas. Figure 7-19 depicts the location of the two sampling points in the seepage section and the single sampling point in the inlet section. Two additional sediment sampling points were established in the basin outfall area, and a single sediment sampling point was located in an outside area to establish background concentrations. All sediment samples were taken to a depth of 5.0 ft below ground surface (Johnson et al., 1988).

Results from the background area (TNX 106) were compared to the results from the remaining sample points to evaluate the areas of potential contamination. Concentrations for the background sample were consistent throughout the depth of the sample, with only slight variations observed. In general, the following parameters were elevated in the basin sampling points: aluminum, iron, sodium, arsenic, boron, beryllium, barium, chloride, chromium, copper, cyanide, fluoride, magnesium, manganese, ammonia, nitrates, nitrites, and sulfides. Extraction Procedure (EP) toxicity tests performed on the basin soil/sediment samples indicate extractable metal and organic levels less than 1% of Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24) (Dunaway et al., 1987a).

7.08.07 Groundwater Monitoring Results

Groundwater monitoring results from 1982 through 1986 are presented in Appendix E. Groundwater chemical characterization data since July 1984 are summarized in Table 7-15.

Comparisons of the monitoring results among upgradient well YSB 2A, side-to-downgradient wells YSB 1A and YSB 3A, and downgradient well YSB 4A were made to evaluate the effect of the New TNX Seepage Basin on groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Discharges to the basin consist mostly of DWPF sludge and salt supernate, the main constituents of which are iron hydroxide and sodium nitrate (Tables 7-11 and 7-12). Given the insolubility of iron hydroxide and the solubility of sodium nitrate in water, the indicator parameters most likely to show the effects of the New TNX Seepage Basin are conductivity, sodium, and nitrate.

The groundwater data summarized in Table 7-15 indicate that the New TNX Seepage Basin has influenced groundwater quality in side-to-downgradient well YSB 3A and downgradient well YSB 4A, as indicated by the elevated levels of conductivity, nitrate, and average sodium reported for these two wells compared to upgradient well YSB 2A.

Groundwater quality in upgradient well YSB 2A and side-to-downgradient well YSB 1A has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for a single excursion each of iron and gross alpha in well YSB 1A. The average conductivity values for wells YSB 2A (42.1 μmhos/cm) and YSB 1A (28.1 μmhos/cm) were low. Sodium levels in both wells remained below 5.6 mg/L over the monitoring period except for a concentration of 20.8 mg/L in well YSB 2A reported in the third quarter of 1984. Nitrate levels in wells YSB 2A (0.73 to 1.70 mg/L) and YSB 1A (0.90 to 1.30 mg/L) remained well below the drinking water standard of 10 mg/L. Iron in side-to-downgradient well YSB 1A (0.018 to 1.04 mg/L) was over the drinking water standard of 0.3 mg/L in a single excursion. Iron concentrations as high as 0.52 mg/L are found to occur naturally in Barnwell Formation groundwater (Appendix B). Gross alpha in side-to-downgradient well YSB 1A (<2.0 to 17.0 pCi/L) was over the drinking water standard of 15 pCi/L in a single excursion.

Groundwater quality in side-to-downgradient well YSB 3A and downgradient well YSB 4A apparently has been influenced by the basin. The average conductivity levels in wells YSB 3A (240.05 μmhos/cm) and YSB 4A (74.69 μmhos/cm) were elevated compared to the average conductivity value of 42.1 μmhos/cm obtained for upgradient well YSB 2A. Sodium concentrations in wells YSB 3A (2.40 to 50.4 mg/L) and YSB 4A (6.70 to 14.0 mg/L) averaged consistently higher than the levels reported for upgradient well YSB 2A, which averaged below 5.60 mg/L. Similarly, nitrate levels in wells YSB 3A (0.35 to 22.1 mg/L) and YSB 4A (1.20 to 8.70 mg/L) were elevated compared to the levels reported for upgradient well YSB 2A (below 1.80 mg/L). Figures 7-20 and 7-21 illustrate more clearly the relative differences in indicator parameter levels among wells YSB 3A and YSB 4A and upgradient well YSB 2A. These figures also demonstrate that side-to-downgradient well YSB 3A has been more influenced by the basin than downgradient well YSB 4A, which may be due to the close proximity of well YSB 3A to the basin (less than 10 ft).

Groundwater samples from side-to-downgradient well YSB 3A and downgradient well YSB 4A met drinking water standards except for nitrate in well YSB 3A and iron and radium in well YSB 4A. Nitrate levels in side-to-downgradient well YSB 3A (0.35 to 22.1 mg/L) were greater than the drinking water standard of 10 mg/L in a single excursion. As discussed above, nitrate is related to past site activities. Iron in downgradient well YSB 4A (0.056 to 0.661 mg/L) was above the drinking water standard of 0.3 mg/L in a single excursion. Iron concentrations as high as 0.52 mg/L are generally consistent with iron levels reported as naturally occurring in Barnwell Formation groundwater (Appendix B). Total radium activity in well YSB 4A (<1.0 to 14.0 pCi/L) ranged over the drinking water standard of 5 pCi/L.

The groundwater pH ranged between 4.4 and 6.3 in all four site wells. This pH range is consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

7.08.08 Planned Action

The New TNX Seepage Basin is active. As indicated in Section 16, a site assessment is being conducted and is scheduled to be completed in 1988. Following the completion of the TNX Effluent Treatment Plant (ETP), a closure plan will be developed. Groundwater monitoring will continue at this site.

7.09 OLD TNX SEEPAGE BASIN

7.09.01 Summary

From 1958 to 1980, the Old TNX Seepage Basin (Building 904-76T) received process wastewater from pilot-scale tests conducted at TNX in support of the Defense Waste Processing Facility (DWPF) and from the SRS Separations Areas. In 1981, the basin was backfilled with approximately 10 ft of a sand and clay mixture followed by a 6-in. clay cap. An 18-in. layer of topsoil, graded to divert rainwater, was placed on top of the clay. The area was then seeded to control surface erosion and has since been paved with asphalt (Dunaway et al., 1987c). The site is currently inactive.

The basin contents were not sampled during the operational life of the basin. The soil/sediments of the Old TNX Seepage Basin were sampled in 1984 as part of a characterization program (Simmons et al., 1985). Radionuclides detected above background levels were ^{243}Cm, ^{244}Cm, ^{239}Pu, ^{240}Pu, ^{228}Ra, ^{228}Th, ^{235}U, and ^{238}U. Inorganic parameters detected above background levels were silver, chromium, copper, mercury, and cyanide. Extraction Procedure (EP) toxicity test results for metals indicate concentrations less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24). No organic constituents were detected above background levels.

The groundwater monitoring data indicate that the Old TNX Seepage Basin has had an effect on local groundwater quality. Mercury, nitrate, and manganese (site-related constituents) have exceeded South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards. Excursions also were recorded for total dissolved solids (TDS), cadmium, lead, carbon tetrachloride, trichloroethylene, gross alpha, and total radium.

7.09.02 Waste-Site Description and Nature of Disposal

From 1958 to 1980, the Old TNX Seepage Basin (Building 904-76T) received process wastewater from pilot-scale tests conducted at TNX in support of the Defense Waste Processing Facility (DWPF) and from the SRS Separations Areas. The constituents discharged to the basin are listed in Table 7-16. Mercury, in the form of mercuric nitrate, and depleted uranium, in the form of uranyl nitrate, were among the wastes discharged to the basin (Dunaway et al., 1987c).

In 1980, the discharge of process water to the Old TNX Seepage Basin ceased. In 1981, residual liquid in the basin was allowed to drain into the adjacent wetlands. The basin was then backfilled with approximately 10 ft of a sand and clay mixture followed by a 6-in. clay cap. A final 18-in. layer of topsoil, graded to a 1% slope to divert rainwater, was placed on top of the clay layer. The area was then seeded to control surface erosion, and part of the area is presently covered with a layer of asphalt (Dunaway et al., 1987c).

The Old TNX Seepage Basin is in the southwest part of the TNX facility, approximately 700 ft west of River Road (Figure 7-17). The ground surface elevation at the site is approximately 150 ft msl and rapidly declines to the southwest toward the swampy flood plain of the Savannah River. The Savannah River, approximately 1,000 ft to the west of the Old TNX Seepage Basin, is the nearest plant boundary.

The Old TNX Seepage Basin consisted of two cells: a rectangular settling section, with approximate dimensions of 35 ft by 25 ft, and a rectangular main section, with approximate dimensions of 125 ft by 75 ft (Figure 7-3). Both basin sections were 10 ft deep with steeply sloping walls. The process wastewater entered the basin through an underground 8-in. vitrified pipeline that extended through the northern wall. The maximum storage capacities of the main basin and settling section were 920,000 gal and 131,000 gal, respectively. The settling section was separated from the main section by a 5-in. weir that allowed effluent to flow into the main basin. A similar-sized weir in the west wall of the main basin allowed effluent to overflow into the TNX swamp. This overflow has resulted in the formation of a 100-ft-wide outfall delta inside the swamp.

A portion of the top of the old basin has been paved with asphalt. An office trailer (Building 675-7T) rests on top of the pavement, alongside an equipment lay-down area. Vegetation outside the security fence ranges from lightly to thickly wooded. The vegetation inside the fence consists primarily of a grass lawn.

7.09.03 Groundwater Monitoring Program

Eight wells (XSB Series) have been installed to monitor the water-table elevation and groundwater quality at the Old TNX Seepage Basin. Four wells, XSB 1 through XSB 4, were installed in April 1980 using galvanized steel casings and screens. Because of possible water-quality interferences from the galvanized steel, well XSB 3 was abandoned and replaced with well XSB 3A in the second quarter of 1984. Well XSB 3A was constructed using PVC casing. The other three steel-cased wells are scheduled to be replaced in 1988.

Three additional wells (XSB 5, XSB 5A, and XSB 3T) were installed downgradient of the Old TNX Seepage Basin in 1984 to verify the upward vertical hydraulic gradients and to monitor the groundwater quality of the Tuscaloosa Formation (Dunaway et al., 1987c). The location of these wells with respect to the basin is shown in Figure 7-17.

Old TNX Seepage Basin wells XSB 1, XSB 2, XSB 3A, XSB 4, and XSB 5A are included in the SRS quarterly groundwater monitoring program. Plant-wide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

7.09.04 Site-Specific Hydrology

Water-table elevation measurements and geophysical logs obtained from the Old TNX Seepage Basin wells indicate that the water-table well screen zones intersect two permeable sand zones that are separated by an aquitard. The rapid 10-ft decline in the water levels in wells XSB 1 and XSB 3A during the first half of 1984 (Figure 7-22) is attributable to a change in equilibration in these two wells from the upper to the lower sands. Figure 7-23 illustrates the screen zone elevations and their relationship to the postulated geology and geophysical logs at this site.

Because it is difficult to access the piezometric head in each sand zone affecting the wells, a water-table contour map is not presented for this site. Both sand zones probably drain toward the Savannah River flood plain swamp, which would make well XSB 2 upgradient, wells XSB 1 and XSB 3A sidegradient, and wells XSB 4 and XSB 5A downgradient. If water is flowing through the well screens from the upper to the lower sand zones, then each well will form a cone of depression in the upper aquifer, disrupting the normal hydraulic gradient. This disruption, combined with the close proximity of wells XSB 1 through XSB 4 to the basin, makes the site hydrology difficult to determine.

7.09.05 Waste-Site Content Characterization Data

The basin contents were not sampled during the operating life of the basin. The chemicals discharged to the basin are listed in Table 7-16 (Christensen and Gordon, 1983). Influent volumes and compositions were not recorded except for mercury. It is estimated that 44 lb of mercury were discharged to the basin over its lifetime, mostly in the form of mercuric nitrate.

A swamp water grab sample was obtained in 1984. The constituents that were detected in the swamp water grab sample are listed in Table 7-17. Gross alpha (900 pCi/L), total radium (174 pCi/L), chromium (0.562 mg/L), and mercury (0.102 μg/L) levels were elevated. It is believed that the gross beta-gamma reading of 361 pCi/L is due to tritium (Simmons et al., 1985).

7.09.06 Soil/Sediment Characterization Data

The soil/sediments of the Old TNX Seepage Basin were sampled in 1984 as part of a basin characterization program (Simmons et al., 1985). At the time of sampling, the basin contained approximately 10 ft of fill overlying the bottom sediments. Seven 30-ft continuous borings were obtained within the basin. In addition, two 20-ft borings were obtained from locations outside the basin: one within the basin outfall delta in the swamp and the other in a remote location to establish background levels for comparison purposes. Sample locations are shown in Figures 7-24 and 7-25.

The soil/sediment borings were separated into intervals ranging from 0.25 ft to 3 ft in length for radionuclides, metals, inorganic ions, and organics analyses. Analytical results for the radionuclides, metals, and inorganic ions detected at concentrations above site background levels are summarized in Table 7-18 along with the background values established by the remote sample. No organic constituents were detected above background in any of the nine soil/sediment samples.

The radionuclides detected above background in the basin sediments were ^{243}Cm, ^{244}Cm, ^{239}Pu, ^{240}Pu, ^{228}Ra, ^{228}Th, ^{235}U, and ^{238}U. These radionuclides were limited to the northeast area of the basin in the location that had been the upper inlet. In addition, the levels detected above background were associated with the upper 2 ft of the bottom sediments that had been covered by a 10-ft layer of fill (Simmons et al., 1985).

Metals found above SRS background concentrations were silver (up to 20 μg/kg), chromium (up to 940 μg/kg), copper (up to 190 μg/kg), and mercury (up to 64 μg/kg). Cyanide (up to 15 μg/kg) was also present in levels above background. All of these metals and inorganic ions are potentially related to previous disposal practices, as indicated in Table 7-16 (Simmons et al., 1985). Extraction Procedure (EP) toxicity test results for metals indicate concentrations less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

In addition to the basin soil/sediment sampling, 12 shallow soil borings were obtained from the swamp (Figure 7-25) and separated into intervals of either 6 or 12 in. Ten of the sampling locations (T02 to T11) were within the basin outfall delta; the other two locations (D01 and D02) were along the ditchline of an active rainwater outfall.

Analytical results for the swamp sediments are shown in Table 7-19. Levels above background for ^{228}Ra, ^{228}Th, ^{3}H, ^{235}U, and ^{238}U were detected in samples taken along the discharge gully from the Old TNX Seepage Basin. Two metals were detected above background levels: mercury (up to 14 mg/kg), which was present in localized areas within the swamp, and chromium (up to 71 mg/kg), which was dispersed throughout the sampling area. The radionuclides and metals detected above background in the swamp were concentrated in the upper 2-ft layer of sediment (Simmons et al., 1985).

Swamp vegetation was tested for mercury and chromium, and it was found that higher sediment concentrations corresponded to elevated concentrations in the nearby vegetation. The uptake appeared to be localized to the plant roots. The detected concentrations of mercury and chromium in the vegetation were below the levels considered toxic to herbivorous wildlife (Simmons et al., 1985).

7.09.07 Groundwater Monitoring Results

Groundwater monitoring data from 1982 through 1986 are presented in Appendix E. Chemical characterization data since July 1984 are summarized in Table 7-20.

As discussed in Section 7.09.04 and shown in Figure 7-22 and 7-23, the near-surface groundwater flow direction and hydraulic gradient at this site are difficult to determine. Because there is no clear upgradient well for this site, the analytical data from all five monitoring wells were compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards to determine the effect of the basin on the groundwater. Indicator parameters for the site are mercury, nickel, nitrate, and radionuclides.

The groundwater data summarized in Table 7-20 indicate that there has been an effect on groundwater quality from the Old TNX Seepage Basin. Mercury, nitrate, and manganese (all site-related constituents) have exceeded South Carolina and federal drinking water standards. Excursions also were recorded for total dissolved solids (TDS), cadmium, lead, carbon tetrachloride, trichloroethylene, gross alpha, and total radium.

Mercury frequently has exceeded the drinking water standard of 0.002 mg/L in well XSB 2 and XSB 4, although it has met the standard in wells XSB 1, XSB 3A, and XSB 5A. Nitrate concentrations follow a similar pattern, with higher levels found in wells XSB 2 (137 to 200 mg/L) and XSB 4 (27.2 to 138 mg/L) compared to wells XSB 1, XSB 3A, and XSB 5A (2.9 to 34.0 mg/L). All five site wells have on occasion contained nitrate levels above the 10 mg/L drinking water standard. Figure 7-26 illustrates the elevated nitrate levels in the site wells compared to drinking water standards and the elevated mercury and nitrate levels in wells XSB 2 and XSB 4 relative to wells XSB 1, XSB 3A, and XSB 5A.

Manganese concentrations above the 0.05 mg/L drinking water standard were detected in wells XSB 2, XSB 3A, and XSB 4. The highest manganese levels were found in well XSB 2 (1.72 to 2.27 mg/L). Figure 7-27 illustrates the elevated levels of manganese in wells XSB 2 through XSB 4 compared to the drinking water standard (0.05 mg/L). Nickel concentrations exhibited a similar trend, with the highest concentrations in wells XSB 2 and XSB 4.

As indicated above, the distribution pattern observed for the site-related compounds indicates that the effect on well XSB 2 has been greater than that on wells XSB 3A and XSB 5A. As illustrated in Figures 7-26 through 7-28, a number of other parameters with concentrations below drinking water standards exhibited the same pattern, including barium, chloride, and sodium. Conductivity levels in the site wells also exhibited this pattern (Figure 7-29), with levels in wells XSB 2 (990 to 3,100 μmhos/cm) and XSB 4 (260 to 1,440 μmhos/cm) averaging higher than the levels in wells XSB 1 (85 to 220 μmhos/cm), XSB 3A (47 to 390 μmhos/cm), and XSB 5A (239 μmhos/cm).

Groundwater pH in wells XSB 2, XSB 3A, XSB 4, and XSB 5A ranged from 3.0 to 5.3, which is slightly lower than the pH range of 4.6 to 5.8 observed in well XSB 1. Figure 7-29 illustrates that well XSB 1 has had an average pH of 5.3, compared to averages of 4.0 to 4.3 for the other site wells. The materials disposed in the Old TNX Seepage Basin were acidic. Cadmium concentrations up to 0.038 mg/L in wells XSB 2, XSB 3A, and XSB 4 ranged above the drinking water standard of 0.010 mg/L. Lead concentrations exceeding the drinking water standard of 0.05 mg/L have been detected in all five site wells, but the average lead concentration detected in well XSB 2 is 10 times higher than the average for any of the other site wells (Figure 7-30).

The TOH levels in well XSB 2 (0.366 to 1.022 mg/L) were elevated compared to the remaining site wells (Figure 7-30). The TOH constituents (chloroform, carbon tetrachloride, 1,1,1-trichloroethane (1,1,1-TCE), trichloroethylene, and tetrachloroethylene) have been detected in site groundwater. Chloroform has been detected in well XSB 2 (up to 0.012 mg/L) below the drinking water standard of 0.100 mg/L for trihalomethanes. Similarly, 1,1,1-trichloroethane (1,1,1-TCE) has been detected in wells XSB 1, XSB 2, and XSB 4 but has not exceeded drinking water limits. Carbon tetrachloride levels up to 0.038 mg/L have been detected in well XSB 2, routinely exceeding the 0.005 mg/L drinking water standard. Trichloroethylene (up to 0.826 mg/L) has been detected in wells XSB 1, XSB 2, XSB 3A, and XSB 4 at concentrations above the drinking water standard of 0.005 mg/L (Figure 7-31). Tetrachloroethylene has been detected in these wells at levels up to 0.006 mg/L.

All wells except well XSB 1 and well XSB 5A contained gross alpha activity above the 15 pCi/L drinking water standard. Activities were highest in wells XSB 2 (125.6 to 391 pCi/L) and XSB 4 (278 to 418.3 pCi/L) (Figure 7-31). Nonvolatile beta activities exhibited the same trend, with higher activities in wells XSB 2 (55.4 to 160 pCi/L) and XSB 4 (168.1 to 195 pCi/L) compared to wells XSB 1 (12.0 to 16.0 pCi/L), XSB 3A (4.3 to 41.0 pCi/L), and XSB 5A (7.9 pCi/L) (Figure 7-32). Total radium levels similarly were lower in wells XSB 1 (3.5 to 7.0 pCi/L), XSB 3A (2.0 to 13.0 pCi/L), and XSB 5A (4.1 pCi/L), with wells XSB 2 (82.0 to 154 pCi/L) and XSB 4 (46.0 to 64.0 pCi/L) consistently exceeding the drinking water standard of 5 pCi/L (Figure 7-32).

7.09.08 Planned Action

The Old TNX Seepage Basin is inactive. As indicated in Section 16, a closure plan is scheduled to be developed in 1988. Groundwater monitoring will continue at the site.

7.10 D-AREA ASBESTOS PIT

7.10.01 Summary

The D-Area Asbestos Pit (Building 080-20G) received material containing asbestos, typically consisting of used asbestos pipe insulation in polyethylene bags and asbestos-contaminated scrap piping. Quantities of materials containing asbestos in the pit are not known. The D-Area Asbestos Pit operated from 1972 to 1973, after which time it was covered with a layer of soil (Christensen and Gordon, 1983).

Surveillance and site maintenance for this inactive pit consist of erosion control only. Groundwater monitoring has not been conducted at the D-Area Asbestos Pit. Asbestos is not regulated as a water contaminant but as an inhalation hazard.

7.10.02 Waste-Site Description and Nature of Disposal

The D-Area Asbestos Pit is northwest of D Area (Figure 7-2). The irregularly shaped pit had original dimensions of 556 ft by 294 ft by 503 ft by 160 ft by 100 ft. The D-Area Asbestos Pit was opened in 1973 and received waste until 1974. The pit has been covered with soil, graded, and seeded.

The D-Area Asbestos Pit (Building 080-20G) received material typically consisting of asbestos, metal pipe, and scrap from bubble towers. Quantities of asbestos-containing material present in the D-Area Asbestos Pit are unknown (Christensen and Gordon, 1983).

7.10.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the D-Area Asbestos Pit.

7.10.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the D-Area Asbestos Pit. Therefore, water-table conditions beneath the waste site have not been defined.

7.10.05 Waste-Site Content Characterization Data

The contents of the D-Area Asbestos Pit have not been sampled. Section 6.06.02 contains information on the nature of the materials disposed in this waste site.

7.10.06 Soil/Sediment Characterization Data

Soil/sediments at the D-Area Asbestos Pit have not been sampled.

7.10.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the D-Area Asbestos Pit.

7.10.08 Planned Action

The D-Area Asbestos Pit is currently inactive. As indicated in Section 16, a site assessment is scheduled for 1988 from which a closure plan will be developed.

TABLE 7-1

Summary of Groundwater Quality: Well Concentration Ranges for the D-Area Oil Disposal Basin (7/84-12/86)

Constituent	SC and Federal DWS	DOB 1	DOB 2	DOB 3	DOB 4
pH (pH)	6.5-8.5	4.4-6.6	4.5-5.2	4.6-5.5	4.2-4.9
Conductivity (µmhos/cm)	NA	96-350	40-77	26-54	30-49
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	<0.0004
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.012-0.030	0.019-0.023	0.011-0.033	0.026-0.028
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005	---	---
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.005	<0.005	---	---
Chloride (mg/L)	250	2.4-4.3	3.4-4.8	1.7-3.2	3.5-3.8
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004	<0.004	<0.004-0.005	---
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	14.1-26.0	<5.0-7.0	<5.0-5.3	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.18	<0.10-0.14	<0.10-0.19	<0.10
Iron (mg/L)	0.3	0.017-0.554	0.076-0.982	0.017-0.848	0.008-0.112
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002-0.0002	<0.0002
Manganese (mg/L)	0.05	0.003-0.074	0.009-0.053	0.004-0.013	0.012-0.019
Sodium (mg/L)	NA	1.62-3.18	3.29-4.55	1.18-3.13	2.31-2.65
Nickel (mg/L)	NA	<0.004	<0.004	<0.004	---
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	<0.50-0.67	0.95-1.05	0.80-1.20	1.05-1.38
Lead (mg/L)	0.05	<0.004	0.006	0.004-0.007	<0.010-0.014
Phenols (mg/L)	NA	<0.002	<0.002	<0.002-0.005	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	18.0-46.0	7.0-16.0	<5.0-15.0	<5.0-7.5
Tetrachloroethylene (mg/L)	NA	0.012	0.006	---	---
TDS (mg/L)	500	96-160	28-30	16-40	---
TOC (mg/L)	NA	2.00-18.2	1.62-7.00	0.504-1.44	0.590-2.71
TOH (mg/L)	NA	<0.005-0.035	0.006-0.053	<0.005-0.029	<0.005
Trichloroethylene (mg/L)	0.005	0.009	0.037	---	---
1,1,1-TCE (mg/L)	0.20	<0.005	<0.005	---	---
Zinc (mg/L)	5	0.012-0.013	0.033-0.205	0.108-0.179	---
Gross alpha (pCi/L)	15	<2.0	<2.0	<2.0	<2.0-3.0
Nonvol. beta (pCi/L)	NA	<3.0-3.0	<3.0	<3.0	<3.0
Total radium (pCi/L)	5	<1.0	<1.0	<1.0	<1.0

Note: DWS are the lower of South Carolina or federal primary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 7-2

D-Area Coal Pile Basin Influent Characterization Data

Parameter	Units	Area D Initial	Final	Composite	Area D2 Initial	Final
Time	NA	1120	1609	NA	1115	1557
Temperature	°C	23.5	28.5	NA	22.0	24.0
Flow	gal/min	20-25	2-3	NA	5-10	2-3
pH	pH	2.35	2.25	2.26	2.41	2.60
Conductivity	µmhos/cm	4,720	8,500	7,440	1,850	2,900
Sulfate (as SO_4)	mg/L	3,670	8,540	8,460	1,600	1,880
Total suspended solids	mg/L	10,150	32	54	275	36
Total dissolved solids	mg/L	5,888	11,949	12,400	2,028	2,411
Phenols	mg/L	<0.001	0.002	0.001	0.006	0.011
Acidity (as $CaCO_3$)	mg/L	1,545	3,380	3,335	654	390
Beryllium	mg/L	0.0275	0.0303	0.031	0.0229	0.0248
Cadmium	mg/L	0.038	0.077	0.074	0.020	0.030
Copper	mg/L	1.62	2.32	2.23	0.573	0.547
Chromium	mg/L	0.340	0.358	0.329	0.099	0.131
Iron	mg/L	938	1170	1450	190	0.155
Lead	mg/L	0.0606	0.0047	0.0025	0.0025	0.0036
Mercury	mg/L	0.00183	0.00013	0.00015	0.00015	0.00011
Nickel	mg/L	4.42	7.91	7.90	1.64	1.36
Selenium	mg/L	0.0173	0.0045	0.0063	0.0054	0.0032
Zinc	mg/L	8.00	14.6	14.1	0.227	0.288
Aluminum	mg/L	295	393	398	113	147
Manganese	mg/L	25.4	46.8	59.0	6.91	7.66
Magnesium	mg/L	169	340	308	44.6	59.1
Arsenic	mg/L	0.263	0.133	0.135	0.0240	0.0155
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.111	<0.03	<0.03	<0.03	<0.03

Note: The coal pile runoff basin in D Area has two inputs. D is the input at the upper end of the basin; D2 is the input at the middle of the basin. NA = not applicable.

TABLE 7-3

Summary of Groundwater Quality: Well Concentration Ranges for the D-Area Coal Pile Runoff Containment Basin (7/84-12/86)

Constituent	SC and Federal DWS	DCB 1A	DCB 2A	DCB 3A	DCB 4A
pH (pH)	6.5-8.5	2.2-2.8	3.9-4.9	4.3-5.0	4.0-4.7
Conductivity (µmhos/cm)	NA	3,420-7,700	38-58	55-83	118-741
Silver (mg/L)	0.05	0.0100-0.0390	<0.0020	<0.0020	<0.0020-0.0040
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.011-0.020	0.017-0.026	0.032-0.043	0.052-0.246
Beryllium (mg/L)	NA	0.030-0.094	<0.001	<0.001	0.003-0.007
Carbon tetrachloride (mg/L)	0.005	<0.005	---	<0.005	<0.005
Cadmium (mg/L)	0.010	0.020-0.046	<0.001	<0.001	0.001
Chloroform (mg/L)	0.100*	<0.005	---	<0.005	<0.005
Chloride (mg/L)	250	<3.0-17.3	3.0-4.3	3.5-8.1	2.0-3.2
Chromium (mg/L)	0.05	0.124-0.232	<0.004	<0.004	<0.004
Copper (mg/L)	1	0.674-1.570	<0.004-0.024	<0.004-0.010	0.007-0.013
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	7.9-12.0	<5.0	<5.0-7.3	<5.0-7.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	1.05-2.45	<0.10-0.15	<0.10-0.27	0.30-0.55
Iron (mg/L)	0.3	101.000-986.000	<0.004-0.394	0.043-0.070	0.049-0.460
Mercury (mg/L)	0.002	<0.0002-0.0007	<0.0002-0.0006	<0.0002	<0.0002-0.0010
Manganese (mg/L)	0.05	22.600-40.200	0.003-0.057	0.072-0.178	0.141-1.090
Sodium (mg/L)	NA	13.00-25.40	2.34-2.65	4.22-5.86	3.19-5.14
Nickel (mg/L)	NA	1.420-4.560	<0.004-0.006	<0.004	0.010-0.062
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	<0.50	2.70-2.83	<0.50-3.77	0.63-0.83
Lead (mg/L)	0.05	<0.050-0.196	<0.004-0.028	0.006-0.015	<0.010-0.019
Phenols (mg/L)	NA	<0.002-0.003	<0.002	<0.002-0.011	<0.002
Selenium (mg/L)	0.01	<0.001-0.021	<0.001	<0.001	<0.002-0.003
Sulfate (mg/L)	250	480.0-7,486.0	3.0-7.0	<10.0-34.0	127.0-290.0
Tetrachloroethylene (mg/L)	NA	<0.005	---	<0.005	<0.005
TDS (mg/L)	500	5,638-11,048	30-82	22-50	392-414
TOC (mg/L)	NA	5.000-14.000	0.430-2.090	0.510-1.410	0.540-1.000
TOH (mg/L)	NA	0.034-0.260	<0.005-0.010	<0.005-0.016	<0.005-0.033
Trichloroethylene (mg/L)	0.005	0.088	---	0.008	<0.005
1,1,1-TCE (mg/L)	0.20	<0.005	---	<0.005	<0.005
Zinc (mg/L)	5	5.560-12.100	<0.002-0.042	0.007-0.023	0.063-0.162
Gross alpha (pCi/L)	15	12.0-95.0	<2.0	<2.0	<3.0-9.0
Nonvol. beta (pCi/L)	NA	14.0-32.0	<3.0-3.0	<3.0-3.0	5.0-13.0
Total radium (pCi/L)	5	7.0-39.0	<1.0	<1.0	4.0-8.0

TABLE 7-3 (cont.)

Constituent	SC and Federal DWS	DCB 5A
pH (pH)	6.5-8.5	4.6-6.0
Conductivity (µmhos/cm)	NA	235-525
Silver (mg/L)	0.05	<0.0020-0.0030
Arsenic (mg/L)	0.05	<0.001
Barium (mg/L)	1.0	0.051-0.086
Beryllium (mg/L)	NA	0.003-0.005
Carbon tetrachloride (mg/L)	0.005	<0.005
Cadmium (mg/L)	0.010	<0.001
Chloroform (mg/L)	0.100*	<0.005
Chloride (mg/L)	250	2.5-4.9
Chromium (mg/L)	0.05	<0.004
Copper (mg/L)	1	<0.004-0.012
Cyanide (mg/L)	0.2	<0.005
DOC (mg/L)	NA	<5.0
Endrin (mg/L)	0.0002	<0.00004
Fluoride (mg/L)	1.6	0.31-0.55
Iron (mg/L)	0.3	0.416-3.830
Mercury (mg/L)	0.002	<0.0002-0.0005
Manganese (mg/L)	0.05	0.221-0.842
Sodium (mg/L)	NA	3.70-7.05
Nickel (mg/L)	NA	0.019-0.045
Nitrite (as N) (mg/L)	NA	<0.50
Nitrate (as N) (mg/L)	10	1.95-2.50
Lead (mg/L)	0.05	<0.004-0.018
Phenols (mg/L)	NA	<0.002-0.010
Selenium (mg/L)	0.01	<0.001-0.002
Sulfate (mg/L)	250	95.0-243.0
Tetrachloroethylene (mg/L)	NA	<0.005
TDS (mg/L)	500	302-342
TOC (mg/L)	NA	0.480-2.250
TOH (mg/L)	NA	0.021-0.041
Trichloroethylene (mg/L)	0.005	0.036
1,1,1-TCE (mg/L)	0.20	<0.005
Zinc (mg/L)	5	0.052-0.120
Gross alpha (pCi/L)	15	<2.0-6.0
Nonvol. beta (pCi/L)	NA	<3.0-8.0
Total radium (pCi/L)	5	<1.0-3.0

Note: DWS are the lower of South Carolina or federal primary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 7-4

Summary of Groundwater Quality: Well Concentration Ranges for the D-Area Burning/Rubble Pits (7/84-12/86)

Constituent	SC and Federal DWS	DBP 1	DBP 2	DBP 3	DBP 4
pH (pH)	6.5-8.5	3.7-4.6	3.6-5.1	4.3-5.2	3.5-4.4
Conductivity (µmhos/cm)	NA	34-78	96-930	39-67	89-217
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	<0.0004-0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.013-0.033	0.037-0.072	0.005-0.011	0.038-0.053
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.001	<0.001	<0.001	<0.001
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.001	0.001	<0.001	<0.001
Chloride (mg/L)	250	3.9-5.8	8.8-10.2	5.7-6.4	4.4-6.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	0.008-0.009	0.004-0.006	<0.004	---
Cyanide (mg/L)	0.2	<0.005	<0.005 .	<0.005	---
DOC (mg/L)	NA	<5.0	<5.0	<5.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.13	<0.10-0.18	<0.10-0.12	<0.10-0.22
Iron (mg/L)	0.3	0.034-0.106	0.120-0.458	0.029-0.116	0.026-0.317
Mercury (mg/L)	0.002	<0.0002-0.0003	<0.0002-0.0003	<0.0002-0.0002	<0.0002
Manganese (mg/L)	0.05	0.012-0.031	0.059-0.164	0.008-0.025	0.387-2.260
Sodium (mg/L)	NA	4.27-5.06	5.18-9.98	5.86-9.00	6.43-8.36
Nickel (mg/L)	NA	0.004-0.005	<0.004	<0.004	---
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	2.65-3.35	1.40-3.43	<0.50-1.70	<0.50-0.51
Lead (mg/L)	0.05	0.008-0.027	0.006-0.024	<0.004-0.007	0.009-0.066
Phenols (mg/L)	NA	<0.002	<0.002-0.005	<0.002-0.003	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	7.0-61.0	5.0-9.0	28.0-112.0
Tetrachloroethylene (mg/L)	NA	0.002	0.003	<0.001	<0.001
TDS (mg/L)	500	16-28	70-246	40-278	---
TOC (mg/L)	NA	0.400-2.300	0.840-6.700	0.540-3.900	0.700-2.000
TOH (mg/L)	NA	<0.005-0.023	0.019-0.035	<0.005-0.019	<0.005-0.010
Trichloroethylene (mg/L)	0.005	0.014	0.004	0.002	0.002
1,1,1-TCE (mg/L)	0.200	<0.001	0.002	<0.001	<0.001
Zinc (mg/L)	5	0.035-0.226	0.077-0.353	0.002-0.076	0.097
Gross alpha (pCi/L)	15	<2.0	<2.0	<2.0	<2.0-2.0
Nonvol. beta (pCi/L)	NA	<3.0-8.0	<3.0-9.0	<3.0	<3.0-8.0
Total radium (pCi/L)	5	<1.0	<1.0-2.0	<1.0	<1.0-2.0

Note: DWS are the lower of South Carolina or federal primary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 7-5

Chemical Inventory in the TNX Storage Area

Material	Quantity (Drums)
Frit and calcine	66
TDS-O AFF sludge with Frit-131	1
Sludge for erosion wear loop	1
Frit	104
PNL-80-476	10
Calcine	7
Waste glass shards	4
EXXON Nuto-H	2
Waste oil	4
Used 30 and 40 wt. oil Texaco	2
G-32 glycerin	2
Fuel--solvent fireside additive FS-20	1
EXXON Univolt N-61	2
Synthetic waste slurry NO frit	4
Sludge kaolin	10
AFF sludge SME	1
OGF filter waste	1
Sludge for descaling	2
Feed slurry DWPF stream FS4-4	2
Incinerator feed	3
Sodium aluminate	38
Aluminum nitrate	3
Fly ash	2
Ferric sulphate solution	18
48-in. centrifuge centrate	8
Supernate A-5	7
Oxidizing materials (NOS)	34
Nitric acid	1
Supernate	1
Calcium nitrate	6
Unknown	59
Caustic	2
Stainless steel drums, unknown	7
Water treatment	1
Resin	4
50% hydrogen peroxide	1
Ferric nitrate	131*
Ground clay	15**
Oxalic acid	12

Note: The inventory was conducted on April 28, 1982. Data are from Christensen and Gordon (1983).

* The ferric nitrate is contained in boxes.
** The ground clay is contained in bags.

TABLE 7-6

Materials Removed from the TNX Storage Area After April 1982

Type	Amount (drums)	Current Location
Used oil	11	400-D
Sludge kaolin	10	Rubble pit
Sodium aluminate	38	710-U
Oxalic acid	12	710-U
Ethylene glycol	13	710-U
Caustic	2	678-G neutralized
Nitric acid	1	678-G
Supernate	25	SRL research project
Glycerin	4	Rubble pit
Frit	40	Vendor for reprocessing
Calcium nitrate	6	710-U
Ferric nitrate	114	710-U

Note: Data are from Christensen and Gordon (1983).

TABLE 7-7

Chemical Inventory in the Old TNX Storage Area

Material	Quantity (drums)
Frit and calcine	66
TDS-O AFF sludge with Frit-131	1
Sludge for erosion wear loop	1
Frit	104
PNL-80-476	10
Calcine	7
Waste glass shards	4
Synthetic waste slurry (no frit)	4
AFF sludge SME	1
OGF filter waste	1
Sludge for descaling	2
Feed slurry DWPF stream FS4-4	2
Incinerator feed	3
Fly ash	2
Ferric sulphate solution	18
48-in. centrifuge centrate	8
DWPF sludge	34
Resin	4

Chemical Inventory in the New TNX Storage Area

Material	Quantity (drums)
Formated sludge	14
STPB waste	7
60% wt. frit/water (pH 8)	2
PTF filtrate	13
Fyrquel 220	2
Glycerin	2
STPB/supernate waste	3
LSFM-6 feed slurry	10
Glass shards	1
35% slurry LSFM-1	6
Dirty sumpwater & n-paraffin	6
Frit & water from blaster	32
Calcine & frit	45
Frit	78

Note: The inventory was conducted on November 17, 1982.
Data are from Christensen and Gordon (1983).

TABLE 7-8

Chemical Compositions of TNX Wastes

Glass Frit

Component	Concentration Range (wt %)
SiO_2	52.5-58.3
Na_2O	17.7-22.5
B_2O_3	10.0-14.7
TiO_2	0-10.0
CaO	0-5.6
Li_2O	0-5.7
MgO	0-2.0
La_2O_3	0-0.5
ZrO_2	0-0.5

Calcine

Component	Concentration Range (wt %)
Fe_2O_3	49.7
MnO_2	13.2
Zeolite	9.8
Al_2O_3	10.8
NiO	5.8
$CaCO_3$	6.2
$NaNO_3$	3.2
$NaSO_4$	1.3

Glass Frit/Calcine Mixtures

Component	Concentration Range (wt %)
SiO_2	41.4-43.1
Na_2O	12.8-15.2
Fe_2O_3	13.0-14.4
B_2O_3	7.9-10.6
CaO	0-4.1
MnO_2	3.4-3.8
Zeolite	2.6-2.8
Al_2O_3	2.8-3.1
NiO	1.5-1.7
Li_2O	3.1-4.1
$CaCO_3$	1.6-1.8
MgO	0-1.4
$NaNO_3$, $NaSO_4$, TiO_2	Trace
La_2O_3, ZrO_2	Trace

Note: Data are from Christensen and Gordon (1983).

TABLE 7-9

Trace Elements in Different Types of Ash

Element	Ash Type (mg/L) Fly Ash (Electrostatic Precipitator)	Fly Ash (Mechanical Collector)	Bottom Ash
Barium	889	792	808
Strontium	579	589	333
Manganese	352	275	811
Zinc	280	116	95
Vanadium	218	166	140
Cerium	189	251	150
Chromium	171	140	160
Arsenic	164	55	4
Copper	130	93	67
Nickel	89	87	77
Gallium	72	32	20
Lanthanum	69	61	61
Cobalt	67	47	40
Lead	60	28	5
Bromine	47	12	3
Scandium	32	28	20
Thorium	23	24	25
Antimony	19	6	3
Molybdenum	18	11	7
Beryllium	16	12	9
Samarium	15	13	12
Selenium	15	6	3
Cesium	14	13	10
Uranium	13	8	8
Europium	11	12	8
Ytterbium	12	8	10
Terbium	2.5	2.1	2
Mercury	0.84	0.33	0.08
Cadmium	0.71	0.39	0.5

Note: Data, from Christensen and Gordon (1983), were collected in 1977.

TABLE 7-10

Trace Metal Analysis of 488-D Ash Basin Sludge Sample Extracts

Metal	Ash Basin Sludge (mg/L)	EPA Extract Level Limit (mg/L)
Chromium	<0.002	5.0
Cadmium	<0.001	1.0
Barium	1	100.0
Silver	<0.001	5.0
Mercury	<0.01	0.2
Lead	<0.002	5.0
Arsenic	<0.01	5.0
Selenium	<0.01	1.0

Note: Data, from Christensen and Gordon (1983), were collected in January 1980.

TABLE 7-11

Composition of Simulated DWPF Sludge Discharged to the New TNX Seepage Basin

Component	Wt %
$Fe(OH)_3$	43.19
$Al(OH)_3$	17.81
SiO_2	4.94
MnO_2	7.41
NaOA	4.43
Zeolite*	4.87
$NaNO_3$	4.43
$CaCO_3$	5.66
$Ni(OH)_2$	3.42
Rare Earth	0.55
$Ca_3(PO_4)_2$	0.20
KOH	0.32
Na_2SO_4	0.27
NaCl	0.40
CaF_2	0.16
C	0.13
$SrCO_3$**	0.15
$CsNO_3$**	0.26
$CaSO_4$	0.42
$Cr(OH)_3$	0.35
Na_3PO_4	0.02
$NaAl(OH)_4$	0.24
NaI	0.02

Note: The weight compositions for this simulation mixture are on a washed sludge basis. Data are from Dunaway et al. (1987a).

* Linde Ion-Siv IE-95.
** Nonradioactive isotopes.

TABLE 7-12

Chemical Composition of Simulated Salt Supernate Discharged to the New TNX Seepage Basin

Soluble Solids	Wt. %
$NaNO_3$	41.6
$NaNO_2$	14.8
$NaAlO_2$	9.10
NaOH	19.06
Na_2CO_3	6.55
Na_2SO_4	8.34

Note: Data are from Christensen and Gordon (1983).

TABLE 7-13

Analysis of New TNX Seepage Basin Influent

Parameters	Units	Average	Maximum	Minimum	No. of Samples
BOD_5	mg/L	40	311	<6	56
Total suspended solids	mg/L	35	296	1	53
Total dissolved solids	mg/L	124	804	54	36
Total organic carbon	mg/L	13	86	<5	57
Grease and oil	mg/L	<5	7	<5	8
pH	pH	7.5-8.0	12.3	2.2	1,018 (hourly)
Flow rate	gpm	26	87	1.0	1,018 (hourly)

Note: Influent quality parameters values were obtained from 24-hr flow-weighted composite samples. Samples were collected from 676-3T manhole. Data are from Lopez (1984).

TABLE 7-14

Analysis of New TNX Seepage Basin Effluent

Parameters	Units	Average	Maximum	Minimum	No. of Samples
BOD_5	mg/L	29	133	<6	37
Total suspended solids	mg/L	33	108	5	37
Total dissolved solids	mg/L	113	168	40	34
Totol organic carbon	mg/L	10	17	<5	37
Grease and oil	mg/L	<5	5	4	10
pH	pH	9.8	11.6	7.5	35

Note: Grab samples from NPDES Outfall X-013A were obtained to determine these waste quality parameters at the overflow of the New TNX Seepage Basin. Data are from Lopez (1984).

TABLE 7-15

Summary of Groundwater Quality: Well Concentration Ranges for the New TNX Seepage Basin (7/84-12/86)

Constituent	SC and Federal DWS	YSB 1A	YSB 2A	YSB 3A	YSB 4A
pH (pH)	6.5-8.5	4.5-5.6	4.4-5.3	5.1-6.3	4.5-5.8
Conductivity (μmhos/cm)	NA	22-70	30-67	180-265	33-138
Silver (mg/L)	0.05	<0.0020	<0.0020-0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.008-0.011	0.006-0.010	0.006-0.021	0.008-0.014
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloride (mg/L)	250	3.8-5.8	4.3-12.6	2.3-4.4	3.8-8.7
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.010	<0.004-0.006	<0.004	<0.004
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	<0.005
DOC (mg/L)	NA	<5.0	<5.0	<5.0	<5.0-29.7
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10-0.35	<0.10-0.19	<0.10
Iron (mg/L)	0.3	0.018-1.040	0.026-0.184	<0.004-0.108	0.056-0.661
Mercury (mg/L)	0.002	<0.0002	<0.0002-0.0003	<0.0002	<0.0002-0.0002
Manganese (mg/L)	0.05	0.004-0.007	<0.002-0.004	<0.002-0.005	0.005-0.016
Sodium (mg/L)	NA	1.69-4.39	3.43-20.80	2.40-50.40	6.70-14.00
Nickel (mg/L)	NA	<0.004	<0.004	<0.004-0.008	<0.004-0.007
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	<0.50
Nitrate (as N) (mg/L)	10	0.90-1.30	0.73-1.70	0.35-22.10	1.20-8.70
Lead (mg/L)	0.05	<0.004	<0.004-0.005	<0.004	<0.004-0.006
Phenols (mg/L)	NA	<0.002-0.006	<0.002	<0.002-0.008	<0.002-0.011
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0-45.0	<10.0-35.0	5.0-26.0
TDS (mg/L)	500	26-90	136-260	14-98	142-290
TOC (mg/L)	NA	0.257-6.000	0.335-11.640	0.610-12.350	0.557-12.570
TOH (mg/L)	NA	<0.005-0.019	<0.005-0.040	<0.005-0.031	<0.005-0.021
Zinc (mg/L)	5	<0.010-0.091	0.012-0.038	0.022-0.218	0.061-0.326
Gross alpha (pCi/L)	15	<2.0-17.0	<2.0	<2.0	<2.0-14.0
Nonvol. beta (pCi/L)	NA	<2.0-12.0	<2.0	<2.0	1.4-17.0
Total radium (pCi/L)	5	<1.0-5.0	<1.0	<1.0	<1.0-14.0

Note: DWS are the lower of South Carolina or federal primary drinking water standards.
NA = not applicable.

TABLE 7-16

Process Chemicals Discharged to the Old TNX Seepage Basin

Aluminum monohydrate
Aluminum nitrate
Aluminum oxide
Ammonium carbonate
Ammonium hydroxide
Ammonium hydroxyisobutyrate
Ammonium nitrate
Aqueous ammonia
Calcium nitrate
Charcoal
DPTA
Dysprosium
Ferric nitrate
Ferric oxide
Ferric sulfate
Formic acid
Gluconic acid
Hydrofluoric acid
Hydrogen peroxide
Lanthanum nitrate
Manganese nitrate
Manganese oxide
Mercuric nitrate
Neodymium
Nickel carbonate
Nickel nitrate
Nitric acid
Oxalic acid
Potassium hydroxide
Potassium nitrate
Potassium permanganate
Samarium
Silver nitrate
Sodium aluminate
Sodium carbonate
Sodium hydroxide
Sodium nitrate
Sodium nitrite
Sodium sulfate
Sulfamic acid
Thorium
Tributyl phosphate
Trisodium phosphate
Ultrascene
Uranyl nitrate
Zinc nitrate

Note: Data are from Christensen and Gordon (1983).

TABLE 7-17

Old TNX Seepage Basin Swamp Water Sample Analyses

Constituent	Units	Concentrations
Gross alpha	pCi/L	900
Gross beta-gamma	pCi/L	361
Radium	pCi/L	174
Silver	mg/L	0.014
Chromium	mg/L	0.562
Copper	μg/L	0.260
Mercury	μg/L	102
Cyanide	μg/L	80

Note: Data are from Simmons et al. (1985).

TABLE 7-18

Old TNX Seepage Basin Sediment Analyses (Deep Borings)

Constituent	Units	Range	Background
$^{243,244}Cm$	pCi/g	0.02-1.6	0.14
$^{239,240}Pu$	pCi/g	0.004-0.8	0.13
^{228}Ra	pCi/g	0.18-750	2.0
^{228}Th	pCi/g	0.18-620	1.9
^{235}U	pCi/g	0.01-55	0
^{238}U	pCi/g	0.18-460	0.3
Copper	µg/g	2.5-190	1.3
Chromium	µg/g	1.7-940	2.7
Cyanide	µg/g	0.25-15	0.25
Mercury	µg/g	0.2-64	0.2
Silver	µg/g	0.01-20	0.4

Note: Data are from Simmons et al. (1985).

TABLE 7-19

Old TNX Seepage Basin Swamp Sediment Analyses (Shallow Borings)

Constituent	Units	Range	Background
^{228}Ra	pCi/g	2-96	2.0
^{228}Th	pCi/g	0.4-92	1.9
^{3}H	pCi/g	1,200-31,000	21,000
^{235}U	pCi/g	0-30	0
^{238}U	pCi/g	0.2-220	0.3
Chromium	μg/g	1-71	2.7
Mercury	μg/g	0.2-14	0.2

Note: Data are from Simmons et al. (1985).

TABLE 7-20

Summary of Groundwater Quality: Well Concentration Ranges for the Old TNX Seepage Basin (7/84-12/86)

Constituent	SC and Federal DWS	XSB 1	XSB 2	XSB 3A	XSB 4
pH (pH)	6.5-8.5	4.6-5.8	3.5-4.8	3.8-5.3	3.0-4.7
Conductivity (µmhos/cm)	NA	85-220	990-3100	47-390	260-1440
Silver (mg/L)	0.05	<0.0020	<0.0020-0.0030	0.0005	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001-0.004	<0.001
Barium (mg/L)	1.0	0.080-0.099	0.429-0.531	0.019-0.111	0.152-0.538
Beryllium (mg/L)	NA	---	---	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.001	0.026-0.038	<0.001	0.002-0.017
Cadmium (mg/L)	0.010	<0.002-0.007	<0.002-0.017	<0.002-0.038	<0.002-0.027
Chloroform (mg/L)	0.100*	<0.001-0.001	<0.001-0.012	<0.001	<0.001
Chloride (mg/L)	250	2.7-3.9	6.7-12.6	4.2-6.6	7.2-14.6
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004-0.013
Copper (mg/L)	1	<0.004	0.012	<0.004-0.006	0.013
Cyanide (mg/L)	0.2	<0.005	0.008	<0.005	0.005
DOC (mg/L)	NA	<5.0	<5.0-15.0	<5.0	<5.0-14.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10-0.26	<0.10-0.21	<0.10-0.24
Iron (mg/L)	0.3	0.063-0.184	0.010-0.087	0.018-0.092	0.030-0.064
Mercury (mg/L)	0.002	<0.0002-0.0003	0.0056-0.0153	<0.0002-0.0018	0.0004-0.015
Manganese (mg/L)	0.05	0.012-0.025	1.720-2.270	0.039-0.299	0.400-0.803
Sodium (mg/L)	NA	3.60-4.22	132.00-899.00	5.48-30.90	28.40-142.00
Nickel (mg/L)	NA	<0.004-0.006	0.083-0.121	0.004-0.012	0.034-0.146
Nitrite (as N) (mg/L)	NA	---	---	<2.00	---
Nitrate (as N) (mg/L)	10	11.00-16.00	137.00-200.00	2.90-34.00	27.20-138.00
Lead (mg/L)	0.05	<0.004-0.170	0.022-5.190	<0.004-0.068	0.021-0.108
Phenols (mg/L)	NA	<0.002	<0.002-0.012	<0.002-0.014	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0-24.0	<5.0-5.0
Tetrachloroethylene (mg/L)	NA	0.001-0.006	0.003	<0.001	0.003-0.005
TDS (mg/L)	500	150-152	1,874-2,448	108-284	988-1,208
TOC (mg/L)	NA	0.663-5.00	2.50-35.0	<1.00-4.78	1.03-13.0
TOH (mg/L)	NA	0.123-0.442	0.366-1.022	<0.005-0.190	0.029-0.414
Trichloroethylene (mg/L)	0.005	0.001-0.491	0.436-0.826	0.006-0.027	0.025-0.342
1,1,1-TCE (mg/L)	0.200	<0.001-0.033	<0.005-0.038	<0.001	<0.005-0.005
Zinc (mg/L)	5	0.586	0.373	0.035-0.377	0.313
Gross alpha (pCi/L)	15	7.5-15.0	125.6-391.0	6.1-47.0	278.0-418.3
Nonvol. beta (pCi/L)	NA	12.0-16.0	55.4-160.0	4.3-41.0	168.1-195.0
Total radium (pCi/L)	5	3.5-7.0	82.0-154.0	2.0-13.0	46.2-64.0
Tritium (pCi/mL)	20	5	7	5	9

TABLE 7-20 (cont.)

Constituent	SC and Federal DWS	XSB 5A
Ph (pH)	6.5-8.5	4.1
Conductivity (µmhos/cm)	NA	239
Silver (mg/L)	0.05	0.0040
Arsenic (mg/L)	0.05	<0.002
Barium (mg/L)	1.0	0.053
Cadmium (mg/L)	0.010	<0.002
Chloride (mg/L)	250	7.3
Chromium (mg/L)	0.05	<0.004
Endrin (mg/L)	0.0002	<0.00004
Fluoride (mg/L)	1.6	<0.10
Iron (mg/L)	0.3	0.052
Mercury (mg/L)	0.002	<0.0002
Manganese (mg/L)	0.05	0.030
Sodium (mg/L)	NA	23.00
Nitrate (as N) (mg/L)	10	19.50
Lead (mg/L)	0.05	0.168
Phenols (mg/L)	NA	<0.002
Selenium (mg/L)	0.01	<0.002
Sulfate (mg/L)	250	6.0
TOC (mg/L)	NA	<1.00
TOH (mg/L)	NA	0.016
Gross alpha (pCi/L)	15	14.5
Nonvol. beta (pCi/L)	NA	7.9
Total radium (pCi/L)	5	4.1

Note: DWS are the lower of South Carolina or federal primary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

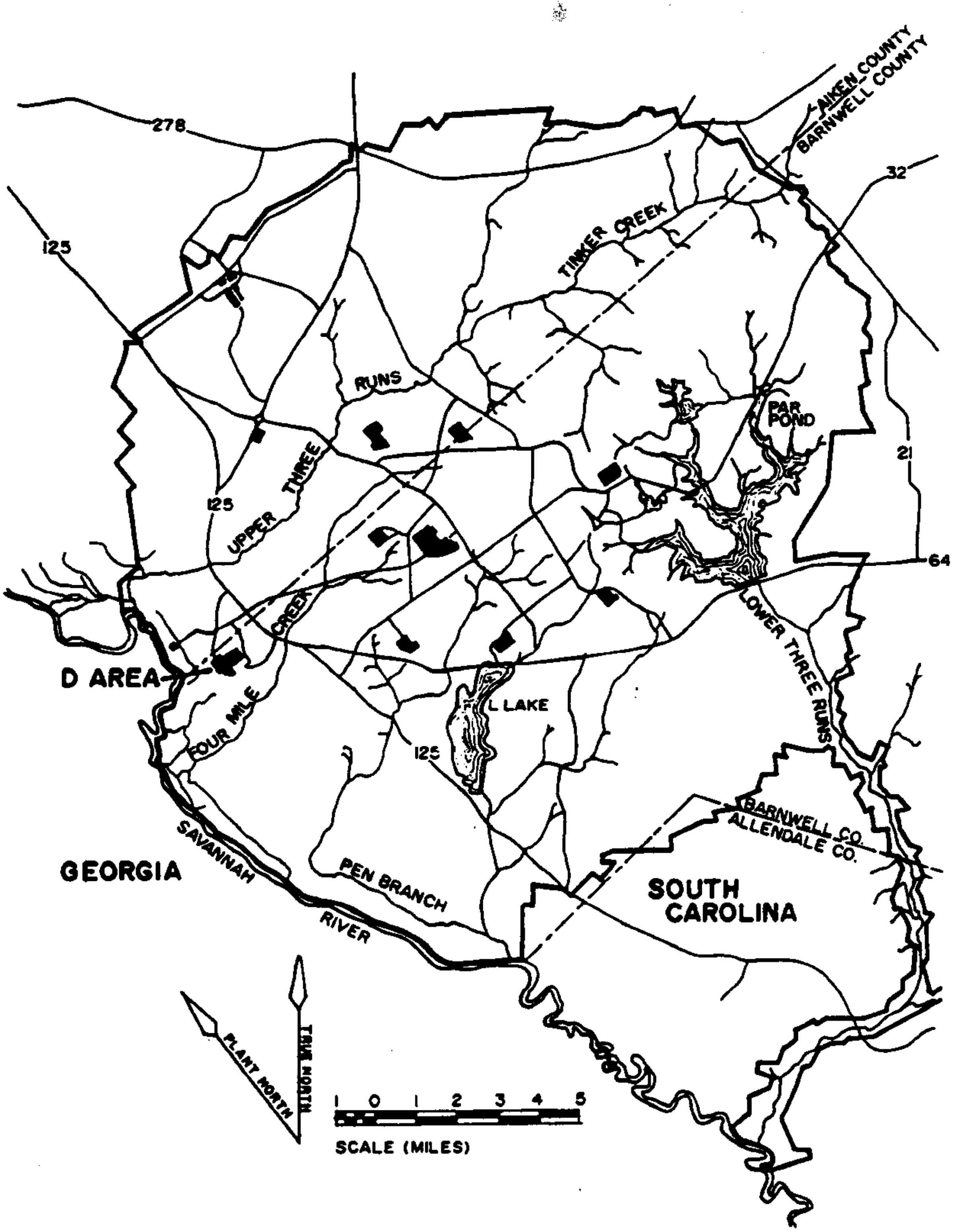


FIGURE 7-1. Location of D Area at SRS

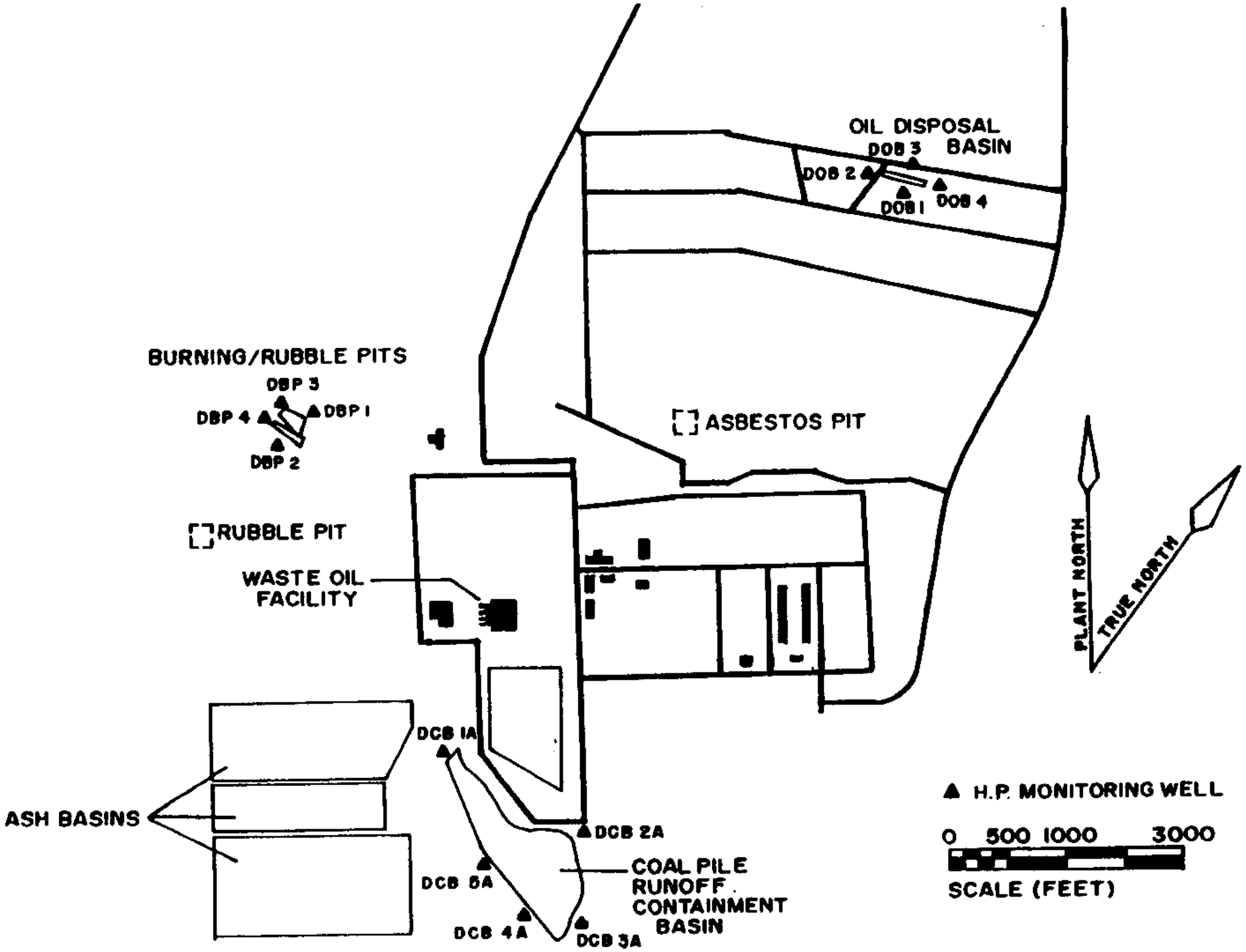


FIGURE 7-2. D-Area Waste Sites

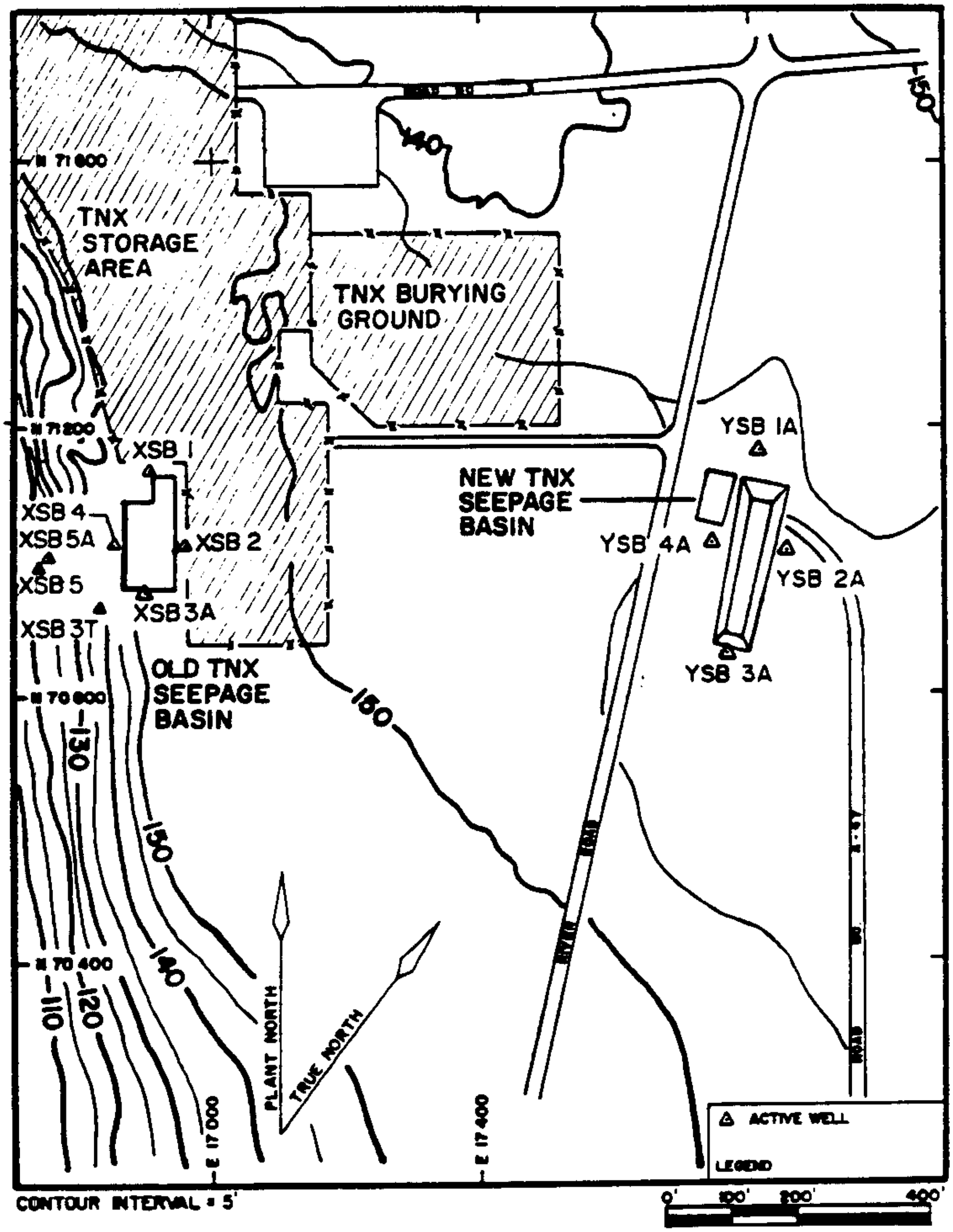


FIGURE 7-3. TNX Waste Sites

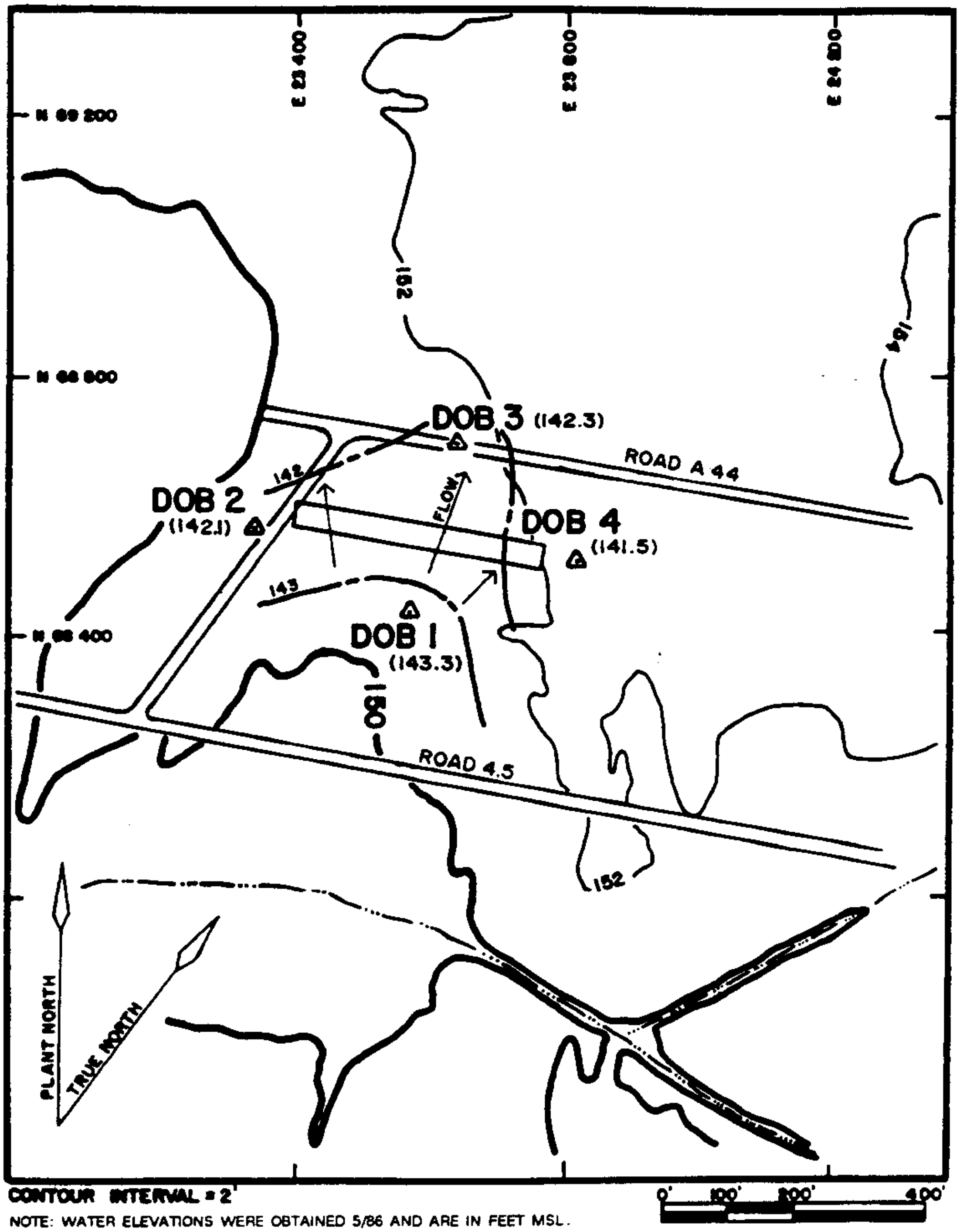


FIGURE 7-4. D-Area Oil Disposal Basin Water-Table Elevation Map (1986)

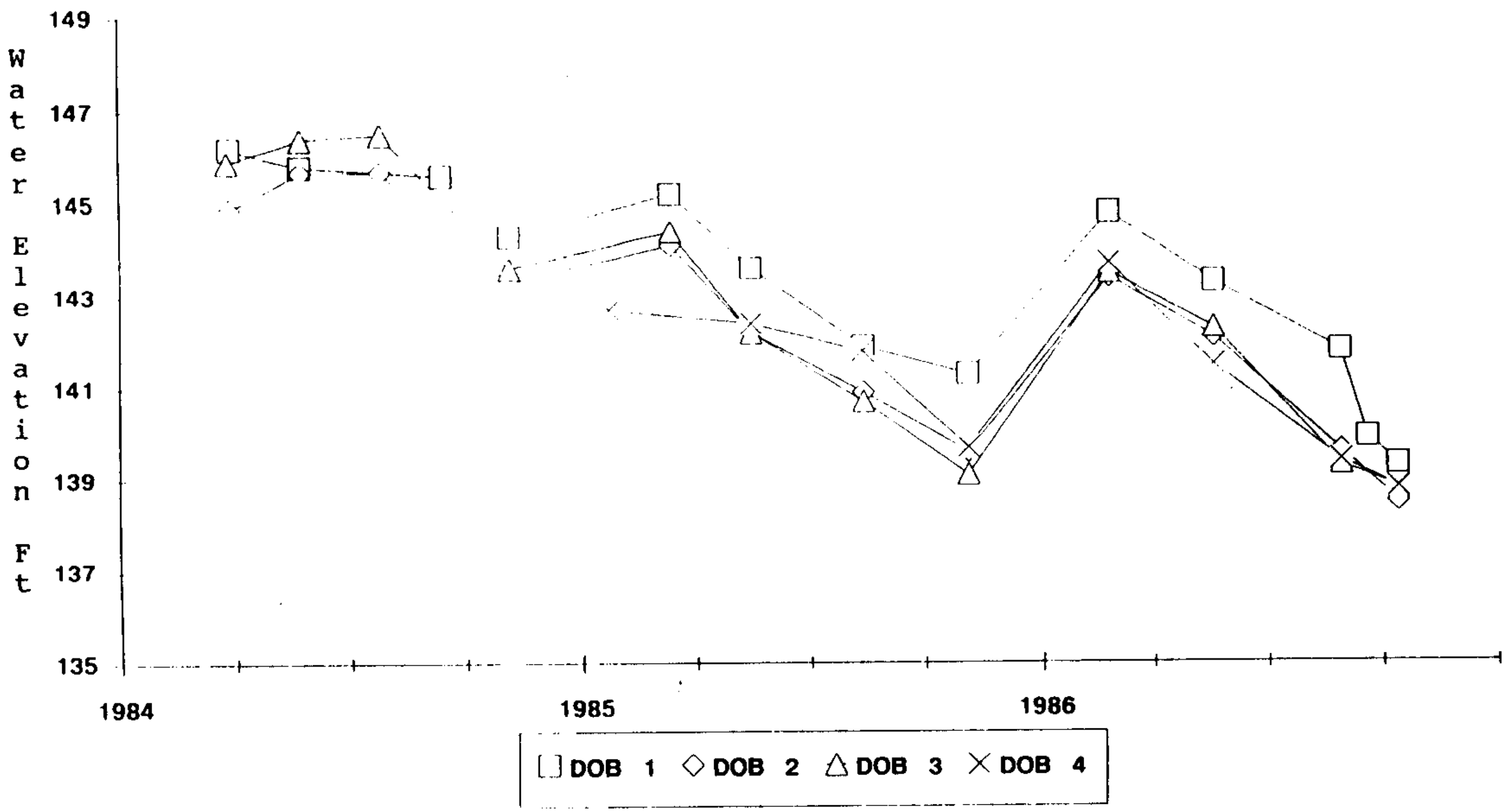


FIGURE 7-5. Hydrograph of the D-Area Oil Disposal Basin Wells

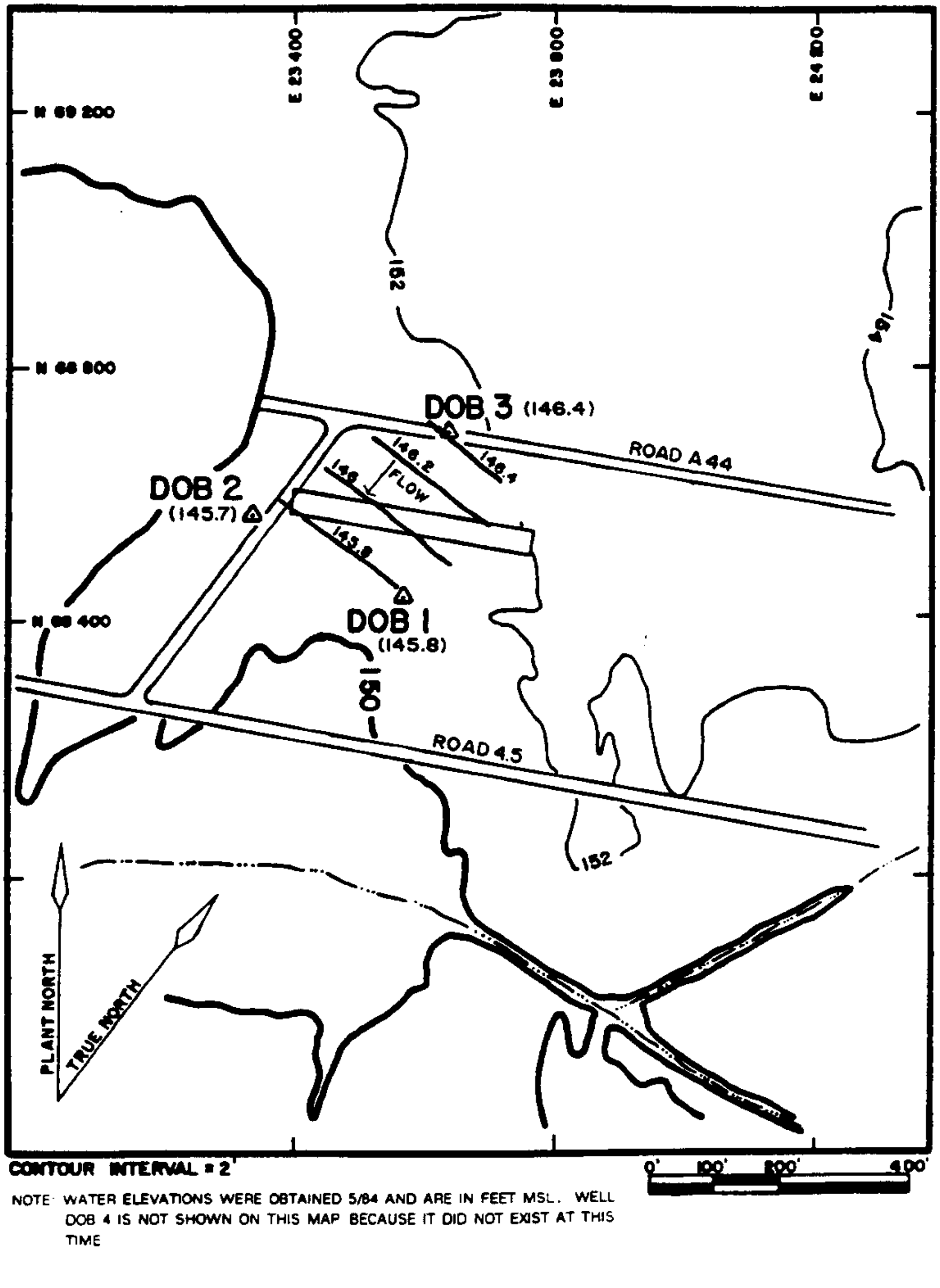


FIGURE 7-6. D-Area Oil Disposal Basin Water-Table Elevation Map (1984)

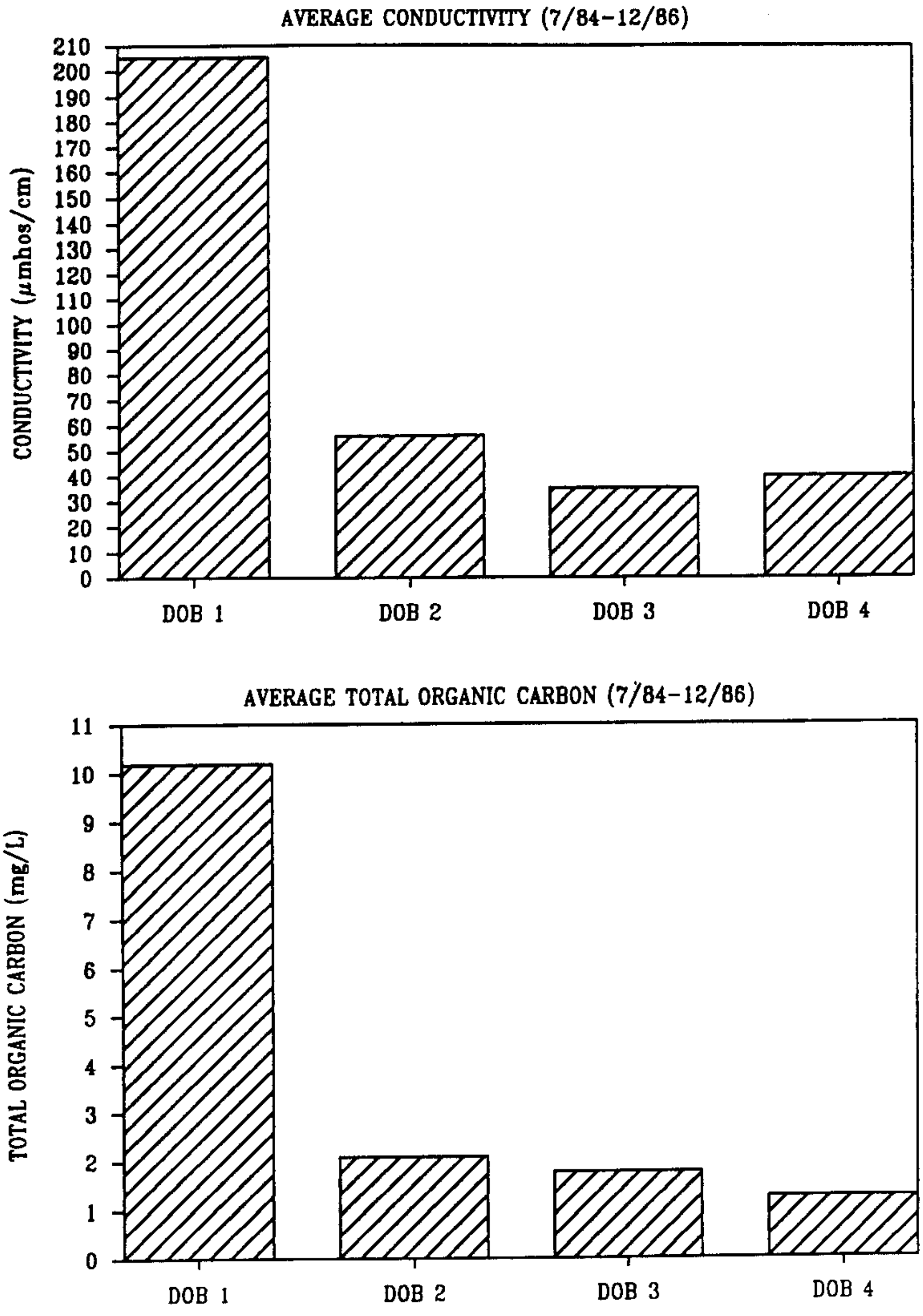


FIGURE 7-7. Average Conductivity and Total Organic Carbon (TOC) Concentrations in the D-Area Oil Disposal Basin Wells

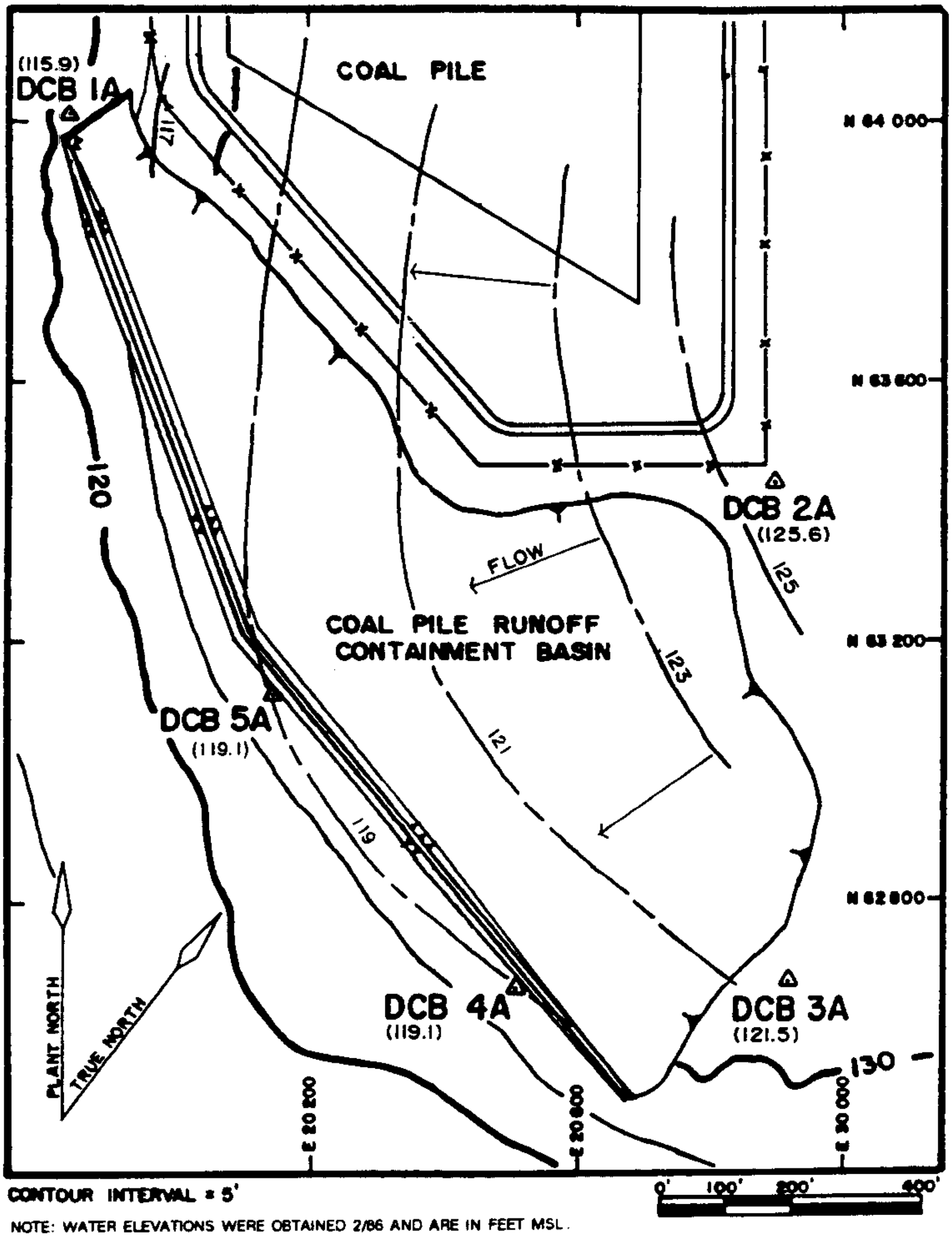


FIGURE 7-8. D-Area Coal Pile Runoff Containment Basin (CPRB) Water-Table Elevation Map

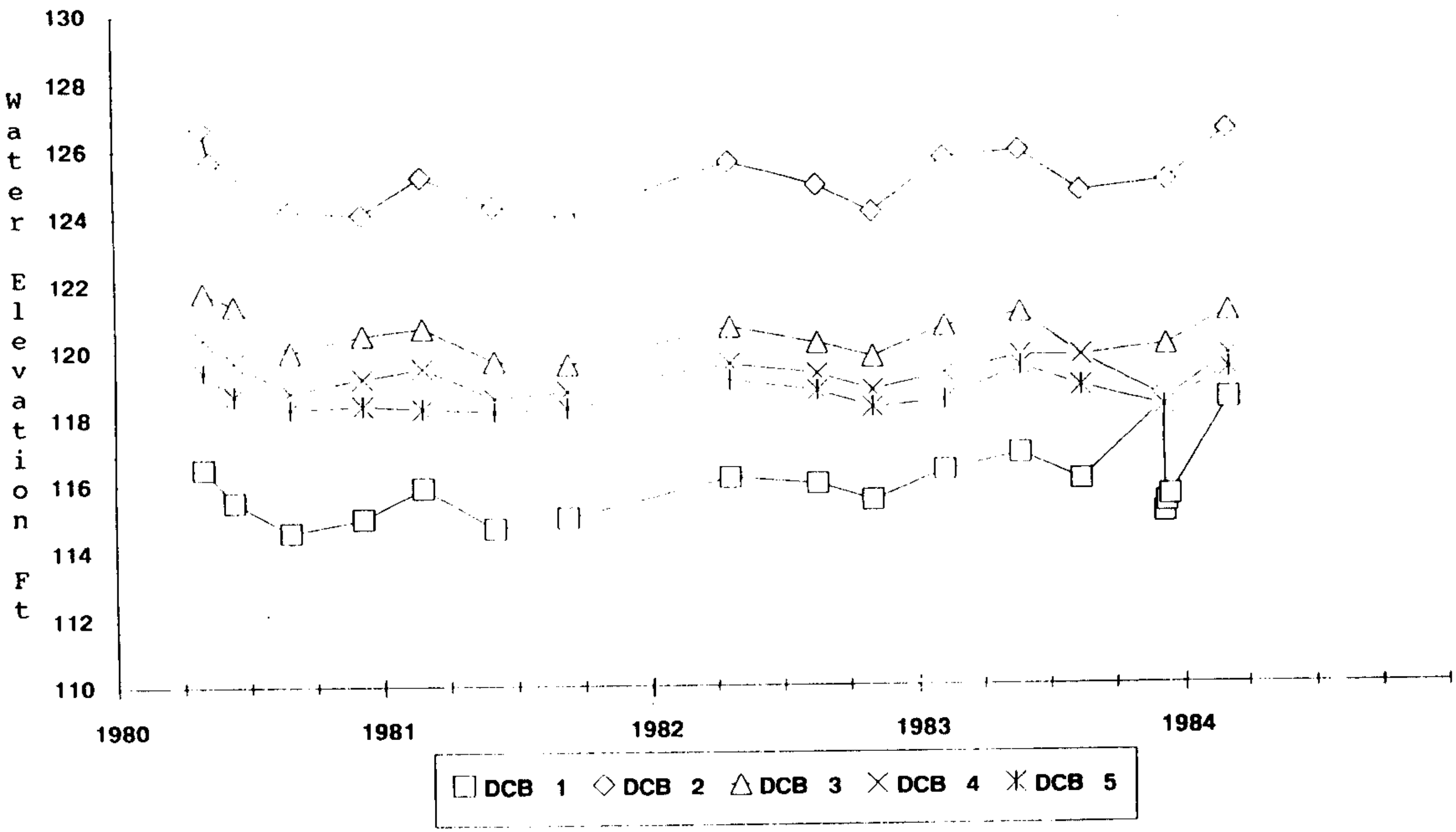


FIGURE 7-9. Hydrograph of D-Area Coal Pile Runoff Containment Basin (CPRB) Wells DCB 1 Through DCB 5 and DCB 1A Through DCB 5A

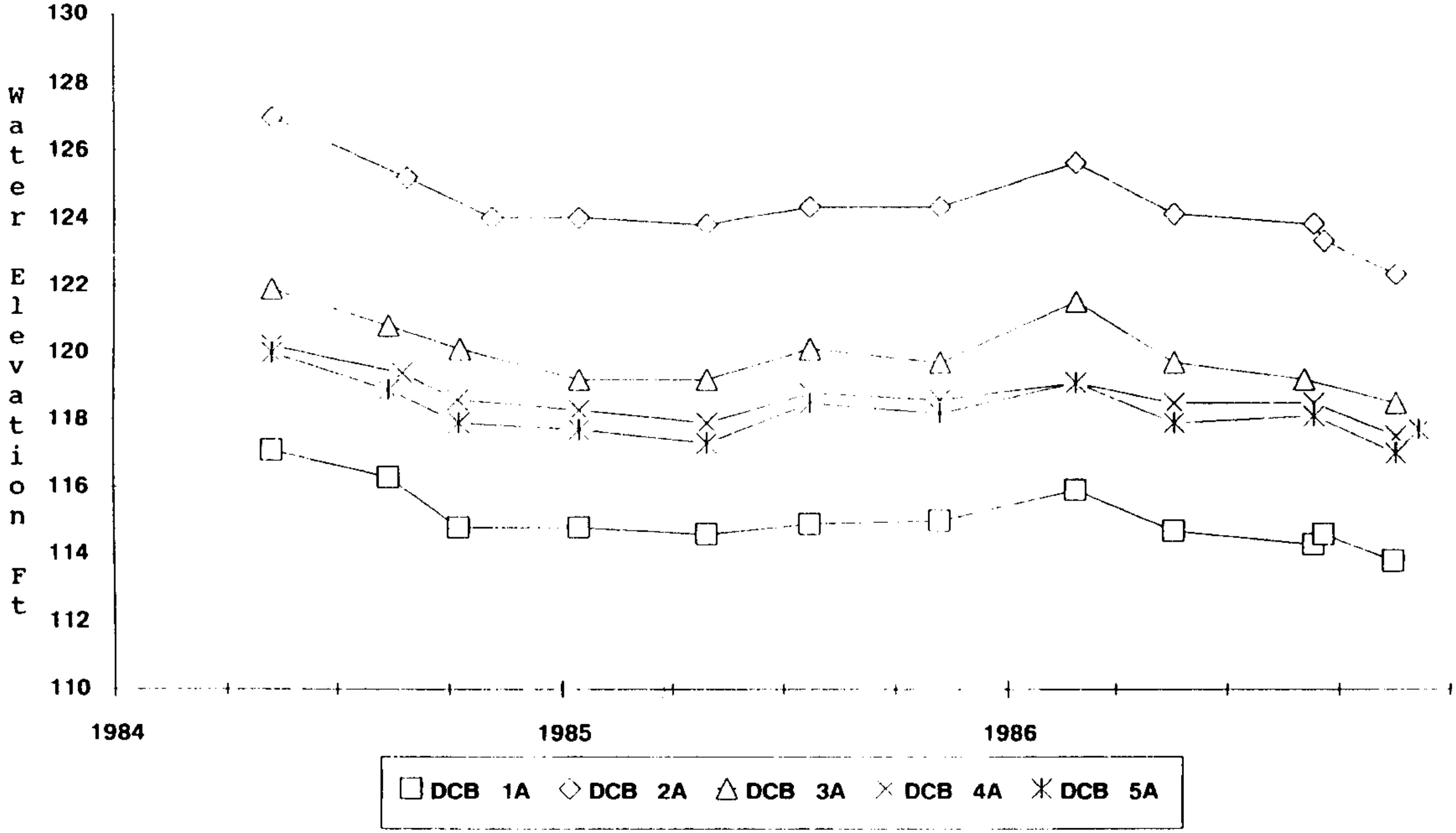
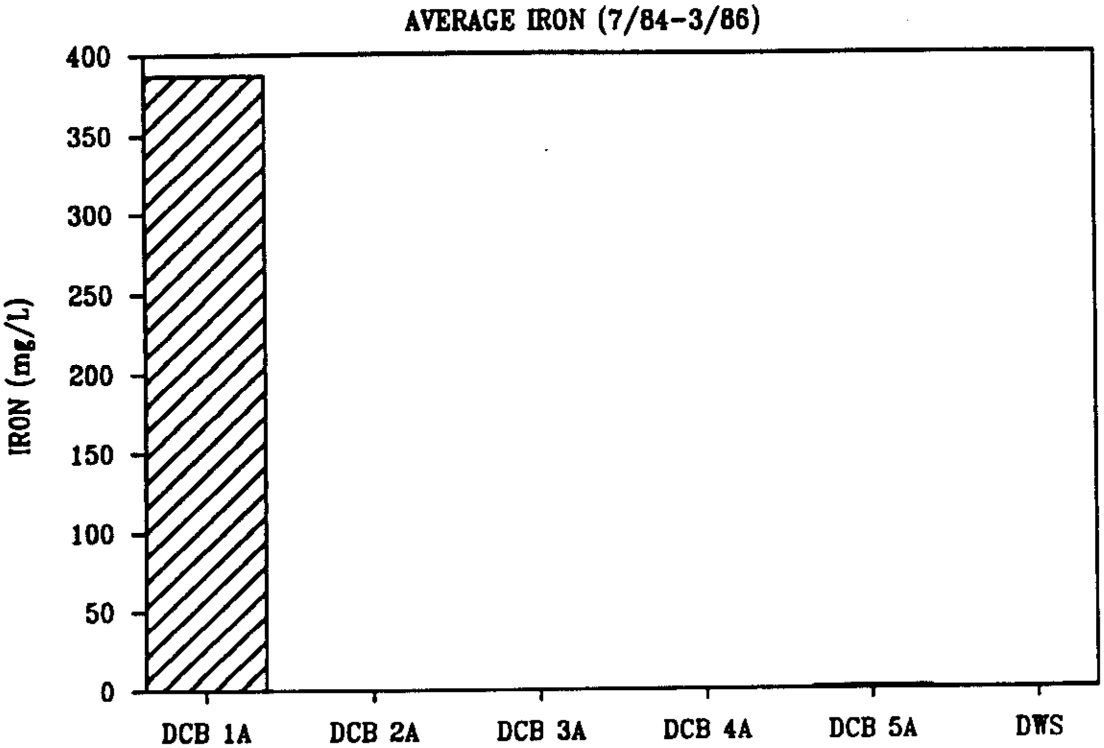


FIGURE 7-9 (cont.). Hydrograph of the D-Area Coal Pile Runoff Containment Basin (CPRB) Wells DCB 1 Through DCB 5 and DCB 1A Through DCB 5A



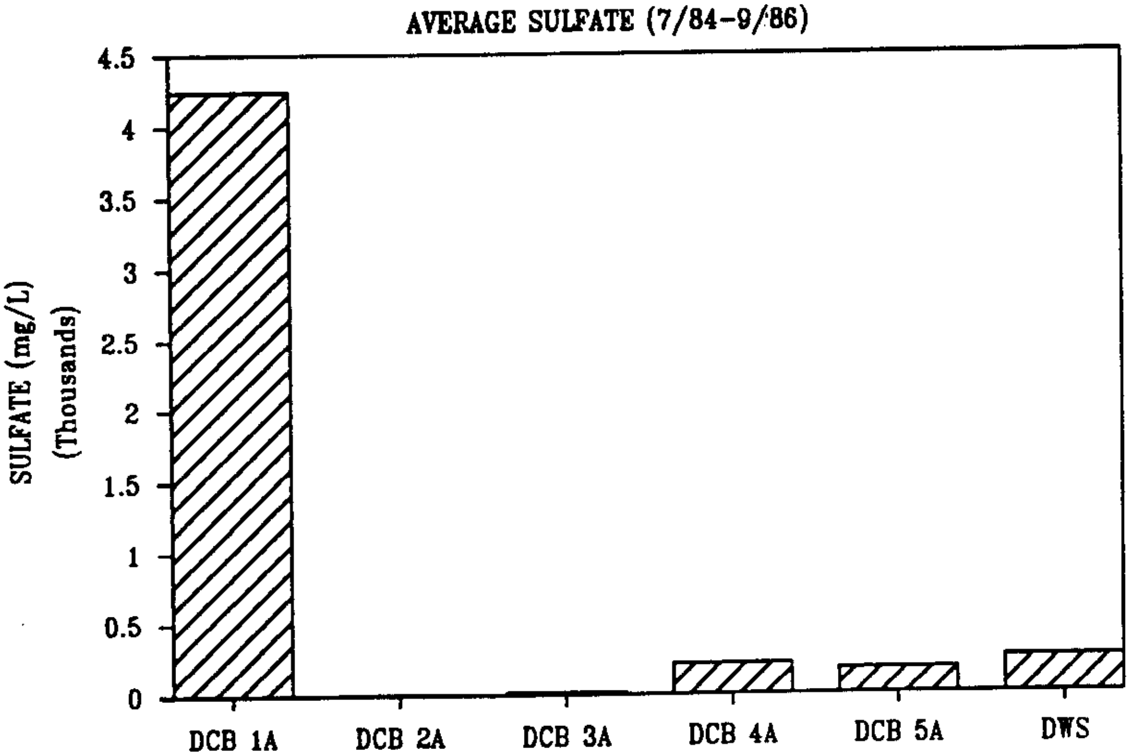


FIGURE 7-10. Average Iron and Sulfate Concentrations in the D-Area Coal Pile Runoff Containment Basin (CPRB) Wells

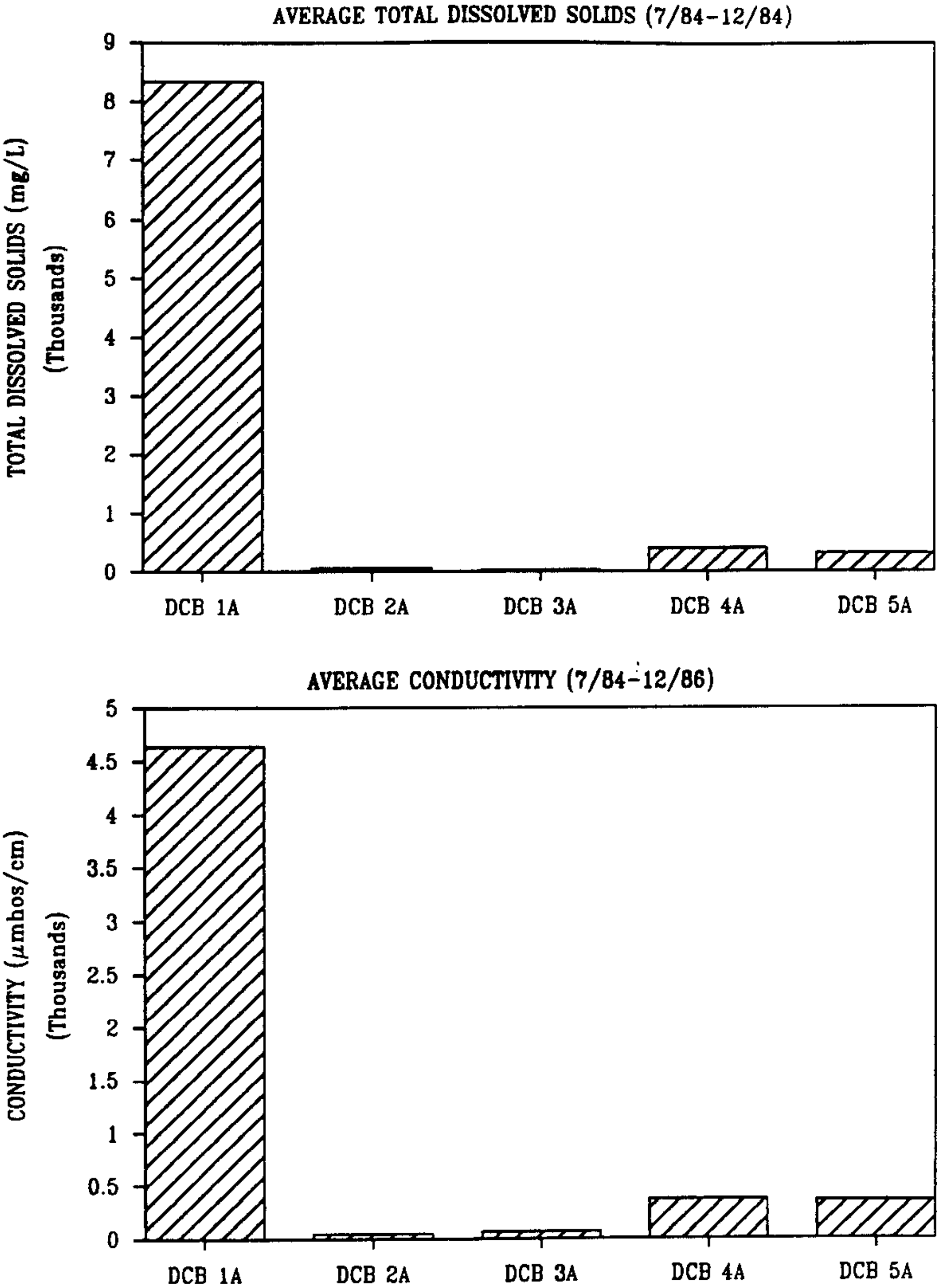


FIGURE 7-11. Average Total Dissolved Solids (TDS) Concentrations and Conductivity in the D-Area Coal Pile Runoff Containment Basin (CPRB) Wells

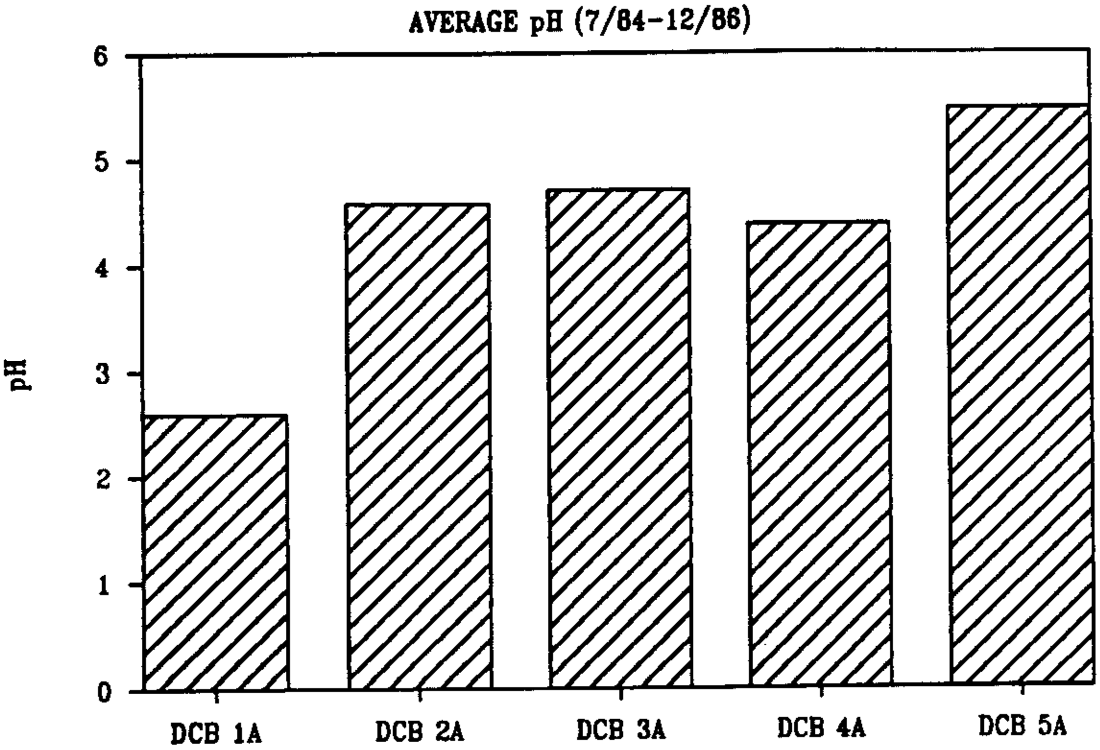


FIGURE 7-12. Average pH in the D-Area Coal Pile Runoff Containment Basin (CPRB) Wells

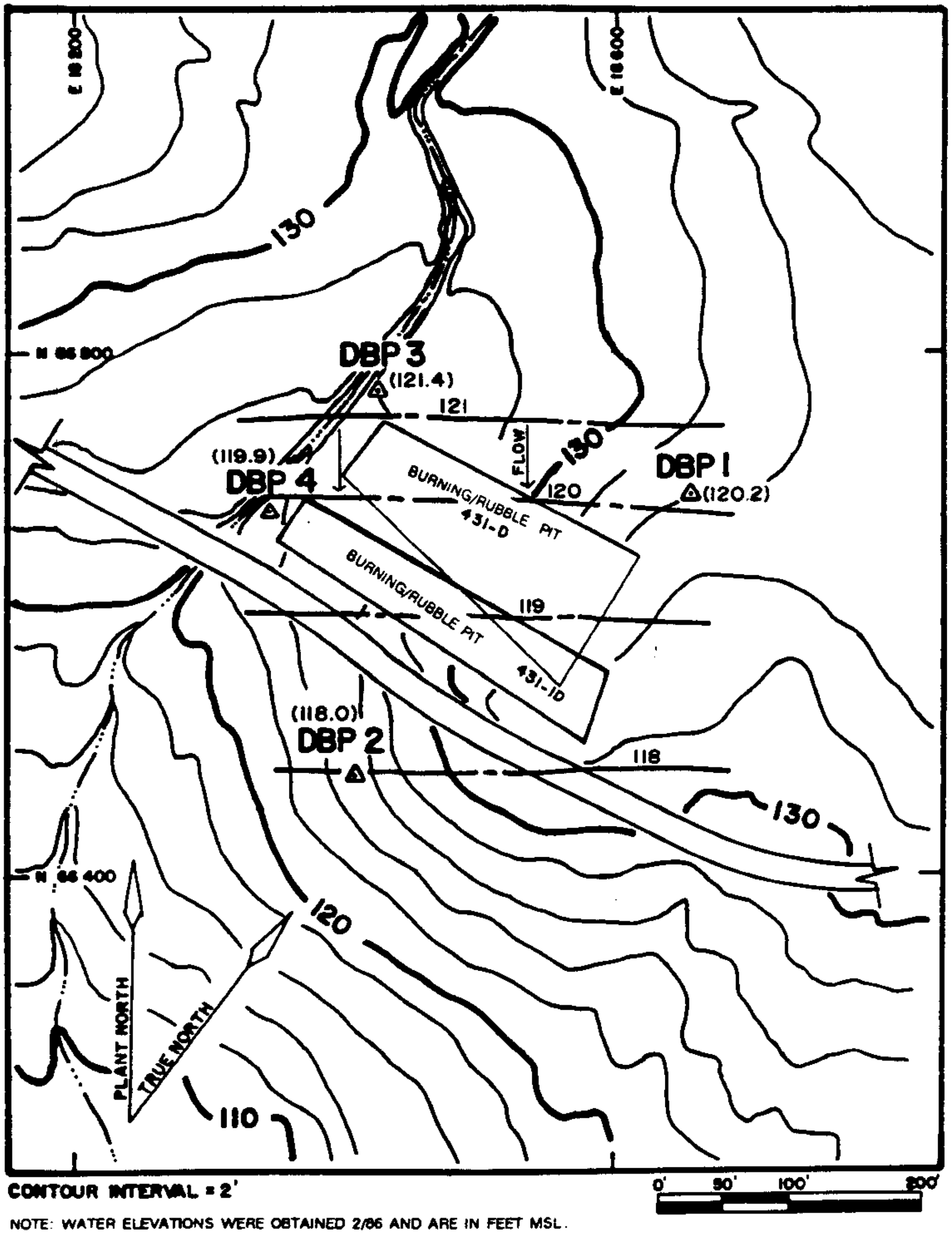


FIGURE 7-13. D-Area Burning/Rubble Pits Water-Table Elevation Map

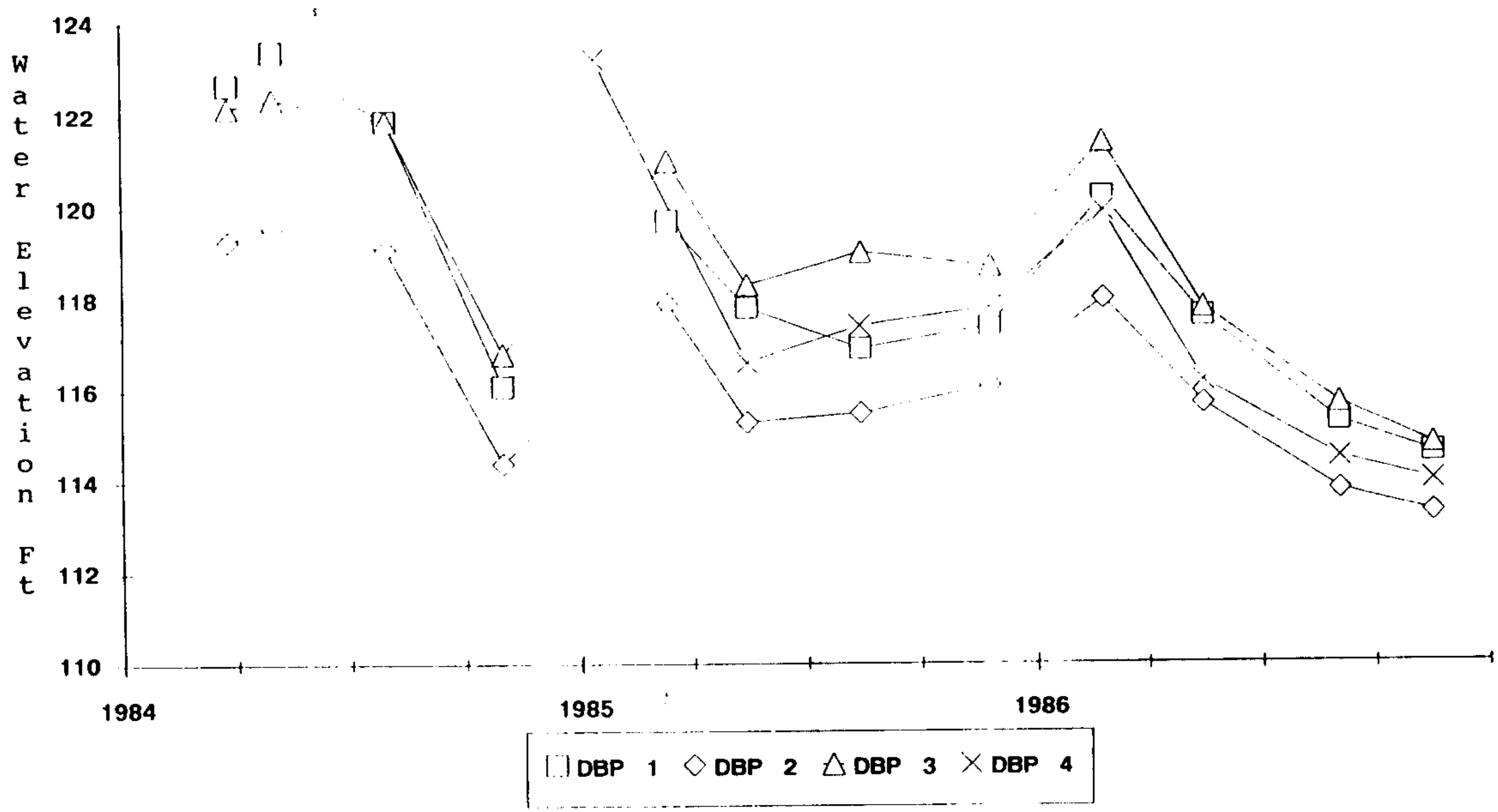


FIGURE 7-14. Hydrograph of the D-Area Burning/Rubble Pits Wells

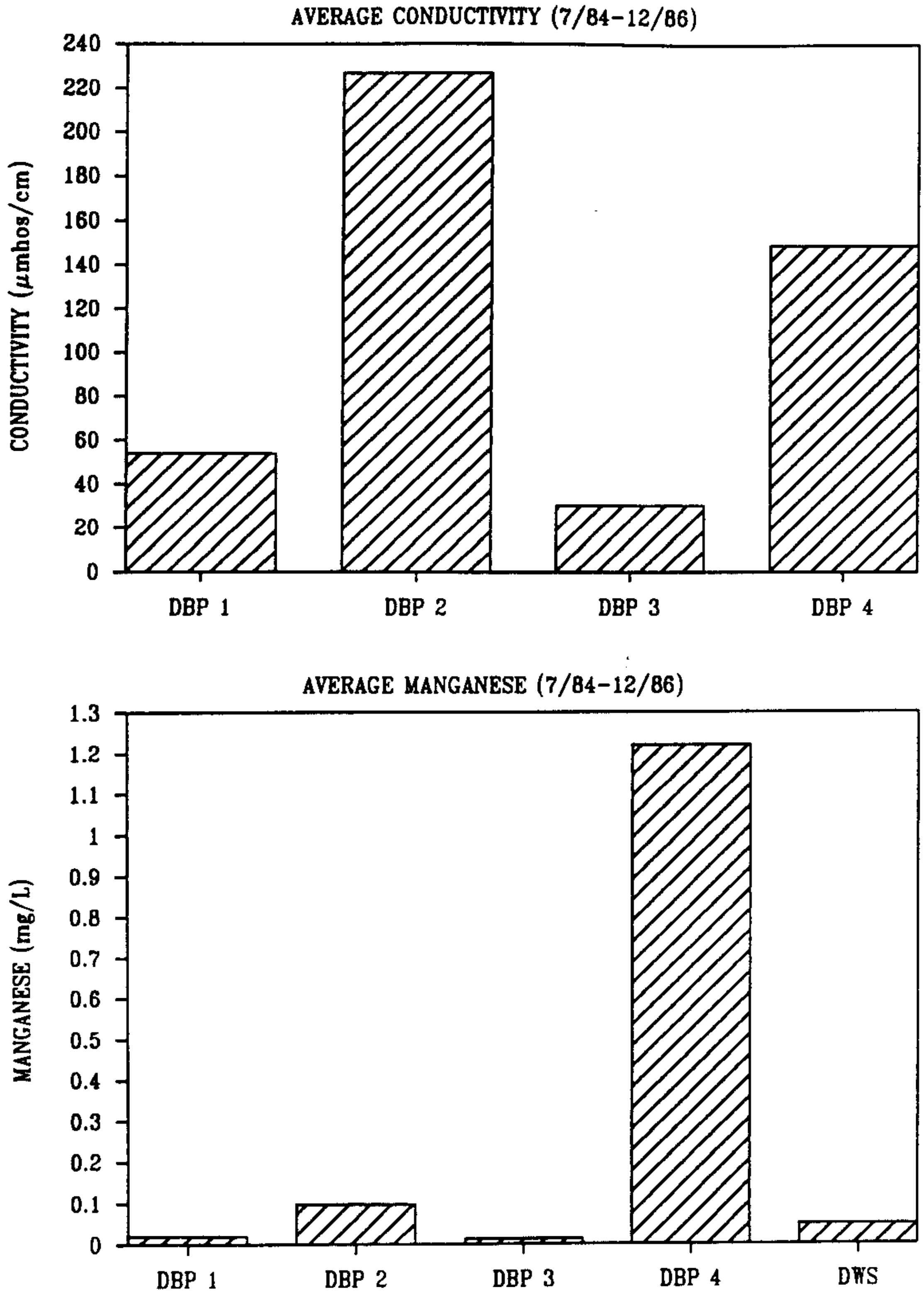


FIGURE 7-15. Average Conductivity and Manganese Concentrations in the D-Area Burning/Rubble Pits Wells

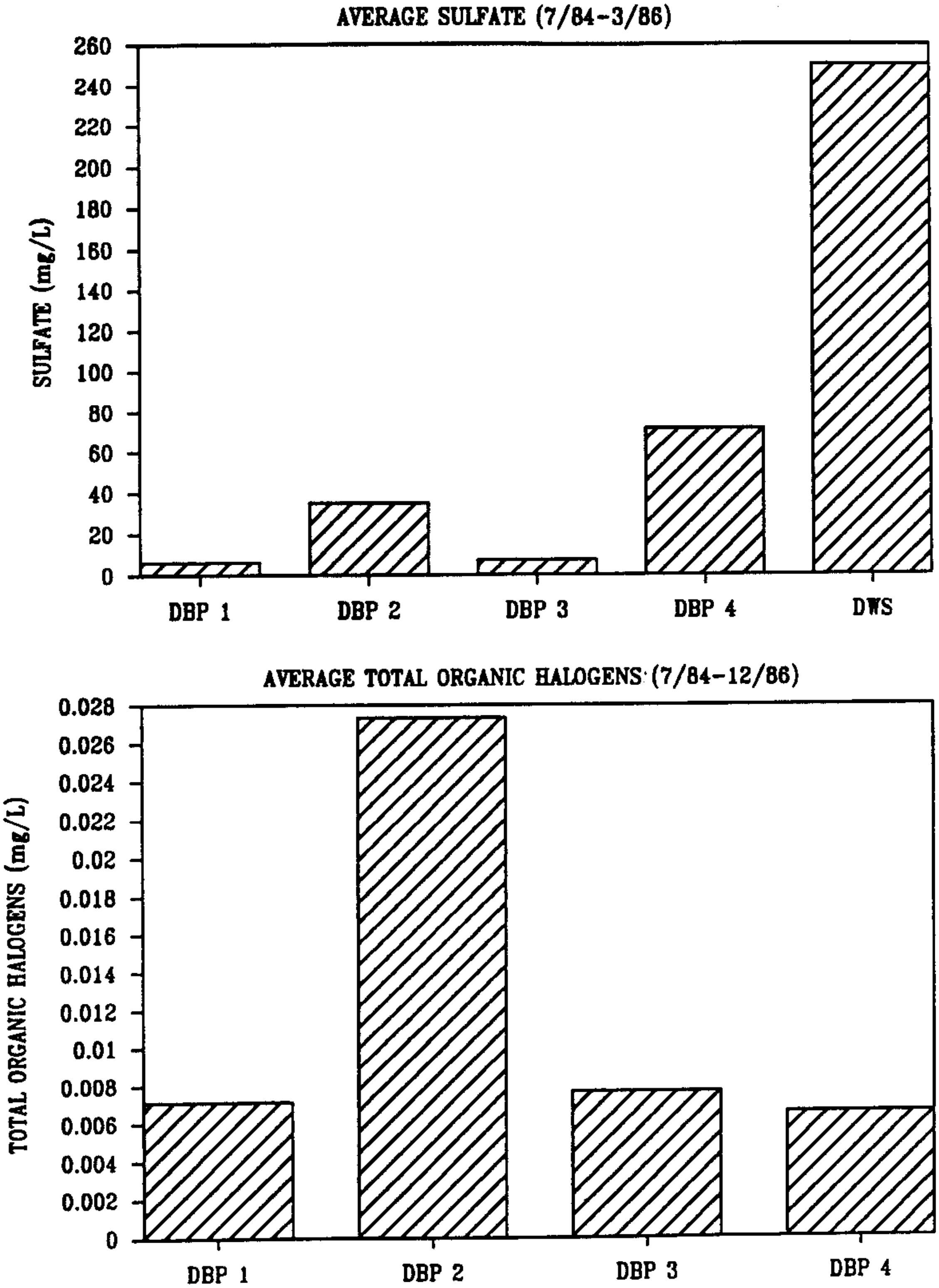


FIGURE 7-16. Average Sulfate and Total Organic Halogens (TOH) Concentrations in the D-Area Burning/Rubble Pits Wells

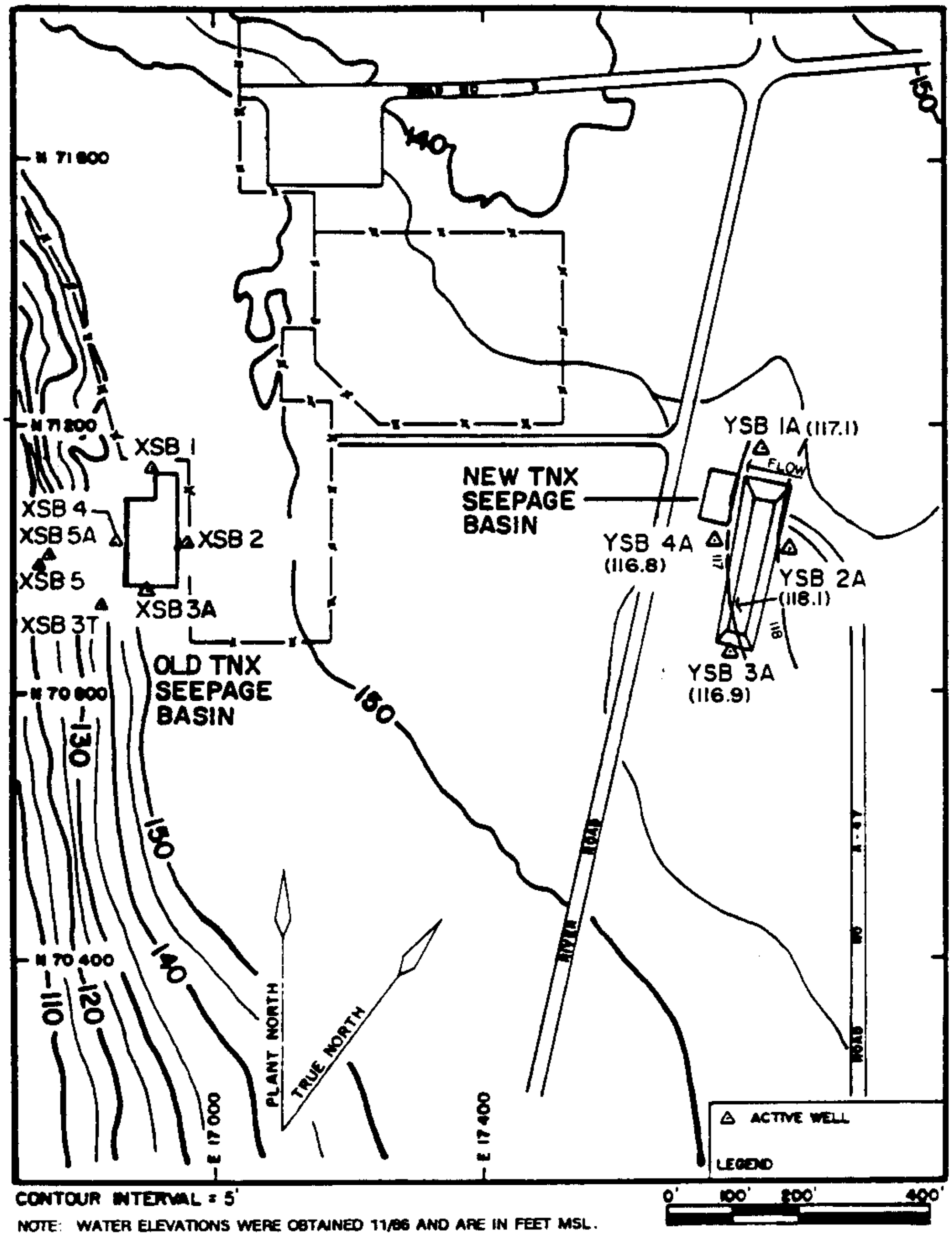


FIGURE 7-17. New TNX Seepage Basin and Old TNX Seepage Basin Water-Table Elevation Map

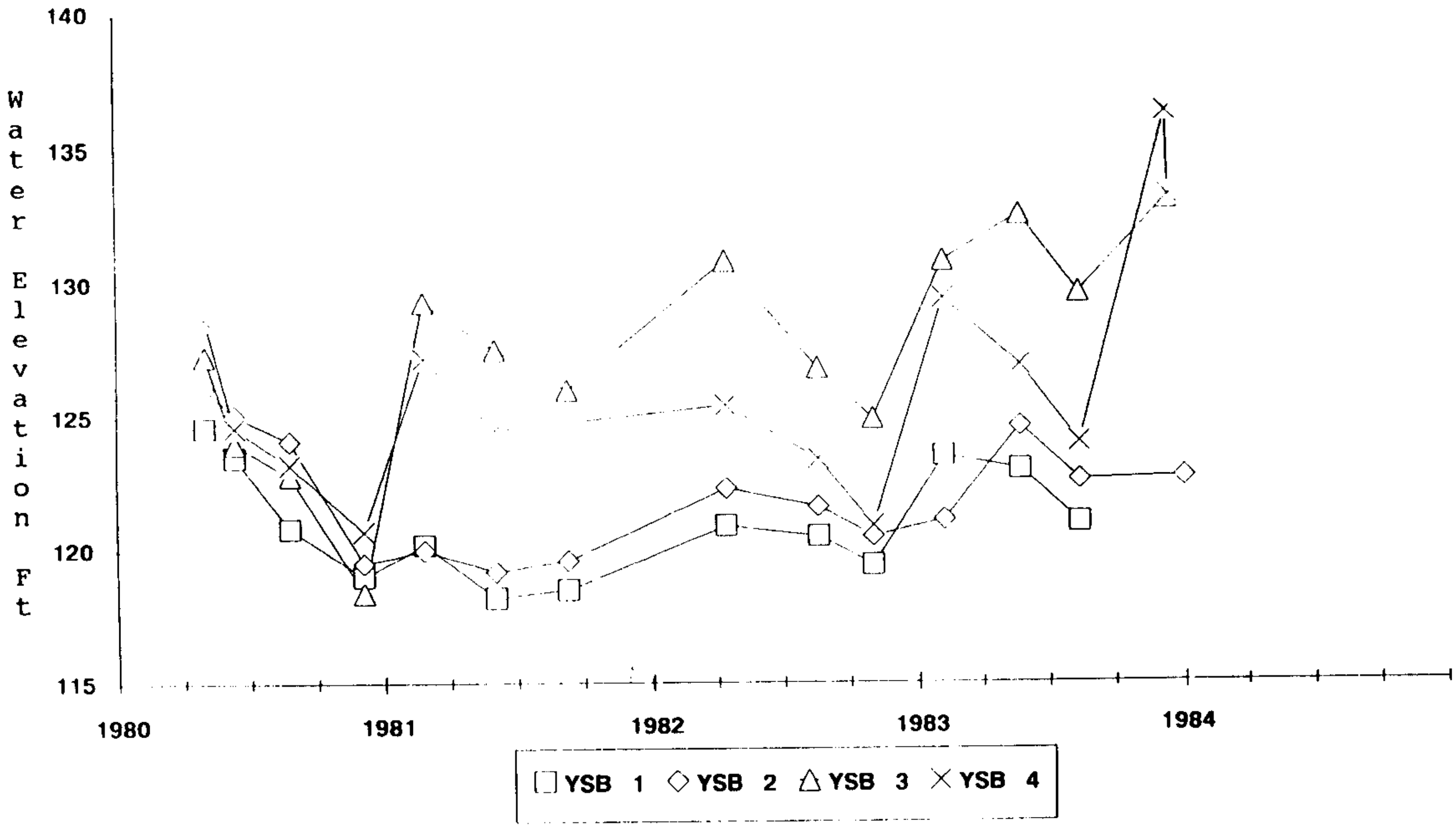


FIGURE 7-18. Hydrograph of the New TNX Seepage Basin Wells

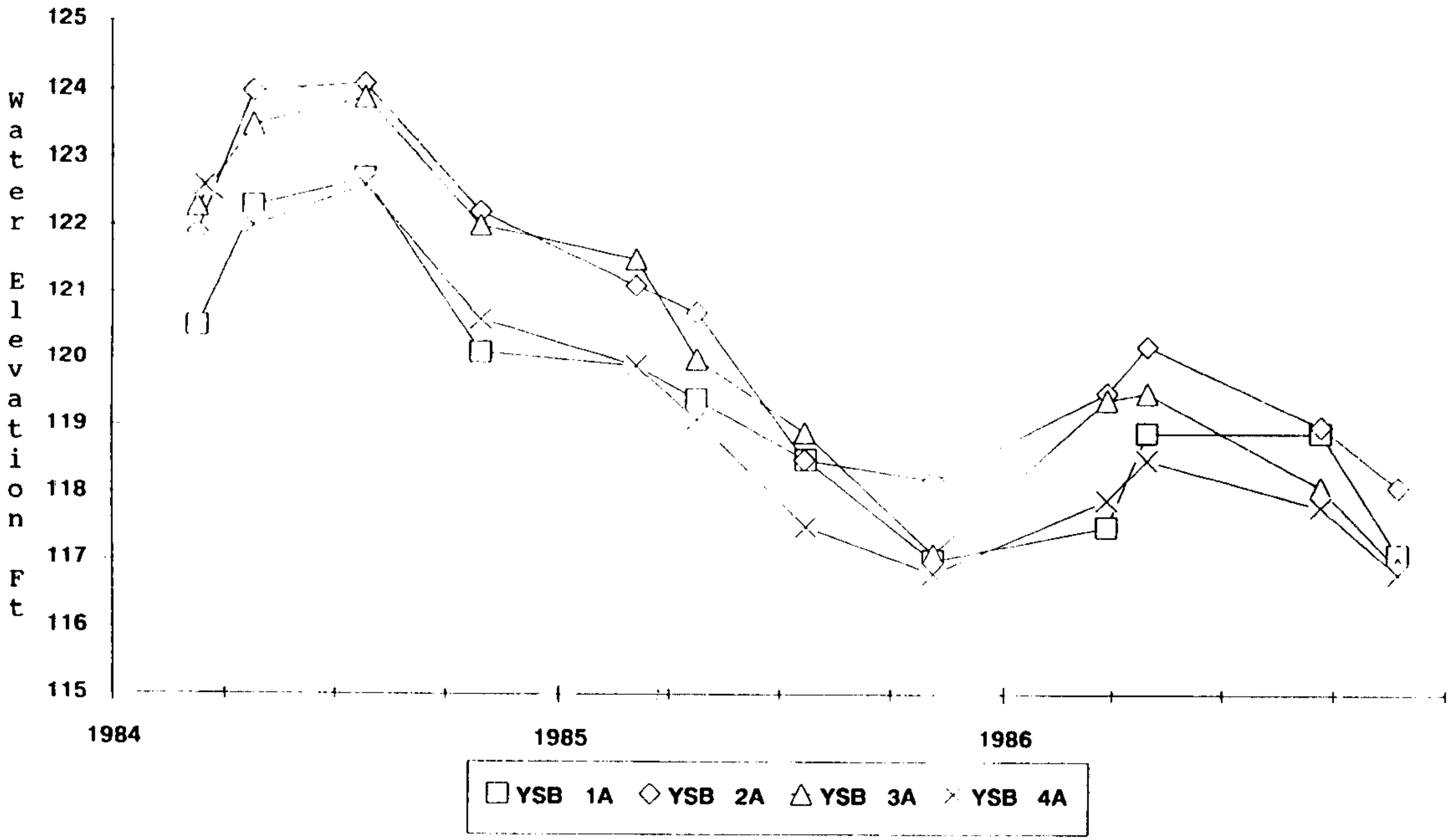


FIGURE 7-18 (cont.). Hydrograph of the New TNX Seepage Basin Wells

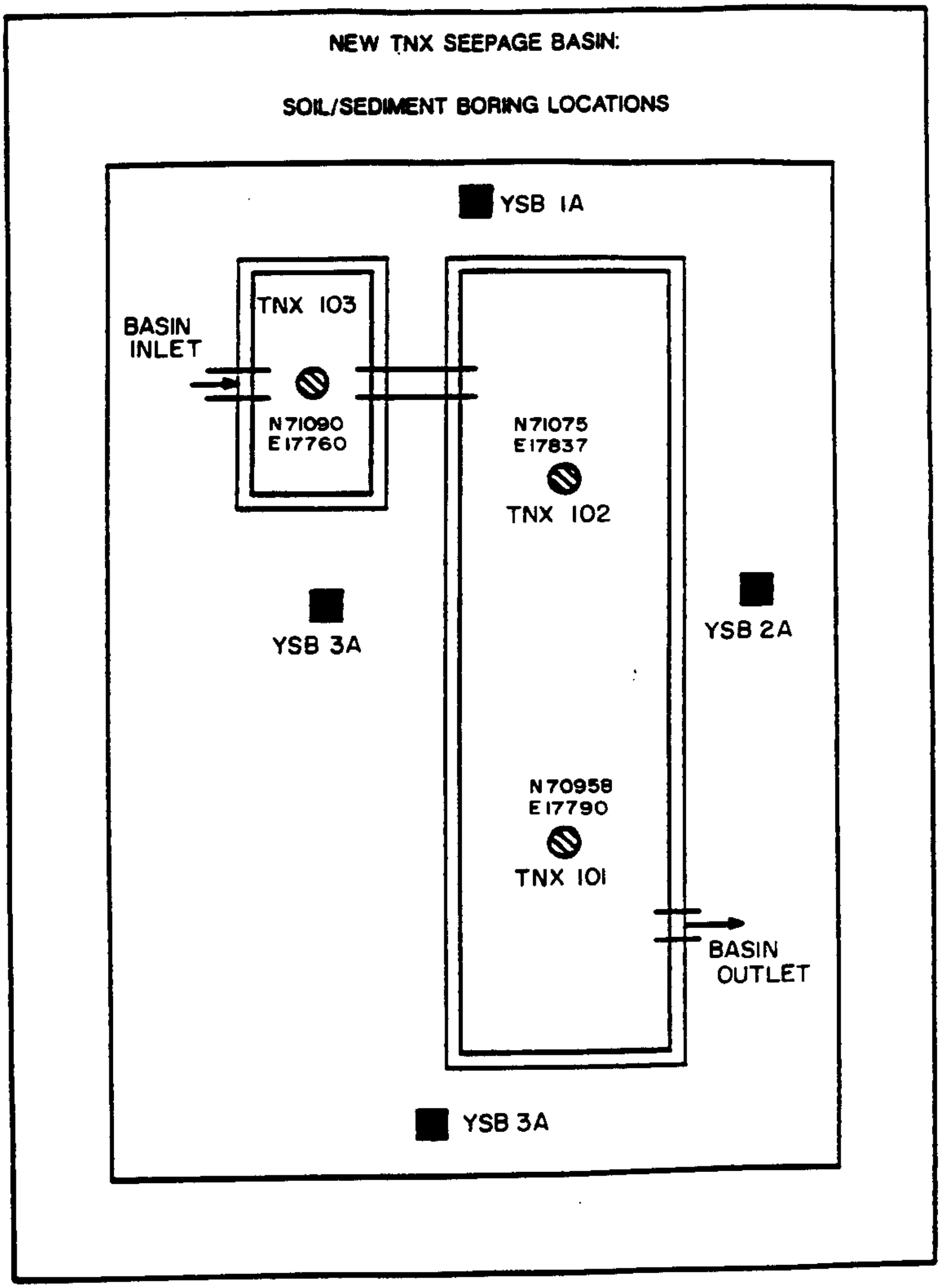


FIGURE 7-19. Soil Sampling Locations at the New TNX Seepage Basin

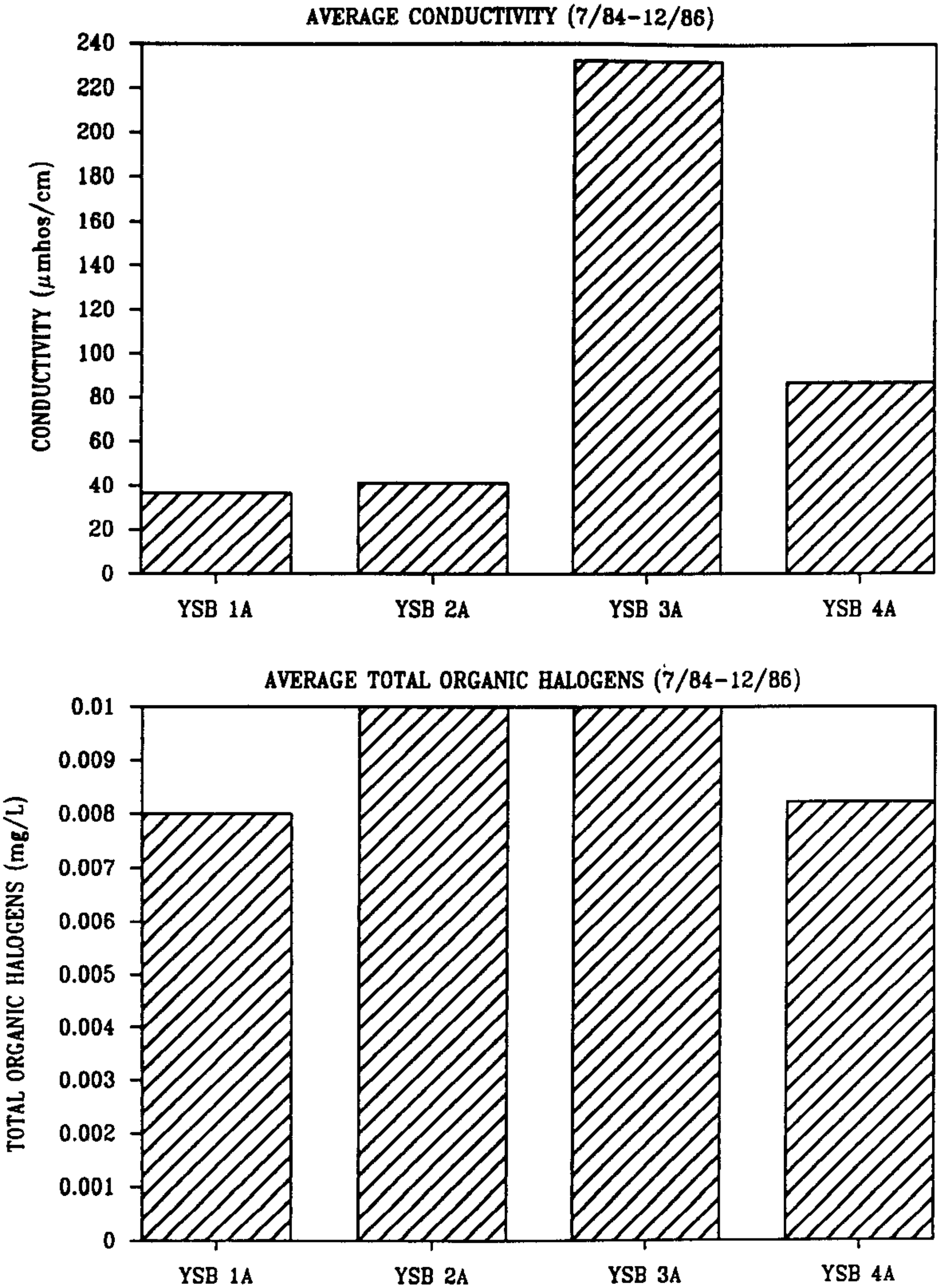


FIGURE 7-20. Average Conductivity and Total Organic Halogens (TOH) Concentrations in the New TNX Seepage Basin Wells

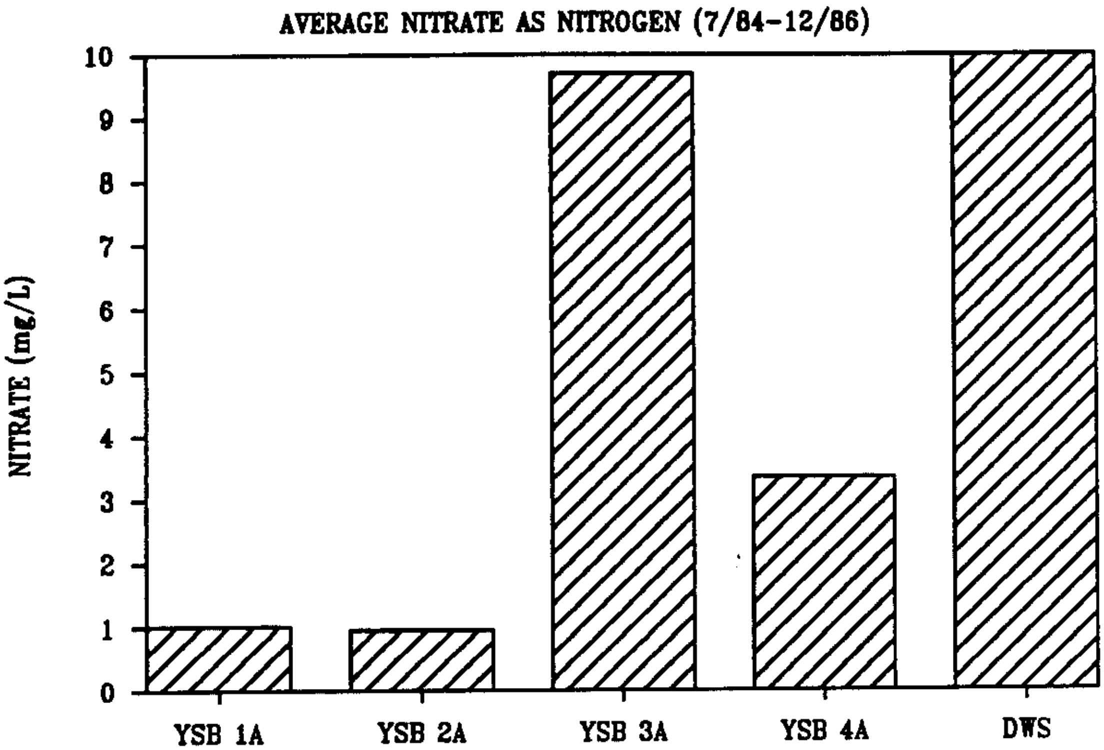


FIGURE 7-21. Average Nitrate (as N) Concentrations in the New TNX Seepage Basin Wells

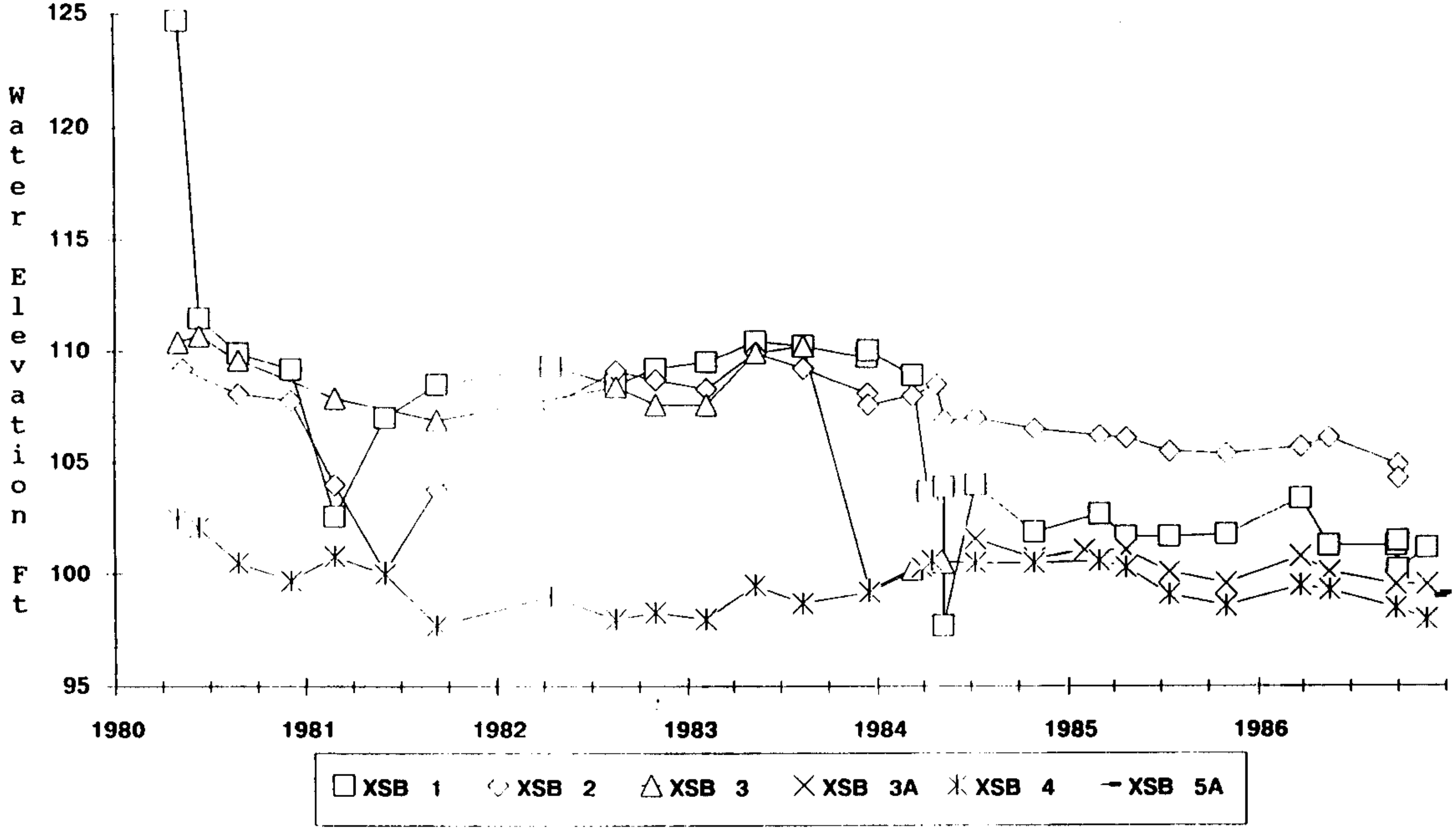


FIGURE 7-22. Hydrograph of the Old TNX Seepage Basin Wells

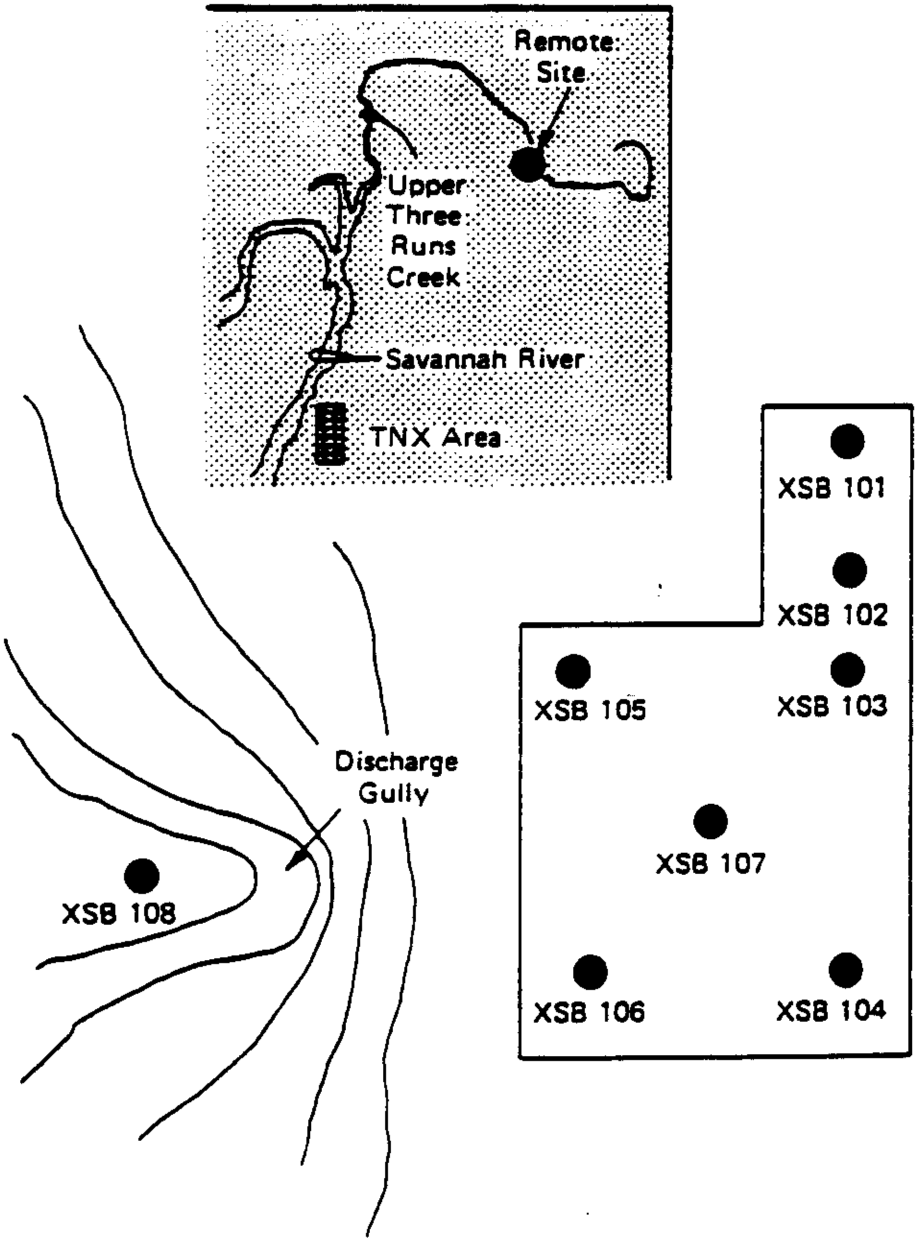


FIGURE 7-23. Deep Soil Sampling Locations at the Old TNX Seepage Basin

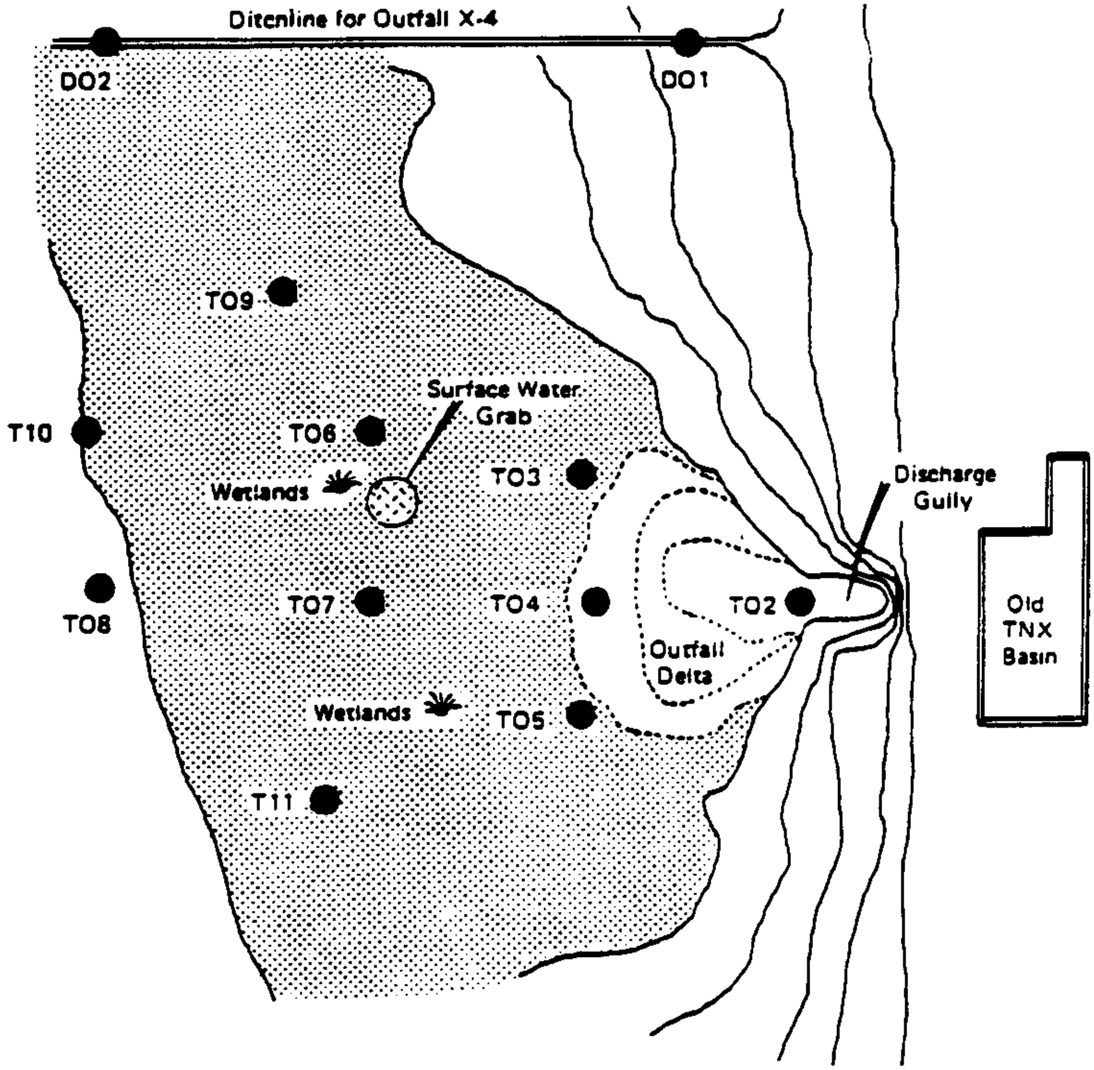
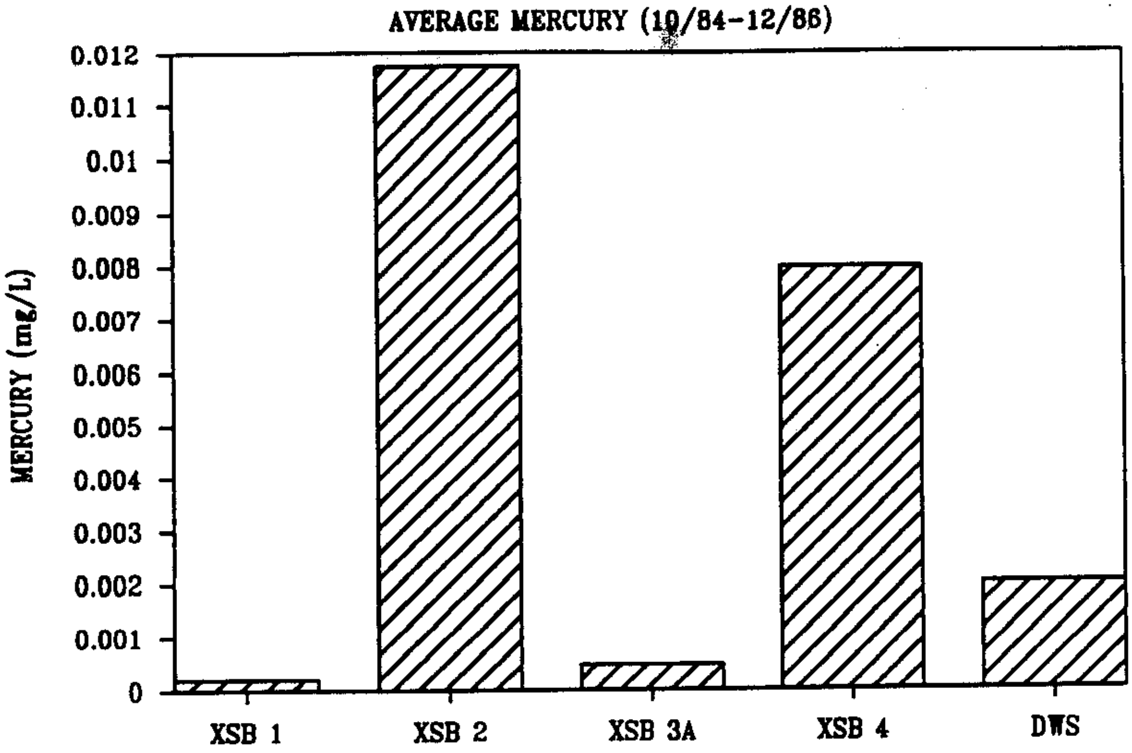
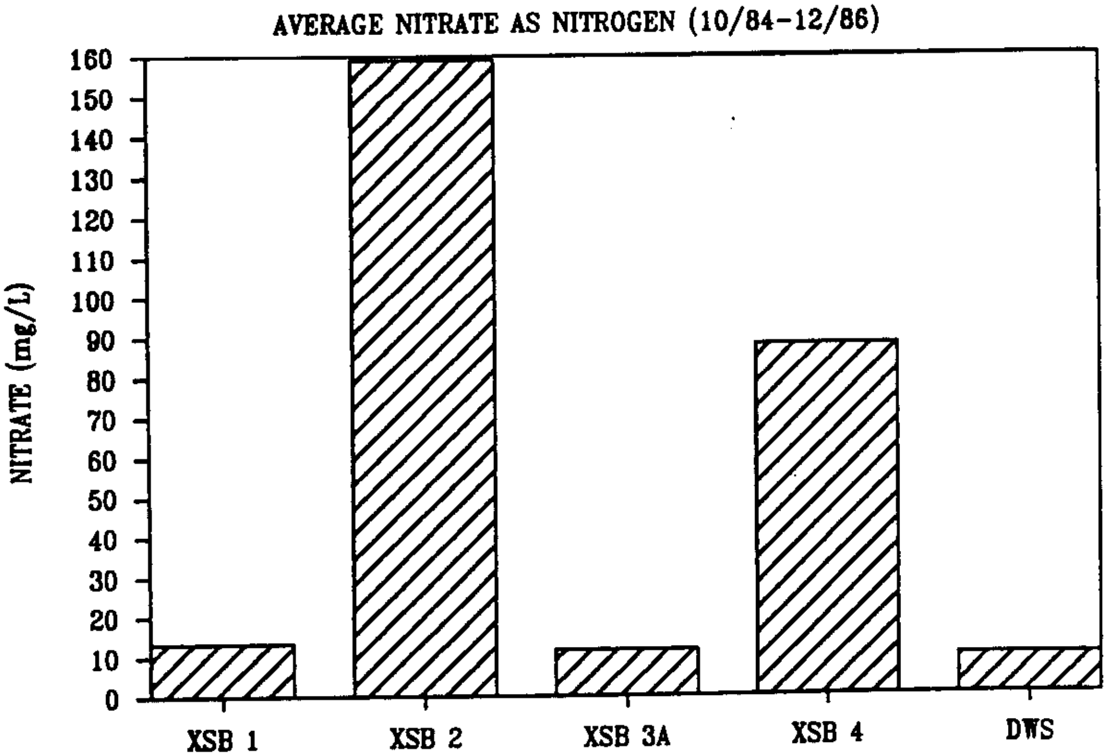


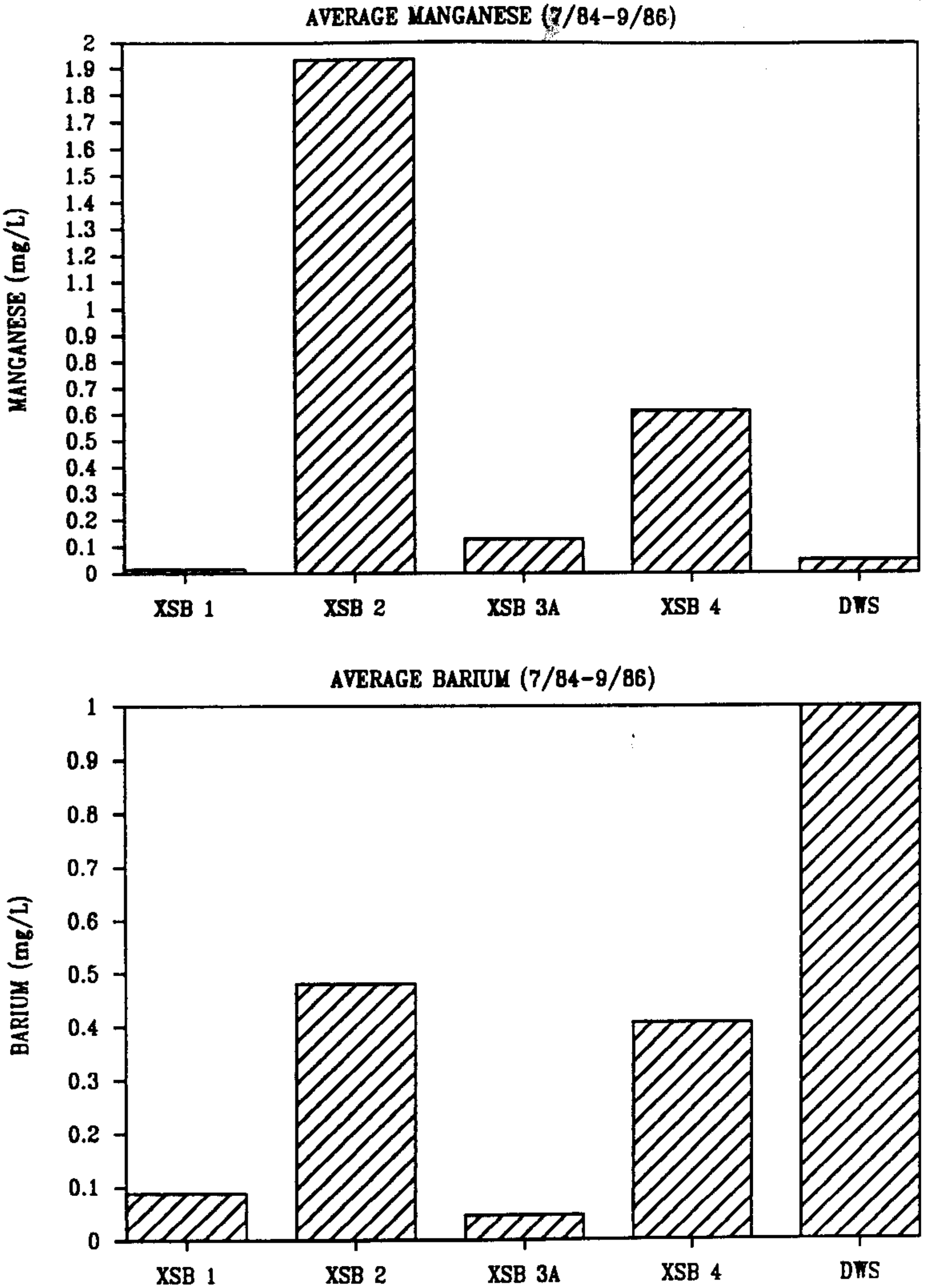
FIGURE 7-24. Shallow Soil Sampling Locations in the Delta and Swamp





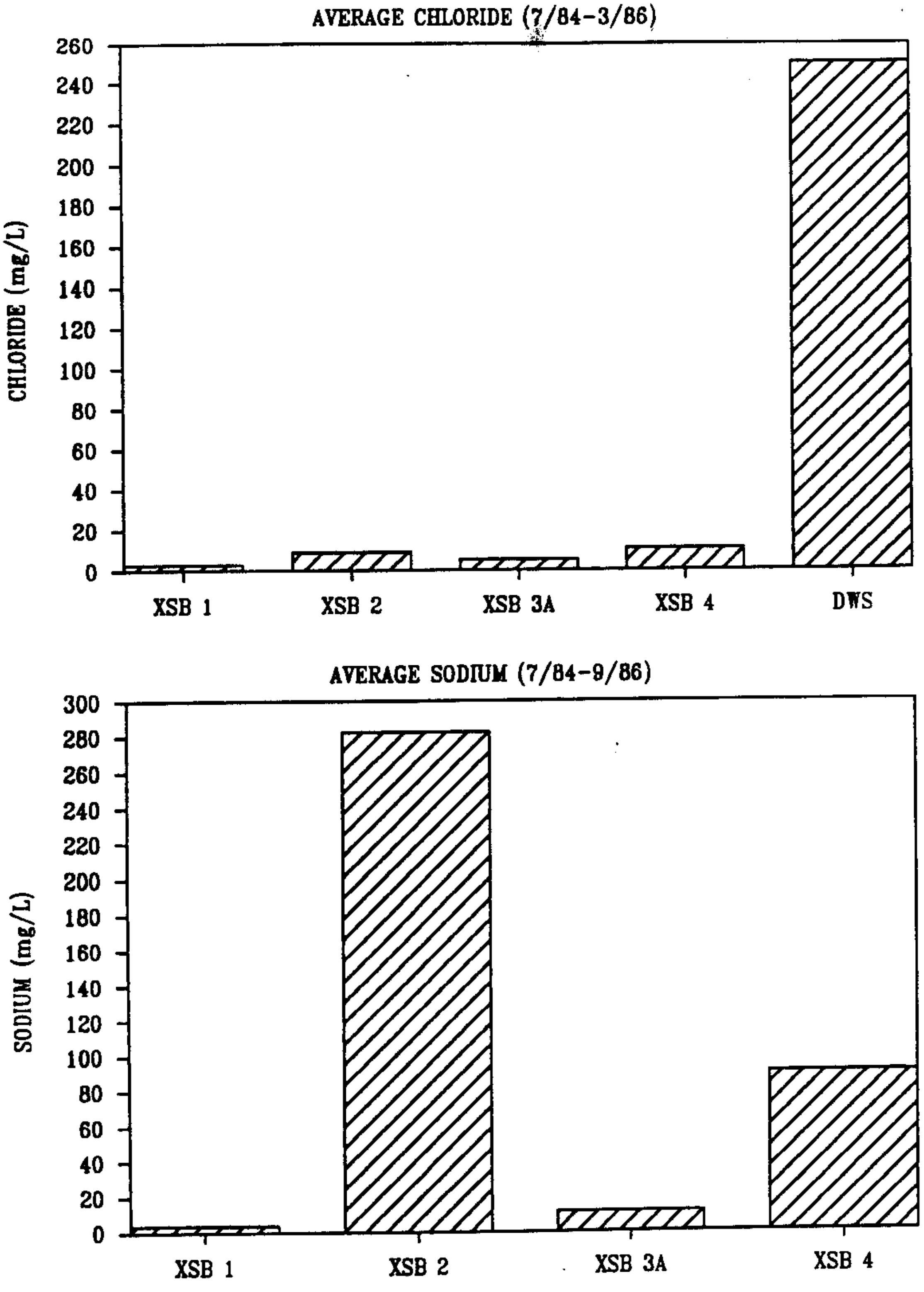
NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-25. Average Mercury and Nitrate (as N) Concentrations in the Old TNX Seepage Basin Wells



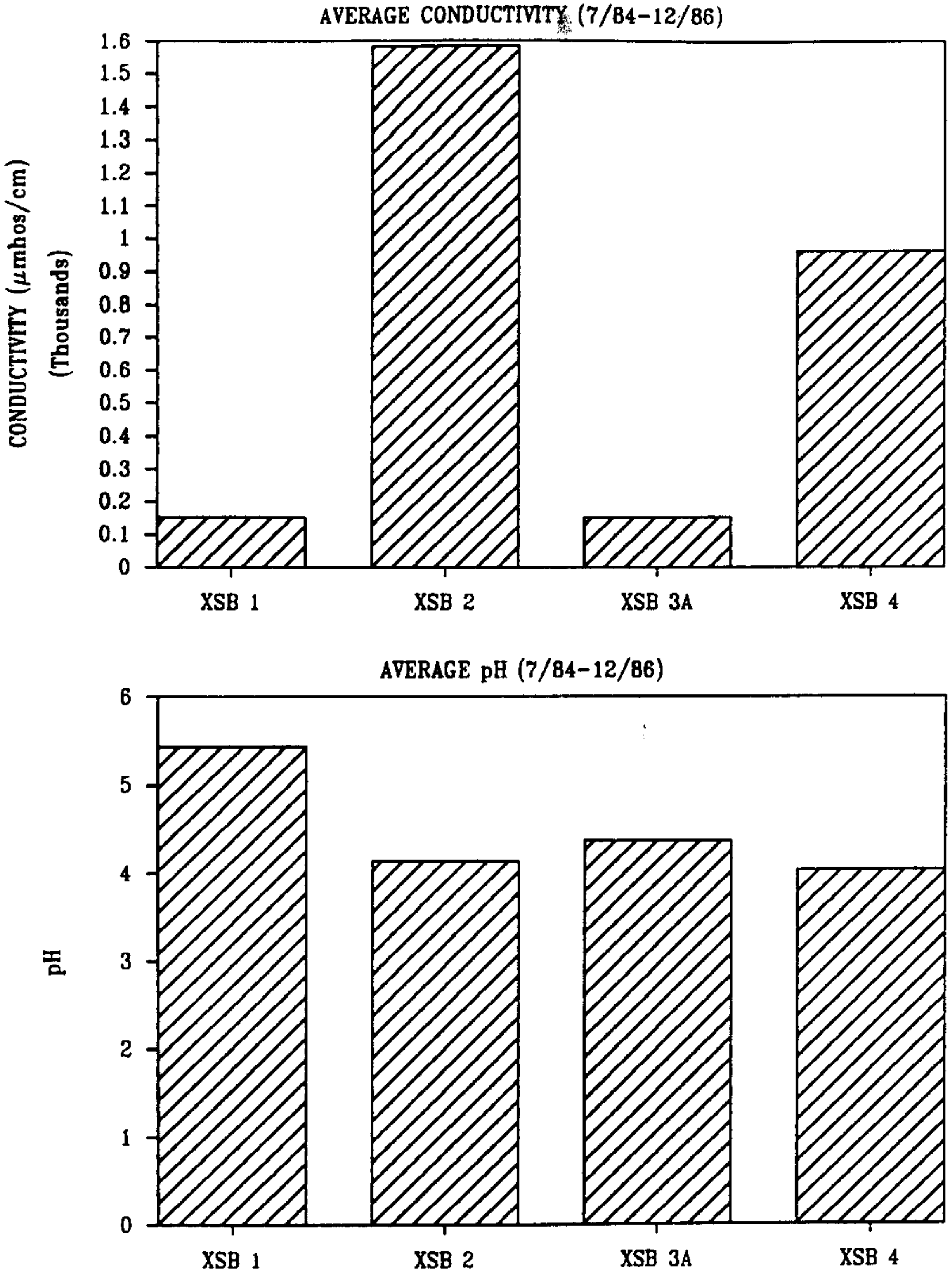
NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-26. Average Manganese and Barium Concentrations in the Old TNX Seepage Basin Wells



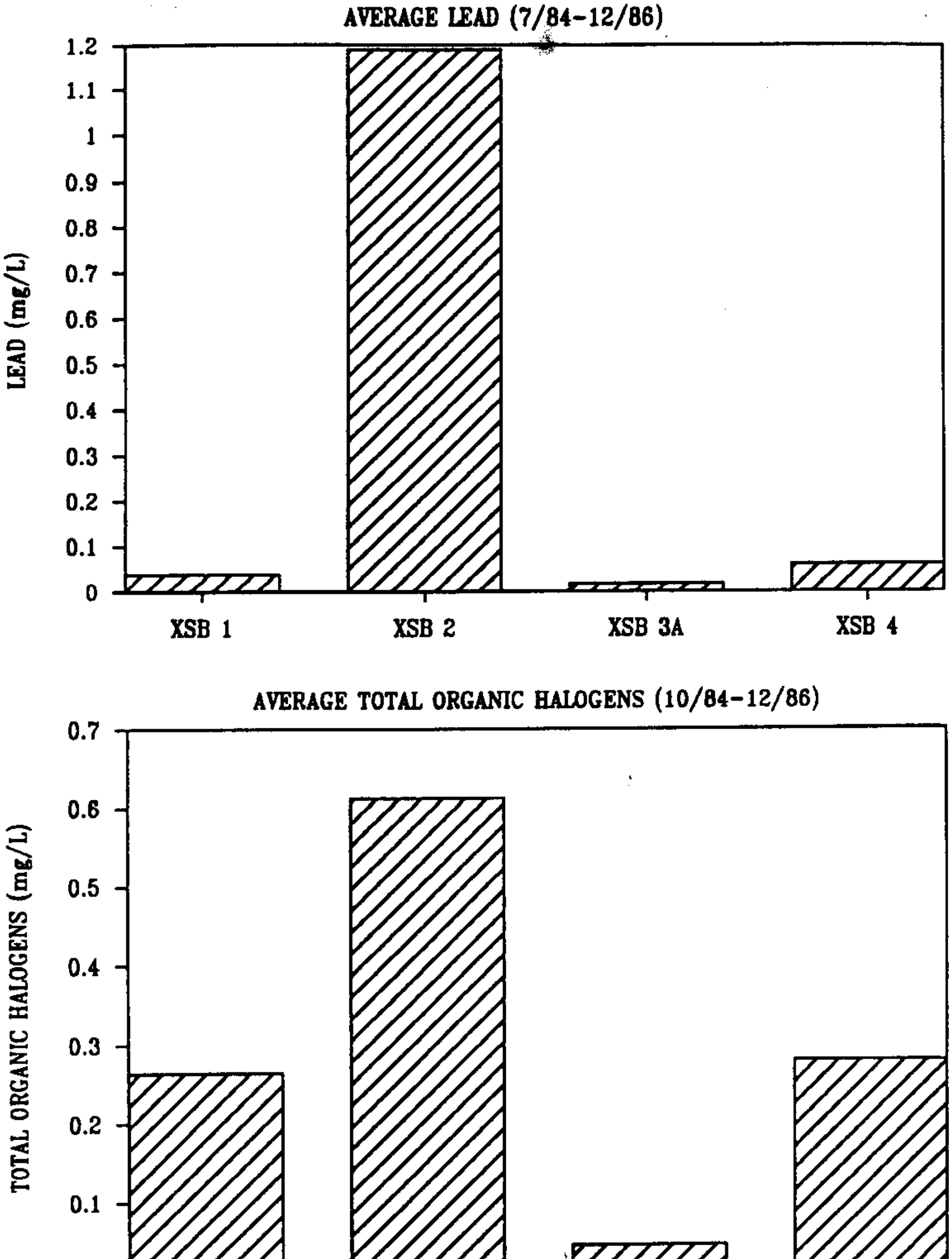
NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-27. Average Chloride and Sodium Concentrations in the Old TNX Seepage Basin Wells



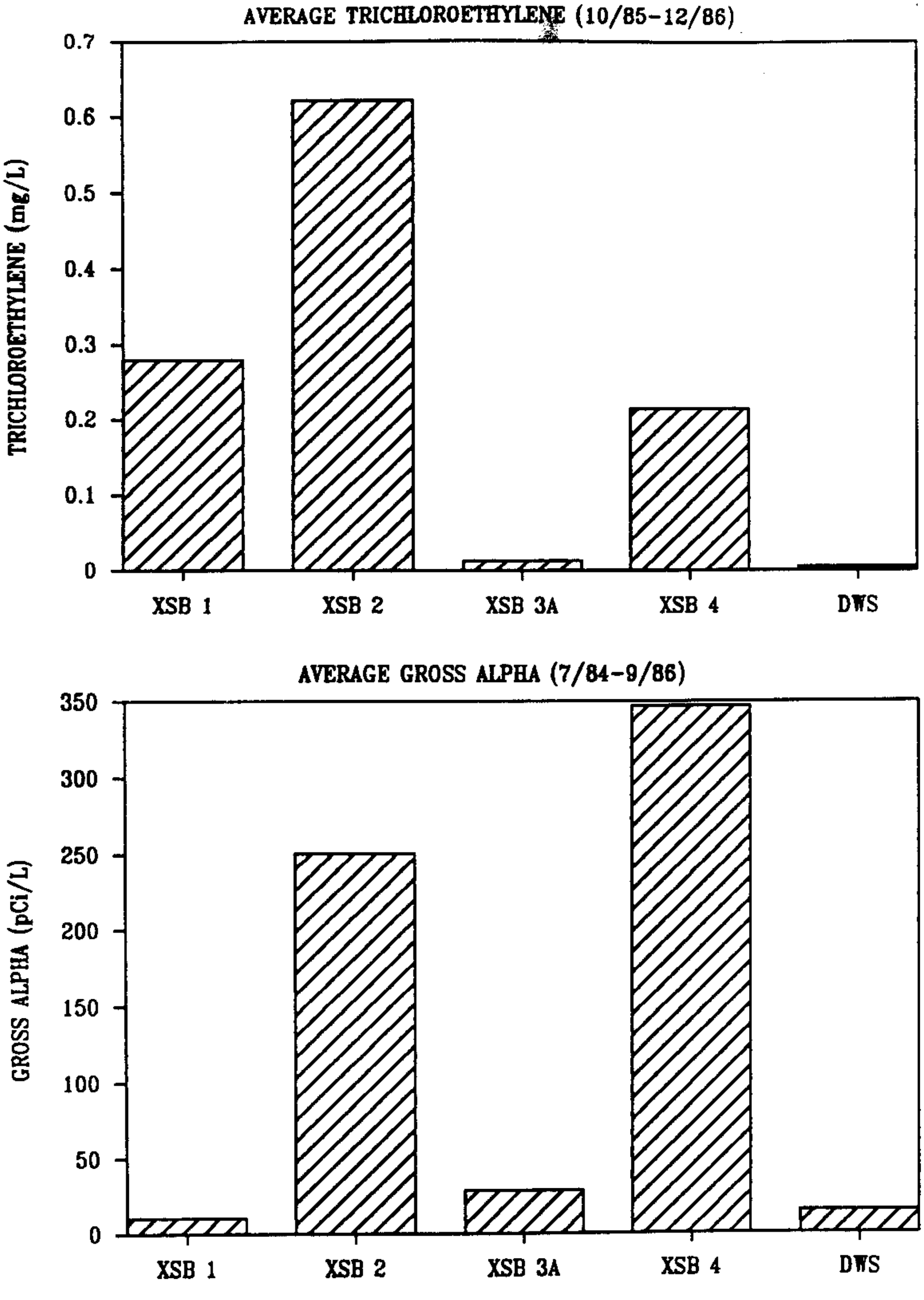
NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-28. Average Conductivity and pH in the Old TNX Seepage Basin Wells



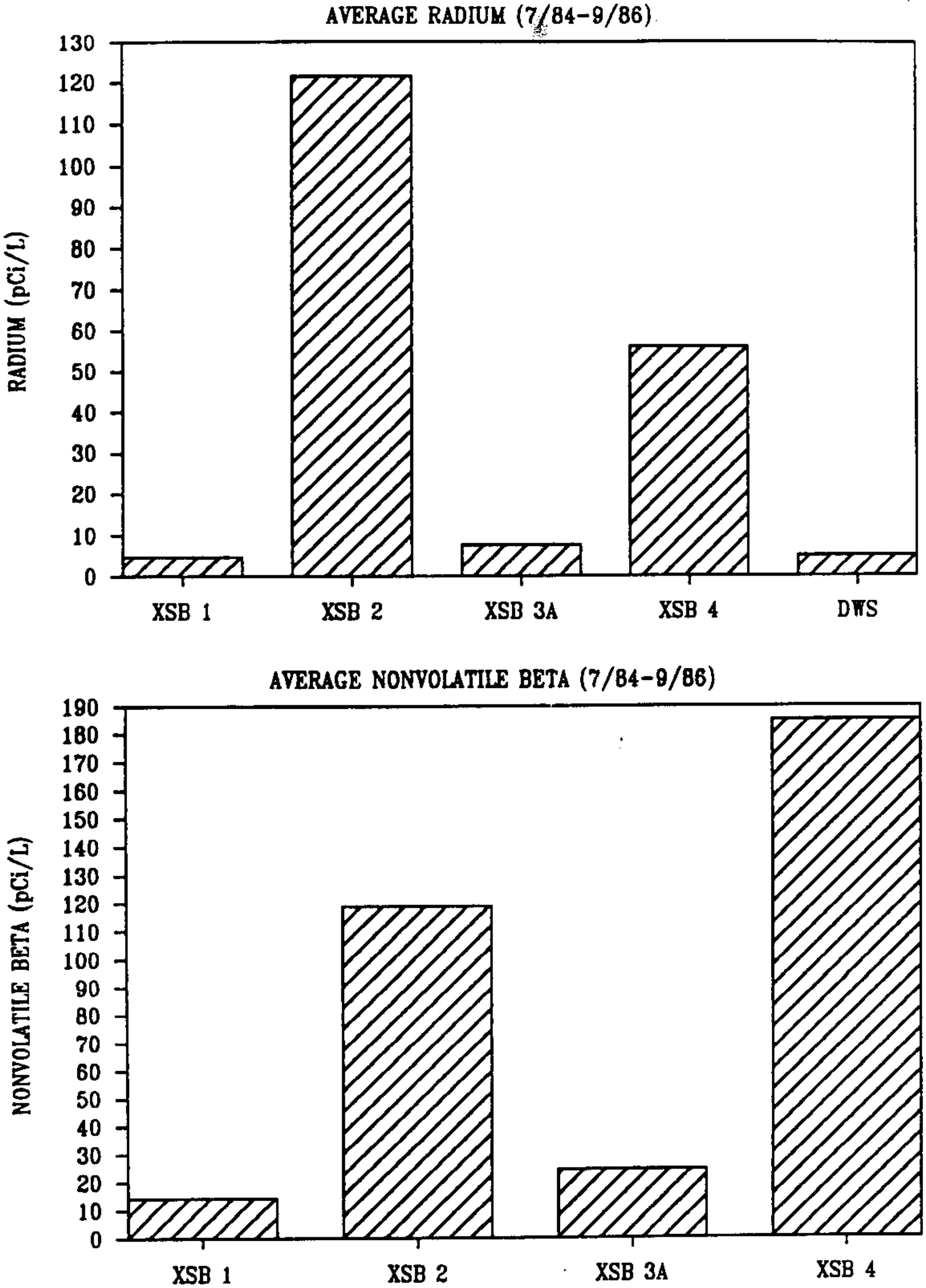
NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-29. Average Lead and Total Organic Halogens (TOH) Concentrations in the Old TNX Seepage Basin Wells



NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-30. Average Trichloroethylene Concentrations and Gross Alpha Activities in the Old TNX Seepage Basin Wells



NOTE: BECAUSE ONLY ONE QUARTER (FOURTH, 1986) OF RESULTS IS AVAILABLE FOR WELL XSB 5A, IT IS NOT INCLUDED ON THE GRAPHS.

FIGURE 7-31. Average Total Radium and Nonvolatile Beta Activities in the Old TNX Seepage Basin Wells

SECTION 8 F AREA

8.01 GENERAL INFORMATION

8.01.01 General Area Description

F Area is located in the central part of SRS as shown in Figure 8-1. Surface elevations across F Area range approximately from 260 to 320 ft msl. F Area is incised by a number of tributaries of Upper Three Runs Creek, approximately 2,200 ft to the north and west, and of Four Mile Creek, approximately 2,000 ft to the south.

There are 17 F-Area waste sites as indicated in Figure 8-2:

L The F-Area Acid/Caustic Basin

L The F-Area Coal Pile Runoff Containment Basin

L The F-Area Ash Basins (2 basins)

L The F-Area Burning/Rubble Pits (2 pits)

L The F-Area Scrap Lumber Pile

L The F-Area Retention Basins (2 basins)

L The F-Area Tank Farm

L The F-Area Seepage Basins (3 basins)

L The Old F-Area Seepage Basin

L The F-Area Rubble Pits (2 pits) (see Section 15)

L The F-Area Erosion Control Site (see Section 15)

8.01.02 General Hydrologic Conditions

By the end of 1986, 105 monitoring wells had been installed around the F-Area waste sites to delineate subsurface conditions and to monitor groundwater elevation and quality. Seventy-two of the 105 wells are currently being monitored. The remaining 33 monitoring wells have been abandoned, as discussed in the following specific waste-site sections. According to the surface geologic map presented by Siple (1967), the water-table monitoring wells in F Area were installed in the Barnwell Formation. Section 3 contains a detailed discussion of the hydrostratigraphy beneath SRS.

The water-table elevation in F Area has been about 240 to 200 ft msl, and the vadose zone has been approximately 60 to 80 ft thick. Perched water zones are known to exist in F Area. As shown in Figure 8-2, F Area is on a near-surface groundwater divide between Upper Three Runs Creek and an unnamed tributary of Four Mile Creek. The near-surface groundwater from the southern part of F Area discharges to an unnamed tributary of Four Mile Creek, approximately 2,000 ft to the south. The near-surface groundwater from the northern part of F Area discharges to one of many tributaries of Upper Three Runs Creek, approximately 1,500 ft to the north.

Mathematical modeling of the Barnwell Formation in this area indicates that the horizontal groundwater flow velocity ranges approximately from 15 to 60 ft/yr per percent gradient (Duffield et al., 1986; Parizek and Root, 1986). As shown in Figure 8-2, the hydraulic gradient of the water table is variable across F Area. Therefore, the near-surface groundwater flow velocity across F Area will vary. The horizontal flow direction and estimated flow velocity for the water table at each F-Area waste site are discussed in the following specific waste-site sections.

8.01.03 Migration Potential of Dissolved Chemical Constituents from F Area

The potential for any dissolved constituents to be naturally discharged from a waste site to nearby surface water from the near-surface groundwater system depends on the location of the waste site, the hydraulic gradient, and the flow path between the waste site and the discharge point. Horizontal and vertical groundwater flow velocities depend upon the distribution and hydraulic properties of the medium through which the groundwater travels (i.e., sand, silt, or clay). Similarly, interactions with the soil/sediment medium (retardation) will affect the horizontal and vertical movements of dissolved chemical constituents.

The nearest plant boundary to F Area is approximately 6 mi to the west. Because of the large number of incised tributaries and streams between the plant boundary and F Area, migration of dissolved constituents through the near-surface groundwater system to the plant boundary is not likely.

Water enters the McBean Formation on the Aiken Plateau and flows toward either Upper Three Runs Creek or Four Mile Creek, discharging to the surface water. The valley of Upper Three Runs Creek cuts into the Congaree Formation and creates a groundwater sink that separates water in that formation beneath F Area from the offplant areas to the north and northwest. Natural horizontal flow in the Tuscaloosa Formation is to the southwest toward the Savannah River.

In the Separations Areas of the plant (F and H areas), a head reversal occurs in the lower aquifers. Beneath F Area, piezometric head is lowest in the Upper Congaree aquifer, inhibiting vertical groundwater flow from the Congaree to the Tuscaloosa aquifer. Thus, the head reversal helps prevent contamination of the lower aquifers in this area.

8.02 F-AREA ACID/CAUSTIC BASIN

8.02.01 Summary

The F-Area Acid/Caustic Basin (Building 904-74G) received dilute sulfuric acid and sodium hydroxide solutions used to regenerate ion-exchange units in the water purification process areas. This basin allowed for the mixing and neutralization of the dilute solutions before their discharge to an unnamed tributary of Upper Three Runs Creek. The basin was constructed between 1952 and 1954 and remained in service until new neutralization facilities became operational in 1982. The F-Area Acid/Caustic Basin is currently inactive and contains rainwater (Ward et al., 1987).

Basin surface water and soil/sediments were sampled in August 1985. Basin surface water data indicate that all tested parameters were low except for an elevated concentration of iron (26.6 mg/L) and slightly elevated concentrations of sodium (68.3 mg/L) and sulfate (47 mg/L). Concentrations of tested parameters for the F-Area Acid/Caustic Basin soil/sediments, including sulfate and sodium, were generally consistent with background levels. Extraction Procedure (EP) toxicity test results for metals and pesticides in the soil/sediments indicate that levels were below Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

Chemical inventory records indicate that sulfate and sodium were discharged to the F-Area Acid/Caustic Basin. These ions serve as indicator parameters because they are soluble and migrate readily in soil or groundwater. Upgradient well FAC 3 has apparently been affected by the leaching of well grout, as indicated by elevated pH and conductivity levels, and cannot be used as a background water-quality well. A comparison of water quality and indicator parameter levels between downgradient well FAC 1 and sidegradient wells FAC 2 and FAC 4 indicates that the F-Area Acid/Caustic Basin has had no apparent effect on groundwater quality. Groundwater samples from downgradient well FAC 1 have been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for manganese. Manganese also exceeded drinking water standards in the sidegradient wells.

Groundwater from sidegradient wells FAC 2 and FAC 4 has met drinking water standards for all tested dissolved chemical constituents except manganese, gross alpha, total radium, and a single excursion of mercury. Radioactivity and mercury are not known to be related to past F-Area Acid/Caustic Basin site activities.

Concentrations of indicator parameters (conductivity, sulfate, and sodium) in the F-Area Acid/Caustic Basin wells have not shown any consistent increasing or decreasing trends over the monitoring period.

8.02.02 Waste-Site Description and Nature of Disposal

The F-Area Acid/Caustic Basin (Building 904-74G) was constructed between 1952 and 1954 (Ward et al., 1987) and is located within an area of relatively low topographic relief. Surface elevations around the basin range approximately from 304 to 306 ft msl (Figure 8-3). The F-Area Acid/Caustic Basin is an unlined earthen depression with approximate dimensions of 50 ft long by 50 ft wide by 7 ft deep. The basin was formed by removing existing soils below grade and building sloped side walls. The soils in the area are predominantly composed of medium-to-coarse grained, well-sorted, subangular sand, with clay content ranging from 40 to 60%.

Dilute sulfuric acid and sodium hydroxide solutions were used to regenerate ion exchange units in the F-Area water purification process area. The F-Area Acid/Caustic Basin provided containment for the mixing and neutralization of the spent solutions. Effluent resulting from discharges and rainwater runoff intermittently flowed from the basin to an unnamed tributary of Upper Three Runs Creek through an overflow weir set to maintain a maximum working water depth of 3 ft in the basin. Detailed effluent records for the F-Area Acid/Caustic Basin were not maintained.

Calculated annual acid and caustic discharge rates to the basin are summarized in Table 8-1. Discharges to the basin were terminated in 1982 when the influent process piping was deactivated and a neutralization facility was installed in F Area.

The basin is currently inactive and contains rainwater. The side slopes of the basin are well vegetated above the water line.

8.02.03 Groundwater Monitoring Program

Four wells (FAC 1 through FAC 4) were installed to monitor the water-table elevation and groundwater quality near the F-Area Acid/Caustic Basin (Figure 8-3). Wells FAC 1 through FAC 3 were installed in August 1983, and well FAC 4 was installed in July 1984, using PVC casings and 30-ft screens.

Wells FAC 1 through FAC 3 were included in the SRS quarterly groundwater monitoring program in the second quarter of 1984, and well

FAC 4 was included in the first quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

8.02.04 Site-Specific Hydrology

Measurements obtained from the F-Area Acid/Caustic Basin wells since the second quarter of 1984 indicate a declining trend in the water-table elevation beginning in the third quarter of 1984. A hydrograph for the F-Area Acid/Caustic Basin wells (Figure 8-4) shows that the water-table elevation during the fourth quarter of 1986 was approximately 230 ft msl and that the vadose zone was approximately 75 ft thick.

A water-table elevation contour map for the third quarter of 1985 is presented in Figure 8-3. As shown, the near-surface groundwater flow direction was to the west toward Upper Three Runs Creek. The hydrograph (Figure 8-4) indicates that this has been the predominant flow direction, although fluctuations in water-level elevations indicate that minor changes in direction and hydraulic gradient have occurred. Relative to the basin, well FAC 3 has been predominantly upgradient, wells FAC 2 and FAC 4 sidegradient, and well FAC 1 predominantly downgradient.

The hydraulic gradient beneath the basin has been approximately 0.01 ft/ft. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation in this area of 15 to 60 ft/yr per percent gradient, the horizontal near-surface groundwater flow velocity beneath the F-Area Acid/Caustic Basin has ranged approximately from 15 to 60 ft/yr.

8.02.05 Waste-Site Content Characterization Data

Analytical data from F-Area Acid/Caustic Basin water samples collected in August 1985 are listed in Table 8-2. These data indicate that surface water dissolved chemical constituent levels were low except for an elevated concentration of iron (26.6 mg/L) and slightly elevated concentrations of sodium (68.3 mg/L) and sulfate (47 mg/L). Concentrations of anticipated indicator parameters other than sodium and sulfate, such as calcium (3.68 mg/L) and magnesium (2.03 mg/L), were low. The pH of the basin water was 6.3. Relatively high turbidity (160 NTU) has been attributed to the disturbance of bottom sediments during water sampling. Section 8.02.02 contains information on the basin influent data.

8.02.06 Soil/Sediment Characterization Data

F-Area Acid/Caustic Basin soil/sediments were sampled in August 1985 as part of the basin characterization program. Three 5-ft continuous borings were obtained near the basin inlet and outlet structures and along one side wall. Soil boring samples were separated into 0.5-ft intervals for analysis. Soil/sediment analytical results, including Extraction Procedure (EP) toxicity test results for metals, are summarized in Table 8-3. EP toxicity test results for metals and pesticides indicate concentrations less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24). Concentrations of other soil/sediment parameters tested were generally consistent with background soil levels, such as magnesium (37.0 to 1,310 mg/kg), sulfate (42.45 to 374.5 mg/kg), and sodium (510 to 1,880 mg/kg) (Ward et al., 1987).

8.02.07 Groundwater Monitoring Results

Groundwater monitoring data from 1984 through 1986 for the F-Area Acid/Caustic Basin are presented in Appendix F. Groundwater chemical characterization data since July 1984 are summarized in Table 8-4.

Monitoring well locations relative to the F-Area Acid/Caustic Basin are presented in Figure 8-3, along with the predominant near-surface groundwater flow direction. As shown in Figure 8-3, well FAC 3 is the only well located directly upgradient of the F-Area Acid/Caustic Basin. However, as illustrated in Figure 8-5, elevated pH (8.6 to 9.9) and conductivity (155 to 280 µmhos/cm) relative to the other F-Area Acid/Caustic Basin wells indicate that samples from this well may have been affected by leaching of the surrounding grout column. Elevated sulfate and sodium levels would be expected if upgradient well FAC 3 were being affected by seepage from the basin. However, average sulfate and sodium levels in well FAC 3 were 50.0 mg/L and 4.2 mg/L, respectively, which are similar to the average sulfate and sodium levels reported for the other F-Area Acid/Caustic Basin wells (Figure 8-6). Sidegradient wells FAC 2 and FAC 4 have been used in lieu of upgradient well FAC 3 to establish background groundwater quality because of their positions relative to the basin and their similar water-table elevations (Figures 8-3 and 8-4).

Comparisons of the monitoring results between downgradient well FAC 1 and sidegradient wells FAC 2 and FAC 4 were used to evaluate the effect on the groundwater from the F-Area Acid/Caustic Basin. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters are sulfate, sodium, and conductivity because elevated levels of these parameters are indicative of basin seepage effect and because sulfate and sodium are soluble and will migrate readily in soil or groundwater (Section 8.02.02).

A comparison of water quality and indicator parameter levels between downgradient well FAC 1 and sidegradient wells FAC 2 and FAC 4 indicates that the F-Area Acid/Caustic Basin has had no apparent effect on local groundwater quality. Groundwater samples from downgradient well FAC 1 have been characterized by low dissolved chemical constituent levels compared to the drinking water standards except for manganese. Low conductivity levels were reported for well FAC 1 (42 to 120 μmhos/cm) compared to the levels measured for the sidegradient wells (74 to 179 μmhos/cm). Similarly, sulfate levels in downgradient well FAC 1 (<5.0 to 13.0 mg/L) were consistently lower than levels reported for the sidegradient wells (17.0 to 59.0 mg/L) and the drinking water standard of 250 mg/L. Sodium levels in all of the F-Area Acid/Caustic Basin wells remained below 8.5 mg/L. Figures 8-5 and 8-6 illustrate the low indicator parameter levels in downgradient well FAC 1 compared to sidegradient wells FAC 2 and FAC 4. Manganese levels in downgradient well FAC 1 (0.088 to 0.138 mg/L) exceeded the drinking water standard of 0.05 mg/L. Manganese levels above drinking water standards were also reported in the sidegradient wells.

Groundwater samples from sidegradient wells FAC 2 and FAC 4 have met South Carolina and federal drinking water standards except for manganese, mercury, and radioactivity. Manganese (0.031 to 0.052 mg/L) and mercury (<0.0002 to 0.0042 mg/L) levels in sidegradient well FAC 2 exceeded their respective drinking water standards of 0.05 mg/L and 0.002 mg/L in a single excursion for each parameter. Manganese concentrations (0.401 to 0.499 mg/L) and gross alpha (9.1 to 56.0 pCi/L) and total radium (11.7 to 24.0 pCi/L) activities in sidegradient well FAC 4 exceeded the drinking water standards of 0.05 mg/L, 15 pCi/L, and 5 pCi/L, respectively. Radioactivity and mercury are not known to be related to past F-Area Acid/Caustic Basin site activities.

Radioactivity levels in well FAC 3 also exceeded the drinking water standard. Gross alpha activity ranged up to 391 pCi/L, exceeding the drinking water standard of 15 pCi/L; radium activity ranged up to 40 pCi/L, exceeding the drinking water standard of 5 pCi/L. Nonvolatile beta activity was also elevated in groundwater samples from this well, ranging from 4.0 to 1,076 pCi/L. Measured radioactivity in groundwater samples from well FAC 3 has been declining since the beginning of 1985.

Groundwater pH ranged from 4.6 to 6.3 in downgradient well FAC 1 and from 4.5 to 6.6 in the sidegradient wells. These pH values are consistent with pH values reported as naturally occurring in Barnwell Formation groundwater (Appendix B). Concentrations of indicator parameters (conductivity, sulfate, and sodium) in the F-Area Acid/Caustic Basin wells have not shown any consistent increasing or decreasing trends over the monitoring period.

8.02.08 Planned Action

The F-Area Acid/Caustic Basin is inactive. As discussed in Section 16, a site assessment has been completed, and a closure plan is to be developed. Groundwater monitoring will continue at the site.

8.03 F-AREA COAL PILE RUNOFF CONTAINMENT BASIN

8.03.01 Summary

The F-Area Coal Pile Runoff Containment Basin (Building 289-F) received runoff from the F-Area coal storage pile (Christensen and Gordon, 1983). Groundwater monitoring data indicate that the F-Area Coal Pile Runoff Containment Basin (CPRB) has had no apparent effect on near-surface groundwater quality. Groundwater quality from downgradient well FCB 3 and background wells FCB 2 and FCB 4 has been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for radioactivity in well FCB 3 and an isolated excursion of iron in background well FCB 4 (1.86 mg/L). The coal storage pile was removed in 1985, and the basin is no longer in use.

Water-quality data from the most directly upgradient well (FCB 1) indicate that this well has been affected by the leaching of cement grout. Therefore, water-quality data from background wells FCB 2 and FCB 4 were used for comparison.

8.03.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses. The F-Area coal supply was stored in an open pile. The coal was generally moderate-to-low sulfur coal (1-2%) received via rail from Kentucky, Pennsylvania, and Virginia. Coal was placed on a hopper, sprayed with water to control coal dust, and loaded onto a pile at the F-Area facility (Christensen and Gordon, 1983).

The facility generally contained a 90-day reserve of coal. The coal pile was not rotated, resulting in long-term exposure of the unused coal to the environment. Weathering allowed for the formation of sulfuric acid caused by the oxidation of sulfur materials in the coal. Rainfall then washed the acid from the coal pile into the coal pile runoff containment basin via gravity flow ditches and sewers.

Prior to the construction of the coal pile runoff containment basins, rainfall runoff from coal storage piles flowed to nearby streams onsite. The National Pollutant Discharge Elimination System (NPDES) permit issued in 1977 specifies limits on pH and suspended solids for coal pile runoff from rainfall up to the maximum 24-hr, 10-yr recurrence event (5.9 in. for SRS). Suspended solids are limited to 50 mg/L, and pH is limited to between 6 and 9. To achieve compliance, the F-Area CPRB was constructed in 1981 to contain coal pile runoff and prevent direct discharge to an unnamed tributary of Four Mile Creek. This containment basin allowed for the passive equalization of runoff prior to its seepage into the subsurface where it could undergo natural renovation. There has been minimal discharge from the F-Area CPRB to the tributary.

The F-Area CPRB (Building 289-F) is located on a south-trending slope, and elevations range from 300 to 310 ft msl across the basin (Figure 8-7). Surface drainage is to the south toward a small, unnamed tributary of Four Mile Creek. The basin is located approximately 550 ft southeast of where the coal pile stood. The basin is square, covering approximately 2 acres. The total runoff containment volume is about 454,600 ft^3 (3.4 million gal). The coal pile that drained to this basin was removed in 1985. While in use, it typically contained 10,000 tons of low-sulfur (1-2%) coal and occupied approximately 1.4 acres (Christensen and Gordon, 1983).

Influent (rainfall runoff) to the F-Area CPRB was not analyzed because the F-Area coal storage pile was removed prior to plantwide coal pile runoff containment basin sampling in October 1985. Typical coal pile runoff indicator parameters (conductivity, total dissolved solids, iron, sulfate, and pH) were used to evaluate groundwater impact from the basin. These parameters were established by the influent characterization data from active coal pile runoff containment basins.

8.03.03 Groundwater Monitoring Program

Four wells (FCB 1 through FCB 4) were installed in the third and fourth quarters of 1981 to monitor the water-table elevation and groundwater quality at the F-Area CPRB (Figure 8-7). These wells were constructed using PVC casings and 30-ft screens.

Wells FCB 1 through FCB 4 were included in the SRS quarterly groundwater monitoring program in the second quarter of 1982. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

8.03.04 Site-Specific Hydrology

Measurements obtained from the F-Area CPRB wells since the second quarter of 1982 indicate that the water-table elevation has been approximately 240 to 220 ft msl and that the vadose zone has been approximately 70 to 90 ft thick. A hydrograph for the F-Area CPRB wells (Figure 8-8) shows that the water-table elevation for the fourth quarter of 1986 ranged approximately from 232 to 222 ft msl and that the vadose zone was approximately 75 to 85 ft thick. A water-table elevation contour map for the second quarter of 1985 (Figure 8-7) indicates that the near-surface, horizontal groundwater flow direction was to the south, consistent with local topography. The water-level data indicate that wells FCB 1 and FCB 2 have maintained upgradient positions throughout the monitoring period; well FCB 4 has been side-gradient, and well FCB 3 has been downgradient. Fluctuations in water-level elevations indicate that minor changes in the water-table flow direction and gradient have occurred.

Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient and a horizontal hydraulic gradient of 0.024 ft/ft calculated from the water-table elevations in the monitoring wells, the horizontal near-surface groundwater flow velocity beneath the basin has ranged from 36 to 144 ft/yr. Because well FCB 3 is screened 10 ft below the other site wells, possibly resulting in a lower water-table elevation in this well, the calculated horizontal hydraulic gradient and horizontal near-surface groundwater flow velocity beneath the basin are probably high.

8.03.05 Waste-Site Content Characterization Data

The contents of the F-Area CPRB have not been sampled. Section 8.03.02 contains information on the nature of the materials disposed at the site.

8.03.06 Soil/Sediment Characterization Data

The F-Area CPRB soil/sediments have not been sampled.

8.03.07 Groundwater Monitoring Results

Groundwater monitoring results from 1982 through 1986 are included in Appendix F. Groundwater chemical characterization data since July 1984 are summarized in Table 8-5.

Comparisons of the monitoring results among downgradient well FCB 3 and the other F-Area CPRB wells were used to evaluate the effect on the groundwater from the F-Area CPRB. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters are pH, sulfate, iron, conductivity, and total dissolved solids (TDS).

Monitoring well locations relative to the F-Area CPRB are presented in Figure 8-7 along with the predominant horizontal near-surface groundwater flow direction. As shown in Figures 8-7 and 8-8, well FCB 1 has been the most directly upgradient and background well. However, as illustrated in Figures 8-9 and 8-10, the high pH (11.1 to 12.3) and elevated barium (0.048 to 0.183 mg/L) and sodium (3.32 to 6.12 mg/L) concentrations in well FCB 1 relative to the other F-Area CPRB wells suggest that well FCB 1 has been affected by the leaching of the surrounding grout column. Elevated levels of TDS (1,280 mg/L) and conductivity (560 to 7,040 μmhos/cm) are also indicative of cement grout leaching. Figure 8-11 shows the relative difference in average conductivity and TDS values between background well FCB 1 and the other F-Area CPRB wells. Sulfate concentrations in well FCB 1 have been low (<5.0 to 8.0 mg/L), which, in addition to the elevated pH, indicate that well FCB 1 is being affected by cement grout and not by the F-Area CPRB. As demonstrated in Figures 8-7 and 8-8, wells FCB 2 and FCB 4 have water-table elevations similar to FCB 1; because of their positions relative to the basin they have been used in lieu of well FCB 1 to establish background groundwater quality.

The groundwater data summarized in Table 8-5 indicate that there has been no apparent effect on local groundwater quality from the F-Area CPRB. Sampled groundwater from wells FCB 2 through FCB 4 has met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards for dissolved chemical constituents since filtering was included in the sampling protocol in August 1984 except for an isolated excursion of iron in background well FCB 4 (1.86 mg/L). The data in Table 8-5 indicate that downgradient well FCB 3 and background wells FCB 2 and FCB 4 have contained low dissolved chemical constituents levels. TDS concentrations ranged from 18 to 60 mg/L in downgradient well FCB 3 and from 20 to 48 mg/L in the background wells, providing further indication that the F-Area CPRB has had no apparent effect on local groundwater quality.

Sulfate concentrations were consistently below 10 mg/L in all F-Area CPRB wells, which is well below the secondary drinking water standard of 250 mg/L. Iron concentrations in background well FCB 2 (0.06 to 0.089 mg/L) and downgradient well FCB 3 (0.018 to 0.12 mg/L) met drinking water standards. Iron concentrations in downgradient well FCB 4 (0.06 to 1.86 mg/L) ranged above the drinking water standard of 0.3 mg/L; iron levels as high as 0.52 mg/L are generally consistent with iron levels reported for Barnwell Formation groundwater (Appendix B). Elevated iron levels are not independently a strong indication of groundwater impact. Concentrations of organics in wells FCB 2 through FCB 4 were relatively low, as indicated by the levels of dissolved organic carbon (DOC; <5.0 mg/L), total organic carbon (TOC; below 16 mg/L), total organic halogens (TOH; below 0.06 mg/L), phenols (<0.002 mg/L), GC Scan (<40 μg/L), and pesticides, which are below detectable levels. Groundwater pH ranged from 3.6 to 5.9 in downgradient well FCB 3 and from 4.1 to 6.3 in the background wells. These pH values are generally consistent with pH values as low as 4.0 reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

Radioactivity above drinking water standards (gross alpha activity up to 37.0 pCi/L and total radium activity up to 22.0 pCi/L) was reported for well FCB 3. Gross alpha activity in groundwater from FCB 1 (<2.0 to 24.3 pCi/L) also ranged above the drinking water standard of 15 pCi/L. Radioactivity is not known to be related to past site activities. The concentrations of the indicator parameters (conductivity, sulfate, and pH) have not shown any consistent increasing or decreasing trends over the monitoring period.

8.03.08 Planned Action

The F-Area CPRB is inactive. As indicated in Section 16, a site assessment is currently being conducted. Groundwater monitoring well FCB 1 will be replaced, and groundwater monitoring will continue at this site.

8.04 F-AREA ASH BASINS

8.04.01 Summary

The two F-Area Ash Basins (Buildings 288-F and 288-1F) received ash sluice water from the F-Area powerhouse from plant startup in 1951 until 1984. The annual ash disposal rate into the F-Area Ash Basins was approximately 15,000 yd^3/yr (Christensen and Gordon, 1983). The F-Area Ash Basins are currently uncovered and inactive. Groundwater monitoring and soil characterization have not been conducted at the F-Area Ash Basins.

8.04.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses, which produces dry ash. Ash sluice water from the F-Area powerhouse was discharged to the F-Area Ash Basins from 1951 until 1984. Overflow from the site was discharged through National Pollutant Discharge Elimination System (NPDES) Outfall No. F-7. The annual ash disposal rate into the F-Area Ash Basins was approximately 15,000 yd^3/yr (Christensen and Gordon, 1983).

The F-Area Ash Basins (Buildings 288-F and 288-1F) are east of the F-Area perimeter fence (Figure 8-2). Surface elevations at the basins range approximately from 300 to 310 ft msl and slope toward a tributary of Upper Three Runs Creek to the north. The nearest plant boundary to the F-Area Ash Basins is approximately 6 mi to the west. Both F-Area Ash Basins are currently uncovered and inactive.

Ash sluice water contains fly and bottom ash. Horton, Dorsett, and Cooper conducted a study in 1977 to identify trace metals present in the fly and bottom ash disposed to the SRS ash basins and piles. Table 8-6 lists typical trace metal concentrations obtained for fly and bottom ash. These results indicate significant levels of barium, strontium, manganese, zinc, vanadium, cerium, and chromium (Horton et al., 1977).

8.04.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the F-Area Ash Basins.

8.04.04 Site-Specific Hydrology

Groundwater monitoring wells have not been installed at the F-Area Ash Basins; therefore, near-surface groundwater conditions beneath the waste site are undefined.

8.04.05 Waste-Site Content Characterization Data

The F-Area Ash Basins contents have not been sampled or analyzed. Section 8.04.02 contains information on the nature of materials disposed at the site.

In conjunction with 1980 monitoring for NPDES permit renewal, analyses were performed on discharges from the F-Area Ash Basins. Results of these analyses are presented in Table 8-7. These results indicate that concentrations of the tested parameters were low except for a manganese concentration of 0.052 mg/L. All tested organic parameters were close to or less than detection limits.

8.04.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been performed at the F-Area Ash Basins. The materials and nature of disposal into the F-Area Ash Basins are similar to those of the D-Area Ash Basin (488-D); therefore, Extraction Procedure (EP) toxicity test results from analyses performed on the 488-D Ash Basin sludge are presented in Table 8-8. The data in Table 8-8 demonstrate that extractable metal concentrations in the D-Area Ash Basin were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

8.04.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the F-Area Ash Basins.

8.04.08 Planned Action

The F-Area Ash Basins are inactive. As indicated in Section 16, a site assessment is planned for 1988 from which a closure plan will be developed.

8.05 F-AREA BURNING/RUBBLE PITS

8.05.01 Summary

Burnable wastes such as paper, wood, plastics, rubber, rags, cardboard, oil, degreasers, and drummed solvents were received and incinerated in the two F-Area Burning/Rubble Pits (Buildings 231-F and 231-1F) from 1951 to 1973, at which time the pits were covered with a layer of soil. Rubble wastes (including concrete, metal, lumber, and telephone poles) were then disposed in the pits until each pit reached capacity and was capped with soil in 1978 and 1980, respectively. The pits are currently inactive (Huber et al., 1987c).

Groundwater monitoring data indicate that there has been no apparent effect from the pits on groundwater quality except for influence from halogenated organics in well FBP 2A. Groundwater in wells FBP 4 and FBP 3A has been characterized by low dissolved chemical constituent levels compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for radioactivity in well FBP 4 and isolated excursions of iron and cadmium in well FBP 3A. Groundwater monitoring data from well FBP 1A show elevated levels of conductivity, manganese, nitrate, radioactivity, and trichloroethylene. Manganese, nitrate, and radioactivity are not known to be related to past site activities.

8.05.02 Waste-Site Description and Nature of Disposal

The F-Area Burning/Rubble Pits (Buildings 231-F and 231-1F) were constructed in 1951 to collect burnable waste generated at the plant. The burnable waste collected for monthly incineration at the F-Area pits included paper, plastics, wood, rubber, rags, cardboard, oil, degreasers, and drummed solvents. Disposal of chemically contaminated oils was not allowed at the F-Area Burning/Rubble Pits (Huber et al., 1987c).

In 1973 the plantwide procedure of burning waste ceased, and the F-Area Burning/Rubble Pits were converted to receive only rubble by placing a layer of soil over the incinerated waste. Rubble waste disposed in the pits included concrete, metal, lumber, and telephone poles. Rubble disposal continued until the pits reached capacity and were backfilled in 1978 and 1980 (Huber et al., 1987c).

The F-Area Burning/Rubble Pits are west of the F-Area perimeter fence. The surface elevation around the pits is approximately 290 ft msl, and surface drainage is to the west-northwest toward unnamed tributaries of Upper Three Runs Creek (Figure 8-12). The pits were rectangular, with approximate dimensions of 275 ft long by 62 ft wide by 10 ft deep for pit 231-F and 325 ft long by 88 ft wide by 10 ft deep for pit 231-1F. The combined original capacity of the pits was 456,500 ft^3.

8.05.03 Groundwater Monitoring Program

Seven wells (FBP Series) were installed to monitor the water-table elevation and groundwater quality at the F-Area Burning/Rubble Pits. Wells FBP 1 through FBP 3 were installed in the third quarter of 1983. These wells were replaced by wells FBP 1A through FBP 3A in the second quarter of 1984. Well FBP 4 was added to the monitoring network in the third quarter of 1984. All of the wells were constructed using PVC casings and 30-ft screens.

Groundwater samples were obtained from wells FBP 1A through FBP 3A beginning in the second quarter of 1984. Sampling of well FBP 4 began in the first quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

8.05.04 Site-Specific Hydrology

The F-Area Burning/Rubble Pits monitoring wells are screened below the water table, making determination of the horizontal groundwater flow direction difficult. Two of the wells (FBP 2A and FBP 3A) are also screened approximately 25 ft lower than the other site wells, affecting the configuration of the hydrograph (see Figure 8-13). Therefore, a water-table contour map is not presented for this site, and an upgradient well cannot be determined.

8.05.05 Waste-Site Content Characterization Data

The contents of the F-Area Burning/Rubble Pits have not been sampled. Section 8.05.02 contains information on the materials incinerated or disposed at the waste site.

8.05.06 Soil/Sediment Characterization Data

In late 1985 and early 1986, soils were collected and analyzed for volatile organic constituents from thirty-six 18 to 24 in. deep auger holes at the F-Area Burning/Rubble Pits (Figure 8-14). In addition, a 60-ft-deep hole was augered, and a sample from each 1-ft interval was analyzed for volatile organics. The maximum concentrations found in the samples were from Site 15, which contained 20.91 μg/kg tetrachloroethylene and 1.6 μg/kg trichloroethylene. This was the only site at which trichloroethylene was detected. The concentrations of tetrachloroethylene at the remaining sites were below 3 μg/kg (Price et al., 1987).

8.05.07 Groundwater Monitoring Results

The groundwater monitoring data from 1984 through 1986 for the F-Area Burning/Rubble Pits are included in Appendix F. Groundwater chemical characterization data since July 1984 are summarized in Table 8-9.

All of the site wells are screened below the water table, making designation of an upgradient well difficult. Therefore, groundwater monitoring data from the site wells were compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards to assess the effect of the pits on groundwater quality. Because organic solvents are known to be related to past site activities (Section 8.05.02), likely indicator parameters are total organic carbon (TOC), total organic halogens (TOH), trichloroethylene, 1,1,1-trichloroethane (1,1,1-TCE), and chloroform.

The monitoring data summarized in Table 8-9 show that groundwater in well FBP 4 and well FBP 3A has consistently met South Carolina and federal drinking water standards for all tested organic and inorganic parameters except iron, cadmium, and radioactivity. Trichloroethylene levels in wells FBP 4 and FBP 3A (<0.001 mg/L) met the drinking water standard of 0.005 mg/L. Chloroform levels in wells FBP 4 and FBP 3A were less than the detection limit (<0.001 mg/L). Carbon tetrachloride (<0.001 to 0.001 mg/L) and 1,1,1-trichloroethane (1,1,1-TCE; <0.001 mg/L) concentrations in wells FBP 4 and FBP 3A remained below the drinking water standards of 0.005 mg/L and 0.2 mg/L, respectively. Phenols concentrations in these wells were below the detection limit (0.002 mg/L). For the period of monitoring, TOH levels in wells FBP 4 and FBP 3A were below 0.065 mg/L, and TOC levels in these wells remained below 7.0 mg/L.

Inorganic chemical constituent levels were also below drinking water standards except for single excursions of iron (0.323 mg/L) and cadmium (0.046 mg/L) in well FBP 3A. Iron at 0.323 mg/L is consistent with naturally occurring iron levels in Barnwell Formation groundwater (Appendix B). Cadmium is not known to be related to past site activities. The average conductivity reported for well FBP 4 (21.3 μmhos/cm) and well FBP 3A (60.0 μmhos/cm) provides further indication that groundwater near these two wells has been characterized by low dissolved chemical constituent concentrations.

Radioactivity was below drinking water standards in well FBP 3A but was elevated in well FBP 4. Gross alpha (2.0 to 41.0 pCi/L) and radium (<1.0 to 7.0 pCi/L) activities in well FBP 4 exceeded the drinking water standards. Tritium activity in both wells was at or below 10 pCi/mL, which is below the drinking water standard (20 pCi/mL). Radioactivity is not known to be related to past site activities.

Groundwater samples from well FBP 2A have been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards for all tested parameters except some halogenated organics. The TOH levels in well FBP 2A (0.056 to 0.294 mg/L) have consistently remained above the TOH levels reported for the other F-Area Burning/Rubble Pits wells (Figure 8-15). Carbon tetrachloride (0.005 to 0.017 mg/L) and trichloroethylene (0.025 to 0.105 mg/L) levels in well FBP 2A have been elevated compared to the other F-Area Burning/Rubble Pits wells and the drinking water standards (Figures 8-15 and 8-16). Chloroform, phenols, and 1,1,1-trichloroethane (1,1,1-TCE) concentrations were below detection limits for the monitoring period. TOC concentrations were below 7.0 mg/L.

Conductivity levels reported for well FBP 1A (ranging from 148 to 260 μmhos/cm since January 1985) were elevated compared to the other F-Area Burning/Rubble Pits wells (Figure 8-17). Trichloroethylene levels in well FBP 1A (0.020 to 0.029 mg/L) remained above the drinking water standard of 0.005 mg/L. Nitrate levels in well FBP 1A (1.85 to 24.55 mg/L) have remained above the drinking water standard of 10 mg/L since January 1985. Figure 8-17 shows a comparison of average nitrate levels among the F-Area Burning/Rubble Pits wells. Manganese concentrations in well FBP 1A (0.019 to 0.087 mg/L) were above the drinking water standard of 0.05 mg/L on a few occasions. The F-Area Burning/Rubble Pits are not a likely source of nitrate and manganese because these constituents are not known to be related to past site activities.

Radioactivity in well FBP 1A has been elevated relative to the drinking water standards and the other F-Area Burning/Rubble Pits wells. Gross alpha (<2.0 to 130 pCi/L) and total radium (<1.0 to 8.0 pCi/L) activities in well FBP 1A ranged above their respective drinking water standards of 15 pCi/L and 5 pCi/L. Tritium activity (17 pCi/mL) was below the drinking water standard of 20 pCi/mL, but was elevated compared to the activities in the other site wells. Nonvolatile beta activity in well FBP 1A has ranged from 145.2 to 206 pCi/L since January 1985. A comparison of average nonvolatile beta activities among the F-Area Burning/Rubble Pits wells (Figure 8-18) shows that radioactivity has had an effect on groundwater quality near well FBP 1A. The F-Area Burning/Rubble Pits are not a likely source because radioactivity is not known to be related to past site activities.

The influent process water pipeline leading to the F-Area Seepage Basins runs near well FBP 1A. Because it is composed of vitrified clay, it is possible that when this pipeline was in service it leaked near well FBP 1A, which would account for the elevated levels of conductivity, nitrate, manganese, and radioactivity in this well. Information concerning the F-Area Seepage Basins is presented in Section 8.09.

8.05.08 Planned Action

The F-Area Burning/Rubble Pits are inactive. As indicated in Section 16, a site assessment is planned for 1988 from which a closure plan will be developed. Groundwater monitoring will continue at this site.

8.06 F-AREA SCRAP LUMBER PILE

8.06.01 Summary

The F-Area Scrap Lumber Pile (Building 231-3F) receives approximately 100 yd^3 of scrap lumber per month for burning (Christensen and Gordon, 1983). Groundwater monitoring and content characterization have not been conducted at the F-Area Scrap Lumber Pile. The F-Area Scrap Lumber Pile is currently active and receiving scrap lumber.

8.06.02 Waste-Site Description and Nature of Disposal

Approximately 200 yd^3 of scrap lumber (including poles, crates, pallets, and unsalvageable wooden furniture) accumulate at SRS each month. Plant policy requires that all scrap lumber be disposed onsite because of the expense of monitoring all such material for possible radioactive contamination before offsite disposal.

Two scrap lumber burning sites were established in 1975. These sites are located in F Area (Building 231-3F) and CS Area (Building 631-2G). The scrap lumber piles have been burned periodically, after notification to the South Carolina Department of Health and Environmental Control (SCDHEC) (Christensen and Gordon, 1983).

The F-Area Scrap Lumber Pile is west of the F-Area perimeter fence and north of SRS Route C (Figure 8-2). The surface elevation at the site is approximately 280 ft msl. Surface drainage from the F-Area Scrap Lumber Pile is to the west toward Upper Three Runs Creek. Access to the F-Area Scrap Lumber Pile has been restricted since May 1983. The site is currently active and receiving scrap lumber.

8.06.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the F-Area Scrap Lumber Pile.

8.06.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the F-Area Scrap Lumber Pile; therefore, groundwater conditions beneath the site are undefined.

8.06.05 Waste-Site Content Characterization Data

No radioactive or chemical constituents have been identified as having been discharged to the F-Area Scrap Lumber Pile, and the F-Area Scrap Lumber Pile contents have not been sampled. Section 8.06.02 contains information on the nature of materials disposed at the site.

8.06.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the F-Area Scrap Lumber Pile.

8.06.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the F-Area Scrap Lumber Pile.

8.06.08 Planned Action

The F-Area Scrap Lumber Pile is active, and continued use is planned. No other action is scheduled for this site.

8.07 F-AREA RETENTION BASINS

8.07.01 Summary

The unlined F-Area Retention Basin (Building 281-3F) was constructed in 1955 and used until 1973 to provide temporary emergency storage for potentially radioactively contaminated cooling water from separation processes. The basin was partially excavated and backfilled with clean soil in 1978 and 1979 (Scott et al., 1987b). The lined retention basin (Building 281-8F) has been used for the same purpose since 1972 and is currently active.

Soil/sediment sampling of the unlined basin was conducted in 1978 to characterize the radionuclides present. The primary radionuclides found were ^{137}Cs and $^{89,90}Sr$. Soil/sediment sampling of the lined basin has not been conducted. Groundwater monitoring has not been conducted at the F-Area Retention Basins.

8.07.02 Waste-Site Description and Nature of Disposal

The F-Area Retention Basins (Buildings 281-3F and 281-8F) are southeast and south, respectively, of the F-Area perimeter fence (Figure 8-2). The unlined basin was rectangular, with original dimensions of

120 ft wide by 200 ft long by 7 ft deep, providing a storage capacity of approximately 168,000 ft^3 (1.2 million gal). The lined basin is approximately 400 ft by 250 ft.

The unlined F-Area Retention Basin was used from 1955 to 1973 to provide temporary emergency storage for potentially radioactively contaminated cooling water from separation processes. When radioactivity was observed in the cooling water, it was diverted from the surface stream to the retention basin. If needed, the wastewater was processed by deionization to reduce contamination to allow release. The exact quantities of water disposed in this retention basin are unknown. The volume and curie content of the water in the intermittent discharge varied. Only trace quantities of chemicals are believed to have been discharged to this basin (Scott et al., 1987b).

The unlined F-Area Retention Basin stopped receiving effluent in 1973. Following a characterization study, 2 ft of sediment were removed from the basin floor in 1978 and 1979. The basin then was backfilled with dirt and covered with vegetation to prevent erosion (Scott et al., 1987b).

The lined retention basin was put into service in 1972 and remains active.

8.07.03 Groundwater Monitoring Program

There are no groundwater monitoring wells at the F-Area Retention Basins.

8.07.04 Site-Specific Hydrology

Because there are no groundwater monitoring wells at the F-Area Retention Basins, the groundwater conditions beneath these sites are undefined.

8.07.05 Waste-Site Content Characterization Data

Records of discharges to the basins have not been maintained. Section 8.07.02 contains information regarding the nature of waste disposal at the sites.

8.07.06 Soil/Sediment Characterization Data

In December 1978, four 1.5-in. diameter soil cores were taken from the bottom of the unlined F-Area Retention Basin (Figure 8-19). The primary radionuclides present in the soil cores were ^{137}Cs and $^{89,90}Sr$.

Most of the ^{137}Cs was found to a depth of 18 in. below ground surface, and most of the $^{89,90}Sr$ was found in the top half of the soil column sampled. Maximum activities found in the soil were 80,600 pCi/g of ^{137}Cs at a depth of 0.5 to 1 ft below ground surface and 1,540 pCi/g of $^{89,90}Sr$ at a depth of 0.0 to 0.5 ft below ground surface. The data are presented in Table 8-10.

In December 1978 and January 1979, after the basin had been cored, approximately 34,000 ft^3 of soil was excavated from the basin and transported to the Radioactive Waste Burial Grounds (Building 643-7G). The transferred radionuclide inventory was calculated to be 11.5 Ci of ^{137}Cs and 0.5 Ci of $^{89,90}Sr$ (Scott et al., 1987b).

After the excavation of soil from the basin, 53 soil cores (up to depths of 18 ft) from the basin floor and berm were surveyed in the field. Ten cores, seven from the basin floor and three from the berm, were chosen for further analysis because they contained the highest levels of radioactivity (Scott et al., 1987b). The results are given in Table 8-11.

8.07.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the F-Area Retention Basins.

8.07.08 Planned Action

The unlined F-Area Retention Basin is inactive. As indicated in Section 16, a site assessment is planned for 1988. Use of the lined F-Area Retention Basin will continue; no additional study or action is planned for this site.

8.08 F-AREA TANK FARM

8.08.01 Summary

The F-Area Tank Farm (Building 241-F) contains 22 large subsurface tanks for the storage of aqueous, radioactive wastes. These liquid wastes are produced primarily from nuclear fuel reprocessing operations and consist of sludges, supernatant liquid of varying salt concentrations, and salt cake. The sludges stored in the F-Area Tank Farm are primarily a mixture of oxides and hydroxides of manganese, iron, and aluminum and a small amount of uranium, plutonium, and mercury, with almost all of the fission products originally in the irradiated fuel except cesium. The supernate is primarily a solution of sodium nitrate, sodium nitrite, sodium hydroxide, sodium aluminate, and most of the soluble fission products including the major cesium isotopes. The solution volume is reduced in the tank farm evaporators, then stored in tanks to precipitate the sodium nitrate and sodium nitrite. This precipitate forms the salt cake (ERDA, 1977).

The nonvolatile beta and tritium monitoring data indicate that the F-Area Tank Farm has influenced groundwater quality in the center of the Tank Farm. In particular, elevated nonvolatile beta and tritium activities were detected in the downgradient wells near Tanks 3 through 8, in the wells surrounding Tank 20, and in the wells downgradient of Tanks 17 through 20. Average annual gross alpha activities in all of the site wells remained below the drinking water standard of 15 pCi/L over the monitoring period except for well FTF 6 in 1983 (37.0 pCi/L) and 1984 (31.0 pCi/L).

8.08.02 Waste-Site Description and Nature of Disposal

Liquid radioactive wastes at SRS result primarily from the nuclear fuel reprocessing operations taking place in F and H areas. Currently, SRS has 51 large subsurface tanks for the storage of these aqueous, radioactive wastes, which consist of sludges, supernatant liquids of varying salt concentrations, and salt cake. Twenty-two of these tanks are located in F Area, and the remaining 29 are in H Area. The waste tanks were built below ground using carbon steel and reinforced concrete. Four different tank designs are used at SRS. Three of these tank designs (Types I, II, and III) incorporate a primary and secondary containment compartment consisting of concentric steel cylinders. All three of these designs use forced water-cooling systems and are primarily for high-heat waste and waste concentrate. The Type-III tank was developed following an investigation into the possible causes of leaks in the Type-I and Type-II primary tanks. The Type-IV tank, which is not cooled, is a single-wall, vertically cylindrical tank made of steel-lined, prestressed concrete. Type-IV tanks are primarily used for the storage of low-heat waste (ERDA, 1977).

The recovery processes in the F-Area hot and warm canyons generate aqueous waste streams that contain most of the fission products. Waste products coming from the warm canyon are referred to as low-heat waste (LHW), and the waste products received from the hot canyon are termed high-heat waste (HHW). The only significant difference between the two waste products is that the HHW discharge requires auxiliary heat removal. Both types of waste are regarded as high-level liquid waste and must be stored indefinitely. The wastes are alkaline and flow by gravity from the F-Area processing building to the F-Area Tank Farm. The flow pipes are underground and are enclosed in a secondary concrete conduit (ERDA, 1977).

High-heat waste from the hot canyon is received in cooled waste storage tanks (Types I, II, or III). Fresh waste is aged for 1 to 2 yr to allow for settling and for the decay of short-lived fission products. The insoluble waste settles, forming a layer of sludge on the bottom of the tank.

The sludge is a mixture of oxides and hydroxides of manganese, iron, and aluminum and a small amount of uranium, plutonium, and mercury, with almost all of the fission products originally in the irradiated fuel except cesium. Following the aging process, the supernate, consisting of dissolved salts and radioactive cesium, is channeled to a continuous evaporator. Condensate from the evaporator is passed through an ion-exchange column to remove entrained cesium before the condensate is discharged to the F-Area Seepage Basins. If the process waste contains mercury, a mercury trap is placed in the system up-line of the cesium-removal column. Concentrate from the evaporator is transferred to a cooled waste storage tank, where the suspended salts settle out and additional salts crystallize as cooling occurs. The supernate is then returned to the evaporator for further concentration (ERDA, 1977). Low-heat waste is processed using a similar technique except that the low-heat salts are accumulated in the uncooled waste tanks (Type IV).

The F-Area Tank Farm (Building 241-F) is in the southwest corner of F-Area on a topographic divide between Upper Three Runs Creek and Four Mile Creek (Figure 8-20). Surface drainage from the F-Area Tank Farm is to the southeast toward Four Mile Creek.

8.08.03 Groundwater Monitoring Program

Thirty-four wells (FTF and 241-F series) have been installed around the F-Area Tank Farm to monitor the water-table elevation and groundwater quality. Twenty-seven of the 34 wells are active; 7 wells have been abandoned. The five 241-F Series wells were installed in 1969 and abandoned in 1978. Wells FTF 1 through FTF 14 were installed in 1972 and 1973. Wells FTF 24 and FTF 25 were installed in 1981 and abandoned in 1984. The remaining FTF Series wells (FTF 15 through FTF 27, including FTF 24A and FTF 25A) were constructed in 1984. The locations of the active wells are shown in Figure 8-20.

Groundwater at the F-Area Tank Farm is monitored monthly for gross alpha, nonvolatile beta, tritium, pH, and the specific radionuclides listed in Appendix F.

8.08.04 Site-Specific Hydrology

Water-level data obtained from the F-Area Tank Farm wells since January 1985 indicate that the water-table elevation has declined from approximately 230 to 228 ft msl to approximately 225 to 222 ft msl and that the vadose zone has increased from 42 to 59 ft thick to 47 to 64 ft thick. Hydrographs of the monitoring wells are presented in Figures 8-21 through 8-25.

A water-table elevation map for the second quarter of 1986 is presented in Figure 8-20. As shown, the general horizontal flow direction was to the west to southwest. The water-level data indicate that this has been the predominant flow direction. The approximate horizontal hydraulic gradient has been 0.005 ft/ft. However, this gradient is variable across the F-Area Tank Farm, as shown in Figure 8-20. Using a groundwater flow velocity estimated for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the site has ranged approximately from 7.5 to 30 ft/yr.

8.08.05 Waste-Site Content Characterization Data

Information regarding the nature of the wastes disposed to the F-Area Tank Farm is presented in Section 8.08.02.

8.08.06 Soil/Sediment Characterization Data

In April 1961, Tank 8 was overfilled, resulting in soil contamination around the west edge of the tank by the inlet pipe (Ashley and Zeigler, 1981). Core samples taken in 1975 defined the contaminated zone as varying from 1 to 14 ft thick, totaling approximately 1,000 ft^3. Soil analysis and groundwater monitoring results obtained from continuous pumping of wells FTF 6 and FTF 7 identified the contaminants as ^{106}Ru and ^{137}Cs (Ashley, 1972).

In 1986, 123 one-foot-deep soil core samples were taken in a spoke pattern from the 292-F Stack to beyond the perimeter fence. One of these spokes transected the F-Area Tank Farm, and six cores were taken within the tank farm boundaries. Maximum activities below 1 pCi/g of uranium and 0.2 pCi/g of plutonium were found in the samples from this area (Zeigler et al., 1987).

8.08.07 Groundwater Monitoring Results

Monitoring data from 1973 through 1986 for the F-Area Tank Farm wells are given in Table 8-12, which lists the gross alpha, nonvolatile beta, and tritium yearly activity averages and maximum values for the site wells. Currently active groundwater monitoring well and tank locations in the F-Area Tank Farm are shown in Figure 8-20, along with the predominant groundwater flow direction. As shown in Figure 8-20 and discussed in Section 8.08.04, near-surface groundwater flow has generally been to the west to southwest across the site.

The nonvolatile beta and tritium monitoring data indicate that the F-Area Tank Farm has influenced groundwater quality in the downgradient wells near Tanks 3 through 8, in the wells surrounding Tank 20, and in the wells downgradient of Tanks 17 through 20. Average annual gross alpha activities in all of the site wells remained less than the drinking water standard of 15 pCi/L over the monitoring period except for well FTF 6 in 1983 (37.0 pCi/L) and in 1984 (31.0 pCi/L).

Monitoring wells FTF 5, FTF 6, and FTF 7 are close to or downgradient of Tank 8 (Figure 8-20), which was overfilled in 1961. The elevated levels of nonvolatile beta detected in wells FTF 5 through 7 have been attributed to the ^{106}Ru and ^{137}Cs contained in this spill. Since 1981, average annual nonvolatile beta activities have ranged from 70.0 to 510 pCi/L in well FTF 5, from 770 to 10,000 pCi/L in well FTF 6, and from 95.0 to 330 pCi/L in well FTF 7. The average nonvolatile beta activity in well FTF 6 peaked in 1981 at 10,000 pCi/L and decreased to an average of 980 pCi/L in 1986. Average tritium activities in wells FTF 5 (19 to 400 pCi/mL) and FTF 6 (19 to 170 pCi/mL) have remained above the drinking water standard of 20 pCi/mL since 1977 and 1981, respectively. The average tritium levels in well FTF 5 peaked in 1981 at 400 pCi/mL and decreased to an average level of 96 pCi/mL in 1986. The annual average tritium activities in well FTF 7 have met the drinking water standard of 20 pCi/mL except in 1973 (54 pCi/mL), in 1982 (21 pCi/mL), and in 1983 (33 pCi/mL).

As shown in Figure 8-20, wells FTF 24A, FTF 25A, FTF 26, and FTF 27 are adjacent to Tank 20, and wells FTF 11, FTF 12, and FTF 19 are downgradient of Tanks 17 through 20. The groundwater monitoring data summarized in Table 8-12 indicate that elevated nonvolatile beta and tritium activities have been detected in these wells. Average annual nonvolatile beta levels from 1984 through 1986 were predominantly greater than 10 pCi/L in wells FTF 24A (6.80 to 23.0 pCi/L), FTF 25A (11.0 to 17.0 pCi/L), FTF 26 (18.0 to 45.0 pCi/L), FTF 27 (7.10 to 13.0 pCi/L), FTF 11 (10.0 to 16.0 pCi/L), and FTF 19 (26.0 to 41.0 pCi/L). The average annual nonvolatile beta activities in the remaining site wells (excluding wells FTF 5, FTF 6, and FTF 7) were mainly less than 10 pCi/L. Average annual tritium activities in wells FTF 24A (27 to 30 pCi/mL), FTF 25A (23 to 31 pCi/mL), FTF 26 (33 to 50 pCi/mL), FTF 27 (37 to 46 pCi/mL), FTF 12 (19 to 41 pCi/mL), and FTF 14 (18 to 26 pCi/mL) were predominantly above the drinking water standard of 20 pCi/mL. The average tritium activities in the remaining site wells (excluding wells FTF 5, FTF 6, and FTF 7) were predominantly less than the drinking water standard (20 pCi/mL).

8.08.08 Planned Action

The F-Area Tank Farm is active, and continued use is planned. Groundwater monitoring will continue at this site.

8.09 F-AREA SEEPAGE BASINS

8.09.01 Summary

The F-Area Seepage Basins (Buildings 904-41G, 904-42G, and 904-43G) routinely receive evaporator wastewater containing low-level radioactivity and chemicals from the F-Area separations facilities. Primary sources of effluent sent to the basins are the nitric acid recovery unit overheads, the general purpose evaporator overheads, the F-Area Tank Farm evaporator overheads, overheads from several other process evaporators, and retention basin transfers. The F-Area Seepage Basins are unlined earthen basins that allow slow seepage through the soil column, which immobilizes most of the radionuclides contained in the wastewater. In the case of tritium, which moves with the groundwater, the time required for groundwater to discharge to surface streams allows for some radioactive decay. The basins were placed in service during 1955 and are expected to remain in service until 1988. The F-Area Seepage Basins currently contain process wastewater and rainwater (Killian et al., 1987a).

Basin influent is analyzed routinely, and soil/sediments were sampled in 1971 (Basin 3) and 1984 (all three basins). Basin influent data indicate that the following tested parameters were present at elevated concentrations: iron, chromium, zinc, nitrate, fluoride, lead, and mercury. Concentrations of many tested soil/sediment parameters for the F-Area Seepage Basins were above background levels. Extraction Procedure (EP) toxicity test results for metals indicate that concentrations in the basin soil/sediments were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

Groundwater monitoring results for the water-table wells since the third quarter of 1984 indicate that the F-Area Seepage Basins have been affecting the quality of the water table. Low pH and elevated levels of radioactivity, conductivity, nitrate, sodium, and lead were reported for sidegradient well FSB 87D and downgradient wells FSB 77, FSB 78, and FSB 79. Groundwater quality in upgradient well FSB 76 also apparently has been affected as indicated by the elevated tritium levels reported for this well. This effect, however, is less than in the other site wells and may be attributable to a nearby vitrified clay influent process pipeline, which was in service from 1955 to 1982. In 1982, it was replaced with a polyethylene pipeline.

Groundwater monitoring results from the wells screened in the McBean Formation indicate that the F-Area Seepage Basins have been influencing groundwater quality in this formation also, as indicated by the low pH and elevated levels of radioactivity, conductivity, nitrate, sodium, and lead reported for the two downgradient wells (FSB 78C and FSB 79C). Groundwater quality in the upgradient and sidegradient McBean monitoring wells has apparently not been affected except for elevated levels of tritium.

Groundwater monitoring results for the Upper and Lower Congaree Formation wells indicate that the F-Area Seepage Basins have had little apparent effect on Congaree Formation groundwater quality. All radioactive and dissolved chemical constituent levels consistently met drinking water standards except for tritium. Indicator parameter concentrations in these wells were consistent with background levels. At this location, the head in the Upper Congaree Formation is the lowest of all the formations. Vertical groundwater flow, therefore, is from the Lower to the Upper Congaree Formation, making contamination of the Lower Congaree Formation from basin seepage unlikely.

8.09.02 Waste-Site Description and Nature of Disposal

The F-Area Seepage Basins (Buildings 904-41G, 904-42G, and 904-43G) were constructed in 1955 by removing existing soils below grade and building sloped side walls at the surface. The soils in the area are predominantly composed of medium-to-fine grained, poorly sorted sand, with silt and clay content ranging from 30 to 50%. The basins are within an area of relatively high topographic relief, with surface elevations around the site ranging approximately from 275 to 285 ft msl (Figure 8-26). The F-Area Seepage Basins are three unlined earthen depressions with approximate dimensions of 300 ft long by 90 ft wide by 12 ft deep (Basin 1), 525 ft long by 90 ft wide by 12 ft deep (Basin 2), and 720 ft long by 310 ft wide by 12 ft deep (Basin 3). The combined maximum operating capacity of the basins is approximately 20.5 million gal. Wastewater flows from Basin 1 to Basin 2 and then to Basin 3 through underground pipelines.

The F-Area Seepage Basins have been in use since 1955 to contain effluent from the F-Area separations facilities. The primary sources of effluent sent to the basins are the nitric acid recovery unit overheads, the general purpose evaporator overheads, the Tank Farm evaporator overheads, and other process evaporator overheads. Retention basin transfers are also sent to the seepage basins.

The F-Area Seepage Basins receive significant amounts of nitric acid (HNO_3) and caustic (NaOH). The nitric acid is generated during the evaporation of process liquid wastes and enters the seepage basins from the acid recovery unit overheads. Nitrate releases to the basins vary but have averaged 234,300 kg/yr in the past. Table 8-13 presents the estimated annual nitrate discharge rates from 1961 to 1983. Caustic is used to neutralize the high-level radioactive waste stream before it is stored in tanks and enters the seepage basins from the Tank Farm evaporator overheads. Combined discharges of caustic from F- and H-Area operations average 90,700 kg/yr (Killian et al., 1987a).

Mercury is used in F-Area operations as an aid in dissolving aluminum alloy fuels. The caustic also contains trace amounts of mercury as an impurity. Although most of the mercury is sent to the high-level waste tanks, some is released to the basins from the evaporator overheads. Table 8-14 lists the estimated mercury releases from 1955 to 1984. A summary of the radioactive releases to the F-Area Seepage Basins (1955 to 1985) is presented in Table 8-15. Discharge from the basins has been limited to groundwater seepage; no discharge to surface water has occurred.

The basins are currently active and receiving wastewater. The side slopes of the basins are well vegetated above the water line.

8.09.03 Groundwater Monitoring Program

Fifty-two wells (35 F Series wells and 17 FSB Series wells) have been installed to monitor the water-table elevation and groundwater quality at the F-Area Seepage Basins (Figure 8-27). The F Series wells were installed under the radioactive program to monitor the water table at the seepage basins for radioactive parameters only. A total of 35 F Series monitoring wells have been installed: from 1956 through 1965 wells F 1 through F 34 were installed; well F 18A was installed in January 1985 to replace well F 18. The following 12 wells are currently active: F 1, F 2, F 9, F 10, F 14, F 15, F 16, F 17, F 18A, F 19, F 24, and F 25. Well F 23 was active until May 1986, when it was abandoned because it went dry. Wells F 1, F 5, F 6, F 7, F 10, and F 12 were screened in the perched water zone beneath the basins. Two of these perched water wells (F 1 and F 10) are currently active.

Wells FSB 76, FSB 77, FSB 78, and FSB 79 were installed in 1981 to monitor the water table (Barnwell Formation) at the basins. In the fall of 1984, four well clusters (FSB 76A, B, and C; FSB 78A, B, and C; FSB 79A, B, and C; and FSB 87A, B, C, and D) were installed to define the hydrostratigraphy and to allow monitoring of the deeper formations (Figure 8-27). These wells are screened in the aquifers of the Barnwell Formation (D wells and wells without a letter designation), McBean Formation (C wells), Upper Congaree Formation (B wells), and the Lower Congaree Formation (A wells).

The FSB Series wells are part of the SRS quarterly groundwater monitoring program. Monitoring began in the first quarter of 1982 for water-table wells FSB 76, FSB 77, FSB 78, and FSB 79. Monitoring for the remaining wells began in the first quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

8.09.04 Site-Specific Hydrology

Wells F 1 and F 10 monitor the perched water zone beneath the basins. Well F 1 is adjacent to Basin 1, and well F 10 is adjacent to Basin 3.

A water-table elevation map for the fourth quarter of 1985 (Figure 8-28) shows that the near-surface groundwater flow direction was to the southeast toward Four Mile Creek. Hydrographs for the water-table wells (Figures 8-29 through 8-31) show that the water-table elevation near the basins has ranged from 222 to 200 ft msl. The hydrographs indicate that this has been the predominant horizontal flow direction, although fluctuations in water-table elevations indicate that minor changes in direction and hydraulic gradient have occurred. The water-level fluctuations in wells F 15, F 16, F 17, and F 19 in late 1984 and early 1985 are unexplained. Relative to the basins, wells FSB 76 and F 24 have been consistently upgradient. Well FSB 87D has been sidegradient; well F 23 was sidegradient to the basins when it was active. The remaining water-table wells are downgradient of one or more of the basins. The horizontal hydraulic gradient has been approximately 0.005 ft/ft. Using an estimated horizontal groundwater flow velocity range determined for the Barnwell Formation in this area of 15 to 60 ft/yr per percent gradient, the near-surface horizontal groundwater flow velocity beneath the F-Area Seepage Basins has ranged from 7.5 to 30 ft/yr.

A review of the water-level elevation measurements obtained for the McBean Formation from the appropriate F-Area Seepage Basins wells indicates that the piezometric surface of the McBean aquifer has changed little since 1985. A hydrograph for these wells is presented in Figure 8-32. A water-level elevation map generated for the McBean Formation from data obtained during the fourth quarter of 1985 (Figure 8-33) shows that the medium-depth horizontal groundwater flow has been to the south-southeast. In the vicinity of the basins, the horizontal hydraulic gradient has been approximately 0.0025 ft/ft in the McBean Formation. The gradient appears much steeper to the south of the basins. Relative to the basins, well FSB 76C has been upgradient, well FSB 87C sidegradient, and wells FSB 78C and FSB 79C downgradient.

A review of the Upper and Lower Congaree water-level elevation measurements obtained from the appropriate F-Area Seepage Basins wells indicates that the piezometric surface of the Congaree aquifers also has changed little since 1985. Hydrographs for these wells are shown in Figures 8-34 and 8-35, respectively. A Congaree water-level elevation map for the fourth quarter of 1985 (Figure 8-36) shows that the deep horizontal groundwater flow direction has been to the west toward the tributary system of Upper Three Runs Creek. The hydraulic gradient has been approximately 0.003 ft/ft. Because of the change in the horizontal flow direction between the Barnwell and McBean formations and the Congaree Formation, it is difficult to determine the hydraulic positioning of these wells relative to the basins. Therefore, an upgradient well has not been designated for the Congaree wells. At this location a head reversal occurs; thus, vertical groundwater flow is from the Lower to the Upper Congaree Formation.

8.09.05 Waste-Site Content Characterization Data

Section 8.09.02 contains information on the F-Area Seepage Basins influent. Selected data from the chemical analyses of seepage basin influent collected at a Trebler monitor upstream of Basin 1 are listed in Table 8-16. These data indicate that the average dissolved chemical constituent concentrations of nitrate (1,220 mg/L), lead (0.12 mg/L), iron (1.7 mg/L), sodium (790 mg/L), and mercury (0.004 mg/L) were elevated. The pH of the basin influent ranged from 1.52 to 12.8, with an average pH of 2.93.

Selected data from radioactivity analyses of seepage basin influent collected at the Trebler monitor upstream of Basin 1 are listed in Table 8-17. These data indicate elevated average activities of gross alpha (3,080 pCi/L), tritium (101,608,900 pCi/L), and ^{90}Sr (6,200 pCi/L). The average activities of the remaining tested radionuclides are shown in Table 8-17.

The F-Area Seepage Basins water has been analyzed for radioactive parameters. Gross alpha, nonvolatile beta, and specific radionuclide activities in basin water from 1957 through 1986 are given in Table 8-18. The tritium activities in all three basins have been elevated throughout the monitoring period.

8.09.06 Soil/Sediment Characterization Data

The F-Area Seepage Basin soil/sediments were sampled in 1971 and 1984 as part of a basin characterization program. The 1971 soil/sediment samples consisted of three 8 to 18 ft soil/sediment cores obtained from the floor of Basin 3 while it was temporarily dry. More than 99% of the plutonium was retained in the top 8 in. of soil/sediment. The maximum plutonium concentration found was 1.7 nCi/g. Cesium-137 was found throughout the 18-ft borings but was mainly concentrated in the top half (Killian et al., 1987a).

The 1984 soil/sediment samples consisted of eight 3-ft continuous cores obtained from the floors of all three basins. Soil/sediment analytical results are summarized in Table 8-19. Although most of the radionuclide inventory was found in the top foot of the cores, ^{3}H and ^{90}Sr were found throughout the lengths of the cores. The majority of the cations and anions were also found in the top foot of the cores; however, elevated levels of iron, sodium, and occasionally nitrate and fluoride were found throughout the lengths of the cores (Corbo et al., 1985). Extraction Procedure (EP) toxicity test results for metals indicate concentrations less than the Resource Conservation and Recovery Act (RCRA) criteria for identifying hazardous waste (40 CFR 261.24).

8.09.07 Groundwater Monitoring Results

The groundwater monitoring data for the FSB Series wells from 1982 through 1986 are presented in Appendix F. Monitoring data for the F Series wells from the radioactive program from 1956 through 1986 are given in Table 8-20.

Comparisons of the monitoring results among the downgradient wells and upgradient wells in the water-table and McBean aquifers were used to evaluate groundwater impact from the F-Area Seepage Basins in the Barnwell and McBean formations. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Because an upgradient well could not be determined for the wells screened in the Congaree Formation, results from these wells were compared to drinking water standards to assess any effect from the basins on the groundwater in this formation. Indicator parameters for the F-Area Seepage Basins are conductivity, nitrate, sodium, lead, pH, and radioactivity. Groundwater pH was used as an indicator parameter because the average pH of the basin influent was low (2.93), and conductivity was used because it is a good indicator of groundwater quality. Nitrate, sodium, lead, and radioactivity were chosen as indicator parameters because elevated levels of these constituents were discharged to the F-Area Seepage Basins (see Sections 8.09.02 and 8.09.05). Lead concentrations in the basin influent are insufficient to account for the observed levels in the groundwater, however. In the third quarter of 1986, brass fittings were found in the monitoring wells. These were replaced with PVC or stainless steel fittings before the fourth quarter samples were drawn. Lead analyses in the fourth quarter samples were lower by a factor of 4 to 10 than lead analyses in earlier quarters. More data are needed, however, before a definitive conclusion can be drawn concerning the contribution of the brass fittings to dissolved lead concentrations in the groundwater samples.

<u>Perched Water Wells</u>

Table 8-20 includes the radioactive monitoring data for the wells monitoring the perched water zone at the site (F 1 and F 10). Gross alpha levels have averaged over the drinking water standard of 15 pCi/L since 1957 except for well F 1 in 1986 (13.0 pCi/L). Nonvolatile beta levels in these two wells have averaged 700 pCi/L or more since monitoring began in 1956. Average tritium levels have ranged from 10,000 to 125,000 pCi/mL in these two wells since tritium monitoring began in 1961. Average radioactivity levels in well F 1 have been declining since 1981.

Water-Table Wells

The locations of the monitoring wells screened in the water table relative to the F-Area Seepage Basins are presented in Figure 8-28, along with the predominant water-table flow direction. The FSB Series wells are used to acquire chemical and radioactivity data, and the F Series wells monitor for radioactivity.

Groundwater monitoring results for the FSB water-table wells since the third quarter of 1984 are summarized in Table 8-21. The data show that the F-Area Seepage Basins have been affecting the quality of the water table, as indicated by the lower pH and elevated levels of radioactivity, conductivity, nitrate, sodium, and lead reported for downgradient wells FSB 77, FSB 78, and FSB 79 and sidegradient well FSB 87D. Groundwater quality in upgradient well FSB 76 also apparently has been affected as indicated by the elevated tritium levels reported for this well. This effect, however, is less than in the other site wells and may be attributable to a nearby vitrified clay influent process pipeline that was in service from 1955 to 1982 and may have leaked during that time.

Groundwater quality in upgradient well FSB 76 has been characterized by low dissolved chemical constituent levels compared to drinking water standards. However, as indicated above, radioactivity, specifically tritium, has been elevated relative to drinking water standards. Tritium levels in upgradient well FSB 76 (867 to 1,050 pCi/mL) have remained above the drinking water standard of 20 pCi/mL. Gross alpha activity in well FSB 76 (<2.0 to 83.0 pCi/L) exceeded the drinking water standard of 15 pCi/L on one occasion in April 1985. Nonvolatile beta levels in well FSB 76 remained below 22.0 pCi/L, excluding a value of 59.0 pCi/L reported for April 1985. Total radium levels in well FSB 76 met the drinking water standard of 5 pCi/L over the monitoring period. Conductivity in upgradient well FSB 76 ranged from 62 to 135 μmhos/cm, and sodium levels remained below 20 mg/L. Nitrate (4.00 to 9.66 mg/L) and lead (0.009 to 0.047 mg/L) remained below their respective drinking water standards of 10 mg/L and 0.05 mg/L. Groundwater pH in upgradient well FSB 76 ranged from 3.9 to 5.7, averaging 5.0. Zinc levels (1.16 to 6.94 mg/L) ranged above the drinking water standard of 5 mg/L.

The F-Area Seepage Basins have affected groundwater quality in downgradient wells FSB 77, FSB 78, and FSB 79 and sidegradient well FSB 87D as evidenced by the elevated indicator parameter and lower pH levels reported for these wells. Conductivity in wells FSB 77 (205 to 1,200 μmhos/cm), FSB 78 (1,200 to 3,600 μmhos/cm), FSB 79 (970 to 2,000 μmhos/cm), and FSB 87D (400 to 2,400 μmhos/cm) has been greater than the upgradient well conductivity (62 to 135 μmhos/cm). Sodium concentrations in wells FSB 77 (9.80 to 110 mg/L), FSB 78 (122 to 195 mg/L), FSB 79 (56.6 to 146 mg/L), and FSB 87D (45.0 to 172 mg/L) have been elevated relative to the upgradient well (6.29 to 19.6 mg/L). Nitrate levels in wells FSB 77 (19.4 to 81.0 mg/L), FSB 78 (300 to 447 mg/L), FSB 79 (34.5 to 195 mg/L), and FSB 87D (50.2 to 360 mg/L) have been consistently above the levels reported for the upgradient well (4.00 to 9.66 mg/L) and the drinking water standard of 10 mg/L. Lead and manganese concentrations in wells FSB 77 (0.007 to 0.164 mg/L and 0.073 to 0.479 mg/L), FSB 78 (<0.005 to 0.299 mg/L and 0.618 to 1.34 mg/L), FSB 79 (<0.005 to 0.082 mg/L and 2.66 to 3.84 mg/L), and FSB 87D (0.011 to 0.31 mg/L and 1.095 to 1.56 mg/L) exceeded the drinking water standard of 0.05 mg/L for both. Iron and cadmium levels were above their respective drinking water standards in wells FSB 77 (0.014 to 0.321 mg/L and 0.001 to 0.06 mg/L), FSB 78 (0.138 to 1.80 mg/L and <0.002 to 0.022 mg/L), and FSB 87D (1.20 to 1.735 mg/L and 0.004 to 0.029 mg/L). Total dissolved solids (TDS) levels were above the drinking water standard of 500 mg/L in wells FSB 77 (638 to 904 mg/L), FSB 78 (1,238 to 1,294 mg/L), and FSB 79 (502 to 542 mg/L). Chromium concentrations in well FSB 77 (<0.004 to 0.051 mg/L) were occasionally above the drinking water standard of 0.05 mg/L.

Groundwater pH in downgradient wells FSB 77 (2.8 to 4.2), FSB 78 (2.7 to 3.3), and FSB 79 (3.0 to 3.4) and sidegradient well FSB 87D (3.2 to 5.0) was generally lower than the pH reported for the upgradient well (3.9 to 5.7). Figures 8-37 through 8-39, which show graphic comparisons of the average chemical indicator parameter concentrations among the water-table wells, demonstrate the relative differences in groundwater quality between the upgradient water-table well and the other site water-table wells. Figures 8-37 through 8-39 also demonstrate the varying effects on the downgradient/sidegradient wells, with wells FSB 78 and FSB 87D showing the greatest impact. Figure 8-40 shows the isoconcentration contours of nitrates in the water table for 1983 and the 1985 terrain conductivity survey results around the F-Area Seepage Basins.

Elevated radioactivity in downgradient wells FSB 77, FSB 78, and FSB 79 and sidegradient well FSB 87D also indicates an effect from the F-Area Seepage Basins on groundwater quality in the water table. Gross alpha activity in wells FSB 77 (66.4 to 717 pCi/L), FSB 78 (63.7 to 1,614 pCi/L), FSB 79 (<2 to 1,087 pCi/L), and FSB 87D (91 to 1,652 pCi/L) usually has been greater than the activity in the upgradient well (<2 to 83 pCi/L) and the drinking water standard of 15 pCi/L. Nonvolatile beta activities in wells FSB 77 (185.6 to 991 pCi/L), FSB 78 (722.3 to 3,461 pCi/L), FSB 79 (<3 to 1,427 pCi/L), and FSB 87D (305 to 1,799 pCi/L) usually have been greater than the levels reported for the upgradient well (7.0 to 59.0 pCi/L). Total radium activity in wells FSB 77 (7.8 to 56.0 pCi/L), FSB 78 (21.6 to 67.0 pCi/L), FSB 79 (<1.0 to 42.0 pCi/L), and FSB 87D (14.1 to 61.0 pCi/L) usually has been greater than the upgradient well levels (<1.0 to 5.0 pCi/L) and the drinking water standard of 5 pCi/L. Similarly, tritium activities in wells FSB 77 (1,090 to 1,339 pCi/mL), FSB 78 (42,500 to 56,145 pCi/mL), FSB 79 (16,499 to 25,000 pCi/mL), and FSB 87D (3,920 to 44,000 pCi/mL) have remained above levels reported for the upgradient well (867 to 1,050 pCi/mL) and the drinking water standard of 20 pCi/mL.

Monitoring results from the F Well Series, which has been used to obtain groundwater radioactivity measurements for the water table near the F-Area Seepage Basins, also indicate an effect on groundwater quality (Table 8-20). Annual average gross alpha levels in downgradient wells F 2 (0.45 to 19,000 pCi/L), F 14 (1.30 to 220 pCi/L), F 15 (0.27 to 24.0 pCi/L), F 16 (0.40 to 94.67 pCi/L), F 18 (0.70 to 28.0 pCi/L), F 18A (31.0 pCi/L), and F 19 (0.90 to 42.46 pCi/L) ranged over the drinking water standard of 15 pCi/L. Annual average nonvolatile beta activities in all of the active wells have ranged over 30 pCi/L. Annual average tritium activity in these wells since 1977 has been above the drinking water standard of 20 pCi/mL. Figure 8-41 shows the isoconcentration contours of tritium in the water table near the F-Area Seepage Basins.

McBean Formation Wells

The locations of the monitoring wells screened in the McBean Formation relative to the F-Area Seepage Basins are presented in Figure 8-33, along with the predominant McBean Formation groundwater flow direction. As shown in Figure 8-33, well FSB 76C has been upgradient, well FSB 87C sidegradient, and wells FSB 78C and FSB 79C downgradient relative to the basins.

Groundwater monitoring results for the McBean Formation wells since the third quarter of 1984 are summarized in Table 8-22. The monitoring data summarized in this table show that the F-Area Seepage Basins have been affecting groundwater quality in the McBean Formation as indicated by the lower pH and elevated levels of radioactivity, conductivity, nitrate, sodium, and lead reported for downgradient wells FSB 78C and FSB 79C. Groundwater quality near upgradient well FSB 76C and sidegradient well FSB 87C has apparently not been affected except for elevated levels of tritium.

Groundwater quality near upgradient well FSB 76C and sidegradient well FSB 87C has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for tritium in both wells and lead (<0.005 to 1.05 mg/L) and an isolated excursion of manganese (0.058 mg/L) in well FSB 76C. Relatively low conductivity has been reported for upgradient well FSB 76C (30 to 56 μmhos/cm) and sidegradient well FSB 87C (62 to 69 μmhos/cm). Nitrate and sodium levels in these two wells remained below 4.1 mg/L and 3.9 mg/L, respectively. As indicated above, reported activities for the radiological parameters (gross alpha, nonvolatile beta, total radium, and tritium) in upgradient well FSB 76C and sidegradient well FSB 87C remained less than drinking water standards except for tritium. Tritium levels in sidegradient well FSB 87C (75 to 1,730 pCi/mL) remained above the drinking water standard of 20 pCi/mL, and levels in upgradient well FSB 76C (3 to 459 pCi/mL) were generally above this standard. Groundwater pH ranged from 4.9 to 6.0 in upgradient well FSB 76C and from 6.4 to 7.0 in sidegradient well FSB 87C.

Groundwater quality near downgradient wells FSB 78C and FSB 79C has been affected by the F-Area Seepage Basins as evidenced by the elevated indicator parameter levels and lower pH reported. Conductivity in downgradient wells FSB 78C (1,420 to 2,200 µmhos/cm) and FSB 79C (1,400 to 2,200 µmhos/cm) has been greater than the conductivity reported for the other site McBean Formation monitoring wells. Sodium levels in downgradient wells FSB 78C (82.3 to 138 mg/L) and FSB 79C (8.97 to 148 mg/L) have been elevated relative to the other site McBean Formation monitoring wells. Nitrate concentrations in wells FSB 78C (237 to 260 mg/L) and FSB 79C (216 to 245 mg/L) have been consistently above the levels reported for the other site McBean Formation monitoring wells and the drinking water standard of 10 mg/L. Similarly, lead concentrations in wells FSB 78C (0.013 to 0.293 mg/L) and FSB 79C (<0.005 to 0.055 mg/L) have been elevated compared to the other site McBean Formation monitoring wells and have ranged above the drinking water standard (0.05 mg/L). Groundwater pH in downgradient wells FSB 78C (4.3 to 5.1) and FSB 79C (3.1 to 3.5) has been low compared to the pH reported for the other site McBean Formation monitoring wells. Graphic comparisons of the average chemical indicator parameter concentrations among the McBean Formation site wells (Figures 8-42 through 8-44) demonstrate the relative differences in groundwater quality among the wells that are directly downgradient of the seepage basins and the site background wells.

In addition to some of the chemical indicator parameters discussed above, manganese, cadmium, and iron concentrations exceeded drinking water standards in one or both of the downgradient wells. Manganese levels in downgradient wells FSB 78C (3.89 to 5.16 mg/L) and FSB 79C (3.90 to 4.35 mg/L) have been consistently above the drinking water standard of 0.05 mg/L. Cadmium levels in downgradient wells FSB 78C (0.003 to 0.022 mg/L) and FSB 79C (0.014 to 0.026 mg/L) generally have remained above the drinking water standard of 0.010 mg/L. Iron concentrations in downgradient well FSB 78C (0.266 to 0.553 mg/L) exceeded the drinking water standard of 0.3 mg/L on two occasions, while iron concentrations remained below this standard in well FSB 79C (below 0.05 mg/L).

Elevated radioactivity levels in the downgradient wells also indicate an effect from the F-Area Seepage Basins on groundwater quality in the McBean Formation. Gross alpha activity in downgradient wells FSB 79C (70.1 to 2,269 pCi/L) and FSB 78C (1.8 to 205 pCi/L) generally remained above levels in the other site McBean monitoring wells (below 2.0 pCi/L) and the drinking water standard of 15 pCi/L. Nonvolatile beta activity in downgradient wells FSB 78C (481.6 to 1,264 pCi/L) and FSB 79C (1,409.7 to 4,007 pCi/L) consistently has been greater than the activities reported in the other site McBean monitoring wells (below 14.0 pCi/L). Total radium levels in wells FSB 78C (16.7 to 29.5 pCi/L) and FSB 79C (97.8 to 153 pCi/L) remained above levels in the other site McBean monitoring wells (<1.0 pCi/L) and the drinking water standard of 5 pCi/L. Similarly, tritium levels in downgradient wells FSB 78C (9,963 to 12,100 pCi/mL) and FSB 79C (15,900 to 57,740 pCi/mL) remained above the levels in the other site McBean Formation monitoring wells (3 to

1,730 pCi/mL) and the drinking water standard of 20 pCi/mL. Graphic comparisons of the average radioactivity indicator parameter levels among the McBean Formation site wells (Figures 8-44 and 8-45) demonstrate the relative differences in groundwater quality between the downgradient wells and the other site wells.

Congaree Formation Wells

Locations of the monitoring wells screened in the Upper Congaree Formation relative to the F-Area Seepage Basins are presented in Figure 8-36, along with the predominant groundwater flow direction. Because of the change in horizontal groundwater flow direction between the Barnwell and McBean formations and the Congaree Formation, it is difficult to determine an upgradient well. Comparisons of the monitoring data with drinking water standards were used to determine groundwater quality in these wells.

Groundwater monitoring results for the Upper Congaree Formation wells since the third quarter of 1984 are summarized in Table 8-23. Radioactive and dissolved chemical constituent levels consistently met drinking water standards in all four Upper Congaree Formation wells except for tritium. Tritium activity exceeded the drinking water standard in wells FSB 78B, FSB 76B, and FSB 87B.

Conductivity in well FSB 78B (159 to 260 µmhos/cm) was slightly greater than the conductivity in wells FSB 76B (82 to 160 µmhos/cm), FSB 87B (65 to 76 µmhos/cm), and FSB 79B (120 to 165 µmhos/cm). Groundwater pH in well FSB 78B (7.0 to 8.3) was above the groundwater pH in wells FSB 76B (5.7 to 6.8), FSB 87B (5.9 to 6.3), and FSB 79B (6.0 to 6.9). The pH reported for wells FSB 76B, FSB 87B, and FSB 79B was consistent with the pH range reported as naturally occurring in Upper Congaree Formation groundwater, while the pH reported for well FSB 78B was generally greater than the naturally occurring groundwater pH range (Appendix B). Figure 8-46, which shows graphic comparisons of the average conductivity and pH ranges among the Upper Congaree Formation wells, demonstrates the relative difference in groundwater quality between the site wells.

Nitrate levels in the site wells were less than the drinking water standard of 10 mg/L, ranging from <0.50 to 4.66 mg/L. Tritium activity in wells FSB 78B (188 to 239 pCi/mL), FSB 76B (0.4 to 32 pCi/mL), and FSB 87B (98 to 120 pCi/mL) usually exceeded the drinking water standard of 20 pCi/mL. Figure 8-47, which shows graphic comparisons of the average nitrate and tritium levels among the Upper Congaree Formation wells, demonstrates the relative differences in groundwater quality among the site wells. Activity levels for the remaining radioactivity parameters (gross alpha, nonvolatile beta, total radium) remained less than drinking water standards in all four Upper Congaree Formation wells.

Groundwater monitoring results for the Lower Congaree Formation wells since the third quarter of 1984 are summarized in Table 8-24. At this location, the vertical groundwater flow direction is upward from the Lower Congaree to the Upper Congaree Formation. All radioactivity and dissolved chemical constituent levels consistently met drinking water standards except for an isolated excursion of tritium. Conductivity in wells FSB 76A, FSB 78A, FSB 79A, and FSB 87A ranged from 64 to 190 µmhos/cm. Nitrate levels in all four of these wells remained below 0.20 mg/L. Groundwater pH in wells FSB 76A (6.0 to 7.1), FSB 78A (5.6 to 6.6), FSB 79A (5.6 to 6.7), and FSB 87A (5.8 to 6.4) was consistent with the naturally occurring Congaree Formation groundwater pH range (Appendix B).

8.09.08 Planned Action

The F-Area Seepage Basins are active, and continued use is planned until November 1988. An Effluent Treatment Facility is being constructed to handle the wastewater currently sent to the F-Area Seepage Basins. As indicated in Section 16, point-of-compliance wells are scheduled for installation in 1987, and a closure plan is to be developed in 1988. Groundwater monitoring will continue at this site.

8.10 OLD F-AREA SEEPAGE BASIN

8.10.01 Summary

The Old F-Area Seepage Basin (Building 904-49G) received effluent from Building 221-F from November 1954 until May 1955. After May 1955, three additional basins (the F-Area Seepage Basins--see Section 8.09) were opened, and the Old F-Area Seepage Basin was abandoned. During its use in 1954 and 1955, the basin received a variety of wastewaters including evaporator overheads, laundry wastewater, and an unknown amount of chemicals. An estimated 9.2 to 9.3 million gal of wastewater were discharged to the basin. In addition, approximately 3,500 gal of spent etching solution from Building 313-M were discharged to the basin under a test authorization in October 1969. Currently, ponding takes place in the basin, and, depending upon seasonal weather conditions, the depth of water in the basin varies (Odum et al., 1987).

Groundwater monitoring data indicate that the Old F-Area Seepage Basin has had an effect on groundwater quality near sidegradient well FNB 3 and downgradient well FNB 2. Elevated levels of gross alpha, total radium, nonvolatile beta, tritium, nitrate, manganese, lead, barium, and conductivity were reported for these two wells compared to South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards and the levels reported for sidegradient wells FNB 1 and FNB 4. Slightly elevated indicator parameter levels in sidegradient well FNB 1 are possibly caused by the influent process line, which is upgradient of this well. Groundwater quality near sidegradient well FNB 4 apparently has not been affected.

8.10.02 Waste-Site Description and Nature of Disposal

The Old F-Area Seepage Basin (Building 904-49G) was the first seepage basin constructed in the area and received effluent from Building 221-F from November 1954 until mid-May 1955. After May 1955, three additional basins (the F-Area Seepage Basins--see Section 8.09) south of F Area were opened, and the Old F-Area Seepage Basin was subsequently abandoned.

The estimated flow volumes to the Old F-Area Seepage Basin when it was active are presented in Table 8-25. During its process use in 1954 and 1955, the basin received a variety of wastewaters including evaporator overheads, laundry wastewater, and an unknown amount of chemicals. An estimated 9.2 to 9.3 million gal of wastewater were discharged to the basin. In addition, on October 9, 1969, approximately 3,500 gal of spent etching solution from Building 313-M were discharged to the basin under a test authorization. Since 1955, the basin has also been used intermittently to divert rainfall runoff or process effluents from National Pollutant Discharge Elimination System (NPDES) Outfall F-2 (Odum et al., 1987). Estimated radionuclide releases to the basin (decay-corrected through December 1985) are presented in Table 8-26. Basin water has been pumped to Upper Three Runs Creek on two occasions: from January 15 to 19, 1955, 1.12 million gal were discharged; and during the week of December 13, 1965, 321,000 gal were discharged (Odum et al., 1987).

The Old F-Area Seepage Basin is rectangular with nominal dimensions of 298 ft long by 193 ft wide. It is surrounded by the remains of an old, 10-ft high exclusion fence. The basin is separated into two compartments: the first is 298 by 39 ft, and the second is 298 ft by 137 ft. A 10-ft high berm separates the two compartments. The basin inlet was located at the southeast corner of the basin, with an overflow located at the west corner. Effluent entering the first compartment flowed to the second compartment via a spillway through the berm at the northeast end of the basin.

The Old F-Area Seepage Basin is just northwest of the F-Area perimeter security fence and north of the 221-F Building at a surface elevation of approximately 285 ft msl. Surface drainage in the area of the seepage basin is to the north-northwest toward a tributary to Upper Three Runs Creek. Currently, ponding takes place in the basin, and, depending upon seasonal weather conditions, the depth of water in the basin varies.

8.10.03 Groundwater Monitoring Program

Four wells (FNB 1 through FNB 4) have been installed to monitor the water-table elevation and groundwater quality near the Old F-Area Seepage Basin (Figure 8-48). Monitoring wells FNB 1 through FNB 3 were installed in August 1983, and well FNB 4 was added in July 1984. All the wells were constructed using PVC casings and 30-ft screens.

Monitoring wells FNB 1 through FNB 3 were included in SRS's quarterly groundwater monitoring program during the first quarter of 1984. Well FNB 4 was incorporated into this program in the first quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

8.10.04 Site-Specific Hydrology

Measurements obtained from the Old F-Area Seepage Basin wells indicate a declining trend in water-table elevations beginning in the fourth quarter of 1984 and continuing over the monitoring period. A hydrograph for the Old F-Area Seepage Basin wells (Figure 8-49) shows that the water-table elevation for the fourth quarter of 1986 ranged from 212 to 206 ft msl and that the vadose zone was approximately 75 to 80 ft thick.

A water-table elevation contour map for the third quarter of 1986 (Figure 8-48) shows that the water-table flow direction is to the north-northeast toward Upper Three Runs Creek. As indicated on the hydrograph, this flow direction appears relatively consistent over the period of monitoring, although minor fluctuations in flow direction and gradient have occurred. Monitoring wells FNB 1, FNB 3, and FNB 4 have been sidegradient to the Old F-Area Seepage Basin, and well FNB 2 has been downgradient of the basin.

The horizontal hydraulic gradient of the water table beneath the seepage basin has been approximately 0.018 ft/ft. Using an estimated horizontal groundwater flow velocity range for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the Old F-Area Seepage Basin has ranged approximately from 27 to 108 ft/yr.

8.10.05 Waste-Site Content Characterization Data

Information on the wastes discharged to the Old F-Area Seepage Basin is presented in Section 8.10.02. In February 1985, basin water samples were collected at two locations: near the inlet and near the outlet. The analytical results are presented in Table 8-27 and indicate that the basin effectively settled out dissolved chemical constituents. All tested chemical constituent concentrations were lower in basin water taken near the outlet than in water taken from near the inlet except for lead (0.0057 mg/L by the inlet; 0.0064 mg/L by the outlet). The conductivity dropped from 62.4 μmhos/cm by the inlet to 24.0 μmhos/cm near the outlet. The pH rose from 4.93 to 5.13.

8.10.06 Soil/Sediment Characterization Data

In 1986, four sediment cores to a depth of 14 ft were collected. Selected chemical and radionuclide analyses were conducted, and the results are presented in Shedrow (1986). All Appendix VIII organics and organic priority pollutants were less than detection limits. Concentrations of mercury and uranium were detected at levels higher than background in the cores (Odum et al., 1987).

8.10.07 Groundwater Monitoring Results

Groundwater monitoring results from 1984 through 1986 are presented in Appendix F. Groundwater chemical characterization data since July 1984 are summarized in Table 8-28.

Monitoring results from the sidegradient wells and the downgradient well were compared to evaluate the effect from the Old F-Area Seepage Basin on groundwater quality. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Based on the materials discharged to the site (Section 8.10.02), the indicator parameters most likely to show the effect from the basin on the groundwater are radioactivity, sodium, nitrate, and conductivity.

The groundwater monitoring data summarized in Table 8-28 indicate that the Old F-Area Seepage Basin has had an effect on groundwater quality in sidegradient well FNB 3 and downgradient well FNB 2. Elevated levels of gross alpha, total radium, nonvolatile beta, tritium, nitrate, manganese, lead, and conductivity were reported for these two wells. Slightly elevated indicator parameter levels in sidegradient well FNB 1 are possibly caused by the influent process line, which is upgradient of this well. Groundwater quality near sidegradient well FNB 4 apparently has not been affected.

Groundwater quality near sidegradient well FNB 4 has been characterized by low dissolved chemical and radioactive constituent levels compared to drinking water standards except for iron on one occasion. Low conductivity was reported for well FNB 4 (29 to 46 μmhos/cm). Iron levels in sidegradient well FNB 4 (0.019 to 0.592 mg/L) exceeded the drinking water standard of 0.3 mg/L in an isolated excursion. An iron concentration of 0.592 mg/L is generally consistent with iron levels as high as 0.52 mg/L reported as naturally occurring in Barnwell Formation groundwater (Appendix B).

Groundwater from sidegradient well FNB 1 has met drinking water standards except for tritium on two occasions (313 pCi/mL and 316 pCi/mL) and an isolated excursion each of gross alpha (16.0 pCi/L), total radium (9.0 pCi/L), chromium (0.073 mg/L), iron (0.327 mg/L), and trichloroethylene (0.086 mg/L). The conductivity range reported for sidegradient well FNB 1 (44 to 80 μmhos/cm) was low compared to that of downgradient well FNB 2 and sidegradient well FNB 3 but higher than that of sidegradient well FNB 4. Other indicator parameter levels in well FNB 1, such as sodium (3.97 to 6.45 mg/L) and nitrate (4.45 to 5.23 mg/L), were low relative to those in wells FNB 2 and FNB 3 but higher than those in well FNB 4. Well FNB 1 is downgradient of the basin influent pipeline, which could account for the slight increase in indicator parameter levels.

As indicated above, groundwater quality in sidegradient well FNB 3 and downgradient well FNB 2 apparently has been influenced by the Old F-Area Seepage Basin. A review of the radioactivity data shows that radioactivity levels in sidegradient well FNB 3 and downgradient well FNB 2 have been elevated compared to drinking water standards and the levels reported for the remaining site wells. Gross alpha activities in sidegradient well FNB 3 (12.2 to 118 pCi/L) and FNB 2 (3.0 to 301 pCi/L) exceeded the drinking water standard of 15 pCi/L and the levels reported for the remaining site wells (0.5 to 16.0 pCi/L). Tritium activities in wells FNB 3 (160 to 257 pCi/mL) and FNB 2 (1,339 to 2,638 pCi/mL) consistently exceeded the drinking water standard of 20 pCi/mL. Nonvolatile beta activities in sidegradient well FNB 3 (136 to 779 pCi/L) and downgradient well FNB 2 (5.0 to 1,949.9 pCi/L) were elevated relative to the levels reported for the remaining site wells (2.1 to 9.0 pCi/L).

The dissolved chemical constituent levels in sidegradient well FNB 3 and downgradient well FNB 2 also demonstrate the apparent influence on groundwater quality from the Old F-Area Seepage Basin. Conductivity in sidegradient well FNB 3 (134 to 440 μmhos/cm) and downgradient well FNB 2 (395 to 910 μmhos/cm) has been elevated compared to the levels reported for wells FNB 1 and FNB 4 (29 to 80 μmhos/cm). Nitrate levels in wells FNB 3 (11.5 to 34.0 mg/L) and FNB 2 (36.0 to 92.0 mg/L) were elevated compared to the drinking water standard of 10 mg/L and the levels reported for the remaining site wells (below 5.25 mg/L). Manganese levels in wells FNB 3 (0.285 to 1.324 mg/L) and FNB 2 (0.405 to 0.686 mg/L) consistently exceeded the drinking water standard (0.05 mg/L) and the levels reported for wells FNB 1 and FNB 4 (below 0.03 mg/L). Lead levels in wells FNB 3 (0.021 to 0.082 mg/L) and FNB 2 (<0.005 to 0.309 mg/L) ranged above the drinking water standard of 0.05 mg/L. Chromium (0.153 mg/L), iron (3.52 mg/L), and barium (1.10 mg/L) exceeded the drinking water standards of 0.05 mg/L, 0.3 mg/L, and 1.0 mg/L, respectively, in sidegradient well FNB 3 in an isolated excursion for each. Trichloroethylene in well FNB 2 (0.008 mg/L) exceeded the drinking water standard of 0.005 mg/L in an isolated excursion. Groundwater pH ranges in sidegradient well FNB 3 (3.3 to 4.3) and downgradient well FNB 2 (3.1 to 3.9) were generally low compared to naturally occurring pH values as low as 4.0 in Barnwell Formation groundwater (Appendix B).

8.10.08 Planned Action

The Old F-Area Seepage Basin is inactive. As indicated in Section 16, a site assessment is scheduled for completion in 1988, from which a closure plan will be developed. Groundwater monitoring will continue at this site.

TABLE 8-1

Calculated Annual Discharges from Cation and Anion Exchange Units for the F-Area Acid/Caustic Basin

Calculated Annual Discharges from Cation Exchange Unit

Acid Wastewater Volume (m^3/yr)	Conc. Wt. % H_2SO_4	Total Excess H_2SO_4 (kg)	Total Cations (kg)
7,200	0.12	9,400	7,400

Calculated Annual Discharges from Anion Exchange Unit

Basic Wastewater Volume (m^3/yr)	Conc. Wt. % NaOH	Total Excess NaOH (kg)	Total Anions (kg)
7,100	0.22	20,100	11,500

Note: Data, from Ward et al. (1987), are for 1974 and are representative of the total period. Values were calculated using assumed resin performance.

TABLE 8-2

Selected Surface Water Chemical Analyses for the F-Area Acid/Caustic Basin

Parameter	Units	Results
pH	SU	6.3
Calcium	mg/L	3.68
Chloride	mg/L	3.53
Dissolved organic carbon	mg/L	9.98
Fluoride	mg/L	0.22
Iron	mg/L	26.6
Mercury	mg/L	0.00027
Potassium	mg/L	2.84
Magnesium	mg/L	2.03
Sodium	mg/L	68.3
Nitrate	mg/L	<0.5
Sulfate	mg/L	47
Odor	TON	0
Total organic carbon	mg/L	15.4
Turbidity	NTU	160
Specific conductance	μmhos/cm	318.2
Surfactants	mg/L	<10

Note: Samples were collected in August 1985.

TABLE 8-3

Summary of Sediment and Soil Chemical Analyses for the F-Area Acid/Caustic Basin

Metals	Concentration Range (μg/g)*	EP Toxicity Results (mg/L)	EP Toxicity Standards (mg/L)**
Aluminium	4,490-19,400	---	---
Arsenic	0.42-9.03	0.002	5.0
Barium	6.6-34.2	0.315	100.0
Cadmium	<2.0	0.04	1.0
Chromium	<4.0-43.2	0.08	5.0
Copper	<4.0-5.4	---	---
Iron	10,800-39,100	---	---
Lead	<5.0-12.0	0.1	5.0
Magnesium	37.0-1,310	---	---
Manganese	5.1-60.6	---	---
Mercury	<0.2	0.0002	0.2
Nickel	<4.0-7.7	---	---
Selenium	<0.25-0.77	0.002	1.0
Silver	<2.0	0.2	5.0
Sodium	510-1,880	---	---
Tin	<15.0-27.1	---	---
Zinc	3.1-8.8	---	---
Inorganics			
Boron	<0.25-41.32		
Sulfate	42.45-374.50		
Sulfide	<25		
Nitrate	<1.25-2.10		
Nitrite	<0.50-0.55		
Ammonia	2.8-5.6		
Fluoride	0.48-8.20		
Chloride	7.2-83.3		
Phosphate	12.0-227.0		
Radioactivity			
Gross alpha	82.0-88.3 pCi/g		
Nonvolatile beta	Background levels		
Gross gamma	Background levels		

* Concentration range for samples taken at 0-0.5 ft, 0.5-1.0 ft, 1.5-2.0 ft, and 4.5-5.0 ft depth intervals.

** Federal Regulation 40 CFR 261.

TABLE 8-4

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Acid/Caustic Basin (7/84-12/86)

Constituent	SC and Federal DWS	FAC 1	FAC 2	FAC 3	FAC 4
pH (pH)	6.5-8.5	4.6-6.3	4.5-5.9	8.6-9.9	4.6-6.6
Conductivity (µmhos/cm)	NA	42-120	74-179	155-280	98-160
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0005	<0.0004
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.020-0.030	0.023-0.032	0.015-0.025	0.028-0.035
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.005	---	---	---
Cadmium (mg/L)	0.010	<0.002-0.002	<0.002	<0.002	<0.001
Chloroform (mg/L)	0.100*	<0.005	---	---	---
Chloride (mg/L)	250	2.9-4.6	3.2-3.9	1.9-3.2	2.2-2.9
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004-0.018	<0.004
Copper (mg/L)	1	0.006-0.009	<0.004-0.009	<0.004	---
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	<5.0	<5.0	<5.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.12	<0.10-0.16	0.13-0.36	<0.10-0.13
Iron (mg/L)	0.3	0.045-0.124	0.050-0.104	0.024-0.079	0.016-0.086
Mercury (mg/L)	0.002	<0.0002-0.0004	<0.0002-0.0042	<0.0002	<0.0002-0.0004
Manganese (mg/L)	0.05	0.088-0.138	0.031-0.052	<0.002-0.004	0.401-0.499
Sodium (mg/L)	NA	3.94-8.25	3.65-6.70	2.86-7.02	3.40-4.68
Nickel (mg/L)	NA	<0.004-0.006	<0.004-0.005	<0.004-0.004	---
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	<0.50	<0.50	<0.50	<0.50-0.92
Lead (mg/L)	0.05	<0.005-0.027	<0.005-0.009	<0.004-0.011	<0.005-0.007
Phenols (mg/L)	NA	<0.002-0.008	<0.002	<0.002-0.005	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001-0.002	<0.001
Sulfate (mg/L)	250	<5.0-13.0	17.0-30.0	12.0-78.0	44.0-59.0
Tetrachloroethylene (mg/L)	NA	<0.005	---	---	---
TDS (mg/L)	500	28-206	24-44	22-114	---
TOC (mg/L)	NA	0.394-1.10	0.490-1.76	0.530-22.0	0.470-1.31
TOH (mg/L)	NA	<0.005-0.039	<0.005-0.018	<0.005-0.023	0.003-0.007
Trichloroethylene (mg/L)	0.005	<0.005	---	---	---
1,1,1-TCE (mg/L)	0.200	<0.005	---	---	---
Zinc (mg/L)	5	0.273-0.392	0.305-0.873	<0.002-0.022	0.029
Gross alpha (pCi/L)	15	<2.0	<2.0-5.0	<2.0-391.0	9.1-56.0
Nonvol. beta (pCi/L)	NA	<3.0-3.0	<3.0-4.0	4.0-1,076.0	10.0-58.0
Total radium (pCi/L)	5	<1.0	2.0-4.0	<1.0-40.0	11.7-24.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-5

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Coal Pile Runoff Containment Basin (7/84-12/86)

Constituent	SC and Federal DWS	FCB 1	FCB 2	FCB 3	FCB 4
pH (pH)	6.5-8.5	11.1-12.3	4.1-6.3	3.6-5.9	4.1-5.4
Conductivity (µmhos/cm)	NA	560-7,040	22-35	20-75	27-42
Silver (mg/L)	0.05	0.0030-0.0070	<0.0020	<0.0020-0.0030	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.048-0.183	0.004	0.004-0.006	0.008
Beryllium (mg/L)	NA	---	---	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.005	---	---	<0.005
Cadmium (mg/L)	0.010	<0.002	<0.002	<0.002	<0.002
Chloroform (mg/L)	0.100*	<0.005	---	---	<0.005
Chloride (mg/L)	250	3.3-8.1	2.4-2.9	2.5-5.5	2.4-3.5
Chromium (mg/L)	0.05	0.016-0.017	<0.004	<0.004	<0.004
Copper (mg/L)	1	0.004-0.060	<0.004-0.006	<0.004-0.016	<0.004-0.004
Cyanide (mg/L)	0.2	---	---	<0.005	---
DOC (mg/L)	NA	<5.0	<5.0	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10	<0.10	<0.10	<0.10
Iron (mg/L)	0.3	0.018-0.060	0.060-0.089	0.018-0.120	0.060-1.860
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002-0.0002	<0.0002-0.0003
Manganese (mg/L)	0.05	<0.002	0.005	0.002-0.003	0.014-0.039
Sodium (mg/L)	NA	3.32-6.12	2.33-2.85	1.92-2.26	1.94-2.01
Nickel (mg/L)	NA	---	---	<0.004	---
Nitrite (as N) (mg/L)	NA	---	---	<0.50	---
Nitrate (as N) (mg/L)	10	1.15	1.40	0.90	<0.50
Lead (mg/L)	0.05	0.049-0.276	0.009-0.015	<0.004-0.009	<0.005-0.009
Phenols (mg/L)	NA	0.016-0.020	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0-8.0	<5.0-5.0	<5.0-7.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.005	---	---	<0.005
TDS (mg/L)	500	1,280	20	18-60	48
TOC (mg/L)	NA	0.691-5.80	0.317-2.00	0.363-1.00	0.400-15.3
TOH (mg/L)	NA	<0.005-0.139	<0.005-0.042	<0.005-0.008	<0.005-0.050
Trichloroethylene (mg/L)	0.005	<0.005	---	---	<0.005
1,1,1-TCE (mg/L)	0.200	<0.005	---	---	<0.005
Zinc (mg/L)	5	0.540	0.029	0.009-0.060	0.679
Gross alpha (pCi/L)	15	<2.0-24.3	<2.0-5.0	6.0-37.0	<2.0
Nonvol. beta (pCi/L)	NA	<3.0-6.0	<3.0-4.0	9.0-22.0	<3.0-3.0
Total radium (pCi/L)	5	2.4-4.0	<1.0-2.0	2.0-22.0	<1.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-6

Trace Elements in Different Types of Ash

Element	Ash Type (mg/L) Fly Ash (Electrostatic Precipitator)	Fly Ash (Mechanical Collector)	Bottom Ash
Barium	889	792	808
Strontium	579	589	333
Manganese	352	275	811
Zinc	280	116	95
Vanadium	218	166	140
Cerium	189	251	150
Chromium	171	140	160
Arsenic	164	55	4
Copper	130	93	67
Nickel	89	87	77
Gallium	72	32	20
Lanthanum	69	61	61
Cobalt	67	47	40
Lead	60	28	5
Bromine	47	12	3
Scandium	32	28	20
Thorium	23	24	25
Antimony	19	6	3
Molybdenum	18	11	7
Beryllium	16	12	9
Samarium	15	13	12
Selenium	15	6	3
Cesium	14	13	10
Uranium	13	8	8
Europium	11	12	8
Ytterbium	12	8	10
Terbium	2.5	2.1	2
Mercury	0.84	0.33	0.08
Cadmium	0.71	0.39	0.5

Note: Data, from Christensen and Gordon (1983), were collected in 1977.

TABLE 8-7

NPDES Monitoring of F-Area Ash Basin Discharges (Outfall F-7) in 1980

Parameter	Unit	Discharge
Biochemical oxygen demand	mg/L	<2
Chemical oxygen demand	mg/L	<5
Total organic carbon	mg/L	2
Total suspended solids	mg/L	<4
Ammonia (as N)	mg/L	<1.0
Flow	L/min	430
pH	Std. units	3.5-3.9
Bromide	mg/L	<2.0
Total residual chlorine	mg/L	ND
Color	Pt-Co units	17
Fecal coliform	No/100 mL	0
Fluoride	mg/L	0.15
Nitrate/nitrite (as N)	mg/L	0.07
Total organic nitrogen (as N)	mg/L	<1.0
Oil and grease	mg/L	<10
Phosphorus (as P)	mg/L	0.10
Radioactivity		
Alpha	pCi/L	4.7 ±1.4
Beta	pCi/L	10.1 ±1.5
Radium	pCi/L	1.25 ±0.48
Radium 226	pCi/L	2.0 ±0.4
Sulfate (as SO_4)	mg/L	52
Sulfide (as S)	mg/L	<1
Sulfite (as SO_3)	mg/L	<2
Surfactants	mg/L	<0.025
Aluminum	mg/L	1.0
Barium	mg/L	<0.30
Boron	mg/L	0.24
Cobalt	mg/L	0.033
Iron	mg/L	0.12
Magnesium	mg/L	1.1
Molybdenum	mg/L	0.002
Manganese	mg/L	0.052
Tin	mg/L	0.055
Titanium	mg/L	<0.02
Antimony	mg/L	<0.003
Arsenic	mg/L	0.004
Beryllium	mg/L	0.004
Cadmium	mg/L	<0.001
Chromium	mg/L	0.004
Copper	mg/L	0.052
Lead	mg/L	0.006
Mercury	mg/L	<0.0002
Nickel	mg/L	0.035

TABLE 8-7 (cont.)

Parameter	Unit	Discharge
Selenium	mg/L	<0.002
Silver	mg/L	<0.001
Thallium	mg/L	<0.003
Zinc	mg/L	0.12
Phenols	mg/L	<0.002
Dioxin		ND
Acrolein	µg/L	ND
Acrylonitrile	µg/L	ND
Benzene	µg/L	ND
Bis(chloromethyl)ether	µg/L	ND
Bromoform	µg/L	ND
Carbon tetrachloride	µg/L	ND
Chlorobenzene	µg/L	ND
Chlorodibromomethane	µg/L	ND
Chloromethane	µg/L	ND
2-Chloroethylvinyl ether	µg/L	ND
Chloroform	µg/L	ND
Dichlorobromomethane	µg/L	ND
Dichlorodifluoromethane	µg/L	ND
1,1-Dichloroethane	µg/L	ND
1,2-Dichloroethane	µg/L	ND
1,1-Dichloroethylene	µg/L	ND
1,2-Dichloropropane	µg/L	ND
1,2-Dichloropropylene	µg/L	ND
Ethylbenzene	µg/L	ND
Methylbromide	µg/L	ND
Methylchloride	µg/L	ND
Methylene chloride	µg/L	1*
1,1,2,2-Tetrachloroethane	µg/L	ND
Tetrachloroethylene	µg/L	ND
Toluene	µg/L	<1*
1,2-trans-Dichloroethylene	µg/L	ND
1,1,1-Trichloroethane	µg/L	ND
1,1,2-Trichloroethane	µg/L	ND
Trichloroethylene	µg/L	ND
Trichlorofluoromethane	µg/L	ND
Vinyl chloride	µg/L	ND
2-Chlorophenol	µg/L	ND
2,4-Dichlorophenol	µg/L	ND
2,4-Dimethylphenol	µg/L	ND
4,6-Dinitro-o-cresol	µg/L	ND
2,4-Dinitrophenol	µg/L	ND
2-Nitrophenol	µg/L	ND
4-Nitrophenol	µg/L	ND
p-Chloro-m-cresol	µg/L	ND
Pentachlorophenol	µg/L	ND
Phenol	µg/L	ND

TABLE 8-7 (cont.)

Parameter	Unit	Discharge
2,4,6-Trichlorophenol	µg/L	ND
Acenaphthene	µg/L	ND
Acenaphtylene	µg/L	ND
Anthracene	µg/L	ND
Benzidine	µg/L	ND
Benzo(a)anthracene	µg/L	ND
Benzo(a)pyrene	µg/L	ND
3,4-Benzofluoranthene	µg/L	ND
Benzo(ght)perylene	µg/L	ND
Benzo(k)fluoranthene	µg/L	ND
Bis(2-chloroethoxy)methane	µg/L	ND
Bis(2-chloroethyl)ether	µg/L	ND
Bis(2-chloroisopropyl)ether	µg/L	ND
Bis(2-ethylhexyl)phthalate	µg/L	ND
4-Bromophenyl phenyl ether	µg/L	<1*
Butyl benzyl phthalate	µg/L	ND
2-Chloronapthalene	µg/L	ND
4-Chlorophenyl phenyl ether	µg/L	ND
Chrysene	µg/L	ND
Dibenzo(a,h)anthracene	µg/L	ND
1,2-Dichlorobenzene	µg/L	ND
1,3-Dichlorobenzene	µg/L	ND
1,4-Dichlorobenzene	µg/L	ND
3,3-Dichlorobenzidine	µg/L	ND
Diethylphthalate	µg/L	1*
Dimethylphthalate	µg/L	ND
Di-n-butyl phthalate	µg/L	<1*
2,4-Dinitrotoluene	µg/L	ND
2,6-Dinitrotoluene	µg/L	ND
Di-n-octyl phthalate	µg/L	ND
1,2-Diphenylhydrazine	µg/L	ND
Fluoranthene	µg/L	ND
Fluorene	µg/L	ND
Hexachlorobenzene	µg/L	ND
Hexachlorobutadiene	µg/L	ND
Hexachlorocyclopentadiene	µg/L	ND
Hexachloroethane	µg/L	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND
Isophorone	µg/L	ND
Naphthalene	µg/L	ND
Nitrobenzene	µg/L	ND
n-Nitrosodimethylamine	µg/L	ND
n-Nitrosodi-n-propylamine	µg/L	ND
n-Nitrosodiphenylamine	µg/L	ND
Phenanthrene	µg/L	ND
Pyrene	µg/L	ND
1,2,4-Trichlorobenzene	µg/L	ND

TABLE 8-7 (cont.)

Parameter	Unit	Discharge
Aldrin	µg/L	ND
alpha BHC	µg/L	ND
beta BHC	µg/L	ND
gamma BHC	µg/L	ND
delta BHC	µg/L	ND
Chlordane	µg/L	ND
4,4' DDT	µg/L	ND
4,4' DDE	µg/L	ND
4,4' DDD	µg/L	ND
Dieldrin	µg/L	ND
alpha-Endosulfan	µg/L	ND
beta-Endosulfan	µg/L	ND
Endosulfan sulfate	µg/L	ND
Endrin	µg/L	ND
Endrin aldehyde	µg/L	ND
Heptachlor	µg/L	ND

Note: ND = not detected.

* Present in laboratory blank.

TABLE 8-8

Trace Metal Analysis of 488-D Ash Basin Sludge Sample Extracts

Metal	Ash Basin Sludge (mg/L)	EPA Extract Level Limit (mg/L)
Chromium	<0.002	5.0
Cadmium	<0.001	1.0
Barium	1	100.0
Silver	<0.001	5.0
Mercury	<0.01	0.2
Lead	<0.002	5.0
Arsenic	<0.01	5.0
Selenium	<0.01	1.0

Note: Data, from Christensen and Gordon (1983), were collected in January 1980.

TABLE 8-9

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Burning/Rubble Pits (7/84-12/86)

Constituent	SC and Federal DWS	FBP 1A	FBP 2A	FBP 3A	FBP 4
pH (pH)	6.5-8.5	3.5-5.0	4.1-5.4	4.3-5.7	4.0-4.8
Conductivity (µmhos/cm)	NA	43-260	50-81	51-72	16-29
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0004
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.008-0.069	0.004-0.007	0.007-0.012	<0.004
Beryllium (mg/L)	NA	<0.002	<0.002	<0.002	---
Carbon tetrachloride (mg/L)	0.005	<0.001	0.005-0.017	0.001	<0.001
Cadmium (mg/L)	0.010	<0.001	<0.001	<0.001-0.046	<0.001
Chloroform (mg/L)	0.100*	<0.001-0.002	<0.001	<0.001	<0.001
Chloride (mg/L)	250	2.5-5.2	4.5-8.7	4.0-6.9	2.4-2.9
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004	<0.004-0.007	<0.004-0.009	---
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	<5.0-5.8	<5.0-5.0	<5.0-7.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.11	<0.10-0.11	<0.10-0.34	<0.10-0.22
Iron (mg/L)	0.3	0.007-0.112	0.019-0.128	0.019-0.323	0.014-0.047
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002	<0.0002	<0.0002
Manganese (mg/L)	0.05	0.019-0.087	0.009-0.020	0.006-0.023	0.002-0.003
Sodium (mg/L)	NA	2.19-6.05	6.84-14.10	4.24-7.83	1.57-1.87
Nickel (mg/L)	NA	<0.004-0.012	<0.004	<0.004-0.009	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	1.85-24.55	1.29-2.00	0.40-1.08	0.30-0.62
Lead (mg/L)	0.05	<0.004-0.038	<0.004-0.026	<0.004-0.010	<0.004-0.022
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0-10.0	<5.0-12.0	<5.0
Tetrachloroethylene (mg/L)	NA	<0.001-0.004	0.023-0.104	0.006-0.012	<0.001-0.003
TDS (mg/L)	500	36-40	68-90	46-62	---
TOC (mg/L)	NA	0.340-5.300	0.383-6.000	0.470-6.000	0.402-3.600
TOH (mg/L)	NA	0.011-0.068	0.056-0.294	0.005-0.062	<0.005-0.017
Trichloroethylene (mg/L)	0.005	0.020-0.029	0.025-0.105	<0.001	<0.001
1,1,1-TCE (mg/L)	0.200	<0.001	<0.001	<0.001	<0.001
Zinc (mg/L)	5	0.012-0.037	0.015	0.023-0.048	---
Gross alpha (pCi/L)	15	<2.0-130.0	1.9-7.0	<2.0-2.8	2.0-41.0
Nonvol. beta (pCi/L)	NA	8.0-206.0	4.0-21.9	1.8-13.4	2.5-49.0
Total radium (pCi/L)	5	<1.0-8.0	<1.0-1.4	<1.0-2.0	<1.0-7.0
Tritium (pCi/mL)	20	17	11	6	10

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-10

^{137}Cs and $^{89,90}Sr$ in the F-Area Retention Basin Prior to Soil Excavation

	Concentration (pCi/g--dry)							
	Core 1		Core 2		Core 3		Core 4	
Depth (in.)	^{137}Cs	$^{89,90}Sr$	^{137}Cs	$^{89,90}Sr$	^{137}Cs	$^{89,90}Sr$	^{137}Cs	$^{89,90}Sr$
0-6	24,450	1,540	17,000	---	3,700	90	15,000	440
6-12	90	310	4,670	---	80,600	430	100	360
12-18	20	310	30	510	2,900	220	150	230
18-24	25	100	---	---	100	520	180	80
40-48	50	---	100	---	20	410	20	60
65-70	20	---	120	---	10	440	10	170
88-95	10	---	70	---	10	300	30	7
112-118	6	7	190	6	30	340	10	1
136-142	<2	---	---	---	---	---	---	---

Note: Samples were taken in December 1978. Data are from Scott et al. (1987b).

TABLE 8-11

^{137}Cs and $^{89,90}Sr$ in the F-Area Retention Basin After Soil Excavation

Basin Floor Cores	Depth (ft)	Concentration (pCi/g) ^{137}Cs	$^{89,90}Sr$
No. 25	0 to 0.5	400	388
	0.5 to 1.0	430	---
	1.0 to 1.5	56	530
No. 31	0 to 0.5	19	1,700
	0.5 to 1.0	7	---
	1.0 to 1.5	4	1,380
No. 36	0 to 0.5	230	330
	0.5 to 1.0	48	---
	1.0 to 1.5	25	390
No. 46D	0.5 to 1.0	1	330
	1.5 to 2.0	6	460
	17.5 to 18	<1	2
No. 47D	0.5 to 1.0	4	1,500
	3.5 to 4.0	12	550
	5.5 to 6.0	<1	550
	13.5 to 14.0	1	5
No. 48D	0.5 to 1.0	8	500
	5.5 to 6.0	<1	26
No. 49D	11.5 to 12.0	39	7
	13.5 to 14.0	5	4
Basin Berm Cores			
No. 3	14.5 to 15.0	1	---
	15.5 to 16.0	1	---
	17.5 to 18.0	1	---
No. 5B	1.5 to 2.0	6	26
	4.5 to 5.0	1,410	1,000
	6.5 to 7.0	<1	19
No. 8	6.5 to 7.0	1	33
	7.5 to 8.0	3	---
	8.0 to 8.5	180	---
	8.5 to 9.0	1	13

Note: Samples were taken in 1979. Data are from Scott et al. (1987b).

TABLE 8-12

Radioactivity in the F-Area Tank Farm Wells

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
FTF 1						
1973	2.19	3.34	16.00	32.00	40	77
1974	3.30	6.56	16.51	28.92	24	36
1975	2.67	4.52	11.36	18.64	18	21
1976	2.00	3.02	17.13	26.26	13	18
1977	2.30	4.10	16.00	37.00	10	14
1978	1.90	3.70	13.00	38.00	6	10
1979	2.00	3.30	16.00	29.00	12	18
1980	0.94	1.90	7.90	13.00	16	19
1981	1.20	2.10	10.00	18.00	9	14
1982	---	---	---	---	1	1
1983	0.47	1.60	8.10	12.00	22	29
1984	0.85	2.50	6.30	11.00	18	20
1985	0.46	0.96	4.30	7.90	14	17
1986	2.40	5.70	9.80	16.00	16	17
FTF 2						
1973	1.09	1.19	4.00	5.00	1	1
1974	1.40	1.93	6.98	17.60	3	5
1975	0.63	1.47	2.62	10.88	0	1
1976	0.49	1.51	3.69	11.95	2	16
1977	0.49	1.40	4.50	19.00	0	1
1978	0.61	1.10	3.90	15.00	1	7
1979	0.62	1.60	2.90	7.10	0	1
1980	0.38	0.73	1.10	10.00	0	2
1981	0.43	1.00	7.80	20.00	1	4
1982	0.54	1.60	4.00	14.00	1	2
1983	0.27	1.30	1.80	8.30	0	1
1984	0.28	0.78	2.70	4.50	1	5
1985	0.44	1.10	2.00	3.80	3	6
1986	1.40	3.10	3.50	7.50	7	12
FTF 3						
1973	0.80	1.09	27.00	30.00	6	7
1974	0.73	1.70	14.44	33.68	6	9
1975	0.76	1.38	5.28	26.55	6	7
1976	0.70	1.00	5.51	10.15	6	8
1977	1.10	2.00	8.20	16.00	5	8
1978	1.10	2.80	6.40	11.00	6	8
1979	0.82	2.90	4.00	16.00	8	11
1980	0.72	1.60	0.12	12.00	6	8
1981	0.52	1.20	5.00	13.00	6	7
1982	0.43	1.20	4.70	14.00	8	14

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
FTF 3 (cont.)						
1983	0.43	1.60	2.20	6.30	5	6
1984	0.67	1.50	5.20	13.00	5	6
1985	0.59	1.70	3.50	6.00	5	6
1986	0.94	1.50	4.30	7.70	6	7
FTF 4						
1973	1.18	1.83	12.00	21.00	16	21
1974	0.90	2.93	9.59	28.66	14	24
1975	0.47	0.84	3.15	7.82	27	45
1976	0.68	1.29	5.76	10.59	14	19
1977	1.10	2.50	12.00	43.00	15	19
1978	2.20	5.60	8.40	26.00	2	7
1979	0.84	2.00	4.30	9.10	4	6
1980	0.60	1.40	1.70	3.70	4	8
1981	0.52	1.10	6.60	27.00	9	12
1982	0.48	0.91	3.80	7.20	9	17
1983	0.42	1.80	2.70	4.30	1	3
1984	0.44	0.88	2.70	4.60	1	2
1985	0.30	1.10	2.30	4.10	6	14
1986	0.81	2.30	4.40	9.90	6	13
FTF 5						
1973	1.22	2.58	9.00	17.00	39	84
1974	1.48	3.10	14.50	24.90	47	79
1975	1.37	2.64	8.64	22.80	26	36
1976	0.95	1.59	22.64	85.39	19	36
1977	1.80	3.70	26.00	180.00	24	33
1978	1.50	3.10	8.50	16.00	29	46
1979	1.40	2.70	9.80	17.00	27	34
1980	0.62	1.40	7.70	19.00	24	30
1981	0.17	0.97	510.00	1,300.00	400	730
1982	0.31	1.10	260.00	500.00	340	620
1983	1.30	2.30	130.00	190.00	200	250
1984	1.60	4.50	72.00	130.00	170	200
1985	0.86	5.60	70.00	120.00	110	170
1986	1.60	7.90	180.00	480.00	96	130
FTF 6						
1974	2.21	5.52	4,507.35	21,949.11	24	56
1975	1.31	2.67	717.27	5,291.40	27	73
1976	1.10	1.67	4,041.21	14,912.29	45	168

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
FTF 6 (cont.)						
1977	1.30	2.30	5,300.00	27,000.00	35	120
1978	1.50	2.20	1,200.00	4,200.00	24	46
1979	1.50	2.20	390.00	630.00	19	34
1980	1.10	1.80	180.00	730.00	19	31
1981	0.88	1.80	10,000.00	25,000.00	150	370
1982	0.44	0.90	7,800.00	12,000.00	170	240
1983	37.00	100.00	3,400.00	5,700.00	81	160
1984	31.00	70.00	1,500.00	2,700.00	35	58
1985	1.90	4.70	770.00	4,300.00	22	74
1986	3.60	11.00	980.00	4,100.00	30	89
FTF 7						
1973	0.33	0.46	577.00	959.00	54	75
1974	0.41	0.92	215.92	1,368.60	15	41
1975	0.29	1.19	209.55	439.11	14	20
1976	0.23	0.75	188.21	438.48	11	18
1977	0.52	1.20	97.00	180.00	6	11
1978	0.47	1.70	60.00	160.00	6	10
1979	0.32	0.91	18.00	25.00	6	10
1980	0.18	1.50	14.00	27.00	7	10
1981	0.75	2.80	270.00	1,200.00	18	67
1982	0.13	0.58	330.00	1,000.00	21	29
1983	2.40	8.80	290.00	730.00	33	81
1984	1.60	2.60	95.00	500.00	11	16
1985	2.30	15.00	210.00	660.00	9	11
1986	2.00	10.00	190.00	280.00	9	10
FTF 8						
1973	1.94	3.09	18.00	31.00	22	46
1974	2.05	5.36	15.97	36.20	27	44
1975	2.10	3.28	7.84	16.50	23	33
1976	1.41	2.60	10.58	28.35	19	25
1977	2.10	3.00	14.00	45.00	12	18
1978	1.70	3.10	10.00	35.00	11	19
1979	2.50	4.40	9.50	19.00	10	12
1980	1.10	2.30	3.60	15.00	9	11
1981	1.80	4.70	11.00	38.00	8	11
1982	1.60	2.60	8.70	28.00	10	20
1983	0.57	1.90	4.30	9.60	10	14
1984	0.65	1.40	4.50	7.90	11	31
1985	0.52	1.40	3.10	5.10	7	10
1986	1.00	2.40	6.40	14.00	9	11

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
FTF 9						
1973	1.93	6.80	35.00	90.00	41	54
1974	4.58	8.80	20.40	58.50	21	31
1975	3.36	8.00	9.69	21.77	17	24
1976	1.74	3.10	13.95	42.33	14	18
1977	1.90	3.60	9.80	43.00	10	15
1978	1.90	3.60	5.70	13.00	9	14
1979	1.50	3.00	6.70	19.00	10	15
1980	1.70	3.60	5.60	14.00	10	12
1981	1.50	2.50	15.00	110.00	9	15
1982	1.50	2.60	7.00	17.00	7	9
1983	1.00	2.80	3.60	10.00	13	21
1984	1.50	2.80	3.70	6.60	15	24
1985	1.00	2.10	2.40	5.20	10	13
1986	1.10	2.20	4.80	7.20	10	12
FTF 10						
1973	5.12	6.49	21.00	45.00	18	23
1974	3.44	5.85	20.87	83.98	19	23
1975	2.18	3.22	7.54	16.10	20	30
1976	1.87	2.76	9.79	18.06	17	36
1977	1.50	2.40	16.00	38.00	11	16
1978	1.20	2.10	9.80	32.00	10	15
1979	2.00	4.30	18.00	23.00	8	10
1980	1.00	2.40	11.00	22.00	9	10
1981	2.30	5.10	24.00	58.00	10	13
1982	1.70	5.10	20.00	59.00	44	360
1983	0.42	1.90	9.00	18.00	10	14
1984	0.73	1.50	6.00	12.00	10	14
1985	0.38	1.00	4.00	7.00	9	11
1986	0.86	1.80	7.00	9.40	11	14
FTF 11						
1973	9.43	13.04	33.00	70.00	25	40
1974	8.67	13.59	26.17	34.93	20	25
1975	9.11	15.13	20.39	73.03	23	25
1976	7.81	10.64	20.92	62.01	19	23
1977	11.00	17.00	24.00	40.00	18	24
1978	7.50	18.00	23.00	62.00	20	25
1979	11.00	16.00	29.00	45.00	20	24
1980	5.00	12.00	15.00	33.00	20	22
1981	6.20	9.80	31.00	50.00	18	21
1982	3.90	5.00	13.00	20.00	22	29
1983	1.70	4.10	4.60	16.00	18	23

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
FTF 11 (cont.)						
1984	4.80	12.00	10.00	25.00	17	19
1985	7.80	11.00	15.00	19.00	15	19
1986	10.00	14.00	16.00	21.00	21	22
FTF 12						
1973	6.15	11.71	109.00	109.00	35	35
1974	0.42	1.03	13.46	22.01	34	47
1975	0.35	1.02	7.79	15.24	37	44
1976	0.23	0.67	7.56	12.65	31	40
1977	0.27	0.76	9.10	37.00	28	35
1978	0.66	3.60	5.60	18.00	31	37
1979	0.55	4.00	7.60	20.00	32	41
1980	0.17	0.99	3.50	9.80	36	43
1981	0.10	0.74	6.80	19.00	26	37
1982	0.31	2.10	8.60	14.00	23	29
1983	0.20	2.20	8.90	15.00	23	26
1984	0.15	0.68	6.00	11.00	41	210
1985	0.07	0.38	7.70	11.00	23	29
1986	0.18	0.54	7.10	8.70	19	21
FTF 13						
1973	0.07	0.07	13.00	13.00	13	13
1974	0.31	0.67	11.89	21.46	15	20
1975	0.92	1.81	3.08	8.21	15	18
1976	0.54	1.38	3.50	8.45	15	18
1977	0.47	1.40	2.40	9.00	13	19
1978	0.56	1.30	3.20	9.30	12	16
1979	0.66	1.50	2.10	8.10	11	16
1980	0.32	0.84	0.13	11.00	12	13
1981	0.42	0.85	3.00	23.00	11	14
1982	0.53	2.70	8.80	59.00	12	20
1983	0.54	1.30	1.60	4.00	9	11
1984	0.39	0.95	0.91	1.50	19	130
1985	0.39	0.96	0.77	1.50	11	12
1986	0.37	1.10	1.20	3.30	11	12
FTF 14						
1973	5.94	5.94	8.00	8.00	18	18
1974	3.92	6.90	21.31	57.36	51	104
1975	2.58	6.19	7.47	17.04	68	82
1976	1.29	1.84	7.78	27.77	51	65
1977	1.40	1.90	12.00	23.00	31	39
1978	1.50	2.50	3.60	9.30	28	54

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
FTF 14 (cont.)						
1980	0.36	0.91	1.20	1.90	31	44
1981	1.70	2.70	4.40	15.00	22	28
1982	0.76	1.50	8.30	15.00	11	22
1983	0.60	1.10	2.40	7.30	23	32
1984	0.73	1.90	1.70	3.10	24	34
1985	0.35	1.10	0.40	2.10	18	22
1986	0.20	0.39	0.68	0.84	26	28
FTF 15						
1985	0.32	1.20	0.33	1.80	12	14
1986	0.66	1.20	1.00	3.80	11	12
FTF 16						
1985	0.81	3.40	1.50	5.10	9	11
1986	0.66	1.70	1.80	3.40	10	12
FTF 17						
1985	0.50	0.94	0.67	1.60	10	12
1986	1.00	2.00	5.90	51.00	10	11
FTF 18						
1985	0.44	0.82	0.56	2.30	7	8
1986	0.58	0.97	1.40	2.30	8	9
FTF 19						
1985	0.51	4.30	41.00	74.00	10	11
1986	0.92	6.30	26.00	58.00	10	11
FTF 20						
1985	0.53	1.80	2.10	7.20	14	15
1986	1.50	3.30	32.00	52.00	17	20
FTF 21						
1985	0.22	0.52	4.50	6.60	12	14
1986	0.40	1.60	6.50	8.30	11	13

TABLE 8-12 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
FTF 22						
1985	1.10	1.80	1.20	2.10	12	13
1986	1.20	2.60	2.50	4.00	13	15
FTF 23						
1985	0.74	1.60	0.75	2.70	11	12
1986	1.40	2.00	1.90	2.50	9	10
FTF 24A						
1984	0.71	1.50	6.80	16.00	27	30
1985	0.45	0.92	17.00	57.00	30	38
1986	0.69	2.00	23.00	50.00	30	42
FTF 25A						
1984	0.78	1.60	11.00	18.00	23	28
1985	0.55	1.50	17.00	24.00	31	40
1986	0.63	1.30	17.00	26.00	29	35
FTF 26						
1984	0.64	1.30	22.00	39.00	50	84
1985	0.33	1.20	18.00	23.00	33	41
1986	0.56	1.70	45.00	110.00	41	51
FTF 27						
1984	1.20	5.00	13.00	39.00	46	60
1985	0.21	0.82	7.10	11.00	37	42
1986	0.30	0.97	11.00	15.00	42	50

Additional Analyses

FTF 24A

Year	^{144}Ce (pCi/mL) Mean	Max	^{60}Co (pCi/mL) Mean	Max	^{51}Cr (pCi/mL) Mean	Max
1985	0.02	0.08	0.05	0.21	0.36	2.40

TABLE 8-12 (cont.)

FTF 24A (cont.)

Year	^{134}Cs (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max
1985	0.00	0.00	0.00	0.01	0.01	0.06

Year	^{106}Ru (pCi/mL) Mean	Max	$^{95}Zr,Nr$ (pCi/mL) Mean	Max
1985	0.00	0.00	0.00	0.03

FTF 25A

Year	^{144}Ce (pCi/mL) Mean	Max	^{60}Co (pCi/mL) Mean	Max	^{51}Cr (pCi/mL) Mean	Max
1985	0.00	0.01	0.03	0.14	0.08	0.40

Year	^{134}Cs (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max
1985	0.00	0.00	0.00	0.00	0.01	0.07

Year	^{106}Ru (pCi/mL) Mean	Max	$^{95}Zr,Nr$ (pCi/mL) Mean	Max
1985	0.00	0.00	0.01	0.04

FTF 26

Year	^{144}Ce (pCi/mL) Mean	Max	^{60}Co (pCi/mL) Mean	Max	^{51}Cr (pCi/mL) Mean	Max
1985	0.01	0.07	0.04	0.25	0.06	0.32

Year	^{134}Cs (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max
1985	0.00	0.00	0.00	0.01	0.01	0.10

Year	^{106}Ru (pCi/mL) Mean	Max	$^{95}Zr,Nr$ (pCi/mL) Mean	Max
1985	0.01	0.11	0.01	0.06

TABLE 8-12 (cont.)

FTF 27

Year	^{144}Ce (pCi/mL) Mean	Max	^{60}Co (pCi/mL) Mean	Max	^{51}Cr (pCi/mL) Mean	Max
1985	0.03	0.18	0.02	0.10	0.09	0.28

Year	^{134}Cs (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max
1985	0.00	0.00	0.00	0.02	0.00	0.03

Year	^{106}Ru (pCi/mL) Mean	Max	$^{95}Zr,Nr$ (pCi/mL) Mean	Max
1985	0.02	0.16	0.00	0.02

Note: These results are from SRS annual and semiannual reports. Omitted wells and years indicate the absence of data in these reports.

TABLE 8-13

Estimated Nitrates Released to the F-Area Seepage Basins from 1961 to 1983

Year	Estimated Nitrates Released (kg)
1961	82,600
1962	281,000
1963	394,000
1964	745,000
1965	159,000
1966	139,000
1967	176,000
1968	222,000
1969	232,000
1970	245,000
1975*	45,000**
1983*	86,000+

Note: Data are from Christensen and Gordon (1983).

* Ryan and Stimson (1984).
** Estimated.
\+ Based on extrapolation of 4th quarter 1983 average concentration over the entire year.

TABLE 8-14

Estimated Mercury Releases to the F-Area Seepage Basins from 1955 to 1984

Year	Estimated Mercury Released (kg)
1955-1970	380.0
1971	24.0
1972	7.0
1973	5.7
1974	2.6
1975	0.8
1976	2.9
1977	2.9
1978	0.8
1979	1.4
1980	3.2
1981	0.7
1982	0.3
1983	1.4
1984	7.4

Note: Data are from Christensen and Gordon (1983). Data for 1984 are from the Health Protection Department.

TABLE 8-15

Radionuclide Releases to the F-Area Seepage Basins (1955-1985)

Radionuclide	First Year of Measurement	Cumulative Original Release (Ci)	Decay Corrected Release through 12/31/85 (Ci)
^{3}H	1955	2.7E+05	1.5E+05
^{60}Co	1969	1.2E-01	1.54E-02
^{89}Sr	1971	6.2E-01	2.2E-03
^{90}Sr	1955	4.13E+01	2.31E+01
^{95}Zr	1971	6.77E+01	2.6
^{95}Nb	1971	5.3E+01	1.1E-01
^{99}Tc	Estimated	1	1
^{129}I	Estimated	2	2
^{103}Ru	1971	1.78E+01	1.2E-01
^{106}Ru	1955	1.08E+03	3.9
$^{124,125}Sb$	1973	8.0E-02	9.5E-04
^{131}I	1971	70	<2.7E-03
^{134}Cs	1971	6.92E-01	2.2E-02
^{137}Cs	1955	2.12E+02	1.35E+02
^{141}Ce	1971	7.03E-02	2.7E-08
^{144}Ce	1971	3.92	1.4E-01
^{147}Pm	1955	1.15+02	9.2E-01
Natural U	1955	12.6	12.6
^{238}Pu	1967	1.53	1.36
^{239}Pu	1955	5.64	5.64
$^{241,243}Am$	1977	2.16E-01	2.15E-01
$^{242,244}Cm$	1973	3.12-01	2.36E-01

Note: The total volume released in 1955 was 4.21E+06 m^3. Data are from Killian et al. (1987a).

TABLE 8-16

F-Area Seepage Basins Influent Characteristics

Constituent	Concentration (mg/L except pH) Average	Maximum	Minimum
Sodium	790	1,900	110
Calcium	0.5	1.78	0.01
Iron	1.7	24	0.01
Zinc	0.3	1.16	0.001
Ammonia	24	30	9
Barium	0.01	0.05	0
Potassium	0.67	1.11	0.11
Aluminum	0.78	1.99	0
Manganese	0.016	0.04	0
Magnesium	0.060	0.16	0
Nitrate	1,220	6,740	90
Carbonate	131	180	0
Nitrite	2	16	0
Chloride	1.2	9.6	0
Sulfate	4.6	31	0
Fluoride	1.5	12	0
Silicon (total)	7.1	39	0.6
Silicon (<0.45 μm)	5.0	22	0.4
Phosphorus	2.2	4.4	0.92
pH	2.93	12.8	1.52
Lead	0.12	0.55	0
Mercury	0.004	0.012	0
Chromium	0.013	0.08	0
Copper	0.010	0.04	0

Note: Data are from Ryan (1984). Samples were taken at the F-Area Trebler Station from September to December 1983.

TABLE 8-17

Radionuclide Analysis of F-Area Seepage Basins Influent

Constituent	Average Activity
^{241}Am*	308
^{141}Ce	1,540
^{144}Ce	1,540
^{242}Cm*	154
^{134}Cs	6,200
^{137}Cs	62,000
^{131}I	15,400
^{95}Nb	62,000
^{147}Pm	7,690
^{238}Pu*	308
^{239}Pu*	308
^{103}Ru	30,800
^{106}Ru	308,000
^{89}Sr	3,080
^{90}Sr	6,200
Tritium	**
^{235}U*	2,080
^{238}U	2,080
^{95}Zr	62,000
Gross alpha	3,080

Note: Activities are in pCi/L. Samples taken at the F-Area Trebler station from September to December 1983. Reference: Ryan (1984).

* Alpha emitters (all others are beta-gamma emitters).

** Tritium was not included in this specific study; however, an approximate activity based on 1983 data is 101,608,900 pCi/L.

TABLE 8-18

Radioactivity Levels in F-Area Seepage Basins Water

Basin 1

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
$^{95}Zr,^{95}Nb$	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	---	---	94.5	52	47	30.5
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	5.09	16.2	14.4	11.0	6.3	6.65
Nonvolatile beta	1,300	885	946	1,880	2,700	915

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	47	12.5	28	11	10	11.5
$^{95}Zr,^{95}Nb$	97	120	77.5	43	51	40
^{103}Ru	475*	1,405*	955*	294*	295*	325*
^{106}Ru	475*	1,405*	955*	294*	295*	325*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	5	24	25.5	24	37	ND
^{134}Cs	111**	102**	47**	35**	54**	125**
^{137}Cs	111**	102**	47**	35**	54**	125**
$^{141,144}Ce$	180	65	236	23	25	19
^{3}H	86,500	125,000	145,000	173,000	103,000	110,000
Gross alpha	8	8	11.5	10	8	4.5
Nonvolatile beta	1,010	1,200	1,500	495	335	425

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 1

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	ND	ND	<2	---
$^{89,90}Sr$	11	14	22	4	2	2.40
$^{95}Zr,^{95}Nb$	45	56	54	48.5	55	---
^{103}Ru	51.5	61	15	19.5	30	---
^{106}Ru	51.5	130	76	51	130	---
$^{124,125}Sb$	---	---	---	ND	2	---
^{131}I	11.5	ND	9	13	9	---
^{134}Cs	114*	66*	65*	23.5*	23*	51.9*
^{137}Cs	114*	66*	65*	23.5*	23*	51.9*
$^{141,144}Ce$	21.5	20.5	26.5	3.5	<4	---
^{3}H	71,500	52,000	50,500	46,500	74,000	54,300
Gross alpha	10.95	5.95	3.65	2.95	1.5	1.22
Nonvolatile beta	335	440	370	165	310	165

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	0.00	0.00	0.77	0.92
$^{58,60}Co$	---	---	1.2	0.66	1.0	1.0
$^{89,90}Sr$	3.46	0.27	0.99	0.47	0.28	0.14
$^{95}Zr,^{95}Nb$	---	---	14	4.8	5.0	17
^{103}Ru	---	---	8.6	7.7	10	16
^{106}Ru	---	---	47	110	57	120
$^{124,125}Sb$	---	---	0.09	---	0.04	0.07
^{131}I	---	---	0.04	---	0.18	0.13
^{134}Cs	35.5*	1.87*	0.21	---	0.05	0.00
^{137}Cs	35.5*	1.87*	5.6	---	4.5	2.7
$^{141,144}Ce$	---	---	0.88	0.42	2.9	2.7
^{3}H	62,700	32,200	19,000	32,000	34,000	31,000
Gross alpha	1.53	1.14	1.7	1.2	1.1	1.2
Nonvolatile beta	145	82.7	120	120	94	83

* Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 1

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	0.18	0.20	1.7	3.2	0.64	0.66
$^{58,60}Co$	0.41	3.5	1.7	0.92	1.3	0.05
$^{89,90}Sr$	0.82	0.96	0.31	0.46	0.54	0.34
$^{95}Zr, ^{95}Nb$	2.6	18	29	80	64	8.4
^{103}Ru	5.9	13	6.9	3.3	9.7	1.0
^{106}Ru	43	9.9	8.5	4.3	24	8.5
$^{124,125}Sb$	0.00	0.17	0.24	1.0	0.21	0.00
^{131}I	0.08	0.29	0.36	0.80	930	0.00
^{134}Cs	0.10	0.00	0.00	0.03	0.00	0.00
^{137}Cs	2.4	4.2	6.6	10	11	17
$^{141,144}Ce$	3.1	2.0	2.8	4.4	0.00	0.42
^{3}H	27,000	28,000	39,000	100,000	58,000	38,000
Gross alpha	1.3	1.7	2.1	2.1	1.3	81
Nonvolatile beta	110	80	36	47	50	200

Basin 2

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
$^{95}Zr, ^{95}Nb$	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	---	---	16.5	12.8	65	16
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	3.74	8.55	14.0	8.1	4.65	7.95
Nonvolatile beta	828	420	710	990	1,200	640

TABLE 8-18 (cont.)

Basin 2

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	29	8	16.5	10	7	12
$^{95}Zr,^{95}Nb$	44	71	27.5	23	16	9.5
^{103}Ru	285*	575*	710*	290*	225*	235*
^{106}Ru	285*	575*	710*	290*	225*	235*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	3	17.5	2	11	6	ND
^{134}Cs	120**	61.5**	38**	29**	41.5**	122**
^{137}Cs	120**	61.5**	38**	29**	41.5**	122**
$^{141,144}Ce$	109	50.5	144.5	35.5	16.5	15
^{3}H	85,500	103,000	105,000	119,000	86,000	80,000
Gross alpha	4	5.5	7	7	6.5	4.3
Nonvolatile beta	595	545	1,045	445	305	330

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	ND	ND	<2	---
$^{89,90}Sr$	5.5	11.5	18.5	5.5	2	1.39
$^{95}Zr,^{95}Nb$	21	20.5	12	17	12	---
^{103}Ru	31	52.5	11.5	11.5	16	---
^{106}Ru	54	125	59	66.5	78	---
$^{124,125}Sb$	---	---	---	ND	1	---
^{131}I	4	ND	3	3	3	---
^{134}Cs	125**	72**	52.5**	28**	18**	41.5**
^{137}Cs	125**	72**	52.5**	28**	18**	41.5**
$^{141,144}Ce$	14	22.5	20	4	<3	---
^{3}H	54,500	47,000	38,000	49,000	50,000	49,700
Gross alpha	4.65	8.7	3.8	3.05	1.2	1.83
Nonvolatile beta	250	405	275	150	160	105.2

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 2

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	0.00	0.17	0.41	1.0
$^{58,60}Co$	---	---	0.95	0.48	1.1	0.69
$^{89,90}Sr$	3.37	0.15	0.34	0.40	0.04	0.13
$^{95}Zr,^{95}Nb$	---	---	3.0	1.3	1.5	18
^{103}Ru	---	---	7.2	4.8	6.6	14
^{106}Ru	---	---	43	93	42	82
$^{124,125}Sb$	---	---	0.03	---	0.03	0.27
^{131}I	---	---	0.00	---	0.08	0.14
^{134}Cs	58.1*	1.55*	0.21	---	0.05	0.02
^{137}Cs	58.1*	1.55*	4.8	---	3.2	3.1
$^{141,144}Ce$	---	---	0.19	1.9	3.3	3.3
^{3}H	43,700	34,100	23,000	36,000	37,000	33,000
Gross alpha	1.05	1.54	0.76	1.3	1.2	1.3
Nonvolatile beta	99.8	49.1	49	100	65	39

Basin 3

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	0.51	0.52	2.5	1.6	7.6	0.00
$^{58,60}Co$	0.13	3.4	0.73	0.43	1.5	0.00
$^{89,90}Sr$	0.78	0.91	0.31	0.32	0.45	0.29
$^{95}Zr,^{95}Nb$	1.2	20	19	57	30	11
^{103}Ru	3.8	20	2.7	1.7	8.2	1.6
^{106}Ru	30	27	6.8	3.4	11	4.4
$^{124,125}Sb$	0.00	0.32	0.20	0.25	0.00	0.00
^{131}I	0.07	0.39	0.32	0.22	0.48	0.00
^{134}Cs	0.02	0.00	0.00	0.08	0.00	0.00
^{137}Cs	2.0	4.3	5.8	7.0	6.9	15
$^{141,144}Ce$	3.0	2.4	3.2	2.3	0.00	1.2
^{3}H	26,000	30,000	50,000	76,000	69,000	50,000
Gross alpha	1.4	4.8	1.7	1.1	0.71	16
Nonvolatile beta	76	100	29	15	49	57

* Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 3

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
$^{95}Zr, ^{95}Nb$	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	---	---	6.5	4.0	23.5	6.5
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	4.14	6.3	6.86	6.1	2.8	4.25
Nonvolatile beta	545	213	444	480	590	485

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	29.5	7	18.5	9.5	6.5	13.5
$^{95}Zr, ^{95}Nb$	25	37	13.5	5	5.5	5.5
^{103}Ru	225*	350*	375*	208*	180*	190*
^{106}Ru	225*	350*	375*	208*	180*	190*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	2.5	8.5	2	3	1.5	ND
^{134}Cs	120**	33.5**	56**	23.5**	29.5**	101.5**
^{137}Cs	120**	33.5**	56**	23.5**	29.5**	101.5**
$^{141,144}Ce$	96	54.5	175	29	16.5	17.5
^{3}H	56,000	63,000	90,000	72,500	58,500	50,000
Gross alpha	4	5	5	6	4	3.85
Nonvolatile beta	545	475	830	330	240	315

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 3

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	ND	ND	<1	---
$^{89,90}Sr$	6	12	11	3	2	1.16
$^{95}Zr, ^{95}Nb$	9	10	8	7	5	---
^{103}Ru	27.5	34	6.5	8	7	---
^{106}Ru	50.5	105	34.5	63.5	59	---
$^{124,125}Sb$	---	---	---	ND	<1	---
^{131}I	ND	ND	1	1	<1	---
^{134}Cs	103.5*	66*	39*	24*	17*	36.89*
^{137}Cs	103.5*	66*	39*	24*	17*	36.89*
$^{141,144}Ce$	14	17.5	11.5	7	<2	---
^{3}H	49,500	34,000	21,500	37,000	34,000	37,000
Gross alpha	5.65	8.1	4.5	2.7	1.1	1.24
Nonvolatile beta	240	350	155	130	110	98.53

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	0.02	0.08	0.45	0.93
$^{58,60}Co$	---	---	0.88	0.27	0.47	0.99
$^{89,90}Sr$	1.72	0.22	0.21	0.49	0.29	0.09
$^{95}Zr, ^{95}Nb$	---	---	1.4	0.18	0.70	3.1
^{103}Ru	---	---	3.8	2.3	4.3	12
^{106}Ru	---	---	41	74	31	67
$^{124,125}Sb$	---	---	0.12	---	0.05	0.13
^{131}I	---	---	0.01	---	0.05	0.14
^{134}Cs	38.78*	2.7*	0.19	---	0.19	0.02
^{137}Cs	38.78*	2.7*	3.5	---	2.4	3.6
$^{141,144}Ce$	---	---	0.13	0.39	2.2	2.8
^{3}H	30,000	28,500	19,000	22,000	25,000	26,000
Gross alpha	1.17	1.86	0.72	1.0	0.99	0.87
Nonvolatile beta	54.67	35.24	39	65	55	85

* Reported as $^{134,137}Cs$.

TABLE 8-18 (cont.)

Basin 3

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	0.60	0.56	0.90	0.64	5.2	0.00
$^{58,60}Co$	0.54	1.1	0.35	0.69	0.66	0.00
$^{89,90}Sr$	0.69	0.60	0.23	0.23	0.48	0.56
^{95}Zr, ^{95}Nb	0.59	4.1	1.8	5.3	43	2.4
^{103}Ru	3.4	10	2.5	1.1	5.1	0.74
^{106}Ru	25	32	15	4.5	4.6	14
$^{124,125}Sb$	0.00	0.29	0.06	0.10	0.05	0.00
^{131}I	0.09	0.03	0.09	0.09	0.00	0.00
^{134}Cs	0.00	0.00	0.11	0.08	0.00	0.00
^{137}Cs	2.1	3.8	4.7	3.5	1.5	10
$^{141,144}Ce$	3.5	1.4	1.5	0.92	0.73	0.94
^{3}H	22,000	30,000	24,000	71,000	44,000	41,000
Gross alpha	1.2	4.3	1.4	1.3	0.97	8.0
Nonvolatile beta	69	110	29	13	22	43

Note: Prior to 1973, means were reported for 6-month intervals. Values given in this table prior to 1973 are the average of the 6-month values.

TABLE 8-19

Range of Concentrations for Radionuclides, Cations, and Anions Found in F-Area Seepage Basins Soil Cores

Radionuclides Species	Range (pCi/g)	Cations and Anions Species	Range (μg/g)
^{241}Am	0.2-80.6	Silver	LTDL
^{141}Ce	LTDL	Arsenic	2-9
^{144}Ce	0.44-3.7	Boron	10-10
$^{243,244}Cm$	0.17-5	Barium	15-15
^{60}Co	0.17-13.5	Beryllium	LTDL
^{134}Cs	0.05-4.5	Bismuth	2-2
^{137}Cs	0.59-4,920	Cadmium	LTDL
^{3}H	2,561-13,211	Cyanide	LTDL
^{129}I	1.8-117	Chromium	8-48
^{95}Nb	17-2,620	Copper	11-11
^{147}Pm	0.08-88	Iron	2,466-7,633
^{238}Pu	0.70-709	Fluoride	43-125
$^{239,240}Pu$	2.1-2,944	Mercury	2.3-11
^{103}Ru	0.49-4.5	Lithium	2.1-5
^{106}Ru	1.04-325	Manganese	5.3-90
^{89}Sr	2.21-28.4	Sodium	18-1,698
^{90}Sr	0.98-2,461	Nickel	5.7-47
^{99}Tc	0.32-13.8	Nitrite	LTDL
^{232}Th	1.83-17	Nitrate	110-210
$^{233,234}U$	2.1-25.2	Lead	LTDL
^{235}U	0.3-15.6	Selenium	LTDL
^{238}U	3.7-32.4	Tin	10-53
^{95}Zr	0.08-38.8	Titanium	7.7-87
		Tungsten	LTDL
		Zinc	6.7-30

Note: Data are from Corbo et al. (1985). LTDL = less than detection limits for all samples.

TABLE 8-20

Radioactivity Analyses from the F-Area Seepage Basins Wells

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 1						
1956	1.37	6.31	1,334.00	21,000.00	---	---
1957	69.37	247.75	22,250.00	82,000.00	---	---
1958	66.67	184.68	37,000.00	68,000.00	---	---
1959	7,252.25	28,828.83	191,000.00	990,000.00	---	---
1960	1,164.00	8,800.00	191,000.00	380,000.00	---	---
1961	2,100.00	7,000.00	99,000.00	210,000.00	87,000	130,000
1962	1,565.00	3,900.00	129,000.00	300,000.00	60,500	118,000
1963	9,250.00	17,000.00	391,000.00	690,000.00	74,500	110,000
1964	2,592.50	7,023.00	329,054.00	482,429.00	51,024	91,322
1965	3,080.00	12,000.00	305,000.00	630,000.00	106,500	170,000
1966	3,490.00	7,960.00	250,000.00	450,000.00	125,000	270,000
1967	1,140.00	3,600.00	204,000.00	870,000.00	90,000	140,000
1968	1,310.00	7,600.00	61,000.00	130,000.00	73,000	89,000
1969	4,250.00	27,000.00	207,500.00	660,000.00	109,500	620,000
1970	4,009.00	26,800.00	260,000.00	490,000.00	41,500	79,000
1971	89.50	350.00	150,000.00	250,000.00	50,500	54,000
1972	805.00	4,470.00	93,900.00	180,000.00	31,650	81,800
1973	1,200.00	7,500.00	320,000.00	630,000.00	57,000	200,000
1974	1,711.90	3,447.60	95,362.00	146,136.00	41,424	80,547
1975	1,775.83	4,817.30	105,505.00	336,263.00	59,594	126,018
1976	3,741.11	7,840.80	48,167.00	78,558.00	30,861	48,223
1977	900.00	3,400.00	130,000.00	410,000.00	21,000	55,000
1978	3,300.00	11,000.00	95,000.00	250,000.00	25,000	45,000
1979	2,100.00	4,100.00	110,000.00	290,000.00	48,000	180,000
1980	2,600.00	4,200.00	140,000.00	360,000.00	37,000	53,000
1981	2,700.00	5,200.00	160,000.00	330,000.00	24,000	35,000
1986	13.00	14.00	700.00	790.00	10,000	11,000
F 2						
1956	1.87	4.50	119.00	480.00	---	---
1957	1.58	2.25	641.00	5,600.00	---	---
1958	2.70	6.31	285.00	1,200.00	---	---
1959	3.15	5.41	345.00	540.00	---	---
1960	1.05	2.40	89.00	140.00	---	---
1961	0.45	0.90	148.00	500.00	78,000	43,000
1962	0.80	1.50	140.00	190.00	35,000	44,000
1971	1,345.00	4,100.00	41,000.00	170,000.00	42,000	33,000
1972	3,880.00	7,900.00	41,450.00	61,000.00	32,750	47,500
1973	3,300.00	9,200.00	190,000.00	560,000.00	56,000	120,000
1974	7,293.68	21,127.80	31,279.00	70,296.00	44,850	63,049
1975	3,906.23	6,532.50	23,150.00	33,267.00	45,710	75,059
1976	653.10	844.20	23,901.00	38,852.00	34,916	36,660

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 2 (cont.)						
1977	3,100.00	9,100.00	68,000.00	170,000.00	23,000	48,000
1979	2,200.00	2,200.00	79,000.00	79,000.00	---	---
1980	19,000.00	19,000.00	7,500.00	7,500.00	23,000	23,000
F 3						
1956	1.60	5.41	24.50	120.00	---	---
1957	1.35	2.70	22.50	61.00	---	---
1958	1.35	2.25	20.00	41.00	---	---
1959	0.68	1.35	12.50	20.00	---	---
1960	0.25	0.60	367.00	1,400.00	---	---
1961	0.50	1.30	500.00	890.00	75,000	32,000
1962	2.05	20.00	245.00	990.00	52,500	64,000
1963	1.30	1.90	192.00	300.00	44,000	49,000
1965	57.00	140.00	15,500.00	28,000.00	39,500	140,000
F 4						
1956	1.37	2.25	21.50	200.00	---	---
1958	2.70	23.87	37.00	320.00	---	---
1959	1.13	1.80	19.00	81.00	---	---
1960	0.35	1.20	192.50	1,500.00	---	---
1961	0.20	0.60	795.00	2,000.00	110,000	320,000
1962	0.20	0.40	830.00	1,100.00	50,000	54,000
1966	24.50	68.00	1,050.00	1,400.00	92,500	140,000
1973	630.00	1,000.00	23,000.00	27,000.00	32,000	36,000
F 5						
1956	1.69	7.66	2,818.00	12,000.00	---	---
1957	2.70	9.01	418.00	620.00	---	---
1958	OS	22.52	OS	76.00	---	---
1959	3.60	22.07	3,050.00	17,000.00	---	---
1960	0.40	1.50	5,450.00	16,000.00	---	---
1961	1.55	3.90	5,700.00	42,000.00	11,000	84,000
1962	0.40	0.50	2,200.00	2,600.00	59,000	60,000
F 6						
1956	30.41	441.44	8,455.00	67,000.00	---	---
1957	121.17	1,036.04	15,700.00	42,000.00	---	---
1958	18.47	24.32	13,500.00	21,000.00	---	---
1959	135.81	1,036.04	33,500.00	130,000.00	---	---
1960	600.00	5,500.00	60,000.00	430,000.00	---	---
1961	560.00	1,300.00	71,500.00	200,000.00	127,000	400,000
1962	410.00	580.00	63,000.00	90,000.00	68,000	120,000

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 7						
1956	3.27	24.77	4,347.50	16,000.00	---	---
1957	27.93	76.58	14,625.00	27,000.00	---	---
1958	13.96	17.12	7,900.00	13,000.00	---	---
1959	327.03	3,243.24	23,500.00	130,000.00	---	---
1960	300.00	810.00	11,150.00	27,000.00	---	---
1961	420.00	1,300.00	64,050.00	300,000.00	98,000	170,000
1962	470.00	750.00	27,000.00	61,000.00	37,000	76,000
F 8						
1956	1.22	2.70	11.00	22.00	---	---
1957	1.13	2.25	20.00	72.00	---	---
1958	0.90	1.80	12.00	21.00	---	---
1959	0.90	1.35	10.50	18.00	---	---
1960	0.65	1.00	9.00	15.60	---	---
1961	0.70	1.20	80.50	490.00	6,300	14,000
1962	0.70	1.00	34.50	76.00	9,500	12,000
F 9						
1956	0.95	2.25	12.00	53.00	---	---
1957	0.68	1.80	19.50	93.00	---	---
1958	0.68	1.35	13.50	38.00	---	---
1959	0.68	1.35	12.00	19.00	---	---
1960	0.50	1.70	18.50	101.00	---	---
1961	0.55	1.00	17.50	59.00	4,000	4,900
1962	0.50	0.90	16.50	35.00	3,000	8,000
1963	0.20	0.40	36.00	85.00	17,000	26,000
1964	LS	0.20	76.00	160.00	50,441	80,006
1965	0.40	0.70	98.00	160.00	34,000	39,000
1966	0.30	0.50	600.00	900.00	44,000	85,000
1967	0.40	0.60	23.00	29.00	25,700	25,800
1973	1.00	1.00	21.00	30.00	25,000	27,000
1974	0.67	0.67	35.39	35.39	26,860	26,860
1975	6.47	16.50	141.28	329.60	19,321	20,994
1976	0.47	0.59	10.20	13.03	4,241	4,812
1977	0.57	0.84	29.00	70.00	910	1,100
1978	0.11	0.17	15.00	18.00	450	480
1979	0.19	0.41	18.00	26.00	1,700	2,100
1980	0.08	0.16	12.00	19.00	2,400	2,800
1982	0.27	0.66	29.00	37.00	280	410
1983	0.77	0.97	26.00	32.00	910	1,200
1984	1.10	1.50	28.00	45.00	2,300	4,400
1985	0.05	0.10	16.00	20.00	6,800	7,200

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 10						
1956	59.50	495.50	5,179.50	11,000.00	---	---
1957	123.42	351.35	122,000.00	210,000.00	---	---
1958	333.33	720.72	58,000.00	120,000.00	---	---
1959	2,941.22	15,315.32	219,500.00	520,000.00	---	---
1960	1,705.00	6,600.00	155,000.00	42,000.00	---	---
1961	480.00	1,300.00	296,500.00	710,000.00	71,000	100,000
1962	2,850.00	7,800.00	104,500.00	200,000.00	82,000	111,000
1963	3,000.00	3,300.00	390,000.00	550,000.00	105,000	105,000
1964	6,433.00	8,922.00	247,885.00	389,925.00	19,442	19,925
1965	2,400.00	3,500.00	460,000.00	760,000.00	72,000	93,000
1973	760.00	760.00	28,000.00	28,000.00	14,000	14,000
1979	460.00	460.00	32,000.00	32,000.00	25,000	25,000
1980	440.00	440.00	36,000.00	36,000.00	28,000	28,000
1984	300.00	640.00	22,000.00	32,000.00	36,000	36,000
1985	---	---	---	---	39,000	39,000
1986	910.00	910.00	20,000.00	20,000.00	44,000	45,000
F 11						
1956	1.55	4.23	15.00	30.00	---	---
1957	1.58	10.81	52.00	114.00	---	---
1958	1.80	9.01	39.00	67.00	---	---
1959	0.68	1.35	66.50	400.00	---	---
1960	0.70	1.60	23.50	44.00	---	---
1961	1.00	4.10	33.50	78.00	6,000	8,400
1962	1.20	1.90	110.00	240.00	14,000	23,000
F 12						
1956	4.19	16.67	2,431.00	5,400.00	---	---
1957	79.28	171.17	48,000.00	110,000.00	---	---
1958	18.24	63.06	18,000.00	37,000.00	---	---
1959	1,650.90	8,558.56	147,000.00	420,000.00	---	---
1960	1,360.00	7,600.00	93,000.00	460,000.00	---	---
1961	510.00	3,000.00	114,500.00	600,000.00	54,000	61,000
1962	4,600.00	8,000.00	40,000.00	53,000.00	74,000	100,000
F 13						
1956	1.37	3.06	1,007.00	1,500.00	---	---
1957	4.50	13.06	11,100.00	27,000.00	---	---
1958	12.39	31.08	18,000.00	34,000.00	---	---
1959	588.74	3,243.24	130,500.00	360,000.00	---	---
1960	1,320.00	3,500.00	64,500.00	190,000.00	---	---
1961	43.00	50.00	41,000.00	64,000.00	---	---
1962	360.00	1,300.00	180,000.00	310,000.00	65,000	100,000

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
F 14						
1962	1.50	2.20	1,200.00	1,300.00	25,000	25,000
1963	1.30	2.00	1,700.00	2,400.00	29,000	36,000
1964	9.20	12.00	4,268.00	5,400.00	38,292	46,225
1965	11.00	14.00	10,000.00	18,000.00	56,000	67,000
1966	5.00	6.00	1,200.00	1,800.00	51,000	55,000
1967	8.40	12.70	3,400.00	5,600.00	49,000	49,000
1968	7.40	9.00	5,600.00	6,600.00	42,000	48,000
1969	36.50	41.70	5,000.00	5,300.00	33,000	35,000
1970	33.80	36.60	5,100.00	5,400.00	25,000	35,000
1971	28.00	40.00	9,000.00	11,000.00	29,000	31,000
1972	27.00	37.00	6,500.00	7,600.00	17,300	18,200
1973	37.00	48.00	6,000.00	9,400.00	19,000	20,000
1974	54.89	58.04	2,338.72	2,647.67	25,004	25,212
1975	78.42	90.17	1,992.09	2,358.80	18,870	24,587
1976	86.51	104.18	1,747.56	2,192.94	18,959	19,800
1977	25.00	34.00	500.00	620.00	21,000	25,000
1978	34.00	38.00	350.00	570.00	12,000	16,000
1979	35.00	40.00	1,800.00	2,200.00	3,700	5,900
1980	41.00	48.00	400.00	780.00	11,000	20,000
1982	25.00	30.00	1,300.00	1,400.00	16,000	16,000
1983	44.00	59.00	1,800.00	2,400.00	15,000	20,000
1984	35.00	51.00	1,300.00	1,900.00	27,000	41,000
1985	30.00	57.00	770.00	1,500.00	41,000	55,000
1986	220.00	220.00	4,100.00	4,100.00	12,000	12,000
F 15						
1962	0.30	0.60	74.00	94.00	2,000	3,000
1963	0.40	0.70	130.00	230.00	3,800	6,300
1964	1.10	2.40	138.00	339.00	842	1,302
1965	0.60	1.00	310.00	370.00	5,600	6,500
1966	1.30	2.40	120.00	220.00	400	500
1967	0.80	1.10	50.00	58.00	320	770
1970	2.20	1.30	160.00	210.00	32,000	39,000
1971	6.30	9.00	400.00	700.00	1,600	31,000
1972	5.00	7.00	130.00	230.00	360	740
1973	3.00	4.00	85.00	97.00	450	760
1974	2.26	2.51	64.11	64.71	210	332
1975	3.25	5.95	42.05	51.83	52	57
1976	1.89	2.60	86.00	124.08	467	666
1977	2.00	2.90	50.00	87.00	340	450
1978	0.69	0.74	54.00	59.00	530	730
1979	0.71	1.20	80.00	110.00	800	1,100
1980	0.91	1.60	800.00	970.00	2,100	2,200
1982	0.27	0.74	630.00	970.00	1,900	5,400
1983	8.00	14.00	740.00	1,200.00	940	1,400

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 15 (cont.)						
1984	5.20	7.90	910.00	1,100.00	3,200	4,900
1985	2.30	2.50	370.00	720.00	1,300	1,500
1986	24.00	41.00	400.00	530.00	6,400	10,000
F 16						
1962	0.40	0.60	120.00	160.00	14,000	14,000
1963	0.40	0.60	110.00	170.00	12,000	17,000
1964	1.60	2.60	1,125.00	1,849.00	19,104	22,195
1965	16.00	23.00	11,000.00	15,000.00	24,000	47,000
1966	9.00	11.00	5,200.00	7,200.00	31,000	41,000
1967	5.80	7.20	950.00	1,600.00	14,000	17,000
1968	4.60	7.20	7,100.00	7,600.00	38,000	40,000
1969	23.80	24.40	7,200.00	7,400.00	38,000	39,000
1970	33.20	38.30	1,500.00	2.000.00	4,200	6,000
1971	15.00	27.00	380.00	1,000.00	1,000	3,000
1972	29.00	62.00	2,500.00	5,500.00	6,700	7,900
1973	47.00	68.00	2,300.00	3,700.00	21,000	42,000
1974	94.67	141.96	1,659.98	2,174.22	8,846	13,392
1975	88.57	105.10	1,761.89	2,404.06	23,698	25,099
1976	68.61	75.04	1,428.14	1,468.41	21,309	21,821
1977	46.00	51.00	710.00	780.00	16,000	22,000
1978	40.00	43.00	680.00	1,000.00	9,600	12,000
1979	48.00	50.00	2,900.00	4,300.00	6,400	9,900
1980	39.00	69.00	820.00	1,500.00	15,000	16,000
1982	20.00	29.00	1,700.00	1,700.00	13,000	15,000
1983	47.00	58.00	1,200.00	1,500.00	12,000	16,000
1984	31.00	50.00	800.00	970.00	23,000	45,000
1985	28.00	41.00	810.00	830.00	32,000	37,000
1986	34.00	46.00	860.00	990.00	26,000	34,000
F 17						
1962	0.70	1.10	33.00	46.00	100	200
1963	0.80	0.90	34.00	50.00	64	100
1964	1.00	1.20	420.00	1,147.00	77	119
1965	1.40	2.70	60.00	88.00	100	120
1966	2.90	4.40	50.00	60.00	2,000	4,000
1967	1.80	2.60	44.00	72.00	5,000	9,300
1968	1.70	1.80	480.00	710.00	15,000	22,000
1969	4.60	5.30	502.00	700.00	18,000	20,000
1970	2.20	3.00	620.00	1,400.00	10,000	14,000
1971	5.00	7.00	400.00	1,000.00	300	700
1972	3.00	4.00	150.00	200.00	80	140
1973	2.00	2.00	24.00	40.00	52	78
1974	2.23	3.35	359.44	433.48	2,562	3,401

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 17 (cont.)						
1975	5.96	10.56	44.45	75.79	207	529
1976	4.68	10.13	27.93	39.76	95	161
1977	2.70	3.80	18.00	26.00	120	290
1978	1.80	3.60	19.00	28.00	61	100
1979	2.50	3.50	25.00	40.00	80	150
1980	0.88	1.20	16.00	19.00	72	79
1982	0.62	1.20	20.00	31.00	220	330
1983	0.93	1.90	26.00	56.00	390	650
1984	0.60	1.90	5.80	8.40	61	140
1985	0.42	0.63	22.00	34.00	730	1,700
1986	1.20	1.80	250.00	490.00	2,000	3,900
F 18						
1962	0.70	1.80	19.00	33.00	2,000	6,000
1963	1.80	3.90	62.50	110.00	6,620	18,000
1964	1.50	3.40	65.00	366.00	822	4,499
1965	1.70	3.70	35.50	230.00	755	3,900
1966	2.10	2.70	55.00	90.00	5,500	6,100
1973	2.00	4.00	35.00	62.00	36	45
1974	3.73	5.02	85.51	132.29	222	460
1975	2.20	3.30	14.30	15.57	42	45
1976	1.80	4.69	11.77	30.71	44	83
1977	1.80	3.20	48.00	130.00	170	600
1978	1.10	2.10	26.00	57.00	300	660
1979	1.40	1.50	11.00	14.00	34	36
1980	0.82	1.20	40.00	40.00	210	350
1982	0.73	0.73	32.00	32.00	33	33
1983	0.86	1.00	6.20	8.70	32	38
1984	1.30	1.50	30.00	33.00	48	69
1985	28.00	40.00	200.00	260.00	5,100	11,000
F 18A						
1986	31.00	35.00	550.00	680.00	42,000	54,000
F 19						
1962	1.00	1.50	19.00	38.00	200	200
1963	0.90	1.00	14.00	19.00	220	340
1964	1.70	3.70	92.00	240.00	99	154
1965	3.00	4.50	230.00	380.00	300	340
1966	2.80	4.20	60.00	100.00	50	60
1967	---	---	---	---	70	70
1973	3.00	4.00	48.00	68.00	38	53
1974	3.75	4.29	28.44	28.46	20	23

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 19 (cont.)						
1975	42.46	54.12	495.08	505.52	56	65
1976	2.76	4.44	14.14	21.29	30	37
1977	1.30	2.20	10.00	17.00	23	27
1978	1.80	2.90	9.80	12.00	29	30
1979	3.40	5.00	23.00	48.00	33	38
1980	2.00	4.70	15.00	32.00	56	69
1983	2.60	5.90	14.00	32.00	130	310
1984	1.40	2.00	3.90	6.70	36	39
1985	0.00	0.00	0.00	0.00	190	190
F 23						
1962	2.10	2.40	31.00	58.00	5,000	6,000
1963	0.80	1.30	34.00	47.00	220	500
1964	2.70	3.70	143.00	242.00	260	497
1965	2.60	6.30	560.00	1,900.00	400	860
1966	1.10	2.00	200.00	400.00	150	160
1967	0.80	1.20	48.00	72.00	240	360
1968	3.50	3.50	200.00	200.00	360	360
1973	1.00	2.00	28.00	48.00	150	220
1976	2.48	3.77	8.59	11.71	48	52
1977	4.60	6.50	24.00	29.00	20	30
1978	0.72	1.10	5.40	9.70	23	23
1979	---	---	---	---	94	120
1980	1.30	1.80	6.10	8.90	59	60
1982	0.74	1.60	110.00	270.00	3,200	6,200
1983	0.62	1.10	7.70	11.00	64	72
1984	0.44	0.68	5.40	10.00	260	570
F 24						
1962	1.90	3.10	21.00	29.00	500	900
1963	2.00	2.40	39.00	82.00	69	84
1964	1.20	2.00	46.00	87.00	27	33
1965	0.70	0.80	44.00	63.00	130	300
1966	0.50	0.80	10.00	10.00	70	70
1967	1.50	2.40	20.00	28.00	260	490
1968	1.40	1.20	90.00	130.00	1,500	4,200
1969	1.50	1.90	72.00	90.00	110	150
1972	11.00	26.00	140.00	300.00	25	30
1973	2.00	3.00	20.00	39.00	58	68
1974	1.68	3.04	11.35	16.06	48	57
1975	9.16	23.28	10.11	23.25	32	33
1976	3.54	4.37	11.25	16.66	25	29
1977	1.80	2.90	9.60	13.00	26	29
1978	2.20	3.30	7.30	12.00	21	25

TABLE 8-20 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
F 24 (cont.)						
1979	0.59	0.75	3.30	6.60	27	29
1980	0.63	1.20	6.50	8.40	22	23
1982	0.66	1.80	6.70	29.00	28	38
1983	0.48	0.97	3.90	5.10	25	31
1984	0.43	1.30	3.40	5.20	44	55
1985	0.17	0.31	2.60	4.10	44	47
1986	0.55	0.98	3.00	4.20	41	51
F 25						
1962	1.60	2.40	21.00	28.00	600	800
1963	1.40	2.00	56.00	110.00	2,000	2,300
1964	1.10	1.50	38.00	55.00	1,889	3,916
1965	0.90	2.00	84.00	140.00	220	370
1966	1.80	3.20	90.00	200.00	650	760
1967	1.20	1.70	240.00	570.00	930	1,500
1968	2.00	1.40	69.00	130.00	3,800	5,700
1969	2.10	2.30	240.00	440.00	1,400	1,500
1970	2.80	3.70	180.00	330.00	2,700	3,800
1971	2.10	3.10	30.00	44.00	460	1,200
1972	2.00	2.00	30.00	50.00	30	40
1973	3.00	4.00	51.00	82.00	67	69
1974	2.50	3.94	18.18	20.03	212	354
1975	8.98	15.92	48.24	84.56	457	518
1976	2.70	5.02	10.81	16.25	205	272
1977	2.40	3.00	16.00	20.00	680	860
1978	1.50	2.30	12.00	15.00	400	400
1979	2.20	2.70	12.00	29.00	670	770
1980	7.20	16.00	12.00	22.00	340	430
1982	2.50	7.30	180.00	330.00	1,700	2,000
1983	2.50	3.80	100.00	180.00	1,100	1,700
1984	1.60	2.80	18.00	28.00	140	230
1985	0.81	1.20	16.00	24.00	79	100
1986	1.90	3.50	57.00	83.00	37	48

TABLE 8-20 (cont.)

Additional Analyses

F 1

Year	^{131}I (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	$^{141,144}Ce$ (pCi/mL) Mean	Max
1956	7.7	60.0	---	---	---	---
1957	5.1	12.0	---	---	---	---
1963	0.7	2.8	17.0	97.0	135.0	250.0
1964	3.8	6.2	21.4	49.0	90.0	156.0
1965	1.3	13.0	8.8	41.0	57.0	139.0
1966	1.0	2.0	17.5	46.0	43.0	121.0
1967	1.0	5.0	9.5	15.0	4.5	26.0
1968	---	---	9.5	16.0	2.5	11.0
1969	2.0	2.0	19.5	27.0	12.0	36.0
1970	---	---	37.0	310.0	10.5	36.0
1971	1.1	1.1	61.0	93.0	2.8	6.0
1972	8.0	8.0	31.0	70.0	4.0	6.0
1978	<0.3	<0.3	10.0	31.0	1.4	6.2*
1979	0.2	0.5	5.6	16.0	1.7	6.6*
1980	0.2	0.4	14.0	23.0	3.0	7.6*
1981	0.0	0.1	4.3	16.0	1.6	6.2*

Year	^{60}Co (pCi/mL) Mean	Max	^{51}Cr (pCi/mL) Mean	Max	^{134}Cs (pCi/mL) Mean	Max
1978	<1.9	<1.9	<1.6	<1.6	<0.9	<0.9
1979	0.7	3.3	0.7	3.2	0.1	0.6
1980	2.1	7.5	1.3	2.2	0.1	0.3
1981	0.3	1.2	0.7	3.7	0.1	0.4

* Only ^{144}Ce was measured.

TABLE 8-20 (cont.)

F 1 (cont.)

Year	$^{89,90}Sr$ (pCi/mL) Mean	Max	$^{95}Zr,Nb$ (pCi/mL) Mean	Max	$^{103,106}Ru$ (pCi/mL) Mean	Max
1959	79.0	180.0	---	---	---	---
1960	5.0	29.0	---	---	---	---
1961	3.2	18.0	---	---	---	---
1962	56.0	360.0	---	---	---	---
1963	27.0	61.0	0.4	0.9	82.5	350.0
1964	15.1	33.0	0.1	0.5	217.0	508.0
1965	11.5	32.0	9.5	53.0	395.5	1,590.0
1966	10.0	26.0	12.0	46.0	238.5	646.0
1967	4.5	12.0	<1.0	2.0	84.5	300.0
1968	17.0	26.0	1.0	3.0	20.5	51.0
1969	13.5	43.0	3.0	7.0	---	---
1970	11.5	69.0	6.0	40.0	---	---
1971	50.0	53.0	1.0	5.0	---	---
1972	12.5	40.0	3.0	9.0	---	---
1973	---	---	---	---	---	---
1974	2.1	5.8	---	---	---	---
1975	2.8	10.0	---	---	---	---
1976	0.5	0.8	---	---	---	---
1977	0.5	3.2	---	---	---	---
1978	4.2	9.1	0.4	1.3	---	---
1979	0.7	1.3	0.2	1.0	---	---
1980	0.6	1.5	4.2	7.8	---	---
1981	1.2	2.9	2.4	4.1	---	---

Year	^{125}Sb (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max	^{106}Ru (pCi/mL) Mean	Max
1969	---	---	16.0	60.0	51.0	60.0
1970	---	---	23.0	66.0	184.5	840.0
1971	---	---	4.0	4.0	28.0	65.0
1972	---	---	24.0	80.0	24.0	80.0
1978	<0.0	<0	2.0	11.0	110.0	530.0
1979	0.1	1	5.5	23.0	56.0	160.0
1980	0.9	3	17.0	99.0	84.0	190.0
1981	0.0	0	6.9	28.0	45.0	160.0

TABLE 8-20 (cont.)

F 2

Year	$^{141,144}Ce$ (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	$^{95}Zr,Nb$ (pCi/mL) Mean	Max
1971	2.6	7.0	18.5	59.0	0.2	1.0
1972	4.5	7.0	10.0	13.0	2.0	2.0

Year	^{131}I (pCi/mL) Mean	Max	^{103}Ru (pCi/mL) Mean	Max	^{106}Ru (pCi/mL) Mean	Max
1956	0.3	1.3	---	---	---	---
1971	1.1	1.1	1.1	1.1	14.0	23.0
1972	---	---	2.0	2.0	12.0	12.0

Year	$^{89,90}Sr$ (pCi/mL) Mean	Max
1971	9.9	28.0
1972	10.0	21.0
1973	---	---
1974	2.4	4.8
1975	3.9	7.3
1976	1.3	2.0
1977	2.1	6.6

F 3

Year	$^{141,144}Ce$ (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{131}I (pCi/mL) Mean	Max
1956	---	---	---	---	0.1	0.6
1963	0.2	0.4	0.1	0.3	0.1	0.2

Year	$^{103,106}Ru$ (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max	$^{95}Zr,Nb$ (pCi/mL) Mean	Max
1962	---	---	0.4	0.7	---	---
1963	0.9	1.6	0.2	0.2	0.1	0.2

TABLE 8-20 (cont.)

F 4

Year	^{131}I (pCi/mL) Mean	Max
1956	0.1	0.4

F 5

Year	^{131}I (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
1956	4.8	26.0	---	---
1957	0.9	2.9	---	---
1959	---	---	0.5	0.6

F 6

Year	^{131}I (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
1956	52.7	140.0	---	---
1957	6.3	36.0	---	---
1959	---	---	17.0	45.0
1960	---	---	6.2	21.0
1961	---	---	15.3	44.0
1962	---	---	20.0	41.0

F 7

Year	^{131}I (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
1956	31.8	98.0	---	---
1959	---	---	7.0	20.0
1960	---	---	2.5	7.3
1961	---	---	22.7	110.0
1962	---	---	14.0	42.0

F 8

Year	^{131}I (pCi/mL) Mean	Max
1956	0.2	1.2

TABLE 8-20 (cont.)

F 9

Year	^{131}I (pCi/mL) Mean	Max
1956	0.2	0.8

F 10

Year	^{131}I (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
1956	34.6	80.2	---	---
1957	6.1	17.0	---	---
1959	---	---	55.0	140.0
1960	---	---	8.6	36.0
1961	---	---	72.0	280.0
1962	---	---	15.4	50.0

F 11

Year	^{131}I (pCi/mL) Mean	Max
1956	0.1	0.4

F 12

Year	^{131}I (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
1956	39.6	73.5	---	---
1957	4.4	10.0	---	---
1959	---	---	53.0	130.0
1960	---	---	8.8	44.0
1961	---	---	11.4	75.0
1962	---	---	20.0	33.0

TABLE 8-20 (cont.)

F 13

	^{131}I (pCi/mL)		$^{89,90}Sr$ (pCi/mL)	
Year	Mean	Max	Mean	Max
1956	7.5	15.0	---	---
1959	---	---	56.0	130.0
1960	---	---	7.15	42.0
1961	---	---	0.8	1.8
1962	---	---	21.0	29.0

Note: These results are from SRS annual and semiannual reports. Omitted wells and years indicate the absence of data in these reports.

TABLE 8-21

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Seepage Basins Water-Table Wells (7/84-12/86)

Constituent	SC and Federal DWS	FSB 76	FSB 77	FSB 78	FSB 79
pH (pH)	6.5-8.5	3.9-5.7	2.8-4.2	2.7-3.3	3.0-3.4
Conductivity (µmhos/cm)	NA	62-135	205-1,200	1,200-3,600	970-2,000
Silver (mg/L)	0.05	<0.0005	<0.0005	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.009-0.012	0.041-0.165	0.183-0.287	0.316-0.552
Carbon tetrachloride (mg/L)	0.005	---	<0.005	<0.005	<0.005
Cadmium (mg/L)	0.010	<0.001-0.004	0.001-0.060	<0.002-0.022	0.003-0.006
Chloroform (mg/L)	0.100*	---	<0.005	<0.005	<0.005
Chloride (mg/L)	250	2.2-3.3	1.7-4.3	1.4-3.4	1.6-2.4
Chromium (mg/L)	0.05	<0.004	<0.004-0.051	0.011-0.014	<0.004
Cyanide (mg/L)	0.2	<0.005	---	---	<0.005
DOC (mg/L)	NA	1.8	<5.0	<5.0	2.8
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.12-0.18	0.19-0.66	0.45-0.70	0.25-0.38
Iron (mg/L)	0.3	<0.004-0.048	0.014-0.321	0.138-1.800	0.140-0.212
Mercury (mg/L)	0.002	<0.0002	<0.0002-0.0009	<0.0002-0.0005	0.0003-0.0019
Manganese (mg/L)	0.05	0.007-0.022	0.073-0.479	0.618-1.340	2.660-3.840
Sodium (mg/L)	NA	6.29-19.60	9.80-110.00	122.00-195.00	56.60-146.00
Nitrate (as N) (mg/L)	10	4.00-9.66	19.40-81.00	300.00-447.00	34.50-195.00
Lead (mg/L)	0.05	0.009-0.047	0.007-0.164	<0.005-0.299	<0.005-0.082
Phenols (mg/L)	NA	<0.002-0.003	<0.002	<0.002	0.002-0.004
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	10.0-11.0	<5.0-11.0
Tetrachloroethylene (mg/L)	NA	---	<0.005	<0.005	<0.005
TDS (mg/L)	500	72	638-904	1,238-1,294	502-542
TOC (mg/L)	NA	0.443-3.499	0.330-83.0	1.997-15.0	0.971-17.0
TOH (mg/L)	NA	<0.005-0.015	<0.005-0.010	<0.005-0.055	<0.005-0.038
Trichloroethylene (mg/L)	0.005	---	<0.005	<0.005	<0.005
1,1,1-TCE (mg/L)	0.200	---	<0.005	<0.005	<0.005
Zinc (mg/L)	5	1.160-6.940	0.045-3.880	0.196-4.230	0.206-1.570
Gross alpha (pCi/L)	15	<2.0-83.0	66.4-717	63.7-1,614	<2.0-1,087
Nonvol. beta (pCi/L)	NA	7.0-59.0	185.6-991	722.3-3,461	<3.0-1,427
Total radium (pCi/L)	5	<1.0-5.0	7.8-56.0	21.6-67.0	<1.0-42.0
Tritium (pCi/mL)	20	867-1,050	1,090-1,339	42,500-56,145	16,499-25,000

TABLE 8-21 (cont.)

Constituent	SC and Federal DWS	FSB 87D
pH (pH)	6.5-8.5	3.2-5.0
Conductivity (µmhos/cm)	NA	400-2,400
Silver (mg/L)	0.05	<0.0020
Arsenic (mg/L)	0.05	<0.002
Barium (mg/L)	1.0	0.188-0.468
Carbon tetrachloride (mg/L)	0.005	<0.005
Cadmium (mg/L)	0.010	0.004-0.029
Chloroform (mg/L)	0.100*	<0.005
Chloride (mg/L)	250	1.7-5.7
Chromium (mg/L)	0.05	<0.004
Cyanide (mg/L)	0.2	---
DOC (mg/L)	NA	---
Endrin (mg/L)	0.0002	---
Fluoride (mg/L)	1.6	<0.10-0.46
Iron (mg/L)	0.3	1.200-1.735
Mercury (mg/L)	0.002	<0.0002
Manganese (mg/L)	0.05	1.095-1.560
Sodium (mg/L)	NA	45.00-172.00
Nitrate (as N) (mg/L)	10	50.20-360.00
Lead (mg/L)	0.05	0.011-0.310
Phenols (mg/L)	NA	<0.002-0.002
Selenium (mg/L)	0.01	<0.002
Sulfate (mg/L)	250	6.0-11.0
Tetrachloroethylene (mg/L)	NA	<0.005
TDS (mg/L)	500	---
TOC (mg/L)	NA	0.760-13.000
TOH (mg/L)	NA	<0.005-0.025
Trichloroethylene (mg/L)	0.005	<0.005
1,1,1-TCE (mg/L)	0.200	<0.005
Zinc (mg/L)	5	0.443-0.757
Gross alpha (pCi/L)	15	91.0-1,652
Nonvol. beta (pCi/L)	NA	305.0-1,799
Total radium (pCi/L)	5	14.1-61.0
Tritium (pCi/mL)	20	3,920-44,000

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-22

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Seepage Basins McBean Wells (7/84-12/86)

Constituent	SC and Federal DWS	FSB 76C	FSB 78C	FSB 79C	FSB 87C
pH (pH)	6.5-8.5	4.9-6.0	4.3-5.1	3.1-3.5	6.4-7.0
Conductivity (µmhos/cm)	NA	30-56	1,420-2,200	1,400-2,200	62-69
Silver (mg/L)	0.05	<0.0020	0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	0.006-0.009	0.409-0.451	0.606-0.696	0.007-0.010
Beryllium (mg/L)	NA	---	---	---	<0.005
Carbon tetrachloride (mg/L)	0.005	---	<0.005	<0.005	<0.005
Cadmium (mg/L)	0.010	<0.002-0.002	0.003-0.022	0.014-0.026	<0.001
Chloroform (mg/L)	0.100*	---	<0.005	<0.005	<0.005
Chloride (mg/L)	250	3.4	2.3-17.4	1.7-3.1	2.8-3.5
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	---	---	---	<0.025
Cyanide (mg/L)	0.2	---	---	---	---
DOC (mg/L)	NA	---	---	---	---
Endrin (mg/L)	0.0002	---	---	---	<0.00010
Fluoride (mg/L)	1.6	0.10-0.19	0.40-0.67	0.45-0.48	<0.10-0.12
Iron (mg/L)	0.3	0.009-0.020	0.266-0.553	0.040-0.047	0.008-0.020
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002-0.0002	<0.0002
Manganese (mg/L)	0.05	0.036-0.058	3.890-5.160	3.900-4.350	0.002-0.003
Sodium (mg/L)	NA	1.70-2.68	82.30-138.00	8.97-148.00	2.85-3.86
Nickel (mg/L)	NA	---	---	---	<0.040
Nitrate (as N) (mg/L)	10	1.05-1.25	237.00-260.00	216.00-245.00	3.30-4.02
Lead (mg/L)	0.05	<0.005-1.050	0.013-0.293	<0.005-0.055	<0.005
Phenols (mg/L)	NA	<0.002-0.003	<0.002-0.005	<0.002-0.004	<0.002-0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<3.0	<5.0-8.0	<3.0	<5.0-6.0
Tetrachloroethylene (mg/L)	NA	---	<0.005	<0.005	<0.005
TDS (mg/L)	500	---	---	---	---
TOC (mg/L)	NA	0.470-1.200	3.000-10.000	0.530-13.000	0.420
TOH (mg/L)	NA	<0.005-0.010	0.006-0.100	0.005-0.029	<0.005
Trichloroethylene (mg/L)	0.005	---	<0.005	<0.005	<0.005
1,1,1-TCE (mg/L)	0.200	---	<0.005	<0.005	<0.005
Zinc (mg/L)	5	0.018-0.054	0.251-0.573	0.155-0.193	<0.002-0.025
Gross alpha (pCi/L)	15	0.6	1.8-205.0	70.1-2,269.0	0.7
Nonvol. beta (pCi/L)	NA	0.8-1.8	481.6-1,264.0	1,409.7-4,007.0	3.1-13.0
Total radium (pCi/L)	5	<1.0	16.7-29.5	97.8-153.0	<1.0
Tritium (pCi/mL)	20	3-459	9,963-12,100	15,900-57,740	75-1,730

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-23

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Seepage Basins Upper Congaree Wells (7/84-12/86)

Constituent	SC and Federal DWS	FSB 76B	FSB 78B	FSB 79B	FSB 87B
pH (pH)	6.5-8.5	5.7-6.8	7.0-8.3	6.0-6.9	5.9-6.3
Conductivity (μmhos/cm)	NA	82-160	159-260	120-165	65-76
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	0.019-0.022	0.043-0.049	0.020-0.025	0.005-0.006
Carbon tetrachloride (mg/L)	0.005	---	---	---	---
Cadmium (mg/L)	0.010	<0.001	<0.001	<0.001	<0.001
Chloroform (mg/L)	0.100*	---	---	---	---
Chloride (mg/L)	250	2.8	2.8-4.6	2.8-4.6	2.8-5.8
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Cyanide (mg/L)	0.2	---	---	---	---
DOC (mg/L)	NA	---	---	---	---
Endrin (mg/L)	0.0002	---	---	---	---
Fluoride (mg/L)	1.6	0.12-0.30	<0.10	0.10-0.12	0.29-0.52
Iron (mg/L)	0.3	0.008-0.016	<0.004-0.007	<0.004-0.007	0.004-0.108
Mercury (mg/L)	0.002	<0.0002	<0.0002-0.0003	<0.0002	<0.0002-0.0011
Manganese (mg/L)	0.05	<0.002	<0.002	<0.002-0.004	0.005-0.009
Sodium (mg/L)	NA	1.54-2.10	2.92-4.18	1.69-2.72	2.68-3.92
Nitrate (as N) (mg/L)	10	0.46	3.20-4.66	<0.50-0.58	<0.50-1.87
Lead (mg/L)	0.05	<0.005	<0.005-0.005	<0.005	<0.005-0.005
Phenols (mg/L)	NA	<0.002-0.003	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	3.0	<3.0	<3.0	<3.0
Tetrachloroethylene (mg/L)	NA	---	---	---	---
TDS (mg/L)	500	---	---	---	---
TOC (mg/L)	NA	0.360-1.700	0.390-1.100	0.350-0.560	0.500-0.530
TOH (mg/L)	NA	<0.005-0.006	<0.005	<0.005	<0.005-0.006
Trichloroethylene (mg/L)	0.005	---	---	---	---
1,1,1-TCE (mg/L)	0.200	---	---	---	---
Zinc (mg/L)	5	0.003-0.040	<0.002-0.014	<0.002-0.039	<0.002-0.023
Gross alpha (pCi/L)	15	0.2	0.2-3.8	0.1-1.5	0.2-12.0
Nonvol. beta (pCi/L)	NA	1.4-3.6	7.0-9.0	1.6-6.0	3.7-17.0
Total radium (pCi/L)	5	<1.0	<1.0-2.0	<1.0-1.0	<1.0
Tritium (pCi/mL)	20	0.4-32	188-239	10-18	98-120

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-24

Summary of Groundwater Quality: Well Concentration Ranges for the F-Area Seepage Basins Lower Congaree Wells (7/84-12/86)

Constituent	SC and Federal DWS	FSB 76A	FSB 78A	FSB 79A	FSB 87A
pH (pH)	6.5-8.5	6.0-7.1	5.6-6.6	5.6-6.7	5.8-6.4
Conductivity (µmhos/cm)	NA	91-190	92-127	69-110	64-120
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	0.019-0.023	0.019-0.023	0.014-0.018	0.017-0.019
Carbon tetrachloride (mg/L)	0.005	---	---	---	---
Cadmium (mg/L)	0.010	<0.001	<0.001	<0.001	<0.001
Chloroform (mg/L)	0.100*	---	---	---	---
Chloride (mg/L)	250	2.8	2.8-4.9	2.8-5.5	2.8-4.6
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Cyanide (mg/L)	0.2	---	---	---	---
DOC (mg/L)	NA	---	---	---	---
Endrin (mg/L)	0.0002	---	---	---	---
Fluoride (mg/L)	1.6	0.16-0.29	0.13-0.16	<0.10-0.13	0.10-0.25
Iron (mg/L)	0.3	0.007-0.029	0.006-0.105	<0.004-0.009	<0.004-0.050
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002-0.0007	<0.0002
Manganese (mg/L)	0.05	0.004-0.008	0.020-0.026	<0.002	0.002-0.008
Sodium (mg/L)	NA	3.18-4.88	2.42-4.07	1.51-1.93	1.64-2.54
Nitrate (as N) (mg/L)	10	<0.05	0.11	0.19	0.09
Lead (mg/L)	0.05	<0.005	<0.005	<0.005	<0.005
Phenols (mg/L)	NA	<0.002-0.003	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	10.0-11.0	5.0-9.0	4.0	5.0-7.0
Tetrachloroethylene (mg/L)	NA	---	---	---	---
TDS (mg/L)	500	---	---	---	---
TOC (mg/L)	NA	0.290-2.700	0.460-1.300	0.470-1.200	0.360-0.420
TOH (mg/L)	NA	<0.005-0.007	<0.005-0.006	<0.005-0.005	<0.005-0.006
Trichloroethylene (mg/L)	0.005	---	---	---	---
1,1,1-TCE (mg/L)	0.200	---	---	---	---
Zinc (mg/L)	5	0.004-0.050	<0.002-0.020	<0.002-0.025	<0.002-0.018
Gross alpha (pCi/L)	15	<1.0-1.9	1.0-1.7	1.0-4.0	0.1
Nonvol. beta (pCi/L)	NA	4.9-20.6	3.3-10.9	1.3-6.0	1.8-4.5
Total radium (pCi/L)	5	<1.0	<1.0	<1.0	<1.0
Tritium (pCi/mL)	20	1-1.2	14-24	12-15	9-20

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 8-25

Volume of Flow to the Old F-Area Seepage Basin During 1954-1955

Date	Average Basin Inflow (gal/day)
November 24 to November 30, 1954	38,200
December 1954	38,200
January 1955	41,000
February 1955	52,385
March 1955	55,290
April 1955	66,890
May 1 to May 13, 1955	66,890
Total estimated flow	9.2 to 9.3 million gal

Date	Basin Contents (million gal)
May 27, 1955	2.2
June 20, 1955	1.5
July 20, 1955	1.0

Note: Discharge of process streams to the basin was discontinued on May 13, 1955. Data are from Odum et al. (1987).

TABLE 8-26

Estimated Radionuclide Releases to the Old F-Area Seepage Basin

Radionuclide	Original Release (Ci)	Decay Corrected Through 12/31/1985 (Ci)
^{95}Zr, ^{95}Nb	0.48	Negligible
$^{103,106}Ru$	0.32	2.0E-10
$^{89,90}Sr$	0.32	0.15
^{239}Pu	0.02	0.02
U*	0.64	0.64

Note: Data are from Odum et al. (1987).

* Primarily ^{238}U in depleted uranium.

TABLE 8-27

Old F-Area Seepage Basin Water Characteristics

Parameter	Units	Sample Location By Inlet	By Outlet
pH		4.93	5.13
Conductivity	μmhos/cm	62.4	24.0
Total alkalinity (as $CaCO_3$)	mg/L	<1	<1
Nitrite/nitrate (as N)	mg/L	0.1	0.10
Hardness (as $CaCO_3$)	mg/L	15.5	4.3
TDS	mg/L	48	23
Sulfate	mg/L	1.0	0.2
Aluminum	mg/L	3.50	0.50
Cadmium	mg/L	<0.003	<0.003
Chromium	mg/L	<0.004	<0.004
Copper	mg/L	<0.01	<0.01
Iron	mg/L	1.09	0.31
Lead	mg/L	0.0057	0.0064
Magnesium	mg/L	0.748	0.197
Manganese	mg/L	0.273	0.024
Mercury	mg/L	<0.00002	<0.00002
Nickel	mg/L	0.0026	<0.001
Zinc	mg/L	0.071	0.008
Silver	mg/L	<0.002	<0.002
Uranium	mg/L	0.023	0.015
Barium	mg/L	<0.02	<0.02

Note: Samples were collected on February 6, 1985. Data are from Odum et al. (1987).

TABLE 8-28

Summary of Groundwater Quality: Well Concentration Ranges for the Old F-Area Seepage Basin (7/84-12/86)

Constituent	SC and Federal DWS	FNB 1	FNB 2	FNB 3	FNB 4
pH (pH)	6.5-8.5	3.5-4.6	3.1-3.9	3.3-4.3	4.2-4.8
Conductivity (μmhos/cm)	NA	44-80	395-910	134-440	29-46
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020-0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.014-0.020	0.130-0.352	0.078-1.100	0.006-0.023
Beryllium (mg/L)	NA	<0.001	<0.002-0.002	0.001-0.004	<0.001
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005	<0.005	---
Cadmium (mg/L)	0.010	<0.002	<0.002-0.002	<0.002-0.006	<0.001
Chloroform (mg/L)	0.100*	<0.005	<0.005	<0.005	---
Chloride (mg/L)	250	2.5-4.0	1.9-5.4	1.1-3.5	2.5-3.9
Chromium (mg/L)	0.05	<0.004-0.073	<0.004-0.007	<0.004-0.153	<0.004
Copper (mg/L)	1	0.005-0.013	0.013-0.570	0.006-0.054	<0.004-0.017
Cyanide (mg/L)	0.2	<0.005	<0.005	<0.005	---
DOC (mg/L)	NA	<5.0	<5.0	<5.0	---
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.18	0.13-0.33	<0.10-0.29	<0.10-0.80
Iron (mg/L)	0.3	0.018-0.327	0.035-0.131	0.032-3.520	0.019-0.592
Mercury (mg/L)	0.002	<0.0002-0.0002	<0.0002-0.0006	<0.0002-0.0003	<0.0002
Manganese (mg/L)	0.05	0.016-0.022	0.405-0.686	0.285-1.324	0.008-0.028
Sodium (mg/L)	NA	3.97-6.45	15.30-41.40	6.32-13.70	2.17-2.91
Nickel (mg/L)	NA	<0.004-0.035	0.027-0.038	0.009-0.099	<0.004
Nitrite (as N) (mg/L)	NA	<0.50	<0.50	<0.50	---
Nitrate (as N) (mg/L)	10	4.45-5.23	36.00-92.00	11.50-34.00	1.45-2.72
Lead (mg/L)	0.05	<0.010-0.024	<0.005-0.309	0.021-0.082	<0.005-0.031
Phenols (mg/L)	NA	<0.002-0.049	<0.002-0.010	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	<0.001	<0.001	<0.001
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<5.0-5.0
Tetrachloroethylene (mg/L)	NA	<0.005	<0.005	<0.005	---
TDS (mg/L)	500	30	204-214	<5-42	---
TOC (mg/L)	NA	0.389-1.30	<1.000-11.0	<1.000-2.09	0.360-3.49
TOH (mg/L)	NA	<0.005-0.077	0.006-0.038	<0.005-0.027	<0.005-0.008
Trichloroethylene (mg/L)	0.005	0.086	0.008	<0.005	---
1,1,1-TCE (mg/L)	0.200	<0.005	<0.005	<0.005	---
Zinc (mg/L)	5	0.017-0.053	0.053-3.310	0.156-0.440	0.008-0.055
Gross alpha (pCi/L)	15	0.5-16.0	3.0-301.0	12.2-118.0	<2.0-9.0
Nonvol. beta (pCi/L)	NA	3.0-8.7	5.0-1,949.9	136.0-779.0	2.1-9.0
Total radium (pCi/L)	5	<1.0-9.0	2.0-51.0	4.5-56.0	2.0-3.0
Tritium (pCi/mL)	20	313-316	1,339-2,638	160-257	7-8

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

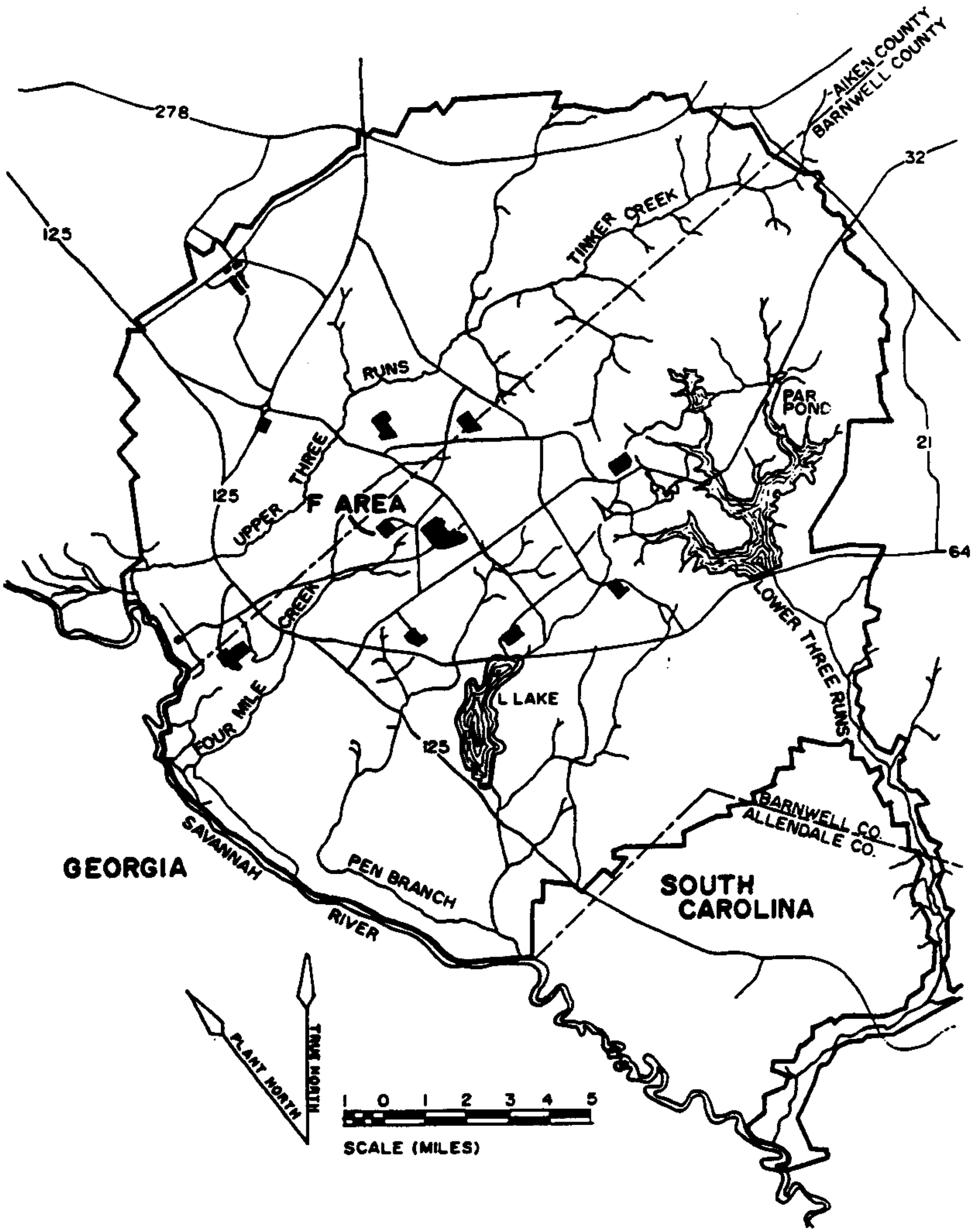


FIGURE 8-1. Location of F Area at SRS

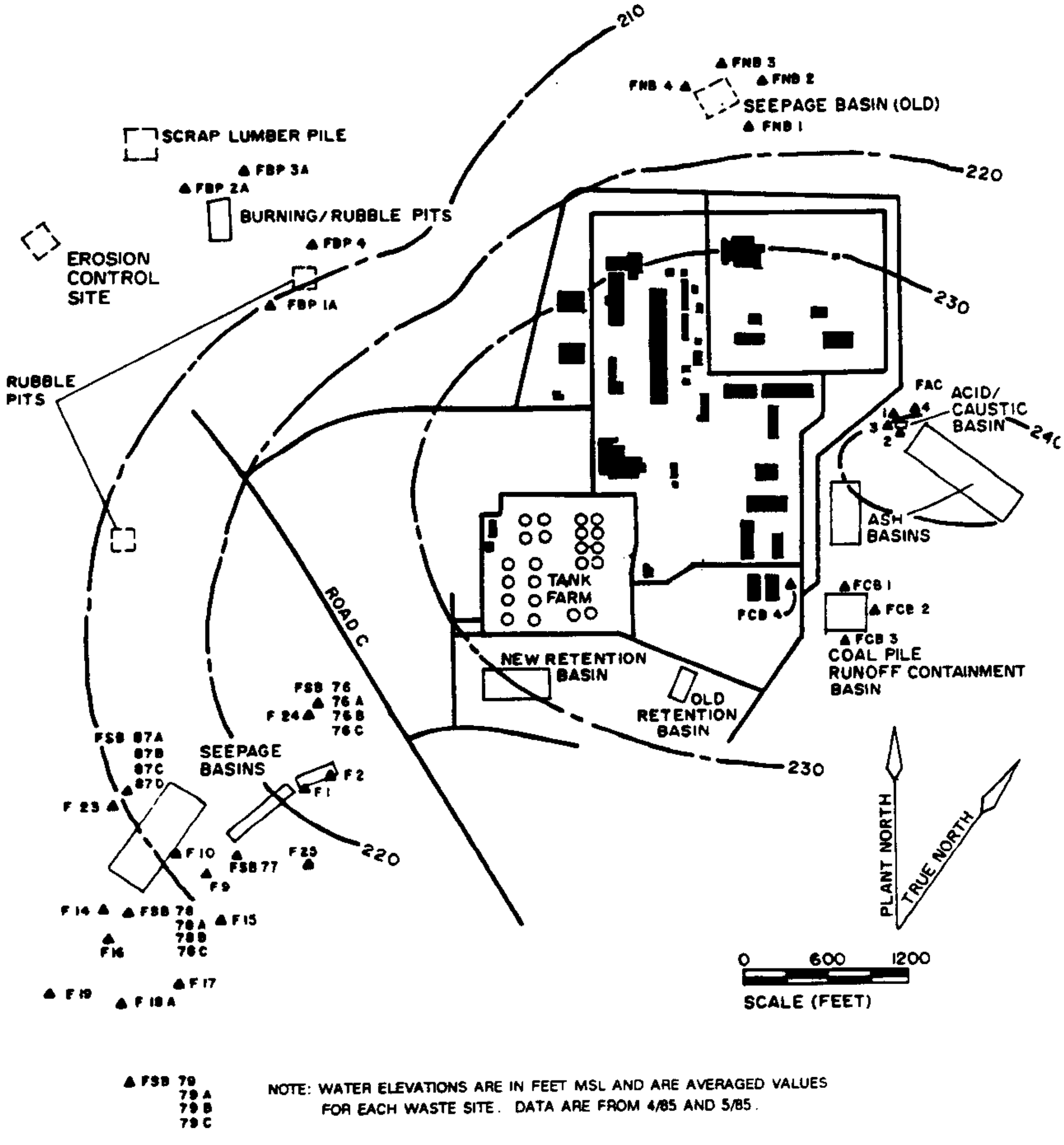


FIGURE 8-2. F-Area Water-Table Elevation Map

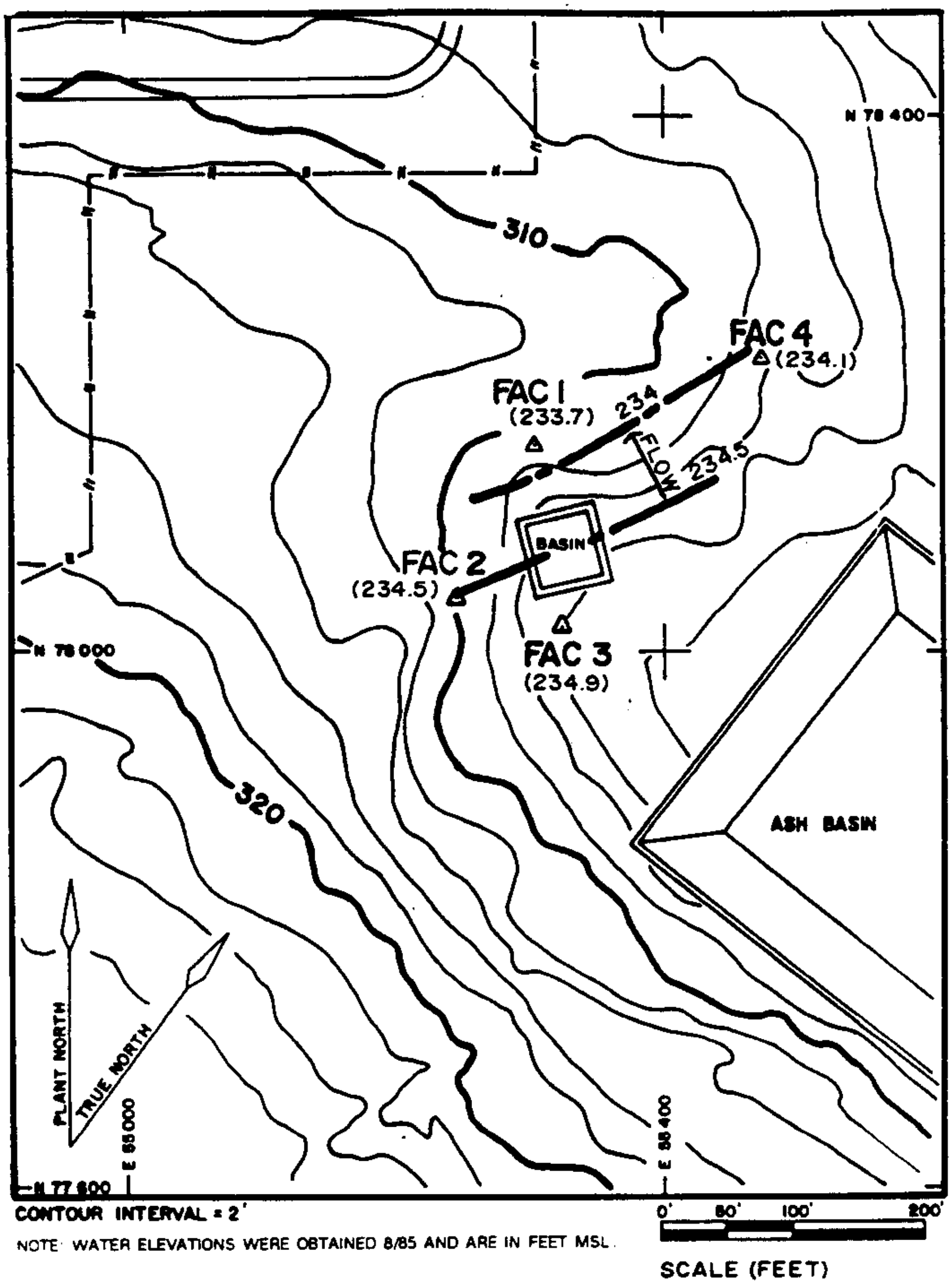


FIGURE 8-3. F-Area Acid/Caustic Basin Water-Table Elevation Map

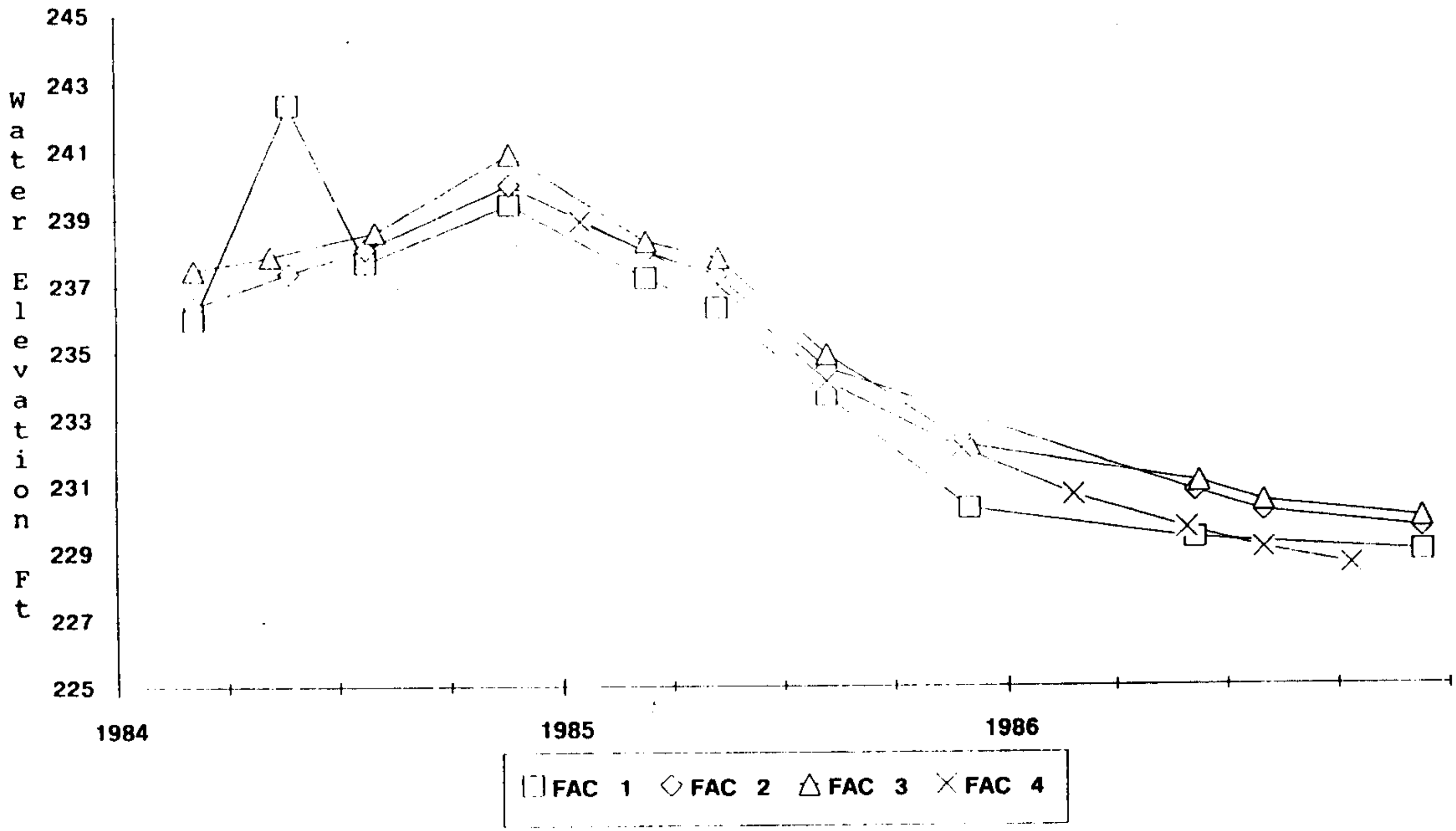


FIGURE 8-4. Hydrograph of the F-Area Acid/Caustic Basin Wells

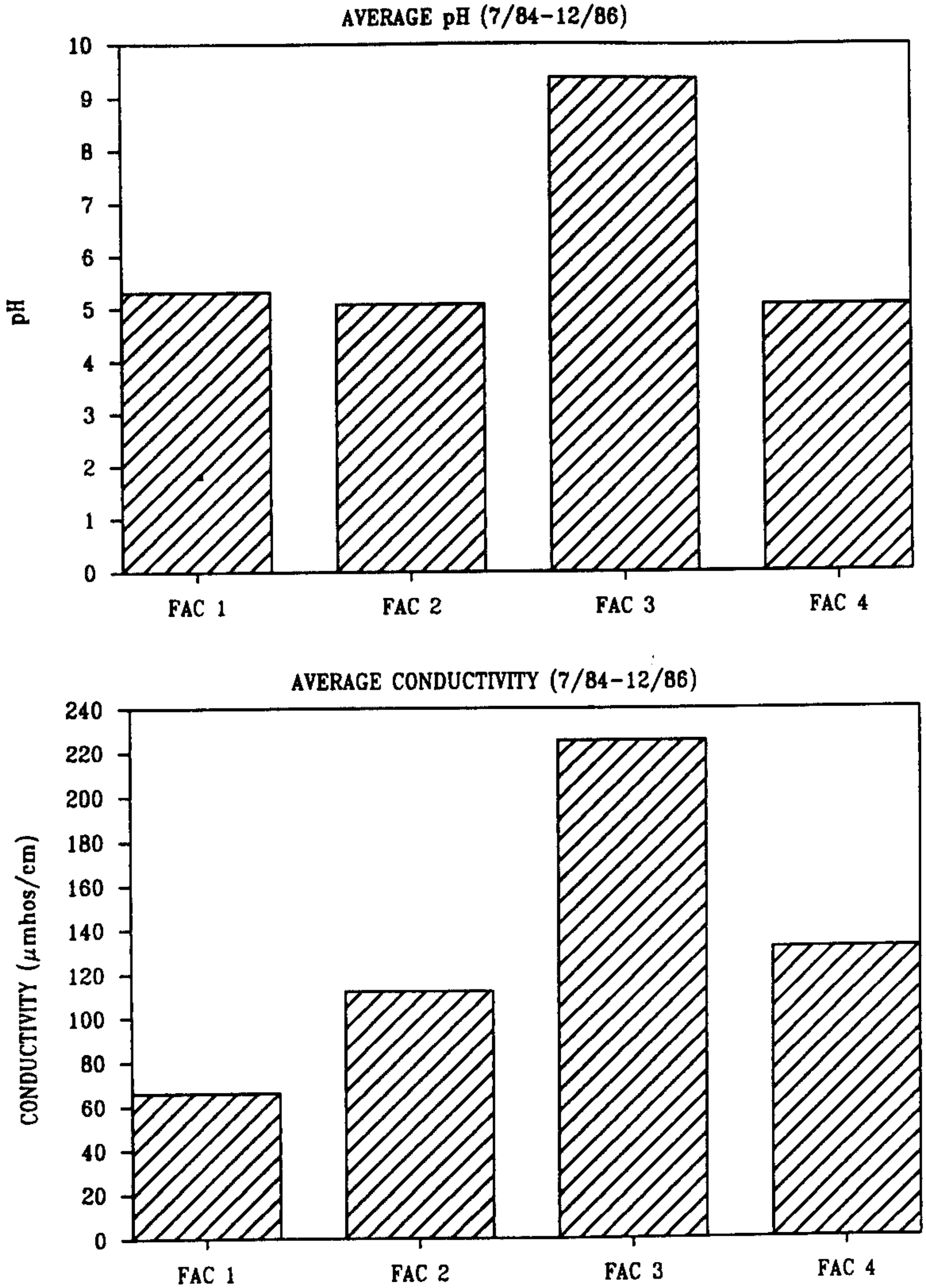


FIGURE 8-5. Average pH and Conductivity in the F-Area Acid/Caustic Basin Wells

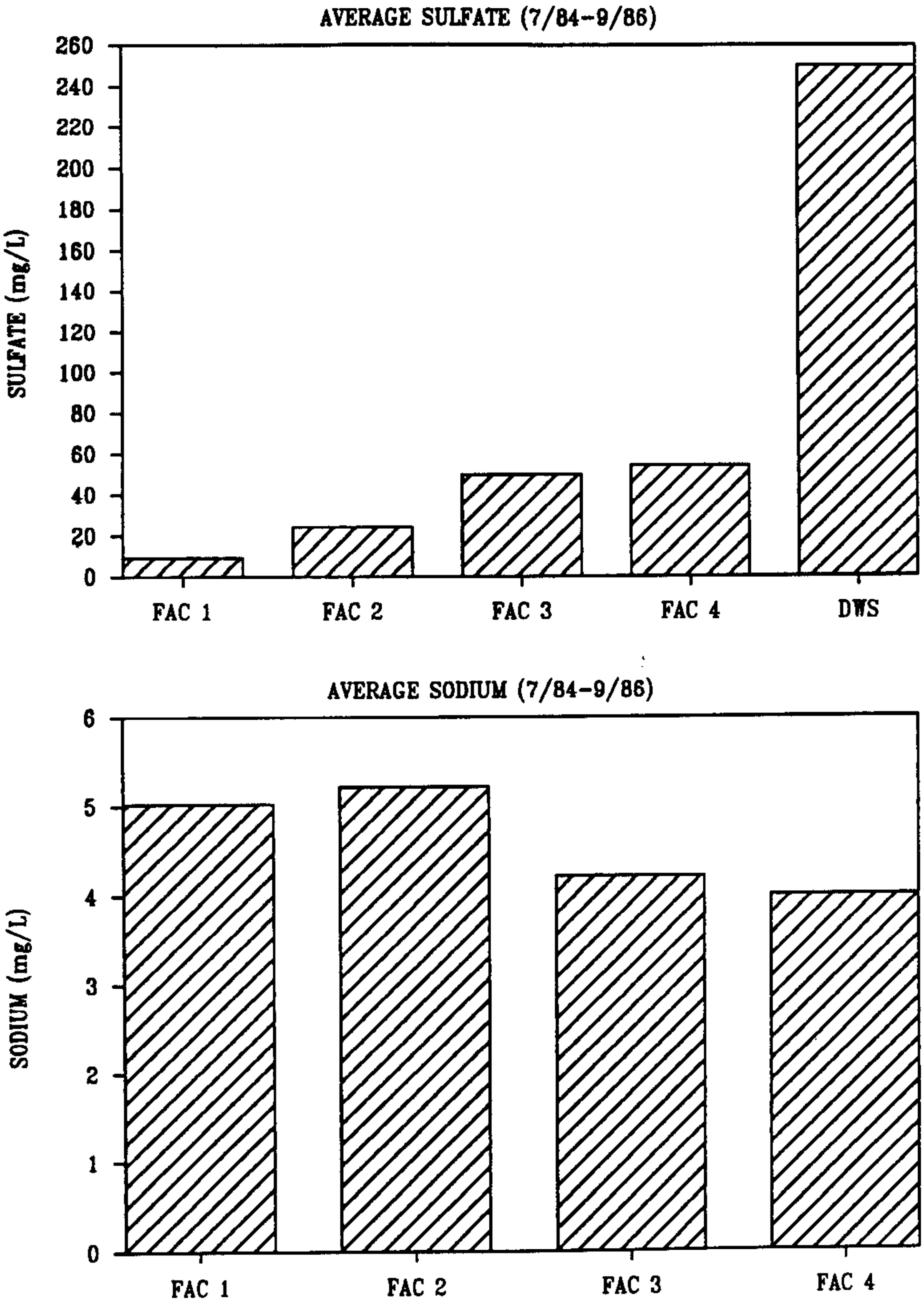
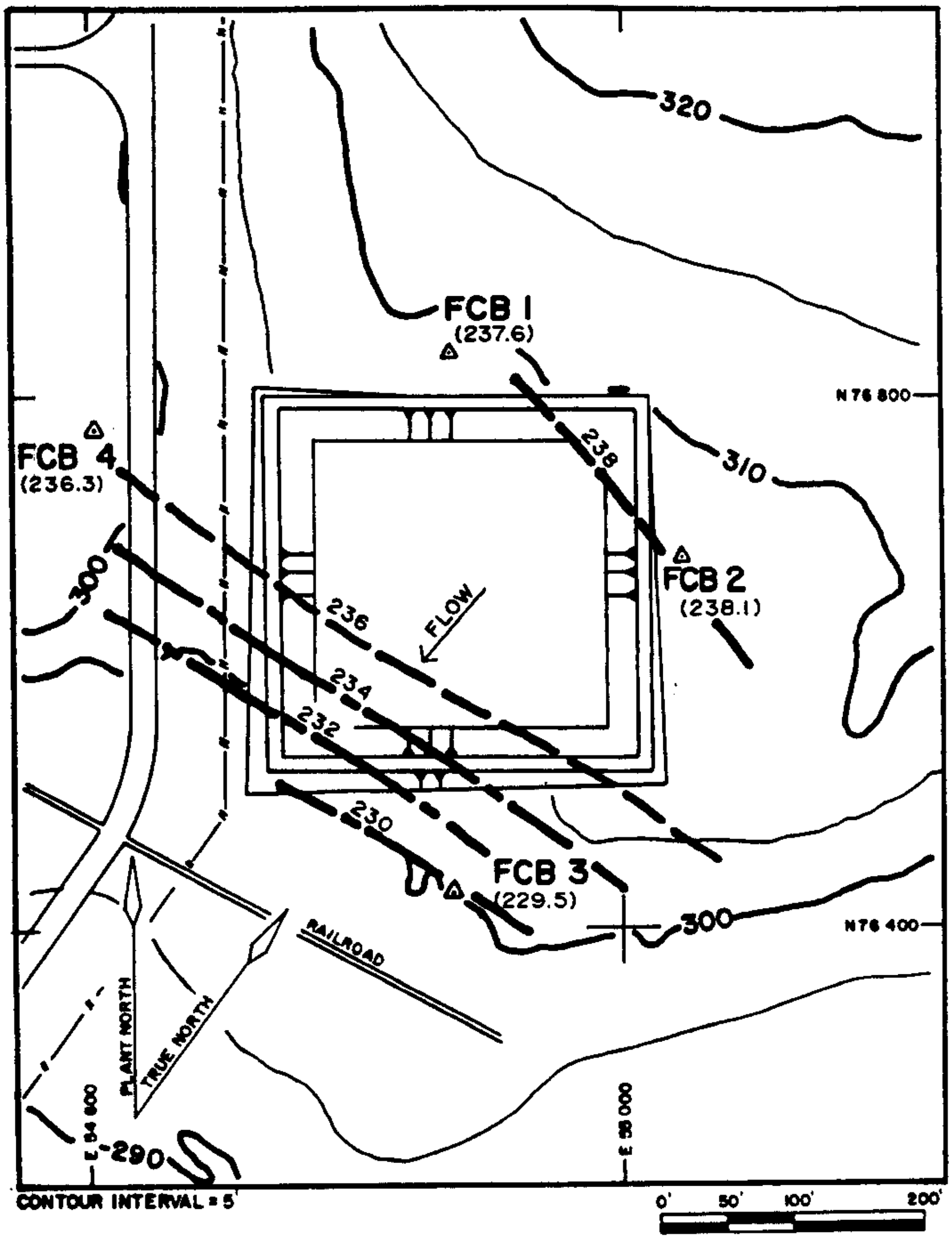


FIGURE 8-6. Average Sulfate and Sodium Concentrations in the F-Area Acid/Caustic Basin Wells



NOTE: WELL FCB 3 IS SCREENED 10 FT BELOW THE OTHER SITE WELLS. WATER ELEVATIONS WERE OBTAINED 4/85 AND ARE GIVEN IN FEET MSL.

FIGURE 8-7. F-Area Coal Pile Runoff Containment Basin (CPRB) Water-Table Elevation Map

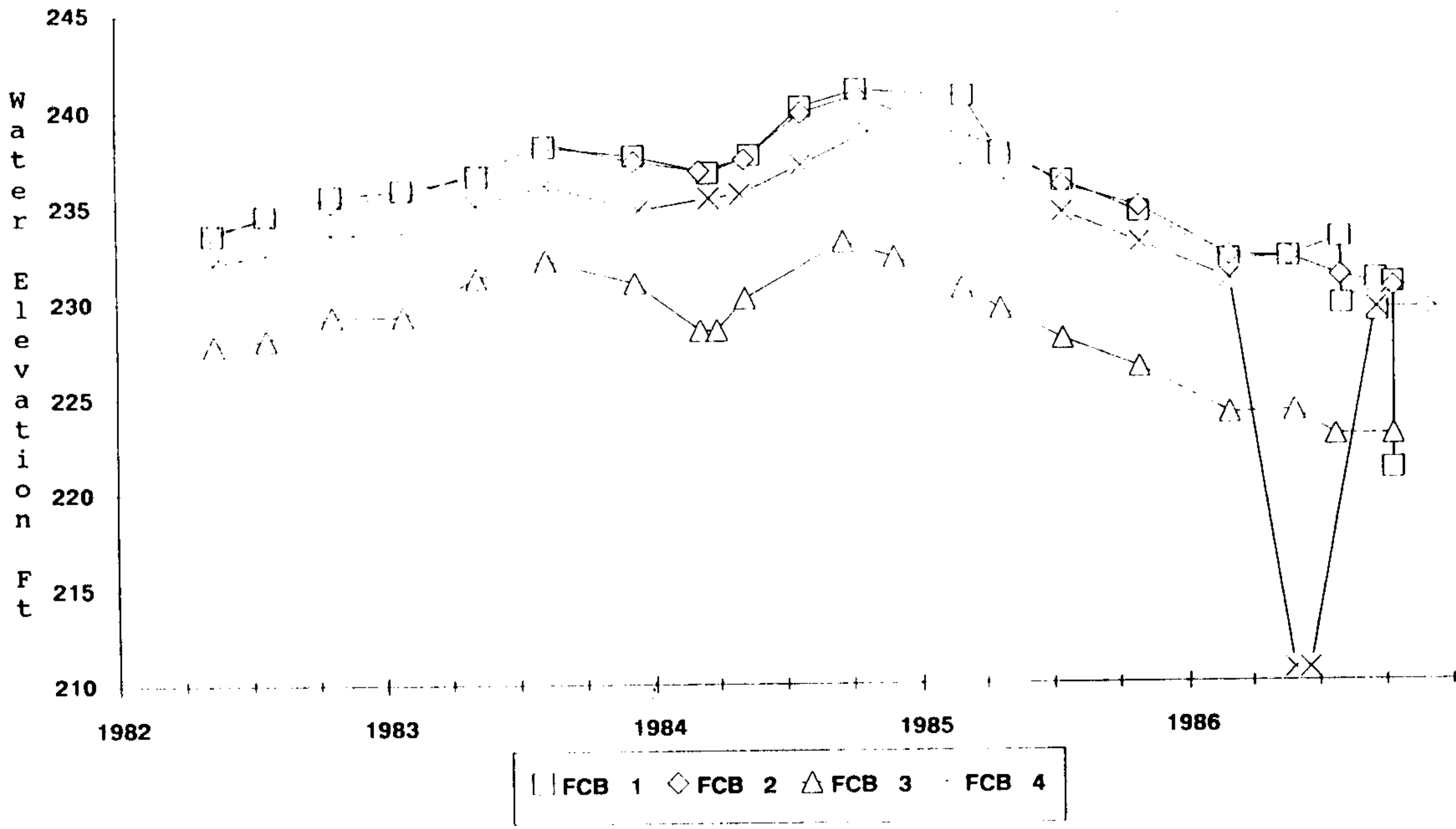
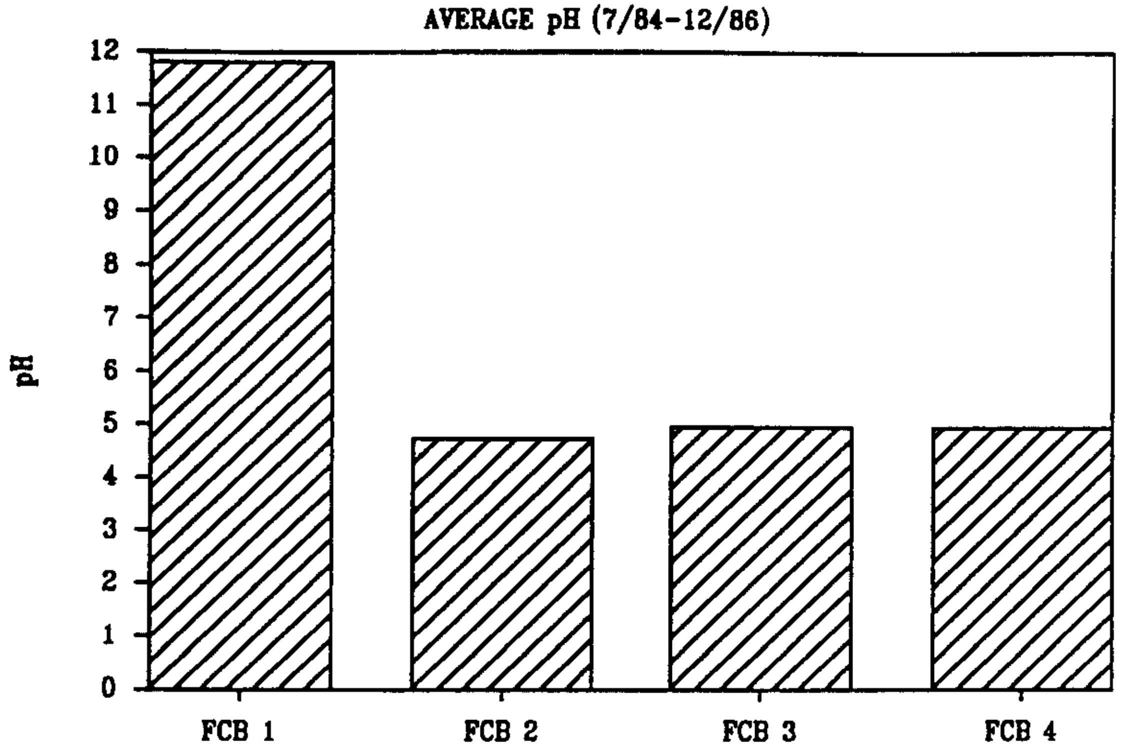


FIGURE 8-8. Hydrograph of the F-Area Coal Pile Runoff Containment Basin (CPRB) Wells



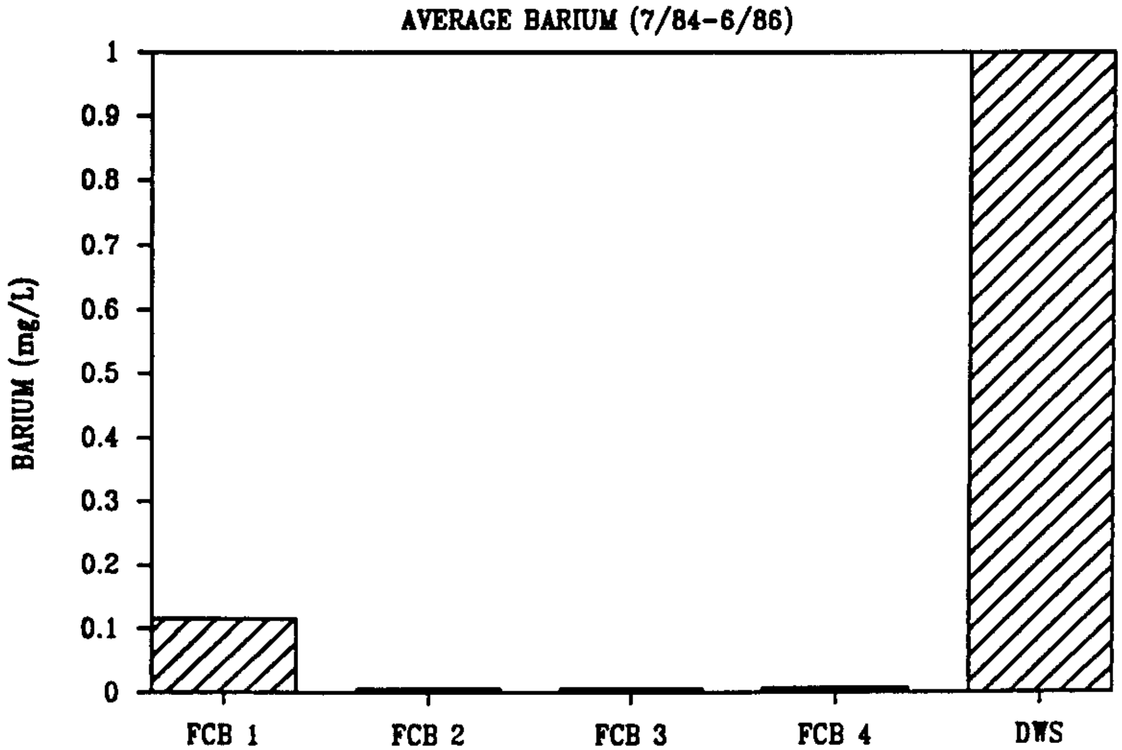


FIGURE 8-9. Average pH and Barium Concentrations in the F-Area Coal Pile Runoff Containment Basin (CPRB) Wells

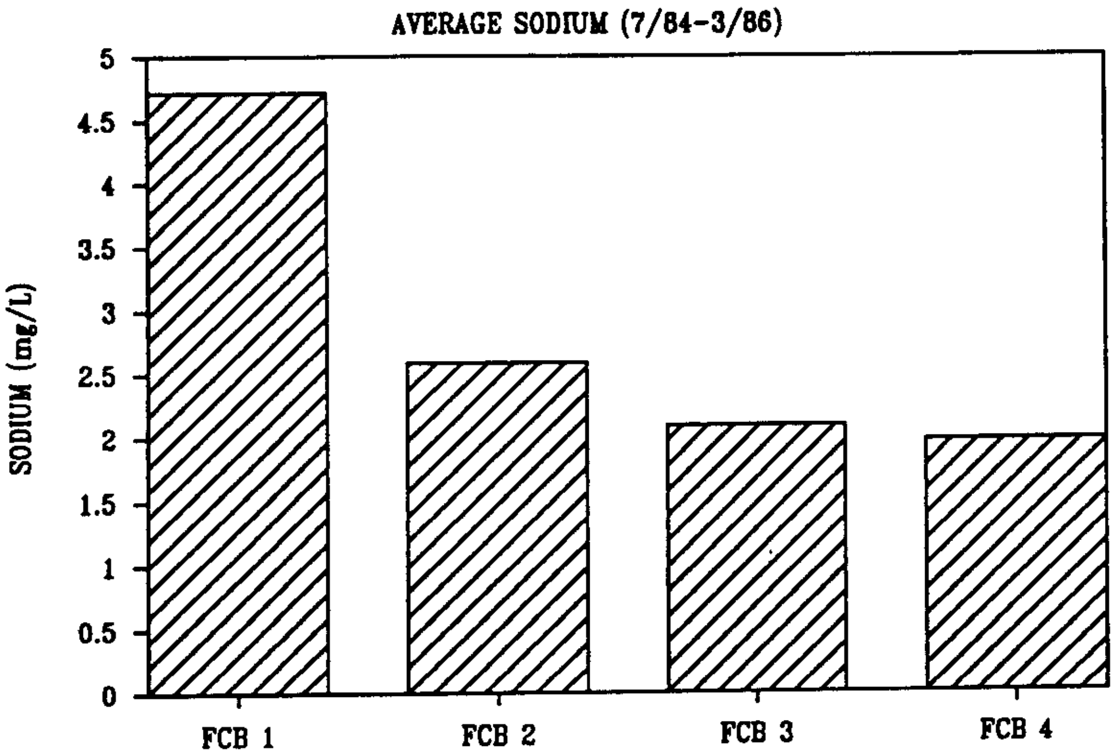


FIGURE 8-10. Average Sodium Concentrations in the F-Area Coal Pile Runoff Containment Basin (CPRB) Wells

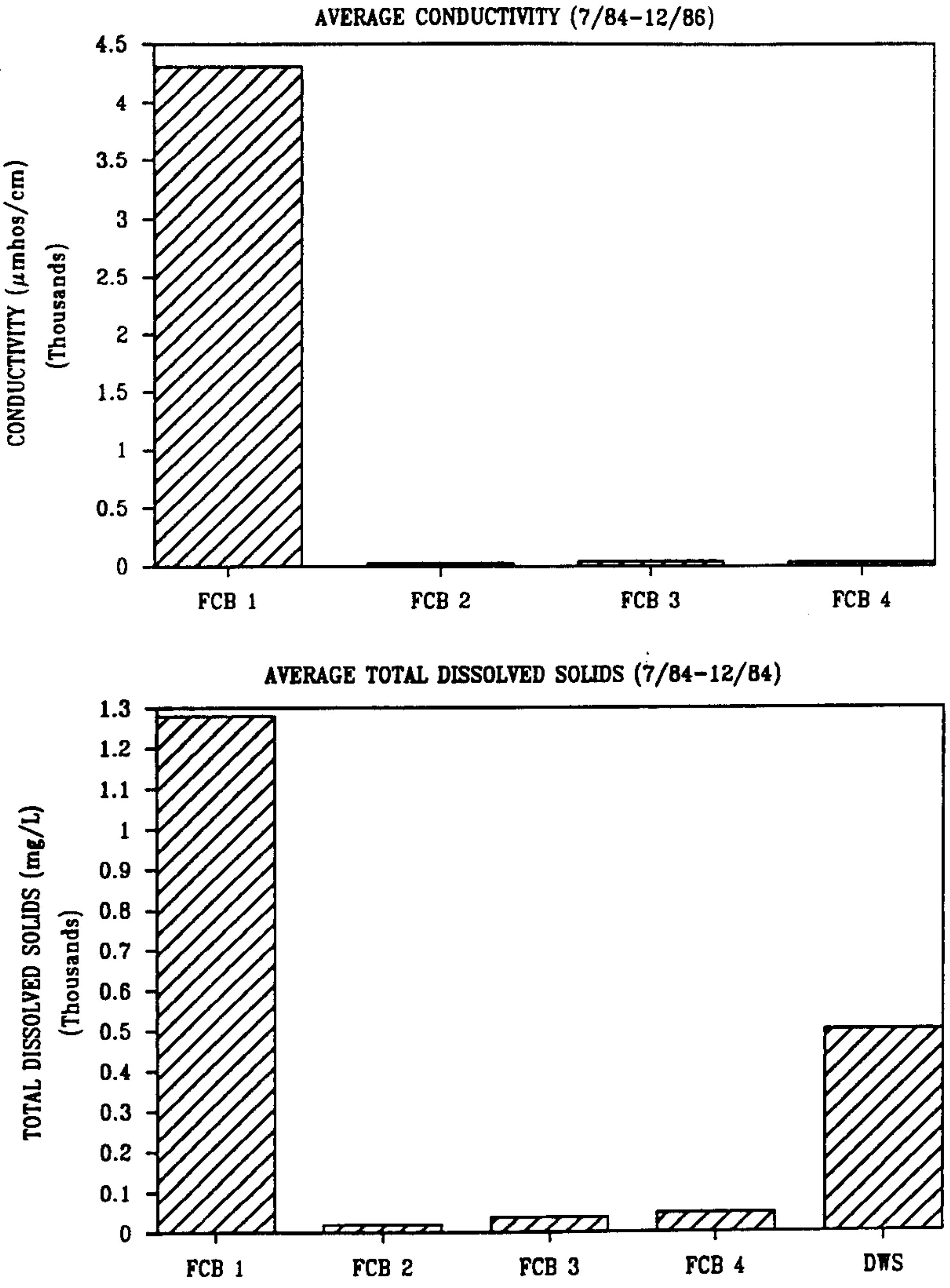


FIGURE 8-11. Average Conductivity and Total Dissolved Solids (TDS) Concentrations in the F-Area Coal Pile Runoff Containment (CPRB) Basin Wells

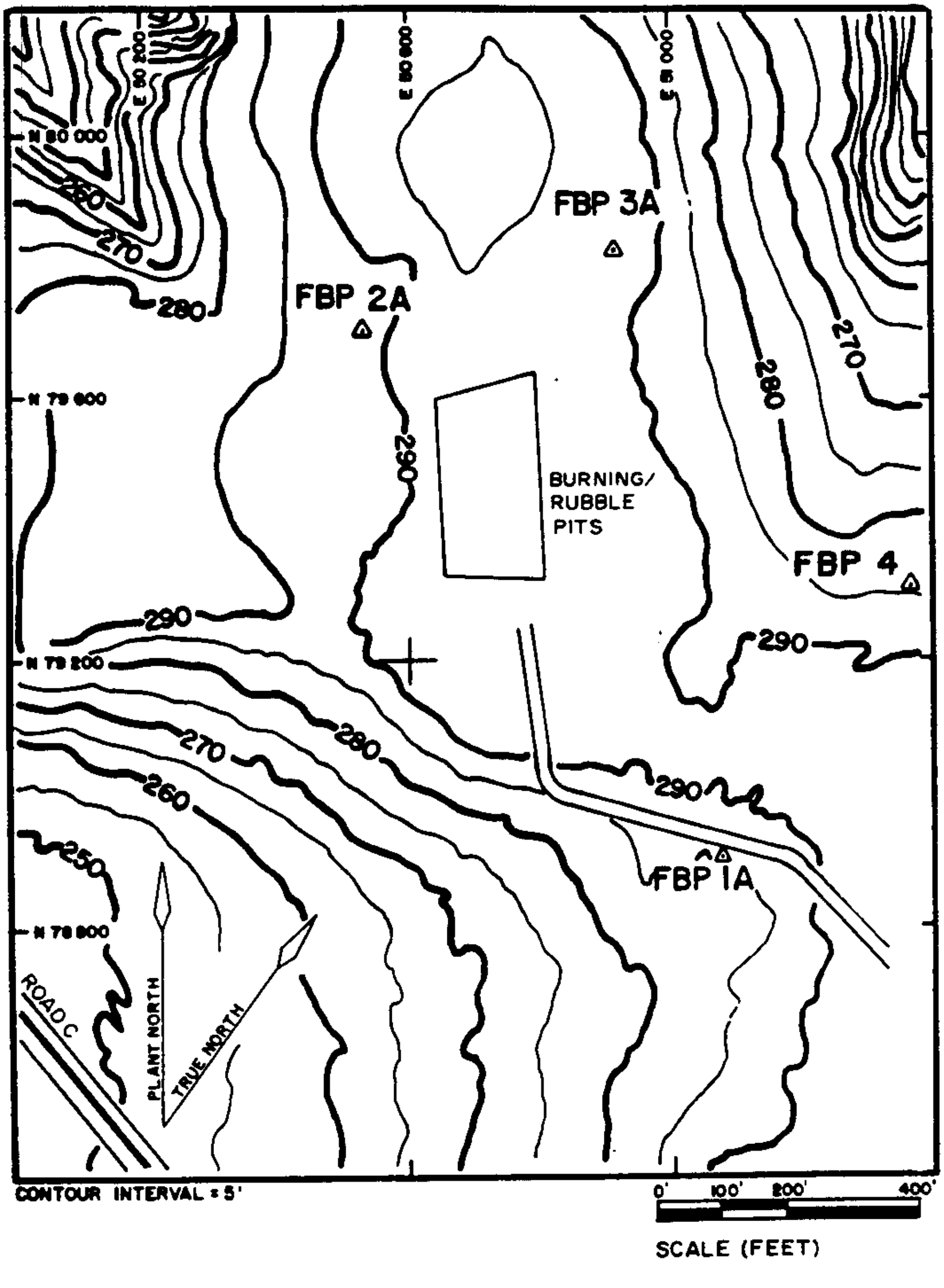


FIGURE 8-12. The F-Area Burning/Rubble Pits

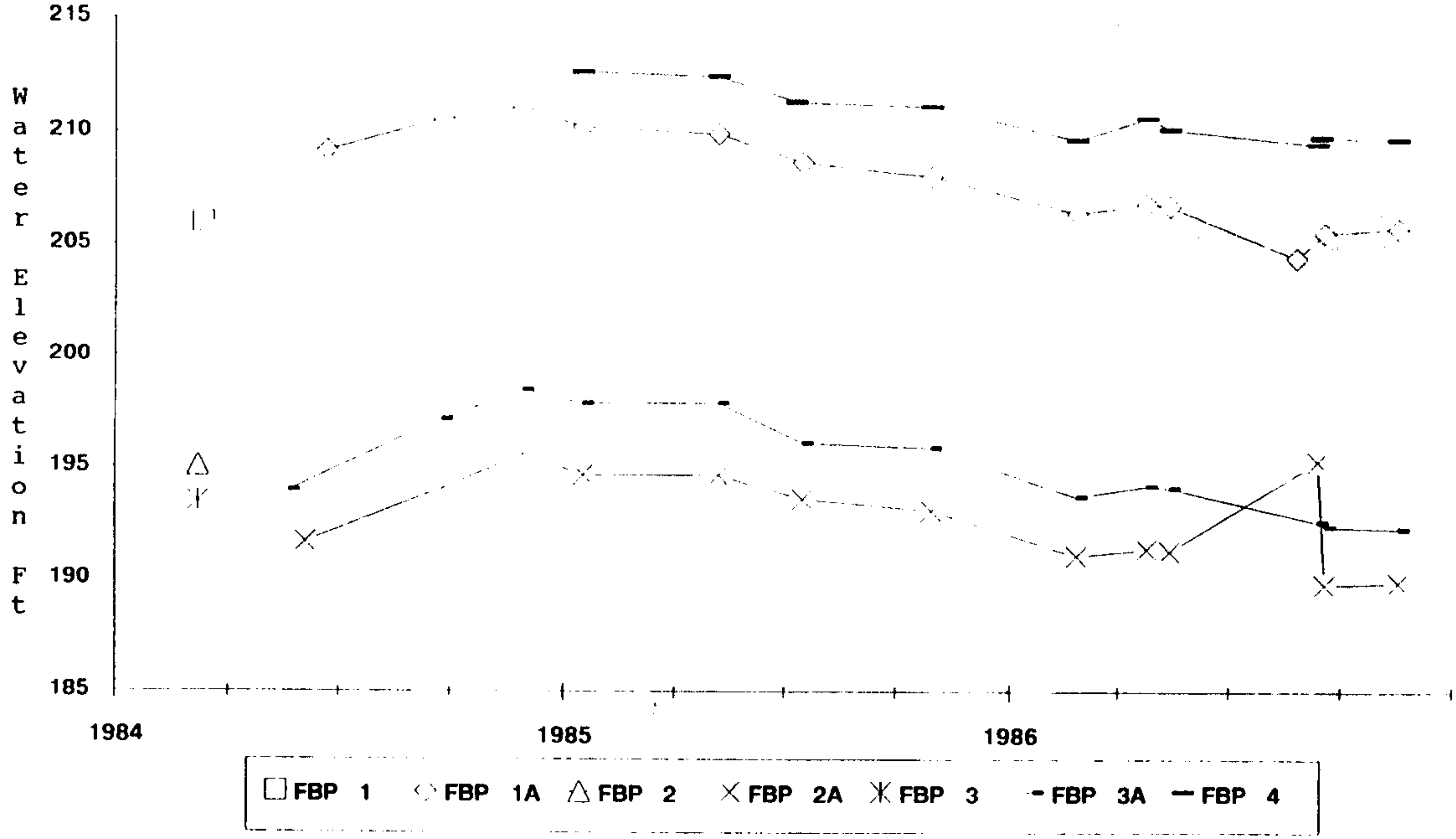


FIGURE 8-13. Hydrograph of the F-Area Burning/Rubble Pits Wells

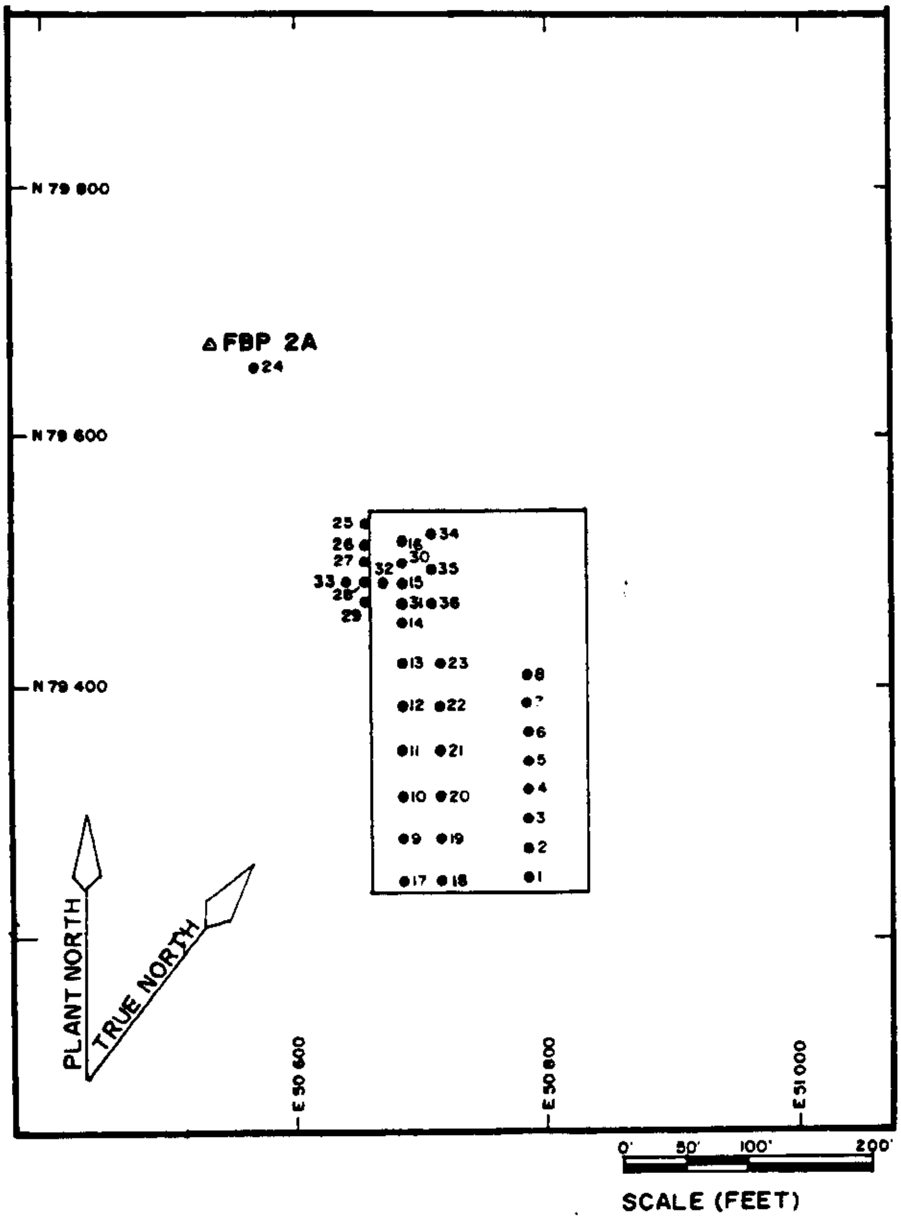


FIGURE 8-14. Soil Sampling Locations at the F-Area Burning/Rubble Pits

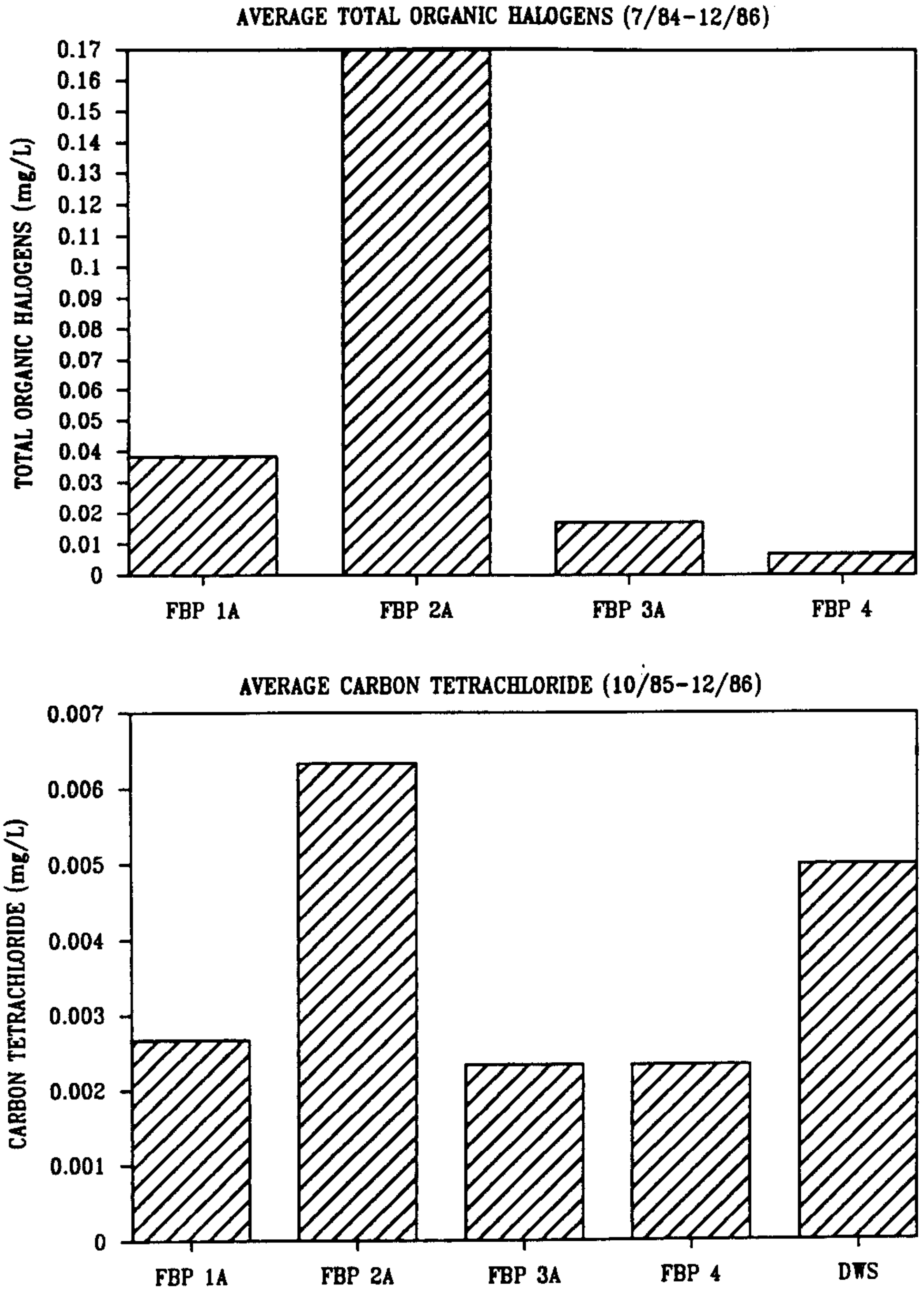


FIGURE 8-15. Average Total Organic Halogens (TOH) and Carbon Tetrachloride Concentrations in the F-Area Burning/Rubble Pits Wells

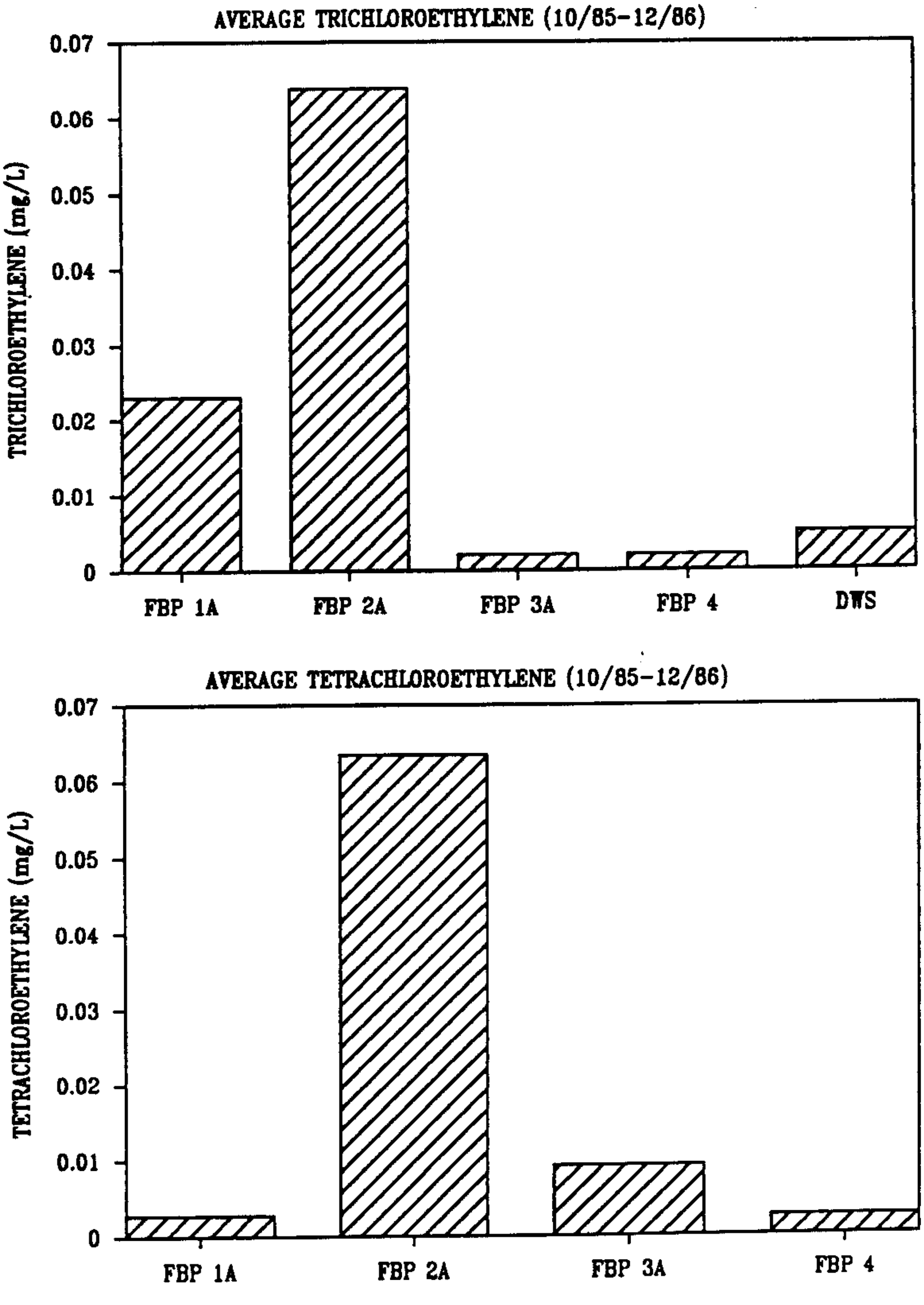


FIGURE 8-16. Average Trichloroethylene and Tetrachloroethylene Concentrations in the F-Area Burning/Rubble Pits Wells

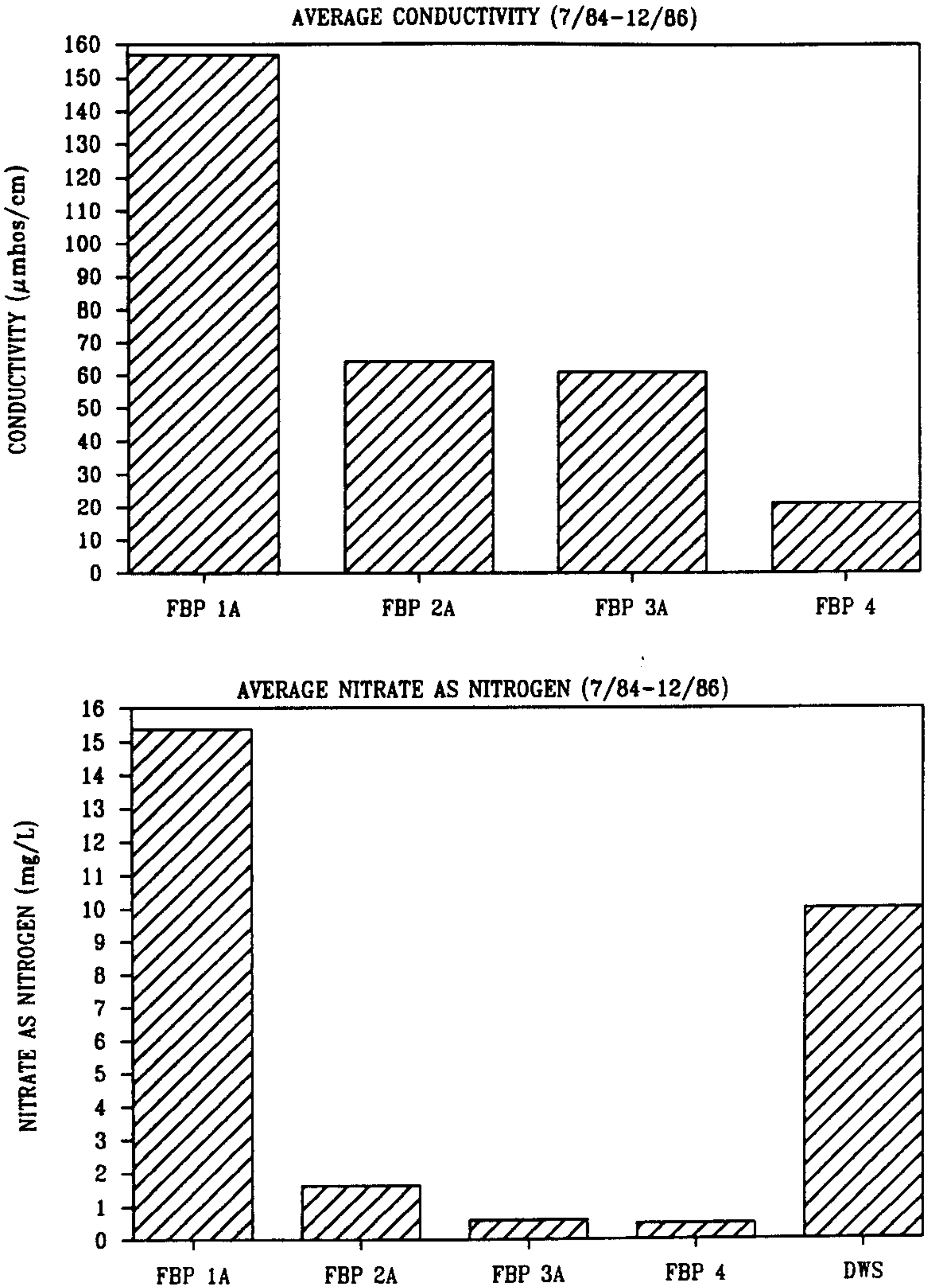


FIGURE 8-17. Average Conductivity and Nitrate (as N) Concentrations in the F-Area Burning/Rubble Pits Wells

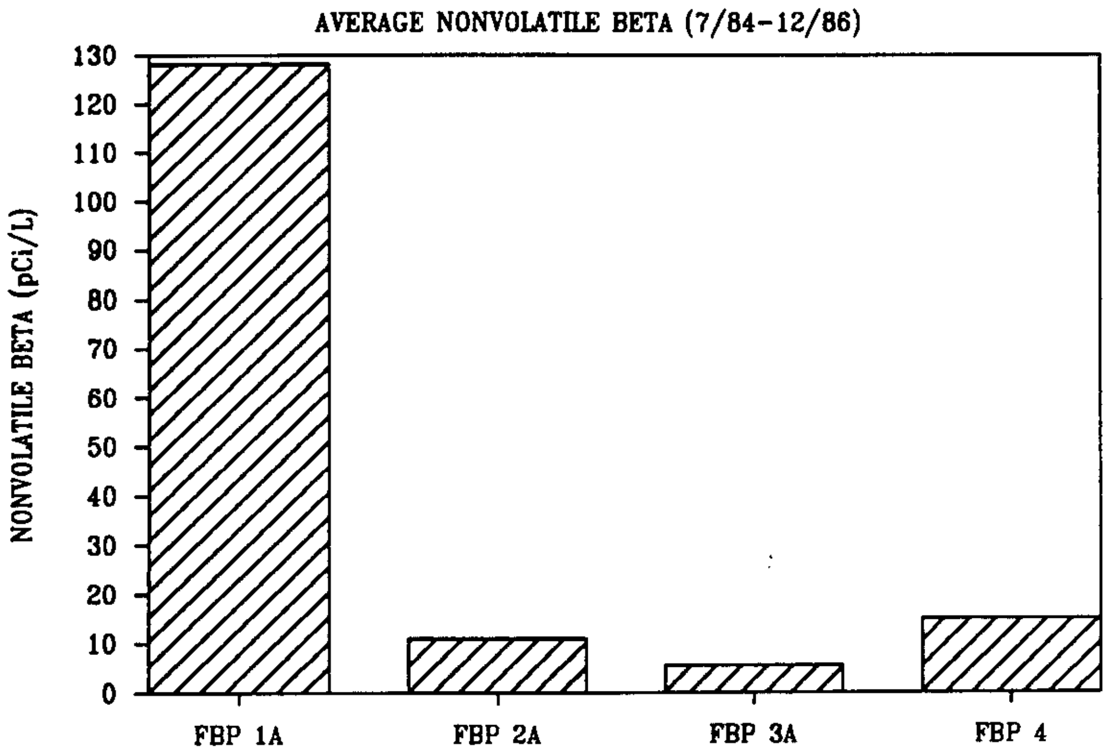


FIGURE 8-18. Average Nonvolatile Beta Activities in the F-Area Burning/Rubble Pits Wells

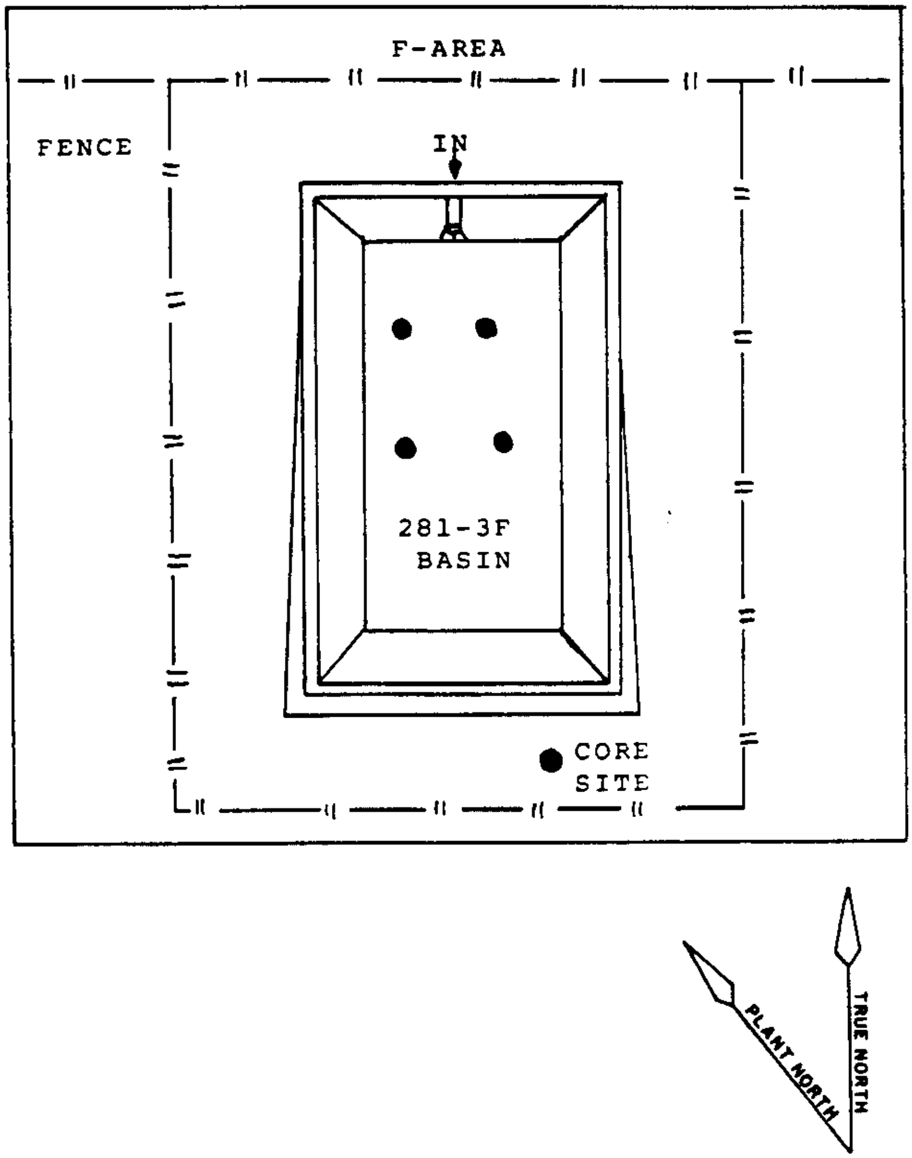


FIGURE 8-19. Soil Sampling Locations at the Unlined F-Area Retention Basin

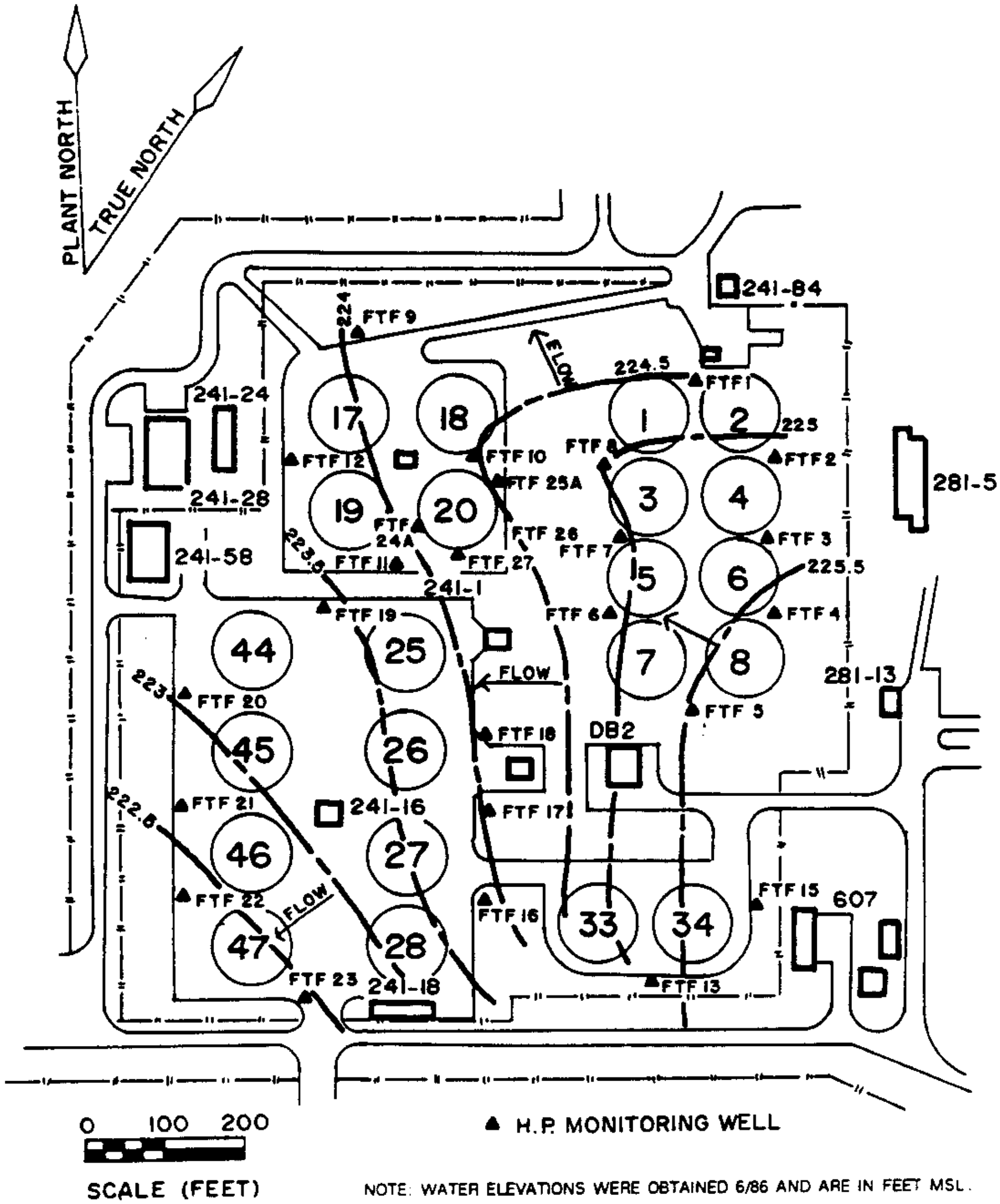


FIGURE 8-20. F-Area Tank Farm Water-Table Elevation Map

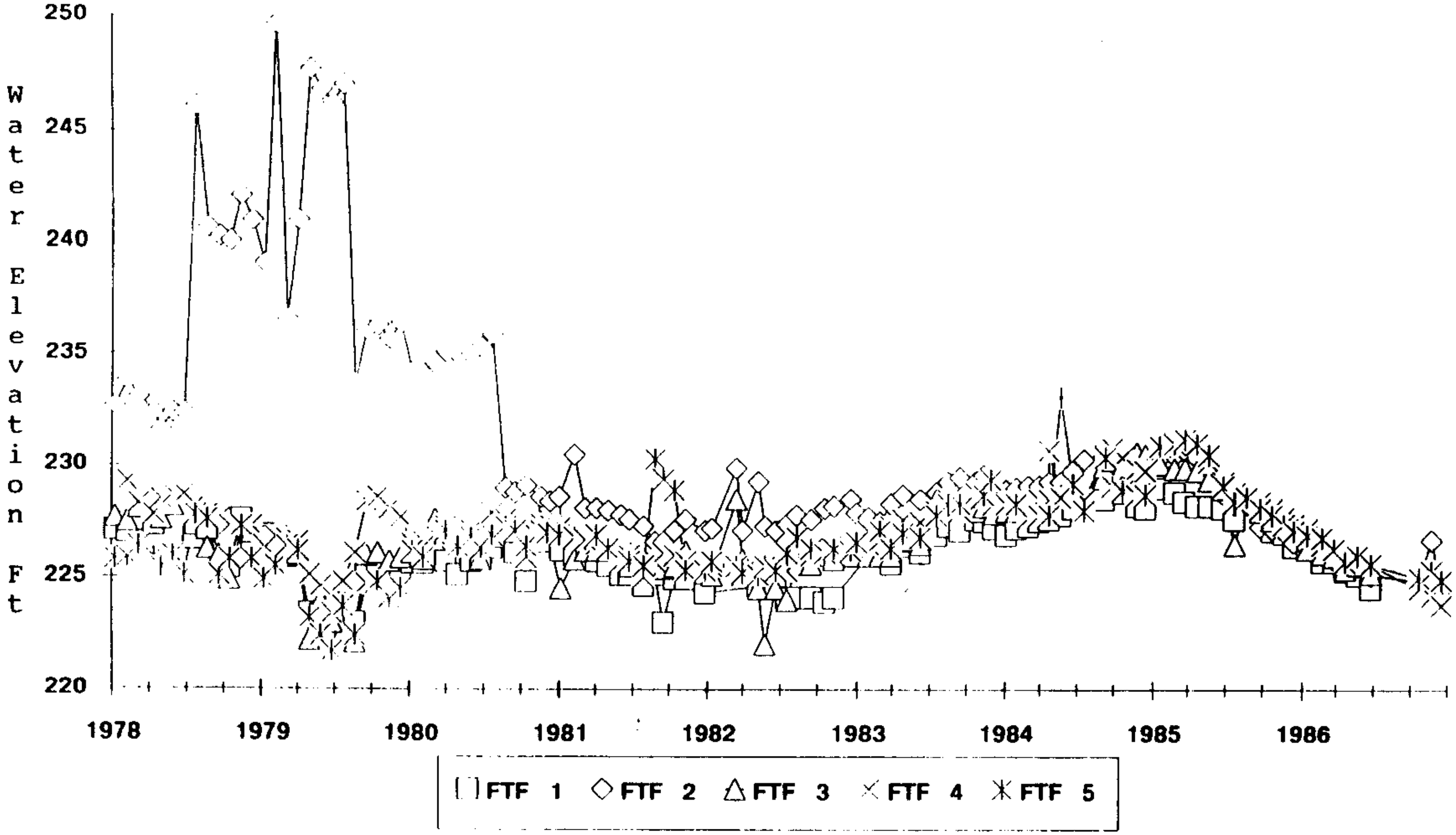


FIGURE 8-21. Hydrograph of F-Area Tank Farm Wells FTF 1 Through FTF 5

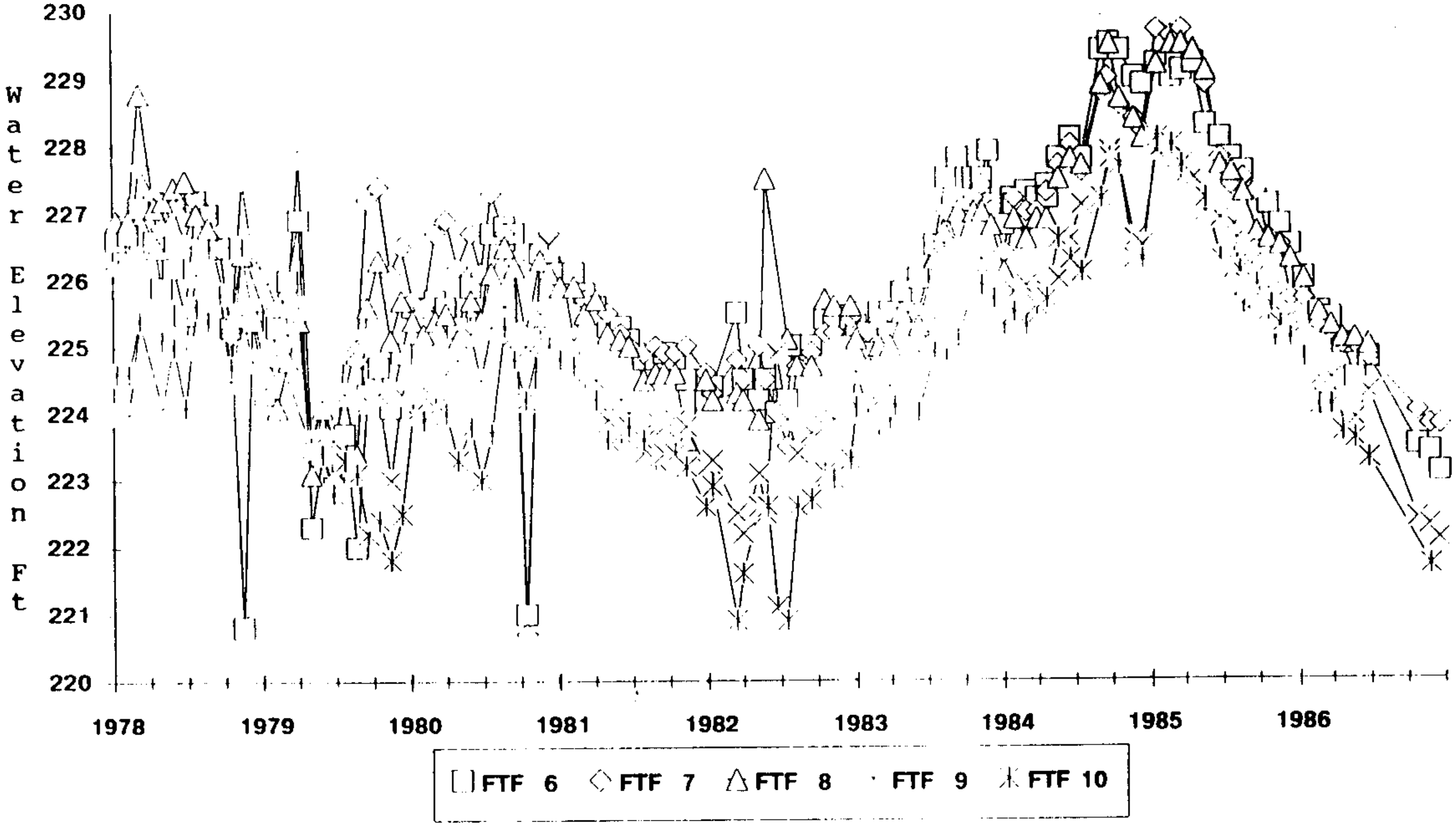


FIGURE 8-22. Hydrograph of F-Area Tank Farm Wells FTF 6 Through FTF 10

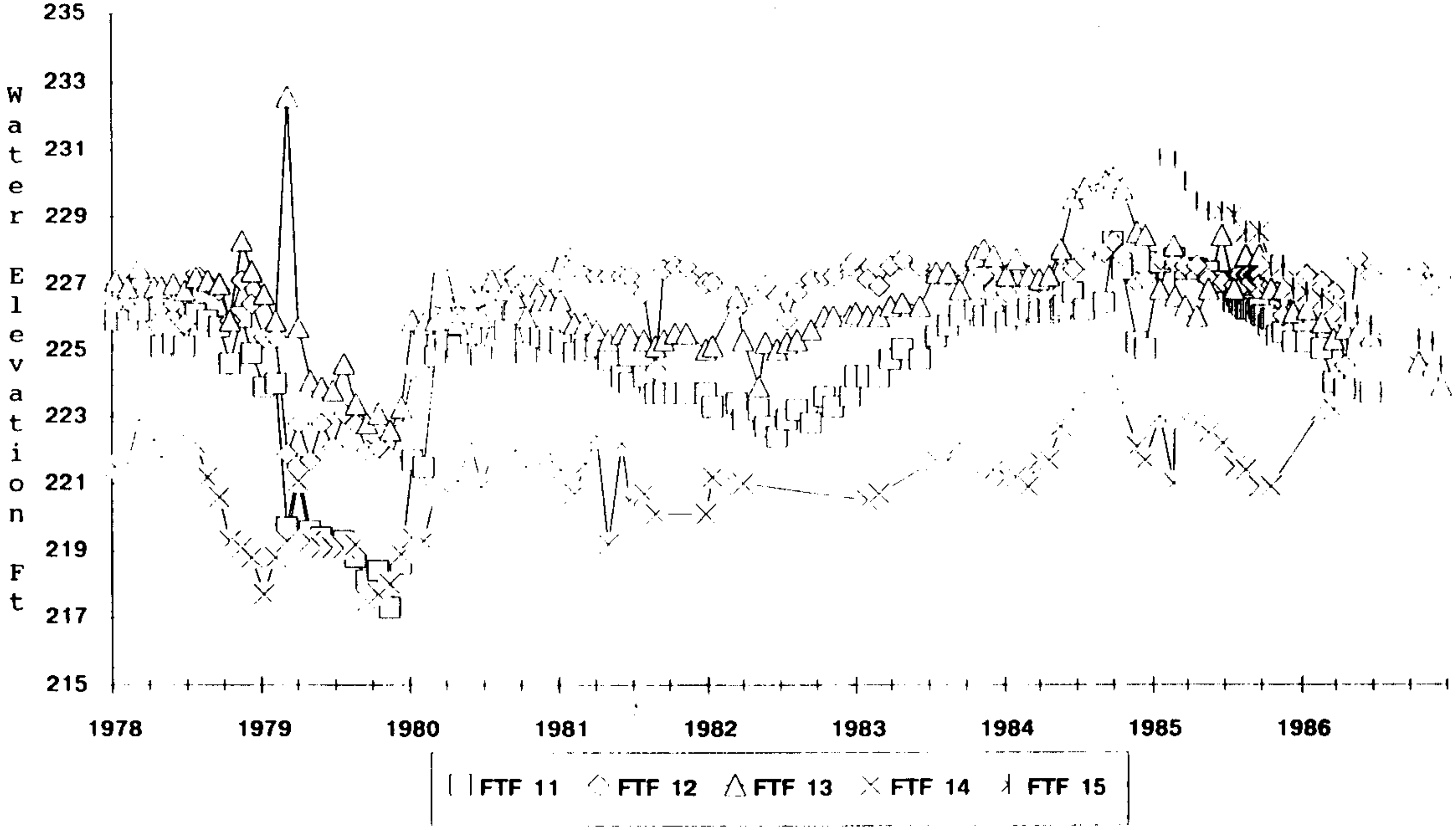


FIGURE 8-23. Hydrograph of F-Area Tank Farm Wells FTF 11 Through FTF 15

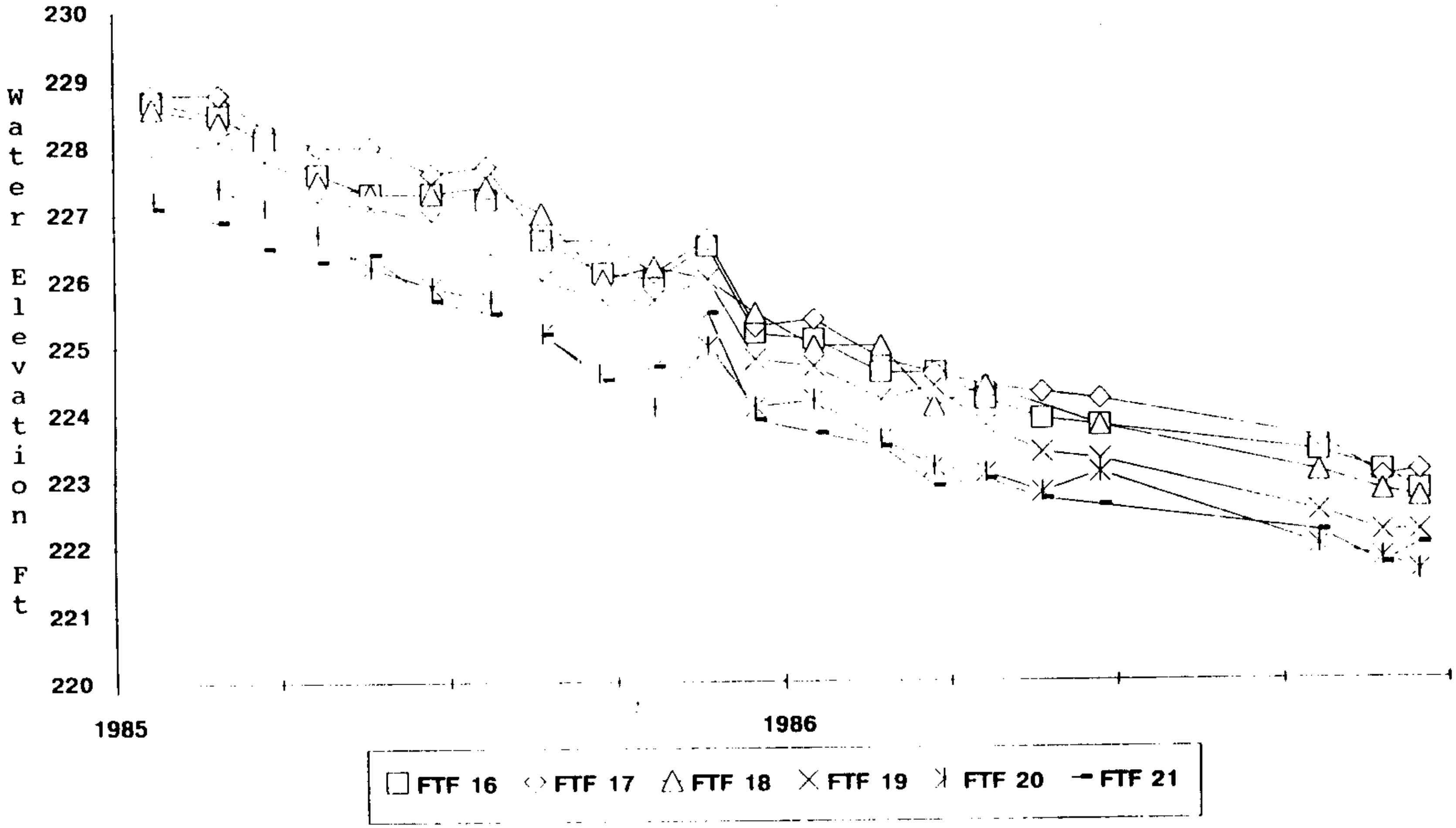


FIGURE 8-24. Hydrograph of F-Area Tank Farm Wells FTF 16 Through FTF 21

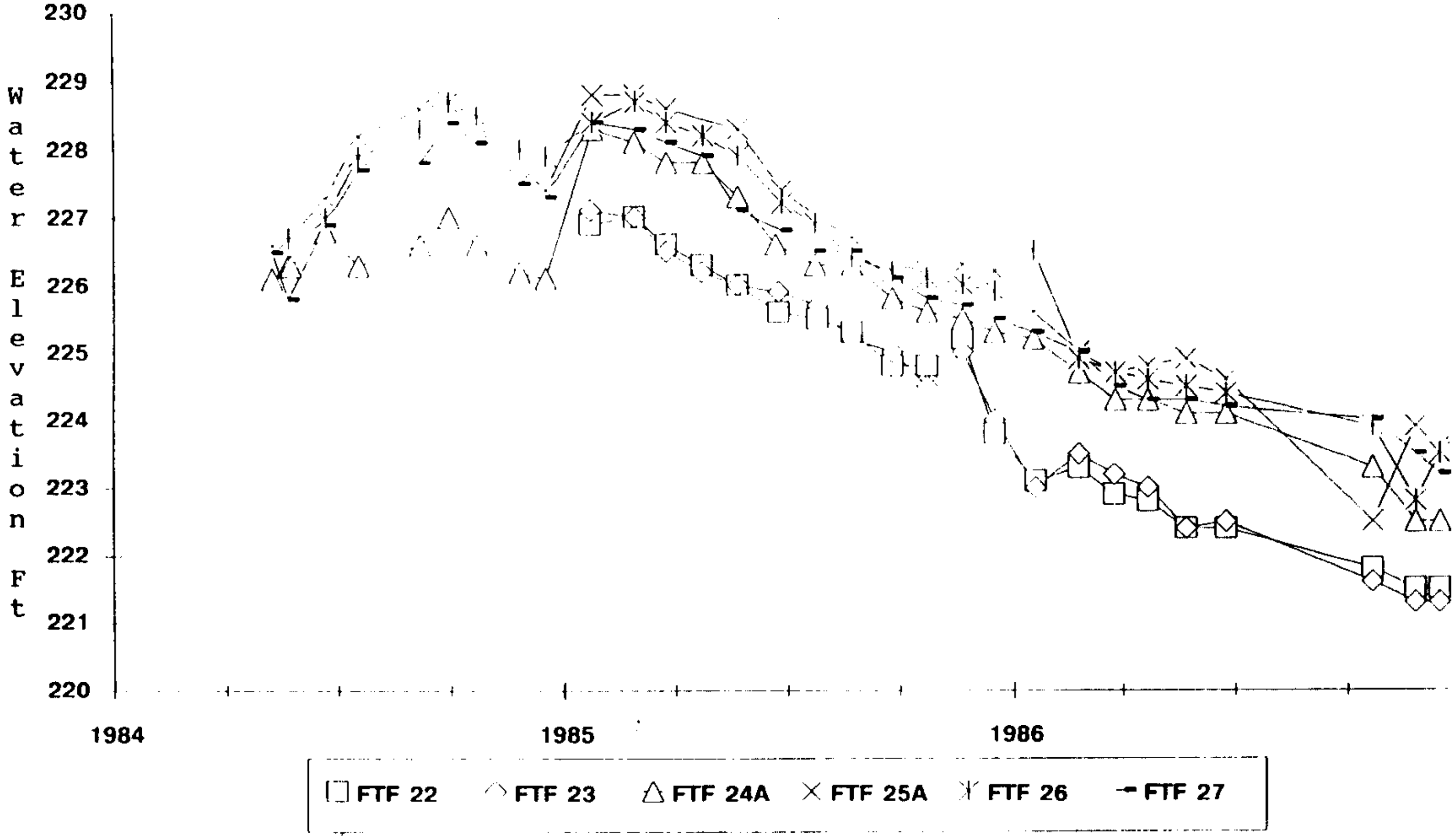


FIGURE 8-25. Hydrograph of F-Area Tank Farm Wells FTF 22 Through FTF 27

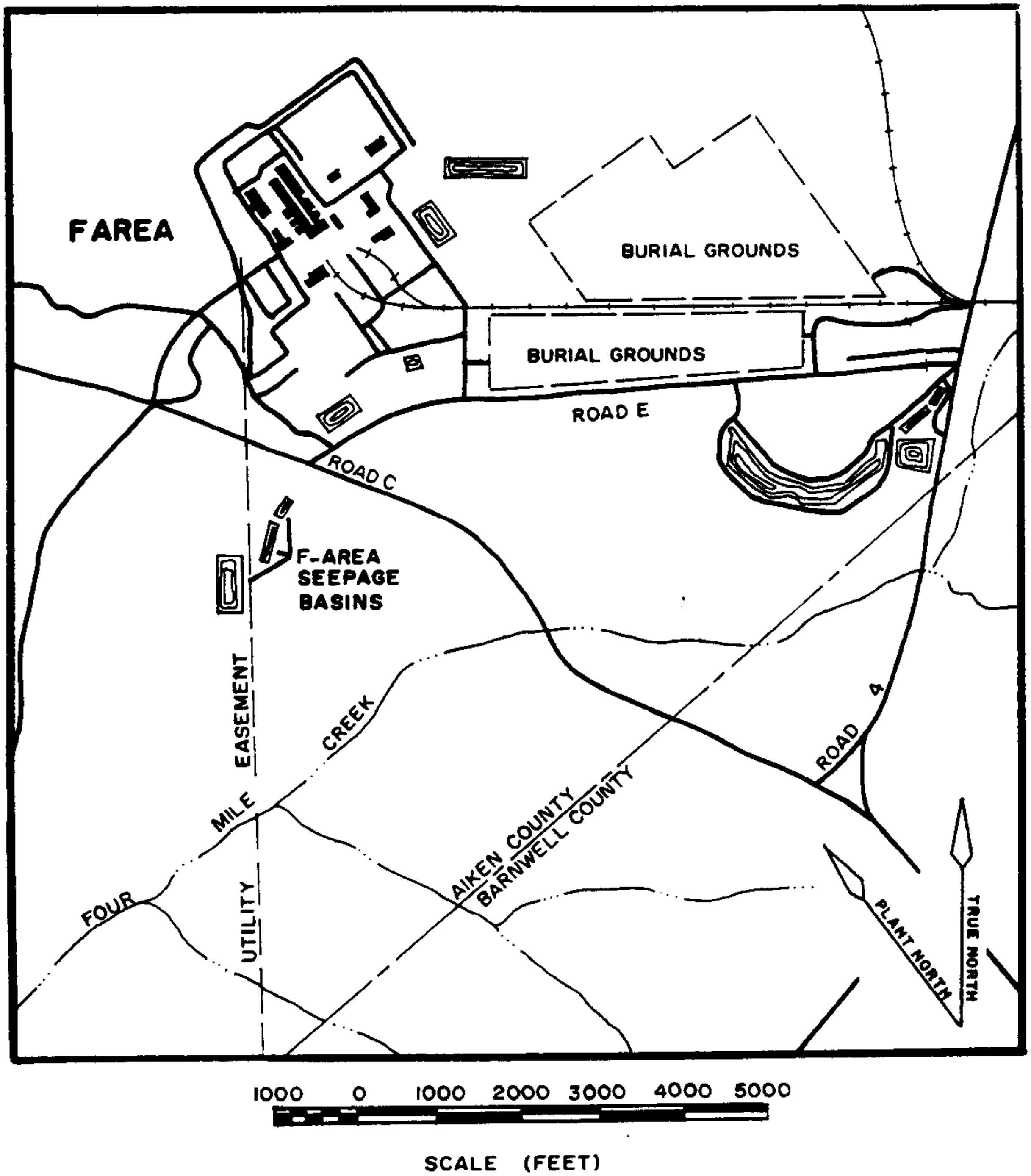


FIGURE 8-26. The F-Area Seepage Basins

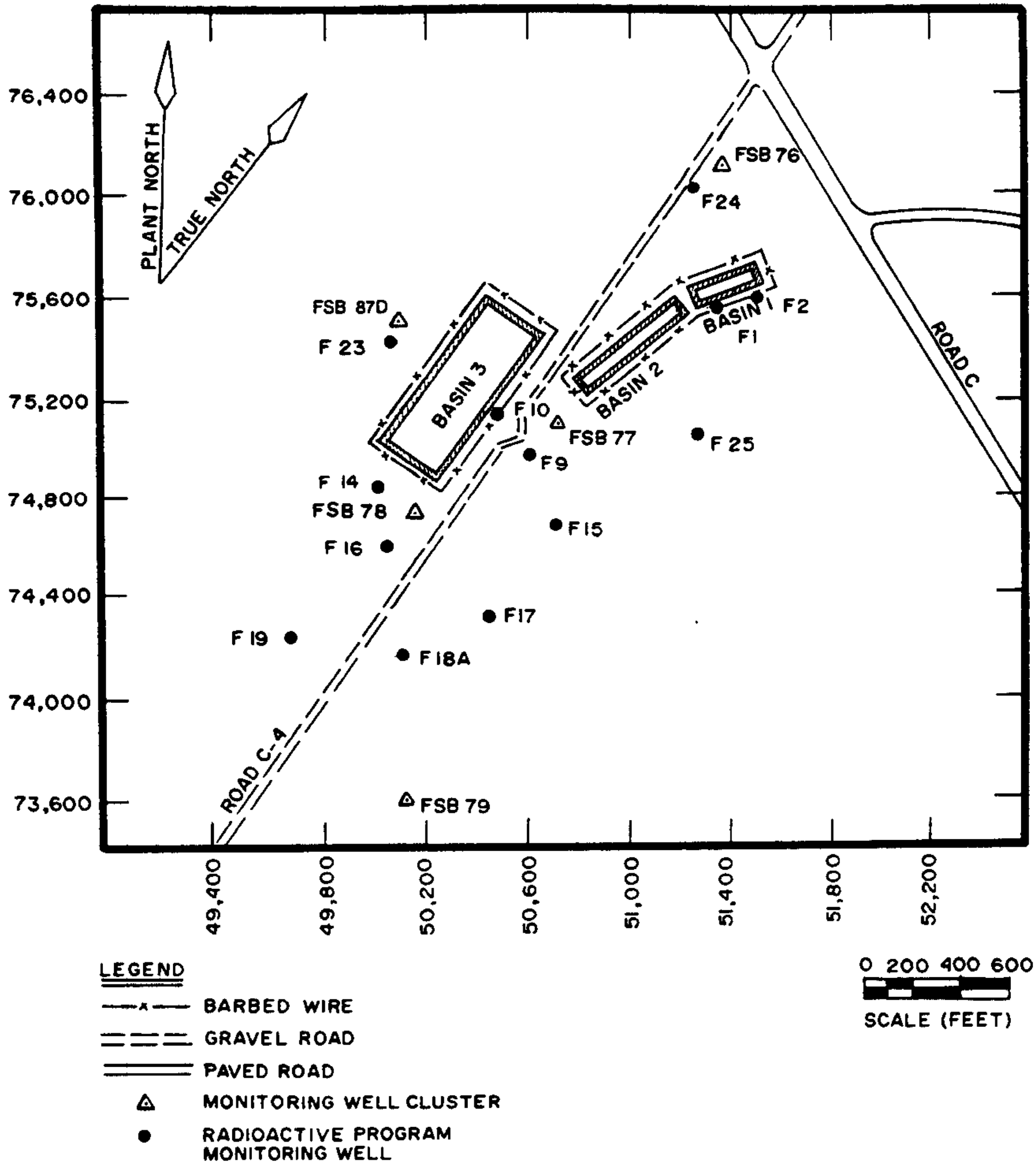


FIGURE 8-27. Water-Table Monitoring Wells at the F-Area Seepage Basins

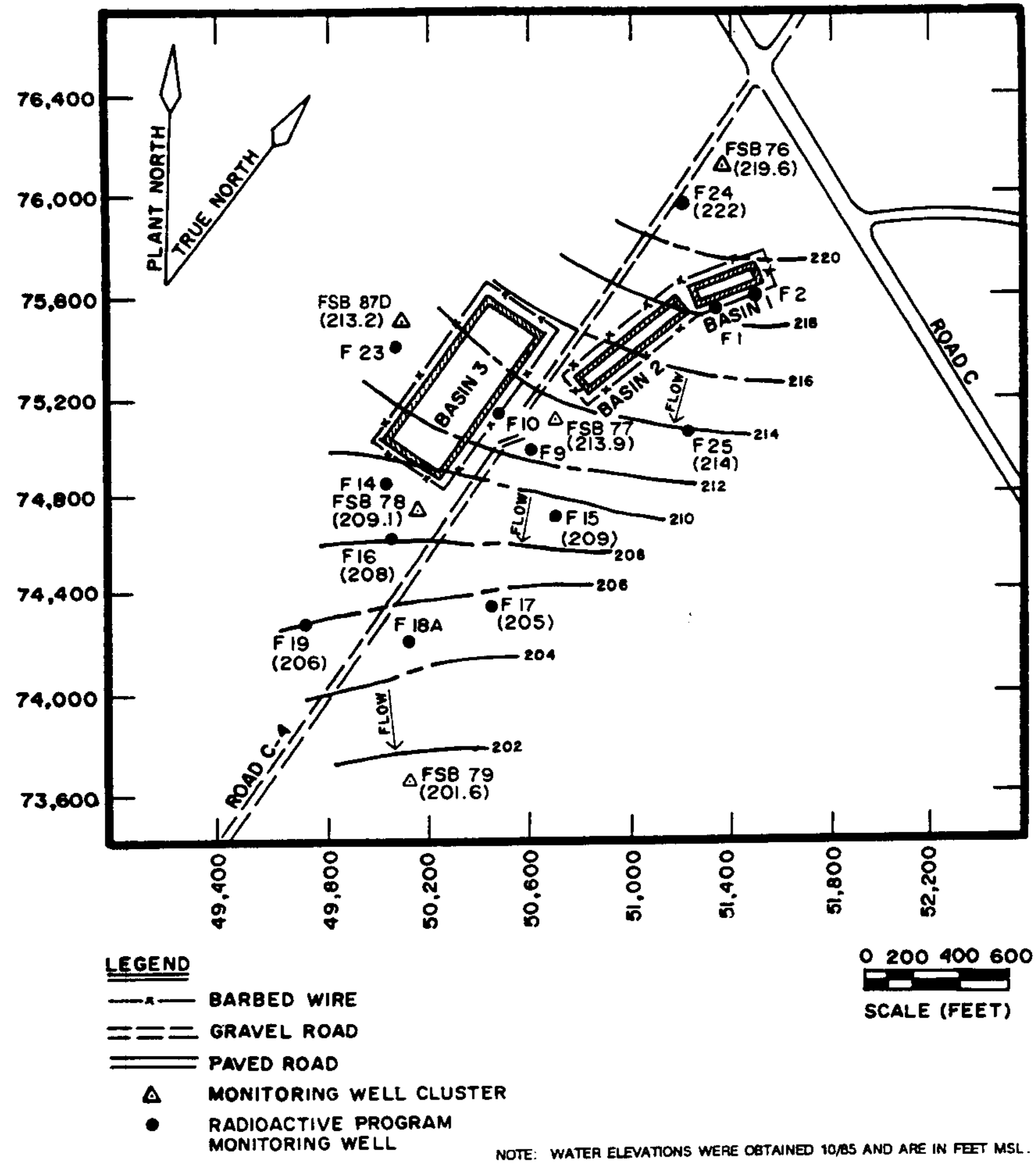


FIGURE 8-28. F-Area Seepage Basins Water-Table Elevation Map

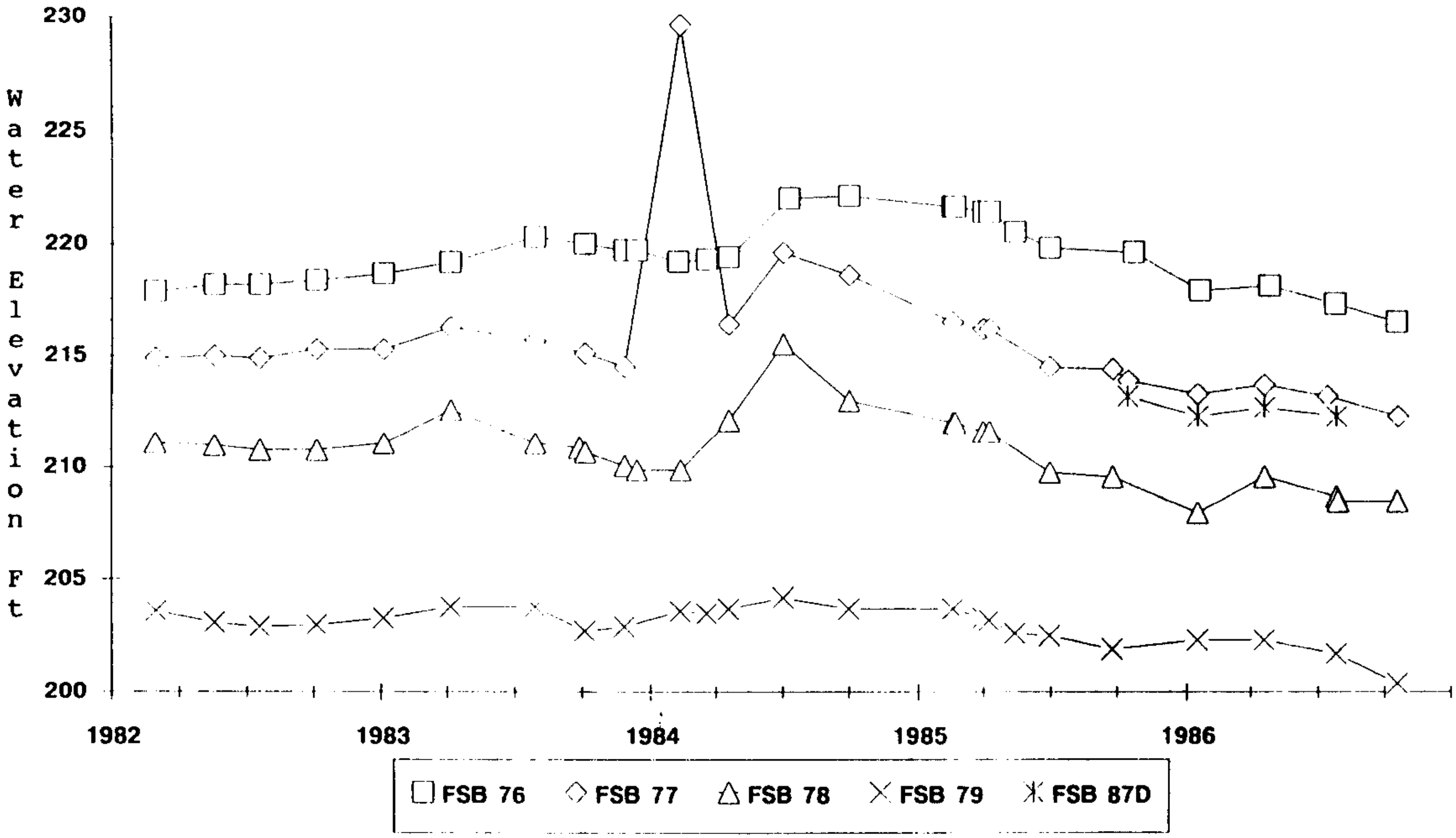


FIGURE 8-29. Hydrograph of F-Area Seepage Basins Water-Table Monitoring Wells FSB 76 Through FSB 87D

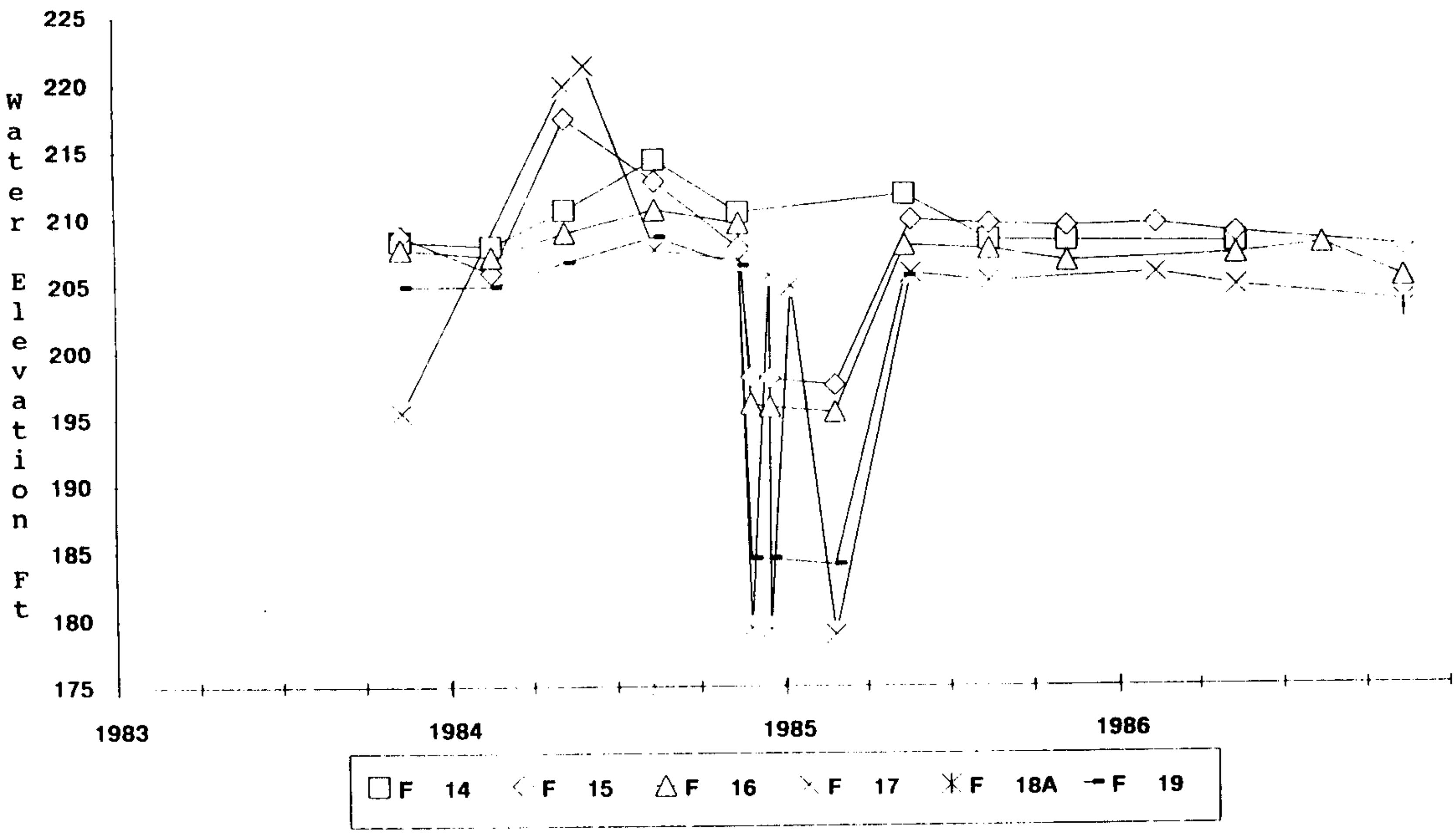


FIGURE 8-30. Hydrograph of F-Area Seepage Basins Water-Table Monitoring Wells F 14 Through F 19

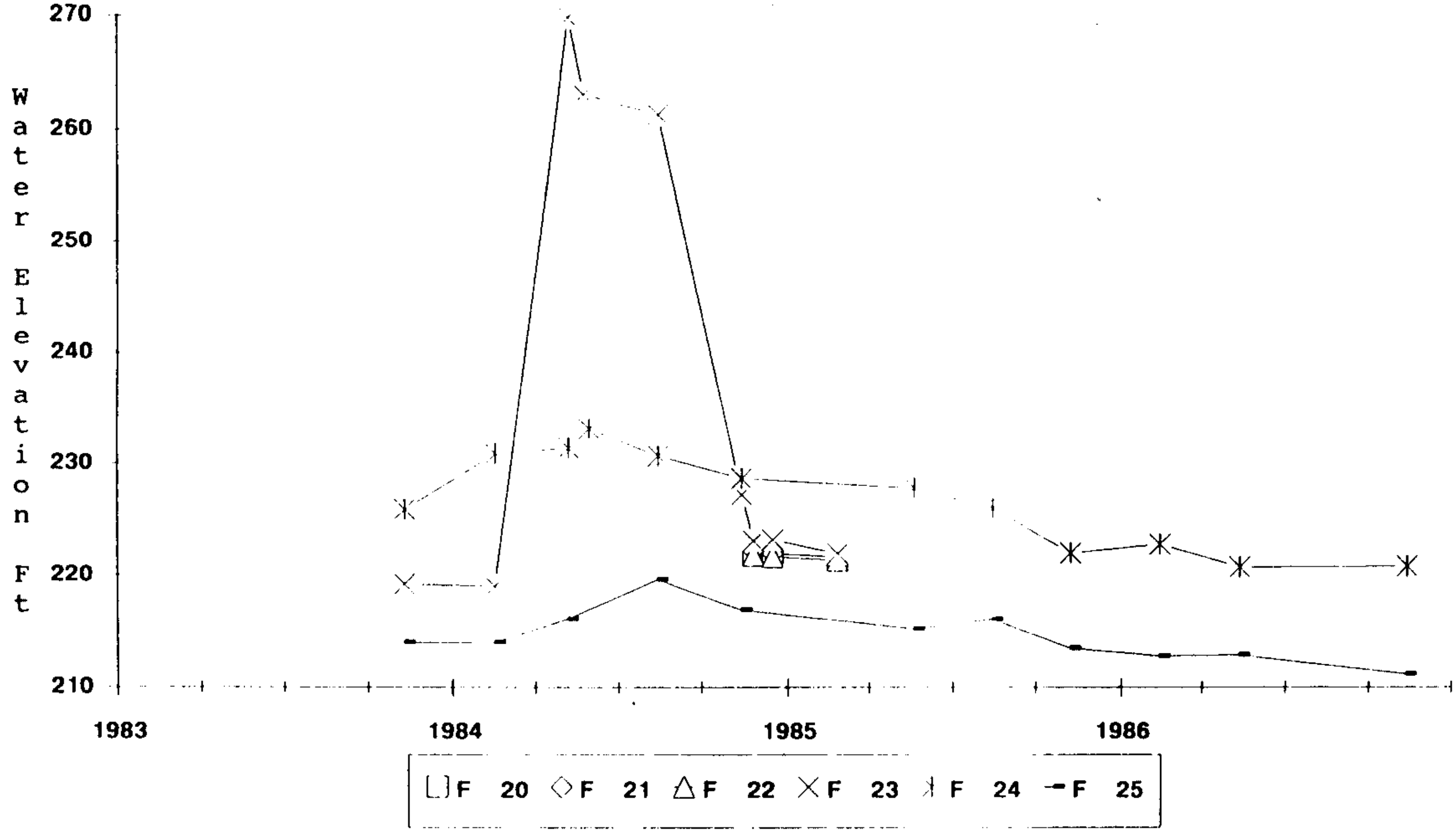


FIGURE 8-31. Hydrograph of F-Area Seepage Basins Water-Table Monitoring Wells F 20 Through F 25

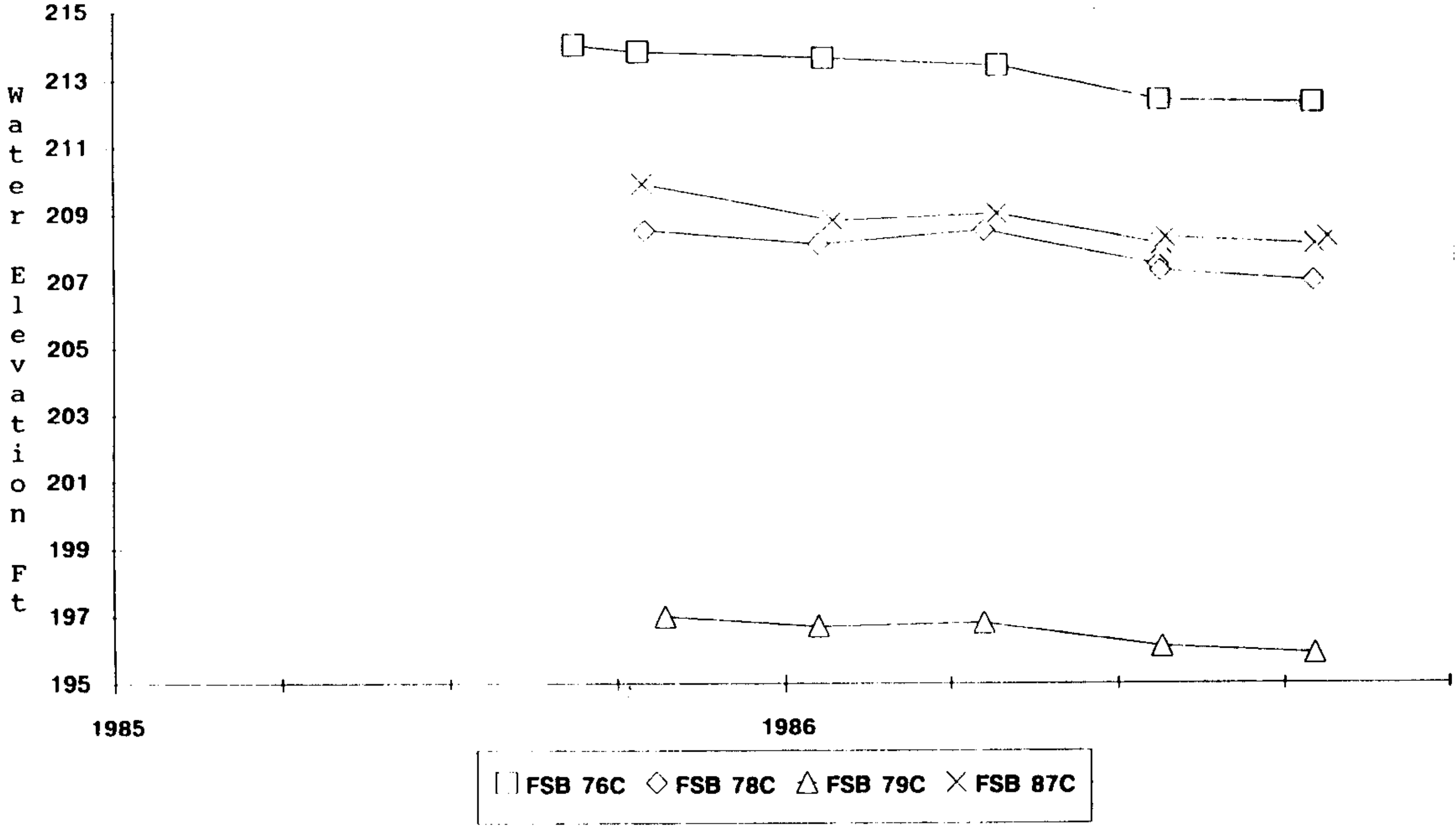


FIGURE 8-32. Hydrograph of the F-Area Seepage Basins McBean Formation Monitoring Wells

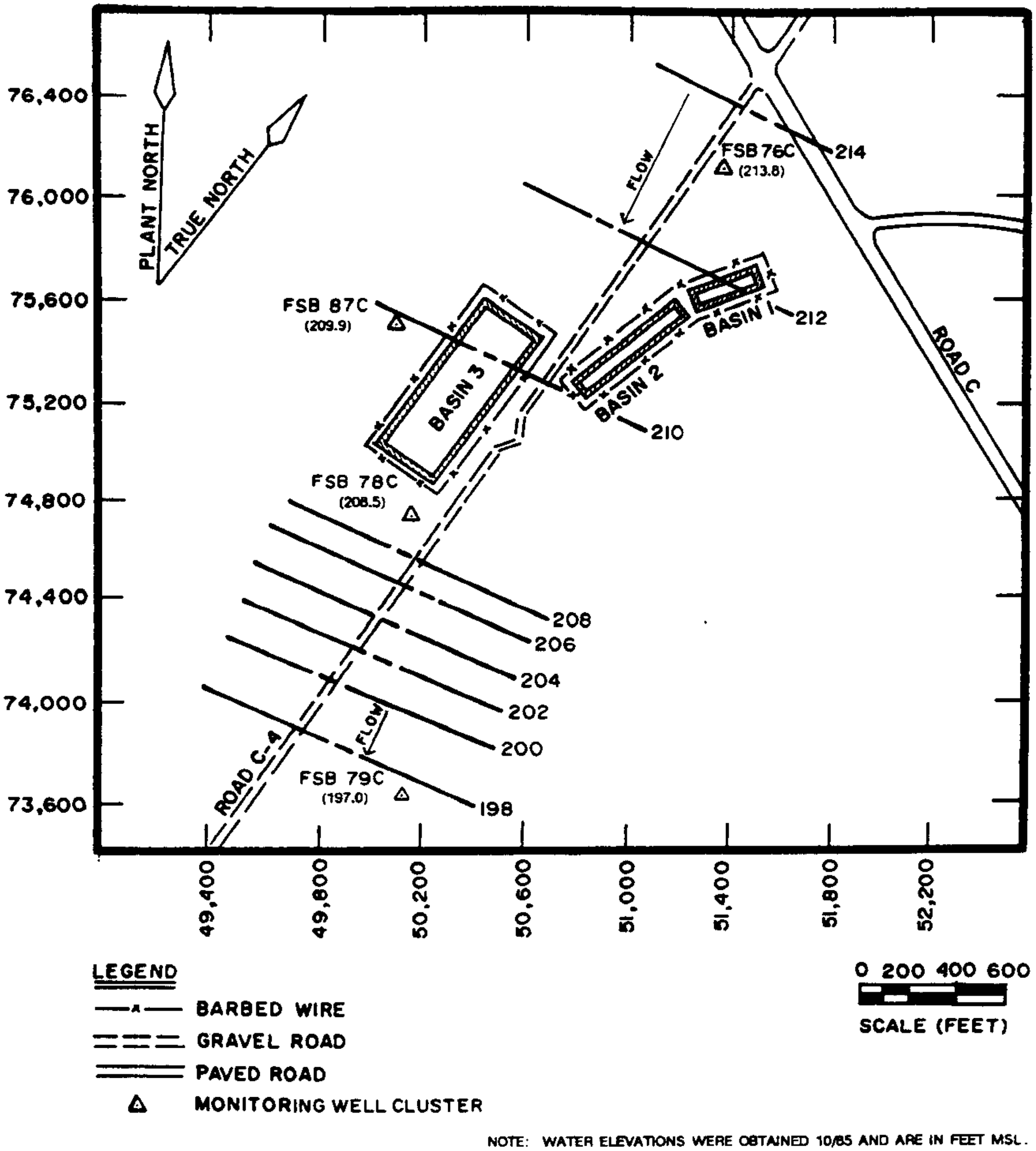


FIGURE 8-33. McBean Formation Piezometric Contour Map at the F-Area Seepage Basins

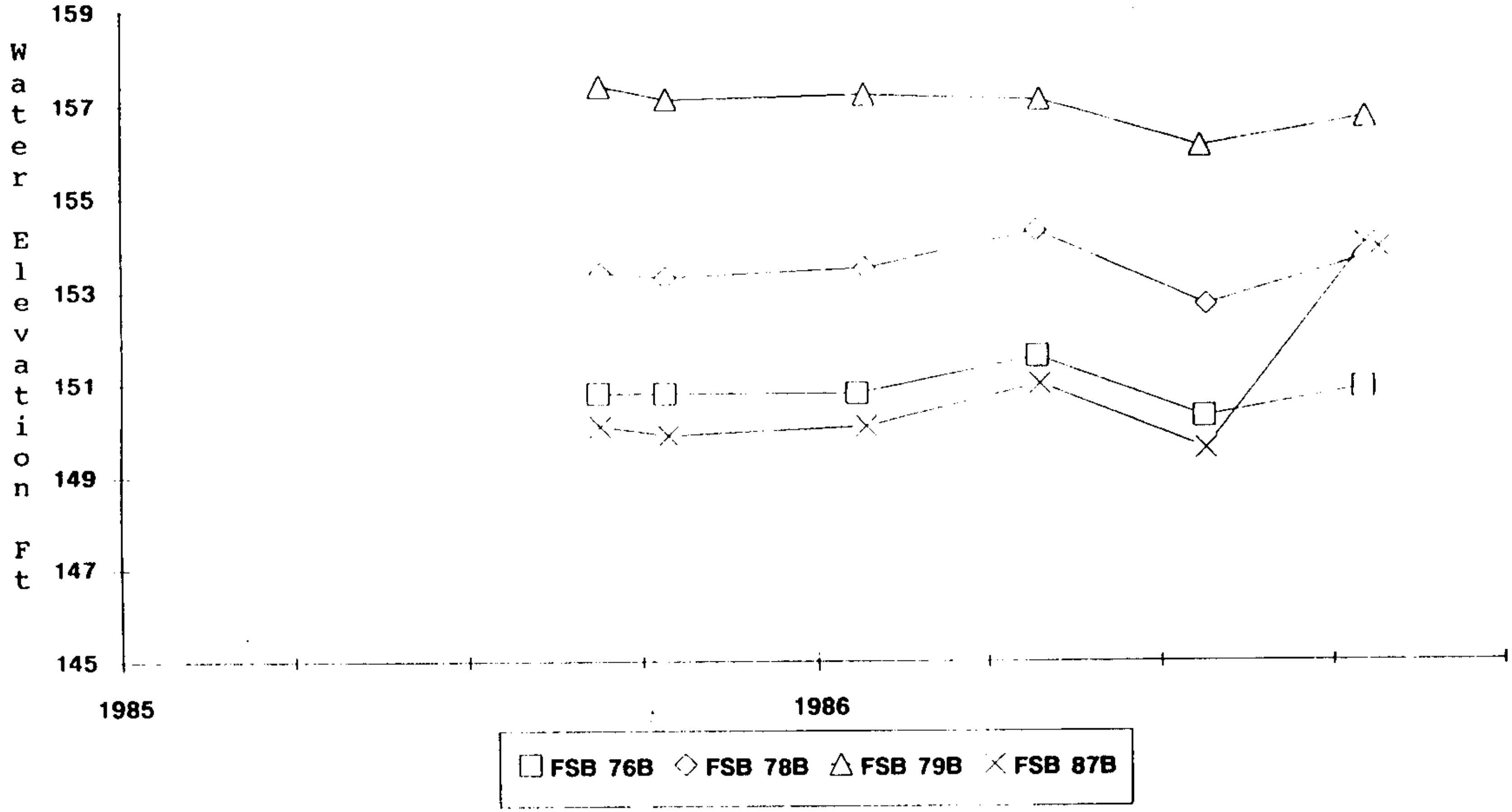


FIGURE 8-34. Hydrograph of the F-Area Seepage Basins Upper Congaree Formation Monitoring Wells

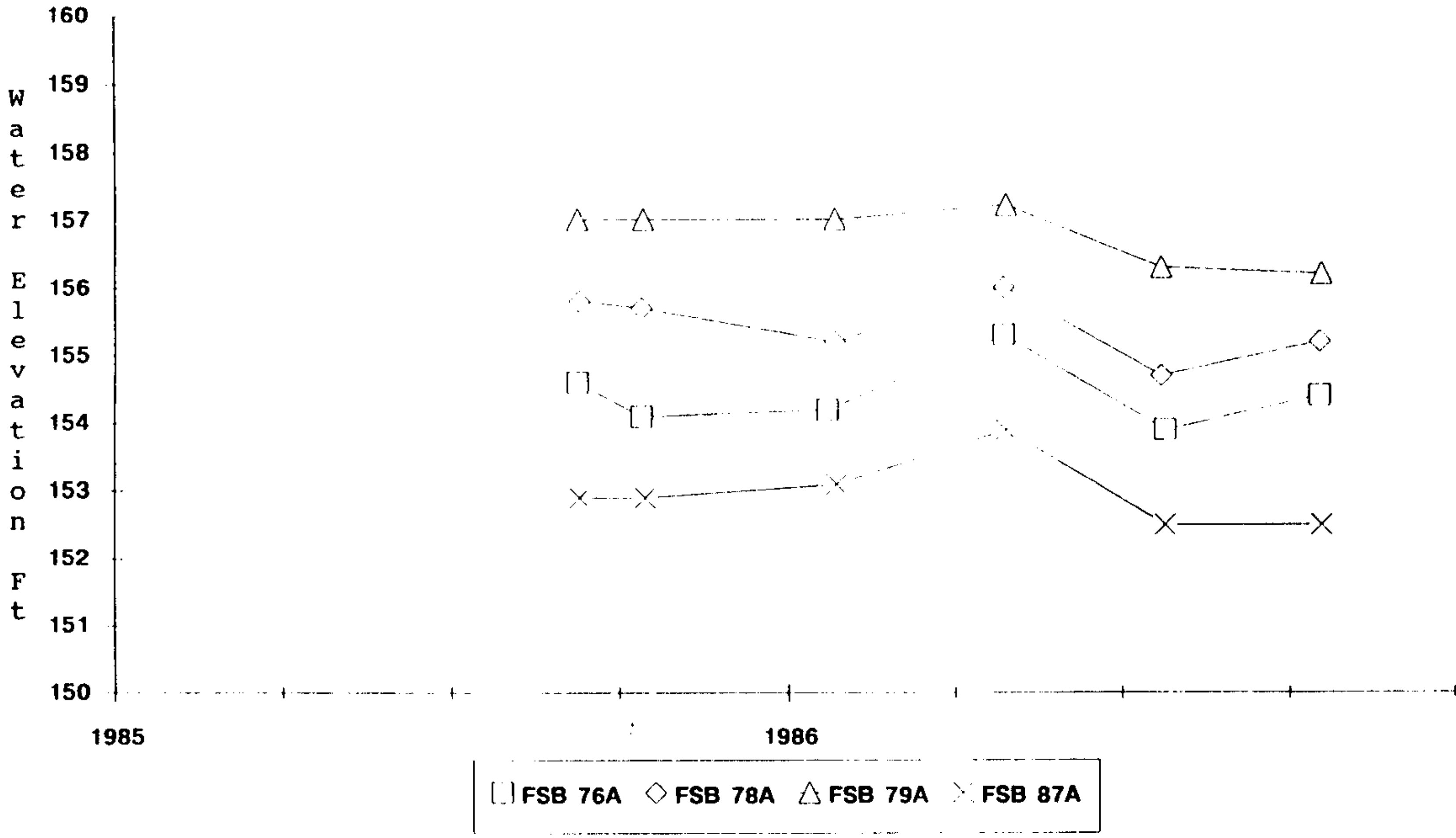


FIGURE 8-35. Hydrograph of the F-Area Seepage Basins Lower Congaree Formation Monitoring Wells

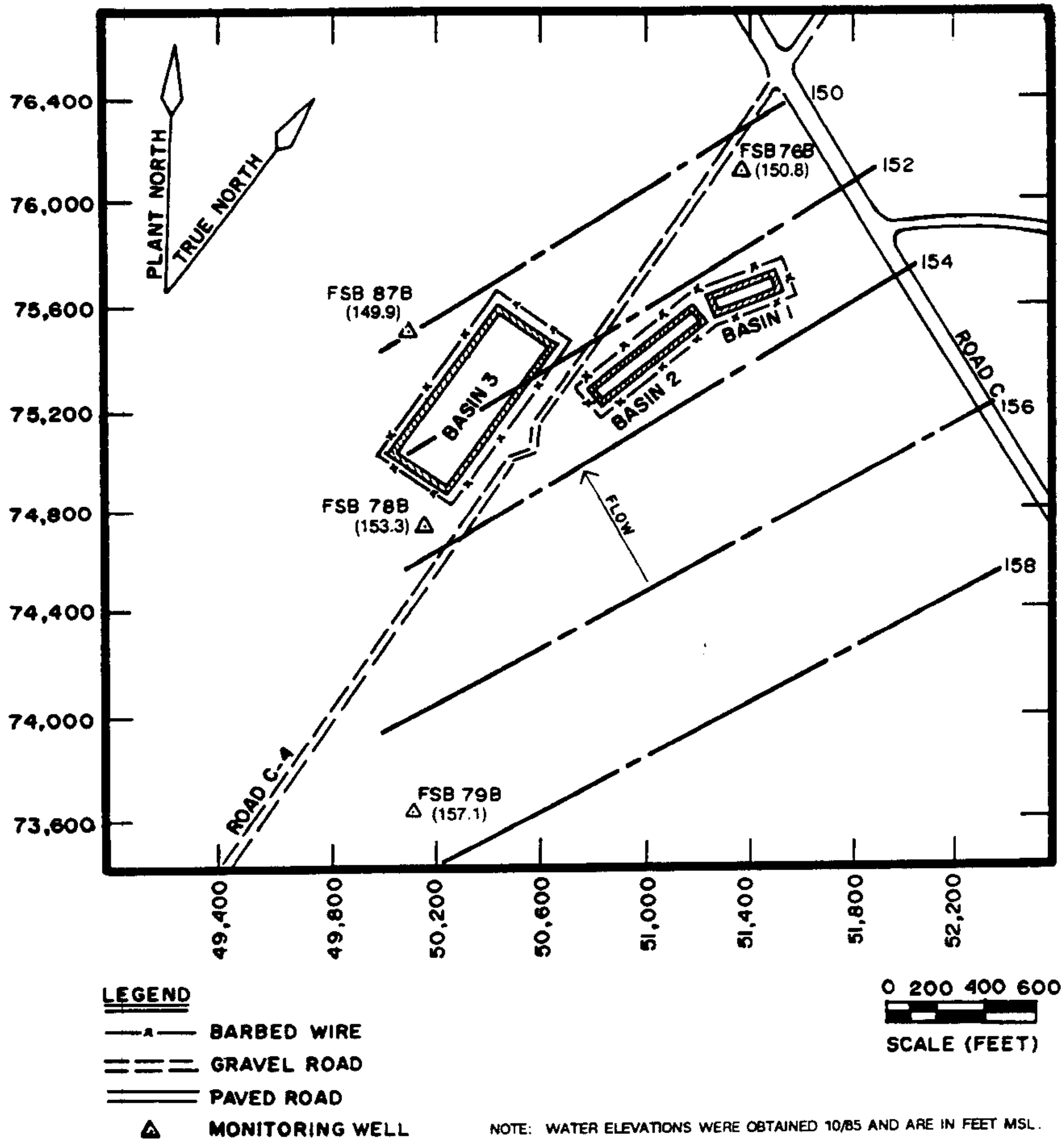


FIGURE 8-36. Congaree Formation Piezometric Contour Map at the F-Area Seepage Basins

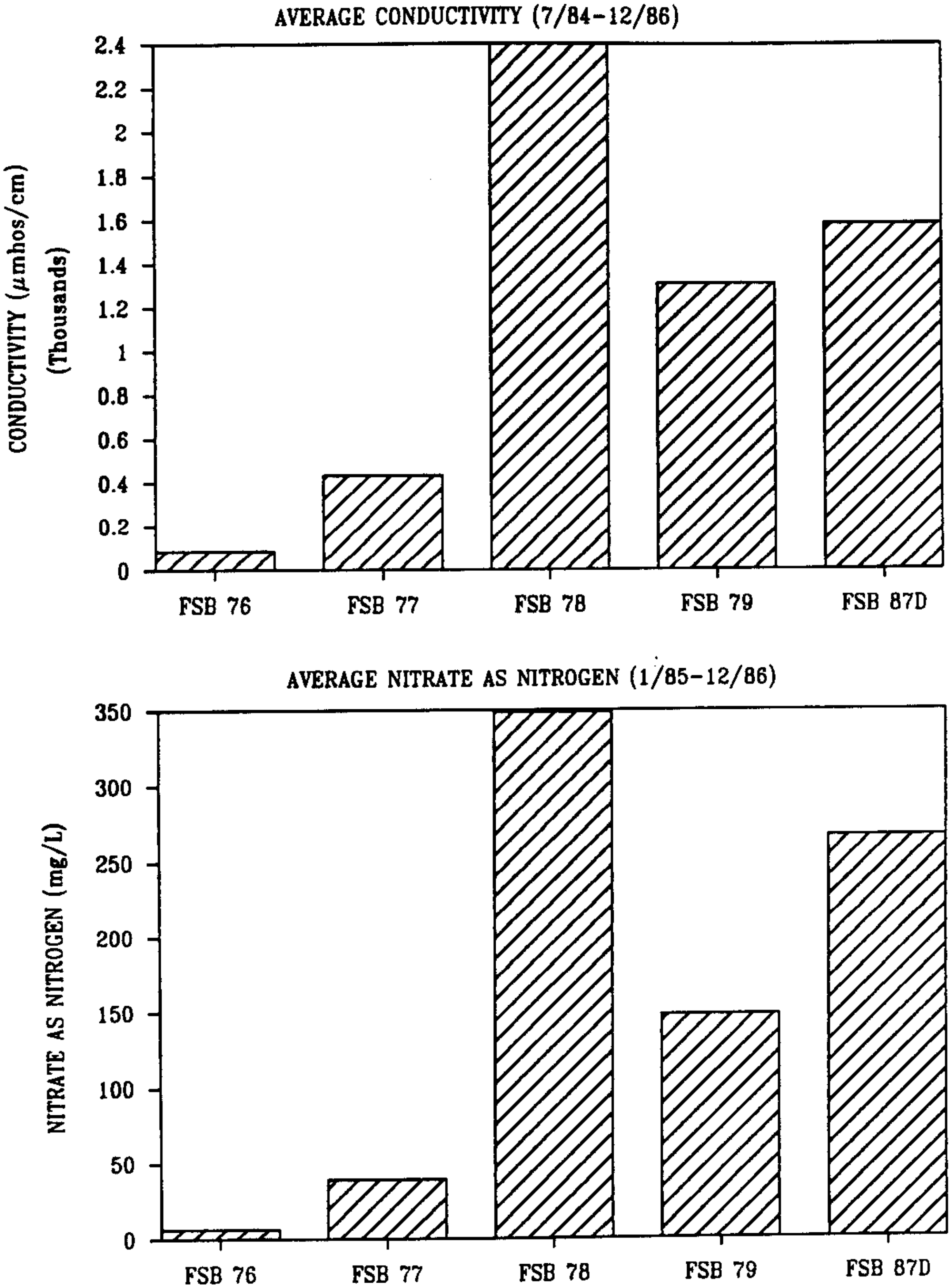


FIGURE 8-37. Average Conductivity and Nitrate (as N) Concentrations in the F-Area Seepage Basins Water-Table Monitoring Wells

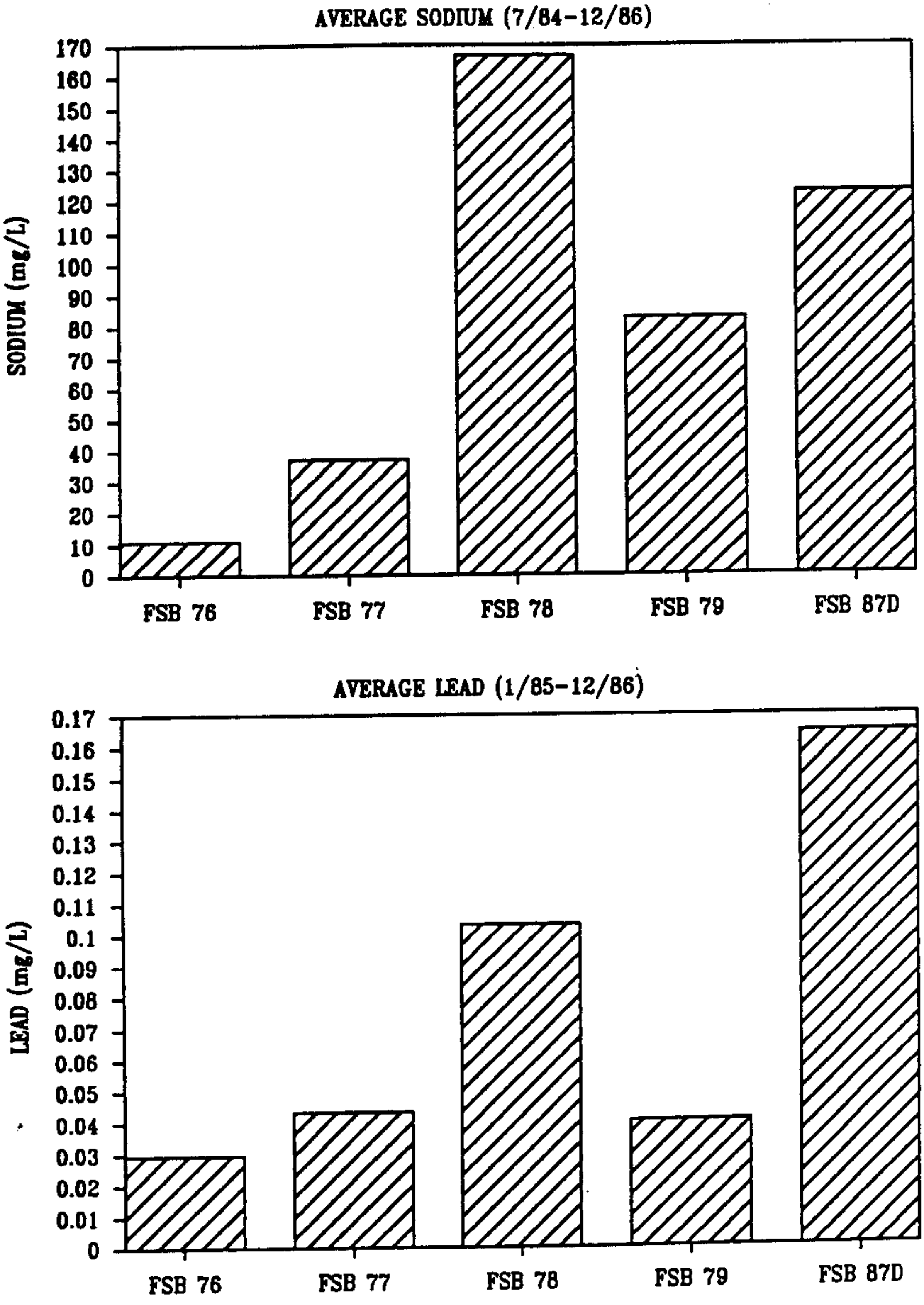


FIGURE 8-38. Average Sodium and Lead Concentrations in the F-Area Seepage Basins Water-Table Monitoring Wells

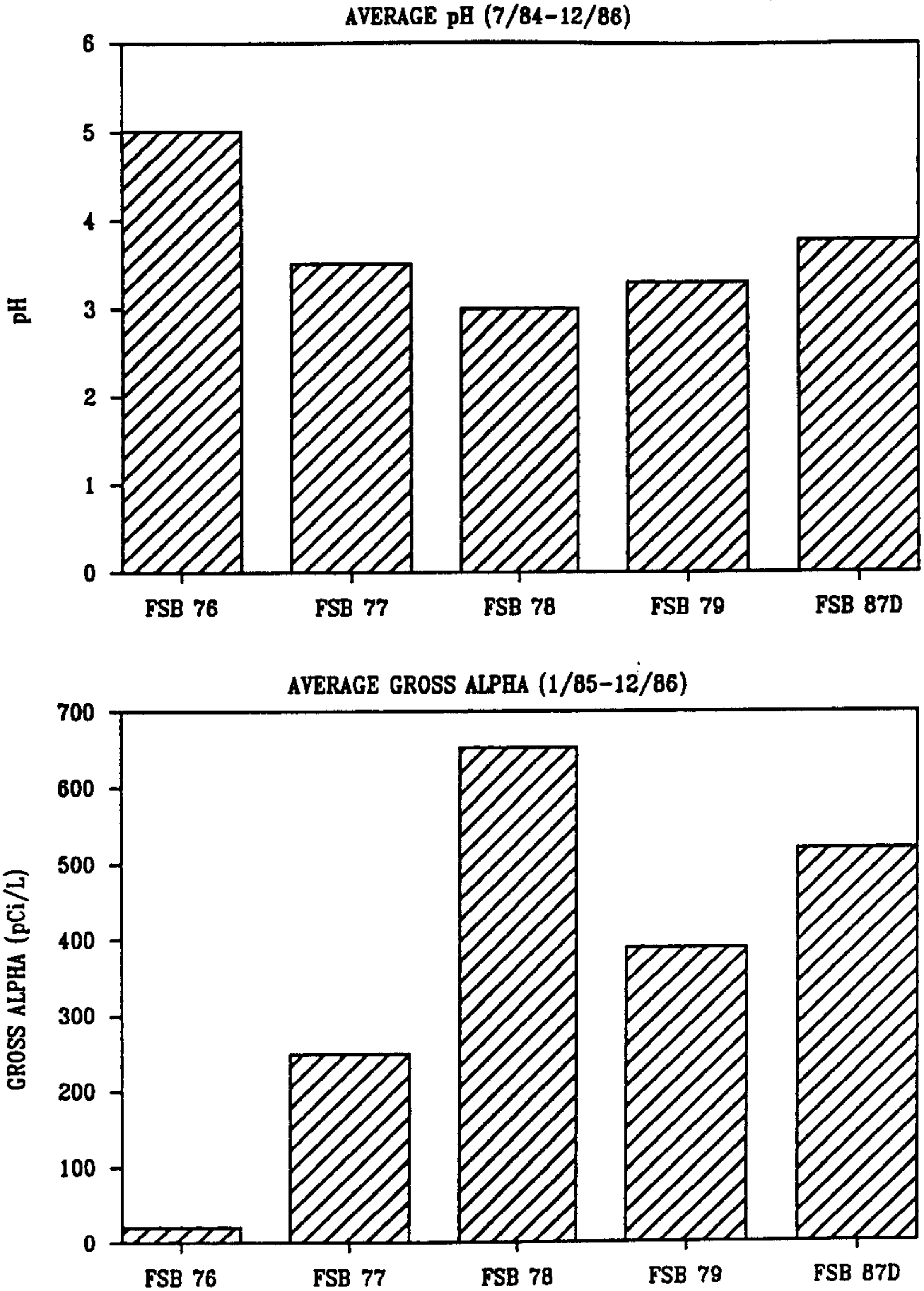


FIGURE 8-39. Average pH and Gross Alpha Activity in the F-Area Seepage Basins Water-Table Monitoring Wells

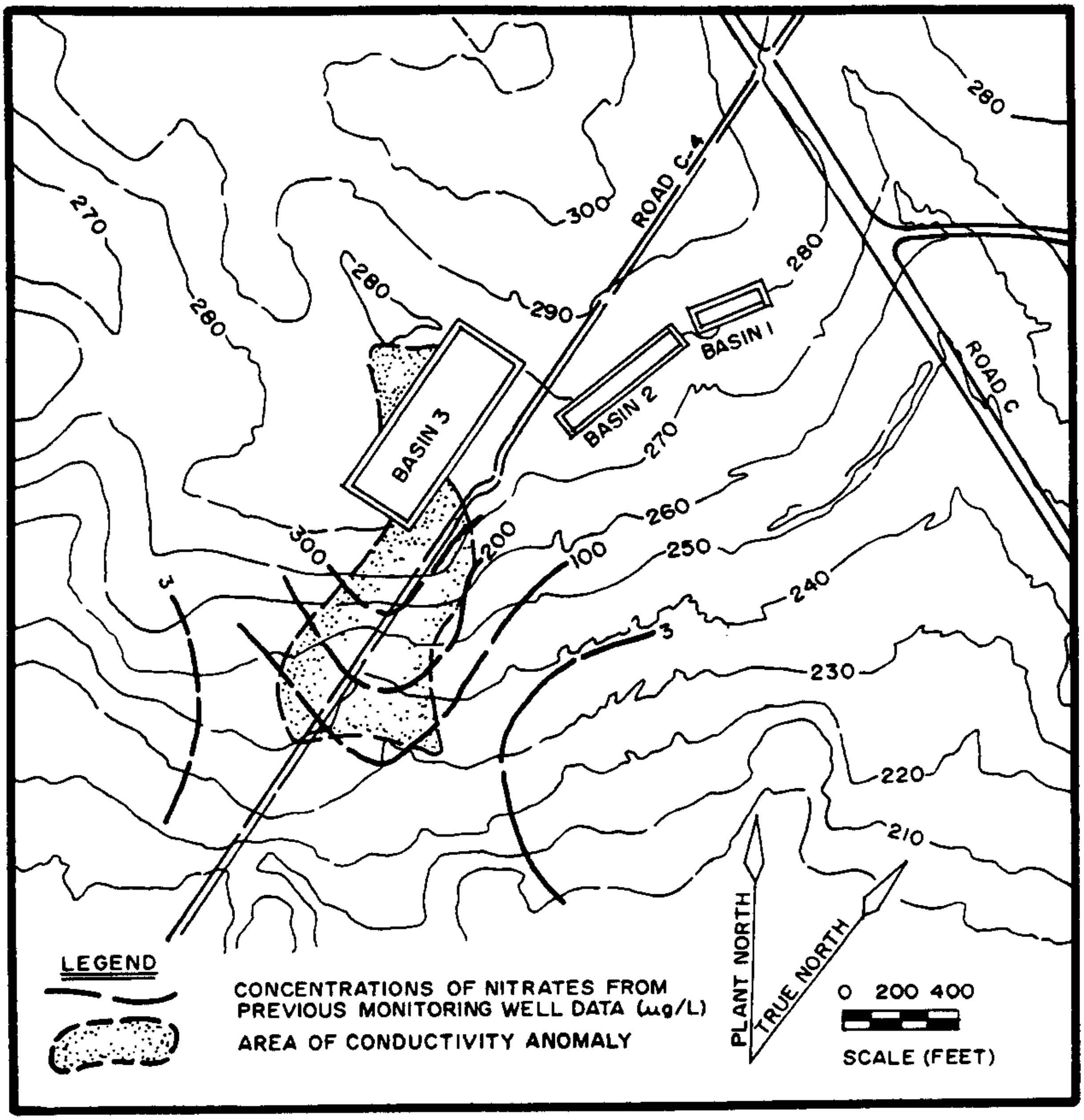


FIGURE 8-40. Isoconcentration Contours of Nitrates in Groundwater at the F-Area Seepage Basins

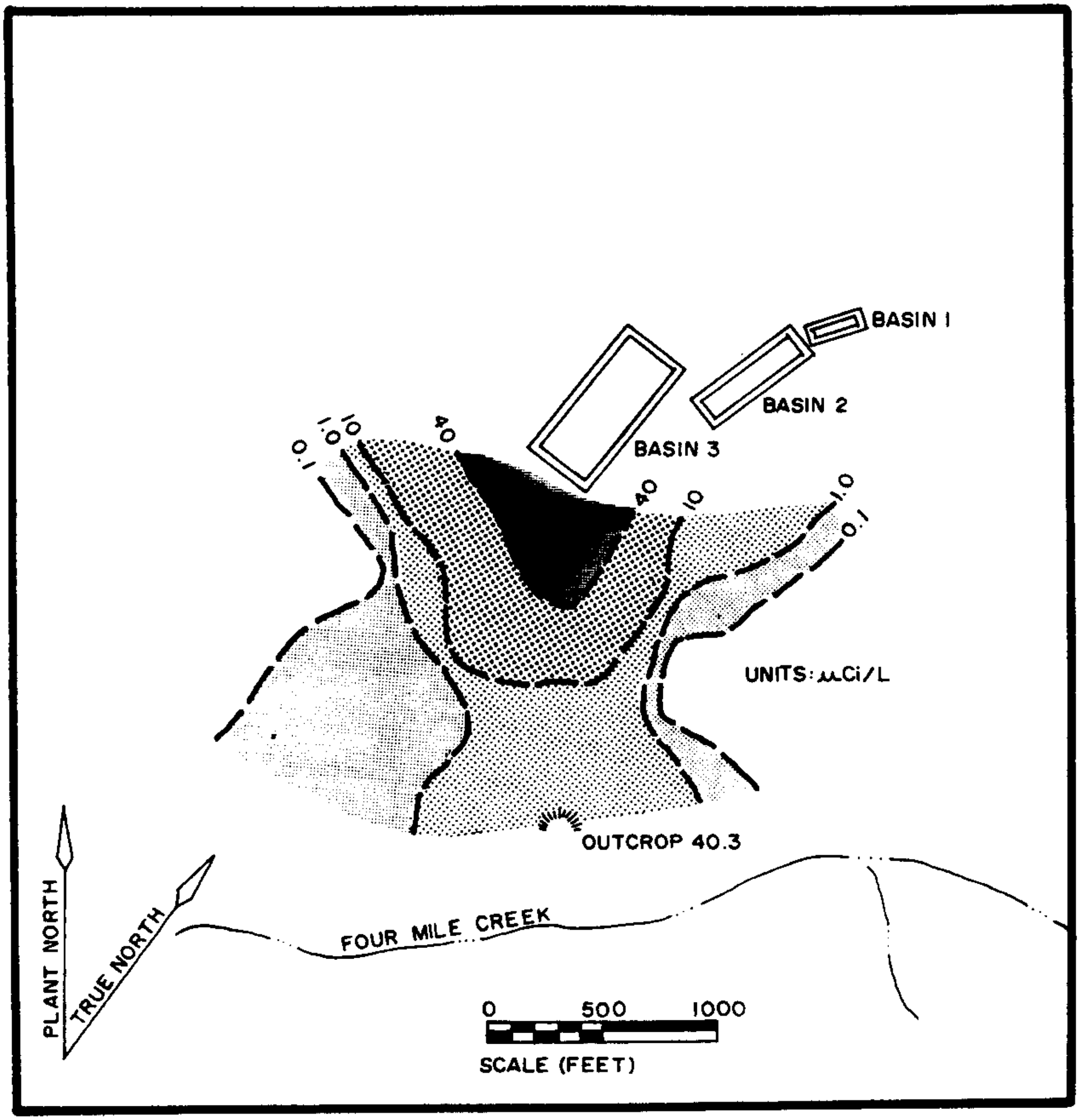


FIGURE 8-41. Isoconcentration Contours of Tritium in Groundwater at the F-Area Seepage Basins

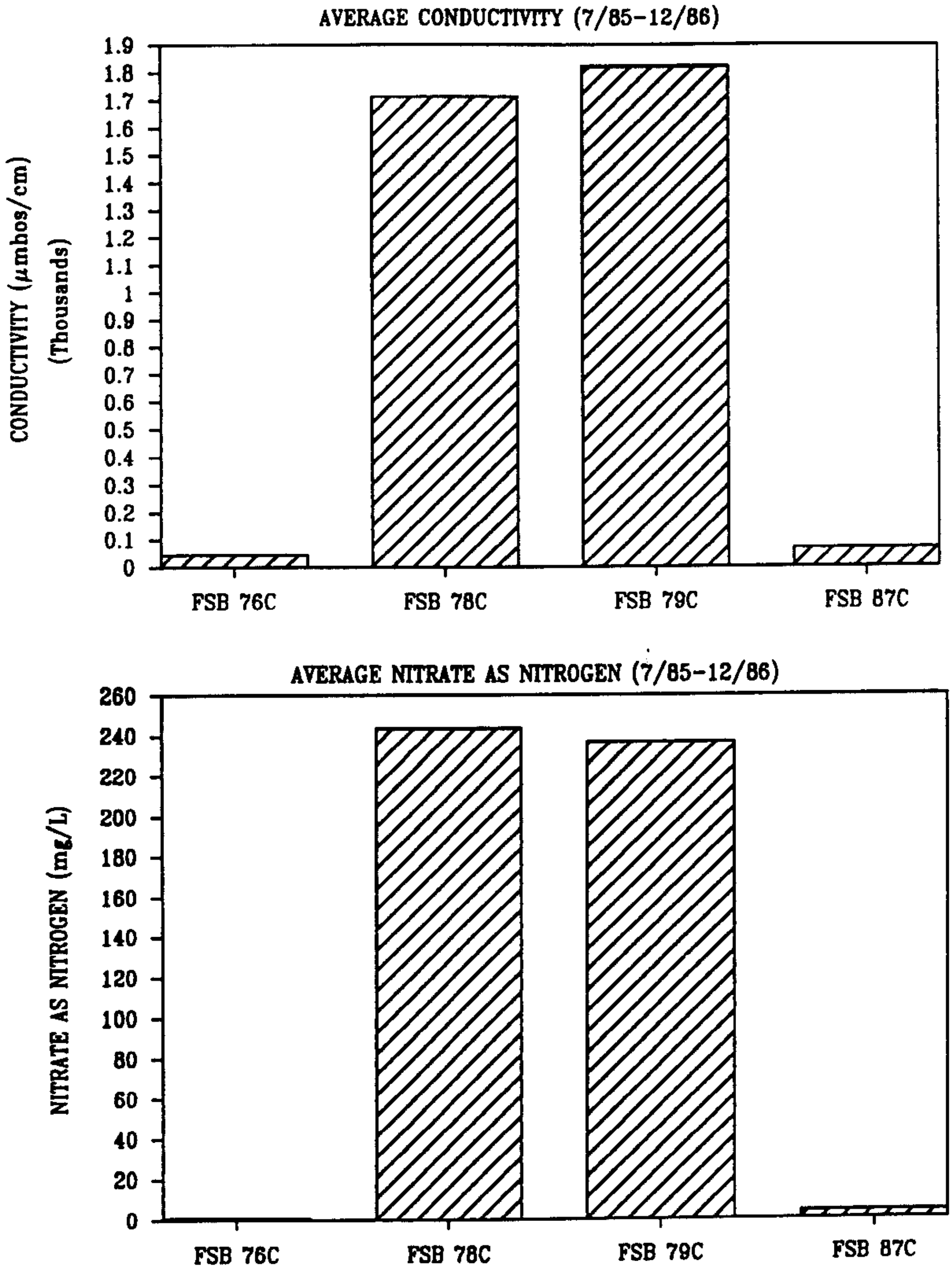
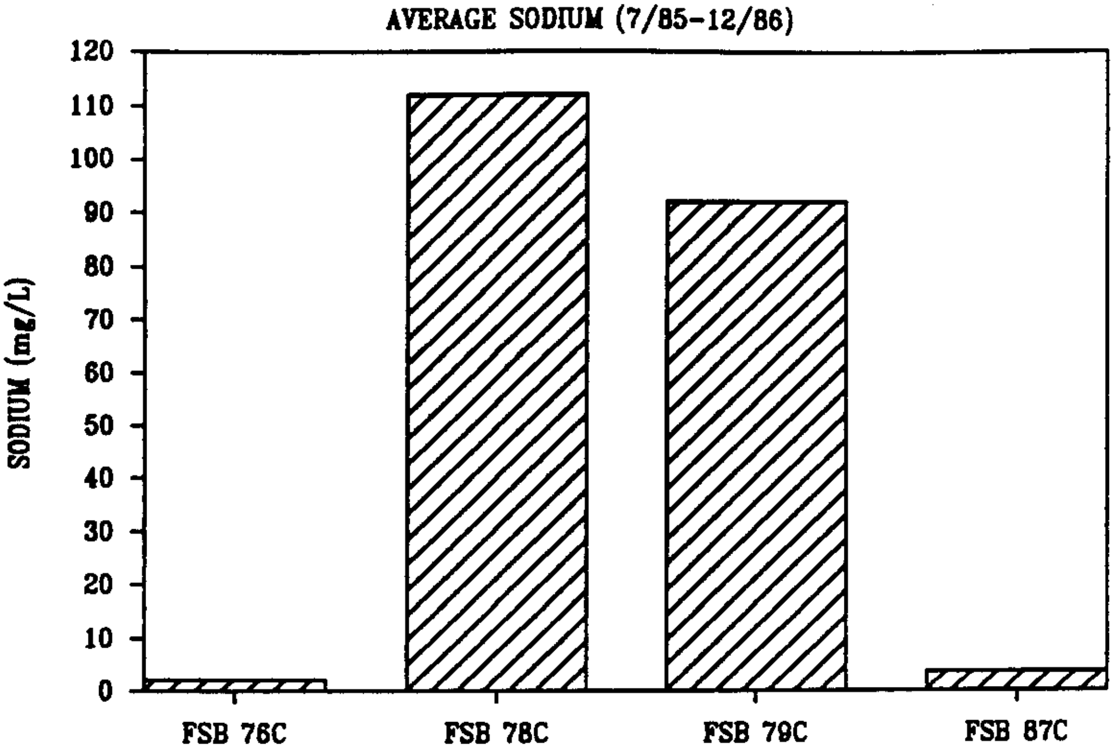


FIGURE 8-42. Average Conductivity and Nitrate (as N) Concentrations in the F-Area Seepage Basins McBean Formation Monitoring Wells



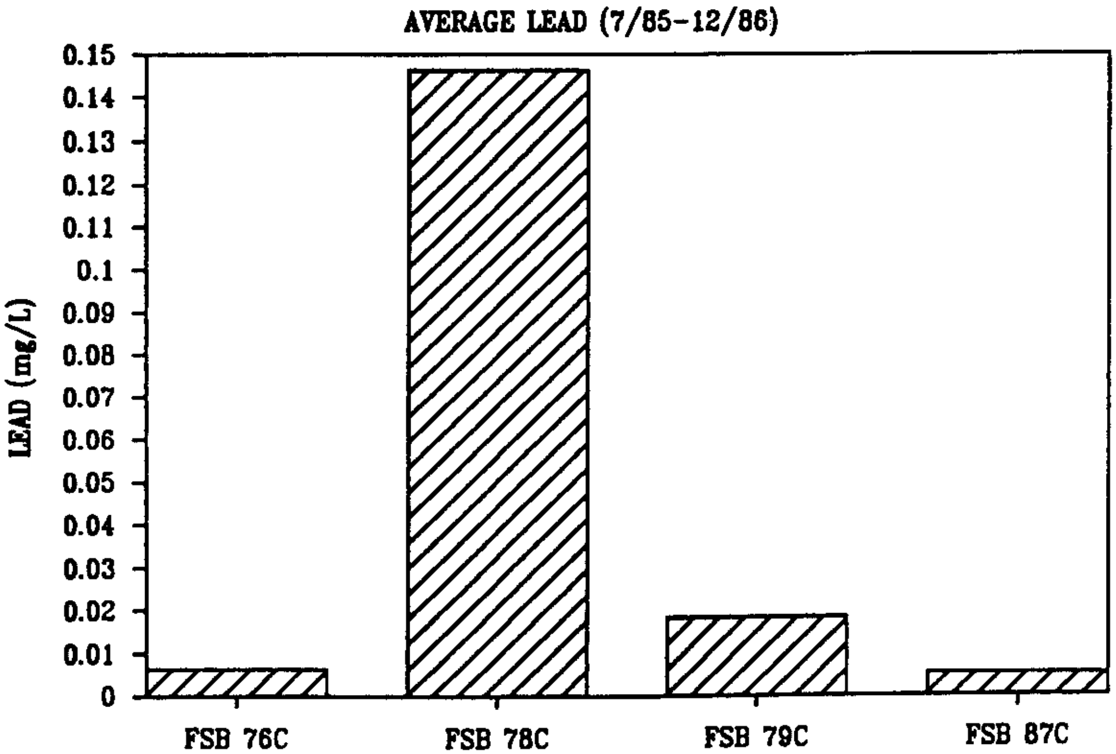


FIGURE 8-43. Average Sodium and Lead Concentrations in the F-Area Seepage Basins McBean Formation Monitoring Wells

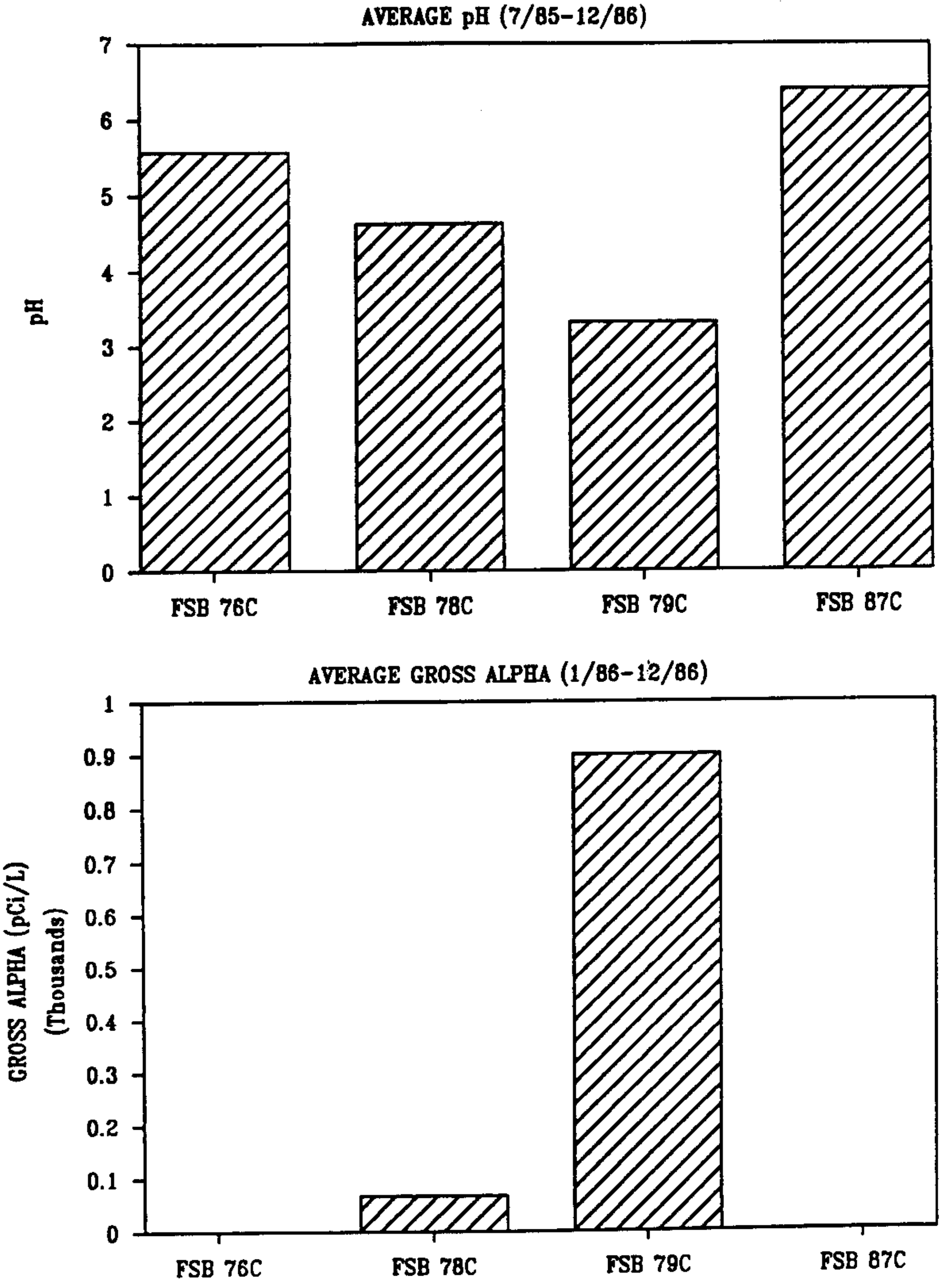
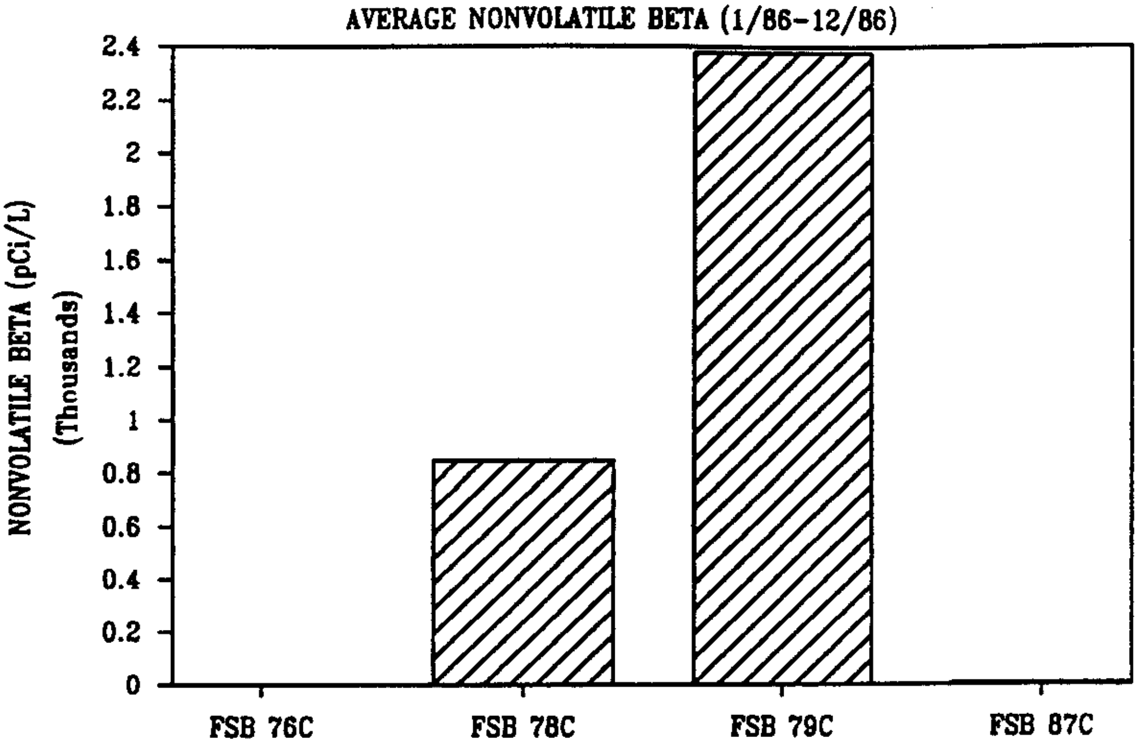


FIGURE 8-44. Average pH and Gross Alpha Activities in the F-Area Seepage Basins McBean Formation Monitoring Wells



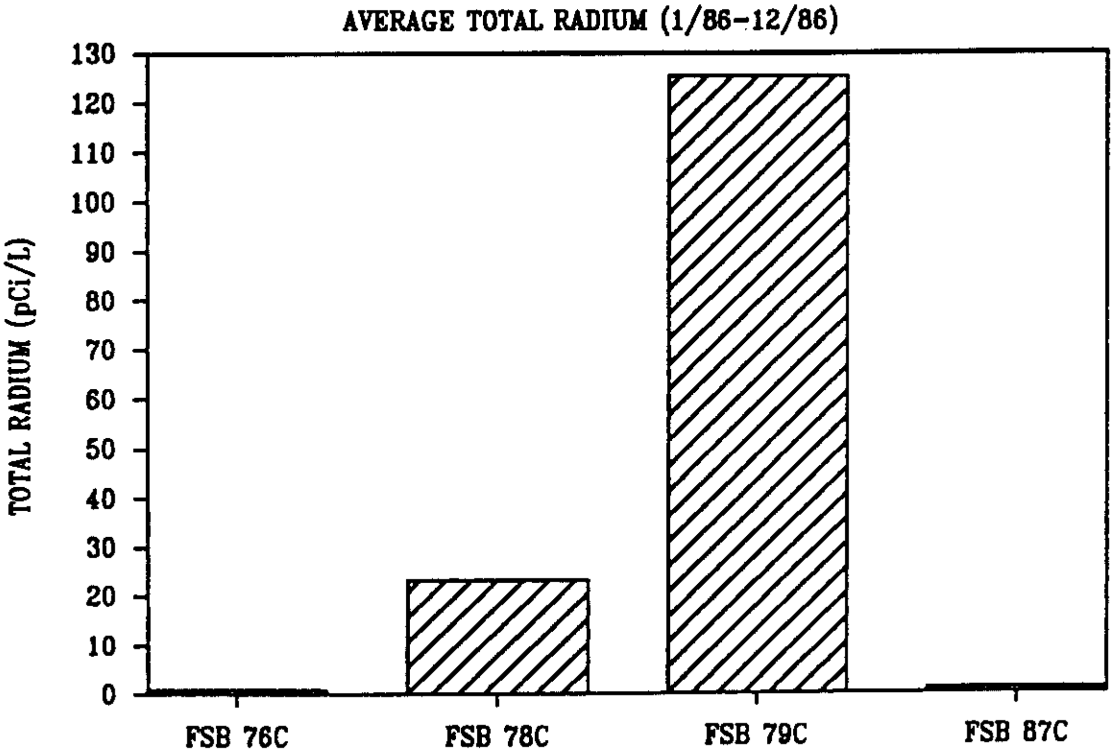


FIGURE 8-45. Average Nonvolatile Beta and Total Radium Activities in the F-Area Seepage Basins McBean Formation Monitoring Wells

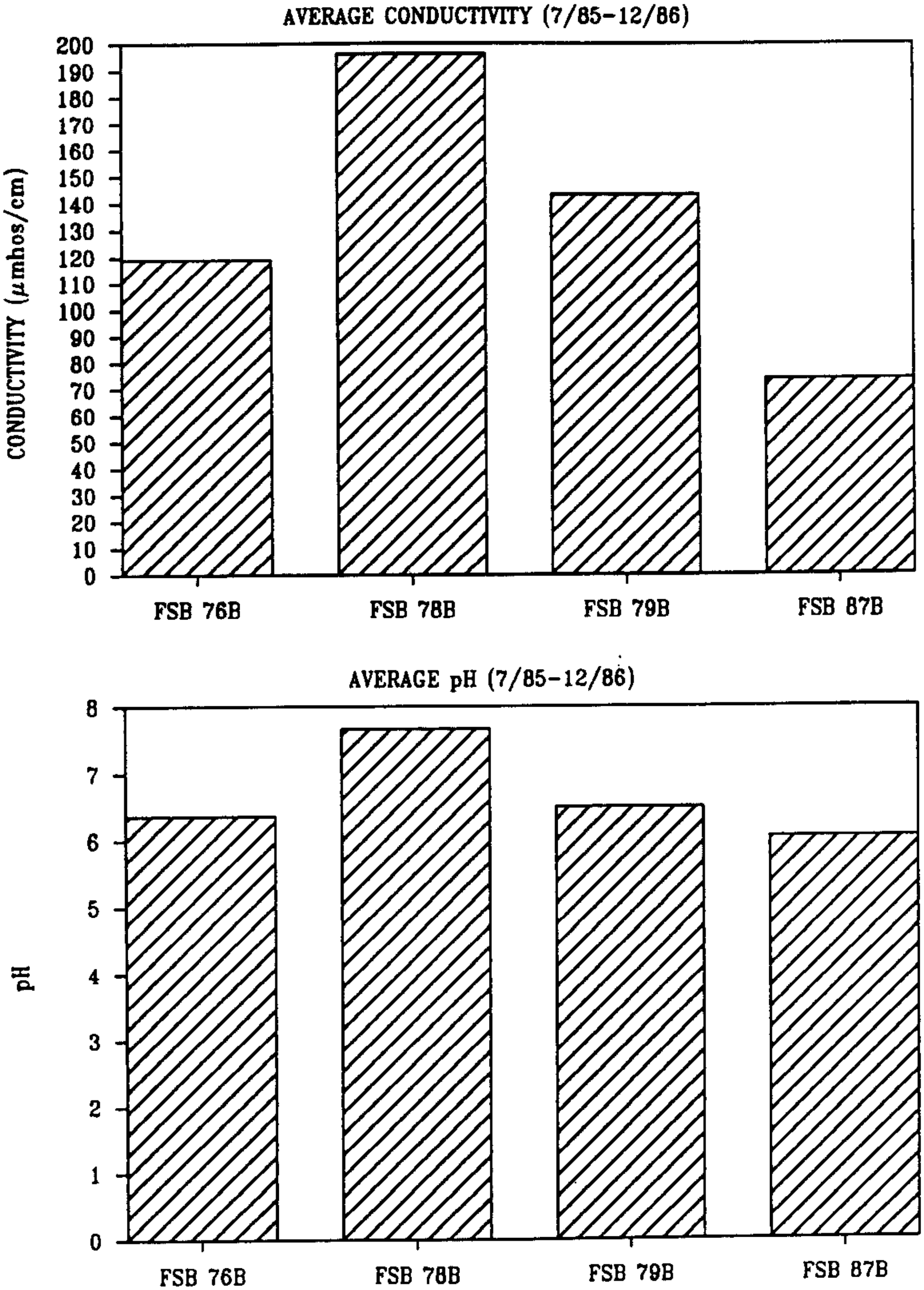


FIGURE 8-46. Average Conductivity and pH in the F-Area Seepage Basins Congaree Formation Monitoring Wells

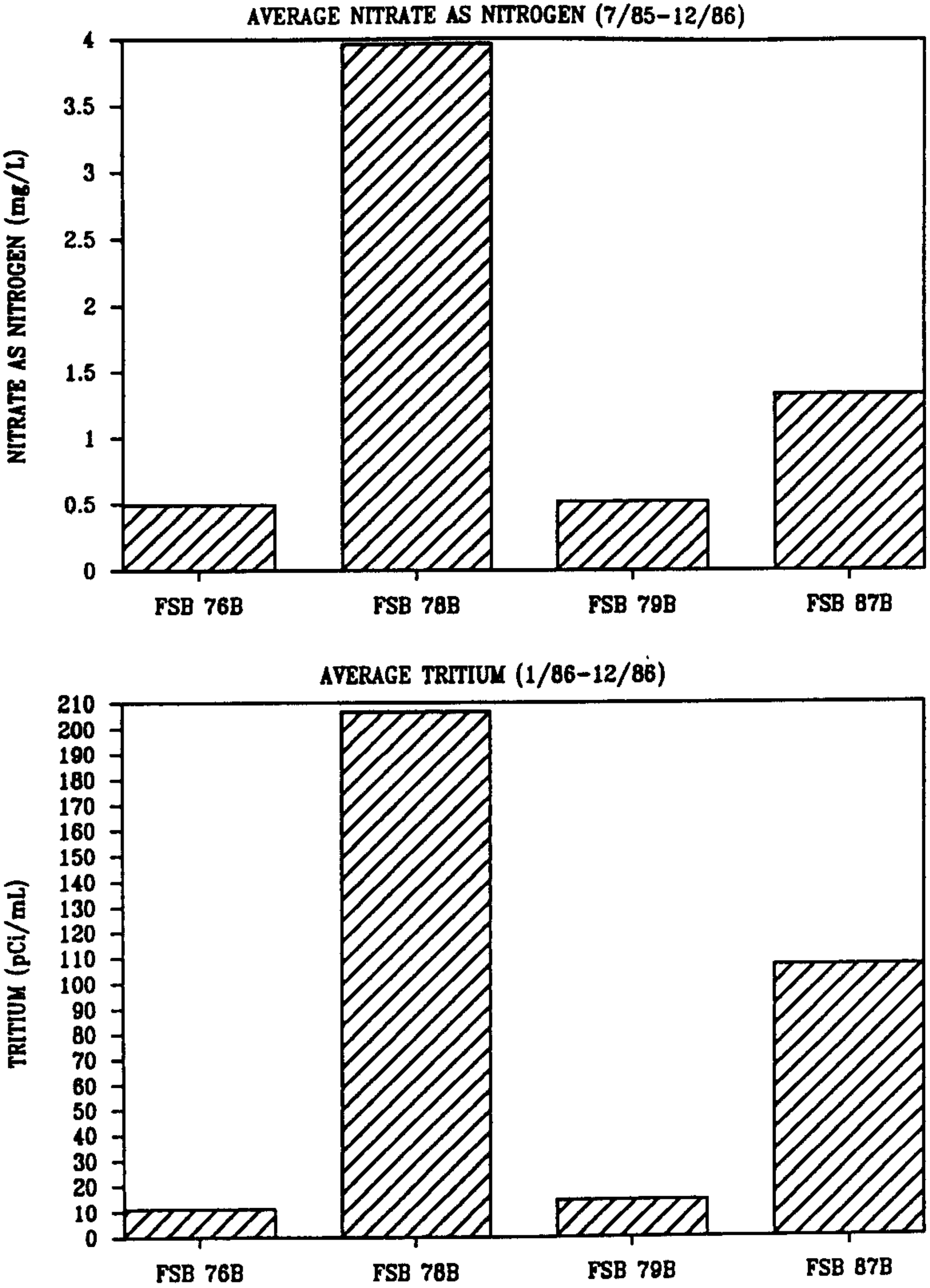


FIGURE 8-47. Average Nitrate (as N) Concentrations and Tritium Activities in the F-Area Seepage Basins Congaree Formation Monitoring Wells

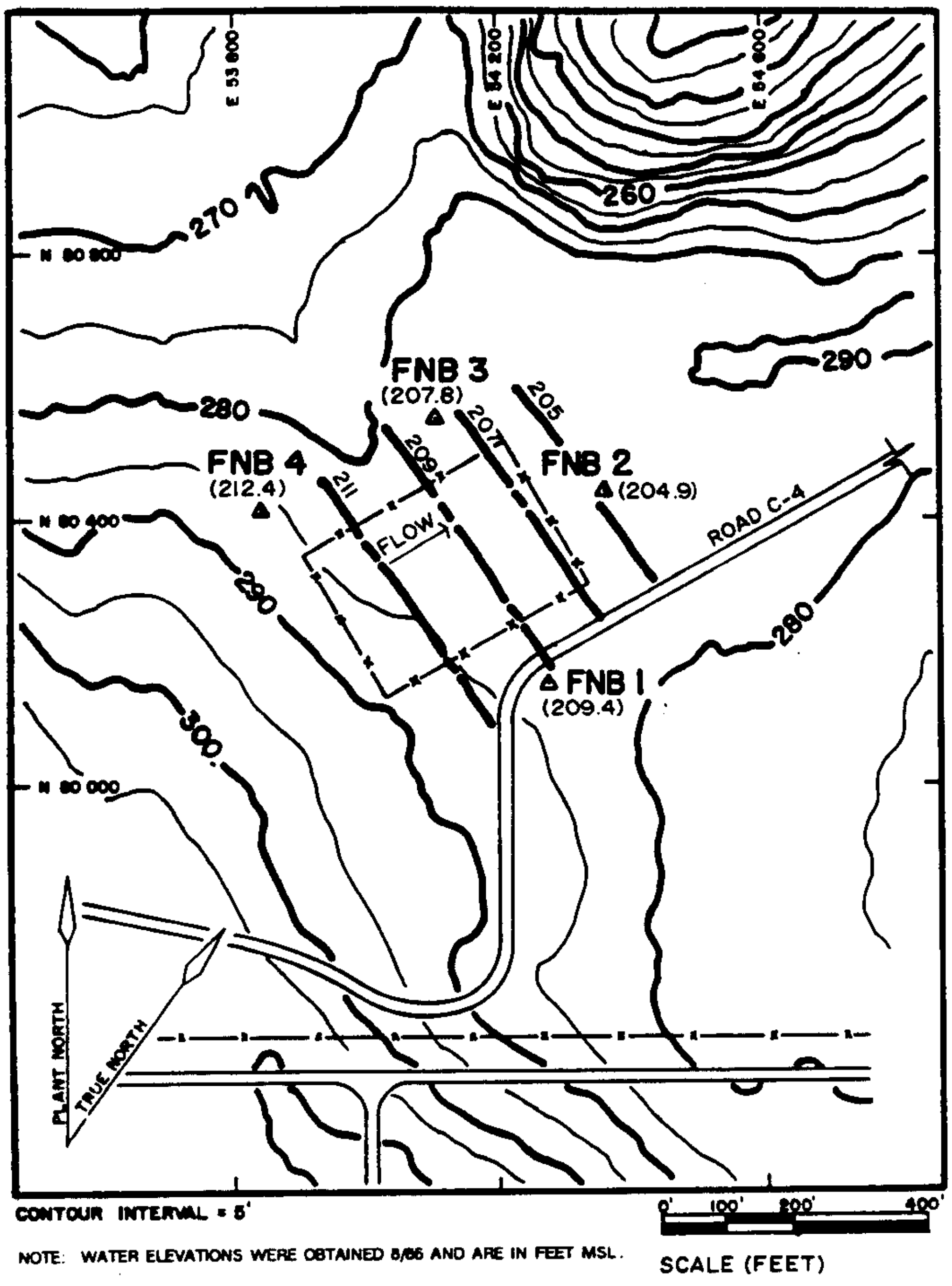


FIGURE 8-48. Old F-Area Seepage Basins Water-Table Elevation Map

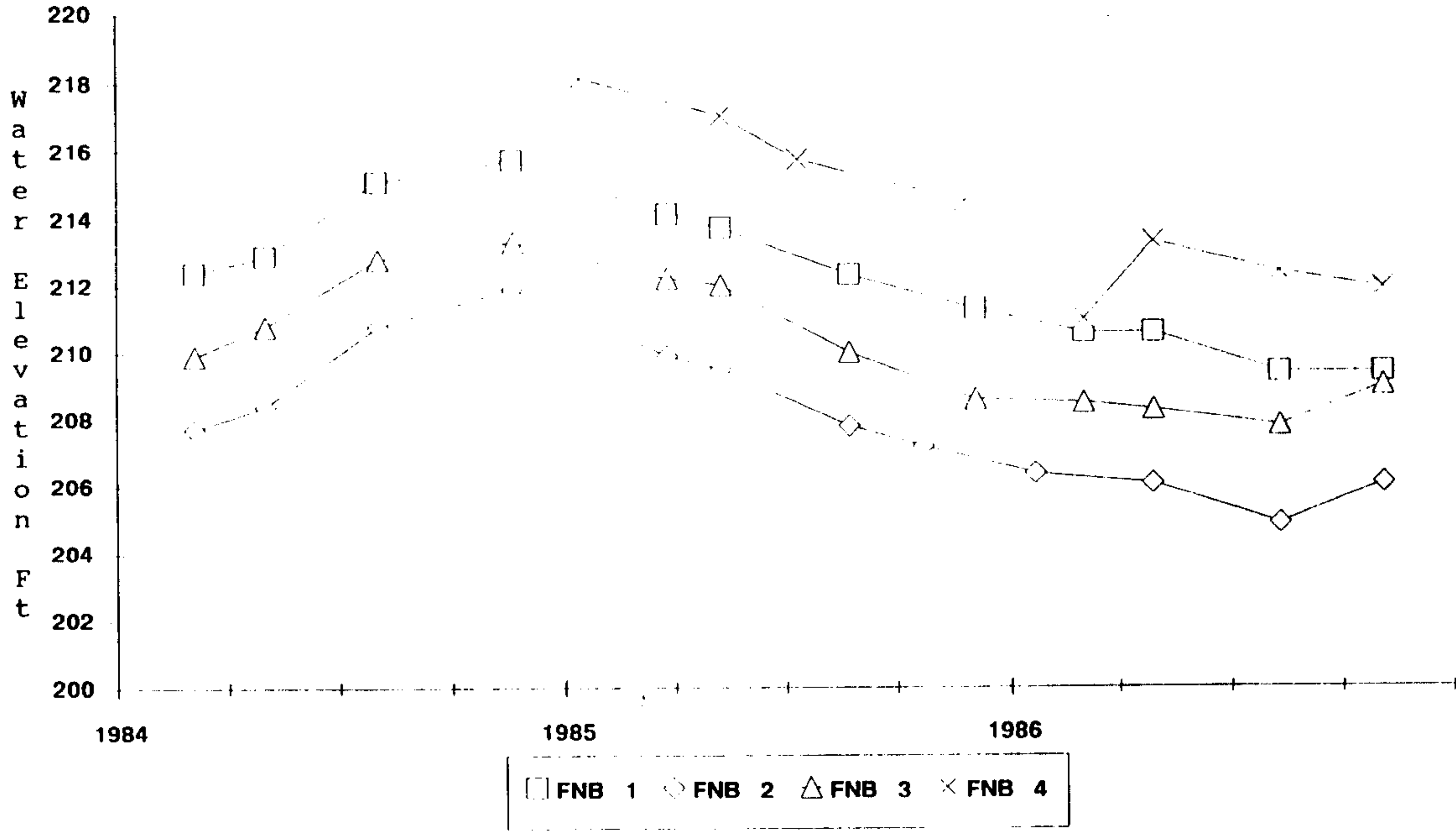


FIGURE 8-49. Hydrograph of the Old F-Area Seepage Basin Wells

SECTION 9 H AREA

9.01 GENERAL INFORMATION

9.01.01 General Area Description

H Area is located in the central part of SRS as shown in Figure 9-1. Surface elevations across H Area range approximately from 240 to 290 ft msl. H Area is flanked to the north by Upper Three Runs Creek and to the south by Four Mile Creek. Surface drainage from H Area is toward tributaries of these two streams.

There are 11 H-Area waste sites as indicated in Figure 9-2:

L The H-Area Retention Basins (2 basins)

L The H-Area Acid/Caustic Basin

L The H-Area Coal Pile Runoff Containment Basin

L The H-Area Ash Basin

L The H-Area Tank Farm

L The H-Area Seepage Basins (4 basins)

L The H-Area Erosion Control Site (See Section 15)

9.01.02 General Hydrologic Conditions

By the end of 1986, 144 monitoring wells had been installed around the H-Area waste sites to delineate the subsurface conditions and to monitor groundwater elevation and quality. Eighty-six of the 144 wells are currently being monitored. The remaining 58 monitoring wells have been abandoned, as discussed in the following specific waste-site sections. According to the surface geologic map presented by Siple (1967), the water-table monitoring wells in H Area were installed in the Barnwell Formation. Section 3 contains a detailed discussion of the hydrostratigraphy beneath SRS.

The water-table elevation in H Area has ranged approximately from 275 to 225 ft msl, and the vadose zone has been approximately 15 ft thick. As shown in Figure 9-2, H Area is located near a water-table divide between Upper Three Runs Creek and Four Mile Creek. Near-surface groundwater from the south part of H Area discharges to an unnamed tributary of Four Mile Creek approximately 1,000 ft south of H Area. Near-surface groundwater from the north part of H Area discharges to one of two tributaries of Upper Three Runs Creek, which are approximately 1,500 and 4,000 ft north of H Area, respectively.

Mathematical modeling of the Barnwell Formation in this area indicates that the horizontal groundwater flow velocity ranges approximately from 15 to 60 ft/yr per percent gradient (Duffield et al., 1986; Parizek and Root, 1986). Because the hydraulic gradient across H Area is variable, the near-surface groundwater flow velocity across H Area will vary. The horizontal flow direction and estimated flow velocity of the water table at each H-Area waste site are discussed in the following specific waste-site sections.

9.01.03 Migration Potential of Dissolved Chemical Constituents from H Area

The potential for any dissolved constituents to be naturally discharged from a waste site to nearby surface water from the near-surface groundwater system depends upon the location of the waste site, the hydraulic gradient, and the flow path between the waste site and the discharge point. Horizontal and vertical groundwater flow velocities depend upon the distribution and hydraulic properties of the medium through which the groundwater travels (i.e., sand, silt, or clay). Similarly, interactions with the soil/sediment medium (retardation) will affect the horizontal and vertical movements of dissolved chemical constituents.

The nearest plant boundary to H Area is approximately 8 mi to the west. Because of the large number of incised tributaries and streams between the plant boundary and H Area, migration of dissolved constituents through the near-surface groundwater system to the plant boundary is not likely.

The dissection of the Aiken Plateau by Upper Three Runs Creek and Four Mile Creek creates a groundwater island in the McBean Formation in this area. Water enters this formation on the Aiken Plateau and flows toward either of the two creeks, discharging to the surface water. The valley of Upper Three Runs Creek cuts into the Congaree Formation and creates a groundwater sink that separates water in that formation beneath H Area from the offplant areas to the north and northwest. Natural horizontal flow in the Tuscaloosa Formation is southerly toward the Savannah River. In the Separations Areas of the plant (F and H areas), a head reversal occurs in the lower aquifers, which helps prevent contamination of the lower aquifers in this area.

9.02 H-AREA RETENTION BASINS

9.02.01 Summary

The unlined H-Area Retention Basin (Building 281-3H) provided temporary storage for potentially radioactive contaminated cooling water and rainwater runoff from the chemical separation process area from 1955 until 1973. Depending on its radioactivity level, wastewater in the basin was either returned to H Area for processing or released to a tributary of Four Mile Creek. Only trace quantities of chemicals are believed to have been discharged to the basin. The unlined H-Area Retention Basin was deactivated in 1973 and replaced by a lined basin. The older, unlined basin is inactive, uncovered, and contains water. The newer, lined basin (Building 281-8H) is currently active and receiving potentially contaminated discharged cooling water and rainwater runoff. The H-Area Retention Basins are fenced, and vegetation surrounds the site (Scott et al., 1987b).

Water collected from the unlined basin in 1979 contained 0.8 pCi/mL of gross alpha activity and 120 pCi/mL of ^{137}Cs activity. Radiological surveys of soil and vegetation performed around the basins in 1977 recorded a maximum of 90 mrad/hr of radiation at 8 cm from the basin edge and 8,200 to 8,900 pCi/g of ^{137}Cs and 58,000 pCi/g of $^{89,90}Sr$ in nearby vegetation. Soil samples collected from the unlined basin floor in 1979 contained gross alpha activity of 6,700 pCi/g and gross beta activity of 54,000 pCi/g.

A comparison between groundwater quality in upgradient well HR3 11 and the other site wells indicates that the H-Area Retention Basins have been affecting groundwater quality near downgradient well HR8 14. In addition, the data suggest that downgradient well HR8 13 has been influenced by radioactivity from the basins, although gross alpha and nonvolatile beta levels in well HR8 13 have decreased consistently with time since December 1985. Radioactivity in the other wells has not shown any consistent increasing or decreasing trends over the monitoring period. Groundwater quality in sidegradient well HR8 11 and downgradient well HR8 12 has not been influenced by the H-Area Retention Basins. Upgradient well HR3 13 apparently has been affected by the leaching of well grout. Tritium activity in all of the H-Area Retention Basin wells except downgradient well HR8 14 remained above the drinking water standard of 20 pCi/mL. Elevated tritium activity in the upgradient wells, the sidegradient well, and only two of the three downgradient wells is indicative of a tritium source other than the basins.

9.02.02 Waste-Site Description and Nature of Disposal

The open, unlined H-Area Retention Basin (Building 281-3H) provided temporary storage for potentially radioactive contaminated cooling water and rainwater runoff from the chemical separation process area from 1955 to 1973. Depending on the level of radioactivity, wastewater was either returned to H Area for further processing or released to a local surface stream. The total quantity of cooling water disposed to this basin is unknown. The volume and radioactivity of the water in the intermittent discharge varied. Only trace quantities of chemicals are believed to have been discharged to this basin (Scott et al., 1987b). In 1973, the unlined H-Area Retention Basin was deactivated and replaced by a lined basin. The lined H-Area Retention Basin (Building 281-8H) has a discharge pathway to the H-Area Seepage Basins (Scott et al., 1987b).

The unlined and lined H-Area Retention Basins are on a west-trending slope in the west part of H Area. Surface elevations range approximately from 250 to 270 ft msl at these sites (Figure 9-3). The older, unlined H-Area Retention Basin has nominal dimensions of 120 ft by 200 ft. The newer, lined basin has nominal dimensions of 425 ft by 300 ft. The H-Area Retention Basins are flanked by two intermittent streams that flow into an unnamed tributary of Four Mile Creek.

The unlined basin is inactive and contains rainwater and local surface drainage. The lined basin is currently active and receives potentially contaminated discharged cooling water and rainwater runoff. The H-Area Retention Basins are fenced, and vegetation surrounds the site (Scott et al., 1987b).

9.02.03 Groundwater Monitoring Program

Six wells (HR3 and HR8 series) were installed around the H-Area Retention Basins (Figure 9-3) during the fourth quarter of 1984 to monitor the water-table elevation and groundwater quality. These six wells were constructed using PVC casings and 30-ft screens. Originally sampled in 1985 as part of the radioactive monitoring program, they were included in the SRS quarterly groundwater monitoring program in the third quarter of 1985.

9.02.04 Site-Specific Hydrology

Measurements obtained from the H-Area Retention Basin wells since the third quarter of 1985 indicate that the water-table elevation has ranged approximately from 260 to 237 ft msl and that the vadose zone has been approximately 15 ft thick. A hydrograph for the H-Area Retention Basin wells is presented in Figure 9-4. All of the wells are screened below the water table, making interpretation of the site hydrology difficult. However, because the screen-zone elevations are similar and the vadose zone in this area is thin, the water elevations in these wells should closely approximate the water-table elevation. A water-table elevation contour map for the second quarter of 1986 is shown in Figure 9-3. The water-level data indicate that the horizontal groundwater flow direction has been to the southwest toward a tributary of Four Mile Creek. Fluctuations in water levels indicate that minor changes in flow direction and gradient have occurred.

The water-level data indicate that wells HR3 11 and HR3 13 have been upgradient of both basins, and well HR8 11 has been sidegradient. Wells HR8 13 and HR8 14 have been downgradient of the unlined basin; wells HR8 12 and HR8 13 have been downgradient of the lined basin. The horizontal hydraulic gradient of the water table beneath the basins has been approximately 0.025 ft/ft. Using a groundwater flow velocity range estimated for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the basins has ranged approximately from 37.5 to 150 ft/yr.

9.02.05 Waste-Site Content Characterization Data

Radionuclide activities in a water sample taken from the unlined H-Area Retention Basin in 1979 were 1.0 pCi/mL for ^{134}Cs, 120 pCi/mL for ^{137}Cs, and 5.0 pCi/mL for ^{144}Ce. Gross alpha activity in the water sample measured 0.8 pCi/mL. The basin water sample was not analyzed for nonvolatile beta activity (Scott et al., 1987b).

9.02.06 Soil/Sediment Characterization Data

Soil cores were taken from the unlined H-Area Retention Basin in 1973. Based on radioactivity analyses of these soil cores, the radionuclide inventory was estimated to be 0.35 to 0.5 Ci of ^{238}Pu, 8.5 to 10 Ci of ^{137}Cs, and 2.5 to 3.5 Ci of $^{89,90}Sr$ (Scott et al., 1987b).

In 1977, radiological surveys of soil and vegetation around the H-Area Retention Basins were performed. Radiation was measured at levels of up to 90 mrad/hr at 8 cm from the edge of the basin. Vegetation near the basin exhibited elevated levels of ^{137}Cs (8,200 to 8,900 pCi/g) and $^{89,90}Sr$ (58,000 pCi/g). Sediments within an area of about 930 m^2 around the basin contained radioactivity (Scott et al., 1987b).

In 1979, soil was moved from the unlined basin floor to the sides of the basin. Soil/sediment samples were taken from the basin and analyzed prior to the movement of soil. Soil from the basin floor contained gross alpha activity of 6,700 pCi/g and nonvolatile beta activity of 54,000 pCi/g (Scott et al., 1987b).

9.02.07 Groundwater Monitoring Results

The SRS quarterly groundwater monitoring program data from 1985 and 1986 for the H-Area Retention Basins wells are included in Appendix G. Groundwater characterization data from this program are summarized in Table 9-1. Data for 1985 from the radioactive monitoring program are summarized in Table 9-2.

Monitoring well locations relative to the H-Area Retention Basins are presented in Figure 9-3, along with the predominant near-surface groundwater flow direction. As shown in Figure 9-3 and discussed in Section 9.02.04, wells HR3 11 and HR3 13 have been upgradient of the basins, well HR8 11 sidegradient, and wells HR8 12 through HR8 14 downgradient of one or both basins. Wells HR3 11 and HR3 13 are the only upgradient wells; however, the elevated pH reported for well HR3 13 (8.6 to 10.0) relative to the other wells (Figure 9-5) indicates that groundwater samples from this well may have been affected by leaching of the surrounding grout column. Elevated conductivity in samples from well HR3 13 (121 to 250 μmhos/cm) compared to conductivity levels in background well HR3 11 (30 to 55 μmhos/cm) is further indication that groundwater samples from well HR3 13 have been affected by well grout. Although well grout has elevated the pH of groundwater samples from upgradient well HR3 13, the samples have consistently met dissolved chemical constituent and radioactivity drinking water standards except for tritium (48 to 52 pCi/mL), which has a drinking water standard of 20 pCi/mL.

A comparison of the monitoring data between upgradient well HR3 11 and the other site wells was used to evaluate the effect of the H-Area Retention Basins on local groundwater. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess local groundwater quality. Indicator parameters are gross alpha, gross beta, tritium, total radium, and conductivity. Radionuclide parameters were used because radioactivity is known to be related to past site activities (Section 9.02.02).

The monitoring data summarized in Tables 9-1 and 9-2 indicate that water quality from upgradient well HR3 11 has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for tritium. Low average conductivity (39.2 μmhos/cm) was reported for well HR3 11 (Figure 9-5). Gross alpha activity in upgradient well HR3 11 ranged from 0.26 to 6.0 pCi/L, excluding a single and inconsistently high value of 238 pCi/L reported in September 1985, which was over the drinking water standard (15 pCi/L). Similarly, nonvolatile beta activity in well HR3 11 ranged from 0.85 to 5.0 pCi/L, excluding an inconsistently high value of 96.0 pCi/L also reported in September 1985. Total radium levels for well HR3 11 ranged from <1.0 to 8.0 pCi/L, occasionally exceeding the drinking water standard of 5 pCi/L. Tritium activity in upgradient well HR3 11 (24 to 28 pCi/mL) was consistently above the drinking water standard of 20 pCi/mL.

A comparison of the groundwater quality monitoring data between upgradient well HR3 11 and the other site wells indicates that the H-Area Retention Basins have affected groundwater quality near downgradient well HR8 14. In addition, the data suggest that downgradient well HR8 13 has been influenced by radioactivity from the basins. Groundwater quality near wells HR8 11 and HR8 12 apparently has not been influenced by the H-Area Retention Basins.

Groundwater samples from downgradient well HR8 14 have contained gross alpha, total radium, lead, nitrate, and manganese levels above their respective drinking water standards. Elevated conductivity levels (215 to 520 μmhos/cm) also have been reported for well HR8 14 compared to the other site wells. Figure 9-5, which is a graphic comparison of average conductivity values among the H-Area Retention Basins wells, illustrates the relative differences in water quality among well HR8 14 and the other basin wells. Gross alpha (2.3 to 28.8 pCi/L) and total radium (8.0 to 21.0 pCi/L) levels in well HR8 14 have been above the drinking water standards of 15 pCi/L and 5 pCi/L, respectively. A comparison of average radioactivity levels among well HR8 14, the other site monitoring wells, and the drinking water standards (Figure 9-6) clearly indicates that the gross alpha and total radium activities have been higher in well HR8 14. Nonvolatile beta activity in downgradient well HR8 14 ranged from 7.0 to 20.0 pCi/L (Tables 9-1 and 9-2). This was the only site well, however, in which tritium activity (2 to 5 pCi/mL) did not exceed the drinking water standard (20 pCi/mL). Radioactivity in downgradient well HR8 14 has not shown any consistent increasing or decreasing trends over the monitoring period. As previously discussed, radioactivity is known to be related to past site activities.

Lead levels in downgradient well HR8 14 (0.036 to 0.065 mg/L) did not meet the drinking water standard of 0.05 mg/L on a few occasions. Lead concentrations above the drinking water standard were also reported in downgradient wells HR8 12 and HR8 13 and sidegradient well HR8 11. Nitrate (38.5 to 51.0 mg/L) and manganese (0.099 to 0.118 mg/L) levels in downgradient well HR8 14 were consistently above the drinking water standards of 10 mg/L and 0.05 mg/L, respectively. Nitrate and manganese levels in the other H-Area Retention Basins wells remained below the drinking water standards. Lead, nitrate, and manganese are not known to be related to past site activities.

The monitoring data for downgradient well HR8 13 indicate low dissolved chemical constituent levels compared to drinking water standards except for lead (0.035 to 0.222 mg/L). A low conductivity range of 43 to 62 μmhos/cm was reported for downgradient well HR8 13. However, elevated radioactivity was observed in well HR8 13 compared to the drinking water standards and levels observed in upgradient well HR3 11. Gross alpha (0.24 to 49.0 pCi/L) and total radium (2.3 to 13.0 pCi/L) activities in well HR8 13 ranged above their respective drinking water standards of 15 pCi/L and 5 pCi/L. Figure 9-6 illustrates the differences in average gross alpha and total radium activities among downgradient well HR8 13, upgradient well HR3 11, and the drinking water standards. Gross alpha and total radium activities in well HR8 13 have consistently decreased since December 1985 and have met drinking water standards since March 1986. Tritium activity in well HR8 13 (37 to 40 pCi/mL) was above the drinking water standard of 20 pCi/mL. As previously discussed, tritium activity was also above the drinking water standard in upgradient well HR3 11, indicating a source of tritium other than the basins. Nonvolatile beta activity in well HR8 13 ranged from 4.1 to 26.0 pCi/L.

Monitoring data for sidegradient well HR8 11 and downgradient well HR8 12 show that groundwater quality in these wells has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for tritium and lead. Low conductivity levels were reported for wells HR8 11 (22 to 36 μmhos/cm) and HR8 12 (25 to 42 μmhos/cm). Tritium activities in wells HR8 11 (66 to 71 pCi/mL) and HR8 12 (36 to 42 pCi/mL) were above the drinking water standard of 20 pCi/mL (Tables 9-1 and 92). Lead concentrations in wells HR8 11 (0.017 to 0.058 mg/L) and HR8 12 (0.041 to 0.090 mg/L) were occasionally above the drinking water standard (0.05 mg/L).

Except for an isolated excursion in well HR8 12 (36.0 pCi/L), gross alpha levels in wells HR8 11 and HR8 12 remained below the drinking water standard of 15 pCi/L. Similarly, except for an isolated excursion of total radium in well HR8 12 (8.0 pCi/L), total radium levels in wells HR8 11 and HR8 12 remained below the drinking water standard of 5 pCi/L. Nonvolatile beta activity ranged from 1.6 to 11.0 pCi/L in well HR8 11 and from <3.0 to 23.0 pCi/L in well HR8 12. Radioactivity in sidegradient well HR8 11 and downgradient well HR8 12 has not shown any consistent increasing or decreasing trends over the monitoring period.

9.02.08 Planned Action

The unlined H-Area Retention Basin is inactive. As indicated in Section 16, a site assessment is planned for 1988, from which a closure plan will be developed. Use of the lined retention basin will continue; no additional study or action is planned for this site. Groundwater monitoring will continue at these sites.

9.03 H-AREA ACID/CAUSTIC BASIN

9.03.01 Summary

The H-Area Acid/Caustic Basin (Building 904-75G) received dilute sulfuric acid and sodium hydroxide solutions used to regenerate ion-exchange units in the water purification process areas. This basin allowed for the mixing and neutralization of the dilute solutions before their discharge to a tributary of Four Mile Creek. Constructed between 1952 and 1954, the basin received acid/caustic discharges until new neutralization facilities became operational in 1982. Influent process piping from chemical pad drainage and from steam condensate from a hose box were deactivated in 1986. The H-Area Acid/Caustic Basin is currently inactive and contains water (Ward et al., 1987).

Basin surface water and soil/sediments were sampled in August 1985. Basin water data indicate that all tested parameters were low except for iron at 0.44 mg/L. Concentrations of tested parameters for the H-Area Acid/Caustic Basin soil/sediments generally were consistent with background levels, although sulfate (12.6 mg/L) and sodium (44.8 mg/L) concentrations were somewhat elevated. Extraction Procedure (EP) toxicity test results for metals and pesticides indicate that concentrations in the basin soil/sediments were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

Groundwater monitoring has not been conducted at the H-Area Acid/Caustic Basin.

9.03.02 Waste-Site Description and Nature of Disposal

The H-Area Acid/Caustic Basin (Building 904-75G) was constructed between 1952 and 1954 (Ward et al., 1987). The basin is located within the H-Area operations fence line in a relatively flat area at an elevation of approximately 295 ft msl (Figure 9-7). The H-Area Acid/Caustic Basin is an unlined earthen depression approximately 50 ft long by 50 ft wide by 7 ft deep, resulting in a maximum storage capacity of approximately 17,500 ft^3 (0.13 million gal). The basin was formed by removing existing soil below grade and building sloped side walls. The soils in the area are predominantly composed of brownish-to-yellow mottled sandy clay, with a clay content of about 40%.

Dilute sulfuric acid and sodium hydroxide solutions were used to regenerate ion exchange units in the H-Area water purification process area. The H-Area Acid/Caustic Basin provided containment for the mixing and neutralization of the spent solutions before their discharge to a tributary of Four Mile Creek.

Calculated annual acid and caustic discharge rates to the basin are summarized in Table 9-3. Approximately 5 gal/yr of water containing 1% sodium dichromate and 10% phosphoric acid also were discharged into the basin via chemical pad drainage. However, this volume is minor relative to the estimated 2.4 million gal of spent regenerant solutions discharged annually to the basin. Effluent resulting from discharges and rainwater runoff intermittently flowed from the basin to the tributary of Four Mile Creek through an overflow weir set to maintain a maximum working water depth of 3 ft in the basin. Detailed effluent records for the H-Area Acid/Caustic Basin were not maintained.

Discharges to the basin were terminated in 1982 when a new neutralization facility was installed in H Area. Influent process piping to the H-Area Acid/Caustic Basin from chemical pad drainage in Building 244-H and from steam condensate from a hose box were deactivated in April 1986 and November 1986, respectively.

The basin is currently inactive and contains water. The side slopes of the basin are well vegetated above the water line.

9.03.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the H-Area Acid/Caustic Basin.

9.03.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the H-Area Acid/Caustic Basin; therefore, groundwater conditions beneath the site are undefined.

9.03.05 Waste-Site Content Characterization Data

Data from analyses of water samples collected from the H-Area Acid/Caustic Basin in August 1985 are listed in Table 9-4. These data indicate that surface water chemical constituent concentrations generally were low except for iron at 0.44 mg/L. Levels of anticipated indicator parameters such as calcium (5.30 mg/L), magnesium (0.728 mg/L), sulfate (12.6 mg/L), and sodium (44.8 mg/L) were somewhat elevated compared to background levels. Section 9.03.02 contains information on the basin influent data.

9.03.06 Soil/Sediment Characterization Data

H-Area Acid/Caustic Basin soil/sediments were sampled in August 1985. Three 5-ft continuous borings were obtained near the basin inlet and outlet structures and along one side wall. Soil boring samples were separated into 0.5-ft intervals for analysis. Soil/sediment analytical results, including EP toxicity test results for metals, are summarized in Table 9-5. EP toxicity test results for metals and pesticides indicate concentrations less than RCRA hazardous waste classification criteria (40 CFR 261.24). Concentrations of other soil/sediment parameters tested were generally consistent with background soil levels, including indicator parameters such as magnesium (20.8 to 1,060 μg/g), sulfate (53.6 to 134.3 μg/g), and sodium (946 to 4,540 μg/g).

Small amounts of sodium dichromate and phosphoric acid were also discharged to the H-Area Acid/Caustic Basin. However, chromium (15.0 to 37.6 μg/g) and phosphate (24.0 to 138 μg/g) levels in the basin soil/sediments were consistent with background soil concentrations.

9.03.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the H-Area Acid/Caustic Basin.

9.03.08 Planned Action

The H-Area Acid/Caustic Basin is inactive. As indicated in Section 16, a site assessment has been completed, and a closure plan is to be developed in 1987. Monitoring wells are scheduled for installation in 1988.

9.04 H-AREA COAL PILE RUNOFF CONTAINMENT BASIN

9.04.01 Summary

The H-Area Coal Pile Runoff Containment Basin (Building 289-H) receives runoff from the H-Area coal storage pile (Christensen and Gordon, 1983). The groundwater monitoring data indicate that the H-Area Coal Pile Runoff Containment Basin has had no effect on groundwater quality in upgradient to sidegradient well HCB 3 and sidegradient to downgradient well HCB 1. Dissolved chemical constituent levels in wells HCB 3 and HCB 1 have consistently met South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards except for manganese and iron in well HCB 1. Upgradient to sidegradient well HCB 2 has apparently been affected by coal pile runoff since November 1983, although the positioning of this well indicates that the effect is attributable to the H-Area coal storage pile and not the runoff containment basin.

A comparison of average indicator parameter concentrations between well HCB 3 and downgradient well HCB 4 suggests that there has been a slight influence from the basin on groundwater quality in well HCB 4. However, sampled groundwater from well HCB 4 has been characterized by low dissolved chemical constituent and indicator parameter concentrations relative to South Carolina and federal drinking water standards. In addition, indicator parameter levels in this well have steadily decreased since February 1985.

9.04.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in the powerhouses. The H-Area coal supply is stored in an open pile. The coal is generally moderate-to-low sulfur coal (1-2%) received via rail from Kentucky, Pennsylvania, and Virginia. Coal is placed on a hopper, sprayed with water to control coal dust, and loaded onto a pile at the H-Area facility (Christensen and Gordon, 1983).

The facility generally contains a 90-day reserve of coal. The coal pile is not rotated, resulting in long-term exposure of the unused coal to the environment. Weathering allows for the formation of sulfuric acid caused by the oxidation of sulfur materials in the coal. Rainfall then washes the acid from the coal pile into the coal pile runoff containment basins via gravity flow ditches and sewers.

Prior to the construction of the coal pile runoff containment basins, rainfall runoff from coal storage piles flowed to nearby onsite streams. The National Pollutant Discharge Elimination System (NPDES) permit issued in 1977 specifies limits on pH and suspended solids for coal pile runoff up to the maximum 24-hr, 10-yr recurrence event (5.9 in. for SRS). Suspended solids are limited to 50 mg/L, and pH is limited to between 6 and 9. To achieve compliance, the H-Area CPRB was constructed in 1981 to contain coal pile runoff and prevent direct discharge to a small, unnamed tributary of Upper Three Runs Creek. This containment basin allows for the passive equalization of runoff prior to its seepage into the subsurface where it can undergo natural renovation. There has been minimal discharge from the H-Area CPRB to this unnamed tributary.

The H-Area CPRB (Building 289-H) is on an east-trending slope, and ground surface elevations range approximately from 275 to 278 ft msl near the basin (Figure 9-8). Surface drainage is to the east toward an unnamed tributary of Upper Three Runs Creek. The basin is approximately 1,000 ft east of the coal storage area and occupies about 1.3 acres. The total runoff containment volume is about 240,000 ft^3 (1.8 million gal). The coal pile that drains to this basin occupies approximately 1.3 acres and typically contains approximately 12,000 tons of low-sulfur (1-2%) coal (Christensen and Gordon, 1983).

Coal pile runoff samples were collected on October 2, 1985, to characterize the H-Area CPRB influent and to establish indicator parameters for identifying the effects on the groundwater from the H-Area CPRB. The first individual grab sample was collected 15 to 30 min after the beginning of a storm and the second several hours after the end of the storm. In addition, a composite sample was taken during the period between the two individual sampling times.

The H-Area CPRB influent characterization data are presented in Table 9-6. These analytical results indicate that dissolved metals concentrations were low except for cadmium, chromium, and selenium. Elevated levels of conductivity, total dissolved solids (TDS), iron, and sulfate and low pH are typical of coal pile runoff and are the indicator parameters used to assess the effect of the basin on the local groundwater. Basin influent samples were not filtered prior to analysis and may have contained insoluble, particulate matter.

9.04.03 Groundwater Monitoring Program

Four wells (HCB 1 through HCB 4) were installed in September 1981 to monitor the water-table elevation and groundwater quality at the H-Area CPRB (Figure 9-8). These wells were constructed using PVC casings and 30-ft screens.

In 1982, SRS initiated a quarterly groundwater monitoring program, and the HCB wells are sampled as part of this program. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

9.04.04 Site-Specific Hydrology

Measurements obtained from the H-Area CPRB wells since May 1982 indicate that the water-table elevation was 270 ft msl and that the vadose zone was approximately 8 ft thick until the middle of 1984 when a decline in water-table elevation began. A hydrograph for the H-Area CPRB wells (Figure 9-9) shows that the water-table elevation has ranged approximately from 256 ft to 275 ft msl, or approximately 5 to 20 ft below the ground surface. As indicated, wells HCB 2 and HCB 3 have maintained higher water-level elevations since the first quarter of 1985. Figure 9-8 presents a water-table elevation contour map for the first quarter of 1985 and shows that the horizontal near-surface groundwater flow direction has been to the north-northeast. Well HCB 1 is screened lower than the other HCB wells, which could account for the lower water elevation in this well. Relative to the basin, wells HCB 2 and HCB 3 are upgradient to sidegradient, well HCB 1 is sidegradient to downgradient, and well HCB 4 is downgradient. The variability in water-level elevations indicates that minor shifts in groundwater flow direction and gradient have occurred.

The approximate hydraulic gradient of the water table beneath the basin has been 0.01 ft/ft. Using a horizontal groundwater flow velocity range estimated for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the horizontal groundwater flow velocity beneath the basin has ranged approximately from 15 to 60 ft/yr.

9.04.05 Waste-Site Content Characterization Data

The contents of the H-Area CPRB have not been sampled. Section 9.04.02 contains information on the basin influent characterization data.

9.04.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been performed at the H-Area CPRB.

9.04.07 Groundwater Monitoring Results

The groundwater monitoring results from 1982 through 1986 are included in Appendix G. Groundwater chemical characterization data since July 1984 are summarized in Table 9-7.

Comparisons of the monitoring results between upgradient to sidegradient well HCB 3 and the other H-Area CPRB wells were used to evaluate the effect on the groundwater from the H-Area CPRB. South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters are pH, sulfate, iron, conductivity, and total dissolved solids (TDS). Monitoring data from upgradient to sidegradient well HCB 2 were not used for background characterization because of the possible effects of direct coal pile runoff on this well.

The groundwater data summarized in Table 9-7 indicate that there has been no apparent effect on water quality from coal pile runoff in wells HCB 3 and HCB 1. Groundwater from wells HCB 3 and HCB 1 has met South Carolina and federal drinking water standards for dissolved chemical constituents and radioactivity except for manganese and iron. The low dissolved chemical constituent levels in these wells are reflected by the low total dissolved solids (TDS) levels of <5 to 20 mg/L for well HCB 3 and 6 mg/L for well HCB 1 compared to the secondary drinking water standard of 500 mg/L. Likewise, sulfate concentrations in well HCB 3 (<5.0 mg/L) and well HCB 1 (3.0 to 10.0 mg/L) met the secondary drinking water standard of 250 mg/L. The relatively low conductivity levels, ranging from 29 to 130 μmhos/cm in well HCB 3 and from 37 to 72 μmhos/cm in well HCB 1, provide further indication that the H-Area CPRB has had no apparent effect on groundwater quality near these wells.

Groundwater pH in wells HCB 1 and HCB 4 ranged between 3.9 and 4.9, while ranging from 3.5 to 6.5 in well HCB 3; pH values as low as 4.0 are generally consistent with naturally occurring Barnwell Formation groundwater pH levels (Appendix B). Iron levels in well HCB 1 (0.053 to 0.542 mg/L) ranged above the drinking water standard of 0.3 mg/L. Iron concentrations as high as 0.52 mg/L occur naturally in Barnwell Formation groundwater (Appendix B) and are not independently a strong indication of CPRB impact. Manganese concentrations in well HCB 1 (0.254 to 0.361 mg/L) and downgradient well HCB 4 (0.033 to 0.202 mg/L) were above the drinking water standard of 0.05 mg/L.

A comparison of the water-quality data between well HCB 3 and downgradient well HCB 4 suggests that the H-Area CPRB has had some effect on well HCB 4. Although dissolved chemical constituent concentrations in well HCB 4 met drinking water standards except for manganese, indicator parameter concentrations were slightly elevated. TDS levels ranged from 136 to 164 mg/L, sulfate concentrations ranged from <5 to 45 mg/L, and conductivity ranged from 22 to 270 μmhos/cm. Figures 9-10 through 9-12, which are graphic comparisons of the average indicator parameter concentrations, show the effect of the H-Area CPRB on downgradient well HCB 4. The indicator parameter concentrations in this well have been steadily declining since February 1985.

Indicator parameter concentrations reported for well HCB 2 generally were high compared to both drinking water standards and water-quality data from the other H-Area CPRB wells. Conductivity levels in well HCB 2 ranged from 180 to 2,900 μmhos/cm. Sulfate levels in well HCB 2, ranging from 78.0 to 2,260 mg/L, ranged over the secondary drinking water standard of 250 mg/L. Iron levels, ranging from 0.139 to 0.436 mg/L, ranged above the secondary drinking water standard of 0.3 mg/L. Groundwater pH values in well HCB 2 (2.8 to 4.3) generally were lower than the pH values reported for the other H-Area CPRB wells.

Figures 9-10 through 9-12 show the differences in groundwater quality between well HCB 2 and the other H-Area CPRB wells. Well HCB 2 is approximately 75 ft upgradient to sidegradient of the H-Area CPRB, but the H-Area coal storage pile is approximately 925 ft upgradient of this well. Because of its hydraulic positioning, well HCB 2 probably is being affected by direct coal pile runoff and not by seepage from the H-Area CPRB. As indicated in Figure 9-10, TDS levels in well HCB 2 (108 to 118 mg/L) were not elevated relative to well HCB 4 and the secondary drinking water standard of 500 mg/L. However, the data base for TDS analyses is limited; from 1984 through 1986, TDS levels were analyzed on only two occasions. Indicator parameter concentrations in well HCB 2 generally have been higher since November 1983. Prior to this date, indicator parameter levels in well HCB 2 were similar to the levels indicated for the other H-Area CPRB wells.

Gross alpha (35.0 to 189 pCi/L) and total radium (50.0 to 68.0 pCi/L) activities were above their respective drinking water standards in well HCB 2. Radioactivity is not known to be related to past site activities.

Concentrations of organics in all of the H-Area CPRB wells were relatively low, as indicated by the low levels of dissolved organic carbon (DOC; <5.0 mg/L), total organic carbon (TOC; 0.290 to 30.67 mg/L), total organic halogens (TOH; <0.005 to 0.033 mg/L), phenols (<0.002 mg/L), GC Scan (below 45 μg/L), and extractable pesticides (all reported levels were less than detection limits).

9.04.08 Planned Action

The H-Area CPRB is active. As indicated in Section 16, an ongoing site assessment is scheduled for completion in 1988. Groundwater monitoring will continue at this site.

9.05 H-AREA ASH BASIN

9.05.01 Summary

The H-Area Ash Basin (Building 288-H) has received ash sluice water from the H-Area powerhouse since plant startup in 1951. The annual ash disposal rate into the H-Area Ash Basin has been about 13,000 yd^3/yr (Christensen and Gordon, 1983). The H-Area Ash Basin is currently active and receiving ash sluice water. Groundwater monitoring and soil characterization have not been conducted at the H-Area Ash Basin.

9.05.02 Waste-Site Description and Nature of Disposal

Electricity and steam at SRS are generated by burning coal in powerhouses, which produces dry ash. Ash sluice water from the H-Area powerhouse has been discharged to the H-Area Ash Basin since plant startup in

1951. The annual ash disposal rate into the H-Area Ash Basin has been approximately 13,000 yd^3/yr. Overflow from this basin has been discharged through National Pollutant Discharge Elimination System (NPDES) Outfall No. H-8 (Christensen and Gordon, 1983).

The H-Area Ash Basin (Building 288-H) is south of the H-Area perimeter fence (Figure 9-2). The surface elevation near the basin is approximately 290 ft msl and slopes to the southwest toward a tributary of Four Mile Creek. The nearest plant boundary to the H-Area Ash Basin is approximately 7.5 mi to the west. The H-Area Ash Basin is currently active and receiving ash sluice water.

Ash sluice water contains fly and bottom ash. Horton, Dorsett, and Cooper conducted a study in 1977 to identify trace metals present in the fly and bottom ash disposed to the SRS ash basins and piles. Table 9-8 lists typical trace metal concentrations obtained for fly and bottom ash. These results indicate significant levels of barium, strontium, manganese, zinc, vanadium, cerium, and chromium (Horton et al., 1977).

9.05.03 Groundwater Monitoring Program

Groundwater monitoring has not been conducted at the H-Area Ash Basin.

9.05.04 Site-Specific Hydrology

There are no groundwater monitoring wells at the H-Area Ash Basin; therefore, near-surface groundwater conditions beneath the waste site are undefined.

9.05.05 Waste-Site Content Characterization Data

Sampling and analysis of the H-Area Ash Basin contents have not been conducted. Section 9.05.02 contains information on the nature of materials disposed at the site.

In conjunction with 1980 monitoring for NPDES permit renewal, analyses were performed on H-Area Ash Basin effluent. Results of these analyses are presented in Table 9-9. These results indicate that levels of the tested parameters were low except for iron (1.3 mg/L). Most tested organics were below detection limits.

9.05.06 Soil/Sediment Characterization Data

Soil/sediment sampling and analysis have not been conducted at the H-Area Ash Basin. The materials and nature of disposal into the H-Area

Ash Basin are similar to those of the D-Area Ash Basin (488-D); therefore, Extraction Procedure (EP) toxicity test results from analyses performed on the 488-D Ash Basin sludge are presented in Table 9-10. The data in Table 9-10 demonstrate that extractable metal concentrations in the D-Area Ash Basin were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24).

9.05.07 Groundwater Monitoring Results

Groundwater monitoring has not been conducted at the H-Area Ash Basin.

9.05.08 Planned Action

The H-Area Ash Basin is active, and continued use is planned. No other action is scheduled for this site.

9.06 H-AREA TANK FARM

9.06.01 Summary

The H-Area Tank Farm (Building 241-H) contains 29 large, subsurface tanks for the storage of aqueous, radioactive wastes. These liquid wastes are produced primarily from nuclear fuel reprocessing operations and consist of sludges, supernatant liquid of varying salt concentrations, and salt cake. The sludges stored in the H-Area Tank Farm are primarily a mixture of oxides and hydroxides of manganese, iron, and aluminum and a small amount of uranium, plutonium, and mercury, with almost all of the fission products originally in the irradiated fuel except cesium. The supernate is primarily a solution of sodium nitrate, sodium nitrite, sodium hydroxide, sodium aluminate, and most of the soluble fission products including the major cesium isotopes. The solution volume is reduced in the tank farm evaporators, then stored in tanks to precipitate the sodium nitrate and sodium nitrite. This precipitate forms the salt cake (ERDA, 1977).

Seven tanks in the H-Area Tank Farm have experienced some leakage from the primary tank to the annular space inside the secondary container. The observed leaks have occurred through small hairline cracks that usually are adjacent to welds. The rate of leakage has been small except for the leakage from Tank 16. Minor leakage was detected in November 1959 from the primary tank to the annular space inside the secondary container and concrete vault of Tank 16. During September 1960, a large number of small leaks resulted in a leak rate of approximately 4 gal/min, and the level of waste in the annular space exceeded the 5-ft height of the steel pan for approximately 6 hr while a transfer jet was being installed in the annulus to remove the leaked waste. The waste rose above the top of the steel pan liner, and some overflowed into the clearance space between the concrete tank and the steel pan. Leakage from the primary tank was stopped by reducing the liquid level inside the tank below the major leak sites (ERDA, 1977).

In December 1983, a waste spill occurred around Tank 13 when a feed pump froze. The only contaminant detected was ^{137}Cs. Some of the waste was transported by rain to drainage ditches on either side of the tank that lead to Four Mile Creek. Flow from the drainage ditches was diverted to the retention basin, but 236 mCi of ^{137}Cs are estimated to have reached the creek (Zeigler et al., 1985).

Groundwater monitoring data indicate that the H-Area Tank Farm has influenced local groundwater quality, particularly in areas surrounding three specific tank groups: Tanks 13 through 16, Tanks 21 through 24, and Tanks 29 through 31. Elevated radioactivity in these specific regions is caused by nonvolatile beta activity near Tanks 13 through 16 and tritium activity near Tanks 21 through 24 and Tanks 29 through 31. Gross alpha activity in all of the site wells remained less than the drinking water standard of 15 pCi/L over the monitoring period except for well HPM 12 in 1984, which had gross alpha activity up to 160 pCi/L following the spill around Tank 13, and well HTF 5, which had a maximum gross alpha activity of 40 pCi/L, also in 1984.

9.06.02 Waste-Site Description and Nature of Disposal

Liquid radioactive wastes at SRS result primarily from the nuclear fuel reprocessing operations taking place in F and H areas. Currently, SRS has 51 large, subsurface tanks for the storage of these aqueous, radioactive wastes, which consist of sludges, supernatant liquids of varying salt concentrations, and salt cake. Twenty-nine of these tanks are located in H Area, and the remaining 22 are in F Area. The waste tanks were built below ground using carbon steel and reinforced concrete. Four different tank designs are used at SRS. Three of these tank designs (Types I, II, and III) incorporate a primary and secondary containment compartment consisting of concentric steel cylinders. All three of these designs use forced water-cooling systems and are primarily for high-heat waste and waste concentrate. The Type-III tank was developed following an investigation into the possible causes of leaks in the Type-I and Type-II primary tanks. The Type-IV tank, which is not cooled, is a single-wall, vertically cylindrical tank made of steel-lined, prestressed concrete. Type-IV tanks are primarily used for the storage of low-heat waste (ERDA, 1977).

The recovery processes in the H-Area hot and warm canyons generate aqueous waste streams that contain most of the fission products. Waste products coming from the warm canyon are referred to as low-heat waste (LHW), and the waste products received from the hot canyon are termed high-heat waste (HHW). The only significant difference between the two waste products is that the HHW discharge requires auxiliary heat removal. Both types of waste are regarded as high-level liquid waste and must be stored indefinitely. The wastes are alkaline and flow by gravity from the H-Area processing building to the H-Area Tank Farm. The flow pipes are underground and are enclosed in a secondary concrete conduit (ERDA, 1977).

High-heat waste from the hot canyon is received in cooled waste storage tanks (Types I, II, or III). Fresh waste is aged for 1 to 2 yr to allow for settling and for the decay of short-lived fission products. The insoluble waste settles, forming a layer of sludge on the bottom of the tank.

The sludge is a mixture of oxides and hydroxides of manganese, iron, and aluminum and a small amount of uranium, plutonium, and mercury, with almost all of the fission products originally in the irradiated fuel except cesium. Following the aging process, the supernate, consisting of dissolved salts and radioactive cesium, is channeled to a continuous evaporator. Condensate from the evaporator is passed through an ion-exchange column to remove entrained cesium before the condensate is discharged to the H-Area Seepage Basins. If the process waste contains mercury, a mercury trap is placed in the system up-line of the cesium-removal column. Concentrate from the evaporator is transferred to a cooled waste storage tank, where the suspended salts settle out and additional salts crystallize as cooling occurs. The supernate is then returned to the evaporator for further concentration (ERDA, 1977). Low-heat waste is processed using a similar technique except that the low-heat salts are accumulated in the uncooled waste tanks (Type IV).

Seven tanks in the H-Area Tank Farm have experienced some leakage from the primary tank to the annular space inside the secondary container. The observed leaks have occurred through small hairline cracks that usually are adjacent to welds. The rate of leakage has been small except for the leakage from Tank 16. Minor leakage was detected in November 1959 from the primary tank to the annular space inside the secondary container and concrete vault of Tank 16. During September 1960, a large number of very small leaks resulted in a leak rate of about 4 gal/min, and the level of waste in the annular space exceeded the 5-ft height of the steel pan for approximately 6 hr while a transfer jet was being installed in the annulus to remove the leaked waste. The waste rose above the top of the steel pan liner, and some overflowed into the clearance space between the concrete tank and the steel pan. Leakage from the primary tank was stopped by reducing the liquid level inside the tank below the major leak sites (ERDA, 1977). To help contain the contamination, well HP 3 and riser 5 were pumped continuously to create a cone of depression in the groundwater, and the groundwater produced was treated and released to the seepage basins.

In 1961 and 1962, leakage was observed by periscope on the primary tank walls of Tanks 14 and 16. No leak sites were visible during limited inspections of Tanks 9 and 10, even though these two tanks contained appreciable amounts of dried waste that had leaked into their secondary pans and that was visible in the annular spaces (ERDA, 1977).

To prevent possible future overfilling of the tank pans in the event of major primary tank leaks, 75 gal/min jets have been installed in the annular spaces of the tanks so that leaked liquid waste may be rapidly returned to primary storage. All tank annuli are purged with air to dehumidify the space and evaporate any leakage to dry, immobile salt.

In December 1983, a waste spill occurred around Tank 13 when a feed pump froze. The only contaminant detected was ^{137}Cs. Some of the waste was transported by rain to drainage ditches on either side of the tank that lead to Four Mile Creek. Flow from the drainage ditches was diverted to the retention basin, but 236 mCi of ^{137}Cs are estimated to have reached the creek (Zeigler et al., 1985).

The H-Area Tank Farm is in the southwest corner of the H-Area perimeter fence (Figure 9-2). The tank farm is on a topographic divide between Upper Three Runs and Four Mile Creek. Surface drainage from the H-Area Tank Farm is to the southwest toward Four Mile Creek.

9.06.03 Groundwater Monitoring Program

Fifty-five monitoring wells have been installed at the H-Area Tank Farm to monitor the water-table elevation and groundwater quality. Thirty-three wells are currently active; 22 wells have been abandoned.

Well 241-H is a shallow (approximately 6-ft deep) monitoring well located in the middle of Tanks 9 through 12. Installed in 1959 with a steel casing, this well is still in use. Five TW wells (1, 3, 4, 5, and 6) were also installed around this time using steel casings. These wells surrounded Tanks 13 through 16 and were abandoned in approximately 1980.

The four HP wells (1, 3, 5, and 8) were installed in September 1960 following the spill around Tank 16. Constructed using aluminum casings and 4-ft screens, they were drilled about 5 ft from the tank encasement and down to the concrete pad. Three months later, wells HPM 1 through 12 were installed at the perimeter of the concrete pad (Figure 9-13). These wells also were constructed using aluminum casings with 4-ft or 10-ft screens. Both the HP and HPM well series were abandoned in 1985 because of failed groutings around the well casings.

Seventeen HTF series wells (HTF 1 through HTF 17) were installed in 1973 with galvanized steel casings and 20-ft screens. Wells HTF 17 through HTF 34 were installed in late 1984 and 1985 using PVC casings and 20- or 30-ft screens (Figure 9-14). There is no well HTF 33; well HTF 30 was abandoned in 1986.

The H-Area Tank Farm wells are monitored under the radioactive monitoring program. Gross alpha, nonvolatile beta, tritium, pH, and the specific radionuclides listed in Appendix G are monitored monthly.

9.06.04 Site-Specific Hydrology

Measurements obtained from the H-Area Tank Farm wells since August 1985 indicate that the water-table elevation has ranged approximately from 283 to 256 ft msl and that the vadose zone has been 30 to 70 ft thick. A water-table elevation contour map for the second quarter of 1986 (Figure 9-14) shows that the H-Area Tank Farm lies in an area of divergent groundwater flow: the horizontal near-surface groundwater flow in the west part of the facility is to the northwest, while the horizontal near-surface groundwater flow in the east part of the facility is to the northeast. Hydrographs of the HTF wells are shown in Figures 9-15 through 9-20. The water elevations remained relatively constant from 1977 through 1984 but have declined since that time.

The hydraulic gradient in the east part of the facility appears to increase to the northeast in the direction of flow, approximately from 0.005 to 0.025 ft/ft. Using a flow velocity range estimated for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the flow velocity across the southeast area has been approximately 7.5 to 150 ft/yr. The gradient in the west part of the facility has been approximately 0.01 ft/ft. The corresponding flow velocity for the west part of the facility has been approximately 15 to 60 ft/yr.

9.06.05 Waste-Site Content Characterization Data

Information regarding the nature of wastes disposed to the H-Area Tank Farm is presented in Section 9.06.02.

9.06.06 Soil/Sediment Characterization Data

Soil/sediment sampling has been conducted at the H-Area Tank Farm in connection with the two waste spills at the site: around Tank 16 in 1960 and around Tank 13 in 1983. Drilling around Tank 16 in 1960 revealed elevated nonvolatile beta activity and contamination of the concrete slab beneath the tank.

The only contaminant detected from the 1983 spill around Tank 13 was ^{137}Cs. Most of the spill was confined to the drainage ditches, which lead to Four Mile Creek. The drainage ditch flow was diverted to the retention basin, but approximately 236 mCi of ^{137}Cs reached the creek. Sediment sampling in the creek during 1984 revealed that the ^{137}Cs activity was caused by the resuspension of contaminated sediments already present in the system and was not directly related to the transport of ^{137}Cs from the spill area. Since October 1984, ^{137}Cs activity in the creek sediments has remained at or below the levels detected before the spill (Zeigler et al., 1985).

9.06.07 Groundwater Monitoring Results

The monitoring data from 1962 through 1986 for the H-Area Tank Farm wells are given in Table 9-11, which summarizes the gross alpha, nonvolatile beta, and tritium yearly activity averages and maximum values for the site wells. Currently active monitoring wells and tank locations are presented in Figure 9-14, along with the water-table elevation contours. As shown in Figure 9-14 and discussed in Section 9.06.04, near-surface groundwater in the west part of the facility flows to the northwest, while the near-surface groundwater in the east part of the facility flows to the northeast.

Groundwater monitoring data indicate that the H-Area Tank Farm has influenced local groundwater quality, particularly in areas surrounding three specific tank groups: Tanks 13 through 16, Tanks 21 through 24, and Tanks 29 through 31. Elevated radioactivity in these specific regions is caused by nonvolatile beta activity near Tanks 13 through 16 and tritium activity in the vicinity of Tanks 21 through 24 and 29 through 31. Gross alpha activity in all of the site wells remained less than the drinking water standard of 15 pCi/L over the monitoring period except for well HTF 5 in 1984, which had a maximum gross alpha reading of 40 pCi/L, and well HPM 12 in 1984, which contained gross alpha activity up to 160 pCi/L following the spill around Tank 13. Well HPM 12 was abandoned in 1985 because of failed grouting around the casing; thus, it is possible that this value is not indicative of the groundwater at the site but represents contamination of the well from surface runoff. For this same reason, the elevated levels of nonvolatile beta and tritium recorded for the HP and HPM wells in 1984 are suspect.

Nonvolatile beta and tritium levels in monitoring wells HTF 22 through HTF 32, which surround Tanks 38 through 43 and 48 through 51, have generally remained consistent with site background levels over the monitoring period. Average nonvolatile beta activities in these wells ranged from 0.03 to 5.80 pCi/L. Average tritium activity in these wells was equal to or below the drinking water standard of 20 pCi/mL except for well HTF 23, which had average tritium activity ranging from 38 to 110 pCi/mL.

Nonvolatile beta and tritium activities in monitoring wells HTF 18 through HTF 21, which surround Tanks 35 through 37, also have remained consistent with site background levels. Average nonvolatile beta activities in wells HTF 18 through HTF 21 remained low, ranging from 1.7 to 5.8 pCi/L. Average tritium activity in these wells ranged from 13 to 33 pCi/mL; the values recorded for wells HTF 19 and HTF 20 remained below the drinking water standard of 20 pCi/mL.

From 1984 to 1986, groundwater from wells HTF 13 through HTF 15, which surround Tanks 29 through 32, has been characterized by average nonvolatile beta activities (0.77 to 2.00 pCi/L) consistent with area background levels and by elevated average tritium activities (37 to 76 pCi/mL) with respect to the drinking water standard (20 pCi/mL). Tritium activity in well HTF 13 has shown a generally increasing trend since 1980, from an average of 10 pCi/mL in 1980 to 46 pCi/mL in 1986. The maximum average tritium activity in these wells was reported in 1976 in well HTF 15 (303 pCi/mL), which is downgradient of Tanks 29 through 32. Tritium activity in this well has shown a consistent decreasing trend with time, from an average of 303 pCi/mL in 1976 to an average of 71 pCi/mL in 1986.

From 1984 through 1986, wells HTF 9 through HTF 12, which surround Tanks 21 through 24, had average nonvolatile beta activities consistent with area background levels and average tritium activities above the drinking water standard of 20 pCi/mL. Average nonvolatile beta activities in wells HTF 9 through HTF 12 ranged from 0.71 to 5.3 pCi/L over the monitoring period. From 1984 through 1986, average tritium activities in these four wells ranged from 52 to 290 pCi/mL. Tritium activity in wells HTF 9, HTF 10, and HTF 12 has shown a general increasing trend since 1973. The maximum average tritium activity was detected in well HTF 12, which is downgradient of the tank group.

Groundwater in wells HTF 1 through HTF 4, which surround Tanks 9 through 12, has been characterized by nonvolatile beta activities generally consistent with site background levels and by tritium activities in excess of the drinking water standard of 20 pCi/mL. From 1984 through 1986, average nonvolatile beta activities in these wells ranged from 1.8 to 9.6 pCi/L except for well HTF 3 in 1986, which had an average nonvolatile beta activity of 36 pCi/L. Average tritium levels in wells HTF 1 through HTF 4 ranged from 26 to 90 pCi/mL. The maximum average tritium activity was detected in well HTF 1, which is downgradient of the four tanks.

Well 241-H is a shallow (approximately 6-ft deep) monitoring well located in the middle of Tanks 9 through 12. From 1984 through 1986 groundwater from this well has been characterized by low average gross alpha (0.19 to 0.54 pCi/L) and nonvolatile beta (7.9 to 15 pCi/L) activities. Tritium activity in this well averaged 450 pCi/mL in 1986; tritium activities were not determined in 1984 and 1985. Average tritium activities in well 241-H have shown a general increasing trend since 1973.

Wells HTF 5 through HTF 8 surround Tanks 13 through 16. One gross alpha excursion (40 pCi/L) occurred in well HTF 5 in 1984; otherwise, gross alpha activities in these wells were below the drinking water standard of 15 pCi/L. Average nonvolatile beta activities in wells HTF 5 and 6 from 1984 through 1986 ranged from 22 to 160 pCi/L and were consistently greater than background levels. Average nonvolatile beta activities in wells HTF 7 and 8 during this same time period ranged from 2.3 to 9.5 pCi/L. Average tritium activities (32 to 50 pCi/mL) were consistently above the drinking water standard of 20 pCi/mL in all of these wells except HTF 7. Average tritium activity in HTF 7 from 1984 through 1986 ranged from 8 to 12 pCi/mL, with only one reading (22 pCi/mL) over the drinking water standard recorded in 1984. Well HTF 34, which is downgradient of wells HTF 5 through HTF 8, had an average tritium activity of 27 pCi/mL is 1986, which is above the drinking water standard (20 pCi/mL). Wells HTF 5 and 6 are downgradient of Tanks 13 and 16, respectively, and their elevated levels of radioactivity are attributable to the spills around these two tanks.

Wells HTF 16 and 17 are located northwest of the waste storage tanks. Groundwater from these wells has been characterized by low gross alpha and nonvolatile beta activities. From 1984 through 1986 average gross alpha activity ranged from 0.33 to 0.78 pCi/L, and average nonvolatile beta activity ranged from 2.2 to 3.1 pCi/L. Average tritium levels were consistently above the drinking water standard (20 pCi/mL), ranging from 40 to 120 pCi/mL during this same time period.

9.06.08 Planned Action

The H-Area Tank Farm is active, and continued use is planned. Groundwater monitoring will continue at this site.

9.07 H-AREA SEEPAGE BASINS

9.07.01 Summary

The H-Area Seepage Basins (Buildings 904-44G, 904-45G, 904-46G, and 904-56G) routinely receive evaporator wastewater containing low-level radioactivity and chemicals from the H-Area separations facilities. Primary sources of effluent sent to the basins are the nitric acid recovery unit overheads, the general purpose evaporator overheads, the H-Area Tank Farm evaporator overheads, overheads from several other process evaporators, and retention basin transfers. The H-Area Seepage Basins are unlined earthen basins that allow slow seepage through the soil column, which immobilizes most radionuclides contained in the wastewater. In the case of tritium, which moves with the groundwater, the time required for groundwater to discharge to surface streams allows for some radioactive decay. The basins were placed in service during 1955, and Basins 1, 2, and 4 will remain in service until 1988. Basin 3 has been inactive since 1962. The H-Area Seepage Basins currently contain process wastewater and rainwater (Killian et al., 1987b).

Basin influent is analyzed routinely, and basin soil/sediments were sampled in 1984. Basin influent data indicate that the average concentrations of the following tested parameters were elevated: nitrate, lead, mercury, chromium, sodium, iron, and manganese. The following tested radioactive parameters also were elevated: gross alpha, tritium, and ^{90}Sr. The pH of the basin influent ranged from 1.96 to 5.48, averaging 2.37. Concentrations of many of the tested soil/sediment parameters for the H-Area Seepage Basins were significantly different from background levels. Extraction Procedure (EP) toxicity test results for metals indicate that concentrations in the basin soil/sediments were less than Resource Conservation and Recovery Act (RCRA) hazardous waste classification criteria (40 CFR 261.24) (Killian et al., 1987b).

The groundwater monitoring results for the HSB and H series water-table wells indicate that the H-Area Seepage Basins have affected the quality of the water table. Groundwater from the downgradient HSB water-table wells has been characterized by low pH and elevated conductivity and nitrate and sodium concentrations. Groundwater quality in the downgradient wells screened 20 to 30 ft lower in the water table apparently has been less affected than that in the water-table wells screened at higher elevations. Groundwater quality in the upgradient HSB water-table wells also apparently has not been affected by the seepage basins except for tritium in wells HSB 65, HSB 66, and HSB 65C. The H series and downgradient HSB series water-table wells have contained elevated levels of radioactivity, indicating they have been affected by the seepage basins.

The groundwater monitoring results for the McBean Formation wells indicate that the H-Area Seepage Basins have had no apparent effect on groundwater quality in the McBean Formation except for tritium, as evidenced by the low dissolved chemical constituent and radioactivity levels. Tritium activity in wells HSB 68B, HSB 83B, HSB 84B, HSB 85B, and HSB 86B exceeded the drinking water standard of 20 pCi/mL.

The groundwater monitoring results for the Congaree Formation wells suggest that groundwater quality in well HSB 68A has been affected by the seepage basins as evidenced by the elevated levels of tritium. Groundwater quality in wells HSB 65A, HSB 83A, HSB 85A, and HSB 86A apparently has not been affected by the H-Area Seepage Basins, as indicated by the low radioactivity and dissolved chemical constituent levels reported for these four wells compared to drinking water standards. Groundwater from well HSB 84A has been characterized by elevated levels of conductivity, sodium, nitrate, and radioactivity. It is uncertain whether the monitoring data from this well are indicative of Congaree Formation groundwater or if the well has been contaminated, possibly by surface runoff.

9.07.02 Waste-Site Description and Nature of Disposal

The H-Area Seepage Basins (Buildings 904-44G, 904-45G, 904-46G, and 904-56G) were constructed in 1955 by removing existing soils below grade and building sloped side walls at the surface. The soils in the area are predominantly composed of medium- to fine-grained, poorly sorted sand, with silt and clay content ranging from 30 to 50%. The basins are within an area of relatively high topographic relief, with surface elevations around the site ranging approximately from 250 to 265 ft msl (Figure 9-21). The H-Area Seepage Basins are four unlined earthen depressions with approximate dimensions of 240 ft long by 90 ft wide by 9 ft deep (Basin 1), 460 ft long by 110 ft wide by 9 ft deep (Basin 2), 480 ft long by 350 ft wide by 17 ft deep (Basin 3), and 2,400 ft long by 130 to 430 ft wide by 7 ft deep (arc-shaped, Basin 4). The combined maximum storage capacity of the four basins is approximately 4.8 million ft^3 (35.9 million gal).

The H-Area Seepage Basins have been in use since 1955 to contain effluent from the H-Area separations facilities. In 1958 2.5 ft of soil were added to the walls of Basin 3 to prevent overflow caused by reduced seepage. Algal growth and high pH contributed to the reduced seepage rate. Basin 3 was taken offline in 1962, and flow was routed from Basin 2 to Basin 4. In 1977 Basin 4 also experienced reduced flow because of high pH. Concentrated nitric acid was added to Basin 3 and Basin 4, but Basin 3 remained plugged. The seepage rates of the other basins have been constant since 1980 when a regular program of pH monitoring and acid additions was initiated (Holcomb and Emslie, 1984).

The primary sources of effluent sent to the basins are the nitric acid recovery unit overheads, the general purpose evaporator overheads, the Tank Farm evaporator overheads, and other process evaporator overheads. Retention basin transfers are also sent to the seepage basins.

The H-Area Seepage Basins receive significant amounts of nitric acid (HNO_3) and caustic (NaOH). The nitric acid is generated during the evaporation of process liquid wastes and enters the seepage basins from the acid recovery unit overheads. Nitrate releases to the basins vary but have averaged 234,300 kg/yr. Table 9-12 presents the estimated annual nitrate discharge rates from 1961 to 1983. Caustic is used to neutralize the high-level radioactive waste stream before it is stored in tanks and enters the seepage basins from the Tank Farm evaporator overheads. Combined discharges of caustic from F- and H-Area operations average 90,700 kg/yr (Killian et al., 1987b).

Mercury is used in H-Area operations as an aid in dissolving aluminum alloy fuels. The caustic also contains trace amounts of mercury as an impurity. Although most of the mercury is sent to the high-level waste tanks, some is released to the basins from the evaporator overheads. Table 9-13 lists the estimated mercury releases from 1955 to 1984. Radioactive releases to the H-Area Seepage Basins (1955 to 1985) are summarized in Table 9-14.

Basins 1, 2, and 4 are currently active and receiving wastewater. Basin 3 is currently inactive and contains rainwater. Discharge from the basins has been limited to groundwater seepage; no direct discharge to surface waters has occurred. Vegetation grows on the dikes and side slopes of the basins above the water line.

9.07.03 Groundwater Monitoring Program

Eighty wells (H and HSB series) have been installed to monitor the elevation and water quality of the water-table, McBean, and Congaree aquifers at the H-Area Seepage Basins (Figure 9-22).

The H series wells were installed to monitor the water table at the H-Area Seepage Basins as part of the radioactive monitoring program. Fifty-two H series wells have been installed around the basin since 1956; 16 are currently active. Wells H 1 through H 12 were installed in 1956 and 1957 using steel casings and 10-ft screens. Wells H 13 through H 19 were installed in 1962 using steel casings. Wells H 20 through H 51 were added in 1964 and were also steel cased. In 1985, well H 18 was abandoned and replaced with PVC-cased well H 18A, which was installed in the same hole as well H 18. Two of the currently active wells (H 12 and H 14) had their steel casings replaced with PVC casings in 1984 and 1985, respectively. The locations of the 16 currently active H series monitoring wells are shown in Figure 9-22.

Wells HSB 65, HSB 66, HSB 67, HSB 68, HSB 69, HSB 70, and HSB 71 were installed in 1981 to monitor the water table (Barnwell Formation). In the fall of 1984, six well clusters were installed to define the hydrostratigraphy and to allow monitoring of the deeper formations. Of these wells, HSB 65C, HSB 83D, HSB 84D, HSB 85C, HSB 86C, and HSB 86D monitor the water table; HSB 68C, HSB 83C, and HSB 84C were installed lower in the water-table aquifer; the HSB B-designated wells monitor the McBean Formation; and the HSB A-designated wells monitor the Congaree Formation. All of the HSB wells were constructed using PVC casings and 10- to 30-ft screens.

Well BG 10, although part of the Burial Grounds monitoring system, is adjacent to the east end of H-Area Seepage Basin 4. Analytical data from this monitoring well are often used to supply information for the seepage basins. Well BG 10 was installed in 1957 with a steel casing.

Monitoring began in the first quarter of 1982 for water-table wells HSB 65 through HSB 71. Monitoring for the remaining HSB wells began during the third quarter of 1985. Plantwide, samples for metals analyses were unfiltered through the second quarter of 1984, after which time filtering was included in the sampling and analysis program.

9.07.04 Site-Specific Hydrology

A water-table elevation contour map for the fourth quarter of 1985 is presented in Figure 9-23. As shown, the horizontal near-surface groundwater flow is to the south toward Four Mile Creek. Hydrographs generated with data from 1982 through 1986 for the H-Area Seepage Basins water-table wells are presented in Figures 9-24 through 9-29. Water-table elevations in the wells have ranged approximately from 245 to 220 ft msl. Fluctuations in water-table elevations indicate that minor changes in flow direction and hydraulic gradient have occurred. Relative to the seepage basins, wells HSB 65, HSB 65C, HSB 66, and HSB 85C have been consistently upgradient; wells HSB 71 and H 2 have been predominantly sidegradient; and the remaining water-table wells in the H and HSB series have been consistently downgradient of one or more of the basins. The horizontal hydraulic gradient has been about 0.008 ft/ft, increasing as the water table approaches Four Mile Creek. Using an estimated horizontal groundwater flow velocity range determined for the Barnwell Formation in this area of approximately 15 to 60 ft/yr per percent gradient, the near-surface horizontal groundwater flow velocity beneath the seepage basins has ranged approximately from 12 to 48 ft/yr.

Water-level elevation measurements obtained for the McBean Formation from the B-designated H-Area Seepage Basins wells indicate that the piezometric surface of the McBean aquifer has changed little since 1985 (Figure 9-30). A water-level elevation map generated for the McBean Formation from data obtained during the fourth quarter of 1985 is presented in Figure 9-31. As shown in Figure 9-31, the medium-depth, horizontal groundwater flow has been to the south-southeast toward Four Mile Creek. The horizontal hydraulic gradient has been about 0.006 ft/ft in the McBean Formation. Relative to the seepage basins, McBean Formation wells HSB 65B and HSB 85B have been upgradient; well HSB 83B has been sidegradient to downgradient; and wells HSB 68B, HSB 84B, and HSB 86B have been downgradient of one or more of the basins.

Upper and Lower Congaree Formation water-level elevation measurements obtained from the A-designated H-Area Seepage Basins wells indicate that the piezometric surface of the Congaree aquifers has changed little since 1985 (Figure 9-32). A Congaree Formation water-level elevation contour map for the fourth quarter of 1985 is presented in Figure 9-33, which shows that the deep groundwater flow has been to the northwest toward Upper Three Runs Creek. The hydraulic gradient has been approximately 0.003 ft/ft. All of the Congaree monitoring wells are downgradient of the basins or of water flowing from the basins in the upper aquifers.

9.07.05 Waste-Site Content Characterization Data

Section 9.07.02 contains information on the H-Area Seepage Basins influent. Chemical analytical data of seepage basin influent collected at a Trebler monitor upstream of Basin 1 are listed in Table 9-15. These data indicate that the average dissolved chemical constituent levels of nitrate (538 mg/L), lead (0.18 mg/L), mercury (0.043 mg/L), chromium (0.072 mg/L), sodium (17.6 mg/L), iron (5.1 mg/L), and manganese (0.560 mg/L) were elevated. The pH of the basin influent ranged from 1.96 to 5.48; the average pH was 2.37.

Data from radioactivity analyses of seepage basin influent collected at the Trebler monitor upstream of Basin 1 are presented in Table 9-16. These data indicate that the average gross alpha (1,333 pCi/L) and ^{90}Sr (6,670 pCi/L) activities were elevated. The average activities of the remaining tested radionuclides are given in Table 9-16.

Table 9-17 lists measured radioactivity levels in H-Area Seepage Basins 1 through 4 from 1957 through 1986. Measured levels of radioactivity historically have been highest in Basin 1, the first basin on line, and lowest in Basin 3, because this basin has been inactive since 1962. From 1984 through 1986, Basin 1 contained gross alpha activity up to 3,000 pCi/L and tritium activity up to 110,000 pCi/mL. Average nonvolatile beta activity (up to 34,000 pCi/L) was elevated in Basin 1 during this same time period. In Basin 3, gross alpha activity (0.0 to 1,100 pCi/L) has declined since 1984, while the nonvolatile beta (250 to 2,500 pCi/L) and tritium (3,800 to 5,300 pCi/mL) activities have declined since 1985 but are still elevated.

9.07.06 Soil/Sediment Characterization Data

H-Area Seepage Basins soil/sediments were sampled in 1984 as part of a basin characterization program. Thirteen 3-ft continuous cores were taken from the floors of the basins. Approximately 90% of the radionuclides, cations, and anions were contained within the top foot of soil (Corbo et al., 1985). Table 9-18 presents the concentration ranges found in these cores. Extraction procedure (EP) toxicity test results for extractable metals indicated concentrations less than Resource Conservation and Recovery Act (RCRA) criteria for classifying hazardous waste (40 CFR 261.24).

9.07.07 Groundwater Monitoring Results

The groundwater monitoring data for the H series wells from 1956 through 1986 are presented in Table 9-19. Data from the HSB series wells from 1982 through 1986 are presented in Appendix G, and data from 1984 through 1986 are summarized in Tables 9-20 through 9-23.

South Carolina (R. 61-58) and federal (40 CFR 141-143) drinking water standards were used to assess groundwater quality. Indicator parameters for the H-Area Seepage Basins are conductivity, nitrate, sodium, and radioactivity. Nitrate, sodium, and radioactivity were chosen as indicator parameters because elevated levels of these constituents were discharged to the H-Area Seepage Basins (see Sections 9.07.02 and 9.07.05). Conductivity was chosen because it is a good indicator of groundwater quality.

Water-Table Wells

The locations of the monitoring wells screened in the water table relative to the H-Area Seepage Basins are shown in Figure 9-22. A water-table elevation map indicating the predominant water-table flow direction is shown in Figure 9-23. As indicated in Figure 9-23, relative to the basins, wells HSB 65, HSB 65C, HSB 66, and HSB 85C have been upgradient; well HSB 71 has been predominantly sidegradient; well H 2 has been sidegradient of and adjacent to Basin 1; and the remaining water-table wells in the HSB and H series have been consistently downgradient of one or more of the basins. The H series wells are part of the radioactive monitoring program; the HSB series wells are part of the nonradioactive monitoring program. Well BG 10 is part of the Burial Grounds monitoring well series for the radioactive program, but it is adjacent to and sidegradient of Basin 4. Because of its close proximity to the basins, the radioactive data from this well are included with the radioactive data from the H series wells given in Table 9-19.

The H series wells and well BG 10, which have been used to obtain groundwater radioactivity measurements for the water table at the H-Area Seepage Basins, indicate that the basins have had an effect on groundwater quality. Table 9-19 summarizes the average annual gross alpha, nonvolatile beta, and tritium activities for these wells from 1956 through 1986. Analyses for some additional radionuclides were conducted on groundwater from the H series wells, and these results also are given in Table 9-19. As discussed in Section 9.07.03, well H 18A replaced well H 18 in 1985 and was installed in the same hole. Therefore, analytical results from wells H 18 and H 18A have been combined.

Gross alpha activity has exceeded the drinking water standard of 15 pCi/L in wells H 1, H 4 through H 6, and H 8 through H 10. From 1984 to 1986, gross alpha activity exceeded the drinking water standard in wells H 4 (averaging 14 to 23 pCi/L), H 6 (averaging 31 to 75 pCi/L), and once in H 9 (20 pCi/L). The gross alpha activities in wells H 4 and H 6 have shown a general increasing trend. Well H 4 is downgradient of and adjacent to Basin 1; well H 6 is downgradient of and adjacent to Basin 2.

Nonvolatile beta activities were elevated in many of the H series monitoring wells. From 1984 through 1986 all of the H series wells had average nonvolatile beta activities over 30 pCi/L except for the following: wells H 10, H 11, and H 13 through H 19. Average tritium activities in the H series wells were above the drinking water standard of 20 pCi/mL except for well H 18A in 1985, which had an average tritium activity of 4 pCi/mL but a maximum value of 66 pCi/mL. Excluding the 1985 average of 4 pCi/mL for well H 18A, from 1984 through 1986 the average tritium activities ranged from 33 to 50,000 pCi/mL in the H series wells and from 21,000 to 38,000 pCi/mL in well BG 10. The maximum recorded values during this time were 110,000 pCi/mL for the H series wells and 150,000 pCi/mL for well BG 10. The average tritium activities have shown an overall declining trend in wells H 9 through H 11, H 15, H 17, and H 18/18A. These wells are downgradient of Basin 3, which has been out of service since 1962.

The groundwater monitoring results for the HSB series water-table wells since the third quarter of 1984 are summarized in Tables 9-20 and 9-21. The monitoring data summarized in these tables indicate that the H-Area Seepage Basins have been affecting the quality of the water table, as indicated by the low pH and elevated levels of radioactivity, conductivity, nitrate, and sodium reported for most of the downgradient wells screened in the upper part of the water table. Groundwater from the wells screened in the lower part of the water table (wells HSB 68C, HSB 83C, and HSB 84C) apparently has been less affected.

Groundwater from the upgradient wells (HSB 65, HSB 66, HSB 65C, and HSB 85C) has been characterized by low radioactivity and dissolved chemical constituent levels compared to drinking water standards except for tritium in wells HSB 65, HSB 65C, and HSB 66 and an isolated excursion of lead in well HSB 65. Well HSB 85C, which is about 1,850 ft upgradient of the seepage basins, did not have any recorded groundwater excursions over the monitoring period. Low conductivity levels (18 to 72 μmhos/cm) were reported for wells HSB 65, HSB 66, HSB 65C, and HSB 85C as well as low sodium (1.90 to 7.74 mg/L) and nitrate (<0.5 to 3.75 mg/L) concentrations. Lead concentrations in the upgradient wells remained below the drinking water standard of 0.05 mg/L, excluding an isolated excursion (0.067 mg/L) in upgradient well HSB 65 in October 1985. Tritium activities in upgradient wells HSB 65 (60 to 70 pCi/mL), HSB 65C (32 to 35 pCi/mL), and HSB 66 (11 to 61 pCi/mL) exceeded the drinking water standard of 20 pCi/mL. Tritium activities in upgradient well HSB 85C and the remaining tested radioactivity parameters in all four upgradient wells remained below drinking water standards over the monitoring period. Groundwater pH values in the upgradient wells (4.0 to 6.5) were consistent with pH values reported as naturally occurring in groundwaters at SRS (Appendix B).

Groundwater quality in downgradient wells HSB 67, HSB 68, HSB 69, HSB 70, HSB 83D, HSB 84D, HSB 86C, and HSB 86D and sidegradient well HSB 71 apparently has been affected by the H-Area Seepage Basins, as evidenced by the elevated indicator parameter concentrations and low pH levels reported for these wells. The conductivity levels in these wells ranged from 40 to 870 μmhos/cm, averaging higher than the upgradient well conductivity levels (18 to 72 μmhos/cm). Sodium concentrations in these wells (1.1 to 137.79 mg/L) also have been elevated relative to the upgradient wells (below 8.0 mg/L). Groundwater pH levels in all of the downgradient wells (2.9 to 4.8) except well HSB 70 generally were lower than the pH levels reported for the upgradient wells (4.0 to 6.5). The pH range in downgradient well HSB 70 (4.3 to 5.7) and sidegradient well HSB 71 (4.0 to 5.6) was consistent with the pH range in the upgradient wells. Nitrate concentrations in all of the downgradient wells (11.8 to 97.2 mg/L) have been above both the drinking water standard of 10 mg/L and the upgradient well levels (<0.5 to 3.75 mg/L), excluding an isolated case in well HSB 70 (<0.5 mg/L).

Manganese concentrations (0.014 to 3.58 mg/L) ranged above the drinking water standard in all of the downgradient wells except for well HSB 70. Lead levels, ranging from <0.005 to 0.118 mg/L, exceeded the drinking water standard in five of the downgradient and sidegradient wells (HSB 67, HSB 68, HSB 69, HSB 71, and HSB 86D). Excursions were recorded for mercury (0.0016 to 0.0051 mg/L) in well HSB 67, for cadmium (0.004 to 0.013 mg/L) in well HSB 68, and for total dissolved solids (TDS; 466 to 526 mg/L) in well HSB 69.

Elevated radioactivity in the downgradient wells (HSB 67, HSB 68, HSB 69, HSB 70, HSB 83D, HSB 84D, HSB 86C, and HSB 86D) and sidegradient well HSB 71 also indicates the effect of the H-Area Seepage Basins on groundwater quality in the water table. Tritium activity in these wells (458 to 76,400 pCi/mL) has been greater than the tritium activity measured in the upgradient wells (1 to 70 pCi/mL) and above the drinking water standard of 20 pCi/mL. Gross alpha activity in the sidegradient and downgradient wells (0.8 to 775 pCi/L) exceeded the upgradient well gross alpha activity levels (1.1 to 3.0 pCi/L) and, with the exception of well HSB 70, ranged above the drinking water standard of 15 pCi/L. Similarly, total radium activity in these wells (<1.0 to 62.6 pCi/L), with the exception of wells HSB 70 and HSB 86C, exceeded upgradient well activities (<1.0 to 4.0 pCi/L) and the drinking water standard of 5 pCi/L. Nonvolatile beta activity in these wells (<3.0 to 9,640 pCi/L) exceeded the nonvolatile beta activity reported for the upgradient wells (<2.0 to 14.0 pCi/L).

Downgradient wells HSB 68C, HSB 83C, and HSB 84C are screened lower in the water table and apparently have not been as affected by the seepage basins. Radioactivity and dissolved chemical constituent levels have remained below drinking water standards except for tritium in wells HSB 68C and HSB 84C and manganese and nitrate in well HSB 68C. Sodium levels in these wells (1.44 to 17.0 mg/L) were lower than those reported for the downgradient wells screened higher in the water table (1.1 to 137.79 mg/L). Nitrate levels in these wells (0.11 to 12.99 mg/L) were also lower than those recorded for the wells screened higher in the water table (11.8 to 97.2 mg/L). The nitrate levels in well HSB 68C (9.75 to 12.99 mg/L) ranged over the drinking water standard (10 mg/L). Manganese concentrations in this well (0.055 to 0.071 mg/L) consistently exceeded the drinking water standard (0.05 mg/L).

Tritium activity in wells HSB 68C (1,516 to 2,620 pCi/mL) and HSB 84C (285 to 298 pCi/mL) consistently exceeded the drinking water standard of 20 pCi/mL. Tritium levels in downgradient well HSB 83C and the remaining tested radioactivity parameters in all three wells remained below drinking water standards over the monitoring period. Conductivity levels in these wells ranged from 23 to 180 μmhos/cm, averaging slightly higher than the conductivity levels measured for the upgradient wells (18 to 72 μmhos/cm).

Figures 9-34 through 9-37, which are graphic comparisons of the average chemical indicator parameter concentrations recorded for the water-table wells, demonstrate the relative differences in groundwater quality among the downgradient and upgradient wells and among the wells screened at different intervals in the water table. Figure 9-38 shows the isoconcentration contours of nitrate in the water table determined in 1983, and Figure 9-39 shows the terrain conductivity survey results for the H-Area Seepage Basins in 1985. These figures identify the areas of potential contaminant migration and correspond with the data presented in Figures 9-34 and 9-37. The water-quality differences evident on these figures between the C- and D-designated wells within the same well cluster and the 20-to-30 ft difference in screen zone depth between these wells suggest that the C- and D-designated wells are hydraulically separate.

Figures 9-40 through 9-46 graphically compare the average radioactivity parameter levels recorded for the water-table wells (HSB and H well series). Figures 9-40, 9-42, and 9-44 demonstrate that wells H 11, H 15, H 16, H 17, and H 18/18A have not been as affected by the seepage basins as the remaining H series wells. Figure 9-47 shows the isoconcentration contours of tritium in the water table near the H-Area Seepage Basins. The contours shown are in agreement with the results from Figures 9-40 and 9-41.

McBean Formation Wells

The locations of the monitoring wells screened in the McBean Formation relative to the H-Area Seepage Basins are presented in Figure 9-31, along with the predominant McBean Formation groundwater flow direction. As indicated in Figure 9-31, wells HSB 65B and HSB 85B have been upgradient; well HSB 83B has been sidegradient to downgradient; and wells HSB 68B, HSB 84B, and HSB 86B have been downgradient relative to the basins.

The groundwater monitoring analytical data for the McBean Formation wells since the third quarter of 1984 are summarized in Table 9-22. The monitoring data summarized in these tables indicate that the H-Area Seepage Basins have had no apparent effect on groundwater quality in the McBean Formation except for tritium. Dissolved chemical constituent and radioactivity levels have remained less than drinking water standards in all six McBean Formation wells except for tritium and an isolated excursion of iron in well HSB 86B (0.467 mg/L). Nitrate levels in all six wells remained below 3.0 mg/L, and sodium levels remained below 20 mg/L. Tritium activities in five of these wells (0.3 to 1,033 pCi/mL) exceeded the drinking water standard of 20 pCi/mL, although the excursion in upgradient well HSB 85B was an isolated occurrence. Figure 9-48 is a graphic comparison of the average tritium levels among the six McBean Formation site wells. Tritium activity in upgradient well HSB 65B and the remaining tested radioactive parameters in all six wells consistently met drinking water standards.

Groundwater pH in well HSB 83B ranged from 6.1 to 6.7, and conductivity in this well ranged from 110 to 150 μmhos/cm. The pH range reported for well HSB 83B is consistent with pH levels reported as naturally occurring in SRS groundwaters (Appendix B). Groundwater pH levels in the other McBean Formation monitoring wells (6.2 to 10.7) were elevated compared to the pH levels reported for well HSB 83B. Similarly, conductivity levels in the other McBean Formation monitoring wells were usually elevated (120 to 690 μmhos/cm) compared to the conductivity levels reported for well HSB 83B. Because the pH of the basin influent was low (see Section 9.07.02) and the levels of the indicator parameters in these wells were not elevated, the elevated conductivity and pH levels suggest that leaching of the surrounding grout column has occurred in these wells and that they have not been affected by the basins. Figures 9-48 and 9-49 are graphic comparisons of the average pH and conductivity levels among the McBean Formation site wells.

Congaree Formation Wells

Locations of the monitoring wells screened in the Congaree Formation relative to the H-Area Seepage Basins are presented in Figure 9-33, along with the predominant groundwater flow direction. All of these wells are downgradient of the basins or of water flowing from the basins in the upper aquifers.

The groundwater monitoring results for the Congaree Formation wells since the third quarter of 1985 are summarized in Table 9-23. These data suggest that the H-Area Seepage Basins have affected groundwater quality in wells HSB 68A and HSB 84A. Groundwater from well HSB 68A has contained elevated levels of tritium; groundwater from well HSB 84A has contained elevated levels of conductivity, sodium, nitrate, manganese, and radioactivity.

Groundwater quality in wells HSB 65A, HSB 83A, HSB 85A, and HSB 86A apparently has not been affected by the H-Area Seepage Basins, as indicated by the low radioactivity and dissolved chemical constituent levels reported for these wells compared to drinking water standards. Specifically, tritium (below 10 pCi/mL), gross alpha (below 4.0 pCi/L) and total radium (below 2.0 pCi/L) activities in these four wells remained less than their respective drinking water standards. Nonvolatile beta activities in these wells remained below 11 pCi/L. Nitrate levels in these four wells (<0.50 mg/L) were consistently below the drinking water standard of 10 mg/L, and sodium levels remained below 3.0 mg/L, excluding an excursion of 19.9 mg/L reported for well HSB 85A in September 1985. Groundwater pH in these four wells ranged from 5.8 to 7.6, and conductivity ranged from 60 to 280 μmhos/cm.

Groundwater quality in well HSB 68A has been characterized by low dissolved chemical constituent and radioactivity levels compared to drinking water standards except for tritium. Tritium activity in well

HSB 68A (96 to 130 pCi/mL) exceeded the drinking water standard of 20 pCi/mL. Gross alpha (0.5 to 4.7 pCi/L), total radium (<1.0 to 2.0 pCi/L), and nitrate (0.15 to 0.65 mg/L) levels in well HSB 68A remained below their respective drinking water standards. Nonvolatile beta activity in well HSB 68A ranged from 16.0 to 32.0 pCi/L, while sodium levels ranged from 2.69 to 8.10 mg/L and conductivity ranged from 138 to 205 μmhos/cm. Groundwater pH in well HSB 68A ranged from 7.2 to 9.5, which is elevated compared to levels reported as naturally occurring in SRS groundwater (Appendix B) and the levels reported for the other Congaree Formation wells (Figure 9-50). Because the pH of the basin influent was low (see Section 9.07.02) and the levels of the indicator parameters were not elevated except for tritium, the elevated pH levels reported for well HSB 68A indicate that leaching of the surrounding grout column has occurred in this well.

Groundwater in well HSB 84A has been characterized by much higher dissolved chemical constituent levels and radioactivity than that of the other site wells screened in the Congaree Formation. Low pH (4.2 to 5.5) and elevated levels of conductivity (320 to 460 μmhos/cm), sodium (22.63 to 68.9 mg/L), nitrate (37.2 to 54 mg/L), and manganese (0.273 to 0.561 mg/L) were reported for this well. Tritium (16,500 to 46,545 pCi/mL) and total radium (30.3 to 45.6 pCi/L) activities in well HSB 84A were consistently above their respective drinking water standards of 20 pCi/mL and 5 pCi/L. Gross alpha activity (4.5 to 516 pCi/L) ranged above the drinking water standard of 15 pCi/L, and nonvolatile beta activity was elevated (1,927.4 to 6,474.9 pCi/L). Figures 9-50 through 9-53, graphic comparisons of the average indicator parameter levels among the Congaree Formation site wells, demonstrate the relative differences in groundwater quality between well HSB 84A and the other Congaree Formation wells. It is uncertain whether the monitoring data from this well are indicative of Congaree Formation groundwater or if the well has been contaminated, possibly by surface runoff. Additional studies are planned.

9.07.08 Planned Action

The H-Area Seepage Basins are active, and continued use is planned until 1988. An Effluent Treatment Facility is being constructed to replace the basins. As indicated in Section 16, point-of-compliance wells are scheduled for installation, and a closure plan is to be developed in 1988. Groundwater monitoring will continue at this site.

TABLE 9-1

Summary of Groundwater Quality: Well Concentration Ranges for the H-Area Retention Basins (7/85-12/86)

Constituent	SC and Federal DWS	HR8 11	HR8 12	HR8 13	HR8 14
pH (pH)	6.5-8.5	3.8-4.7	3.7-4.3	3.6-4.4	3.9-4.2
Conductivity (µmhos/cm)	NA	22-36	25-42	43-62	215-520
Silver (mg/L)	0.05	<0.0004	<0.0004	<0.0004	<0.0004
Arsenic (mg/L)	0.05	<0.002	<0.002	<0.002	<0.002
Barium (mg/L)	1.0	<0.004-0.005	0.005-0.006	0.008-0.010	0.056-0.078
Cadmium (mg/L)	0.010	<0.001	<0.001	<0.001	<0.001
Chloride (mg/L)	250	2.9-5.0	2.9-10.0	9.6-15.0	5.7-10.0
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.06	0.02-0.07	0.03-0.08	0.07-0.11
Iron (mg/L)	0.3	0.009-0.111	0.016-0.154	0.019-0.136	0.023-0.182
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	<0.0002-0.0003
Manganese (mg/L)	0.05	<0.002-0.004	<0.002-0.006	0.006-0.012	0.099-0.118
Sodium (mg/L)	NA	2.50-3.31	3.37-4.04	1.51-8.39	33.30-78.10
Nitrate (as N) (mg/L)	10	0.84-1.00	1.20-1.40	1.20-1.88	38.50-51.00
Lead (mg/L)	0.05	0.017-0.058	0.041-0.090	0.035-0.222	0.036-0.065
Phenols (mg/L)	NA	<0.002	<0.002-0.003	<0.002-0.003	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	<5.0	<5.0	<5.0
TOC (mg/L)	NA	0.440-0.730	0.480-1.000	0.640-0.670	0.540-1.000
TOH (mg/L)	NA	0.006-0.016	<0.005-0.013	0.005-0.011	0.005-0.007
Zinc (mg/L)	5	0.054	0.080	0.059	0.080
Gross alpha (pCi/L)	15	1.3-13.0	1.8-36.0	1.0-49.0	2.3-28.8
Nonvol. beta (pCi/L)	NA	1.6-11.0	<3.0-23.0	4.1-26.0	7.0-13.0
Tritium (pCi/mL)	20	66-71	36-39	37-38	2-5
Total radium (pCi/L)	5	<1.0-3.0	<1.0-8.0	2.3-13.0	8.0-21.0

TABLE 9-1 (cont.)

Constituent	SC and Federal DWS	HR3 11	HR3 13
pH (pH)	6.5-8.5	3.8-4.7	8.6-10.0
Conductivity (µmhos/cm)	NA	30-55	121-250
Silver (mg/L)	0.05	<0.0004	<0.0004
Arsenic (mg/L)	0.05	<0.002	<0.002-0.003
Barium (mg/L)	1.0	<0.004	<0.004-0.004
Cadmium (mg/L)	0.010	<0.001	<0.002
Chloride (mg/L)	250	7.1-15.0	4.1-100.0
Chromium (mg/L)	0.05	<0.004	<0.004-0.014
Endrin (mg/L)	0.0002	<0.00004	<0.00004
Fluoride (mg/L)	1.6	0.07	<0.10
Iron (mg/L)	0.3	0.012-0.132	0.008-0.121
Mercury (mg/L)	0.002	0.0003-0.0010	0.0001
Manganese (mg/L)	0.05	0.002-0.006	<0.002-0.009
Sodium (mg/L)	NA	4.85-6.19	4.09-6.61
Nitrate (as N) (mg/L)	10	1.10-1.33	2.70-2.95
Lead (mg/L)	0.05	<0.005-0.011	<0.002
Phenols (mg/L)	NA	<0.002-0.008	<0.002
Selenium (mg/L)	0.01	<0.002	<0.002
Sulfate (mg/L)	250	<5.0	4.4-10.0
TOC (mg/L)	NA	0.590-2.890	0.430-0.510
TOH (mg/L)	NA	0.012-0.032	<0.005-0.007
Zinc (mg/L)	5	0.021	<0.002
Gross alpha (pCi/L)	15	1.0-238.0	<2.0
Nonvol. beta (pCi/L)	NA	<2.0-96.0	1.8-10.0
Tritium (pCi/mL)	20	24-28	48-52
Total radium (pCi/L)	5	<1.0-8.0	<1.0-2.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards. NA = not applicable.

TABLE 9-2

Radioactivity in the H-Area Retention Basins Wells (Annual Averages)

	Gross Alpha (pCi/L)		Nonvol. Beta (pCi/L)		Tritium (pCi/mL)	
Year	Mean	Max	Mean	Max	Mean	Max
HR3 11						
1985	0.26	0.73	0.85	1.50	26	28
HR3 13						
1985	0.24	0.45	1.40	2.00	48	50
HR8 11						
1985	1.10	2.20	2.90	5.00	68	71
HR8 12						
1985	1.40	2.10	5.80	8.30	39	42
HR8 13						
1985	1.50	2.40	3.30	4.00	38	40
HR8 14						
1985	2.70	3.60	9.00	20.00	3	4

TABLE 9-3

Calculated Annual Discharges from Cation and Anion Exchange Units for the H-Area Acid/Caustic Basin

Calculated Annual Discharges from Cation Exchange Unit

<u>Acid Wastewater</u>

Volume (m^3/yr)	Conc. Wt. % H_2SO_4	Total Excess H_2SO_4 (kg)	Total Cations (kg)
4,500	0.12	6,000	4,500

Calculated Annual Discharges from Anion Exchange Unit

<u>Basic Wastewater</u>

Volume (m^3/yr)	Conc. Wt. % NaOH	Total Excess NaOH (kg)	Total Anions (kg)
4,700	0.28	14,500	7,600

Note: Data, from Ward et al. (1987), are for 1974 and are representative of the total period. Values were calculated using assumed resin performance.

TABLE 9-4

Selected Surface Water Chemical Analyses for the H-Area Acid/Caustic Basin

Parameter	Units	Results
pH	SU	4.1
Calcium	mg/L	5.30
Chloride	mg/L	9.71
Dissolved organic carbon	mg/L	1.08
Fluoride	mg/L	0.11
Iron	mg/L	0.44
Mercury	mg/L	<0.002
Potassium	mg/L	2.38
Magnesium	mg/L	0.728
Sodium	mg/L	44.8
Nitrate	mg/L	<0.5
Sulfate	mg/L	12.6
Odor	TON	0
Total organic carbon	mg/L	0.98
Turbidity	NTU	0.8
Specific conductance	μmhos/cm	5.99

Note: Samples were collected in August 1985.

TABLE 9-5

Summary of Sediment and Soil Chemical Analyses for the H-Area Acid/Caustic Basin

Metals	Concentration Range (µg/g)*	EP Toxicity Results (mg/L)	EP Toxicity Standards (mg/L)**
Aluminium	<4,040-34,100	---	---
Arsenic	0.59-2.78	0.002	5.0
Barium	14.0-129.0	0.43	100.0
Cadmium	<2.0	0.04	1.0
Chromium	15.0-37.6	0.08	5.0
Copper	<4.0-18.7	---	---
Iron	8,120-37,200	---	---
Lead	<5.0-15.9	0.1	5.0
Magnesium	20.8-1,060	---	---
Manganese	<2.0-60.8	---	---
Mercury	<0.2-0.25	0.0002	0.2
Nickel	<4.0-20.9	---	---
Selenium	<0.25	0.002	1.0
Silver	<2.0	0.289	5.0
Sodium	946-4,540	---	---
Tin	<15.0-31.0	---	---
Zinc	38.4-476.0	---	---
Inorganics			
Boron	6.89-40.91		
Sulfate	53.6-134.3		
Sulfide	<25		
Nitrate	1.80-4.95		
Nitrite	<0.5-2.5		
Ammonium	<2.8-19.6		
Fluoride	0.45-5.50		
Chloride	22.4-230		
Phosphate	24.0-138.0		
Radioactivity			
Gross alpha	0-44.16 pCi/g		
Nonvolatile beta	Background levels		
Gross gamma	Background levels		

* Concentration range for samples taken at 0-0.5 ft, 0.5-1.0 ft, 1.5-2.0 ft, and 4.5-5.0 ft depth intervals.
** Federal Regulation 40 CFR 261.

TABLE 9-6

H-Area Coal Pile Runoff Containment Basin Influent Characterization Data

Parameter	Units	Initial	Final	Composite
Time	NA	1015	1508	NA
Temperature	°C	23.5	24.5	NA
Flow	gal/min	5-10	1.2	NA
pH	pH	2.87	2.60	2.63
Conductivity	µmhos/cm	1,200	1,950	1,868
Sulfate (as SO_4)	mg/L	480	903	885
Total suspended solids	mg/L	341	5	5
Total dissolved solids	mg/L	700	1,219	1,205
Phenols	mg/L	0.002	0.001	0.001
Acidity (as $CaCO_3$)	mg/L	123	325	320
Beryllium	mg/L	0.0132	0.0148	0.0187
Cadmium	mg/L	0.024	0.024	0.011
Copper	mg/L	0.422	0.753	0.644
Chromium	mg/L	0.051	0.102	0.073
Iron	mg/L	63.9	95.8	102
Lead	mg/L	0.0041	0.0022	<0.001
Mercury	mg/L	0.00035	0.00009	0.00010
Nickel	mg/L	0.592	0.439	0.628
Selenium	mg/L	0.0109	0.0144	0.0180
Zinc	mg/L	0.140	0.179	0.164
Aluminum	mg/L	21.3	30.7	30.9
Manganese	mg/L	1.58	2.27	2.08
Magnesium	mg/L	15.9	17.2	19.2
Arsenic	mg/L	0.0628	0.0360	0.0382
Silver	mg/L	<0.001	<0.001	<0.001
Barium	mg/L	<0.03	<0.03	<0.03

Note: NA = not applicable.

TABLE 9-7

Summary of Groundwater Quality: Well Concentration Ranges for the H-Area Coal Pile Runoff Containment Basin (7/84-12/86)

Constituent	SC and Federal DWS	HCB 1	HCB 2	HCB 3	HCB 4
pH (pH)	6.5-8.5	4.2-4.9	2.8-4.3	3.5-6.5	3.9-4.9
Conductivity (µmhos/cm)	NA	37-72	180-2,900	29-130	22-270
Silver (mg/L)	0.05	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (mg/L)	0.05	<0.001	<0.001	<0.001	<0.001
Barium (mg/L)	1.0	0.030-0.059	0.008-0.111	0.024-0.032	0.026-0.032
Carbon tetrachloride (mg/L)	0.005	<0.005	<0.005	---	---
Cadmium (mg/L)	0.010	<0.001	0.003-0.004	<0.001	<0.001
Chloroform (mg/L)	0.100*	<0.005	<0.005	---	---
Chloride (mg/L)	250	4.9-10.4	2.9-4.6	3.9-6.9	3.4-5.2
Chromium (mg/L)	0.05	<0.004	<0.004	<0.004	<0.004
Copper (mg/L)	1	<0.004-0.004	0.014-2.170	0.010-0.011	<0.004
DOC (mg/L)	NA	<5.0	<5.0	<5.0	<5.0
Endrin (mg/L)	0.0002	<0.00004	<0.00004	<0.00006	<0.00004
Fluoride (mg/L)	1.6	<0.10-0.11	0.53-0.78	<0.10-0.16	<0.10-0.15
Iron (mg/L)	0.3	0.053-0.542	0.139-0.436	0.050-0.092	0.057-0.147
Mercury (mg/L)	0.002	<0.0002	<0.0002	<0.0002	0.0003
Manganese (mg/L)	0.05	0.254-0.361	4.770-12.700	0.004-0.031	0.033-0.202
Sodium (mg/L)	NA	2.75-3.36	8.38-8.75	2.30-3.00	2.72-3.27
Nitrate (as N) (mg/L)	10	1.30	0.70	2.15	1.00
Lead (mg/L)	0.05	0.015-0.021	0.015-0.022	0.022-0.029	0.014-0.015
Phenols (mg/L)	NA	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)	0.01	<0.001	0.002	<0.001	<0.001
Sulfate (mg/L)	250	3.0-10.0	78.0-2,260.0	<5.0	<5.0-45.0
Tetrachloroethylene (mg/L)	NA	<0.005	<0.005	---	---
TDS (mg/L)	500	6	108-118	<5-20	136-164
TOC (mg/L)	NA	0.680-10.832	3.000-9.024	0.290-2.741	0.410-30.67
TOH (mg/L)	NA	<0.005-0.027	0.008-0.033	<0.005-0.009	<0.005-0.019
Trichloroethylene (mg/L)	0.005	<0.005	<0.005	---	---
1,1,1-TCE (mg/L)	0.200	<0.005	<0.005	---	---
Zinc (mg/L)	5	0.015	1.040	0.036	0.052
Gross alpha (pCi/L)	15	<2.0-3.0	35.0-189.0	<2.0-2.0	<2.0-3.0
Nonvol. beta (pCi/L)	NA	2.1-3.0	80.0-116.0	1.6	1.9-4.0
Total radium (pCi/L)	5	<1.0-1.0	50.0-68.0	<1.0-2.0	<1.0-3.0

Note: DWS are the lower of South Carolina or federal primary and secondary drinking water standards.
NA = not applicable.

* South Carolina and federal primary drinking water standard for trihalomethanes.

TABLE 9-8

Trace Elements in Different Types of Ash

Element	Ash Type (mg/L) Fly Ash (Electrostatic Precipitator)	Fly Ash (Mechanical Collector)	Bottom Ash
Barium	889	792	808
Strontium	579	589	333
Manganese	352	275	811
Zinc	280	116	95
Vanadium	218	166	140
Cerium	189	251	150
Chromium	171	140	160
Arsenic	164	55	4
Copper	130	93	67
Nickel	89	87	77
Gallium	72	32	20
Lanthanum	69	61	61
Cobalt	67	47	40
Lead	60	28	5
Bromine	47	12	3
Scandium	32	28	20
Thorium	23	24	25
Antimony	19	6	3
Molybdenum	18	11	7
Beryllium	16	12	9
Samarium	15	13	12
Selenium	15	6	3
Cesium	14	13	10
Uranium	13	8	8
Europium	11	12	8
Ytterbium	12	8	10
Terbium	2.5	2.1	2
Mercury	0.84	0.33	0.08
Cadmium	0.71	0.39	0.5

Note: Data were collected in 1977. Source: Christensen and Gordon (1983).

TABLE 9-9

NPDES Monitoring of H-Area Ash Basin Discharges (Outfall H-8) in 1980

Parameter	Unit	Discharge
Biochemical oxygen demand	mg/L	<2
Chemical oxygen demand	mg/L	<5
Total organic carbon	mg/L	<1
Total suspended solids	mg/L	32
Ammonia (as N)	mg/L	<1.0
Bromide	mg/L	<2.0
Total residual chlorine	mg/L	ND
Color	Pt-Co Units	5
Fecal coliform	No/100 mL	330
Fluoride	mg/L	<0.10
Nitrate/Nitrite (as N)	mg/L	<0.05
Total organic nitrogen (as N)	mg/L	<1.0
Oil and grease	mg/L	<10
Phosphorus (as P)	mg/L	0.02
Radioactivity		
Alpha	pCi/L	2.4 ±1.2
Beta	pCi/L	23.4 ±3.4
Radium	pCi/L	<0.6
Radium 226	pCi/L	0.93 ±0.3
Sulfate (as SO_4)	mg/L	15
Sulfide (as S)	mg/L	<1
Sulfite (as SO_3)	mg/L	<2
Surfactants	mg/L	<0.025
Aluminum	mg/L	<0.3
Barium	mg/L	<0.30
Boron	mg/L	0.11
Cobalt	mg/L	0.003
Iron	mg/L	1.3
Magnesium	mg/L	0.69
Molybdenum	mg/L	<0.005
Manganese	mg/L	0.035
Tin	mg/L	0.12
Titanium	mg/L	<0.10
Antimony	mg/L	<0.003
Arsenic	mg/L	<0.001
Beryllium	mg/L	<0.003
Cadmium	mg/L	0.006
Chromium	mg/L	0.004
Copper	mg/L	<0.014
Lead	mg/L	0.004
Mercury	mg/L	0.0011
Nickel	mg/L	0.014

TABLE 9-9 (cont.)

Parameter	Unit	Discharge
Selenium	mg/L	0.003
Silver	mg/L	<0.0003
Thallium	mg/L	<0.003
Zinc	mg/L	0.063
Cyanide	mg/L	<0.02
Phenols	mg/L	<0.002
Dioxin		ND
Acrolein	μg/L	ND
Acrylonitrile	μg/L	ND
Benzene	μg/L	<1*
Bis(chloromethyl)ether	μg/L	ND
Bromoform	μg/L	ND
Carbon tetrachloride	μg/L	ND
Chlorobenzene	μg/L	ND
Chlorodibromomethane	μg/L	ND
Chloromethane	μg/L	ND
2-Chloroethylvinyl ether	μg/L	ND
Chloroform	μg/L	ND
Dichlorobromomethane	μg/L	ND
Dichlorodifluoromethane	μg/L	ND
1,1-Dichloroethane	μg/L	ND
1,2-Dichloroethane	μg/L	ND
1,1-Dichloroethylene	μg/L	ND
1,2-Dichloropropane	μg/L	ND
1,2-Dichloropropylene	μg/L	ND
Ethylbenzene	μg/L	<1*
Methylbromide	μg/L	ND
Methylchloride	μg/L	ND
Methylene chloride	μg/L	4*
1,1,2,2-Tetrachloroethane	μg/L	ND
Tetrachloroethylene	μg/L	<1*
Toluene	μg/L	<1*
1,2-trans-Dichloroethylene	μg/L	ND
1,1,1-Trichloroethane	μg/L	<1*
1,1,2-Trichloroethane	μg/L	ND
Trichloroethylene	μg/L	<1*
Trichlorofluoromethane	μg/L	ND
Vinyl chloride	μg/L	ND
2-Chlorophenol	μg/L	ND
2,4-Dichlorophenol	μg/L	ND
2,4-Dimethylphenol	μg/L	ND
4,6-Dinitro-o-cresol	μg/L	ND
2,4-Dinitrophenol	μg/L	ND
2-Nitrophenol	μg/L	ND
4-Nitrophenol	μg/L	ND
p-Chloro-m-cresol	μg/L	ND
Pentachlorophenol	μg/L	ND
Phenol	μg/L	ND

TABLE 9-9 (cont.)

Parameter	Unit	Discharge
2,4,6-Trichlorophenol	μg/L	ND
Acenaphthene	μg/L	ND
Acenaphtylene	μg/L	ND
Anthracene	μg/L	ND
Benzidine	μg/L	ND
Benzo(a)anthracene	μg/L	ND
Benzo(a)pyrene	μg/L	ND
3,4-Benzofluoranthene	μg/L	ND
Benzo(ght)perylene	μg/L	ND
Benzo(k)fluoranthene	μg/L	ND
Bis(2-chloroethoxy)methane	μg/L	ND
Bis(2-chloroethyl)ether	μg/L	ND
Bis(2-chloroisopropyl)ether	μg/L	ND
Bis(2-ethylhexyl)phthalate	μg/L	<1*
4-Bromophenyl phenyl ether	μg/L	ND
Butyl benzyl phthalate	μg/L	ND
2-Chloronapthalene	μg/L	ND
4-Chlorophenyl phenyl ether	μg/L	ND
Chrysene	μg/L	ND
Dibenzo(a,h)anthracene	μg/L	ND
1,2-Dichlorobenzene	μg/L	ND
1,3-Dichlorobenzene	μg/L	ND
1,4-Dichlorobenzene	μg/L	ND
3,3-Dichlorobenzidine	μg/L	ND
Diethylphthalate	μg/L	ND
Dimethylphthalate	μg/L	ND
Di-n-butyl phthalate	μg/L	<1*
2,4-Dinitrotoluene	μg/L	ND
2,6-Dinitrotoluene	μg/L	ND
Di-n-octylphthalate	μg/L	ND
1,2-Diphenylhydrazine	μg/L	5
Fluoranthene	μg/L	ND
Fluorene	μg/L	ND
Hexachlorobenzene	μg/L	ND
Hexachlorobutadiene	μg/L	ND
Hexachlorocyclopentadiene	μg/L	ND
Hexachloroethane	μg/L	ND
Indeno(1,2,3-cd)pyrene	μg/L	ND
Isophorone	μg/L	ND
Naphthalene	μg/L	ND
Nitrobenzene	μg/L	ND
n-Nitrosodimethylamine	μg/L	ND
n-Nitrosodi-n-propylamine	μg/L	ND
n-Nitro-sodiphenylamine	μg/L	ND
Phenanthrene	μg/L	ND
Pyrene	μg/L	ND
1,2,4-Trichlorobenzene	μg/L	ND

TABLE 9-9 (cont.)

Parameter	Unit	Discharge
Aldrin	µg/L	ND
alpha BHC	µg/L	0.010
beta BHC	µg/L	0.014
gamma BHC	µg/L	0.011
delta BHC	µg/L	ND
Chlordane	µg/L	ND
4,4' DDT	µg/L	ND
4,4' DDE	µg/L	ND
4,4' DDD	µg/L	ND
Dieldrin	µg/L	ND
alpha-Endosulfan	µg/L	ND
beta-Endosulfan	µg/L	ND
Endosulfansulfate	µg/L	ND
Endrin	µg/L	ND
Endrinaldehyde	µg/L	ND
Heptachlor	µg/L	ND
Heptachlor epoxide	µg/L	ND
PCB 1242	µg/L	ND
PCB 1254	µg/L	ND
PCB 1221	µg/L	ND
PCB 1232	µg/L	ND
PCB 1248	µg/L	ND
PCB 1260	µg/L	ND
PCB 1016	µg/L	ND
Toxaphene	µg/L	ND

Note: ND = not detected.

* Present in laboratory blank.

TABLE 9-10

Trace Metal Analysis of 488-D Ash Basin Sludge Sample Extracts

Metal	Ash Basin Sludge (mg/L)	EPA Extract Level Limit (mg/L)
Chromium	<0.002	5.0
Cadmium	<0.001	1.0
Barium	1	100.0
Silver	<0.001	5.0
Mercury	<0.01	0.2
Lead	<0.002	5.0
Arsenic	<0.01	5.0
Selenium	<0.01	1.0

Note: Data, from Christensen and Gordon (1983), were collected in January 1980.

TABLE 9-11

Radioactivity in the H-Area Tank Farm Wells (Annual Averages)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
TW 3						
1962	---	---	47,000.00	91,000.00	---	---
1963	---	---	13,800.00	18,300.00	---	---
1964	---	---	7,730.00	11,970.00	---	---
1965	---	---	7,850.00	24,000.00	---	---
1966	---	---	5,166.00	5,166.00	---	---
TW 4						
1962	---	---	240.00	388.00	---	---
1963	---	---	645.00	1,100.00	---	---
1964	---	---	830.00	1,740.00	---	---
1965	---	---	575.00	2,500.00	---	---
1966	---	---	1,423.00	2,720.00	---	---
HP 1						
1962	---	---	280.00	329.00	---	---
1963	---	---	205.00	300.00	---	---
1964	---	---	103.00	140.00	---	---
1965	---	---	74.00	140.00	---	---
1966	---	---	81.00	94.00	---	---
1967	---	---	75.00	110.00	---	---
1968	---	---	150.00	250.00	---	---
1971	---	---	140.00	250.00	---	---
1972	1.15	2.00	91.00	120.00	40	90
1973	0.90	1.72	139.00	310.00	45	75
1974	0.77	0.97	181.24	289.86	42	59
1975	0.38	0.59	112.54	147.75	95	441
1976	0.46	0.82	116.33	133.98	16	20
1977	0.78	1.40	120.00	150.00	27	44
1978	0.37	0.58	250.00	320.00	26	32
1979	0.30	0.73	480.00	700.00	36	47
1980	0.54	0.82	1,200.00	2,000.00	36	58
1981	0.30	0.41	920.00	1,100.00	52	85
1982	1.40	5.10	600.00	740.00	39	41
1983	1.50	2.40	390.00	700.00	31	40
1984	2.50	2.90	270.00	320.00	27	28

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HP 5						
1962	---	---	46.00	57.00	---	---
1963	---	---	64.50	80.00	---	---
1964	---	---	47.00	61.00	---	---
1965	---	---	94.50	150.00	---	---
1966	---	---	143.00	202.00	---	---
1967	---	---	165.00	210.00	---	---
1968	---	---	395.00	440.00	---	---
1971	---	---	185.00	240.00	---	---
1972	0.75	1.40	165.00	190.00	176	320
1973	1.09	1.47	297.00	546.00	62	122
1974	0.84	1.19	387.55	494.49	52	66
1975	0.61	0.92	187.16	255.66	79	186
1976	0.50	0.67	224.83	289.74	44	77
1977	0.53	0.67	190.00	210.00	57	87
1978	1.40	3.20	180.00	250.00	37	81
1979	0.53	1.10	230.00	270.00	21	39
1980	0.14	0.32	130.00	170.00	16	24
1981	0.41	0.57	94.00	120.00	26	32
1982	0.39	0.65	490.00	700.00	25	38
1983	1.20	1.90	310.00	540.00	34	48
1984	1.40	2.00	180.00	200.00	20	21
HP 8						
1962	---	---	133.00	158.00	---	---
1963	---	---	110.00	150.00	---	---
1964	---	---	46.00	99.00	---	---
1967	---	---	20.00	20.00	---	---
1971	---	---	475.00	630.00	---	---
1972	1.15	1.90	390.00	510.00	70	100
1973	1.02	2.04	776.00	1,970.00	83	124
1974	0.48	1.29	567.70	1,013.78	125	165
1975	0.55	1.90	282.82	404.38	107	153
1976	0.56	2.68	186.78	327.99	91	181
1977	0.41	1.10	610.00	1,300.00	79	91
1978	0.98	2.40	240.00	440.00	79	97
1979	1.60	12.00	2,000.00	11,000.00	51	140
1980	0.69	2.20	1,000.00	1,900.00	36	81
1981	0.56	1.10	1,000.00	1,400.00	41	85
1982	1.70	5.60	490.00	680.00	30	35
1983	3.60	8.90	730.00	910.00	46	56
1984	5.00	6.00	640.00	720.00	47	58

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HPM 1						
1973	1.66	2.28	28.00	41.00	---	---
1974	1.21	1.59	22.20	49.61	---	---
1975	1.35	1.76	28.95	34.75	---	---
1976	1.50	2.01	20.58	27.52	---	---
1977	1.30	1.90	13.00	21.00	---	---
1978	2.30	3.80	17.00	28.00	---	---
1979	1.20	1.40	22.00	28.00	---	---
1980	0.57	1.10	24.00	51.00	---	---
1981	1.20	1.80	15.00	18.00	---	---
1982	1.10	1.90	9.80	19.00	---	---
1983	1.10	2.30	9.40	15.00	---	---
1984	1.80	3.60	23.00	33.00	---	---
HPM 2						
1973	1.16	1.57	36.00	41.00	---	---
1974	0.89	1.24	27.01	43.49	---	---
1975	2.82	7.01	108.02	213.43	---	---
1976	0.89	1.24	63.13	85.11	---	---
1977	1.40	1.60	110.00	150.00	---	---
1978	0.73	1.10	30.00	35.00	---	---
1979	0.50	0.73	32.00	38.00	---	---
1980	0.86	1.10	14.00	26.00	---	---
1981	1.10	1.60	29.00	34.00	---	---
1982	0.76	1.50	9.30	18.00	---	---
1983	0.24	0.58	12.00	17.00	---	---
1984	0.73	1.20	23.00	39.00	---	---
HPM 3						
1973	1.15	2.52	166.00	2,041.00	---	---
1974	0.92	1.29	68.39	90.63	---	---
1975	0.98	1.42	84.51	131.76	---	---
1976	1.54	1.98	65.83	76.55	---	---
1977	1.50	1.70	170.00	220.00	---	---
1978	1.50	1.70	50.00	59.00	---	---
1979	0.70	0.89	53.00	73.00	---	---
1980	0.89	1.30	23.00	40.00	---	---
1981	0.66	1.10	65.00	120.00	---	---
1982	0.51	1.20	71.00	78.00	---	---
1983	0.60	1.90	58.00	77.00	---	---
1984	1.10	1.60	53.00	100.00	---	---

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HPM 4						
1973	1.58	4.82	88.00	189.00	---	---
1974	1.46	1.79	63.05	84.09	---	---
1975	1.46	2.85	27.24	45.48	---	---
1976	1.72	2.01	31.56	35.25	---	---
1977	1.10	1.10	15.00	17.00	---	---
1978	1.20	2.10	17.00	21.00	---	---
1979	1.50	2.10	16.00	21.00	---	---
1980	1.40	1.50	6.90	16.00	---	---
1981	1.30	1.50	31.00	42.00	---	---
1982	0.67	0.91	7.90	12.00	---	---
1983	0.23	0.38	11.00	20.00	---	---
1984	0.52	0.58	10.00	11.00	---	---
HPM 6						
1973	0.93	2.04	339.00	584.00	---	---
1974	0.81	1.10	395.71	628.47	---	---
1975	0.92	1.34	305.05	562.25	---	---
1976	0.54	0.91	157.05	175.37	---	---
1977	0.66	0.89	200.00	360.00	---	---
1978	0.93	1.40	78.00	95.00	---	---
1979	1.10	1.90	150.00	220.00	---	---
1980	0.88	1.70	120.00	180.00	---	---
1981	1.00	1.60	130.00	250.00	---	---
1982	0.41	1.10	82.00	140.00	---	---
1983	0.51	1.00	78.00	110.00	---	---
1984	1.60	1.60	430.00	430.00	---	---
HPM 7						
1973	1.55	2.20	26.00	76.00	---	---
1974	1.71	2.51	15.62	22.74	---	---
1975	1.61	1.93	8.44	11.86	---	---
1976	1.02	1.09	9.04	9.61	---	---
HPM 8						
1973	0.80	1.32	21.00	44.00	---	---
1974	0.73	1.03	24.47	30.37	---	---
1975	1.43	3.13	19.18	21.83	---	---
1976	1.06	1.51	20.71	25.58	---	---
1977	0.83	1.10	20.00	24.00	---	---
1978	0.60	1.00	26.00	32.00	---	---
1979	0.97	1.70	30.00	50.00	---	---

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
HPM 8 (cont.)						
1980	1.00	1.50	33.00	69.00	---	---
1981	1.20	1.60	80.00	89.00	---	---
1982	0.47	0.73	32.00	38.00	---	---
1983	1.10	1.70	44.00	56.00	---	---
1984	1.90	2.10	61.00	72.00	---	---
HPM 9						
1973	1.26	1.76	20.00	66.00	---	---
1974	1.10	1.51	11.95	23.71	---	---
1975	0.88	1.59	3.52	4.34	---	---
1976	1.14	1.98	8.59	15.19	---	---
1977	1.30	1.90	3.50	7.70	---	---
1978	0.99	1.40	3.80	6.00	---	---
1979	0.60	0.82	4.80	12.00	---	---
1980	0.53	1.30	3.40	14.00	---	---
1981	0.92	1.40	7.30	15.00	---	---
1982	0.69	1.10	7.80	29.00	---	---
1983	0.61	1.20	81.00	180.00	---	---
1984	2.40	3.20	73.00	95.00	---	---
HPM 10						
1973	0.88	1.76	32.00	103.00	---	---
1974	0.66	0.97	15.10	29.98	---	---
1975	0.77	1.34	18.94	32.63	---	---
1976	0.54	0.99	6.87	8.54	---	---
1977	0.49	0.80	11.00	14.00	---	---
1978	1.30	1.80	190.00	400.00	---	---
1979	1.10	3.80	110.00	360.00	---	---
1980	0.43	1.40	35.00	160.00	---	---
1981	0.63	1.30	47.00	82.00	---	---
1982	0.64	1.10	25.00	37.00	---	---
1983	2.30	6.70	260.00	390.00	---	---
1984	2.30	4.40	110.00	150.00	---	---
HPM 11						
1973	1.28	2.64	23.00	363.00	---	---
1974	0.95	1.81	146.63	367.38	---	---
1975	0.81	1.59	32.49	84.61	---	---
1976	0.83	1.59	12.86	22.87	---	---
1977	0.29	0.62	7.30	8.40	---	---
1978	0.72	0.88	21.00	34.00	---	---
1979	0.50	0.84	27.00	50.00	---	---

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HPM 11 (cont.)						
1980	0.35	0.99	39.00	50.00	---	---
1981	0.57	0.73	49.00	63.00	---	---
1982	0.31	0.39	72.00	96.00	---	---
1983	2.30	7.30	340.00	620.00	---	---
1984	2.50	4.30	120.00	140.00	---	---
HPM 12						
1973	1.40	3.84	39.00	594.00	---	---
1974	0.60	0.84	34.54	50.24	---	---
1975	0.72	1.00	21.75	41.81	---	---
1976	0.88	1.26	21.56	23.75	---	---
1977	0.29	0.71	13.00	19.00	---	---
1978	0.76	1.20	46.00	68.00	---	---
1979	0.66	1.50	88.00	210.00	---	---
1980	0.39	1.20	42.00	64.00	---	---
1981	0.42	0.97	70.00	82.00	---	---
1982	0.45	0.84	44.00	57.00	---	---
1983	5.00	11.00	900.00	1,500.00	---	---
1984	78.00	160.00	5,400.00	6,200.00	---	---
241-B						
1973	0.82	3.08	16.00	192.00	50	90
1974	1.30	11.56	12.29	67.04	63	88
1975	1.24	6.10	8.56	63.58	82	94
1976	1.02	8.50	12.74	95.43	88	338
1977	1.10	2.20	11.00	23.00	73	96
1978	0.88	1.60	9.50	51.00	110	160
1979	0.75	1.30	10.00	100.00	200	220
1980	0.61	1.70	22.00	160.00	210	390
1981	0.58	1.40	21.00	49.00	410	440
1982	1.20	2.60	42.00	22.00	500	560
1983	0.26	0.38	10.00	17.00	450	500
1984	0.29	0.29	15.00	15.00	---	---
1985	0.19	0.38	11.00	12.00	---	---
1986	0.54	0.54	7.90	9.30	450	470
HTF 1						
1973	0.30	0.33	2.00	4.00	109	109
1974	0.44	1.03	11.42	21.91	105	123
1975	0.60	2.64	6.08	12.57	79	116
1976	0.27	0.75	9.97	16.66	76	86
1977	0.36	0.76	6.30	14.00	71	89
1978	0.59	1.70	4.60	13.00	59	65

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HTF 1 (cont.)						
1979	0.36	1.00	3.80	11.00	52	62
1980	0.30	0.75	3.90	11.00	47	53
1981	0.43	1.10	5.90	24.00	40	47
1982	0.33	0.59	5.90	26.00	42	53
1983	0.09	0.49	4.10	18.00	35	40
1984	0.36	0.92	3.80	5.80	30	33
1985	0.14	0.38	2.80	4.60	32	37
1986	0.27	0.68	3.90	5.60	90	290
HTF 2						
1973	0.47	0.54	2.00	3.00	18	18
1974	0.59	1.03	7.52	25.41	26	37
1975	0.60	1.09	1.66	7.34	33	37
1976	0.67	1.09	8.09	18.73	37	71
1977	0.67	1.00	4.80	13.00	36	42
1978	0.53	1.10	3.30	9.40	39	61
1979	0.62	1.10	1.10	7.80	35	48
1980	0.36	0.75	1.40	8.20	32	36
1981	0.46	1.10	4.60	20.00	34	43
1982	0.40	0.99	2.90	9.30	42	58
1983	0.23	1.10	2.30	4.00	36	44
1984	0.34	0.97	2.20	4.30	33	36
1985	0.25	0.72	1.80	3.80	38	49
1986	0.31	0.51	2.40	4.20	43	51
HTF 3						
1973	0.26	0.26	4.00	6.00	36	36
1974	0.14	0.45	8.30	23.20	30	35
1975	0.69	2.72	10.74	84.49	55	72
1976	0.44	0.91	19.99	40.46	40	48
1977	0.77	1.30	11.00	17.00	32	42
1978	0.60	1.30	11.00	26.00	34	60
1979	0.36	0.75	14.00	56.00	31	34
1980	0.27	0.74	13.00	26.00	37	40
1981	0.31	0.65	25.00	49.00	31	39
1982	0.30	0.67	24.00	33.00	33	42
1983	0.17	0.58	13.00	26.00	33	41
1984	0.26	0.49	9.60	12.00	26	31
1985	0.23	0.62	6.50	11.00	28	32
1986	0.47	0.91	36.00	99.00	35	38

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
HTF 4						
1973	0.37	0.59	5.00	8.00	67	67
1974	0.30	1.06	9.98	44.83	33	51
1975	0.56	0.92	3.77	9.90	32	35
1976	0.42	1.09	5.16	13.06	32	51
1977	0.47	1.10	4.20	9.80	26	33
1978	0.41	0.92	2.80	13.00	30	58
1979	0.36	0.92	2.90	6.70	34	43
1980	0.26	1.00	1.70	7.60	33	37
1981	0.58	1.80	10.00	56.00	32	39
1982	0.37	0.75	2.70	8.30	35	38
1983	0.25	0.73	3.20	9.00	31	36
1984	0.58	1.10	3.60	5.90	30	33
1985	0.13	0.31	2.60	4.80	32	34
1986	0.39	0.71	2.20	3.60	34	37
HTF 5						
1973	1.19	1.19	3.00	3.00	56	56
1974	1.14	2.90	6.03	12.90	47	60
1975	0.74	1.51	3.24	8.21	61	70
1976	0.78	1.26	3.93	14.16	59	66
1977	0.79	1.40	3.60	7.10	48	55
1978	0.77	1.30	3.70	12.00	45	51
1979	0.72	1.20	2.50	6.30	37	49
1980	0.59	1.30	3.60	8.50	30	34
1981	0.55	0.99	7.50	46.00	30	35
1982	0.54	1.20	7.00	12.00	35	60
1983	0.48	0.97	17.00	45.00	38	48
1984	5.70	40.00	160.00	1,100.00	41	49
1985	0.74	2.50	79.00	330.00	45	48
1986	0.90	3.40	47.00	190.00	50	56
HTF 6						
1973	1.19	1.19	7.00	7.00	17	17
1974	1.15	1.86	5.13	21.02	19	29
1975	1.04	1.76	3.94	19.29	34	46
1976	0.89	1.76	4.51	12.66	27	43
1977	1.20	1.70	11.00	52.00	23	28
1978	0.94	2.30	8.10	26.00	27	45
1979	1.10	2.30	38.00	57.00	35	47
1980	0.48	1.20	42.00	70.00	43	56
1981	1.00	1.70	38.00	72.00	26	31
1982	0.90	2.00	39.00	160.00	28	36
1983	0.86	1.50	24.00	65.00	30	34
1984	0.78	1.50	22.00	32.00	36	48

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HTF 6 (cont.)						
1985	0.32	0.94	30.00	36.00	38	44
1986	0.94	2.90	32.00	44.00	48	120
HTF 7						
1973	2.05	2.31	33.00	44.00	2	2
1974	0.85	1.79	8.87	21.27	3	5
1975	0.57	1.15	4.58	9.45	4	6
1976	0.53	0.92	7.09	12.37	4	10
1977	0.90	1.60	7.00	11.00	2	6
1978	0.76	1.90	5.40	10.00	4	6
1979	0.86	1.80	5.10	9.60	5	9
1980	0.38	1.20	2.30	8.60	8	14
1981	0.47	0.89	6.50	17.00	4	6
1982	0.37	0.99	6.30	18.00	4	5
1983	0.23	0.74	2.80	7.10	6	9
1984	0.66	1.60	9.50	47.00	12	22
1985	0.30	0.72	4.60	14.00	8	11
1986	0.14	0.22	2.90	5.30	8	9
HTF 8						
1973	0.34	0.40	24.00	24.00	---	---
1974	0.91	1.67	6.66	18.84	36	45
1975	2.01	14.93	1.83	14.64	42	50
1976	0.98	2.01	4.03	10.00	40	45
1977	0.73	1.20	2.20	5.90	36	41
1978	0.78	1.40	3.90	9.50	30	35
1979	1.10	2.20	3.40	8.80	29	37
1980	0.37	0.81	13.00	50.00	32	40
1981	0.75	1.60	4.00	7.10	36	44
1982	0.69	1.60	4.30	13.00	40	50
1983	0.39	0.88	4.20	8.10	31	33
1984	0.44	1.20	3.80	12.00	33	40
1985	0.33	0.73	2.40	4.10	35	37
1986	0.74	1.10	2.30	3.60	32	36
HTF 9						
1973	1.69	5.68	15.00	25.00	16	18
1974	0.47	0.94	10.09	39.63	13	16
1975	0.63	2.47	5.22	20.48	9	15
1976	0.40	0.91	6.32	12.09	12	27
1977	0.53	0.93	4.90	10.00	9	13
1978	0.50	0.84	2.80	8.30	8	12
1979	0.31	0.57	7.30	22.00	8	11

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
BTF 9 (cont.)						
1980	0.60	1.20	6.60	18.00	9	12
1981	0.58	0.92	6.20	16.00	11	15
1982	0.53	0.92	9.30	19.00	32	39
1983	0.45	0.99	7.50	16.00	52	61
1984	0.56	1.20	2.90	3.80	78	120
1985	0.47	1.10	2.20	3.70	110	140
1986	0.56	0.91	5.30	7.30	120	200
BTF 10						
1973	0.46	0.57	21.00	28.00	3	4
1974	0.30	1.31	24.57	180.89	2	4
1975	0.25	0.74	3.98	11.41	2	3
1976	0.38	0.92	5.40	12.90	2	5
1977	0.35	1.00	2.20	6.40	3	6
1978	0.36	0.82	5.40	19.00	19	83
1979	0.51	1.20	0.87	4.80	31	42
1980	0.28	1.20	2.20	11.00	52	68
1981	0.78	5.90	4.90	68.00	61	78
1982	0.23	0.84	1.60	7.10	82	100
1983	0.28	1.10	1.40	2.30	85	97
1984	0.31	0.51	1.40	2.30	100	120
1985	0.23	0.72	1.10	2.00	120	130
1986	0.51	1.20	2.10	4.40	100	140
BTF 11						
1973	0.56	0.69	15.00	36.00	7	7
1974	0.40	0.69	8.51	20.24	8	12
1975	0.30	0.58	1.56	7.20	9	10
1976	0.79	1.34	29.06	74.71	30	39
1977	0.73	1.50	3.80	11.00	61	76
1978	0.38	1.00	1.90	13.00	80	86
1979	0.29	0.65	0.57	4.30	76	87
1980	0.12	0.58	0.58	5.50	74	85
1981	0.31	0.76	1.40	17.00	72	90
1982	0.05	0.50	2.70	9.70	82	110
1983	0.06	0.48	0.96	2.30	67	76
1984	0.25	1.30	1.10	4.30	62	73
1985	0.36	0.92	1.30	1.90	52	58
1986	0.62	1.30	4.40	32.00	72	120
BTF 12						
1973	0.63	1.20	5.00	5.00	14	14
1974	0.47	0.76	4.35	9.49	43	148

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
HTF 12 (cont.)						
1975	0.37	1.24	4.11	7.82	103	256
1976	0.56	1.26	3.94	11.05	129	373
1977	0.40	0.75	1.90	8.90	140	290
1978	0.35	0.59	2.40	9.40	150	290
1979	0.34	1.00	1.90	4.90	110	180
1980	0.12	0.49	2.20	9.30	160	210
1981	0.37	1.30	0.67	12.00	220	270
1982	0.48	1.20	2.70	12.00	270	340
1983	0.38	1.20	1.90	10.00	230	280
1984	0.25	1.00	0.77	2.10	290	330
1985	0.35	0.82	0.71	2.50	270	300
1986	0.65	1.70	1.70	3.40	260	360
HTF 13						
1973	0.73	0.73	4.00	4.00	15	15
1974	1.29	2.35	5.61	11.86	12	15
1975	1.15	3.05	2.47	6.60	10	12
1976	0.70	1.20	2.26	6.24	13	63
1977	0.70	1.60	3.90	11.00	7	14
1978	0.69	1.40	1.40	8.20	15	80
1979	0.81	1.40	0.96	3.50	14	90
1980	0.34	0.74	1.80	10.00	10	14
1981	0.81	1.30	3.40	8.30	9	12
1982	0.77	1.30	3.00	7.50	10	12
1983	0.68	2.10	1.90	4.40	11	14
1984	0.43	1.40	1.50	2.80	38	79
1985	0.21	0.48	0.81	1.70	37	44
1986	0.59	1.10	0.77	1.60	47	53
HTF 14						
1973	0.86	0.86	1.00	1.00	21	21
1974	0.87	1.74	4.52	11.13	29	34
1975	0.98	1.76	2.86	12.05	31	37
1976	0.54	0.92	2.56	4.93	30	37
1977	0.59	1.10	2.20	6.30	30	35
1978	1.00	2.50	3.10	9.40	31	35
1979	0.66	1.60	2.60	6.10	35	56
1980	0.56	1.70	2.20	11.00	56	63
1981	0.77	1.50	4.30	13.00	41	52
1982	0.86	3.40	5.30	18.00	48	63
1983	1.30	3.10	6.90	13.00	48	52
1984	0.65	1.40	4.10	7.10	60	84
1985	0.46	1.20	2.40	5.10	39	48
1986	0.82	1.70	2.50	5.80	51	58

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HTF 15						
1973	1.12	1.12	8.00	8.00	216	216
1974	1.16	1.93	7.76	14.49	222	395
1975	1.53	2.60	2.58	6.25	254	349
1976	1.50	2.26	4.32	9.90	303	365
1977	1.50	2.50	4.90	11.00	270	310
1978	1.50	2.80	4.30	8.90	200	260
1979	1.00	1.70	3.50	7.60	160	220
1980	0.58	1.10	4.10	21.00	96	180
1981	0.82	1.50	4.30	8.60	130	160
1982	0.72	2.00	3.90	11.00	140	170
1983	0.61	1.30	2.20	6.30	110	160
1984	0.43	1.10	1.70	2.80	76	110
1985	0.41	0.91	0.90	2.00	74	79
1986	0.77	2.00	1.00	2.00	71	78
HTF 16						
1974	1.81	3.35	7.60	17.49	61	76
1975	1.90	3.13	5.12	8.37	69	100
1976	1.41	2.60	5.01	10.12	42	48
1977	1.50	2.30	4.20	8.70	43	51
1978	1.10	2.20	5.20	12.00	61	220
1979	1.40	2.50	2.70	6.50	51	77
1980	0.79	2.30	3.20	15.00	44	56
1981	0.97	1.60	2.90	11.00	34	42
1982	0.73	2.40	4.80	21.00	49	76
1983	0.88	1.60	2.40	4.60	58	70
1984	0.61	1.20	2.50	4.20	63	74
1985	0.74	1.70	2.50	3.40	53	69
1986	0.78	1.20	3.10	13.00	40	58
HTF 17						
1974	0.98	1.94	9.96	23.00	126	189
1975	0.93	1.76	2.93	6.92	214	358
1976	0.95	1.48	4.66	7.37	129	239
1977	1.00	1.90	5.00	11.00	90	110
1978	1.30	2.70	4.70	11.00	90	120
1979	1.20	2.40	8.20	18.00	130	170
1980	0.81	1.60	8.20	20.00	100	170
1981	0.82	1.70	2.70	9.10	93	120
1982	0.92	3.90	11.00	34.00	180	300
1983	0.68	1.60	5.80	16.00	140	170
1984	0.51	0.78	2.50	3.70	120	170
1985	0.33	1.10	2.20	3.40	92	120
1986	0.47	0.88	3.10	5.50	77	81

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
HTF 18						
1985	0.37	0.52	1.70	2.30	18	19
1986	1.00	2.10	2.90	5.40	21	32
HTF 19						
1985	0.56	0.94	5.80	13.00	13	15
1986	0.62	1.30	3.00	4.80	13	14
HTF 20						
1985	0.27	0.73	2.20	5.30	17	22
1986	0.61	1.40	1.20	2.60	18	21
HTF 21						
1985	0.20	0.52	0.95	1.80	25	34
1986	0.89	1.90	2.20	3.10	33	36
HTF 22						
1985	0.10	0.31	0.88	1.80	13	17
1986	0.19	0.44	0.77	1.40	18	26
HTF 23						
1985	0.06	0.21	3.20	4.70	110	140
1986	0.20	0.61	4.80	6.50	38	60
HTF 24						
1985	0.04	0.19	0.19	1.10	20	25
1986	0.19	0.44	0.03	0.91	12	24
HTF 25						
1985	0.22	0.63	0.51	1.10	11	13
1986	1.00	1.90	1.90	3.10	16	17
HTF 26						
1985	0.23	0.52	5.50	7.70	17	18
1986	1.20	3.40	5.80	7.80	20	23

TABLE 9-11 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
HTF 27						
1985	1.20	1.70	4.00	5.70	17	19
1986	1.00	2.30	2.50	11.00	16	19
HTF 28						
1985	0.40	0.94	0.67	1.30	14	15
1986	0.50	1.10	0.67	1.80	10	18
HTF 29						
1985	0.18	0.31	0.63	1.10	13	15
1986	0.32	0.76	0.70	1.90	10	14
HTF 30						
1985	0.41	0.73	1.10	2.10	14	17
1986	0.75	1.30	1.20	2.00	15	16
HTF 31						
1985	0.12	0.31	0.57	1.30	13	14
1986	0.46	1.10	1.40	6.10	11	14
HTF 32						
1985	0.08	0.29	0.35	1.00	14	16
1986	0.32	0.76	0.95	2.40	15	19
HTF 34						
1986	0.51	1.00	1.20	2.50	27	34

Note: These results are from SRS annual and semiannual reports. Omitted wells and years indicate the absence of data in these reports.

TABLE 9-12

Estimated Nitrate Releases to the H-Area Seepage Basins From 1961 to 1983

Year	Estimated Nitrate Released (kg)
1961	90,000
1962	169,000
1963	281,500
1964	510,300
1965	337,800
1966	158,900
1967	185,200
1968	142,600
1969	365,000
1970	185,000
1975*	102,600**
1983*	107,100+

Note: Data are from Christensen and Gordon (1983).

* Ryan and Stimson (1984).
** Estimated.
\+ Based on extrapolation of 4th quarter 1983 average concentration over the entire year.

TABLE 9-13

Estimated Mercury Releases to the H-Area Seepage Basins from 1955 to 1984

Year	Estimated Mercury Released (kg)
1955-1970	1,630*
1971	28
1972	22
1973	15.4
1974	7.7
1975	6.9
1976	7.4
1977	8.3
1978	6.9
1979	4.4
1980	2.4
1981	2.6
1982	8.9
1983	24.5
1984**	27.6

Note: Data are from Christensen and Gordon (1983).

* Estimated.
** Data are from the Health Protection Department.

TABLE 9-14

Radioactive Releases to the H-Area Seepage Basins (1955-1985)

Radionuclide	First Year of Measurement	Cumulative Original Release (Ci)	Decay Corrected Release Through 12/31/1985 (Ci)
^{3}H	1955	3.3E+05	1.5E+05
^{51}Cr	1971	1.1E+02	3.8E-01
^{58}Co	1971	2.72	2.0E-03
^{60}Co	1969	4.91	1.77
^{65}Zn	1974	2.84	1.5E-02
^{89}Sr	1971	7.97	3.7E-07
^{90}Sr	1955	42.9	2.69E-01
^{95}Zr	1971	8.53	2.3E-02
^{95}Nb	1971	12.6	2.1E-02
^{99}Tc	Estimated	0.5	0.5
^{103}Ru	1971	14.8	6.1E-04
^{106}Ru	1955	5.59E+02	5.09
^{129}I	Estimated	0.4	0.4
^{131}I	1955	1,400	<1.0E-04
^{134}Cs	1971	6.5	4.65E-01
^{137}Cs	1955	1.57E+02	1.12E+02
^{141}Ce	1971	2.62	5.4E-08
^{144}Ce	1971	40.4	2.0E-01
^{147}Pm	1955	45.5	1.17
Natural U	1955	1.40	1.40
^{238}Pu	1967	2.38	2.13
^{239}Pu	1955	1.96	1.95
$^{241,243}Am$	1977	5.07E-02	5.04E-02
$^{242,244}Cm$	1973	7.12E-02	5.19E-02
Total volume (m^3)	1955	5.30E+06	

Note: Data are from Killian et al. (1987b).

TABLE 9-15

H-Area Seepage Basins Influent Characteristics

Constituent	Concentration (mg/L except pH) Average	Maximum	Minimum
Sodium	17.6	61.55	6.1
Calcium	28	239	1.25
Iron	5.1	25	0.01
Zinc	3.1	26.5	0.01
Ammonia	8	28.0	2
Barium	0.08	0.41	0
Potassium	1.0	1.7	0.63
Aluminum	3.2	12.4	0
Manganese	0.560	3.20	0
Magnesium	1.3	4.45	0.15
Nitrate	538	1,950	67
Carbonate	47	180	0
Nitrite	1	7.8	0
Chloride	1.1	4.15	0
Sulfate	3.9	11.9	0
Fluoride	0.1	1.1	0
Silicon (total)	6.3	16.3	2.78
Silicon (<0.45 μm)	6.1	16.3	2.7
Phosphorus	0.6	1.23	0.09
pH	2.37	5.48	1.96
Lead	0.18	0.54	0
Mercury	0.043	0.28	0
Chromium	0.072	0.36	0
Copper	0.43	2.7	0

Note: Samples were taken at the H-Area Trebler Station from September to December 1983. Source: Ryan (1984).

TABLE 9-16

Radioactivity Analyses of H-Area Seepage Basins Influent

Constituent	Average Activity
^{241}Am*	13
^{141}Ce	3,333
^{144}Ce*	17,333
^{242}Cm*	6.7
^{244}Cm*	6.7
^{58}Co	6,670
^{60}Co	6,670
^{51}Cr	33,300
^{134}Cs	10,000
^{137}Cs	60,000
^{131}I	3,333
^{95}Nb	13,300
^{147}Pm	10,000
^{238}Pu*	60
^{239}Pu*	40
^{103}Ru	50,000
^{106}Ru	50,000
^{124}Sb	1,333
^{125}Sb	1,333
^{89}Sr	3,300
^{90}Sr	6,670
^{95}Zr	6,670
Tritium	**
^{235}U*	33
^{238}U*	33
^{65}Zn	6,670
Total alpha	1,333

Note: Activities are in pCi/L. Samples taken at the H-Area Trebler station from September to December 1983. Source: Ryan (1984).

* Alpha emitters (all others are beta-gamma emitters).

** Tritium was not included in this specific study: an appropriate concentration based on 1983 data ranges from 60 to 250 pCi/L.

TABLE 9-17

Radioactivity in the H-Area Seepage Basins Water

Basin 1

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
$^{95}Zr,^{95}Nb$	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	4,525	185	89.05	3.9	3.5	4
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	4.1	3.6	2.95	2.06	1.45	0.3
Nonvolatile beta	465	663	950	685	650	200

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	95	6.5	9.5	7	7	7
$^{95}Zr,^{95}Nb$	26.5	30	4.5	19.5	12	8.5
^{103}Ru	78.5*	91.5*	17.5*	134*	65.5*	225*
^{106}Ru	78.5*	91.5*	17.5*	134*	65.5*	225*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	5.5	3	3	15	4	2
^{134}Cs	35**	14.5**	30.5**	63**	38**	54**
^{137}Cs	35**	14.5**	30.5**	63**	38**	54**
$^{141,144}Ce$	23.5	11	6	8	6	14.5
^{3}H	52,500	14,500	20,200	95,000	57,000	105,000
Gross alpha	0.3	0.1	0.45	0.6	0.15	1.6
Nonvolatile beta	330	72.5	70.5	195	393	557

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 1 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	120	---
$^{58,60}Co$	---	6	8	4	6	---
$^{89,90}Sr$	9.5	4.5	15	14.5	16	6.81
^{95}Zr, ^{95}Nb	6	13.5	10	67.5	33	---
^{103}Ru	54.5	23	22.5	64.5	29	---
^{106}Ru	145	45	83	115	98	---
$^{124,125}Sb$	---	---	---	6.5	3	---
^{131}I	2	59	1	5.5	12	---
^{134}Cs	26*	12*	17.5*	42*	28*	42.2*
^{137}Cs	26*	12*	17.5*	42*	28*	42.2*
$^{141,144}Ce$	9	28	12.5	26	54	---
^{3}H	35,000	81,500	62,000	94,500	110,000	49,000
Gross alpha	0.95	1.55	0.55	1	0.3	0.25
Nonvolatile beta	415	250	315	460	410	263

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	84	38	6.9	13
$^{58,60}Co$	---	---	2.7	0.34	3.1	3.1
$^{89,90}Sr$	12.0	8.38	7.8	16	5.2	1.5
^{95}Zr, ^{95}Nb	---	---	2.6	0.07	0.00	0.20
^{103}Ru	---	---	0.17	4.8	14	0.99
^{106}Ru	---	---	100	140	32	11
$^{124,125}Sb$	---	---	2.7	---	0.78	0.48
^{131}I	---	---	0.00	---	0.12	0.16
^{134}Cs	89.1*	212*	7.4	---	2.1	0.47
^{137}Cs	89.1*	212*	110	---	15	11
$^{141,144}Ce$	---	---	4.7	7.3	49	4.4
^{3}H	69,000	186,000	110,000	110,000	68,000	56,000
Gross alpha	0.43	1.01	0.77	0.23	0.09	0.21
Nonvolatile beta	216	306	180	180	170	47

* Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 1 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	15	8.0	11	23	20	1.2
$^{58,60}Co$	2.0	1.5	3.1	0.68	0.00	0.47
$^{89,90}Sr$	11	1.6	0.84	0.26	0.10	0.09
$^{95}Zr, ^{95}Nb$	0.17	0.36	0.03	0.13	0.30	0.00
^{103}Ru	1.5	1.0	1.2	2.2	0.00	0.00
^{106}Ru	10	3.1	13	11	4.0	1.9
$^{124,125}Sb$	1.3	0.31	0.77	1.2	0.15	0.00
^{131}I	0.07	0.05	0.22	0.18	56	0.00
^{134}Cs	0.26	0.05	0.22	0.97	0.46	0.13
^{137}Cs	12	5.8	7.8	30	6.0	14
$^{141,144}Ce$	9.6	0.62	2.4	3.4	0.00	0.00
^{3}H	110,000	29,000	93,000	60,000	110,000	98,000
Gross alpha	0.09	0.19	0.79	3.0	0.23	0.10
Nonvolatile beta	89	31	41	25	8.2	34

Basin 2

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
$^{95}Zr, ^{95}Nb$	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	2,830	21.5	54	1.8	3.5	2.5
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	4	0.45	1.98	0.285	1.2	0.5
Nonvolatile beta	175	105	548	206	515	165

TABLE 9-17 (cont.)

Basin 2 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	61	4	4.5	5.5	5	5.5
^{95}Zr, ^{95}Nb	14.5	11	2	11	6.5	4
^{103}Ru	70*	47*	12*	122*	56.5*	151*
^{106}Ru	70*	47*	12*	122*	56.5*	151*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	3.5	5.5	2	12	3	ND
^{134}Cs	33.5**	16.5**	27**	61.5**	44.5**	43**
^{137}Cs	33.5**	16.5**	27**	61.5**	44.5**	43**
$^{141,144}Ce$	13.5	7	5.5	14.5	3.5	13
^{3}H	74,100	20,500	23,000	62,500	47,500	85,000
Gross alpha	0.55	0.1	0.075	0.4	0.15	1.55
Nonvolatile beta	225	60.5	55	220	293	416

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	56	---
$^{58,60}Co$	---	4.5	9	3.5	3	---
$^{89,90}Sr$	15.5	7.5	18	9.5	10	3.63
^{95}Zr, ^{95}Nb	4	5	6.5	14	7	---
^{103}Ru	39	13.5	25	29	9	---
^{106}Ru	135	49	106	47.5	24	---
$^{124,125}Sb$	---	---	---	4	2	---
^{131}I	ND	27	1	2	4	---
^{134}Cs	25*	11*	23.5*	38*	23*	34.5*
^{137}Cs	25*	11*	23.5*	38*	23*	34.5*
$^{141,144}Ce$	8	9.5	13	12	15	---
^{3}H	37,500	73,000	53,000	68,000	95,000	39,000
Gross alpha	1.15	0.65	0.5	0.3	0.2	0.10
Nonvolatile beta	465	180	325	320	210	229

* Reported as $^{103,106}Ru$.
** Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 2 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	31	15	4.6	6.4
$^{58,60}Co$	---	---	0.15	0.01	1.5	2.2
$^{89,90}Sr$	9.53	6.56	9.8	15	7.6	1.5
$^{95}Zr, ^{95}Nb$	---	---	0.00	0.00	0.00	0.08
^{103}Ru	---	---	0.07	1.2	6.1	0.64
^{106}Ru	---	---	87	100	33	11
$^{124,125}Sb$	---	---	1.1	---	0.69	0.42
^{131}I	---	---	0.00	---	0.21	0.17
^{134}Cs	66.0*	107*	6.6	---	2.5	0.49
^{137}Cs	66.0*	107*	100	---	16	12
$^{141,144}Ce$	---	---	2.0	7.0	57	5.1
^{3}H	55,000	174,000	110,000	83,000	68,000	40,000
Gross alpha	0.10	0.11	0.19	0.16	0.03	0.33
Nonvolatile beta	150	159	130	160	180	63

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	7.1	8.0	4.6	9.9	0.00	0.00
$^{58,60}Co$	1.9	2.2	0.90	0.21	0.00	1.7
$^{89,90}Sr$	6.8	3.3	0.82	0.15	0.07	0.07
$^{95}Zr, ^{95}Nb$	0.22	0.08	0.04	0.08	0.00	0.00
^{103}Ru	0.75	0.58	0.45	0.34	0.00	0.00
^{106}Ru	5.0	4.7	9.4	5.7	0.00	2.2
$^{124,125}Sb$	0.94	0.41	0.58	0.83	0.00	0.00
^{131}I	0.08	0.02	0.13	0.33	0.00	0.00
^{134}Cs	0.09	0.05	0.36	0.96	0.00	0.00
^{137}Cs	12	7.1	11	26	1.0	8.7
$^{141,144}Ce$	3.5	0.67	2.1	2.0	0.00	0.00
^{3}H	79,000	42,000	49,000	41,000	68,000	73,000
Gross alpha	0.11	0.04	0.50	1.9	0.08	0.13
Nonvolatile beta	47	27	37	28	4.5	24

* Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 3

Radionuclide	Average Concentration (pCi/mL) 1957	1958	1959	1960	1961	1962
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	---	---	---	---	---	---
^{95}Zr, ^{95}Nb	---	---	---	---	---	---
^{103}Ru	---	---	---	---	---	---
^{106}Ru	---	---	---	---	---	---
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	1,615	3.5	13	0.39	1.65	1
^{134}Cs	---	---	---	---	---	---
^{137}Cs	---	---	---	---	---	---
$^{141,144}Ce$	---	---	---	---	---	---
^{3}H	---	---	---	---	---	---
Gross alpha	1.46	0.59	0.88	0.335	0.35	ND
Nonvolatile beta	80	41	107	42	42	28.5

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	6	4.5	1.5	1	2.5	1.5
^{95}Zr, ^{95}Nb	1.5	1.5	<1	1.5	2	2
^{103}Ru	18*	13*	4*	3*	5.5*	32*
^{106}Ru	18*	13*	4*	3*	5.5*	32*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	0.4	1	2	ND	ND	ND
^{134}Cs	8.5**	8**	2.5**	3**	6**	15.5**
^{137}Cs	8.5**	8**	2.5**	3**	6**	15.5**
$^{141,144}Ce$	2	5	1.0	2	1	1
^{3}H	32,750	22,200	9,500	6,500	7,150	15,600
Gross alpha	0.2	0.1	0.11	0.1	0.065	0.25
Nonvolatile beta	31	25.5	10	11	14	68.5

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 3 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	<1	---
$^{58,60}Co$	---	ND	1	ND	<1	---
$^{89,90}Sr$	6	1	1	1	1	0.50
^{95}Zr, ^{95}Nb	1.5	2	3.5	4	2	---
^{103}Ru	1	ND	ND	ND	<1	---
^{106}Ru	20	8	4	3	<1	---
$^{124,125}Sb$	---	---	---	ND	<1	---
^{131}I	ND	ND	ND	ND	<1	---
^{134}Cs	12*	4.5*	2.5*	2.5*	2*	2.35*
^{137}Cs	12*	4.5*	2.5*	2.5*	2*	2.35*
$^{141,144}Ce$	2	ND	ND	ND	<1	---
^{3}H	29,500	13,000	4,850	2	2	2,000
Gross alpha	0.2	0.15	0.2	0.2	<0.1	0.07
Nonvolatile beta	71	23.5	20.5	10	7	6.63

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	0.11	0.07	0.31	1.2
$^{58,60}Co$	---	---	0.10	0.03	0.30	1.2
$^{89,90}Sr$	0.51	0.73	0.61	3.2	3.7	2.4
^{95}Zr, ^{95}Nb	---	---	0.01	0.00	0.11	0.15
^{103}Ru	---	---	0.02	0.00	0.19	0.35
^{106}Ru	---	---	0.83	1.6	0.59	1.3
$^{124,125}Sb$	---	---	0.03	---	0.17	0.29
^{131}I	---	---	0.01	---	0.10	0.11
^{134}Cs	1.73*	1.40*	0.14	---	0.11	0.14
^{137}Cs	1.73*	1.40*	1.3	---	6.8	9.2
$^{141,144}Ce$	---	---	0.10	0.29	0.98	2.9
^{3}H	1,200	2,700	440	380	270	11,000
Gross alpha	0.02	0.05	0.03	0.05	0.12	0.05
Nonvolatile beta	1.04	3.31	2.7	9.9	11	14

* Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 3 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	0.70	0.38	0.14	0.22	0.55	0.00
$^{58,60}Co$	1.2	0.30	0.08	0.02	0.04	0.00
$^{89,90}Sr$	1.7	0.19	0.30	0.19	0.07	0.11
$^{95}Zr, ^{95}Nb$	0.05	0.00	0.01	0.02	0.00	0.00
^{103}Ru	0.38	0.14	0.02	0.02	0.00	0.00
^{106}Ru	1.6	1.3	1.1	0.62	0.00	0.00
$^{124,125}Sb$	0.34	0.14	0.12	0.10	0.00	0.00
^{131}I	0.05	0.01	0.06	0.05	0.22	0.00
^{134}Cs	0.10	0.06	0.14	0.05	0.04	0.00
^{137}Cs	4.7	3.1	0.85	2.2	0.23	0.67
$^{141,144}Ce$	0.87	0.46	0.38	0.13	0.07	0.00
^{3}H	31,000	3,900	1,200	3,800	5,300	4,000
Gross alpha	0.03	0.02	0.05	1.1	0.00	0.00
Nonvolatile beta	21	9.0	2.0	2.5	0.25	1.1

Basin 4

Radionuclide	Average Concentration (pCi/mL) 1963	1964	1965	1966	1967	1968
^{51}Cr	---	---	---	---	---	---
$^{58,60}Co$	---	---	---	---	---	---
$^{89,90}Sr$	42.5	2.5	6.5	11.5	4.5	4
$^{95}Zr, ^{95}Nb$	13	9	2.5	4.5	8.5	3
^{103}Ru	62*	34.5*	9.5*	131*	61*	97.5*
^{106}Ru	62*	34.5*	9.5*	131*	61*	97.5*
$^{124,125}Sb$	---	---	---	---	---	---
^{131}I	2	1.5	2.5	1.5	2.5	ND
^{134}Cs	27**	16.5**	26**	73**	46.5**	41.5**
^{137}Cs	27**	16.5**	26**	73**	46.5**	41.5**
$^{141,144}Ce$	10.5	8	3.5	15.5	5	7
^{3}H	71,100	27,500	20,500	45,000	39,500	59,500
Gross alpha	0.1	0.1	0.06	0.8	0.1	0.65
Nonvolatile beta	147	47.5	44.5	255	280	325

* Reported as $^{103,106}Ru$.

** Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 4 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1969	1970	1971	1972	1973	1974
^{51}Cr	---	---	---	---	29	---
$^{58,60}Co$	---	3.5	6	3	2	---
$^{89,90}Sr$	9.5	7.5	4	12	6	1.39
^{95}Zr, ^{95}Nb	2.5	4	3	6	2	---
^{103}Ru	24	10.5	18	17.5	5	---
^{106}Ru	105	49.5	15	22.5	19	---
$^{124,125}Sb$	---	---	---	4	22	---
^{131}I	ND	19	<1	2	2	---
^{134}Cs	29.5*	14.5*	9*	32*	16*	18.8*
^{137}Cs	29.5*	14.5*	9*	32*	16*	18.8*
$^{141,144}Ce$	ND	8	4	7.5	26	---
^{3}H	38,000	68,000	34,000	54,500	76,000	34,000
Gross alpha	0.95	0.5	0.2	0.45	0.1	0.06
Nonvolatile beta	435	161	140	270	150	108

Radionuclide	Average Concentration (pCi/mL) 1975	1976	1977	1978	1979	1980
^{51}Cr	---	---	3.4	3.7	5.2	3.8
$^{58,60}Co$	---	---	0.02	0.00	0.67	1.6
$^{89,90}Sr$	2.30	1.77	2.5	13	12	1.4
^{95}Zr, ^{95}Nb	---	---	0.00	0.00	0.00	0.08
^{103}Ru	---	---	0.00	0.33	2.0	0.49
^{106}Ru	---	---	28	70	41	4.8
$^{124,125}Sb$	---	---	0.56	---	0.88	0.43
^{131}I	---	---	0.01	---	0.16	0.15
^{134}Cs	21.2*	25.0*	2.6	---	2.7	0.24
^{137}Cs	21.2*	25.0*	33	---	19	8.2
$^{141,144}Ce$	---	---	0.46	5.1	37	2.9
^{3}H	36,000	63,000	62,000	65,000	49,000	32,000
Gross alpha	0.09	0.02	0.02	0.07	0.02	0.39
Nonvolatile beta	57.7	52.8	37	120	120	68

* Reported as $^{134,137}Cs$.

TABLE 9-17 (cont.)

Basin 4 (cont.)

Radionuclide	Average Concentration (pCi/mL) 1981	1982	1983	1984	1985	1986
^{51}Cr	5.7	7.6	3.6	6.5	5.8	0.00
$^{58,60}Co$	2.8	1.7	0.70	0.00	0.07	0.34
$^{89,90}Sr$	5.6	3.2	0.66	0.19	0.06	0.11
$^{95}Zr,^{95}Nb$	0.16	0.03	0.03	0.00	1.0	0.00
^{103}Ru	1.1	1.1	0.45	0.01	1.2	0.00
^{106}Ru	2.1	5.6	6.5	7.3	0.03	8.0
$^{124,125}Sb$	1.1	0.36	0.39	0.68	0.11	0.00
^{131}I	0.10	0.06	0.29	0.14	4,400	0.00
^{134}Cs	0.02	0.14	0.41	1.1	0.00	0.00
^{137}Cs	13	8.0	10	25	3.6	13
$^{141,144}Ce$	6.9	0.97	2.0	1.6	0.50	0.00
^{3}H	74,000	53,000	39,000	53,000	57,000	64,000
Gross alpha	0.01	0.07	0.20	0.14	0.10	0.06
Nonvolatile beta	46	32	34	17	4.0	18

Note: Prior to 1973, means were reported for 6-month intervals. Values given in this table prior to 1973 are the average of the 6-month values.
ND = not detected.

TABLE 9-18

Range of Concentrations for Radionuclides, Cations, and Anions Found in H-Area Seepage Basins Soil Cores

Radionuclides Species	Range (pCi/g)*	Cations and Anions Species	Range (μg/g)*
^{241}Am	0.2-982	Silver	6-17
^{141}Ce	LTDL	Arsenic	2-6
^{144}Ce	1.66-303	Boron	5-75
$^{243,244}Cm$	0.06-704	Barium	7-84
^{60}Co	0.13-1,270	Beryllium	LTDL
^{134}Cs	0.05-178	Bismuth	9-25
^{137}Cs	0.14-18,400	Cadmium	LTDL
^{3}H	80-34,722	Cyanide	5-9
^{129}I	1.0-190	Chromium	4-3,833
^{95}Nb	0.18-43.1	Copper	8-79
^{147}Pm	0.23-2,869	Iron	386-115,218
^{238}Pu	0.3-2,171	Fluoride	30-225
$^{239,240}Pu$	0.3-11,230	Mercury	2-120
^{103}Ru	1.28-61.8	Lithium	2-14
^{106}Ru	1.48-453	Manganese	5-967
^{89}Sr	1.52-1,031	Sodium	14-1,676
^{90}Sr	0.87-4,869	Nickel	21.7-87
^{99}Tc	0.30-267	Nitrite	LTDL
^{232}Th	0.38-9.1	Nitrate	130-500
$^{233,234}U$	2.1-127	Lead	1.8-2,780
^{235}U	0.16-15.6	Selenium	2-2
^{238}U	0.9-26.5	Tin	6.7-57
		Titanium	6-140
		Tungsten	10-101
		Zinc	5-323

Note: LTDL = Less than detection limits for all samples. Data are from Corbo et al. (1985).

* Minimum value represents lowest measured positive value.

TABLE 9-19

Radioactivity in the H-Area Seepage Basins Wells (Annual Averages)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
BC 10						
1967	---	---	---	---	23,500	3,0000
1968	---	---	---	---	19,000	27,000
1969	---	---	---	---	32,500	46,000
1970	---	---	---	---	36,000	60,000
1971	---	---	---	---	21,500	35,000
1972	---	---	---	---	29,500	144,000
1973	---	---	---	---	34,000	37,000
1974	---	---	---	---	43,127	53,374
1975	---	---	---	---	27,860	29,578
1976	---	---	---	---	26,410	28,520
1977	---	---	---	---	28,000	28,000
1978	---	---	---	---	43,000	88,000
1979	---	---	---	---	39,000	57,000
1980	---	---	---	---	31,000	38,000
1981	---	---	---	---	19,000	27,000
1982	---	---	---	---	43,000	46,000
1983	---	---	---	---	38,000	93,000
1984	---	---	---	---	33,000	150,000
1985	---	---	---	---	38,000	53,000
1986	---	---	---	---	21,000	39,000
H 1						
1956	581.08	1,306.31	45,000.00	120,000.00	---	---
1957	90.09	157.66	14,000.00	24,000.00	---	---
1958	58.11	139.64	6,100.00	19,000.00	---	---
1959	365.77	3,378.38	14,100.00	150,000.00	---	---
1960	20.00	44.00	3,550.00	26,000.00	---	---
1961	23.50	85.00	4,995.00	38,000.00	34,000	73,000
1962	35.00	110.00	5,500.00	16,000.00	7,005	38,000
1963	5.30	6.50	442.00	550.00	820	890
1964	8.10	17.00	257.00	286.00	1,224	1,224
1965	2.50	4.00	840.00	2,100.00	250	370
1966	1.50	1.60	30.00	40.00	32,000	94,000
1973	22.00	25.00	440.00	450.00	860	1,600
H 2						
1956	2.03	3.15	21.00	130.00	---	---
1957	1.13	2.25	133.00	380.00	---	---
1958	0.68	1.80	14.00	29.00	---	---
1959	0.45	0.90	17.50	51.00	---	---
1960	0.49	0.90	11.50	29.00	---	---
1961	0.60	1.00	88.00	540.00	65,000	120,000

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
H 2 (cont.)						
1962	0.55	0.70	149.50	1,300.00	28,021	58,000
1963	0.20	0.30	18.00	28.00	31,000	35,000
1964	0.73	1.20	55.00	78.00	72,141	87,154
1965	0.33	0.80	27.00	37.00	100,000	110,000
1966	0.70	1.00	50.00	50.00	89,000	95,000
1967	0.70	1.10	44.00	72.00	42,000	48,000
1968	1.10	2.00	36.00	55.00	32,000	34,000
1972	0.80	1.40	22.00	37.00	9,700	10,000
1973	3.00	4.00	41.00	44.00	14,000	15,000
1974	1.03	1.09	30.27	37.96	8,146	8,251
1975	2.14	3.35	61.13	71.35	7,527	7,893
1976	0.91	1.40	33.84	38.67	5,884	6,121
1977	0.72	0.92	17.00	18.00	4,700	5,700
1978	1.20	1.40	29.00	48.00	4,200	4,900
1979	3.20	4.40	150.00	260.00	2,600	2,600
1980	3.50	4.40	110.00	140.00	8,200	9,000
1982	1.10	1.50	96.00	140.00	19,000	25,000
1983	6.00	6.90	130.00	140.00	18,000	22,000
1984	4.10	6.30	120.00	210.00	50,000	110,000
1985	1.00	1.20	85.00	86.00	31,000	32,000
1986	---	---	---	---	23,000	23,000
H 3						
1956	0.68	1.35	31.00	170.00	---	---
1957	0.45	0.90	40.00	150.00	---	---
1958	0.45	0.90	41.50	130.00	---	---
1959	0.45	0.45	200.00	480.00	---	---
1960	0.40	0.65	165.00	380.00	---	---
1961	1.50	3.70	6,645.00	42,000.00	120,000	190,000
1962	2.60	6.00	8,800.00	40,000.00	59,070	124,000
1963	2.50	2.70	3,300.00	3,800.00	126,000	132,000
1964	1.40	1.70	2,316.00	3,789.00	117,469	134,538
1965	3.40	4.00	4,900.00	6,400.00	79,000	88,000
1966	3.30	3.30	190.00	190.00	1,400	1,400
H 4						
1956	0.68	1.80	12.50	35.00	---	---
1957	0.90	1.35	30.50	100.00	---	---
1958	0.45	0.90	18.00	52.00	---	---
1959	0.68	1.35	19.00	41.00	---	---
1960	0.41	0.65	8.00	13.00	---	---
1961	0.60	1.60	43.50	220.00	1,600	4,500
1962	0.80	1.30	97.50	160.00	4,502	11,000
1963	3.00	3.30	2,900.00	4,100.00	18,000	34,000

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
E 4 (cont.)						
1964	1.60	2.20	75.00	142.00	701	931
1965	1.10	2.10	260.00	780.00	2,300	6,000
1966	1.40	1.50	80.00	80.00	800	900
1967	3.20	5.20	4,000.00	7,700.00	36,000	50,000
1968	4.10	5.20	6,000.00	9,900.00	55,000	61,000
1969	5.60	6.10	4,500.00	5,300.00	35,000	42,000
1970	2.20	4.00	3,800.00	6,400.00	21,000	34,000
1971	4.40	4.90	3,700.00	5,200.00	3,400	5,000
1972	3.90	5.10	4,600.00	5,600.00	6,800	8,400
1973	3.00	4.00	560.00	1,300.00	1,200	3,000
1974	5.54	6.95	6,271.90	8,024.87	8,316	8,380
1975	4.31	7.54	389.54	694.53	332	618
1976	5.36	6.52	4,729.17	6,842.39	3,419	4,533
1977	7.80	9.00	7,400.00	8,700.00	5,100	6,800
1978	7.50	9.70	6,800.00	8,100.00	4,800	6,200
1979	6.10	7.30	4,500.00	4,900.00	1,400	1,800
1980	4.50	4.50	3,300.00	3,300.00	3,300	6,600
1982	8.60	15.00	8,500.00	10,000.00	4,400	6,200
1983	24.00	45.00	1,500.00	2,900.00	1,400	3,400
1984	14.00	35.00	1,600.00	3,800.00	46,000	110,000
1985	16.00	25.00	4,300.00	5,900.00	30,000	34,000
1986	23.00	38.00	5,100.00	6,700.00	18,000	19,000
E 5						
1956	503.15	1,396.40	35,250.00	110,000.00	---	---
1957	166.67	720.72	56,000.00	270,000.00	---	---
1958	10.14	36.94	3,150.00	15,000.00	---	---
1959	7.66	54.05	5,275.00	32,000.00	---	---
1960	22.50	40.00	14,500.00	42,000.00	---	---
1961	175.50	630.00	133,000.00	230,000.00	100,000	340,000
1962	281.50	1,100.00	51,500.00	280,000.00	34,565	160,000
1963	275.00	400.00	43,000.00	66,000.00	129,000	210,000
1964	163.50	365.00	31,399.00	64,988.00	46,941	103,564
1965	200.00	480.00	19,000.00	42,000.00	84,500	42,000
E 6						
1956	0.90	4.05	25.50	55.00	---	---
1957	0.45	1.35	40.00	100.00	---	---
1958	0.45	0.90	33.50	140.00	---	---
1959	0.68	1.35	20.00	43.00	---	---
1960	0.33	0.90	120.00	324.00	---	---
1961	0.35	0.60	170.00	460.00	73,000	77,000
1962	0.85	3.20	400.00	2,200.00	34,032	70,000
1963	0.60	0.80	470.00	700.00	57,000	59,000

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
B 6 (cont.)						
1964	0.80	2.00	100.00	126.00	69,124	82,416
1965	0.66	1.00	90.00	160.00	70,000	76,000
1966	1.50	2.40	100.00	200.00	13,000	35,000
1967	3.40	5.30	3,100.00	3,800.00	58,000	61,000
1968	6.30	8.90	2,400.00	3,200.00	63,000	66,000
1969	7.30	12.50	3,000.00	6,200.00	58,000	59,000
1970	5.50	8.60	660.00	1,000.00	16,000	20,000
1971	4.00	4.40	170.00	200.00	54,000	37,000
1972	6.30	10.80	380.00	460.00	26,000	27,000
1973	2.00	3.00	2,500.00	3,400.00	35,000	38,000
1974	2.29	2.41	705.09	809.49	34,743	34,954
1975	3.53	3.77	1,307.73	1,758.31	34,204	34,955
1976	4.17	4.44	1,274.06	1,892.71	38,573	40,075
1977	2.80	3.90	1,300.00	1,900.00	40,000	42,000
1978	5.40	7.60	610.00	790.00	8,900	14,000
1979	12.00	18.00	3,000.00	4,300.00	9,200	9,600
1980	31.00	12.00	5,100.00	7,400.00	26,000	27,000
1982	5.20	10.00	5,700.00	6,800.00	41,000	47,000
1983	49.00	55.00	4,700.00	4,700.00	33,000	36,000
1984	31.00	47.00	4,800.00	6,400.00	28,000	33,000
1985	46.00	67.00	6,000.00	24,000.00	47,000	51,000
1986	75.00	130.00	34,000.00	42,000.00	48,000	56,000
B 7						
1956	1.13	1.80	16.50	40.00	---	---
1957	0.68	1.35	27.50	77.00	---	---
1958	0.45	1.80	19.50	78.00	---	---
1959	0.68	1.80	28.50	180.00	---	---
1960	0.35	0.85	7.00	12.00	---	---
1961	0.40	0.80	39.50	150.00	1,800	3,200
1962	0.50	1.00	32.50	85.00	1,003	4,000
1963	0.90	1.00	22.00	25.00	1,400	2,100
1964	0.71	0.84	16.00	28.00	723	745
1965	1.30	1.60	47.00	94.00	900	1,500
1966	0.60	1.00	40.00	50.00	62,000	77,000
1967	1.20	1.70	36.00	73.00	1,500	2,300
1968	0.90	2.20	15.00	25.00	2,400	3,600
1969	2.80	4.60	145.00	330.00	740	820
1970	1.60	3.30	37.00	64.00	1,100	1,700
1971	2.30	2.60	21.00	24.00	270	450
1972	2.60	3.50	26.00	47.00	170	200
1973	2.00	3.00	16.00	28.00	210	240
1974	0.49	0.90	10.47	16.49	235	254
1975	1.80	2.51	5.35	8.94	179	190
1976	0.80	1.15	15.58	35.80	147	186

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
B 7 (cont.)						
1977	0.80	1.00	18.00	38.00	140	210
1978	2.20	1.50	5.70	7.10	110	110
1979	1.30	2.70	56.00	100.00	130	180
1980	1.20	2.70	52.00	110.00	110	120
1982	0.38	0.66	17.00	19.00	120	150
1983	1.10	1.40	12.00	17.00	94	100
1984	0.90	1.90	8.10	16.00	120	130
1985	0.56	1.40	94.00	340.00	450	790
1986	0.67	1.40	110.00	230.00	1,100	2,300
B 8						
1956	0.45	1.80	16.50	59.00	---	---
1957	0.45	0.90	25.00	79.00	---	---
1958	0.45	0.90	20.00	41.00	---	---
1959	0.45	0.90	33.00	69.00	---	---
1960	0.34	1.20	56.00	87.00	---	---
1961	0.20	0.60	100.50	270.00	31,000	21,000
1962	0.10	0.30	97.00	380.00	8,000	19,000
1963	0.10	0.20	61.00	73.00	6,000	18,000
1964	---	0.12	29.00	34.00	9,299	22,961
1965	0.20	0.30	72.00	91.00	1,000	22,000
1966	0.80	1.60	80.00	220.00	6,000	19,000
1967	0.30	0.30	25.00	35.00	5,000	15,000
1972	0.80	1.40	87.00	120.00	5,900	6,200
1973	1.00	1.00	85.00	130.00	8,600	9,100
1974	0.57	0.67	47.41	70.18	7,207	7,245
1975	0.69	1.42	116.73	141.29	4,899	7,467
1976	0.61	0.75	257.94	265.32	6,720	7,060
1977	0.83	1.20	320.00	320.00	4,700	5,600
1978	1.10	1.70	170.00	330.00	3,400	3,600
1979	0.83	1.10	97.00	120.00	2,100	2,100
1980	0.30	0.41	30.00	43.00	1,800	1,900
1982	0.57	0.97	460.00	590.00	3,900	4,500
1983	11.00	17.00	960.00	1,600.00	5,000	5,600
1984	0.84	1.30	120.00	290.00	5,100	5,200
1985	1.10	1.70	200.00	280.00	4,900	5,200
1986	1.40	1.90	330.00	460.00	6,800	8,200
B 9						
1956	0.45	0.90	38.00	99.00	---	---
1957	0.45	0.45	27.50	60.00	---	---
1958	0.45	0.90	28.00	140.00	---	---
1959	0.45	0.90	12.50	27.00	---	---
1960	0.31	0.60	14.00	16.00	---	---

TABLE 9-19 (cont.)

Year	Cross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 9 (cont.)						
1961	0.20	0.40	36.50	120.00	15,000	17,000
1962	0.15	0.50	71.50	420.00	6,506	15,000
1963	0.30	0.30	31.00	40.00	15,000	16,000
1964	---	0.20	23.00	34.00	16,892	18,610
1965	0.30	0.60	49.00	110.00	21,000	22,000
1966	0.70	1.80	90.00	240.00	21,000	21,000
1967	0.60	0.90	260.00	370.00	13,000	14,000
1968	3.10	5.40	270.00	380.00	16,000	16,000
1969	7.30	16.70	610.00	1,400.00	12,000	13,000
1970	1.30	3.80	690.00	1,600.00	20,000	24,000
1971	1.30	1.80	44.00	72.00	8,100	12,000
1972	3.10	4.40	380.00	490.00	8,300	9,600
1973	4.00	5.00	140.00	160.00	6,500	6,800
1974	3.87	4.44	175.37	176.96	3,838	4,239
1975	5.48	6.95	172.09	205.72	5,839	5,997
1976	1.58	1.98	174.33	197.44	4,232	4,264
1977	4.00	4.90	140.00	190.00	4,200	4,500
1978	3.90	4.10	100.00	140.00	2,600	2,800
1979	6.50	9.70	600.00	1,400.00	1,800	2,100
1980	1.60	1.80	36.00	38.00	2,200	2,300
1982	0.44	0.49	37.00	45.00	3,000	3,500
1983	1.10	2.00	49.00	72.00	3,400	4,600
1984	2.50	3.00	630.00	1,600.00	4,900	7,100
1985	10.00	20.00	1,400.00	1,900.00	5,700	6,200
1986	8.80	11.00	1,500.00	2,500.00	6,300	6,800
H 10						
1956	0.45	0.90	32.00	88.00	---	---
1957	0.45	0.45	27.00	73.00	---	---
1958	0.45	1.35	33.00	110.00	---	---
1959	0.45	1.35	88.00	1,100.00	---	---
1960	0.33	0.72	13.00	18.00	---	---
1961	0.30	1.00	96.00	290.00	10,000	22,000
1962	0.15	0.30	50.00	110.00	5,006	11,000
1963	0.30	0.30	58.00	93.00	9,000	11,000
1964	---	0.12	25.00	28.00	13,117	13,999
1965	0.30	0.40	40.00	90.00	13,000	15,000
1966	0.20	0.30	230.00	370.00	14,000	15,000
1967	0.80	1.20	60.00	73.00	12,000	12,000
1968	0.60	1.00	11.00	15.00	13,000	14,000
1969	0.70	0.90	22.00	31.00	13,000	13,000
1970	0.60	0.70	34.00	58.00	15,000	---
1971	0.80	1.30	100.00	140.00	12,000	13,000
1972	1.40	1.70	17.00	20.00	11,000	11,000
1973	1.00	1.00	8.00	15.00	9,100	9,400

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 10 (cont.)						
1974	0.47	0.67	8.97	11.29	8,944	8,989
1975	0.72	0.84	13.03	40.40	8,891	9,249
1976	0.61	0.91	14.59	17.22	8,660	8,805
1977	0.68	1.10	19.00	27.00	7,500	7,800
1978	0.52	0.74	6.60	7.40	6,600	6,800
1979	0.11	0.25	21.00	32.00	5,600	5,900
1980	0.33	0.66	15.00	34.00	4,500	4,800
1982	30.00	90.00	17.00	40.00	4,100	4,300
1983	0.49	0.68	1.90	2.40	3,400	4,000
1984	0.34	0.58	3.10	4.20	3,000	3,500
1985	0.28	0.63	2.00	5.30	3,000	3,100
1986	0.58	0.98	3.90	5.80	2,600	2,700
H 11						
1956	0.45	0.90	140.00	80.00	---	---
1957	0.45	0.45	26.50	76.00	---	---
1958	0.45	0.45	85.50	210.00	---	---
1959	0.45	0.45	190.00	320.00	---	---
1960	0.20	0.40	158.50	341.00	---	---
1961	0.15	0.60	115.00	230.00	18,000	23,000
1962	0.20	0.30	71.50	150.00	9,009	19,000
1963	0.10	0.20	62.00	62.00	6,000	20,000
1964	---	0.00	29.00	32.00	11,071	13,163
1965	0.20	0.50	120.00	320.00	8,000	9,000
1966	0.20	0.50	10.00	20.00	4,800	6,000
1967	0.50	0.80	75.00	80.00	3,900	4,000
1968	0.20	0.40	17.00	23.00	2,700	3,000
1969	1.70	2.50	140.00	230.00	2,200	2,400
1970	0.40	1.30	34.00	43.00	2,600	---
1971	0.50	0.70	9.00	16.00	260	350
1972	0.60	0.90	59.00	150.00	290	320
1973	1.00	1.00	50.00	120.00	150	180
1974	0.32	0.50	7.67	10.74	207	249
1975	0.58	0.75	8.70	16.86	91	93
1976	0.67	0.91	7.54	9.07	79	110
1977	0.45	0.47	10.00	16.00	84	170
1978	0.03	0.16	7.80	11.00	64	67
1979	0.08	0.25	3.30	8.50	51	67
1980	0.41	0.49	15.00	18.00	52	55
1982	0.25	0.41	17.00	23.00	330	1,100
1983	0.49	0.71	2.70	3.10	120	160
1984	0.34	0.58	8.00	14.00	96	97
1985	0.05	0.21	5.20	7.00	180	250
1986	0.24	0.58	4.80	7.50	190	260

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 12						
1962	2.10	4.20	96.00	130.00	47,000	52,000
1963	1.40	1.90	109.00	450.00	48,250	165,000
1964	1.25	3.80	82.50	138.00	75,808	213,052
1965	0.95	1.80	63.00	140.00	40,500	54,000
1966	1.05	3.80	65.00	110.00	23,000	35,000
1967	0.75	3.10	44.50	74.00	18,000	26,000
1968	0.70	1.80	22.50	40.00	9,250	14,000
1969	0.45	1.10	19.50	46.00	8,500	12,000
1970	0.45	0.80	22.50	37.00	12,700	68,000
1971	0.85	1.10	36.00	40.00	6,050	9,100
1972	0.50	1.00	46.50	90.00	5,150	6,900
1973	1.00	1.00	58.00	138.00	7,400	11,000
1974	0.69	1.21	126.90	220.95	5,784	10,500
1975	0.54	1.07	42.80	66.69	3,872	5,455
1976	2.02	3.22	26.06	38.75	1,882	2,730
1977	0.61	1.40	41.00	66.00	1,300	2,800
1978	0.74	1.40	54.00	93.00	4,900	14,000
1979	0.58	0.89	78.00	150.00	4,000	14,000
1980	0.39	0.92	55.00	160.00	3,900	8,900
1982	0.42	0.67	48.00	93.00	1,000	1,800
1983	1.20	2.90	77.00	120.00	4,900	25,000
1984	1.50	2.40	75.00	110.00	9,100	18,000
1985	0.63	1.10	47.00	76.00	2,300	2,800
1986	1.40	2.70	60.00	110.00	1,300	3,000
H 13						
1962	0.40	0.70	35.00	58.00	3,000	4,000
1963	0.20	0.30	13.00	17.00	3,600	3,800
1964	0.33	0.52	10.00	12.00	107	133
1965	0.70	1.10	30.00	45.00	220	290
1966	0.30	0.40	10.00	10.00	800	1,000
1967	1.60	2.70	83.00	220.00	3,100	5,200
1968	0.80	1.60	34.00	54.00	4,100	6,000
1969	1.00	1.50	39.00	81.00	3,000	4,400
1970	0.60	1.30	19.00	35.00	5,100	5,500
1971	1.20	2.40	9.00	11.00	100	220
1972	0.30	0.60	12.00	22.00	240	360
1973	1.00	1.00	5.00	9.00	110	250
1974	0.90	1.38	23.32	23.44	76	110
1975	0.86	1.17	11.24	19.52	62	80
1976	0.30	0.50	0.77	2.31	275	364
1977	0.71	2.00	9.80	23.00	1,100	2,100
1978	0.75	1.20	9.90	17.00	130	140
1979	0.39	0.75	7.80	16.00	100	100
1980	0.21	0.41	7.20	8.20	260	400

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 13 (cont.)						
1982	0.41	0.82	47.00	120.00	560	830
1983	0.00	0.10	7.30	11.00	170	210
1984	0.41	0.97	3.80	11.00	510	970
1985	0.08	0.21	4.40	7.60	1,000	1,300
1986	0.30	0.58	8.40	11.00	2,900	3,400
H 14						
1962	0.60	1.00	21.00	32.00	2,000	3,000
1963	0.40	0.60	15.00	20.00	2,500	3,700
1964	0.59	0.84	14.00	24.00	588	1,560
1965	0.50	1.10	16.00	23.00	7,300	11,000
1966	2.30	6.10	130.00	370.00	6,900	8,600
1967	0.60	0.80	34.00	57.00	10,000	13,000
1968	0.70	0.80	33.00	82.00	11,000	12,000
1969	1.50	2.10	70.00	130.00	10,000	10,000
1970	1.10	1.50	39.00	58.00	9,500	9,900
1971	1.50	2.20	22.00	27.00	2,500	4,600
1972	1.40	1.80	16.00	18.00	3,800	4,000
1973	1.00	2.00	29.00	57.00	3,100	3,600
1974	1.80	2.01	16.48	21.78	3,986	4,675
1975	1.47	1.76	7.40	12.42	2,663	2,971
1976	1.55	2.23	6.57	15.60	3,059	3,035
1977	0.47	0.84	7.60	12.00	2,800	2,900
1978	0.53	0.58	5.70	7.50	2,300	2,400
1979	0.91	1.40	9.00	13.00	1,800	2,000
1980	1.00	2.10	6.00	12.00	1,600	1,900
1982	0.58	1.20	8.00	8.70	1,000	1,000
1983	0.26	0.88	4.10	8.80	640	1,000
1984	0.27	0.49	3.60	7.70	760	1,200
1985	0.43	0.87	4.90	7.20	3,500	6,000
1986	0.38	0.68	8.80	15.00	5,100	8,100
H 15						
1962	0.50	0.70	13.00	17.00	200	400
1963	0.60	0.70	12.00	14.00	49	73
1964	0.88	1.20	18.00	32.00	90	175
1965	0.70	1.00	11.00	23.00	98	110
1966	1.00	1.30	20.00	50.00	100	100
1967	1.10	1.20	8.00	11.00	97	100
1968	1.00	1.50	23.00	42.00	140	173
1969	2.00	2.30	28.00	29.00	242	248
1970	1.60	2.30	13.00	25.00	1,500	2,500
1971	1.00	1.40	6.00	8.00	400	1,000
1972	1.60	1.80	27.00	63.00	780	840

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
B 15 (cont.)						
1973	2.00	3.00	5.00	7.00	270	670
1974	1.20	1.66	9.20	13.16	231	408
1975	1.44	1.81	2.29	4.44	54	55
1976	0.75	0.75	7.77	9.57	40	43
1977	0.89	1.50	4.90	8.40	39	39
1978	0.58	0.75	6.20	8.50	46	48
1979	0.47	0.92	1.00	4.70	56	69
1980	0.58	0.74	3.20	3.50	48	49
1982	0.44	0.49	9.50	30.00	55	68
1983	0.45	0.78	2.90	4.80	67	70
1984	0.58	0.78	2.90	4.70	65	74
1985	0.46	0.73	2.70	3.40	64	71
1986	0.36	0.39	0.87	1.40	58	59
B 16						
1962	0.90	1.60	55.00	91.00	5,000	5,000
1963	0.80	1.00	24.00	27.00	220	270
1964	0.56	0.76	19.00	24.00	150	240
1965	0.70	1.40	26.00	32.00	150	230
1966	0.60	0.80	10.00	20.00	100	200
1967	1.00	1.10	17.00	20.00	110	130
1968	0.70	1.00	14.00	14.00	110	140
1969	2.50	3.60	47.00	69.00	110	120
1970	0.80	1.20	45.00	100.00	210	240
1971	0.80	1.60	7.00	11.00	70	91
1972	0.70	0.80	9.00	13.00	85	92
1973	1.00	2.00	7.00	10.00	63	66
1974	1.48	1.51	9.15	9.54	84	123
1975	0.92	1.51	4.63	9.23	53	58
1976	0.72	1.07	1.53	2.64	54	59
1977	0.84	1.40	3.50	4.00	62	72
1978	0.74	1.20	6.00	8.10	60	63
1979	0.55	0.67	1.70	3.40	58	59
1980	0.44	0.58	3.20	4.50	55	58
1982	0.44	1.10	12.00	19.00	59	79
1983	0.48	0.58	3.20	4.30	74	76
1984	0.41	0.58	2.90	4.20	63	72
1985	0.33	0.58	3.40	5.10	140	210
1986	0.50	0.97	3.30	4.70	110	140
B 17						
1962	1.40	1.70	28.00	48.00	200	200
1963	1.40	2.00	42.00	52.00	700	12,000
1964	1.30	1.40	52.00	59.00	174	396

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
B 17 (cont.)						
1965	1.40	1.80	120.00	340.00	220	230
1966	1.10	1.60	20.00	30.00	200	200
1967	2.40	4.80	500.00	1,400.00	140	160
1968	1.80	2.60	43.00	58.00	130	150
1969	1.80	2.00	35.00	56.00	200	220
1970	1.10	1.40	20.00	29.00	510	770
1971	1.20	1.20	11.00	15.00	70	87
1972	1.50	1.70	17.00	19.00	77	82
1973	1.00	2.00	10.00	12.00	82	89
1974	2.31	2.62	30.38	39.78	95	96
1975	1.76	3.18	12.13	15.27	74	76
1976	0.94	1.24	10.26	15.34	67	72
1977	0.64	1.10	7.90	12.00	62	66
1978	1.10	2.30	8.50	10.00	73	75
1979	1.10	1.50	9.30	15.00	80	87
1980	1.20	2.20	5.60	12.00	60	65
1982	1.20	1.60	19.00	36.00	75	89
1983	1.40	1.60	4.40	4.50	75	87
1984	0.68	0.96	3.20	4.90	62	67
1985	0.34	0.73	10.00	30.00	60	65
1986	0.99	1.80	23.00	30.00	66	67
B 18/18A						
1962	1.20	1.50	23.00	37.00	100	1,100
1963	0.90	1.00	21.00	29.00	510	12,000
1964	0.98	1.00	20.00	27.00	399	1,105
1965	1.40	1.90	56.00	150.00	1,500	3,200
1966	2.00	5.30	80.00	210.00	2,000	2,000
1967	1.00	1.30	21.00	36.00	3,000	3,300
1968	0.90	1.50	35.00	57.00	3,600	4,400
1969	0.90	1.70	30.00	49.00	2,900	3,000
1970	1.00	1.30	24.00	49.00	570	600
1971	0.70	0.80	14.00	22.00	30	53
1972	1.20	1.60	13.00	17.00	75	91
1973	2.00	3.00	19.00	24.00	130	130
1974	1.30	1.86	19.39	24.96	347	386
1975	1.58	1.84	8.94	11.92	160	166
1976	2.11	2.48	11.28	12.70	72	79
1977	1.80	2.60	23.00	34.00	83	110
1978	0.72	1.10	7.20	13.00	54	63
1979	0.56	0.84	6.80	12.00	48	63
1980	0.95	1.70	10.00	12.00	59	62
1982	0.46	0.66	12.00	14.00	62	85
1983	0.65	0.99	7.30	8.50	62	79
1984	0.32	0.58	5.00	6.90	120	140

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Gross Alpha (pCi/L) Max	Nonvol. Beta (pCi/L) Mean	Nonvol. Beta (pCi/L) Max	Tritium (pCi/mL) Mean	Tritium (pCi/mL) Max
H 18/18A (cont.)						
1985	0.36	0.63	6.20	17.00	4	66
1986	1.10	1.40	5.90	8.80	33	38
H 19						
1962	0.30	0.70	11.00	19.00	200	200
1963	0.30	0.40	13.00	20.00	425	1,200
1964	0.44	0.56	17.00	20.00	360	672
1965	0.30	0.40	24.00	54.00	1,500	4,200
1966	2.20	6.00	80.00	240.00	2,000	2,000
1967	0.60	1.30	11.00	11.00	1,800	2,000
1968	0.30	0.60	8.00	13.00	2,600	2,900
1969	0.60	0.60	25.00	25.00	5,500	5,800
1970	1.30	1.40	40.00	66.00	7,700	9,300
1971	0.50	0.90	6.00	7.00	7,700	9,300
1972	0.60	0.70	4.00	6.00	2,700	3,400
1973	1.00	1.00	9.00	12.00	2,700	3,100
1974	0.44	0.55	7.18	8.17	2,920	3,003
1975	1.30	1.90	4.25	10.99	2,879	3,208
1976	0.50	0.58	12.45	16.57	1,521	1,789
1977	0.15	0.25	6.10	8.40	1,600	1,900
1978	0.19	0.41	6.40	8.30	1,200	1,600
1979	0.11	0.25	5.10	5.90	2,100	2,200
1980	0.62	1.70	7.50	12.00	870	900
1982	0.17	0.58	3.70	5.70	5,300	8,400
1983	0.10	0.19	3.40	5.30	790	1,400
1984	0.29	0.58	5.20	9.90	360	550
1985	0.15	0.31	1.90	3.50	1,500	2,100
1986	0.34	0.98	2.90	8.70	2,100	2,600
H 20						
1964	---	---	---	---	4,100	6,400
H 21						
1964	---	---	---	---	1,200	3,200
H 22						
1964	---	---	---	---	8,300	10,700
H 23						
1964	---	---	---	---	120	200

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 24						
1964	---	---	---	---	80	170
H 25						
1964	---	---	---	---	90	130
H 26						
1964	---	---	---	---	2,400	4,400
H 27						
1964	---	---	---	---	2,700	5,000
H 28						
1964	---	---	---	---	14,600	30,600
H 29						
1964	---	---	---	---	3,700	19,000
H 30						
1964	---	---	---	---	200	430
H 31						
1964	---	---	---	---	483	980
H 32						
1964	---	---	---	---	85	120
H 33						
1964	---	---	---	---	1,200	2,100
H 39						
1965	---	---	---	---	9,950	20,000
1966	---	---	---	---	14,000	20,000
1967	---	---	---	---	13,000	20,000
1968	---	---	---	---	14,000	17,000

TABLE 9-19 (cont.)

Year	Cross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 40						
1965	---	---	---	---	1,030	16,000
1966	---	---	---	---	6,000	16,000
1967	---	---	---	---	818	13,000
1968	---	---	---	---	1,500	7,000
H 41						
1965	---	---	---	---	4,500	16,000
1966	---	---	---	---	9,500	20,000
1967	---	---	---	---	10,000	13,000
1968	---	---	---	---	10,000	14,000
H 42						
1965	---	---	---	---	6,250	16,000
1966	---	---	---	---	11,500	21,000
1967	---	---	---	---	7,650	17,000
1968	---	---	---	---	6,000	7,500
H 43						
1965	---	---	---	---	3,600	11,000
1966	---	---	---	---	9,000	22,000
1967	---	---	---	---	5,250	13,000
1968	---	---	---	---	6,000	6,500
H 44						
1965	---	---	---	---	1,650	13,000
1966	---	---	---	---	9,000	21,000
1967	---	---	---	---	6,650	13,000
1968	---	---	---	---	6,700	7,500
H 45						
1965	---	---	---	---	240	710
1966	---	---	---	---	3,500	17,000
1967	---	---	---	---	750	1,200
1968	---	---	---	---	910	2,900
H 46						
1965	---	---	---	---	394	18,000
1966	---	---	---	---	3,350	16,000
1967	---	---	---	---	495	6,500
1968	---	---	---	---	1,400	1,700

TABLE 9-19 (cont.)

Year	Gross Alpha (pCi/L) Mean	Max	Nonvol. Beta (pCi/L) Mean	Max	Tritium (pCi/mL) Mean	Max
H 47						
1965	---	---	---	---	71	300
1966	---	---	---	---	800	5,000
1967	---	---	---	---	130	141
H 48						
1965	---	---	---	---	89	130
1966	---	---	---	---	150	1,400
1967	---	---	---	---	125	161
1968	---	---	---	---	130	130
H 49						
1965	---	---	---	---	50	100
1966	---	---	---	---	200	2,700
1967	---	---	---	---	82	112
1968	---	---	---	---	120	130
H 50						
1965	---	---	---	---	77	140
1966	---	---	---	---	150	1,000
1967	---	---	---	---	77	166
1968	---	---	---	---	86	120
H 51						
1965	---	---	---	---	101	290
1966	---	---	---	---	150	1,400
1967	---	---	---	---	105	488
1968	---	---	---	---	100	240

Other Radioactivity Determinations

Year	^{131}I (pCi/L) Mean	Max
H 1		
1956	2,857,000	5,000,000
1957	4,415	23,000
1958	67	110
1959	200	550

TABLE 9-19 (cont.)

Year	^{131}I (pCi/L) Mean	Max
H 2		
1956	3,200	6,000
H 3		
1956	6,900	130,000
H 4		
1956	2,100	4,100

Year	^{144}Ce (pCi/mL) Mean	Max	^{137}Cs (pCi/mL) Mean	Max	^{131}I (pCi/L) Mean	Max
H 5						
1956	---	---	---	---	3,202,500	7,900,000
1957	---	---	---	---	304,500	400,000
1958	---	---	---	---	360	1,100
1959	---	---	---	---	1,100	2,700
1963	6.0	11.0	0.0	2.0	1	2
1964	5.0	9.0	1.0	1.0	4	6
1965	3.0	7.0	0.0	1.0	1	1

Year	$^{103,106}Ru$ (pCi/mL) Mean	Max	$^{89,90}Sr$ (pCi/mL) Mean	Max
H 5				
1961	---	---	48.0	270.0
1963	38.0	53.0	---	---
1964	17.5	59.0	---	---
1965	18.0	30.0	---	---